Resource International, Inc.

WYA-23-3.47
INTERCHANGE IMPROVEMENTS
PID NO. 121424
WYANDOT COUNTY, OHIO

ROADWAY EXPLORATION REPORT

Prepared For:
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Rii Project No. W-25-026

June 2026

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February 11, 2026 (Revised June 12, 2026)

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Re: Roadway Exploration Report
WYA-23-3.47 Interchange Improvements
PID No. 121424
Wyandot County, Ohio
Rii Project No. W-25-026 (Rev. 1)

Ms. Fedak:

Resource International, Inc. (Rii) is pleased to submit this revised roadway exploration report for the above referenced project. Engineering logs have been prepared and are attached to this report along with the results of laboratory testing. This report includes the recommendations for the design and construction of the improvements to the interchange of US Route 23 and State Route 294 in Wyandot County, Ohio. This revised report supersedes our previous submittal.

We sincerely appreciate the opportunity to be of service to you on this project. If you have any questions regarding the structure foundation exploration or this report, please contact us.

Sincerely,

RESOURCE INTERNATIONAL, INC.

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Enclosure: Roadway Exploration Report

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EXECUTIVE SUMMARY

This report is a presentation of the structure foundation exploration and roadway exploration performed for the design and construction of the proposed interchange at the intersection of US Route 23 and State Route 294 in Wyandot County, Ohio. In addition to the proposed new interchange, the project also includes realignment and widening of the TR 127.

Based on the Stage 1 plans provided by E.L. Robinson, the existing at-grade crossing at US 23 and SR 294 will be removed and new diamond interchange will be constructed. The proposed interchange will include four (4) new ramp alignments (Ramp A through Ramp D), a grade-separation structure consisting of a new bridge on semi-integral abutments atop MSE walls, and extension of SR 294 along the new alignment. In addition, the project includes realignment and widening of TR 127 and SR 294, drainage improvements consisting of the installation of pavement underdrains and storm sewers, as well as extension, replacement and construction of culvert structures, and pavement improvements.

Analyses and Recommendations

MSE Wall Recommendations

The proposed MSE walls may be designed recommended in the following tables:

MSE Walls 1 and 2 Summary

Retaining Wall ID	Max. Wall Height Analyzed [1] (feet)	Top of Leveling Pad Elevation [2] (feet)	Proposed Ground Surface [3] (feet)	Minimum Required Reinforcement Width
Rear Abutment / Wall 1 (B-003-0-25 and B-005-0-25)	29.1	870.75	876 or higher	20.4 feet (0.70H)
Forward Abutment / Wall 2 (B-007-0-25 and B-009-0-25)	27.9	873.0	877 or higher	19.5 feet (0.70H)

1. *Maximum wall height is measured from top of the leveling pad to the profile grade at the face of the wall (at roadway surface).*
2. *Top of the leveling pad elevation at the front face of the proposed wall.*
3. *Proposed ground surface elevation at the front face of the proposed wall. The ground surface is considered to slope down away from the wall at a rate of 5.0H: 1V or flatter*

MSE Walls 1 and 2 - Bearing Resistance

Retaining Wall ID	Wall Height Analyzed (feet)	Backslope Behind Wall	Top of Leveling Pad Elevation at the Front Face of Wall (feet)	Minimum Required Reinforcement Width [1]	Bearing Resistance at Strength Limit [2] (ksf)	
					Nominal	Factored [3]
Rear Abutment / Wall 1 (B-003-0-25 and B-005-0-25)	29.1	Level	870.75	20.4 feet (0.70H)	11.75	7.63
Forward Abutment / Wall 2 (B-007-0-25 and B-009-0-25)	27.9	Level	873.0	19.5 feet (0.70H)	12.35	8.02

1. *Minimum required foundation width is expressed as a percentage of the wall height, H, at the respective location.*
2. *Values represent the limiting nominal and factored bearing resistance between drained and undrained conditions for each wall.*
3. *Geotechnical resistance factor of φ_b=0.65 was considered in calculating the factored bearing resistance at the strength limit state.*

Embankment Evaluation

Rii utilized one (1) representative cross-section from each of the proposed Ramp A, Ramp B, Ramp C, Ramp D and SR 294 alignments to check the overall stability of the proposed embankments. The cross-sections utilized in the stability analyses were selected in such a manner that these are representative of the most critical embankment slopes. Based on the ODOT GDM manual a factor of safety of 1.3 or greater is considered acceptable for the roadway embankments that does not support structural element. The global slope stability analysis performed for the representative cross-sections along the alignments Ramp A, Ramp B, Ramp C, Ramp D and SR 294 indicated factor of safety more than 1.5 for both the drained (long-term) and undrained condition (short-term).

Rii utilized one (1) representative cross-section from each of the proposed Ramp A, Ramp B, Ramp C, Ramp D and SR 294 alignments to determine the settlement of the foundation soils due to the proposed embankments construction. The settlement analyses performed at representative cross-sections along Ramp A, Ramp B, Ramp C and Ramp D alignments indicated an estimated maximum total settlement of 2.36, 1.14, 2.31 and 2.41 inches, respectively. Settlement analysis performed at a representative cross-section along the SR 294 alignment indicated a maximum total settlement of 3.07 inches.

Driven Pile Recommendations

Based on the subsurface conditions encountered, it is recommended that a driven pile foundation system consisting of steel H-piles (ODOT Item 507.07) driven to refusal on bedrock be employed for foundation support. The geotechnical/structural resistance recommendations for HP 10x42 piles as provided in the following table may be utilized for the proposed foundation design.

Driven Pile Recommendations

Substructure/ Boring Location	Pile Type and Size [1]	Pile Elevation (feet)		Est. Pile Length [4] (feet)	$P_{R\ max}$ [5] (kips/pile)	Factored Downdrag Load [6] (kips/pile)	Design Capacity of Pile P_R [7] (kips/pile)	Sleeve Length [8] (feet)	φ [9]
		Top [2]	Tip [3]						
Rear Abutment (B-004-0-25)	HP 10x42	887.75	834.4	55.0	372	126	246	18.5	N/A
Pier 1 (B-006-0-25)	HP 10x42	873.25	838.3	40.0	310	N/A	310	N/A	N/A
Forward Abutment (B-008-0-25)	HP 10x42	889.25	839.2	55.0	372	80	292	20.5	N/A

1. *H-piles should consist of Grade 50 steel with a yield strength of 50 ksi.*
2. *The top of pile elevation corresponds to the pile cutoff elevation, which is the sum of proposed bottom of footing/pile cap elevation plus embedment depth of pile into footing. Pile embedment depth of 1.0-foot is considered.*
3. *The pile tip elevation is based on the top of the competent bedrock elevation in the nearest boring per Section 305.3.5.2 of the 2020 ODOT BDM.*
4. *Per Section 305.3.5.2 of the 2020 ODOT BDM, the estimated pile length was determined as the pile cutoff elevation (top) minus the pile tip elevation, rounded up to the nearest 5.0 feet. Order (furnished) length for each pile should be calculated by adding 5 feet on estimated pile length.*
5. *The factored structural axial resistance for H-piles is based on the structural limit state of the steel H-pile section per Section 305.3.3 of the 2020 ODOT BDM. Factored structural axial resistances are calculated utilizing the structural resistance factor, $\varphi_c = 0.50$ for H-piles subject to damage due to severe driving conditions. Where downdrag is anticipated, factored structural axial resistance are calculated utilizing the structural resistance factor, $\varphi_c = 0.60$ for H-piles considering good driving conditions. Factored axial load (plus factored downdrag, if any) should be resisted by factored axial structural resistance.*
6. *Refer to Section 5.1.2 of this for downdrag load calculations.*
7. ***Design capacity is the maximum factored design load that can be applied on the pile.***
8. *Sleeve length represents the required length of pile that should be sleeved within the MSE wall backfill. The sleeves should extend to the bottom of the foundation preparation.*
9. *For H-piles driven to refusal on bedrock, no geotechnical resistance factor should be applied to the factored structural axial resistance values.*

Pavement Subgrade Recommendations

Station-by-Station Stabilization Recommendations

For the estimating proposes, the approximate locations and depths of subgrade stabilization using excavate and replace options determined from subgrade analysis spreadsheet are summarized the following table:

Subgrade Treatment Summary

Project Section	From Station [1]	To Station [1]	Length (feet)	Problem	Representative Boring(s)	ODOT Subgrade Stabilization
Ramp A	166+80, US 23	169+15, US 23	235	Unstable	B-013-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, over 712.09 Geotextile Fabric Type D.
	177+60, US 23	481+85, Ramp A	425	Unstable	B-016-0-25	
Ramp B	601+00, Ramp B	605+10, Ramp B	410	Unstable and Unsuitable	B-022-0-25	Excavate 36 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
Ramp C	671+00, Ramp C	673+75, Ramp C	275	Unstable	B-023-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
Ramp D	787+00, Ramp D	789+40, Ramp D	240	Unstable	B-027-0-25	
	789+40, Ramp D	793+00, Ramp D	360	Unsuitable	B-028-0-25	Excavate 36 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
	793+00, Ramp D	797+00, Ramp D	400	Unstable	B-029-0-25	Excavate 15 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
	197+00, US 23	205+10, US 23	810	Unstable	B-030-0-25 and B-031-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
	205+10, US 23	208+60, US 23	350	Unstable	B-032-0-25	Excavate 15 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
SR 294	323+70, SR 294	326+00, SR 294	230	Unstable	B-012-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, over 712.09 Geotextile Fabric Type D.
TR 127	900+00, TR 127	916+80, TR 127	1,680	Unstable	B-012-0-25, B-036-0-25 thru B-039-0-25	

1. *Station limits estimated based on soil conditions encountered during the field exploration. Actual limits of stabilization may vary based on the conditions encountered during construction.*

Global Stabilization Recommendations

Based on the ODOT GDM, when approximately 30 percent or more of the subgrade requires stabilization, consideration should be given to utilizing a global stabilization option. For this project, ODOT GDM subgrade analysis indicate that stabilization will be required for approximately 33 to 88 percent of the subgrade across the six alignments designated as Ramp A, Ramp B, Ramp C, Ramp D, TR 127 and SR 294. These percentages reflect only the areas that require less than 3.0 feet of fill and not the percentage of entire alignment. The stabilization alternatives included in the following table can be utilized for sections where global stabilization is considered an option.

Global Stabilization Recommendations

Project Section(s)	Representative Boring(s)	Recommended Mechanical Subgrade Stabilization (Option 1)	Recommended Chemical Subgrade Stabilization (Option 2)
Ramp A	B-002-0-25, B-013-0-25 through B-019-0-25	**Excavate 12 inches and Replace with ODOT Item 703.16C, Granular Material Type C, over 712.09 Geotextile Fabric Type D.**	**12" Item 206 (Lime or Cement)** (Chemical Stabilization with Lime or Cement)
Ramp B	B-002-0-25, B-020-0-25 through B-022-0-25		**12" Item 206 (Cement)** (Chemical Stabilization with Cement)
Ramp C	B-010-0-25, B-023-0-25 through B-026-0-25		**14" Item 206 (Lime)** (Chemical Stabilization with Lime)
Ramp D	B-010-0-25, B-027-0-25 through B-033-0-25		**14" Item 206 (Cement)** (Chemical Stabilization with Cement)
SR 294	B-001-0-25, B-002-0-25, B-010-0-25 through B-012-0-25		**12" Item 206 (Lime)** (Chemical Stabilization with Lime)
TR 127	B-012-0-25, B-036-0-25 through B-039-0-25		**12" Item 206 (Lime)** (Chemical Stabilization with Lime)

Subgrade Design Considerations

Based on the conditions encountered across the site and provided that the recommendations of this report are implemented, **it is recommended that pavement design be based on a California Bearing Ratio (CBR) value and corresponding resilient modulus, M_R, as provided** in the following table:

Recommended Pavement Design Parameters

Alignment	CBR [1]	Resilient Modulus [1] (M_R)	Modulus of Subgrade Reaction (K) Value	Soil Support Value
Ramp A	5	6,000	135	3.8
Ramp B	6	7,200	150	4.4
Ramp C	4	4,800	120	3.2
Ramp D	6	7,200	150	4.4
SR 294	6	7,200	150	4.4
TR 127	4	4,800	120	3.2

1. *If global chemical stabilization option is implemented, the resilient modulus value and corresponding CBR value along each alignment may be increased by 36 percent.*

Please note that this executive summary does not contain all the information presented in the report. The unabridged subsurface exploration report should be read in its entirety to obtain a more complete understanding of the information presented.

1.0 INTRODUCTION

This report is a presentation of the structure foundation and roadway exploration performed for the design and construction of the proposed interchange at the intersection of US Route 23 and State Route 294 in Wyandot County, Ohio. In addition to the proposed new interchange, the project also includes realignment and widening of the TR 127.

Based on the Stage 1 plans provided by E.L. Robinson, the existing at-grade crossing at US 23 and SR 294 will be removed and new diamond interchange will be constructed. The proposed interchange will include four (4) new ramp alignments (Ramp A through Ramp D), a grade-separation structure consisting of a new bridge on semi-integral abutments atop MSE walls, and extension of SR 294 along the new alignment. In addition, the project includes realignment and widening of TR 127 and SR 294, drainage improvements consisting of the installation of pavement underdrains and storm sewers, as well as extension, replacement and construction of culvert structures, and pavement improvements.

As per the available plans, proposed grade separation structure (WYA-23-03.47) includes a two-span bridge with span lengths of 124.2 feet between center-to-center of bearings, with a reinforced deck on semi-integral abutments atop MSE walls and a cap and column center pier. Two (2) new MSE walls will be constructed for grade separation at the proposed rear and forward abutments designated as MSE Wall 1 and MSE Wall 2, respectively. Based on the Stage 1 plans, the total height of MSE Wall 1 and MSE Wall 2 will be approximately 29.1 and 27.9 feet, respectively. The proposed ground surface slope in front of the MSE walls are understood to be graded at a rate of 5.0H:1.0V (horizontal: vertical) or flatter. The proposed roadway grade within the footprint or in the vicinity of the MSE walls will be up to approximately 24.0 feet higher than the existing ground surface.

Based on the available Stage 1 plans, up to approximately 14.0 feet of fill and up to 16.0 feet of cut will be required to bring the site to the proposed grade within the footprint of the proposed new ramps. Additionally, along the proposed SR 294 realignment, up to approximately 17.5 feet of fill and minimal cut (less than 3 feet) will be required to bring the site to the proposed grade. In addition, minimal (less than 3 feet) cut and fill will be required to bring the site to the proposed grade along the proposed TR 127 realignment. The available plans indicate that the embankment side slopes will be graded at a rate of embankment slopes of 2H:1V or flatter along all alignments.

The exploration was performed within general accordance of the Ohio Department of Transportation (ODOT) Specifications for Geotechnical Explorations (SGE), the Geotechnical Design Manual (GDM), and the Bridge Design Manual (BDM). The project site is shown on the vicinity map and boring plan presented in Appendix I.

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 Site Geology

Physiographically, the site lies within the Central Ohio Clayey Till Plain Region of the Till Plains Section. The Central Ohio Clayey Till Plains is covered with well-defined ground and end moraines composed of clayey till deposits with sparse intermorainal lake basins throughout. Ground moraines are deposited during the retreat of a glacier, resulting in an undifferentiated mixture of clay, silt, sand and gravel. End moraines are normally associated with ice melting that is neither advancing nor retreating for a period of time. The debris left behind by the ice ranges in composition, from clay sizes to boulders (including silt, sand, and gravel). Lake basin in the Central Ohio Clayey Till Plains predominantly consists of silt, clay and till filled area.

Based on the bedrock geology and bedrock topography maps of the area, obtained from Ohio Department of Natural Resources (ODNR), the bedrock at the project sites consists of Silurian age bedrock described as Salina Undifferentiated. Salina Undifferentiated consists of gray and brown dolomite bedrock with thin bedding. The Salina Undifferentiated formation ranges from 235 to 335 feet and characterized by argillaceous partings, brecciated intervals, anhydrite/gypsum zones and algal lamination.

Based on the ODNR bedrock topography mapping, the bedrock surface within the project limit appears to be relatively flat with bedrock elevations ranging from 840 to 845 feet above mean sea level (msl) which is approximately 35 to 50 feet below the existing ground surface.

2.2 Existing Conditions

The project site is located at the intersection of US 23 and SR 294 in Wyandot County, Ohio. Along US 23, the project limits extend approximately 1,900 feet south of the existing intersection (Sta. 166+87.82) to approximately 2,700 feet north of the intersection (Sta. 213+17.55). Along SR 294, the project limits extend approximately 1,000 feet northwest of the intersection (Sta. 304+75) to 1,100 feet southeast of the intersection (Sta. 326+05). Along TR 127, the project limit extends approximately 1,700 feet starting at Station 900+00 and ending at Station 917+00.

The existing US 23 is a bi-directional, asphalt surfaced, divided rural principal arterial roadway, with two (2) approximately 12-foot wide lanes in each direction of travel. The existing US 23 has an approximately 4-foot wide inside shoulder and an approximately 8-foot-wide outside shoulder along each direction of travel. The two travel bounds are divided by a grass covered median. The existing SR 294 is a bi-directional, asphalt surfaced, undivided rural minor collector roadway with one (1) approximately 11-foot-wide lane in each direction of travel. The existing TR 127 is a bi-directional, asphalt paved,

undivided rural local roadway with one (1) approximately 7-foot-wide lane in each direction of travel.

Based on the Stage 1 plans, the majority alignments of the proposed ramps will be constructed within existing easement of the roadway with some portion at northeast and southwest likely will be within current private properties consisting of agricultural land and grass covered lawn. Additionally, the majority of the proposed new TR 127 alignment will be constructed within field current private properties used as an agricultural land.

Within the footprint of the proposed ramps the ground surface elevations appear to be gradually sloping upward from southern end of the project limit to the existing intersection. The ground surface elevations then slope gradually downward from intersection to the northern end of the project limit. During the site reconnaissance, an existing pond was observed near the project limit and located southwest of the proposed Ramp A. Additionally, a tree and brush line along with fence is located within the project footprint and near the proposed Ramp A. Along the majority of the project limits, the surface runoff appears to be collected in the ditches located on the both side of the roadways and/or at the median. Regionally, the site drains to the west toward the Little Sandusky River.

3.0 EXPLORATION

Between May 19 and 30, 2025, a total of thirty-nine (39) borings, designated as B-001-0-25 to B-039-0-25, were performed for this project and were advanced to depths ranging from 6.0 to 63.3 feet below the existing ground surface. Additionally, offset borings B-004-1-25 and B-009-1-25 were performed in the vicinity of boring B-004-0-25 and B-009-0-25 to obtain undisturbed soil sample, respectively

Borings B-003-0-25 to B-009-0-25 were performed in the vicinity of the proposed bridge and MSE walls. Borings B-001-0-25, B-002-0-25 and B-010-0-25 through B-012-0-25 were performed along the proposed SR 294 alignment. Borings B-013-0-25 through B-019-0-25 were drilled along the proposed Ramp A alignment, and B-020-0-25 through B-022-0-25 along the proposed Ramp B alignment. Additionally, borings B-023-0-25 and B-026-0-25 were performed along the proposed Ramp C alignment, and borings B-027-0-25 through B-033-0-25 were performed along the proposed Ramp D alignment. Further, borings B-036-0-25 through B-039-0-25 were performed along the proposed alignment of TR 127.

In addition to the soil borings, twelve (12) pavement cores, designated as X-001-0-25 to X-012-0-25, were obtained from the travel lanes of US 23 and SR 294 to determine the composition and thickness of the existing pavement.

The soil borings and pavement cores were performed at the locations shown on the boring plan provided in Appendix I of this report. A summary of soil borings and pavement core information is presented in Appendix II.

The boring locations were determined and located in the field by Rii personnel. Rii utilized a handheld GPS unit to obtain geographic latitude and longitude coordinates of the boring locations. Ground surface elevations at the boring locations were interpolated from basemapping provided by E.L. Robinson.

The borings were drilled using a CME 750X all-terrain vehicle (ATV) mounted rotary drilling machine, as well as Mobile B53 and CME 55 truck-mounted drill rigs, utilizing 3.25-inch inside diameter hollow stem augers (HSA) or 4.5-inch continuous flight augers (CFA) to advance the boreholes. Standard penetration test (SPT) and split spoon sampling were performed at 2.5-foot intervals to a depth of 30.0 feet below the existing grade and at 5.0-foot intervals thereafter to the top of the bedrock or to the termination depth, whichever is shallower. For borings B-001-0-25, B-013-0-25, B-022-0-25, B-034-0-25 and B-035-0-25, split spoon sampling was performed continuously to the termination depth.

The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted using a 140-pound hammer falling 30.0 inches to drive a 2.0-inch outside diameter split spoon sampler 18.0 inches. Rii utilized a calibrated automatic drop hammer to generate consistent energy transfer to the sampler. Driving resistance is recorded on the boring logs in terms of blows per 6.0-inch interval of the driving distance. The second and third intervals are added to obtain the number of blows per foot (N). Standard penetration blow counts aid in determining soil properties applicable in foundation design. Measured blow count (N) values are corrected to an equivalent (60%) energy ratio, N_{60}, by the following equation. Both values are represented on boring logs in Appendix IV.

$$N_{60} = N*(ER/60)$$

Where:
N = measured N value
ER = drill rod energy ratio, expressed as a percent, for the system used

The hammers for the CME 750X, Mobile B53, and CME 55 drill rigs were calibrated on March 25, 22, and 22, 2024, and have drill rod energy ratios of 87.9, 80.6, and 85.1 percent, respectively.

In general, for instances of no recovery from standard split spoon sampling, a 2.5-inch outside diameter split spoon sampler was driven the full length of the standard split spoon interval and/or plus an additional 6.0 inches to obtain a representative sample. These samples are designated with a “2S” preceding the sample number on the boring logs. Please note, based on the input provided by ODOT on similar projects, the information of “2S” sample are presented in description portion of logs. Only the final 6.0 inches of sample were retained for classification.

Hand penetrometer readings, which provide a rough estimate of the unconfined compressive strength of the soil, were reported on the boring logs in units of tons per

square foot (tsf) and were utilized to classify the consistency of the cohesive soil in each layer. An indirect estimate of the unconfined compressive strength of the cohesive split spoon samples can also be made from a correlation with the blow counts (N_{60}). Please note that split spoon samples are considered to be disturbed and the laboratory determination of their shear strengths may vary from undisturbed conditions.

In addition to the aforementioned sampling and testing, several undisturbed (Shelby tube) soil samples were obtained from several borings for shear strength testing. The undisturbed samples were obtained by hydraulically pushing a 3.0-inch outside diameter thin-walled, seamless steel tube into the soil at a constant rate of penetration in accordance with AASHTO T207. The recovered samples were cleaned of soil cuttings and preserved within the tube using expansion caps.

The depth to bedrock was determined by split spoon refusal, auger refusal on bedrock, increased resistance in the auger advancement and/or recovered bedrock samples from the split spoon. Split spoon refusal is defined as the sampler penetration of less than 6 inches for 50 or more hammer blows. Auger refusal is defined as the auger penetration of less than 6 inches under 500 psi of down pressure for a reasonable time (generally 10 minutes). It should be noted, however, that cobbles and boulders were observed to be present in borings B-003-0-25 and B-008-0-25, with the drilling and sampling equipment experiencing refusal on such features.

Borings B-004-0-25, B-006-0-25 and B-008-025 were extended into the bedrock using an NQ-2 double-tube diamond bit core barrel (utilizing wire line equipment). The rock cores obtained from the borings were logged in the field and visually classified in the laboratory. The retrieved cores were analyzed to identify the type of rock, color, mineral content, bedding planes and other geological and mechanical features of interest in this project. The rock quality designation (RQD) for each rock core run was calculated according to the following equation:

$$RQD = \frac{\sum \text{segments equal to or longer than 4.0 inches}}{\text{core run length}} \text{ x } 100$$

Upon the completion of drilling, the boreholes of the structure and retaining wall borings were sealed with cement-bentonite grout, and remaining borings were backfilled with mixture of soil cuttings and bentonite chips. All the boreholes were sealed or backfilled in accordance with ODOT SGE standards. The pavement was patched with an equivalent thickness of cold patch asphalt.

During drilling, Rii personnel prepared field logs showing the encountered subsurface conditions. Soil samples obtained from the drilling operation were preserved and sealed in glass jars, rock core samples were preserved in core boxes, and the soil and rock samples were delivered to the laboratory. In the laboratory, the soil and rock samples were visually classified and select samples were tested, as noted in Table 1.

Table 1. Laboratory Test Schedule

Laboratory Test	Test Designation	Number of Tests Performed
Natural Moisture Content	ASTM D 2216	242
Plastic and Liquid Limits	AASHTO T89, T90	76
Gradation – Sieve/Hydrometer	AASHTO T88	87
Sulfate Content	ODOT Supplement 1122	26
Consolidation Test	ASTM D2435	2
Unconfined Compressive Strength Testing (Soil)	ASTM D2166	5
Unconfined Compressive Strength Testing (Rock)	ASTM D 7012	2
Point Load Strength Index Test	ASTM D 5731-08	1

The tests performed are necessary to classify the existing soil and rock according to the ODOT classification system and to estimate engineering properties of importance for foundation design and construction recommendations. Results of the laboratory testing are presented on the boring logs in Appendix IV, with laboratory test sheets included in Appendix V.

4.0 FINDINGS

Interpreted engineering logs have been prepared based on the field logs, visual examination of samples and laboratory test results. Classification follows the version of the ODOT SGE at the time the exploration borings were performed. The following is a summary of what was found in the test borings and what is represented on the boring logs. A description of the soil and rock terms used throughout this report is presented in Appendix III.

4.1 Surface Materials

Borings B-002-0-25 through B-010-0-25, B-015-0-25, B-017-0-25 through B-021-0-25, B-023-0-25 through B-031-0-25 and B-036-0-25 through B-038-0-25 were performed outside the pavement limits. With the exception of borings B-003-0-25 and B-015-0-25, these borings encountered 3.25 to 13.5 inches of topsoil. Boring B-003-0-25 did not encounter surficial materials and B-015-0-25 encountered 11.0 inches of gravel.

The remaining borings, B-001-0-25, B-011-0-25 through B-014-0-25, B-016-0-25, B-022-0-25, B-032-0-25 though B-035-0-25 and B-039-0-25, encountered a full depth hot mix asphalt (HMA) section consisting of 7.0 to 14.0 inches of asphalt overlying 4.0 to 28.0 inches of aggregate base.

A total of twelve (12) pavement cores, designated as X-001-0-25 through X-012-0-25, were obtained for this project. The composition and thickness of the pavement cores are summarized in Table 2, and the pavement core data sheets including pavement core photographs are included in Appendix VI.

Table 2. Pavement Cores Summary

Pavement Core ID	Station [1]	Offset [1]	Alignment	Asphalt Thickness (inches)	Aggregate Base (inches)
X-001-0-25	304+79	0 CL	SR 294	7.5	5.0
X-002-0-25	325+33	11' LT	SR 294	7.0	4.0
X-003-0-25	202+93	45' LT	US 23	12.0	16.0
X-004-0-25	194+82	51' LT	US 23	12.0	26.0
X-005-0-25	187+67	49' LT	US 23	13.5	24.0
X-006-0-25	180+08	47' LT	US 23	12.0	23.0
X-007-0-25	167+19	40' LT	US 23	12.0	21.0
X-008-0-25	210+19	41' RT	US 23	13.75	24.0
X-009-0-25	195+32	41' RT	US 23	13.5	21.0
X-010-0-25	187+81	46' RT	US 23	14.5	20.0
X-011-0-25	179+41	43' RT	US 23	13.0	10.0
X-012-0-25	171+08	45' RT	US 23	12.5	10.0

1. *Station and offset were interpolated from basemapping provided by E.L. Robinson.*

4.2 Subsurface Soils

4.2.1 Structure Borings

Below the surface materials, the structure borings, B-003-0-25 through B-009-0-25, predominantly encountered cohesive and cohesionless fine-grained soils extended to the top of the bedrock or boring termination depths, whichever is shallower. A thin layer of granular soil was encountered in boring B-003-0-25 at a depth of 3.0 feet.

The cohesive soils were described as silt and clay, silty clay, sandy silt and silt (ODOT A-6a, A-6b, A-4a and A-4b) with varying amounts of sand and gravel. The consistency of the cohesive soils is primarily derived from the hand penetrometer values (HP). The consistency of the cohesive soils ranged from stiff ($1.0 \leq HP \leq 4.0$ tsf) to hard ($HP > 4.0$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 1.75 to 4.5 tsf (limit of instrument).

The granular soils were described as gravel with sand and silt (ODOT A-2-4). The cohesionless fine-grained soils were described as sandy silt and silt (ODOT A-4a and A-4b) with varying amounts of sand and gravel. The relative density of granular soils and non-cohesive fine-grained soils is primarily derived from SPT blow counts (N_{60}) values. Based on the N_{60} values obtained, the relative density of the granular soils and cohesionless fine-grained soils ranged from medium dense ($11 \leq N_{60} \leq 30$ blows per foot [bpf]) to very dense ($N_{60} > 50$ bpf) with the N_{60} values ranging from 12 bpf to split spoon refusal.

Natural moisture contents of the cohesive soil samples tested ranged from 4 to 27 percent with majority the cohesive soils exhibiting moisture content values ranging from 12 to 22 percent. The natural moisture content of the non-cohesive fine-grained soils ranged from 17 to 27 percent, and natural moisture content of the granular soils ranged from 18 to 30 percent. The natural moisture content of the cohesive soil samples tested for plasticity index ranged from 2 percent below to 5 percent above their corresponding plastic limits indicating natural moisture contents to be slightly to significantly above their estimated optimum moisture levels.

4.2.2 Roadway and Embankment Borings

Beneath the surficial materials, boring B-001-0-25 encountered existing fill extending to a depth of 4.5 feet below the existing grade, as indicated by the presence of asphalt fragments in sample SS-2. The fill materials were described as clay (ODOT A-7-6) and gravel with sand (ODOT A-1-b).

Beneath the surficial materials and/or existing fill materials, the roadway and embankment borings, designated as B-001-0-25, B-002-0-25 and B-010-0-25 through B-039-0-25, predominantly encountered cohesive soils with intermittent layers of cohesionless fine grained soils or granular soils encountered in some borings.

The natural cohesive soils were described as clay, silt and clay, silty clay, sandy silt and silt (ODOT A-7-6, A-6a, A-6b, A-4a and A-4b) with varying amounts of sand and gravel. The consistency of the cohesive soils ranged from medium stiff ($0.5 \leq HP \leq 1.0$ tsf) to hard ($HP > 4.0$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 1.0 to 4.5 tsf.

The natural granular soils were described as coarse and find sand (A-3a). The cohesionless fine-grained soils were described as sandy silt, and silt (ODOT A-4a and A-4b) with varying amounts of sand and gravel. Based on the N_{60} values obtained, the relative density of the granular soils and cohesionless fine-grained soils ranged from loose ($4 < N_{60} \leq 10$ bpf) to medium dense ($10 < N_{60} \leq 30$ bpf) with the N_{60} values ranging from 6 to 27 bpf.

Natural moisture contents of the cohesive soil samples tested ranged from 13 to 28 percent. The natural moisture content of the cohesionless fine-grained and granular soils ranged from 14 to 28 percent. The natural moisture content of the cohesive soil samples tested for plasticity index ranged from 3 percent below to 9 percent above their corresponding plastic limits indicating natural moisture contents to be near their estimated optimum moisture levels to significantly above their estimated optimum moisture levels.

4.3 Bedrock

Bedrock was encountered in three (3) borings at the depths as shown in Table 3.

Table 3. Top of Bedrock Elevations

Boring Number	Ground Surface Elevation (feet)	Top of Bedrock		Top of Bedrock Core		Bedrock Description
		Depth (feet)	Depth (feet)	Depth (feet)	Elevation (feet)	
B-004-0-25	884.0	47.5	836.5	49.6	834.4	Dolomite
B-006-0-25	873.3	34.5	838.8	35.0	838.3	Dolomite
B-008-0-25	883.1	43.9	839.2	43.9	839.2	Dolomite

The top of the bedrock was encountered in borings B-004-0-25, B-006-0-25 and B-008-0-25 at depths ranging from 34.5 to 47.5 feet below the existing grade corresponding to elevations ranging from 836.5 to 839.2 feet. The bedrock samples recovered from split spoon sampler were described as gray to brown, slightly weathered dolomite.

Borings B-003-0-25, B-007-0-25 and B-009-0-25 were terminated upon encountering auger refusal at depths ranging from 27.5 to 38.5 feet corresponding to elevations ranging from 844.6 to 849.8 feet. Rock coring was not performed in these borings and therefore the top of bedrock could not be verified. At these locations, the auger penetrated through possible cobbles and boulders, or fractured dolomite prior to encountering refusal.

Upon encountering auger refusal on bedrock, a changeover to rock coring techniques was made and bedrock coring was performed in borings B-004-0-25, B-006-0-25 and B-008-0-25 to the boring termination depths. The recovered bedrock core samples were described as brown to gray, slightly weathered, highly fractured to moderately fractured, moderately strong to very strong dolomite. The rock core samples exhibited recovery values ranging from 78 to 100 percent with RQD values ranging from 0 to 67 percent. The unconfined compressive strength values determined from unconfined compressive strength (UCS) testing as well as estimated UCS values correlated from point load testing on the representative rock cores samples ranged from 5,466 to 29,998 psi. Detailed information of the rock cores along with rock cores photographs are provided in Appendix IV, and a summary of rock core information is provided as follows in Table 4.

Table 4. Rock Core Summary

Boring	Core No.	Depth (feet)	RQD (%)	Recovery (%)	Bedrock	Note
B-004-0-25	NQ-1	49.6' to 53.2'	0	78	Dolomite	---
	NQ-2	53.2' to 58.2'	24	100	Dolomite	Qu @ 54.7' = 13,753 psi
	NQ-3	58.2' to 63.2'	19	77	Dolomite	---
B-006-0-25	NQ-1	35.0' to 40.0'	0	100	Dolomite	---
	NQ-2	40.0' to 45.0'	67	99	Dolomite	Qu @ 42.1' = 5,466 psi
B-008-0-25 [1]	NQ-3	43.9' to 45.2'	0	75	Dolomite	Qu @ 43.9' = 29,998 psi [2]
	NQ-4	45.2' to 50.2'	15	100	Dolomite	---
	NQ-5	50.2' to 65.2'	28	100	Dolomite	---

1. *NQ-1 was performed upon auger refusal at 39.1 feet, and NQ-2 was extended from 39.6 to 43.8 feet. Auger refusal at 39.1 observed to be a cobble/boulder. Auger refusal on bedrock observed at 43.9 feet.*
2. *Q_u value correlated from point load test on bedrock core sample.*

4.4 Groundwater

During drilling groundwater was encountered in borings B-002-0-25, B-004-0-25, B-005-0-25, B-006-0-25 through B-010-0-25, B-017-0-25, B-018-0-25, B-020-0-25, B-026-0-25 through B-028-0-25, B-030-0-25, B-031-0-25 and B-035-0-25 at depths ranging from 3.5 to 16.0 feet corresponding to elevations ranging from 863.8 to 872.3 feet, and remaining borings were observed to be dry. Upon the completion of drilling groundwater was encountered in borings B-005-0-25, B-017-0-25, B-018-0-25, B-020-0-25, B-026-0-25 through B-028-0-25, B-030-0-25 and B-031-0-25 at depths ranging from 3.1 to 39.0 feet corresponding to elevations ranging from 846.5 to 872.7 feet.

Groundwater was not measured upon completion of drilling and rock coring in borings B-004-0-25, B-006-0-25 and B-008-0-25 due to the influence of water added during the rock coring process.

Please note that short-term water level readings, especially in cohesive soils, are not necessarily an accurate indication of the actual groundwater level. In addition, groundwater levels or the presence of groundwater are considered to be dependent on seasonal fluctuations in precipitation.

A summary of groundwater depths encountered in soil borings is presented in Table 5. A more comprehensive description of what was encountered during the drilling process may be found on the boring logs in Appendix IV.

Table 5. Groundwater Levels

Boring Number	Boring Depth (feet)	Ground Elevation (feet)	Initial Groundwater		Upon Completion	
			Depth (feet)	Elevation (feet)	Depth (feet)	Elevation (feet)
B-002-0-25	15.0	884.0	14.3	869.7	11.3	872.7
B-004-0-25	63.3	884.0	16.0	868.0	--- [1]	--- [1]
B-005-0-25	40.0	885.0	16.0	869.0	39.0	846.0
B-006-0-25	45.0	873.3	6.0	867.3	--- [1]	--- [1]
B-007-0-25	38.5	883.3	11.0	872.3	Dry	Dry
B-008-0-25	55.2	883.1	16.0	867.1	--- [1]	--- [1]
B-009-0-25	27.5	877.3	6.0	871.3	Dry	Dry
B-010-0-25	20.0	882.5	12.3	870.2	Dry	Dry
B-017-0-25	15.0	875.7	11.0	864.7	10.5	865.2
B-018-0-25	10.0	874.1	3.5	870.6	7.0	867.1
B-020-0-25	10.0	877.0	6.0	871.0	8.0	869.0
B-026-0-25	20.0	880.4	11.0	869.4	13.8	866.7
B-027-0-25	20.0	884.9	16.0	868.9	12.8	872.2
B-028-0-25	20.0	883.1	11.0	872.1	11.0	872.1
B-030-0-25	10.0	869.8	6.0	863.8	3.1	866.7
B-031-0-25	10.0	869.1	3.5	865.6	4.6	864.5
B-035-0-25	8.0	877.8	7.2	870.6	Dry	Dry

1. *Groundwater at completion was not measured upon the completion boring due to the introduction of water as a circulating fluid during the rock coring process.*

4.5 Historical Borings

Historical geotechnical records were obtained from ODOT'S Transportation Information Mapping System (TIMS) for project WYA-23-0.20 completed between March 30 and April 7, 1964.

Details of the historic borings including boring number, boring depths, and SPT blow count values were not available. However, results of this explorations indicated that the subsurface profile predominantly consist of cohesive soils described as clay, silt and clay, silty clay, sand silt, and silt (A-7-6, A-6a, A-6b, A-4a, A-4b). These results were not utilized during the current design.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the subsurface exploration has been used to determine the foundation support capabilities and the settlement potential for the soils encountered at the site. These parameters have been used to provide guidelines for the design of foundation systems for the proposed bridge and MSE walls foundations, as well as the construction specifications related to the placement of foundation systems and general earthwork recommendations, which are discussed in the following paragraphs.

5.1 Bridge Foundation Recommendations

Based on the Stage 1 plans, Rii understands that a new bridge carrying SR 294 over US 23 (WYA-0021-03.47) will be designed and constructed for this project. The proposed structure will be a two-span bridge with a reinforced deck on semi-integral abutments atop MSE walls with a cap and column central pier. It is understood that each span of the bridge will be 124.2 feet in length between center-to-center of bearings, and will have 38.0 feet of roadway width between toe-to-toe of bridge railing.

Design details of the proposed bridge including elevations for the substructure units and design loads were provided by E.L. Robinson and are summarized in Table 6.

Table 6. Summary of Bridge Design Information

Bridge Structure	Substructure Unit (Boring)	Bottom of Footing (Pile Cap) Elevation [1] (feet)	Design Maximum Factored Load [2] (kips/pile)
WYA-0021-03.47	Rear Abutment (B-004-0-25)	886.75	150.0
	Pier 1 (B-006-0-25)	872.25	216.0
	Forward Abutment (B-008-0-25)	888.25	150.0

5.1.1 Driven Pile Recommendations

Based on the subsurface conditions encountered, it is recommended that a driven pile foundation system consisting of steel H-piles (ODOT Item 507.07) driven to refusal on bedrock be employed for foundation support. The geotechnical/structural resistance recommendations for HP 10x42 piles as provided in Table 7 may be utilized for the proposed foundation design.

Per Section 305.3.1.2 of the 2020 ODOT BDM, refusal on bedrock is met during driving when the pile penetration is an inch or less after receiving at least 20 blows from the pile hammer. As per ODOT GDM Section 1304.1, the bearing resistance of the point bearing piles on bedrock is not limited by geotechnical resistance but by the structural resistance of the pile. Table 7 shows the recommended pile lengths and the corresponding factored

structural axial resistance ($P_{R\ max}$) and recommended design pile capacity (P_R) of the steel H-piles.

As stated, the factored resistance of H-piles driven to refusal on bedrock is typically governed by the structural resistance of the pile element. The factored structural axial resistances listed in Table 7 consider an axially loaded pile with negligible moment, no appreciable loss of section due to deterioration throughout the life of the structure, a steel yield strength of 50 ksi, a structural resistance factor for H-piles (φ_c = 0.50 or φ_c = 0.60 Section 6.5.4.2 of the 2020 AASHTO LRFD BDS) and piles fully braced along the length. Static or dynamic load testing is not required for H-piles driven to refusal on bedrock. It is anticipated that the piles will be able to be driven a few inches into the surficial bedrock before satisfying the driving conditions that meet the refusal criterion. Settlement is estimated to be less than 0.5 inch for H-piles driven to refusal on bedrock.

The UCS testing as well as estimated UCS values correlated from point load testing on the representative rock cores samples ranged from 5,466 to 29,998 psi and the overburden soils below the bottom of MSE wall consists of predominantly cohesive soils with thickness of less than 50 feet. Therefore, steel points are recommended for the proposed driven piles as per ODOT BDM Section 305.3.5.6.

Table 7. Driven Pile Recommendations

Substructure/ Boring Location	Pile Type and Size [1]	Pile Elevation (feet)		Est. Pile Length [4] (feet)	$P_{R\ max}$ [5] (kips/pile)	Factored Downdrag Load [6] (kips/pile)	Design Capacity of Pile P_R [7] (kips/pile)	Sleeve Length [8] (feet)	φ [9]
		Top [2]	Tip [3]						
Rear Abutment (B-004-0-25)	HP 10x42	887.75	834.4	55.0	372	126	246	18.5	N/A
Pier 1 (B-006-0-25)	HP 10x42	873.25	838.3	40.0	310	N/A	310	N/A	N/A
Forward Abutment (B-008-0-25)	HP 10x42	889.25	839.2	55.0	372	80	292	20.5	N/A

1. *H-piles should consist of Grade 50 steel with a yield strength of 50 ksi.*
2. *The top of pile elevation corresponds to the pile cutoff elevation, which is the sum of proposed bottom of footing/pile cap elevation plus embedment depth of pile into footing. Pile embedment depth of 1.0-foot is considered.*
3. *The pile tip elevation is based on the top of the competent bedrock elevation in the nearest boring per Section 305.3.5.2 of the 2020 ODOT BDM.*
4. *Per Section 305.3.5.2 of the 2020 ODOT BDM, the estimated pile length was determined as the pile cutoff elevation (top) minus the pile tip elevation, rounded up to the nearest 5.0 feet. Order (furnished) length for each pile should be calculated by adding 5 feet on estimated pile length.*
5. *The factored structural axial resistance for H-piles is based on the structural limit state of the steel H-pile section per Section 305.3.3 of the 2020 ODOT BDM. Factored structural axial resistances are calculated utilizing the structural resistance factor, φ_c = 0.50 for H-piles subject to damage due to severe driving conditions. Where downdrag is anticipated, factored structural axial resistance are calculated utilizing the structural resistance factor, φ_c = 0.60 for H-piles considering good driving conditions. Factored axial load (plus factored downdrag, if any) should be resisted by factored axial structural resistance.*
6. *Refer to Section 5.1.2 of this for downdrag load calculations.*
7. ***Design capacity is the maximum factored design load that can be applied on the pile.***
8. *Sleeve length represents the required length of pile that should be sleeved within the MSE wall backfill. The sleeves should extend to the bottom of the foundation preparation.*
9. *For H-piles driven to refusal on bedrock, no geotechnical resistance factor should be applied to the factored structural axial resistance values.*

5.1.2 Downdrag Considerations at Abutments

The estimated total settlement at the facing of the MSE Wall 1 and MSE Wall 2 are 1.37 and 2.72 inches, respectively. Please note, as per ODOT BDM Section 305.3.2.2 downdrag loads are considered to be induced in the pile foundation for the ground settlement of 0.4 inches or higher. As such, downdrag loads will act on the piles if they are installed to the final tip elevation prior to settlement of subsurface soils due to construction of the proposed MSE walls are attenuated to less than 0.4 inches. Results of the settlement analysis indicate that following the construction of MSE walls and the wait periods of 35 and 32 days for MSE Wall 1 and MSE Wall 2, respectively, the remaining settlement will be reduced to less than 0.4 inches, which is the threshold amount of relative movement to develop downdrag loading.

Rii performed the analysis to calculate the additional load due to the downdrag if the piles are installed to the final tip elevation prior to the completion of wait period. As per the settlement analysis performed, the effective neutral plane is calculated to be 3 to 7 feet above the top of bedrock. The additional loading due to the nominal downdrag at the rear and forward abutments were calculated to be 119.5 and 75.7 kips, respectively. A detailed analysis performed for the downdrag loading is provided in Appendix VIII.

As per ODOT BDM Section 305.3.2 and 305.3.2.2, when piles are driven to end bearing on a bedrock, the design of the pile is structurally controlled, and downdrag shall be considered at the strength limit states. Additionally, the factored structural compressive resistance ($P_{R\ max}$) is calculated considering good driving conditions if downdrag load is considered in the analysis. The Table 8 provides the results of the structural resistance check for the piles subjected to downdrag load.

Table 8. Downdrag Load

Substructure/ Boring Location	Pile Type and Size	$P_{R\ max}$ [1] (kips/pile)	Nominal Downdrag Load [2] (kips/pile)	Factored Downdrag Load (DD) [3] (kips/pile)	Factored Design Load (Q_p), (kips/pile)	Remark
Rear Abutment (B-004-0-25)	HP 10x42	372	119.5	126.0	150.0	***$P_{R\ max}$ > DD+ Q_p: OK***
Forward Abutment (B-008-0-25)	HP 10x42	372	75.7	80.0	150.0	***$P_{R\ max}$ > DD+ Q_p: OK***

1. *Per ODOT BDM 305.3.2.2, when downdrag load are included, factored axial structural compressive resistance is calculated considering resistance factor for good driving condition (φ_c = 0.60)*
2. *Calculated downdrag load per pile. Refer Appendix VIII for detailed calculations.*
3. *Factored downdrag load calculated as per ODOT BDM 305.3.2.2, rounded up to nearest whole number.*

As summarized in Table 8, factored axial structural compressive resistance is higher than the sum of proposed factored design load per pile and factored downward load. As such, the waiting period is not required, and the piles may be installed to the final tip elevation immediately following the completion of MSE wall construction.

5.1.3 Drivability

A drivability analysis was performed in accordance with Section 10.7.8 of the 2020 AASHTO LRFD BDS using the GRLWEAP software program, and the results are provided in Appendix IX. In the driveability analysis, a Delmag 19-42 hammer with a rated energy of approximately 43,200 ft-lbs was used in conjunction with the H-pile sections. Based on the results of this analysis, driving stresses induced on the H-piles would not exceed 90 percent of the yield stress of the steel (f_y = 50 ksi, $0.9f_y$ = 45 ksi) if driven through the overburden soils to the bedrock elevations provided in Table 7. Care should be exercised during pile driving operations when approaching the bedrock, and when extending the piles into the surficial bedrock material, to ensure that the driving stresses induced on the pile elements do not exceed the maximum allowable value of 90 percent of the yield stress of the steel, subsequently damaging the pile elements. Pile driving should be terminated upon achieving the required 20 blows (on bedrock) from the pile hammer with an inch or less of penetration to reduce the possibility of damaging the pile element.

As previously noted, the UCS testing as well as estimated UCS values correlated from point load testing on the representative rock cores samples ranged from 5,466 to 29,998 psi and the overburden soils below the bottom of MSE wall consists of predominantly cohesive soils with thickness of less than 50 feet. Therefore, steel points are recommended for the proposed driven piles as per ODOT BDM Section 305.3.5.6.

5.1.4 Lateral Design

If lateral loads or moments are expected to be applied on the foundation elements, they should be analyzed to verify the pile has enough lateral and bending resistance against these loads. A boring-by-boring tabulation of parameters for lateral loading design provided in Appendix VII should be used in lateral pile analyses. In order to evaluate the lateral capacity, it is recommended that a derivation of COM624, such as LPILE, be utilized to determine the proper embedment depth required to resist the lateral load for a given end condition and deflection. Table 9 lists the eleven (11) different soil types internal to the LPILE program. These strata were utilized to define the soil strata in the soil profile for each boring provided in Appendix VII.

Table 9. Subsurface Strata Description

Strata	Description
1	Soft Clay
2	Stiff Clay with Water
3	Stiff Clay without Free Water
4	Sand (Reese)
5	User Defined
6	Vuggy Limestone (Strong Rock)
7	Silt (with cohesion and internal friction angle)
8	API Sand
9	Weak Rock

5.2 MSE Wall 1 and Wall 2 Recommendations

Rii understands that MSE walls will be constructed at Rear Abutment (MSE Wall 1) and Forward Abutment (MSE Wall 2) to facilitate the grade separation for the proposed bridge over US 23. Based on the Stage 1 plans, the total height of the MSE Wall 1 and MSE Wall 2 will be approximately 29.6 and 28.7 feet, respectively, and will have approximate lengths of 172 and 170 feet, respectively.

As per the Stage 1 plans, the proposed top of the leveling pad elevation ranges from 875.75 (at the turnback wingwall) to 870.75 (at the face of the wall) for the MSE Wall 1. Further, the proposed top of the leveling pad elevation ranges from 875.5 (at the turnback wingwall) to 873.0 (at the face of the wall) for the MSE Wall 2. The proposed ground surface slope in front of the MSE walls are understood to be graded at a rate of 5.0H:1.0V or flatter. Based on the available Stage 1 plans, the proposed roadway grade within the footprint or in the vicinity of the MSE walls will be up to approximately 24.0 higher than the existing ground surface.

As per ODOT BDM Section 307.4, the minimum vertical distance from top of the leveling pad to any point on the ground surface within 4.0 feet of the face of wall shall be 3.0 feet. As per ODOT Supplemental Specification 840 (SS 840), the height of the MSE wall at the bridge abutment is defined as the elevation difference between the profile grade at the face of the wall (at roadway surface) and the top of the leveling pad. However, at the abutment, it is noted that the reinforced soil mass only extends from the foundation bearing elevation (top of leveling pad) to the bottom of footing elevation. Additionally, per Section 201.4.1.C.7 of the 2020 ODOT BDM, a minimum of one row of soil reinforcement straps should be attached to the backside of the abutment footing to resist horizontal forces from the bridge structure and lateral pressures along the back wall of the abutment footing, and prevent any load transfer from these forces to the coping and facing panels.

The width of the MSE wall foundation (B) is defined by the length of the reinforced soil mass. Per Section 307.4.A of the 2020 ODOT BDM and Section 840.04.A.2 of ODOT SS 840, the minimum length of the reinforced soil mass is equal to 70 percent of the height of the MSE wall or 8.0 feet, whichever is greater. A non-structural bearing leveling pad consisting of a minimum of 6.0 inches of unreinforced concrete should be placed at the base of the wall facing for constructability purposes. Please note that the leveling pad is not a structural foundation.

Per Section 307.4.C of the 2020 AASHTO LRFD BDS and Section 840.06.D of ODOT SS 840, following foundation subgrade inspection and acceptance, a foundation preparation layer consisting of a minimum of 12.0 inches of ODOT Item 703.16.C, Granular Material Type C, should be placed below the bottom of the labeling pad and compacted in accordance with ODOT Item 204.07.

A summary of proposed MSE wall information along with recommended foundation improvement is also provided as follows in Table 10.

Table 10. MSE Walls 1 and 2 Summary

Retaining Wall ID	Max. Wall Height Analyzed [1] (feet)	Top of Leveling Pad Elevation [2] (feet)	Proposed Ground Surface [3] (feet)	Minimum Required Reinforcement Width
Rear Abutment / Wall 1 (B-003-0-25 and B-005-0-25)	29.1	870.75	876 or higher	20.4 feet (0.70H)
Forward Abutment / Wall 2 (B-007-0-25 and B-009-0-25)	27.9	873.0	877 or higher	19.5 feet (0.70H)

1. *Maximum wall height measured from top of the leveling pad to the profile grade at the face of the wall (at roadway surface).*
2. *Top of the leveling pad elevation at the front face of the proposed wall.*
3. *Proposed ground surface elevation at the front face of the proposed wall. The ground surface is considered to slope down away from the wall at a rate of 5.0H: 1V or flatter.*

Sliding, overturning, and bearing checks along with global stability and settlement evaluations of the proposed MSE walls were performed by Rii, and results of those analyses are summarized in Sections 5.2.1 to 5.2.7 of this report. Detailed calculation sheets of the proposed MSE wall are enclosed in Appendix X of this report.

The internal stability of the proposed MSE retaining wall is beyond the scope of this report and shall be performed by the others following the requirements of AASHTO LRFD design manual.

5.2.1 Soil Strength and Consolidation Parameters

The estimated shear strength and consolidation parameters utilized in the external and global (slope) stability analyses of the proposed MSE walls are provided in Table 11 and Table 12, respectively.

The subsurface soil parameters utilized in the analyses were primarily determined from laboratory test results performed on similar soil samples, correlating subsurface information with available literature, along with estimated based on the subsurface conditions encountered in the soil borings and our experience with similar project and site conditions.

Table 11. Shear Strength Parameters Utilized in MSE Wall Stability Analyses

Material Type	γ (pcf)	φ' (°)	c' (psf)	S_u (psf)
Select Granular Backfill - MSE Wall (*Structure Backfill per SS840.03. E*)	120	34	0	N/A
Retained Soil (*As per ODOT BDM Section 307.1*)	125	30	0	N/A
Foundation Preparation (*ODOT C&MS Granular Material Type C, per 703.16.C*)	130	34	0	N/A
Embankment Fill (*ODOT C&MS Item 203 Embankment Material*)	125	26 [1]	250 [1]	2,000 [1]
Natural Granular soils (ODOT A-4a, A-4b, A-2-4)	125	30 to 32 [2]	0	N/A
Natural Cohesive soils (ODOT A-4a, A-4b, A-6a, A-6b)	115 to 125	27 to 28 [3]	85 to 195 [2]	1,710 to 3,190 [4]
Bedrock	140 to 150	29	4,800	---

1. *As per ODOT GDM Section 502.*
2. *As per ODOT GDM Section 404.*
3. *Soil parameters were estimated based on available literature by Terzaghi-Ralph-Peck (1996), and Rii experience with similar subsurface condition. Bedrock strength parameters are determined from empirical correlation provided by Bieniawski (1989).*
4. *Determined from laboratory test performed on similar soil samples.*

Table 12. Consolidation Parameters Utilized in MSE Wall Analyses

Material Type	γ (pcf)	LL (%)	C_c	C_r	e_o	C_v (ft^2/yr)	C'
Silt and Clay (AASHTO A-6a)	125	26 to 31	0.058 [1]	0.023 [1]	0.42 [1]	300 [1]	N/A
Sandy Silt and Silt – Cohesive [1] (AASHTO A-4a, A-4b)	125	29 to 29	0.030 [1]	0.007 [1]	0.36 [1]	350 [1]	N/A
Sandy Silt and Silt – Granular (AASHTO A-4a, A-4b)	125	23 to 25	N/A	N/A	N/A	500 [3]	33 to 77 [2]

1. *Consolidation parameters were determined from laboratory tests on similar soil samples.*
2. *Estimated from Figure 10.6.2.4.2-1, AASHTO LRFD BDS.*

5.2.2 Eccentricity (Overturning Stability)

The resistance of the MSE walls to overturning will be dependent on the on the location of the resultant force at the bottom of the wall due to the overturning and resisting moments acting on the wall. For MSE walls, overturning stability is determined by calculating the eccentricity of the resultant force from the midpoint of the base of the wall and comparing this value to a limiting eccentricity value. Per Section 11.10.5.5 of the 2020 AASHTO LRFD BDS, for foundations bearing on soil, the location of the resultant of the reaction forces shall be within the middle two-thirds ($^2/_3$) of the base width. Therefore, the limiting eccentricity is one-third ($^1/_3$) of the base width of the wall. Rii performed a verification of the eccentricity of the resultant force for the maximum specified wall heights indicated in Table 10 for each wall alignment. Based on the minimum length of reinforced soil mass presented in Table 10 and utilizing the soil parameters listed in Section 5.2.1, the calculated eccentricity of the resultant force **will not exceed** the limiting eccentricity at the strength limit state.

5.2.3 Sliding Stability

The resistance of the MSE walls to sliding was evaluated per Section 11.10.5.3 of the 2020 AASHTO LRFD BDS. For retaining wall bearing on cohesive soils, the sliding resistance was evaluated under both drained and undrained conditions. For retaining wall bearing on non-cohesive or granular soils, the sliding resistance was evaluated under both drained and undrained conditions.

Please note, as per ODOT GDM section 1504, sliding resistance needs to be analyzed at both the top and bottom of the foundation preparation layer. However, because of the weaker foundation soils, the bottom of the foundation preparation layer/foundation soil interface will control the sliding resistance and the sliding check at top of the foundation preparation layer was excluded.

For undrained conditions, the sliding resistance is taken as the limiting value between the undrained shear strength of the bearing soil and half of the vertical stress applied by the wall multiplied by the width of the MSE wall. For drained conditions, the sliding resistance is determined by multiplying a coefficient of sliding friction “f” by the total vertical force at the base of the wall. The coefficient of sliding friction is determined based on the limiting friction angle between the foundation soil and the reinforced soil backfill.

A geotechnical resistance factor of φ_T=1.0 was considered in calculating the factored shear resistance between the select granular backfill and foundation soil. Based on the analyses performed, the resultant horizontal forces on the back of the MSE walls **will not exceed** the factored shear resistance at the strength limit state under both drained and undrained condition conditions.

5.2.4 Bearing Stability

The bearing resistance of the foundation soil at both MSE walls was evaluated per Section 11.10.5.4 of the AASHTO LRFD BDS. Please note bearing resistance checks were performed for the improved foundation conditions as described in Section 5.2 of this report.

The bearing resistance was calculated for both drained and undrained conditions for both walls considering foundation improvement as described in this report, and the limiting value was used for verification of bearing stability. A geotechnical resistance factor of φ_b=0.65 was considered in calculating the factored bearing resistance of the foundation material.

Please note, as per ODOT GDM Section 1504, bearing resistance is to be analyzed at both the top and bottom of the foundation preparation layer; however, because of the weaker foundation soils, the interface between the bottom of the foundation preparation layer and the foundation soil will control the bearing resistance. Therefore, the bearing resistance check at top of the foundation preparation layer was excluded.

For the bearing stability check, the equivalent bearing pressure exerted along the bottom of the reinforced soil mass due to the eccentricity of the wall was determined using the appropriate load factors and combination of lateral and live load surcharge on the wall per Section 11.10.5.2 of the AASHTO LRFD BDS. Based on the minimum length of reinforced soil mass recommended in this report, the factored equivalent bearing pressure exerted below the walls **will not exceed** the factored bearing resistance at the strength limit state. A summary of calculated bearing resistance for both walls is provided in Table 13.

Table 13. MSE Walls 1 and 2 - Bearing Resistance

Retaining Wall ID	Wall Height Analyzed (feet)	Backslope Behind Wall	Top of Leveling Pad Elevation [2] at the Front Face of Wall (feet)	Minimum Required Reinforcement Width [1]	Bearing Resistance at Strength Limit [2] (ksf)	
					Nominal	Factored [3]
Rear Abutment / Wall 1 (B-003-0-25 and B-005-0-25)	29.1	Level	870.75	20.4 feet (0.70H)	11.75	7.63
Forward Abutment / Wall 2 (B-007-0-25 and B-009-0-25)	27.9	Level	873.0	19.5 feet (0.70H)	12.35	8.02

1. *Minimum required foundation width is expressed as a percentage of the wall height, H, at the respective location.*
2. *Values represent the limiting nominal and factored bearing resistance between drained and undrained conditions for each wall.*
3. *Geotechnical resistance factor of φ_b=0.65 was considered in calculating the factored bearing resistance at the strength limit state.*

5.2.5 Settlement Evaluation

The settlement analyses were performed considering the unit weight and height (H) of the select granular backfill, along with the loading from foundation preparation layer over the effective width of the walls at the service limit state. Results of the settlement analyses are presented in Table 14.

Maximum total settlements of 1.37 inches at the center of the reinforced soil mass and 1.10 inches at the facing of the wall are estimated along MSE Wall 1. Based on the results of the analysis, 90 percent of the total settlement at the facing of the wall is anticipated to occur within 140 days following the completion of construction of the wall. In addition, maximum total settlements of 2.72 inches at the center of the reinforced soil mass and 1.97 inches at the facing of the wall are estimated along MSE Wall 2. Based on the results of the analysis, 90 percent of the total settlement at the facing of the wall is anticipated to occur within 68 days following the completion of construction of the wall.

Table 14. MSE Walls 1 and 2 Settlement Values

Wall No.	Approx. Station Along Wall Alignment		Reference Boring(s)	Total Settlement Values (inches)		Differential Settlement Along Wall Facing (inches)	Time for 90% Consolidation (Days)
	From [1]	To [1]		Center of Wall Mass	Facing of Wall		
1	0+10	1+82	B-003-0-25 to B-05-0-25	1.37	1.10	Less than 0.5 in. / 75 ft.	140
2	0+10	1+80	B-007-0-25 and B-009-0-25	2.72	1.97	Less than 0.5 in. / 75 ft.	68

1. Stationing referenced to C/L of corresponding walls.

Per Section 307.1.6 of the 2020 ODOT BDM, the maximum allowable differential settlement in the longitudinal direction (regardless of the size of panels) is one (1) percent (1/100.). Based on the total anticipated settlement at the facing of Walls 1 and 2, the maximum differential settlement in the longitudinal direction is anticipated to be less than 0.5 in. / 75 ft., which is within the tolerable limit of 1/100. If the total or differential settlement values predicted for the proposed wall presents an issue with respect to the deformation tolerances that the wall can withstand, then measures should be taken to minimize the amount of settlement that will occur.

5.2.6 Overall (Global) Stability

Slope stability analyses were performed at each MSE wall location to check the global stability of the proposed walls. The stability analyses of the proposed walls were evaluated using Spencer method and the SLIDE computer software program (Version 9.009). The existing and proposed cross-sections at the proposed MSE walls locations were determined from available plan information prepared by E.L. Robinson. For the global stability analysis, the MSE wall was considered to be a rigid reinforced mass and

the failure plane was not allowed to cross through the wall. A summary of soil and rock strength properties utilized in global stability analysis is presented in Section 5.2.1 of this report.

Per Section 11.6.2.3 of the 2012 AASHTO LRFD BDS, overall (global) stability for MSE walls that are integrated with or supporting structural foundations or elements is satisfied if the product of the factor of safety from the slope stability output multiplied by the resistance factor φ=0.65 is greater than 1.0. Therefore, global stability for the proposed MSE walls are satisfied when a minimum factor of safety of 1.5 is obtained. For MSE walls designed with the minimum strap lengths listed in Table 10, the resulting factor of safety values under drained conditions (long-term stability) and undrained conditions (short-term stability) for the proposed alignments were greater than 1.5. ***As such, the minimum factor of safety for global stability is satisfied.***

5.2.7 Final MSE Wall Considerations

Based on the results of the external and global stability analysis performed for the both MSE walls at the rear abutment (MSE Wall 1) and the forward abutment (MSE Wall 2) all the requirements of bearing and sliding resistance and limiting eccentricity and overall (global) stability are satisfied provided the proposed walls are designed as recommended in this report.

Calculations for external (bearing and sliding resistance and limiting eccentricity) and overall (global) stability of the MSE walls are provided in Appendix X.

5.3 Embankment Construction Considerations

Prior to embankment construction or subgrade preparation, perform clearing and grubbing, in accordance with ODOT CMS Item 201 and remove existing pavement and base materials, as well as other structures or obstructions, as necessary, in accordance with Item 202. The site should be stripped of any topsoil, organics, or other deleterious, or unsuitable materials within the footprint of the proposed embankment and subgrade. The embankment foundation shall then be prepared in accordance with ODOT CMS Item 203.05.

Material to be utilized as borrow should be restricted to conform to Item 203 for embankment and Item 204 for subgrade. Engineered fill materials should be spread and compacted in accordance Items 203 and for earthen embankment and Item 204 for subgrade. Frozen material should not be incorporated into any new fill or built upon with new fill or pavement materials.

Any borrow materials to be used as new fill within 3 feet of the proposed subgrade level should be tested in the laboratory to verify the soil exhibits a minimum design CBR value of the subgrade soils as recommended in this report.

Once the design subgrade elevation is achieved, the subgrade should be compacted and proof rolled in accordance with ODOT CMS Item 204. Areas exhibiting instability should be repaired in accordance with ODOT CMS Item 204.07.

5.4 Embankment Evaluation

Based on the Stage 1 plans provided by E.L. Robinson, up to approximately 8.8, 9.0, 14.1, 12.1, and 17.5 feet of fill will be required to bring the site to the proposed grade along Ramp A, Ramp B, Ramp C, Ramp D and SR 294, respectively. In addition, up to approximately 11.0, 13.5, 5.5, 16.0 and 13.5 feet of cut will be required to achieve the proposed grade elevations along Ramp A, Ramp B, Ramp C, Ramp D and US 23, respectively. Additionally, minimal (less than 3 feet) cut and fill will be required to bring the site to the proposed grade along the proposed TR 127 realignment. The available plans indicate that the embankment side slopes will be graded at a rate of embankment slopes of 2H:1V or flatter along all alignments.

5.4.1 Embankment Settlement Analysis

Rii utilized one (1) representative cross-section from each of the proposed Ramp A, Ramp B, Ramp C, Ramp D and SR 294 alignments to determine the settlement of the foundation soils due to the proposed embankments construction. The cross-sections utilized in settlement analysis were selected in such a manner that these are representative of worst-case condition for the respective alignments.

The settlement analyses were performed utilizing the estimated load from the proposed fill embankment, the general soil profile obtained from the field exploration, and results of the laboratory testing. A summary of cross-sections used in settlement analyses and representative borings is shown in Table 15. A summary of consolidation parameters is summarized in Table 16. A detailed calculation of settlement analyses is presented in Appendix XI.

The settlement analyses performed at representative cross-sections along Ramp A, Ramp B, Ramp C and Ramp D alignments indicated an estimated maximum total settlement of 2.36, 1.14, 2.31 and 2.41 inches, respectively. Settlement analysis performed at a representative cross-section along the SR 294 alignment indicated a maximum total settlement of 3.07 inches. The estimated time to occur the 90% of the total settlement is summarized as follows in Table 15.

If the estimated maximum settlement is considered to be beyond the tolerable limits and waiting period or settlement mitigation measures are planned, especially for approach embankments, settlement monitoring platforms shall be installed.

Table 15. Summary of Cross-Section Utilized in Settlement Analyses

Alignment	Station where Analysis is Performed	Approx. Maximum Embankment Fill Height, (feet)	Soil Boring	Est. Maximum Settlement (inches)	Time to Occur 90% Settlement (days)	Time to Occur 90% Settlement With Drainage Layer (days) [2]
Ramp A	492+00	9.0	B-017-0-25 through B-019-0-25	2.36	550	210
Ramp B	596+50	9.0	B-020-0-25 and B-021-0-25	1.14	220	60
Ramp C	685+00	14.0	B-025-0-25 and B-026-0-25	2.31	715	190
Ramp D	784+50	12.0	B-027-0-25 through B-029-0-25	2.41	535	195
SR 294	316+00 [1]	17.5	B-010-0-25 through B-012-0-25	3.07	625	180

1. *Near proposed bridge approach slab*
2. *First layer of fill at the bottom of embankment is considered as granular layer*

Table 16. Consolidation Parameters Utilized in Embankment Analysis

Material Type	γ (pcf)	LL (%)	C_c	C_r	e_o	C_v (ft²/yr)	C'
Silt and Clay (AASHTO A-6a)	125	25 to 30	0.058 [1]	0.023 [1]	0.424 [1]	300 [3]	N/A
Silty Clay (AASHTO A-6b)	125	38	0.252 [3]	0.019 [3]	0.569 [3]	250 [3]	N/A
Clay [2] (AASHTO A-7-6)	120 to 125	41 to 62	0.279 to 0.468 [3]	0.021 to 0.035 [3]	0.593 to 0.757 [3]	125 [3]	N/A
Sandy Silt and Silt – Cohesive (AASHTO A-4a, A-4b)	125	22	0.030 [1]	0.007 [1]	0.360 [1]	350 [3]	N/A
Sandy Silt and Silt – Granular [2] (AASHTO A-4a, A-4b)	120 to 125	N/A	N/A	N/A	N/A	500 [3]	21 to 31 [2]

1. *Consolidation parameters were determined from laboratory tests on similar soil samples.*
2. *Estimated from Figure 10.6.2.4.2-1, AASHTO LRFD BDS.*
3. *From available empirical correlation.*

5.4.2 Embankment Slope Stability Analysis

Rii utilized one (1) representative cross-section from each of the proposed Ramp A, Ramp B, Ramp C, Ramp D and SR 294 alignments to check the overall stability of the proposed embankments. The cross-sections utilized in the stability analyses were selected in such a manner that these are representative of the most critical embankment slopes. These critical cross-sections were selected based on the subsurface conditions encountered and/or the height of the proposed embankment fill.

Global stability analyses were performed using Morgenstern-Price methods and SLIDE2 computer software. Rii utilized cross-sections from Sta. 316+00 along SR 294, Sta. 492+00 along Ramp A, Sta. 596+50 along Ramp B, Sta. 685+00 along Ramp C, and Sta. 784+50 along Ramp D for global the stability analyses. The subsurface parameters utilized in the stability analyses were estimated based on the subsurface conditions encountered in the soil borings, results of the field and laboratory testing, correlation of N_{60} values with soil strength parameters, and Rii's experience with similar project and site conditions.

A distributed load of 250 pound per square foot (psf) was applied at the ground surface of the proposed roadway to account for the vehicular loading. The shear strength parameters utilized in global stability analyses are summarized in Table 17.

Table 17. Soil and Rock Parameters Utilized in Slope Stability Analysis

Material Type	Unit Weight, γ (pcf)	Effective Friction Angle, φ' (°)	Effective Cohesion, c' (psf)	Undrained Shear Strength, s_u (psf)
Item 203 Embankment (New Engineered Fill)	125	26	250	2,000
Medium Stiff to Stiff Clay (ODOT A-7-6)	115 to 125	22 to 24	85 to 205	875 to 2,125
Very Stiff to Hard Clay (ODOT A-7-6)	125	24	260	3,125
Medium Stiff to Stiff Silt and Clay or Silty Clay (ODOT A-6a, A-6b)	125	24 to 26	110 to 205	1,500 to 1,625
Very Stiff to Hard Silt and Clay (ODOT A-6a)	125	26 to 27	210 to 295	2,500 to 3,750
Very Stiff to Hard Sandy Silt (ODOT A-4a)	125	27	110	---
Loose to Medium Dense Sandy Silt or Silt (ODOT A-4b, A-4a)	120 to 125	28 to 31	---	2,500
Dolomite Bedrock	150	29	4,800	---

Based on the ODOT GDM manual a factor of safety of 1.3 or is considered acceptable for the roadway embankments that does not support structural element. Roadway embankments that support structural element should have a minimum factor of safety of 1.5. The global slope stability analysis performed for the representative cross-sections along the alignments Ramp A, Ramp B, Ramp C, Ramp D and SR 294 indicated factor of safety more than 1.5 for both the drained (long-term) and undrained condition (short-term). A summary of global stability analyses results is provided in Table 18 and the graphical representation of global stability analyses is presented in Appendix XII. Please note that, the global stability analyses consider the proposed embankment will be constructed using engineered fill materials with shear strength properties equal to or exceeding those presented in this report.

Table 18. Results of Global Stability Analysis

Alignment	Station	Approx. Maximum Embankment Fill Height (feet)	Soil Boring	Proposed Slope Rate [1]	Drained Condition	Undrained Condition
Ramp A	492+00	6.2	B-017-0-25 through B-019-0-25	7.7H:1V	5.979	13.212
Ramp B	596+50	6.6	B-020-0-25 and B-021-0-25	4H:1V	3.536	11.397
Ramp C	685+00	14.1	B-025-0-25 and B-026-0-25	4H:1V	3.969	8.274
Ramp D	784+50	13.0	B-027-0-25 through B-029-0-25	4H:1V	3.460	7.435
SR 294	316+00	23.0	B-010-0-25 through B-012-0-25	2.2H:1V	1.955	4.216

1. Embankment slope.

5.4.3 Final Embankment Considerations

Based on the Stage 1 plans, Rii understands that the proposed embankment slopes are planned to be constructed with slope inclination of 2H:1V or flatter. Slopes steeper than 2H:1V are not recommended for the new embankment construction and/or roadway widening without additional reinforcement measures.

All site work shall conform to local codes, and to the latest ODOT CMS, including that all excavation and embankment preparation and construction should follow ODOT Item 200 (Earthwork). Proposed fill on existing slopes steeper than 8H:1V shall be benched into the existing slope and constructed in accordance with ODOT Items 201 and 203. Special benching (as per ODOT GDM Section 800) is required for proposed fill on existing slopes steeper than 4H:1V to ensure the embankment is “knitted” together.

Note that, upper 4 to 6 feet of soils encountered in majority of the soil borings performed within the footprint of proposed embankment generally exhibited moisture contents ranging from moderately to significantly above their estimated optimum moisture content levels (OMC). As such, it is anticipated that majority of these soils will likely experience difficulty in achieving the required compaction specification for embankment foundation preparation. This condition is likely to be exacerbated during wet seasons, when additional moisture may increase the degree of saturation, further inhibiting compaction efforts. In such cases, a “bridge lift” in accordance with ODOT CMS Item 204.05 may be considered for the initial lift, to help establish the working platform and enable uniform compaction in the subsequent lifts per ODOT CMS Item 204.07. However, Rii recommends that this approach not be utilized unless more than 3 feet of fill will be required to achieve final subgrade elevation. Additionally, “bridge lift” is not recommended within and in the vicinity of existing ditches due to the potential presence of organic soils in those areas, which could compromise stability and long-term performance.

5.5 Pavement Subgrade Recommendations

Borings B-001-0-25, B-002-0-25 and B-010-0-25 through B-039-0-25 were performed along the proposed alignments Ramp A, Ramp B, Ramp C and Ramp D, TR 127, and along SR 294. The soils at and near the anticipated subgrade elevation predominantly consist of natural cohesive soils described as stiff to hard as clay, silt and clay, silty clay, and sandy silt (ODOT A-7-6, A-6a, A-6b and A-4a). In borings B-022-0-25, B-028-0-25 and B-030-0-25, cohesionless fine-grained soils described as medium dense sandy silt and silt (ODOT A-4a and A-4b) were encountered. The moisture content of the upper 3 feet of the final subgrade elevation is observed to be ranging from near their estimated optimum moisture levels to significantly above their estimated optimum moisture levels.

The depth and type of subgrade stabilization/modification is determined by the subgrade analysis spreadsheet and guidelines included in ODOT GDM utilizing SPT N_{60} values, HP values, moisture content values (relative to OMC values), site grading and the type of subgrade soils encountered. Based on the subgrade analysis performed, the proposed widening area requiring subgrade stabilization and the method and depths of stabilization are provided in section.

The moisture content of cohesive soil has a significant effect on the physical properties of the material. It should be noted that the moisture contents provided on the boring logs, and utilized in this analysis, represent the conditions during the drilling phase of the project. The referenced borings for subgrade analysis were drilled on May 19 and 30, 2025. These soil conditions, especially in the surficial soils, may not coincide with the soil conditions that will be encountered during construction. Consequently, the extent/need for subgrade improvement is entirely dependent on the subgrade conditions (i.e., moisture contents) encountered at the time of construction.

5.5.1 Subgrade Stabilization

The subgrade soils for this project may be stabilized by spot stabilization or global stabilization method as described in this report.

Based on the information provided in Stage 1 plans, the proposed pavement built-up thickness will be approximately 13.0 inches. As such, the proposed subgrade was considered at approximately 1.1 feet below the proposed roadway surface grade elevation provided in the design plans.

5.5.1.1 Station by Station Stabilization Recommendations

For the estimating proposes, the approximate locations and depths of subgrade stabilization using excavate and replace options determined from subgrade analysis spreadsheet are summarized in Table 19.

Table 19. Subgrade Treatment Summary

Project Section	From Station [1]	To Station [1]	Length (feet)	Problem	Representative Boring(s)	ODOT Subgrade Stabilization
Ramp A	166+80, US 23	169+15, US 23	235	Unstable	B-013-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, over 712.09 Geotextile Fabric Type D.
	177+60, US 23	481+85, Ramp A	425	Unstable	B-016-0-25	
Ramp B	601+00, Ramp B	605+10, Ramp B	410	Unstable and Unsuitable	B-022-0-25	Excavate 36 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
Ramp C	671+00, Ramp C	673+75, Ramp C	275	Unstable	B-023-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
Ramp D	787+00, Ramp D	789+40, Ramp D	240	Unstable	B-027-0-25	
	789+40, Ramp D	793+00, Ramp D	360	Unsuitable	B-028-0-25	Excavate 36 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
	793+00, Ramp D	797+00, Ramp D	400	Unstable	B-029-0-25	Excavate 15 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
	197+00, US 23	205+10, US 23	810	Unstable	B-030-0-25 and B-031-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
	205+10, US 23	208+60, US 23	350	Unstable	B-032-0-25	Excavate 15 inches and replace with ODOT Item 703.16C, Type C, with 712.09 Geotextile Fabric Type D.
SR 294	323+70, SR 294	326+00, SR 294	230	Unstable	B-012-0-25	Excavate 12 inches and replace with ODOT Item 703.16C, Type C, over 712.09 Geotextile Fabric Type D.
TR 127	900+00, TR 127	916+80, TR 127	1,680	Unstable	B-012-0-25, B-036-0-25 thru B-039-0-25	

1. *Station limits estimated based on soil conditions encountered during the field exploration. Actual limits of stabilization may vary based on the conditions encountered during construction.*

Please note, the limits and depth of stabilization provided in Table 19 are estimated based on the soil conditions encountered in the borings performed during the field exploration. Actual limits and depth of stabilization may differ from the recommendations provided. Per ODOT GDM requirements, if it is elected to perform station by station stabilization, the entire exposed subgrade should be proof rolled to identify the actual limits of unstable subgrade and depth of stabilization required. Upon completion of the stabilization, areas that required stabilization should be proof rolled to verify that stability has been achieved.

5.5.1.2 Global Stabilization

Based on the ODOT GDM, when approximately 30 percent or more of the subgrade requires stabilization, consideration should be given to utilizing a global stabilization option. For this project, ODOT GDM subgrade analysis indicate that stabilization will be required for approximately 33 to 88 percent of the subgrade across the six alignments designated as Ramp A, Ramp B, Ramp C, Ramp D, TR 127 and SR 294. These percentages reflect only the areas that require less than 3.0 feet of fill and not the percentage of entire alignment. The detailed subgrade analyses for each alignment are shown in Appendix XIII.

Per ODOT subgrade analysis spreadsheet, global stabilization recommendations are based upon the overall average site parameters, as noted in Table 20.

Table 20. Average Site Parameters

Project Section(s)	Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index
Ramp A	13	21	19	16	13
Ramp B	13	12	18	12	10
Ramp C	11	24	20	18	15
Ramp D	9	16	20	15	8
SR 294	14	25	17	15	11
TR 127	11	28	20	18	16

After applying the averages in Table 20 and considering the conditions and type of soils encountered in the project, the following stabilization alternatives can be considered for sections where global stabilization is considered an option within the project limits, as identified in Table 21.

Option 1: **Mechanically stabilize the entire subgrade via a 12-inches of over excavation and replacement to proposed subgrade with ODOT Item 703.16C Granular Material, Type C installed over ODOT Item 712.09 Geotextile Fabric, Type D as detailed in accordance with ODOT Item 204.**

Option 2: **Chemically stabilize the entire subgrade with 12 to 14 inches of cement or lime, according to the thickness shown in Table 21 and as per ODOT Construction and Materials Specification (CMS) Item 206. For estimating purposes, utilize a cement or lime content of 5.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils. Actual depth of chemical stabilization may vary based on the conditions encountered during construction.**

Table 21. Global Stabilization Recommendations

Project Section(s)	Representative Boring(s)	Recommended Mechanical Subgrade Stabilization (Option 1)	Recommended Chemical Subgrade Stabilization (Option 2)
Ramp A	B-002-0-25, B-013-0-25 through B-019-0-25	**Excavate 12 inches and Replace with ODOT Item 703.16C, Granular Material Type C, over 712.09 Geotextile Fabric Type D.**	**12" Item 206 (Lime or Cement)** (Chemical Stabilization with Lime or Cement)
Ramp B	B-002-0-25, B-020-0-25 through B-022-0-25		**12" Item 206 (Cement)** (Chemical Stabilization with Cement)
Ramp C	B-010-0-25, B-023-0-25 through B-026-0-25		**14" Item 206 (Lime)** (Chemical Stabilization with Lime)
Ramp D	B-010-0-25, B-027-0-25 through B-033-0-25		**14" Item 206 (Cement)** (Chemical Stabilization with Cement)
SR 294	B-001-0-25, B-002-0-25, B-010-0-25 through B-012-0-25		**12" Item 206 (Lime)** (Chemical Stabilization with Lime)
TR 127	B-012-0-25, B-036-0-25 through B-039-0-25		**12" Item 206 (Lime)** (Chemical Stabilization with Lime)

Silt soil (ODOT A-4b) was encountered in boring B-022-0-25 and B-028-0-25 within 3 feet of the proposed subgrade. Silt soils are susceptible to frost heaving and are considered unsuitable for pavement support. Therefore, if option 1 is selected as the global stabilization alternative, silt (ODOT A-4b) soils should be removed to a depth of 36 inches below the anticipated final subgrade elevation.

If chemical stabilization option is implemented, the resilient modulus value and corresponding CBR value along each alignment may be increased by 36 percent in accordance with Section 203.4.1 of the ODOT Pavement Design Manual (PDM).

If global stabilization option is considered, per ODOT GDM requirements, the entire subgrade should be stabilized using one of the global stabilization options provided above. Upon completion of the stabilization, the entire subgrade should be proof rolled to verify that stability has been achieved.

5.5.2 Subgrade Design Considerations

Based on the conditions encountered across the site and provided that the recommendations of this report are implemented, **it is recommended that pavement design be based on a California Bearing Ratio (CBR) value and corresponding resilient modulus, M_R, as provided** in Table 22. Corresponding modulus of subgrade reaction (K) value of and soil support value determined from correlation charts are also provided in Table 22.

Table 22. Recommended Pavement Design Parameters

Alignment	CBR [1]	Resilient Modulus [1] (M_R)	Modulus of Subgrade Reaction (K) Value	Soil Support Value
Ramp A	5	6,000	135	3.8
Ramp B	6	7,200	150	4.4
Ramp C	4	4,800	120	3.2
Ramp D	6	7,200	150	4.4
SR 294	6	7,200	150	4.4
TR 127	4	4,800	120	3.2

1. *If global chemical stabilization option is implemented, the resilient modulus value and corresponding CBR value along each alignment may be increased by 36 percent.*

It should be noted, per ODOT GDM, soils with sulfate content in excess of 5,000 parts per million (ppm) cannot be chemically stabilized due to the potential for sulfate heave in the soil. Based on the results of the testing, the sulfate contents of the subgrade soils range from less than 40 ppm to 940 ppm.

Please note that the recommended CBR values assume that the materials utilized for the subgrade in fill areas are equivalent to, or better than materials at the existing subgrade elevation. Sources of borrow material should be designated in advance of construction. The material should be tested in the laboratory to verify the soil exhibits a minimum design CBR value as provided above.

Pavement design is dependent on the inclusion of adequate surface and subsurface drainage in order to maintain the compacted subgrade near optimum moisture conditions throughout the lifetime of the pavement. If underdrain systems are considered, they should be installed in accordance to the specifications presented in Item 204 of the ODOT CMS.

5.6 Lateral Earth Pressure

For the soil types encountered in the borings, the “in-situ” unit weight (γ), cohesion (c), effective angle of friction (φ’), and lateral earth pressure coefficients for at-rest conditions (k_o), active conditions (k_a), and passive conditions (k_p) have been estimated and are provided in Table 23 and Table 24.

Table 23. Estimated Undrained (Short-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ	k_a	k_o	k_p
Stiff Cohesive Soil	125	1,500	0°	N/A	N/A	N/A
Very Stiff to Hard Cohesive Soil	125	2,500	0°	N/A	N/A	N/A
Medium Dense Silt (Cohesionless)	125	0	30°	0.33	0.50	3.00
Medium Dense to Very Dense Granular Soil	125	0	32°	0.31	0.47	3.25
Compacted Cohesive Engineered Fill	120	2,000	0°	N/A	N/A	N/A
Compacted Granular Engineered Fill	125	0	32°	0.31	0.47	3.25

1. When below groundwater table, use effective unit weight, γ' = γ - 62.4 pcf and add hydrostatic water pressure.

Table 24. Estimated Drained (Long-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c' (psf)	φ'	k_a	k_o	k_p
Stiff Cohesive Soil	120	0	26°	0.42	0.59	2.37
Very Stiff to Hard Cohesive Soil	125	0	28°	0.39	0.56	2.56
Medium Dense Silt (Cohesionless)	125	0	30°	0.33	0.50	3.00
Medium Dense to Very Dense Granular Soil	120	0	32°	0.31	0.47	3.25
Compacted Cohesive Engineered Fill	120	0	28°	0.39	0.56	2.56
Compacted Granular Engineered Fill	125	0	32°	0.31	0.47	3.25

1. When below groundwater table, use effective unit weight, γ' = γ - 62.4 pcf and add hydrostatic water pressure.

These parameters are considered appropriate for the design of all subsurface structures and any excavation support systems. Subsurface structures (where the top of the structure is restrained from movement) should be designed based on at-rest conditions (k_o). For proposed temporary retaining structures (where the top of the structure is allowed to move), earth pressure distributions should be based on active (k_a) and passive (k_p) conditions.

These recommendations do not take into consideration the effect of any surcharge loading or a sloped ground surface (a flat surface is assumed). Earth pressures on excavation support systems will be dependent on the type of sheeting and method of bracing or anchorage. Surcharge loads, such as that imposed by traffic loading, will create additional lateral loading on the subsurface structures and excavation support systems. The resulting lateral earth pressure should be evaluated based on active (k_a) and at-rest (k_o) conditions and the anticipated magnitude of the loading.

Where necessary, temporary retaining structures, such as sheet pile system, should be designed using the undrained soil parameters provided in Table 23, and the design should follow all applicable guidelines for the type of retaining structure utilized. Permanent retaining and subsurface structures should be designed using the drained soil parameters provided in Table 24. Regardless of whether the retaining structure is temporary or permanent, the effective unit weight (γ' = γ - 62.4 pcf) plus the hydrostatic water pressure ($\gamma_w * h_w$, where h_w is the height of water behind the wall above the base of the wall) should be utilized below the design groundwater level. The lateral earth pressure coefficients should only be applied to the horizontal pressure resulting from the effective overburden pressure, and should not be applied to the hydrostatic water pressure.

5.7 Construction Considerations

All site work shall conform to local codes and to the latest ODOT Construction and Materials Specifications (CMS), including that all excavation and embankment preparation and construction should follow ODOT Item 200 (Earthwork).

Please note, very low plasticity to non-plastic silt soils (ODOT A-4b) were encountered at or near the bearing elevations of proposed MSE walls. Silt soils are prone to be easily disturbed, generally tend to exhibit soft and/or loose conditions upon the removal of soil overburden, and are moisture-sensitive. As such, soft and/or loose soils may be encountered at the proposed bearing elevations. If soft and/or loose condition are encountered at the bearing elevations, these soils should be over-excavated and replaced with ODOT C&MS Granular Material Type C, per 703.16.C.

5.7.1 Excavation Considerations

All excavations should be shored / braced or laid back at a safe angle in accordance with Occupational Safety and Health Administration (OSHA) guidelines. During excavation, if slopes cannot be laid back to OSHA Standards due to adjacent structures or other obstructions, temporary shoring may be required. Actual excavation back slopes must be field verified by qualified personnel at the time of excavation in strict accordance with OSHA guidelines.

5.7.2 Groundwater Considerations

The soil borings encountered short-term groundwater at depths as summarized in Table 5 of this report. As stated, short-term water level readings, especially in cohesive soils, are not necessarily an accurate indication of the actual groundwater level which could be higher than that observed in the soil borings. Additionally, groundwater conditions affecting construction may be encountered within the trapped/perched zones. These trapped/perched zones are generally the layer(s) of granular soils/ silt soils that are isolated within the fine-grained cohesive soil layers and may not be evident in the boring logs.

Groundwater, wherever encountered, proper groundwater control measures should be implemented to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or “boiling” condition if soft/loose silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 36.0 inches below the deepest excavation. Note that determining and maintaining actual groundwater levels during construction is the responsibility of the contractor.

6.0 LIMITATIONS OF STUDY

The above recommendations are predicated upon construction inspection by a qualified soil technician under the direct supervision of a professional geotechnical engineer. Adequate testing and inspection during construction are considered necessary to assure an adequate foundation system and are part of these recommendations.

The recommendations for this project were developed utilizing soil and bedrock information obtained from the test borings that were made at the proposed site for the current investigation. Resource International is not responsible for the data, conclusions, opinions or recommendations made by others during previous investigations at this site. At this time, we would like to point out that soil borings only depict the soil and bedrock conditions at the specific locations and time at which they were made. The conditions at other locations on the site may differ from those occurring at the boring locations.

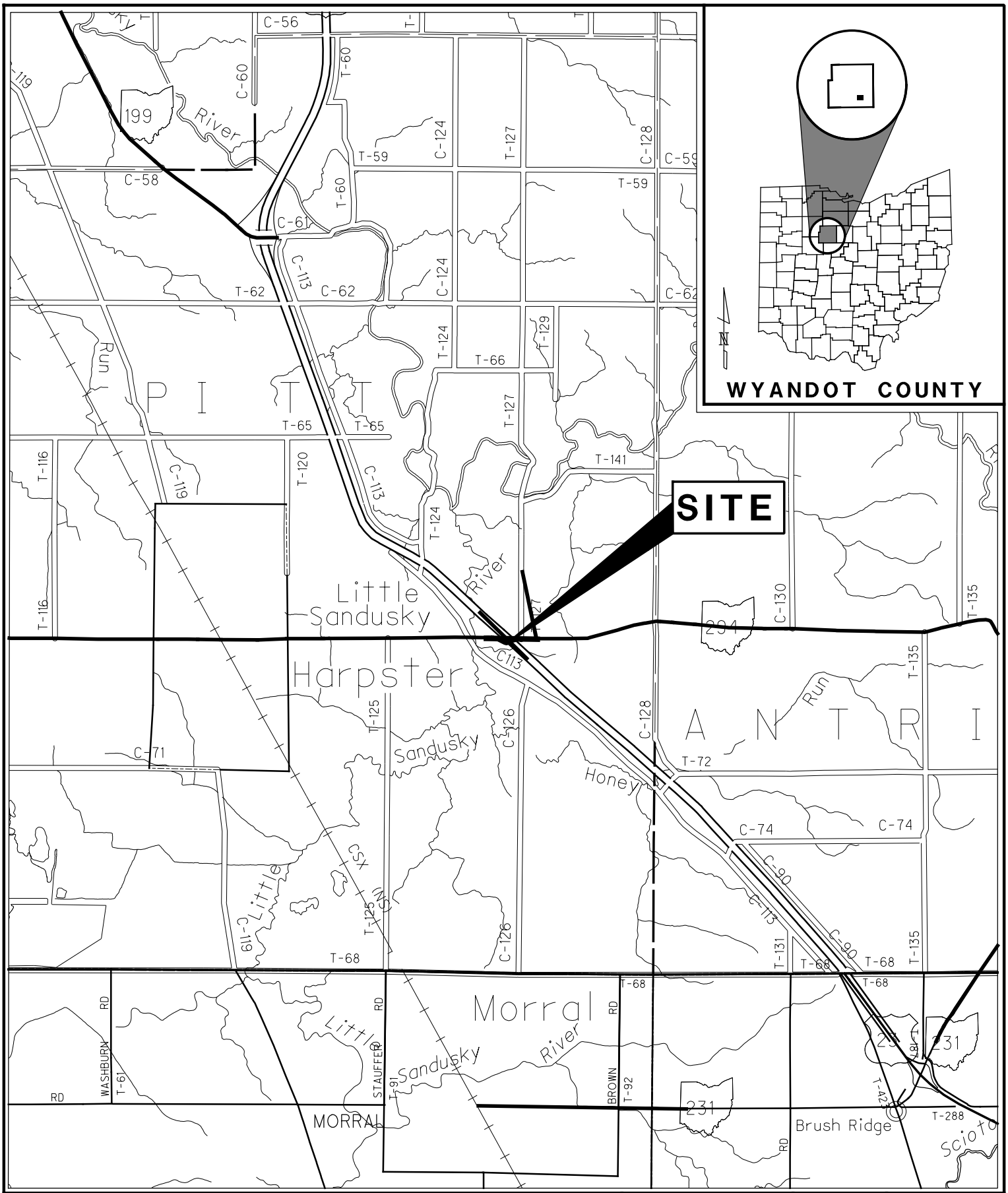
The conclusions and recommendations herein have been based upon the available soil and bedrock information and the design details furnished by a representative of the owner of the proposed project. Any revision in the plans for the proposed construction from those anticipated in this report should be brought to the attention of the geotechnical engineer to determine whether any changes in the foundation or earthwork recommendations are necessary. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the geotechnical engineer.

