Resource International, Inc.

HAM-75-7.85
HAM-75-0791
I-75 OVER RAMP J SR-562
PID NO. 77889
HAMILTON COUNTY, OHIO

STRUCTURE FOUNDATION EXPLORATION REPORT (REV. 1)

Prepared For:
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Rii Project No. B-10-020

June 2023

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June 20, 2023

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Re: Structure Foundation Exploration (Rev. 1)
HAM-75-7.85
HAM-75-0791 – I-75 over Ramp J SR-562
PID No. 77889
Rii Project No. B-10-020

Ms. Cueva:

Resource International, Inc. (Rii) is pleased to submit this revised structure foundation exploration report for the referenced project. Engineering logs have been prepared and are attached to this report along with the results of laboratory testing. This report includes recommendations for the proposed replacement of the HAM-75-0791 bridge carrying Interstate 75 over Ramp J of State Route 562 as part of the HAM-75-7.85 project. The proposed bridge is located approximately 2.6 miles south of the Lockland Split on the north side of Cincinnati, in Hamilton County, Ohio.

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.

Brian Trenner

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Enclosure: Structure Foundation Exploration Report (Rev. 1)

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EXECUTIVE SUMMARY

Resource International, Inc. (Rii) has completed a structure foundation exploration performed for the HAM-75-0791 bridge structure carrying the I-75 over Ramp J of SR-562. The existing structure is three-span bridge with a total length of approximately 130 feet. It is understood that the existing structure will be completely removed and that the proposed structure will be located approximately 40 feet north of the existing structure and will consist of a single-span steel beam structure with a reinforced concrete deck and a total length of approximately 125 feet.

A preliminary structure foundation exploration was performed by CTL Engineering for this bridge structure replacement as part of the HAM-75-2.30 Step 7 Preliminary Engineering (PID No. 76257) and their findings are presented in the report dated December 17, 2007. No additional borings were obtained at this structure for the current exploration. Therefore, all recommendations contained herein are based on information obtained from the preliminary exploration. For a complete summary of the field operations and findings for the borings performed by CTL Engineering, please reference the December 2007 report.

Exploration and Findings

Two borings, designated as B-160-0-07 and B-162-0-07, were performed for this bridge, both near the proposed rear abutment location, as part of a preliminary geotechnical exploration performed CTL Engineering. The borings were advanced to a completion depth of 115.0 and 95.0 feet below the existing ground surface, respectively.

In general, the borings performed by CTL encountered primarily cohesive soils with intermittent seams of granular material. The cohesive soils were generally described as soft to hard, gray, brown, brownish gray and dark brown sandy silt, silt, silt and clay, silty clay and clay (ODOT A-4a, A-4b, A-6a, A-6b, A-7-6). The granular soils were generally described as loose to very dense granular soil generally described as brown, gray and dark gray gravel, gravel with sand, silt and clay, fine sand and coarse and fine sand (ODOT A-1-a, A-2-6, A-3, A-3a). Groundwater was encountered in borings B-160 and B-162 at an elevation of 499.6 and 511.7 feet msl, respectively. Bedrock was not encountered in any of the borings performed for this exploration.

Analyses and Recommendations

Design details of the structure proposed were provided to Rii by EMH&T. It is understood that the new structure will consist of a single-span steel beam structure with a reinforced concrete deck, semi-integral abutments supported on deep foundation systems comprised of driven piles and an MSE wall at the rear abutment and soldier pile and lagging wall with tieback anchors at the forward abutment. It is understood that the proposed structure will be located approximately 40 feet north of the existing structure, and that the existing structure will be completely removed.

Deep Foundation Recommendations

It is recommended that a deep foundation system consisting of driven piles be employed for support of the proposed bridge foundation elements. Based on the soil encountered at this site, it is recommended that 16.0-inch cast-in-place (CIP) pipe piles (ODOT Item 507.06) be employed for foundation support. The following table shows recommended pile lengths of the CIP pipe piles and the corresponding ultimate bearing value (R_{ndr}) and LRFD reduction factors (φ).

Pile Recommendations

Boring No.	Ground Elevation [1] (feet msl)	Pile Size [2]	Elevations (feet msl)		Embedment Depth [4] (feet)	R_{ndr} [5,6] (kips/pile)	Sleeve Length [7] (feet)	φ [8]
			Top [3]	Tip				
B-162 (Rear Abutment)	516.2	16" CIP	525.9	445.8	65	246 / 336	21.7	0.7
B-162 (Forward Abutment)	516.2	16" CIP	526.6	458.6	68	255 / 365	N/A	0.7

1. *Ground elevation listed is the ground elevation at the boring location.*
2. *The pile wall thickness utilized in the analysis was determined in accordance with the equation provided in ODOT Item 507.06 and was rounded up to the nearest 1/16-inch increment.*
3. *Pile top elevation is at the proposed bottom of footing elevation.*
4. *Embedment depths represent the length of pile in contact with the soil.*
5. *The embedment depth and corresponding ultimate bearing value listed above are based on the maximum driving depth that can be achieved based on driveability requirements for the pile wall thickness required per ODOT Item 506.07.*
6. *The ultimate bearing value listed does not include capacity reduction due to downdrag loads at the rear abutment. Downdrag loads and considerations are presented in Section 5.1.2 of the full report. The first value listed is the ultimate bearing value during the driven condition (immediately after driving the pile). The second value listed is the ultimate bearing value after soil setup has occurred following* ***a minimum waiting period of 5 days after the initial drive*** *(at the time of restrike on the pile). Note that the values provided are based on the static analysis performed and represent the anticipated resistance available. The design plans should list the required UBV based on the pile loading.*
7. *Sleeve length represents the required length of pile that should be sleeved within the MSE wall backfill at the rear abutment, including the 6.5-foot undercut depth below the bottom of wall elevation.*
8. *The resistance factor listed considers dynamic testing of the pile elements will be performed per Section 303.4.2.7 of the ODOT BDM. Alternate resistance factors may be applied based on the type and frequency of field testing specified.*

NOTE: The top of pile elevation coincides with the bottom of footing elevations, and the estimated pile lengths reflect exclusively the length of the pile in contact with the soil. **Embedment length of the pile into the footing is not included.** Estimated pile lengths are rounded up to the nearest foot.

The anticipated total settlement at the facing of the MSE wall at the rear abutment is 5.35 inches. Given the anticipated amount of settlement at the MSE wall facing, downdrag loads may be induced on the pile elements if installed to the final tip elevation prior to construction of the walls. Based on the results of the settlement analysis, the time rate of consolidation to achieve 0.4 inches of total settlement is 350 days, which is well beyond a reasonable timeframe for a hold period. Therefore, the rear abutment will need to be designed to accommodate the estimated drag load.

The depth of the neutral plane is 31.0 feet below the bottom of wall elevation at the rear abutment, and the calculated drag load based on the depth of the neutral plane is 86 kips. Per Section 305.3.2.2 of the 2020 ODOT BDM, the factored structural axial resistance of the pile at the strength limit state shall equal or exceed the combined effect of the factored drag load and the maximum factored load per pile. Based on a maximum factored load of 230 kips/pile and a drag load of 93 kips at the rear abutment, the combined factored load of 323 kips/pile at the rear abutment is less than the factored structural pile resistance.

In addition to resisting the factored drag load on the piles, the bridge design will need to accommodate the anticipated soil settlement and elastic compression of the pile due to the combined structure load and drag load under service (unfactored) loading conditions within the depth to the neutral plane. Based on a combined service load of 206 kips at the rear abutment, the resulting elastic compression is 0.144 inches.

The total settlements noted in the last column in the following table will need to be accommodated in the bridge design, provided the piles are driven to the final pile tip elevation following completion of construction of the MSE wall (including placement of a surcharge up to the roadway profile grade) or specified hold period at the rear abutment.

Summary of Settlement Analysis at Rear Abutment [1]

Duration Following Completion of Construction (days)	Settlement within Depth of Neutral Plane (inches)	Elastic Compression of Pile within Depth of Neutral Plane (inches)	Total Settlement within Depth of Neutral Plane (inches)
0	3.590	0.144	3.734
30	1.284	0.144	1.428
45	1.002	0.144	1.146
60	0.806	0.144	0.950
75	0.676	0.144	0.820
90	0.569	0.144	0.713

1. *The analysis assumes the placement of a surcharge load in order to preload the site under the full weight of the MSE wall height (from the bottom of wall elevation to the profile grade of the roadway).*

MSE Wall Recommendations

It is proposed to construct an MSE wall at the rear abutment of the proposed structure. Based upon the proposed plan information, a wall height of 28.6 feet from the top of the leveling pad to the proposed profile grade of the roadway is anticipated at the rear abutment.

The anticipated bearing materials at the rear abutment consist of medium stiff to stiff clay (ODOT A-7-6). Soft to medium stiff clay (ODOT A-7-6) was encountered at the proposed bearing elevation in boring B-162 and extending to a depth of 6.5 feet below the ground surface. Hand penetrometer values were not provided on the boring logs; however, based on the low blow counts obtained within this soil layer, it recommended that this material be stabilized or excavated and replaced with suitable embankment fill to provide a stable bearing surface for the MSE wall. In addition, groundwater was encountered in boring B-162 at an elevation of 511.2 feet msl, which is approximately at the proposed bearing elevation.

MSE wall foundations bearing on this soil or engineered fill, placed and compacted as described in Section 5.5 of the full report, may be proportioned for a nominal bearing resistance as indicated in the following table. A geotechnical resistance factor of φ_b=0.65 was considered in calculating the factored nominal bearing resistance at the strength limit state. Based on the minimum length of reinforced soil mass presented in the table below and utilizing the soil parameters listed in Section 5.2.1 of the full report, the bearing pressure on the front portion of the wall **will not exceed** the factored nominal bearing resistance at the strength limit state at the rear abutment provided the subgrade is prepared as noted above.

HAM-75-0791 MSE Wall Spread Footing Design Parameters

Boring No.	Maximum Wall Height (ft)	Minimum Reinforcement Length [1]	Nominal Bearing Resistance (ksf)		Total Settlement [3] (inches)
			Service	Strength [2]	
B-162 (Rear Abutment)	28.6	0.9(H)	3.9	11.8	6.77 / 5.35

1. *The minimum reinforcement length is expressed as a percentage of the wall height, H.*
2. *The nominal bearing resistance at the strength limit state is unfactored. Rii recommends that a resistance factor of φ_b=0.65 be considered when calculating the factored nominal bearing resistance at the strength limit state.*
3. *The first value represents the anticipated total settlement at the center of the reinforced soil mass, and the second values represents the anticipated total settlement at the facing of the wall.*

For MSE walls bearing on soil, the limiting eccentricity is one-fourth of the base width of the wall. Based on the soil parameters listed in Section 5.2.1 of the full report, for an MSE wall designed with a minimum strap length as noted above, the calculated eccentricity of the resultant force **will not exceed** the limiting eccentricity at the strength limit state.

Based on the soil parameters listed in Section 5.2.1 of the full report, for an MSE wall designed with minimum a strap length as noted above, the resultant horizontal forces on the back of the MSE wall **will not exceed** the factored shear resistance at the strength limit state.

Based on the soil parameters listed in Section 5.2.1 of the full report for the foundation and reinforced soil backfill, a coefficient of sliding friction of 0.38 was utilized for design at the rear abutment. A geotechnical resistance factor of φ_{τ}=1.0 was considered when calculating the factored shear resistance between the foundation soil and reinforced soil backfill for sliding. Based on the minimum length of reinforced soil mass presented in above and utilizing the soil parameters listed in Section 5.2.1 of the full report for the for the foundation and reinforced soil backfill, the resultant horizontal forces on the back of the MSE wall **will not exceed** the factored shear resistance at the strength limit state.

Overall (global) stability for MSE walls supporting structural elements is satisfied when a minimum factor of safety of 1.5 is obtained under loading conditions at the service limit state. Based on the soil parameters listed in Section 5.2.1 of the full report, for MSE walls designed with minimum strap lengths as noted above, the resulting factor of safety under drained and undrained conditions was greater than 1.5.

Soldier Pile and Lagging Wall Recommendations

It is proposed to construct a soldier pile and lagging (SPL) retaining wall at the forward abutment of the proposed structure. Based on preliminary design information provided by EMH&T, it is understood that the top of wall will generally follow along the bottom of footing elevation of the abutment, and that the bottom of wall elevation will vary from approximately 515.0 at the east side of the structure to approximately 519.0 at the west side of the abutment. It is understood that a steel H-pile section will be utilized and embedded within a drilled shaft below the proposed bottom of wall grade and that tieback anchors will be utilized to provide resistance to any lateral forces exerted on the wall by the abutment footing. The following material properties should be utilized for determining the required section size for the H-piles and embedment depth of the drilled shaft.

1. Retained Soil

- φ = 26°
- c = 0 psf
- γ = 120 pcf
- k_a = 0.39

2. Bearing Soil (below the bottom of wall)

- φ = 24°
- c = 100 psf
- γ = 115 pcf
- k_p = 2.37
- s_u = 1000 psf

For H-pile sizes of HP10x42, HP12x53 and HP14x73 sizes (and other similar sizes), it is recommend that a shaft diameter of 2.0 feet be utilized for the embedded section of the pile. Depending on the final loading conditions and the section size utilized, it is anticipated that the required embedment depth will range between 1.0 and 2.0 times the height of the wall. Drilled shafts bearing at or below this elevation may be proportioned for a nominal bearing resistance as shown in the following table. Based on this angle of inclination, the tieback anchors will likely be installed with the bonded zone within the existing embankment material. An estimated adhesion value of 1,000 psf should be utilized for design of the tieback anchors for the wall.

Axial Design Parameters

Boring No.	Elevation (feet)	Shaft Length (feet)	Nominal Resistance [1]	
			End (ksf)	Side (ksf) [2]
B-162 (Forward Abutment)	513.0 – 492.0	0 – 21	7.0	0.40
	492.0 – 462.0	21 – 51	25.0	1.50
	462.0 – 458.0	51 – 55	110	0.65
	458.0 – 448.0	55 – 65	29.0	1.70

1. *A resistance factor of 0.40 and 0.45 should be applied to the nominal end bearing and side friction resistance, respectively, for shafts that end bear or penetrate within cohesive soil layers.*
2. *Side resistance should be neglected for the upper 5.0 feet of soil and the bottom one-diameter length of the pile.*

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

The overall purpose of this project is to provide detailed subsurface information and recommendations for the design and construction of the HAM-75-7.85 project in Hamilton County, Ohio. This project represents the northern portion of HAM-75-2.30 Mill Creek Expressway improvements. The project will consist of roadway improvements, several new retaining walls and bridge replacements along I-75 from Vine Street to State Route 126. The project site is located in the community limits of St. Bernard, Elmwood Place, Roselawn, and Cincinnati, in Hamilton County, Ohio.

This report is a presentation of the structure foundation exploration performed for the HAM-75-0791 bridge structure carrying the I-75 over Ramp J of SR-562, as shown on the vicinity map and boring plan presented in Appendix II. The existing structure is three-span bridge with a total length of approximately 130 feet. It is understood that the existing structure will be completely removed and that the proposed structure will be located approximately 40 feet north of the existing structure and will consist of a single-span steel beam structure with a reinforced concrete deck and a total length of approximately 125 feet.

A preliminary structure foundation exploration was performed by CTL Engineering for this bridge structure replacement as part of the HAM-75-2.30 Step 7 Preliminary Engineering (PID No. 76257) and their findings are presented in the report dated December 17, 2007. No additional borings were obtained at this structure for the current exploration. Therefore, all recommendations contained herein are based on information obtained from the preliminary exploration. For a complete summary of the field operations and findings for the borings performed by CTL Engineering, please reference the December 2007 report.

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 Site Geology

Both the Illinoian and Wisconsinan glaciers advanced over two-thirds of the State of Ohio, leaving behind glacial features such as moraines, kame deposits, lacustrine deposits and outwash terraces. The glacial and non-glacial regions comprise five physiographic sections grouped by age, depositional process and geomorphic occurrence. Physiographically, the site lies within the Illinoian Till Plain of the Till Plains Section. This area is characterized by rolling ground moraine deposits with many buried valleys alternating between broad floodplains and bedrock gorges. The site area contains silty loam till deposited as ground moraine covered with loess and dissected by the modern day Mill Creek. Ground moraines are deposited during the retreat of a glacier which results in an undifferentiated mixture of clay, silt, sand and gravel. The valley area also contains outwash and alluvium which eroded from hills and valleys with moderate relief. Outwash deposits consist of undifferentiated sand and gravel deposited by meltwater in front of glacial ice and often occurs as valley terraces or low plains.

Alluvium and alluvial terrace deposits range in composition from silty clay particles to cobbles, usually deposited in present and former floodplain areas.

Based on Bedrock Geology and Topography Maps of the area, from the Ohio Department of Natural Resources (ODNR), the underlying bedrock consists of the Ordovician-aged Point Pleasant Formation. The Point Pleasant Formation, encountered in the bedrock valleys, is comprised of interbedded limestone and shale, averaging 60 percent limestone and 40 percent shale, and ranges from 0 to 80 feet thick. The bedrock surface forms a narrow valley roughly beneath, and following, SR 562 and is aligned northwest to southeast in the vicinity of the site. The bedrock valley continues crossing under I-75 to the west of the site where the alignment of the valley changes to northeast to southwest, roughly following the existing Mill Creek Valley. The bedrock surface at the bottom of this valley is at an approximate elevation of 350 feet mean sea level (msl). According to bedrock topography mapping, the overburden soil in the vicinity of the site is approximately 170 feet thick. An illustration of the general geology of Ohio is presented in Appendix I.

2.2 Existing Conditions

The site for the proposed HAM-75-0791 structure is located approximately 40 feet north of the existing overpass of I-75 over SR-562 Ramp J, approximately 2.6 miles south of the Lockland Split. The existing structure is a three-span bridge that is approximately 125 feet wide and 130 feet long and carries six lanes of traffic for both northbound and southbound I-75 over Ramp J and under Ramp M of SR-562. Ramp J underneath I-75 is a single-lane, asphalt paved roadway that carries traffic from I-75 southbound to SR-562 eastbound. The terrain in the vicinity of the structure is undulated due to the presence of the existing embankments that support the roadway and abutments of the ramp bridge structures at the interchange, and I-75 through this area is relatively flat.

3.0 EXPLORATION

A preliminary geotechnical exploration was performed within this project study area by CTL Engineering for the HAM-75-2.30 project (PID No. 76257). Their findings were published in a report dated December 17, 2007. Two borings, designated as B-160-0-07 and B-162-0-07, were performed for this bridge, both near the proposed rear abutment location. The borings were advanced to a completion depth of 115.0 and 95.0 feet below the existing ground surface, respectively, and SPT sampling was performed at a maximum of 5.0-foot intervals to obtain representative soil samples for laboratory classification testing. Rii has included a plan showing the soil borings performed in the project area in Appendix II.

An automatic drop hammer was utilized by CTL Engineering to generate consistent energy transfer to the sampler. No calibration data is available for the hammer used during the SPT testing for the borings performed for this project. Therefore, an estimated drill rod energy ratio of 80 percent was utilized to determine the energy corrected blow counts.

4.0 FINDINGS

In general, the borings performed by CTL encountered primarily cohesive soils with intermittent seams of granular material. The cohesive soils were generally described as soft to hard, gray, brown, brownish gray and dark brown sandy silt, silt, silt and clay, silty clay and clay (ODOT A-4a, A-4b, A-6a, A-6b, A-7-6). The granular soils were generally described as loose to very dense granular soil generally described as brown, gray and dark gray gravel, gravel with sand, silt and clay, fine sand and coarse and fine sand (ODOT A-1-a, A-2-6, A-3, A-3a). Groundwater was encountered in borings B-160 and B-162 at an elevation of 499.6 and 511.7 feet msl, respectively.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the drilling and testing program have been used to determine foundation support capabilities and the settlement potential for the soil encountered at the site. These parameters have been used to provide guidelines for the design of the structure foundation systems, as well as the construction specifications related to the placement of foundation systems and general earthwork recommendations, which are discussed in the following paragraphs.

Design details of the structure proposed were provided to Rii by EMH&T. It is understood that the new structure will consist of a single-span steel beam structure with a reinforced concrete deck, semi-integral abutments supported on deep foundation systems comprised of driven piles and an MSE wall at the rear abutment and soldier pile and lagging wall with tieback anchors at the forward abutment. It is understood that the proposed structure will be located approximately 40 feet north of the existing structure, and that the existing structure will be completely removed.

Proposed structural data was obtained from design details provided by EMH&T and are included in Table 1:

Table 1. Structure & Bridge Design Elevations

Reference	Reference Boring	Structure Component	Elevation [1] (feet msl)
Rear Abutment	B-162-0-07	Profile Grade	539.4
		Bottom of Footing	525.9
		Bottom of Wall (Leveling Pad)	510.8
Forward Abutment	B-162-0-07	Profile Grade	539.3
		Bottom of Footing	526.6
		Bottom of Wall	512.3 / 526.1

1. *Boring B-062 was used for the analysis at both the rear and forward abutments.*
2. *Elevations based on structure information provided by EMH&T. Multiple values at the forward abutment indicate that the bottom of wall elevation increases from west to east along the length of the abutment. The elevations listed indicate the lowest and highest elevations along the abutment.*

Borings B-160 and B-162 were both performed near the rear abutment location. Boring B-160 was performed approximately 40 feet east of the proposed rear abutment location. Given the significant distance of this boring with respect to both abutment locations, boring B-162 was utilized in the analysis for both the rear and forward abutments.

In addition to the design elevations, proposed structural loading information was provided by EMH&T for each substructure unit and are included in Table 2:

Table 2. Structural Loading Details

Substructure Reference	Maximum Factored Load per Pile (kips)	Required R_{ndr} per Pile [1] (kips)
Rear Abutment	230	329
Forward Abutment	230	329

1. *Required R_{ndr} based on a resistance factor of 0.7.*

5.1 Deep Foundation Recommendations

It is recommended that a deep foundation system consisting of driven piles be employed for support of the proposed bridge foundation elements. Based on the soil encountered at this site, it is recommended that 16.0-inch cast-in-place (CIP) pipe piles (ODOT Item 507.06) be employed for foundation support. Table 3 shows recommended pile lengths of the CIP pipe piles and the corresponding ultimate bearing value (R_{ndr}) and LRFD reduction factors (φ).