The scope of our services does not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater or surface water within or beyond the site studied. Any statements in this report or on the test boring logs regarding odors, staining of soils or other unusual conditions observed are strictly for the information of our client.

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. Resource International is not responsible for the conclusions, opinions or recommendations made by others based upon the data included.

APPENDIX I

VICINITY MAP AND BORING PLAN



VICINITY MAP

WAY-023-3.47 INTERCHANGE IMPROVEMENTS

WYANDOT COUNTY, OHIO

RII PROJECT NO. W-25-026	DRAWN JAS
SCALE: 1"=5000' (0 2500 5000)	REVIEWED AG
	DATE 7/7/2025

RESOURCE INTERNATIONAL Rii

MATCH LINE STA. 594+00, SHEET 8

PC STA. 593+12.30

℄ CONST. RAMP B

B-002-0-25

PC STA. 307+39.19

PT STA. 309+49.39

℄ CONST. SR 294

B-001-0-25

X-001-0-25

℄ CONST. RAMP A

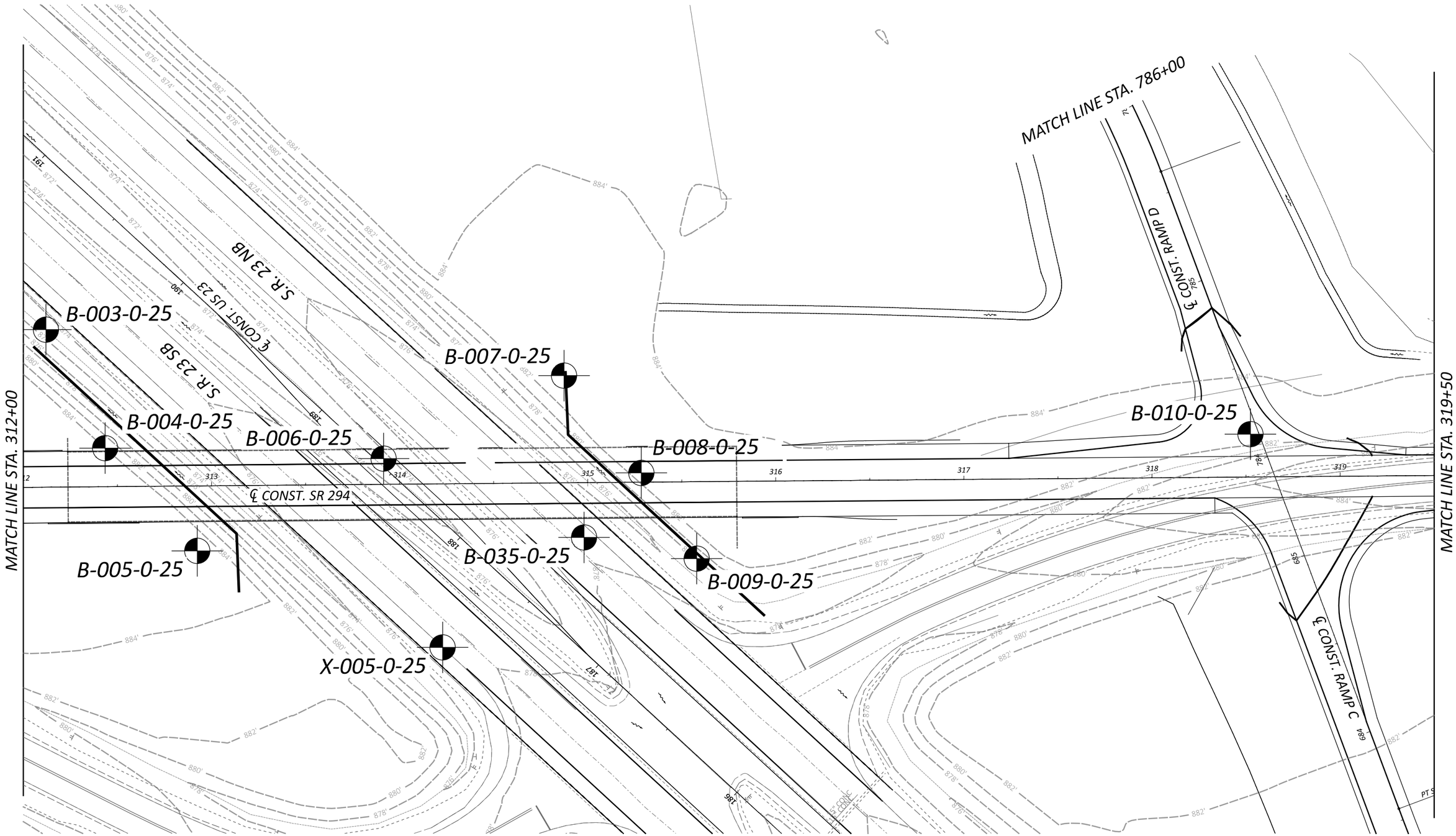
MATCH LINE STA. 491+00, SHEET 14

MATCH LINE STA. 312+00

BORING PLAN, SHEET 1
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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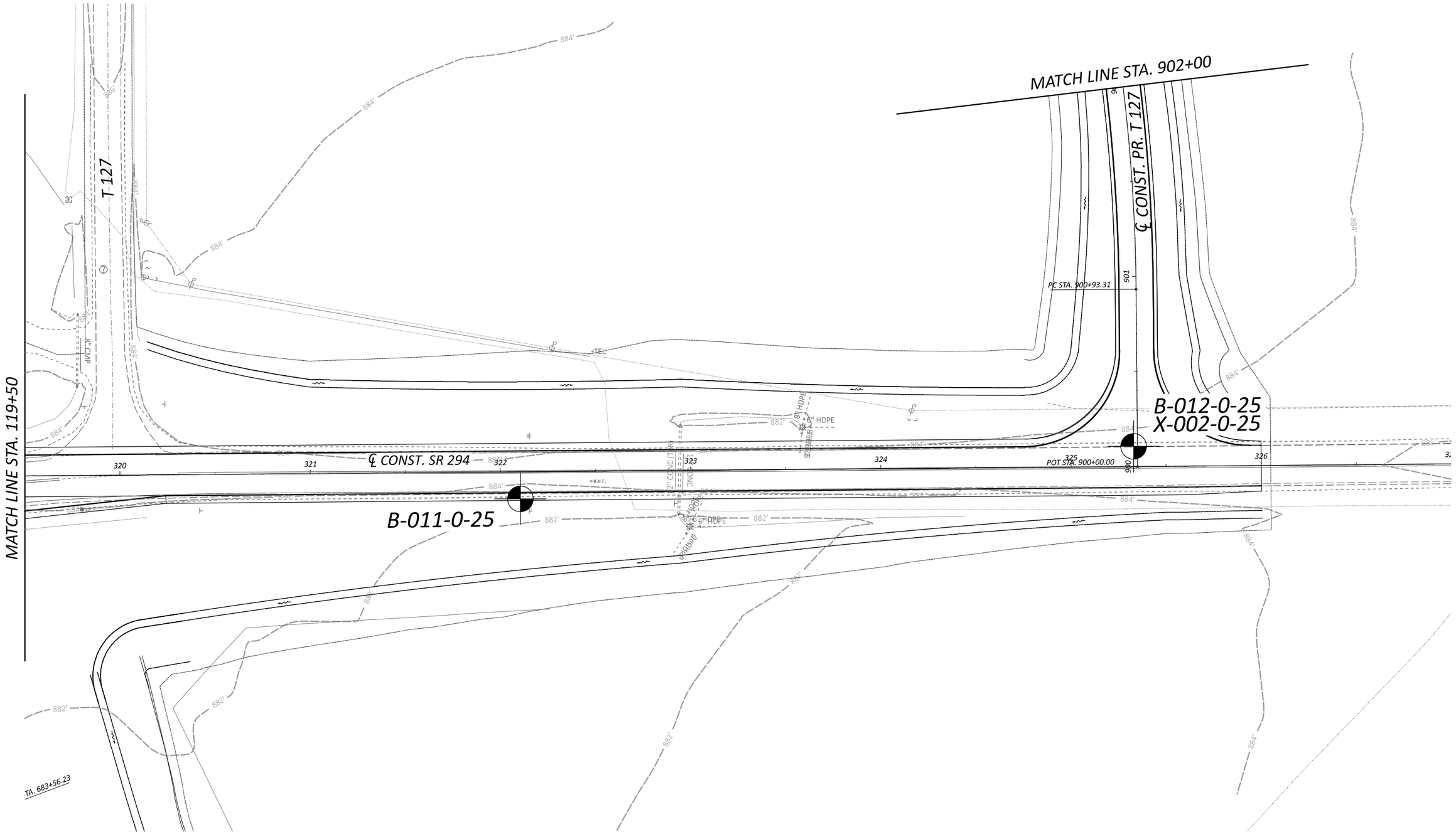
RESOURCE INTERNATIONAL Rii



BORING PLAN, SHEET 2
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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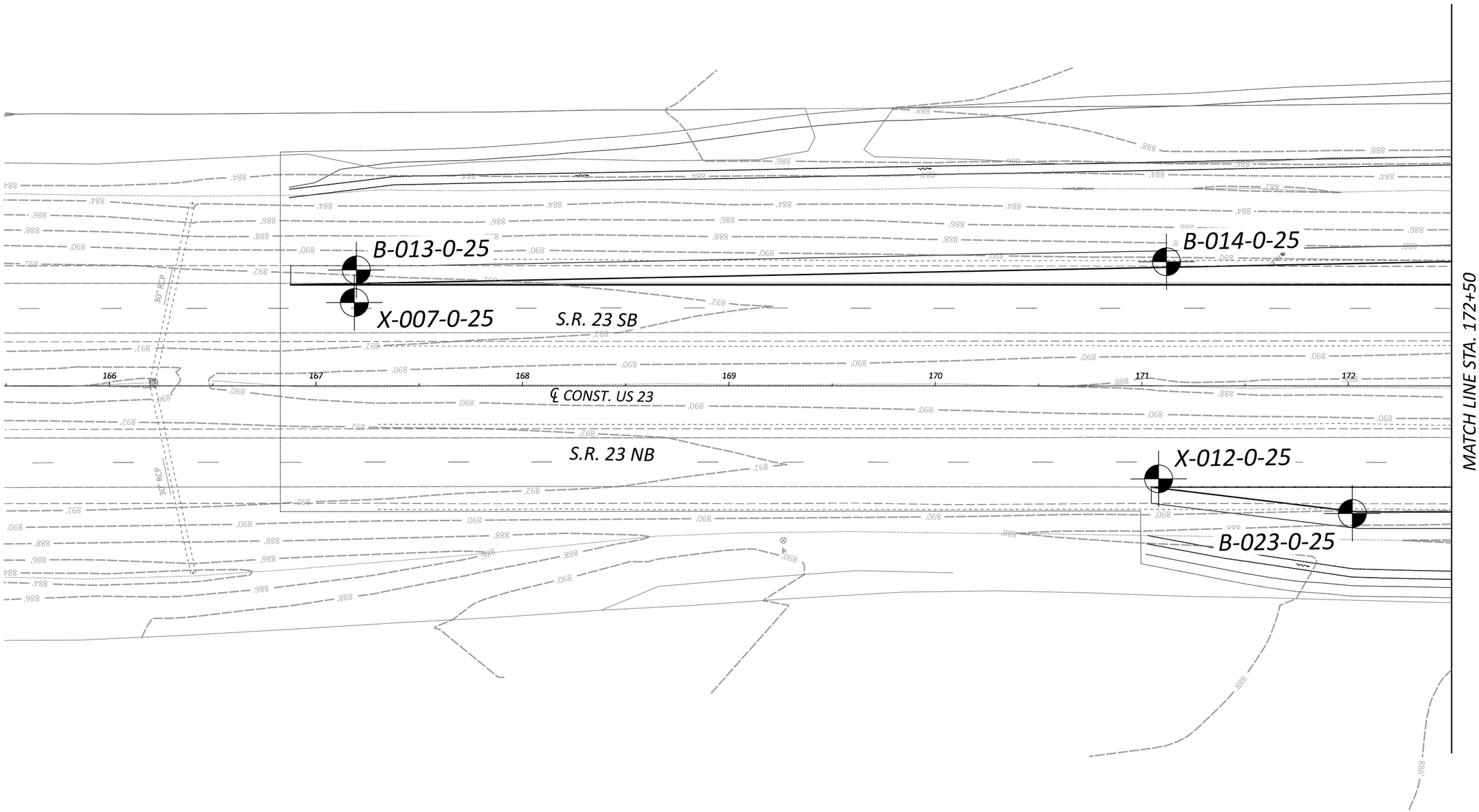
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BORING PLAN, SHEET 3
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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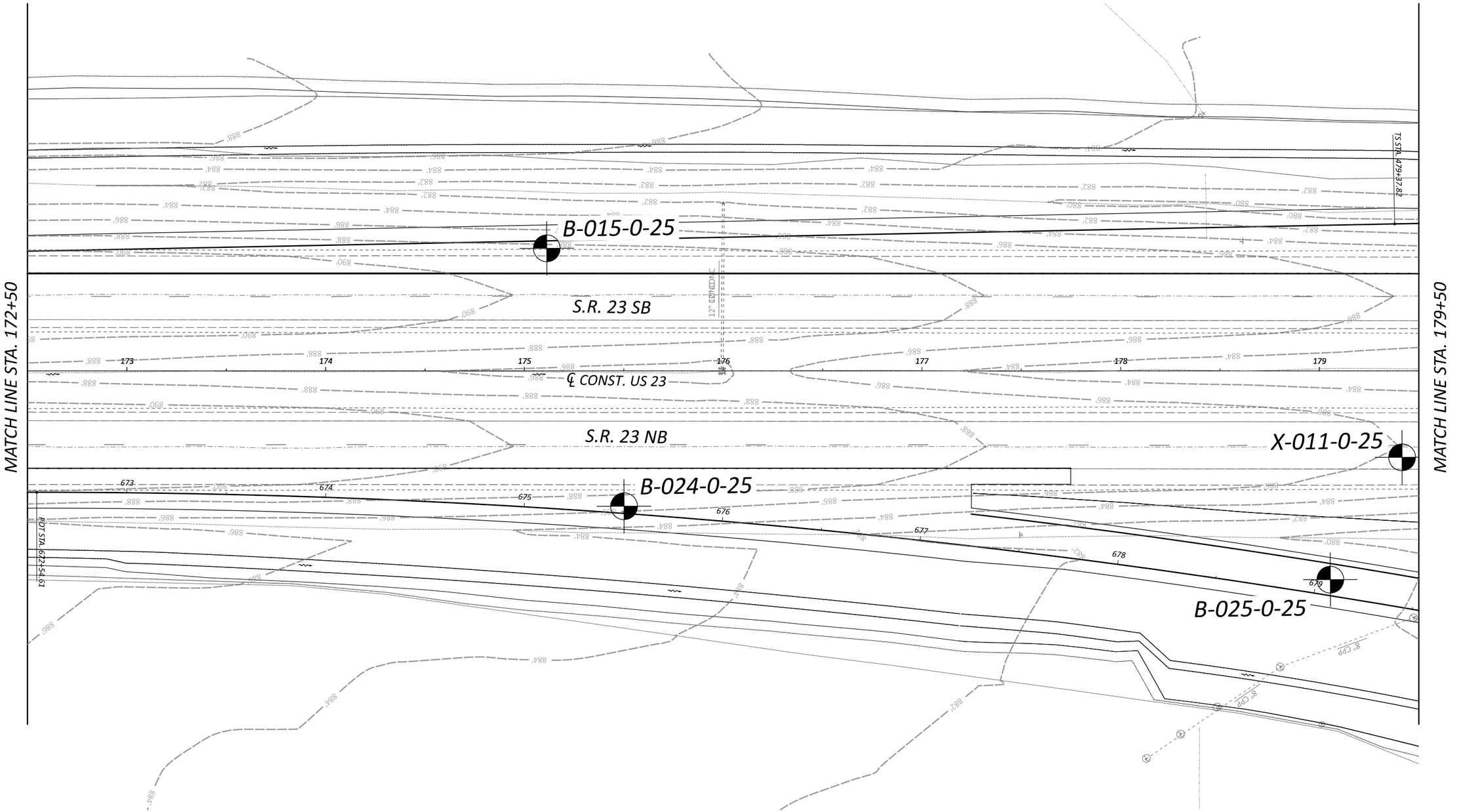
RESOURCE INTERNATIONAL



BORING PLAN, SHEET 4
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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		DATE 7/7/2025

RESOURCE INTERNATIONAL Rii



BORING PLAN, SHEET 5
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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		DATE 7/7/2025

RESOURCE INTERNATIONAL Rii

MATCH LINE STA. 484+50, SHEET 14

MATCH LINE STA. 179+50

MATCH LINE STA. 186+50

B-017-0-25

B-016-0-25

X-006-0-25

B-034-0-25

B-026-0-25

S.R. 23 SB

℄ CONST. US 23

S.R. 23 NB

℄ CONST. RAMP C

SC STA. 481+47.82

PCC STA. 681+07.18

42" CONC

15" CONC

12" CPP

18" CMP

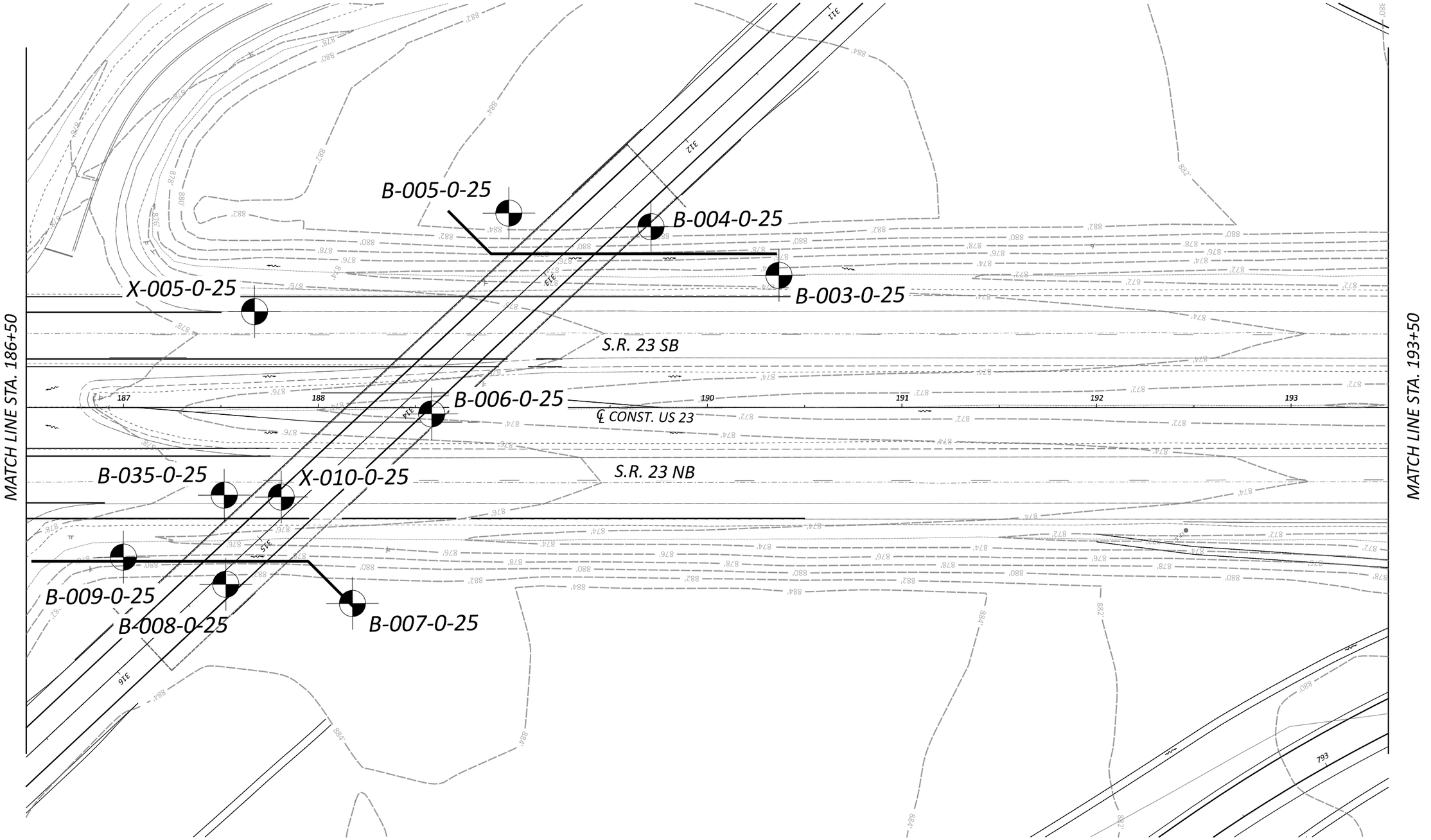
6" DWMP

SEE SHEET 2

BORING PLAN, SHEET 6
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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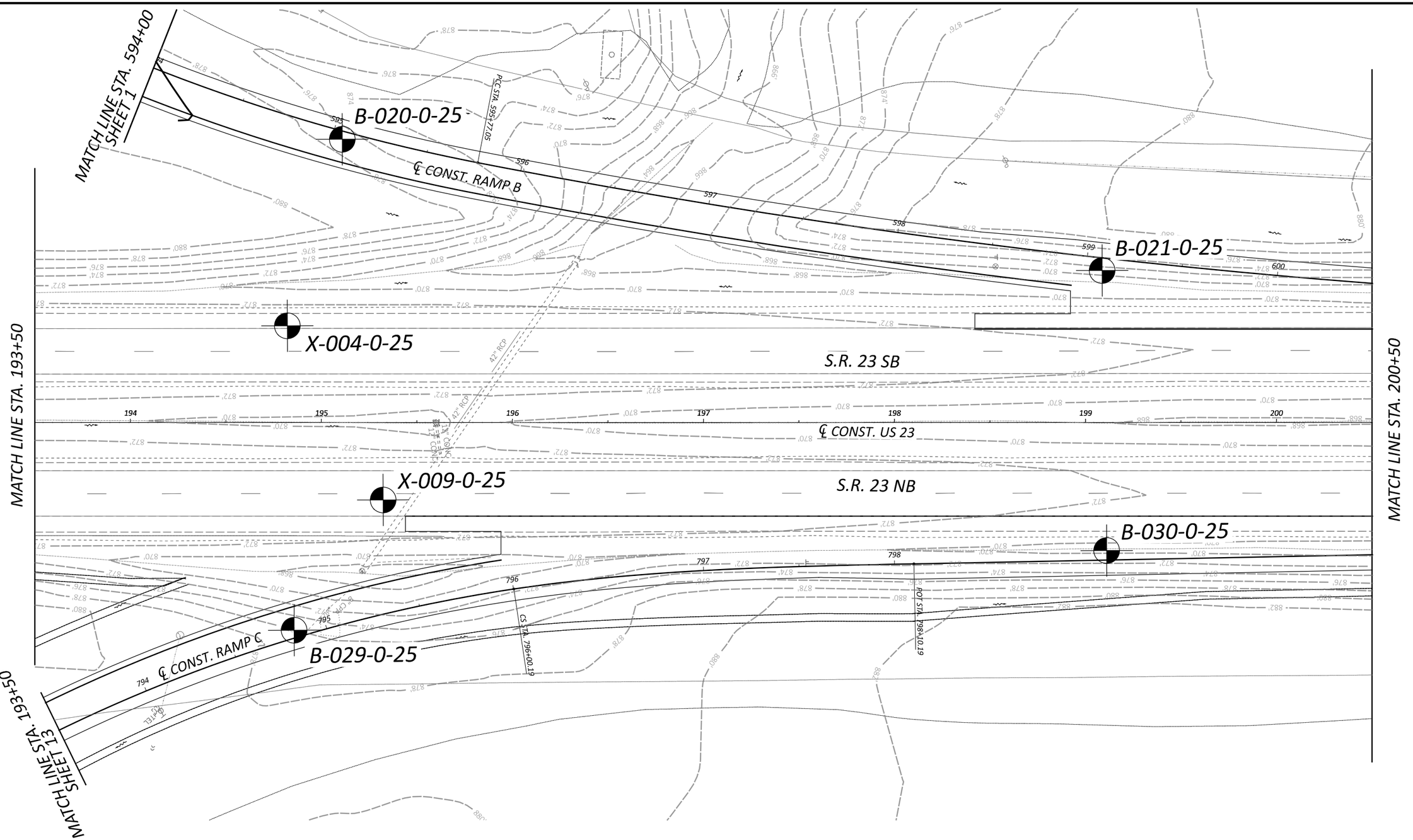
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BORING PLAN, SHEET 7
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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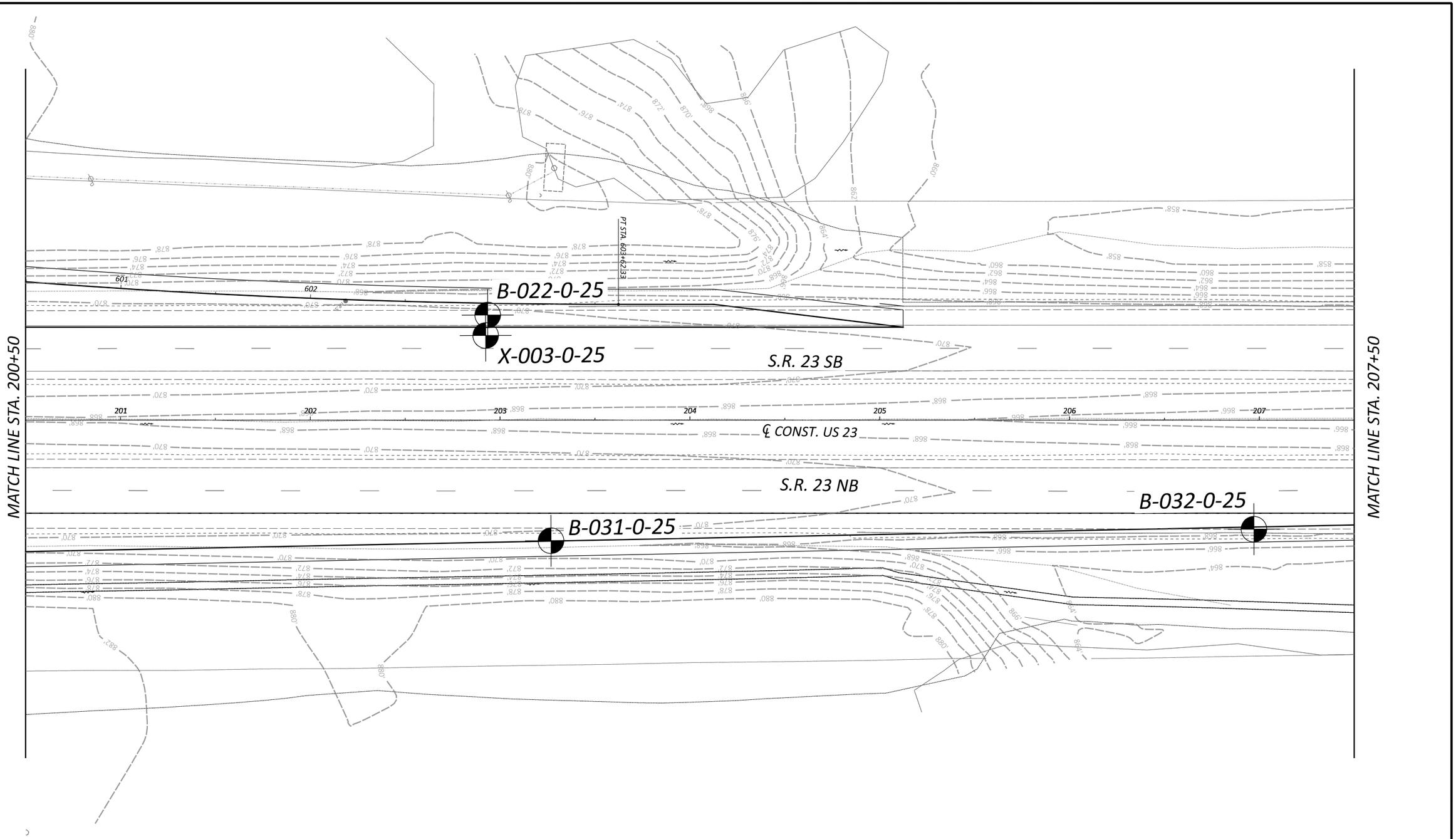
RESOURCE INTERNATIONAL Rii



BORING PLAN, SHEET 8
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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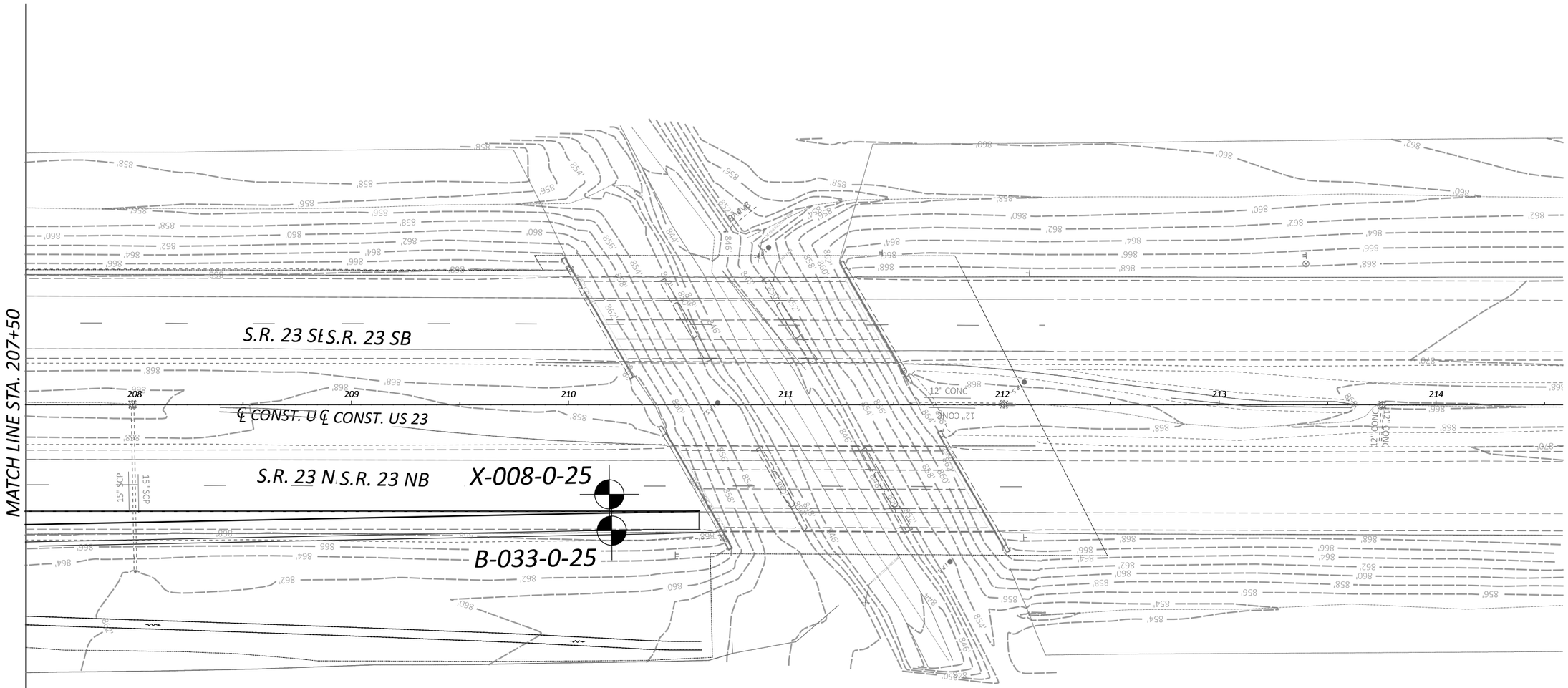
RESOURCE INTERNATIONAL



BORING PLAN, SHEET 9
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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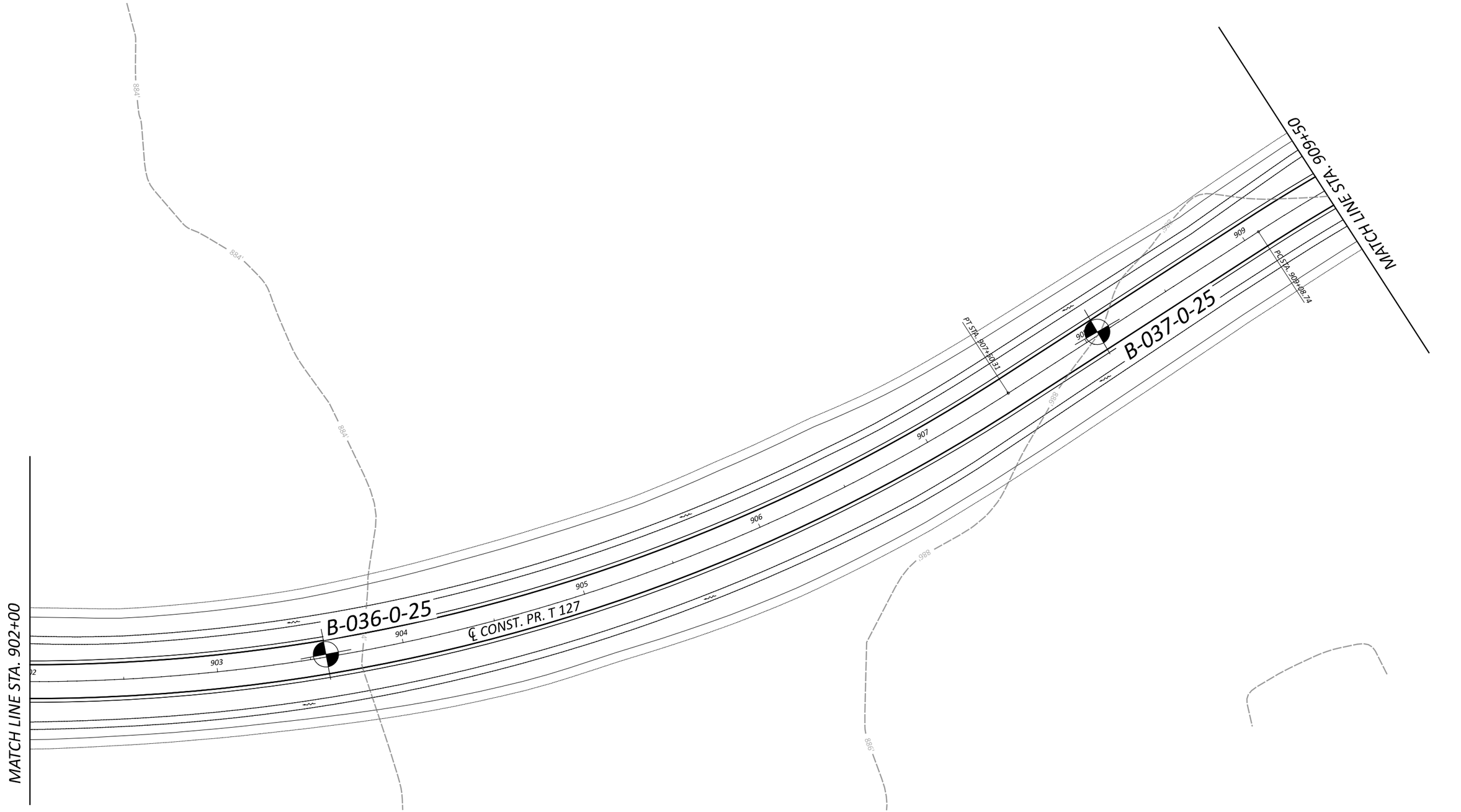
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BORING PLAN, SHEET 10
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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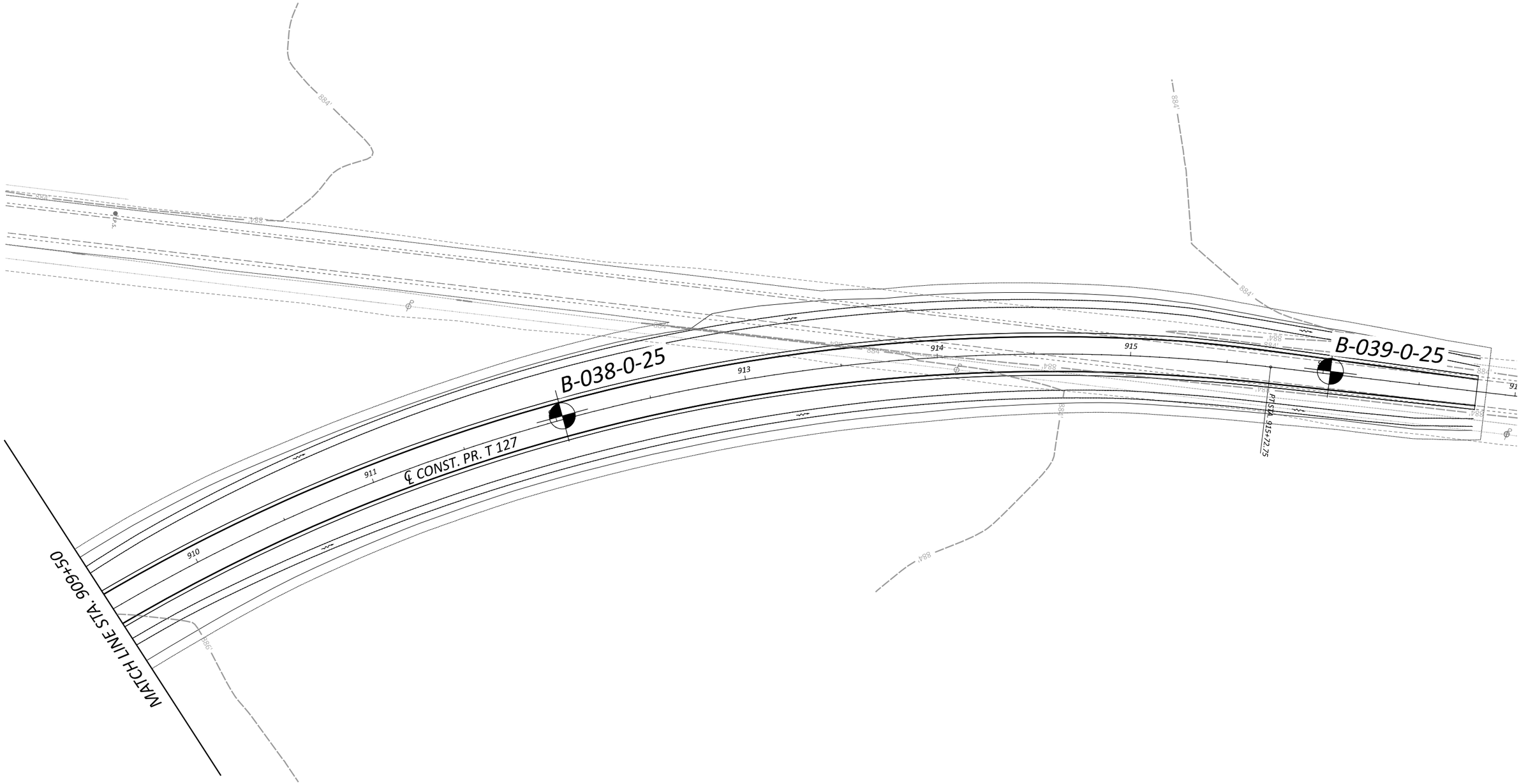
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BORING PLAN, SHEET 11
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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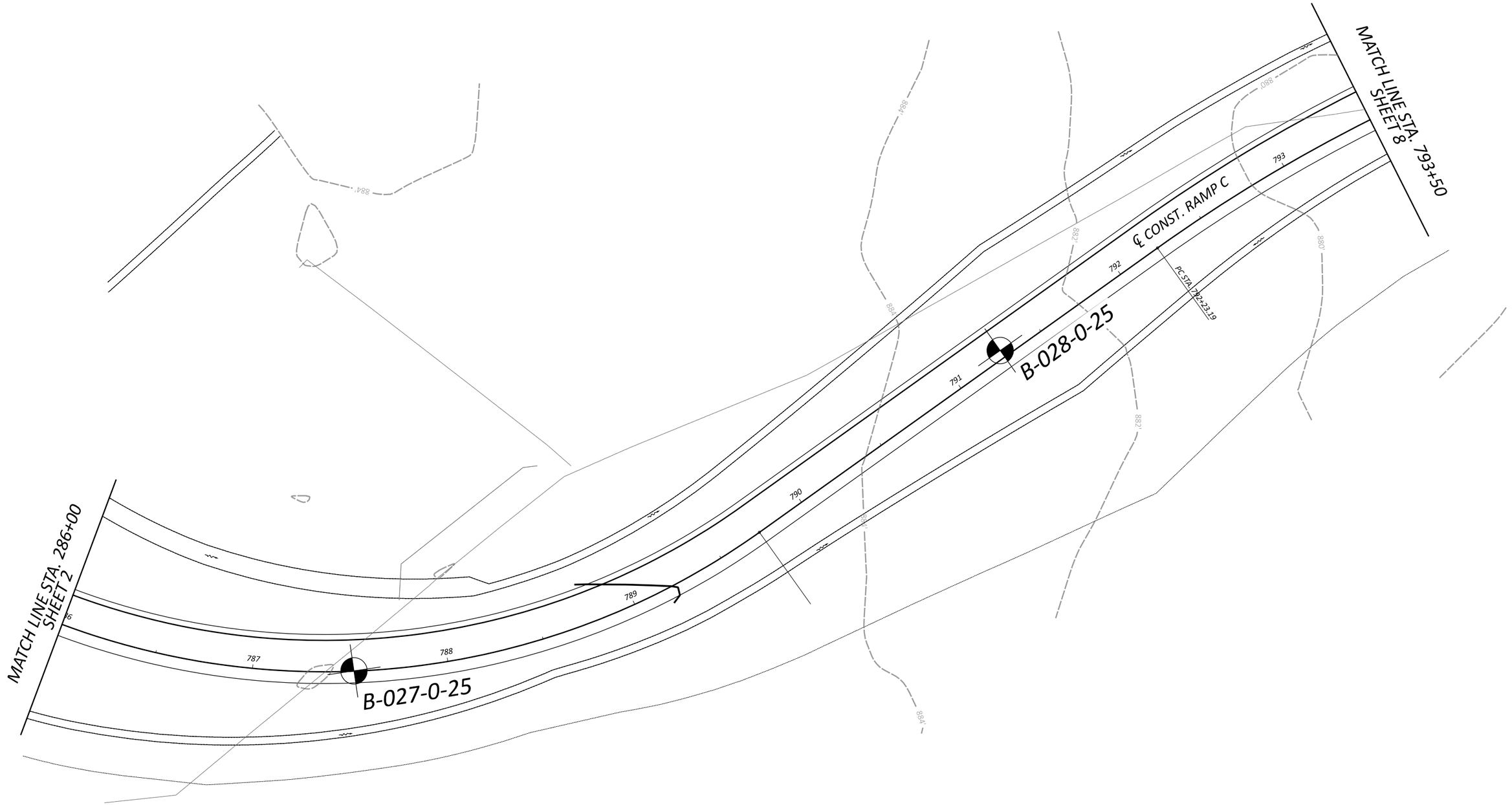
RESOURCE INTERNATIONAL Rii



BORING PLAN, SHEET 12
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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RESOURCE INTERNATIONAL Rii



BORING PLAN, SHEET 13
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

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RESOURCE INTERNATIONAL Rii



BORING PLAN, SHEET 14
WAY-023-3.47 INTERCHANGE IMPROVEMENTS
WYANDOT COUNTY, OHIO

RII PROJECT NO. W-25-026		DRAWN JAS	RESOURCE INTERNATIONAL Rii
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		DATE 7/7/2025	

APPENDIX II

SCHEDULE OF BORINGS

Schedule of Borings
WYA-23-3.47 Interchange Improvements
ODOT PID No. 121424
Wyandot County, Ohio
Rii Project No. W-25-026

Boring/Pavement Core No.	Station [1]	Offset [1]	Alignment [1]	Longitude	Latitude	Surface Elevation (feet) [1]	Pavement Core	Boring Depth (feet)
B-001-0-25/ X-001-0-25	304+79	0' CL	SR 294	40.738560	-83.212871	873.3	X	7.5
B-002-0-25	309+35	16' LT	SR 294	40.738593	-83.211224	884.0	-	15.0
B-003-0-25	312+13	84' LT	SR 294	40.738765	-83.210234	873.0	-	28.4
B-004-0-25	312+46	23' LT	SR 294	40.738622	-83.210106	884.0	-	63.3
B-005-0-25	312+93	35' RT	SR 294	40.738463	-83.209935	885.0	-	40.0
B-006-0-25	313+92	14' LT	SR 294	40.738599	-83.209581	873.3	-	45.0
B-007-0-25	314+89	56' LT	SR 294	40.738718	-83.209231	883.3	-	38.5
B-008-0-25	315+30	4' LT	SR 294	40.738576	-83.209083	883.1	-	55.2
B-009-0-25	315+48	43' RT	SR 294	40.738451	-83.208977	877.3	-	27.5
B-010-0-25	318+52	23' LT	SR 294	40.738632	-83.207914	882.5	-	20.0
B-011-0-25	322+11	14' RT	SR 294	40.738537	-83.206622	883.1	-	10.0
B-012-0-25/ X-002-0-25	325+33	11' LT	SR 294	40.738612	-83.205459	885.6	X	10.0
B-013-0-25	167+20	56' LT	US 23	40.734497	-83.204051	891.4	-	7.5
B-014-0-25	171+12	60' LT	US 23	40.735219	-83.205101	888.3	-	10.0
B-015-0-25	175+11	62' LT	US 23	40.735959	-83.206164	888.5	-	10.0
B-016-0-25	180+12	59' LT	US 23	40.736896	-83.207487	885.2	-	15.0
B-017-0-25	483+48	10' RT	CL RAMP A	40.737358	-83.208549	875.7	-	15.0
B-018-0-25	488+22	6' RT	CL RAMP A	40.737576	-83.210232	874.1	-	10.0
B-019-0-25	490+83	7' RT	CL RAMP A	40.738049	-83.210879	882.2	-	10.0
B-020-0-25	595+05	4' RT	CL RAMP B	40.739506	-83.211679	877.0	-	10.0
B-021-0-25	599+09	7' RT	CL RAMP B	40.740385	-83.212566	871.1	-	15.0
B-022-0-25	602+93	6' RT	CL RAMP B	40.741150	-83.213527	870.5	-	7.5
B-023-0-25	172+02	62' RT	US 23	40.735632	-83.205042	889.9	-	10.0
B-024-0-25	175+50	68' RT	US 23	40.736293	-83.205950	886.6	-	10.0
B-025-0-25	679+07	8' LT	CL RAMP C	40.737029	-83.206801	880.6	-	10.0
B-026-0-25	682+43	8' LT	CL RAMP C	40.737915	-83.207569	880.4	-	20.0
B-027-0-25	787+52	0' LT	CL RAMP D	40.739439	-83.208472	884.9	-	20.0
B-028-0-25	791+27	4' LT	CL RAMP D	40.739734	-83.209742	883.1	-	20.0
B-029-0-25	794+83	4' LT	CL RAMP D	40.739978	-83.210983	876.0	-	10.0
B-030-0-25	199+11	67' RT	US 23	40.740685	-83.212213	869.8	-	10.0
B-031-0-25	203+27	63' RT	US 23	40.741452	-83.213325	869.1	-	10.0
B-032-0-25	206+97	57' RT	US 23	40.742129	-83.214322	868.2	-	10.0
B-033-0-25	210+20	58' RT	US 23	40.742731	-83.215177	868.1	-	10.0

Schedule of Borings
WYA-23-3.47 Interchange Improvements
ODOT PID No. 121424
Wyandot County, Ohio
Rii Project No. W-25-026

Boring/Pavement Core No.	Station [1]	Offset [1]	Alignment [1]	Longitude	Latitude	Surface Elevation (feet) [1]	Pavement Core	Boring Depth (feet)
B-034-0-25	185+48	44' LT	US 23	40.737924	-83.208872	879.9	-	9.0
B-035-0-25	187+52	45' RT	US 23	40.738482	-83.209193	877.8	-	8.0
B-036-0-25	903+59	2' LT	CL PR T 127	40.739556	-83.205597	883.9	-	10.0
B-037-0-25	908+08	2' LT	CL PR T 127	40.740619	-83.206387	886.0	-	10.0
B-038-0-25	912+03	2' LT	CL PR T 127	40.741525	-83.207164	885.0	-	10.0
B-039-0-25	916+04	1' LT	CL PR T 127	40.742601	-83.207416	884.5	-	10.0
X-003-0-25	202+93	45' LT	US 23	40.741170	-83.213498	870.5	X	-
X-004-0-25	194+82	51' LT	US 23	40.739650	-83.211364	873.4	X	-
X-005-0-25	187+67	49' LT	US 23	40.738325	-83.209460	877.8	X	-
X-006-0-25	180+08	47' LT	US 23	40.736915	-83.207445	885.2	X	-
X-007-0-25	167+19	40' LT	US 23	40.734527	-83.204010	891.7	X	-
X-008-0-25	210+19	41' RT	US 23	40.742695	-83.215215	868.9	X	-
X-009-0-25	195+36	42' RT	US 23	40.739927	-83.211274	874.2	X	-
X-010-0-25	187+82	47' RT	US 23	40.738539	-83.209266	877.6	X	-
X-011-0-25	179+41	43' RT	US 23	40.736972	-83.207048	885.9	X	-
X-012-0-25	171+08	45' RT	US 23	40.735424	-83.204834	891.2	X	-

1. Station, offset and surface elevations were determined from basemapping provided by E.L. Robinson.

APPENDIX III

DESCRIPTION OF SOIL AND ROCK TERMS

CLASSIFICATION OF SOILS

Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart.
The first classification that the test data fits is the correct classification.)

SYMBOL	DESCRIPTION	Classifcation		LL_O/LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
		AASHTO	OHIO							
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	76 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	76 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		76 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	76 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	76 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		76 Min.		36 Min.	41 Min.	$\leq$LL-30	20	
	Clay	A-7-6		76 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	75 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	75 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6

MATERIAL CLASSIFIED BY VISUAL INSPECTION

 Sod and Topsoil

 Pavement or Base

 Uncontrolled Fill (Describe)

 Bouldery Zone



Peat

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

DESCRIPTION OF SOIL TERMS

The following terminology was used to describe soils throughout this report and is generally adapted from ASTM 2487/2488 and ODOT Specifications for Geotechnical Explorations.

Granular Soils - The relative compactness of granular soils is described as:
ODOT A-1, A-2, A-3, A-4 (non-plastic) or USCS GW, GP, GM, GC, SW, SP, SM, SC, ML (non-plastic)

Description	Blows per foot – SPT (N_{60})		
Very Loose	Below		5
Loose	5	-	10
Medium Dense	11	-	30
Dense	31	-	50
Very Dense	Over		50

Cohesive Soils - The relative consistency of cohesive soils is described as:
ODOT A-4, A-5, A-6, A-7, A-8 or USCS ML, CL, OL, MH, CH, OH, PT

Description	Unconfined Compression (tsf)		
Very Soft	Less than		0.25
Soft	0.25	-	0.5
Medium Stiff	0.5	-	1.0
Stiff	1.0	-	2.0
Very Stiff	2.0	-	4.0
Hard	Over		4.0

Gradation - The following size-related denominations are used to describe soils:

Soil Fraction		USCS Size	ODOT Size
Boulders		Larger than 12”	Larger than 12”
Cobbles		12” to 3”	12” to 3”
Gravel	coarse	3” to ¾”	3” to ¾“
	fine	¾” to 4.75 mm (¾” to #4 Sieve)	¾” to 2.0 mm (¾” to #10 Sieve)
Sand	coarse	4.75 mm to 2.0 mm (#4 to #10 Sieve)	2.0 mm to 0.42 mm (#10 to #40 Sieve)
	medium	2.0 mm to 0.42 mm (#10 to #40 Sieve)	-
	fine	0.42 mm to 0.074 mm (#40 to #200 Sieve)	0.42 mm to 0.074 mm (#40 to #200 Sieve)
Silt		0.074 mm to 0.005 mm (#200 to 0.005 mm)	0.074 mm to 0.005 mm (#200 to 0.005 mm)
Clay		Smaller than 0.005 mm	Smaller than 0.005 mm

Modifiers of Components - Modifiers of components are as follows:

Term	Range		
Trace	0%	-	10%
Little	10%	-	20%
Some	20%	-	35%
And	35%	-	50%

Moisture Table - The following moisture-related denominations are used to describe cohesive soils:

Term	Range - USCS	Range - ODOT
Dry	0% to 10%	Well below Plastic Limit
Damp	>2% below Plastic Limit	Below Plastic Limit
Moist	2% below to 2% above Plastic Limit	Above PL to 3% below LL
Very Moist	>2% above Plastic Limit	
Wet	≥ Liquid Limit	3% below LL to above LL

Organic Content – The following terms are used to describe organic soils:

Term	Organic Content (%)
Slightly organic	2-4
Moderately organic	4-10
Highly organic	>10

Bedrock – The following terms are used to describe the relative strength of bedrock:

Description	Field Parameter
Very Weak	Can be carved with knife and scratched by fingernail. Pieces 1 in. thick can be broken by finger pressure.
Weak	Can be grooved or gouged with knife readily. Small, thin pieces can be broken by finger pressure.
Slightly Strong	Can be grooved or gouged 0.05 in deep with knife. 1 in. size pieces from hard blows of geologist hammer.
Moderately Strong	Can be scratched with knife or pick. 1/4 in. size grooves or gouges from blows of geologist hammer.
Strong	Can be scratched with knife or pick with difficulty. Hard hammer blows to detach hand specimen.
Very Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to detach hand specimen.
Extremely Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to chip hand specimen.

DESCRIPTION OF ROCK TERMS

The following terminology was used to describe the rock throughout this report and is generally adapted from ASTM D5878 and the ODOT Specifications for Geotechnical Explorations.

Weathering – Describes the degree of weathering of the rock mass:

Description	Field Parameter
Unweathered	No evidence of any chemical or mechanical alteration of the rock mass. Mineral crystals have a right appearance with no discoloration. Fractures show little or not staining on surfaces.
Slightly Weathered	Slight discoloration of the rock surface with minor alterations along discontinuities. Less than 10% of the rock volume presents alteration.
Moderately Weathered	Portions of the rock mass are discolored as evident by a dull appearance. Surfaces may have a pitted appearance with weathering "halos" evident. Isolated zones of varying rock strengths due to alteration may be present. 10 to 15% of the rock volume presents alterations.
Highly Weathered	Entire rock mass appears discolored and dull. Some pockets of slightly to moderately weathered rock may be present and some areas of severely weathered materials may be present.
Severely Weathered	Majority of the rock mass reduced to a soil-like state with relic rock structure discernable. Zones of more resistant rock may be present but the material can generally be molded and crumbled by hand pressures.

Strength of Bedrock – The following terms are used to describe the relative strength of bedrock:

Description	Field Parameter
Very Weak	Can be carved with knife and scratched by fingernail. Pieces 1 in. thick can be broken by finger pressure.
Weak	Can be grooved or gouged with knife readily. Small, thin pieces can be broken by finger pressure.
Slightly Strong	Can be grooved or gouged 0.05 in deep with knife. 1 in. size pieces from hard blows of geologist hammer.
Moderately Strong	Can be scratched with knife or pick. 1/4 in. size grooves or gouges from blows of geologist hammer.
Strong	Can be scratched with knife or pick with difficulty. Hard hammer blows to detach hand specimen.
Very Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to detach hand specimen.
Extremely Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to chip hand specimen.

Bedding Thickness – Description of bedding thickness as the average perpendicular distances between bedding surfaces:

Description	Thickness
Very Thick	Greater than 36 inches
Thick	18 to 36 inches
Medium	10 to 18 inches
Thin	2 to 10 inches
Very Thin	0.4 to 2 inches
Laminated	0.1 to 0.4 inches
Thinly Laminated	Less than 0.1 inches

Fracturing – Describes the degree and condition of fracturing (fault, joint, or shear):

Degree of Fracturing

Description	Spacing
Unfractured	Greater than 10 feet
Intact	3 to 10 feet
Slightly Fractured	1 to 3 feet
Moderately Fractured	

Aperture Width

Description	Width
Open	Greater than 0.2 inches
Narrow	0.05 to 0.2 inches
Tight	Less than 0.05 inches

Surface Roughness

Description	Criteria
Very Rough	Near vertical steps and ridges occur on surface
Slightly Rough	Asperities on the surfaces distinguishable
Slickensided	Surface has smooth, glassy finish, evidence of Striations

RQD – Rock Quality Designation (calculation shown in report) and Rock Quality (ODOT, GB 3, January 13, 2006):

RQD %	Rock Index Property Classification (based on RQD, not slake durability index)
0 – 25%	Very Poor
26 – 50%	Poor
51 – 70%	Fair
71 – 85%	Good
86 – 100%	Very Good

APPENDIX IV

BORING LOGS: B-001-0-25 THROUGH B-039-0-25

ROCK CORE PHOTOGRAPHS

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 304+79 / CL	**EXPLORATION ID B-001-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 873.3 (ft) EOB: 7.5 ft.	PAGE 1 OF 1
START: 5/20/25 END: 5/20/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.738560, -83.212871	

MATERIAL DESCRIPTION AND NOTES	ELEV. 873.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.6' - ASPHALT (7.5")	872.7																	
0.4' - AGGREGATE BASE (5.0")	872.3																	
FILL: VERY STIFF, BROWNISH GRAY **CLAY**, SOME SILT, LITTLE FINE GRAVEL, LITTLE COARSE TO FINE SAND, MOIST.	870.3	1	13 6 7	18	44	SS-1	4.00	14	2	8	33	43	42	17	25	18	A-7-6 (14)	
FILL: VERY DENSE, DARK BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, DAMP. -ASPHALT FRAGMENTS PRESENT IN SS-2	868.8	2 3 4	4 19 25	62	53	SS-2	-	57	20	7	9	7	NP	NP	NP	6	A-1-b (0)	
MEDIUM DENSE, BROWN **SANDY SILT**, LITTLE CLAY, MOIST.	865.8	5 6 7	11 7 5	17	72	SS-3	-	-	-	-	-	-	-	-	-	14	A-4a (V)	
		EOB	6 6 7	18	72	SS-4	-	-	-	-	-	-	-	-	-	24	A-4a (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 3.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 309+35 / 16' LT.	**EXPLORATION ID B-002-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / ET	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 884.0 (ft) EOB: 15.0 ft.	PAGE 1 OF 1
START: 5/28/25 END: 5/28/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738593, -83.211224	

MATERIAL DESCRIPTION AND NOTES	ELEV. 884.0	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
1.0' - TOPSOIL (12.0")	883.0																	
STIFF TO HARD, BROWN **SILT AND CLAY**, SOME TO LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		1																
		2	3 4 5	13	56	SS-1	3.50	-	-	-	-	-	-	-	-	21	A-6a (V)	
		3																
		4																
		5	5 9 12	31	100	SS-2	4.50	5	9	17	36	33	26	15	11	14	A-6a (7)	
		6																
		7	7 9 13	32	67	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	
		8																
		9	7 10 13	34	100	SS-4	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
		10																
		11 ▽ 872.7																
		12	9 13 18	45	100	SS-5	4.50	3	5	12	41	39	27	16	11	14	A-6a (8)	
		13																
		14 W 869.7																
	869.0		3 6 9	22	83	SS-6	1.25	-	-	-	-	-	-	-	-	24	A-6a (V)	
		15 EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 14.34'. GROUNDWATER UPON COMPLETION @ 11.3'. CAVE-IN DEPTH @ 3.6'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 312+13 / 84' LT.	**EXPLORATION ID B-003-0-25**
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 873.0 (ft) EOB: 28.4 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738765, -83.210234	

MATERIAL DESCRIPTION AND NOTES	ELEV. 873.0	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
VERY STIFF, BROWNISH GRAY **SILTY CLAY**, TRACE COARSE TO FINE SAND, MOIST.	870.0	1	1 4 5	13	72	SS-1	4.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
MEDIUM DENSE, BROWNISH GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, WET.		4	3 4 5	13	33	SS-2	-	-	-	-	-	-	-	-	-	18	A-2-4 (V)	
- @6.0': SLIGHTLY ORGANIC (LOI = 3.4%)	865.0	7	6 6 9	22	50	SS-3	-	21	8	39	25	7	NP	NP	NP	30	A-2-4 (0)	
VERY STIFF TO HARD, BROWNISH GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE COARSE TO FINE GRAVEL, MOIST.		10	6 6 6	18	78	SS-4	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
		12			0	ST-5	-	-	-	-	-	-	-	-	-	-	A-6a (V)	
	852.0	14	9 11 13	35	33	SS-6	3.50	15	11	19	31	24	24	13	11	15	A-6a (4)	
MEDIUM DENSE TO DENSE, BROWNISH GRAY **SANDY SILT**, TRACE CLAY, MOIST.		17	7 8 9	25	56	SS-7	4.5+	-	-	-	-	-	24	13	11	12	A-6a (V)	
		19	5 8 13	31	33	SS-8	-	-	-	-	-	-	-	-	-	18	A-6a (V)	
	847.0	22	5 8 10	26	0	SS-9	-	-	-	-	-	-	-	-	-	-		
		23	15	-	75	2S-9A	-	-	-	-	-	-	-	-	-	14	A-4a (V)	
		24	10 15 17	47	72	SS-10	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
COBBLE AND BOULDERS		26	50/3"	-	67	SS-11	-	-	-	-	-	-	-	-	-	14	Rock (V)	
AUGER REFUSAL @ 28.4'	844.6	EOB 28																

NOTES: GROUNDWATER COULD NOT BE RECORDED DUE TO THE INFLUENCE OF SURFACE WATER FLOW FROM DRAINAGE DITCH TO BOREHOLE. CAVE-IN DEPTH @ 10.1'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 312+46 / 23' LT.	**EXPLORATION ID B-004-0-25**
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: 8803902	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 3/25/24	ELEVATION: 884.0 (ft) EOB: 63.2 ft.	PAGE 1 OF 3
START: 5/27/25 END: 5/28/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738622, -83.210106	

MATERIAL DESCRIPTION AND NOTES	ELEV. 884.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
1.1' - TOPSOIL (13.0")	882.9																	
VERY STIFF TO HARD, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		1	2 3 4	10	67	SS-1	3.50	-	-	-	-	-	-	-	-	21	A-6a (V)	
		2																
		3																
		4	6 7 12	28	89	SS-2	4.00	-	-	-	-	-	-	-	-	12	A-6a (V)	
		5																
		6	5 7 8	22	100	SS-3	4.00	-	-	-	-	-	-	-	-	14	A-6a (V)	
		7																
		8																
- QU @ 9.0'-9.5' = 3.19 tsf @ 2.69% Strain		9			94	ST-4	4.5+	2	7	14	39	38	29	17	12	15	A-6a (9)	
		10																
		11	8 9 10	28	100	SS-5	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
	871.0	12																
VERY STIFF, BROWN **SILT**, LITTLE COARSE TO FINE SAND, SOME CLAY, MOIST.		13																
		14	4 5 5	15	89	SS-6	2.50	-	-	-	-	-	-	-	-	19	A-4b (V)	
		15																
W 868.0		16																
		17	4 2 3	7	83	SS-7	2.50	0	1	15	56	28	22	15	7	20	A-4b (8)	
	866.0	18																
VERY STIFF, BROWNISH GRAY **SANDY SILT**, LITTLE CLAY, MOIST.		19	3 3 3	9	94	SS-8	3.00	-	-	-	-	-	-	-	-	18	A-4a (V)	
		20																
		21																
- QU @ 21.0'-21.5' = 3.15 tsf @ 7.35 % Strain (Lab test was performed on sample from offset boring)		22	2 3 2	7	72	SS-9	3.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		23																
		24	6 6 7	19	83	SS-10	3.00	-	-	-	-	-	-	-	-	11	A-4a (V)	
		25																
		26																
		27	10 13 16	42	39	SS-11	2.25	17	8	16	36	23	20	14	6	15	A-4a (5)	
	856.0	28																
MEDIUM DENSE, BROWNISH GRAY **SILT**, LITTLE COARSE TO FINE SAND, TRACE CLAY, MOIST.		29	5 6 8	21	67	SS-12	-	-	-	-	-	-	-	-	-	12	A-4b (V)	

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

PID: 121424	SFN: NA	PROJECT: WYA-23-3.47	STATION / OFFSET: 31246, 23' LT.	START: 5/27/25	END: 5/28/25	PG 2 OF 3	B-004-0-25

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE, BROWNISH GRAY **SILT**, LITTLE COARSE TO FINE SAND, TRACE CLAY, MOIST. *(continued)*	854.0	31																
	852.0	32																
HARD, BROWNISH GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP.		33																
		34	7 9 10	28	94	SS-13	4.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
	847.0	35																
MEDIUM DENSE, GRAYISH BROWN **SILT**, LITTLE CLAY, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, WET.		36																
		37																
		38																
		39	7 8 8	23	50	SS-14	-	5	7	10	60	18	18	16	2	19	A-4b (8)	
	842.0	40																
VERY DENSE, BROWNISH GRAY **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP TO MOIST.		41																
		42																
		43																
		44	16 16 19	51	89	SS-15	-	-	-	-	-	-	-	-	-	12	A-4a (V)	
	836.5	45																
		46																
		47																
DOLOMITE : BROWN. AUGER REFUSAL AT 49.6'		TR 48	50/2"	-	100	SS-16	4.5+	-	-	-	-	-	-	-	-	-	Rock (V)	
	834.4	49																
DOLOMITE : GRAY TO BROWN, SLIGHTLY WEATHERED, MODERATELY STRONG TO VERY STRONG, THIN BEDDED, ARGILLACEOUS PARTINGS.		50																
		51	0		78	NQ-1											CORE	
		52																
		53																
		54																
-QU @ 54.7' = 13,753 PSI @ 4.77 % Strain		55																
		56	24		100	NQ-2											CORE	
		57																
		58																
		59																
		60																
		61	19		77	NQ-3											CORE	

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

PID: 121424	SFN: NA	PROJECT: WYA-23-3.47	STATION / OFFSET: 31246, 23' LT.	START: 5/27/25	END: 5/28/25	PG 3 OF 3	B-004-0-25

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
								GR	CS	FS	SI	CL	LL	PL	PI			
	821.9																	
	820.8	EOB 63																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 16.0'. GROUNDWATER COULD NOT BE RECORDED DUE TO THE INFLUENCE OF WASH WATER ADDED DURING ROCK CORING. CAVE-IN DEPTH @ 30.1'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: GROUTED WITH A MIXTURE OF CEMENT AND BENTONITE POWDER.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

Project Name: WYA-23-3.47 Interchange Improvements	**Location:** Wyandot County, Ohio	**Project No.:** RII. W-25-026

Photo No. 1 of 2	
Boring: B-004-0-25	
RC-1: 49.6' to 53.2' REC (%):78 RQD (%)0	
RC-2: 53.2' to 58.2' REC (%):100 RQD (%):24	

Project Name: WYA-23-3.47 Interchange Improvements	**Location:** Wyandot County, Ohio	**Project No.:** RII. W-25-026

Photo No. 2 of 2	
Boring: B-004-0-25	
RC-4: 58.2' to 63.2' REC (%):77 RQD (%):19	

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 312+46 / 27' LT.	**EXPLORATION ID B-004-1-25**
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: 8803902	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 884.0 (ft) EOB: 22.0 ft.	PAGE 1 OF 1
START: 5/28/25 END: 5/28/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738626, -83.210106	

MATERIAL DESCRIPTION AND NOTES	ELEV. 884.0	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
1.1' - TOPSOIL (13.0")	882.9	1																
BROWN **SILT AND CLAY** -REFER TO BORING B-004-0-25 FOR SOIL DESCRIPTION	871.0	2 3 4 5 6 7 8 9 10 11 12 13																
BROWN **SILT**	866.0	14 15 16 17 18 19																
BROWNISH GRAY **SANDY SILT** - QU @ 21.0'-21.5' = 3.15 tsf @ 7.35 % Strain	862.0 EOB	20 21 22			77	ST-1	4.5+	1	5	11	48	35	25	16	9	16	A-4a (8)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 13.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 312+93 / 35' RT.	**EXPLORATION ID B-005-0-25**
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: MJ / DB	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 885.0 (ft) EOB: 40.0 ft.	PAGE 1 OF 2
START: 5/22/25 END: 5/23/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738463, -83.209935	

MATERIAL DESCRIPTION AND NOTES	ELEV. 885.0	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
0.8' - TOPSOIL (10.0")	884.2																	
VERY STIFF TO HARD, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.			2 2 4	9	58	SS-1	3.00	-	-	-	-	-	-	-	-	22	A-6a (V)	
			4 8 10	26	83	SS-2	3.75	11	10	15	30	34	32	17	15	15	A-6a (8)	
			4 10 13	34	100	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
			12 13 16	42	78	SS-4	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
			3 6 9	22	89	SS-5	4.25	-	-	-	-	-	-	-	-	17	A-6a (V)	
- SAND SEAM ENCOUNTERED AT 14.8'			3 4 10	21	100	SS-6	2.00	-	-	-	-	-	-	-	-	24	A-6a (V)	
	869.5																	
STIFF, GRAYISH BROWN **SILT**, LITTLE CLAY, LITTLE COARSE TO FINE SAND, MOIST.		W 869.0	2 3 4	10	94	SS-7	2.00	-	-	-	-	-	-	-	-	21	A-4b (V)	
- @16.0': SLIGHTLY ORGANIC (LOI = 1.4%)	867.0																	
VERY STIFF, GRAYISH BROWN **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP.					100	ST-8	-	10	10	15	36	29	24	15	9	15	A-4a (6)	
- QU @ 19.5'-20.0' = 1.71 tsf @ 7.56 % Strain																		
Consolidation Test Results: Sample Depth: 18.5' -20.5' Pc = 9,000 psf, eo = 0.36, Cc = 0.03, Cr = 0.007			4 6 8	21	100	SS-9	2.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
			4 5 8	19	67	SS-10	3.50	-	-	-	-	-	-	-	-	13	A-4a (V)	
			4 6 8	21	33	SS-11	2.25	-	-	-	-	-	-	-	-	16	A-4a (V)	
			1 3 5	12	78	SS-12	2.25	-	-	-	-	-	-	-	-	14	A-4a (V)	

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI\PROJECTS\2025\W-25-026.GPJ

PID: 121424	SFN: NA	PROJECT: WYA-23-3.47	STATION / OFFSET: 31293, 35' RT.	START: 5/22/25	END: 5/23/25	PG 2 OF 2	B-005-0-25

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
VERY STIFF, GRAYISH BROWN **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP. *(continued)*	855.0																	
	853.0																	
VERY DENSE, GRAYISH BROWN **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, DAMP.		31																
		32																
		33																
		34	19 28 36	94	89	SS-13	-	12	7	19	46	16	NP	NP	NP	11	A-4a (5)	
		35																
		36																
		37																
		38																
	▽ 846.0	39	16 23 21	64	83	SS-14	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
	845.0	EOB 40																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 16.0'. GROUNDWATER UPON COMPLETION @ 39.0'. CAVE-IN DEPTH @ 5.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 313+92 / 14' LT.	**EXPLORATION ID B-006-0-25**
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: 8803902	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 3/25/24	ELEVATION: 873.3 (ft) EOB: 45.0 ft.	PAGE 1 OF 2
START: 5/22/25 END: 5/22/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738599, -83.209581	

MATERIAL DESCRIPTION AND NOTES	ELEV. 873.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.5' - TOPSOIL (6.0")	872.8																	
STIFF TO HARD, BROWN **SILTY CLAY**, TRACE COARSE TO FINE SAND, DAMP TO MOIST.		1	3															
		2	7 8	22	100	SS-1	4.5+	-	-	-	-	-	-	-	-	25	A-6b (V)	
		3																
		4	5															
		5	6 6	18	72	SS-2	2.50	-	-	-	-	-	-	-	-	23	A-6b (V)	
	867.8																	
DENSE, GRAYISH BROWN **SANDY SILT**, MOIST.		W 867.3 6	7															
		7	10 11	31	81	SS-3	-	-	-	-	-	-	-	-	-	22	A-4a (V)	
	865.3	8																
VERY STIFF TO HARD, BROWNISH GRAY TO GRAYISH BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.		9	2															
		10	4 6	15	89	SS-4	4.5+	-	-	-	-	-	-	-	-	19	A-6a (V)	
		11																
		12	3															
		13	6 9	22	61	SS-5	3.00	-	-	-	-	-	-	-	-	12	A-6a (V)	
		14	3															
		15	8 8	23	100	SS-6	-	-	-	-	-	-	-	-	-	12	A-6a (V)	
-@16.0': SLIGHTLY ORGANIC (LOI = 2.1%)		16	3															
		17	3 7	15	44	SS-7	2.75	19	7	16	32	26	24	13	11	13	A-6a (5)	
		18																
		19	4															
		20	6 15	31	50	SS-8	3.00	-	-	-	-	-	-	-	-	13	A-6a (V)	
		21																
		22	8															
		23	10 10	29	75	SS-9	4.5+	-	-	-	-	-	-	-	-	10	A-6a (V)	
		24	7															
		25	7 11	26	83	2S-10	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
		26																
- LIMESTONE COBBLE IN SS-11			50/5"	-	30	SS-11	-	-	-	-	-	-	-	-	-	4	A-6a (V)	
		27																
		28																
ODOT CLASS OF SS-12 SAMPLE IS ESTIMATED BASED ON SS-11 AND SS-13A SAMPLES		29	36 38 26	94	0	SS-12	-	-	-	-	-	-	-	-	-	-	A-6a (V)	

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

PID: 121424	SFN: NA	PROJECT: WYA-23-3.47	STATION / OFFSET: 31392, 14' LT.	START: 5/22/25	END: 5/22/25	PG 2 OF 2	B-006-0-25

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, BROWNISH GRAY TO GRAYISH BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP. *(continued)*	843.3	31 32 33																
	838.8	34	12 18 50/5"	-	100	SS-13A	4.5+	-	-	-	-	-	-	-	-	11	A-6a (V)	
DOLOMITE : BROWN.	838.3	TR 35				SS-13B	-	-	-	-	-	-	-	-	-	-	Rock (V)	
AUGER REFUSAL @ 35.0'																		
DOLOMITE : GRAY TO BROWN, SLIGHTLY WEATHERED, MODERATELY STRONG TO VERY STRONG, THIN BEDDED, ARGILLACEOUS PARTINGS, HIGHLY FRACTURED TO MODEREATELY FRACTURED.		36 37 38 39 40	0		100	NQ-1												CORE
-QU @ 42.1' = 5,466 PSI @ 2.5 % Strain		41 42 43 44	67		99	NQ-2												CORE
	828.3	EOB 45																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 6.0'. GROUNDWATER COULD NOT BE RECORDED DUE TO THE INFLUENCE OF WASH WATER ADDED DURING ROCK CORING. CAVE-IN DEPTH @ 18.2'.

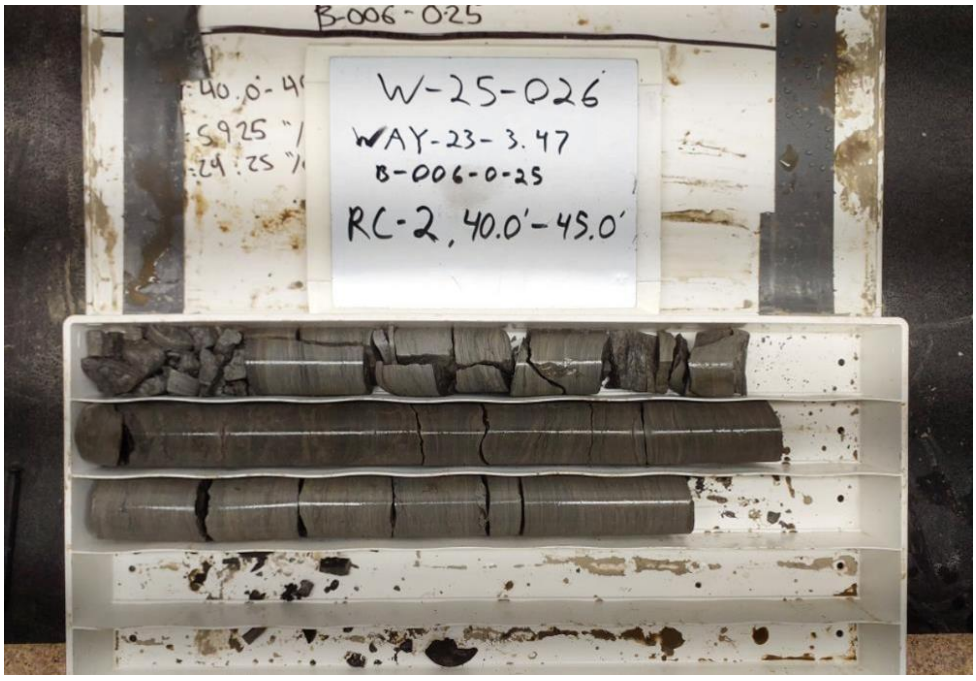
ABANDONMENT METHODS, MATERIALS, QUANTITIES: GROUTED WITH A MIXTURE OF CEMENT AND BENTONITE POWDER.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

Project Name: WYA-23-3.47 Interchange Improvements	Location: Wyandot County, Ohio	Project No.: RII. W-25-026

Photo No. 1 of 2	
Boring: B-006-0-25	
RC-1: 35.0' to 40.0' REC (%):100 RQD (%): 0	

Project Name: WYA-23-3.47 Interchange Improvements	Location: Wyandot County, Ohio	Project No.: RII. W-25-026

Photo No. 2 of 2	
Boring: B-006-0-25	
RC-4: 40.0' to 45.0' REC (%):99 RQD (%):67	

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 314+89 / 56' LT.	**EXPLORATION ID B-007-0-25**
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 883.3 (ft) EOB: 38.5 ft.	PAGE 1 OF 2
START: 5/20/25 END: 5/20/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738718, -83.209231	

MATERIAL DESCRIPTION AND NOTES	ELEV. 883.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5' - TOPSOIL (6.5")	882.8																	
VERY STIFF TO HARD, LIGHT BROWN TO BROWNISH GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, DAMP TO MOIST.			1 2 2	6	58	SS-1	2.75	-	-	-	-	-	-	-	-	25	A-6b (V)	
			3 4 5	13	53	SS-2	2.50	-	-	-	-	-	-	-	-	24	A-6b (V)	
	877.8																	
MEDIUM STIFF TO HARD, BROWNISH GRAY TO GRAYISH BROWN **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP.			8 13 16	42	89	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-4a (V)	
			4 6 7	19	61	SS-4	4.5+	13	5	12	42	28	26	16	10	14	A-4a (7)	
		W 872.3																
			3 3 4	10	50	SS-5	1.75	-	-	-	-	-	-	-	-	27	A-4a (V)	
	870.3																	
MEDIUM DENSE, GRAYISH BROWN **SILT**, SOME CLAY, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.			2 2 6	12	56	SS-6	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
			3 6 6	18	100	SS-7	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
			2 3 5	12	83	SS-8	-	2	4	8	62	24	23	18	5	18	A-4b (8)	
	862.8																	
VERY STIFF, GRAYISH BROWN **SILT AND CLAY**, TRACE COARSE TO FINE SAND, MOIST.			2 4 4	12	50	SS-9	2.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
- QU @ 25.0'-25.5' = 2.5 tsf @ 14.96 % Strain					92	ST-10	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
	857.6																	
DENSE, GRAYISH BROWN **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, LITTLE CLAY, MOIST TO WET.			7 9 10	28	36	SS-11	-	16	7	31	30	16	-	-	-	19	A-4a (V)	
			11 11 15	38	28	SS-12	-	-	-	-	-	-	-	-	-	16	A-4a (V)	

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

PID: 121424	SFN: NA	PROJECT: WYA-23-3.47	STATION / OFFSET: 31489, 56' LT.	START: 5/20/25	END: 5/20/25	PG 2 OF 2	B-007-0-25

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
DENSE, GRAYISH BROWN **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, LITTLE CLAY, MOIST TO WET. *(continued)*	853.3	31																
	851.6	32																
HARD, BROWNISH GRAY **SILT AND CLAY**, SOME CLAY, LITTLE COARSE TO FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP.		33																
		34	11 13 12	37	83	SS-13	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
		35																
		36																
SPLIT SPOON REFUSAL AT 38.5'		37																
AUGER REFUSAL @ 38.5'	844.8	38																

ETR3

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 11.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 315+30 / 4' LT.	**EXPLORATION ID B-008-0-25**
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: 8803902	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 3/25/24	ELEVATION: 883.1 (ft) EOB: 55.2 ft.	PAGE 1 OF 2
START: 5/30/25 END: 5/30/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738576, -83.209083	

MATERIAL DESCRIPTION AND NOTES	ELEV. 883.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.5' - TOPSOIL (5.5")	882.6																	
STIFF TO HARD, BROWN **SILTY CLAY**, LITTLE TO NO SAND, LITTLE TO NO GRAVEL, TRACE COARSE TO FINE SAND, MOIST TO DAMP.		1	1 2 5	10	50	SS-1	3.00	-	-	-	-	-	-	-	-	23	A-6b (V)	
		2																
		3																
		4	6 6 10	23	100	SS-2	4.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
		5																
		6	6 10 12	32	72	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		7																
		8																
		9	6 12 17	42	100	SS-4	4.50	-	-	-	-	-	-	-	-	17	A-6b (V)	
		10																
		11	9 10 12	32	100	SS-5	4.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
		12																
SAND SEAM ENCOUNTERED AT 13.0'		13			100	ST-6	-	0	0	0	38	62	37	20	17	25	A-6b (11)	
	867.6	14																
VERY STIFF, BROWNISH GRAY **SILT**, SOME CLAY, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		15																
		W 867.1 16	5 7 7	21	100	SS-7	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
		17																
		18																
		19	4 5 7	18	100	SS-8	3.50	1	2	9	63	25	21	16	5	18	A-4b (8)	
		20																
		21																
		22			100	ST-9	-	2	6	10	59	23	23	18	5	19	A-4b (8)	
- QU @ 22.5'-23.0' = 1.5 tsf @ 9.95 % Strain		23																
		24	5 6 7	19	39	SS-10	-	-	-	-	-	-	-	-	-	26	A-4b (V)	
	857.6	25																
VERY STIFF TO HARD, BROWNISH GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP.		26																
		27	3 4 7	16	72	SS-11	2.50	-	-	-	-	-	-	-	-	16	A-4a (V)	
		28																
		29	8 10 13	34	72	SS-12	3.50	14	7	16	41	22	20	14	6	13	A-4a (6)	

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

PID: 121424	SFN: NA	PROJECT: WYA-23-3.47	STATION / OFFSET: 31530, 4' LT.	START: 5/30/25	END: 5/30/25	PG 2 OF 2	B-008-0-25

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, BROWNISH GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP. *(continued)*	853.1	31																
		32																
		33																
		34	9 11 11	32	67	SS-13	4.50	-	-	-	-	-	-	-	-	13	A-4a (V)	
		35																
		36																
		37																
		38																
COBBLE AND BOULDER FROM 38.5' to 40'		39																
	844.0		50/5"	-	60	SS-14	-	-	-	-	-	-	-	-	-	-	A-4a (V)	
AUGER REFUSAL @ 39.1'			0		72	NQ2-1											CORE	
DENSE, BROWNISH GRAY **SANDY SILT**		40																
A changeover to rock coring techniques was made upon encountering auger refusal at 39.1' and coring was performed from 39.1' to 43.9'. Subsurface appeared to be soils and therefore auger was extended again until refusal encountered at a depth of 43.9'.		41																
		42	0		0	NQ2-2											CORE	
		43																
	839.2																	
AUGER REFUSAL @ 43.9'		TR 44	0		75	NQ2-3											CORE	
DOLOMITE : GRAY TO LIGHT BROWN, SLIGHTLY WEATHERED, MODERATELY STRONG TO VERY STRONG, VERY FINE GRAINED, THIN BEDDED, ARGILLACEOUS PARTINGS, HIGHLY FRACTURED TO MODEREATELY FRACTURED.		45																
		46																
		47																
		48	15		100	NQ2-4											CORE	
-Sc @ 43.9'-45.2' = 29,998 PSI		49																
		50																
		51																
		52																
		53	28		100	NQ2-5											CORE	
		54																
	827.9	EOB 55																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 16.0'. GROUNDWATER COULD NOT BE RECORDED DUE TO THE INFLUENCE OF WASH WATER ADDED DURING ROCK CORING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: GROUTED WITH A MIXTURE OF CEMENT AND BENTONITE POWDER.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:37 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

Project Name: WYA-23-3.47 Interchange Improvements	Location: Wyandot County, Ohio	Project No.: RII. W-25-026

Photo No. 1 of 2 **Boring:** B-008-0-25 RC-1: 39.1' to 39.7' REC (%):72 RQD (%): NA RC-3: 43.9' to 45.2' REC (%):75 RQD (%): 0 RC-4: 45.2' to 50.2' REC (%):100 RQD (%):15	

Project Name: WYA-23-3.47 Interchange Improvements	Location: Wyandot County, Ohio	Project No.: RII. W-25-026

Photo No. 2 of 2 **Boring:** B-008-0-25 RC-5: 50.2' to 55.2' REC (%):100 RQD (%):28	

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 315+48 / 43' RT.	**EXPLORATION ID B-009-0-25**
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 877.3 (ft) EOB: 27.5 ft.	PAGE 1 OF 1
START: 5/19/25 END: 5/19/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738447, -83.208977	

MATERIAL DESCRIPTION AND NOTES	ELEV. 877.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5' - TOPSOIL (5.5")	876.8																	
HARD, BROWN **SILTY CLAY**, TRACE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP.		1	4 5 7	18	89	SS-1	4.5+	-	-	-	-	-	-	-	-	19	A-6b (V)	
		2																
		3																
		4	6 12 13	37	100	SS-2	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
	871.8	5																
MEDIUM DENSE, BROWNISH GRAY **SANDY SILT**, TRACE CLAY, MOIST.		W 871.3 6	4 6 7	19	61	SS-3	-	-	-	-	-	-	-	-	-	22	A-4a (V)	
	869.3	7																
MEDIUM DENSE, GRAYISH BROWN **SILT**, LITTLE COARSE TO FINE SAND, LITTLE CLAY, TRACE FINE GRAVEL, WET.		8																
		9	3 6 7	19	100	SS-4	-	2	0	15	73	10	NP	NP	NP	21	A-4b (8)	
		10																
		11																
		12	2 4 6	15	86	SS-5	-	-	-	-	-	-	-	-	-	20	A-4b (V)	
		13																
		14	1 3 5	12	33	SS-6	-	-	-	-	-	-	-	-	-	17	A-4b (V)	
	862.3	15																
HARD, BROWNISH GRAY **SILT AND CLAY**, TRACE COARSE AND FINE SAND, TRACE FINE GRAVEL, DAMP. AUGER REFUSAL AT 27.5'		16																
		17	4 7 8	22	81	SS-7	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
		18																
		19	4 5 8	19	33	SS-8	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
		20																
		21																
		22	5 10 12	32	33	SS-9	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		23																
		24	7 9 16	37	42	SS-10	4.5+	3	2	5	39	51	32	18	14	16	A-6a (10)	
		25																
		26																
	849.8	27	5 12 22	50	72	SS-11	4.5+	-	-	-	-	-	-	-	-	13	A-6a (V)	
		EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 6.0'. GROUNDWATER WAS NOT ENCOUNTERED UPON COMPLETION. CAVE-IN DEPTH @ 10.1'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 315+48 / 47' RT.	**EXPLORATION ID B-009-1-25**
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 877.3 (ft) EOB: 6.0 ft.	PAGE 1 OF 1
START: 5/19/25 END: 5/19/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	COORD: NOT RECORDED	

MATERIAL DESCRIPTION AND NOTES	ELEV. 877.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5' - TOPSOIL (5.5")	876.8	1																
BROWN **SILTY CLAY**		2																
		3																
-REFER TO BORING B-009-0-25 FOR SOIL DESCRIPTION		4																
	871.8	5			0	ST-1	-	-	-	-	-	-	-	-	-	-		
BROWNISH GRAY **SANDY SILT**	871.3	EOB 6																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 318+52 / 23' LT.	**EXPLORATION ID B-010-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 882.5 (ft) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/20/25 END: 5/20/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738632, -83.207914	

MATERIAL DESCRIPTION AND NOTES	ELEV. 882.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5' - TOPSOIL (5.5")	882.0																	
VERY STIFF TO HARD, BROWN TO BROWNISH GRAY **SILT AND CLAY**, SOME TO LITTLE COARSE TO FINE SAND, TRACE TO NO FINE GRAVEL, DAMP TO WET.		1	1 4 5	13	53	SS-1	4.5+	-	-	-	-	-	-	-	-	22	A-6a (V)	
		2																
		3																
		4	6 8 11	28	61	SS-2	4.5+	-	-	-	-	-	-	-	-	20	A-6a (V)	
		5																
Consolidation Test Results: Sample Depth: 6.0'-8.0' Pc = 9,241 psf, eo = 0.424, Cc = 0.058, Cr = 0.023		6																
		7			83	ST-3	4.5+	10	8	14	42	26	28	15	13	14	A-6a (8)	
		8																
		9	5 10 14	35	100	SS-4	4.5+	-	-	-	-	-	-	-	-	19	A-6a (V)	
		10																
		11																
W 870.2		12	3 6 10	23	83	SS-5	4.5+	-	-	-	-	-	-	-	-	26	A-6a (V)	
		13																
		14	2 2 2	6	100	SS-6	2.25	0	1	12	60	27	28	16	12	25	A-6a (9)	
		15																
		16																
		17	1 5 6	16	100	SS-7	4.5+	-	-	-	-	-	-	-	-	22	A-6a (V)	
		18																
		19																
	862.5	EOB 20	3 5 6	16	100	SS-8	2.25	-	-	-	-	-	-	-	-	17	A-6a (V)	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 12.3'. CAVE-IN DEPTH @ 7.8'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 322+11 / 14' RT.	**EXPLORATION ID B-011-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 883.1 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.738537, -83.206622	

MATERIAL DESCRIPTION AND NOTES	ELEV. 883.1	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
0.6' - ASPHALT (7.0")	882.5																	
0.5' - AGGREGATE BASE (6.0")	882.0																	
VERY STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	879.9	1	4 4 5	13	72	SS-1	2.00	6	12	12	42	28	28	17	11	20	A-6a (7)	
VERY STIFF, LIGHT BROWN TO LIGHT ORANGE **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		2																
		3	3 3 5	11	89	SS-2	2.50	4	3	5	41	47	52	19	33	24	A-7-6 (18)	
		4																
		5																
		6	3 6 7	18	100	SS-3	2.75	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		7																
		8																
	873.1	9	7 7 8	21	94	SS-4	3.00	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
		EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 6.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 325+33 / 11' LT.	**EXPLORATION ID B-012-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 294	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 885.6 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/20/25 END: 5/20/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.738612, -83.205459	

MATERIAL DESCRIPTION AND NOTES	ELEV. 885.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.6' - ASPHALT (7.0")	885.0																	
0.3' - AGGREGATE BASE (4.0")	884.7																	
VERY STIFF TO HARD, BROWN **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, TRACE TO NO FINE GRAVEL, DAMP.		1	3 3 5	11	44	SS-1	3.00	3	1	4	43	49	47	18	29	15	A-7-6 (17)	
		2																
		3																
		4	4 6 11	24	89	SS-2	4.00	0	1	2	43	54	47	21	26	21	A-7-6 (16)	
		5																
		6																
		7	9 10 10	28	100	SS-3	4.00	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		8																
		9																
	875.6	EOB 10	7 12 18	43	89	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-7-6 (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 7.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 167+20 / 56' LT.	**EXPLORATION ID B-013-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 891.4 (ft) EOB: 7.5 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.734497, -83.204051	

MATERIAL DESCRIPTION AND NOTES	ELEV. 891.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.9' - ASPHALT (11.0")	890.5																	
0.9' - AGGREGATE BASE (10.0")	889.6	1																
VERY STIFF, BROWNISH GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST.	888.4	2	9 3 3	9	39	SS-1	3.50	11	5	10	37	37	35	17	18	18	A-6b (11)	
VERY STIFF, DARK BROWN **CLAY**, "AND" SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		3	3 5 10	21	44	SS-2	3.75	1	3	8	40	48	43	18	25	20	A-7-6 (15)	
		4																
		5	6 5 9	20	39	SS-3	2.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
- SOIL CLASSIFICATION AND MOISTURE TEST FOR SS-3 WERE DETERMINED FROM 2S-3A SAMPLE.		6																
	883.9	7 EOB	8 8 10	26	50	SS-4	4.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 5.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 171+12 / 60' LT.	**EXPLORATION ID B-014-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 888.3 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.735219, -83.205101	

MATERIAL DESCRIPTION AND NOTES	ELEV. 888.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.9' - ASPHALT (11.0")	887.4																	
0.7' - AGGREGATE BASE (8.0")	886.7																	
VERY STIFF, BROWNISH GRAY **SILT**, SOME CLAY, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.	885.3	1																
		2	11 6 8	20	78	SS-1	4.00	1	1	2	62	34	30	20	10	18	A-4b (8)	
		3																
VERY STIFF TO HARD, BROWNISH GRAY **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		4	6 7 9	23	89	SS-2	3.75	0	1	1	55	43	41	20	21	24	A-7-6 (13)	
		5																
		6	6 5 9	20	100	SS-3	3.75	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		7																
		8																
		9	5 5 8	18	100	SS-4	4.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
	878.3	EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 6.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 175+11 / 62' LT.	**EXPLORATION ID B-015-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 888.5 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.735959, -83.206164	

MATERIAL DESCRIPTION AND NOTES	ELEV. 888.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.9' - GRAVEL (11.0")	887.6																	
VERY STIFF TO HARD, BROWNISH GRAY **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		1																
		2	5 5 6	16	61	SS-1	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		3																
		4	5 6 8	20	89	SS-2	3.00	2	2	5	42	49	47	19	28	22	A-7-6 (17)	
		5																
		6																
		7	9 11 13	34	100	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
		8																
		9	8 12 20	45	89	SS-4	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
	878.5	EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 8.5'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 180+12 / 59' LT.	**EXPLORATION ID B-016-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 885.2 (ft) EOB: 15.0 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.736896, -83.207487	

MATERIAL DESCRIPTION AND NOTES	ELEV. 885.2	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
0.9' - ASPHALT (11.0")	884.3																	
0.7' - AGGREGATE BASE (8.0")	883.6																	
VERY STIFF, BROWNISH GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		1																
		2	5 3 5	11	61	SS-1	3.00	9	5	11	34	41	35	17	18	17	A-6b (11)	
		3																
		4	6 7 9	23	83	SS-2	4.00	2	5	14	37	42	38	17	21	19	A-6b (12)	
	879.7	5																
STIFF TO HARD, BROWNISH GRAY TO GRAYISH BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		6																
		7	7 8 8	23	100	SS-3	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		8																
		9	7 8 12	28	94	SS-4	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		10																
		11	11 16 20	51	100	SS-5	4.50	5	5	10	39	41	29	15	14	13	A-6a (10)	
		12																
		13																
		14	5 5 10	21	78	SS-6	2.00	-	-	-	-	-	-	-	-	25	A-6a (V)	
	870.2	15																
		EOB																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 9.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 483+48 / 10' RT.	**EXPLORATION ID B-017-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP A	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 875.7 (ft) EOB: 15.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.737358, -83.208549	

MATERIAL DESCRIPTION AND NOTES	ELEV. 875.7	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
0.6' - TOPSOIL (6.75")	875.1																	
VERY STIFF TO HARD, BROWN **SILTY CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST TO DAMP.		1	2 2 3	7	44	SS-1	2.50	0	2	14	- 84 -		-	-	-	26	A-6b (V)	
		2																
		3																
		4	7 9 9	26	81	SS-2	3.50	5	6	12	39	38	32	16	16	16	A-6b (10)	
		5																
		6	12 12 16	41	100	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	
		7																
		8	9 9 15	35	100	SS-4	4.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
	865.2	9 ▽ 865.2																
LOOSE TO MEDIUM DENSE, BROWN **SANDY SILT**, LITTLE SILT, LITTLE CLAY, WET.		10 W 864.7																
		11	5 4 6	15	67	SS-5	-	0	8	53	28	11	NP	NP	NP	28	A-4a (1)	
		12																
		13																
		14	2 2 4	9	100	SS-6	-	-	-	-	-	-	-	-	-	24	A-4a (V)	
	860.7	15 EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 11.0'. GROUNDWATER UPON COMPLETION @ 10.5'. CAVE-IN DEPTH @ 12.25'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 488+22 / 6' RT.	**EXPLORATION ID B-018-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP A	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 874.1 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.737576, -83.210232	

MATERIAL DESCRIPTION AND NOTES	ELEV. 874.1	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
0.6' - TOPSOIL (7.25")	873.5																	
VERY STIFF, BROWN TO LIGHT BROWN **CLAY**, "AND" SILT, TRACE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP.	871.1		2 3 5	12	81	SS-1	3.25	4	1	1	44	50	41	22	19	22	A-7-6 (12)	
MEDIUM DENSE, BROWN **SILT**, SOME COARSE TO FINE SAND, LITTLE CLAY, MOIST.		W 870.6	1 4 4	12	81	SS-2	-	0	1	24	56	19	NP	NP	NP	22	A-4b (8)	
		▽ 867.1	4 4 5	13	94	SS-3	-	-	-	-	-	-	-	-	-	20	A-4b (V)	
	866.1																	
STIFF, GRAYISH BROWN **SILT AND CLAY**, TRACE COARSE TO FINE SAND, MOIST.	864.1	EOB	2 4 4	12	67	SS-4	1.75	-	-	-	-	-	-	-	-	19	A-6a (V)	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 3.5'. GROUNDWATER UPON COMPLETION @ 7.0'. CAVE-IN DEPTH @ 9.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 490+83 / 7' RT.	**EXPLORATION ID B-019-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP A	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 882.2 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.738049, -83.210879	

MATERIAL DESCRIPTION AND NOTES	ELEV. 882.2	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
0.5' - TOPSOIL (5.75")	881.7																	
VERY STIFF TO HARD, BROWNISH GRAY **CLAY**, SOME SILT, TRACE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP TO MOIST.		1	1 3 4	10	58	SS-1	3.50	8	1	5	30	56	62	22	40	24	A-7-6 (20)	
		2	2 5 8	19	72	SS-2	3.25	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		3																
		4																
		5																
		6	2 10 10	29	44	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		7																
		8																
		9	4 7 9	23	78	SS-4	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
	872.2	EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 8.75'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 595+05 / 4' RT.	**EXPLORATION ID B-020-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP B	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 877.0 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.739506, -83.211679	

MATERIAL DESCRIPTION AND NOTES	ELEV. 877.0	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
0.6' - TOPSOIL (6.75")	876.4																	
VERY STIFF, BROWN **CLAY**, SOME SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	874.0	1 2 3 4 5	2 3 5	12	50	SS-1	3.75	9	3	8	32	48	48	19	29	19	A-7-6 (17)	
VERY STIFF, BROWNISH GRAY **SANDY SILT**, "AND" CLAY, TRACE FINE GRAVEL, MOIST.	871.5		2 5 6	16	67	SS-2	3.50	5	5	13	39	38	22	17	5	20	A-4a (8)	
MEDIUM DENSE, BROWNISH GRAY **SILT**, LITTLE COARSE TO FINE SAND, TRACE TO LITTLE CLAY, MOIST.	867.0	W 871.0 ▽ 869.0 6 7 8 9 EOB 10	2 4 4	12	67	SS-3	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
			1 3 5	12	61	SS-4	-	-	-	-	-	-	-	-	-	17	A-4b (V)	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 6.0'. GROUNDWATER UPON COMPLETION @ 8.0'. CAVE-IN DEPTH @ 8.25'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 599+09 / 7' RT.	**EXPLORATION ID B-021-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP B	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 871.1 (ft) EOB: 15.0 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.740385, -83.212566	

MATERIAL DESCRIPTION AND NOTES	ELEV. 871.1	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
0.5' - TOPSOIL (6.0")	870.6																	
VERY STIFF, BROWNISH GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		1	3 3 5	12	83	SS-1	-	-	-	-	-	-	-	-	-	21	A-6a (V)	
		2																
		3																
		4	4 4 3	10	100	SS-2	3.75	-	-	-	-	-	-	-	-	20	A-6a (V)	
		5																
-SS-3: LOI = 2.3% (SLIGHTLY ORGANIC)		6	2 4 7	16	89	SS-3	3.25	7	9	16	37	31	25	14	11	18	A-6a (7)	
	863.1	7																
HARD, BROWNISH GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP.		8																
		9	4 4 8	18	75	SS-4	4.5+	15	9	19	32	25	22	13	9	13	A-4a (4)	
		10																
		11																
		12	4 6 9	22	92	SS-5	4.5+	-	-	-	-	-	-	-	-	13	A-4a (V)	
		13																
		14	3 6 8	21	42	SS-6	4.5+	-	-	-	-	-	-	-	-	12	A-4a (V)	
	856.1	EOB 15																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 7.1'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 602+93 / 6' RT.	**EXPLORATION ID B-022-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP B	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 870.5 (ft) EOB: 7.5 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.741150, -83.213527	

MATERIAL DESCRIPTION AND NOTES	ELEV. 870.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.8' - ASPHALT (9.0")	869.7																	
0.9' - AGGREGATE BASE (11.5")	868.8																	
HARD, BROWNISH GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.	867.5	1	4 4 7	16	50	SS-1	4.5+	5	3	8	42	42	34	19	15	16	A-6a (10)	
MEDIUM DENSE, BROWN **SILT**, LITTLE CLAY, TRACE COARSE TO FINE SAND, DAMP.		2	6 7 10	24	50	SS-2	-	2	0	7	67	24	20	17	3	20	A-4b (8)	
		3	9 9 9	26	67	SS-3	-	-	-	-	-	-	-	-	-	16	A-4b (V)	
		4	11 10 9	27	89	SS-4	-	-	-	-	-	-	-	-	-	15	A-4b (V)	
	863.0	5 EOB																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 4.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 172+02 / 62' RT.	**EXPLORATION ID B-023-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / DB	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 889.9 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/19/25 END: 5/19/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 80.6	LAT / LONG: 40.735632, -83.205042	

MATERIAL DESCRIPTION AND NOTES	ELEV. 889.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.4' - TOPSOIL (4.5")	889.5																	
HARD, BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST. - SS-1: LOI = 2.6% (SLIGHTLY ORGANIC)	886.9	1	1 3 5	11	56	SS-1	4.50	14	6	10	- 70 -		-	-	-	17	A-6b (V)	
VERY STIFF TO HARD, BROWN **CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		3	3 8 11	26	64	SS-2	4.50	1	0	2	51	46	47	19	28	20	A-7-6 (17)	
		5	5 6 8	19	100	SS-3	3.00	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
	879.9	EOB 10	4 6 10	21	100	SS-4	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 175+50 / 68' RT.	**EXPLORATION ID B-024-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / DB	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 886.6 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/19/25 END: 5/19/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 80.6	LAT / LONG: 40.736293, -83.205950	

MATERIAL DESCRIPTION AND NOTES	ELEV. 886.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5' - TOPSOIL (6.0")	886.1																	
VERY STIFF, BROWN **SILTY CLAY**, LITTLE FINE GRAVEL, LITTLE COARSE TO FINE SAND, MOIST.	883.6	1	2 4 4	11	56	SS-1	4.00	19	4	9	33	35	34	16	18	19	A-6b (10)	
VERY STIFF TO HARD, BROWN **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		2																
		3	3 5 7	16	75	SS-2	3.75	0	1	2	45	52	46	20	26	25	A-7-6 (16)	
		4																
		5																
		6	2 4 9	17	78	SS-3	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		7																
		8																
	876.6	9	3 6 8	19	92	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 679+07 / 8' LT.	**EXPLORATION ID B-025-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP C	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 880.6 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.737029, -83.206801	

MATERIAL DESCRIPTION AND NOTES	ELEV. 880.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.4' - TOPSOIL (4.75")	880.2																	
VERY STIFF TO HARD, BROWNISH GRAY TO ORANGE **CLAY**, "AND" SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		1	1 3 4	10	53	SS-1	2.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		2																
		3																
		4	3 4 6	15	78	SS-2	2.75	8	5	11	36	40	41	17	24	18	A-7-6 (14)	
		5																
		6																
		7	7 9 9	26	72	SS-3	4.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		8																
		9																
	870.6	EOB 10	5 8 9	25	83	SS-4	4.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 9.5'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 682+43 / 8' LT.	**EXPLORATION ID B-026-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP C	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 880.4 (ft) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.737915, -83.207569	

MATERIAL DESCRIPTION AND NOTES	ELEV. 880.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.4' - TOPSOIL (5.25")	880.0																	
STIFF TO HARD, BROWNISH GRAY **CLAY**, SOME SILT, TRACE FINE GRAVEL, TRACE COARSE TO FINE SAND, MOIST TO DAMP.			0 2 3	7	100	SS-1	1.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
			5 6 6	18	75	SS-2	4.25	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
			5 7 6	19	78	SS-3	4.00	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
	869.9		7 10 13	34	100	SS-4	4.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
MEDIUM DENSE, BROWNISH GRAY **SANDY SILT**, TRACE CLAY, MOIST.	867.4	W 869.4	4 5 3	12	94	SS-5	-	0	7	43	38	12	NP	NP	NP	23	A-4a (3)	
MEDIUM DENSE, BROWNISH GRAY **SILT**, LITTLE COARSE TO FINE SAND, MOIST.	864.9	▽ 866.7	2 3 6	13	83	SS-6	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
VERY STIFF, BROWNISH GRAY **CLAY**, SOME SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.			3 4 8	18	72	SS-7	3.25	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
	860.4	EOB	3 4 7	16	61	SS-8	3.75	-	-	-	-	-	-	-	-	13	A-7-6 (V)	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 11.0'. GROUNDWATER UPON COMPLETION @ 13.75'. CAVE-IN DEPTH @ 17.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 787+52 / LT.	**EXPLORATION ID B-027-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP D	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 884.9 (ft) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.739439, -83.208472	

MATERIAL DESCRIPTION AND NOTES	ELEV. 884.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5' - TOPSOIL (5.5")	884.3																	
VERY STIFF, BROWN **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	881.9		2 4 4	12	58	SS-1	3.50	1	2	7	33	57	47	21	26	23	A-7-6 (16)	
HARD, BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.			8 9 10	28	89	SS-2	4.50	1	5	8	39	47	33	18	15	18	A-6a (10)	
			8 10 12	32	78	SS-3	4.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
			10 10 17	40	100	SS-4	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
	871.9	▽ 872.2	9 10 12	32	92	SS-5	4.50	3	3	6	45	43	30	17	13	16	A-6a (9)	
MEDIUM STIFF, GRAYISH BROWN **CLAY**, SOME SILT, MOIST.	869.4		2 2 4	9	100	SS-6	1.00	-	-	-	-	-	-	-	-	26	A-7-6 (V)	
LOOSE, BROWNISH GRAY **SANDY SILT**, WET.	866.9	W 868.9	0 2 3	7	89	SS-7	-	-	-	-	-	-	-	-	-	28	A-4a (V)	
STIFF, BROWNISH GRAY **SILTY CLAY**, TRACE COARSE TO FINE SAND, MOIST.	864.9	EOB	2 3 5	12	100	SS-8	-	-	-	-	-	-	-	-	-	27	A-6b (V)	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 16.0'. GROUNDWATER UPON COMPLETION @ 12.75'. CAVE-IN DEPTH @ 18.25'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 791+27 / 4' LT.	**EXPLORATION ID B-028-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP D	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 883.1 (ft) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.739734, -83.209742	

MATERIAL DESCRIPTION AND NOTES	ELEV. 883.1	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
0.3' - TOPSOIL (3.75")	882.8																	
VERY STIFF TO HARD, BROWN **CLAY**, "AND" SILT, TRACE FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.			2 4 5	13	56	SS-1	3.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
			5 7 10	25	72	SS-2	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
			6 10 12	32	72	SS-3	4.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
			8 10 15	37	100	SS-4	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
		▼ 872.1																
			9 10 16	38	81	SS-5	4.50	1	0	1	39	59	44	22	22	20	A-7-6 (14)	
	870.1																	
LOOSE TO MEDIUM DENSE, BROWNISH GRAY **SILT**, SOME COARSE TO FINE SAND, MOIST.			3 4 6	15	78	SS-6	-	0	2	19	61	18	20	17	3	24	A-4b (8)	
			2 3 4	10	89	SS-7	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
	865.1																	
VERY STIFF, GRAYISH BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.			2 4 6	15	67	SS-8	3.00	-	-	-	-	-	-	-	-	17	A-6b (V)	
	863.1	EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 11.0'. GROUNDWATER UPON COMPLETION @ 11.0'. CAVE-IN DEPTH @ 18.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 794+83 / 4' LT.	**EXPLORATION ID B-029-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL RAMP D	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 876.0 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/30/25 END: 5/30/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.739978, -83.210983	

MATERIAL DESCRIPTION AND NOTES	ELEV. 876.0	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
0.4' - TOPSOIL (5.0")	875.6																	
STIFF, BROWNISH GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		1	2 3 4	10	39	SS-1	2.00	-	-	-	-	-	-	-	-	14	A-6b (V)	
		2																
		3																
- *SOIL CLASSIFICATION AND MOISTURE TEST FOR SS-2 WERE DETERMINED FROM 2S-2A SAMPLE.*		4	4 3 5	12	33	SS-2	1.50	7	6	12	34	41	38	19	19	20	A-6b (12)	
	870.3	5																
STIFF TO VERY STIFF, BROWN **CLAY**, "AND" SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		6	2 2 3	7	75	SS-3	1.50	2	4	9	38	47	47	21	26	23	A-7-6 (16)	
		7																
		8																
		9	4 4 5	13	56	SS-4	2.25	1	5	15	38	41	52	22	30	27	A-7-6 (18)	
	866.0	EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 9.75'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 199+11 / 67' RT.	**EXPLORATION ID B-030-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 869.8 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/19/25 END: 5/19/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.740685, -83.212213	

MATERIAL DESCRIPTION AND NOTES	ELEV. 869.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.4' - TOPSOIL (4.0")	869.4																	
LOOSE TO MEDIUM DENSE, BROWNISH GRAY **SANDY SILT**, TRACE CLAY, MOIST.		1	4 5 4	13	69	SS-1	-	0	7	56	29	8	NP	NP	NP	21	A-4a (0)	
		▽ 866.7 2 3																
		4	2 2 2	6	81	SS-2	-	1	4	36	39	20	16	13	3	24	A-4a (5)	
	864.3	5																
LOOSE, BROWNISH GRAY **SILT**, SOME CLAY, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, WET.		W 863.8 6	1 2 5	10	100	SS-3	-	1	0	9	71	19	NP	NP	NP	24	A-4b (8)	
	861.8	7 8																
VERY STIFF, BROWNISH GRAY **SILT AND CLAY**, TRACE COARSE TO FINE SAND, DAMP.		9	2 4 6	15	86	SS-4	4.00	-	-	-	-	-	-	-	-	19	A-6a (V)	
	859.8	EOB 10																

NOTES: SEEPAGE @ 1.0'. GROUNDWATER INITIALLY ENCOUNTERED @ 6.0'. GROUNDWATER UPON COMPLETION @ 3.1'. CAVE-IN DEPTH @ 6.2'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 203+27 / 63' RT.	**EXPLORATION ID B-031-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 869.1 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/19/25 END: 5/19/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.741452, -83.213325	

MATERIAL DESCRIPTION AND NOTES	ELEV. 869.1	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
0.3' - TOPSOIL (3.5")	868.8																	
HARD, BROWNISH GRAY **SILTY CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	866.1	1	3 5 4	13	67	SS-1	4.5+	2	2	4	46	46	36	19	17	22	A-6b (11)	
MEDIUM DENSE, BROWNISH GRAY **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, WET.	863.6	2 3 W 865.6 4 ▽ 864.5 5	3 4 4	12	72	SS-2	-	0	2	80	14	4	NP	NP	NP	24	A-3a (0)	
LOOSE TO MEDIUM DENSE, BROWNISH GRAY **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, WET.	859.1	6 7 8 9 EOB 10	4 3 3	9	56	SS-3	-	4	1	41	41	13	NP	NP	NP	24	A-4a (4)	
			3 7 8	22	75	SS-4	-	-	-	-	-	-	-	-	-	22	A-4a (V)	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 3.5'. GROUNDWATER UPON COMPLETION @ 4.6'. CAVE-IN DEPTH @ 7.1'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 206+97 / 57' RT.	**EXPLORATION ID B-032-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 868.2 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/20/25 END: 5/20/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.742129, -83.214322	

MATERIAL DESCRIPTION AND NOTES	ELEV. 868.2	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
1.2' - ASPHALT (14.0")	867.0																	
0.8' - AGGREGATE BASE (10.0")	866.2																	
STIFF, BROWN **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, MOIST. - BASE GRAVEL PRESENT IN SS-1 AND SS-2	865.0		3 2 3	7	72	SS-1	2.00	16	8	18	30	28	24	14	10	15	A-4a (5)	
VERY STIFF, BROWN **SILTY CLAY**, TRACE COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP TO MOIST. - PETROL ODOR IN SS-2			5 6 8	20	44	SS-2	3.00	4	6	9	36	45	37	18	19	19	A-6b (12)	
			7 7 7	20	83	SS-3	4.00	-	-	-	-	-	-	-	-	15	A-6b (V)	
	858.2	EOB	8 9 9	26	50	SS-4	4.00	-	-	-	-	-	-	-	-	16	A-6b (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 7.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 210+20 / 58' RT.	**EXPLORATION ID B-033-0-25**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: US 23		
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 868.1 (ft) EOB: 10.0 ft.		PAGE 1 OF 1
START: 5/20/25 END: 5/20/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.742731, -83.215177		

MATERIAL DESCRIPTION AND NOTES	ELEV. 868.1	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
1.0' - ASPHALT (12.0")	867.1																	
2.25' - AGGREGATE BASE (27.0")	864.9	1	6 5 5	14	67	SS-1	-	25	28	18	21	8	NP	NP	NP	10	A-2-4 (0)	
VERY STIFF, BROWN **SILT AND CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		2																
		3	4 4 1	7	47	SS-2	3.00	1	3	5	50	41	31	17	14	19	A-6a (10)	
		4																
		5																
		6	4 3 5	11	94	SS-3	4.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
		7																
		8																
	858.1	9	4 4 6	14	72	SS-4	3.75	-	-	-	-	-	-	-	-	19	A-6a (V)	
		EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 6.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 185+48 / 44' LT.	**EXPLORATION ID B-034-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 879.9 (ft) EOB: 9.0 ft.	PAGE 1 OF 1
START: 5/21/25 END: 5/21/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.737924, -83.208872	

MATERIAL DESCRIPTION AND NOTES	ELEV. 879.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1.0' - ASPHALT (12.0")	878.9	1																
2.0' - AGGREGATE BASE (24.0")	876.9	2	22 17 8	35	100	SS-1	-	32	32	20	11	5	NP	NP	NP	6	A-1-b (0)	
HARD, BROWNISH GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		3	6 7 13	28	89	SS-2	4.5+	5	4	8	39	44	32	16	16	18	A-6b (10)	
- SOIL CLASSIFICATION AND MOISTURE TEST FOR SS-3 WERE DETERMINED FROM 2S-3A SAMPLE.		4 5	7 10 15	35	50	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
		6 7	8 10 14	34	89	SS-4	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
	870.9	EOB 8 9	20 25 31	79	89	SS-5	4.5+	-	-	-	-	-	-	-	-	22	A-6b (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 6.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 187+52 / 45' RT.	**EXPLORATION ID B-035-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / DB	HAMMER: AUTOMATIC	ALIGNMENT: US 23	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 877.8 (ft) EOB: 8.0 ft.	PAGE 1 OF 1
START: 5/19/25 END: 5/19/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 80.6	LAT / LONG: 40.738482, -83.209193	

MATERIAL DESCRIPTION AND NOTES	ELEV. 877.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1.0' - ASPHALT (12.5")	876.8	1																
2.1' - AGGREGATE BASE (28.0")	874.7	2																
HARD, BROWNISH GRAY **SILT AND CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.	872.8	3	15 10 6	21	78	SS-1A	-	27	33	22	17	1	-	-	-	5	A-1-b (V)	
						SS-1B	4.50	-	-	-	-	-	-	-	-	-	A-6a (V)	
		4	6 9 11	27	94	SS-2	4.50	4	1	3	51	41	31	18	13	20	A-6a (9)	
STIFF, GRAYISH BROWN **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, MOIST.	869.8	5	8 7 7	19	92	SS-3	1.00	-	-	-	-	-	-	-	-	26	A-7-6 (V)	
		6	5 7 10	23	100	SS-4	1.25	-	-	-	-	-	-	-	-	28	A-7-6 (V)	
		W 870.6 7																
		EOB 8																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 7.2'. GROUNDWATER WAS NOT ENCOUNTERED UPON COMPLETION OF DRILLING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 903+59 / 2' LT.	**EXPLORATION ID B-036-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL PR T 127	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 883.9 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.739556, -83.205597	

MATERIAL DESCRIPTION AND NOTES	ELEV. 883.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - TOPSOIL (3.75")	883.6																	
VERY STIFF TO HARD, BROWN **CLAY**, "AND SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		1	2 3 5	12	56	SS-1	2.00	0	2	4	42	52	52	22	30	24	A-7-6 (18)	
		2																
		3																
		4	2 5 7	18	72	SS-2	2.00	4	3	5	37	51	43	21	22	23	A-7-6 (13)	
		5																
		6	7 10 12	32	100	SS-3	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		7																
		8																
		9	7 11 12	34	100	SS-4	4.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
	873.9	EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 10.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 908+08 / 2' LT.	**EXPLORATION ID B-037-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL PR T 127	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 886.0 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.740619, -83.206387	

MATERIAL DESCRIPTION AND NOTES	ELEV. 886.0	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
0.3' - TOPSOIL (3.25")	885.7																	
STIFF TO HARD, BROWN TO LIGHT ORANGE **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, TRACE TO NO FINE GRAVEL, DAMP TO MOIST.		1	3															
		2	3 4	10	56	SS-1	2.00	1	1	2	43	53	59	24	35	24	A-7-6 (20)	
		3																
		4	2															
		5	4 6	15	72	SS-2	2.75	0	1	3	50	46	42	22	20	21	A-7-6 (12)	
		6																
		7	5															
		8	6 8	21	94	SS-3	4.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		9																
	876.0	EOB 10	5 7 9	23	83	SS-4	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 9.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / KC	DRILL RIG: CME 750X (310218)	STATION / OFFSET: 912+03 / 2' LT.	**EXPLORATION ID B-038-0-25**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / IS	HAMMER: AUTOMATIC	ALIGNMENT: CL PR T 127	
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/25/24	ELEVATION: 885.0 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/29/25 END: 5/29/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87.9	LAT / LONG: 40.741525, -83.207164	

MATERIAL DESCRIPTION AND NOTES	ELEV. 885.0	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
0.3' - TOPSOIL (3.5")	884.7																	
VERY STIFF TO HARD, BROWN **CLAY**, "AND" SILT, TRACE TO LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		1																
		2	2 3 5	12	61	SS-1	2.50	1	2	2	37	58	57	24	33	27	A-7-6 (19)	
		3																
		4	3 5 8	19	78	SS-2	4.50	3	5	9	38	45	42	20	22	17	A-7-6 (13)	
		5																
		6																
		7	7 8 10	26	100	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-7-6 (V)	
		8																
		9																
	875.0	EOB 10	7 10 18	41	100	SS-4	4.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. CAVE-IN DEPTH @ 9.5'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: WYA-23-3.47	DRILLING FIRM / OPERATOR: RII / LH	DRILL RIG: CME 55 (386345)	STATION / OFFSET: 916+04 / 1' LT.	**EXPLORATION ID B-039-0-25**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / KC	HAMMER: AUTOMATIC	ALIGNMENT: CL PR T 127		
PID: 121424 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/22/24	ELEVATION: 884.5 (ft) EOB: 10.0 ft.		PAGE 1 OF 1
START: 5/20/25 END: 5/20/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.1	LAT / LONG: 40.742601, -83.207416		

MATERIAL DESCRIPTION AND NOTES	ELEV. 884.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1.0' - ASPHALT (12.0")	883.5																	
0.7' - AGGREGATE BASE (8.0")	882.8																	
VERY STIFF TO HARD, BROWNISH GRAY **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		1																
		2	3 4 4	11	78	SS-1	3.00	7	2	5	38	48	46	20	26	24	A-7-6 (16)	
		3																
		4	4 4 5	13	67	SS-2	3.00	7	2	4	35	52	51	19	32	24	A-7-6 (18)	
		5																
		6	4 5 6	16	100	SS-3	4.5+	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		7																
		8																
		9	7 12 18	43	89	SS-4	4.5+	-	-	-	-	-	-	-	-	14	A-7-6 (V)	
	874.5	EOB 10																

NOTES: GROUNDWATER WAS NOT ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE.

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 6/2/26 12:38 - U:\GI8\PROJECTS\2025\W-25-026.GPJ

APPENDIX V

LABORATORY TEST RESULTS

6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

UNCONFINED COMPRESSION

ASTM D2166

PROJECT	WYA-23-3.47
JOB No.	W-25-026
BORING	B-004-0-25
STATION / OFFSET	312+46/ 23'LT
SAMPLE No. / DEPTH	ST-4 / 9'-9.5'
DATE OF TESTING	06/06/2025
TESTED BY	ML

Soil Description: Silt and Clay
Soil Classification: A-6a (9)

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	Sand%	Silt%	Clay%
	29	17	12	2.0	21.0	39.0	38.0

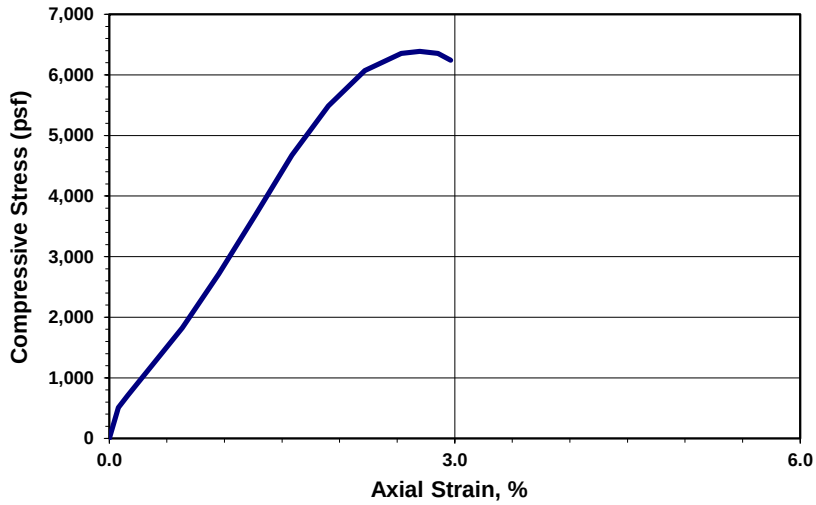
DIAMETER, D_0	2.880 in	73.2 mm	STRAIN RATE	1.50	%/min
AREA, A_0	6.514 in^2	42.0 cm^2	WET SOIL + PAN MASS	1569.6	g
HEIGHT, L_0	6.309 in	160.24 mm	PAN MASS	103.1	g
VOLUME, V_0	41.097 in^3	673.46 cm^3	DRY SOIL + PAN MASS	1376.8	g
MACH. RATE	0.095	in/min	WET DENSITY	135.94	lb/ft^3
WATER CONT.	15.14	%	DRY DENSITY	118.07	lb/ft^3

UNCONFINED COMPRESSION STRESS, q_u	**6,388** **psf**	3.19	tsf
AXIAL STRAIN @ FAILURE		2.69	%
HAND PENETROMETER		4.5+	tsf

Failure Sketch



Unconfined Compression Test



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

UNCONFINED COMPRESSION

ASTM D2166

PROJECT	WYA-23-3.47
JOB No.	W-25-026
BORING	B-004-0-25 (offset)
STATION / OFFSET	
SAMPLE No. / DEPTH	ST-1 / 21'-21.5'
DATE OF TESTING	06/06/2025
TESTED BY	ML

Soil Description: Sandy Silt
Soil Classification:

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	Sand%	Silt%	Clay%
	25	16	9	1.0	16.0	48.0	35.0

DIAMETER, D_0	2.862	in	72.7	mm		
AREA, A_0	6.433	in^2	41.5	cm^2		
HEIGHT, L_0	6.121	in	155.46	mm		
VOLUME, V_0	39.376	in^3	645.25	cm^3		
MACH. RATE	0.092	in/min				
WATER CONT.	15.75	%				

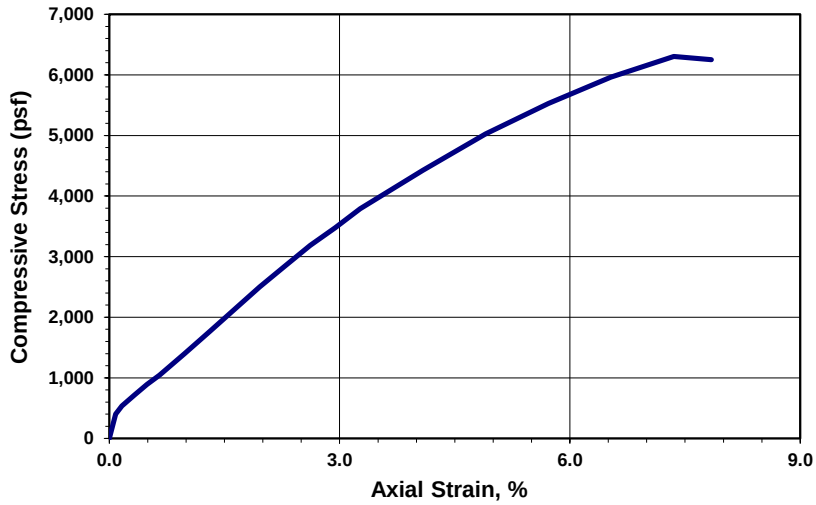
STRAIN RATE	1.50	%/min		
WET SOIL + PAN MASS	1524.6	g		
PAN MASS	116.6	g		
DRY SOIL + PAN MASS	1333.1	g		
WET DENSITY	136.22	lb/ft^3		
DRY DENSITY	117.69	lb/ft^3		

UNCONFINED COMPRESSION STRESS, q_u	**6,304**	**psf**	3.15	tsf
AXIAL STRAIN @ FAILURE			7.35	%
HAND PENETROMETER			4.5+	tsf

Failure Sketch



Unconfined Compression Test



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

UNCONFINED COMPRESSION

ASTM D2166

PROJECT	WYA-23-3.47
JOB No.	W-25-026
BORING	B-005-025
STATION / OFFSET	312+93/ 35' RT
SAMPLE No. / DEPTH	ST-8 / 19.5'-20'
DATE OF TESTING	06/06/2025
TESTED BY	ML

Soil Description: Sandy Silt
Soil Classification: A-4a (6)

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	Sand%	Silt%	Clay%
	24	15	9	10.0	25.0	36.0	29.0

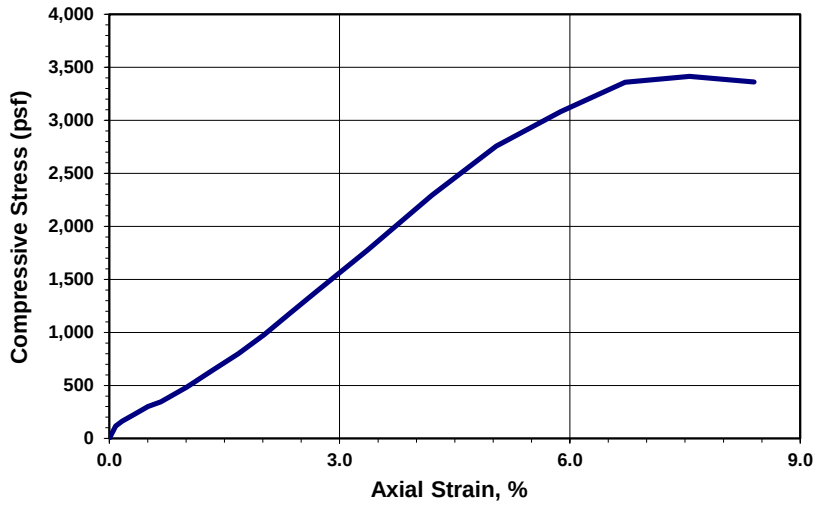
DIAMETER, D_0	2.809	in	71.4	mm	STRAIN RATE	2.00 %/min
AREA, A_0	6.199	in^2	40.0	cm^2	WET SOIL + PAN MASS	1420.2 g
HEIGHT, L_0	5.953	in	151.21	mm	PAN MASS	110.6 g
VOLUME, V_0	36.903	in^3	604.72	cm^3	DRY SOIL + PAN MASS	1219.3 g
MACH. RATE	0.119	in/min			WET DENSITY	135.19 lb/ft^3
WATER CONT.	18.12	%			DRY DENSITY	114.45 lb/ft^3

UNCONFINED COMPRESSION STRESS, q_u	**3,415**	**psf**	1.71 tsf
AXIAL STRAIN @ FAILURE			7.56 %
HAND PENETROMETER			2.75 tsf

Failure Sketch



Unconfined Compression Test



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

UNCONFINED COMPRESSION

ASTM D2166

PROJECT	WYA-23-3.47
JOB No.	W-25-026
BORING	B-007-0-25
STATION / OFFSET	314+89 / 56' LT
SAMPLE No. / DEPTH	ST-10 / 24'-24.5'
DATE OF TESTING	07/01/2025
TESTED BY	ML

Soil Description: Silt and Clay
Soil Classification: A-6a

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	Sand%	Silt%	Clay%

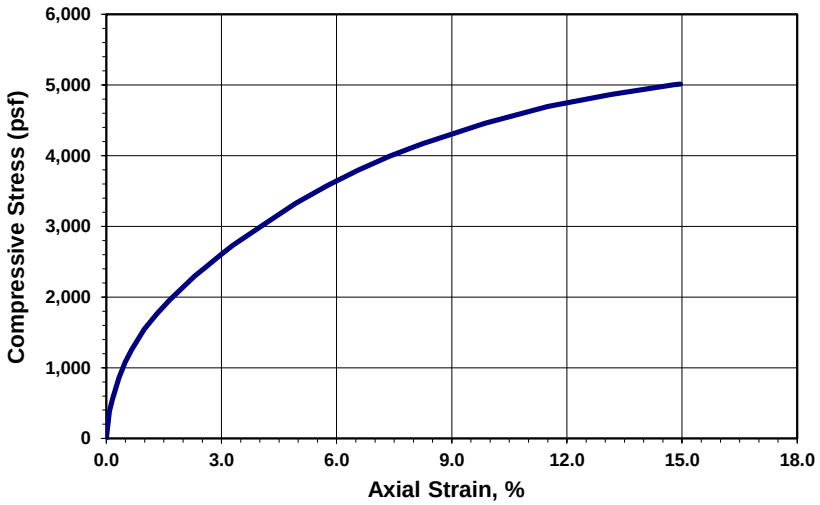
DIAMETER, D_0	2.849 in	72.4 mm	STRAIN RATE	2.00	%/min
AREA, A_0	6.376 in^2	41.1 cm^2	WET SOIL + PAN MASS	1610.1	g
HEIGHT, L_0	6.084 in	154.53 mm	PAN MASS	136.8	g
VOLUME, V_0	38.794 in^3	635.72 cm^3	DRY SOIL + PAN MASS	1462.3	g
MACH. RATE	0.122 in/min		WET DENSITY	144.68	lb/ft^3
WATER CONT.	11.16 %		DRY DENSITY	130.16	lb/ft^3

UNCONFINED COMPRESSION STRESS, q_u	**5,013** **psf**	2.51	tsf
AXIAL STRAIN @ FAILURE		14.96	%
HAND PENETROMETER		3.25	tsf

Failure Sketch



Unconfined Compression Test



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

UNCONFINED COMPRESSION

ASTM D2166

PROJECT	WYA-23-3.47
JOB No.	W-25-026
BORING	B-008-0-25
STATION / OFFSET	315+30/ 4' LT
SAMPLE No. / DEPTH	ST-9 / 22'-22.5'
DATE OF TESTING	06/06/2025
TESTED BY	ML

Soil Description: Silt
Soil Classification: A-4b (8)

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	Sand%	Silt%	Clay%
	23	18	5	6.0	16.0	59.0	23.0

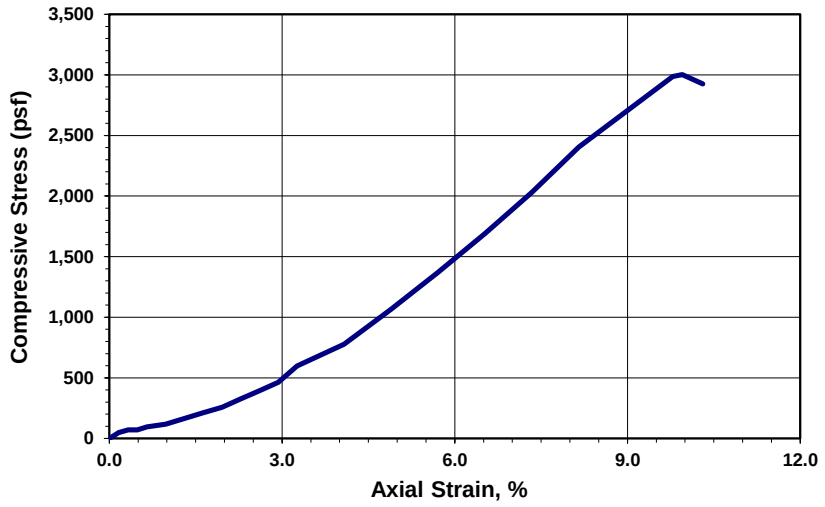
DIAMETER, D_0	2.775	in	70.5	mm	STRAIN RATE	2.00 %/min
AREA, A_0	6.047	in^2	39.0	cm^2	WET SOIL + PAN MASS	1477.9 g
HEIGHT, L_0	6.131	in	155.74	mm	PAN MASS	138.9 g
VOLUME, V_0	37.074	in^3	607.53	cm^3	DRY SOIL + PAN MASS	1261.1 g
MACH. RATE	0.123	in/min			WET DENSITY	137.60 lb/ft^3
WATER CONT.	19.32	%			DRY DENSITY	115.31 lb/ft^3

UNCONFINED COMPRESSION STRESS, q_u	**3,002**	**psf**	1.50	tsf
AXIAL STRAIN @ FAILURE			9.95	%
HAND PENETROMETER			4.5+	tsf

Failure Sketch



Unconfined Compression Test



RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Uniaxial Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: WAY-23-3.47
Project No.: W-25-026
Date of Testing: 6/3/2025
Test Performed by: KL/EM

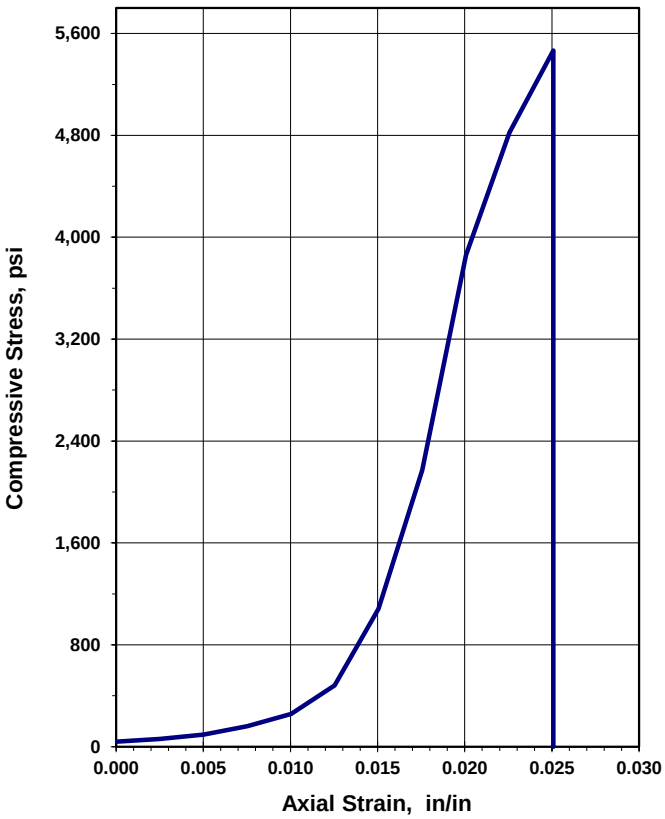
Rock Description: Gray Dolomite
Rock Formation:

Boring No.:	B-006-0-25		Average Length:	3.987	in
Sample No:	RC-2		Average Diameter:	1.997	in
Depth (ft):	42.1'	feet	Length to diameter ratio:	1.996	
Moisture condition:	As received		Cross Sectional Area:	3.132	in^2
Sample Mass:	568.50	grams	Volume:	0.0072	ft^3
Testing Temperature:	23	^oC	Unit Weight (sample specimen)*:	173.42	lbs/ft3
Rate of Loading:	60.7	lbs/sec	Failure Load:	17,120	lbs
Testing Time:	282	sec	Axial Strain at Failure:	0.0251	in/in
(Rate 2-15 mir			Compressive Strength:	5,466	psi

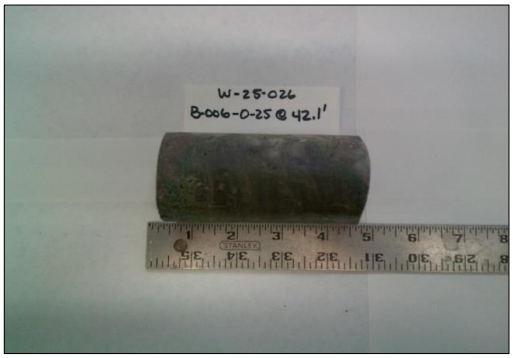
Sample Preparation: Per ASTM D4543

**Actual test sample used for unit weight prior to testing.*

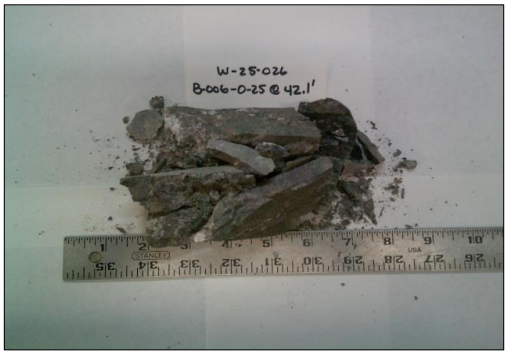
Unconfined Compression Test



Before Testing



After Failure



REMARKS:

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Uniaxial Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: WAY-23-3.47
Project No.: W-25-026
Date of Testing: 7/3/2025
Test Performed by: KL/EM

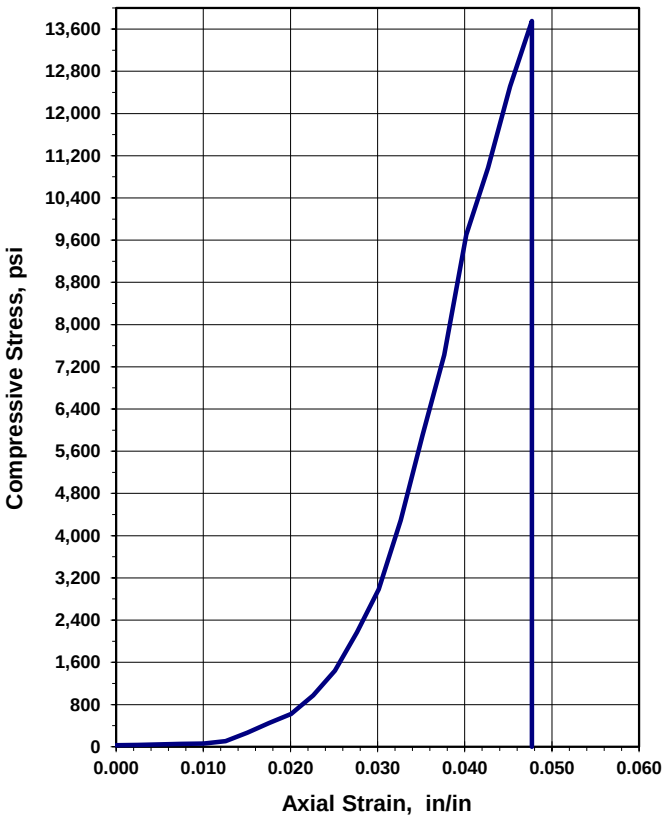
Rock Description: Gray Dolomite
Rock Formation:

Boring No.:	B-004-0-25		Average Length:	3.983	in
Sample No:	RC-2		Average Diameter:	1.997	in
Depth (ft):	54.7'	feet	Length to diameter ratio:	1.994	
Moisture condition:	As received		Cross Sectional Area:	3.132	in^2
Sample Mass:	535.08	grams	Volume:	0.0072	ft^3
Testing Temperature:	23	^oC	Unit Weight (sample specimen)*:	163.39	lbs/ft3
Rate of Loading:	99.7	lbs/sec	Failure Load:	43,076	lbs
Testing Time:	432	sec	Axial Strain at Failure:	0.0477	in/in
(Rate 2-15 mir			Compressive Strength:	13,753	psi

Sample Preparation: Per ASTM D4543

**Actual test sample used for unit weight prior to testing.*

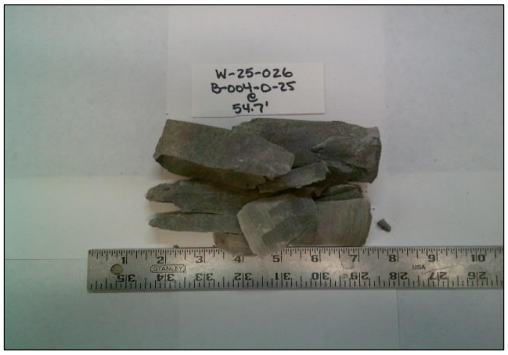
Unconfined Compression Test



Before Testing



After Failure



REMARKS:

RESOURCE INTERNATIONAL, INC.

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Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: WAY-23-3.47
Project No.: W-25-026
Date of Testing: 7/3/2025
Test Performed by: EM/KL

Rock Description: Dolomite

Boring No.: B-008-0-25
Sample: RC-3
Depth: 43.9' -45.2'

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 4/19/2024

Sample No.	Test Type	Depth (ft)	W (mm)	D (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (MPa)	$Is_{(50)}$ (MPa)	σ_c (MPa)
1	a ⊥	43.9-45.2	50.5	28.1	16,429	1,808	42.5	0.93	9.09	8.45	218.08
2	a ⊥	43.9-45.2	50.5	29.7	15,984	1,913	43.7	0.94	8.36	7.87	200.58
3	a ⊥	43.9-45.2	50.5	26.1	13,737	1,678	41.0	0.91	8.19	7.48	196.47
4	a ⊥	43.9-45.2	50.5	24.5	13,110	1,576	39.7	0.90	8.32	7.50	199.59
5	a ⊥	43.9-45.2	50.5	26.4	15,526	1,698	41.2	0.92	9.14	8.38	219.44

STATISTICS	
Mean $Is_{(50)}$ ⊥	7.94 MPa (1151 psi)
Mean $Is_{(50)}$ ∥	
$Ia_{(50)}$	

Specific Specimen Shape:

d = diametrical
a = axial
b = block
i = irregular lump
⊥ = perpendicular to bedding plane
∥ = parallel to bedding plane

Estimated Uniaxial Compression, σ_c = K*Is

K = 24
*Per Section 206.1.3 of 2011 ODOT Rock Slope Design Guide

Mean σ_c = 206.83 MPa (29,998 psi)

Remarks:

One-Dimensional Consolidation Test Report (ASTM D2435)

Project Number:	W-25-026	Boring Number:	B-010-0-25
Project Name:	WYA-23-3.47	Sample No. / Depth:	ST-3 / 6.5'
Project Location:	Wyandot County, Ohio	Date of Testing:	05/23/2025 to 06/05/2025
Client:	E.L.Robinson Engineering	Technician:	W.Vennemeyer

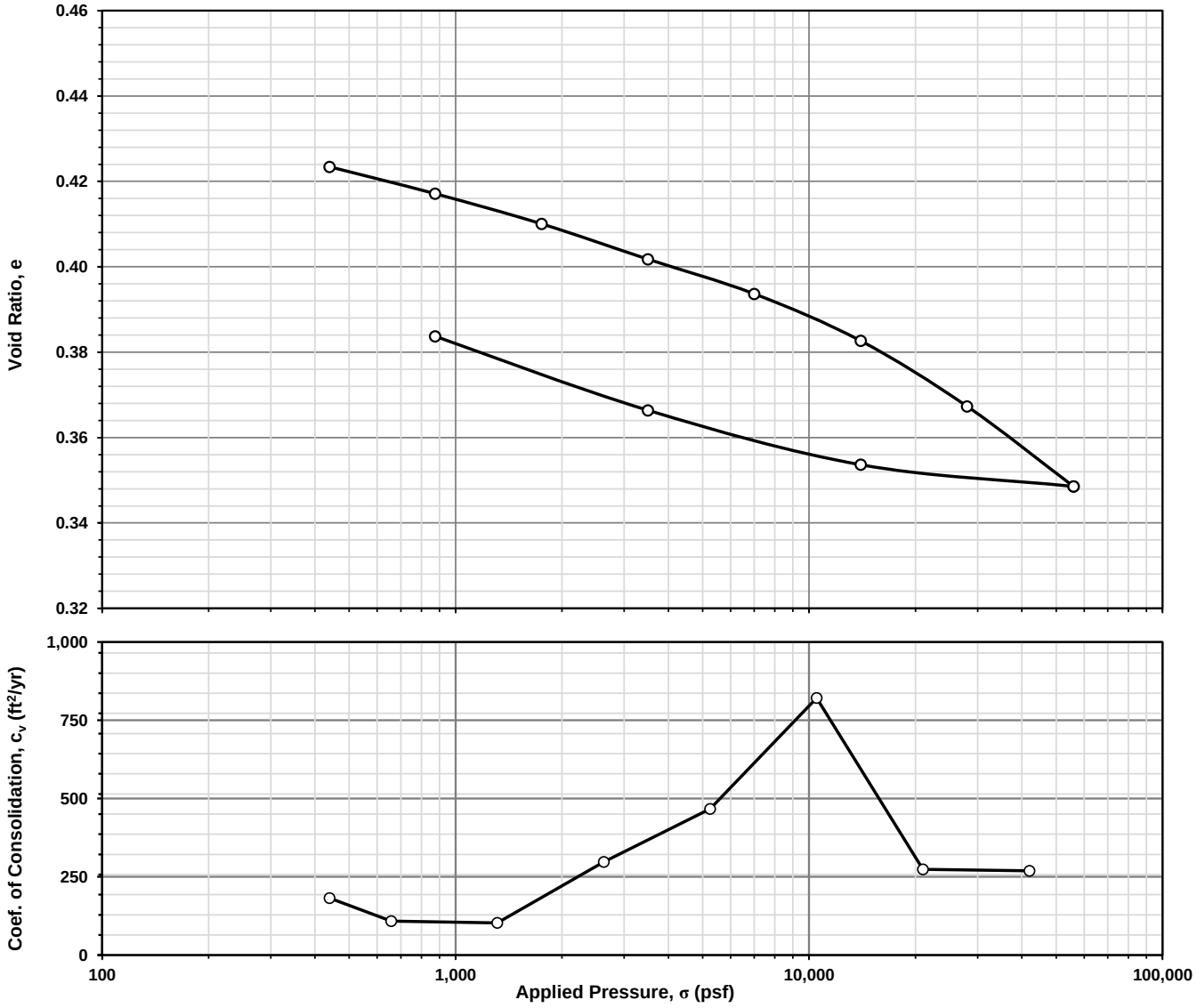
Soil Description: Brown Silt and Clay, some coarse to fine sand, little fine gravel.

Soil Classification: A-6a (8)

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	28	15	13	10.0	8.0	14.0	42.0	26.0

Natural		γ_d (pcf)	γ_{sat} (pcf)	σ_{vo}' (psf)	S_G	e_o	σ_p' [1] (psf)	c_c [1]	c_r [1]
S_o	w_o								
95.4%	15.1%	117.9	135.7	806	2.69	0.424	9,241	0.058	0.023

1. *The vaules listed for σ_p', c_c and c_r are interpreted by Rii using Cassagrande and Schemertman methods. Other interpretation methods may be utilized.*



Notes: _____

Client:	Resource International
Project Name:	W-25-026 WAY-23-3, 47
Project Location:	Wyandot Co., OH
GTX #:	321310

One-Dimensioinal Consolidation by ASTM D2435- Method B
Additional Requested Calculated Engineering Values

Boring ID	Sample ID	Depth	Test ID	Soil Description	Compression Ratio ($C_{c\Sigma}$)	Compression Index (C_c)	Recompression Ratio ($C_{r\Sigma}$)	Recompression Index (C_r)	Estimated Max Past Pressure, tsf
B-005	ST-8	18.5-20.5'	IP-1	Moist, gray sandy silt	0.03	0.03	0.005	0.007	---

Notes: Compression Ratio values are calculated from Strain vs Log p data and are also called Modified Compresion Index which have the following relationship with Compression Index values:

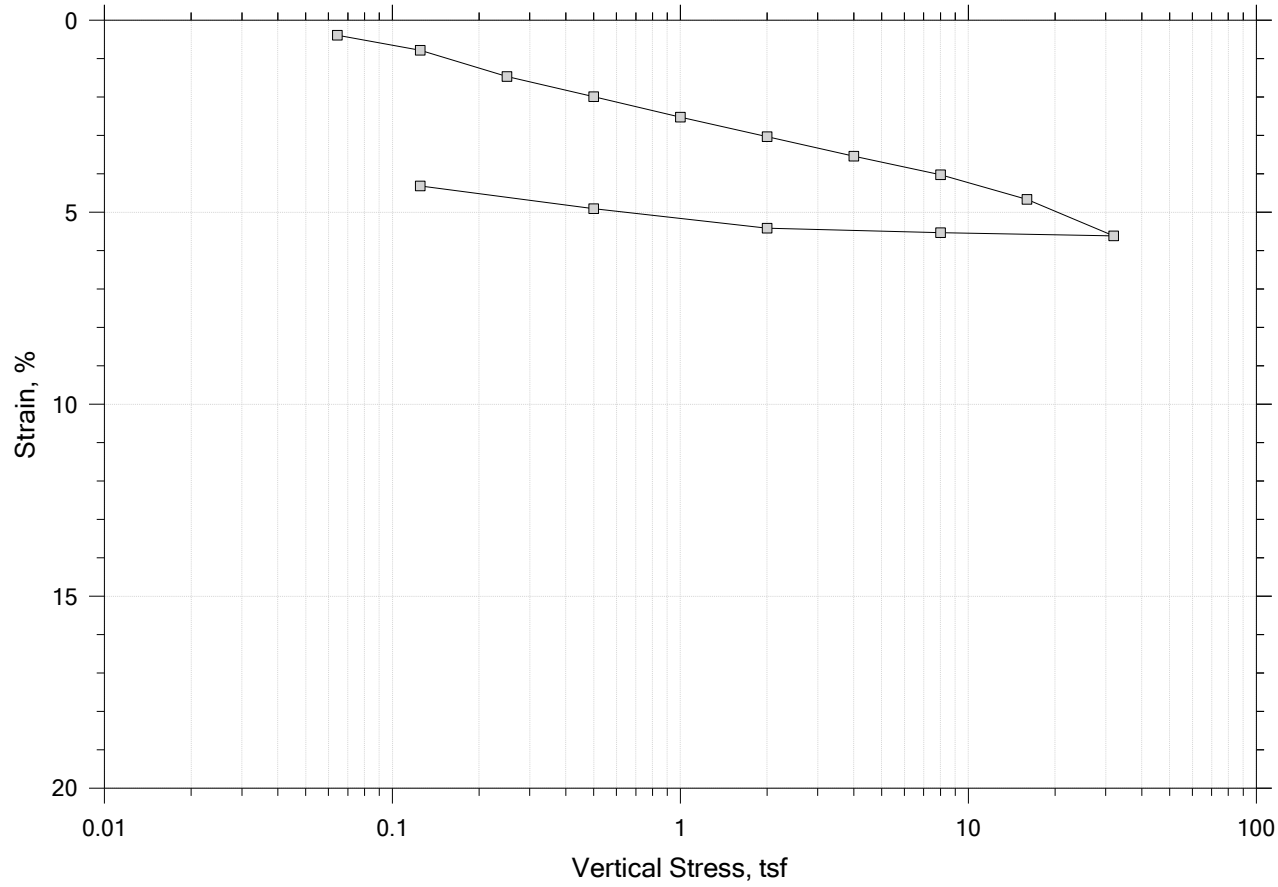
$$C_{c\Sigma} = C_c/(1+e_o)$$

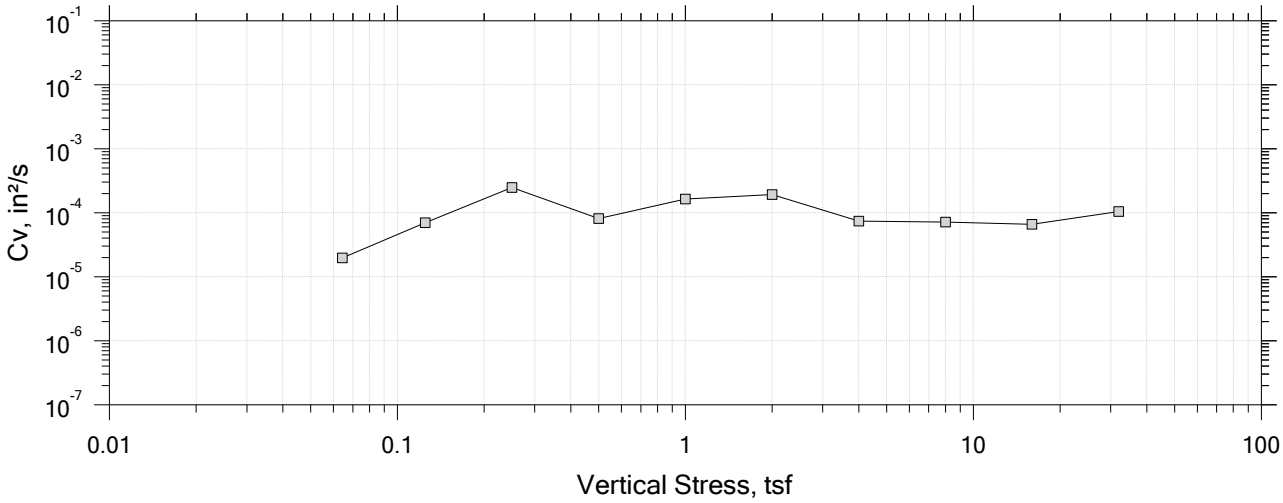
Compression Index values are calculated from Void Ratio Log p data.
Estimated Max Past Pressure values determined using the Casagrande Method.

Values determined from best-fit straight line to the data for the specific test conditions. Actual parameters may vary with other accepted interpretations and should be determined by an engineer for site-specific conditions.

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

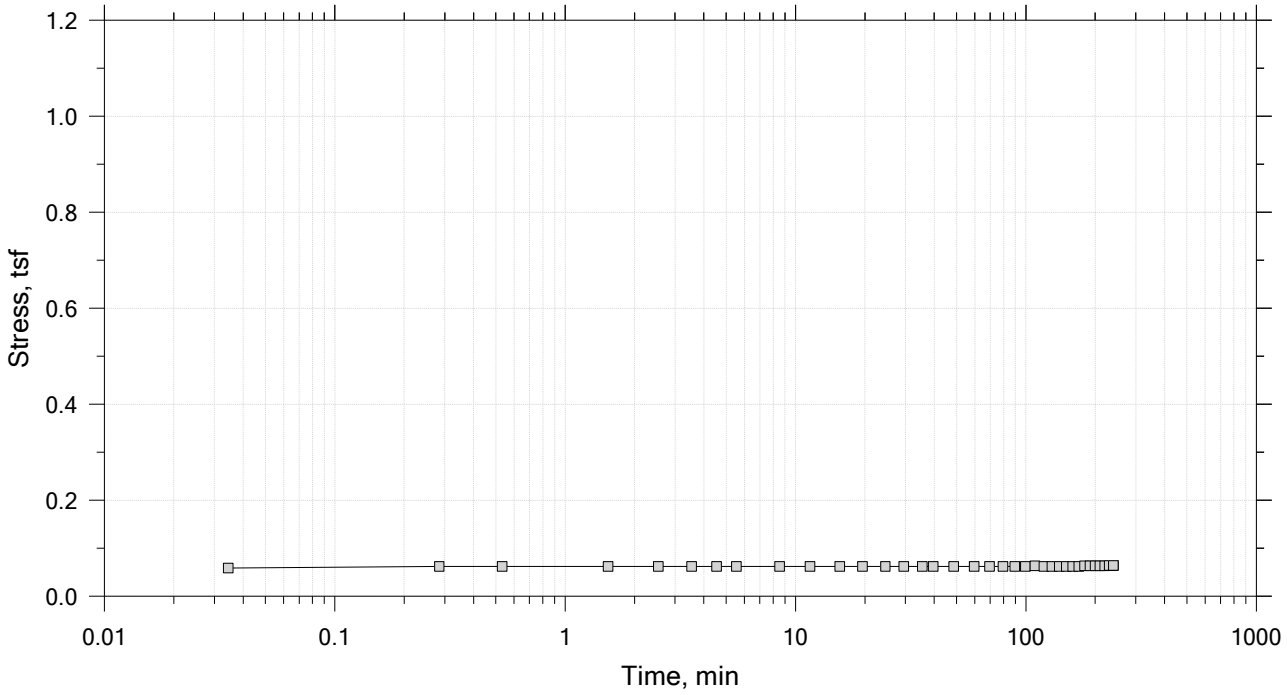


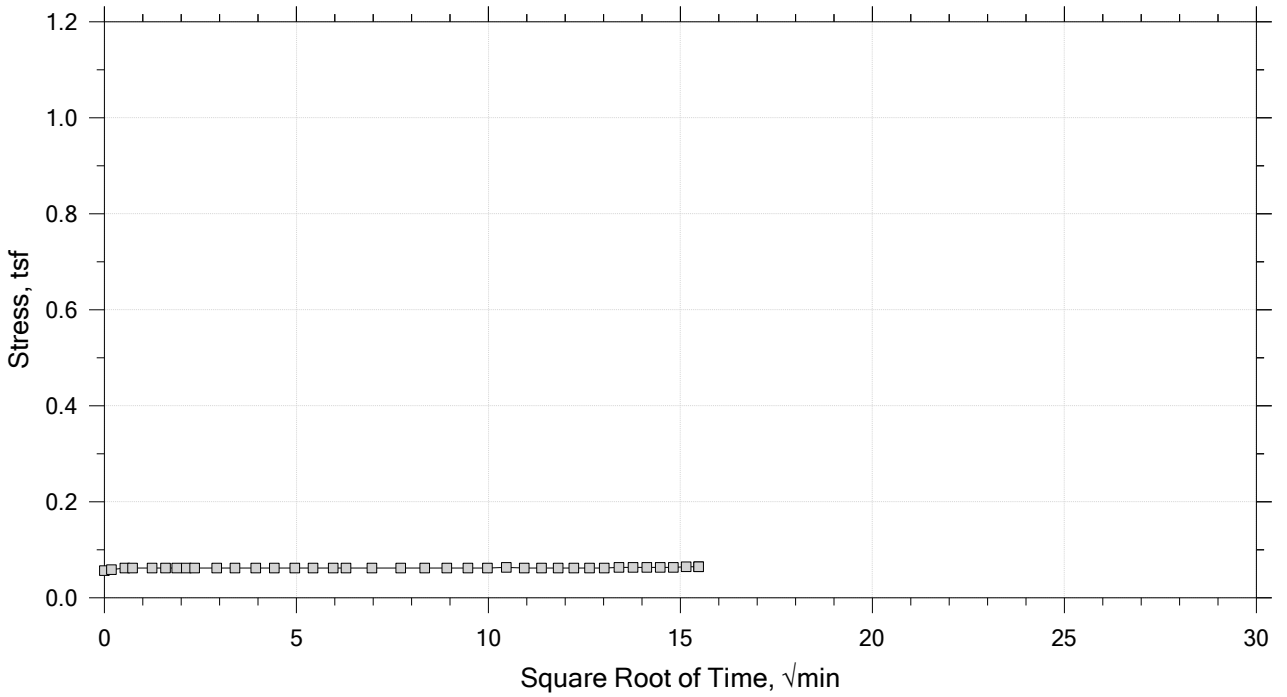


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 14
Constant Volume Step
Stress: 0.0644 tsf

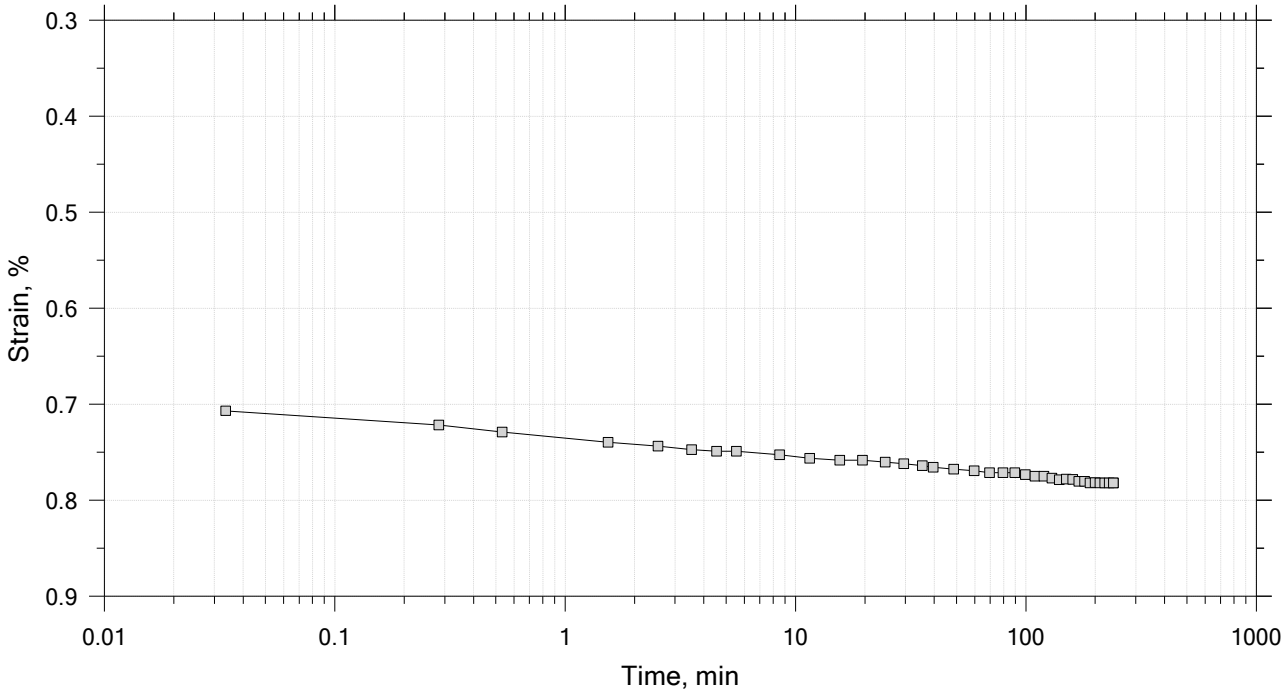


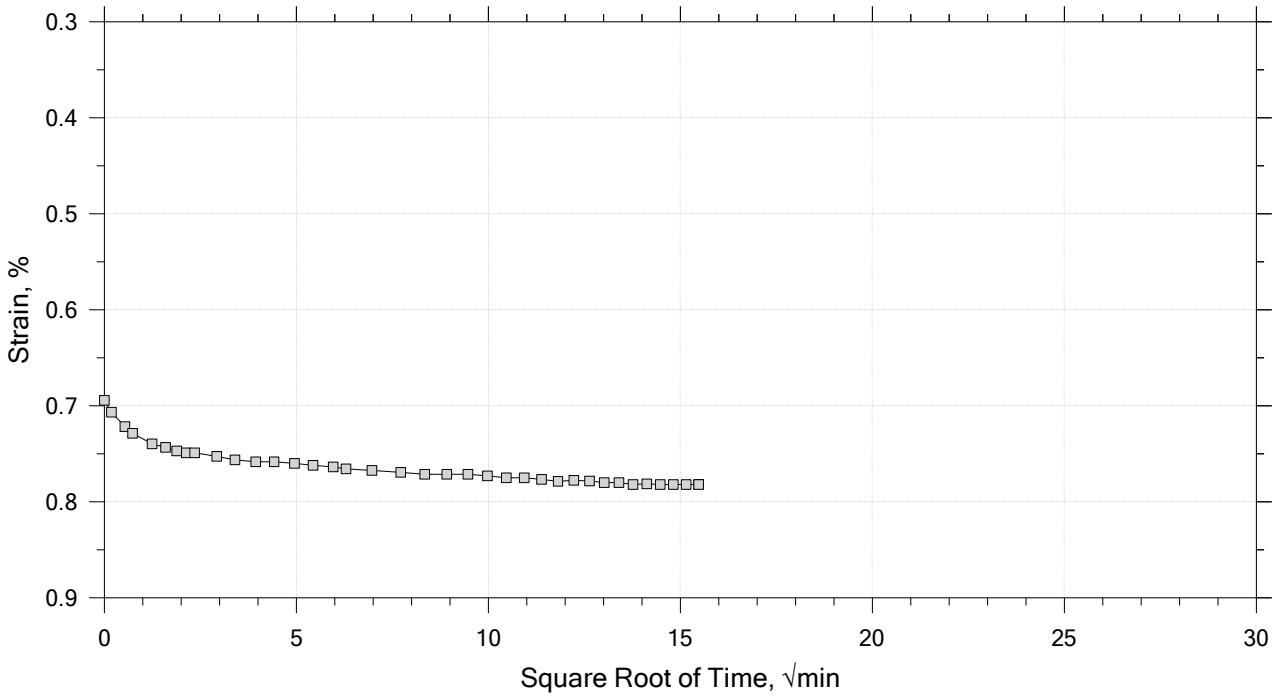


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 14
Constant Load Step
Stress: 0.125 tsf

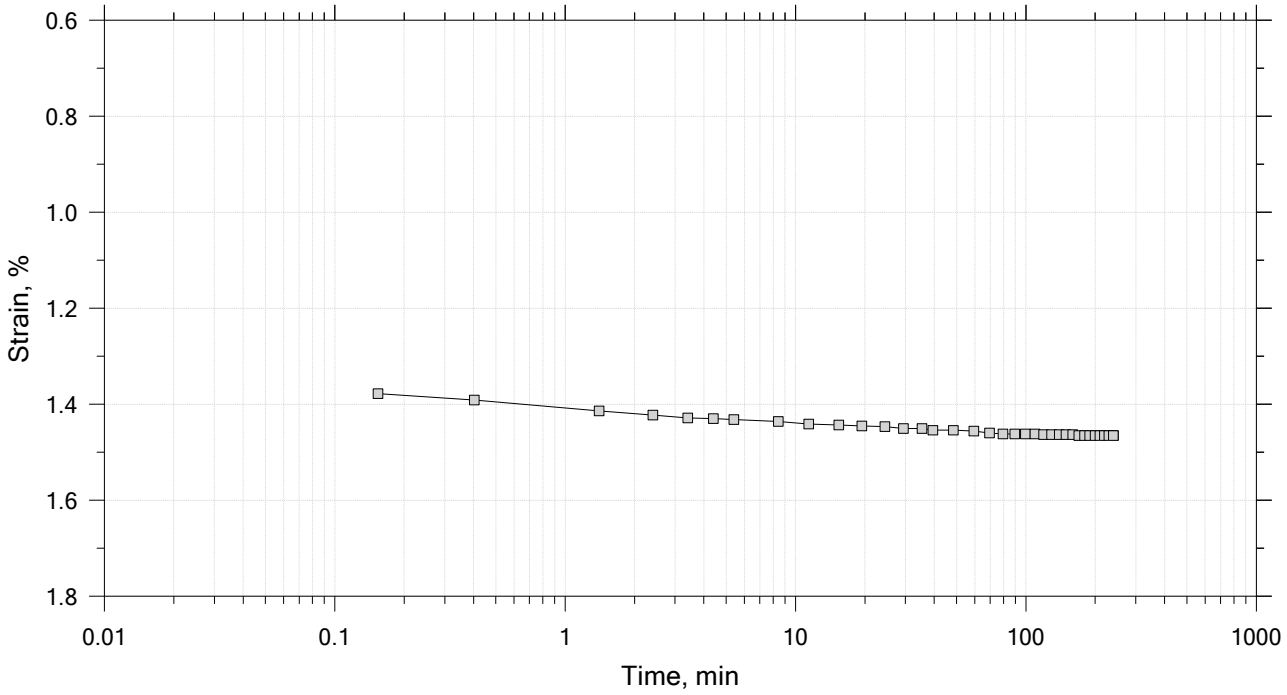


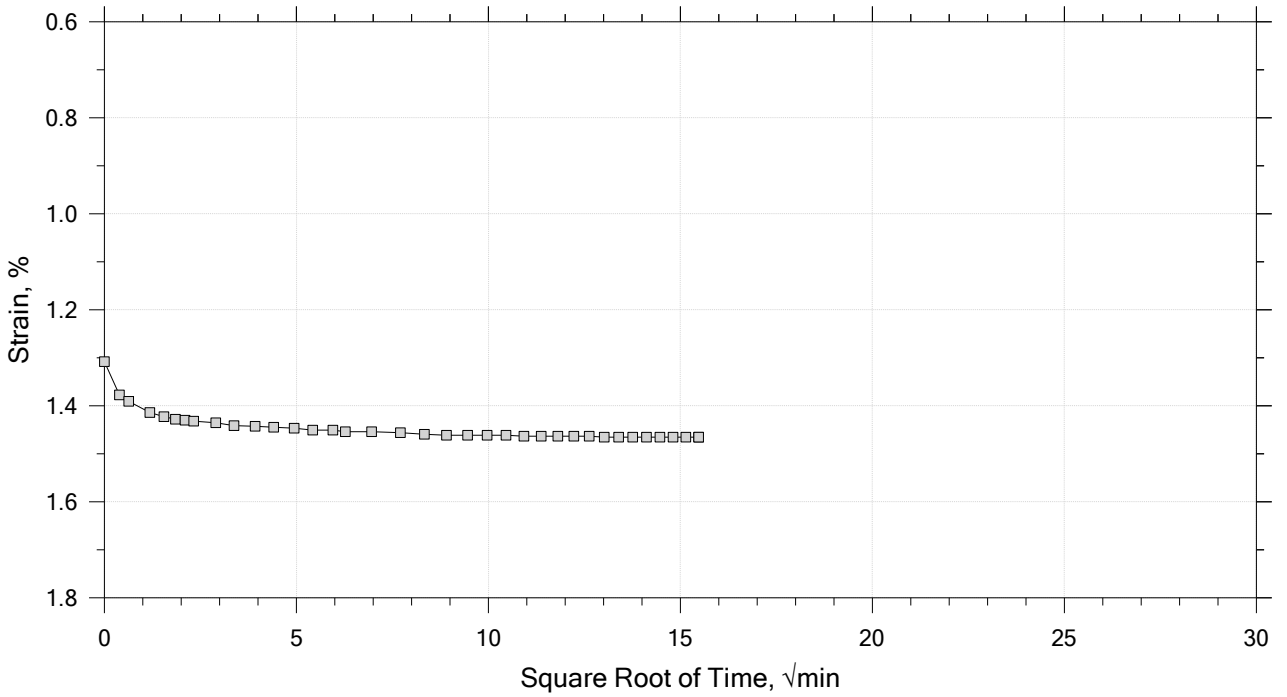


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 14
Constant Load Step
Stress: 0.25 tsf

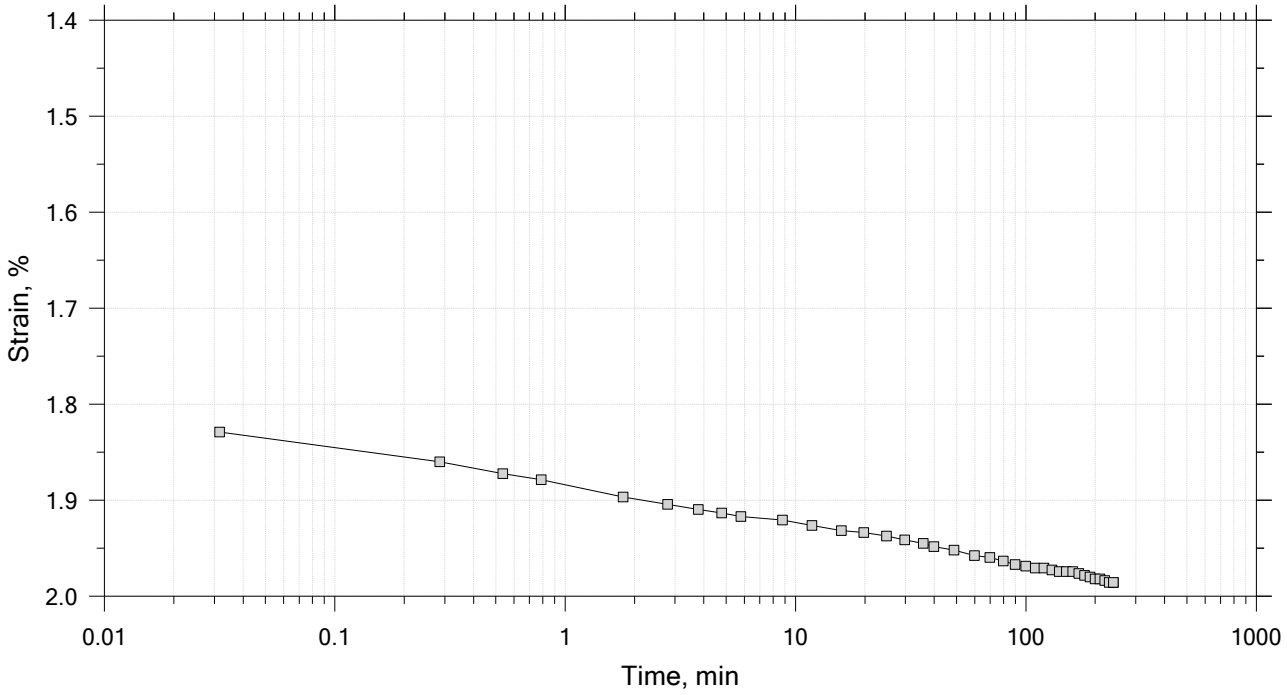


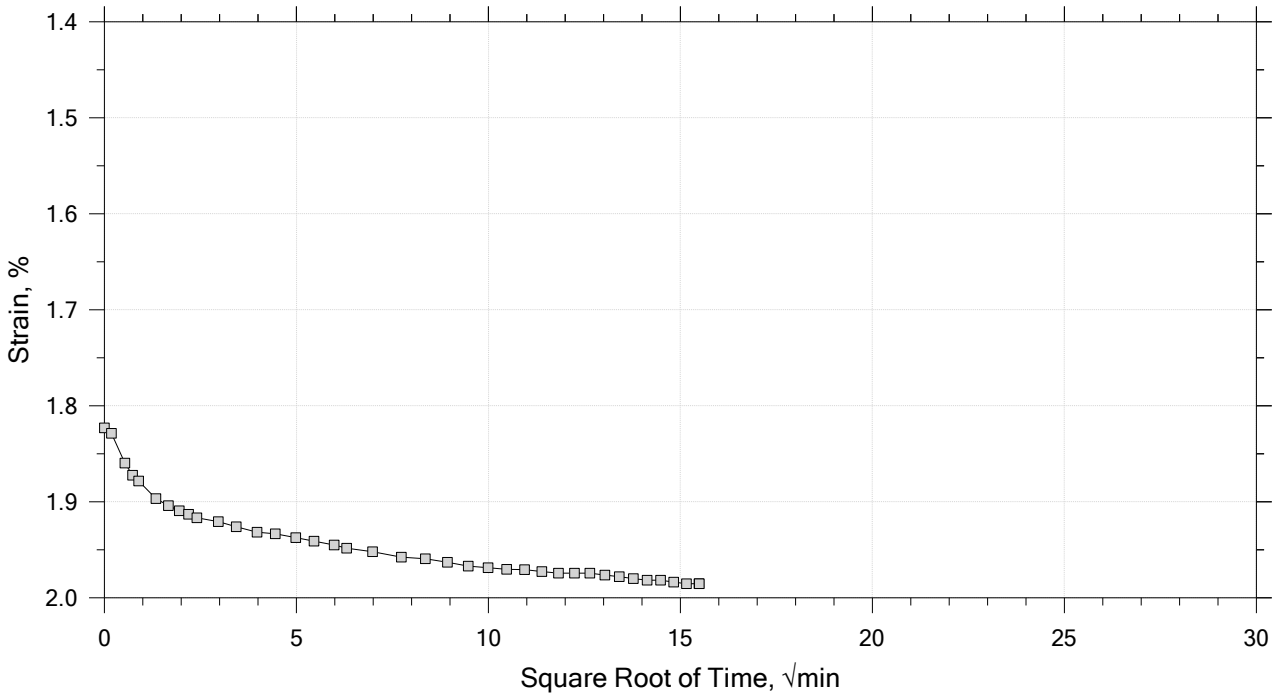


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 14
Constant Load Step
Stress: 0.5 tsf

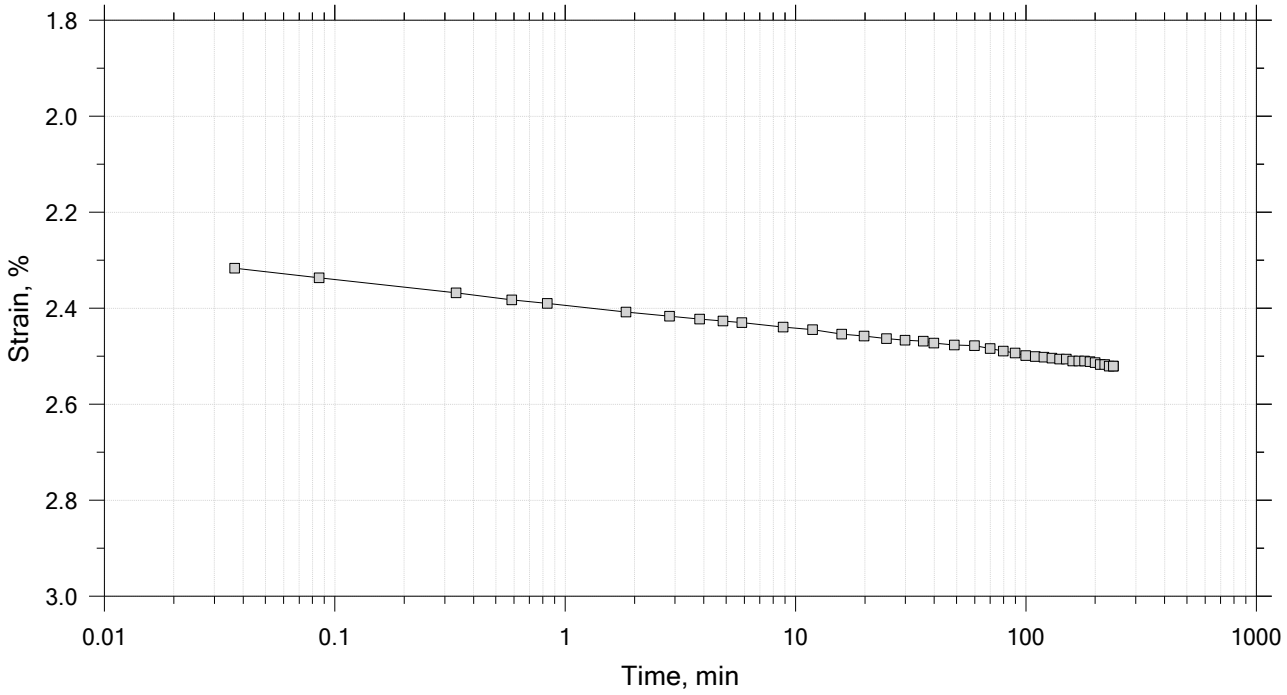


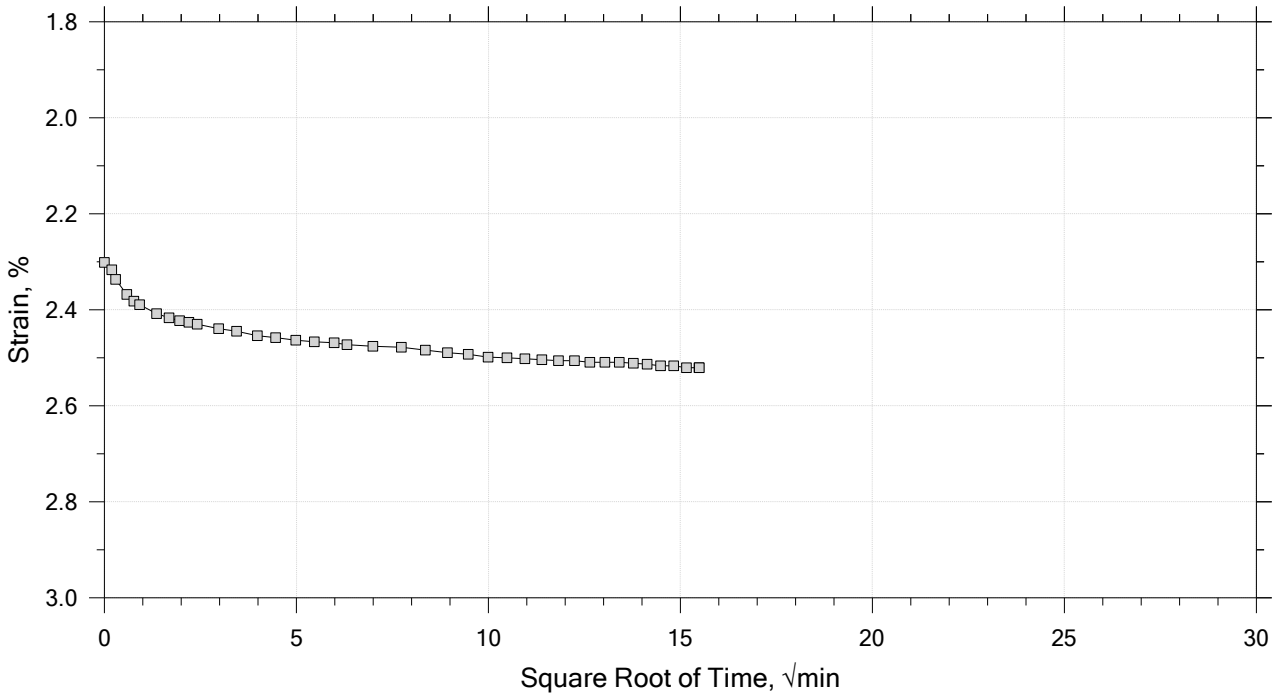


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 14
Constant Load Step
Stress: 1 tsf