Table 3. Pile Recommendations

Boring No.	Ground Elevation [1] (feet msl)	Pile Size [2]	Elevations (feet msl)		Embedment Depth [4] (feet)	R_{ndr} [5,6] (kips/pile)	Sleeve Length [7] (feet)	φ [8]
			Top [3]	Tip				
B-162 (Rear Abutment)	516.2	16" CIP	525.9	445.8	65	246 / 336	21.7	0.7
B-162 (Forward Abutment)	516.2	16" CIP	526.6	458.6	68	255 / 365	N/A	0.7

1. *Ground elevation listed is the ground elevation at the boring location.*
2. *The pile wall thickness utilized in the analysis was determined in accordance with the equation provided in ODOT Item 507.06 and was rounded up to the nearest 1/16-inch increment.*
3. *Pile top elevation is at the proposed bottom of footing elevation.*
4. *Embedment depths represent the length of pile in contact with the soil.*
5. *The embedment depth and corresponding ultimate bearing value listed above are based on the maximum driving depth that can be achieved based on driveability requirements for the pile wall thickness required per ODOT Item 506.07.*
6. *The ultimate bearing value listed does not include capacity reduction due to downdrag loads at the rear abutment. Downdrag loads and considerations are presented in Section 5.1.2. The first value listed is the ultimate bearing value during the driven condition (immediately after driving the pile). The second value listed is the ultimate bearing value after soil setup has occurred following* ***a minimum waiting period of 5 days after the initial drive*** *(at the time of restrike on the pile). Note that the values provided are based on the static analysis performed and represent the anticipated resistance available. The design plans should list the required UBV based on the pile loading.*
7. *Sleeve length represents the required length of pile that should be sleeved within the MSE wall backfill at the rear abutment, including the 6.5-foot undercut depth below the bottom of wall elevation.*
8. *The resistance factor listed considers dynamic testing of the pile elements will be performed per Section 303.4.2.7 of the ODOT BDM. Alternate resistance factors may be applied based on the type and frequency of field testing specified.*

NOTE: The top of pile elevation coincides with the bottom of footing elevations, and the estimated pile lengths reflect exclusively the length of the pile in contact with the soil. **Embedment length of the pile into the footing is not included.** Estimated pile lengths are rounded up to the nearest foot.

No soil boring was obtained at the forward abutment; therefore, the soil conditions within the upper soils of the existing embankment were conservatively estimated using engineering judgment. It is recommended that a confirmation boring be conducted near the proposed forward abutment location to verify the soil conditions of the existing embankment as well as the subsurface soils in which the piles will be installed.

The piles were analyzed utilizing DRIVEN software (Appendix V). The ultimate bearing values listed represents the calculated ultimate bearing value at the end of driving the pile (driven condition) and at after soil setup has occurred following a specified waiting period (at restrike), respectively. If it is not intended to verify the pile capacity after a specified waiting period has passed through dynamic testing (restrike of the driven pile), then the ultimate bearing value for the driven condition should be specified in the design documents and utilized in the foundation design. If a dynamic restrike of the pile is specified, then the ultimate bearing value at restrike should be specified in the design documents and utilized in the foundation design. Based on the subsurface conditions encountered, it is recommended that a minimum hold period of five (5) days be specified between the end of driving the pile and the time of restrike to allow adequate soil setup to occur. Note that the values provided in Table 3 are based on the static analysis performed and represent the anticipated resistance available. The design plans should list the required UBV based on the pile loading. Settlement is estimated to be less than 1.0 inch for CIP piles driven to the frictional resistance values listed in Table 3.

A drivability analysis in accordance with Section 10.7.8 of the 2010 AASHTO LRFD Bridge Design Specifications (BDS) was also performed using the GRLWEAP program, and results of this analysis are presented in Section 5.1.1 of this report. Please note that the embedment depth and corresponding ultimate bearing value for CIP piles presented in Table 3 are based on the maximum embedment depth that can be achieved for the required pile wall thickness as determined below based on driveability requirements. The minimum wall thickness utilized in the driveability analysis for CIP piles was determined from the following equation per ODOT Item 507.06 for the ultimate bearing value listed in Table 3.

$$t = UBV / 900{,}000$$

Where:
t = pile wall thickness in inches
UBV = design ultimate bearing value in pounds

We emphasize that the pile lengths and ultimate bearing values presented in Table 3 are estimates using empirical equations based on the derived characteristics of the soils encountered in the subject borings drilled. The most accurate method for determining pile capacities and lengths is to drive test piling at the site and perform static load testing in accordance with the ASTM D1143 procedure. Dynamic pile load testing should be performed in accordance with ASTM D4945. The actual pile capacities should be verified using static or dynamic pile load testing as detailed in the 2007 ODOT Bridge Design Manual (BDM). Further installation considerations are presented in Section 5.1.3.

The geotechnical resistance factor listed in Table 3 represents the recommended value based on the performance of a minimum of two dynamic pile load tests at the site as specified in Section 303.4.2.7 of the 2007 ODOT BDM. A higher resistance factor may be utilized if alternate or additional field load testing of the pile elements is performed. The 2010 AASHTO LRFD BDS provides alternate resistance factors for use in design based on the type and frequency of field load testing. Figure 1 presents the various testing types and frequency of testing, and lists the corresponding resistance factor that may be selected. ***If no field load testing of the piles (static or dynamic) is performed, then a geotechnical resistance factor of 0.35 should be used for design.***

Figure 1. AASHTO Resistance Factors for Driven Pile Foundations

Table 10.5.5.2.3-1—Resistance Factors for Driven Piles

Condition/Resistance Determination Method		Resistance Factor
Nominal Bearing Resistance of Single Pile—Dynamic Analysis and Static Load Test Methods, φ_{dyn}	Driving criteria established by successful static load test of at least one pile per site condition and dynamic testing* of at least two piles per site condition, but no less than 2% of the production piles	0.80
	Driving criteria established by successful static load test of at least one pile per site condition without dynamic testing	0.75
	Driving criteria established by dynamic testing* conducted on 100% of production piles	0.75
	Driving criteria established by dynamic testing,* quality control by dynamic testing* of at least two piles per site condition, but no less than 2% of the production piles	0.65
	Wave equation analysis, without pile dynamic measurements or load test but with field confirmation of hammer performance	0.50
	FHWA-modified Gates dynamic pile formula (End of Drive condition only)	0.40
	Engineering News (as defined in Article 10.7.3.8.5) dynamic pile formula (End of Drive condition only)	0.10

* Dynamic testing requires signal matching, and best estimates of nominal resistance are made from a restrike. Dynamic tests are calibrated to the static load test, when available.

5.1.1 Driveability

Rii performed a driveability analysis using GRLWEAP (Appendix VI). In the driveability analysis, a Delmag 19-42 hammer with a rated energy of approximately 43,000 ft-lbs was used in conjunction with the CIP pipe pile sections. Based on the results of this analysis using a wall thickness as determined from ODOT Item 507.06, it appears that the driving stresses induced on the CIP pipe piles **would not exceed** 90 percent of the yield stress for A252, Grade 2 steel (f_y = 35 ksi, 0.9f_y = 31.5 ksi) if driven to the depths provided in Table 3. Please note that the required pile wall thickness was determined using the equation provided in ODOT Item 507.06, and that the pile wall thickness utilized in the driveability analysis was rounded up to the near 1/16-inch increment unless otherwise noted in Table 3.

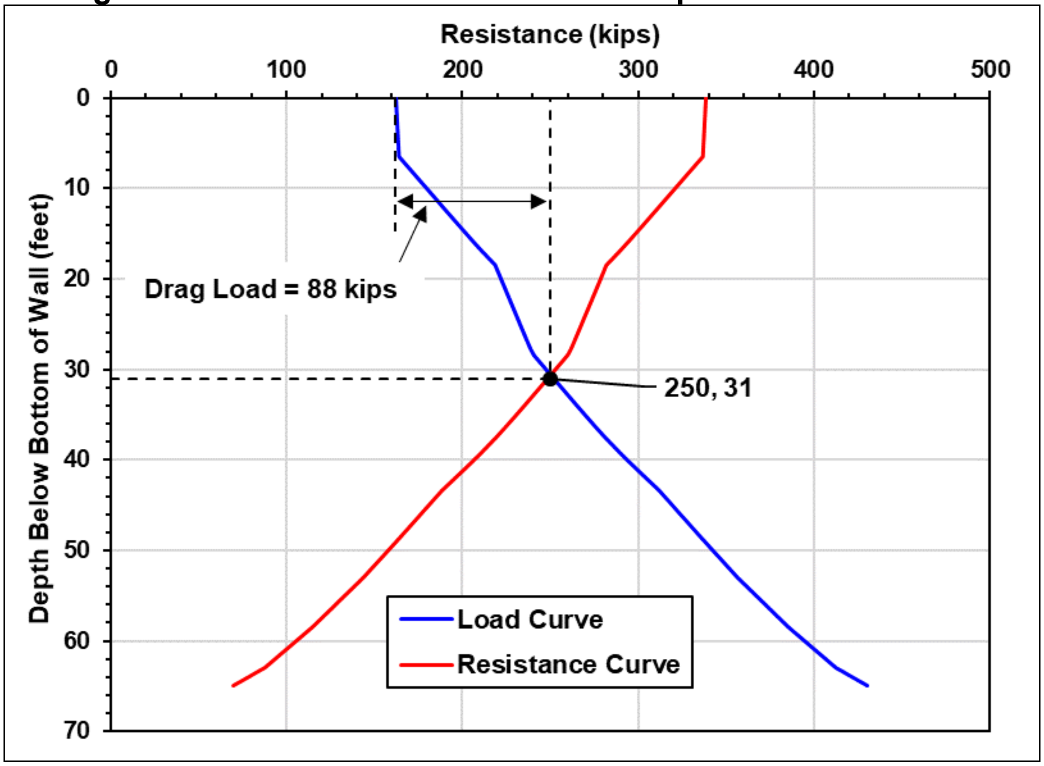
Since no boring was advanced at the proposed forward abutment location, actual driving conditions during pile installation may differ from the conditions predicted in the analysis and provided above.

5.1.2 Downdrag Considerations

The anticipated total settlement at the facing of the MSE wall at the rear abutment is 5.35 inches. Given the anticipated amount of settlement at the MSE wall facing, downdrag loads may be induced on the pile elements if installed to the final tip elevation prior to construction of the walls. To reduce the amount of downdrag induced on the piles, it is recommended that the piles be pre-driven into the soil only as far as necessary to remain vertical, and that the MSE wall should be constructed around the piles and then allowed to sit for a specified holding period such that settlement of the underlying foundation soils can occur prior to driving the piles the to the design tip elevation and reduce or eliminate the amount of downdrag on the piles. Downdrag loads will fully develop when then relative movement of the soil surrounding the piles exceeds 0.4 inches. Per Section 305.3.2.2 of the 2020 ODOT BDM, downdrag should be evaluated using the neutral plane method as outlined in Section 7.3.5.7 and 7.3.6.1 of FHWA Geotechnical Engineering Circular 12 (GEC 12) “Design and Construction of Driven Pile Foundations” (FHWA-NHI-16-009/010). Per the neutral plane methodology, drag loads will develop along the length of the pile above the neutral plane.

Based on the results of the settlement analysis, the time rate of consolidation to achieve 0.4 inches of total settlement is 350 days, which is well beyond a reasonable timeframe for a hold period. Therefore, the rear abutment will need to be designed to accommodate the estimated drag load. Figure 2 is a plot of the axial load and resistance based on the bearing resistance from the DRIVEN analysis included in Appendix V and service load on the piles (162 kips), which indicates the neutral plane depth below the bottom of footing based on fully mobilized toe resistance in accordance with Section 305.3.2.2 of the 2020 ODOT BDM.

Figure 2. Axial Load and Resistance Graph – Rear Abutment



Based on the results of the bearing plot, the depth of the neutral plane is 31.0 feet below the bottom of wall elevation at the rear abutment, and the calculated drag load based on the depth of the neutral plane is 88 kips.

Per Section 305.3.2.2 of the 2020 ODOT BDM, the factored structural axial resistance of the pile at the strength limit state shall equal or exceed the combined effect of the factored drag load and the maximum factored load per pile. For piles subject to downdrag loads, the factored structural resistance of the pile shall consider a resistance factor of 0.7, which results in a factored structural resistance of 886 kips for a 16-inch pipe pile with a pile wall thickness of 0.375 (3/8) inches. A load factor of 1.05 should be applied to the unfactored downdrag load when determining the factored downdrag load per pile at the strength limit state and should be added to the factored load per pile from the superstructure. Based on a maximum factored load of 230 kips/pile and a drag load of 93 kips at the rear abutment, the combined factored load of 323 kips/pile at the rear abutment <u>is less than</u> the factored structural pile resistance.

In addition to resisting the factored drag load on the piles, the bridge design will need to accommodate the anticipated soil settlement and elastic compression of the pile due to the combined structure load and drag load under service (unfactored) loading conditions within the depth to the neutral plane. For the elastic compression of the pile, since the drag load increases with depth from 0 kips at the top of the pile and bottom of wall elevation to the maximum drag load at the depth of the neutral plane, the average drag load was used in the calculation. Based on a combined service load of 206 kips at the rear abutment, the resulting elastic compression is 0.144 inches.

For the soil settlement within the depth of the neutral plane, consideration can be given to either driving the piles to the design pile tip elevation immediately following construction of the MSE wall, or a hold period can be specified following the completion of construction to drive the piles to the required pile tip elevation in an effort to reduce the amount of settlement that will need to be accommodated within the depth of the neutral plane. In order to consolidate the underlying soil to the required settlement, consideration should be given to the placement of a surcharge load in order to preload the site under the full weight of the MSE wall height (from the bottom of wall elevation to the profile grade of the roadway) and left in place until the end of the specified hold period in order to reduce the settlement along the pile length to the neutral plane.

To determine the estimated settlement remaining following completion of a specified hold period, the time rate of settlement will need to be evaluated. The remaining settlement will depend on the degree of consolidation, which represents the amount of primary consolidation that has occurred during the hold period expressed as a percentage of the total settlement that is anticipated and is calculated using the following equations:

$$U = \sqrt{\frac{4T_v}{\pi}} \times 100\% \text{ for } T_v \leq 0.217;$$

$$U = \left[1 + 10^{-\left(\frac{0.085 + T_v}{0.933}\right)}\right] \times 100\% \text{ for } T_v > 0.217;$$

$$T_v = \frac{c_v t}{H_{dr}^{\,2}}$$

Where:

U = the degree of consolidation

T_v = time factor

c_v = coefficient of consolidation

t = hold period

H_{dr} = length of longest drainage path (half the thickness of the compressible stratum)

Results of the settlement analysis and time rate of consolidation at the rear abutment are summarized in Table 4 below. The total settlements noted in the last column in Table 4 will need to be accommodated in the bridge design, provided the piles are driven to the final pile tip elevation following completion of construction of the MSE wall (including placement of a surcharge up to the roadway profile grade, as outlined in the previous paragraph) or specified hold period at the rear abutment.

Table 4. Summary of Settlement Analysis at Rear Abutment [1]

Duration Following Completion of Construction (days)	Settlement within Depth of Neutral Plane (inches)	Elastic Compression of Pile within Depth of Neutral Plane (inches)	Total Settlement within Depth of Neutral Plane (inches)
0	3.590	0.144	3.734
30	1.284	0.144	1.428
45	1.002	0.144	1.146
60	0.806	0.144	0.950
75	0.676	0.144	0.820
90	0.569	0.144	0.713

1. *The analysis assumes the placement of a surcharge load in order to preload the site under the full weight of the MSE wall height (from the bottom of wall elevation to the profile grade of the roadway).*

It is recommended to install settlement platforms within the MSE wall mass as close to the abutment footing as possible, with a minimum of one (1) settlement platform installed for each phase of construction. Settlement platforms should be installed once the embankment surcharge has been placed to monitor the settlement of the embankment over time. A shorter or longer hold period than specified may be required based on the settlement platform readings as directed by the geotechnical engineer.

5.1.3 Driven Pile Considerations

Proper pile installation is as important as pile design in order to obtain a cost effective and safe product. Driven piles must be installed to develop adequate soil resistance without structural damage. Because piles cannot be visually inspected after installation, direct quality control of the finished product is impossible. Consequently, substantial control must be exercised over peripheral operations leading to the pile placement within the foundation. It is essential that installation be considered during the design stage to ensure that piles shown on the plans can be installed. Construction monitoring should be employed in (1) pile materials, (2) installation equipment, and (3) the estimation of the static load capacity.

It is recommended that the contractor submit a wave equation analysis (bearing graph) of his driving equipment, or the necessary pile driving and equipment data to perform the wave equation analysis, for hammer approval. A constant capacity wave equation analysis (inspector's chart) should also be performed to assist field personnel during inspection in accordance with the 2007 ODOT BDM.

As noted in Section 5.1.1, due to the location and distance of the borings performed for this structure with respect to the substructure units, actual driving conditions during pile installation may differ from the conditions predicted in the analysis. Therefore, it is recommended that pile load testing be performed at each substructure unit to determine the actual pile driving criteria for construction. In addition, consideration could also be given to performing multiple pile load tests at the extreme ends of the abutment footings to determine how the driving criteria may vary along the length of the abutments.

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 that should be used for lateral loading design is provided in Appendix VII. 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 5 lists the 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 5. 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
10	Liquefiable Sand (Rollins)
11	Stiff Clay without free water with a specified initial K (Brown)

5.2 MSE Wall Recommendations

It is proposed to construct an MSE wall at the rear abutment of the proposed structure. MSE walls are constructed on earthen foundations at a minimum depth of 3.0 feet below grade, as defined by the top of the leveling pad to the ground surface located 4.0 feet from the face of the wall. Note that the reinforced soil mass extends from the foundation bearing elevation to the top of MSE wall. The width of the MSE wall foundation (B) is defined by the length of the reinforced soil mass. Per the ODOT BDM (October 2007) and Supplemental Specification (SS) 840, the minimum length of the reinforced soil mass is equal to 70 percent 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-inches of unreinforced concrete should be placed at the base of the wall for constructability purposes. Please note that the leveling pad is not a structural foundation.

Based upon the proposed plan information, a wall height of 28.6 feet from the top of the leveling pad to the proposed profile grade of the roadway is anticipated at the rear abutment. Therefore, it is considered that the minimum reinforcement length and the effective foundation width (B) of the MSE wall for external and global stability calculations will be approximately 20.0 feet. For the analysis, the foundation width was set at 70 percent of the wall height and the foundation width was increased, if required, until external and global stability requirements were satisfied for various wall heights and subsurface conditions.

It is recommended that the foundation subgrade (beneath the reinforced soil mass) for the MSE wall be critically proof-rolled and stabilized to create a workable subgrade for the MSE wall reinforced soil mass. Unstable soils, primarily those containing silt (A-4a/A-4b), if encountered, may be stabilized as noted below:

- Undercut 24 inches +/- pending results of proof-roll;
- Place ODOT Item 712.09 Type D Geotextile Fabric;
- Placement of 24 inches of 703. 02A Granular Fill.

Please note that this recommendation for stabilization of unsuitable soils, as identified during the proof roll of the subgrade, are in addition to the foundation preparation measures provided in ODOT SS 840.

Soft to medium stiff clay (ODOT A-7-6) was encountered at the proposed bearing elevation in boring B-162 and extending to a depth of 6.5 feet below the bottom of wall elevation. Hand penetrometer values were not provided on the boring logs; however, based on the low blow counts obtained within this soil layer, it recommended that this material be stabilized or excavated and replaced with suitable embankment fill to provide a stable bearing surface for the MSE wall. In addition, groundwater was encountered in boring B-162 at an elevation of 511.2 feet msl, which is approximately at the proposed bearing elevation.

Please note that the bearing soils present at the proposed bearing elevation along the length of the rear abutment may vary from that encountered in the boring performed for this exploration. The entire bearing surface should be closely observed to verify that adequate bearing soils are present at the proposed bearing elevation.

For MSE walls, Rii recommends that consideration be given to driving the piles prior to the placement of fill and sleeving the piles extending above the existing ground surface with a plastic pipe casing as noted in Section 5.1.2. The MSE wall may then be constructed around the pile sleeves to full height.

5.2.1 Strength Parameters Utilized in External and Global Stability Analyses

The shear strength parameters utilized in the external and global stability analyses for the MSE walls at the abutments are provided in Table 6.

Table 6. Shear Strength Parameters Utilized in Stability Analyses

Material Type	Unit Weight, γ (pcf)	Effective Friction Angle, φ' (°)	Effective Cohesion, c' (psf)	Undrained Shear Strength, S_u (psf)
MSE Wall Backfill (Select granular fill)	120	34	0	N/A
Embankment Fill (Select fill material)	120	33	550	2,000
Medium Stiff to Stiff Clay (ODOT A-7-6) [1]	115	21	200	1,500
Very Stiff to Hard Silty Clay (ODOT A-6b) [1]	120	23	426	3,500
Medium Dense Sandy Silt (ODOT A-4a) [3]	125	31	0	N/A

1. *Based on laboratory consolidated undrained triaxial testing performed on an undisturbed samples from the HAM-75-12.60 Part I project.*
2. *Based on laboratory consolidated undrained triaxial testing performed on an undisturbed samples from the adjacent HAM-75-11.09 project.*

Shear strength parameters for the reinforced soil backfill are provided in ODOT SS 840. Per SS 840, the select granular backfill in the reinforced zone must meet the shear strength requirements provided in Table 6.

Shear strength parameters for new embankment fill were determined using ODOT Geotechnical Bulletin 6 (GB-6) as a guide. In Section 5.2.3 below, it is recommended that the embankment fill material be limited to material classifying as sandy silt (ODOT A-4a) soils or granular material in order to satisfy external and global stability requirements. Per ODOT GB-6, the shear strength parameters of A-4a soils utilized in embankments are as noted in Table 6.

The long term shear strength parameters (drained/effective stress) for the natural cohesive soils were determined from consolidated undrained (CU) triaxial compression tests performed on undisturbed samples from the HAM-75-12.60 Part I and the HAM-75-11.09 projects north of this section of I-75. It should be noted that the results of the CU test performed on the A-7-6 material as part of the HAM-75-12.60 Part I project yielded a friction angle of 21 degrees with no cohesion intercept. While the test result yielded no cohesion intercept, most cohesive soils, especially clays similar in composition as the material tested, typically have a natural cohesion component under drained conditions. Taking into account this consideration, a cohesion value was assigned to this material type using engineering judgment. The undrained shear strength for the cohesive soils is based on indirect correlations with SPT blow counts of the soil. The laboratory test results referenced above are provided in Appendix V.

5.2.2 Bearing Stability

The anticipated bearing materials at the rear abutment consist of medium stiff to stiff clay (ODOT A-7-6). As noted in Section 5.2, it is recommended that the soft to medium stiff clay encountered at the bearing elevation in boring B-162 be excavated and replaced with suitable embankment material as noted in Section 5.2.1. MSE wall foundations bearing on this soil or engineered fill, placed and compacted as described in Section 5.5, may be proportioned for a nominal bearing resistance as indicated in Table 7. A geotechnical resistance factor of φ_b=0.65 was considered in calculating the factored nominal bearing resistance at the strength limit state. The reinforcement length presented in the following table represents the minimum foundation width required to satisfy external and global stability requirements, expressed as a percentage of the wall height.