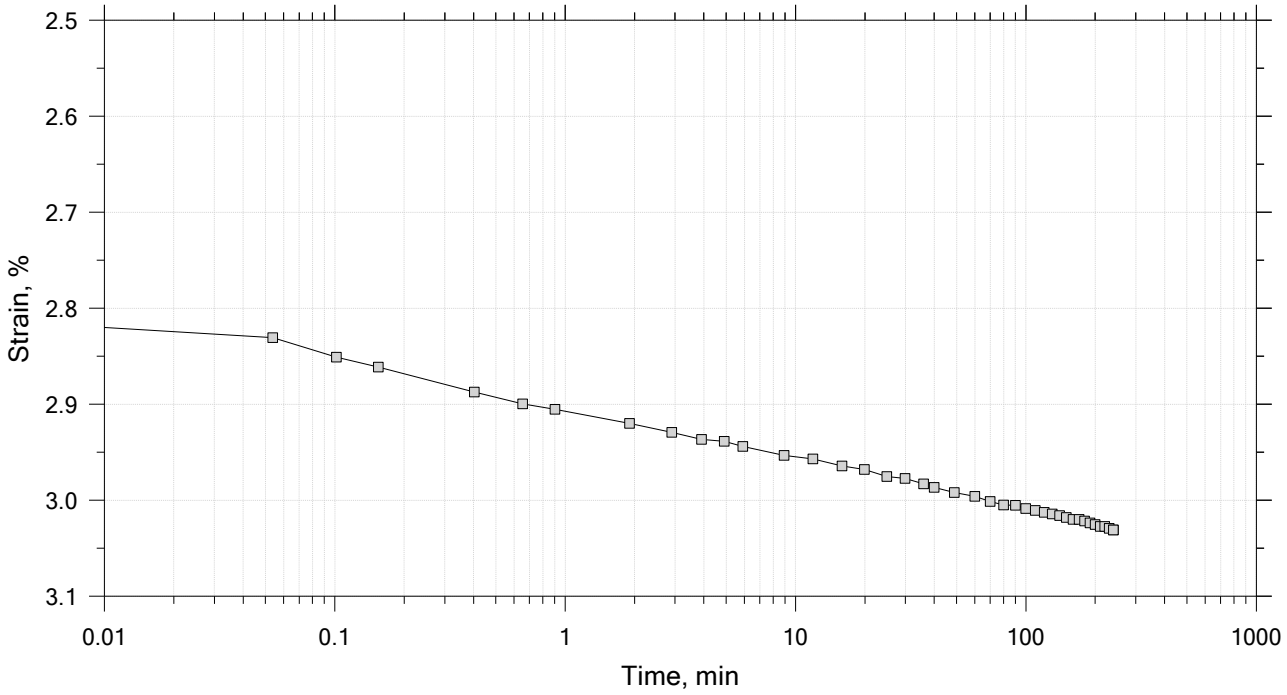


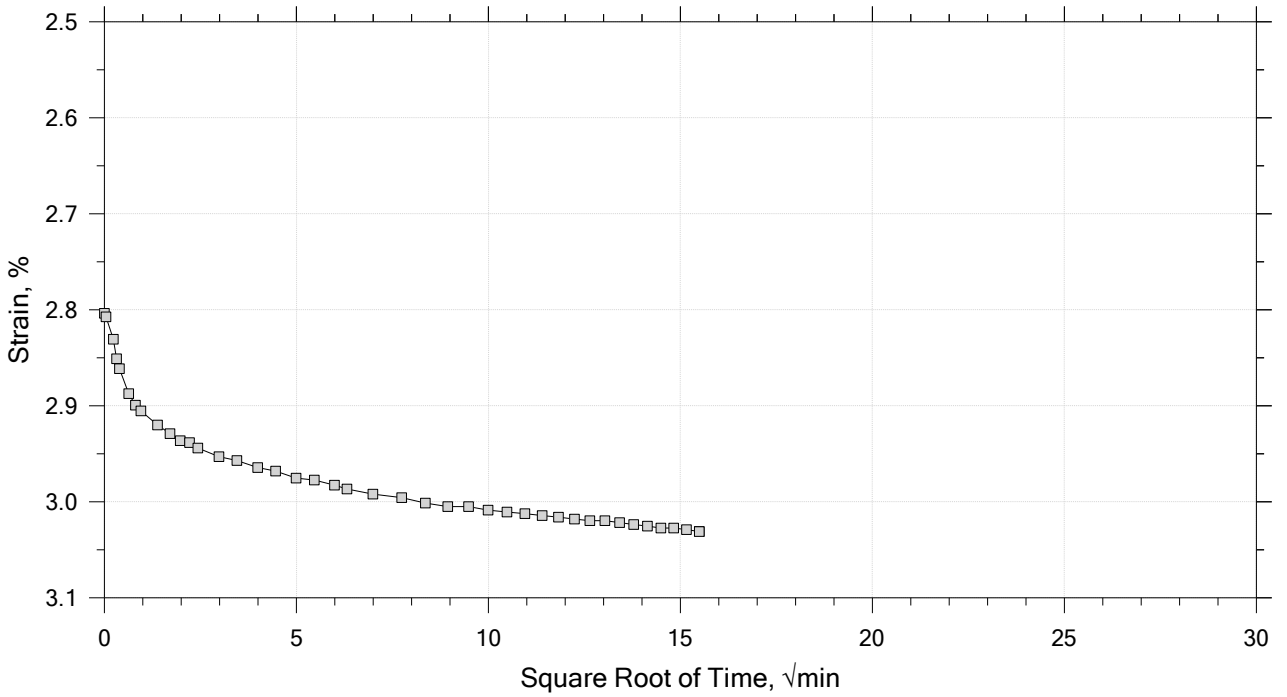


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 14
Constant Load Step
Stress: 2 tsf

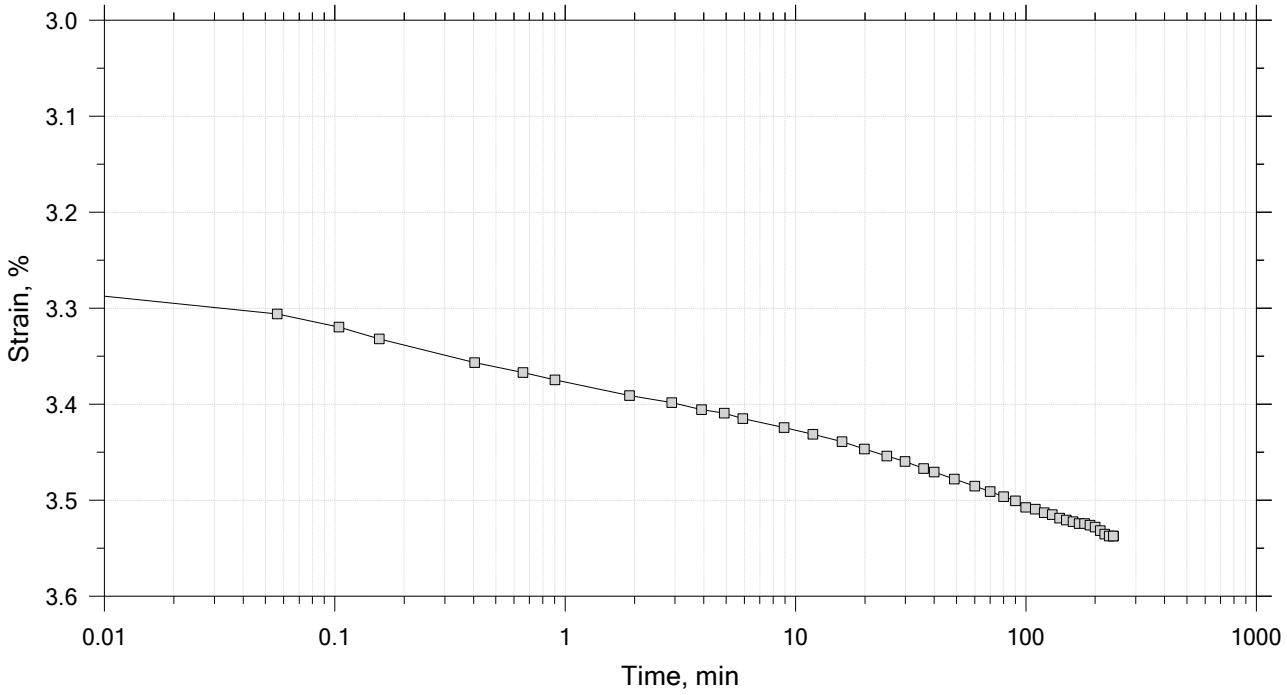


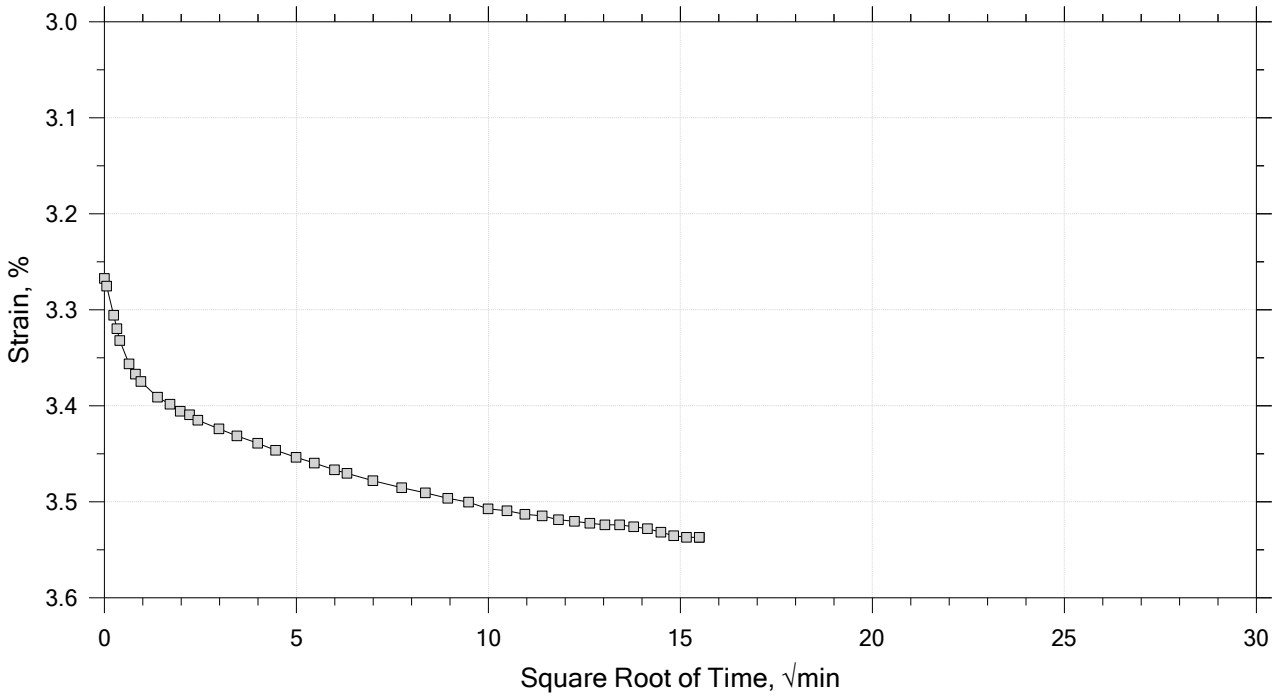


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 14
Constant Load Step
Stress: 4 tsf

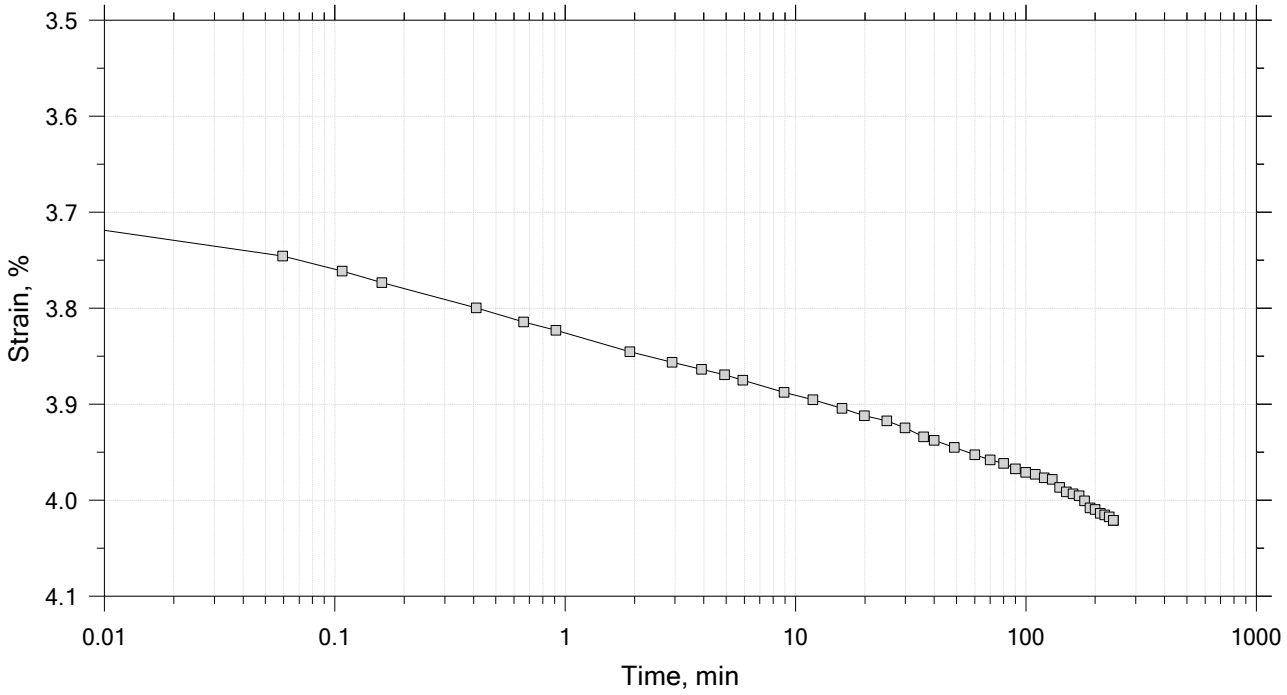


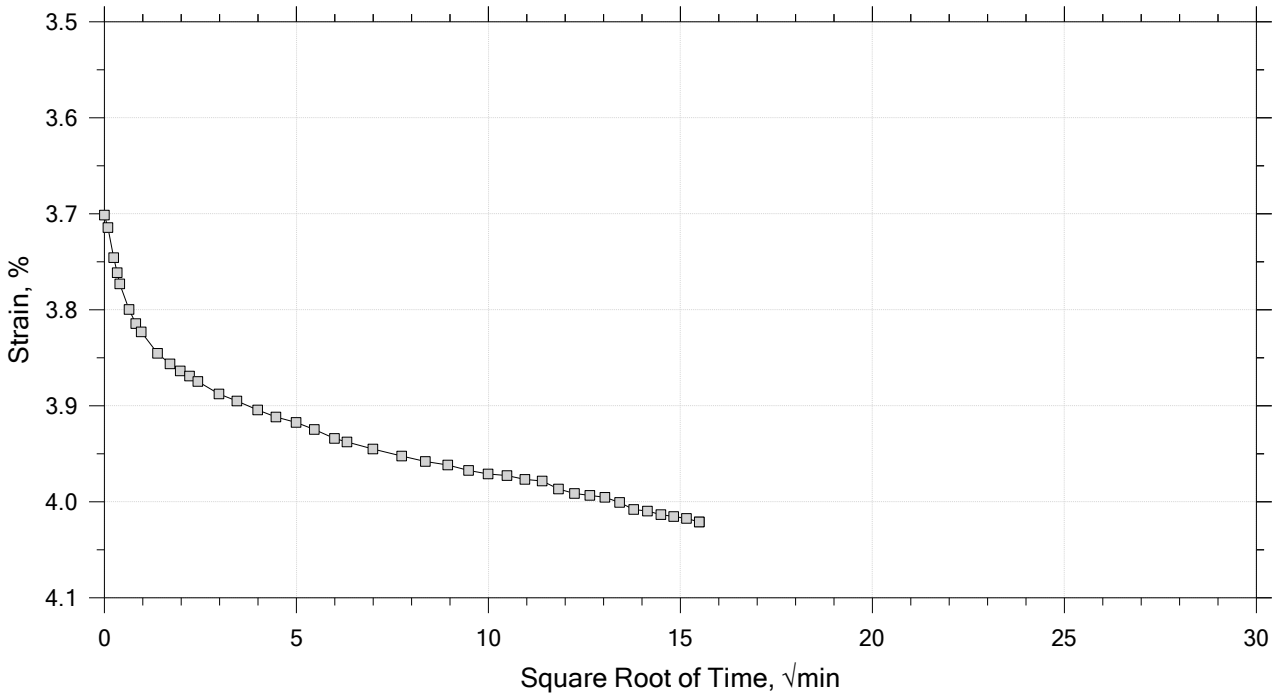


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 14
Constant Load Step
Stress: 8 tsf

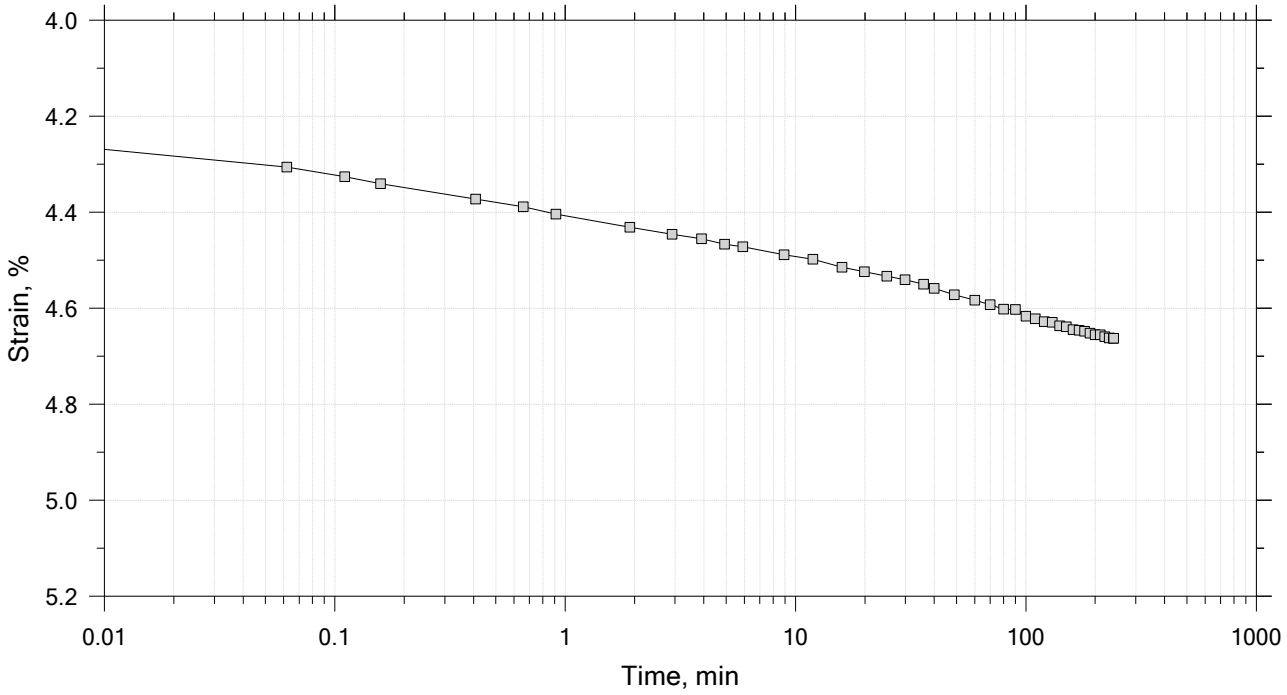


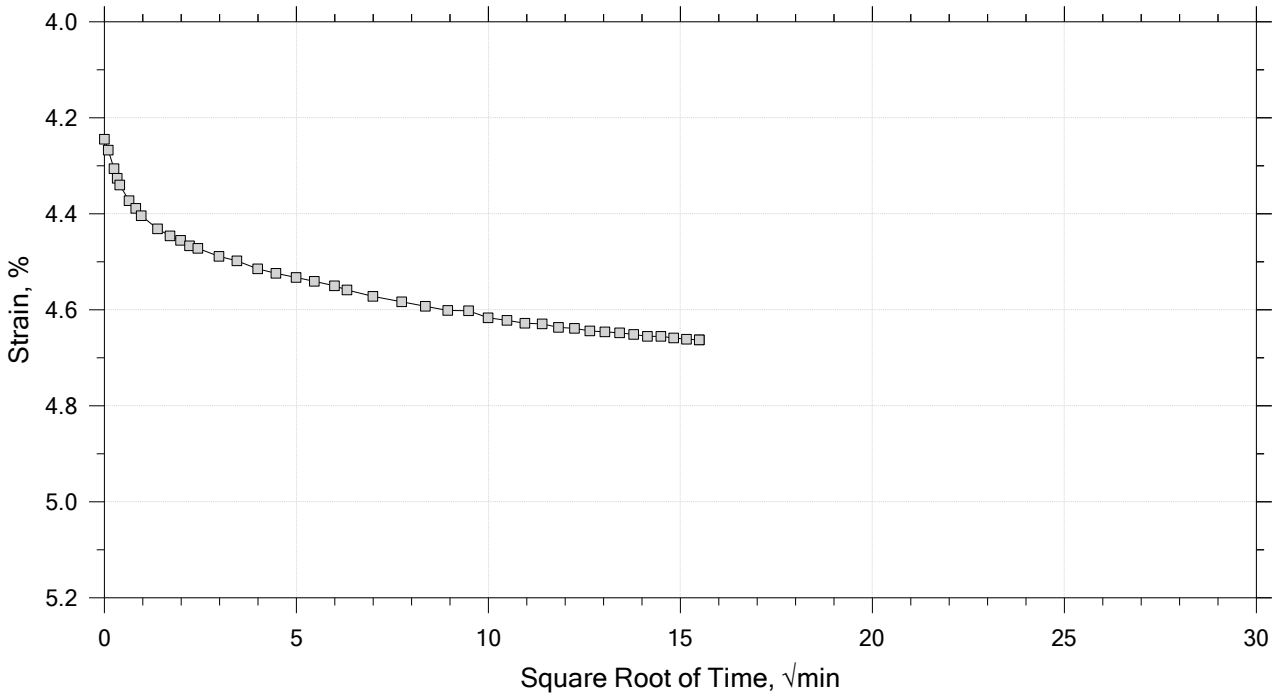


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 14
Constant Load Step
Stress: 16 tsf

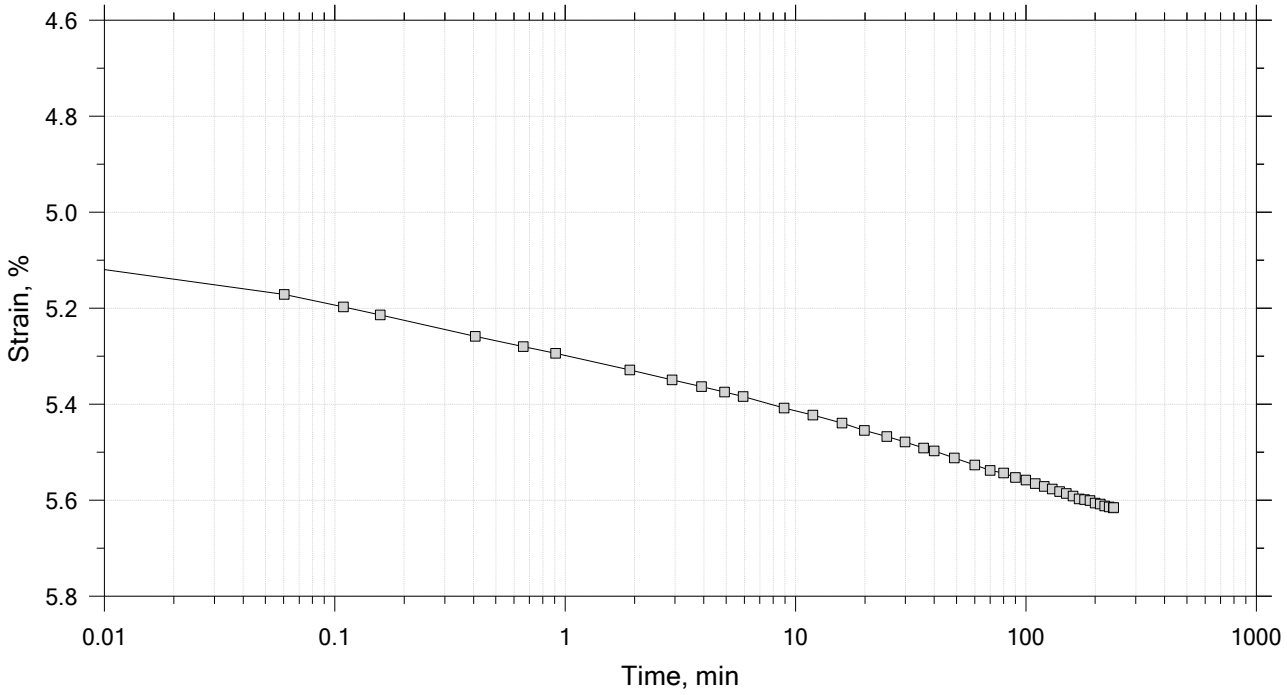


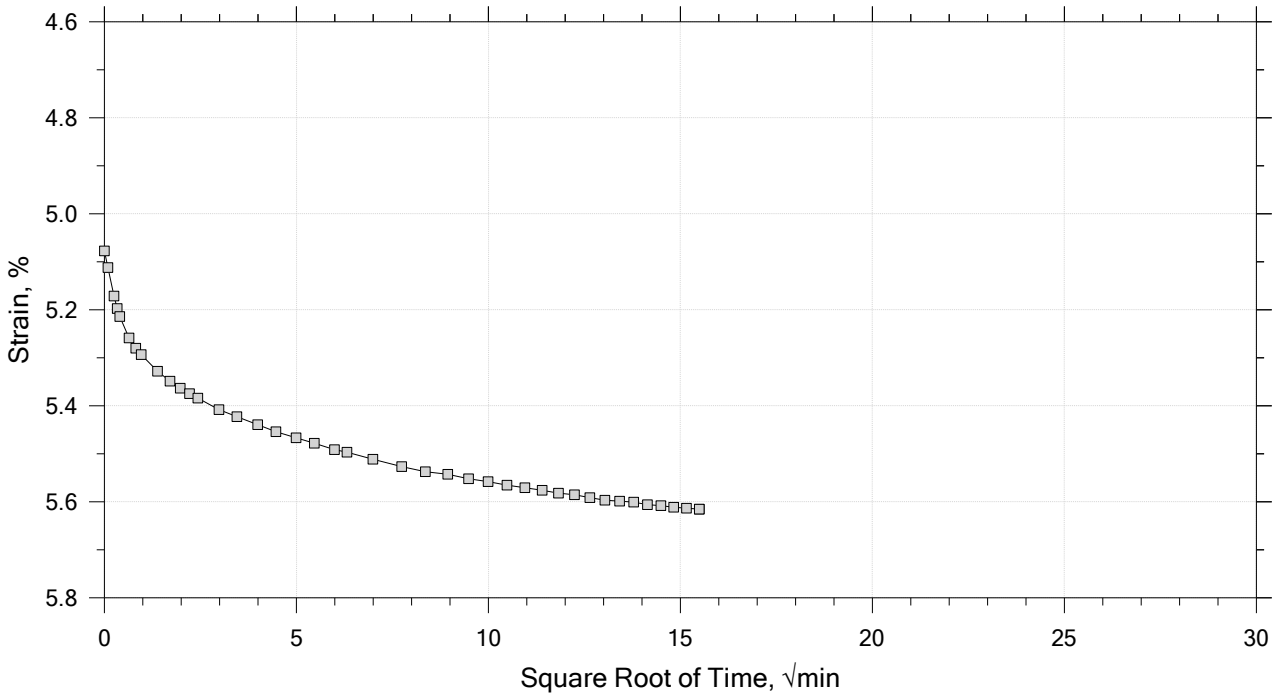


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 14
Constant Load Step
Stress: 32 tsf

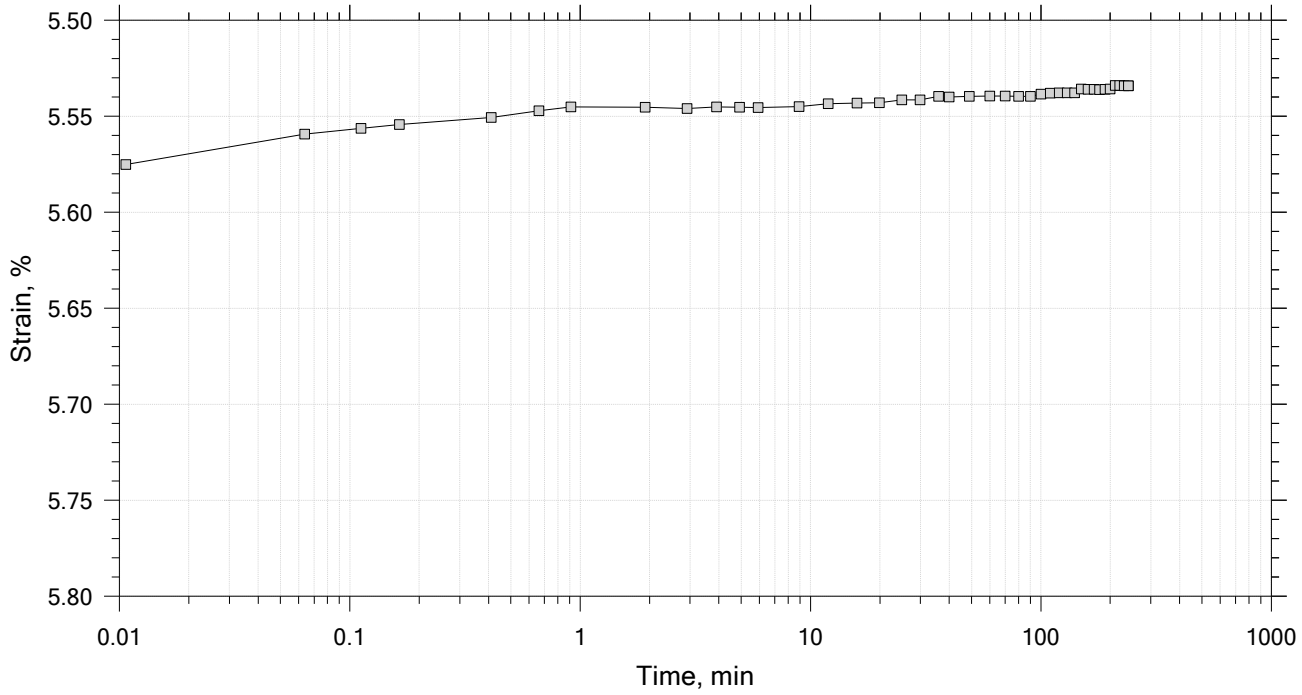


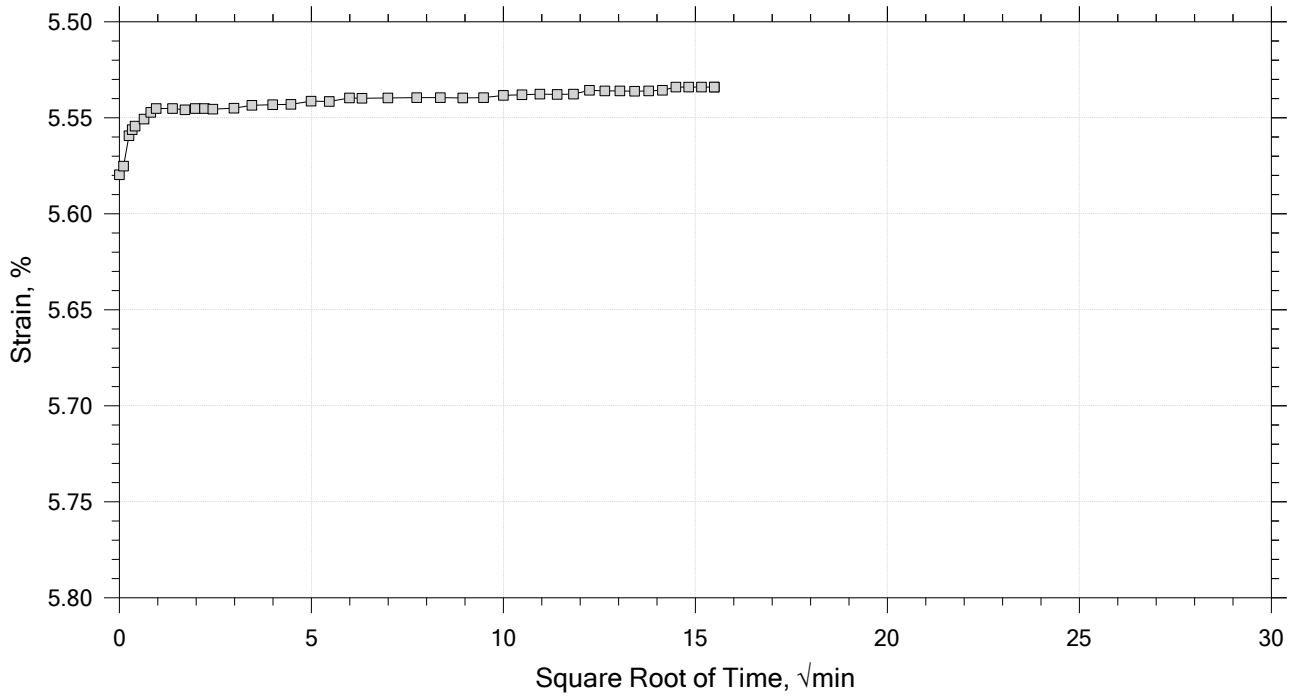


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 14
Constant Load Step
Stress: 8 tsf

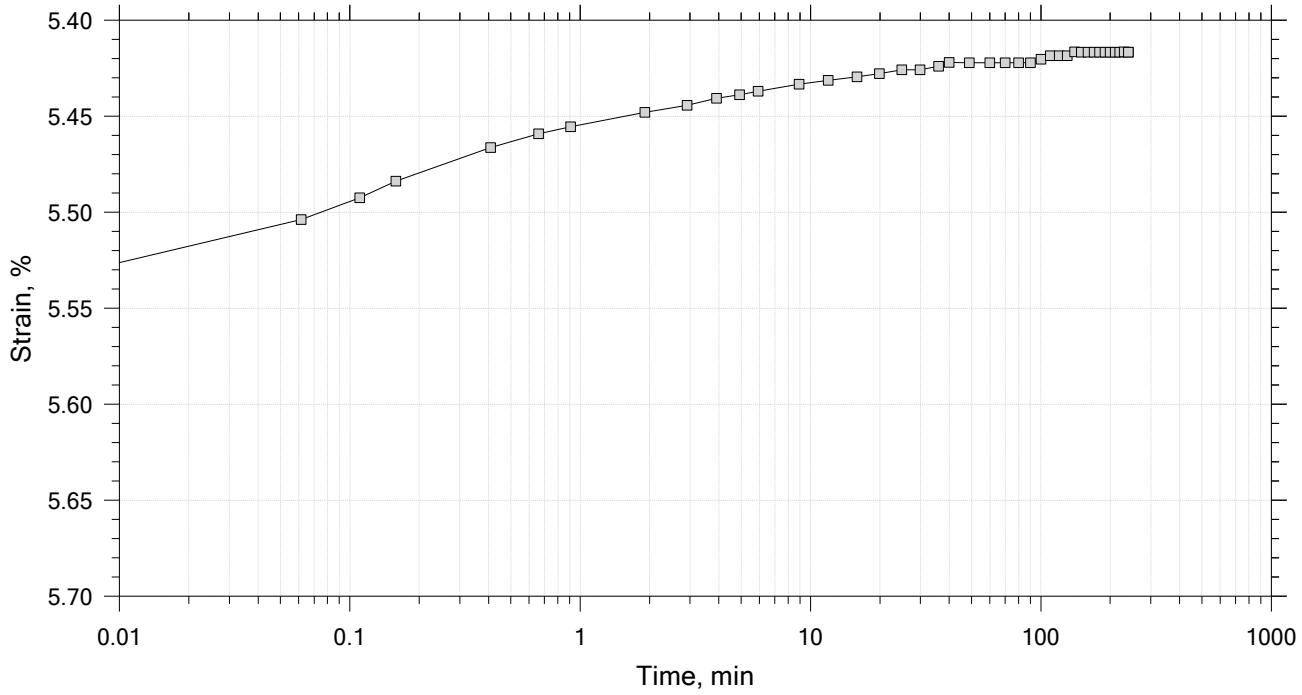


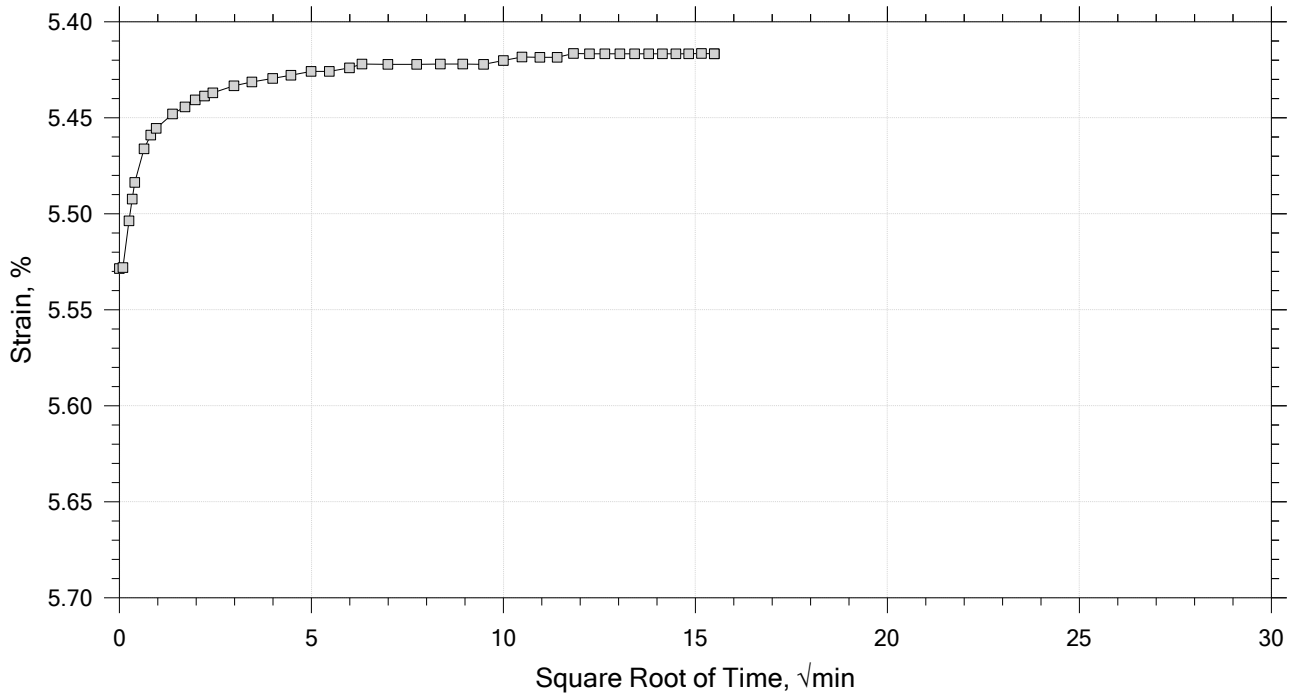


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 12 of 14
Constant Load Step
Stress: 2 tsf

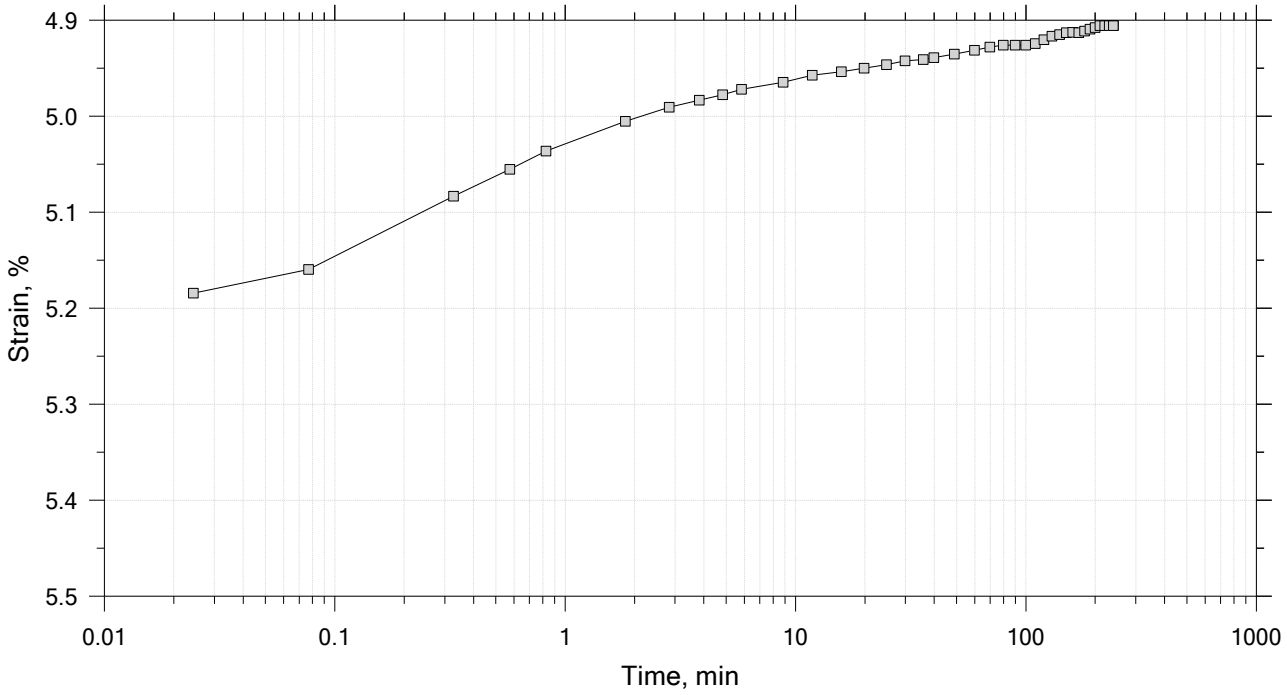


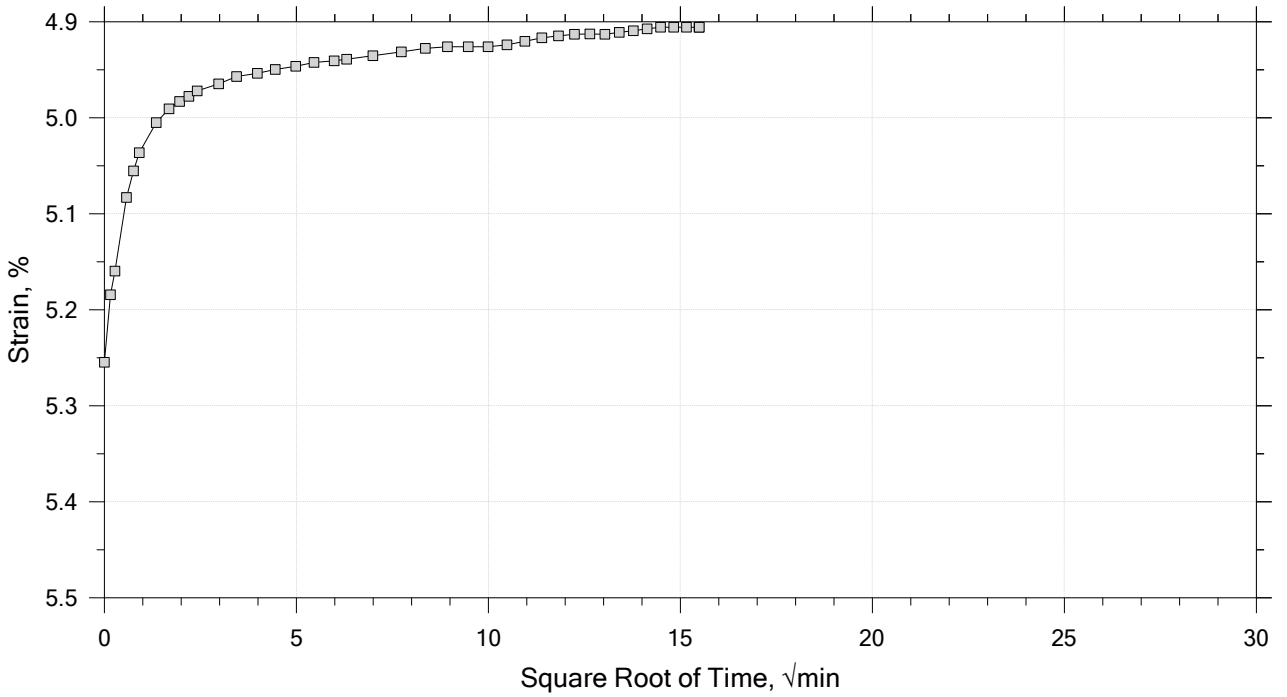


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 13 of 14
Constant Load Step
Stress: 0.5 tsf

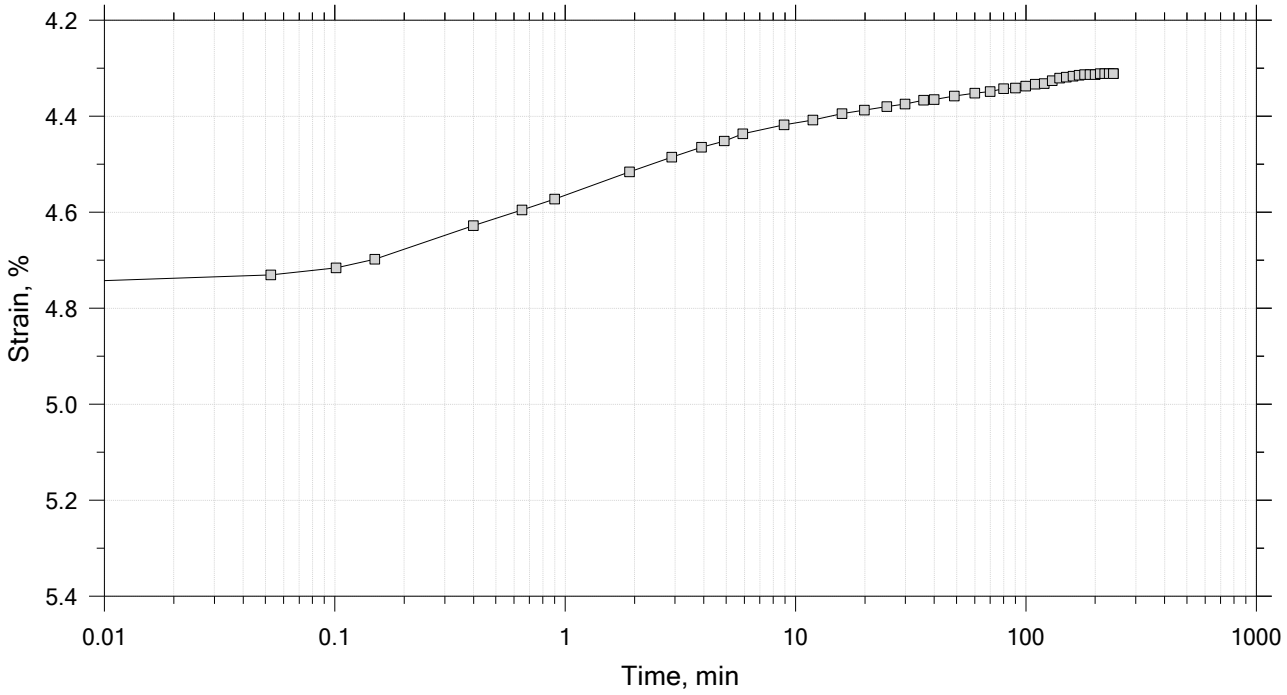


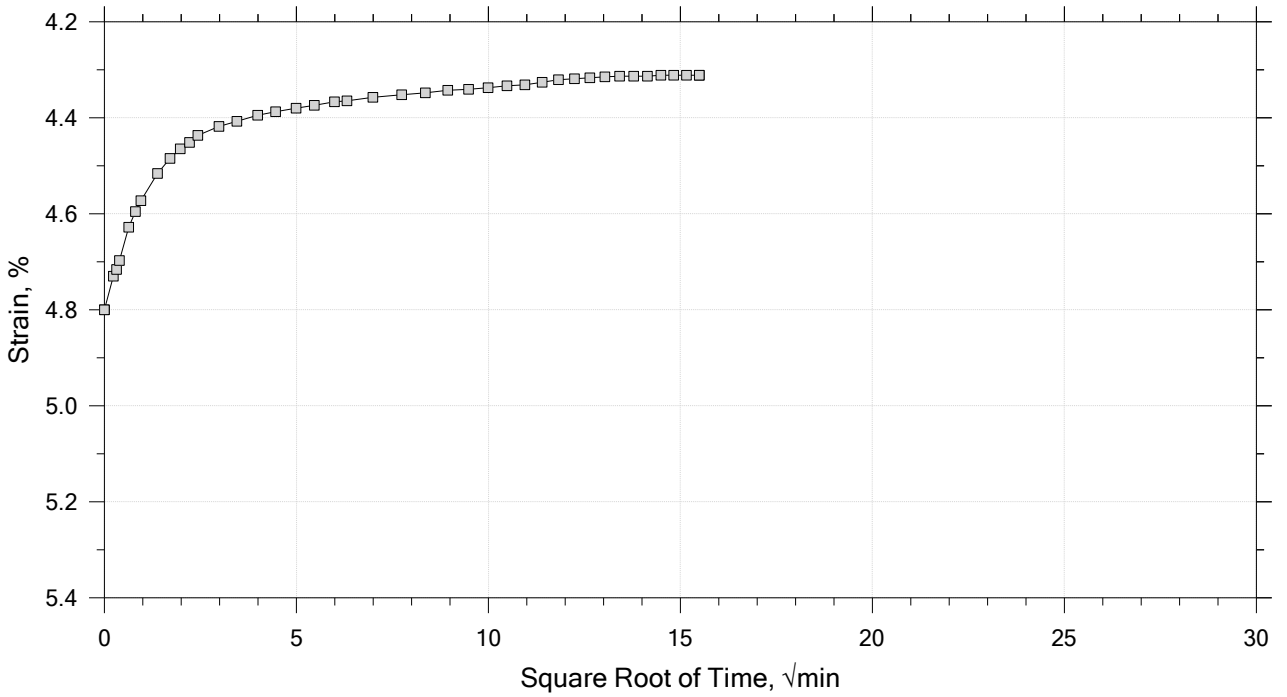


GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 14 of 14
Constant Load Step
Stress: 0.125 tsf





GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.68	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 0.36	Plastic Limit: ---
Final Height: 0.98 in	Final Void Ratio: 0.333	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	E12790	RING		E13681
Mass Container, gm	8.35	109.91	109.91	8.2
Mass Container + Wet Soil, gm	158.22	289.37	287.95	186.04
Mass Container + Dry Soil, gm	139.24	268.27	268.27	166.38
Mass Dry Soil, gm	130.89	158.36	158.36	158.18
Water Content, %	14.50	13.33	12.43	12.43
Void Ratio	---	0.36	0.33	---
Degree of Saturation, %	---	99.11	100.00	---
Dry Unit Weight, pcf	---	122.9	125.41	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS A Sercel Business	Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
	Boring No.: B-005	Tested By: dmt	Checked By: trm
	Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
	Test No.: IP-1	Sample Type: core	Elevation: ---
	Description: Moist, gray sandy silt		
	Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.0644	0.003854	0.355	0.385	178.233	1.97e-05	5.99e-02	2.21e-05
2	0.125	0.007821	0.349	0.782	50.261	6.95e-05	6.54e-02	8.51e-05
3	0.250	0.01465	0.340	1.47	13.931	2.48e-04	5.47e-02	2.54e-04
4	0.500	0.01986	0.333	1.99	42.301	8.07e-05	2.08e-02	3.14e-05
5	1.00	0.02521	0.326	2.52	20.675	1.63e-04	1.07e-02	3.27e-05
6	2.00	0.03031	0.319	3.03	17.400	1.92e-04	5.10e-03	1.83e-05
7	4.00	0.03537	0.312	3.54	44.797	7.38e-05	2.53e-03	3.50e-06
8	8.00	0.04021	0.305	4.02	45.576	7.18e-05	1.21e-03	1.63e-06
9	16.0	0.04663	0.297	4.66	48.980	6.60e-05	8.02e-04	9.92e-07
10	32.0	0.05616	0.284	5.62	30.594	1.04e-04	5.95e-04	1.16e-06
11	8.00	0.05534	0.285	5.53	0.906	3.48e-03	3.39e-05	2.21e-06
12	2.00	0.05417	0.286	5.42	1.632	1.93e-03	1.96e-04	7.09e-06
13	0.500	0.04906	0.293	4.91	3.059	1.04e-03	3.41e-03	6.63e-05
14	0.125	0.04311	0.301	4.31	4.741	6.78e-04	1.58e-02	2.01e-04

GeoTesting EXPRESS
A Sercel Business

Project: W-25-028 WYA-23-3, 47	Location: Wyandot CO.,OH	Project No.: GTX-321310
Boring No.: B-005	Tested By: dmt	Checked By: trm
Sample No.: ST-8	Test Date: 6/26/25	Depth: 18.5-20.5'
Test No.: IP-1	Sample Type: core	Elevation: ---
Description: Moist, gray sandy silt		
Remarks: LTIII-E, Swell Pressure = 0.0644 tsf		
Displacement at End of Increment		

APPENDIX VI

PAVEMENT CORE DATA SHEETS

6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-001-0-25
DATE CORE OBTAINED	5/20/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-001-0-25	0.50	5	✓							
	1.75	4		✓						
	1.75	3		✓						
	2.00	2		✓						
	1.50	1			✓					
	5.00						✓			

Comments/Remarks

- Layer 4 has trace voids.
- Layer 3 has some voids.
- Layers 1 and 2 are slighlty deteriorated.
- The core is delaminated between layers 1 & 2 and 2 & 3.
- Aggregate Base: Gravel with Sand



Total Pavement Thickness =	7.50	in.	Total Asphalt Thickness =	7.50	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	5.00	in.



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-002-0-25
DATE CORE OBTAINED	5/20/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-002-0-25	0.50	5	✓							
	1.50	4	✓							
	1.25	3		✓						
	1.00	2		✓						
	2.75	1		✓						
	4.00						✓			

Comments/Remarks

- Layers 3 and 4 have trace voids.
- The core is delaminated between layers 3 & 4.
- Aggregate Base: Gravel with Sand



Total Pavement Thickness =	7.00	in.	Total Asphalt Thickness =	7.00	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	4.00	in.



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-003-0-25
DATE CORE OBTAINED	5/21/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-003-0-25	1.50	6	✓							
	1.50	5			✓					
	2.00	4		✓						
	1.75	3		✓						
	1.75	2		✓						
	3.50	1			✓					
	16.00						✓			

Comments/Remarks

- The core is intact.
- Layer 5 has some voids.
- Aggregate Base: Gravel with Sand



Total Pavement Thickness =	12.00	in.	Total Asphalt Thickness =	12.00	in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	16.00 in.



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Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-004-0-25
DATE CORE OBTAINED	5/21/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-004-0-25	1.25	6	✓							
	1.75	5			✓					
	1.50	4		✓						
	2.00	3		✓						
	1.00	2		✓						
	4.50	1			✓					
	26.00						✓			

Comments/Remarks

- Layer 5 has some voids.
- Layer 4 is broken at 4.25".
- Layer 1 is broken at 8.00".
- Aggregate Base: Gravel with Sand



Total Pavement Thickness =	12.00 in.	Total Asphalt Thickness =	12.00 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	26.00 in.



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Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-005-0-25
DATE CORE OBTAINED	5/21/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-005-0-25	1.25	7	✓							
	1.75	6			✓					
	2.25	5			✓					
	1.50	4		✓						
	1.00	3		✓						
	1.75	2			✓					
	4.00	1			✓					
	24.00						✓			

Comments/Remarks

- Layer 7 is broken at 1.25".
- Layer 6 has trace voids.
- Layer 5 is broken at 4.00".
- Aggregate Base: Gravel with Sand



Total Pavement Thickness =	7.25 in.	Total Asphalt Thickness =	13.50 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	24.00 in.



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Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-006-0-25
DATE CORE OBTAINED	5/21/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-006-0-25	1.50	6	✓							
	1.75	5			✓					
	2.25	4		✓						
	1.50	3		✓						
	1.75	2			✓					
	3.25	1			✓					
	23.00						✓			

Comments/Remarks

- The core is intact.
- Layer 4 has trace voids.
- Aggregate Base: Gravel with Sand



Total Pavement Thickness =	12.00 in.	Total Asphalt Thickness =	12.00 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	23.00 in.



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Columbus, Ohio 43231
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Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-007-0-25
DATE CORE OBTAINED	5/21/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-007-0-25	1.50	5	✓							
	1.50	4			✓					
	1.50	3			✓					
	4.00	2		✓						
	3.50	1			✓					
	21.00						✓			

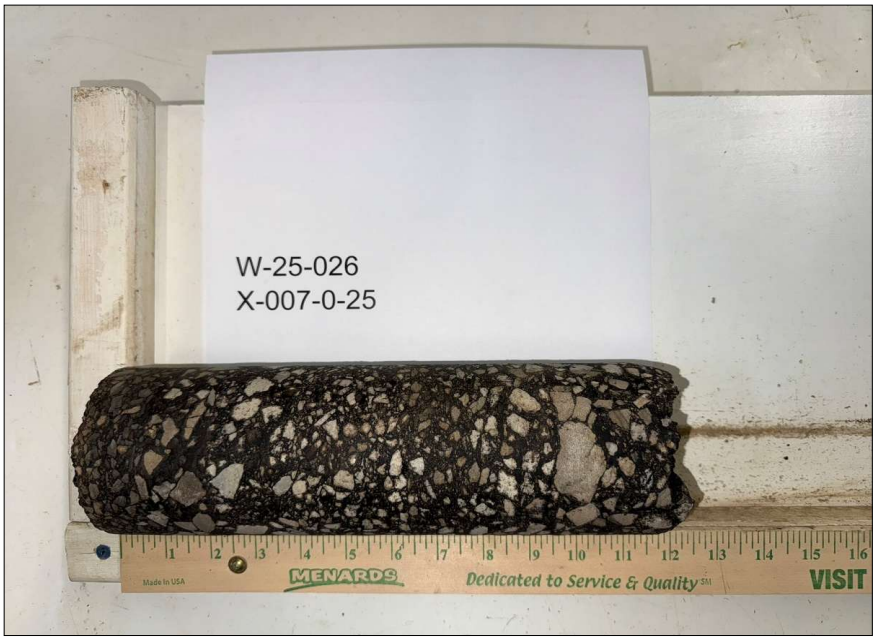
Comments/Remarks

- The core is intact.



- Aggregate Base Gravel with Sand

Total Pavement Thickness =	12.00 in.	Total Asphalt Thickness =	12.00 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	21.00 in.



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Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-008-0-25
DATE CORE OBTAINED	5/20/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

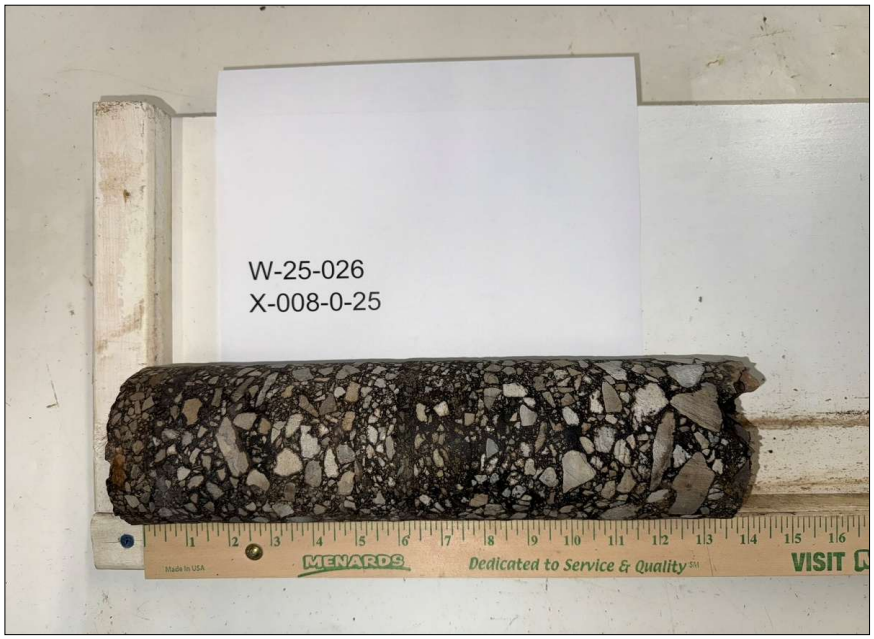
Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-008-0-25	1.50	6	✓							
	2.00	5			✓					
	2.00	4			✓					
	1.25	3		✓						
	3.00	2		✓						
	4.00	1			✓					
	24.00						✓			

Comments/Remarks

- The core is intact.
- Aggregate Base: Gravel with Sand



Total Pavement Thickness =	13.75 in.	Total Asphalt Thickness =	13.75 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	24.00 in.



6350 Presidential Gateway
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Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-009-0-25
DATE CORE OBTAINED	5/20/2025
CORE OBTAINED BY	LH / KC / JE

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-009-0-25	1.75	6	✓							
	1.75	5			✓					
	1.50	4			✓					
	2.25	3		✓						
	1.50	2		✓						
	4.75	1			✓					
	21.00						✓			

Comments/Remarks

- The core is intact.



- Aggregate Base: Gravel with Sand

Total Pavement Thickness =	13.50 in.	Total Asphalt Thickness =	13.50 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	21.00 in.



6350 Presidential Gateway
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Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-010-0-25
DATE CORE OBTAINED	5/19/2025
CORE OBTAINED BY	Kris

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-010-0-25	1.50	6	✓							
	2.50	5			✓					
	1.50	4			✓					
	2.00	3		✓						
	1.25	2		✓						
	5.75	1			✓					
	20.00						✓			

Comments/Remarks

- Layer 6 is broken 1.50" to 4.00".
- Layer 5 is slightly deteriorated.
- The core is delmainated between layer 6 & 7.
- Aggregate Base: Gravel



Total Pavement Thickness =	14.50	in.	Total Asphalt Thickness =	14.50	in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	20.00 in.



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-011-0-25
DATE CORE OBTAINED	5/19/2025
CORE OBTAINED BY	Kris

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-011-0-25	1.50	5	✓							
	1.75	4			✓					
	1.75	3			✓					
	3.00	2		✓						
	5.00	1			✓					
	10.00						✓			

Comments/Remarks

- Layer 3 is disintegrated 1.75" to 3.00".
- The core is delaminatwed between layers 4 & 5.
- Aggregate Base: Gravel



Total Pavement Thickness =	13.00 in.	Total Asphalt Thickness =	13.00 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	10.00 in.



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	WAY-23-3.47
LOCATION	US 23 & SR 294 in Wyandot County, Ohio
JOB No.	W-25-026
BORING/CORE No.	X-012-0-25
DATE CORE OBTAINED	5/19/2025
CORE OBTAINED BY	Kris

Core Composition

Core Number	Lift Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
X-012-0-25	1.50	6	✓							
	2.50	5			✓					
	2.00	4		✓						
	1.25	3		✓						
	1.50	2			✓					
	3.75	1			✓					
	10.00						✓			

Comments/Remarks

- The core is intact.
- Aggregate Base: Gravel



Total Pavement Thickness =	12.50 in.	Total Asphalt Thickness =	12.50 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	10.00 in.



APPENDIX VII

LATERAL DESIGN PARAMETERS

Soil Parameters for Lateral Load Analysis
WYA-23-3.47 Interchange Improvements : PID No. 121424
Wyandot County, Ohio
Rii Project Number: N-25-026

Substructure Unit (Boring)	Elevation (feet)	Soil Class.	Soil Type [1]	Strata	N_{60}	$N1_{60}$ [2]	γ [3] (pcf)	γ' [4] (pcf)	Strength Parameter [5]	k (soil) k_{rm} (rock) [6]	ε_{50} (soil) E_r (rock) [7]	RQD (rock) [8]
Rear Abutment B-004-0-25	884.0 to 881.0	A-6a	C	3	10	18	120	120	Su = 1,250 psf	365 pci	0.0080	-
	881.0 to 871.0	A-6a	C	3	25	31	125	125	Su = 3,190 psf	1,065 pci	0.0049	-
	871.0 to 866.0	A-4b	G	4	14	14	125	125	φ = 30°	50 pci	-	-
	866.0 to 856.0	A-4a	C	2	12	11	125	62.6	Su = 3,150 psf	1,050 pci	0.0050	-
	856.0 to 852.0	A-4b	G	4	21	19	125	62.6	φ = 31°	50 pci	-	-
	852.0 to 847.0	A-4a	C	2	28	24	125	62.6	Su = 3,500 psf	1,165 pci	0.0048	-
	847.0 to 842.0	A-4b	G	4	23	19	125	62.6	φ = 31°	50 pci	-	-
	842.0 to 836.5	A-4a	G	4	51	40	135	72.6	φ = 34°	90 pci	-	-
	836.5 to 834.4	Dolomite	R	9	300	229	140	77.6	Qu = 187 psi	0.0005	18,000 psi	0
	834.4 to 830.9	Dolomite	R	9	-		150	87.6	Qu = 13,753 psi	0.00005	680,000 psi	0
	830.9 to 820.9	Dolomite	R	9	-		150	87.6	Qu = 13,753 psi	0.00005	680,000 psi	22
Pier B-006-0-25	873.3 to 867.8	A-6b	C	3	20	32	125	125	Su = 2,500 psf	835 pci	0.0057	-
	867.8 to 865.3	A-4a	G	4	31	41	130	67.6	φ = 34°	90 pci	-	-
	865.3 to 855.3	A-6a	C	2	19	22	125	62.6	Su = 2,375 psf	790 pci	0.0058	-
	855.3 to 847.3	A-6a	C	2	28	29	125	62.6	Su = 3,500 psf	1,165 pci	0.0048	-
	847.3 to 838.8	A-6a	C	2	50	48	130	67.6	Su = 6,250 psf	2,085 pci	0.0039	-
	838.8 to 838.3	Dolomite	R	9	100	91	140	77.6	Qu = 75 psi	0.0005	18,000 psi	0
	838.3 to 833.3	Dolomite	R	9	-		150	87.6	Qu = 5,466 psi	0.00005	491,940 psi	0
	833.3 to 828.3	Dolomite	R	9	-		150	87.6	Qu = 5,466 psi	0.00005	491,940 psi	67

Soil Parameters for Lateral Load Analysis
WYA-23-3.47 Interchange Improvements : PID No. 121424
Wyandot County, Ohio
Rii Project Number: N-25-026

Substructure Unit (Boring)	Elevation (feet)	Soil Class.	Soil Type [1]	Strata	N_{60}	$N1_{60}$ [2]	γ [3] (pcf)	γ' [4] (pcf)	Strength Parameter [5]	k (soil) k_{rm} (rock) [6]	ε_{50} (soil) E_r (rock) [7]	RQD (rock) [8]
Forward Abutment B-008-0-25	883.1 to 880.1	A-6a	C	3	10	18	120	120	Su = 1,250 psf	365 pci	0.0080	-
	880.1 to 870.6	A-6a	C	3	30	37	125	125	Su = 3,750 psf	1,250 pci	0.0048	-
	870.6 to 867.6	A-6a	C	3	21	22	125	125	Su = 2,625 psf	875 pci	0.0055	-
	867.6 to 857.1	A-4b	G	4	20	19	125	62.6	φ = 31°	50 pci	-	-
	857.1 to 855.1	A-4b	G	4	16	14	125	62.6	φ = 30°	35 pci	-	-
	855.1 to 844.6	A-4a	C	2	33	28	125	62.6	Su = 4,125 psf	1,375 pci	0.0046	-
	844.6 to 839.2	A-4a	G	4	50	40	135	72.6	φ = 34°	90 pci	-	-
	839.2 to 838.0	Dolomite	R	9	-		150	87.6	Qu = 29,998 psi	0.00005	680,000 psi	0
	838.0 to 828.0	Dolomite	R	9	-		150	87.6	Qu = 29,998 psi	0.00005	680,000 psi	22

Description of Superscript

1. *C = cohesive soil stratum; G = granular soil stratum; R =Bedrock*
2. *$N1_{60}$ = SPT Blowcount corrected for hammer efficiency and soil overburden*
3. *γ = total unit weight*
4. *γ' = effective unit weight*
5. *S_u = average undrained shear strength (cohesive soil layers); φ = internal angle of friction (granular layers)*
6. *k = soil soil modulus parameter (static loading); K_{rm} = strain factor (bedrock)*
7. *ε_{50} = strain factor (soil); E= initial modulus of rock mass*
8. *RQD = rock quality designation*

Note. Psi = pounds per square inch; pci = pounds per cubic inch; pcf = pounds per cubic foot; psf = pounds per square foot

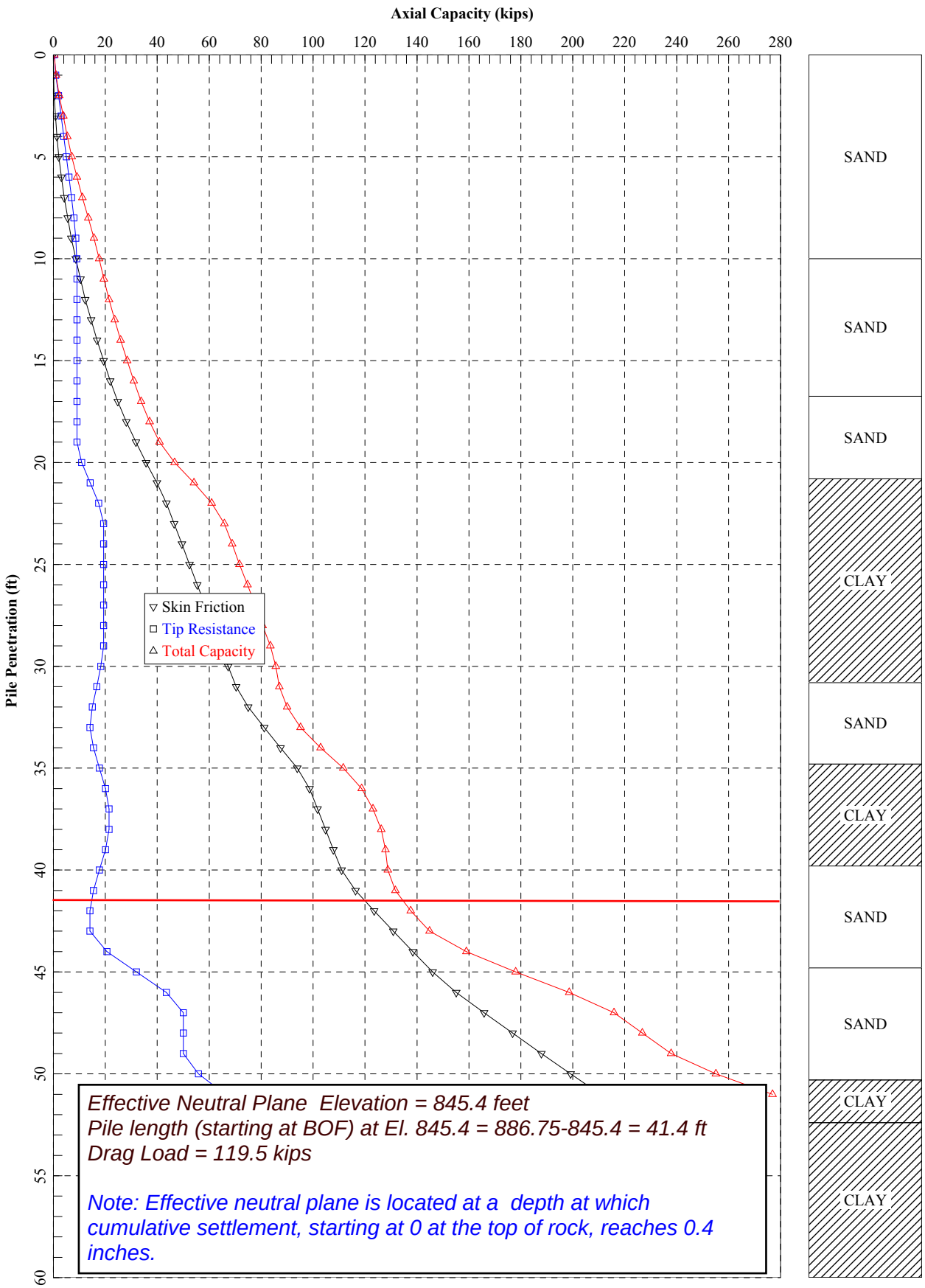
Strata Description

Strata	*Description*
2	*Stiff Clay with Water*
3	*Stiff Clay without Free Water*
4	*Sand (Reese)*
9	*Weak Rock*

APPENDIX VIII

DRIVEN PILE ANALYSIS OUTPUTS

Rear Abutment
Boring B-004-0-25



Effective Neutral Plane Elevation = 845.4 feet
Pile length (starting at BOF) at El. 845.4 = 886.75-845.4 = 41.4 ft
Drag Load = 119.5 kips

Note: Effective neutral plane is located at a depth at which cumulative settlement, starting at 0 at the top of rock, reaches 0.4 inches.

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

                 APILE for Windows, Version 2019.9.12

                  Serial Number :  136090498

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
                (c) Copyright ENSOFT, Inc., 1987-2019
                      All Rights Reserved

==========================================================================

This program is licensed to :

Resource International, Inc.
Columbus, OH

Path to file locations      : C:\Users\legacy\Desktop\W-25-26\
Name of input data file     : W-25-026_B-004-0-25.ap9d
Name of output file         : W-25-026_B-004-0-25.ap9o
Name of plot output file    : W-25-026_B-004-0-25.ap9p

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

          Date:  July 10, 2025     Time:  17:06:00


1
      **********************
      * INPUT INFORMATION *
      **********************


      HP 10x42 Piles_Rear Abt (B-004-0-25)

      DESIGNER   : AG/JPS

      JOB NUMBER : W-25-026 ( WYA-23-3.47 )


      METHOD FOR UNIT LOAD TRANSFERS :
```

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 97.97 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 51.50 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 39.60 IN.
- TIP AREA OF PILE = 97.97 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	Nq FACTOR FHWA
0.00	SAND	0.80*	120.00	28.00	22.80**

10.00	SAND	0.80*	120.00	28.00	22.80**
10.00	SAND	0.80*	120.00	28.00	22.80**
16.75	SAND	0.80*	120.00	28.00	22.80**
16.75	SAND	0.80*	125.00	30.00	30.00**
20.80	SAND	0.80*	125.00	30.00	30.00**
20.80	CLAY	0.80*	62.60	0.00	4.80**
30.80	CLAY	0.80*	62.60	0.00	4.80**
30.80	SAND	0.80*	62.60	31.00	35.20**
34.80	SAND	0.80*	62.60	31.00	35.20**
34.80	CLAY	0.80*	62.60	0.00	4.80**
39.80	CLAY	0.80*	62.60	0.00	4.80**
39.80	SAND	0.80*	62.60	31.00	35.20**
44.80	SAND	0.80*	62.60	31.00	35.20**
44.80	SAND	0.80*	72.60	34.00	55.60**
50.30	SAND	0.80*	72.60	34.00	55.60**
50.30	CLAY	0.80*	77.60	0.00	4.80**
52.40	CLAY	0.80*	77.60	0.00	4.80**
52.40	CLAY	0.80*	87.60	0.00	4.80**
60.00	CLAY	0.80*	87.60	0.00	4.80**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.15	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.15	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	13.46	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	13.46	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	360.00	0.00	0.00	0.00	0.00

0.10E+08*	0.10E+08*	360.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
10.00	1.000	1.000
10.00	1.000	1.000
16.75	1.000	1.000
16.75	1.000	1.000
20.80	1.000	1.000
20.80	1.000	1.000
30.80	1.000	1.000
30.80	1.000	1.000
34.80	1.000	1.000
34.80	1.000	1.000
39.80	1.000	1.000
39.80	1.000	1.000
44.80	1.000	1.000
44.80	1.000	1.000
50.30	1.000	1.000
50.30	1.000	1.000
52.40	1.000	1.000
52.40	1.000	1.000
60.00	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.126 *	0.00
10.00	0.126 *	0.00
10.00	0.126 *	0.00
16.75	0.126 *	0.00
16.75	0.126 *	0.00
20.80	0.126 *	0.00
20.80	0.126 *	0.90 **
30.80	0.126 *	0.90 **
30.80	0.126 *	0.00
34.80	0.126 *	0.00

34.80	0.126 *	0.90 **
39.80	0.126 *	0.90 **
39.80	0.126 *	0.00
44.80	0.126 *	0.00
44.80	0.126 *	0.00
50.30	0.126 *	0.00
50.30	0.126 *	0.90 **
52.40	0.126 *	0.90 **
52.40	0.126 *	0.90 **
60.00	0.126 *	0.90 **

* DEFAULT VALUE = 0.01 D
** DEFAULT VALUE = 0.9

1

****
* COMPUTATION RESULT *
****

****
* FED. HWY. METHOD *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.4	0.4
1.00	0.1	0.9	1.0
2.00	0.3	2.0	2.3
3.00	0.8	3.0	3.8
4.00	1.4	4.0	5.4
5.00	2.1	5.0	7.1
6.00	3.1	6.0	9.1
7.00	4.2	7.0	11.2
8.00	5.5	7.9	13.4
9.00	6.9	8.6	15.6
10.00	8.6	9.0	17.6
11.00	10.4	9.1	19.4
12.00	12.3	9.1	21.4
13.00	14.5	9.1	23.6
14.00	16.8	9.1	25.9
15.00	19.3	9.1	28.4
16.00	21.9	9.1	31.0
17.00	24.8	9.1	33.8

18.00	28.1	9.1	37.1
19.00	31.8	9.1	40.9
20.00	35.7	10.9	46.7
21.00	39.9	14.2	54.1
22.00	43.5	17.4	60.9
23.00	46.5	19.3	65.8
24.00	49.5	19.3	68.8
25.00	52.4	19.3	71.7
26.00	55.4	19.3	74.7
27.00	58.4	19.3	77.7
28.00	61.3	19.3	80.6
29.00	64.3	19.3	83.6
30.00	67.3	18.3	85.6
31.00	70.4	16.7	87.0
32.00	75.0	15.0	90.0
33.00	81.2	14.1	95.2
34.00	87.5	15.4	102.9
35.00	93.9	17.7	111.6
36.00	98.6	20.1	118.7
37.00	101.7	21.4	123.1
38.00	104.8	21.4	126.2
39.00	107.8	20.1	127.9
40.00	111.0	17.7	128.8
41.00	116.3	15.4	131.7
42.00	123.5	14.1	137.6
43.00	130.9	14.1	144.9
44.00	138.4	20.6	159.0
45.00	146.0	32.0	178.0
46.00	155.1	43.5	198.6
47.00	165.8	50.0	215.9
48.00	176.8	50.0	226.8
49.00	187.9	50.0	237.9
50.00	199.2	55.9	255.1
51.00	210.7	66.2	276.9

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

****
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING *
****

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.4510E-02	0.2017E-01
			0.7517E-02	0.3908E-01
			0.1128E-01	0.7185E-01
			0.1353E-01	0.1008E+00
			0.1503E-01	0.1261E+00
			0.1503E-01	0.2521E+00
			0.1503E-01	0.3782E+00
			0.1503E-01	0.6303E+00
			0.1503E-01	0.2521E+01
2	10	0.5000E+01		
			0.0000E+00	0.0000E+00
			0.5412E+00	0.2017E-01
			0.9020E+00	0.3908E-01
			0.1353E+01	0.7185E-01
			0.1624E+01	0.1008E+00
			0.1804E+01	0.1261E+00
			0.1804E+01	0.2521E+00
			0.1804E+01	0.3782E+00
			0.1804E+01	0.6303E+00
			0.1804E+01	0.2521E+01
3	10	0.9958E+01		
			0.0000E+00	0.0000E+00
			0.1078E+01	0.2017E-01
			0.1797E+01	0.3908E-01
			0.2695E+01	0.7185E-01
			0.3234E+01	0.1008E+00
			0.3593E+01	0.1261E+00
			0.3593E+01	0.2521E+00
			0.3593E+01	0.3782E+00
			0.3593E+01	0.6303E+00
			0.3593E+01	0.2521E+01
4	10	0.1004E+02		
			0.0000E+00	0.0000E+00
			0.1087E+01	0.2017E-01
			0.1812E+01	0.3908E-01
			0.2717E+01	0.7185E-01
			0.3261E+01	0.1008E+00
			0.3623E+01	0.1261E+00
			0.3623E+01	0.2521E+00
			0.3623E+01	0.3782E+00
			0.3623E+01	0.6303E+00
			0.3623E+01	0.2521E+01

5	10	0.1338E+02		
			0.0000E+00	0.0000E+00
			0.1448E+01	0.2017E-01
			0.2413E+01	0.3908E-01
			0.3619E+01	0.7185E-01
			0.4343E+01	0.1008E+00
			0.4826E+01	0.1261E+00
			0.4826E+01	0.2521E+00
			0.4826E+01	0.3782E+00
			0.4826E+01	0.6303E+00
			0.4826E+01	0.2521E+01
6	10	0.1671E+02		
			0.0000E+00	0.0000E+00
			0.1809E+01	0.2017E-01
			0.3014E+01	0.3908E-01
			0.4521E+01	0.7185E-01
			0.5426E+01	0.1008E+00
			0.6028E+01	0.1261E+00
			0.6028E+01	0.2521E+00
			0.6028E+01	0.3782E+00
			0.6028E+01	0.6303E+00
			0.6028E+01	0.2521E+01
7	10	0.1679E+02		
			0.0000E+00	0.0000E+00
			0.1818E+01	0.2017E-01
			0.3029E+01	0.3908E-01
			0.4544E+01	0.7185E-01
			0.5453E+01	0.1008E+00
			0.6059E+01	0.1261E+00
			0.6059E+01	0.2521E+00
			0.6059E+01	0.3782E+00
			0.6059E+01	0.6303E+00
			0.6059E+01	0.2521E+01
8	10	0.1878E+02		
			0.0000E+00	0.0000E+00
			0.2399E+01	0.2017E-01
			0.3999E+01	0.3908E-01
			0.5998E+01	0.7185E-01
			0.7198E+01	0.1008E+00
			0.7998E+01	0.1261E+00
			0.7998E+01	0.2521E+00
			0.7998E+01	0.3782E+00
			0.7998E+01	0.6303E+00
			0.7998E+01	0.2521E+01
9	10	0.2076E+02		
			0.0000E+00	0.0000E+00
			0.2662E+01	0.2017E-01
			0.4437E+01	0.3908E-01

			0.6656E+01	0.7185E-01
			0.7987E+01	0.1008E+00
			0.8874E+01	0.1261E+00
			0.8874E+01	0.2521E+00
			0.8874E+01	0.3782E+00
			0.8874E+01	0.6303E+00
			0.8874E+01	0.2521E+01
10	10	0.2084E+02		
			0.0000E+00	0.0000E+00
			0.2673E+01	0.2017E-01
			0.4456E+01	0.3908E-01
			0.6683E+01	0.7185E-01
			0.8020E+01	0.1008E+00
			0.8911E+01	0.1261E+00
			0.8020E+01	0.2521E+00
			0.8020E+01	0.3782E+00
			0.8020E+01	0.6303E+00
			0.8020E+01	0.2521E+01
11	10	0.2580E+02		
			0.0000E+00	0.0000E+00
			0.1874E+01	0.2017E-01
			0.3124E+01	0.3908E-01
			0.4686E+01	0.7185E-01
			0.5623E+01	0.1008E+00
			0.6248E+01	0.1261E+00
			0.5623E+01	0.2521E+00
			0.5623E+01	0.3782E+00
			0.5623E+01	0.6303E+00
			0.5623E+01	0.2521E+01
12	10	0.3076E+02		
			0.0000E+00	0.0000E+00
			0.1975E+01	0.2017E-01
			0.3291E+01	0.3908E-01
			0.4937E+01	0.7185E-01
			0.5925E+01	0.1008E+00
			0.6583E+01	0.1261E+00
			0.5925E+01	0.2521E+00
			0.5925E+01	0.3782E+00
			0.5925E+01	0.6303E+00
			0.5925E+01	0.2521E+01
13	10	0.3084E+02		
			0.0000E+00	0.0000E+00
			0.1986E+01	0.2017E-01
			0.3310E+01	0.3908E-01
			0.4965E+01	0.7185E-01
			0.5958E+01	0.1008E+00
			0.6620E+01	0.1261E+00
			0.6620E+01	0.2521E+00

```
                                    0.6620E+01      0.3782E+00
                                    0.6620E+01      0.6303E+00
                                    0.6620E+01      0.2521E+01
14          10      0.3280E+02
                                    0.0000E+00      0.0000E+00
                                    0.3920E+01      0.2017E-01
                                    0.6533E+01      0.3908E-01
                                    0.9800E+01      0.7185E-01
                                    0.1176E+02      0.1008E+00
                                    0.1307E+02      0.1261E+00
                                    0.1307E+02      0.2521E+00
                                    0.1307E+02      0.3782E+00
                                    0.1307E+02      0.6303E+00
                                    0.1307E+02      0.2521E+01
15          10      0.3476E+02
                                    0.0000E+00      0.0000E+00
                                    0.4066E+01      0.2017E-01
                                    0.6777E+01      0.3908E-01
                                    0.1017E+02      0.7185E-01
                                    0.1220E+02      0.1008E+00
                                    0.1355E+02      0.1261E+00
                                    0.1355E+02      0.2521E+00
                                    0.1355E+02      0.3782E+00
                                    0.1355E+02      0.6303E+00
                                    0.1355E+02      0.2521E+01
16          10      0.3484E+02
                                    0.0000E+00      0.0000E+00
                                    0.4073E+01      0.2017E-01
                                    0.6788E+01      0.3908E-01
                                    0.1018E+02      0.7185E-01
                                    0.1222E+02      0.1008E+00
                                    0.1358E+02      0.1261E+00
                                    0.1222E+02      0.2521E+00
                                    0.1222E+02      0.3782E+00
                                    0.1222E+02      0.6303E+00
                                    0.1222E+02      0.2521E+01
17          10      0.3730E+02
                                    0.0000E+00      0.0000E+00
                                    0.1935E+01      0.2017E-01
                                    0.3225E+01      0.3908E-01
                                    0.4838E+01      0.7185E-01
                                    0.5806E+01      0.1008E+00
                                    0.6451E+01      0.1261E+00
                                    0.5806E+01      0.2521E+00
                                    0.5806E+01      0.3782E+00
                                    0.5806E+01      0.6303E+00
                                    0.5806E+01      0.2521E+01
18          10      0.3976E+02
```

		0.0000E+00	0.0000E+00
		0.2061E+01	0.2017E-01
		0.3434E+01	0.3908E-01
		0.5152E+01	0.7185E-01
		0.6182E+01	0.1008E+00
		0.6869E+01	0.1261E+00
		0.6182E+01	0.2521E+00
		0.6182E+01	0.3782E+00
		0.6182E+01	0.6303E+00
		0.6182E+01	0.2521E+01
19	10	0.3984E+02	
		0.0000E+00	0.0000E+00
		0.2074E+01	0.2017E-01
		0.3457E+01	0.3908E-01
		0.5186E+01	0.7185E-01
		0.6223E+01	0.1008E+00
		0.6915E+01	0.1261E+00
		0.6915E+01	0.2521E+00
		0.6915E+01	0.3782E+00
		0.6915E+01	0.6303E+00
		0.6915E+01	0.2521E+01
20	10	0.4230E+02	
		0.0000E+00	0.0000E+00
		0.4631E+01	0.2017E-01
		0.7718E+01	0.3908E-01
		0.1158E+02	0.7185E-01
		0.1389E+02	0.1008E+00
		0.1544E+02	0.1261E+00
		0.1544E+02	0.2521E+00
		0.1544E+02	0.3782E+00
		0.1544E+02	0.6303E+00
		0.1544E+02	0.2521E+01
21	10	0.4476E+02	
		0.0000E+00	0.0000E+00
		0.4815E+01	0.2017E-01
		0.8025E+01	0.3908E-01
		0.1204E+02	0.7185E-01
		0.1444E+02	0.1008E+00
		0.1605E+02	0.1261E+00
		0.1605E+02	0.2521E+00
		0.1605E+02	0.3782E+00
		0.1605E+02	0.6303E+00
		0.1605E+02	0.2521E+01
22	10	0.4484E+02	
		0.0000E+00	0.0000E+00
		0.4821E+01	0.2017E-01
		0.8035E+01	0.3908E-01
		0.1205E+02	0.7185E-01

		0.1446E+02	0.1008E+00
		0.1607E+02	0.1261E+00
		0.1607E+02	0.2521E+00
		0.1607E+02	0.3782E+00
		0.1607E+02	0.6303E+00
		0.1607E+02	0.2521E+01
23	10	0.4755E+02	
		0.0000E+00	0.0000E+00
		0.6902E+01	0.2017E-01
		0.1150E+02	0.3908E-01
		0.1726E+02	0.7185E-01
		0.2071E+02	0.1008E+00
		0.2301E+02	0.1261E+00
		0.2301E+02	0.2521E+00
		0.2301E+02	0.3782E+00
		0.2301E+02	0.6303E+00
		0.2301E+02	0.2521E+01
24	10	0.5026E+02	
		0.0000E+00	0.0000E+00
		0.7223E+01	0.2017E-01
		0.1204E+02	0.3908E-01
		0.1806E+02	0.7185E-01
		0.2167E+02	0.1008E+00
		0.2408E+02	0.1261E+00
		0.2408E+02	0.2521E+00
		0.2408E+02	0.3782E+00
		0.2408E+02	0.6303E+00
		0.2408E+02	0.2521E+01
25	10	0.5034E+02	
		0.0000E+00	0.0000E+00
		0.7233E+01	0.2017E-01
		0.1206E+02	0.3908E-01
		0.1808E+02	0.7185E-01
		0.2170E+02	0.1008E+00
		0.2411E+02	0.1261E+00
		0.2170E+02	0.2521E+00
		0.2170E+02	0.3782E+00
		0.2170E+02	0.6303E+00
		0.2170E+02	0.2521E+01
26	10	0.5135E+02	
		0.0000E+00	0.0000E+00
		0.7311E+01	0.2017E-01
		0.1219E+02	0.3908E-01
		0.1828E+02	0.7185E-01
		0.2193E+02	0.1008E+00
		0.2437E+02	0.1261E+00
		0.2193E+02	0.2521E+00
		0.2193E+02	0.3782E+00

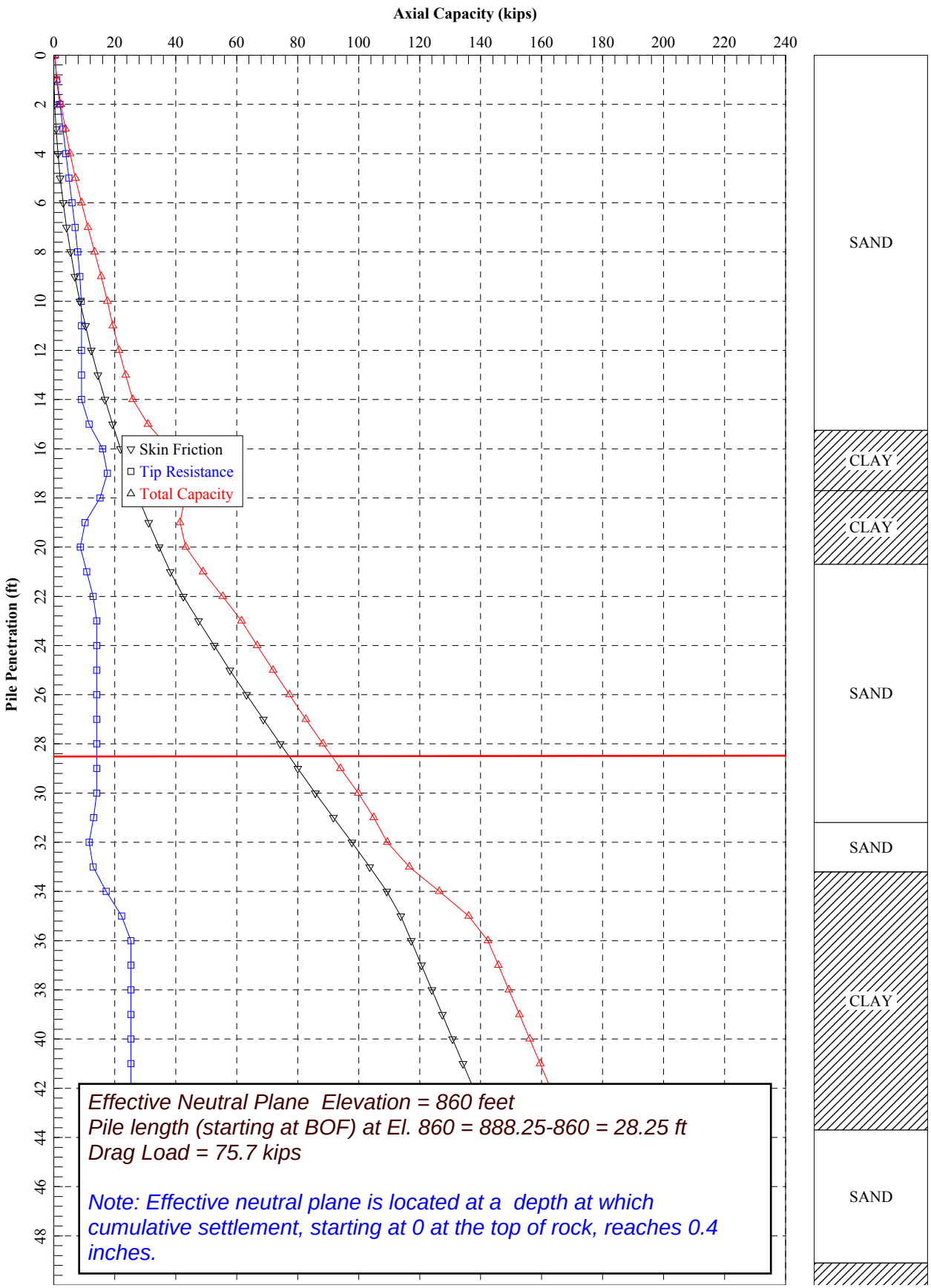
			0.2193E+02	0.6303E+00
			0.2193E+02	0.2521E+01
27	10	0.5236E+02		
			0.0000E+00	0.0000E+00
			0.7311E+01	0.2017E-01
			0.1219E+02	0.3908E-01
			0.1828E+02	0.7185E-01
			0.2193E+02	0.1008E+00
			0.2437E+02	0.1261E+00
			0.2193E+02	0.2521E+00
			0.2193E+02	0.3782E+00
			0.2193E+02	0.6303E+00
			0.2193E+02	0.2521E+01
28	10	0.5244E+02		
			0.0000E+00	0.0000E+00
			0.7311E+01	0.2017E-01
			0.1219E+02	0.3908E-01
			0.1828E+02	0.7185E-01
			0.2193E+02	0.1008E+00
			0.2437E+02	0.1261E+00
			0.2193E+02	0.2521E+00
			0.2193E+02	0.3782E+00
			0.2193E+02	0.6303E+00
			0.2193E+02	0.2521E+01
29	10	0.5620E+02		
			0.0000E+00	0.0000E+00
			0.7311E+01	0.2017E-01
			0.1219E+02	0.3908E-01
			0.1828E+02	0.7185E-01
			0.2193E+02	0.1008E+00
			0.2437E+02	0.1261E+00
			0.2193E+02	0.2521E+00
			0.2193E+02	0.3782E+00
			0.2193E+02	0.6303E+00
			0.2193E+02	0.2521E+01
30	10	0.5996E+02		
			0.0000E+00	0.0000E+00
			0.7311E+01	0.2017E-01
			0.1219E+02	0.3908E-01
			0.1828E+02	0.7185E-01
			0.2193E+02	0.1008E+00
			0.2437E+02	0.1261E+00
			0.2193E+02	0.2521E+00
			0.2193E+02	0.3782E+00
			0.2193E+02	0.6303E+00
			0.2193E+02	0.2521E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.4139E+01	0.6303E-02
0.8279E+01	0.1261E-01
0.1656E+02	0.2521E-01
0.3312E+02	0.1639E+00
0.4967E+02	0.5294E+00
0.5961E+02	0.9202E+00
0.6623E+02	0.1261E+01
0.6623E+02	0.1891E+01
0.6623E+02	0.2521E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.4334E+00	0.1667E-03	0.6568E-01	0.1000E-03
0.4334E+01	0.1667E-02	0.6568E+00	0.1000E-02
0.2167E+02	0.8336E-02	0.3284E+01	0.5000E-02
0.4334E+02	0.1667E-01	0.6568E+01	0.1000E-01
0.8426E+02	0.3313E-01	0.1314E+02	0.2000E-01
0.1544E+03	0.7395E-01	0.1952E+02	0.5000E-01
0.2021E+03	0.1114E+00	0.2310E+02	0.8000E-01
0.2260E+03	0.1352E+00	0.2549E+02	0.1000E+00
0.2468E+03	0.2393E+00	0.3475E+02	0.2000E+00
0.2581E+03	0.5419E+00	0.4834E+02	0.5000E+00
0.2663E+03	0.8437E+00	0.5655E+02	0.8000E+00
0.2709E+03	0.1045E+01	0.6116E+02	0.1000E+01
0.2760E+03	0.2046E+01	0.6623E+02	0.2000E+01

Forward Abutment
Boring B-008-0-25



Effective Neutral Plane Elevation = 860 feet
Pile length (starting at BOF) at El. 860 = 888.25-860 = 28.25 ft
Drag Load = 75.7 kips

Note: Effective neutral plane is located at a depth at which cumulative settlement, starting at 0 at the top of rock, reaches 0.4 inches.

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

                 APILE for Windows, Version 2019.9.12

                  Serial Number :  136090498

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
                (c) Copyright ENSOFT, Inc., 1987-2019
                       All Rights Reserved

==========================================================================

This program is licensed to :

Resource International, Inc.
Columbus, OH

Path to file locations      : C:\Users\legacy\Desktop\W-25-26\
Name of input data file     : W-25-026_B-008-0-25.ap9d
Name of output file         : W-25-026_B-008-0-25.ap9o
Name of plot output file    : W-25-026_B-008-0-25.ap9p

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

          Date:  July 10, 2025     Time:  17:00:44


1
      **********************
      * INPUT INFORMATION *
      **********************


      HP 10x42 Piles_Fwd Abt (B-008-0-25)

      DESIGNER   : AG/JPS

      JOB NUMBER : W-25-026 ( WYA-23-3.47 )


      METHOD FOR UNIT LOAD TRANSFERS :
```

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 97.97 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 48.50 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 39.60 IN.
- TIP AREA OF PILE = 97.97 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	Nq FACTOR FHWA
0.00	SAND	0.80*	120.00	28.00	22.80**

15.25	SAND	0.80*	120.00	28.00	22.80**
15.25	CLAY	0.80*	125.00	0.00	4.80**
17.70	CLAY	0.80*	125.00	0.00	4.80**
17.70	CLAY	0.80*	125.00	0.00	4.80**
20.70	CLAY	0.80*	125.00	0.00	4.80**
20.70	SAND	0.80*	62.60	31.00	35.20**
31.20	SAND	0.80*	62.60	31.00	35.20**
31.20	SAND	0.80*	62.60	30.00	30.00**
33.20	SAND	0.80*	62.60	30.00	30.00**
33.20	CLAY	0.80*	62.60	0.00	4.80**
43.70	CLAY	0.80*	62.60	0.00	4.80**
43.70	SAND	0.80*	72.60	34.00	55.60**
49.10	SAND	0.80*	72.60	34.00	55.60**
49.10	CLAY	0.80*	87.60	0.00	4.80**
55.00	CLAY	0.80*	87.60	0.00	4.80**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.22	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.22	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.12	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.12	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	360.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	360.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
15.25	1.000	1.000
15.25	1.000	1.000
17.70	1.000	1.000
17.70	1.000	1.000
20.70	1.000	1.000
20.70	1.000	1.000
31.20	1.000	1.000
31.20	1.000	1.000
33.20	1.000	1.000
33.20	1.000	1.000
43.70	1.000	1.000
43.70	1.000	1.000
49.10	1.000	1.000
49.10	1.000	1.000
55.00	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.126 *	0.00
15.25	0.126 *	0.00
15.25	0.126 *	0.90 **
17.70	0.126 *	0.90 **
17.70	0.126 *	0.90 **
20.70	0.126 *	0.90 **
20.70	0.126 *	0.00
31.20	0.126 *	0.00
31.20	0.126 *	0.00
33.20	0.126 *	0.00
33.20	0.126 *	0.90 **
43.70	0.126 *	0.90 **
43.70	0.126 *	0.00
49.10	0.126 *	0.00
49.10	0.126 *	0.90 **
55.00	0.126 *	0.90 **

* DEFAULT VALUE = 0.01 D
** DEFAULT VALUE = 0.9

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****
* COMPUTATION RESULT *
****

****
* FED. HWY. METHOD *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.4	0.4
1.00	0.1	0.9	1.0
2.00	0.3	2.0	2.3
3.00	0.8	3.0	3.8
4.00	1.4	4.0	5.4
5.00	2.1	5.0	7.1
6.00	3.1	6.0	9.1
7.00	4.2	7.0	11.2
8.00	5.5	7.9	13.4
9.00	6.9	8.6	15.6
10.00	8.6	9.0	17.6
11.00	10.4	9.1	19.4
12.00	12.3	9.1	21.4
13.00	14.5	9.1	23.6
14.00	16.8	9.1	25.9
15.00	19.3	11.6	30.9
16.00	21.9	16.0	38.0
17.00	24.8	17.6	42.4
18.00	27.8	15.2	43.0
19.00	31.1	10.3	41.4
20.00	34.6	8.7	43.3
21.00	38.2	10.8	49.0
22.00	42.5	12.9	55.4
23.00	47.5	14.1	61.6
24.00	52.6	14.1	66.7
25.00	57.8	14.1	71.9
26.00	63.2	14.1	77.3
27.00	68.7	14.1	82.7
28.00	74.3	14.1	88.3
29.00	80.0	14.1	94.0
30.00	85.8	14.1	99.9
31.00	91.7	13.1	104.9
32.00	97.8	11.6	109.4
33.00	103.6	12.9	116.6

34.00	109.2	17.2	126.4
35.00	113.8	22.3	136.1
36.00	117.2	25.3	142.4
37.00	120.6	25.3	145.8
38.00	124.0	25.3	149.2
39.00	127.4	25.3	152.7
40.00	130.8	25.3	156.1
41.00	134.2	25.3	159.5
42.00	137.6	25.3	162.9
43.00	141.0	29.8	170.8
44.00	144.5	37.6	182.2
45.00	151.6	45.5	197.1
46.00	162.1	50.0	212.2
47.00	172.9	50.0	222.9
48.00	183.9	50.0	233.9

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

****
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING *
****

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.4510E-02	0.2017E-01
			0.7517E-02	0.3908E-01
			0.1128E-01	0.7185E-01
			0.1353E-01	0.1008E+00
			0.1503E-01	0.1261E+00
			0.1503E-01	0.2521E+00
			0.1503E-01	0.3782E+00
			0.1503E-01	0.6303E+00
			0.1503E-01	0.2521E+01
2	10	0.7625E+01		
			0.0000E+00	0.0000E+00
			0.8253E+00	0.2017E-01
			0.1376E+01	0.3908E-01

		0.2063E+01	0.7185E-01
		0.2476E+01	0.1008E+00
		0.2751E+01	0.1261E+00
		0.2751E+01	0.2521E+00
		0.2751E+01	0.3782E+00
		0.2751E+01	0.6303E+00
		0.2751E+01	0.2521E+01
3	10	0.1521E+02	
		0.0000E+00	0.0000E+00
		0.1646E+01	0.2017E-01
		0.2744E+01	0.3908E-01
		0.4115E+01	0.7185E-01
		0.4939E+01	0.1008E+00
		0.5487E+01	0.1261E+00
		0.5487E+01	0.2521E+00
		0.5487E+01	0.3782E+00
		0.5487E+01	0.6303E+00
		0.5487E+01	0.2521E+01
4	10	0.1529E+02	
		0.0000E+00	0.0000E+00
		0.1655E+01	0.2017E-01
		0.2759E+01	0.3908E-01
		0.4138E+01	0.7185E-01
		0.4966E+01	0.1008E+00
		0.5517E+01	0.1261E+00
		0.4966E+01	0.2521E+00
		0.4966E+01	0.3782E+00
		0.4966E+01	0.6303E+00
		0.4966E+01	0.2521E+01
5	10	0.1647E+02	
		0.0000E+00	0.0000E+00
		0.1805E+01	0.2017E-01
		0.3009E+01	0.3908E-01
		0.4514E+01	0.7185E-01
		0.5416E+01	0.1008E+00
		0.6018E+01	0.1261E+00
		0.5416E+01	0.2521E+00
		0.5416E+01	0.3782E+00
		0.5416E+01	0.6303E+00
		0.5416E+01	0.2521E+01
6	10	0.1766E+02	
		0.0000E+00	0.0000E+00
		0.1887E+01	0.2017E-01
		0.3145E+01	0.3908E-01
		0.4717E+01	0.7185E-01
		0.5660E+01	0.1008E+00
		0.6289E+01	0.1261E+00
		0.5660E+01	0.2521E+00

			0.5660E+01	0.3782E+00
			0.5660E+01	0.6303E+00
			0.5660E+01	0.2521E+01
7	10	0.1774E+02		
			0.0000E+00	0.0000E+00
			0.1887E+01	0.2017E-01
			0.3145E+01	0.3908E-01
			0.4717E+01	0.7185E-01
			0.5660E+01	0.1008E+00
			0.6289E+01	0.1261E+00
			0.5660E+01	0.2521E+00
			0.5660E+01	0.3782E+00
			0.5660E+01	0.6303E+00
			0.5660E+01	0.2521E+01
8	10	0.1920E+02		
			0.0000E+00	0.0000E+00
			0.2241E+01	0.2017E-01
			0.3735E+01	0.3908E-01
			0.5602E+01	0.7185E-01
			0.6723E+01	0.1008E+00
			0.7469E+01	0.1261E+00
			0.6723E+01	0.2521E+00
			0.6723E+01	0.3782E+00
			0.6723E+01	0.6303E+00
			0.6723E+01	0.2521E+01
9	10	0.2066E+02		
			0.0000E+00	0.0000E+00
			0.2275E+01	0.2017E-01
			0.3792E+01	0.3908E-01
			0.5688E+01	0.7185E-01
			0.6825E+01	0.1008E+00
			0.7584E+01	0.1261E+00
			0.6825E+01	0.2521E+00
			0.6825E+01	0.3782E+00
			0.6825E+01	0.6303E+00
			0.6825E+01	0.2521E+01
10	10	0.2074E+02		
			0.0000E+00	0.0000E+00
			0.2279E+01	0.2017E-01
			0.3799E+01	0.3908E-01
			0.5698E+01	0.7185E-01
			0.6838E+01	0.1008E+00
			0.7598E+01	0.1261E+00
			0.7598E+01	0.2521E+00
			0.7598E+01	0.3782E+00
			0.7598E+01	0.6303E+00
			0.7598E+01	0.2521E+01
11	10	0.2595E+02		

		0.0000E+00	0.0000E+00
		0.3413E+01	0.2017E-01
		0.5689E+01	0.3908E-01
		0.8533E+01	0.7185E-01
		0.1024E+02	0.1008E+00
		0.1138E+02	0.1261E+00
		0.1138E+02	0.2521E+00
		0.1138E+02	0.3782E+00
		0.1138E+02	0.6303E+00
		0.1138E+02	0.2521E+01
12	10	0.3116E+02	
		0.0000E+00	0.0000E+00
		0.3803E+01	0.2017E-01
		0.6338E+01	0.3908E-01
		0.9507E+01	0.7185E-01
		0.1141E+02	0.1008E+00
		0.1268E+02	0.1261E+00
		0.1268E+02	0.2521E+00
		0.1268E+02	0.3782E+00
		0.1268E+02	0.6303E+00
		0.1268E+02	0.2521E+01
13	10	0.3124E+02	
		0.0000E+00	0.0000E+00
		0.3809E+01	0.2017E-01
		0.6349E+01	0.3908E-01
		0.9523E+01	0.7185E-01
		0.1143E+02	0.1008E+00
		0.1270E+02	0.1261E+00
		0.1270E+02	0.2521E+00
		0.1270E+02	0.3782E+00
		0.1270E+02	0.6303E+00
		0.1270E+02	0.2521E+01
14	10	0.3220E+02	
		0.0000E+00	0.0000E+00
		0.3792E+01	0.2017E-01
		0.6320E+01	0.3908E-01
		0.9480E+01	0.7185E-01
		0.1138E+02	0.1008E+00
		0.1264E+02	0.1261E+00
		0.1264E+02	0.2521E+00
		0.1264E+02	0.3782E+00
		0.1264E+02	0.6303E+00
		0.1264E+02	0.2521E+01
15	10	0.3316E+02	
		0.0000E+00	0.0000E+00
		0.3507E+01	0.2017E-01
		0.5845E+01	0.3908E-01
		0.8767E+01	0.7185E-01

			0.1052E+02	0.1008E+00
			0.1169E+02	0.1261E+00
			0.1169E+02	0.2521E+00
			0.1169E+02	0.3782E+00
			0.1169E+02	0.6303E+00
			0.1169E+02	0.2521E+01
16	10	0.3324E+02		
			0.0000E+00	0.0000E+00
			0.3512E+01	0.2017E-01
			0.5854E+01	0.3908E-01
			0.8781E+01	0.7185E-01
			0.1054E+02	0.1008E+00
			0.1171E+02	0.1261E+00
			0.1054E+02	0.2521E+00
			0.1054E+02	0.3782E+00
			0.1054E+02	0.6303E+00
			0.1054E+02	0.2521E+01
17	10	0.3845E+02		
			0.0000E+00	0.0000E+00
			0.2154E+01	0.2017E-01
			0.3590E+01	0.3908E-01
			0.5384E+01	0.7185E-01
			0.6461E+01	0.1008E+00
			0.7179E+01	0.1261E+00
			0.6461E+01	0.2521E+00
			0.6461E+01	0.3782E+00
			0.6461E+01	0.6303E+00
			0.6461E+01	0.2521E+01
18	10	0.4366E+02		
			0.0000E+00	0.0000E+00
			0.2217E+01	0.2017E-01
			0.3694E+01	0.3908E-01
			0.5542E+01	0.7185E-01
			0.6650E+01	0.1008E+00
			0.7389E+01	0.1261E+00
			0.6650E+01	0.2521E+00
			0.6650E+01	0.3782E+00
			0.6650E+01	0.6303E+00
			0.6650E+01	0.2521E+01
19	10	0.4374E+02		
			0.0000E+00	0.0000E+00
			0.2225E+01	0.2017E-01
			0.3708E+01	0.3908E-01
			0.5561E+01	0.7185E-01
			0.6674E+01	0.1008E+00
			0.7415E+01	0.1261E+00
			0.7415E+01	0.2521E+00
			0.7415E+01	0.3782E+00

			0.7415E+01	0.6303E+00
			0.7415E+01	0.2521E+01
20	10	0.4640E+02		
			0.0000E+00	0.0000E+00
			0.6791E+01	0.2017E-01
			0.1132E+02	0.3908E-01
			0.1698E+02	0.7185E-01
			0.2037E+02	0.1008E+00
			0.2264E+02	0.1261E+00
			0.2264E+02	0.2521E+00
			0.2264E+02	0.3782E+00
			0.2264E+02	0.6303E+00
			0.2264E+02	0.2521E+01
21	10	0.4906E+02		
			0.0000E+00	0.0000E+00
			0.6980E+01	0.2017E-01
			0.1163E+02	0.3908E-01
			0.1745E+02	0.7185E-01
			0.2094E+02	0.1008E+00
			0.2327E+02	0.1261E+00
			0.2327E+02	0.2521E+00
			0.2327E+02	0.3782E+00
			0.2327E+02	0.6303E+00
			0.2327E+02	0.2521E+01
22	10	0.4914E+02		
			0.0000E+00	0.0000E+00
			0.6980E+01	0.2017E-01
			0.1163E+02	0.3908E-01
			0.1745E+02	0.7185E-01
			0.2094E+02	0.1008E+00
			0.2327E+02	0.1261E+00
			0.2094E+02	0.2521E+00
			0.2094E+02	0.3782E+00
			0.2094E+02	0.6303E+00
			0.2094E+02	0.2521E+01
23	10	0.5205E+02		
			0.0000E+00	0.0000E+00
			0.6980E+01	0.2017E-01
			0.1163E+02	0.3908E-01
			0.1745E+02	0.7185E-01
			0.2094E+02	0.1008E+00
			0.2327E+02	0.1261E+00
			0.2094E+02	0.2521E+00
			0.2094E+02	0.3782E+00
			0.2094E+02	0.6303E+00
			0.2094E+02	0.2521E+01
24	10	0.5496E+02		
			0.0000E+00	0.0000E+00

0.6980E+01	0.2017E-01
0.1163E+02	0.3908E-01
0.1745E+02	0.7185E-01
0.2094E+02	0.1008E+00
0.2327E+02	0.1261E+00
0.2094E+02	0.2521E+00
0.2094E+02	0.3782E+00
0.2094E+02	0.6303E+00
0.2094E+02	0.2521E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.3126E+01	0.6303E-02
0.6252E+01	0.1261E-01
0.1250E+02	0.2521E-01
0.2501E+02	0.1639E+00
0.3751E+02	0.5294E+00
0.4502E+02	0.9202E+00
0.5002E+02	0.1261E+01
0.5002E+02	0.1891E+01
0.5002E+02	0.2521E+01

LOAD VERSUS SETTLEMENT CURVE

****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.3638E+00	0.1504E-03	0.4960E-01	0.1000E-03
0.3638E+01	0.1504E-02	0.4960E+00	0.1000E-02
0.1819E+02	0.7522E-02	0.2480E+01	0.5000E-02
0.3638E+02	0.1504E-01	0.4960E+01	0.1000E-01
0.7106E+02	0.2995E-01	0.9920E+01	0.2000E-01
0.1314E+03	0.6824E-01	0.1474E+02	0.5000E-01
0.1729E+03	0.1040E+00	0.1745E+02	0.8000E-01
0.1937E+03	0.1269E+00	0.1925E+02	0.1000E+00
0.2119E+03	0.2301E+00	0.2625E+02	0.2000E+00
0.2201E+03	0.5319E+00	0.3651E+02	0.5000E+00
0.2263E+03	0.8331E+00	0.4271E+02	0.8000E+00
0.2298E+03	0.1034E+01	0.4619E+02	0.1000E+01
0.2336E+03	0.2035E+01	0.5002E+02	0.2000E+01

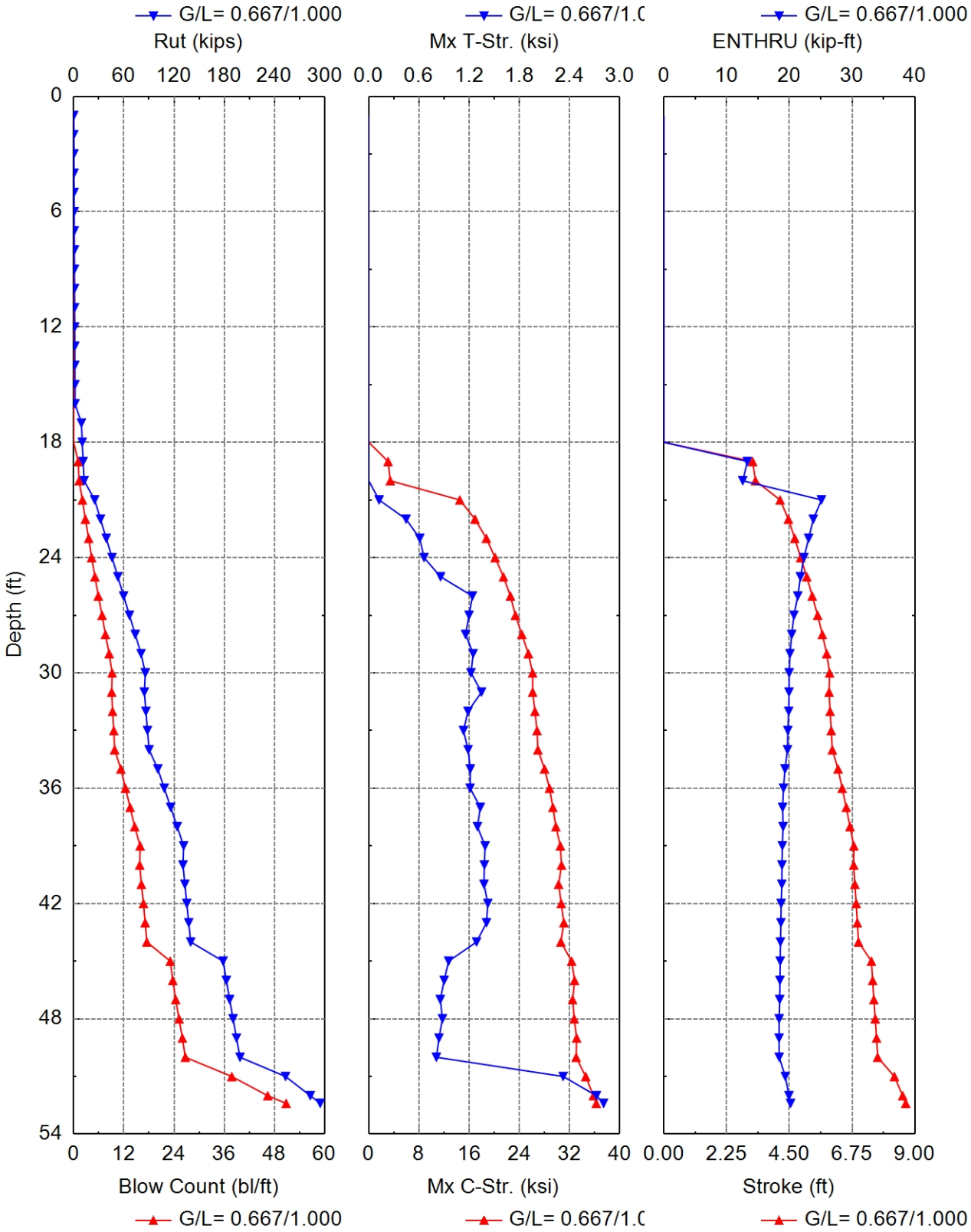
APPENDIX IX

GRLWEAP DRIVABILITY ANALYSIS OUTPUTS

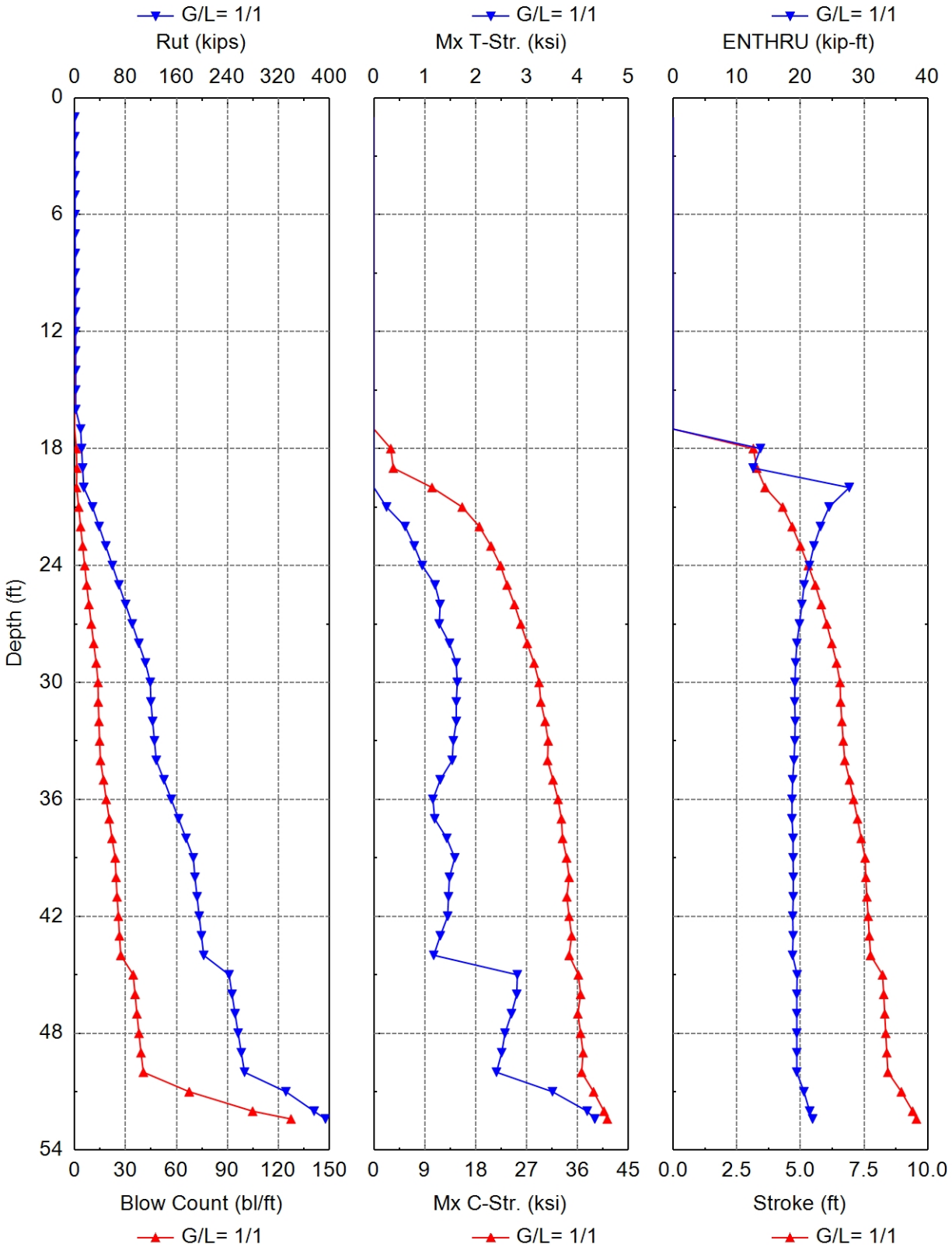
Rear Abt. (B-004-0-25)

Piles driven prior to construction of MSE wall

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.667/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	0.1	0.0	0.1	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	0.2	0.0	0.2	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	0.3	0.0	0.3	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	0.4	0.0	0.4	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	0.5	0.0	0.5	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	0.6	0.0	0.6	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	0.8	0.0	0.8	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	0.9	0.0	0.9	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	1.0	0.0	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	1.1	0.0	1.1	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	1.2	0.0	1.2	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	1.3	0.0	1.3	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	1.4	0.0	1.4	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	1.5	0.0	1.5	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	1.6	0.0	1.6	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	1.7	0.0	1.7	0.3	0.000	0.000	10.81	0.0	D 19-42
17.0	9.3	0.2	9.1	0.0	0.000	0.000	0.00	0.0	D 19-42
18.0	10.3	1.3	9.1	0.0	0.000	0.000	0.00	0.0	D 19-42
19.0	11.4	2.3	9.1	1.1	3.088	0.000	3.18	13.3	D 19-42
20.0	12.6	3.5	9.1	1.3	3.428	0.000	3.28	12.6	D 19-42
21.0	25.1	5.9	19.3	2.1	14.512	0.124	4.17	25.1	D 19-42
22.0	32.1	12.8	19.3	2.8	16.933	0.446	4.47	23.8	D 19-42
23.0	39.0	19.7	19.3	3.6	18.738	0.610	4.69	23.1	D 19-42
24.0	45.9	26.7	19.3	4.3	20.142	0.661	4.91	22.3	D 19-42
25.0	52.9	33.6	19.3	5.1	21.469	0.859	5.13	21.8	D 19-42
26.0	59.8	40.5	19.3	5.9	22.579	1.240	5.32	21.3	D 19-42
27.0	66.7	47.4	19.3	6.8	23.374	1.199	5.51	20.7	D 19-42
28.0	73.7	54.4	19.3	7.6	24.404	1.158	5.68	20.4	D 19-42
29.0	80.6	61.3	19.3	8.5	25.439	1.248	5.84	20.1	D 19-42
30.0	85.7	66.4	19.3	9.2	26.120	1.222	5.94	20.0	D 19-42
31.0	84.5	70.5	14.1	9.1	26.124	1.348	5.92	20.0	D 19-42
32.0	86.4	72.3	14.1	9.3	26.483	1.187	5.96	19.9	D 19-42
33.0	88.3	74.2	14.1	9.6	26.814	1.132	6.00	19.8	D 19-42
34.0	90.2	76.1	14.1	9.8	26.959	1.188	6.04	19.7	D 19-42
35.0	100.7	79.2	21.4	11.3	28.016	1.214	6.25	19.3	D 19-42
36.0	108.4	86.9	21.4	12.4	28.808	1.212	6.39	19.1	D 19-42
37.0	116.1	94.6	21.4	13.5	29.345	1.333	6.54	18.9	D 19-42

38.0	123.8	102.3	21.4	14.6	29.826	1.299	6.68	19.0	D 19-42
39.0	131.5	110.0	21.4	15.9	30.536	1.391	6.81	18.9	D 19-42
40.0	130.7	116.6	14.1	15.8	30.724	1.382	6.81	18.8	D 19-42
41.0	133.0	118.9	14.1	16.2	30.268	1.378	6.85	18.8	D 19-42
42.0	135.2	121.1	14.1	16.7	30.676	1.423	6.90	18.7	D 19-42
43.0	137.6	123.5	14.1	17.1	31.096	1.407	6.94	18.7	D 19-42
44.0	139.9	125.8	14.1	17.5	30.620	1.289	6.98	18.6	D 19-42
45.0	178.6	128.5	50.1	23.1	32.337	0.955	7.44	18.5	D 19-42
46.0	182.5	132.4	50.1	23.7	32.805	0.901	7.49	18.5	D 19-42
47.0	186.5	136.4	50.1	24.4	32.494	0.855	7.53	18.5	D 19-42
48.0	190.5	140.4	50.1	25.2	32.739	0.881	7.58	18.4	D 19-42
49.0	194.7	144.6	50.1	26.0	33.131	0.840	7.63	18.4	D 19-42
50.0	198.9	148.8	50.1	26.7	33.058	0.808	7.67	18.4	D 19-42
51.0	253.2	170.8	82.4	37.8	34.573	2.324	8.27	19.4	D 19-42
52.0	282.9	200.4	82.4	46.4	35.806	2.721	8.56	19.9	D 19-42
52.4	294.7	212.3	82.4	50.8	36.260	2.807	8.67	20.2	D 19-42

Total driving time: 11 minutes; Total Number of Blows: 481 (starting at penetration 1.0 ft)

Gain/Loss Factor at Shaft/Toe = 1.000/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	0.1	0.0	0.1	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	0.2	0.0	0.2	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	0.3	0.0	0.3	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	0.4	0.0	0.4	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	0.5	0.0	0.5	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	0.6	0.0	0.6	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	0.8	0.0	0.8	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	0.9	0.0	0.9	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	1.0	0.0	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	1.1	0.0	1.1	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	1.2	0.0	1.2	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	1.3	0.0	1.3	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	1.4	0.0	1.4	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	1.5	0.0	1.5	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	1.6	0.0	1.6	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	1.7	0.0	1.7	0.3	0.000	0.000	10.81	0.0	D 19-42
17.0	9.4	0.4	9.1	0.0	0.000	0.000	0.00	0.0	D 19-42
18.0	10.9	1.9	9.1	1.0	2.984	0.000	3.15	13.7	D 19-42

Rear Abt. (B-004-0-25)

Piles driven prior to construction of MSE wall

19.0	12.6	3.5	9.1	1.3	3.430	0.000	3.29	12.6	D 19-42
20.0	14.3	5.2	9.1	1.1	10.276	0.000	3.61	27.7	D 19-42
21.0	28.1	8.8	19.3	2.4	15.602	0.247	4.30	24.5	D 19-42
22.0	38.5	19.2	19.3	3.5	18.628	0.613	4.68	23.1	D 19-42
23.0	48.9	29.6	19.3	4.7	20.696	0.792	5.00	22.1	D 19-42
24.0	59.3	40.0	19.3	5.9	22.377	0.949	5.31	21.4	D 19-42
25.0	69.7	50.4	19.3	7.1	23.548	1.201	5.58	20.6	D 19-42
26.0	80.1	60.8	19.3	8.4	24.840	1.300	5.82	20.2	D 19-42
27.0	90.5	71.2	19.3	9.8	25.969	1.283	6.03	19.8	D 19-42
28.0	100.8	81.6	19.3	11.2	27.107	1.485	6.23	19.4	D 19-42
29.0	111.2	92.0	19.3	12.7	28.316	1.617	6.42	19.2	D 19-42
30.0	118.9	99.6	19.3	13.8	29.198	1.638	6.56	19.1	D 19-42
31.0	119.8	105.7	14.1	13.9	29.503	1.619	6.58	19.1	D 19-42
32.0	122.5	108.4	14.1	14.3	30.265	1.619	6.63	19.2	D 19-42
33.0	125.4	111.3	14.1	14.7	30.817	1.560	6.68	19.1	D 19-42
34.0	128.3	114.2	14.1	15.2	30.710	1.538	6.74	19.0	D 19-42
35.0	140.3	118.8	21.4	17.0	31.664	1.303	6.93	18.8	D 19-42
36.0	151.8	130.4	21.4	18.6	32.561	1.159	7.09	18.7	D 19-42
37.0	163.4	141.9	21.4	20.4	33.142	1.194	7.24	18.7	D 19-42
38.0	174.9	153.5	21.4	22.0	33.347	1.431	7.39	18.8	D 19-42
39.0	186.5	165.0	21.4	23.9	34.066	1.589	7.54	18.8	D 19-42
40.0	189.0	174.9	14.1	24.4	34.512	1.484	7.57	18.9	D 19-42
41.0	192.4	178.3	14.1	25.0	34.114	1.465	7.61	18.9	D 19-42
42.0	195.8	181.7	14.1	25.8	34.509	1.449	7.66	18.8	D 19-42
43.0	199.3	185.2	14.1	26.4	34.957	1.304	7.70	18.8	D 19-42
44.0	202.8	188.7	14.1	27.2	34.518	1.175	7.75	18.8	D 19-42
45.0	242.7	192.5	50.1	34.5	36.147	2.817	8.23	19.5	D 19-42
46.0	247.3	197.2	50.1	35.6	36.538	2.806	8.27	19.4	D 19-42
47.0	252.1	202.0	50.1	36.7	36.056	2.702	8.31	19.4	D 19-42
48.0	257.0	206.9	50.1	37.9	36.540	2.575	8.35	19.4	D 19-42
49.0	261.9	211.8	50.1	39.1	36.983	2.510	8.39	19.4	D 19-42
50.0	267.0	216.9	50.1	40.5	36.721	2.408	8.44	19.4	D 19-42
51.0	332.0	249.5	82.4	67.5	38.833	3.508	8.96	20.6	D 19-42
52.0	376.4	293.9	82.4	104.9	40.678	4.190	9.41	21.5	D 19-42
52.4	394.2	311.7	82.4	127.5	41.272	4.340	9.56	21.9	D 19-42

A 50.25' - OK

Total driving time: 18 minutes; Total Number of Blows: 767 (starting at penetration 1.0 ft)

Note: Strength parameters, unit weight or overburden stress are NOT considered above MSE wall foundation preparation layer

GRLWEAP: Wave Equation Analysis of Pile Foundations

WYA-23-3.47 + HP 10x42 12/12/2025
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity-blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors.

WYA-23-3.47 + HP 10x42 RESOURCE INTERNATIONAL INC

SOIL PROFILE

Depth ft	Soil Type -	Spec. Wt lb/ft³	Su ksf	Phi °	Unit Rs ksf	Unit Rt ksf
0.0	Sand	89.1	0.0	0.0	0.00	0.00
10.0	Sand	89.1	0.0	0.0	0.00	1.58
10.0	Sand	89.1	0.0	0.0	0.00	1.58
16.8	Sand	89.1	0.0	0.0	0.00	2.63
16.8	Sand	125.0	0.0	30.0	0.43	13.32
20.8	Sand	125.0	0.0	30.0	0.57	13.32
20.8	Clay	125.0	3.1	0.0	2.98	28.35
30.8	Clay	125.0	3.1	0.0	2.98	28.35
30.8	Sand	125.0	0.0	31.0	0.82	20.71
34.8	Sand	125.0	0.0	31.0	0.90	20.71
34.8	Clay	125.0	3.5	0.0	3.50	31.50
39.8	Clay	125.0	3.5	0.0	3.50	31.50
39.8	Sand	125.0	0.0	31.0	1.00	20.71
44.8	Sand	125.0	0.0	31.0	1.10	20.71
44.8	Sand	135.0	0.0	34.0	1.40	73.64
50.3	Sand	135.0	0.0	34.0	1.56	73.64
50.3	Clay	140.0	13.5	0.0	13.46	121.18
52.4	Clay	140.0	13.5	0.0	13.46	121.18
52.4	Clay	150.0	360.0	0.0	54.00	3,239.99
55.0	Clay	150.0	360.0	0.0	54.00	3,239.99

PILE INPUT

Uniform Pile		Pile Type:	H Pile
Pile Length: (ft)	54.400	Pile Penetration: (ft)	52.400
Pile Size: (ft)	0.84	Toe Area: (in²)	97.97

Pile Profile

Lb Top ft	X-Area in²	E-Modulus ksi	Spec. Wt lb/ft³	Perim. ft	Crit. Index -
0.0	12.4	30,000.0	493.4	3.3	0
54.4	12.4	30,000.0	493.4	3.3	0

HAMMER INPUT

ID	41	Made By:	DELMAG
Model	D 19-42	Type:	OED

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.0	0.0	0.0	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
1.7	0.0	0.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
3.3	0.0	0.5	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
5.0	0.0	0.8	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
6.7	0.0	1.1	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
8.3	0.0	1.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
10.0	0.0	1.6	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
10.0	0.0	1.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
11.7	0.0	1.8	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
13.4	0.0	2.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.1	0.0	2.4	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.8	0.0	2.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.8	0.4	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
18.8	0.5	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
20.8	0.6	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
20.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
22.5	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
24.1	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
25.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
27.5	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
29.1	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
30.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
30.8	0.8	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
32.8	0.9	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
34.8	0.9	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
34.8	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
36.5	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0

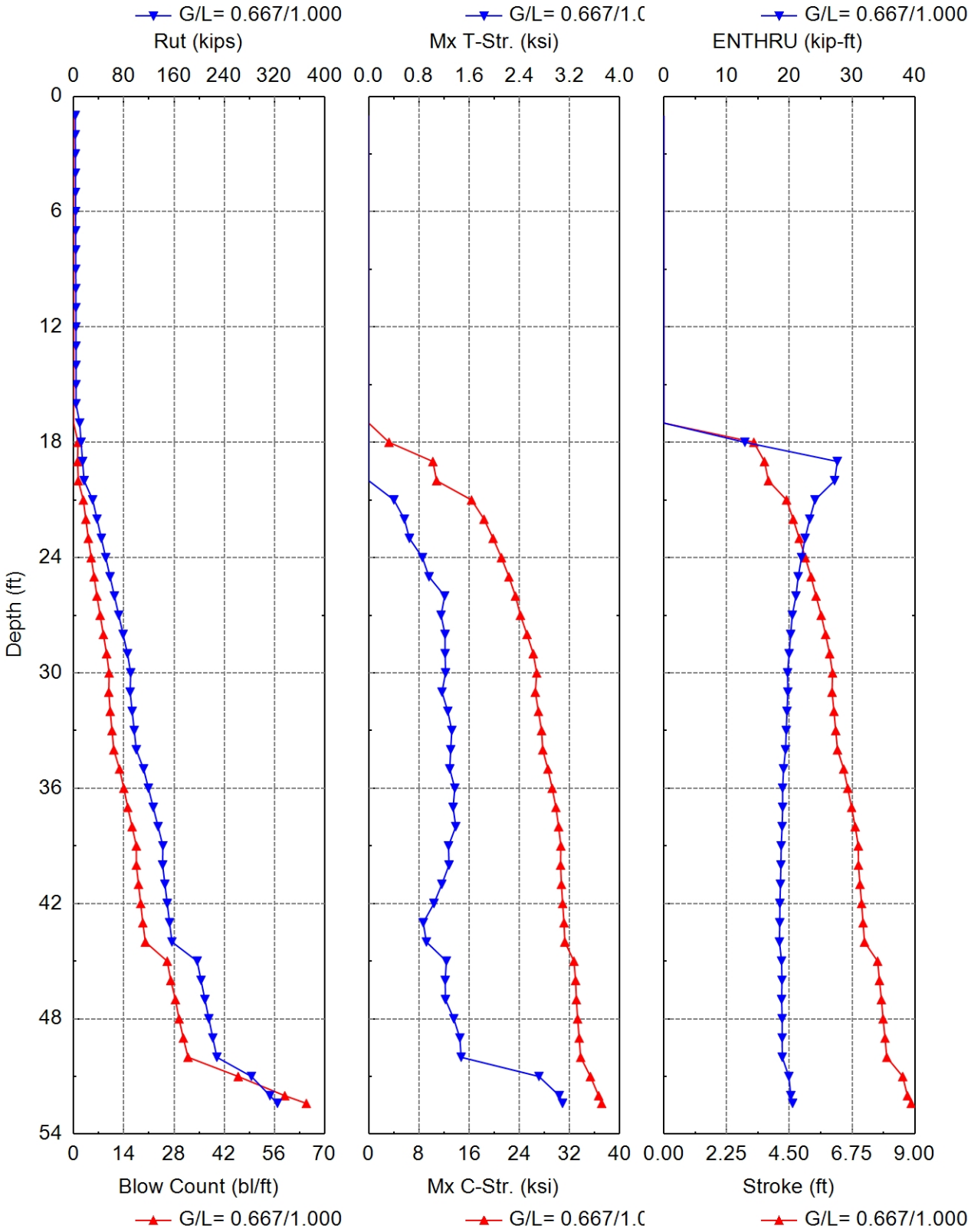
38.1	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
39.8	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
39.8	1.0	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
41.5	1.0	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
43.1	1.1	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
44.8	1.1	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
44.8	1.4	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
46.6	1.4	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
48.5	1.5	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
50.3	1.6	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
50.3	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
51.4	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
52.4	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0

Rear Abt. (B-004-0-25)

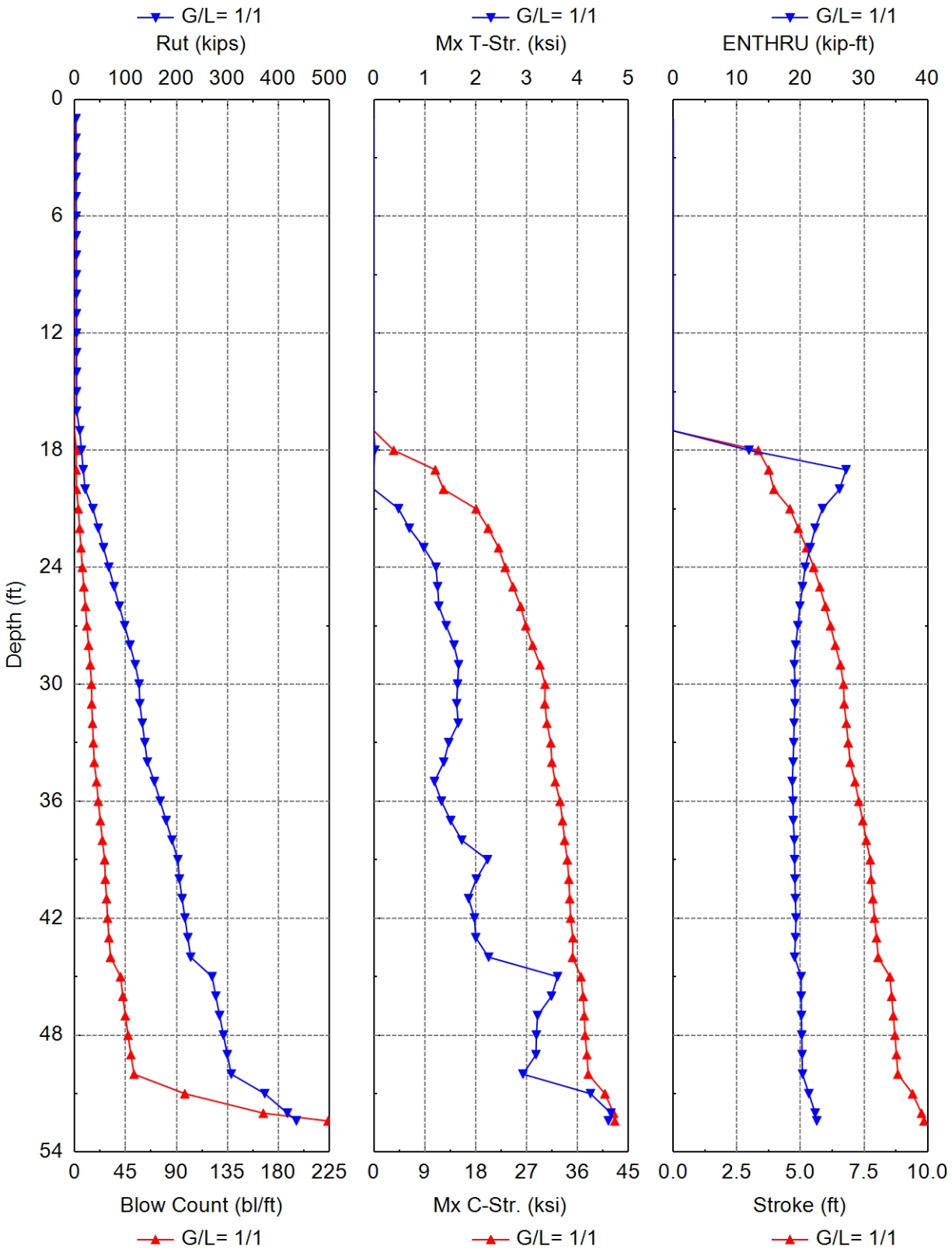
Piles driven to the required bearing resistance through the MSE wall completed to the pile cap elevation.

WYA-23-3.47 + HP 10x42 (B-004-0-25) RESOURCE INTERNATIONAL INC

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.667/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	2.5	0.0	2.5	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.6	0.0	2.6	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	2.8	0.0	2.8	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	2.9	0.0	2.9	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	3.0	0.0	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	3.1	0.0	3.1	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	3.2	0.0	3.2	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	3.3	0.0	3.3	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	3.4	0.0	3.4	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	3.5	0.0	3.5	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	3.6	0.0	3.6	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	3.7	0.0	3.7	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
17.0	9.6	0.6	9.1	0.0	0.000	0.000	0.00	0.0	D 19-42
18.0	11.9	2.9	9.1	1.2	3.229	0.000	3.23	12.9	D 19-42
19.0	14.3	5.2	9.1	1.1	10.227	0.000	3.61	27.6	D 19-42
20.0	16.7	7.7	9.1	1.3	10.814	0.000	3.75	27.2	D 19-42
21.0	30.4	11.1	19.3	2.7	16.380	0.401	4.40	24.1	D 19-42
22.0	37.3	18.0	19.3	3.4	18.369	0.568	4.64	23.2	D 19-42
23.0	44.2	24.9	19.3	4.1	19.809	0.648	4.86	22.5	D 19-42
24.0	51.1	31.9	19.3	4.9	21.144	0.856	5.07	21.9	D 19-42
25.0	58.1	38.8	19.3	5.7	22.343	0.961	5.28	21.4	D 19-42
26.0	65.0	45.7	19.3	6.5	23.378	1.210	5.46	21.1	D 19-42
27.0	71.9	52.6	19.3	7.4	24.176	1.152	5.64	20.5	D 19-42
28.0	78.9	59.6	19.3	8.3	25.226	1.216	5.80	20.2	D 19-42
29.0	85.8	66.5	19.3	9.2	26.216	1.217	5.95	20.0	D 19-42
30.0	90.9	71.6	19.3	9.9	26.770	1.225	6.05	19.7	D 19-42
31.0	90.0	75.9	14.1	9.8	26.548	1.168	6.03	19.8	D 19-42
32.0	93.3	79.2	14.1	10.2	27.042	1.260	6.10	19.6	D 19-42
33.0	96.6	82.5	14.1	10.7	27.545	1.324	6.16	19.5	D 19-42
34.0	99.9	85.8	14.1	11.2	27.735	1.306	6.23	19.4	D 19-42
35.0	111.5	90.1	21.4	12.8	28.554	1.291	6.45	19.1	D 19-42
36.0	119.2	97.8	21.4	14.0	29.234	1.371	6.59	18.9	D 19-42
37.0	126.9	105.5	21.4	15.1	29.832	1.344	6.73	18.9	D 19-42

38.0	134.6	113.2	21.4	16.3	30.258	1.386	6.86	18.8	D 19-42
39.0	142.3	120.9	21.4	17.5	30.618	1.271	6.97	18.7	D 19-42
40.0	141.8	127.7	14.1	17.5	30.573	1.279	6.98	18.7	D 19-42
41.0	145.5	131.4	14.1	18.1	30.707	1.165	7.03	18.6	D 19-42
42.0	149.2	135.1	14.1	18.7	30.906	1.039	7.09	18.5	D 19-42
43.0	152.9	138.8	14.1	19.3	31.120	0.869	7.14	18.5	D 19-42
44.0	156.7	142.6	14.1	20.0	31.252	0.919	7.19	18.4	D 19-42
45.0	196.9	146.8	50.1	26.1	32.699	1.237	7.66	18.8	D 19-42
46.0	203.0	152.9	50.1	27.1	32.965	1.218	7.73	18.8	D 19-42
47.0	209.2	159.1	50.1	28.4	33.091	1.222	7.80	18.8	D 19-42
48.0	215.5	165.4	50.1	29.4	33.290	1.355	7.86	18.9	D 19-42
49.0	221.9	171.8	50.1	30.6	33.542	1.452	7.93	18.8	D 19-42
50.0	228.3	178.2	50.1	31.9	33.772	1.472	7.99	18.9	D 19-42
51.0	283.4	200.9	82.4	45.9	35.329	2.712	8.57	19.9	D 19-42
52.0	313.0	230.5	82.4	58.9	36.640	3.036	8.74	20.2	D 19-42
52.4	324.8	242.4	82.4	64.9	37.125	3.088	8.87	20.5	D 19-42

Total driving time: 13 minutes; Total Number of Blows: 555 (starting at penetration 1.0 ft)

Gain/Loss Factor at Shaft/Toe = 1.000/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	2.5	0.0	2.5	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.6	0.0	2.6	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	2.8	0.0	2.8	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	2.9	0.0	2.9	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	3.0	0.0	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	3.1	0.0	3.1	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	3.2	0.0	3.2	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	3.3	0.0	3.3	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	3.4	0.0	3.4	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	3.5	0.0	3.5	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	3.6	0.0	3.6	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	3.7	0.0	3.7	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
17.0	9.9	0.8	9.1	0.0	0.000	0.000	0.00	0.0	D 19-42
18.0	13.4	4.3	9.1	1.5	3.488	0.019	3.34	11.9	D 19-42

Piles driven to the required bearing resistance through the MSE wall completed to the pile cap elevation.

19.0	16.9	7.8	9.1	1.3	10.854	0.000	3.76	27.2	D 19-42
20.0	20.6	11.5	9.1	1.7	12.305	0.000	3.96	26.1	D 19-42
21.0	35.9	16.6	19.3	3.2	18.059	0.484	4.59	23.5	D 19-42
22.0	46.3	27.0	19.3	4.4	20.207	0.695	4.92	22.3	D 19-42
23.0	56.7	37.4	19.3	5.6	22.047	0.980	5.24	21.5	D 19-42
24.0	67.1	47.8	19.3	6.8	23.216	1.219	5.52	20.7	D 19-42
25.0	77.5	58.2	19.3	8.1	24.585	1.251	5.76	20.3	D 19-42
26.0	87.9	68.6	19.3	9.5	25.944	1.276	5.98	19.9	D 19-42
27.0	98.3	79.0	19.3	10.8	26.852	1.419	6.18	19.6	D 19-42
28.0	108.7	89.4	19.3	12.3	28.067	1.574	6.37	19.3	D 19-42
29.0	119.1	99.8	19.3	13.8	29.368	1.662	6.57	19.0	D 19-42
30.0	126.7	107.4	19.3	14.9	30.257	1.644	6.69	19.1	D 19-42
31.0	128.0	113.9	14.1	15.1	30.209	1.626	6.72	19.1	D 19-42
32.0	132.9	118.8	14.1	15.8	30.591	1.657	6.80	19.0	D 19-42
33.0	137.8	123.7	14.1	16.5	31.279	1.469	6.88	18.9	D 19-42
34.0	142.8	128.7	14.1	17.3	31.457	1.372	6.95	18.8	D 19-42
35.0	156.5	135.1	21.4	19.3	32.050	1.189	7.14	18.7	D 19-42
36.0	168.1	146.6	21.4	20.9	32.906	1.326	7.29	18.8	D 19-42
37.0	179.6	158.2	21.4	22.7	33.346	1.508	7.45	18.9	D 19-42
38.0	191.2	169.7	21.4	24.5	33.710	1.725	7.59	19.0	D 19-42
39.0	202.7	181.3	21.4	26.5	34.196	2.231	7.74	19.1	D 19-42
40.0	205.7	191.6	14.1	27.1	34.459	2.011	7.78	19.1	D 19-42
41.0	211.2	197.1	14.1	28.2	34.627	1.861	7.85	19.2	D 19-42
42.0	216.7	202.6	14.1	29.1	34.773	1.976	7.91	19.3	D 19-42
43.0	222.3	208.2	14.1	30.3	35.190	2.000	7.99	19.2	D 19-42
44.0	227.9	213.8	14.1	31.7	35.124	2.254	8.05	19.1	D 19-42
45.0	270.0	219.9	50.1	40.6	36.610	3.608	8.51	20.1	D 19-42
46.0	277.3	227.2	50.1	42.6	36.983	3.488	8.58	20.1	D 19-42
47.0	284.8	234.7	50.1	44.8	37.194	3.215	8.65	20.2	D 19-42
48.0	292.3	242.2	50.1	47.2	37.331	3.192	8.71	20.2	D 19-42
49.0	299.9	249.8	50.1	49.7	37.657	3.184	8.77	20.3	D 19-42
50.0	307.7	257.6	50.1	52.5	37.895	2.928	8.83	20.3	D 19-42
51.0	373.4	291.0	82.4	97.4	40.847	4.255	9.41	21.3	D 19-42
52.0	417.9	335.4	82.4	166.8	42.388	4.655	9.76	22.3	D 19-42
52.4	435.6	353.2	82.4	224.0	42.589	4.607	9.86	22.6	D 19-42

A 50.25' - OK

Total driving time: 23 minutes; Total Number of Blows: 960 (starting at penetration 1.0 ft)

Note: Strength parameters are NOT considered above MSE wall foundation preparation layer. Overburden stress from BOF to MSE wall foundation preparation layer are considered.

GRLWEAP: Wave Equation Analysis of Pile Foundations

WYA-23-3.47 + HP 10x42 (B-004-0-25) 12/12/2025
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity-blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors.

SOIL PROFILE

Depth ft	Soil Type -	Spec. Wt lb/ft³	Su ksf	Phi °	Unit Rs ksf	Unit Rt ksf
0.0	Sand	89.1	0.0	0.0	0.00	3.57
10.0	Sand	89.1	0.0	0.0	0.00	5.15
10.0	Sand	89.1	0.0	0.0	0.00	5.15
16.8	Sand	89.1	0.0	0.0	0.00	5.51
16.8	Sand	125.0	0.0	30.0	1.02	13.32
20.8	Sand	125.0	0.0	30.0	1.15	13.32
20.8	Clay	125.0	3.1	0.0	2.98	28.35
30.8	Clay	125.0	3.1	0.0	2.98	28.35
30.8	Sand	125.0	0.0	31.0	1.46	20.71
34.8	Sand	125.0	0.0	31.0	1.54	20.71
34.8	Clay	125.0	3.5	0.0	3.50	31.50
39.8	Clay	125.0	3.5	0.0	3.50	31.50
39.8	Sand	125.0	0.0	31.0	1.64	20.71
44.8	Sand	125.0	0.0	31.0	1.74	20.71
44.8	Sand	135.0	0.0	34.0	2.20	73.64
50.3	Sand	135.0	0.0	34.0	2.37	73.64
50.3	Clay	140.0	13.5	0.0	13.46	121.18
52.4	Clay	140.0	13.5	0.0	13.46	121.18
52.4	Clay	150.0	360.0	0.0	54.00	3,239.99
55.0	Clay	150.0	360.0	0.0	54.00	3,239.99

PILE INPUT

Uniform Pile		Pile Type:	H Pile
Pile Length: (ft)	54.400	Pile Penetration: (ft)	52.400
Pile Size: (ft)	0.84	Toe Area: (in²)	97.97

Pile Profile

Lb Top ft	X-Area in²	E-Modulus ksi	Spec. Wt lb/ft³	Perim. ft	Crit. Index -
0.0	12.4	30,000.0	493.4	3.3	0
54.4	12.4	30,000.0	493.4	3.3	0

HAMMER INPUT

ID	41	Made By:	DELMAG
Model	D 19-42	Type:	OED

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

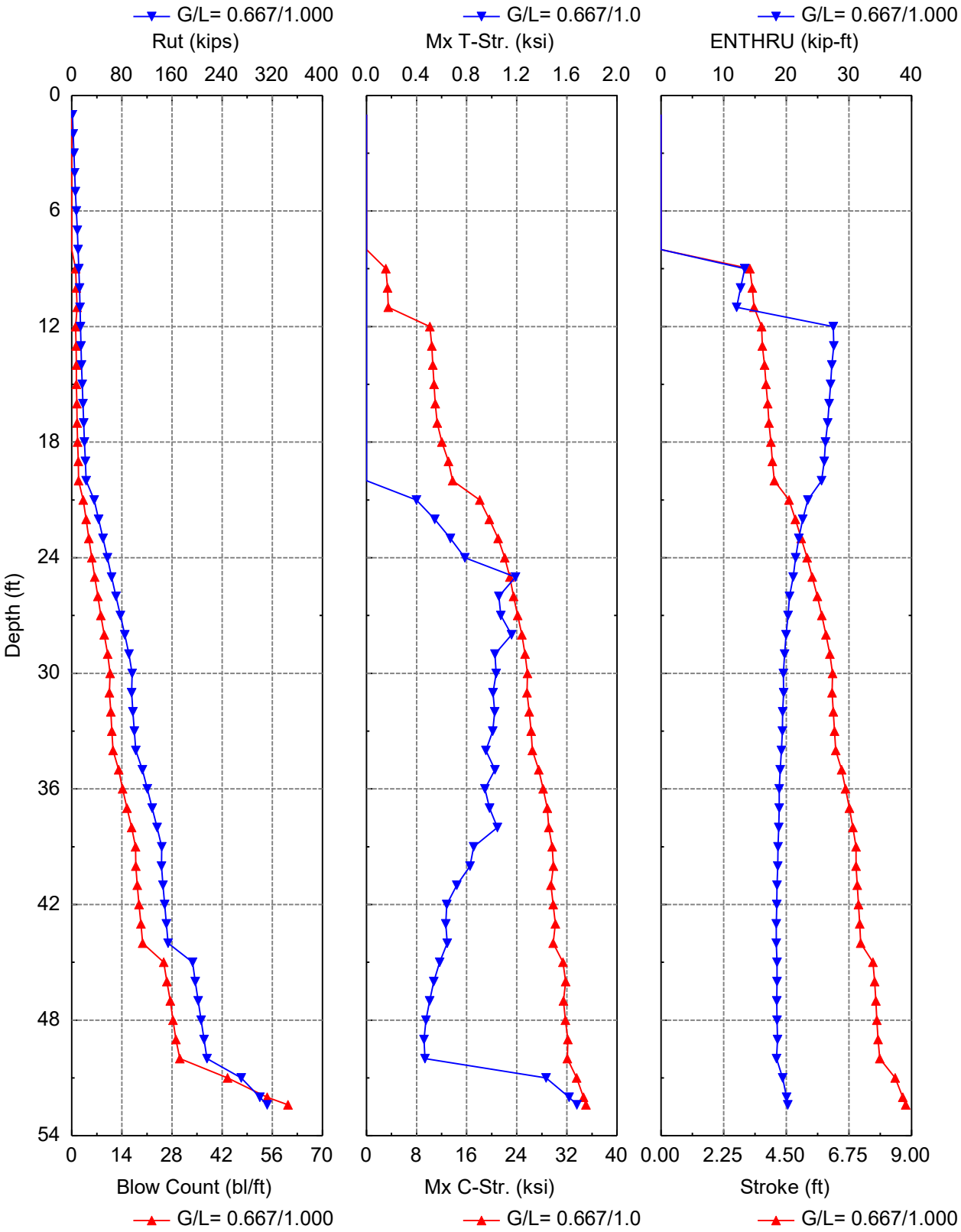
Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.0	0.0	3.6	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
1.7	0.0	3.8	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
3.3	0.0	4.1	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
5.0	0.0	4.4	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
6.7	0.0	4.6	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
8.3	0.0	4.9	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
10.0	0.0	5.2	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
10.0	0.0	5.2	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
11.7	0.0	5.4	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
13.4	0.0	5.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.1	0.0	5.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.8	0.0	5.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.8	1.0	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
18.8	1.1	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
20.8	1.2	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
20.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
22.5	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
24.1	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
25.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
27.5	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
29.1	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
30.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
30.8	1.5	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
32.8	1.5	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
34.8	1.5	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
34.8	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
36.5	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0

38.1	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
39.8	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
39.8	1.6	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
41.5	1.7	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
43.1	1.7	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
44.8	1.7	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
44.8	2.2	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
46.6	2.3	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
48.5	2.3	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
50.3	2.4	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
50.3	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
51.4	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
52.4	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0

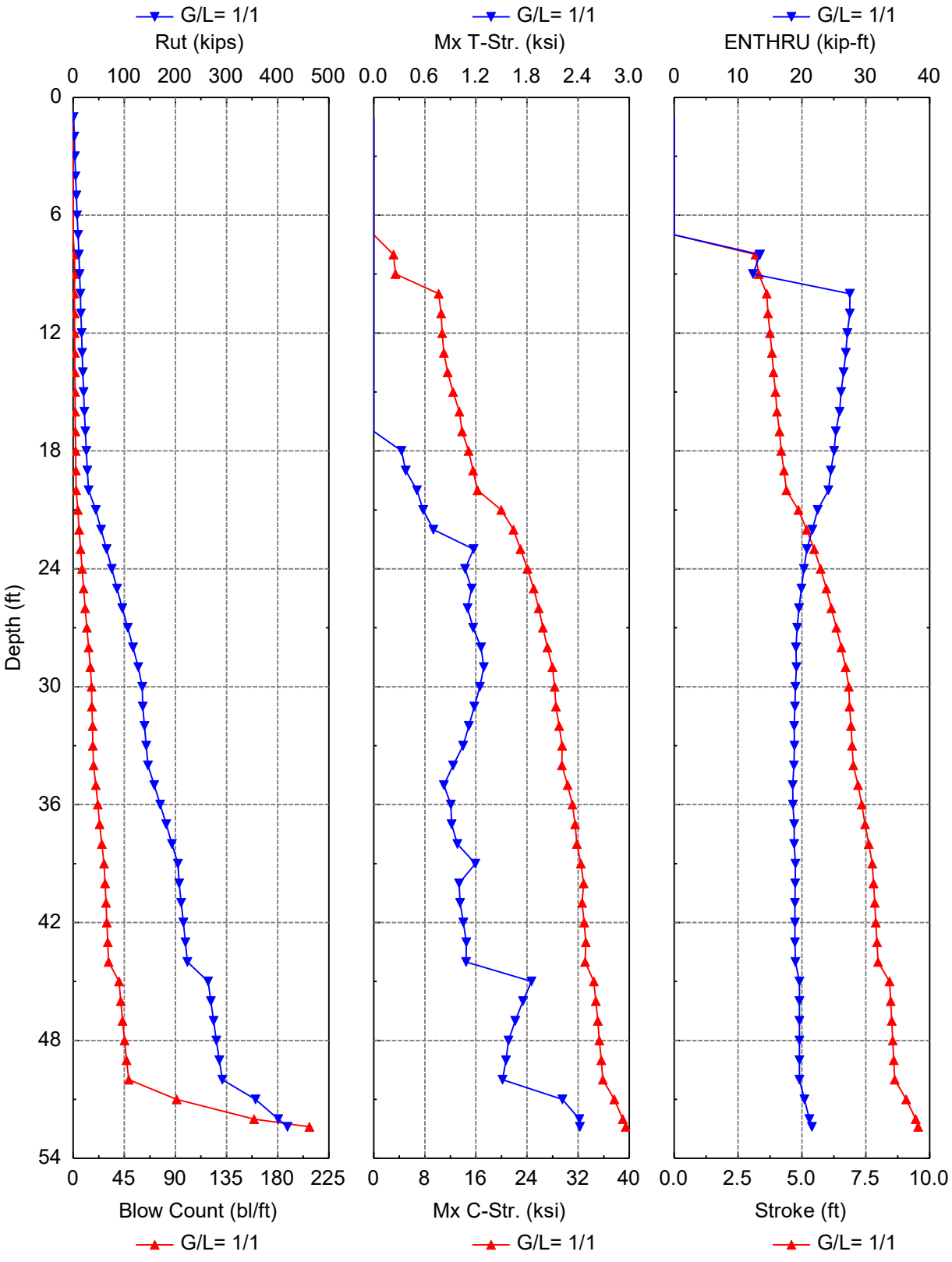
Rear Abt. (B-004-0-25)

Represents the case of piles driven to the required bearing resistance through the MSE wall completed to the pile cap elevation, with conventional granular-filled pipe pile sleeves through the MSE wall fill.

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.667/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	1.0	0.0	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.2	0.1	2.0	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	3.3	0.3	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	4.6	0.5	4.0	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	5.9	0.8	5.0	0.0	0.000	0.000	0.00	0.0	D 19-42
6.0	7.3	1.2	6.0	0.0	0.000	0.000	0.00	0.0	D 19-42
7.0	8.7	1.7	7.1	0.0	0.000	0.000	0.00	0.0	D 19-42
8.0	10.2	2.2	8.1	0.0	0.000	0.000	0.00	0.0	D 19-42
9.0	11.4	2.7	8.7	1.1	3.116	0.000	3.19	13.4	D 19-42
10.0	12.4	3.4	9.1	1.3	3.378	0.000	3.28	12.7	D 19-42
11.0	13.1	4.1	9.1	1.5	3.473	0.000	3.34	12.1	D 19-42
12.0	13.9	4.9	9.1	1.1	10.121	0.000	3.61	27.5	D 19-42
13.0	14.8	5.7	9.1	1.2	10.443	0.000	3.64	27.6	D 19-42
14.0	15.7	6.6	9.1	1.3	10.613	0.000	3.71	27.3	D 19-42
15.0	16.7	7.6	9.1	1.3	10.784	0.000	3.76	27.1	D 19-42
16.0	17.7	8.6	9.1	1.4	10.993	0.000	3.83	26.8	D 19-42
17.0	18.9	9.8	9.1	1.5	11.305	0.000	3.88	26.6	D 19-42
18.0	20.2	11.1	9.1	1.6	12.056	0.000	3.95	26.2	D 19-42
19.0	21.6	12.6	9.1	1.8	13.095	0.000	4.00	26.0	D 19-42
20.0	23.1	14.0	9.1	1.9	13.753	0.000	4.07	25.6	D 19-42
21.0	36.0	16.7	19.3	3.2	18.098	0.398	4.59	23.4	D 19-42
22.0	42.9	23.6	19.3	4.0	19.616	0.545	4.82	22.6	D 19-42
23.0	49.8	30.5	19.3	4.8	21.024	0.670	5.03	22.0	D 19-42
24.0	56.8	37.5	19.3	5.6	22.080	0.786	5.24	21.5	D 19-42
25.0	63.7	44.4	19.3	6.4	22.895	1.189	5.43	21.1	D 19-42
26.0	70.6	51.3	19.3	7.3	23.462	1.058	5.61	20.5	D 19-42
27.0	77.5	58.3	19.3	8.1	24.162	1.073	5.77	20.3	D 19-42
28.0	84.5	65.2	19.3	9.1	24.791	1.159	5.92	20.0	D 19-42
29.0	91.4	72.1	19.3	10.0	25.331	1.025	6.06	19.7	D 19-42
30.0	96.5	77.2	19.3	10.7	25.690	1.036	6.16	19.5	D 19-42
31.0	95.4	81.3	14.1	10.5	25.641	1.010	6.14	19.6	D 19-42
32.0	97.6	83.5	14.1	10.9	25.970	1.023	6.19	19.4	D 19-42
33.0	99.9	85.8	14.1	11.2	26.286	1.008	6.23	19.3	D 19-42
34.0	102.2	88.1	14.1	11.5	26.474	0.954	6.28	19.2	D 19-42
35.0	112.9	91.5	21.4	13.1	27.517	1.025	6.48	19.0	D 19-42
36.0	120.6	99.2	21.4	14.2	28.212	0.946	6.63	18.8	D 19-42
37.0	128.3	106.9	21.4	15.4	28.869	0.982	6.76	18.9	D 19-42
38.0	136.0	114.6	21.4	16.7	29.089	1.045	6.89	18.8	D 19-42

39.0	143.7	122.3	21.4	17.8	29.639	0.857	7.00	18.7	D 19-42
40.0	143.1	129.0	14.1	17.9	29.844	0.826	7.00	18.6	D 19-42
41.0	145.6	131.6	14.1	18.3	29.461	0.721	7.05	18.5	D 19-42
42.0	148.3	134.2	14.1	18.8	29.818	0.641	7.09	18.5	D 19-42
43.0	151.0	136.9	14.1	19.3	30.160	0.634	7.13	18.4	D 19-42
44.0	153.7	139.6	14.1	19.8	29.818	0.646	7.17	18.4	D 19-42
45.0	192.8	142.7	50.1	25.7	31.388	0.584	7.61	18.5	D 19-42
46.0	197.3	147.2	50.1	26.6	31.790	0.537	7.67	18.5	D 19-42
47.0	201.8	151.7	50.1	27.5	31.463	0.503	7.71	18.5	D 19-42
48.0	206.4	156.3	50.1	28.3	31.770	0.476	7.75	18.5	D 19-42
49.0	211.2	161.1	50.1	29.1	32.136	0.460	7.79	18.6	D 19-42
50.0	215.9	165.8	50.1	30.2	32.061	0.467	7.85	18.4	D 19-42
51.0	270.5	188.0	82.4	43.5	33.564	1.433	8.41	19.4	D 19-42
52.0	300.1	217.6	82.4	54.6	34.649	1.617	8.68	20.0	D 19-42
52.4	311.9	229.5	82.4	60.4	35.026	1.679	8.78	20.2	D 19-42

Total driving time: 13 minutes; Total Number of Blows: 563 (starting at penetration 1.0 ft)

Gain/Loss Factor at Shaft/Toe = 1.000/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	1.1	0.1	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.2	0.2	2.0	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	3.5	0.5	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	4.8	0.8	4.0	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	6.3	1.3	5.0	0.0	0.000	0.000	0.00	0.0	D 19-42
6.0	7.9	1.8	6.0	0.0	0.000	0.000	0.00	0.0	D 19-42
7.0	9.5	2.5	7.1	0.0	0.000	0.000	0.00	0.0	D 19-42
8.0	11.3	3.2	8.1	1.1	3.095	0.000	3.18	13.4	D 19-42
9.0	12.8	4.1	8.7	1.4	3.416	0.000	3.31	12.4	D 19-42
10.0	14.1	5.1	9.1	1.1	10.172	0.000	3.62	27.5	D 19-42
11.0	15.2	6.1	9.1	1.2	10.540	0.000	3.67	27.5	D 19-42
12.0	16.4	7.3	9.1	1.3	10.716	0.000	3.75	27.1	D 19-42
13.0	17.6	8.6	9.1	1.4	10.992	0.000	3.82	26.9	D 19-42
14.0	19.0	9.9	9.1	1.5	11.556	0.000	3.89	26.5	D 19-42
15.0	20.5	11.4	9.1	1.7	12.429	0.000	3.96	26.1	D 19-42
16.0	22.0	13.0	9.1	1.8	13.390	0.000	4.02	25.9	D 19-42
17.0	23.8	14.7	9.1	2.0	13.818	0.000	4.12	25.3	D 19-42
18.0	25.8	16.7	9.1	2.2	14.861	0.325	4.19	25.0	D 19-42
19.0	27.9	18.8	9.1	2.4	15.567	0.375	4.30	24.5	D 19-42
20.0	30.1	21.1	9.1	2.6	16.274	0.508	4.39	24.1	D 19-42

21.0	44.3	25.0	19.3	4.2	19.949	0.580	4.86	22.5	D 19-42
22.0	54.7	35.4	19.3	5.3	21.897	0.700	5.19	21.6	D 19-42
23.0	65.1	45.8	19.3	6.6	22.980	1.171	5.48	20.8	D 19-42
24.0	75.5	56.2	19.3	7.9	24.081	1.074	5.73	20.3	D 19-42
25.0	85.9	66.6	19.3	9.2	25.034	1.150	5.95	19.9	D 19-42
26.0	96.3	77.0	19.3	10.6	25.809	1.103	6.15	19.5	D 19-42
27.0	106.7	87.4	19.3	12.1	26.476	1.168	6.34	19.2	D 19-42
28.0	117.1	97.8	19.3	13.6	27.180	1.260	6.54	19.1	D 19-42
29.0	127.5	108.2	19.3	15.1	27.969	1.293	6.71	19.1	D 19-42
30.0	135.1	115.8	19.3	16.2	28.331	1.244	6.84	19.0	D 19-42
31.0	136.1	122.0	14.1	16.4	28.537	1.181	6.86	18.9	D 19-42
32.0	139.4	125.3	14.1	17.0	29.010	1.115	6.92	18.8	D 19-42
33.0	142.8	128.7	14.1	17.4	29.490	1.051	6.96	18.8	D 19-42
34.0	146.2	132.1	14.1	18.0	29.471	0.933	7.01	18.7	D 19-42
35.0	158.7	137.2	21.4	19.9	30.336	0.823	7.19	18.5	D 19-42
36.0	170.2	148.8	21.4	21.6	31.086	0.905	7.34	18.6	D 19-42
37.0	181.8	160.3	21.4	23.3	31.522	0.914	7.47	18.8	D 19-42
38.0	193.3	171.9	21.4	25.3	31.806	0.983	7.62	18.8	D 19-42
39.0	204.9	183.4	21.4	27.2	32.433	1.193	7.75	19.0	D 19-42
40.0	207.5	193.4	14.1	28.0	32.846	1.003	7.80	18.9	D 19-42
41.0	211.4	197.3	14.1	28.9	32.599	1.015	7.84	18.9	D 19-42
42.0	215.4	201.3	14.1	29.6	32.919	1.054	7.89	18.9	D 19-42
43.0	219.4	205.3	14.1	30.4	33.206	1.087	7.94	18.9	D 19-42
44.0	223.5	209.4	14.1	31.1	33.075	1.083	7.98	19.0	D 19-42
45.0	263.9	213.8	50.1	40.4	34.445	1.853	8.42	19.6	D 19-42
46.0	269.3	219.2	50.1	41.8	34.779	1.753	8.47	19.6	D 19-42
47.0	274.7	224.6	50.1	43.5	35.060	1.660	8.51	19.6	D 19-42
48.0	280.3	230.2	50.1	45.2	35.302	1.584	8.55	19.6	D 19-42
49.0	285.9	235.8	50.1	47.0	35.641	1.552	8.59	19.6	D 19-42
50.0	291.7	241.6	50.1	48.9	35.870	1.513	8.63	19.6	D 19-42
51.0	356.8	274.4	82.4	91.2	37.642	2.214	9.08	20.4	D 19-42
52.0	401.3	318.8	82.4	159.2	38.976	2.415	9.45	21.2	D 19-42
52.4	419.0	336.6	82.4	208.0	39.433	2.420	9.55	21.5	D 19-42

A 50.25' - OK

Total driving time: 23 minutes; Total Number of Blows: 968 (starting at penetration 1.0 ft)

Rear Abt. (B-004-0-25)

Represents the case of piles driven to the required bearing resistance through the MSE wall completed to the pile cap elevation, with conventional granular-filled pipe pile sleeves through the MSE wall fill.

GRLWEAP: Wave Equation Analysis of Pile Foundations

WYA-23-3.47 + HP 10x42 10/7/2025
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity-blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors.

SOIL PROFILE

Depth ft	Soil Type -	Spec. Wt lb/ft³	Su ksf	Phi °	Unit Rs ksf	Unit Rt ksf
0.0	Sand	120.0	0.0	28.0	0.00	0.00
10.0	Sand	120.0	0.0	28.0	0.31	13.32
10.0	Sand	120.0	0.0	28.0	0.31	13.32
16.8	Sand	120.0	0.0	28.0	0.51	13.32
16.8	Sand	125.0	0.0	30.0	0.58	13.32
20.8	Sand	125.0	0.0	30.0	0.72	13.32
20.8	Clay	125.0	3.1	0.0	2.98	28.35
30.8	Clay	125.0	3.1	0.0	2.98	28.35
30.8	Sand	125.0	0.0	31.0	0.99	20.71
34.8	Sand	125.0	0.0	31.0	1.07	20.71
34.8	Clay	125.0	3.5	0.0	3.50	31.50
39.8	Clay	125.0	3.5	0.0	3.50	31.50
39.8	Sand	125.0	0.0	31.0	1.17	20.71
44.8	Sand	125.0	0.0	31.0	1.27	20.71
44.8	Sand	135.0	0.0	34.0	1.60	73.64
50.3	Sand	135.0	0.0	34.0	1.76	73.64
50.3	Clay	140.0	13.5	0.0	13.46	121.18
52.4	Clay	140.0	13.5	0.0	13.46	121.18
52.4	Clay	150.0	360.0	0.0	54.00	3,239.99
55.0	Clay	150.0	360.0	0.0	54.00	3,239.99

PILE INPUT

Uniform Pile		Pile Type:	H Pile
Pile Length: (ft)	54.400	Pile Penetration: (ft)	52.400
Pile Size: (ft)	0.84	Toe Area: (in²)	97.97

Pile Profile

Lb Top ft	X-Area in²	E-Modulus ksi	Spec. Wt lb/ft³	Perim. ft	Crit. Index -
0.0	12.4	30,000.0	493.4	3.3	0
54.4	12.4	30,000.0	493.4	3.3	0

HAMMER INPUT

ID	41	Made By:	DELMAG
Model	D 19-42	Type:	OED

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy

-	kips	in	in²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

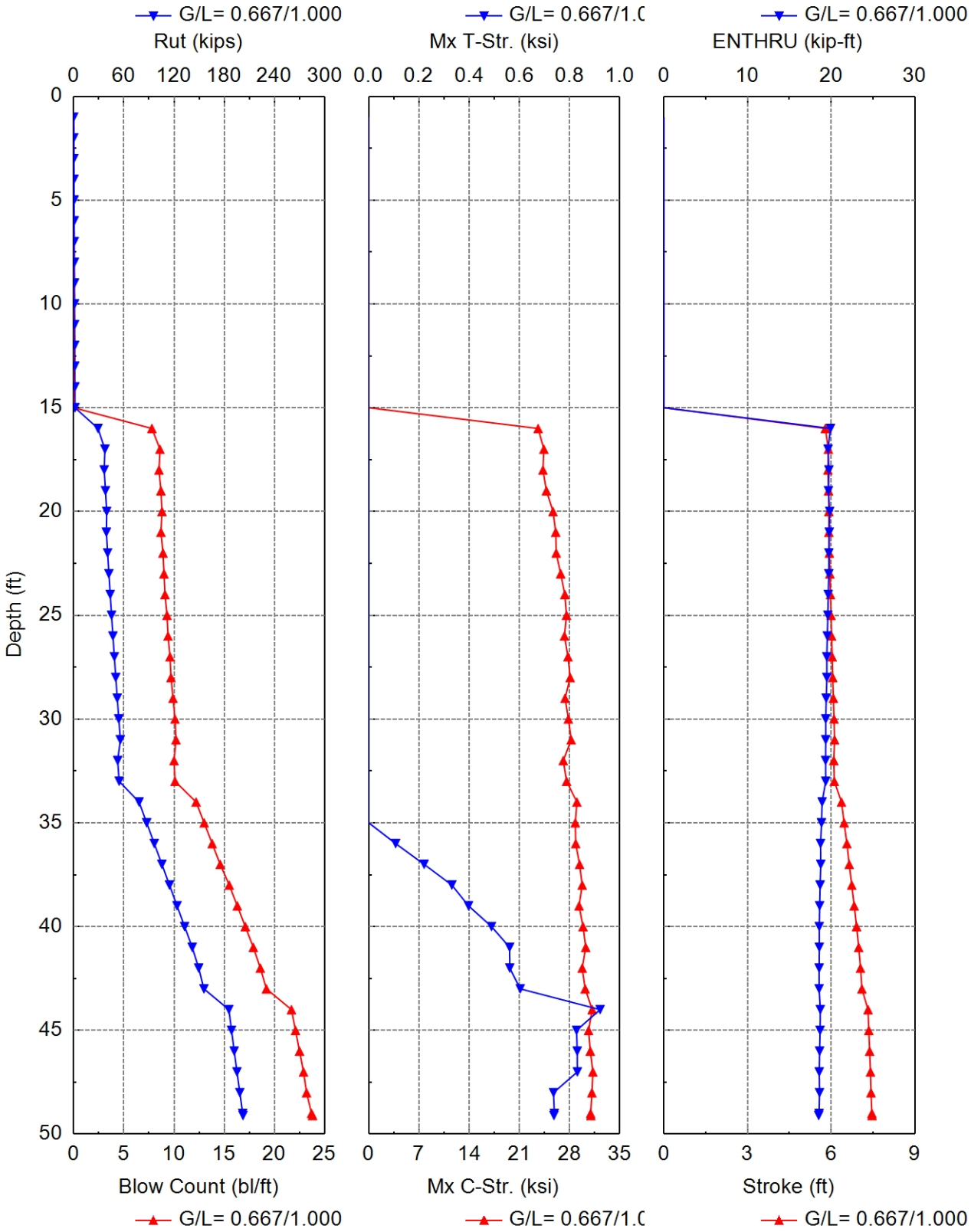
Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

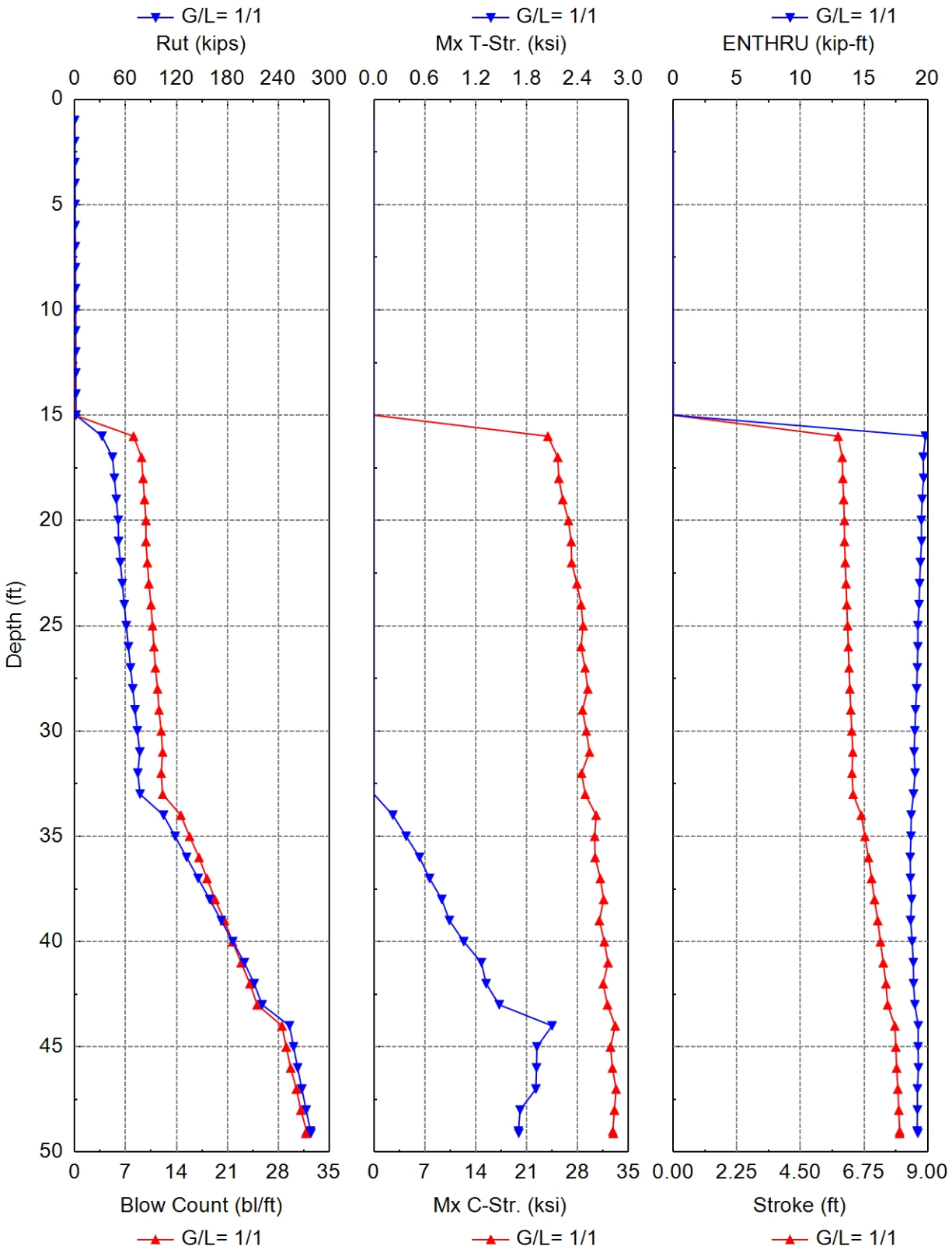
Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.0	0.0	0.0	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
1.7	0.1	2.5	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
3.3	0.1	4.9	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
5.0	0.2	7.4	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
6.7	0.2	9.9	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
8.3	0.3	12.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
10.0	0.3	13.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
10.0	0.3	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
11.7	0.4	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
13.4	0.4	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.1	0.5	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.8	0.5	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.8	0.6	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
18.8	0.7	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
20.8	0.7	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
20.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
22.5	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
24.1	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
25.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
27.5	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
29.1	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
30.8	3.0	28.3	0.10	0.11	0.15	0.15	1.5	6.6	168.0	98.0
30.8	1.0	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
32.8	1.0	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
34.8	1.1	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
34.8	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
36.5	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
38.1	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
39.8	3.5	31.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0

39.8	1.2	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
41.5	1.2	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
43.1	1.2	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
44.8	1.3	20.7	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
44.8	1.6	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
46.6	1.7	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
48.5	1.7	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
50.3	1.8	73.6	0.10	0.09	0.10	0.15	1.2	6.6	24.0	98.0
50.3	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
51.4	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
52.4	13.5	121.2	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.667/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	0.1	0.0	0.1	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	0.2	0.0	0.2	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	0.3	0.0	0.3	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	0.4	0.0	0.4	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	0.5	0.0	0.5	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	0.6	0.0	0.6	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	0.8	0.0	0.8	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	0.9	0.0	0.9	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	1.0	0.0	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	1.1	0.0	1.1	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	1.2	0.0	1.2	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	1.3	0.0	1.3	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	1.4	0.0	1.4	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	1.5	0.0	1.5	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	1.6	0.0	1.6	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	29.1	6.2	23.0	7.8	23.622	0.000	5.79	19.9	D 19-42
17.0	37.4	14.4	23.0	8.6	24.422	0.000	5.90	19.6	D 19-42
18.0	36.6	20.7	15.9	8.5	24.297	0.000	5.88	19.7	D 19-42
19.0	38.1	22.1	15.9	8.7	24.772	0.000	5.90	19.7	D 19-42
20.0	39.5	23.6	15.9	8.8	25.696	0.000	5.92	19.8	D 19-42
21.0	39.2	25.1	14.1	8.7	26.075	0.000	5.92	19.8	D 19-42
22.0	40.6	26.5	14.1	8.9	26.139	0.000	5.94	19.7	D 19-42
23.0	42.1	28.0	14.1	9.0	26.766	0.000	5.95	19.7	D 19-42
24.0	43.7	29.6	14.1	9.1	27.347	0.000	5.97	19.6	D 19-42
25.0	45.3	31.2	14.1	9.3	27.576	0.000	5.99	19.6	D 19-42
26.0	46.9	32.9	14.1	9.4	27.287	0.000	6.02	19.5	D 19-42
27.0	48.6	34.5	14.1	9.6	27.784	0.000	6.04	19.5	D 19-42
28.0	50.4	36.3	14.1	9.7	28.091	0.000	6.06	19.5	D 19-42
29.0	52.2	38.1	14.1	9.9	27.377	0.000	6.08	19.4	D 19-42
30.0	54.0	39.9	14.1	10.1	27.841	0.000	6.10	19.3	D 19-42
31.0	55.9	41.8	14.1	10.2	28.235	0.000	6.12	19.3	D 19-42
32.0	52.6	43.6	9.1	10.0	27.125	0.000	6.09	19.3	D 19-42
33.0	54.4	45.4	9.1	10.1	27.589	0.000	6.11	19.3	D 19-42
34.0	78.2	53.0	25.3	12.2	29.028	0.000	6.37	18.9	D 19-42
35.0	87.3	62.1	25.3	13.0	28.801	0.000	6.46	18.8	D 19-42
36.0	96.4	71.1	25.3	13.8	28.860	0.107	6.56	18.7	D 19-42
37.0	105.5	80.2	25.3	14.6	29.402	0.221	6.65	18.8	D 19-42

38.0	114.5	89.3	25.3	15.5	29.768	0.331	6.74	18.7	D 19-42
39.0	123.6	98.4	25.3	16.3	29.334	0.398	6.83	18.6	D 19-42
40.0	132.7	107.4	25.3	17.1	29.882	0.489	6.91	18.6	D 19-42
41.0	141.8	116.5	25.3	17.9	30.261	0.561	6.99	18.6	D 19-42
42.0	149.5	124.3	25.3	18.6	29.769	0.562	7.05	18.6	D 19-42
43.0	155.7	130.5	25.3	19.2	30.182	0.604	7.10	18.6	D 19-42
44.0	185.6	135.5	50.1	21.7	31.160	0.922	7.32	18.7	D 19-42
45.0	188.7	138.6	50.1	22.1	30.656	0.828	7.35	18.7	D 19-42
46.0	192.0	141.9	50.1	22.5	30.889	0.831	7.38	18.6	D 19-42
47.0	195.3	145.2	50.1	22.9	31.257	0.831	7.41	18.6	D 19-42
48.0	198.6	148.5	50.1	23.2	31.119	0.736	7.43	18.6	D 19-42
49.0	202.1	152.0	50.1	23.7	30.935	0.739	7.46	18.5	D 19-42
49.1	202.4	152.3	50.1	23.8	30.981	0.738	7.47	18.5	D 19-42

Total driving time: 10 minutes; Total Number of Blows: 455 (starting at penetration 1.0 ft)

Gain/Loss Factor at Shaft/Toe = 1.000/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	0.1	0.0	0.1	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	0.2	0.0	0.2	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	0.3	0.0	0.3	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	0.4	0.0	0.4	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	0.5	0.0	0.5	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	0.6	0.0	0.6	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	0.8	0.0	0.8	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	0.9	0.0	0.9	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	1.0	0.0	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	1.1	0.0	1.1	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	1.2	0.0	1.2	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	1.3	0.0	1.3	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	1.4	0.0	1.4	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	1.5	0.0	1.5	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	1.6	0.0	1.6	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	32.2	9.3	23.0	8.1	23.928	0.000	5.83	19.8	D 19-42
17.0	44.6	21.7	23.0	9.2	25.280	0.000	5.98	19.6	D 19-42
18.0	46.9	31.0	15.9	9.4	25.426	0.000	6.00	19.7	D 19-42
19.0	49.1	33.2	15.9	9.6	25.967	0.000	6.03	19.6	D 19-42
20.0	51.3	35.4	15.9	9.8	26.751	0.000	6.06	19.5	D 19-42
21.0	51.7	37.6	14.1	9.8	27.132	0.000	6.06	19.5	D 19-42

22.0	53.9	39.8	14.1	10.0	27.189	0.000	6.09	19.4	D 19-42
23.0	56.2	42.1	14.1	10.2	27.917	0.000	6.11	19.4	D 19-42
24.0	58.5	44.4	14.1	10.5	28.488	0.000	6.14	19.3	D 19-42
25.0	60.9	46.8	14.1	10.7	28.769	0.000	6.17	19.2	D 19-42
26.0	63.4	49.3	14.1	10.9	28.478	0.000	6.19	19.2	D 19-42
27.0	65.9	51.8	14.1	11.1	29.037	0.000	6.22	19.2	D 19-42
28.0	68.5	54.4	14.1	11.4	29.411	0.000	6.25	19.1	D 19-42
29.0	71.2	57.1	14.1	11.6	28.686	0.000	6.28	19.0	D 19-42
30.0	73.9	59.9	14.1	11.9	29.206	0.000	6.31	19.0	D 19-42
31.0	76.8	62.7	14.1	12.1	29.649	0.000	6.35	18.9	D 19-42
32.0	74.4	65.4	9.1	11.9	28.556	0.000	6.32	19.0	D 19-42
33.0	77.1	68.0	9.1	12.1	29.053	0.000	6.36	18.9	D 19-42
34.0	104.7	79.5	25.3	14.6	30.561	0.224	6.65	18.7	D 19-42
35.0	118.4	93.1	25.3	15.8	30.357	0.379	6.78	18.7	D 19-42
36.0	132.0	106.7	25.3	17.1	30.417	0.537	6.91	18.6	D 19-42
37.0	145.6	120.3	25.3	18.2	31.137	0.656	7.02	18.6	D 19-42
38.0	159.2	133.9	25.3	19.3	31.589	0.800	7.12	18.7	D 19-42
39.0	172.8	147.5	25.3	20.6	31.006	0.890	7.24	18.7	D 19-42
40.0	186.4	161.2	25.3	21.7	31.683	1.059	7.33	18.8	D 19-42
41.0	200.0	174.8	25.3	22.9	32.194	1.267	7.43	18.9	D 19-42
42.0	211.6	186.4	25.3	24.1	31.532	1.323	7.52	18.9	D 19-42
43.0	221.0	195.7	25.3	25.1	32.117	1.478	7.58	19.0	D 19-42
44.0	253.3	203.2	50.1	28.5	33.188	2.100	7.84	19.3	D 19-42
45.0	258.0	207.9	50.1	29.1	32.536	1.921	7.87	19.2	D 19-42
46.0	262.9	212.8	50.1	29.7	32.797	1.917	7.90	19.3	D 19-42
47.0	267.8	217.7	50.1	30.5	33.304	1.909	7.95	19.2	D 19-42
ok 48.0	272.9	222.8	50.1	31.1	33.074	1.723	7.98	19.2	D 19-42
49.0	278.1	228.0	50.1	31.9	32.847	1.703	8.01	19.2	D 19-42
49.1	278.6	228.5	50.1	31.8	32.910	1.708	8.01	19.2	D 19-42

Total driving time: 13 minutes; Total Number of Blows: 562 (starting at penetration 1.0 ft)

Fwd. Abt. (B-008-0-25)

Piles driven prior to construction of MSE wall

GRLWEAP: Wave Equation Analysis of Pile Foundations

WYA-23-3.47 (B-008-0-25) + HP 10X42 12/12/2025
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity-blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors.