Table 7. HAM-75-0791 MSE Wall Spread Footing Design Parameters

Boring No.	Maximum Wall Height (feet)	Minimum Reinforcement Length [1]	Nominal Bearing Resistance (ksf)		Total Settlement [3] (inches)
			Service	Strength [2]	
B-162 (Rear Abutment)	28.6	0.9(H)	3.9	11.8	6.77 / 5.35

1. *The minimum reinforcement length is expressed as a percentage of the wall height, H.*
2. *The nominal bearing resistance at the strength limit state is unfactored. Rii recommends that a resistance factor of φ_b=0.65 be considered when calculating the factored nominal bearing resistance at the strength limit state.*
3. *The first value represents the anticipated total settlement at the center of the reinforced soil mass, and the second values represents the anticipated total settlement at the facing of the wall.*

Rii performed a verification of the bearing pressure exerted on the subgrade soils for the maximum specified wall height indicated in Table 7. Based on the minimum length of reinforced soil mass presented in Table 7 and utilizing the soil parameters listed in Section 5.2.1, the bearing pressure on the front portion of the wall **will not exceed** the factored nominal bearing resistance at the strength limit state at the rear abutment provided the subgrade is prepared as noted above.

Per Section 204.6.2.1 of the ODOT BDM, “the maximum allowable differential settlement in the longitudinal direction (regardless of the size of panels) is one (1) percent.” Based on the total anticipated settlement at the facing of the wall, maximum differential settlement in the longitudinal direction is anticipated to be 1/450, which is within the tolerable limit of 1/100. If either the total or differential settlement predicted 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. This can be achieved by preloading the site and consolidating the underlying soils prior to constructing the wall. Settlement calculations are provided in Appendix VIII and consolidation test results are provided in Appendix IV.

5.2.3 Eccentricity (Overturning Stability)

The resistance of the MSE wall 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 2010 AASHTO LRFD BDS, for foundations bearing on soil or bedrock, the location of the resultant of the reaction forces shall be within the middle one-half of the base width. Therefore, the limiting eccentricity is one-fourth of the base width of the wall. Rii performed a verification of the eccentricity of the resultant force for the maximum specified wall height indicated in Table 7. Based on the minimum length of reinforced soil mass presented in Table 7 and utilizing the soil parameters listed in Section 5.2.1 for the retained embankment material, the calculated eccentricity of the resultant force **will not exceed** the limiting eccentricity at the strength limit state.

5.2.4 Sliding Stability

The resistance of the MSE wall to sliding will be dependent on the friction between the reinforced soil backfill and bearing soils per Section 11.10.5.3 of the 2010 AASHTO LRFD BDS. For MSE walls, sliding resistance is determined by multiplying a coefficient of sliding friction "f" times 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. Based on the soil parameters listed in Section 5.2.1 for the foundation and reinforced soil backfill, a coefficient of sliding friction of 0.65 was utilized for design at the rear abutment. A geotechnical resistance factor of φ_τ=1.0 was considered when calculating the factored shear resistance between the foundation soil and reinforced soil backfill for sliding. Based on the minimum length of reinforced soil mass presented in Table 7 and utilizing the soil parameters listed in Section 5.2.1 for the for the foundation and reinforced soil backfill, the resultant horizontal forces on the back of the MSE wall **will not exceed** the factored shear resistance at the strength limit state.

5.2.5 Overall (Global) Stability

A slope stability analysis was performed to check the global stability of the wall. As per AASHTO LRFD BDS, safety against soil failure shall be evaluated at the service limit state by assuming the reinforced soil mass to be a rigid body. Soil parameters utilized in external stability analyses are presented in Section 5.2.1. For the global stability condition, it was considered that the failure plane will not cross through the reinforced soil mass.

Per Section 11.6.2.3 of the 2010 AASHTO LRFD BDS, overall (global) stability for MSE walls supporting structural 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 is satisfied when a minimum factor of safety of 1.5 is obtained. For an MSE wall designed with the minimum strap length listed in Table 7, the resulting factor of safety under drained conditions (long-term stability) greater than 1.5. The wall was also evaluated under undrained conditions (short-term stability) to verify the stability of the wall during and immediately following construction. The resulting factor of safety under undrained conditions was also greater than 1.5.

5.2.6 Final MSE Wall Considerations

Based on the results of the external and global stability analysis performed for the MSE walls, the recommended controlling strap length is 0.9 times the height of the MSE wall (measured from the top of the leveling pad to the proposed profile grade of the roadway) at the rear abutment. Global stability was the controlling factor in the determination of the recommended strap length of 90 percent of the wall height required. It should be noted that the cohesion value assigned to the A-7-6 material was determined based on the limiting value required to satisfy global stability requirements at a strap length of 90 percent of the wall height. Based on the nature of the A-7-6 soil and applying engineering judgment, the cohesion component of 200 psf assigned is reasonable based on typical values for soils of this type. In addition, global stability requirements could only be satisfied using the soil parameters, per ODOT GB6, for A-4a material for the retained embankment fill. The final plan specifications should indicate that embankment fill material meeting the material specifications of A-4a soils or granular material will be required for the embankment fill for the full height of the wall within 5.0 feet of the back of the reinforced soil zone and extending back at a 45 degree plane from this point to the profile grade. Beyond this plane, no specific embankment soil types are required.

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

5.3 Soldier Pile and Lagging Wall Recommendations

It is proposed to construct a soldier pile and lagging (SPL) retaining wall at the forward abutment of the proposed structure. Final loading and design criteria for the retaining wall analysis were not available at the time of this report and will be coordinated with EMH&T during the Stage 2 design phase of the project. Based on preliminary design information provided by EMH&T, it is understood that the top of wall will generally follow along the bottom of footing elevation of the abutment, and that the bottom of wall elevation will vary from approximately 512.3 at the east side of the structure to approximately 526.1 at the west side of the abutment. It is understood that a steel H-pile section will be utilized and embedded within a drilled shaft below the proposed bottom of wall grade and that tieback anchors will be utilized to provide resistance to any lateral forces exerted on the wall by the abutment footing.

As stated noted Section 5.1, no boring was obtained near the proposed forward abutment location. Therefore, the soil parameters for the retained soil behind the wall were conservatively estimated using engineering judgment so that the design of the retaining wall system can progress. The following material properties should be utilized for determining the required section size for the H-piles and embedment depth of the drilled shaft.

1. Retained Soil
   - $\varphi = 26^{o}$
   - c = 0 psf
   - γ = 120 pcf
   - k_a = 0.39

2. Bearing Soil (below the bottom of wall)
   - $\varphi = 24^{o}$
   - c = 100 psf
   - γ = 115 pcf
   - k_p = 2.37
   - s_u = 1000 psf

For H-pile sizes of HP10x42, HP12x53 and HP14x73 sizes (and other similar sizes), it is recommend that a shaft diameter of 2.0 feet be utilized for the embedded section of the pile. Depending on the final loading conditions and the section size utilized, it is anticipated that the required embedment depth will range between 1.0 and 2.0 times the height of the wall. Drilled shafts bearing at or below this elevation may be proportioned for a nominal bearing resistance as shown in Table 8.

Table 8. Axial Design Parameters

Boring No.	Elevation (feet)	Shaft Length (feet)	Nominal Resistance [1]	
			End (ksf)	Side (ksf) [2]
B-162 (Forward Abutment)	513.0 – 492.0	0 – 21	7.0	0.40
	492.0 – 462.0	21 – 51	25.0	1.50
	462.0 – 458.0	51 – 55	110	0.65
	458.0 – 448.0	55 – 65	29.0	1.70

1. *A resistance factor of 0.40 and 0.45 should be applied to the nominal end bearing and side friction resistance, respectively, for shafts that end bear or penetrate within cohesive soil layers.*
2. *Side resistance should be neglected for the upper 5.0 feet of soil and the bottom one-diameter length of the pile.*

Based on the above noted bearing resistance, a maximum settlement of the drilled shafts is estimated to be less than 1.0-inch.

5.3.1 Lateral Design

The foundation elements for the soldier pile and lagging retaining wall should be analyzed to verify the pile section utilized has enough lateral and bending resistance to support the lateral load applied from the retained soil and bridge abutment. Table 9 should be utilized for lateral loading design.

Table 9. Lateral Design Parameters

Boring No.	Depth (feet)	Strata	Effective Unit Weight	Strength Parameter	k (soil)	ε_{50} (soil)
B-162 (Forward Abutment)	0 – 9	2	52.6 pcf	s_u = 750 psf	100 pci	0.010
	9 – 21	2	52.6 pcf	s_u = 1,500 psf	500 pci	0.007
	21 – 51	2	57.6 pcf	s_u = 3,000 psf	1000 pci	0.005
	51 – 55	2	52.6 pcf	s_u = 1,250 psf	500 pci	0.007
	55 – 65	2	57.6 pcf	s_u = 3,250 psf	1000 pci	0.005

1. *Depth listed represents the depth below the ground surface at the base of the wall (embedment depth). Loading above the wall should be modeled using either a triangular load distribution or the reaction loads at the base of the wall (top of drilled shaft) should be applied as end conditions in the analysis.*

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 and cross section to resists the lateral load for given end condition and deflection. Table 9 may be utilized for design. Note that the table was prepared with a design groundwater elevation as indicated on the boring log. The following table lists the eleven different soil types internal to the LPILE Plus 5.0 program. These strata were utilized in Table 9 for evaluating the soil layers.

Table 10. Soil 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
10	Liquefiable Sand (Rollins)
11	Stiff Clay without free water with a specified initial K (Brown)

It is anticipated that the tieback anchors will be installed near the top of the H-pile section and extended back into the existing embankment at an inclination of approximately 10 to 15 degrees. Based on this angle of inclination, the tieback anchors will likely be installed with the bonded zone within the existing embankment material. An estimated adhesion value of 1,000 psf should be utilized for design of the tieback anchors for the wall.

5.3.2 Drilled Shaft Considerations

The minimum requirements for proper inspection of drilled shaft construction are as follows:

- A qualified inspector should record the material types being removed from the hole as excavation proceeds.
- The use of casing for drilled shafts is recommended if caving material and/or groundwater is encountered at any time during the drilling of the shaft, or if groundwater seepage occurs in the drilled shaft.
- The placement of all concrete for the drilled shafts shall follow the American Concrete Institute's Design and Construction of Drilled Piers (ACI 336.3R-93).
- Concrete placed freefall should not be allowed to hit the sidewalls of the excavation and should not pass through any water. Therefore, concrete should be placed by tremie method if groundwater is encountered during construction of the drilled shafts.
- If concrete is placed by tremie method, it must be done so with an adequate head to displace water or slurry if groundwater has entered the caisson (all tremie procedures shall follow applicable ACI specifications).
- The volume of concrete should be checked to ensure voids did not result during extraction of the casing.
- Pulling casing with insufficient concrete inside should be restricted.
- The bottom of drilled shaft excavation should be clean and free of loose material. Any loose material observed should be removed using a clean-out bucket (muck bucket).

In addition, it is recommended that, if casing is used, it be pulled after the concrete is poured, allowing for reuse of the casing, and eliminating reduction of side resistance (between soil and concrete).

5.4 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 11 and Table 12.

Table 11. Estimated Undrained (Short-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ'	k_a	k_o	k_p
Soft to Medium Stiff Cohesive Soil	110	750	0°	1.0	1.0	1.0
Stiff Cohesive Soil	115	1,500	0°	1.0	1.0	1.0
Very Stiff to Hard Cohesive Soil	120	3,500	0°	1.0	1.0	1.0
Medium Dense Granular Soil	125	0	31°	0.32	0.48	3.12
Compacted Cohesive Engineered Fill	125	1,500	0°	1.0	1.0	1.0
Compacted Granular Engineered Fill	135	0	33°	0.30	0.46	3.39

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

Table 12. Estimated Drained (Long-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ'	k_a	k_o	k_p
Soft to Medium Stiff Natural Cohesive Soil	115	0	21°	0.47	0.36	2.12
Stiff to Hard Natural Cohesive Soil	120	0	26°	0.39	0.56	2.56
Medium Dense Granular Soil	125	0	31°	0.32	0.48	3.12
Compacted Cohesive Engineered Fill	125	0	28°	0.36	0.53	2.77
Compacted Granular Engineered Fill	135	0	33°	0.30	0.46	3.39

1. *When below groundwater table, use effective unit weight, $\gamma' = \gamma - 62.4$ 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. The values in this table have been estimated from correlation charts based on minimum standards specified for compacted engineered fill materials. 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.

5.5 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).

5.5.1 Excavation Considerations

All excavations should be shored / braced or laid back at a safe angle in accordance to 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. The following table should be utilized as a general guide for implementing OSHA guidelines when estimating excavation back slopes at the various boring locations. Actual excavation back slopes must be field verified by qualified personnel at the time of excavation in strict accordance with OSHA guidelines.

Table 13. Excavation Back Slopes

Soil	Maximum Back Slope	Notes
Soft to Medium Stiff Cohesive	1.5 : 1.0	Above Ground Water Table and No Seepage
Stiff Cohesive	1.0 : 1.0	
Very Stiff to Hard Cohesive	0.75 : 1.0	
All Granular & Cohesive Soil Below Ground Water Table or with Seepage	1.5 : 1.0	None

5.5.2 Groundwater Considerations

Based on the groundwater observations made during drilling, groundwater may be encountered during construction of the MSE wall and drilled shafts for the soldier pile and lagging wall. Where groundwater is encountered, proper groundwater control should be employed and maintained to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or "boiling" condition where soft silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 36 inches below the deepest excavation. In the case of drilled shafts, the utilization of casing will be required below the water table to maintain an open hole and prevent the sidewalls from collapse. In addition, concrete placed below the water table should be placed by tremie method as described in Section 5.3.2. Any seepage or groundwater encountered at this site should be able to be controlled by pumping from temporary sumps. Additional measures may be required depending on seasonal fluctuations of the groundwater level. 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 our recommendations.

Our 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 preliminary 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

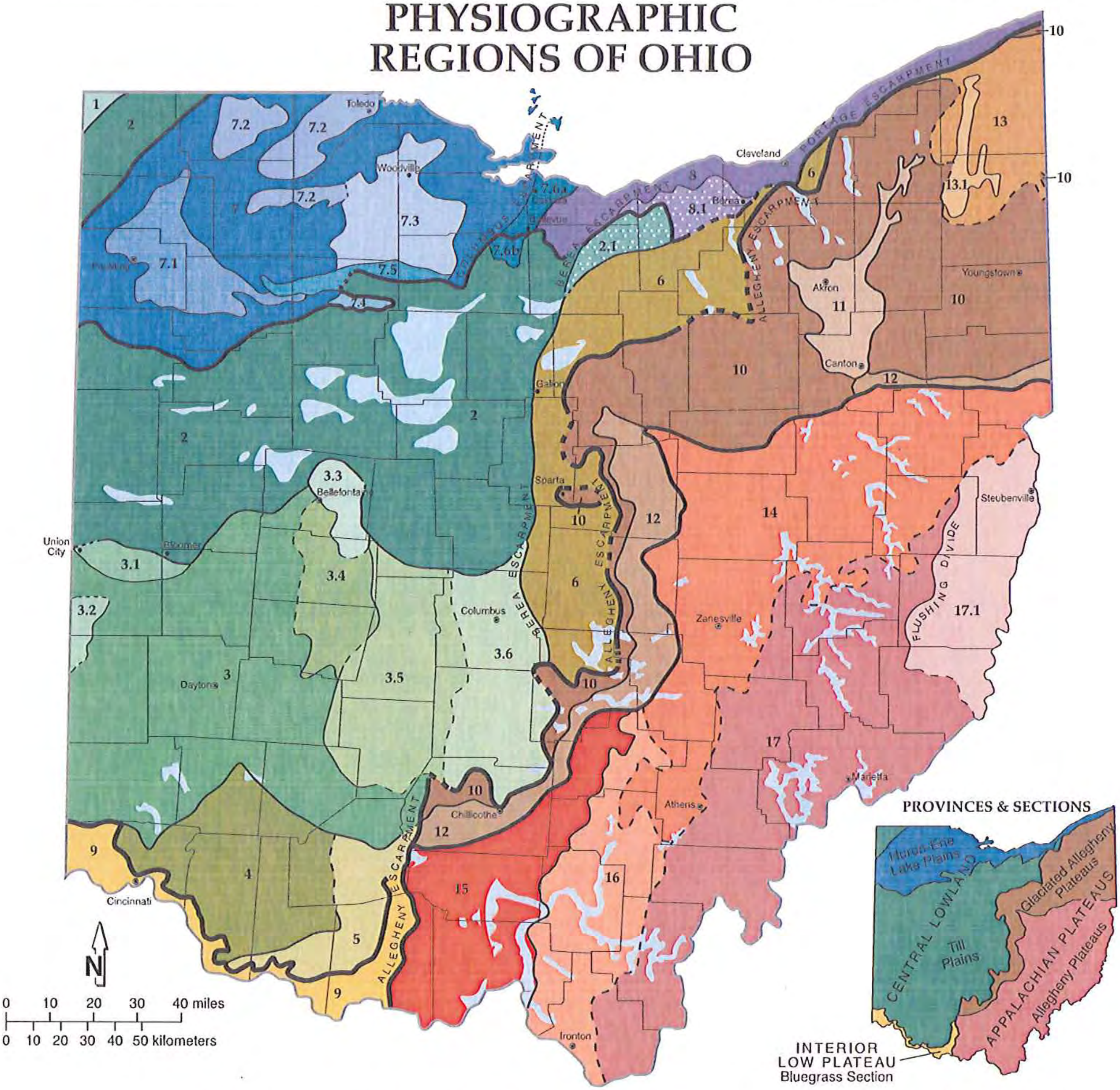
STATE GEOLOGY

STATE OF OHIO
Ted Strickland, Governor

DEPARTMENT OF NATURAL RESOURCES
Sean D. Logan, Director

DIVISION OF GEOLOGICAL SURVEY
Lawrence H. Wickstrom, Chief

PHYSIOGRAPHIC REGIONS OF OHIO



Till Plains

1. Steuben Till Plain
2. Central Ohio Clayey Till Plain
   2.1. Berea Headlands of the Till Plain
3. Southern Ohio Loamy Till Plain
   3.1. Union City-Bloomer Transitional Terrain
   3.2. Whitewater Interlobate Plain
   3.3. Bellefontaine Upland
   3.4. Mad River Interlobate Plain
   3.5. Darby Plain
   3.6. Columbus Lowland
4. Illinoian Till Plain
5. Dissected Illinoian Till Plain
6. Galion Glaciated Low Plateau

Transitional boundary

Lake basin/deposits outside Huron-Erie Lake Plains

Huron-Erie Lake Plains

7. Maumee Lake Plains
   7.1. Paulding Clay Basin
   7.2. Maumee Sand Plains
   7.3. Woodville Lake-Plain Reefs
   7.4. Findlay Embayment
   7.5. Fostoria Lake-Plain Shoals
   7.6a and 7.6b. Bellevue-Castalia Karst Plain
8. Erie Lake Plain
   8.1. Berea Headlands of the Erie Lake Plain

Bluegrass Section

9. Outer Bluegrass Region

Glaciated Allegheny Plateaus

10. Killbuck-Glaciated Pittsburgh Plateau
11. Akron-Canton Interlobate Plateau
12. Illinoian Glaciated Allegheny Plateau
13. Grand River Low Plateau
    13.1 Grand River Finger-Lake Plain

Allegheny Plateaus

14. Muskingum-Pittsburgh Plateau
15. Shawnee-Mississippian Plateau
16. Ironton Plateau
17. Marietta Plateau
    17.1. Little Switzerland Plateau

4/98

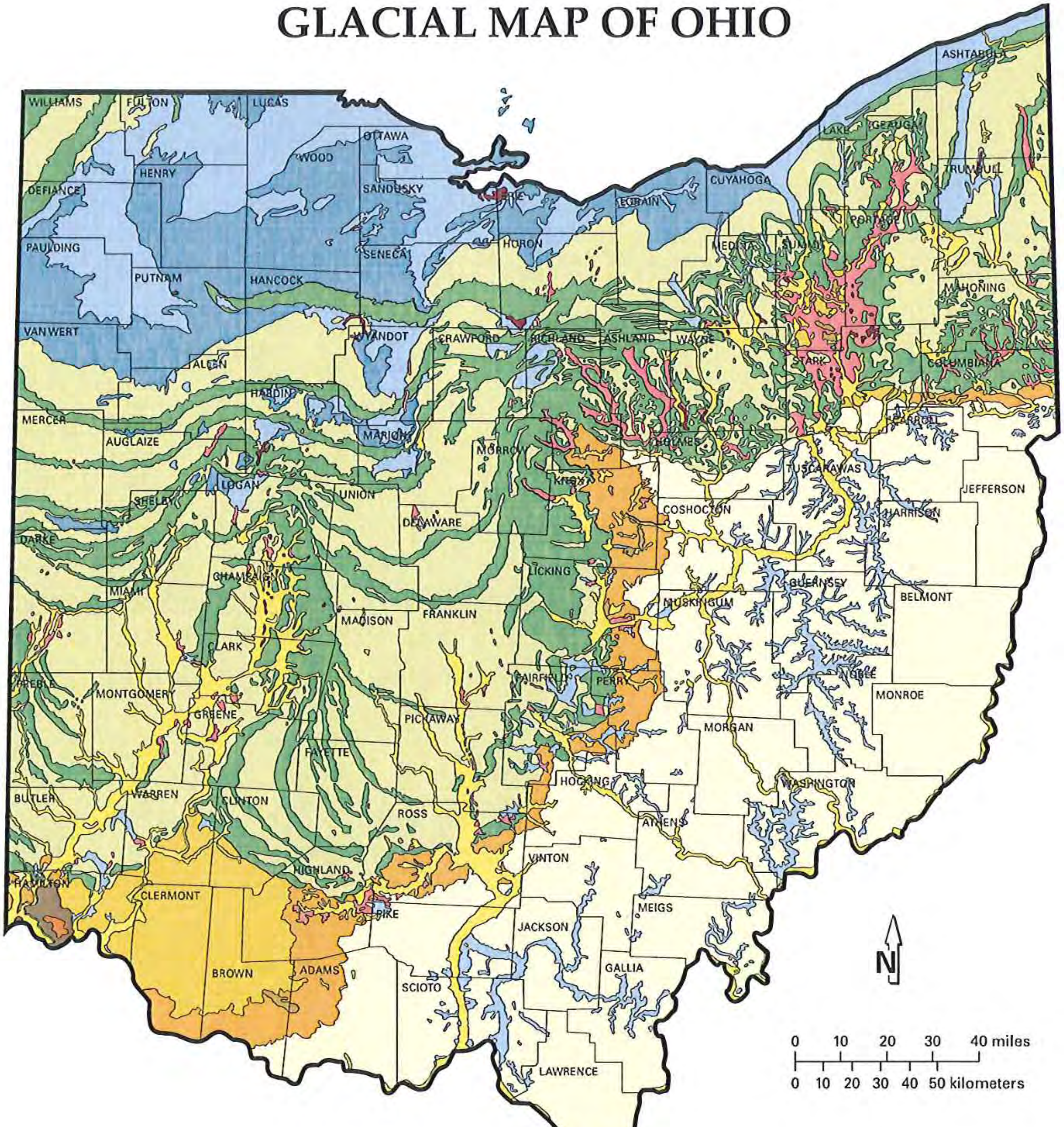
Recommended citation: Ohio Division of Geological Survey, 1998, Physiographic regions of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map with text, 2 p., scale 1:2,100,00.

STATE OF OHIO
Bob Taft, Governor

DEPARTMENT OF NATURAL RESOURCES
Samuel W. Speck, Director

DIVISION OF GEOLOGICAL SURVEY
Thomas M. Berg, Chief

GLACIAL MAP OF OHIO



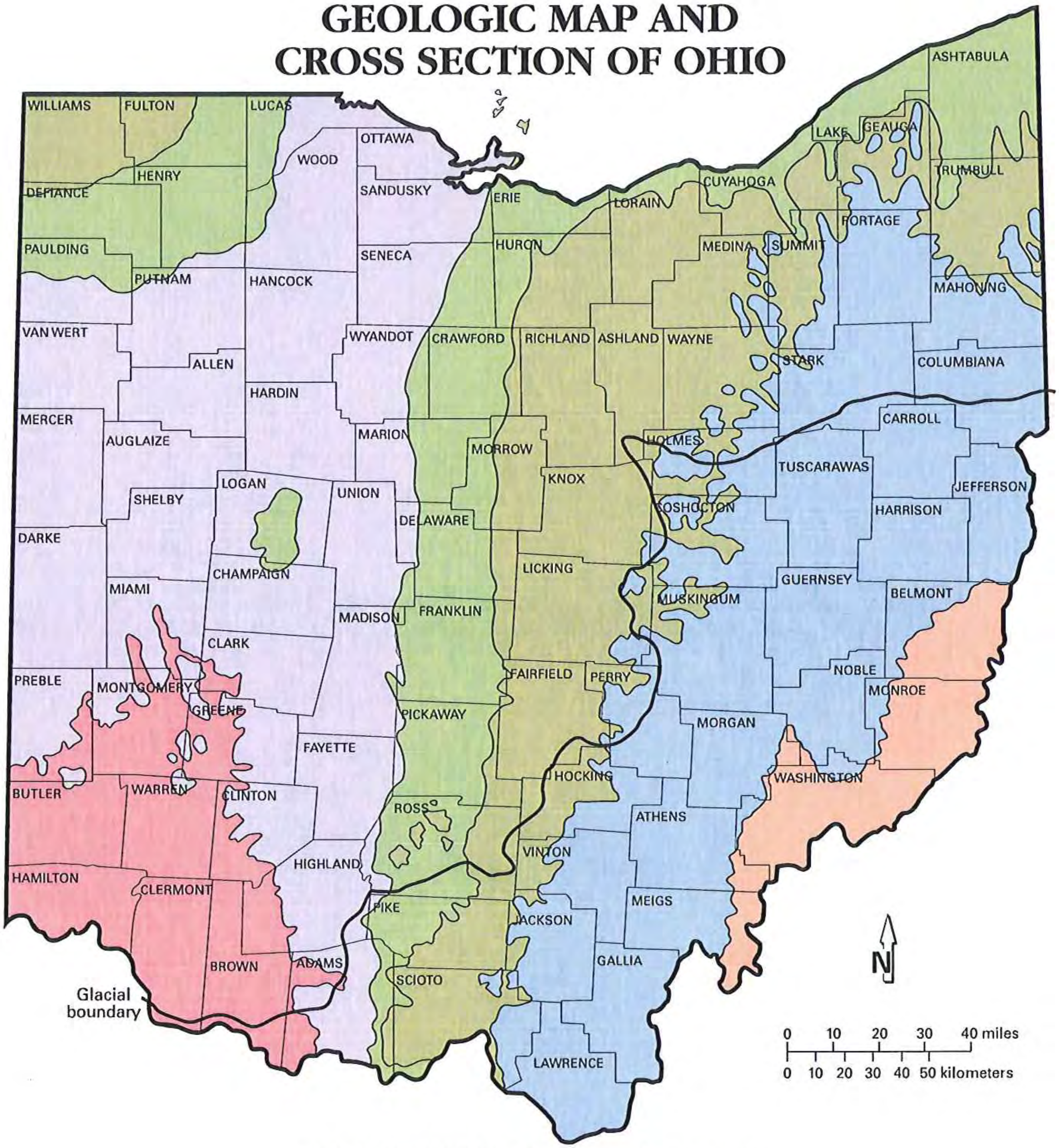
WISCONSINAN (14,000 to 24,000 years old)	ILLINOIAN (130,000 to 300,000 years old)	PRE-ILLINOIAN (older than 300,000 years)	
Ground moraine	Ground moraine	Ground moraine	Kames and eskers
Wave-planed ground moraine	Dissected ground moraine	Dissected ground moraine	Outwash
End moraine	Hummocky moraine		Lake deposits
			Peat
			Colluvium

STATE OF OHIO
Bob Taft, Governor

DEPARTMENT OF NATURAL RESOURCES
Samuel W. Speck, Director

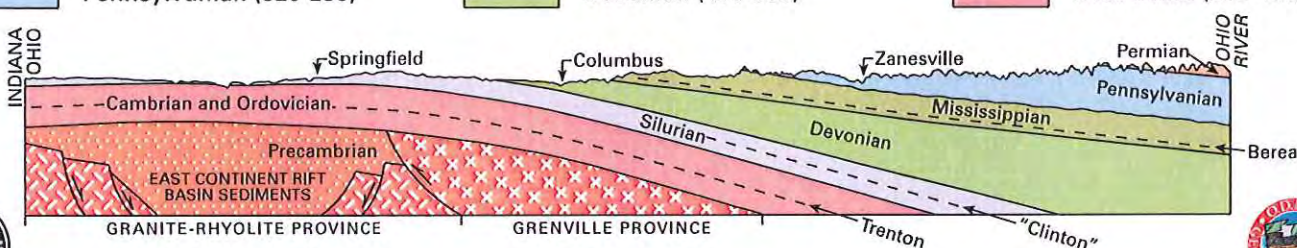
DIVISION OF GEOLOGICAL SURVEY
Thomas M. Berg, Chief

GEOLOGIC MAP AND CROSS SECTION OF OHIO



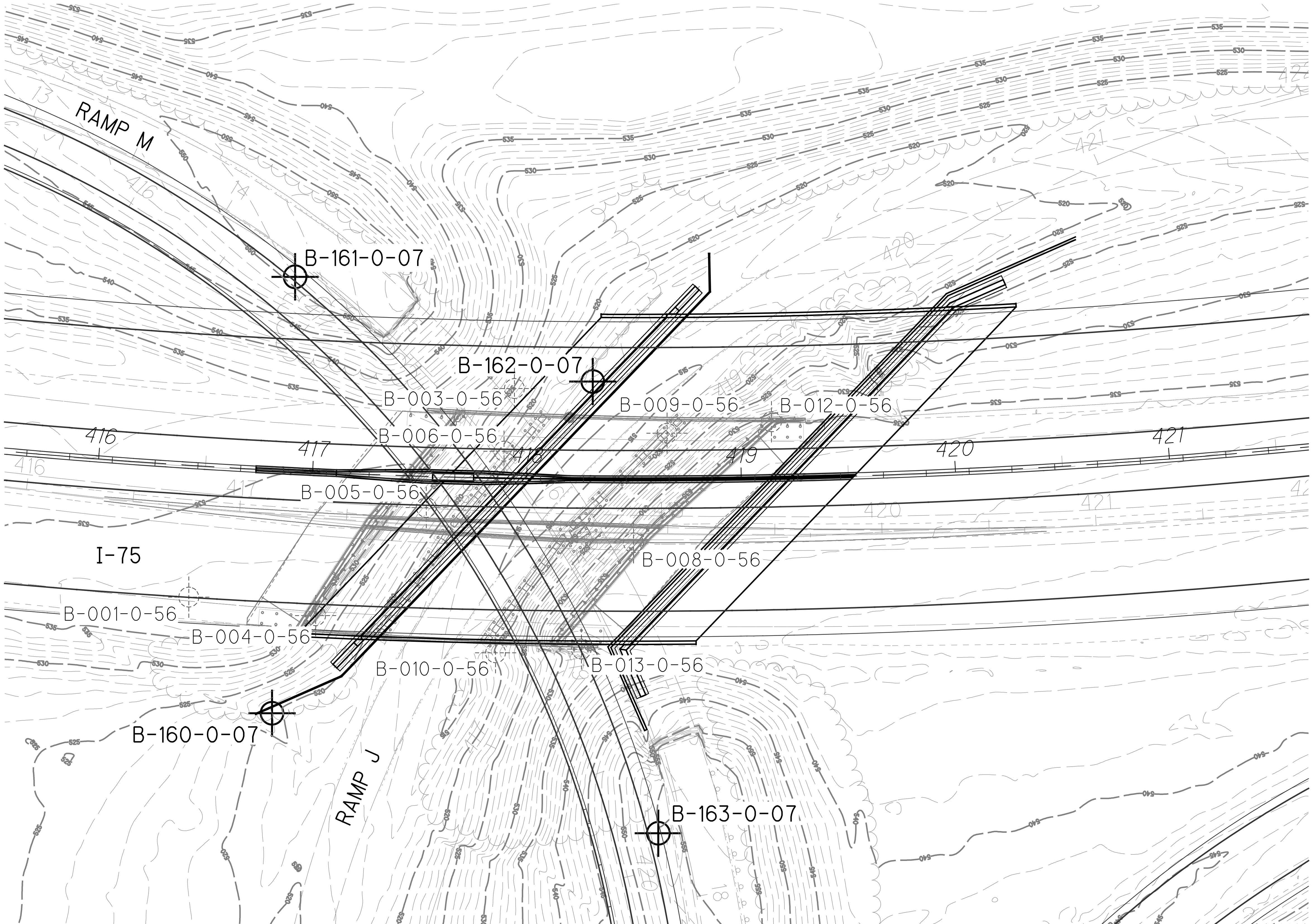
GEOLOGIC SYSTEM (million years before present)

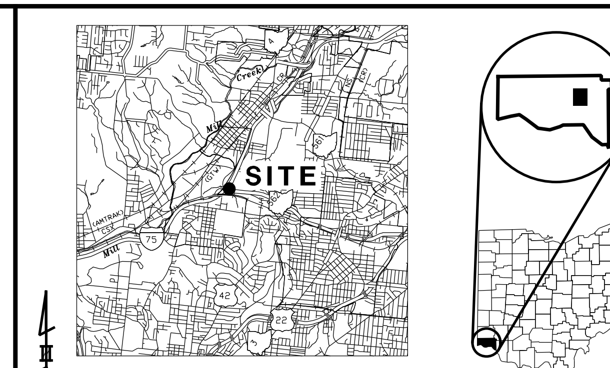
Permian (286-245)	Mississippian (360-320)	Silurian (438-408)
Pennsylvanian (320-286)	Devonian (408-360)	Ordovician (505-438)



APPENDIX II

VICINITY MAP AND BORING PLAN





HAMILTON COUNTY
VICINITY MAP

2007 CTL BORINGS
HISTORIC BORINGS

BORING PLAN

HAM-75-0791 - I-75 OVER SR 562 RAMP J
HAMILTON COUNTY, OHIO

PROJECT NO. Rii B-10-020	DRAWN RRM	RESOURCE INTERNATIONAL, INC.
SCALE: 1"=50' (0 25 50)	REVIEWED BRT	
	DATE 06-12-12	

APPENDIX III

2007 CTL ENGINEERING BORING LOGS

LOG OF BORING

Project Identification: HAM-75-2.30 PID 76257
Hamilton County, Ohio

Date Started 8/1/07 Sampler: Type SS Dia. 1.375"
Date Completed 8/1/07 Casing: Length 115.0ft Dia. 3.25"

Water Elev. 499.6ft
Surface Elev. 520.6ft

Boring No. B-160 Station & Offset 416.86.7, 113.3 RT

CTL Project No. 04120070g

Elev. (ft)	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)		Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
520.6	0															
520.6		AUGERED			0.5'	TOPSOIL (0.6')										VISUAL
520.1		5/6/8				STIFF TO VERY STIFF, BROWN SILT AND CLAY, AND SAND, SOME TO TRACE GRAVEL, DAMP -FILL	1								9	VISUAL
517.6	2	9/9/9					2	6	12	29	37	16	27	12	12	A-6a
515.1	4, 6	8/8/10					3								12	VISUAL
512.1	8	9/6/8					4								14	VISUAL
509.6	10	5/4/4			11.0'	MEDIUM STIFF, BROWN SANDY SILT, LITTLE GRAVEL, LITTLE CLAY, DAMP -FILL	5	15	10	26	35	14	26	9	12	A-4a
507.6	12				13.0'											
507.1	14	4/3/2				SOFT TO MEDIUM STIFF, BROWN SILT AND CLAY, SOME SAND, TRACE GRAVEL, BRICK FRAGMENTS, MOIST -FILL	6	3	7	22	51	17	31	13	22	A-6a
504.6	16	8/1/1					7								11	VISUAL
502.1	18	50-3"			18.5'	NO RECOVERY	8									
499.6	20				21.0'	MEDIUM STIFF TO STIFF, GRAY TO BROWN SILT, SOME CLAY, TRACE SAND, MOIST										
497.1	22, 24	4/3/2					9	0	0	7	67	26	30	10	21	A-4b
492.1	26, 28	3/5/6					10								21	VISUAL
487.6	30, 32				33.0'											
487.1	34	7/17/16				DENSE, GRAY AND BROWN GRAVEL AND/ OR STONE FRAGMENTS WITH SAND, TRACE CLAY, LITTLE SILT, WET	11	34	17	36	11	2	NP	NP	11	A-1-b

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

Project Identification: HAM-75-2.30 PID 76257
Hamilton County, Ohio

Boring No. B-160

Elev. (ft) 485.6	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)			Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
	36																
482.1	38					38.5'											
		4/5/7					LOOSE TO MEDIUM DENSE, GRAY AND BROWN GRAVEL AND/ OR STONE FRAGMENTS WITH SAND, TRACE CLAY, TRACE SILT, WET	12								17	VISUAL
	40																
477.1	42																
	44	3/4/5						13								14	VISUAL
472.1	46																
	48	4/5/7						14	19	32	44	4	1	NP	NP	14	A-1-b
	50																
467.1	52																
	54	5/7/7						15								12	VISUAL
	56																
462.1	58	5/7/9						16								21	VISUAL
	60																
457.1	62																
	64	5/7/8					NO RECOVERY	17									
	66																
452.1	68					68.5'											
		5/8/9			FS		MEDIUM DENSE, BROWN FINE SAND, TRACE SILT, TRACE CLAY, MOIST	18	0	13	79	7	1	NP	NP	17	A-3
	70																

Project Identification: HAM-75-2.30 PID 76257
Hamilton County, Ohio

Boring No. B-160

Elev. (ft) 449.5	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)			Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
	72																
447.1	74	7/9/11			FS			19								22	VISUAL
	76																
443.6						77.0'	MEDIUM DENSE, LIGHT BROWN COARSE AND FINE SAND, LITTLE SILT, MOIST										
442.1	78	7/11/13						20								16	VISUAL
	80																
	82																
437.1	84	12/13/15				83.5'	MEDIUM DENSE TO DENSE, BROWN FINE SAND, TRACE SILT, TRACE CLAY, MOIST	21	0	1	92	6	1	NP	NP	21	A-3
	86																
432.1	88	9/11/14						22								25	VISUAL
	90																
	92																
427.1	94	10/12/14						23								17	VISUAL
	96				FS												
422.1	98	9/12/16						24	0	9	85	5	1	NP	NP	18	A-3
	100																
	102																
417.1	104	12/17/15						25								16	VISUAL
	106																

Project Identification: HAM-75-2.30 PID 76257
Hamilton County, Ohio

Boring No. B-160

Elev. (ft) 413.5	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)			Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
412.1	108, 110, 112	12/14/15			FS			26								15	VISUAL
407.1	114	14/17/16				113.5	DENSE, BROWN COARSE AND FINE SAND, TRACE GRAVEL, TRACE SILT, TRACE CLAY, MOIST	27	6	23	59	7	5	NP	NP	15	A-3a
405.6						115.0											

BOTTOM OF BORING = 115.0'

LOG OF BORING

Project Identification: HAM-75-2.30 PID 76257
Hamilton County, Ohio

Date Started 7/31/07 Sampler: Type SS Dia. 1.375"
Date Completed 7/31/07 Casing: Length 95.0ft Dia. 3.25"

Water Elev. 511.7ft
Surface Elev. 516.2ft

Boring No. B-162 Station & Offset 418+30.5, 45.6 LT

CTL Project No. 04120070g

Elev. (ft)	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)		Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
516.2	0															
515.2	2	4/7/6				MEDIUM DENSE, BROWN COARSE AND FINE SAND, SOME SILT, TRACE CLAY, TRACE GRAVEL, DAMP -FILL	1	9	27	31	26	7	NP	NP	8	A-3a
512.7	4	5/4/4			3.5'	MEDIUM STIFF, BROWN SANDY SILT, AND GRAVEL, TRACE CLAY, MOIST	2A								13	VISUAL
511.7					4.5'	MEDIUM STIFF, GRAY TO BROWN SILT AND CLAY, TRACE SAND, MOIST	2B								24	VISUAL
510.2	6	3/1/3			6.0'	SOFT TO MEDIUM STIFF, GRAY TO BROWN CLAY, AND SILT,TRACE SAND, MOIST	3	0	0	0	45	55	46	24	28	A-7-6
507.7	8	1/2/4					4								29	VISUAL
	10															
	12															
502.7	14	2/4/6			13.5'	STIFF, GRAY TO BROWN CLAY, SOME SILT, TRACE SAND, MOIST	5	0	0	0	27	73	49	26	30	A-7-6
	16															
497.7	18	4/4/5					6A								28	VISUAL
496.7	20					-SILT LAYERS ARE INTERBEDDED	6B								32	VISUAL
	22															
492.7	24	4/7/11			23.5'	STIFF TO VERY STIFF, GRAY TO BROWN SILT, SOME CLAY, TRACE SAND, MOIST	7	0	0	1	71	28	30	9	25	A-4b
	26															
487.7	28	5/6/6					8								26	VISUAL
	30															
	32															
482.7	34	5/10/12			33.5'	VERY STIFF, GRAY TO BROWN SILTY CLAY, TRACE SAND, MOIST	9	0	0	0	55	45	40	17	28	A-6b

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

Project Identification: HAM-75-2.30 PID 76257
Hamilton County, Ohio

Boring No. B-162

Elev. (ft) 481.2	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
477.7		6/10/14				10								29	VISUAL
472.7		4/7/10				11								25	VISUAL
467.7	48.5'	4/6/8			MEDIUM STIFF TO STIFF, GRAY SILT, LITTLE CLAY, LITTLE SAND, TRACE GRAVEL, MOIST	12	0	7	13	63	17	25	8	18	A-4b
462.7		3/3/5				13A								23	VISUAL
461.7	54.5'				MEDIUM STIFF TO VERY STIFF, GRAY SILTY CLAY, SOME SAND, TRACE GRAVEL, MOIST -SAND LAYERS ARE INTERBEDDED	13B								19	VISUAL
457.7		7/9/11				14	0	8	19	28	45	38	18	22	A-6b
452.7	63.5'	9/8/8			VERY STIFF TO HARD, GRAY SANDY SILT, TRACE GRAVEL, TRACE CLAY, WET	15	3	16	41	31	9	18	5	22	A-4a
447.7		9/16/15				16								26	VISUAL

Project Identification: HAM-75-2.30 PID 76257
Hamilton County, Ohio

Boring No. B-162

Elev. (ft)	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)		Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
445.1																
	72															
442.7	74	7/11/14					17								25	VISUAL
	76															
	78															
437.7		4/5/8			78.5'	STIFF, GRAY SILT AND CLAY, SOME SAND, TRACE GRAVEL, MOIST	18	0	2	23	50	25	31	13	30	A-6a
	80															
	82															
432.7	84	8/8/5					19								18	VISUAL
	86															
	88															
426.7	90	3/8/13			89.5'	MEDIUM DENSE, GRAY TO BROWN COARSE AND FINE SAND, LITTLE SILT, TRACE GRAVEL, TRACE CLAY, MOIST	20	0	11	78	11	0	NP	NP	20	A-3a
	92															
422.7	94	7/10/7					21								26	VISUAL
421.2					95.0'											

BOTTOM OF BORING = 95.0'

OH DOT 2 CTL OH DOT.GDT ODOT LIBRARY BY AMC 9-14-06.GLB 04120070G HAM-75 B BORINGS.GPJ 12/10/07

APPENDIX IV

RII LABORATORY TEST RESULTS

CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

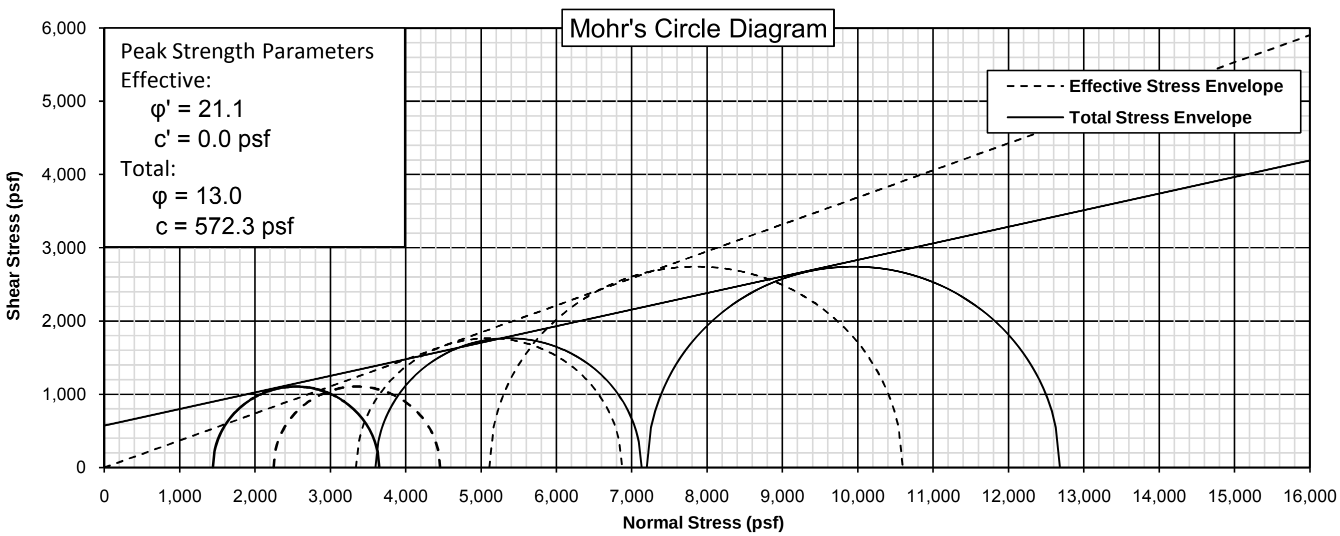
6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