SOIL PROFILE

Depth	Soil Type	Spec. Wt	Su	Phi	Unit Rs	Unit Rt
ft	-	lb/ft³	ksf	°	ksf	ksf
0.0	Sand	89.1	0.0	0.0	0.00	0.00
15.3	Sand	89.1	0.0	0.0	0.00	2.41
15.3	Clay	125.0	3.7	0.0	3.75	33.75
17.7	Clay	125.0	3.7	0.0	3.75	33.75
17.7	Clay	125.0	2.6	31.0	0.67	23.40
20.7	Clay	125.0	2.6	31.0	0.67	23.40
20.7	Sand	125.0	0.0	31.0	0.65	20.71
31.2	Sand	125.0	0.0	31.0	0.87	20.71
31.2	Sand	125.0	0.0	30.0	0.79	13.32
33.2	Sand	125.0	0.0	30.0	0.83	13.32
33.2	Clay	125.0	4.1	0.0	3.84	37.12
43.7	Clay	125.0	4.1	0.0	3.84	37.12
43.7	Sand	140.0	5.4	34.0	1.41	73.64
49.1	Sand	140.0	5.4	34.0	1.58	73.64
49.1	Clay	150.0	360.0	0.0	360.00	3,239.99
54.6	Clay	150.0	360.0	0.0	360.00	3,239.99

PILE INPUT

Uniform Pile		Pile Type:	H Pile
Pile Length: (ft)	52.000	Pile Penetration: (ft)	49.100
Pile Size: (ft)	0.84	Toe Area: (in²)	97.97

Pile Profile

Lb Top	X-Area	E-Modulus	Spec. Wt	Perim.	Crit. Index
ft	in²	ksi	lb/ft³	ft	-
0.0	12.4	30,000.0	492.0	3.3	0
52.0	12.4	30,000.0	492.0	3.3	0

HAMMER INPUT

ID	41	Made By:	DELMAG
Model	D 19-42	Type:	OED

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

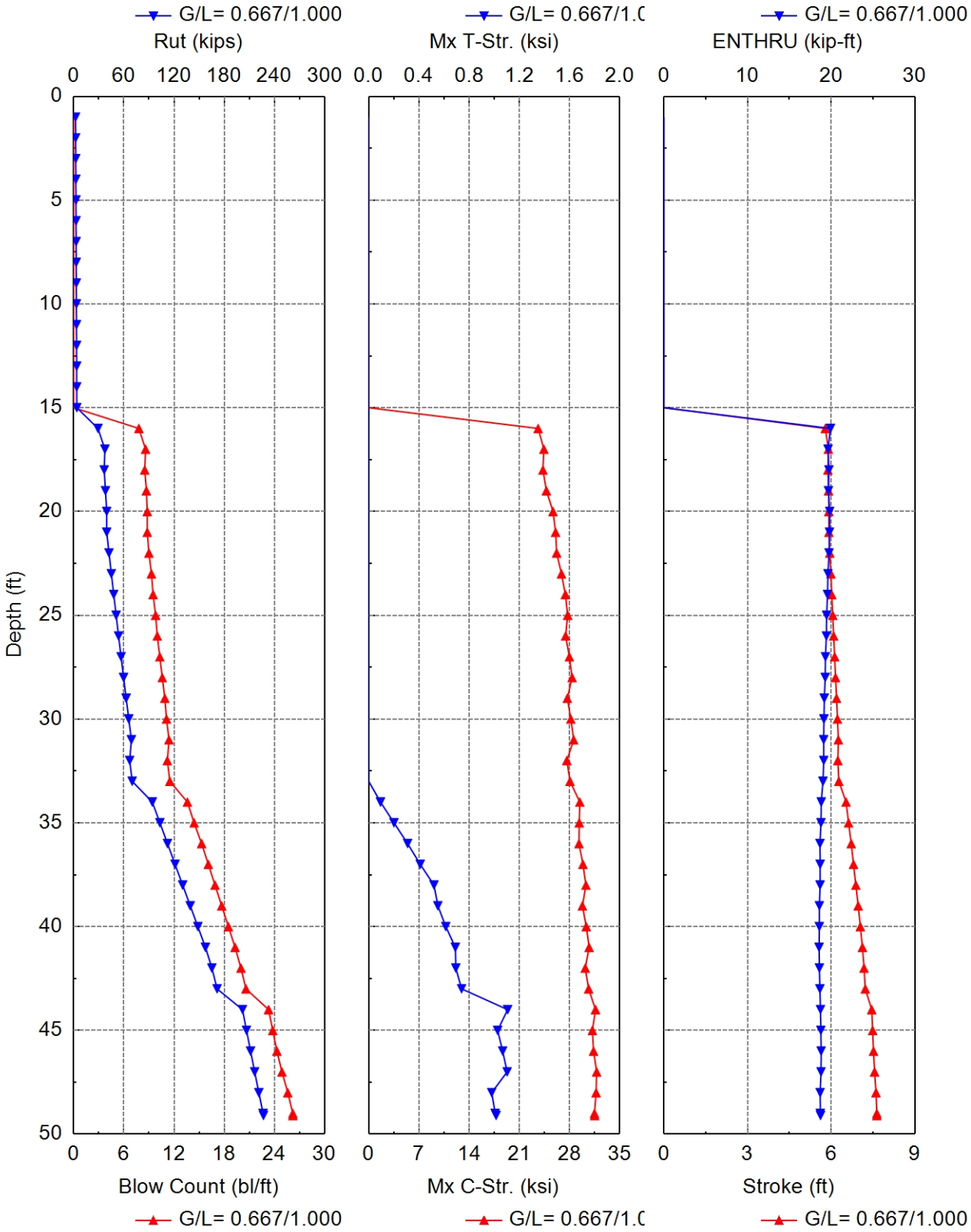
Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.0	0.0	0.0	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
1.7	0.0	0.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
3.4	0.0	0.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
5.1	0.0	0.8	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
6.8	0.0	1.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
8.5	0.0	1.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
10.2	0.0	1.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
11.9	0.0	1.9	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
13.6	0.0	2.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.3	0.0	2.4	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.3	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.5	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
17.7	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
17.7	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
19.2	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
20.7	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
20.7	0.6	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
22.5	0.7	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
24.2	0.7	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
26.0	0.8	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
27.7	0.8	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
29.5	0.8	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
31.2	0.9	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
31.2	0.8	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
32.2	0.8	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
33.2	0.8	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
33.2	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
35.0	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
36.7	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
38.5	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
40.2	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0

42.0	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
43.7	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
43.7	1.4	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
45.5	1.5	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
47.3	1.5	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
49.1	1.6	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0

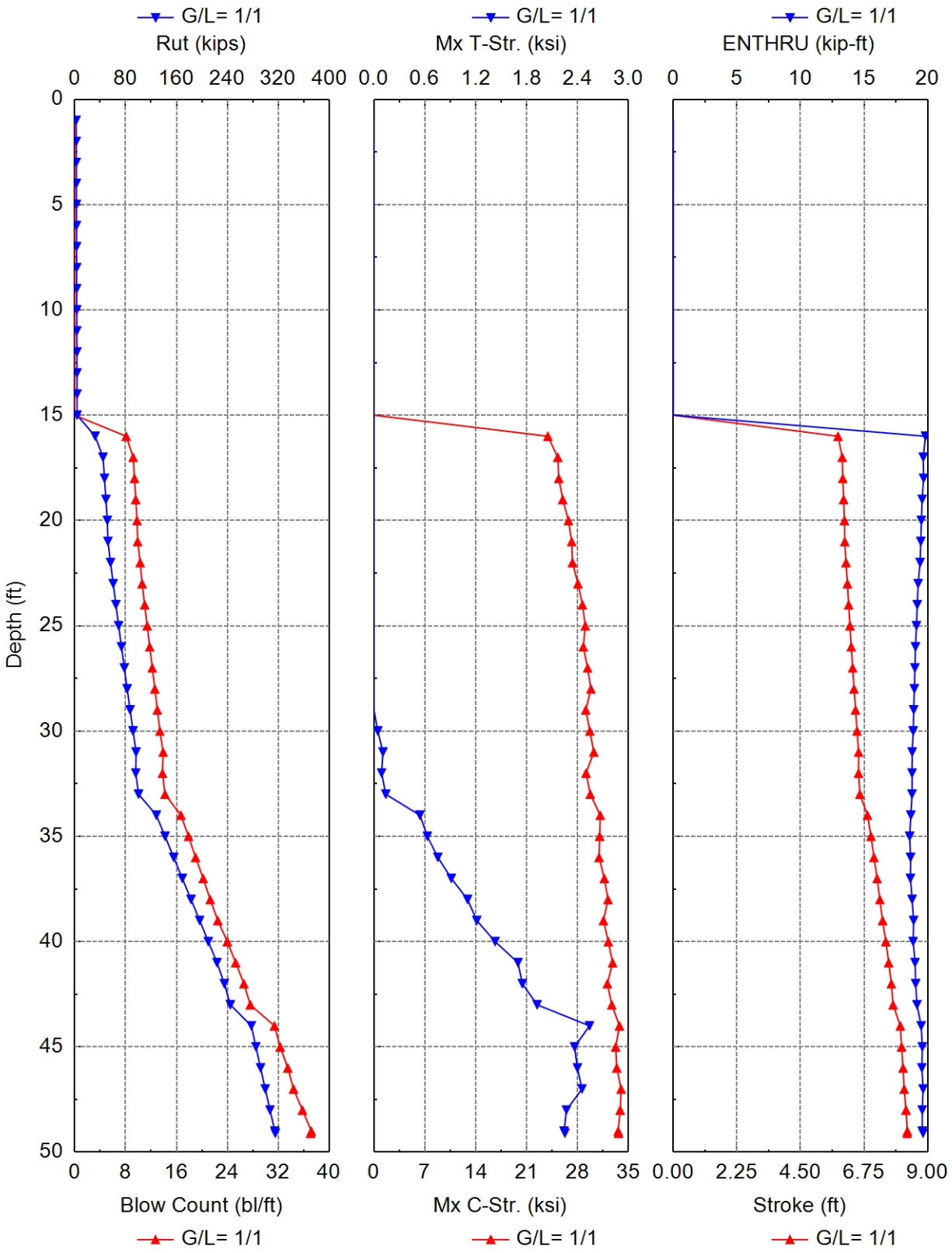
Piles driven to the required bearing resistance through the MSE wall completed to the pile cap elevation.

WYA-23-3.47 (B-008-0-25) + HP 10X42 RESOURCE INTERNATIONAL INC

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.667/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	2.3	0.0	2.3	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.4	0.0	2.4	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	2.5	0.0	2.5	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	2.6	0.0	2.6	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	2.7	0.0	2.7	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	2.9	0.0	2.9	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	3.0	0.0	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	3.1	0.0	3.1	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	3.2	0.0	3.2	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	3.3	0.0	3.3	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	3.4	0.0	3.4	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	3.5	0.0	3.5	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	3.6	0.0	3.6	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	3.7	0.0	3.7	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	29.1	6.2	23.0	7.8	23.622	0.000	5.79	19.9	D 19-42
17.0	37.4	14.4	23.0	8.6	24.422	0.000	5.90	19.6	D 19-42
18.0	36.6	20.7	15.9	8.5	24.297	0.000	5.88	19.7	D 19-42
19.0	38.1	22.1	15.9	8.7	24.772	0.000	5.90	19.7	D 19-42
20.0	39.5	23.6	15.9	8.8	25.696	0.000	5.92	19.8	D 19-42
21.0	39.5	25.5	14.1	8.8	26.052	0.000	5.92	19.8	D 19-42
22.0	42.3	28.2	14.1	9.0	26.202	0.000	5.95	19.7	D 19-42
23.0	45.1	31.0	14.1	9.3	26.877	0.000	5.99	19.6	D 19-42
24.0	47.9	33.8	14.1	9.5	27.419	0.000	6.02	19.6	D 19-42
25.0	50.8	36.7	14.1	9.8	27.745	0.000	6.06	19.5	D 19-42
26.0	53.7	39.6	14.1	10.0	27.447	0.000	6.09	19.4	D 19-42
27.0	56.7	42.6	14.1	10.3	27.980	0.000	6.12	19.3	D 19-42
28.0	59.7	45.6	14.1	10.6	28.359	0.000	6.16	19.3	D 19-42
29.0	62.8	48.7	14.1	10.9	27.693	0.000	6.19	19.2	D 19-42
30.0	65.9	51.8	14.1	11.1	28.185	0.000	6.23	19.1	D 19-42
31.0	69.1	55.0	14.1	11.4	28.582	0.000	6.26	19.1	D 19-42
32.0	67.0	57.9	9.1	11.2	27.622	0.000	6.24	19.1	D 19-42
33.0	70.0	60.9	9.1	11.5	28.068	0.000	6.27	19.0	D 19-42
34.0	94.0	68.8	25.3	13.6	29.439	0.093	6.53	18.8	D 19-42
35.0	103.1	77.8	25.3	14.4	29.354	0.201	6.62	18.8	D 19-42
36.0	112.2	86.9	25.3	15.3	29.320	0.310	6.72	18.7	D 19-42
37.0	121.3	96.0	25.3	16.1	29.871	0.410	6.80	18.7	D 19-42

38.0	130.3	105.1	25.3	16.9	30.284	0.520	6.88	18.7	D 19-42
39.0	139.4	114.1	25.3	17.7	29.799	0.551	6.97	18.6	D 19-42
40.0	148.5	123.2	25.3	18.5	30.333	0.614	7.05	18.6	D 19-42
41.0	157.6	132.3	25.3	19.3	30.736	0.690	7.12	18.6	D 19-42
42.0	165.3	140.0	25.3	20.0	30.188	0.694	7.18	18.6	D 19-42
43.0	171.5	146.3	25.3	20.6	30.663	0.740	7.22	18.6	D 19-42
44.0	201.8	151.7	50.1	23.3	31.621	1.107	7.46	18.7	D 19-42
45.0	206.6	156.5	50.1	23.8	31.189	1.027	7.49	18.8	D 19-42
46.0	211.5	161.4	50.1	24.3	31.345	1.067	7.52	18.8	D 19-42
47.0	216.4	166.3	50.1	24.9	31.784	1.103	7.55	18.8	D 19-42
48.0	221.4	171.3	50.1	25.6	31.705	0.980	7.61	18.7	D 19-42
49.0	226.5	176.3	50.1	26.2	31.473	1.008	7.64	18.7	D 19-42
49.1	227.0	176.9	50.1	26.2	31.508	1.015	7.64	18.7	D 19-42

Total driving time: 11 minutes; Total Number of Blows: 490 (starting at penetration 1.0 ft)

Gain/Loss Factor at Shaft/Toe = 1.000/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	2.3	0.0	2.3	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.4	0.0	2.4	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	2.5	0.0	2.5	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	2.6	0.0	2.6	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	2.7	0.0	2.7	0.3	0.000	0.000	10.81	0.0	D 19-42
6.0	2.9	0.0	2.9	0.3	0.000	0.000	10.81	0.0	D 19-42
7.0	3.0	0.0	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	3.1	0.0	3.1	0.3	0.000	0.000	10.81	0.0	D 19-42
9.0	3.2	0.0	3.2	0.3	0.000	0.000	10.81	0.0	D 19-42
10.0	3.3	0.0	3.3	0.3	0.000	0.000	10.81	0.0	D 19-42
11.0	3.4	0.0	3.4	0.3	0.000	0.000	10.81	0.0	D 19-42
12.0	3.5	0.0	3.5	0.3	0.000	0.000	10.81	0.0	D 19-42
13.0	3.6	0.0	3.6	0.3	0.000	0.000	10.81	0.0	D 19-42
14.0	3.7	0.0	3.7	0.3	0.000	0.000	10.81	0.0	D 19-42
15.0	3.8	0.0	3.8	0.3	0.000	0.000	10.81	0.0	D 19-42
16.0	32.2	9.3	23.0	8.1	23.928	0.000	5.83	19.8	D 19-42
17.0	44.6	21.7	23.0	9.2	25.280	0.000	5.98	19.6	D 19-42
18.0	46.9	31.0	15.9	9.4	25.426	0.000	6.00	19.7	D 19-42
19.0	49.1	33.2	15.9	9.6	25.967	0.000	6.03	19.6	D 19-42
20.0	51.3	35.4	15.9	9.8	26.751	0.000	6.06	19.5	D 19-42
21.0	52.3	38.2	14.1	9.9	27.195	0.000	6.07	19.5	D 19-42

22.0	56.4	42.3	14.1	10.3	27.308	0.000	6.11	19.4	D 19-42
23.0	60.6	46.5	14.1	10.6	28.054	0.000	6.16	19.2	D 19-42
24.0	64.8	50.7	14.1	11.0	28.677	0.000	6.21	19.2	D 19-42
25.0	69.2	55.1	14.1	11.4	29.064	0.000	6.25	19.1	D 19-42
26.0	73.5	59.5	14.1	11.8	28.798	0.000	6.30	19.0	D 19-42
27.0	78.0	63.9	14.1	12.2	29.379	0.000	6.35	19.0	D 19-42
28.0	82.5	68.4	14.1	12.6	29.847	0.000	6.40	19.0	D 19-42
29.0	87.1	73.0	14.1	13.0	29.136	0.000	6.45	18.9	D 19-42
30.0	91.8	77.7	14.1	13.4	29.698	0.046	6.50	18.9	D 19-42
31.0	96.5	82.4	14.1	13.9	30.238	0.106	6.56	18.8	D 19-42
32.0	96.0	86.9	9.1	13.8	29.175	0.090	6.55	18.8	D 19-42
33.0	100.4	91.4	9.1	14.2	29.748	0.139	6.60	18.8	D 19-42
34.0	128.4	103.2	25.3	16.7	31.127	0.542	6.87	18.7	D 19-42
35.0	142.0	116.8	25.3	17.9	31.037	0.630	7.00	18.6	D 19-42
36.0	155.6	130.4	25.3	19.0	30.962	0.753	7.10	18.7	D 19-42
37.0	169.3	144.0	25.3	20.2	31.683	0.912	7.21	18.6	D 19-42
38.0	182.9	157.6	25.3	21.3	32.190	1.104	7.31	18.8	D 19-42
39.0	196.5	171.2	25.3	22.5	31.567	1.213	7.40	18.9	D 19-42
40.0	210.1	184.8	25.3	24.0	32.234	1.429	7.52	18.9	D 19-42
41.0	223.7	198.4	25.3	25.3	32.826	1.698	7.62	19.0	D 19-42
42.0	235.3	210.1	25.3	26.6	32.110	1.750	7.72	19.1	D 19-42
43.0	244.7	219.4	25.3	27.6	32.711	1.924	7.77	19.2	D 19-42
44.0	277.7	227.6	50.1	31.4	33.769	2.541	8.03	19.5	D 19-42
45.0	284.9	234.8	50.1	32.3	33.247	2.365	8.08	19.6	D 19-42
46.0	292.1	242.0	50.1	33.5	33.394	2.398	8.13	19.5	D 19-42
47.0	299.5	249.4	50.1	34.4	33.991	2.453	8.17	19.6	D 19-42
48.0	307.0	256.9	50.1	35.8	33.869	2.269	8.23	19.6	D 19-42
49.0	314.6	264.5	50.1	37.2	33.583	2.241	8.28	19.6	D 19-42
49.1	315.4	265.3	50.1	37.1	33.646	2.252	8.28	19.6	D 19-42

ok

Total driving time: 14 minutes; Total Number of Blows: 619 (starting at penetration 1.0 ft)

Fwd Abt. (B-008-0-25)

Piles driven to the required bearing resistance through the MSE wall completed to the pile cap elevation.

GRLWEAP: Wave Equation Analysis of Pile Foundations

WYA-23-3.47 (B-008-0-25) + HP 10X42 12/12/2025
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity-blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors.

SOIL PROFILE

Depth	Soil Type	Spec. Wt	Su	Phi	Unit Rs	Unit Rt
ft	-	lb/ft³	ksf	°	ksf	ksf
0.0	Sand	89.1	0.0	0.0	0.00	3.25
15.3	Sand	89.1	0.0	0.0	0.00	5.56
15.3	Clay	125.0	3.7	0.0	3.75	33.75
17.7	Clay	125.0	3.7	0.0	3.75	33.75
17.7	Clay	125.0	2.6	31.0	0.67	23.40
20.7	Clay	125.0	2.6	31.0	0.67	23.40
20.7	Sand	125.0	0.0	31.0	1.23	20.71
31.2	Sand	125.0	0.0	31.0	1.45	20.71
31.2	Sand	125.0	0.0	30.0	1.33	13.32
33.2	Sand	125.0	0.0	30.0	1.36	13.32
33.2	Clay	125.0	4.1	0.0	3.84	37.12
43.7	Clay	125.0	4.1	0.0	3.84	37.12
43.7	Sand	140.0	5.4	34.0	2.15	73.64
49.1	Sand	140.0	5.4	34.0	2.32	73.64
49.1	Clay	150.0	360.0	0.0	360.00	3,239.99
54.6	Clay	150.0	360.0	0.0	360.00	3,239.99

PILE INPUT

Uniform Pile		Pile Type:	H Pile
Pile Length: (ft)	52.000	Pile Penetration: (ft)	49.100
Pile Size: (ft)	0.84	Toe Area: (in²)	97.97

Pile Profile

Lb Top	X-Area	E-Modulus	Spec. Wt	Perim.	Crit. Index
ft	in²	ksi	lb/ft³	ft	-
0.0	12.4	30,000.0	492.0	3.3	0
52.0	12.4	30,000.0	492.0	3.3	0

HAMMER INPUT

ID	41	Made By:	DELMAG
Model	D 19-42	Type:	OED

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.0	0.0	3.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
1.7	0.0	3.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
3.4	0.0	3.8	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
5.1	0.0	4.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
6.8	0.0	4.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
8.5	0.0	4.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
10.2	0.0	4.9	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
11.9	0.0	5.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
13.6	0.0	5.4	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.3	0.0	5.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.3	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.5	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
17.7	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
17.7	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
19.2	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
20.7	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
20.7	1.2	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
22.5	1.3	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
24.2	1.3	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
26.0	1.3	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
27.7	1.4	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
29.5	1.4	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
31.2	1.4	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
31.2	1.3	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
32.2	1.3	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
33.2	1.4	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
33.2	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
35.0	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
36.7	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
38.5	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
40.2	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0

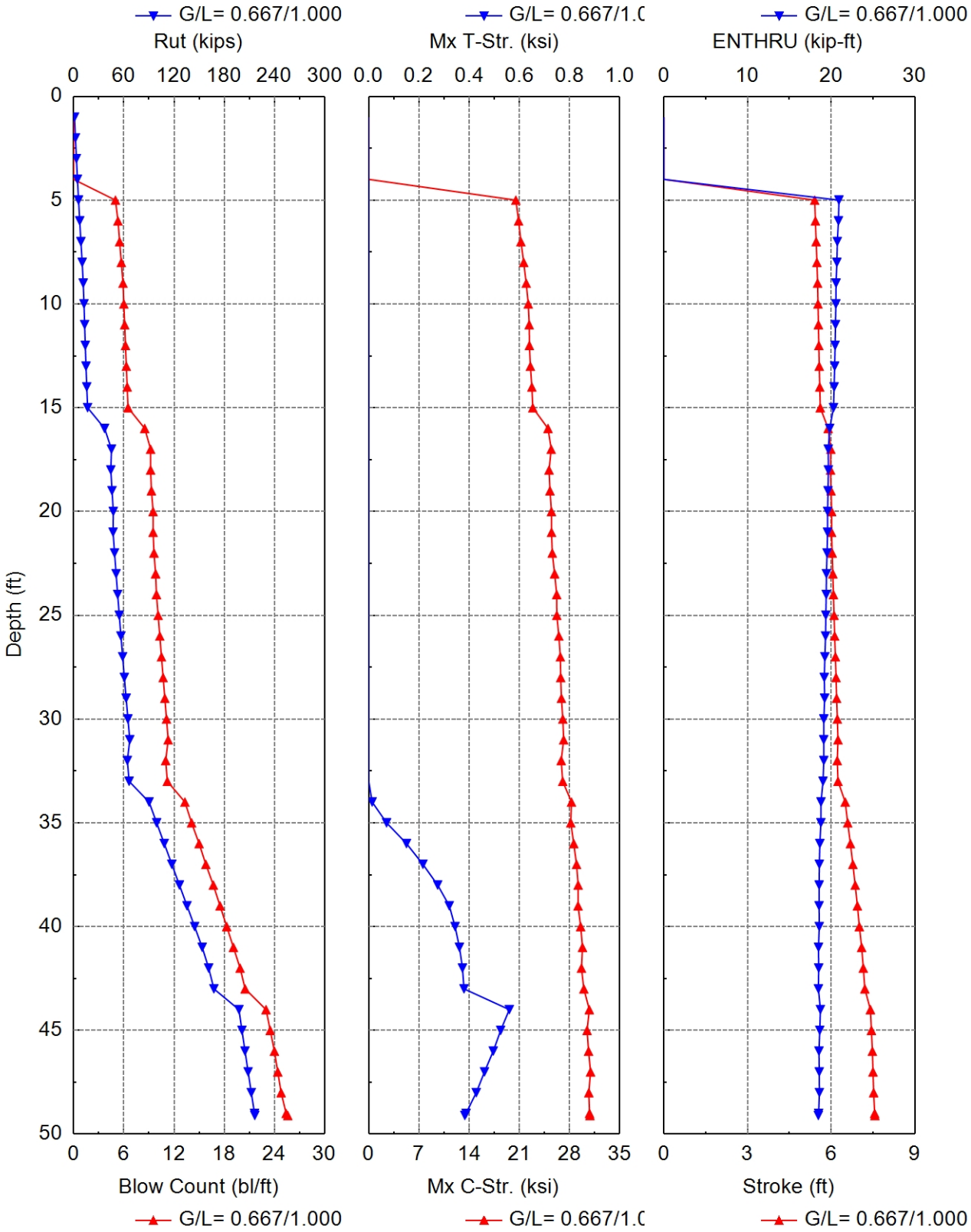
42.0	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
43.7	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
43.7	2.2	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
45.5	2.2	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
47.3	2.3	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
49.1	2.3	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0

Fwd. Abt. (B-008-0-25)

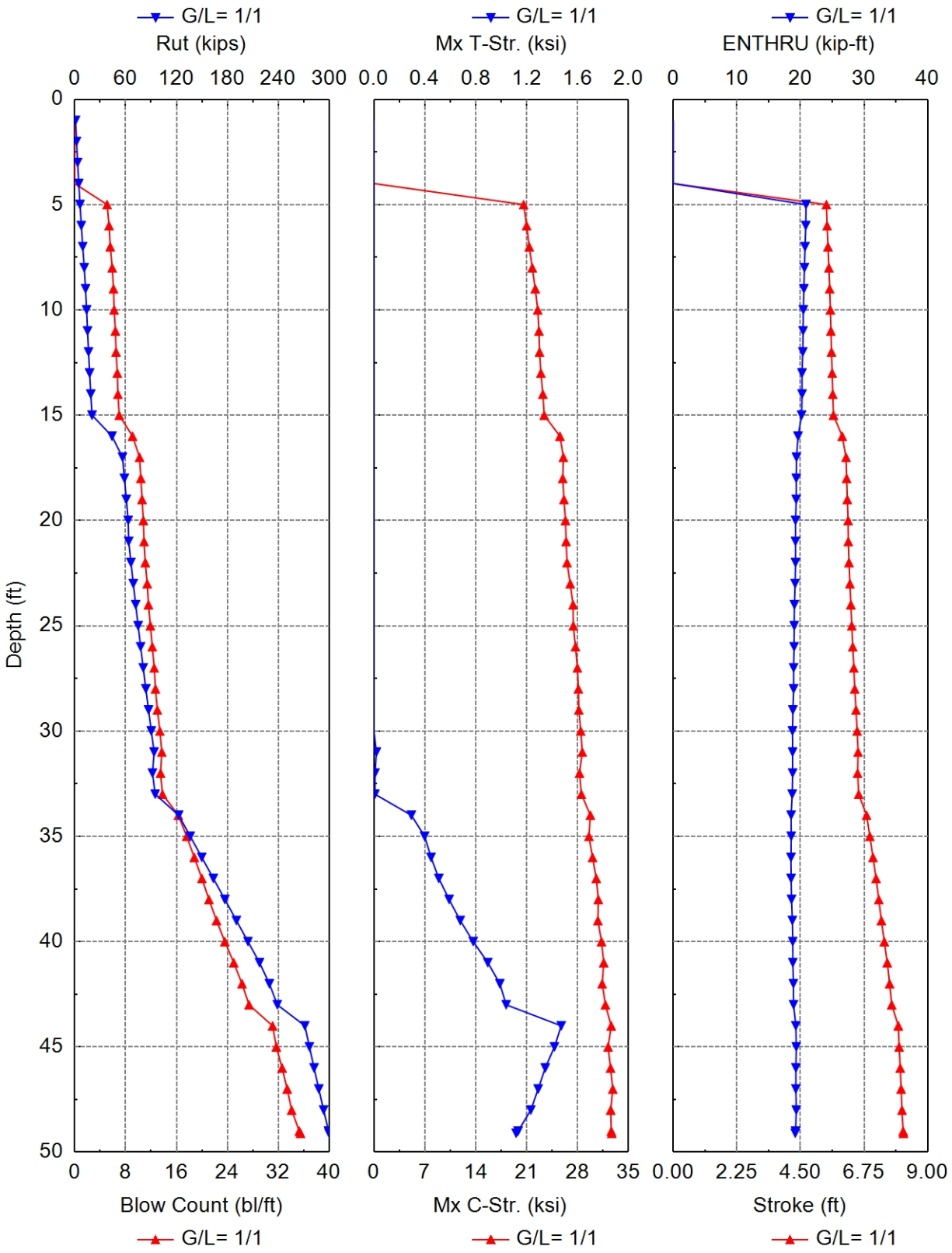
Represents the case of piles driven to the required bearing resistance through the MSE wall completed to the pile cap elevation, with conventional granular-filled pipe pile sleeves through the MSE wall fill.

WYA-23-3.47 (B-008-0-25) + HP 10X42 RESOURCE INTERNATIONAL INC

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.667/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	1.0	0.0	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.2	0.1	2.0	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	3.3	0.3	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	4.6	0.5	4.0	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	5.9	0.8	5.0	5.0	20.514	0.000	5.41	20.9	D 19-42
6.0	7.3	1.2	6.0	5.3	20.895	0.000	5.43	20.9	D 19-42
7.0	8.7	1.7	7.1	5.5	21.225	0.000	5.46	20.7	D 19-42
8.0	10.2	2.2	8.1	5.7	21.609	0.000	5.49	20.7	D 19-42
9.0	11.4	2.7	8.7	5.9	21.959	0.000	5.51	20.6	D 19-42
10.0	12.4	3.4	9.0	6.0	22.244	0.000	5.53	20.6	D 19-42
11.0	13.1	4.1	9.1	6.1	22.377	0.000	5.54	20.5	D 19-42
12.0	13.9	4.9	9.1	6.2	22.403	0.000	5.56	20.5	D 19-42
13.0	14.8	5.7	9.1	6.3	22.538	0.000	5.57	20.4	D 19-42
14.0	15.7	6.6	9.1	6.4	22.747	0.000	5.59	20.4	D 19-42
15.0	16.7	7.6	9.1	6.5	22.874	0.000	5.61	20.3	D 19-42
16.0	37.0	14.0	23.0	8.5	25.002	0.000	5.89	19.8	D 19-42
17.0	45.3	22.3	23.0	9.2	25.446	0.000	5.99	19.7	D 19-42
18.0	44.4	28.5	15.9	9.2	25.139	0.000	5.98	19.7	D 19-42
19.0	45.9	30.0	15.9	9.3	25.274	0.000	6.00	19.6	D 19-42
20.0	47.4	31.5	15.9	9.5	25.473	0.000	6.02	19.6	D 19-42
21.0	47.1	33.0	14.1	9.5	25.491	0.000	6.01	19.6	D 19-42
22.0	48.9	34.8	14.1	9.6	25.590	0.000	6.04	19.5	D 19-42
23.0	50.7	36.7	14.1	9.8	25.920	0.000	6.06	19.4	D 19-42
24.0	52.6	38.5	14.1	9.9	26.211	0.000	6.08	19.4	D 19-42
25.0	54.6	40.5	14.1	10.1	26.224	0.000	6.10	19.4	D 19-42
26.0	56.5	42.5	14.1	10.3	26.512	0.000	6.12	19.3	D 19-42
27.0	58.6	44.5	14.1	10.5	26.719	0.000	6.15	19.2	D 19-42
28.0	60.6	46.5	14.1	10.7	26.766	0.000	6.18	19.2	D 19-42
29.0	62.7	48.7	14.1	10.9	26.869	0.000	6.19	19.2	D 19-42
30.0	64.9	50.8	14.1	11.1	27.060	0.000	6.22	19.1	D 19-42
31.0	67.1	53.0	14.1	11.3	27.184	0.000	6.24	19.1	D 19-42
32.0	64.2	55.1	9.1	11.0	26.837	0.000	6.22	19.1	D 19-42
33.0	66.3	57.2	9.1	11.2	27.045	0.000	6.24	19.0	D 19-42
34.0	90.2	64.9	25.3	13.3	28.272	0.014	6.50	18.8	D 19-42
35.0	99.2	74.0	25.3	14.1	28.176	0.071	6.59	18.8	D 19-42
36.0	108.3	83.1	25.3	15.0	28.585	0.150	6.69	18.6	D 19-42
37.0	117.4	92.1	25.3	15.8	28.976	0.216	6.78	18.6	D 19-42

38.0	126.5	101.2	25.3	16.7	29.204	0.275	6.86	18.6	D 19-42
39.0	135.5	110.3	25.3	17.5	29.190	0.321	6.94	18.6	D 19-42
40.0	144.6	119.4	25.3	18.3	29.555	0.344	7.01	18.6	D 19-42
41.0	153.7	128.4	25.3	19.1	29.811	0.361	7.09	18.5	D 19-42
42.0	161.4	136.2	25.3	19.9	29.666	0.374	7.15	18.5	D 19-42
43.0	167.7	142.4	25.3	20.5	29.994	0.379	7.21	18.5	D 19-42
44.0	197.6	147.5	50.1	23.0	30.760	0.560	7.41	18.7	D 19-42
45.0	201.2	151.1	50.1	23.5	30.444	0.526	7.44	18.6	D 19-42
46.0	204.8	154.7	50.1	24.0	30.656	0.496	7.48	18.5	D 19-42
47.0	208.6	158.4	50.1	24.4	30.927	0.461	7.50	18.6	D 19-42
48.0	212.3	162.2	50.1	24.8	30.688	0.428	7.52	18.6	D 19-42
49.0	216.2	166.1	50.1	25.4	30.791	0.388	7.56	18.5	D 19-42
49.1	216.6	166.5	50.1	25.6	30.846	0.383	7.57	18.5	D 19-42

Total driving time: 12 minutes; Total Number of Blows: 552 (starting at penetration 1.0 ft)

Gain/Loss Factor at Shaft/Toe = 1.000/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.0	1.1	0.1	1.0	0.3	0.000	0.000	10.81	0.0	D 19-42
2.0	2.2	0.2	2.0	0.3	0.000	0.000	10.81	0.0	D 19-42
3.0	3.5	0.5	3.0	0.3	0.000	0.000	10.81	0.0	D 19-42
4.0	4.8	0.8	4.0	0.3	0.000	0.000	10.81	0.0	D 19-42
5.0	6.3	1.3	5.0	5.1	20.589	0.000	5.42	20.9	D 19-42
6.0	7.9	1.8	6.0	5.4	21.006	0.000	5.44	20.8	D 19-42
7.0	9.5	2.5	7.1	5.6	21.365	0.000	5.47	20.7	D 19-42
8.0	11.3	3.2	8.1	5.9	21.777	0.000	5.51	20.6	D 19-42
9.0	12.8	4.1	8.7	6.1	22.187	0.000	5.53	20.5	D 19-42
10.0	14.1	5.1	9.0	6.2	22.528	0.000	5.56	20.5	D 19-42
11.0	15.2	6.1	9.1	6.4	22.696	0.000	5.58	20.4	D 19-42
12.0	16.4	7.3	9.1	6.5	22.774	0.000	5.60	20.4	D 19-42
13.0	17.6	8.6	9.1	6.7	22.960	0.000	5.62	20.2	D 19-42
14.0	19.0	9.9	9.1	6.8	23.231	0.000	5.64	20.3	D 19-42
15.0	20.5	11.4	9.1	7.0	23.411	0.000	5.67	20.2	D 19-42
16.0	44.0	21.1	23.0	9.1	25.585	0.000	5.98	19.6	D 19-42
17.0	56.4	33.4	23.0	10.2	26.054	0.000	6.11	19.4	D 19-42
18.0	58.7	42.8	15.9	10.4	25.961	0.000	6.13	19.3	D 19-42
19.0	60.9	45.0	15.9	10.6	26.132	0.000	6.16	19.3	D 19-42
20.0	63.1	47.2	15.9	10.8	26.339	0.000	6.19	19.2	D 19-42
21.0	63.6	49.5	14.1	10.9	26.433	0.000	6.19	19.2	D 19-42

22.0	66.3	52.2	14.1	11.1	26.556	0.000	6.22	19.2	D 19-42
23.0	69.1	55.0	14.1	11.4	26.990	0.000	6.25	19.2	D 19-42
24.0	71.9	57.8	14.1	11.6	27.387	0.000	6.28	19.1	D 19-42
25.0	74.8	60.7	14.1	11.9	27.415	0.000	6.31	19.0	D 19-42
26.0	77.8	63.7	14.1	12.2	27.719	0.000	6.35	19.0	D 19-42
27.0	80.8	66.7	14.1	12.5	27.979	0.000	6.39	18.9	D 19-42
28.0	83.9	69.8	14.1	12.7	28.119	0.000	6.42	18.9	D 19-42
29.0	87.1	73.0	14.1	13.0	28.177	0.000	6.46	18.8	D 19-42
30.0	90.3	76.2	14.1	13.4	28.438	0.000	6.50	18.8	D 19-42
31.0	93.6	79.5	14.1	13.7	28.653	0.020	6.54	18.8	D 19-42
32.0	91.7	82.7	9.1	13.5	28.267	0.009	6.52	18.8	D 19-42
33.0	94.9	85.8	9.1	13.8	28.530	0.008	6.56	18.7	D 19-42
34.0	122.6	97.4	25.3	16.3	29.767	0.294	6.84	18.5	D 19-42
35.0	136.2	111.0	25.3	17.6	29.570	0.398	6.95	18.5	D 19-42
36.0	149.8	124.6	25.3	18.8	30.067	0.449	7.07	18.5	D 19-42
37.0	163.5	138.2	25.3	20.0	30.576	0.510	7.17	18.5	D 19-42
38.0	177.1	151.8	25.3	21.1	30.856	0.591	7.27	18.6	D 19-42
39.0	190.7	165.4	25.3	22.3	30.803	0.678	7.36	18.7	D 19-42
40.0	204.3	179.0	25.3	23.6	31.292	0.780	7.46	18.8	D 19-42
41.0	217.9	192.6	25.3	25.0	31.604	0.895	7.57	18.8	D 19-42
42.0	229.5	204.3	25.3	26.3	31.393	0.990	7.65	18.9	D 19-42
43.0	238.9	213.6	25.3	27.4	31.834	1.039	7.73	18.9	D 19-42
44.0	271.3	221.2	50.1	31.1	32.636	1.472	7.96	19.3	D 19-42
45.0	276.7	226.6	50.1	31.7	32.205	1.419	7.99	19.3	D 19-42
46.0	282.2	232.1	50.1	32.6	32.539	1.346	8.03	19.3	D 19-42
47.0	287.8	237.7	50.1	33.4	32.849	1.291	8.06	19.3	D 19-42
48.0	293.5	243.4	50.1	34.1	32.561	1.233	8.09	19.3	D 19-42
49.0	299.2	249.1	50.1	35.3	32.641	1.133	8.13	19.2	D 19-42
49.1	299.8	249.7	50.1	35.5	32.706	1.117	8.14	19.2	D 19-42

Total driving time: 15 minutes; Total Number of Blows: 684 (starting at penetration 1.0 ft)

Fwd. Abt. (B-004-0-25)

Represents the case of piles driven to the required bearing resistance through the MSE wall completed to t
pile cap elevation, with conventional granular-filled pipe pile sleeves through the MSE wall fill.

GRLWEAP: Wave Equation Analysis of Pile Foundations

WYA-23-3.47 (B-008-0-25) + HP 10X42 10/7/2025
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity-blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors.

SOIL PROFILE

Depth	Soil Type	Spec. Wt	Su	Phi	Unit Rs	Unit Rt
ft	-	lb/ft³	ksf	°	ksf	ksf
0.0	Sand	120.0	0.0	28.0	0.00	0.00
15.3	Sand	120.0	0.0	28.0	0.47	13.32
15.3	Clay	125.0	3.7	0.0	3.75	33.75
17.7	Clay	125.0	3.7	0.0	3.75	33.75
17.7	Clay	125.0	2.6	31.0	0.67	23.40
20.7	Clay	125.0	2.6	31.0	0.67	23.40
20.7	Sand	125.0	0.0	31.0	0.80	20.71
31.2	Sand	125.0	0.0	31.0	1.02	20.71
31.2	Sand	125.0	0.0	30.0	0.93	13.32
33.2	Sand	125.0	0.0	30.0	0.97	13.32
33.2	Clay	125.0	4.1	0.0	3.84	37.12
43.7	Clay	125.0	4.1	0.0	3.84	37.12
43.7	Sand	140.0	5.4	34.0	1.60	73.64
49.1	Sand	140.0	5.4	34.0	1.77	73.64
49.1	Clay	150.0	360.0	0.0	360.00	3,239.99
54.6	Clay	150.0	360.0	0.0	360.00	3,239.99

PILE INPUT

Uniform Pile		Pile Type:	H Pile
Pile Length: (ft)	52.000	Pile Penetration: (ft)	49.100
Pile Size: (ft)	0.84	Toe Area: (in²)	97.97

Pile Profile

Lb Top	X-Area	E-Modulus	Spec. Wt	Perim.	Crit. Index
ft	in²	ksi	lb/ft³	ft	-
0.0	12.4	30,000.0	492.0	3.3	0
52.0	12.4	30,000.0	492.0	3.3	0

HAMMER INPUT

ID	41	Made By:	DELMAG
Model	D 19-42	Type:	OED

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.0	0.0	0.0	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
1.7	0.1	2.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
3.4	0.1	5.0	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
5.1	0.2	7.5	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
6.8	0.2	10.0	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
8.5	0.3	12.6	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
10.2	0.3	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
11.9	0.4	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
13.6	0.4	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.3	0.5	13.3	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
15.3	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
16.5	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
17.7	3.7	33.7	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
17.7	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
19.2	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
20.7	0.7	23.4	0.10	0.12	0.15	0.15	1.5	6.6	24.0	98.0
20.7	0.8	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
22.5	0.8	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
24.2	0.9	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
26.0	0.9	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
27.7	0.9	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
29.5	1.0	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
31.2	1.0	20.7	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
31.2	0.9	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
32.2	0.9	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
33.2	1.0	13.3	0.10	0.13	0.15	0.15	1.5	6.6	24.0	98.0
33.2	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
35.0	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
36.7	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
38.5	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
40.2	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0

42.0	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
43.7	3.8	37.1	0.10	0.09	0.15	0.15	1.5	6.6	168.0	98.0
43.7	1.6	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
45.5	1.7	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
47.3	1.7	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0
49.1	1.8	73.6	0.10	0.08	0.15	0.15	1.5	6.6	168.0	98.0

APPENDIX X

MSE WALL CALCULATIONS &

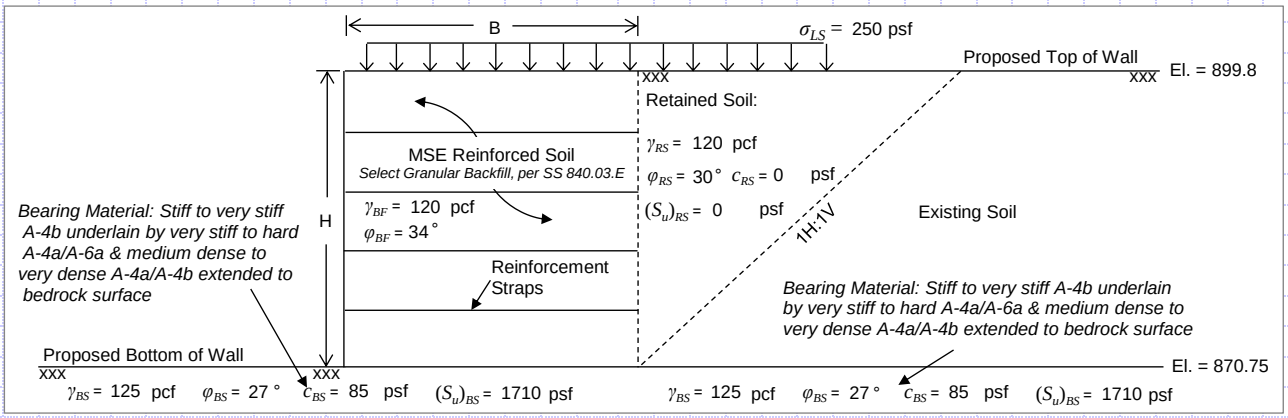
GLOBAL ANALYSIS OUTPUTS

RESOURCE INTERNATIONAL, INC.
12900 N. MERIDIAN STREET, SUITE 195
CARMEL, INDIANA 46032
PHONE: (317) 536-5768
WWW.RESOURCEINTERATIONAL.COM

JOB	WAY-23-3.47	NO.	W-25-026
SHEET NO.	1	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -1 at Rear Abutment

MSE Wall-1 at Rear Abutment. Maximum Wall Height = 29.1 feet; Reinforcement Width = 0.7H; Borings B-003-0-25 through B-005-0-25



MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	29.1	ft
MSE Wall Width (Reinforcement Length), (B) =	20.3	ft
MSE Wall Length, (L) =	162	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion [1], (c_{RS}) =	0	psf
Retained Soil Undrained Shear Strength, [$(S_u)_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°
Foundation Preparation Layer Depth (X)	1.0	ft
Foun. Prep. Layer Unit Weight (γ_{FP}) , Friction Angle	130	psf, 34 °
Height Including Foundation Preparation Layer (H_1)	30.05	ft

Bearing Soil Properties [1]:

	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	85	85	psf
Bearing Soil Undrained Shear Strength, [$(S_u)_{BS}$] =	1710	1710	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater (Below GS), (D_w) =	0.0		ft

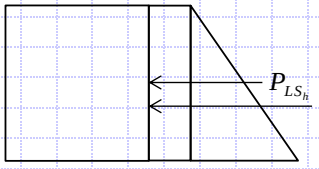
LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Sliding (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.3

Sliding Force:



$$P_H = P_{EH} + P_{LS_h}$$

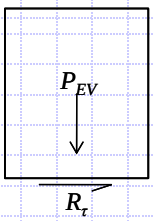
$$P_{EH} = \tfrac{1}{2}\gamma_{RS} H_1^2 K_a \gamma_{EH} = \tfrac{1}{2}(120\text{ pcf})(30.05\text{ ft})^2(0.297)(1.5) = 24.14 \text{ kip/ft}$$

$$P_{LS_h} = \sigma_{LS} H_1 K_a \gamma_{LS} = (250\text{ psf})(30.05\text{ ft})(0.297)(1.75) = 3.9 \text{ kip/ft}$$

$$P_H = 24.14\text{ kip/ft} + 3.9\text{ kip/ft} = 28.04 \text{ kip/ft}$$

Check Sliding Resistance - Drained Condition

Nominal Sliding Resistance:



$$R_\tau = P_{EV} \cdot \tan\delta$$

$$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \gamma_{BF} \cdot X \cdot B \cdot \gamma_{EV}$$

$$= (130\text{ pcf})(1\text{ ft})(20.3\text{ ft})(1.00) + (120\text{ pcf})(29.05\text{ ft})(20.3\text{ ft})(1.00) = 73.4 \text{ kip/ft}$$

$$\tan\delta = (\tan\varphi_{BS} \le \tan\varphi_{BF})$$

$$\tan\delta = \tan(27°) \le \tan(34°) \longrightarrow 0.51 \le 0.67 \longrightarrow \tan\delta = 0.51$$

$$R_\tau = (73.4\text{ kip/ft})(0.51) = 37.43 \text{ kip/ft}$$

Verify $CDR_{Sliding} \ge 1.00$ - Drained Condition

$$CDR_{Sliding} = \frac{R_\tau \cdot \varphi_\tau}{P_H} \longrightarrow \text{CDR} = [(37.43\text{ kip/ft})(1.0)] / 28.04\text{ kip/ft} = 1.33 \quad \text{OK}$$

Use φ_τ = **1.0** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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JOB	WAY-23-3.47	NO.	W-25-026
SHEET NO.	2	OF	8
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CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -1 at Rear Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	29.1	ft
MSE Wall Width (Reinforcement Length), (B) =	20.3	ft
MSE Wall Length, (L) =	162	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	85	85	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	1710	1710	psf
Embedment Depth, (D_f) =	3.0	ft	
Depth to Grounwater, (D_W) =	0.0	ft	

LRFD Load Factors

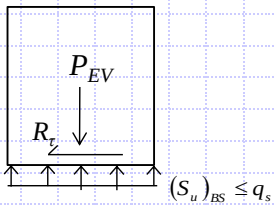
	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Sliding (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.3 ***(Continued)***

Check Sliding Resistance - Undrained Condition

Nominal Sliding Resisting: $R_\tau = \left((S_u)_{BS} \le q_s\right) \cdot B$



$(S_u)_{BS}$ = 1.71 ksf

$q_s = \sigma_v / 2$ = (3.62 ksf) / 2 = 1.81 ksf

$\sigma_v = P_{EV} / B$ = (73.4 kip/ft) / (20.3 ft) = 3.62 ksf

R_τ = (1.71 ksf ≤ 1.81 ksf)(20.3 ft) = 34.71 kip/ft

Verify CDR$_{Sliding}$ ≥ 1.00 - Undrained Condition

$$CDR_{Sliding} = \frac{R_\tau \cdot \varphi_\tau}{P_H} \longrightarrow$$ CDR = [(34.71 kip/ft)(1.0)] / 28.04 kip/ft = 1.24 **OK**

Use φ_τ = **1.0** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -1 at Rear Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	29.1	ft
MSE Wall Width (Reinforcement Length), (B) =	20.3	ft
MSE Wall Length, (L) =	162	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

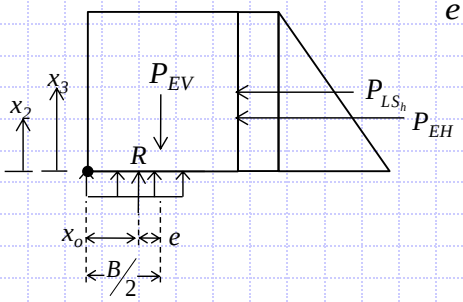
	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	85	85	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	1710	1710	psf
Embedment Depth, (D_f) =	3.0	ft	
Depth to Grounwater, (D_W) =	0.0	ft	

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Eccentricity (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.5



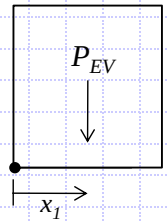
$$e = B/2 - x_o$$

$$x_o = \frac{M_{EV} - M_H}{P_{EV}} = \text{(718.32 kip·ft/ft - 273.16 kip·ft/ft) / (70.77 kip/ft)} = 6.29 \text{ ft}$$

M_{EV} = 718.32 kip·ft/ft
M_H = 273.16 kip·ft/ft
P_{EV} = 70.77 kip/ft
} Defined below

$$e = \text{(20.3 ft)/2 - 6.29 ft} = 3.86 \text{ ft}$$

Resisting Moment, M_{EV}:



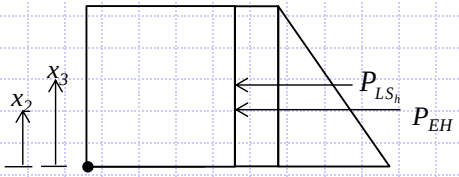
$$M_{EV} = P_{EV}(x_1)$$

$$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} = \text{(120 pcf)(29.05 ft)(20.3 ft)(1.00)} = 70.77 \text{ kip/ft}$$

$$x_1 = B/2 = \text{(20.3 ft) / 2} = 10.15 \text{ ft}$$

$$M_{EV} = \text{(70.77 kip/ft)(10.15 ft)} = 718.32 \text{ kip·ft/ft}$$

Overturning Moment, M_H:



$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3)$$

$$P_{EH} = \tfrac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH} = \text{½(120 pcf)(29.05 ft)²(0.297)(1.5)} = 22.56 \text{ kip/ft}$$

$$P_{LS_h} = \sigma_{LS} H K_a \gamma_{LS} = \text{(250 psf)(29.05 ft)(0.297)(1.75)} = 3.77 \text{ kip/ft}$$

$$x_2 = H/3 = \text{(29.05 ft) / 3} = 9.68 \text{ ft}$$

$$x_3 = H/2 = \text{(29.05 ft) / 2} = 14.53 \text{ ft}$$

$$M_H = \text{(22.56 kip/ft)(9.68 ft) + (3.77 kip/ft)(14.53 ft)} = 273.16 \text{ kip·ft/ft}$$

Limiting Eccentricity: $e_{max} = B/3 \rightarrow e_{max} = \text{(20.3 ft) / 3} = 6.77 \text{ ft}$

Verify $CDR_{Eccentricity} \geq 1.00$

$$CDR_{Eccentricity} = \frac{e_{max}}{e} \rightarrow \text{CDR = 6.77 ft / 3.86 ft = 1.75} \quad \textbf{OK}$$

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MSE Wall -1 at Rear Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	29.1	ft
MSE Wall Width (Reinforcement Length), (B) =	20.3	ft
MSE Wall Length, (L) =	162	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

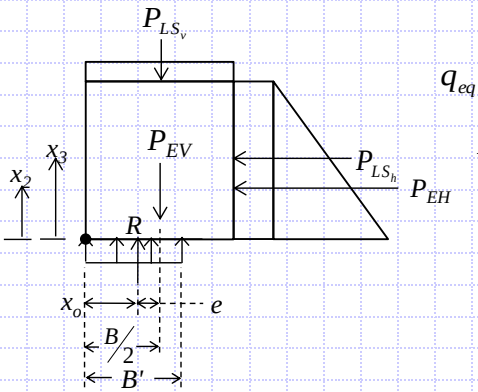
	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	85	85	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	1710	1710	psf
Embedment Depth, (D_f) =	3.0	ft	
Depth to Grounwater, (D_W) =	0.0	ft	

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4



$$q_{eq} = P_V / B'$$

$B' = B - 2e$ = 20.3 ft - 2(2.62 ft) = **15.06** ft

$e = B/2 - x_o$ = (20.3 ft) / 2 - 7.53 ft = 2.62 ft

$x_o = \frac{M_V - M_H}{P_V}$ = (1059.81 kip·ft/ft - 273.2 kip·ft/ft) / 104.42 kip/ft = 7.53 ft

q_{eq} = (104.42 kip/ft) / (15.06 ft) = **6.93** ksf

Bearing Pressure Inc. Foundation Preparation= 7.06 ksf

$$M_V = P_{EV}(x_1) + P_{LS_v}(x_1) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_1) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_1)$$

M_V = [(120 pcf)(29.05 ft)(20.3 ft)(1.35)](10.15 ft) + [(250 psf)(20.3 ft)(1.75)](10.15 ft) = 1059.81 kip·ft/ft

$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3) = (\tfrac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH})(x_2) + (\sigma_{LS} H K_a \gamma_{LS})(x_3)$$

M_H = [½(120 pcf)(29.05 ft)²(0.297)(1.5)](9.68 ft) + [(250 psf)(29.05 ft)(0.297)(1.75)](14.53 ft) = 273.20 kip·ft/ft

$$P_V = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$$

P_V = (120 pcf)(29.05 ft)(20.3 ft)(1.35) + (250 psf)(20.3 ft)(1.75) = 104.42 kip/ft

Check Bearing Resistance - Layered Analysis

Soil Layer 1:

Type:Native A-4b, A-4a and A-6a

γ_{BF} =	**125**	pcf
c_{BF} =	**85**	psf
φ_{BF} =	**27**	°
(s_u)$_{BF}$ =	**1,710**	psf
H_{BF} =	**0.0**	ft

Soil Layer 2 :

Type:Native A-4b, A-4a and A-6a

γ_{BS} =	**125**	pcf
c_{BS} =	**85**	psf
φ_{BS} =	**27**	°
(s_u)$_{BS}$ =	**1710**	psf

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \tfrac{1}{2}\gamma B N_{\gamma m} C_{w\gamma}$$

$$N_{cm} = N_c s_c i_c$$
$$N_{qm} = N_q s_q d_q i_q$$
$$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$$

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MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	29.1	ft
MSE Wall Width (Reinforcement Length), (B) =	20.3	ft
MSE Wall Length, (L) =	162	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	85	85	psf
Bearing Soil Undrained Shear Strength, $[(s_u)_{BS}]$ =	1710	1710	psf
Embedment Depth, (D_f) =	3.0	ft	
Depth to Grounwater, (D_W) =	0.0	ft	

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 *(Continued)*

Check Bearing Resistance - Drained Condition

Soil 1 (Native Soil)		*Soil 2 (Native Soils)*	
q_n =	11.44 ksf	q_n =	11.44 ksf
N_{cm} =	25.17	N_{cm} =	25.17
N_{qm} =	14.65	N_{qm} =	14.65
$N_{\gamma m}$ =	13.93	$N_{\gamma m}$ =	13.93
N_c =	23.94	N_c =	23.94
N_q =	13.20	N_q =	13.20
N_γ =	14.47	N_γ =	14.47
s_c =	1+(15.06 ft/162 ft)(13.2/23.94) = 1.051	s_c =	1+(15.06 ft/162 ft)(13.2/23.94) 1.051
s_q =	1+(15.06 ft/162 ft)tan(27°) = 1.047	s_q =	1+(15.06 ft/162 ft)tan(27°) = 1.047
s_γ =	1-0.4(15.06 ft/162 ft) = 0.963	s_γ =	1-0.4(15.06 ft/162 ft) = 0.963
i_c =	1.000	i_c =	1.000
i_q =	1.000	i_q =	1.000
i_γ =	1.000	i_γ =	1.000
d_q =	1+2tan(27°)[1-sin(27°)]²tan⁻¹(3 ft/15.06 ft) = 1.060	d_q =	1+2tan(27°)[1-sin(27°)]²tan⁻¹(3 ft/15.06 ft) = 1.060
C_{wq} =	0.0 ft < 3.0 ft = 0.500	C_{wq} =	0.0 ft < 3.0 ft = 0.500
$C_{w\gamma}$ =	0.0 ft < 1.5(15.06 ft) + 3 ft = 0.500	$C_{w\gamma}$ =	0.0 ft < 1.5(15.06 ft) + 3 ft = 0.500

$$H_{crit} = \frac{(3B')\ln\frac{q_1}{q_2}}{2\left(1+\frac{B'}{L}\right)}$$ = [3(15.1 ft)ln(11.44 ksf/11.44 ksf)] / [2(1+(15.1 ft/162.0 ft)] = 0 ft ≤ 0.0 ft Use Soil 1 Resistance

$$q_n = \left[q_2 + \left(\frac{1}{K}\right)c'_1\cot\varphi'_1\right]e^{2\left[1+\left(\frac{B'}{L}\right)\right]K\tan\varphi'_1\left(\frac{H}{B'}\right)} - \left(\frac{1}{K}\right)c'_1\cot\varphi'_1$$ For layered analysis

=

= ksf

$$K = \frac{1-\sin^2\varphi'_1}{1+\sin^2\varphi'_1}$$ = [1 - sin²(27°)] / [1 + sin²(27°)] = 0.658

Verify $CDR_{Bearing} \geq 1.00$ - Drained Condition

$$CDR_{Bearing} = \frac{q_n \cdot \varphi_b}{q_{eq}}$$ ⟶ CDR = [(11.44 ksf)(0.65)] / 7.06 ksf = 1.05 **OK**

Use φ_b = **0.65** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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MSE Wall -1 at Rear Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	29.1	ft
MSE Wall Width (Reinforcement Length), (B) =	20.3	ft
MSE Wall Length, (L) =	162	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	85	85	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	1710	1710	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater (D_W) =	0.0		ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 ***(Continued)***

Check Bearing Resistance - Undrained Condition (*Refer page 7 of 9 to 8 of 9*)

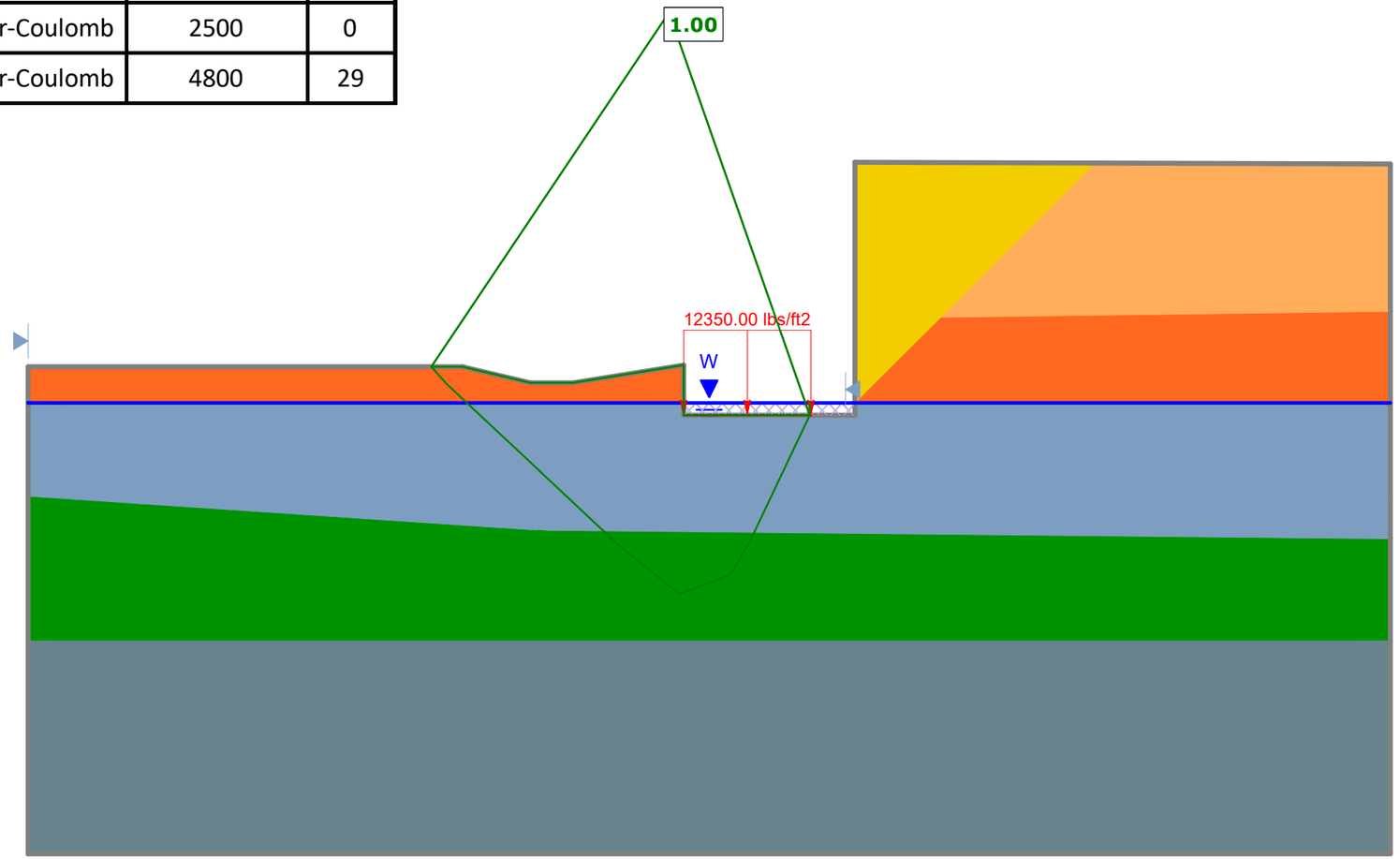
qn = 11.75 ksf — ***q_n is calculated using limit equilibrium method as per ODOT GDM Section 1303.3.2***

Verify $CDR_{Bearing}$ ≥ 1.00 - Undrained Condition

$$CDR_{Bearing} = \frac{q_n \cdot \varphi_b}{q_{eq}} \longrightarrow$$ CDR = [(11.75 ksf)(0.65)] / 7.06 ksf = 1.08 **OK**

Use φ_b = **0.65** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Retained Soil		120	Mohr-Coulomb	0	30
Engineered Fill		120	Mohr-Coulomb	2000	0
Very Stiff to Hard A-6a/A-6b		125	Mohr-Coulomb	3190	0
Medium Dense A-4b		125	Mohr-Coulomb	0	30
Very Stiff to Hard A-4a/A-6a		125	Mohr-Coulomb	2500	0
Dolomite		150	Mohr-Coulomb	4800	29



940
920
900
880
860
840
820

31340 31360 31380 31400 31420 31440 31460 31480 31500 31520 31540 31560 31580 31600

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SLIDEINTERPRET 9.035

Project	WYA-23-3.47 Interchange Improvements		
Analysis Description	MSE Wall at Fwd Abt (MSE Wall-2) - Undrained - Borings B-007-0-25 to B-009-0-25 - Reinforcement = 0.7H		
Drawn By	AG/JPS	*Company*	Resource International Inc.
Date	9/24/2025	*File Name*	1A_Stability MSE-2 - Undrained.slmd

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CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -1 at Rear Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	29.1	ft
MSE Wall Width (Reinforcement Length), (B) =	20.3	ft
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Live Surcharge Load, (σ_{LS}) =	250	psf
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Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

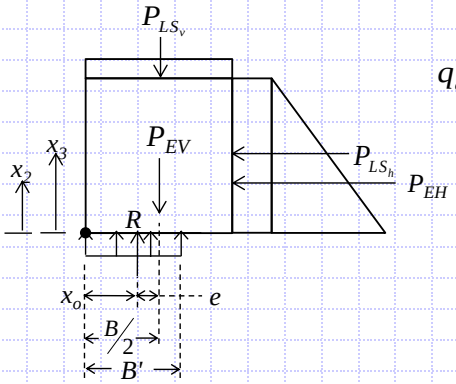
	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	85	85	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	1710	1710	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	0.0		ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Settlement Analysis (Loading Case - Service I) - AASHTO LRFD BDM Section 11.10.4.1



$$q_{eq} = P_V / B'$$

$$B' = B - 2e = 20.3 \text{ ft} - 2(2.33 \text{ ft}) = 15.64 \text{ ft}$$

$$e = B/2 - x_o = (20.3 \text{ ft})/2 - 7.82 \text{ ft} = 2.33 \text{ ft}$$

$$x_o = \frac{M_V - M_H}{P_V} = (769.78 \text{ kip·ft/ft} - 176.91 \text{ kip·ft/ft}) / 75.84 \text{ kip/ft} = 7.82 \text{ ft}$$

$$q_{eq} = (75.84 \text{ kip/ft}) / (15.64 \text{ ft}) = 4.85 \text{ ksf}$$

$$M_V = P_{EV}(x_1) + P_{LS_v}(x_1) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_1) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_1)$$

$$M_V = [(120 \text{ pcf})(29.1 \text{ ft})(20.3 \text{ ft})(1.00)](10.2 \text{ ft}) + [(250 \text{ psf})(20.3 \text{ ft})(1.00)](10.2 \text{ ft}) = 769.78 \text{ kip·ft/ft}$$

$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3) = (\tfrac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH})(x_2) + (\sigma_{LS} H K_a \gamma_{LS})(x_3)$$

$$M_H = [\tfrac{1}{2}(120 \text{ pcf})(29.05 \text{ ft})^2(0.297)(1.00)](9.68 \text{ ft}) + [(250 \text{ psf})(29.05 \text{ ft})(0.297)(1.00)](14.53 \text{ ft}) = 176.91 \text{ kip·ft/ft}$$

$$P_V = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$$

$$P_V = (120 \text{ pcf})(29.1 \text{ ft})(20.3 \text{ ft})(1.00) + (250 \text{ psf})(20.3 \text{ ft})(1.00) = 75.84 \text{ kip/ft}$$

Settlement, Time Rate of Consolidation and Differential Settlement Along Wall:

Wall	Total Settlement at Center of Reinforced Soil Mass	Total Settlement at Wall Facing	Time to 90% Consolidation	Time to 0.4 in Remaining Settlement	Distance Between Borings Along Wall Facing	Differential Settlement Along Wall Facing
MSE-1	1.37 in	1.100 in	140 days	35 days	55 to 60 feet	0.5 in / 75 feet

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -1 (At Rear Abutment)***

Calculated By: AG Date: 9.23.2025
Checked By: JPS Date: 9.23.2025

Borings: *B-003-0-25 to B-005-0-25*
Subsurface Condition: *Stiff to very stiff A-4b underlain by very stiff to hard A-4a/A-6a & medium dense to very dense A-4a/A-4b extended to bedrock surface*

Existing GSE: 879.5 ft *Average of 882 and 877 feet (ithin the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 869.75 ft At the bottom of foundation preparation
H_{wall} = 29.1 ft *Total wall height*
B_{wall} = 15.6 ft *Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} = 120 pcf *Unit weight of MSE wall*
q_{load} = **4,980** psf *Pressure at bottom of wall* *At the bottom of foundation preparation*
q_{net} = **3,761** psf *Net pressure at bottom of wall*
D_w = 0.0 ft *Depth of water table (from bearing elevation)*
Overburden = 1,219 psf

	Cohesionless	Cohesive		
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**	
C_v =	500	350		ft^2/yr Coefficient of consolitation
t =	35	days		Time following completion of construction

																				Total Settlement at Center of Reinforced Soil Mass					*Total Settlement at Facing of Wall*					*Time Rate of Settlement at Facing of Wall*					
Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*c_v (ft^2/yr)*	*H_{dr} (11) (ft)*	*T_v (12)*	*U (13) (%)*	*$(S_c)_t$ (14) (in)*	*Remaining Settlement (in)*
1	A-4b	C	0.0	2.0	869.8	867.8	2.0	***1.0***	125	1,469	1,344	***1,281***	7,281	25	0.14	0.01	0.47				1.00	3,758	***5,039***	0.01	0.13	0.50	1880	3162	0.01	0.09	350	2	8.39	99.9	0.09	0.00
2	A-4a	C	2.0	5.0	867.8	864.8	3.0	***3.5***	125	1,844	1,656	***1,438***	9,000	25	0.03	0.007	0.36				0.97	3,646	***5,084***	0.01	0.10	0.50	1872	3310	0.01	0.07	350	5	1.34	97	0.07	0.00
	A-4a	C	5.0	10.0	864.8	859.8	5.0	***7.5***	125	2,469	2,156	***1,688***	9,000	25	0.03	0.007	0.36				0.83	3,124	***4,812***	0.01	0.14	0.48	1812	3500	0.01	0.10	350	10	0.34	65	0.06	0.03
	A-4a	C	10.0	15.0	859.8	854.8	5.0	***12.5***	125	3,094	2,781	***2,001***	9,000	25	0.03	0.007	0.36				0.64	2,411	***4,413***	0.01	0.11	0.44	1656	3657	0.01	0.08	350	15	0.15	44	0.04	0.05
3	A-4a	G	15.0	20.0	854.8	849.8	5.0	***17.5***	125	3,719	3,406	***2,314***						28	27	50	0.50	1,894	***4,209***	0.03	0.31	0.39	1466	3781	0.02	0.26	500	20	0.12	39	0.10	0.16
	A-4a	G	20.0	25.0	849.8	844.8	5.0	***22.5***	125	4,344	4,031	***2,627***						28	25	48	0.41	1,540	***4,167***	0.02	0.25	0.34	1286	3914	0.02	0.22	500	15	0.21	52	0.11	0.10
	A-4a	G	25.0	30.0	844.8	839.8	5.0	***27.5***	125	4,969	4,656	***2,940***						25	22	43	0.34	1,290	***4,231***	0.02	0.22	0.30	1132	4072	0.02	0.20	500	10	0.48	75	0.15	0.05
	A-4a	G	30.0	35.0	839.8	834.8	5.0	***32.5***	120	5,569	5,269	***3,241***						50	42	73	0.29	1,107	***4,348***	0.01	0.11	0.27	1003	4244	0.01	0.10	500	5	1.92	99	0.10	0.00
4	Rock	R	35.0	40.0	834.8	829.8	5.0	***37.5***	140	6,269	5,919	***3,579***									0.26	968	***4,547***												0.00	
		R	40.0	45.0	829.8	824.8	5.0	***42.5***	150	7,019	6,644	***3,992***									0.23	860	***4,852***												0.00	
		R	45.0	50.0	824.8	819.8	5.0	***47.5***	150	7,769	7,394	***4,430***									0.21	773	***5,202***												0.00	
																						Total Settlement:		***1.37 in***			Total Settlement:		***1.10 in***				Remaining Settlement:		***0.39***	***in***

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; *Estimate σ_m of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab*
2. C_c = 0.009(LL-10); *Ref. Table 6-9, FHWA GEC 5 or from Lab*
3. C_r = 0.10(C_c); *Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab*
4. e_o = (C_c/1.15)+0.35; *Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab*
5. $(N1)_{60} = C_n N_{60}$, *where* C_N = [0.77log(40/σ_{vo}')] ≤ 2.0 ksf; *Ref. Section 10.4.6.2.4, AASHTO LRFD BDS*
6. *Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS*
7. *Influence factor for strip loaded footing*
8. $\Delta\sigma_v = q_e(I)$
9. S_c = [C_c/(1+e_o)](H)log($\sigma_{vf}'/\sigma_{vo}'$) *for* $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; [$C_r$/(1+$e_o$)](H)log($\sigma_p'/\sigma_{vo}'$) *for* $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; [Cr/(1+$e_o$)](H)log($\sigma_p'/\sigma_{vo}'$)+[$C_c$/(1+$e_o$)](H)log($\sigma_{vf}'/\sigma_p'$) *for* $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; *Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)*
10. S_c = H(1/C')log($\sigma_{vf}'/\sigma_{vo}'$); *Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)*
11. *Length of longest drainage path considered*
12. *Time Factor* = C_v*t/H_{dr}^2
13. *Degree of Consolidation*
14. $(S_c)_t$ = *settlement occurred at the particular time*

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -1 (At Rear Abutment)***

Calculated By: AG Date: 9.23.2025
Checked By: JPS Date: 9.23.2025

Borings: *B-003-0-25 to B-005-0-25*
Subsurface Condition: *Stiff to very stiff A-4b underlain by very stiff to hard A-4a/A-6a & medium dense to very dense A-4a/A-4b extended to bedrock surface*

Existing GSE: 879.5 ft *Average of 882 and 877 feet (ithin the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 869.75 ft At the bottom of foundation preparation
H_{wall} = 29.1 ft *Total wall height*
B_{wall} = 15.6 ft *Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} = 120 pcf *Unit weight of MSE wall*
q_{load} = **4,980** psf *Pressure at bottom of wall* *At the bottom of foundation preparation*
q_{net} = **3,761** psf *Net pressure at bottom of wall*
D_w = 0.0 ft *Depth of water table (from bearing elevation)*
Overburden = 1,219 psf

	Cohesionless	***Cohesive***		
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**	
C_v =	500	350		ft^2/yr Coefficient of consolitation
t =	140	days		Time following completion of construction

Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*Total Settlement at Center of Reinforced Soil Mass*					*Total Settlement at Facing of Wall*					*Time Rate of Settlement at Facing of Wall*					
																					I (7)	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*c_v (ft^2/yr)*	*H_{dr} (11) (ft)*	*T_v (12)*	*U (13) (%)*	*$(S_c)_t$ (14) (in)*	*Remaining Settlement (in)*
1	A-4b	C	0.0	2.0	869.8	867.8	2.0	***1.0***	125	1,469	1,344	***1,281***	7,281	25	0.14	0.01	0.47				1.00	3,758	***5,039***	0.01	0.13	0.50	1880	3162	0.01	0.09	350	2	33.56	99.9	0.09	0.00
2	A-4a	C	2.0	5.0	867.8	864.8	3.0	***3.5***	125	1,844	1,656	***1,438***	9,000	25	0.03	0.007	0.36				0.97	3,646	***5,084***	0.01	0.10	0.50	1872	3310	0.01	0.07	350	5	5.37	99.7	0.07	0.00
	A-4a	C	5.0	10.0	864.8	859.8	5.0	***7.5***	125	2,469	2,156	***1,688***	9,000	25	0.03	0.007	0.36				0.83	3,124	***4,812***	0.01	0.14	0.48	1812	3500	0.01	0.10	350	10	1.34	97	0.09	0.00
	A-4a	C	10.0	15.0	859.8	854.8	5.0	***12.5***	125	3,094	2,781	***2,001***	9,000	25	0.03	0.007	0.36				0.64	2,411	***4,413***	0.01	0.11	0.44	1656	3657	0.01	0.08	350	15	0.60	81	0.07	0.02
3	A-4a	G	15.0	20.0	854.8	849.8	5.0	***17.5***	125	3,719	3,406	***2,314***						28	27	50	0.50	1,894	***4,209***	0.03	0.31	0.39	1466	3781	0.02	0.26	500	20	0.48	75	0.19	0.06
	A-4a	G	20.0	25.0	849.8	844.8	5.0	***22.5***	125	4,344	4,031	***2,627***						28	25	48	0.41	1,540	***4,167***	0.02	0.25	0.34	1286	3914	0.02	0.22	500	15	0.85	90	0.19	0.02
	A-4a	G	25.0	30.0	844.8	839.8	5.0	***27.5***	125	4,969	4,656	***2,940***						25	22	43	0.34	1,290	***4,231***	0.02	0.22	0.30	1132	4072	0.02	0.20	500	10	1.92	99	0.20	0.00
	A-4a	G	30.0	35.0	839.8	834.8	5.0	***32.5***	120	5,569	5,269	***3,241***						50	42	73	0.29	1,107	***4,348***	0.01	0.11	0.27	1003	4244	0.01	0.10	500	5	7.67	99.9	0.10	0.00
4	Rock	R	35.0	40.0	834.8	829.8	5.0	***37.5***	140	6,269	5,919	***3,579***									0.26	968	***4,547***												0.00	
		R	40.0	45.0	829.8	824.8	5.0	***42.5***	150	7,019	6,644	***3,992***									0.23	860	***4,852***												0.00	
		R	45.0	50.0	824.8	819.8	5.0	***47.5***	150	7,769	7,394	***4,430***									0.21	773	***5,202***												0.00	
																						Total Settlement:		***1.37 in***			Total Settlement:		***1.10 in***				Remaining Settlement:		***0.11***	***in***

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; *Estimate σ_m of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab*
2. C_c = 0.009(LL-10); *Ref. Table 6-9, FHWA GEC 5 or from Lab*
3. C_r = 0.10(C_c); *Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab*
4. e_o = (C_c/1.15)+0.35; *Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab*
5. $(N1)_{60} = C_n N_{60}$, *where* C_N = [0.77log(40/σ_{vo}')] ≤ 2.0 ksf; *Ref. Section 10.4.6.2.4, AASHTO LRFD BDS*
6. *Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS*
7. *Influence factor for strip loaded footing*
8. $\Delta\sigma_v = q_e(I)$
9. S_c = [C_c/(1+e_o)](H)log($\sigma_{vf}'/\sigma_{vo}'$) *for* $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; [$C_r$/(1+$e_o$)](H)log($\sigma_p'/\sigma_{vo}'$) *for* $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; [Cr/(1+$e_o$)](H)log($\sigma_p'/\sigma_{vo}'$)+[$C_c$/(1+$e_o$)](H)log($\sigma_{vf}'/\sigma_p'$) *for* $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; *Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)*
10. S_c = H(1/C')log($\sigma_{vf}'/\sigma_{vo}'$); *Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)*
11. *Length of longest drainage path considered*
12. *Time Factor* = C_v*t/H_{dr}^2
13. *Degree of Consolidation*
14. $(S_c)_t$ = *settlement occurred at the particulat time*

Note: Remaining settlement is 10%.