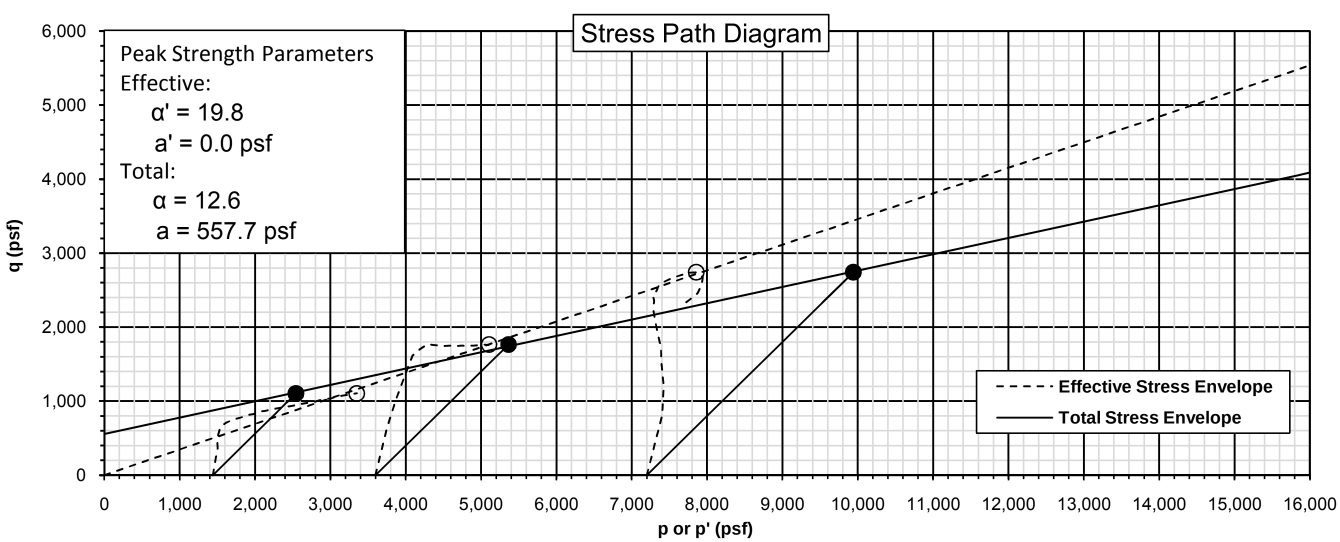
PROJECT NAME:	HAM-75-12.60
JOB NUMBER:	B-10-024
BORING NUMBER:	B-017-0-10
SAMPLE NUMBER:	ST-8a
SAMPLE DEPTH:	19.0 ft - 20.5 ft
DATE OF TESTING:	9/20/2011 through 9/26/2011
TESTED BY:	JH

Soil Description: CLAY With little silt trace sand and Gravel
Soil Classification: CL / A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	50	22	28	2.5	1.7	2.4	23.5	69.9

Stage	Boring No.	Sample No.	Depth (ft)	$(\sigma_3)_f$ (psf)	$(\sigma_1)_f$ (psf)	$(\sigma_3')_f$ (psf)	$(\sigma_1')_f$ (psf)	p'_f (psf)	q_f (psf)
1	B-017-0-10	ST-8a	19.0	7,200.0	12,684.3	5,112.0	10,596.3	7,854.2	2,742.2
2	B-017-0-10	ST-8b	19.5	3,600.0	7,130.6	3,340.8	6,871.4	5,106.1	1,765.3
3	B-017-0-10	ST-8c	20	1,440.0	3,648.6	2,246.4	4,455.0	3,350.7	1,104.3





CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

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

PROJECT NAME:	HAM-75-12.60
JOB NUMBER:	B-10-024
BORING NUMBER:	B-017-0-10
SAMPLE NUMBER:	ST-8a
SAMPLE DEPTH:	19.0 ft
DATE OF TESTING:	9/20/2011
TESTED BY:	JH

Data for Specimen No. 1

Soil Description: CLAY With little silt trace sand and Gravel
Soil Classification: CL / A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	50	22	28	2.5	1.7	2.4	23.5	69.9

Diameter, D_0	2.869	in	Volume of Solids , V_s :	23.836	in^3
Area, A_0	6.466	in^2	Initial Volume of Voids, V_v :	13.160	in^3
Height, L_0	5.721	in	Initial Void Ratio, e_o :	0.552	
Volume, V_0	36.996	in^3	Initial Degree of Saturation, S_0 :	120.191	%

Water Content BEFORE Test

Tin No.:	Paper	g
Wet Soil + Tin :	197.89	g
Dry Soil + Tin :	164.53	g
Tin Weight :	30.3	g
Dry Mass :	134.23	g
Weight of water :	33.36	g
Moisture :	24.85	%

Water Content AFTER Test (Total Specimen)

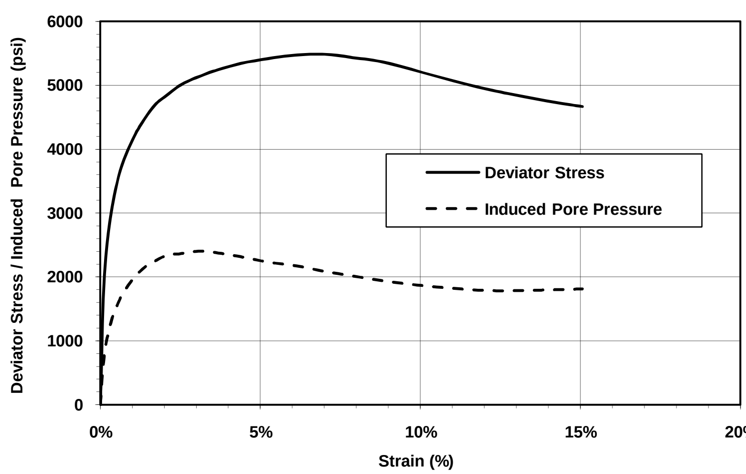
Tin No.:	KDW	g
Wet Soil + Tin :	1331.20	g
Dry Soil + Tin :	1120.90	g
Tin Weight :	78.00	g
Dry Mass :	1042.90	g
Weight of water :	210.30	g
Moisture :	20.16	%
Wet Density :	129.05	pcf
Dry Density :	107.39	pcf

Consolidation Cell Pressure:	130.0	psi
Consolidation Back Pressure:	80.0	psi
Effective Confining Stress, σ_3:	50.0	psi
	7200.00	psf
Strain Rate:	0.0030	in/min

Deviator Stress @ Failure, Ds:	5484.32	psf
Axial Strain @ Failure:	7.01	%
Major Principal Stress @ Failure, σ_1:	12684.32	psf
Induced Pore Pressure @ Failure:	2088.00	psf
Effective Minor Principal Stress, σ'_3:	5112.00	psf
Effective Major Principal Stress, σ'_1:	10596.32	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



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CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

PROJECT NAME:	HAM-75-12.60
JOB NUMBER:	B-10-024
BORING NUMBER:	B-017-0-10
SAMPLE NUMBER:	ST-8b
SAMPLE DEPTH:	19.5 ft
DATE OF TESTING:	9/22/2011
TESTED BY:	JH

Data for Specimen No. 2

Soil Description: CLAY With little silt trace sand and Gravel
Soil Classification: CL / A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	50	22	28	2.5	1.7	2.4	23.5	69.9

Diameter, D_0	2.870	in	Volume of Solids , V_s :	23.427	in^3
Area, A_0	6.469	in^2	Initial Volume of Voids, V_v :	14.531	in^3
Height, L_0	5.867	in	Initial Void Ratio, e_o :	0.620	
Volume, V_0	37.957	in^3	Initial Degree of Saturation, S_0 :	106.98	%

Water Content BEFORE Test

Tin No.:	Paper	g
Wet Soil + Tin :	197.89	g
Dry Soil + Tin :	164.53	g
Tin Weight :	30.3	g
Dry Mass :	134.23	g
Weight of water :	33.36	g
Moisture :	24.85	%

Water Content AFTER Test (Total Specimen)

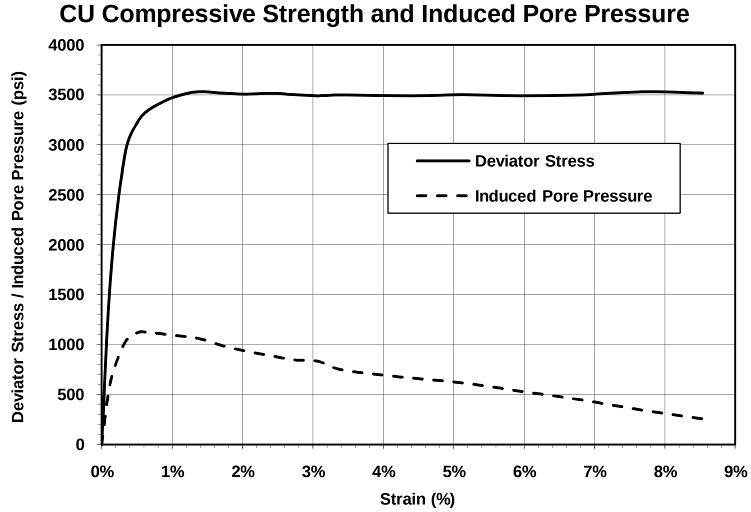
Tin No.:	Freddy	g
Wet Soil + Tin :	1346.50	g
Dry Soil + Tin :	1108.90	g
Tin Weight :	83.90	g
Dry Mass :	1025.00	g
Weight of water :	237.60	g
Moisture :	23.18	%
Wet Density :	126.72	pcf
Dry Density :	102.87	pcf

Consolidation Cell Pressure:	135.0	psi
Consolidation Back Pressure:	110.0	psi
Effective Confining Stress, σ_3:	25.0	psi
	3600.00	psf
Strain Rate:	0.0030	in/min

Deviator Stress @ Failure, Ds:	3530.56	psf
Axial Strain @ Failure:	8.54	%
Major Principal Stress @ Failure, σ_1:	7130.56	psf
Induced Pore Pressure @ Failure:	259.20	psf
Effective Minor Principal Stress, σ'_3:	3340.80	psf
Effective Major Principal Stress, σ'_1:	6871.36	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

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PROJECT NAME:	HAM-75-12.60
JOB NUMBER:	B-10-024
BORING NUMBER:	B-017-0-10
SAMPLE NUMBER:	ST-8c
SAMPLE DEPTH:	20.0 ft
DATE OF TESTING:	9/26/2011
TESTED BY:	Hoyt

Data for Specimen No. 3

Soil Description: CLAY With little silt trace sand and Gravel
Soil Classification: CL / A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	50	22	28	2.5	1.7	2.4	23.5	69.9

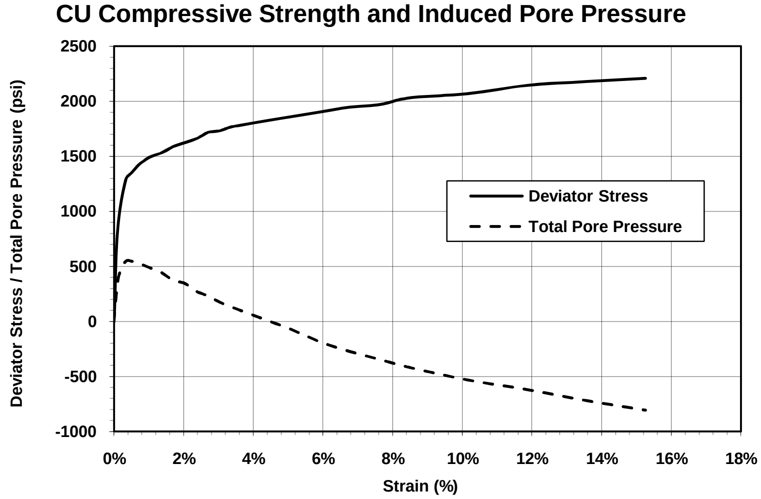
Diameter, D_0	2.869	in	Volume of Solids , V_s :	22.291	in^3
Area, A_0	6.466	in^2	Initial Volume of Voids, V_v :	15.912	in^3
Height, L_0	5.908	in	Initial Void Ratio, e_o :	0.714	
Volume, V_0	38.203	in^3	Initial Degree of Saturation, S_0 :	92.960	%

Water Content BEFORE Test			Water Content AFTER Test (Total Specimen)		
Tin No.:	Paper	g	Tin No.:	KDW	g
Wet Soil + Tin :	197.89	g	Wet Soil + Tin :	1334.20	g
Dry Soil + Tin :	164.53	g	Dry Soil + Tin :	1053.10	g
Tin Weight :	30.3	g	Tin Weight :	77.80	g
Dry Mass :	134.23	g	Dry Mass :	975.30	g
Weight of water :	33.36	g	Weight of water :	281.10	g
Moisture :	24.85286449	%	Moisture :	28.82	%
			Wet Density :	125.29	pcf
			Dry Density :	97.26	pcf

Consolidation Cell Pressure:	120.0	psi	Deviator Stress @ Failure, Ds:	2208.58	psf
Consolidation Back Pressure:	110.0	psi	Axial Strain @ Failure:	15.25	%
Effective Confining Stress, σ_3:	10.0	psi	Major Principal Stress @ Failure, σ_1:	3648.58	psf
	1440.00	psf	Induced Pore Pressure @ Failure:	-806.40	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress, σ'_3:	2246.40	psf
			Effective Major Principal Stress, σ'_1:	4454.98	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

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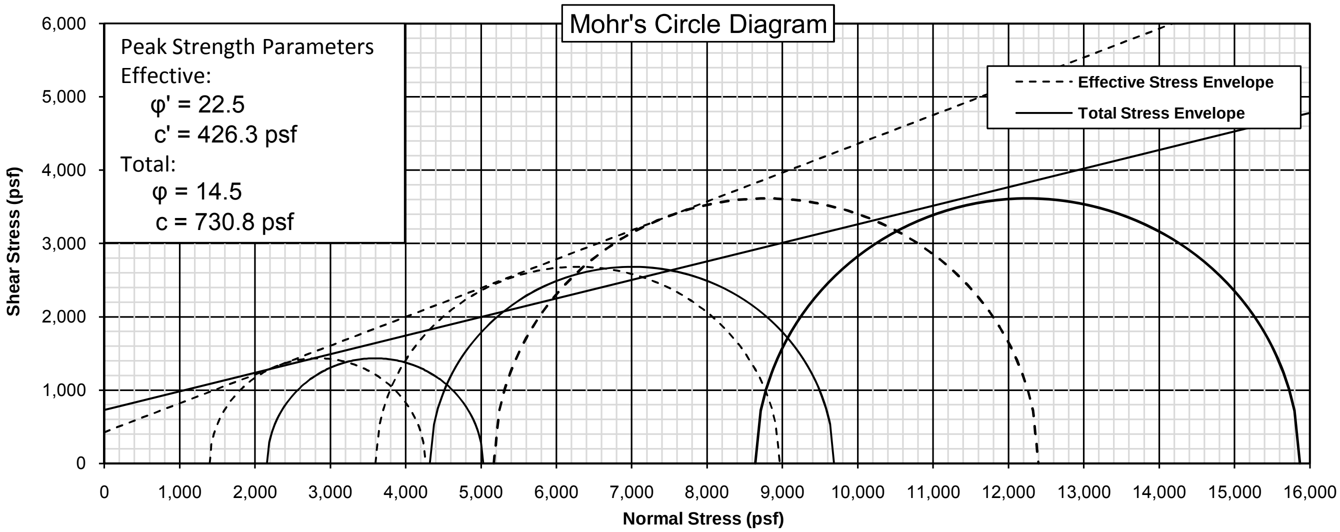
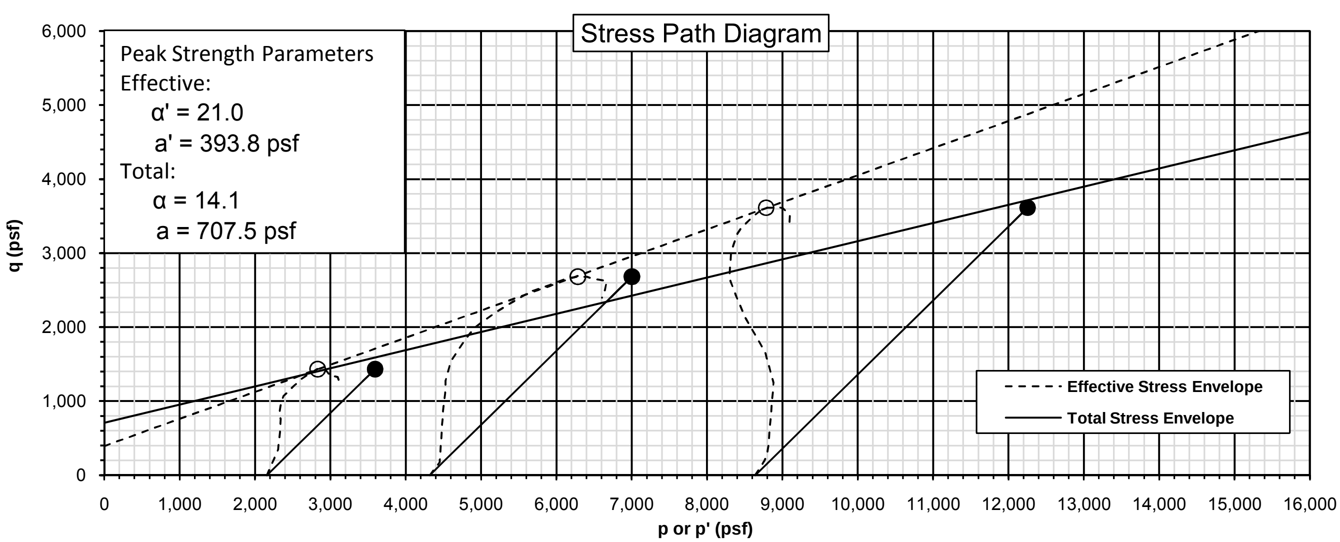
PROJECT NAME: HAM-75-12.60 Part I
JOB NUMBER: B-10-024
BORING NUMBER: B-022-0-11
SAMPLE NUMBER: ST-11
SAMPLE DEPTH: 24.3-25.9
DATE OF TESTING: 02/17/2012 through 02/23/2012
TESTED BY: J.Hoyt

Soil Description: Gray SILTY CLAY, trace coarse to fine sand, trace fine gravel
Soil Classification: ODOT A-6b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	40	19	21	1	1	1	33	64

Stage	Boring No.	Sample No.	Depth (ft)	$(\sigma_3)_f$ (psf)	$(\sigma_1)_f$ (psf)	$(\sigma_3')_f$ (psf)	$(\sigma_1')_f$ (psf)	p'_f (psf)	q_f (psf)
1	B-022-0-11	ST-11	24.3	2,160.0	5,027.9	1,396.8	4,264.7	2,830.7	1,433.9
2	B-022-0-11	ST-11	24.8	4,320.0	9,685.9	3,600.0	8,965.9	6,282.9	2,682.9
3	B-022-0-11	ST-11	25.4	8,640.0	15,868.0	5,169.6	12,397.6	8,783.6	3,614.0





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CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

PROJECT NAME: HAM-75-12.60 Part I
JOB NUMBER: B-10-024
BORING NUMBER: B-022-0-11
SAMPLE NUMBER: ST-11
SAMPLE DEPTH: 24.3
DATE OF TESTING: 2/17/2012
TESTED BY: J.Hoyt

Data for Specimen No. 1

Soil Description: Gray SILTY CLAY, trace coarse to fine sand, trace fine gravel
Soil Classification: ODOT A-6b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	40	19	21	1	1	1	33	64

Diameter, D_0	2.902	in	Volume of Solids , V_s :	24.282	in^3
Area, A_0	6.614	in^2	Initial Volume of Voids, V_v :	14.756	in^3
Height, L_0	5.902	in	Initial Void Ratio, e_o :	0.608	
Volume, V_0	39.038	in^3	Initial Degree of Saturation, S_0 :	99.553	%

Water Content BEFORE Test

Tin No.:	X-11	g
Wet Soil + Tin :	112.47	g
Dry Soil + Tin :	97.25	g
Tin Weight :	30.08	g
Dry Mass :	67.17	g
Weight of water :	15.22	g
Moisture :	22.66	%

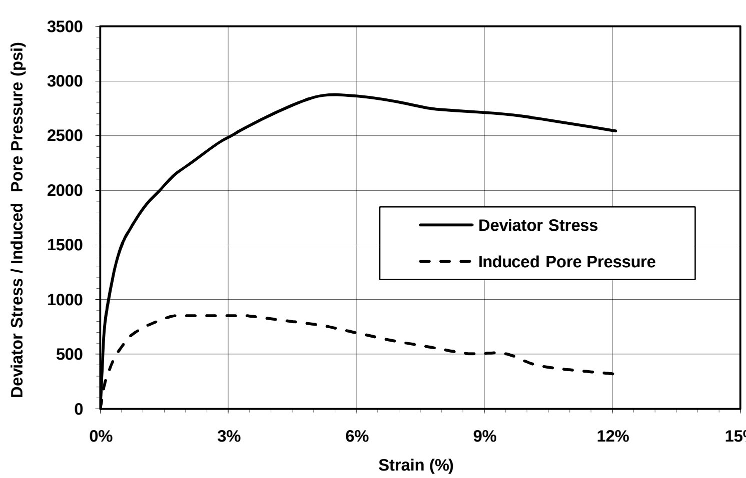
Water Content AFTER Test (Total Specimen)

Tin No.:	Freddy	g
Wet Soil + Tin :	1,378.10	g
Dry Soil + Tin :	1,147.30	g
Tin Weight :	84.90	g
Dry Mass :	1,062.40	g
Weight of water :	230.80	g
Moisture :	21.72	%
Wet Density :	126.20	pcf
Dry Density :	103.68	pcf

Consolidation Cell Pressure:	133.0	psi	Deviator Stress @ Failure, Ds:	2,867.87	psf
Consolidation Back Pressure:	118.0	psi	Axial Strain @ Failure:	5.18	%
Effective Confining Stress, σ_3:	15.0	psi	Major Principal Stress @ Failure, σ_1:	5,027.87	psf
	2,160.00	psf	Induced Pore Pressure @ Failure:	763.20	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress,σ'_3:	1,396.80	psf
			Effective Major Principal Stress, σ'_1:	4,264.67	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



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CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

PROJECT NAME:	HAM-75-12.60 Part I
JOB NUMBER:	B-10-024
BORING NUMBER:	B-022-0-11
SAMPLE NUMBER:	ST-11
SAMPLE DEPTH:	24.8
DATE OF TESTING:	2/23/2012
TESTED BY:	J.Hoyt

Data for Specimen No. 2

Soil Description: Gray SILTY CLAY, trace coarse to fine sand, trace fine gravel
Soil Classification: ODOT A-6b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	40	19	21	1	1	1	33	64

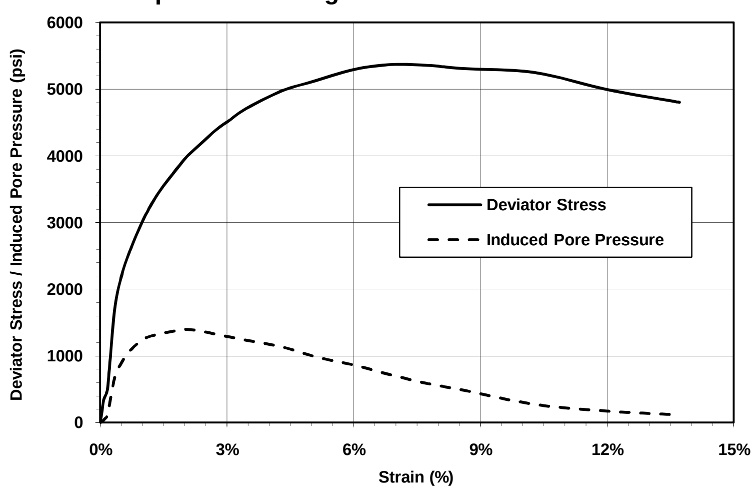
Diameter, D_0	2.869	in	Volume of Solids , V_s :	24.421	in^3
Area, A_0	6.465	in^2	Initial Volume of Voids, V_v :	13.954	in^3
Height, L_0	5.936	in	Initial Void Ratio, e_o :	0.571	
Volume, V_0	38.375	in^3	Initial Degree of Saturation, S_0 :	104.13	%

Water Content BEFORE Test			Water Content AFTER Test (Total Specimen)		
Tin No.:	TS-89	g	Tin No.:	FUNKY	g
Wet Soil + Tin :	126.16	g	Wet Soil + Tin :	1,353.10	g
Dry Soil + Tin :	108.66	g	Dry Soil + Tin :	1,124.80	g
Tin Weight :	30.13	g	Tin Weight :	56.30	g
Dry Mass :	78.53	g	Dry Mass :	1068.50	g
Weight of water :	17.5	g	Weight of water :	228.30	g
Moisture :	22.28	%	Moisture :	21.37	%
			Wet Density :	128.74	pcf
			Dry Density :	106.07	pcf

Consolidation Cell Pressure:	133.0	psi	Deviator Stress @ Failure, Ds:	5,365.90	psf
Consolidation Back Pressure:	103.0	psi	Axial Strain @ Failure:	6.86	%
Effective Confining Stress, σ_3:	30.0	psi	Major Principal Stress @ Failure, σ_1:	9,685.90	psf
	4,320.00	psf	Induced Pore Pressure @ Failure:	720.00	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress,σ'_3:	3,600.00	psf
			Effective Major Principal Stress, σ'_1:	8,965.90	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



RESOURCE INTERNATIONAL

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CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

PROJECT NAME:	HAM-75-12.60 Part I
JOB NUMBER:	B-10-024
BORING NUMBER:	B-022-0-11
SAMPLE NUMBER:	ST-11
SAMPLE DEPTH:	25.4
DATE OF TESTING:	2/21/2012
TESTED BY:	J.Hoyt

Data for Specimen No. 3

Soil Description: Gray SILTY CLAY, trace coarse to fine sand, trace fine gravel
Soil Classification: ODOT A-6b

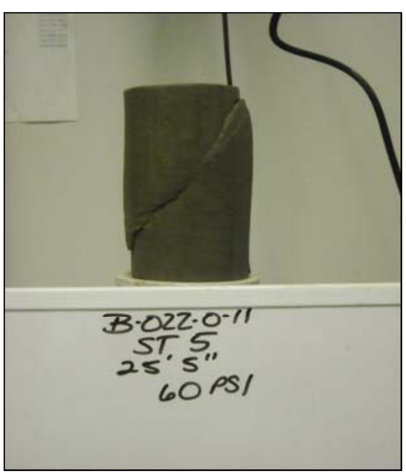
Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	40	19	21	1	1	1	33	64

Diameter, D_0	2.856	in	Volume of Solids , V_s :	23.838	in^3
Area, A_0	6.405	in^2	Initial Volume of Voids, V_v :	14.040	in^3
Height, L_0	5.914	in	Initial Void Ratio, e_o :	0.589	
Volume, V_0	37.878	in^3	Initial Degree of Saturation, S_0 :	100.434	%

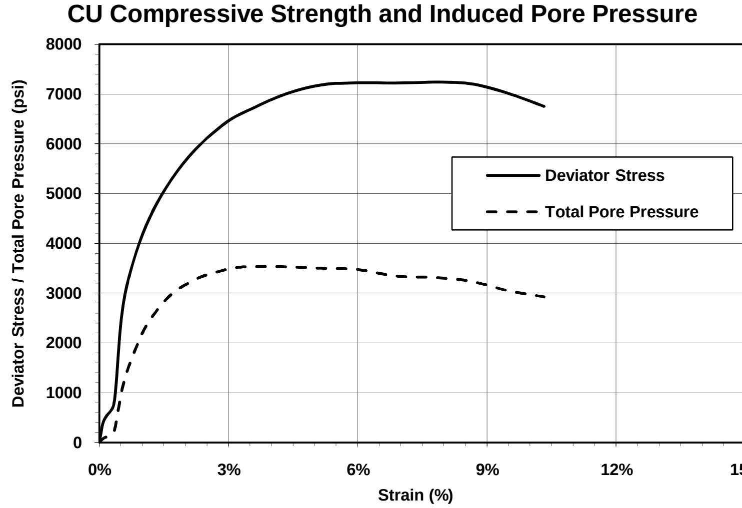
Water Content BEFORE Test			Water Content AFTER Test (Total Specimen)		
Tin No.:	G-25	g	Tin No.:	Funky	g
Wet Soil + Tin :	142.25	g	Wet Soil + Tin :	1,320.20	g
Dry Soil + Tin :	121.93	g	Dry Soil + Tin :	1,099.20	g
Tin Weight :	30.21	g	Tin Weight :	56.20	g
Dry Mass :	91.72	g	Dry Mass :	1,043.00	g
Weight of water :	20.32	g	Weight of water :	221.00	g
Moisture :	22.15	%	Moisture :	21.19	%
			Wet Density :	127.13	pcf
			Dry Density :	104.90	pcf

Consolidation Cell Pressure:	138.0	psi	Deviator Stress @ Failure, Ds:	7,227.96	psf
Consolidation Back Pressure:	78.0	psi	Axial Strain @ Failure:	6.02	%
Effective Confining Stress, σ_3:	60.0	psi	Major Principal Stress @ Failure, σ_1:	15,867.96	psf
	8,640.00	psf	Induced Pore Pressure @ Failure:	3,470.40	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress,σ'_3:	5,169.60	psf
			Effective Major Principal Stress, σ'_1:	12,397.56	psf

Failure Sketch



CU Compressive Strength and Induced Pore Pressure



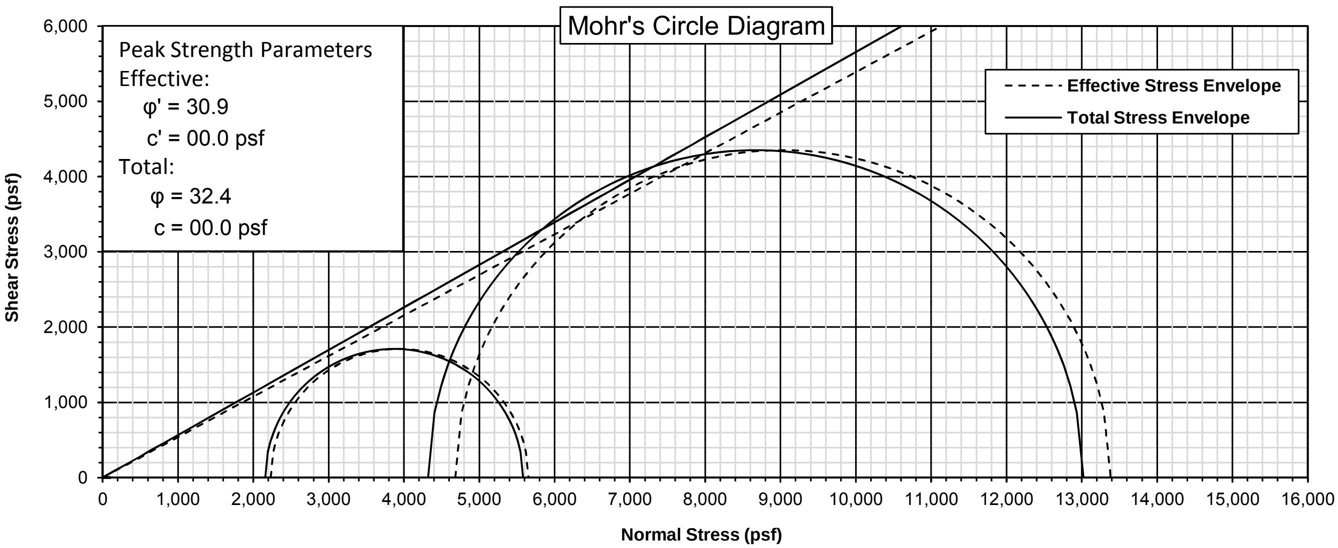
Consolidated, Undrained Triaxial Compression Test Report (ASTM D4767)

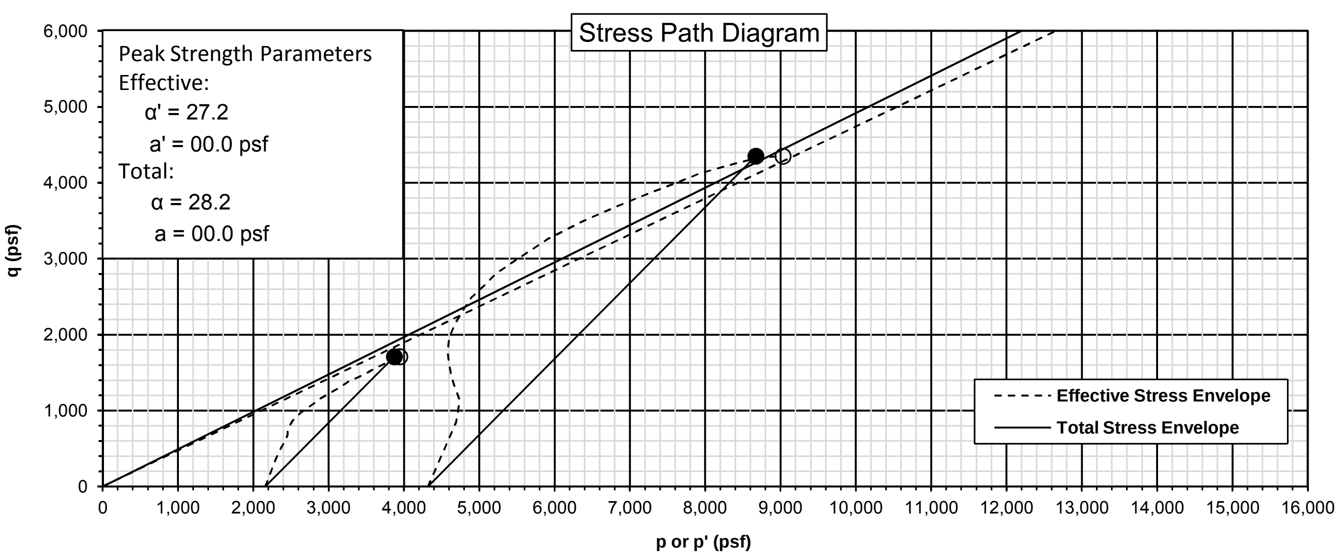
Project Number:	B-11-010	Boring Number:	B-004-0-11
Project Name:	HAM-75-11.09	Sample No. / Depth:	ST-2 and ST-3 / 9.5 ft to 11.4 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	05/11/2012 to 05/17/2012
Client:	M•E Companies, Inc.	Technician:	JJH

Soil Description: Brown SILT, some clay, trace coarse to fine sand.
Soil Classification: ODOT A-4b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	26	17	9	0	1	6	61	32

Stage	Boring No.	Sample No.	Depth (ft)	$(\sigma_3)_f$ (psf)	$(\sigma_1)_f$ (psf)	$(\sigma_3')_f$ (psf)	$(\sigma_1')_f$ (psf)	p'_f (psf)	q_f (psf)
1	B-004-0-11	ST-2	9.5	2,160.0	5,580.9	2,232.0	5,652.9	3,942.5	1,710.5
2	B-004-0-11	ST-3	11.4	4,320.0	13,022.3	4,680.0	13,382.3	9,031.2	4,351.2





Notes: Third point of test eliminated from final results. Physical properties listed based on testing performed on cuttings when samples were trimmed.

Consolidated, Undrained Triaxial Compression Test (ASTM D4767)

Project Number:	B-11-010	Boring Number:	B-004-0-11
Project Name:	HAM-75-11.09	Sample No. / Depth:	ST-2 / 9.5 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	5/11/2012
Client:	M•E Companies, Inc.	Technician:	JJH

Data for Specimen No. 1

Soil Description: Brown SILT, little clay, little fine sand, trace fine gravel.
Soil Classification: ODOT A-4b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	25	18	7	1	0	17	63	19

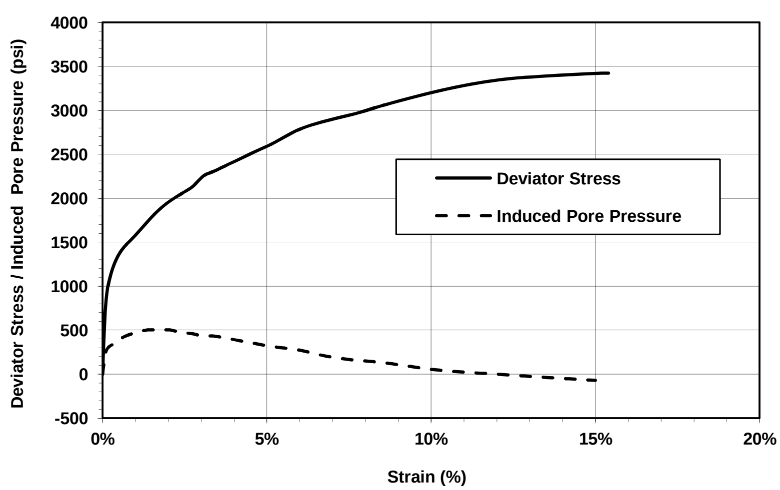
Diameter, D_0	2.836	in	Volume of Solids , V_s :	22.844	in^3
Area, A_0	6.315	in^2	Initial Volume of Voids, V_v :	14.495	in^3
Height, L_0	5.912	in	Initial Void Ratio, e_0 :	0.635	
Volume, V_0	37.339	in^3	Initial Degree of Saturation, S_0 :	106.037	%

Water Content BEFORE Test			Water Content AFTER Test (Total Specimen)		
Tin No.:	R-68	g	Tin No.:	ST	g
Wet Soil + Tin :	90.64	g	Wet Soil + Tin :	1399.80	g
Dry Soil + Tin :	77.67	g	Dry Soil + Tin :	1163.40	g
Tin Weight :	26.2	g	Tin Weight :	163.90	g
Dry Mass :	51.47	g	Dry Mass :	999.50	g
Weight of water :	12.97	g	Weight of water :	236.40	g
Moisture :	25.20	%	Moisture :	23.65	%
			Wet Density :	126.09	pcf
			Dry Density :	101.98	pcf

Consolidation Cell Pressure:	130.0	psi	Deviator Stress @ Failure, Ds:	3420.90	psf
Consolidation Back Pressure:	115.0	psi	Axial Strain @ Failure:	15.39	%
Effective Confining Stress, σ_3:	15.0	psi	Major Principal Stress @ Failure, σ_1:	5580.90	psf
	2160.00	psf	Induced Pore Pressure @ Failure:	-72.00	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress,σ'_3:	2232.00	psf
			Effective Major Principal Stress, σ'_1:	5652.90	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



Notes:

Consolidated, Undrained Triaxial Compression Test (ASTM D4767)

Project Number:	B-11-010	Boring Number:	B-004-0-11
Project Name:	HAM-75-11.09	Sample No. / Depth:	ST-3 / 11.4 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	5/17/2012
Client:	M•E Companies, Inc.	Technician:	JJH

Data for Specimen No. 2

Soil Description: Brown SILT, and clay, trace coarse to fine sand.

Soil Classification: ODOT A-4b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	25	16	9	0	1	1	52	46

Diameter, D_0	2.843	in	Volume of Solids , V_s :	27.218	in^3
Area, A_0	6.347	in^2	Initial Volume of Voids, V_v :	10.265	in^3
Height, L_0	5.906	in	Initial Void Ratio, e_o :	0.377	
Volume, V_0	37.483	in^3	Initial Degree of Saturation, S_0 :	92.53	%

Water Content BEFORE Test

Tin No.:	T-26	g
Wet Soil + Tin :	123.78	g
Dry Soil + Tin :	112.71	g
Tin Weight :	28.01	g
Dry Mass :	84.7	g
Weight of water :	11.07	g
Moisture :	13.07	%

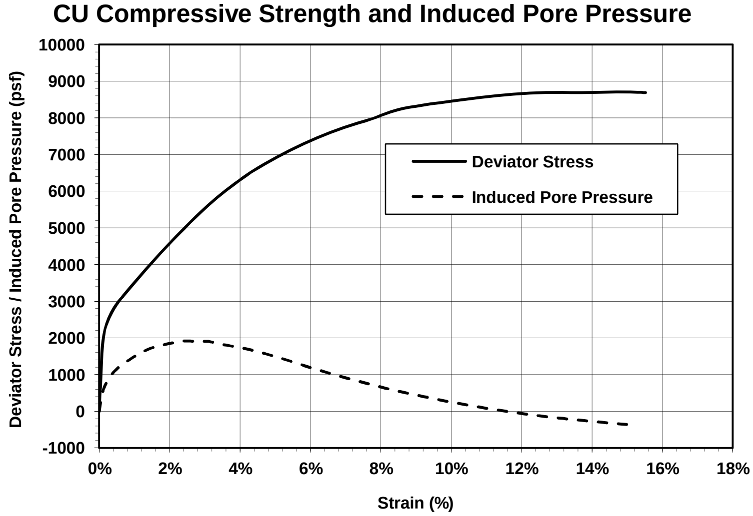
Water Content AFTER Test (Total Specimen)

Tin No.:	ST	g
Wet Soil + Tin :	1473.90	g
Dry Soil + Tin :	1309.00	g
Tin Weight :	118.10	g
Dry Mass :	1190.90	g
Weight of water :	164.90	g
Moisture :	13.85	%
Wet Density :	137.79	pcf
Dry Density :	121.03	pcf

Consolidation Cell Pressure:	143.0	psi	Deviator Stress @ Failure, Ds:	8702.33	psf
Consolidation Back Pressure:	113.0	psi	Axial Strain @ Failure:	14.99	%
Effective Confining Stress, σ_3:	30.0	psi	Major Principal Stress @ Failure, σ_1:	13022.33	psf
	4320.00	psf	Induced Pore Pressure @ Failure:	-360.00	psf
Strain Rate:	0.0036	in/min	Effective Minor Principal Stress,σ'_3:	4680.00	psf
			Effective Major Principal Stress, σ'_1:	13382.33	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



Notes:

Consolidated, Undrained Triaxial Compression Test (ASTM D4767)

Project Number:	B-11-010	Boring Number:	B-004-0-11
Project Name:	HAM-75-11.09	Sample No. / Depth:	ST-2 / 9.0 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	5/15/2012
Client:	M•E Companies, Inc.	Technician:	JJH

Data for Specimen No. 3

Soil Description: Brown SILTY and CLAY, some coarse to fine sand, little fine gravel.

Soil Classification: ODOT A-6a

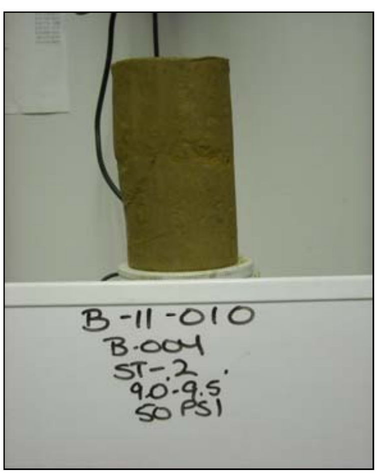
Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	27	15	12	11	9	14	38	28

Diameter, D_0	2.837	in	Volume of Solids , V_s :	22.794	in^3
Area, A_0	6.320	in^2	Initial Volume of Voids, V_v :	14.563	in^3
Height, L_0	5.911	in	Initial Void Ratio, e_o :	0.639	
Volume, V_0	37.357	in^3	Initial Degree of Saturation, S_0 :	99.713	%

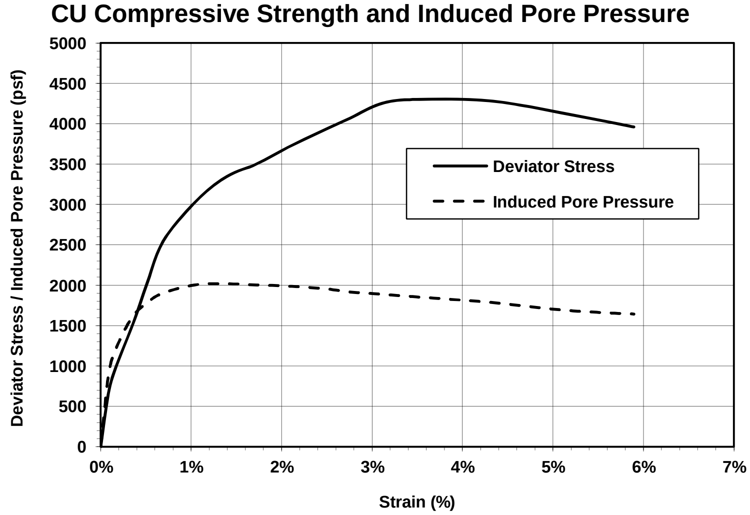
Water Content BEFORE Test			Water Content AFTER Test (Total Specimen)		
Tin No.:	T-33	g	Tin No.:	S	g
Wet Soil + Tin :	85.25	g	Wet Soil + Tin :	1356.80	g
Dry Soil + Tin :	74.1	g	Dry Soil + Tin :	1115.30	g
Tin Weight :	27.37	g	Tin Weight :	118.00	g
Dry Mass :	46.73	g	Dry Mass :	997.30	g
Weight of water :	11.15	g	Weight of water :	241.50	g
Moisture :	23.86047507	%	Moisture :	24.22	%
			Wet Density :	126.33	pcf
			Dry Density :	101.70	pcf

Consolidation Cell Pressure:	140.0	psi	Deviator Stress @ Failure, Ds:	4298.80	psf
Consolidation Back Pressure:	90.0	psi	Axial Strain @ Failure:	5.89	%
Effective Confining Stress, σ_3:	50.0	psi	Major Principal Stress @ Failure, σ_1:	11498.80	psf
	7200.00	psf	Induced Pore Pressure @ Failure:	1641.60	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress, σ'_3:	5558.40	psf
			Effective Major Principal Stress, σ'_1:	9857.20	psf

Failure Sketch



CU Compressive Strength and Induced Pore Pressure



Notes: Point classified as A-6a material type, which is different than the first two points of the test. Results of this point do not line up with remainder of points. Therefore, the results of this point are not utilized in the final results of the test.