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -1 (At Rear Abutment)_ For Differential Settlement Calculation***

Calculated By: AG Date: 5.25.2026
Checked By: JPS Date: 6.1.2026

Borings: *B-004-0-25*
Subsurface Condition: *Stiff to very stiff A-4b underlain by very stiff to hard A-4a/A-6a & medium dense to very dense A-4a/A-4b extended to bedrock surface*

Existing GSE: 879.5 *ft* *Average of 882 and 877 feet (ithin the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 869.75 ft At the bottom of foundation preparation
H_{wall} = 29.1 ft *Total wall height*
B_{wall} = 15.6 ft *Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} = 120 pcf *Unit weight of MSE wall*
q_{load} = **4,980** psf *Pressure at bottom of wall* *At the bottom of foundation preparation*
q_{net} = **3,761** psf *Net pressure at bottom of wall*
D_w = 0.0 ft *Depth of water table* *(from bearing elevation)*
Overburden = 1,219 psf

	Cohesionless	**Cohesive**			
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**		
C_v =	500	350		ft^2/yr	Coefficient of consolitation
t =		days			Time following completion of construction

																			Total Settlement at Center of Reinforced Soil Mass					*Total Settlement at Facing of Wall*				
Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*
1	A-4b	C	0.0	3.8	869.8	866.0	3.8	***1.9***	120	1,669	1,444	***1,327***	7,327	22	0.11	0.01	0.44				0.99	3,741	***5,067***	0.02	0.20	0.50	1879	3206	0.01	0.13
2	A-4a	C	3.8	13.8	866.0	856.0	10.0	***8.8***	122	2,889	2,279	***1,733***	9,000	20	0.03	0.007	0.36				0.78	2,933	***4,665***	0.02	0.27	0.47	1779	3512	0.02	0.19
3	A-4b	G	13.8	17.8	856.0	852.0	4.0	***15.8***	125	3,389	3,139	***2,156***	9,000		0.03	0.007	0.36	24	23	45	0.55	2,053	***4,209***	0.03	0.31	0.41	1533	3689	0.02	0.25
4	A-4a	C	17.8	22.8	852.0	847.0	5.0	***20.3***	125	4,014	3,701	***2,438***	9,000	18	0.03	0.007	0.36				0.45	1,684	***4,121***	0.01	0.07	0.36	1365	3802	0.00	0.06
5	A-4b	G	22.8	27.8	847.0	842.0	5.0	***25.3***	125	4,639	4,326	***2,751***						23	21	41	0.37	1,393	***4,143***	0.02	0.26	0.32	1198	3949	0.02	0.23
6	A-4a	G	27.8	33.3	842.0	836.5	5.5	***30.5***	130	5,354	4,996	***3,093***						51	44	75	0.31	1,174	***4,267***	0.01	0.12	0.28	1051	4144	0.01	0.11
7	Rock	R	33.3	35.0	836.5	834.8	1.8	***34.1***	140	5,599	5,476	***3,347***																		
																						Total Settlement:		***1.23 in***			Total Settlement:		***0.97 in***	

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; *Estimate σ_m of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab*
2. $C_c = 0.009(LL-10)$; *Ref. Table 6-9, FHWA GEC 5 or from Lab*
3. $C_r = 0.10(C_c)$; *Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab*
4. $e_o = (C_c/1.15)+0.35$; *Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab*
5. $(N1)_{60} = C_n N_{60}$, *where* $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ *ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS*
6. *Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS*
7. *Influence factor for strip loaded footing*
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ *for* $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ *for* $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ *for* $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; *Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)*
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; *Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)*
11. *Length of longest drainage path considered*
12. *Time Factor* $= C_v * t/H_{dr}^2$
13. *Degree of Consolidation*
14. $(S_c)_t$ = *settlement occurred at the particular time*

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -1 (At Rear Abutment) _ For Differential Settlement Calculation***

Calculated By: AG Date: 5.25.2026
Checked By: JPS Date: 6.1.2026

Borings: *B-004-0-25 (Below 845 feet information of B-005-0-25 was used)*
Subsurface Condition: *Stiff to very stiff A-4b underlain by very stiff to hard A-4a/A-6a & medium dense to very dense A-4a/A-4b extended to bedrock surface*

Existing GSE: 879.5 *ft* *Average of 882 and 877 feet (ithin the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 869.75 ft At the bottom of foundation preparation
H_{wall} = 29.1 ft *Total wall height*
B_{wall} = 15.6 ft *Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} = 120 pcf *Unit weight of MSE wall*
q_{load} = **4,980** psf *Pressure at bottom of wall* *At the bottom of foundation preparation*
q_{net} = **3,761** psf *Net pressure at bottom of wall*
D_w = 0.0 ft *Depth of water table* *(from bearing elevation)*
Overburden = 1,219 psf

	Cohesionless	**Cohesive**			
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**		
C_v =	500	350		ft^2/yr	Coefficient of consolitation
t =		days			Time following completion of construction

Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*Total Settlement at Center of Reinforced Soil Mass*					*Total Settlement at Facing of Wall*				
																					I (7)	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*
1	A-4b	C	0.0	2.8	869.8	867.0	2.8	***1.4***	120	1,549	1,384	***1,298***	7,298	22	0.11	0.01	0.44				1.00	3,753	***5,051***	0.01	0.15	0.50	1880	3178	0.01	0.10
2	A-4a	C	2.8	12.8	867.0	857.0	10.0	***7.8***	125	2,799	2,174	***1,690***	9,000	20	0.03	0.007	0.36				0.82	3,086	***4,776***	0.02	0.28	0.48	1806	3496	0.02	0.19
3	A-4a	C	12.8	16.8	857.0	853.0	4.0	***14.8***	125	3,299	3,049	***2,128***	9,000		0.03	0.007	0.36				0.57	2,154	***4,283***	0.01	0.08	0.42	1572	3700	0.00	0.06
4	A-4a	G	16.8	24.8	853.0	845.0	8.0	***20.8***	140	4,419	3,859	***2,564***						79	73	118	0.44	1,650	***4,214***	0.01	0.18	0.36	1347	3911	0.01	0.15
5	A-4b	G	24.8	27.8	845.0	842.0	3.0	***26.3***	125	4,794	4,606	***2,968***						23	20	40	0.36	1,345	***4,314***	0.01	0.15	0.31	1168	4136	0.01	0.13
6	A-4a	G	27.8	33.3	842.0	836.5	5.5	***30.5***	130	5,509	5,151	***3,248***						51	43	74	0.31	1,174	***4,422***	0.01	0.12	0.28	1051	4299	0.01	0.11
7	Rock	R	33.3	35.0	836.5	834.8	1.8	***34.1***	140	5,754	5,631	***3,502***																		
																						Total Settlement:		***0.94 in***			Total Settlement:		***0.74 in***	

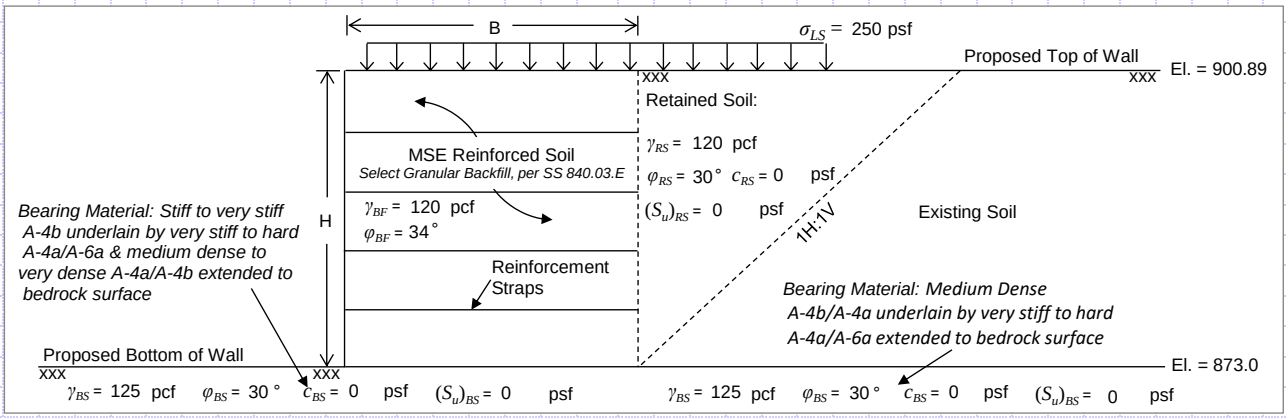
1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; *Estimate σ_m of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab*
2. $C_c = 0.009(LL-10)$; *Ref. Table 6-9, FHWA GEC 5 or from Lab*
3. $C_r = 0.10(C_c)$; *Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab*
4. $e_o = (C_c/1.15)+0.35$; *Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab*
5. $(N1)_{60} = C_n N_{60}$, *where* $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ *ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS*
6. *Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS*
7. *Influence factor for strip loaded footing*
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ *for* $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ *for* $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ *for* $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; *Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)*
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; *Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)*
11. *Length of longest drainage path considered*
12. *Time Factor* $= C_v * t/H_{dr}^2$
13. *Degree of Consolidation*
14. $(S_c)_t$ = *settlement occurred at the particular time*

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JOB	WAY-23-3.47	NO.	W-25-026
SHEET NO.	1	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -2 at Fwd Abutment

MSE Wall-2 at Forward Abutment. Maximum Wall Height = 27.9 feet; Reinforcement Width = 0.7H; Borings B-007-0-25 through B-009-0-25



MSE Wall Dimensions and Retained Soil Parameters		
MSE Wall Height, (H) =	27.9	ft
MSE Wall Width (Reinforcement Length), (B) =	19.5	ft
MSE Wall Length, (L) =	170	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion [1], (c_{RS}) =	0	psf
Retained Soil Undrained Shear Strength, [$(S_u)_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°
Foundation Preparation Layer Depth (X)	1.0	ft
Foun. Prep. Layer Unit Weight (γ_{FP}) , Friction Angle	130	psf, 34 °
Height Including Foundation Preparation Layer (H_1)	28.89	ft

Bearing Soil Properties [1]:	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	30	30	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	0	psf
Bearing Soil Undrained Shear Strength, [$(S_u)_{BS}$] =	0	0	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater (Below GS), (D_w) =	0.0		ft

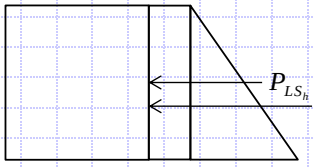
LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Sliding (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.3

Sliding Force:



$$P_H = P_{EH} + P_{LS_h}$$

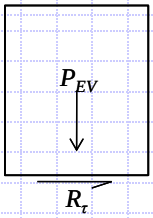
$$P_{EH} = \tfrac{1}{2}\gamma_{RS} H_1^2 K_a \gamma_{EH} = \text{½(120 pcf)(28.89 ft)²(0.297)(1.5)} = 22.31 \text{ kip/ft}$$

$$P_{LS_h} = \sigma_{LS} H K_a \gamma_{LS} = \text{(250 psf)(28.89 ft)(0.297)(1.75)} = 3.75 \text{ kip/ft}$$

P_H = 22.31 kip/ft + 3.75 kip/ft = 26.06 kip/ft

Check Sliding Resistance - Drained Condition

Nominal Sliding Resistance:



$$R_\tau = P_{EV} \cdot \tan\delta$$

$$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \gamma_{BF} \cdot X \cdot B \cdot \gamma_{EV}$$

= (130 pcf)(1 ft)(19.5 ft)(1.00) + (120 pcf)(27.89 ft)(19.5 ft)(1.00) = 67.8 kip/ft

$$\tan\delta = (\tan\varphi_{BS} \le \tan\varphi_{BF})$$

$\tan\delta$ = tan(30°) ≤ tan(34°) ⟶ 0.58 ≤ 0.67 ⟶ $\tan\delta$ = 0.58

R_τ = (67.8 kip/ft)(0.58) = 39.32 kip/ft

Verify $CDR_{Sliding}$ ≥ 1.00 - Drained Condition

$$CDR_{Sliding} = \frac{R_\tau \cdot \varphi_\tau}{P_H} \longrightarrow \text{CDR = [(39.32 kip/ft)(1.0)] / 26.06 kip/ft = 1.51} \quad \text{OK}$$

Use φ_τ = **1.0** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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SHEET NO.	2	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -2 at Fwd Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	27.9	ft
MSE Wall Width (Reinforcement Length), (B) =	19.5	ft
MSE Wall Length, (L) =	170	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	30	30	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	0	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	0	0	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater, (D_W) =	0.0		ft

LRFD Load Factors

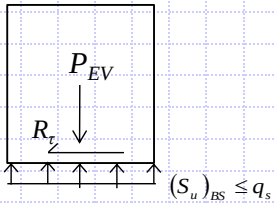
	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Sliding (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.3 ***(Continued)***

Check Sliding Resistance - Undrained Condition

Nominal Sliding Resisting: $R_\tau = \left((S_u)_{BS} \le q_s\right) \cdot B$



$(S_u)_{BS}$ = N/A ksf

$q_s = \sigma_v / 2$ = (3.48 ksf) / 2 = 1.74 ksf

$\sigma_v = P_{EV} / B$ = (67.8 kip/ft) / (19.5 ft) = 3.48 ksf

R_τ = (N/A ksf ≤ 1.74 ksf)(19.5 ft) = N/A kip/ft

Verify CDR$_{Sliding}$ ≥ 1.00 - Undrained Condition

$$CDR_{Sliding} = \frac{R_\tau \cdot \varphi_\tau}{P_H} \longrightarrow$$ N/A

Use φ_τ = **1.0** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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SHEET NO.	3	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -2 at Fwd Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	27.9	ft
MSE Wall Width (Reinforcement Length), (B) =	19.5	ft
MSE Wall Length, (L) =	170	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

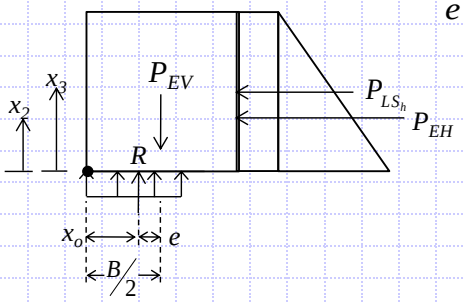
	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	30	30	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	0	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	0	0	psf
Embedment Depth, (D_f) =	3.0	ft	
Depth to Grounwater, (D_W) =	0.0	ft	

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Eccentricity (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.5



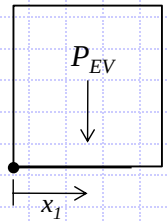
$$e = B/2 - x_o$$

$$x_o = \frac{M_{EV} - M_H}{P_{EV}} = (636.29 \text{ kip·ft/ft} - 243.85 \text{ kip·ft/ft}) / (65.26 \text{ kip/ft}) = 6.01 \text{ ft}$$

M_{EV} = 636.29 kip·ft/ft
M_H = 243.85 kip·ft/ft
P_{EV} = 65.26 kip/ft
} Defined below

$e =$ (19.5 ft)/2 - 6.01 ft = 3.74 ft

Resisting Moment, M_{EV}:



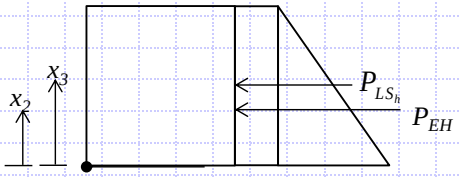
$$M_{EV} = P_{EV}(x_1)$$

$$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} = (120 \text{ pcf})(27.89 \text{ ft})(19.5 \text{ ft})(1.00) = 65.26 \text{ kip/ft}$$

$$x_1 = B/2 = (19.5 \text{ ft}) / 2 = 9.75 \text{ ft}$$

$$M_{EV} = (65.26 \text{ kip/ft})(9.75 \text{ ft}) = 636.29 \text{ kip·ft/ft}$$

Overturning Moment, M_H:



$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3)$$

$$P_{EH} = \tfrac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH} = \tfrac{1}{2}(120 \text{ pcf})(27.89 \text{ ft})^2(0.297)(1.5) = 20.79 \text{ kip/ft}$$

$$P_{LS_h} = \sigma_{LS} H K_a \gamma_{LS} = (250 \text{ psf})(27.89 \text{ ft})(0.297)(1.75) = 3.62 \text{ kip/ft}$$

$$x_2 = H/3 = (27.89 \text{ ft}) / 3 = 9.30 \text{ ft}$$

$$x_3 = H/2 = (27.89 \text{ ft}) / 2 = 13.95 \text{ ft}$$

$$M_H = (20.79 \text{ kip/ft})(9.3 \text{ ft}) + (3.62 \text{ kip/ft})(13.95 \text{ ft}) = 243.85 \text{ kip·ft/ft}$$

Limiting Eccentricity: $e_{max} = B/3 \longrightarrow e_{max} =$ (19.5 ft) / 3 = 6.50 ft

Verify CDR$_{Eccentricity}$ ≥ 1.00

$$CDR_{Eccentricity} = \frac{e_{max}}{e} \longrightarrow \text{CDR} = 6.50 \text{ ft} / 3.74 \text{ ft} = 1.74 \quad \textbf{OK}$$

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SHEET NO.	4	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -2 at Fwd Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	27.9	ft
MSE Wall Width (Reinforcement Length), (B) =	19.5	ft
MSE Wall Length, (L) =	170	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

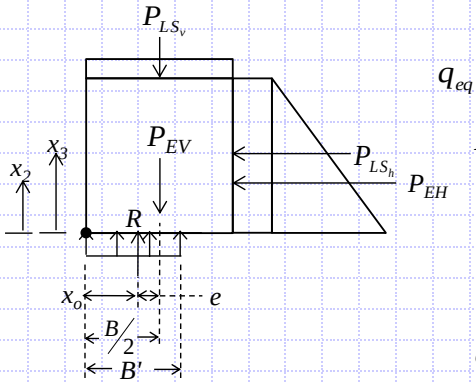
	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	30	30	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	0	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	0	0	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater, (D_W) =	0.0		ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4



$$q_{eq} = P_V / B'$$

$B' = B - 2e$ = 19.5 ft - 2(2.52 ft) = **14.46** ft

$e = B/2 - x_o$ = (19.5 ft) / 2 - 7.23 ft = 2.52 ft

$x_o = \frac{M_V - M_H}{P_V}$ = (942.20 kip·ft/ft - 243.92 kip·ft/ft) / 96.64 kip/ft = 7.23 ft

q_{eq} = (96.64 kip/ft) / (14.46 ft) = **6.68** ksf →

Bearing Pressure Incl. Foundation Preparation=	6.81	ksf

$$M_V = P_{EV}(x_1) + P_{LS_v}(x_1) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_1) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_1)$$

M_V = [(120 pcf)(27.89 ft)(19.5 ft)(1.35)](9.75 ft) + [(250 psf)(19.5 ft)(1.75)](9.75 ft) = 942.20 kip·ft/ft

$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3) = (\tfrac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH})(x_2) + (\sigma_{LS} H K_a \gamma_{LS})(x_3)$$

M_H = [½(120 pcf)(27.89 ft)²(0.297)(1.5)](9.3 ft) + [(250 psf)(27.89 ft)(0.297)(1.75)](13.95 ft) = 243.92 kip·ft/ft

$$P_V = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$$

P_V = (120 pcf)(27.89 ft)(19.5 ft)(1.35) + (250 psf)(19.5 ft)(1.75) = 96.64 kip/ft

Check Bearing Resistance - Layered Analysis

Note: Bearing resistance for drained condition was performed as per ASHTO LRFD 10.6.3.1.2f. However, bearing condition at undrained condition was calculated by limit equilibrium method.

Soil Layer 1:			***Soil Layer 2 :***		
Type: Non-Cohesive Natural Silt			***Type:Native A-4b, A-4a and A-6a***		
γ_{BF} =	***125***	pcf	γ_{BS} =	***125***	pcf
c_{BF} =	***0***	psf	c_{BS} =	***195***	psf
φ_{BF} =	***30***	°	φ_{BS} =	***27***	°
(s_u)$_{BF}$ =	***0***	psf	(s_u)$_{BS}$ =	***2500***	psf
H_{BF} =	***10.0***	ft			

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \tfrac{1}{2}\gamma B N_{\gamma m} C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$

$N_{qm} = N_q s_q d_q i_q$

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$

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JOB	WAY-23-3.47	NO.	W-25-026
SHEET NO.	5	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -2 at Fwd Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	27.9	ft
MSE Wall Width (Reinforcement Length), (B) =	19.5	ft
MSE Wall Length, (L) =	170	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	30	30	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	0	psf
Bearing Soil Undrained Shear Strength, $[(s_u)_{BS}]$ =	0	0	psf
Embedment Depth, (D_f) =	3.0	ft	
Depth to Grounwater, (D_W) =	0.0	ft	

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 ***(Continued)***

Check Bearing Resistance - Drained Condition

Soil 1 (Native Soil)		***Soil 2 (Native Soils)***	
q_n =	13.61 ksf	q_n =	13.95 ksf
N_{cm} =	31.71	N_{cm} =	25.06
N_{qm} =	20.44	N_{qm} =	14.63
$N_{\gamma m}$ =	21.64	$N_{\gamma m}$ =	13.98
N_c =	30.14	N_c =	23.94
N_q =	18.40	N_q =	13.20
N_γ =	22.40	N_γ =	14.47
s_c =	1+(14.46 ft/170 ft)(18.4/30.14) = 1.052	s_c =	1+(14.46 ft/170 ft)(13.2/23.94) 1.047
s_q =	1+(14.46 ft/170 ft)tan(30°) = 1.049	s_q =	1+(14.46 ft/170 ft)tan(27°) = 1.043
s_γ =	1-0.4(14.46 ft/170 ft) = 0.966	s_γ =	1-0.4(14.46 ft/170 ft) = 0.966
i_c =	1.000	i_c =	1.000
i_q =	1.000	i_q =	1.000
i_γ =	1.000	i_γ =	1.000
d_q =	1+2tan(30°)[1-sin(30°)]²tan⁻¹(3 ft/14.46 ft) = 1.059	d_q =	1+2tan(27°)[1-sin(27°)]²tan⁻¹(3 ft/14.46 ft) = 1.062
C_{wq} =	0.0 ft < 3.0 ft = 0.500	C_{wq} =	0.0 ft < 3.0 ft = 0.500
$C_{w\gamma}$ =	0.0 ft < 1.5(14.46 ft) + 3 ft = 0.500	$C_{w\gamma}$ =	0.0 ft < 1.5(14.46 ft) + 3 ft = 0.500

$$H_{crit} = \frac{(3B')\ln\frac{q_1}{q_2}}{2\left(1+\frac{B'}{L}\right)}$$ = [3(14.5 ft)ln(13.61 ksf/13.95 ksf)] / [2(1+(14.5 ft/170.0 ft)] = -0.6 ft ≤ 10.0 ft Use Soil 1 Resistance

$$q_n = \left[q_2 + \left(\frac{1}{K}\right)c'_1\cot\varphi'_1\right]e^{2\left[1+\left(\frac{B'}{L}\right)\right]K\tan\varphi'_1\left(\frac{H}{B'}\right)} - \left(\frac{1}{K}\right)c'_1\cot\varphi'_1$$ For layered analysis

=

= ksf

$$K = \frac{1-\sin^2\varphi'_1}{1+\sin^2\varphi'_1}$$ = [1 - sin²(30°)] / [1 + sin²(30°)] = 0.600

Verify $CDR_{Bearing}$ ≥ 1.00 - Drained Condition

$$CDR_{Bearing} = \frac{q_n \cdot \varphi_b}{q_{eq}}$$ ⟶ CDR = [(13.61 ksf)(0.65)] / 6.81 ksf = 1.30 **OK**

Use φ_b = **0.65** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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JOB	WAY-23-3.47	NO.	W-25-026
SHEET NO.	6	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -2 at Fwd Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	27.9	ft
MSE Wall Width (Reinforcement Length), (B) =	19.5	ft
MSE Wall Length, (L) =	170	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	30	30	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	0	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	0	0	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater (D_W) =	0.0		ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 *(Continued)*

Check Bearing Resistance - Undrained Condition (*Refer page 7 of 8 to 8 of 8*)

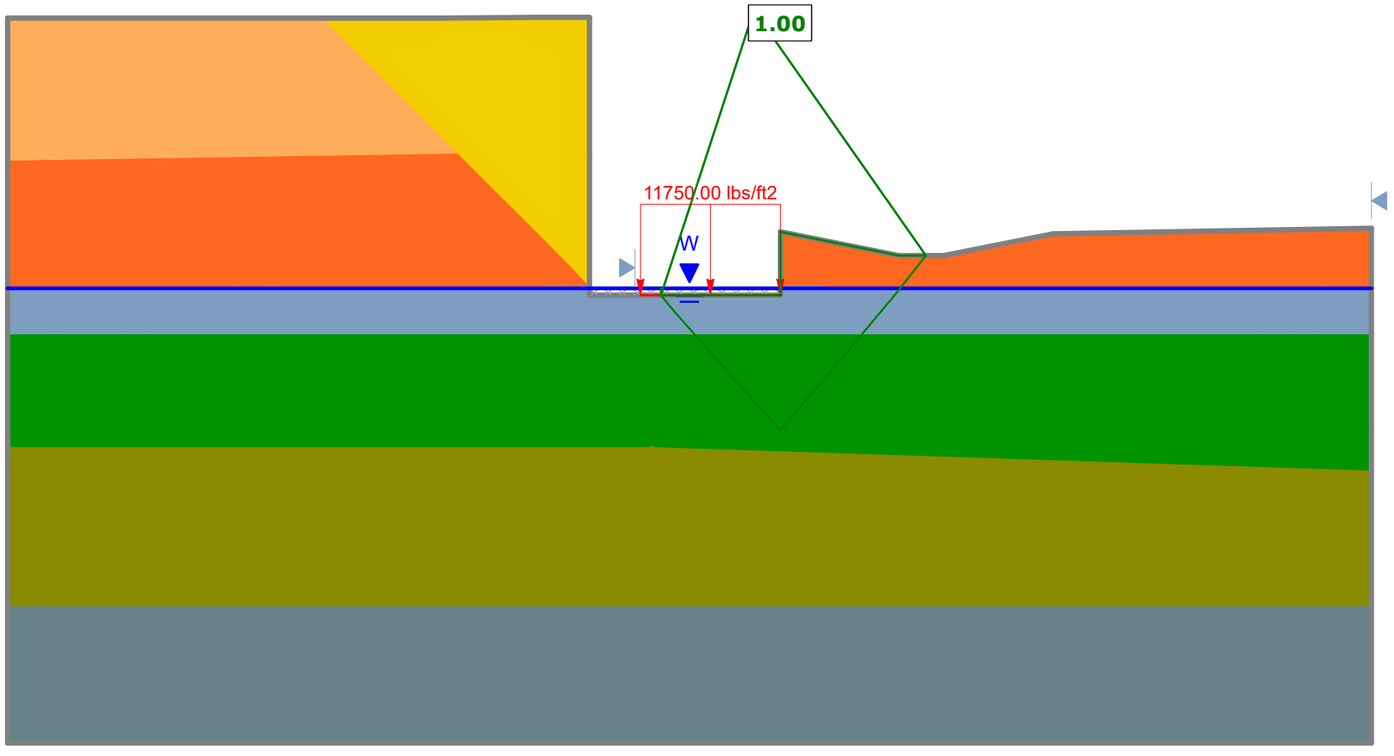
qn = 12.35 ksf — ***q_n is calculated using limit equilibrium method as per ODOT GDM Section 1303.3.2***

Verify $CDR_{Bearing}$ ≥ 1.00 - Undrained Condition

$$CDR_{Bearing} = \frac{q_n \cdot \varphi_b}{q_{eq}} \longrightarrow$$ CDR = [(12.35 ksf)(0.65)] / 6.81 ksf = 1.18 **OK**

Use φ_b = **0.65** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Retained Soil		120	Mohr-Coulomb	0	30
Embankment Fill		125	Mohr-Coulomb	2000	0
Very Stiff to Hard A-6a/A-6b		125	Mohr-Coulomb	3190	0
Stiff to Very Stiff A-4b/A-4a		125	Mohr-Coulomb	1710	0
Very Stiff to Hard A-4a/A-6a		125	Mohr-Coulomb	3150	0
Medium Dense to Very Dense A-4b/A-4a		125	Mohr-Coulomb	0	32
Dolomite		150	Mohr-Coulomb	4800	29



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Project	WYA-23-3.47 Interchange Improvements		
Analysis Description	MSE Wall at Rear Abt (MSE Wall-1) Global Stability Analysis - Undrained - Borings B-003-0-25 to B-005-0-25 -Reinforcement = 0.7H		
Drawn By	AG/JPS	*Company*	Resource International Inc.
Date	9/24/2025	*File Name*	Bearing _Undrained_MSE-1.slmd

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JOB	WAY-23-3.47	NO.	W-25-026
SHEET NO.	8	OF	8
CALCULATED BY	AG	DATE	7/1/2025
CHECKED BY	JPS	DATE	7/3/2025

MSE Wall -2 at Fwd Abutment

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	27.9	ft
MSE Wall Width (Reinforcement Length), (B) =	19.5	ft
MSE Wall Length, (L) =	170	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	0	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties [1]:

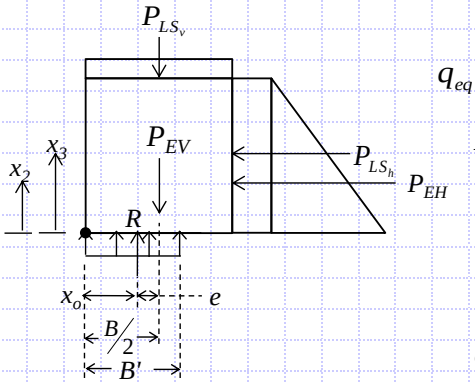
	Bearing	Sliding	
Bearing Soil Unit Weight, (γ_{BS}) =	125	125	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	30	30	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	0	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	0	0	psf
Embedment Depth, (D_f) =	3.0		ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	0.0		ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Settlement Analysis (Loading Case - Service I) - AASHTO LRFD BDM Section 11.10.4.1



$$q_{eq} = P_V / B'$$

$$B' = B - 2e = 19.5 \text{ ft} - 2(2.25 \text{ ft}) = 15.00 \text{ ft}$$

$$e = B/2 - x_o = (19.5 \text{ ft})/2 - 7.5 \text{ ft} = 2.25 \text{ ft}$$

$$x_o = \frac{M_V - M_H}{P_V} = (683.84 \text{ kip·ft/ft} - 157.8 \text{ kip·ft/ft}) / 70.14 \text{ kip/ft} = 7.5 \text{ ft}$$

$$q_{eq} = (70.14 \text{ kip/ft}) / (15 \text{ ft}) = 4.68 \text{ ksf}$$

$$M_V = P_{EV}(x_1) + P_{LS_v}(x_1) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_1) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_1)$$

$$M_V = [(120 \text{ pcf})(27.9 \text{ ft})(19.5 \text{ ft})(1.00)](9.8 \text{ ft}) + [(250 \text{ psf})(19.5 \text{ ft})(1.00)](9.8 \text{ ft}) = 683.84 \text{ kip·ft/ft}$$

$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3) = (\tfrac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH})(x_2) + (\sigma_{LS} H K_a \gamma_{LS})(x_3)$$

$$M_H = [\tfrac{1}{2}(120 \text{ pcf})(27.89 \text{ ft})^2(0.297)(1.00)](9.3 \text{ ft}) + [(250 \text{ psf})(27.89 \text{ ft})(0.297)(1.00)](13.95 \text{ ft}) = 157.80 \text{ kip·ft/ft}$$

$$P_V = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$$

$$P_V = (120 \text{ pcf})(27.9 \text{ ft})(19.5 \text{ ft})(1.00) + (250 \text{ psf})(19.5 \text{ ft})(1.00) = 70.14 \text{ kip/ft}$$

Settlement, Time Rate of Consolidation and Differential Settlement Along Wall:

Wall	Total Settlement at Center of Reinforced Soil Mass	Total Settlement at Wall Facing	Time to 90% Consolidation	Time to 0.4 in Remaining Settlement	Distance Between Borings Along Wall Facing	Differential Settlement Along Wall Facing
MSE-1	2.72 in	1.970 in	68 days	32 days	55 to 60 feet	0.5 in / 75 feet

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -2 (At Fwd Abutment)***

Calculated By: AG Date: 7.7.2025
Checked By: JPS Date: 7.7.2025

Borings: *B-007-0-25 to B-009-0-25 (Overall Profile)*
Subsurface Condition: *Medium Dense A-4b underlain by very stiff to hard A-4a/A-6a extended to bedrock surface*
Existing GSE: *879.5* ft *Average of 882 and 877 feet (within the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 871.2 ft *Bottom of foundation preparation elevation.*
H_{wall} = 27.9 ft *Total wall height*
B_{wall} = 15.0 ft *Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} = 120 pcf *Unit weight of MSE wall*
q_{load} = **4,810** psf *Pressure at bottom of wall* *Including load from foundation preparation*
q_{net} = **3,773** psf *Net pressure at bottom of wall*
D_w = 0.0 ft *Depth of water table* *(from bearing elevation)*
Overburden = 1,037 psf

	Cohesionless	Cohesive		
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**	
C_v =	500	350		ft^2/yr Coefficient of consolitation
t =	32	days		Time following completion of construction

Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*Total Settlement at Center of Reinforced Soil Mass*					*Total Settlement at Facing of Wall*					*Time Rate of Settlement at Facing of Wall*					
																					I (7)	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*c_v (ft^2/yr)*	*H_{dr} (11) (ft)*	*T_v (12)*	*U (13) (%)*	*$(S_c)_t$ (14) (in)*	*Remaining Settlement (in)*
1	A-4b	G	0.0	3.0	871.2	868.2	3.0	***1.5***	125	1,412	1,225	***1,131***						14	17	35	1.00	3,760	***4,892***	0.05	0.66	0.50	1885	3017	0.04	0.44	500	3	4.87	99.99	0.44	0.00
	A-4b	G	3.0	6.0	868.2	865.2	3.0	***4.5***	125	1,787	1,600	***1,319***						14	16	34	0.94	3,534	***4,853***	0.05	0.60	0.49	1867	3186	0.03	0.41	500	6	1.22	96.00	0.39	0.02
	A-4b	G	6.0	9.0	865.2	862.2	3.0	***7.5***	125	2,162	1,975	***1,507***						14	15	33	0.82	3,087	***4,594***	0.04	0.53	0.48	1810	3317	0.03	0.38	500	9	0.54	79.00	0.30	0.08
	A-4b	G	9.0	13.0	862.2	858.2	4.0	***11.0***	125	2,662	2,412	***1,726***						14	15	32	0.68	2,555	***4,281***	0.05	0.59	0.45	1699	3425	0.04	0.45	500	13	0.26	57.00	0.26	0.19
2	A-4a	C	13.0	20.0	858.2	851.2	7.0	***16.5***	125	3,537	3,100	***2,070***	9,000	25	0.03	0.007	0.36				0.51	1,929	***4,000***	0.01	0.12	0.39	1484	3554	0.01	0.10	350	20	0.08	31.00	0.03	0.07
	A-4a	C	20.0	25.0	851.2	846.2	5.0	***22.5***	125	4,162	3,850	***2,446***	9,000	25	0.03	0.007	0.36				0.40	1,493	***3,939***	0.01	0.06	0.33	1260	3706	0.00	0.06	350	14	0.16	45.00	0.03	0.03
	A-4a	C	25.0	29.0	846.2	842.2	4.0	***27.0***	125	4,662	4,412	***2,728***	9,000	25	0.03	0.007	0.36				0.34	1,270	***3,998***	0.00	0.04	0.30	1119	3846	0.00	0.04	350	9	0.38	68.00	0.03	0.01
3	A-4a	G	29.0	34.0	842.2	837.2	5.0	***31.5***	120	5,262	4,962	***2,997***						50	43	75	0.29	1,103	***4,099***	0.01	0.11	0.27	1000	3997	0.01	0.10	500	5	1.75	99.00	0.10	0.00
4	Rock	R	34.0	40.0	837.2	831.2	6.0	***37.0***	140	6,102	5,682	***3,374***									0.25	948	***4,322***											0.00	
		R	40.0	45.0	831.2	826.2	5.0	***42.5***	150	6,852	6,477	***3,825***									0.22	831	***4,656***											0.00	
		R	45.0	50.0	826.2	821.2	5.0	***47.5***	150	7,602	7,227	***4,263***									0.20	746	***5,010***											0.00	
																						Total Settlement:		***2.72 in***			Total Settlement:		***1.97 in***				Remaining Settlement:		***0.40***	***in***

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$, *Estimate* σ_m *of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab*
2. $C_c = 0.009(LL-10)$; *Ref. Table 6-9, FHWA GEC 5 or from Lab*
3. $C_r = 0.10(C_c)$; *Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab*
4. $e_o = (C_c/1.15)+0.35$; *Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab*
5. $(N1)_{60} = C_n N_{60}$, *where* $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ *ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS*
6. *Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS*
7. *Influence factor for strip loaded footing*
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ *for* $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ *for* $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; *Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)*
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; *Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)*
11. *Length of longest drainage path considered*
12. *Time Factor* $= C_v * t/H_{dr}^2$
13. *Degree of Consolidation*
14. $(S_c)_t$ = *settlement occurred at the particular time*

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -2 (At Fwd Abutment)***

Calculated By: AG Date: 7.7.2025
Checked By: JPS Date: 7.7.2025

Borings: *B-007-0-25 to B-009-0-25 (Overall Profile)*
Subsurface Condition: *Medium Dense A-4b underlain by very stiff to hard A-4a/A-6a extended to bedrock surface*

Existing GSE: 879.5 ft *Average of 882 and 877 feet (within the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 871.2 ft *Bottom of foundation preparation elevation.*
H_{wall} = 27.9 ft *Total wall height*
B_{wall} = 15.0 ft *Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} = 120 pcf *Unit weight of MSE wall*
q_{load} = **4,810** psf *Pressure at bottom of wall* *Including load from foundation preparation*
q_{net} = **3,773** psf *Net pressure at bottom of wall*
D_w = 0.0 ft *Depth of water table* *(from bearing elevation)*
Overburden = 1,037 psf

	Cohesionless	Cohesive		
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**	
C_v =	500	350		ft^2/yr Coefficient of consolitation
t =	68	days		Time following completion of construction

																				Total Settlement at Center of Reinforced Soil Mass					*Total Settlement at Facing of Wall*					*Time Rate of Settlement at Facing of Wall*					
Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*c_v (ft^2/yr)*	*H_{dr} (11) (ft)*	*T_v (12)*	*U (13) (%)*	*$(S_c)_t$ (14) (in)*	*Remaining Settlement (in)*
1	A-4b	G	0.0	3.0	871.2	868.2	3.0	***1.5***	125	1,412	1,225	***1,131***						14	17	35	1.00	3,760	***4,892***	0.05	0.66	0.50	1885	3017	0.04	0.44	500	3	10.35	99.99	0.44	0.00
	A-4b	G	3.0	6.0	868.2	865.2	3.0	***4.5***	125	1,787	1,600	***1,319***						14	16	34	0.94	3,534	***4,853***	0.05	0.60	0.49	1867	3186	0.03	0.41	500	6	2.59	99.99	0.41	0.00
	A-4b	G	6.0	9.0	865.2	862.2	3.0	***7.5***	125	2,162	1,975	***1,507***						14	15	33	0.82	3,087	***4,594***	0.04	0.53	0.48	1810	3317	0.03	0.38	500	9	1.15	95.0	0.36	0.02
	A-4b	G	9.0	13.0	862.2	858.2	4.0	***11.0***	125	2,662	2,412	***1,726***						14	15	32	0.68	2,555	***4,281***	0.05	0.59	0.45	1699	3425	0.04	0.45	500	13	0.55	79.0	0.35	0.09
2	A-4a	C	13.0	20.0	858.2	851.2	7.0	***16.5***	125	3,537	3,100	***2,070***	9,000	25	0.03	0.007	0.36				0.51	1,929	***4,000***	0.01	0.12	0.39	1484	3554	0.01	0.10	350	20	0.16	46.0	0.05	0.05
	A-4a	C	20.0	25.0	851.2	846.2	5.0	***22.5***	125	4,162	3,850	***2,446***	9,000	25	0.03	0.007	0.36				0.40	1,493	***3,939***	0.01	0.06	0.33	1260	3706	0.00	0.06	350	14	0.33	64.0	0.04	0.02
	A-4a	C	25.0	29.0	846.2	842.2	4.0	***27.0***	125	4,662	4,412	***2,728***	9,000	25	0.03	0.007	0.36				0.34	1,270	***3,998***	0.00	0.04	0.30	1119	3846	0.00	0.04	350	9	0.81	89.0	0.03	0.00
3	A-4a	G	29.0	34.0	842.2	837.2	5.0	***31.5***	120	5,262	4,962	***2,997***						50	43	75	0.29	1,103	***4,099***	0.01	0.11	0.27	1000	3997	0.01	0.10	500	5	3.73	99.99	0.10	0.00
4	Rock	R	34.0	40.0	837.2	831.2	6.0	***37.0***	140	6,102	5,682	***3,374***									0.25	948	***4,322***											0.00	
		R	40.0	45.0	831.2	826.2	5.0	***42.5***	150	6,852	6,477	***3,825***									0.22	831	***4,656***											0.00	
		R	45.0	50.0	826.2	821.2	5.0	***47.5***	150	7,602	7,227	***4,263***									0.20	746	***5,010***											0.00	

Total Settlement: ***2.72 in*** Total Settlement: ***1.97 in*** Remaining Settlement: ***0.19*** ***in***

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$, *Estimate σ_m of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab*
2. $C_c = 0.009(LL-10)$; *Ref. Table 6-9, FHWA GEC 5 or from Lab*
3. $C_r = 0.10(C_c)$; *Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab*
4. $e_o = (C_c/1.15)+0.35$; *Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab*
5. $(N1)_{60} = C_N N_{60}$, *where* $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ *ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS*
6. *Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS*
7. *Influence factor for strip loaded footing*
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ *for* $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ *for* $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ *for* $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; *Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)*
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; *Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)*
11. *Length of longest drainage path considered*
12. *Time Factor* = $C_v * t/H_{dr}^2$
13. *Degree of Consolidation*
14. $(S_c)_t$ = *settlement occurred at the particular time*

Note: Remaining settlement is 10%

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -2 (At Fwd Abutment)_For Differential Settlement Calculation***

Calculated By: AG Date: 7.7.2025
Checked By: JPS Date: 7.7.2025

Borings: *B-007-0-25*
Subsurface Condition: *Medium Dense A-4b underlain by very stiff to hard A-4a/A-6a extended to bedrock surface*

Existing GSE: *879.5* *ft* *Average of 882 and 877 feet (within the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 871.2 ft *Bottom of foundation preparation elevation.*
H_{wall} = 27.9 ft *Total wall height*
B_{wall} = 15.0 ft *Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} = 120 pcf *Unit weight of MSE wall*
q_{load} = **4,810** psf *Pressure at bottom of wall* *Including load from foundation preparation*
q_{net} = **3,773** psf *Net pressure at bottom of wall*
D_w = 0.0 ft *Depth of water table* *(from bearing elevation)*
Overburden = 1,037 psf

	Cohesionless	Cohesive		
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**	
C_v =	500	350		ft^2/yr Coefficient of consolitation
t =	67	days		Time following completion of construction

Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*Total Settlement at Center of Reinforced Soil Mass*					*Total Settlement at Facing of Wall*				
																						I (7)	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*
1	A-4b	G	0.0	8.4	871.2	862.8	8.4	***4.2***	120	2,046	1,542	***1,279***						14	16	34	0.95	3,570	***4,850***	0.14	1.72	0.50	1870	3150	0.10	1.16
2	A-6a	C	8.4	13.6	862.8	857.6	5.2	***11.0***	120	2,670	2,358	***1,671***	9,000		0.03	0.007	0.36				0.68	2,555	***4,226***	0.01	0.13	0.45	1699	3370	0.01	0.10
3	A-4a	C	13.6	17.2	857.6	854.0	3.6	***15.4***	125	3,120	2,895	***1,934***	9,000		0.03	0.007	0.36				0.54	2,034	***3,967***	0.01	0.07	0.40	1528	3461	0.00	0.06
4	A-4a	C	17.2	18.6	854.0	852.6	1.4	***17.9***	125	3,295	3,207	***2,090***	9,000		0.03	0.007	0.36				0.48	1,809	***3,899***	0.00	0.02	0.38	1429	3519	0.00	0.02
5	A-6a	C	18.6	29.2	852.6	842.0	10.6	***23.9***	125	4,620	3,957	***2,466***	9,000		0.03	0.007	0.36				0.38	1,416	***3,882***	0.01	0.13	0.32	1214	3679	0.01	0.11
6	A-6a	C	29.2	32.0	842.0	839.2	2.8	***30.6***	125	4,969	4,795	***2,885***	9,000		0.03	0.007	0.36				0.30	1,133	***4,018***	0.00	0.02	0.27	1022	3907	0.00	0.02
7	Rock	R	32.0	36.2	839.2	835.0	4.2	***34.1***	140	5,558	5,264	***3,136***																		
																						Total Settlement:			***2.09 in***		Total Settlement:			***1.47 in***

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5 or from Lab
3. $C_r = 0.10(C_c)$; Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for strip loaded footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
11. Length of longest drainage path considered
12. Time Factor = $C_v * t/H_{dr}^2$
13. Degree of Consolidation
14. $(S_c)_t$ = settlement occurred at the particular time

Project: ***WYA-23-3.47 Interchange Improvements***
Project No.: ***W-25-026***
Structure.: ***MSE Wall -2 (At Fwd Abutment)_For Differential Settlement Calculation***

Calculated By: AG Date: 7.7.2025
Checked By: JPS Date: 7.7.2025

Borings: *B-009-0-25 (information of B-008-0-25 was used below 848.8 feet)*
Subsurface Condition: *Medium Dense A-4b underlain by very stiff to hard A-4a/A-6a extended to bedrock surface*
Existing GSE: 879.5 *ft* *Average of 882 and 877 feet (within the footprint of MSE existing surface elev.)*
Prop. Bearing Elev: 871.2 ft *Bottom of foundation preparation elevation.*

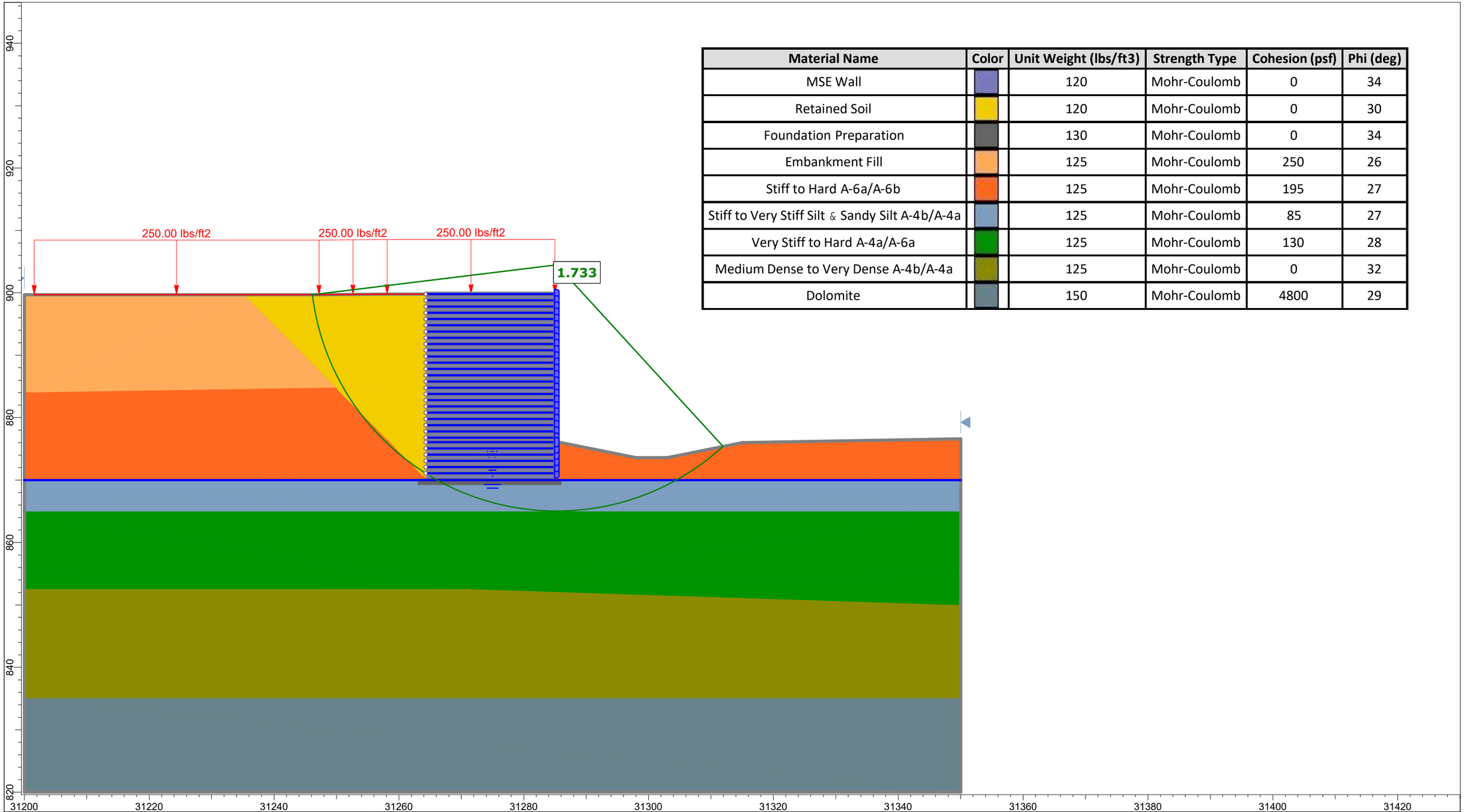
H_{wall} =	27.9	ft	*Total wall height*
B_{wall} =	15.0	ft	*Width of wall* *(Influence factors are calculated similar to wall foundation)*
γ_{wall} =	120	pcf	*Unit weight of MSE wall*
q_{load} =	**4,810**	psf	*Pressure at bottom of wall* *Including load from foundation preparation*
q_{net} =	**3,773**	psf	*Net pressure at bottom of wall*
D_w =	0.0	ft	*Depth of water table* *(from bearing elevation)*
Overburden =	1,037	psf	

	Cohesionless	Cohesive			
Soil Type	**A-4a/ A-4b**	**A-4a/ A-4b**	**A-6a/ A-6b**		
C_v =	500	350		ft^2/yr	Coefficient of consolitation
t =	67	days			Time following completion of construction

Layer	*Soil Class.*	*Soil Type*	*Layer Depth (ft)*		*Layer Elevation (ft msl)*		*Layer Thickness H (ft)*	*Depth to Midpoint (ft)*	*γ (pcf)*	*σ_{vo} Bottom (psf)*	*σ_{vo} Midpoint (psf)*	*σ_{vo}' Midpoint (psf)*	*σ_p' (1) (psf)*	*LL*	*C_c (2)*	*C_r (3)*	*e_o (4)*	*N_{60}*	*$(N1)_{60}$ (5)*	*C' (6)*	*Total Settlement at Center of Reinforced Soil Mass*					*Total Settlement at Facing of Wall*				
																						I (7)	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*	*I (7)*	*$\Delta\sigma_v$ (8) (psf)*	*σ_{vf}' Midpoint (psf)*	*S_c (9,10) (ft)*	*S_c (in)*
1	A-4a	G	0.0	1.9	871.2	869.3	1.9	***1.0***	122	1,269	1,153	***1,094***						19	23	44	1.00	3,769	***4,863***	0.03	0.34	0.50	1886	2980	0.02	0.23
2	A-4b	G	1.9	8.9	869.3	862.3	7.0	***5.4***	122	2,123	1,696	***1,359***						15	17	35	0.90	3,413	***4,772***	0.11	1.30	0.49	1854	3213	0.07	0.89
3	A-6a	C	8.9	16.2	862.3	855.0	7.3	***12.6***	125	3,036	2,580	***1,796***	9,000	32	0.03	0.007	0.36				0.62	2,351	***4,148***	0.01	0.16	0.43	1641	3437	0.01	0.13
4	A-6a	C	16.2	21.4	855.0	849.8	5.2	***18.8***	125	3,686	3,361	***2,188***	9,000	32	0.03	0.007	0.36				0.46	1,738	***3,926***	0.01	0.08	0.37	1394	3582	0.01	0.07
5	A-4a	G	21.4	27.2	849.8	844.0	5.8	***24.3***	125	4,411	4,048	***2,532***						32	30	54	0.37	1,396	***3,928***	0.02	0.25	0.32	1201	3733	0.02	0.22
	A-4a	G	27.2	32.0	844.0	839.2	4.8	***29.6***	125	5,011	4,711	***2,864***						32	28	52	0.31	1,168	***4,032***	0.01	0.16	0.28	1047	3911	0.01	0.15
6	Rock	R	32.0	36.2	839.2	835.0	4.2	***34.1***	140	5,599	5,305	***3,177***																		
																						Total Settlement:		***2.29 in***			Total Settlement:		***1.68 in***	

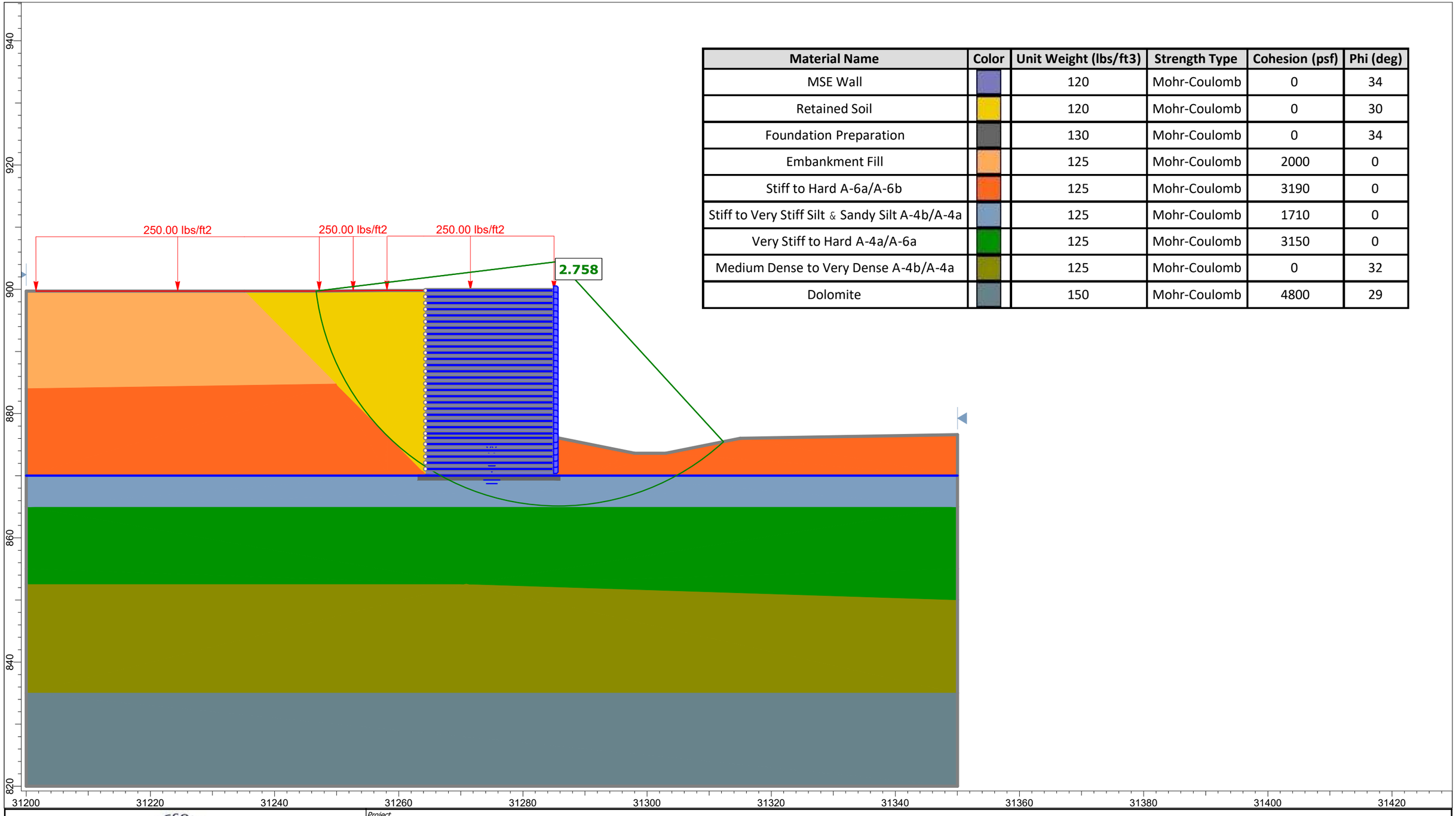
1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; *Estimate σ_m of 3,000 psf for slightly to moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or from Lab*
2. $C_c = 0.009(LL-10)$; *Ref. Table 6-9, FHWA GEC 5 or from Lab*
3. $C_r = 0.10(C_c)$; *Ref. Section 5.4.2.5 of FHWA GEC 5 or from Lab*
4. $e_o = (C_c/1.15)+0.35$; *Ref. Table 8-2, Holtz and Kovacs 1981 or from Lab*
5. $(N1)_{60} = C_n N_{60}$, *where* $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ *ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS*
6. *Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS*
7. *Influence factor for strip loaded footing*
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ *for* $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ *for* $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ *for* $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; *Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)*
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; *Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)*
11. *Length of longest drainage path considered*
12. *Time Factor* = $C_v t/H_{dr}^2$
13. *Degree of Consolidation*
14. $(S_c)_t$ = *settlement occurred at the particular time*

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Wall		120	Mohr-Coulomb	0	34
Retained Soil		120	Mohr-Coulomb	0	30
Foundation Preparation		130	Mohr-Coulomb	0	34
Embankment Fill		125	Mohr-Coulomb	250	26
Stiff to Hard A-6a/A-6b		125	Mohr-Coulomb	195	27
Stiff to Very Stiff Silt & Sandy Silt A-4b/A-4a		125	Mohr-Coulomb	85	27
Very Stiff to Hard A-4a/A-6a		125	Mohr-Coulomb	130	28
Medium Dense to Very Dense A-4b/A-4a		125	Mohr-Coulomb	0	32
Dolomite		150	Mohr-Coulomb	4800	29



SLIDEINTERPRET 9.024

Project	WYA-23-3.47 Interchange Improvements		
Analysis Description	MSE Wall at Rear Abt (MSE Wall-1) Global Stability Analysis - Drained - Borings B-003-0-25 to B-005-0-25 - Spencer Method - Reinforcement = 0.7H		
Drawn By	AG/JPS	*Company*	Resource International Inc.
Date	7/7/2025	*File Name*	1B_Stability MSE-1 - Drained.slmd

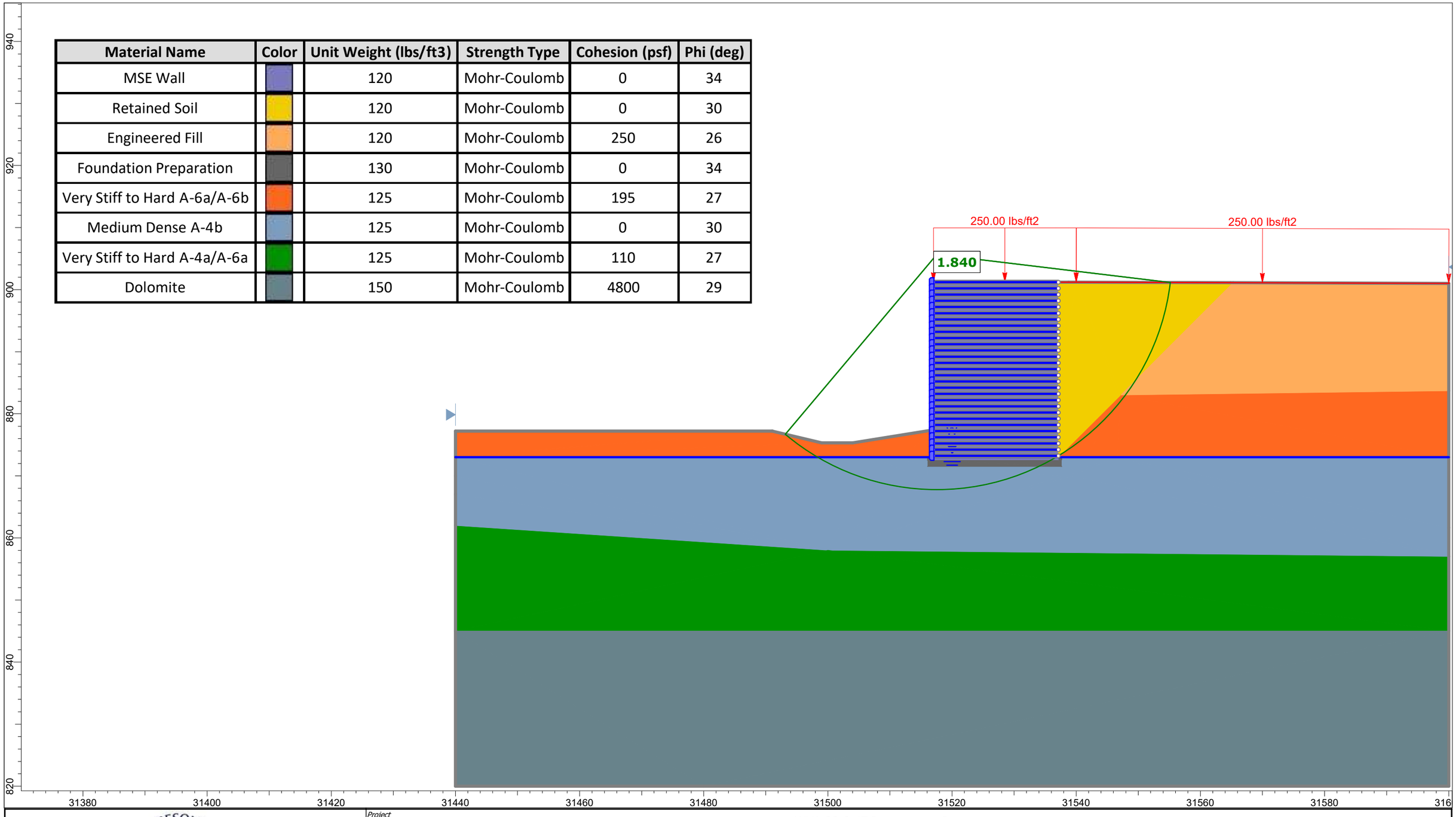


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Wall		120	Mohr-Coulomb	0	34
Retained Soil		120	Mohr-Coulomb	0	30
Foundation Preparation		130	Mohr-Coulomb	0	34
Embankment Fill		125	Mohr-Coulomb	2000	0
Stiff to Hard A-6a/A-6b		125	Mohr-Coulomb	3190	0
Stiff to Very Stiff Silt & Sandy Silt A-4b/A-4a		125	Mohr-Coulomb	1710	0
Very Stiff to Hard A-4a/A-6a		125	Mohr-Coulomb	3150	0
Medium Dense to Very Dense A-4b/A-4a		125	Mohr-Coulomb	0	32
Dolomite		150	Mohr-Coulomb	4800	29

SLIDEINTERPRET 9.024

Project	WYA-23-3.47 Interchange Improvements		
Analysis Description	MSE Wall at Rear Abt (MSE Wall-1) Global Stability Analysis - Undrained - Borings B-003-0-25 to B-005-0-25 - Spencer Method - Reinforcement = 0.7H		
Drawn By	AG/JPS	*Company*	Resource International Inc.
Date	9/19/2025	*File Name*	1B_Stability MSE-1 - Undrained.slmd

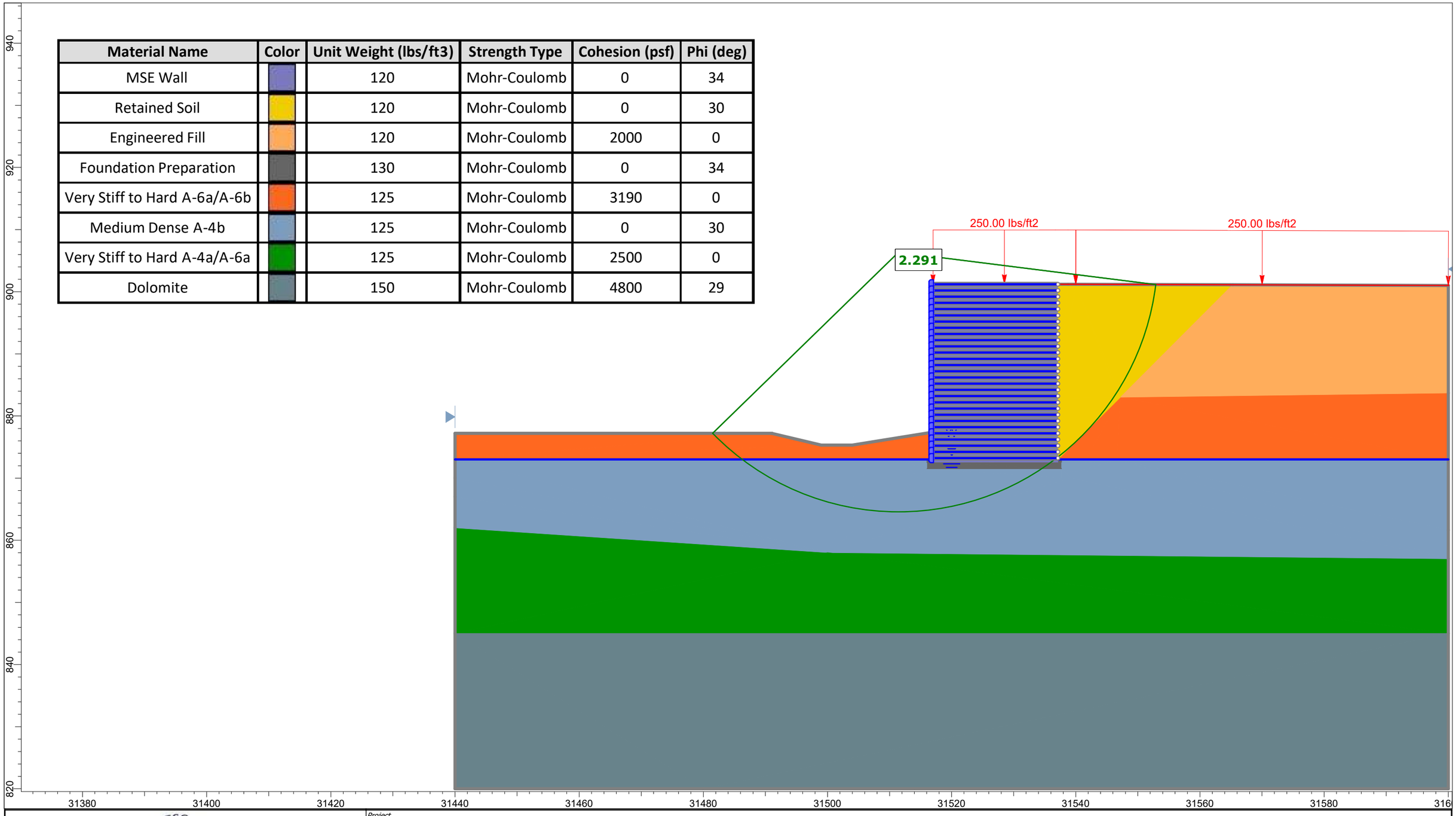
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Wall		120	Mohr-Coulomb	0	34
Retained Soil		120	Mohr-Coulomb	0	30
Engineered Fill		120	Mohr-Coulomb	250	26
Foundation Preparation		130	Mohr-Coulomb	0	34
Very Stiff to Hard A-6a/A-6b		125	Mohr-Coulomb	195	27
Medium Dense A-4b		125	Mohr-Coulomb	0	30
Very Stiff to Hard A-4a/A-6a		125	Mohr-Coulomb	110	27
Dolomite		150	Mohr-Coulomb	4800	29



SLIDEINTERPRET 9.024

Project	WYA-23-3.47 Interchange Improvements
Analysis Description	MSE Wall at Fwd Abt (MSE Wall-2) Global Stability Analysis - Drained - Borings B-007-0-25 to B-009-0-25 - Spencer Method - Reinforcement = 0.7H
Drawn By	AG/JPS
Company	Resource International Inc.
Date	9/19/2025
File Name	1A_Stability MSE-2 - Drained.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Wall		120	Mohr-Coulomb	0	34
Retained Soil		120	Mohr-Coulomb	0	30
Engineered Fill		120	Mohr-Coulomb	2000	0
Foundation Preparation		130	Mohr-Coulomb	0	34
Very Stiff to Hard A-6a/A-6b		125	Mohr-Coulomb	3190	0
Medium Dense A-4b		125	Mohr-Coulomb	0	30
Very Stiff to Hard A-4a/A-6a		125	Mohr-Coulomb	2500	0
Dolomite		150	Mohr-Coulomb	4800	29



SLIDEINTERPRET 9.024

Project	WYA-23-3.47 Interchange Improvements		
Analysis Description	MSE Wall at Fwd Abt (MSE Wall-2) Global Stability Analysis - Undrained - Borings B-007-0-25 to B-009-0-25 - Spencer Method - Reinforcement = 0.7H		
Drawn By	AG/JPS	*Company*	Resource International Inc.
Date	9/19/2025	*File Name*	1A_Stability MSE-2 - Undrained.slmd

APPENDIX XI

EMBANKMENT SETTLEMENT CALCULATIONS

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 316+00 SR 294 (Boring B-010-0-25)

Calculated By: AK Date: 8/28/2025

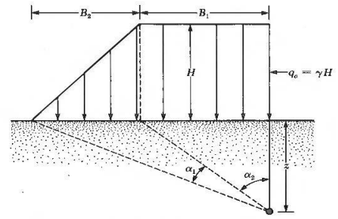
Checked By: AG/JPS Date: 9.1.2025

Ex. Ground Surface Elevation @ Sta. 316+00 = 883.3 ft

Proposed Ground Surface Elevation @ Sta. 316+00 = 900.8 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	17.5	ft	Proposed embankment height above existing grade
B_1 =	25.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	45.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	12.3	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	2,188	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	625	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-6a	C	0.0	5.0	883.3	878.3	5.0	2.5	120	600	300	300	9,240	28	0.058	0.023	0.424				0.064	1.471	1.000	2,187	2,487	0.074	0.890	300	22.5	1.015	93.000	0.828	0.062
	A-6a	C	5.0	10.0	878.3	873.3	5.0	7.5	125	1,225	913	913	9,240	28	0.058	0.023	0.424				0.185	1.279	0.997	2,182	3,094	0.043	0.514	300	27.5	0.679	85.000	0.437	0.077
	A-6a	C	10.0	15.0	873.3	868.3	5.0	12.5	122	1,835	1,530	1,518	9,240	28	0.058	0.023	0.424				0.287	1.107	0.989	2,163	3,681	0.031	0.373	300	32.5	0.486	76.000	0.283	0.090
	A-6a	C	15.0	25.0	868.3	858.3	10.0	20.0	122	3,055	2,445	1,965	9,240	28	0.058	0.023	0.424				0.396	0.896	0.963	2,107	4,071	0.051	0.613	300	25.0	0.822	89.000	0.546	0.067
	A-6a	C	25.0	35.0	858.3	848.3	10.0	30.0	125	4,305	3,680	2,576	9,240	28	0.058	0.023	0.424				0.471	0.695	0.909	1,988	4,564	0.040	0.482	300	20.0	1.284	97.000	0.467	0.014
	A-6a	C	35.0	40.0	848.3	843.3	5.0	37.5	125	4,930	4,618	3,045	9,240	28	0.058	0.023	0.424				0.491	0.588	0.861	1,882	4,927	0.017	0.203	300	5.0	20.548	99.990	0.203	0.000
2	Rock	R	40.0	50.0	843.3	833.3	10.0	45.0	140	6,330	5,630	3,590																					

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation:	**3.07**
Total Remaining Settlement after 625 days =	**0.31**

Time to occur 90% settlement =	625	days

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 492+00 Ramp A (Boring B-019-0-25)

Calculated By: AK Date: 8/28/2025

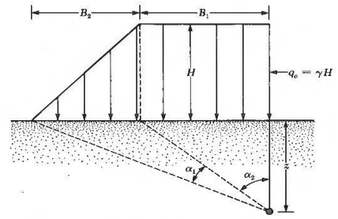
Checked By: AG/JPS Date: 9.1.2025

Ex. Ground Surface Elevation @ Sta. 492+00 = 881.9 ft

Proposed Ground Surface Elevation @ Sta. 492+00 = 890.7 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	8.8	ft	Proposed embankment height above existing grade
B_1 =	20.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	25.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	11.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,100	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	550	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-7-6	C	0.0	5.0	881.9	876.9	5.0	2.5	122	610	305	305	4,305	62	0.468	0.035	0.757				0.069	1.446	1.000	1,100	1,405	0.066	0.795	125	13.8	0.989	93.000	0.739	0.056
	A-7-6	C	5.0	11.0	876.9	870.9	6.0	8.0	125	1,360	985	985	4,985	62	0.468	0.035	0.757				0.205	1.190	0.992	1,091	2,076	0.039	0.466	125	19.8	0.480	75.000	0.349	0.116
	A-4b	G	11.0	15.0	870.9	866.9	4.0	13.0	125	1,860	1,610	1,485	5,485					12	13	30	0.295	0.994	0.971	1,068	2,554	0.032	0.381	500	23.8	1.330	97.000	0.369	0.011
	A-6a	C	15.0	20.0	866.9	861.9	5.0	17.5	125	2,485	2,173	1,767	5,767	28	0.058	0.023	0.424				0.348	0.852	0.941	1,035	2,802	0.016	0.194	300	25.0	0.723	86.000	0.167	0.027
	A-6a	C	20.0	30.0	861.9	851.9	10.0	25.0	125	3,735	3,110	2,236	6,236	28	0.058	0.023	0.424				0.389	0.675	0.875	963	3,199	0.025	0.301	300	20.0	1.130	95.000	0.286	0.015
	A-6a	C	30.0	40.0	851.9	841.9	10.0	35.0	125	4,985	4,360	2,862	6,862	28	0.058	0.023	0.424				0.391	0.519	0.778	856	3,718	0.018	0.220	300	15.0	2.009	99.990	0.220	0.000
2	Rock	R	40.0	50.0	841.9	831.9	10.0	45.0	140	6,385	5,685	3,563																					

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **2.36**

Total Remaining Settlement after 550 days = **0.23**

Time to occur 90% settlement = 550 days

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 596+50 Ramp B (Boring B-021-0-25)

Calculated By: AK Date: 8/28/2025

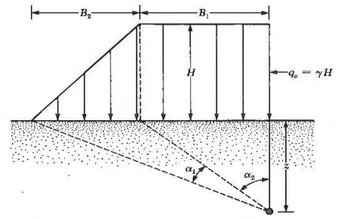
Checked By: AG/JPS Date: 9.1.2025

Ex. Ground Surface Elevation @ Sta. 596+50 = 864.2 ft

Proposed Ground Surface Elevation @ Sta. 596+50 = 873.2 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	9.0	ft	Proposed embankment height above existing grade
B_1 =	18.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	25.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	15.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,125	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	220	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-6a	C	0.0	4.0	864.2	860.2	4.0	2.0	120	480	240	240	4,240	25	0.058	0.023	0.424				0.064	1.460	1.000	1,125	1,365	0.049	0.585	300	13.0	1.070	94.000	0.550	0.035
	A-6a	C	4.0	8.0	860.2	856.2	4.0	6.0	122	968	724	724	4,724	25	0.058	0.023	0.424				0.183	1.249	0.996	1,120	1,844	0.026	0.315	300	17.0	0.626	83.000	0.261	0.054
2	A-4a	C	8.0	13.0	856.2	851.2	5.0	10.5	125	1,593	1,281	1,281	5,281	22	0.030	0.007	0.360				0.289	1.043	0.980	1,102	2,383	0.007	0.083	350	20.0	0.527	78.000	0.065	0.018
	A-4a	C	13.0	18.0	851.2	846.2	5.0	15.5	125	2,218	1,906	1,874	5,874	22	0.030	0.007	0.360				0.365	0.860	0.947	1,065	2,940	0.005	0.060	350	15.0	0.938	92.000	0.056	0.005
	A-4a	C	18.0	23.0	846.2	841.2	5.0	20.5	125	2,843	2,531	2,187	6,187	22	0.030	0.007	0.360				0.405	0.721	0.903	1,015	3,203	0.004	0.051	350	10.0	2.110	99.990	0.051	0.000
	A-4a	C	23.0	28.0	841.2	836.2	5.0	25.5	125	3,468	3,156	2,500	6,500	22	0.030	0.007	0.360				0.421	0.615	0.852	959	3,459	0.004	0.044	350	5.0	8.438	99.990	0.044	0.000
3	Rock	R	28.0	35.0	836.2	829.2	7.0	31.5	140	4,448	3,958	2,928																						

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation:	**1.14**
Total Remaining Settlement after 220 days =	**0.11**

Time to occur 90% settlement =	220	days

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 685+00 Ramp C (Boring B-026-0-25)

Calculated By: AK Date: 8/28/2025

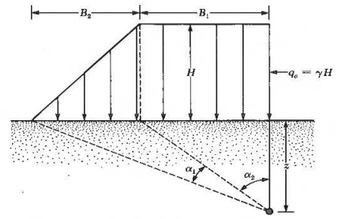
Checked By: AG/JPS Date: 9.1.2025

Ex. Ground Surface Elevation @ Sta. 685+00 = 881.6 ft

Proposed Ground Surface Elevation @ Sta. 685+00 = 895.7 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	14.1	ft	Proposed embankment height above existing grade
B_1 =	20.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	40.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	11.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,763	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	715	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-7-6	C	0.0	5.0	881.6	876.6	5.0	2.5	120	600	300	300	4,300	41	0.279	0.021	0.593				0.083	1.446	1.000	1,762	2,062	0.055	0.660	125	19.1	0.671	85.000	0.561	0.099
	A-7-6	C	5.0	10.5	876.6	871.1	5.5	7.8	122	1,271	936	936	4,936	41	0.279	0.021	0.593				0.241	1.201	0.995	1,754	2,689	0.033	0.398	125	24.1	0.422	71.000	0.282	0.115
2	A-4a	G	10.5	13.0	871.1	868.6	2.5	11.8	122	1,576	1,424	1,377	5,377					12	14	30	0.338	1.040	0.984	1,735	3,112	0.029	0.353	500	19.5	2.576	100.000	0.353	0.000
3	A-4b	G	13.0	15.5	868.6	866.1	2.5	14.3	122	1,881	1,729	1,526	5,526					13	14	31	0.386	0.952	0.974	1,717	3,243	0.026	0.315	500	17.0	3.389	100.000	0.315	0.000
4	A-7-6	C	15.5	22.0	866.1	859.6	6.5	18.8	122	2,674	2,278	1,794	5,794	41	0.279	0.021	0.593				0.450	0.818	0.951	1,675	3,469	0.024	0.294	125	14.5	1.165	95.000	0.279	0.015
	A-7-6	C	22.0	30.0	859.6	851.6	8.0	26.0	122	3,650	3,162	2,226	6,226	41	0.279	0.021	0.593				0.506	0.656	0.901	1,588	3,814	0.025	0.295	125	8.0	3.826	99.990	0.295	0.000
5	Rock	R	30.0	35.0	851.6	846.6	5.0	32.5	140	4,350	4,000	2,658																					

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **2.31**

Total Remaining Settlement after 715 days = **0.23**

Time to occur 90% settlement =	715	days

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 784+50 Ramp D (Boring B-027-0-25)

Calculated By: AK Date: 8/28/2025

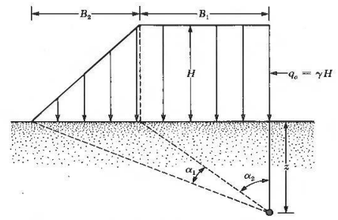
Checked By: AG/JPS Date: 9.1.2025

Ex. Ground Surface Elevation @ Sta. 784+50 = 883.8 ft

Proposed Ground Surface Elevation @ Sta. 784+50= 895.9 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	12.1	ft	Proposed embankment height above existing grade
B_1 =	20.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	40.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	13.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,513	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	535	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-7-6	C	0.0	3.0	883.8	880.8	3.0	1.5	120	360	180	180	4,180	47	0.333	0.025	0.640				0.050	1.496	1.000	1,512	1,692	0.044	0.534	125	15.1	0.804	89.000	0.475	0.059
2	A-6a	C	3.0	8.0	880.8	875.8	5.0	5.5	125	985	673	673	4,673	30	0.058	0.023	0.424				0.177	1.302	0.998	1,510	2,182	0.041	0.495	300	20.1	1.088	94.000	0.466	0.030
	A-6a	C	8.0	13.0	875.8	870.8	5.0	10.5	125	1,610	1,298	1,298	5,298	30	0.058	0.023	0.424				0.310	1.087	0.988	1,495	2,793	0.027	0.323	300	25.1	0.698	86.000	0.277	0.045
3	A-7-6	C	13.0	15.5	870.8	868.3	2.5	14.3	120	1,910	1,760	1,682	5,682	47	0.333	0.025	0.640				0.386	0.952	0.974	1,474	3,156	0.010	0.125	125	27.6	0.241	55.000	0.069	0.056
4	A-4a	G	15.5	18.0	868.3	865.8	2.5	16.8	120	2,210	2,060	1,826	5,826					7	7	21	0.425	0.874	0.962	1,455	3,281	0.031	0.368	500	24.5	1.221	96.000	0.353	0.015
5	A-6b	C	18.0	25.0	865.8	858.8	7.0	21.5	120	3,050	2,630	2,100	6,100	38	0.252	0.019	0.569				0.477	0.749	0.933	1,411	3,511	0.019	0.226	250	22.0	0.757	87.000	0.197	0.029
	A-6b	C	25.0	30.0	858.8	853.8	5.0	27.5	120	3,650	3,350	2,445	6,445	38	0.252	0.019	0.569				0.512	0.629	0.889	1,345	3,791	0.011	0.138	250	15.0	1.629	99.000	0.136	0.001
	A-6b	C	30.0	40.0	853.8	843.8	10.0	35.0	120	4,850	4,250	2,877	6,877	38	0.252	0.019	0.569				0.524	0.519	0.830	1,256	4,133	0.019	0.227	250	10.0	3.664	99.990	0.227	0.000
6	Rock	R	40.0	45.0	843.8	838.8	5.0	42.5	140	5,550	5,200	3,359	7,359																					

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 W_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77/\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **2.4**

Total Remaining Settlement after 535 days = **0.24**

Time to occur 90% settlement = 535 days

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 316+00 SR 294 (Boring B-010-0-25)

Calculated By: AK Date: 8/28/2025

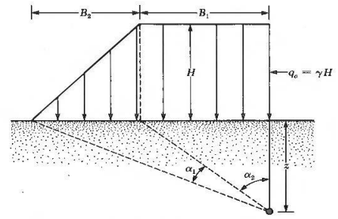
Checked By: AG/JPS Date: 9/1/2025

Ex. Ground Surface Elevation @ Sta. 316+00 = 883.3 ft

Proposed Ground Surface Elevation @ Sta. 316+00 = 900.8 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	17.5	ft	Proposed embankment height above existing grade
B_1 =	25.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	45.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	12.3	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	2,188	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	180	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-6a	C	0.0	5.0	883.3	878.3	5.0	2.5	120	600	300	300	9,240	28	0.058	0.023	0.424				0.064	1.471	1.000	2,187	2,487	0.074	0.890	300	5.0	5.918	99.900	0.889	0.001
	A-6a	C	5.0	10.0	878.3	873.3	5.0	7.5	125	1,225	913	913	9,240	28	0.058	0.023	0.424				0.185	1.279	0.997	2,182	3,094	0.043	0.514	300	10.0	1.479	98.000	0.504	0.010
	A-6a	C	10.0	15.0	873.3	868.3	5.0	12.5	122	1,835	1,530	1,518	9,240	28	0.058	0.023	0.424				0.287	1.107	0.989	2,163	3,681	0.031	0.373	300	15.0	0.658	84.000	0.313	0.060
	A-6a	C	15.0	20.0	868.3	863.3	5.0	17.5	122	2,445	2,140	1,816	9,240	28	0.058	0.023	0.424				0.366	0.960	0.973	2,129	3,945	0.027	0.327	300	20.0	0.370	67.000	0.219	0.108
	A-6a	C	20.0	35.0	863.3	848.3	15.0	27.5	125	4,320	3,383	2,434	9,240	28	0.058	0.023	0.424				0.459	0.738	0.924	2,021	4,455	0.064	0.763	300	15.0	0.658	84.000	0.641	0.122
	A-6a	C	35.0	40.0	848.3	843.3	5.0	37.5	125	4,945	4,633	3,060	9,240	28	0.058	0.023	0.424				0.491	0.588	0.861	1,882	4,942	0.017	0.202	300	5.0	5.918	99.990	0.202	0.000
2	Rock	R	40.0	50.0	843.3	833.3	10.0	45.0	140	6,345	5,645	3,605																						

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **3.07**

Total Remaining Settlement after 180 days = **0.30**

Note: First layer of fill is modeled as granular layer for drainage purposes

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 492+00 Ramp A (Boring B-019-0-25)

Calculated By: AK Date: 8/28/2025

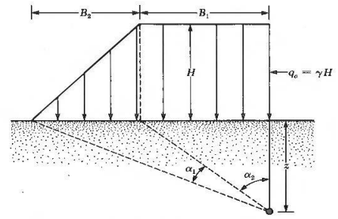
Checked By: AG/JPS Date: 9/1/2025

Ex. Ground Surface Elevation @ Sta. 492+00 = 881.9 ft

Proposed Ground Surface Elevation @ Sta. 492+00 = 890.7 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	8.8	ft	Proposed embankment height above existing grade
B_1 =	20.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	25.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	11.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,100	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	210	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-7-6	C	0.0	5.0	881.9	876.9	5.0	2.5	122	610	305	305	4,305	62	0.468	0.035	0.757				0.069	1.446	1.000	1,100	1,405	0.066	0.795	125	5.0	2.877	99.900	0.794	0.001
	A-7-6	C	5.0	11.0	876.9	870.9	6.0	8.0	125	1,360	985	985	4,985	62	0.468	0.035	0.757				0.205	1.190	0.992	1,091	2,076	0.039	0.466	125	11.0	0.594	81.000	0.377	0.089
	A-4b	G	11.0	15.0	870.9	866.9	4.0	13.0	125	1,860	1,610	1,485	5,485					12	13	30	0.295	0.994	0.971	1,068	2,554	0.032	0.381	500	15.0	1.279	97.000	0.369	0.011
	A-6a	C	15.0	20.0	866.9	861.9	5.0	17.5	125	2,485	2,173	1,767	5,767	28	0.058	0.023	0.424				0.348	0.852	0.941	1,035	2,802	0.016	0.194	300	20.0	0.432	72.000	0.140	0.054
	A-6a	C	20.0	25.0	861.9	856.9	5.0	22.5	125	3,110	2,798	2,080	6,080	28	0.058	0.023	0.424				0.381	0.727	0.899	988	3,068	0.014	0.164	300	20.0	0.432	72.000	0.118	0.046
	A-6a	C	25.0	40.0	856.9	841.9	15.0	32.5	125	4,985	4,048	2,706	6,706	28	0.058	0.023	0.424				0.394	0.552	0.802	883	3,588	0.030	0.356	300	15.0	0.767	88.000	0.314	0.043
2	Rock	R	40.0	50.0	841.9	831.9	10.0	45.0	140	6,385	5,685	3,563																					

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **2.36**

Total Remaining Settlement after 210 days = **0.24**

Note: First layer of fill is modeled as granular layer for drainage purposes

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 596+50 Ramp B (Boring B-021-0-25)

Calculated By: AK Date: 8/28/2025

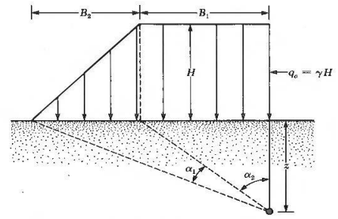
Checked By: AG/JPS Date: 9/1/2025

Ex. Ground Surface Elevation @ Sta. 596+50 = 864.2 ft

Proposed Ground Surface Elevation @ Sta. 596+50 = 873.2 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	9.0	ft	Proposed embankment height above existing grade
B_1 =	18.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	25.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	15.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,125	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	60	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-6a	C	0.0	4.0	864.2	860.2	4.0	2.0	120	480	240	240	4,240	25	0.058	0.023	0.424				0.064	1.460	1.000	1,125	1,365	0.049	0.585	300	4.0	3.082	99.900	0.585	0.001
	A-6a	C	4.0	8.0	860.2	856.2	4.0	6.0	122	968	724	724	4,724	25	0.058	0.023	0.424				0.183	1.249	0.996	1,120	1,844	0.026	0.315	300	8.0	0.771	88.000	0.277	0.038
2	A-4a	C	8.0	13.0	856.2	851.2	5.0	10.5	125	1,593	1,281	1,281	5,281	22	0.030	0.007	0.360				0.289	1.043	0.980	1,102	2,383	0.007	0.083	350	13.0	0.340	65.000	0.054	0.029
	A-4a	C	13.0	18.0	851.2	846.2	5.0	15.5	125	2,218	1,906	1,874	5,874	22	0.030	0.007	0.360				0.365	0.860	0.947	1,065	2,940	0.005	0.060	350	17.0	0.199	50.000	0.030	0.030
	A-4a	C	18.0	23.0	846.2	841.2	5.0	20.5	125	2,843	2,531	2,187	6,187	22	0.030	0.007	0.360				0.405	0.721	0.903	1,015	3,203	0.004	0.051	350	10.0	0.575	80.000	0.041	0.010
	A-4a	C	23.0	28.0	841.2	836.2	5.0	25.5	125	3,468	3,156	2,500	6,500	22	0.030	0.007	0.360				0.421	0.615	0.852	959	3,459	0.004	0.044	350	7.0	1.174	96.000	0.042	0.002
3	Rock	R	28.0	40.0	836.2	824.2	12.0	34.0	140	5,148	4,308	3,122																					

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_0)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_0)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **1.14**

Total Remaining Settlement after 60 days = **0.11**

Note: First layer of fill is modeled as granular layer for drainage purposes

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 685+00 Ramp C (Boring B-026-0-25)

Calculated By: AK Date: 8/28/2025

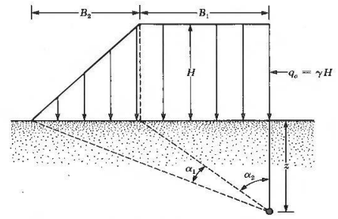
Checked By: AG/JPS Date: 9/1/2025

Ex. Ground Surface Elevation @ Sta. 685+00 = 881.6 ft

Proposed Ground Surface Elevation @ Sta. 685+00 = 895.7 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	14.1	ft	Proposed embankment height above existing grade
B_1 =	20.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	40.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	11.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,763	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	190	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-7-6	C	0.0	5.0	881.6	876.6	5.0	2.5	120	600	300	300	4,300	41	0.279	0.021	0.593				0.083	1.446	1.000	1,762	2,062	0.055	0.660	125	5.0	2.603	99.900	0.659	0.001
	A-7-6	C	5.0	10.5	876.6	871.1	5.5	7.8	122	1,271	936	936	4,936	41	0.279	0.021	0.593				0.241	1.201	0.995	1,754	2,689	0.033	0.398	125	10.5	0.590	81.000	0.322	0.076
2	A-4a	G	10.5	13.0	871.1	868.6	2.5	11.8	122	1,576	1,424	1,377	5,377					12	14	30	0.338	1.040	0.984	1,735	3,112	0.029	0.353	500	13.0	1.540	98.000	0.346	0.007
3	A-4b	G	13.0	15.5	868.6	866.1	2.5	14.3	122	1,881	1,729	1,526	5,526					13	14	31	0.386	0.952	0.974	1,717	3,243	0.026	0.315	500	15.5	1.083	94.000	0.296	0.019
4	A-7-6	C	15.5	22.0	866.1	859.6	6.5	18.8	122	2,674	2,278	1,794	5,794	41	0.279	0.021	0.593				0.450	0.818	0.951	1,675	3,469	0.024	0.294	125	14.5	0.309	62.000	0.182	0.112
	A-7-6	C	22.0	30.0	859.6	851.6	8.0	26.0	122	3,650	3,162	2,226	6,226	41	0.279	0.021	0.593				0.506	0.656	0.901	1,588	3,814	0.025	0.295	125	8.0	1.017	93.000	0.274	0.021
5	Rock	R	30.0	35.0	851.6	846.6	5.0	32.5	140	4,350	4,000	2,658																						

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 w_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **2.31**

Total Remaining Settlement after 190 days = **0.23**

Note: First layer of fill is modeled as granular layer for drainage purposes

W-25-026 WAY-23-3.47

Settlement Analysis - Sta. 784+50 Ramp D (Boring B-027-0-25)

Calculated By: AK Date: 8/28/2025

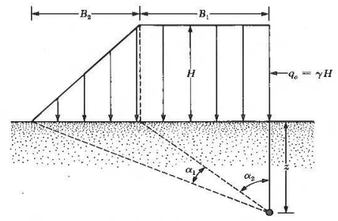
Checked By: AG/JPS Date: 9/1/2025

Ex. Ground Surface Elevation @ Sta. 784+50 = 883.8 ft

Proposed Ground Surface Elevation @ Sta. 784+50= 895.9 ft

γ =	125	pcf	Item 203 Embankment Fill
H =	12.1	ft	Proposed embankment height above existing grade
B_1 =	20.0	ft	Width from centerline to edge of roadway (top of embankment slope)
B_2 =	40.0	ft	Assumed plan width from top to bottom of embankment side slope
D_w =	13.0	ft	Depth below existing ground surface
$q_0 = \gamma H$ =	1,513	psf	Pressure at bottom of embankment

	Cohesive					
Soil Type	**A-4b**	**A-4a**	**A-6a**	**A-6b**	**A-7-6**	
C_v =	350	350	300	250	125	ft^2/yr
t =	195	days				



▼ FIGURE 4.11 Embankment loading

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	Settlement S_c (in)	c_v (ft^2/yr)	H_{dr} (13) (ft)	T_v (14)	U (15) (%)	$(S_c)_t$ (16) (in)	Remaining Settlement (in)
1	A-7-6	C	0.0	3.0	883.8	880.8	3.0	1.5	125	375	188	188	4,188	47	0.333	0.025	0.640				0.050	1.496	1.000	1,512	1,700	0.044	0.525	125	3.0	7.420	99.900	0.525	0.001
2	A-6a	C	3.0	8.0	880.8	875.8	5.0	5.5	125	1,000	688	688	4,688	30	0.058	0.023	0.424				0.177	1.302	0.998	1,510	2,197	0.041	0.489	300	8.0	2.504	99.900	0.489	0.000
	A-6a	C	8.0	13.0	875.8	870.8	5.0	10.5	125	1,625	1,313	1,313	5,313	30	0.058	0.023	0.424				0.310	1.087	0.988	1,495	2,808	0.027	0.320	300	13.0	0.948	92.000	0.294	0.026
3	A-7-6	C	13.0	15.5	870.8	868.3	2.5	14.3	120	1,925	1,775	1,697	5,697	47	0.333	0.025	0.640				0.386	0.952	0.974	1,474	3,171	0.010	0.124	125	15.5	0.278	59.000	0.073	0.051
4	A-4a	G	15.5	18.0	868.3	865.8	2.5	16.8	120	2,225	2,075	1,841	5,841					7	7	21	0.425	0.874	0.962	1,455	3,296	0.031	0.366	500	18.0	0.824	89.000	0.326	0.040
5	A-6b	C	18.0	25.0	865.8	858.8	7.0	21.5	120	3,065	2,645	2,115	6,115	38	0.252	0.019	0.569				0.477	0.749	0.933	1,411	3,526	0.019	0.225	250	22.0	0.276	59.000	0.133	0.092
	A-6b	C	25.0	30.0	858.8	853.8	5.0	27.5	120	3,665	3,365	2,460	6,460	38	0.252	0.019	0.569				0.512	0.629	0.889	1,345	3,806	0.011	0.137	250	15.0	0.594	81.000	0.111	0.026
	A-6b	C	30.0	40.0	853.8	843.8	10.0	35.0	120	4,865	4,265	2,892	6,892	38	0.252	0.019	0.569				0.524	0.519	0.830	1,256	4,148	0.019	0.226	250	10.0	1.336	97.000	0.220	0.007
6	Rock	R	40.0	45.0	843.8	838.8	5.0	42.5	140	5,565	5,215	3,374	7,374																					