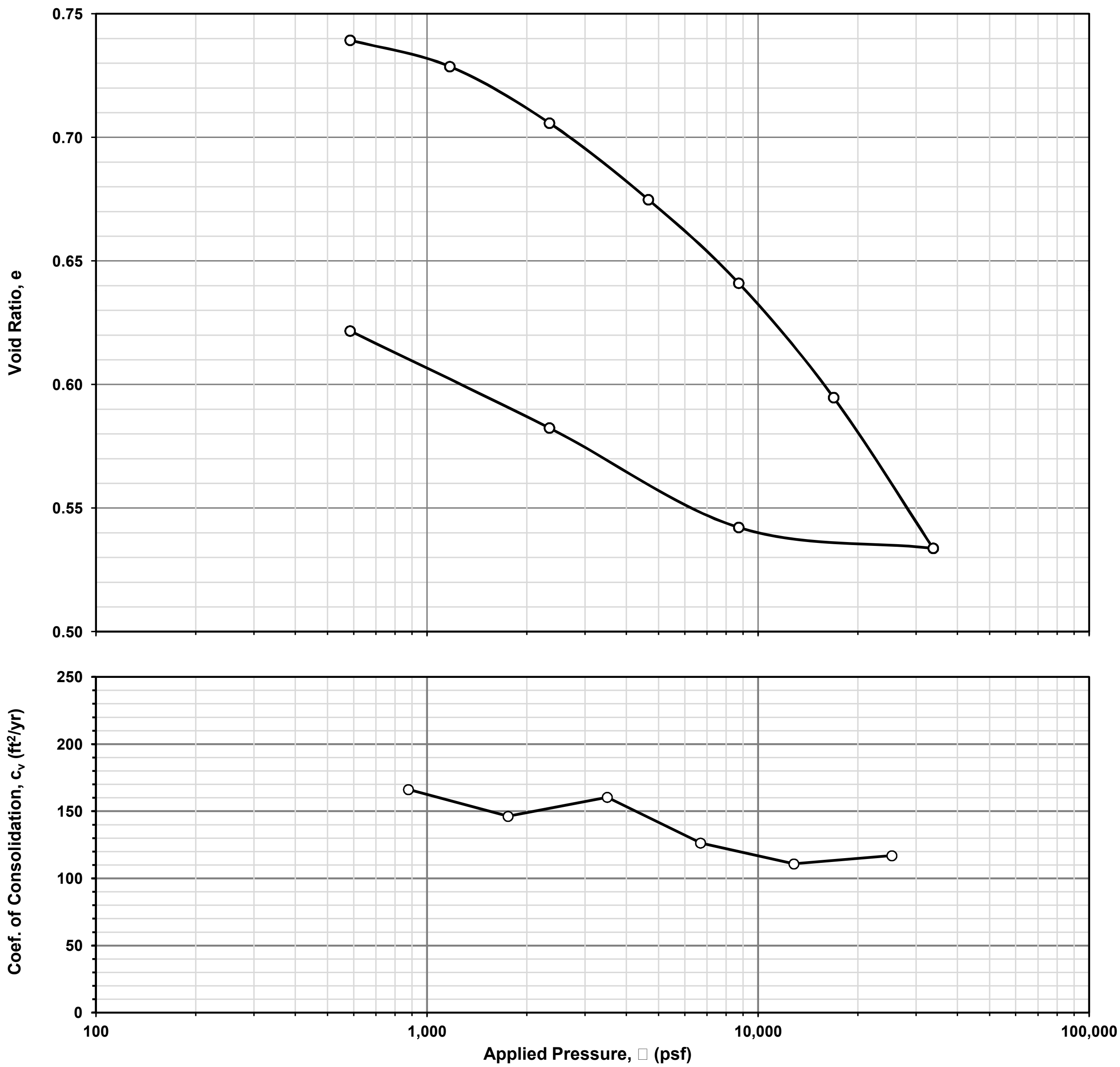
One-Dimensional Consolidation Test Report (ASTM D2435)

Project Number:	B-10-020	Boring Number:	B-008-0-11
Project Name:	HAM-75-7.85	Sample No. / Depth:	ST-10 / 24.0 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	11/3/2011 to 11/16/2011
Client:	EMH&T	Technician:	JJH

Soil Description: Gray CLAY, trace silt
Soil Classification: ODOT A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	54	23	31	0	0	0	8	91

Natural		γ_d (pcf)	γ_{sat} (pcf)	σ_{vo}' (psf)	S_G	e_o	σ_p' (psf)	c_c	c_r
S_o	w_o								
102.2%	28.9%	94.1	121.9	2880	2.67	0.771	4886	0.230	0.068



One-Dimensional Consolidation Test Report (ASTM D2435)

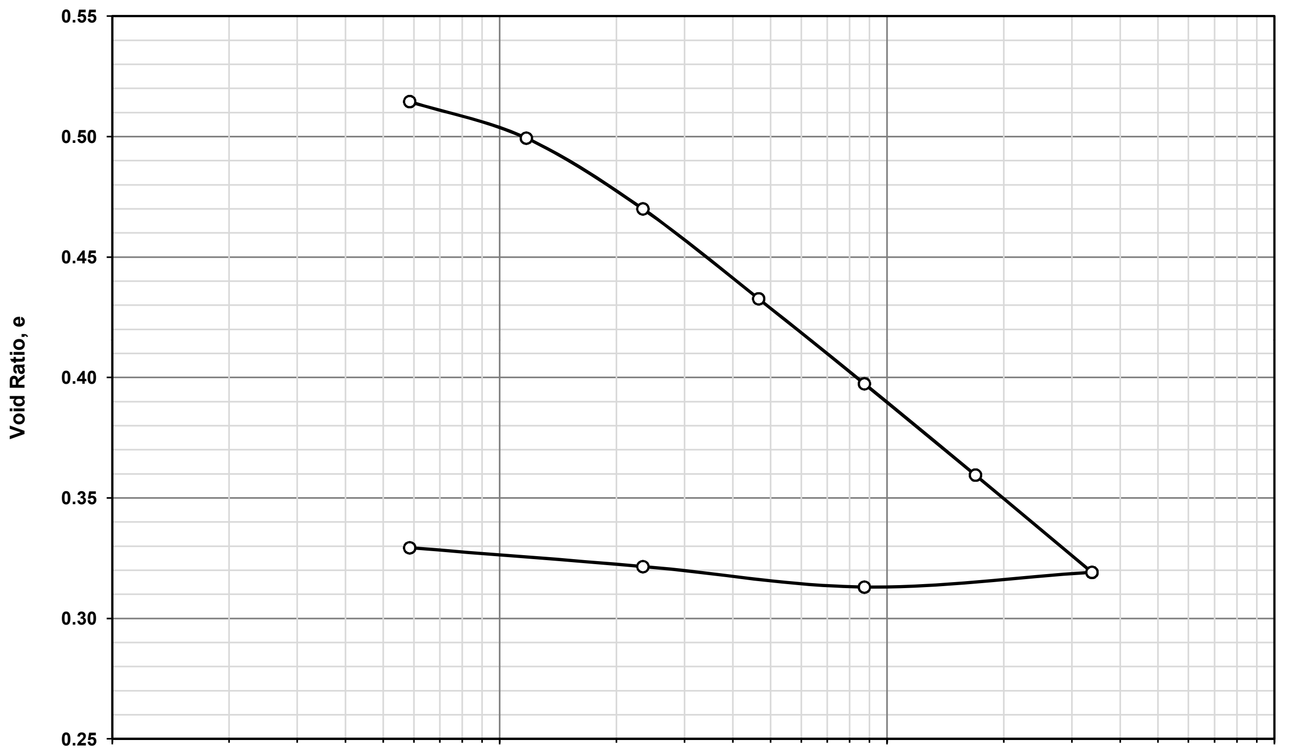
Project Number:	B-10-020	Boring Number:	B-015-0-11
Project Name:	HAM-75-7.85	Sample No. / Depth:	ST-8 / 20.3 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	10/14/2011 to 10/28/2011
Client:	EMH&T	Technician:	JJH

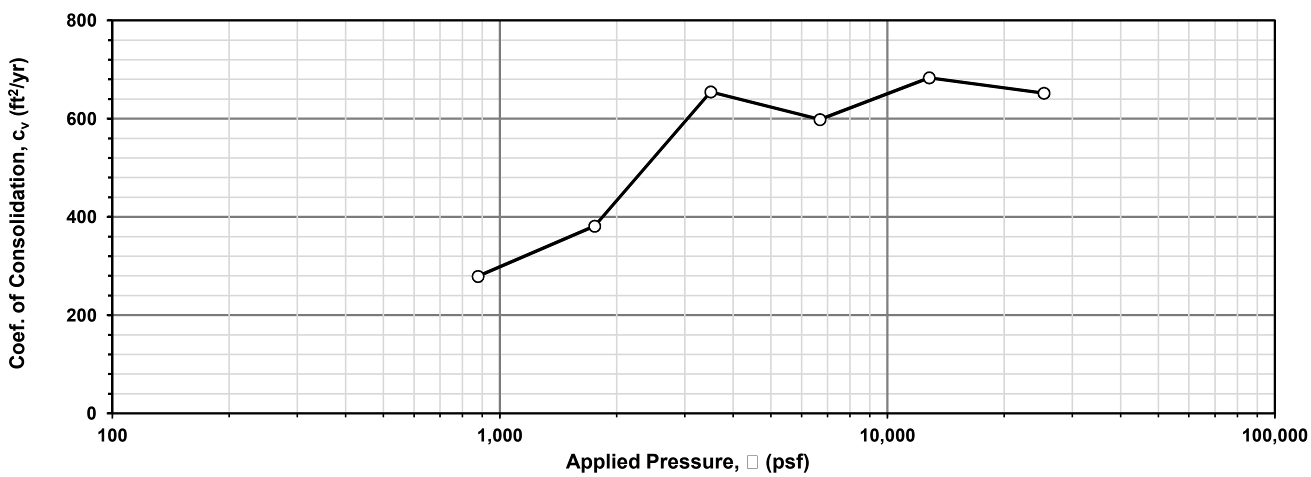
Soil Description: Brownish gray SANDY SILT, little clay, trace fine gravel

Soil Classification: ODOT A-4a

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	24	15	9	7	6	31	37	19

Natural		γ_d (pcf)	γ_{sat} (pcf)	σ_{vo}' (psf)	S_G	e_o	σ_p' (psf)	c_c	c_r
S_o	w_o								
85.1%	15.0%	108.6	127.1	2,556	2.67	0.535	1,857	0.134	0.014





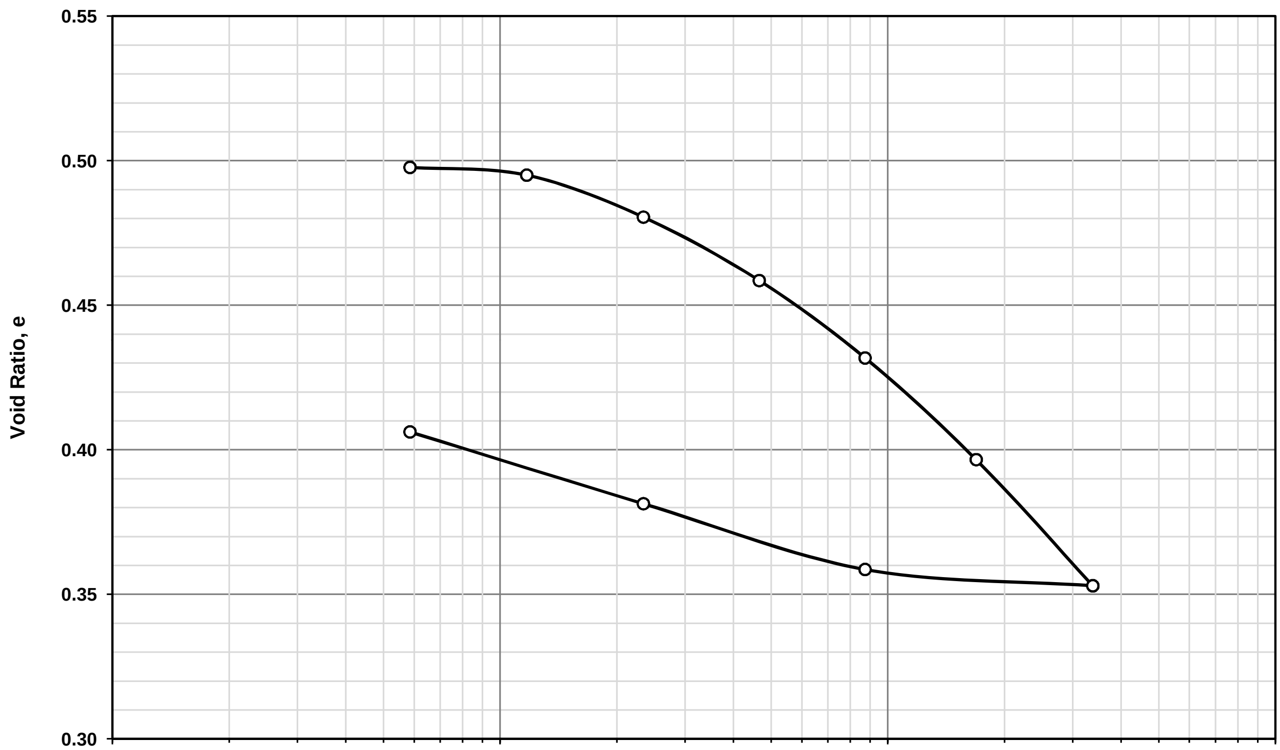
One-Dimensional Consolidation Test Report (ASTM D2435)

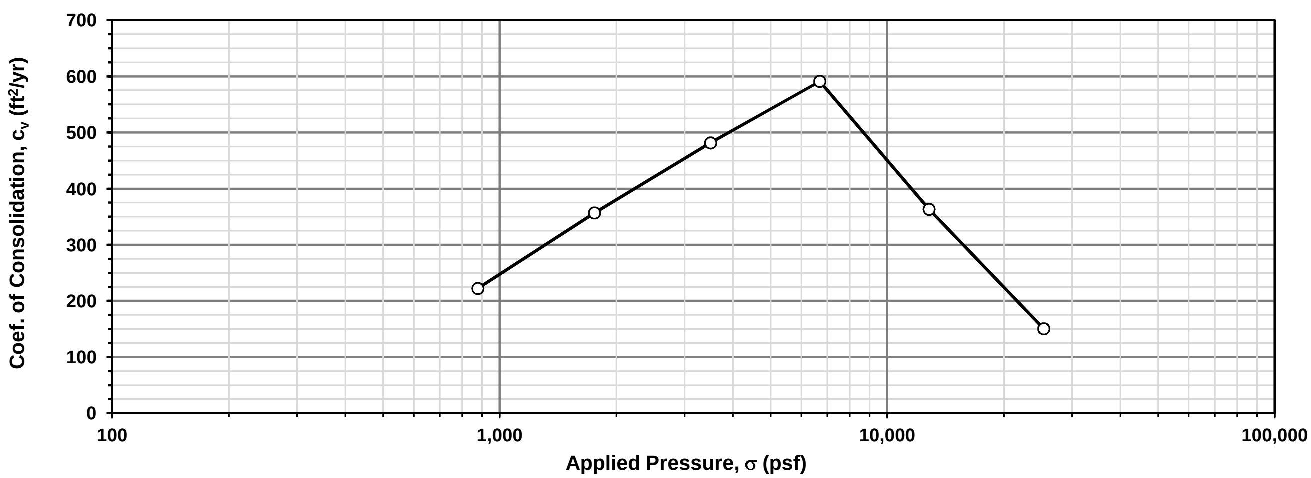
Project Number:	B-10-020	Boring Number:	B-053-0-11
Project Name:	HAM-75-7.85	Sample No. / Depth:	ST-4 / 8.5 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	11/18/2011 to 12/2/2011
Client:	EMH&T	Technician:	JJH

Soil Description: Brown SILTY CLAY, little coarse to fine sand, trace fine gravel
Soil Classification: ODOT A-6b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	35	16	19	1	3	17	37	42

Natural		γ_d (pcf)	γ_{sat} (pcf)	σ_{vo}' (psf)	S_G	e_o	σ_p' (psf)	c_c	c_r
S_o	w_o								
98.4%	19.3%	110.1	130.6	1,020	2.65	0.503	4,645	0.145	0.041





APPENDIX V

DRIVEN ANALYSIS OUTPUT

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: J:\GEOTECH\ANALYSIS\D2BZEP~U.2\B-162-R.DVN
Project Name: HAM-75-0791- B-162-Rear Project Date: 06/08/2012
Project Client: EMHT
Computed By: Brian Trenner
Project Manager: Jonathan Sterenberg