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003 or Lab
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5, or $C_c = 0.0115 W_n$ for Organic Soils or Lab
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5 or Lab
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981 or Lab
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77/\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
13. Length of longest drainage path considered
14. Time Factor = C_v*t/H_{dr}^2
15. Degree of Consolidation
16. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Total Settlement Below Existing Ground Surface Elevation: **2.41**

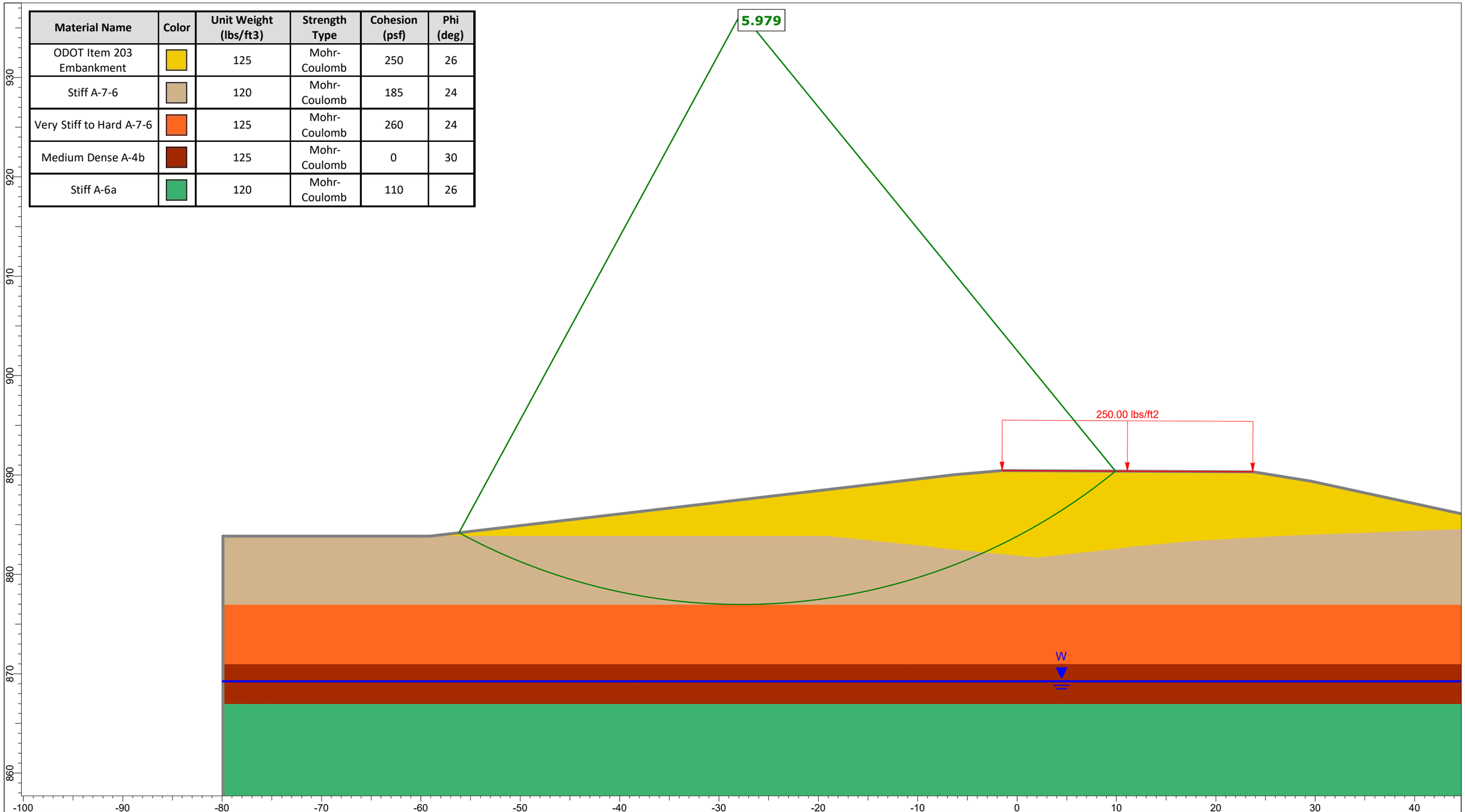
Total Remaining Settlement after 195 days = **0.24**

Note: First layer of fill is modeled as granular layer for drainage purposes

APPENDIX XII

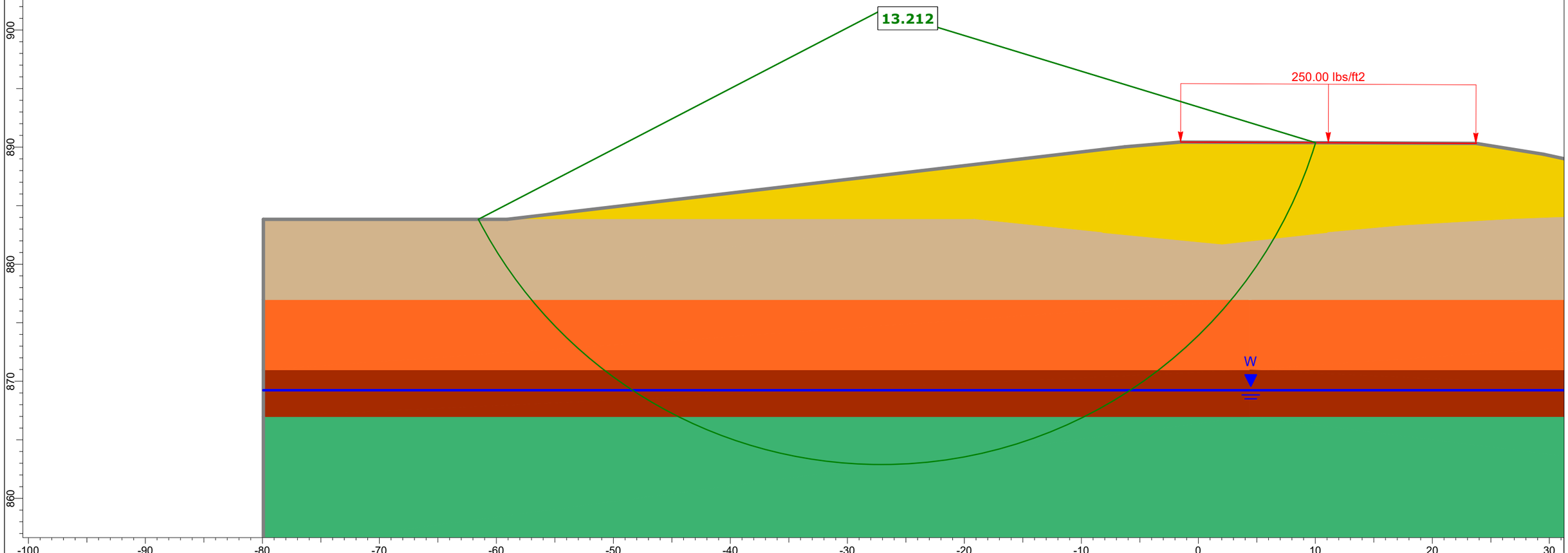
EMBANKMENT GLOBAL STABILITY ANALYSIS

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
ODOT Item 203 Embankment		125	Mohr-Coulomb	250	26
Stiff A-7-6		120	Mohr-Coulomb	185	24
Very Stiff to Hard A-7-6		125	Mohr-Coulomb	260	24
Medium Dense A-4b		125	Mohr-Coulomb	0	30
Stiff A-6a		120	Mohr-Coulomb	110	26



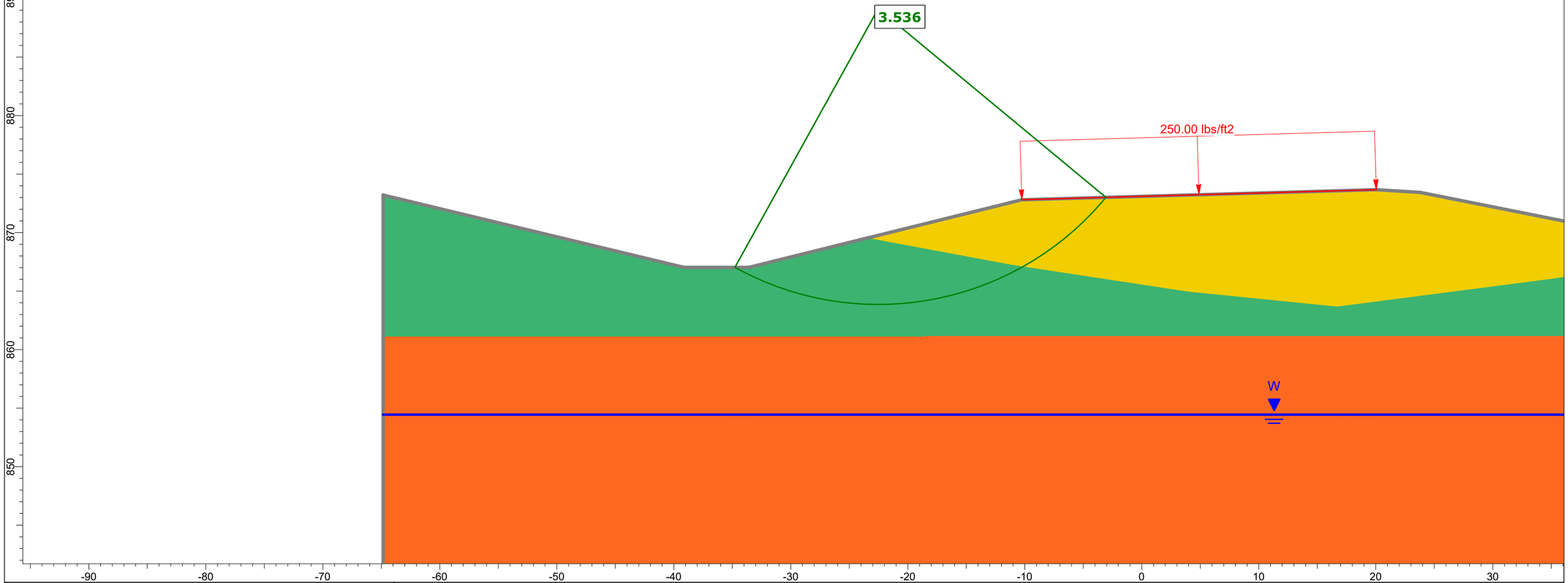
SLIDEINTERPRET 9.024	*Project*	WYA-23-3.47	
	Analysis Description	Global Stability Analysis - Drained- Station 492+00, Ramp A - Embankment Height = 6.3 feet, 7.7H:1V Side Slope -Morgenstern-Price method - Borings B-017-0-25 thru B-019-0-25	
	Drawn By	AK/ AG	*Company* Resource International Inc.
	Date	8/29/2025	*File Name* WYA-23-3.47 - STA. 492+00 - Drained Conditions.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
ODOT Item 203 Embankment		125	Mohr-Coulomb	2000	0
Stiff A-7-6		120	Mohr-Coulomb	1875	0
Very Stiff to Hard A-7-6		125	Mohr-Coulomb	3125	0
Medium Dense A-4b		125	Mohr-Coulomb	0	30
Stiff A-6a		120	Mohr-Coulomb	1500	0



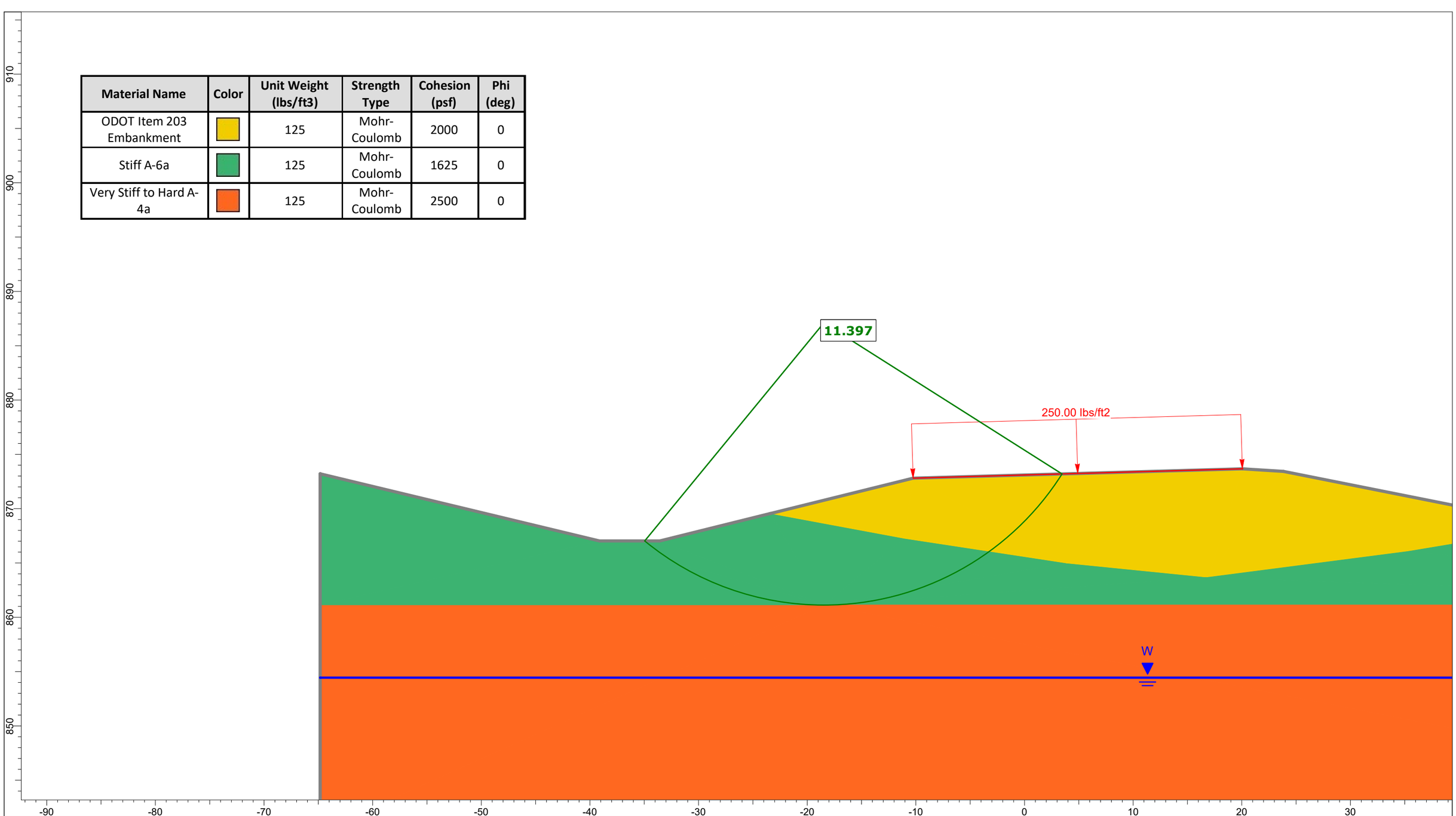
SLIDEINTERPRET 9.024	*Project*	WYA-23-3.47	
	Analysis Description	Global Stability Analysis - Undrained- Station 492+00, Ramp A - Embankment Height = 6.3 feet, 7.7H:1V Side Slope -Morgenstern-Price method - Borings B-017-0-25 thru B-019-0-25	
	Drawn By	AK/ AG	*Company* Resource International Inc.
	Date	8/29/2025	*File Name* WYA-23-3.47 - STA. 492+00 - Undrained Conditions.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
ODOT Item 203 Embankment		125	Mohr-Coulomb	250	26
Stiff A-6a		125	Mohr-Coulomb	120	26
Very Stiff to Hard A-4a		125	Mohr-Coulomb	110	27



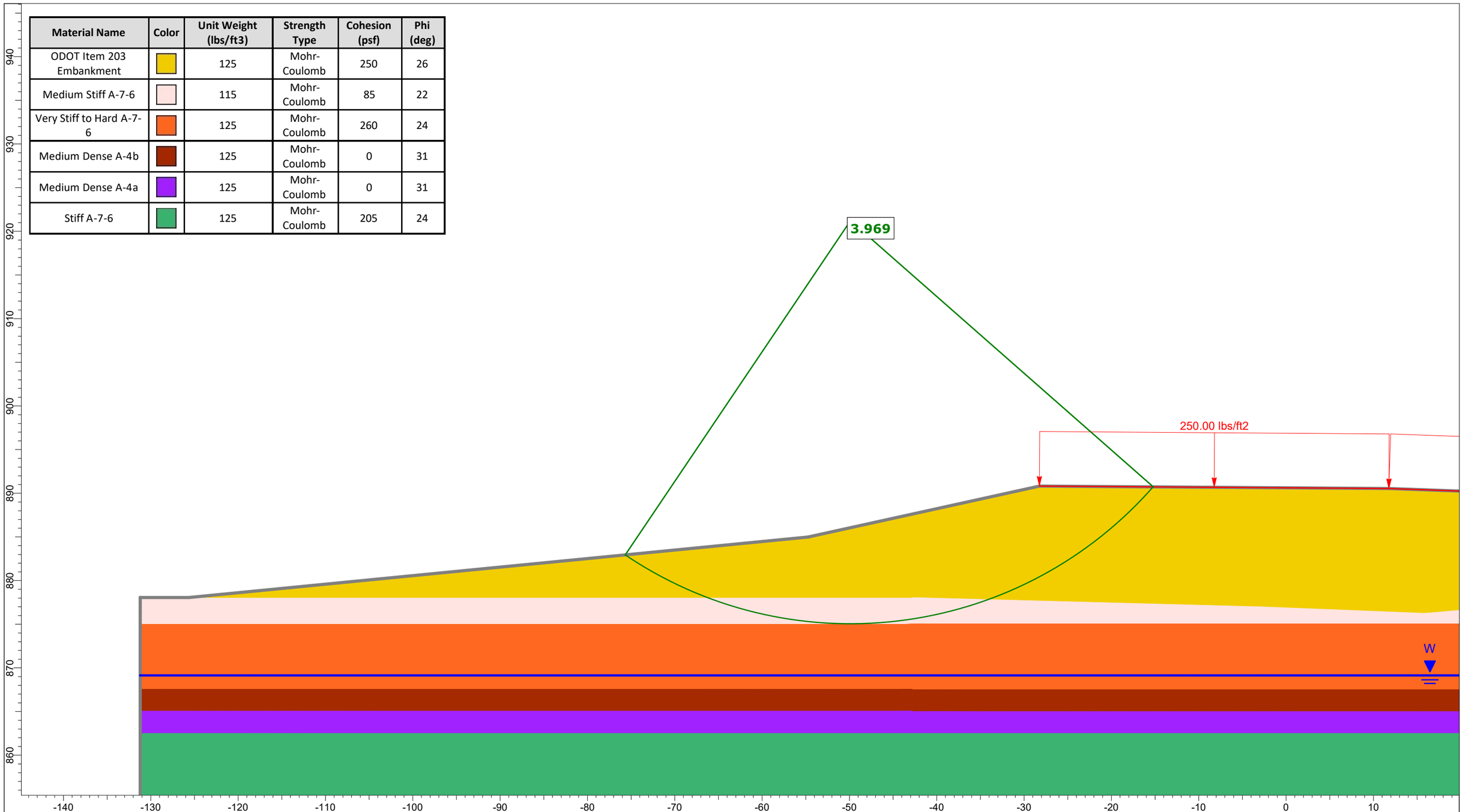
	Project WYA-23-3.47	
	Analysis Description Global Stability Analysis - Drained- Station 596+50, Ramp B - Embankment Height = 6.6 feet, 4H:1V Side Slope -Morgenstern-Price method - Borings B-020-0-25 thru B-021-0-25	
	Drawn By AK/ AG	*Company* Resource International Inc.
SLIDEINTERPRET 9.024	*Date* 8/29/2025	*File Name* WYA-23-3.47 - STA. 596+50 - Drained Conditions.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
ODOT Item 203 Embankment		125	Mohr-Coulomb	2000	0
Stiff A-6a		125	Mohr-Coulomb	1625	0
Very Stiff to Hard A-4a		125	Mohr-Coulomb	2500	0



SLIDEINTERPRET 9.024	*Project*	WYA-23-3.47	
	Analysis Description	Global Stability Analysis - Undrained- Station 596+50, Ramp B - Embankment Height = 6.6 feet, 4H:1V Side Slope -Morgenstern-Price method - Borings B-020-0-25 thru B-021-0-25	
	Drawn By	AK/ AG	*Company* Resource International Inc.
	Date	8/29/2025	*File Name* WYA-23-3.47 - STA. 596+50 - Undrained Conditions.slmd

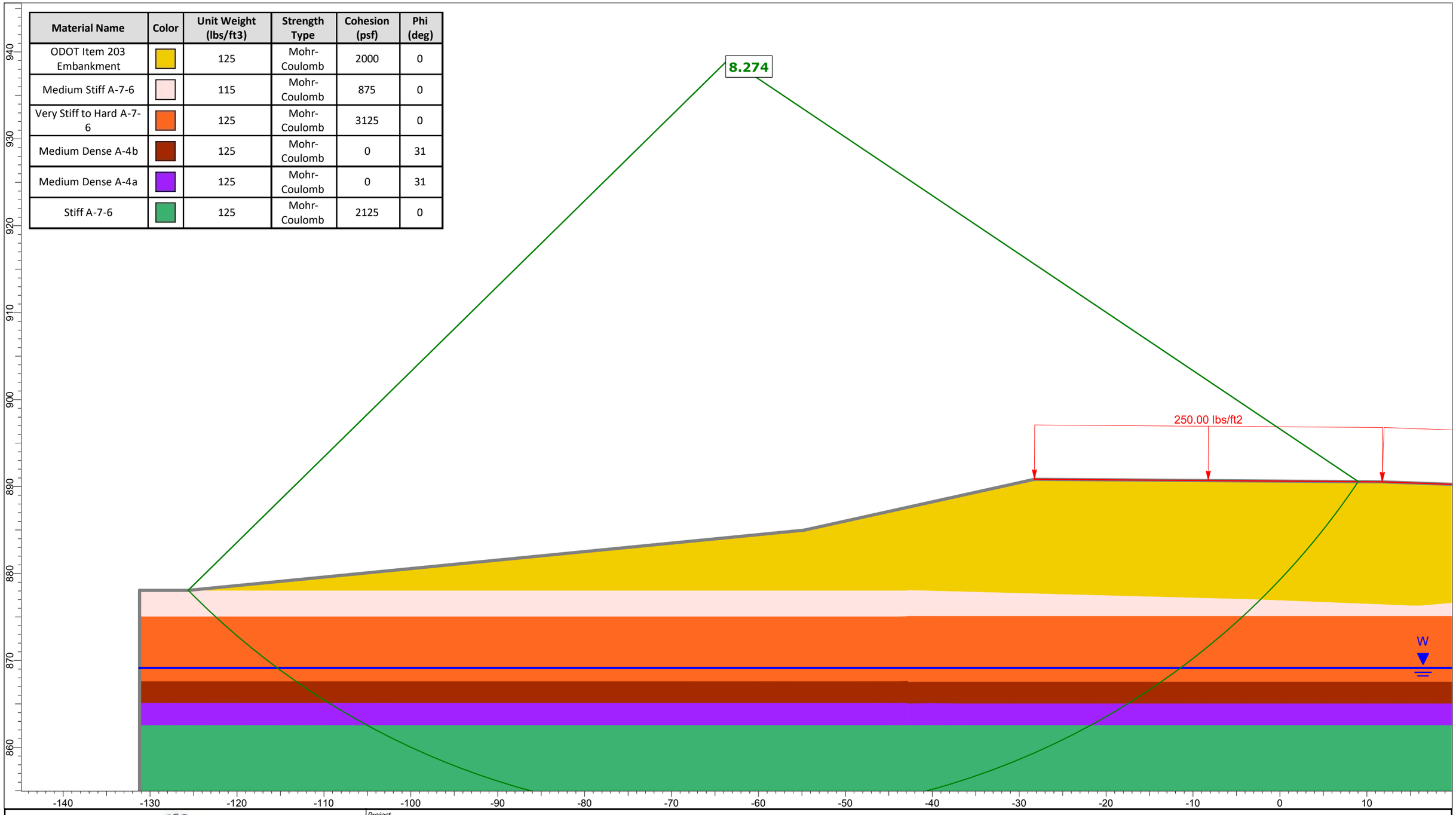
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
ODOT Item 203 Embankment		125	Mohr-Coulomb	250	26
Medium Stiff A-7-6		115	Mohr-Coulomb	85	22
Very Stiff to Hard A-7-6		125	Mohr-Coulomb	260	24
Medium Dense A-4b		125	Mohr-Coulomb	0	31
Medium Dense A-4a		125	Mohr-Coulomb	0	31
Stiff A-7-6		125	Mohr-Coulomb	205	24



SLIDEINTERPRET 9.024

Project	WYA-23-3.47		
Analysis Description	Global Stability Analysis - Drained- Station 685+00, Ramp C - Embankment Height = 14.1 feet, 4H:1V Side Slope -Morgenstern-Price method - Borings B-025-0-25 thru B-026-0-25		
Drawn By	AK/ AG	*Company*	Resource International Inc.
Date	8/29/2025	*File Name*	WYA-23-3.47 - STA. 685+00 - Drained Conditions.slmd

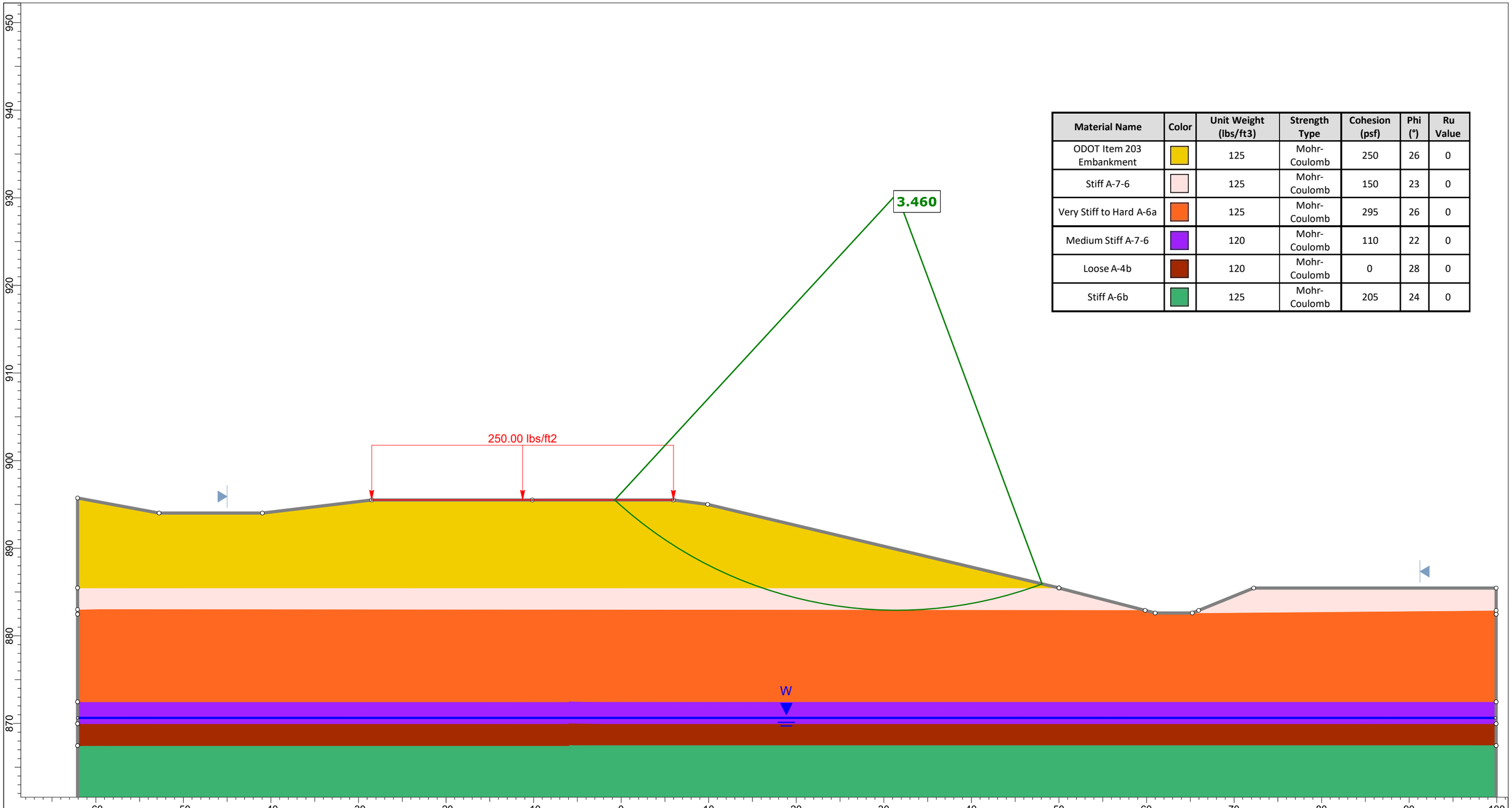
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
ODOT Item 203 Embankment		125	Mohr-Coulomb	2000	0
Medium Stiff A-7-6		115	Mohr-Coulomb	875	0
Very Stiff to Hard A-7-6		125	Mohr-Coulomb	3125	0
Medium Dense A-4b		125	Mohr-Coulomb	0	31
Medium Dense A-4a		125	Mohr-Coulomb	0	31
Stiff A-7-6		125	Mohr-Coulomb	2125	0



SLIDEINTERPRET 9.024

Project	WYA-23-3.47
Analysis Description	Global Stability Analysis - Undrained- Station 685+00, Ramp C - Embankment Height = 14.1 feet, 4H:1V Side Slope -Morgenstern-Price method - Borings B-025-0-25 thru B-026-0-25
Drawn By	AK/ AG
Company	Resource International Inc.
Date	8/29/2025
File Name	WYA-23-3.47 - STA. 685+00 - Undrained Conditions.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Ru Value
ODOT Item 203 Embankment		125	Mohr-Coulomb	250	26	0
Stiff A-7-6		125	Mohr-Coulomb	150	23	0
Very Stiff to Hard A-6a		125	Mohr-Coulomb	295	26	0
Medium Stiff A-7-6		120	Mohr-Coulomb	110	22	0
Loose A-4b		120	Mohr-Coulomb	0	28	0
Stiff A-6b		125	Mohr-Coulomb	205	24	0

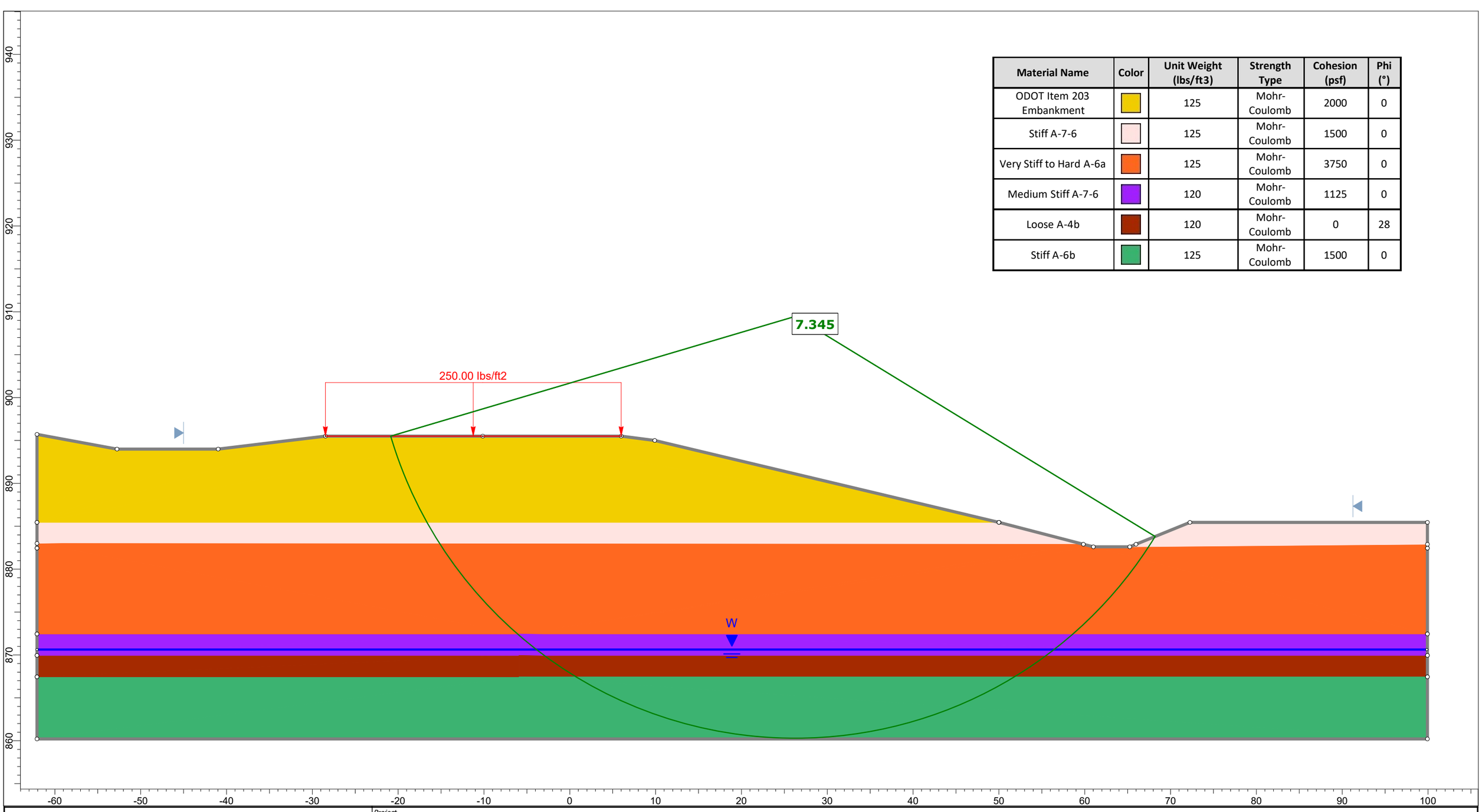


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SLIDEINTERPRET 9.035

Project	WYA-23-3.47		
Analysis Description	Global Stability Analysis - Drained- Station 784+50, Ramp D - Embankment Height = 13 feet, 4.1H:1V Side Slope -Morgenstern-Price method - Borings B-027-0-25 thru B-029-0-25		
Drawn By	AK/ AG	Company	Resource International Inc.
Date	8/29/2025	File Name	WYA-23-3.47 - STA. 784+50 - Drained Conditions.slmd

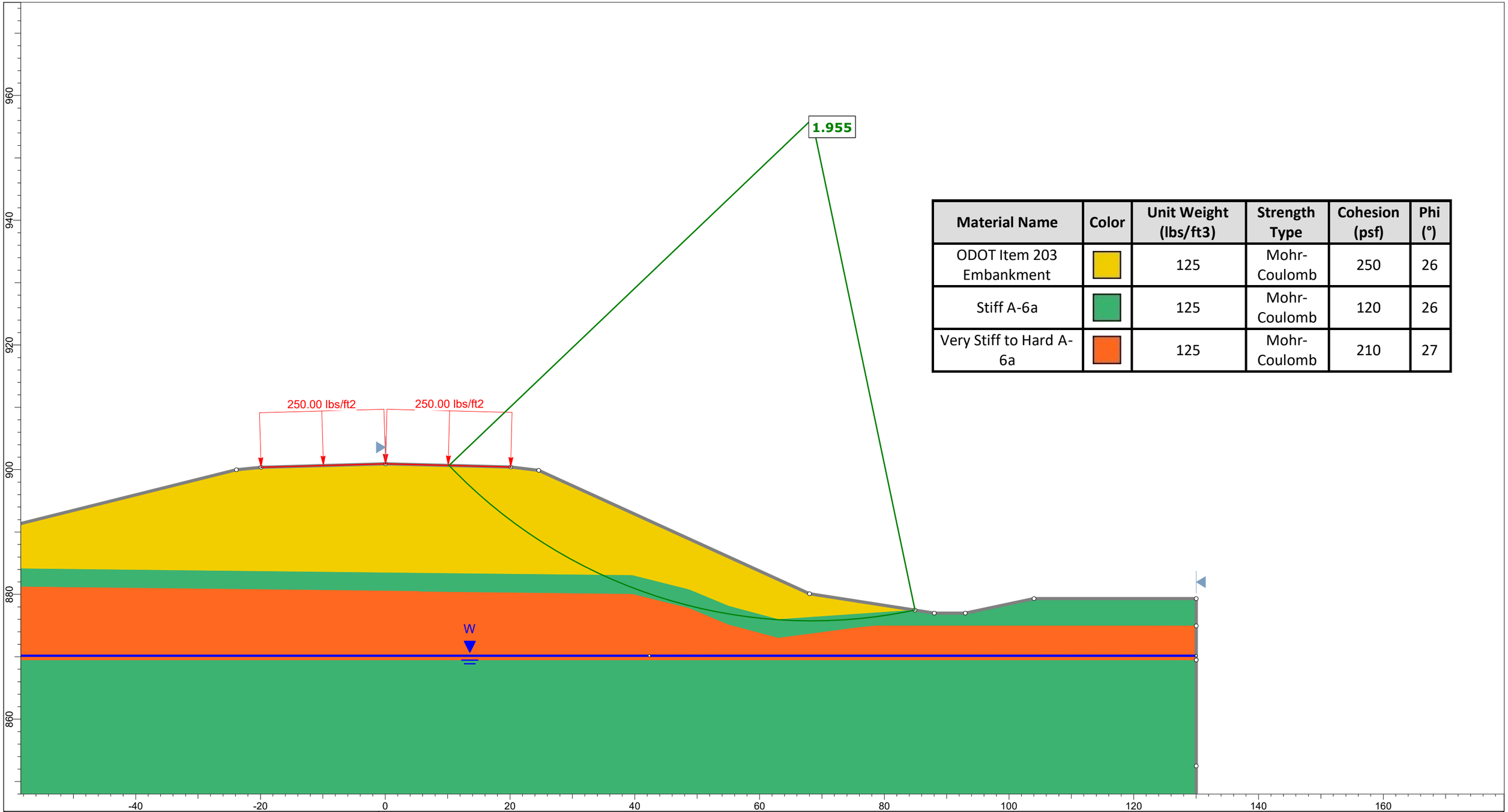
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
ODOT Item 203 Embankment		125	Mohr-Coulomb	2000	0
Stiff A-7-6		125	Mohr-Coulomb	1500	0
Very Stiff to Hard A-6a		125	Mohr-Coulomb	3750	0
Medium Stiff A-7-6		120	Mohr-Coulomb	1125	0
Loose A-4b		120	Mohr-Coulomb	0	28
Stiff A-6b		125	Mohr-Coulomb	1500	0



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SLIDEINTERPRET 9.035

Project	WYA-23-3.47		
Analysis Description	Global Stability Analysis - Undrained- Station 784+50, Ramp D - Embankment Height = 13 feet, 4.1H:1V Side Slope -Morgenstern-Price method - Borings B-027-0-25 thru B-029-0-25		
Drawn By	AK/ AG	*Company*	Resource International Inc.
Date	8/29/2025	*File Name*	WYA-23-3.47 - STA. 784+50 - Undrained Conditions -.slmd



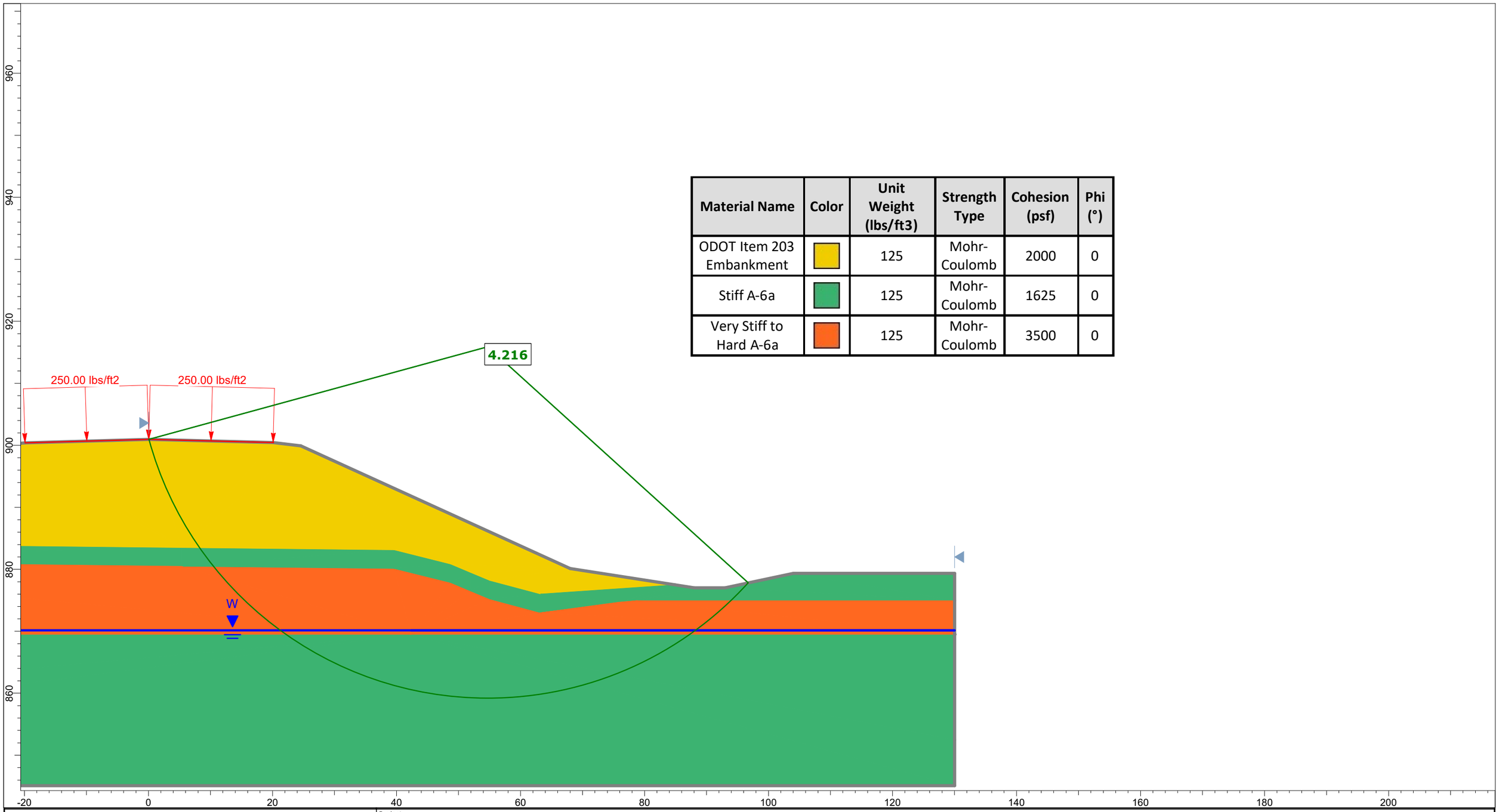
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
ODOT Item 203 Embankment		125	Mohr-Coulomb	250	26
Stiff A-6a		125	Mohr-Coulomb	120	26
Very Stiff to Hard A-6a		125	Mohr-Coulomb	210	27

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SLIDEINTERPRET 9.035

Project	WYA-23-3.47		
Analysis Description	Global Stability Analysis - Drained- Station 316+00, SR 294 - Embankment Height = 23 feet, 2.2H:1V Side Slope -Morgenstern-Price method - Borings B-010-0-25 thru B-012-0-25		
Drawn By	AK/ AG	*Company*	Resource International Inc.
Date	8/29/2025	*File Name*	WYA-23-3.47 - STA. 316+00 - Drained Conditions.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
ODOT Item 203 Embankment		125	Mohr-Coulomb	2000	0
Stiff A-6a		125	Mohr-Coulomb	1625	0
Very Stiff to Hard A-6a		125	Mohr-Coulomb	3500	0



RESOURCE INTERNATIONAL, INC.
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SLIDEINTERPRET 9.035

Project	WYA-23-3.47		
Analysis Description	Global Stability Analysis - Undrained- Station 316+00, SR 294 - Embankment Height = 23 feet, 2.2H:1V Side Slope -Morgenstern-Price method - Borings B-010-0-25 thru B-012-0-25		
Drawn By	AK/ AG	*Company*	Resource International Inc.
Date	8/29/2025	*File Name*	WYA-23-3.47 - STA. 316+00 - Undrained Conditions.slmd

APPENDIX XIII

ODOT SUBGRADE ANALYSIS SUMMARY

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

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

WYA-23-3.47
PID 121424

Interchange Improvements (Intersection of US 23 and SR 294) - Ramp A

Resource International, Inc.

Prepared By: Abed Al-Kalabani, E.I.
Date prepared: Wednesday, February 4, 2026

Resource International, Inc.
Ashok Gaire, P.E.
6350 Presidential Gateway
Columbus, Ohio 43231
614-823-4949
ashokg@resourceinternational.com

NO. OF BORINGS: 6

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-013-0-25	US 23	167+20	56'	LT	CME 55	85.1	891.4	890.9	0.5 C
2	B-014-0-25	US 23	171+12	60'	LT	CME 55	85.1	888.3	889.9	1.6 F
3	B-016-0-25	US 23	180+12	59'	LT	CME 55	85.1	885.2	884.1	1.1 C
4	B-017-0-25	CL RAMP A	483+48	10'	RT	CME 750X	87.9	875.7	877.2	1.5 F
5	B-018-0-25	CL RAMP A	488+22	6'	RT	CME 750X	87.9	874.1	877.2	3.1 F
6	B-019-0-25	CL RAMP A	490+83	7'	RT	CME 750X	87.9	882.2	884.9	2.7 F

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.5	3.0	1.0	2.5	9		3.5	35	17	18	37	37	74	18	16	A-6b	11	490		N_{60}		12"	12"
	013-0	SS-2	3.0	4.5	2.5	4.0	21		3.75	43	18	25	40	48	88	20	18	A-7-6	15						204 Geotextile
	25	SS-3	4.5	6.0	4.0	5.5	20		2.5							20	18	A-7-6	16						
		SS-4	6.0	7.5	5.5	7.0	26	9	4							22	18	A-7-6							
2	B	SS-1	1.5	3.0	3.1	4.6	20		4	30	20	10	62	34	96	18	15	A-4b	8	640					
	014-0	SS-2	3.5	5.0	5.1	6.6	23		3.75	41	20	21	55	43	98	24	18	A-7-6							
	25	SS-3	6.0	7.5	7.6	9.1	20		3.75							20	18	A-7-6							
		SS-4	8.5	10.0	10.1	11.6	18	20	4.5							23	18	A-7-6							
3	B	SS-1	1.5	3.0	0.4	1.9	11		3	35	17	18	34	41	75	17	16	A-6b	11	300		N_{60}		12"	12"
	016-0	SS-2	3.5	5.0	2.4	3.9	23		4	38	17	21	37	42	79	19	16	A-6b	12						204 Geotextile
	25	SS-3	6.0	7.5	4.9	6.4	23		4.5							13	14	A-6a	10						
		SS-4	8.5	10.0	7.4	8.9	28	11	4.5							13	14	A-6a							
4	B	SS-1	1.0	2.5	2.5	4.0	7		2.5				42	42	84	26	16	A-6b	16	220					
	017-0	SS-2	3.5	5.0	5.0	6.5	26		3.5	32	16	16	39	38	77	16	16	A-6b	10						
	25	SS-3	6.0	7.5	7.5	9.0	41		4.5							15	16	A-6b							
		SS-4	8.5	10.0	10.0	11.5	35	7	4.5							19	16	A-6b							
5	B	SS-1	1.0	3.0	4.1	6.1	12		3.25	41	22	19	44	50	94	22	19	A-7-6	12						
	018-0	SS-2	3.5	5.0	6.6	8.1	12			NP	NP	NP	56	19	75	22	11	A-4b							
	25	SS-3	6.0	7.5	9.1	10.6	13									20	10	A-4b							
		SS-4	8.5	10.0	11.6	13.1	12	12	1.75							19	14	A-6a							
6	B	SS-1	1.0	2.5	3.7	5.2	10		3.5	62	22	40	30	56	86	24	19	A-7-6	20						
	019-0	SS-2	3.5	5.0	6.2	7.7	19		3.25							15	18	A-7-6							
	25	SS-3	6.0	7.5	8.7	10.2	29		4.5							15	18	A-7-6							
		SS-4	8.5	10.0	11.2	12.7	23	10	4.5							18	18	A-7-6							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: PID 121424

County-Route-Section: WYA-23-3.47
No. of Borings: 6

Geotechnical Consultant: Resource International, Inc.
Prepared By: Abed Al-Kalabani, E.I.
Date prepared: 2/4/2026

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

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

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	31%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	8%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	62%	HP > 2	100%
M+	0%		
Rock	0%		
Unsuitable	13%		

Excavate and Replace at Surface	
Average	4"
Maximum	12"
Minimum	0"

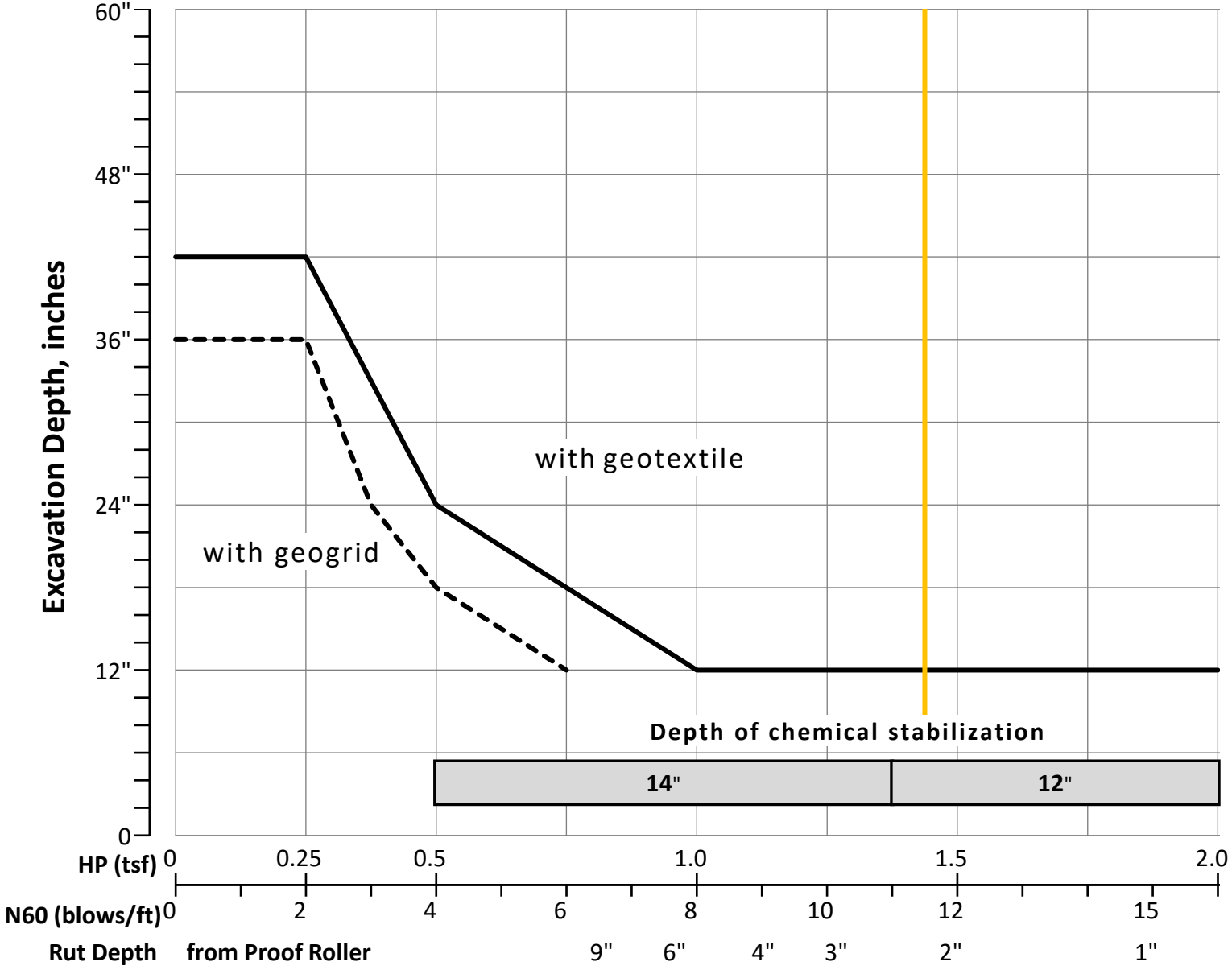
% Proposed Subgrade Surface	
Unstable & Unsuitable	40%
Unstable	40%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	20	12	3.70	40	19	21	43	41	84	19	16	13
Maximum	41	20	4.50	62	22	40	62	56	98	26	19	20
Minimum	7	7	1.75	30	16	10	30	19	74	13	10	8

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	3	0	3	7	0	11	0	0	24
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	13%	0%	13%	29%	0%	46%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%									100%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	5
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	80%	0%	20%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.70		☐ HP
11.50		☐ N60L

Average HP
Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

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

WYA-23-3.47
PID 121424

Interchange Improvements (Intersection of US 23 and SR 294) - Ramp B

Resource International, Inc.

Prepared By: Abed Al-Kalabani, E.I.
Date prepared: Wednesday, February 4, 2026

Resource International, Inc.
Ashok Gaire, P.E.
6350 Presidential Gateway
Columbus, Ohio 43231
614-823-4949
ashokg@resourceinternational.com

NO. OF BORINGS: 3

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-020-0-25	CL RAMP B	595+05	4'	RT	CME 750X	87.9	877.0	875.8	1.2 C
2	B-021-0-25	CL RAMP B	599+09	7'	RT	CME 750X	87.9	871.1	875.8	4.6 F
3	B-022-0-25	CL RAMP B	602+93	6'	RT	CME 55	85.1	870.5	869.0	1.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.0	2.5	-0.2	1.3	12		3.75	48	19	29	32	48	80	19	18	A-7-6	17	180					
	020-0	SS-2	3.5	5.0	2.3	3.8	16		3.5	22	17	5	39	38	77	20	12	A-4a	8						
	25	SS-3	6.0	7.5	4.8	6.3	12									23	10	A-4b	8						
		SS-4	8.5	10.0	7.3	8.8	12	12								17	10	A-4b							
2	B	SS-1	1.0	2.5	5.6	7.1	12									21	14	A-6a							
	021-0	SS-2	3.5	5.0	8.1	9.6	10		3.75							20	14	A-6a							
	25	SS-3	6.0	7.5	10.6	12.1	16		3.25	25	14	11	37	31	68	18	14	A-6a		900					
		SS-4	8.5	10.0	13.1	14.6	18	12	4.5	22	13	9	32	25	57	13	10	A-4a							
3	B	SS-1	1.5	3.0	0.0	1.5	16		4.5	34	19	15	42	42	84	16	14	A-6a	10	180					**36" 204 Geotextile**
	022-0	SS-2	3.0	4.5	1.5	3.0	24			20	17	3	67	24	91	20	12	A-4b	8		A-4b	Mc			
	25	SS-3	4.5	6.0	3.0	4.5	26									16	10	A-4b	8						
		SS-4	6.0	7.5	4.5	6.0	27	16								15	10	A-4b	8						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: PID 121424

County-Route-Section: WYA-23-3.47
No. of Borings: 3

Geotechnical Consultant: Resource International, Inc.
Prepared By: Abed Al-Kalabani, E.I.
Date prepared: 2/4/2026

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

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

Design CBR	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	0%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	38%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	38%	HP > 2	38%
M+	13%		
Rock	0%		
Unsuitable	42%		

Excavate and Replace at Surface	
Average	12"
Maximum	36"
Minimum	0"

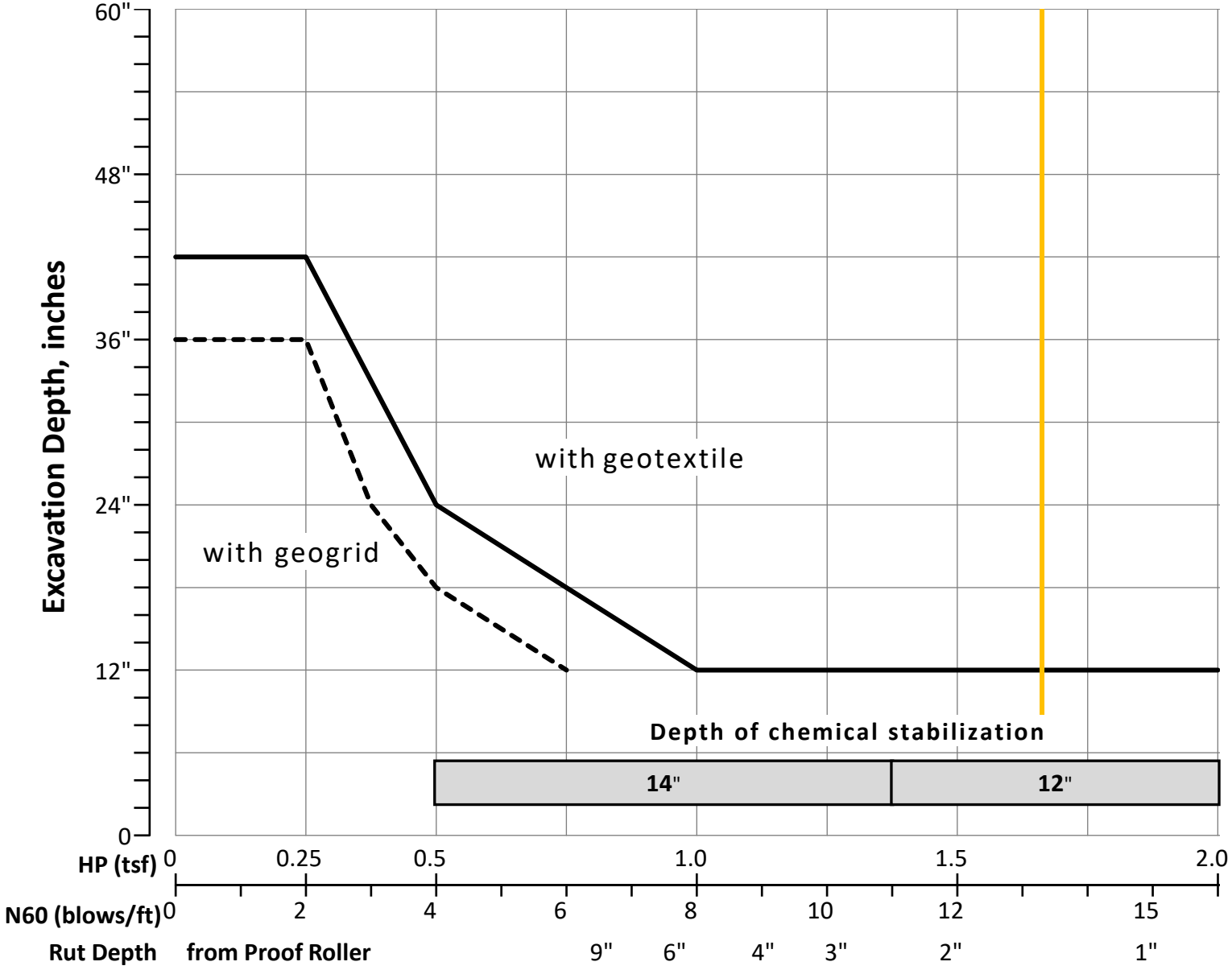
% Proposed Subgrade Surface	
Unstable & Unsuitable	50%
Unstable	25%
Unsuitable	25%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	17	13	3.88	29	17	12	42	35	76	18	12	10
Maximum	27	16	4.50	48	19	29	67	48	91	23	18	17
Minimum	10	12	3.25	20	13	3	32	24	57	13	10	8

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	2	5	0	4	0	0	1	0	0	12
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	42%	0%	33%	0%	0%	8%	0%	0%	100%
% Rock|Granular|Cohesive	0%	17%									83%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	4
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	25%	0%	25%	0%	0%	25%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.88		☐ HP
13.33		☐ N60L

Average HP
Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

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

WYA-23-3.47
PID 121424

Interchange Improvements (Intersection of US 23 and SR 294) - Ramp C

Resource International, Inc.

Prepared By: Abed Al-Kalabani, E.I.
Date prepared: Wednesday, February 4, 2026

Resource International, Inc.
Ashok Gaire, P.E.
6350 Presidential Gateway
Columbus, Ohio 43231
614-823-4949
ashokg@resourceinternational.com

NO. OF BORINGS: 3

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-025-0-25	CL RAMP C	679+07	8'	LT	CME 750X	87.9	880.6	884.7	4.1 F
2	B-024-0-25	US 23	175+50	68'	RT	Mobile B53	80.6	886.6	887.6	1.1 F
3	B-023-0-25	US 23	172+02	62'	RT	Mobile B53	80.6	889.9	889.4	0.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.0	2.5	5.1	6.6	10		2.5							22	18	A-7-6							
	025-0	SS-2	3.5	5.0	7.6	9.1	15		2.75	41	17	24	36	40	76	18	18	A-7-6							
	25	SS-3	6.0	7.5	10.1	11.6	26		4.5							17	18	A-7-6							
		SS-4	8.5	10.0	12.6	14.1	25	10	4							22	18	A-7-6							
2	B	SS-1	1.0	2.5	2.1	3.6	11		4	34	16	18	33	35	68	19	16	A-6b	10	100					
	024-0	SS-2	3.5	5.0	4.6	6.1	16		3.75	46	20	26	45	52	97	25	18	A-7-6	16						
	25	SS-3	6.0	7.5	7.1	8.6	17		4.5							20	18	A-7-6							
		SS-4	8.5	10.0	9.6	11.1	19	11	4.5							15	18	A-7-6							
3	B	SS-1	1.0	2.5	0.5	2.0	11		4.5				35	35	70	17	16	A-6b	15	140		N_{60}		12"	12"
	023-0	SS-2	3.5	5.0	3.0	4.5	26		4.5	47	19	28	51	46	97	20	18	A-7-6	17						204 Geotextile
	25	SS-3	6.0	7.5	5.5	7.0	19		3							20	18	A-7-6							
		SS-4	8.5	10.0	8.0	9.5	21	11	4.5							20	18	A-7-6							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: PID 121424

County-Route-Section: WYA-23-3.47
No. of Borings: 3

Geotechnical Consultant: Resource International, Inc.
Prepared By: Abed Al-Kalabani, E.I.
Date prepared: 2/4/2026

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	No
	Lime Stabilization	Option
206	Depth	14"

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

Design CBR	4

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	50%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	0%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	17%	HP > 2	100%
M+	0%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	4"
Maximum	12"
Minimum	0"

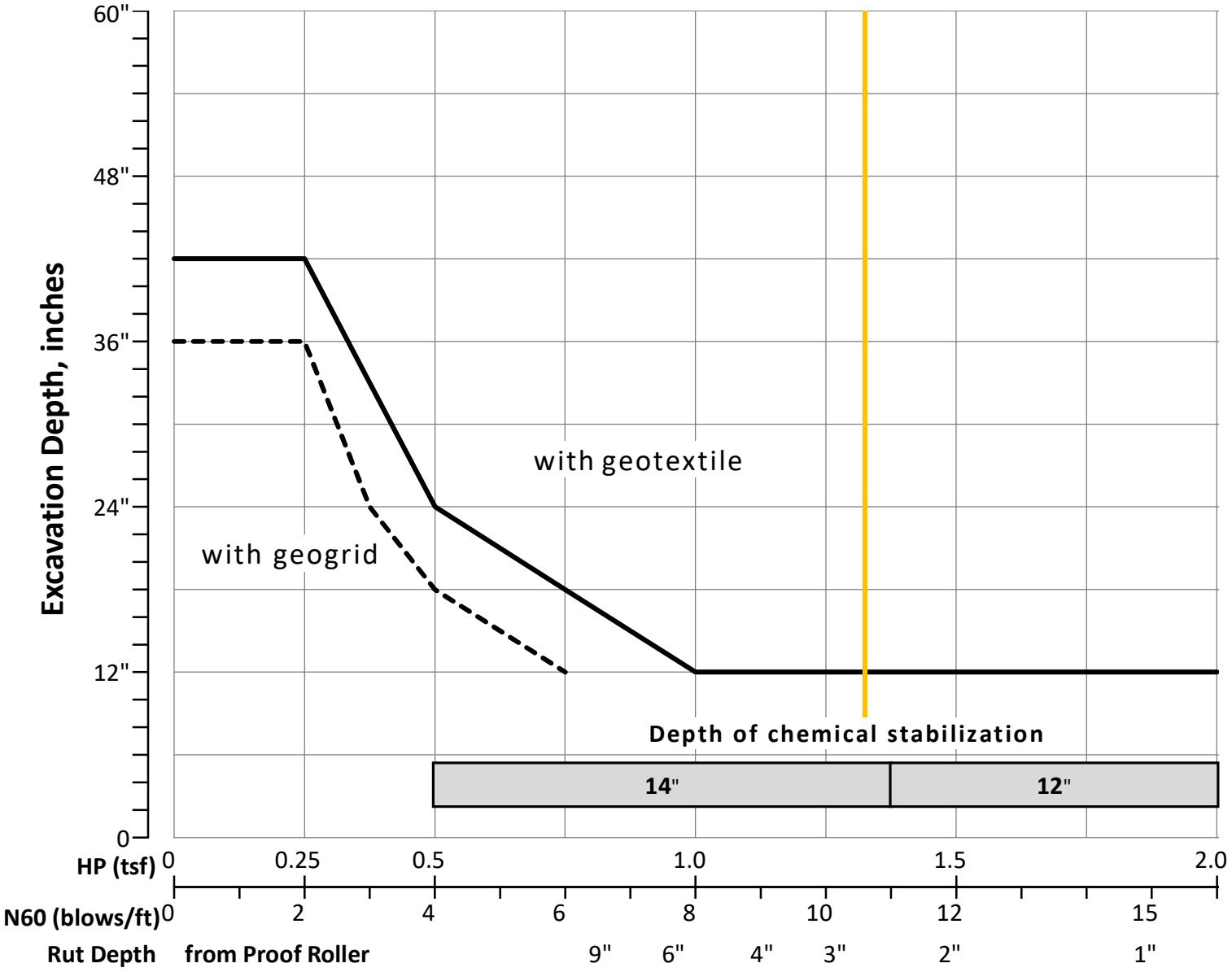
% Proposed Subgrade Surface	
Unstable & Unsuitable	50%
Unstable	50%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	18	11	3.92	42	18	24	40	42	82	20	18	15
Maximum	26	11	4.50	47	20	28	51	52	97	25	18	17
Minimum	10	10	2.50	34	16	18	33	35	68	15	16	10

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	10	0	0	12
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%	83%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%									100%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.92		☐ HP
10.67		☐ N60L

Average HP
Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

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

WYA-23-3.47
PID 121424

Interchange Improvements (Intersection of US 23 and SR 294) - Ramp D

Resource International, Inc.

Prepared By: Abed Al-Kalabani, E.I.
Date prepared: Wednesday, February 4, 2026

Resource International, Inc.
Ashok Gaire, P.E.
6350 Presidential Gateway
Columbus, Ohio 43231
614-823-4949
ashokg@resourceinternational.com

NO. OF BORINGS: 7

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-027-0-25	CL RAMP D	787+52	0'	LT	CME 750X	87.9	884.9	884.8	0.1 C
2	B-028-0-25	CL RAMP D	791+27	4'	LT	CME 750X	87.9	883.1	872.6	10.5 C
3	B-029-0-25	CL RAMP D	794+83	4'	LT	CME 750X	87.9	876.0	869.2	6.8 C
4	B-030-0-25	US 23	199+11	67'	RT	CME 750X	87.9	869.8	870.4	0.6 F
5	B-031-0-25	US 23	203+27	63'	RT	CME 750X	87.9	869.1	869.2	0.1 F
6	B-032-0-25	US 23	206+97	57'	RT	CME 55	85.1	868.2	867.9	0.3 C
7	B-033-0-25	US 23	210+20	58'	RT	CME 55	85.1	868.1	867.6	0.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.0	2.5	0.9	2.4	12		3.5	47	21	26	33	57	90	23	18	A-7-6	16	100		N_{60} & Mc		12"	12"
	027-0	SS-2	3.5	5.0	3.4	4.9	28		4.5	33	18	15	39	47	86	18	14	A-6a	10						204 Geotextile
	25	SS-3	6.0	7.5	5.9	7.4	32		4.5							18	14	A-6a							
		SS-4	8.5	10.0	8.4	9.9	40	12	4.5							17	14	A-6a							
2	B	SS-5	11.0	12.5	0.5	2.0	38		4.5	44	22	22	39	59	98	20	19	A-7-6	14						36"
	028-0	SS-6	13.5	15.0	3.0	4.5	15			20	17	3	61	18	79	24	12	A-4b	8	140					204 Geotextile
	25	SS-7	16.0	17.5	5.5	7.0	10									22	10	A-4b							
		SS-8	18.5	20.0	8.0	9.5	15	10	3							17	16	A-6b							
3	B	SS-1	1.0	2.5	-5.8	-4.3	10		2							14	16	A-6b	16						15"
	029-0	SS-2	3.5	5.0	-3.3	-1.8	12		1.5	38	19	19	34	41	75	20	16	A-6b	12	200					204 Geotextile
	25	SS-3	6.0	7.5	-0.8	0.7	7		1.5	47	21	26	38	47	85	23	18	A-7-6	16			HP & Mc		15"	
		SS-4	8.5	10.0	1.7	3.2	13	7	2.25	52	22	30	38	41	79	27	19	A-7-6	18			N_{60} & Mc			
4	B	SS-1	1.0	2.5	1.6	3.1	13			NP	NP	NP	29	8	37	21	11	A-4a	0			N_{60} & Mc			12"
	030-0	SS-2	3.5	5.0	4.1	5.6	6			16	13	3	39	20	59	24	10	A-4a	5	850					204 Geotextile
	25	SS-3	6.0	7.5	6.6	8.1	10			NP	NP	NP	71	19	90	24	11	A-4b							
		SS-4	8.5	10.0	9.1	10.6	15	6	4							19	14	A-6a							
5	B	SS-1	1.0	2.5	1.1	2.6	13		4.5	36	19	17	46	46	92	22	16	A-6b	11			N_{60} & Mc		12"	12"
	031-0	SS-2	3.5	5.0	3.6	5.1	12			NP	NP	NP	14	4	18	24	8	A-3a	0	380					204 Geotextile
	25	SS-3	6.0	7.5	6.1	7.6	9			NP	NP	NP	41	13	54	24	11	A-4a							
		SS-4	8.5	10.0	8.6	10.1	22	12								22	10	A-4a							
6	B	SS-1	1.0	2.5	0.7	2.2	7		2	24	14	10	30	28	58	15	10	A-4a	5	100		N_{60} & Mc		15"	15"
	032-0	SS-2	3.5	5.0	3.2	4.7	20		3	37	18	19	36	45	81	19	16	A-6b	12						204 Geotextile
	25	SS-3	6.0	7.5	5.7	7.2	20									15	16	A-6b							
		SS-4	8.5	10.0	8.2	9.7	26	7								16	16	A-6b							
7	B	SS-1	1.0	2.5	0.5	2.0	14			NP	NP	NP	21	8	29	10	10	A-2-4	0	100					
	033-0	SS-2	3.5	5.0	3.0	4.5	7		3	50	41	9	31	17	48	19	36	A-6a	3						
	25	SS-3	6.0	7.5	5.5	7.0	11		4							17	14	A-6a							
		SS-4	8.5	10.0	8.0	9.5	14	7	3.75							19	14	A-6a							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: PID 121424

County-Route-Section: WYA-23-3.47
No. of Borings: 7

Geotechnical Consultant: Resource International, Inc.
Prepared By: Abed Al-Kalabani, E.I.
Date prepared: 2/4/2026

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	14''

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

Design CBR	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	37%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	32%	1 < HP ≤ 2	11%
$N_{60} \geq 20$	26%	HP > 2	47%
M+	32%		
Rock	0%		
Unsuitable	12%		

Excavate and Replace at Surface	
Average	15''
Maximum	36''
Minimum	0''

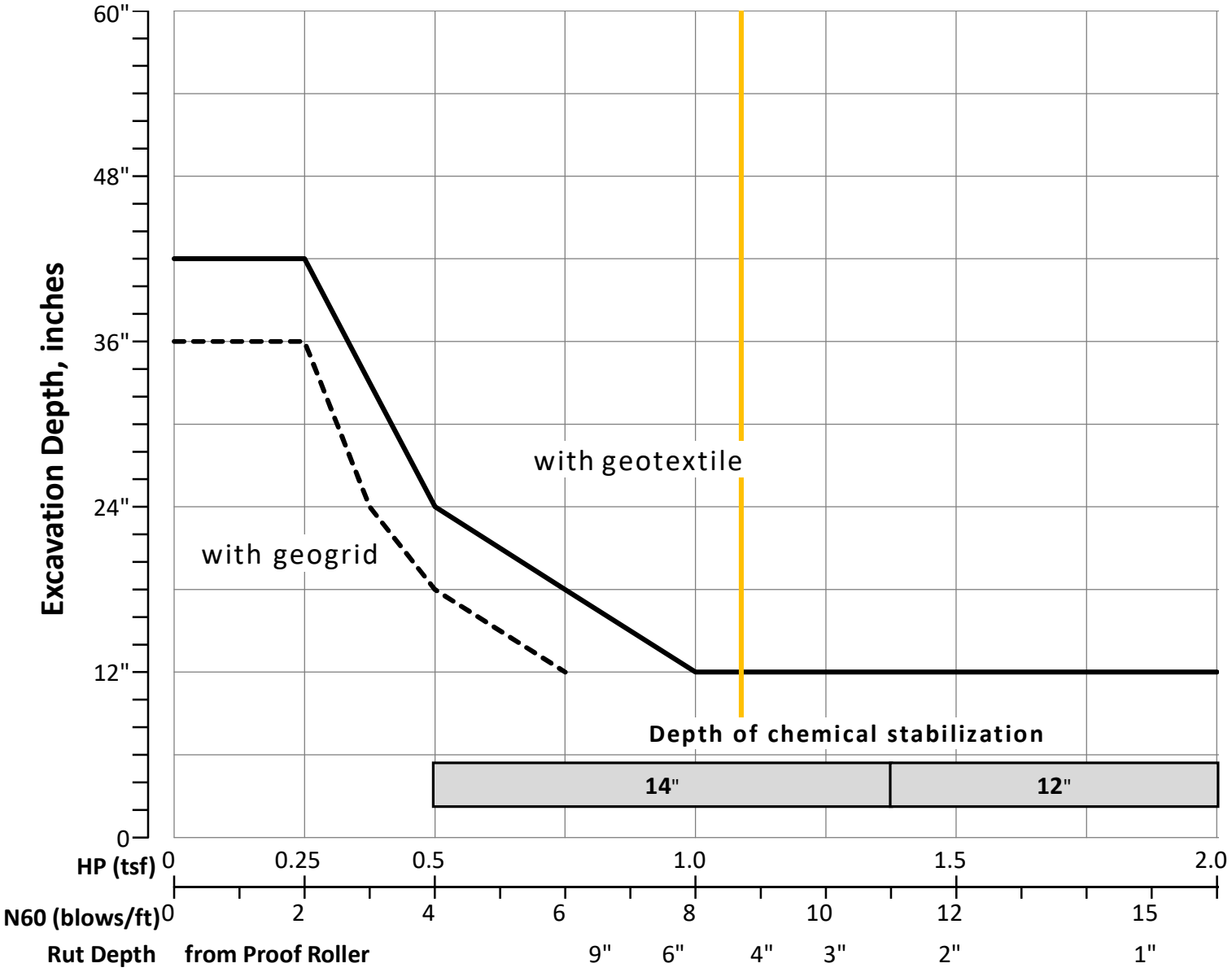
% Proposed Subgrade Surface	
Unstable & Unsuitable	60%
Unstable	60%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	17	9	3.50	37	21	16	38	30	68	20	15	8
Maximum	40	12	4.50	52	41	30	71	59	98	27	36	18
Minimum	6	6	1.50	16	13	3	14	4	18	10	8	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	1	0	0	0	0	1	5	3	0	7	5	0	4	0	0	26
Percent	0%	0%	0%	4%	0%	0%	0%	0%	4%	19%	12%	0%	27%	19%	0%	15%	0%	0%	100%
% Rock|Granular|Cohesive	0%	27%									73%								100%
Surface Class Count	0	0	0	1	0	0	0	0	0	2	0	0	0	3	0	4	0	0	10
Surface Class Percent	0%	0%	0%	10%	0%	0%	0%	0%	0%	20%	0%	0%	0%	30%	0%	40%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.50		☐ HP
8.71		☐ N60L

Average HP
Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

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

WYA-23-3.47
PID 121424

Interchange Improvements (Intersection of US 23 and SR 294) - SR 294

Resource International, Inc.

Prepared By: Abed Al-Kalabani, E.I.
Date prepared: Wednesday, February 4, 2026

Resource International, Inc.
Ashok Gaire, P.E.
6350 Presidential Gateway
Columbus, Ohio 43231
614-823-4949
ashokg@resourceinternational.com

NO. OF BORINGS: 3

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-25	SR 294	304+79	0	CL	CME 55	85.1	873.3	872.2	1.1 C
2	B-011-0-25	SR 294	322+11	14'	RT	CME 55	85.1	883.1	885.8	2.7 F
3	B-012-0-25	SR 294	325+33	11'	LT	CME 55	85.1	885.6	883.7	1.9 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.5	3.0	0.4	1.9	18		4	42	17	25	33	43	76	18	18	A-7-6	14	420					
	001-0	SS-2	3.0	4.5	1.9	3.4	62			NP	NP	NP	9	7	16	6	6	A-1-b	0						
	25	SS-3	4.5	6.0	3.4	4.9	17									14	10	A-4a	8						
		SS-4	6.0	7.5	4.9	6.4	18	17								24	10	A-4a	8						
2	B	SS-1	1.5	3.0	4.2	5.7	13		2	28	17	11	42	28	70	20	14	A-6a	7	440					
	011-0	SS-2	3.5	5.0	6.2	7.7	11		2.5	52	19	33	41	47	88	24	18	A-7-6							
	25	SS-3	6.0	7.5	8.7	10.2	18		2.75							17	18	A-7-6							
		SS-4	8.5	10.0	11.2	12.7	21	13	3							16	18	A-7-6							
3	B	SS-1	1.5	3.0	-0.4	1.1	11		3	47	18	29	43	49	92	15	18	A-7-6	17	460		N_{60}		12"	12"
	012-0	SS-2	3.5	5.0	1.6	3.1	24		4	47	21	26	43	54	97	21	18	A-7-6	16			Mc			204 Geotextile
	25	SS-3	6.0	7.5	4.1	5.6	28		4							19	18	A-7-6	16						
		SS-4	8.5	10.0	6.6	8.1	43	11	4.5							14	18	A-7-6							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: PID 121424

County-Route-Section: WYA-23-3.47
No. of Borings: 3

Geotechnical Consultant: Resource International, Inc.
Prepared By: Abed Al-Kalabani, E.I.
Date prepared: 2/4/2026

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

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

Design CBR	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	13%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	13%	1 < HP ≤ 2	13%
$N_{60} \geq 20$	38%	HP > 2	50%
M+	13%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	4"
Maximum	12"
Minimum	0"

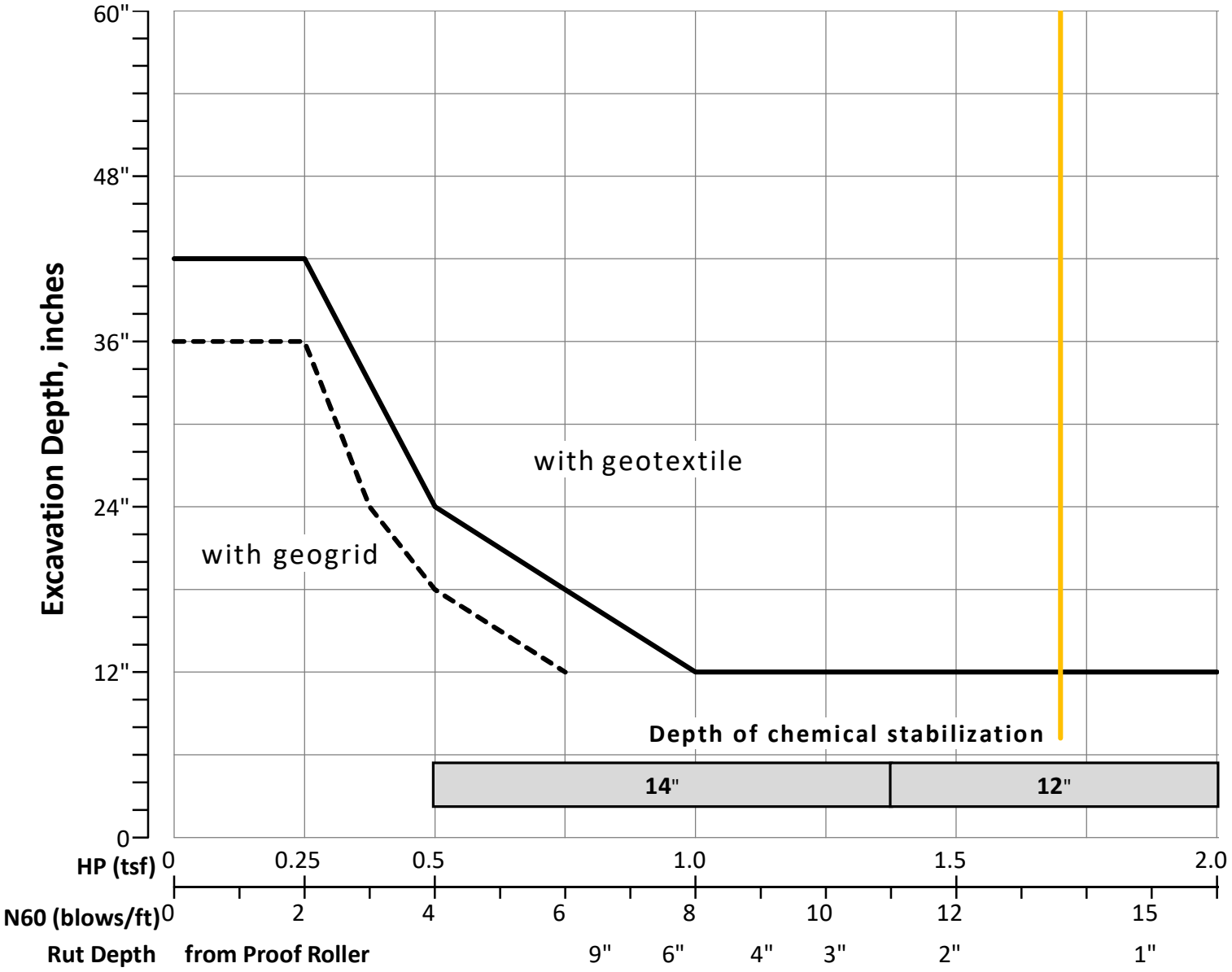
% Proposed Subgrade Surface	
Unstable & Unsuitable	50%
Unstable	50%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	24	14	3.31	43	18	25	35	38	73	17	15	11
Maximum	62	17	4.50	52	21	33	43	54	97	24	18	17
Minimum	11	11	2.00	28	17	11	9	7	16	6	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	1	0	0	0	0	0	0	2	0	0	1	0	0	8	0	0	12
Percent	0%	0%	8%	0%	0%	0%	0%	0%	0%	17%	0%	0%	8%	0%	0%	67%	0%	0%	100%
% Rock|Granular|Cohesive	0%	25%									75%								100%
Surface Class Count	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	4
Surface Class Percent	0%	0%	25%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	75%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.31		☐ HP
13.67		☐ N60L

Average HP
Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

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

WYA-23-3.47
PID 121424

Interchange Improvements (Intersection of US 23 and SR 294) - PR T 127

Resource International, Inc.

Prepared By: Abed Al-Kalabani, E.I.
Date prepared: Thursday, September 4, 2025

Resource International, Inc.
Ashok Gaire, P.E.
6350 Presidential Gateway
Columbus, Ohio 43231
614-823-4949
ashokg@resourceinternational.com

NO. OF BORINGS: 5

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-012-0-25	SR 294	325+33	11'	LT	CME 55	85.1	885.6	883.7	1.9 C
2	B-036-0-25	CL PR T 127	903+59	2'	LT	CME 750X	87.9	883.9	882.3	1.6 C
3	B-037-0-25	CL PR T 127	908+08	2'	LT	CME 750X	87.9	886.0	884.3	1.7 C
4	B-038-0-25	CL PR T 127	912+03	2'	LT	CME 750X	87.9	885.0	885.6	0.6 F
5	B-039-0-25	CL PR T 127	916+04	1'	LT	CME 55	85.1	884.5	883.9	0.6 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.5	3.0	-0.4	1.1	11		3	47	18	29	43	49	92	15	18	A-7-6	17	460		N_{60}		12"	12"
	012-0	SS-2	3.5	5.0	1.6	3.1	24		4	47	21	26	43	54	97	21	18	A-7-6	16			Mc			204 Geotextile
	25	SS-3	6.0	7.5	4.1	5.6	28		4							19	18	A-7-6	16						
		SS-4	8.5	10.0	6.6	8.1	43	11	4.5							14	18	A-7-6							
2	B	SS-1	1.0	2.5	-0.6	0.9	12		2	52	22	30	42	52	94	24	19	A-7-6	18	100		N_{60} & Mc		12"	12"
	036-0	SS-2	3.5	5.0	1.9	3.4	18		2	43	21	22	37	51	88	23	18	A-7-6	13			Mc			204 Geotextile
	25	SS-3	6.0	7.5	4.4	5.9	32		4.5							20	18	A-7-6	16						
		SS-4	8.5	10.0	6.9	8.4	34	12	4.5							21	18	A-7-6							
3	B	SS-1	1.0	2.5	-0.7	0.8	10		2	59	24	35	43	53	96	24	21	A-7-6	20	160		N_{60} & Mc		12"	12"
	037-0	SS-2	3.5	5.0	1.8	3.3	15		2.75	42	22	20	50	46	96	21	19	A-7-6	12						204 Geotextile
	25	SS-3	6.0	7.5	4.3	5.8	21		4.5							21	18	A-7-6	16						
		SS-4	8.5	10.0	6.8	8.3	23	10	4.5							20	18	A-7-6							
4	B	SS-1	1.0	2.5	1.6	3.1	12		2.5	57	24	33	37	58	95	27	21	A-7-6	19	140		N_{60} & Mc			12"
	038-0	SS-2	3.5	5.0	4.1	5.6	19		4.5	42	20	22	38	45	83	17	18	A-7-6	13						204 Geotextile
	25	SS-3	6.0	7.5	6.6	8.1	26		4.5							14	18	A-7-6							
		SS-4	8.5	10.0	9.1	10.6	41	12	4.5							17	18	A-7-6							
5	B	SS-1	1.5	3.0	0.9	2.4	11		3	46	20	26	38	48	86	24	18	A-7-6	16	100		N_{60} & Mc		12"	12"
	039-0	SS-2	3.5	5.0	2.9	4.4	13		3	51	19	32	35	52	87	24	18	A-7-6	18						204 Geotextile
	25	SS-3	6.0	7.5	5.4	6.9	16		4.5							15	18	A-7-6							
		SS-4	8.5	10.0	7.9	9.4	43	11	4.5							14	18	A-7-6							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: PID 121424

County-Route-Section: WYA-23-3.47
No. of Borings: 5

Geotechnical Consultant: Resource International, Inc.
Prepared By: Abed Al-Kalabani, E.I.
Date prepared: 9/4/2025

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

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

Design CBR	4

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	21%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	21%	1 < HP ≤ 2	21%
$N_{60} \geq 20$	29%	HP > 2	79%
M+	43%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	12"
Maximum	12"
Minimum	12"

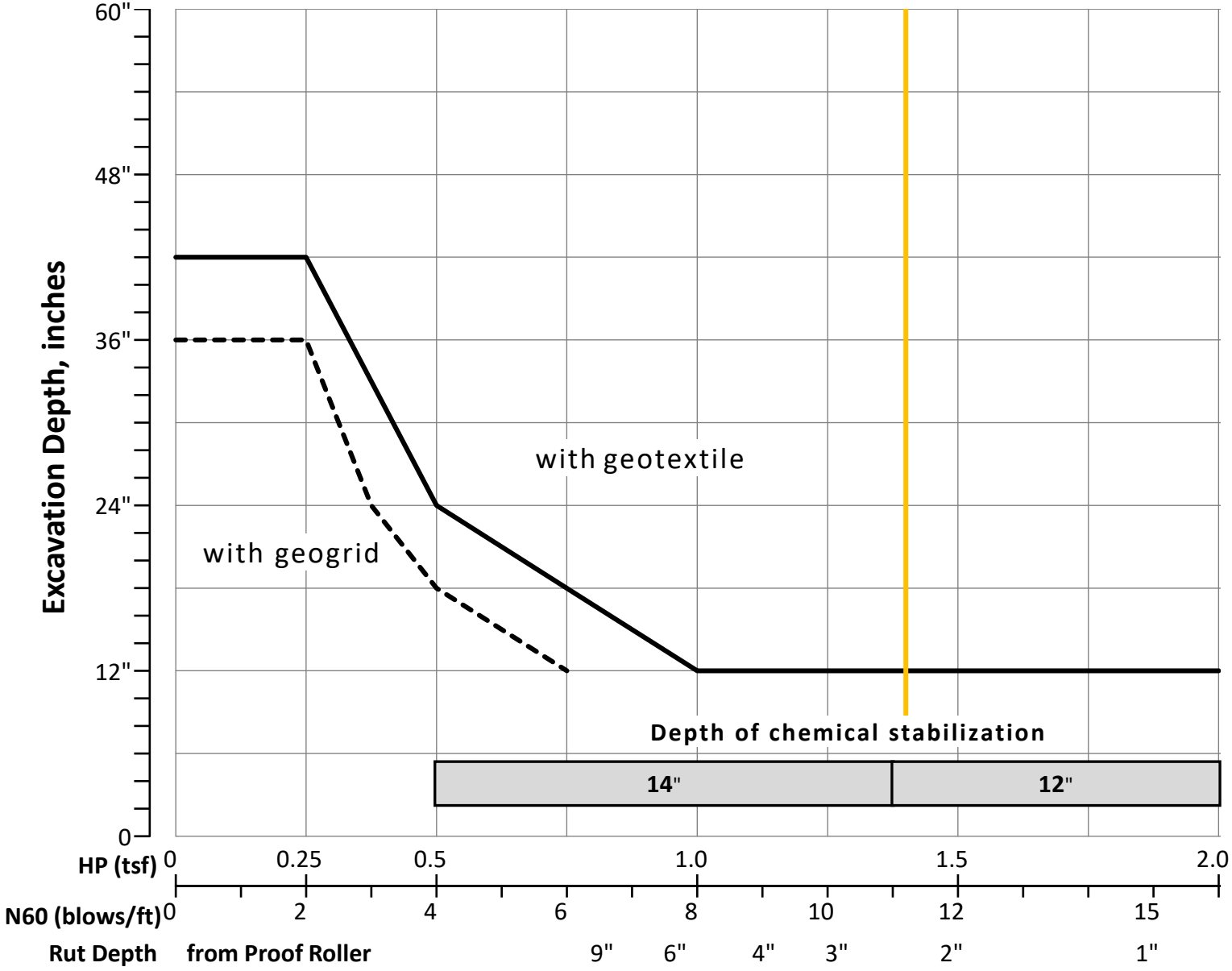
% Proposed Subgrade Surface	
Unstable & Unsuitable	88%
Unstable	88%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	23	11	3.66	49	21	28	41	51	91	20	18	16
Maximum	43	12	4.50	59	24	35	50	58	97	27	21	20
Minimum	10	10	2.00	42	18	20	35	45	83	14	18	12

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	20
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%									100%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.66		☐ HP
11.20		☐ N60L

Average HP
Average N_{60L}