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 16.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil: (Downdrag Condition)	13.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	7.00 ft	50.00%	115.00 pcf	750.00 psf	T-79 Steel
2	Cohesive	11.50 ft	50.00%	115.00 pcf	1500.00 psf	T-79 Steel
3	Cohesionless	10.00 ft	33.00%	125.00 pcf	30.0/30.0	Nordlund
4	Cohesive	15.00 ft	33.00%	125.00 pcf	3750.00 psf	T-79 Steel
5	Cohesionless	5.00 ft	33.00%	125.00 pcf	30.0/30.0	Nordlund
6	Cohesive	4.50 ft	33.00%	115.00 pcf	1250.00 psf	T-79 Steel
7	Cohesive	5.50 ft	33.00%	120.00 pcf	3250.00 psf	T-79 Steel
8	Cohesionless	4.50 ft	17.00%	125.00 pcf	30.0/30.0	Nordlund
9	Cohesionless	7.00 ft	17.00%	130.00 pcf	33.0/33.0	Nordlund
10	Cohesionless	3.50 ft	17.00%	130.00 pcf	33.0/33.0	Nordlund
11	Cohesive	11.00 ft	33.00%	120.00 pcf	2000.00 psf	T-79 Steel
12	Cohesionless	6.50 ft	0.00%	125.00 pcf	31.0/31.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	622.50 psf	0.03 Kips
6.99 ft	Cohesive	N/A	N/A	622.50 psf	18.23 Kips
7.01 ft	Cohesive	N/A	N/A	1060.00 psf	18.30 Kips
16.01 ft	Cohesive	N/A	N/A	1075.73 psf	58.85 Kips
18.49 ft	Cohesive	N/A	N/A	1090.30 psf	70.73 Kips
18.51 ft	Cohesionless	973.41 psf	21.97	N/A	70.79 Kips
27.51 ft	Cohesionless	1255.11 psf	21.97	N/A	89.80 Kips
28.49 ft	Cohesionless	1285.79 psf	21.97	N/A	92.39 Kips
28.51 ft	Cohesive	N/A	N/A	955.91 psf	92.45 Kips
37.51 ft	Cohesive	N/A	N/A	1066.16 psf	132.65 Kips
43.49 ft	Cohesive	N/A	N/A	1139.42 psf	163.96 Kips
43.51 ft	Cohesionless	2538.41 psf	21.97	N/A	164.06 Kips
48.49 ft	Cohesionless	2694.29 psf	21.97	N/A	186.63 Kips
48.51 ft	Cohesive	N/A	N/A	1099.29 psf	186.73 Kips
52.99 ft	Cohesive	N/A	N/A	1120.85 psf	207.76 Kips
53.01 ft	Cohesive	N/A	N/A	1256.04 psf	207.86 Kips
58.49 ft	Cohesive	N/A	N/A	1260.00 psf	236.78 Kips
58.51 ft	Cohesionless	3404.91 psf	21.97	N/A	236.89 Kips
62.99 ft	Cohesionless	3545.14 psf	21.97	N/A	263.62 Kips
63.01 ft	Cohesionless	3686.64 psf	24.17	N/A	263.77 Kips
69.99 ft	Cohesionless	3922.56 psf	24.17	N/A	328.81 Kips
70.01 ft	Cohesionless	4159.84 psf	24.17	N/A	329.01 Kips
73.49 ft	Cohesionless	4277.46 psf	24.17	N/A	364.37 Kips
73.51 ft	Cohesive	N/A	N/A	1515.00 psf	364.54 Kips
82.51 ft	Cohesive	N/A	N/A	1515.00 psf	421.65 Kips
84.49 ft	Cohesive	N/A	N/A	1515.00 psf	434.21 Kips
84.51 ft	Cohesionless	5030.01 psf	22.70	N/A	434.37 Kips
90.99 ft	Cohesionless	5232.84 psf	22.70	N/A	499.03 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
6.99 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
7.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
18.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
18.51 ft	Cohesionless	973.73 psf	30.00	18.60 Kips	18.60 Kips
27.51 ft	Cohesionless	1537.13 psf	30.00	18.60 Kips	18.60 Kips
28.49 ft	Cohesionless	1598.47 psf	30.00	18.60 Kips	18.60 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
43.49 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
43.51 ft	Cohesionless	2538.73 psf	30.00	18.60 Kips	18.60 Kips
48.49 ft	Cohesionless	2850.47 psf	30.00	18.60 Kips	18.60 Kips
48.51 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
58.49 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
58.51 ft	Cohesionless	3405.23 psf	30.00	18.60 Kips	18.60 Kips
62.99 ft	Cohesionless	3685.67 psf	30.00	18.60 Kips	18.60 Kips
63.01 ft	Cohesionless	3686.98 psf	47.20	69.81 Kips	69.81 Kips
69.99 ft	Cohesionless	4158.82 psf	47.20	69.81 Kips	69.81 Kips
70.01 ft	Cohesionless	4160.18 psf	47.20	69.81 Kips	69.81 Kips
73.49 ft	Cohesionless	4395.42 psf	47.20	69.81 Kips	69.81 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
82.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
84.49 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
84.51 ft	Cohesionless	5030.33 psf	35.20	28.85 Kips	28.85 Kips
90.99 ft	Cohesionless	5435.97 psf	35.20	28.85 Kips	28.85 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.03 Kips	9.42 Kips	9.45 Kips
6.99 ft	18.23 Kips	9.42 Kips	27.65 Kips
7.01 ft	18.30 Kips	18.85 Kips	37.15 Kips
16.01 ft	58.85 Kips	18.85 Kips	77.70 Kips
18.49 ft	70.73 Kips	18.85 Kips	89.58 Kips
18.51 ft	70.79 Kips	18.60 Kips	89.39 Kips
27.51 ft	89.80 Kips	18.60 Kips	108.40 Kips
28.49 ft	92.39 Kips	18.60 Kips	110.98 Kips
28.51 ft	92.45 Kips	47.12 Kips	139.58 Kips
37.51 ft	132.65 Kips	47.12 Kips	179.78 Kips
43.49 ft	163.96 Kips	47.12 Kips	211.08 Kips
43.51 ft	164.06 Kips	18.60 Kips	182.65 Kips
48.49 ft	186.63 Kips	18.60 Kips	205.23 Kips
48.51 ft	186.73 Kips	15.71 Kips	202.43 Kips
52.99 ft	207.76 Kips	15.71 Kips	223.47 Kips
53.01 ft	207.86 Kips	40.84 Kips	248.70 Kips
58.49 ft	236.78 Kips	40.84 Kips	277.62 Kips
58.51 ft	236.89 Kips	18.60 Kips	255.49 Kips
62.99 ft	263.62 Kips	18.60 Kips	282.21 Kips
63.01 ft	263.77 Kips	69.81 Kips	333.58 Kips
69.99 ft	328.81 Kips	69.81 Kips	398.62 Kips
70.01 ft	329.01 Kips	69.81 Kips	398.82 Kips
73.49 ft	364.37 Kips	69.81 Kips	434.18 Kips
73.51 ft	364.54 Kips	25.13 Kips	389.67 Kips
82.51 ft	421.65 Kips	25.13 Kips	446.78 Kips
84.49 ft	434.21 Kips	25.13 Kips	459.35 Kips
84.51 ft	434.37 Kips	28.85 Kips	463.23 Kips
90.99 ft	499.03 Kips	28.85 Kips	527.88 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	622.50 psf	0.01 Kips
6.99 ft	Cohesive	N/A	N/A	622.50 psf	9.11 Kips
7.01 ft	Cohesive	N/A	N/A	1060.00 psf	9.15 Kips
16.01 ft	Cohesive	N/A	N/A	1075.73 psf	29.43 Kips
18.49 ft	Cohesive	N/A	N/A	1090.30 psf	35.36 Kips
18.51 ft	Cohesionless	973.41 psf	21.97	N/A	35.41 Kips
27.51 ft	Cohesionless	1255.11 psf	21.97	N/A	48.14 Kips
28.49 ft	Cohesionless	1285.79 psf	21.97	N/A	49.88 Kips
28.51 ft	Cohesive	N/A	N/A	955.91 psf	49.92 Kips
37.51 ft	Cohesive	N/A	N/A	1066.16 psf	76.85 Kips
43.49 ft	Cohesive	N/A	N/A	1139.42 psf	97.83 Kips
43.51 ft	Cohesionless	2538.41 psf	21.97	N/A	97.89 Kips
48.49 ft	Cohesionless	2694.29 psf	21.97	N/A	113.02 Kips
48.51 ft	Cohesive	N/A	N/A	1099.29 psf	113.08 Kips
52.99 ft	Cohesive	N/A	N/A	1120.85 psf	127.18 Kips
53.01 ft	Cohesive	N/A	N/A	1256.04 psf	127.24 Kips
58.49 ft	Cohesive	N/A	N/A	1260.00 psf	146.62 Kips
58.51 ft	Cohesionless	3404.91 psf	21.97	N/A	146.71 Kips
62.99 ft	Cohesionless	3545.14 psf	21.97	N/A	168.89 Kips
63.01 ft	Cohesionless	3686.64 psf	24.17	N/A	169.02 Kips
69.99 ft	Cohesionless	3922.56 psf	24.17	N/A	223.00 Kips
70.01 ft	Cohesionless	4159.84 psf	24.17	N/A	223.17 Kips
73.49 ft	Cohesionless	4277.46 psf	24.17	N/A	252.52 Kips
73.51 ft	Cohesive	N/A	N/A	1515.00 psf	252.63 Kips
82.51 ft	Cohesive	N/A	N/A	1515.00 psf	290.90 Kips
84.49 ft	Cohesive	N/A	N/A	1515.00 psf	299.31 Kips
84.51 ft	Cohesionless	5030.01 psf	22.70	N/A	299.47 Kips
90.99 ft	Cohesionless	5232.84 psf	22.70	N/A	364.13 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
6.99 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
7.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
18.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
18.51 ft	Cohesionless	973.73 psf	30.00	18.60 Kips	18.60 Kips
27.51 ft	Cohesionless	1537.13 psf	30.00	18.60 Kips	18.60 Kips
28.49 ft	Cohesionless	1598.47 psf	30.00	18.60 Kips	18.60 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
43.49 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
43.51 ft	Cohesionless	2538.73 psf	30.00	18.60 Kips	18.60 Kips
48.49 ft	Cohesionless	2850.47 psf	30.00	18.60 Kips	18.60 Kips
48.51 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
58.49 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
58.51 ft	Cohesionless	3405.23 psf	30.00	18.60 Kips	18.60 Kips
62.99 ft	Cohesionless	3685.67 psf	30.00	18.60 Kips	18.60 Kips
63.01 ft	Cohesionless	3686.98 psf	47.20	69.81 Kips	69.81 Kips
69.99 ft	Cohesionless	4158.82 psf	47.20	69.81 Kips	69.81 Kips
70.01 ft	Cohesionless	4160.18 psf	47.20	69.81 Kips	69.81 Kips
73.49 ft	Cohesionless	4395.42 psf	47.20	69.81 Kips	69.81 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
82.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
84.49 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
84.51 ft	Cohesionless	5030.33 psf	35.20	28.85 Kips	28.85 Kips
90.99 ft	Cohesionless	5435.97 psf	35.20	28.85 Kips	28.85 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.01 Kips	9.42 Kips	9.44 Kips
6.99 ft	9.11 Kips	9.42 Kips	18.54 Kips
7.01 ft	9.15 Kips	18.85 Kips	28.00 Kips
16.01 ft	29.43 Kips	18.85 Kips	48.28 Kips
18.49 ft	35.36 Kips	18.85 Kips	54.21 Kips
18.51 ft	35.41 Kips	18.60 Kips	54.01 Kips
27.51 ft	48.14 Kips	18.60 Kips	66.74 Kips
28.49 ft	49.88 Kips	18.60 Kips	68.47 Kips
28.51 ft	49.92 Kips	47.12 Kips	97.04 Kips
37.51 ft	76.85 Kips	47.12 Kips	123.98 Kips
43.49 ft	97.83 Kips	47.12 Kips	144.95 Kips
43.51 ft	97.89 Kips	18.60 Kips	116.49 Kips
48.49 ft	113.02 Kips	18.60 Kips	131.62 Kips
48.51 ft	113.08 Kips	15.71 Kips	128.79 Kips
52.99 ft	127.18 Kips	15.71 Kips	142.88 Kips
53.01 ft	127.24 Kips	40.84 Kips	168.08 Kips
58.49 ft	146.62 Kips	40.84 Kips	187.46 Kips
58.51 ft	146.71 Kips	18.60 Kips	165.31 Kips
62.99 ft	168.89 Kips	18.60 Kips	187.49 Kips
63.01 ft	169.02 Kips	69.81 Kips	238.83 Kips
69.99 ft	223.00 Kips	69.81 Kips	292.82 Kips
70.01 ft	223.17 Kips	69.81 Kips	292.98 Kips
73.49 ft	252.52 Kips	69.81 Kips	322.33 Kips
73.51 ft	252.63 Kips	25.13 Kips	277.76 Kips
82.51 ft	290.90 Kips	25.13 Kips	316.03 Kips
84.49 ft	299.31 Kips	25.13 Kips	324.45 Kips
84.51 ft	299.47 Kips	28.85 Kips	328.33 Kips
90.99 ft	364.13 Kips	28.85 Kips	392.98 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	622.50 psf	-0.03 Kips
6.99 ft	Cohesive	N/A	N/A	622.50 psf	-18.23 Kips
7.01 ft	Cohesive	N/A	N/A	1060.00 psf	-18.30 Kips
12.99 ft	Cohesive	N/A	N/A	1060.00 psf	-44.85 Kips
13.00 ft	Cohesive	N/A	N/A	1060.00 psf	-44.89 Kips
16.01 ft	Cohesive	N/A	N/A	1075.73 psf	-31.33 Kips
18.49 ft	Cohesive	N/A	N/A	1090.30 psf	-19.82 Kips
18.51 ft	Cohesionless	973.41 psf	21.97	N/A	-19.76 Kips
27.51 ft	Cohesionless	1255.11 psf	21.97	N/A	-0.75 Kips
28.49 ft	Cohesionless	1285.79 psf	21.97	N/A	1.84 Kips
28.51 ft	Cohesive	N/A	N/A	955.91 psf	1.90 Kips
37.51 ft	Cohesive	N/A	N/A	1066.16 psf	42.10 Kips
43.49 ft	Cohesive	N/A	N/A	1139.42 psf	73.41 Kips
43.51 ft	Cohesionless	2538.41 psf	21.97	N/A	73.51 Kips
48.49 ft	Cohesionless	2694.29 psf	21.97	N/A	96.08 Kips
48.51 ft	Cohesive	N/A	N/A	1099.29 psf	96.18 Kips
52.99 ft	Cohesive	N/A	N/A	1120.85 psf	117.21 Kips
53.01 ft	Cohesive	N/A	N/A	1256.04 psf	117.31 Kips
58.49 ft	Cohesive	N/A	N/A	1260.00 psf	146.23 Kips
58.51 ft	Cohesionless	3404.91 psf	21.97	N/A	146.34 Kips
62.99 ft	Cohesionless	3545.14 psf	21.97	N/A	173.07 Kips
63.01 ft	Cohesionless	3686.64 psf	24.17	N/A	173.22 Kips
69.99 ft	Cohesionless	3922.56 psf	24.17	N/A	238.26 Kips
70.01 ft	Cohesionless	4159.84 psf	24.17	N/A	238.46 Kips
73.49 ft	Cohesionless	4277.46 psf	24.17	N/A	273.82 Kips
73.51 ft	Cohesive	N/A	N/A	1515.00 psf	273.99 Kips
82.51 ft	Cohesive	N/A	N/A	1515.00 psf	331.10 Kips
84.49 ft	Cohesive	N/A	N/A	1515.00 psf	343.67 Kips
84.51 ft	Cohesionless	5030.01 psf	22.70	N/A	343.82 Kips
90.99 ft	Cohesionless	5232.84 psf	22.70	N/A	408.48 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
6.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
12.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
13.00 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
18.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
18.51 ft	Cohesionless	973.73 psf	30.00	18.60 Kips	18.60 Kips
27.51 ft	Cohesionless	1537.13 psf	30.00	18.60 Kips	18.60 Kips
28.49 ft	Cohesionless	1598.47 psf	30.00	18.60 Kips	18.60 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
43.49 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
43.51 ft	Cohesionless	2538.73 psf	30.00	18.60 Kips	18.60 Kips
48.49 ft	Cohesionless	2850.47 psf	30.00	18.60 Kips	18.60 Kips
48.51 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
58.49 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
58.51 ft	Cohesionless	3405.23 psf	30.00	18.60 Kips	18.60 Kips
62.99 ft	Cohesionless	3685.67 psf	30.00	18.60 Kips	18.60 Kips
63.01 ft	Cohesionless	3686.98 psf	47.20	69.81 Kips	69.81 Kips
69.99 ft	Cohesionless	4158.82 psf	47.20	69.81 Kips	69.81 Kips
70.01 ft	Cohesionless	4160.18 psf	47.20	69.81 Kips	69.81 Kips
73.49 ft	Cohesionless	4395.42 psf	47.20	69.81 Kips	69.81 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
82.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
84.49 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
84.51 ft	Cohesionless	5030.33 psf	35.20	28.85 Kips	28.85 Kips
90.99 ft	Cohesionless	5435.97 psf	35.20	28.85 Kips	28.85 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	-0.03 Kips	0.00 Kips	-0.03 Kips
6.99 ft	-18.23 Kips	0.00 Kips	-18.23 Kips
7.01 ft	-18.30 Kips	0.00 Kips	-18.30 Kips
12.99 ft	-44.85 Kips	0.00 Kips	-44.85 Kips
13.00 ft	-44.89 Kips	18.85 Kips	-26.04 Kips
16.01 ft	-31.33 Kips	18.85 Kips	-12.48 Kips
18.49 ft	-19.82 Kips	18.85 Kips	-0.97 Kips
18.51 ft	-19.76 Kips	18.60 Kips	-1.16 Kips
27.51 ft	-0.75 Kips	18.60 Kips	17.85 Kips
28.49 ft	1.84 Kips	18.60 Kips	20.44 Kips
28.51 ft	1.90 Kips	47.12 Kips	49.03 Kips
37.51 ft	42.10 Kips	47.12 Kips	89.23 Kips
43.49 ft	73.41 Kips	47.12 Kips	120.53 Kips
43.51 ft	73.51 Kips	18.60 Kips	92.10 Kips
48.49 ft	96.08 Kips	18.60 Kips	114.68 Kips
48.51 ft	96.18 Kips	15.71 Kips	111.88 Kips
52.99 ft	117.21 Kips	15.71 Kips	132.92 Kips
53.01 ft	117.31 Kips	40.84 Kips	158.15 Kips
58.49 ft	146.23 Kips	40.84 Kips	187.08 Kips
58.51 ft	146.34 Kips	18.60 Kips	164.94 Kips
62.99 ft	173.07 Kips	18.60 Kips	191.67 Kips
63.01 ft	173.22 Kips	69.81 Kips	243.03 Kips
69.99 ft	238.26 Kips	69.81 Kips	308.07 Kips
70.01 ft	238.46 Kips	69.81 Kips	308.27 Kips
73.49 ft	273.82 Kips	69.81 Kips	343.63 Kips
73.51 ft	273.99 Kips	25.13 Kips	299.12 Kips
82.51 ft	331.10 Kips	25.13 Kips	356.23 Kips
84.49 ft	343.67 Kips	25.13 Kips	368.80 Kips
84.51 ft	343.82 Kips	28.85 Kips	372.68 Kips
90.99 ft	408.48 Kips	28.85 Kips	437.33 Kips

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: J:\GEOTECH\ANALYSIS\D2BZEP~U.2\B-162-R.DVN
Project Name: HAM-75-0791- B-162-Fwd Project Date: 06/08/2012
Project Client: EMHT
Computed By: Brian Trenner
Project Manager: Jonathan Sterenberg

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 16.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	14.90 ft
	- Driving/Restrike	14.90 ft
	- Ultimate:	14.90 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	16.00 ft	17.00%	115.00 pcf	1250.00 psf	T-79 Steel
2	Cohesive	6.00 ft	50.00%	115.00 pcf	750.00 psf	T-79 Steel
3	Cohesive	11.50 ft	50.00%	115.00 pcf	1500.00 psf	T-79 Steel
4	Cohesionless	10.00 ft	33.00%	125.00 pcf	30.0/30.0	Nordlund
5	Cohesive	15.00 ft	33.00%	125.00 pcf	3750.00 psf	T-79 Steel
6	Cohesionless	5.00 ft	33.00%	125.00 pcf	30.0/30.0	Nordlund
7	Cohesive	4.50 ft	33.00%	115.00 pcf	1250.00 psf	T-79 Steel
8	Cohesive	6.00 ft	33.00%	120.00 pcf	3250.00 psf	T-79 Steel
9	Cohesive	4.00 ft	33.00%	120.00 pcf	3250.00 psf	T-79 Steel
10	Cohesionless	5.00 ft	17.00%	125.00 pcf	30.0/30.0	Nordlund
11	Cohesionless	5.50 ft	17.00%	130.00 pcf	33.0/33.0	Nordlund
12	Cohesive	11.00 ft	33.00%	120.00 pcf	2000.00 psf	T-79 Steel
13	Cohesionless	5.50 ft	0.00%	125.00 pcf	31.0/31.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	930.00 psf	0.04 Kips
9.01 ft	Cohesive	N/A	N/A	930.00 psf	35.10 Kips
15.99 ft	Cohesive	N/A	N/A	942.79 psf	63.15 Kips
16.01 ft	Cohesive	N/A	N/A	631.03 psf	63.22 Kips
21.99 ft	Cohesive	N/A	N/A	650.09 psf	79.50 Kips
22.01 ft	Cohesive	N/A	N/A	1110.98 psf	79.58 Kips
31.01 ft	Cohesive	N/A	N/A	1163.85 psf	123.45 Kips
33.49 ft	Cohesive	N/A	N/A	1178.42 psf	136.25 Kips
33.51 ft	Cohesionless	2692.17 psf	21.97	N/A	136.34 Kips
42.51 ft	Cohesionless	2973.87 psf	21.97	N/A	181.38 Kips
43.49 ft	Cohesionless	3004.55 psf	21.97	N/A	186.80 Kips
43.51 ft	Cohesive	N/A	N/A	1139.66 psf	186.90 Kips
52.51 ft	Cohesive	N/A	N/A	1249.91 psf	234.02 Kips
58.49 ft	Cohesive	N/A	N/A	1260.00 psf	265.97 Kips
58.51 ft	Cohesionless	4257.17 psf	21.97	N/A	266.09 Kips
63.49 ft	Cohesionless	4413.05 psf	21.97	N/A	303.07 Kips
63.51 ft	Cohesive	N/A	N/A	1122.50 psf	303.19 Kips
67.99 ft	Cohesive	N/A	N/A	1122.50 psf	324.26 Kips
68.01 ft	Cohesive	N/A	N/A	1260.00 psf	324.36 Kips
73.99 ft	Cohesive	N/A	N/A	1260.00 psf	355.92 Kips
74.01 ft	Cohesive	N/A	N/A	1260.00 psf	356.02 Kips
77.99 ft	Cohesive	N/A	N/A	1260.00 psf	377.03 Kips
78.01 ft	Cohesionless	5382.87 psf	21.97	N/A	377.17 Kips
82.99 ft	Cohesionless	5538.75 psf	21.97	N/A	423.58 Kips
83.01 ft	Cohesionless	5695.90 psf	24.17	N/A	423.81 Kips
88.49 ft	Cohesionless	5881.12 psf	24.17	N/A	500.37 Kips
88.51 ft	Cohesive	N/A	N/A	1515.00 psf	500.58 Kips
97.51 ft	Cohesive	N/A	N/A	1515.00 psf	557.69 Kips
99.49 ft	Cohesive	N/A	N/A	1515.00 psf	570.26 Kips
99.51 ft	Cohesionless	6701.27 psf	22.70	N/A	570.45 Kips
104.99 ft	Cohesionless	6872.80 psf	22.70	N/A	642.26 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
15.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
21.99 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
22.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
31.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
33.51 ft	Cohesionless	2692.49 psf	30.00	18.60 Kips	18.60 Kips
42.51 ft	Cohesionless	3255.89 psf	30.00	18.60 Kips	18.60 Kips
43.49 ft	Cohesionless	3317.23 psf	30.00	18.60 Kips	18.60 Kips
43.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
52.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
58.49 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
58.51 ft	Cohesionless	4257.49 psf	30.00	18.60 Kips	18.60 Kips
63.49 ft	Cohesionless	4569.23 psf	30.00	18.60 Kips	18.60 Kips
63.51 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
67.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
73.99 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
74.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
78.01 ft	Cohesionless	5383.19 psf	30.00	18.60 Kips	18.60 Kips
82.99 ft	Cohesionless	5694.93 psf	30.00	18.60 Kips	18.60 Kips
83.01 ft	Cohesionless	5696.24 psf	47.20	69.81 Kips	69.81 Kips
88.49 ft	Cohesionless	6066.68 psf	47.20	69.81 Kips	69.81 Kips
88.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
97.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
99.49 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
99.51 ft	Cohesionless	6701.59 psf	35.20	28.85 Kips	28.85 Kips
104.99 ft	Cohesionless	7044.63 psf	35.20	28.85 Kips	28.85 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	15.71 Kips	15.75 Kips
9.01 ft	35.10 Kips	15.71 Kips	50.81 Kips
15.99 ft	63.15 Kips	15.71 Kips	78.85 Kips
16.01 ft	63.22 Kips	9.42 Kips	72.64 Kips
21.99 ft	79.50 Kips	9.42 Kips	88.93 Kips
22.01 ft	79.58 Kips	18.85 Kips	98.42 Kips
31.01 ft	123.45 Kips	18.85 Kips	142.30 Kips
33.49 ft	136.25 Kips	18.85 Kips	155.09 Kips
33.51 ft	136.34 Kips	18.60 Kips	154.94 Kips
42.51 ft	181.38 Kips	18.60 Kips	199.97 Kips
43.49 ft	186.80 Kips	18.60 Kips	205.39 Kips
43.51 ft	186.90 Kips	47.12 Kips	234.02 Kips
52.51 ft	234.02 Kips	47.12 Kips	281.15 Kips
58.49 ft	265.97 Kips	47.12 Kips	313.09 Kips
58.51 ft	266.09 Kips	18.60 Kips	284.69 Kips
63.49 ft	303.07 Kips	18.60 Kips	321.67 Kips
63.51 ft	303.19 Kips	15.71 Kips	318.90 Kips
67.99 ft	324.26 Kips	15.71 Kips	339.96 Kips
68.01 ft	324.36 Kips	40.84 Kips	365.20 Kips
73.99 ft	355.92 Kips	40.84 Kips	396.76 Kips
74.01 ft	356.02 Kips	40.84 Kips	396.86 Kips
77.99 ft	377.03 Kips	40.84 Kips	417.87 Kips
78.01 ft	377.17 Kips	18.60 Kips	395.77 Kips
82.99 ft	423.58 Kips	18.60 Kips	442.18 Kips
83.01 ft	423.81 Kips	69.81 Kips	493.62 Kips
88.49 ft	500.37 Kips	69.81 Kips	570.18 Kips
88.51 ft	500.58 Kips	25.13 Kips	525.71 Kips
97.51 ft	557.69 Kips	25.13 Kips	582.83 Kips
99.49 ft	570.26 Kips	25.13 Kips	595.39 Kips
99.51 ft	570.45 Kips	28.85 Kips	599.30 Kips
104.99 ft	642.26 Kips	28.85 Kips	671.11 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	930.00 psf	0.03 Kips
9.01 ft	Cohesive	N/A	N/A	930.00 psf	29.13 Kips
15.99 ft	Cohesive	N/A	N/A	942.79 psf	52.41 Kips
16.01 ft	Cohesive	N/A	N/A	631.03 psf	52.45 Kips
21.99 ft	Cohesive	N/A	N/A	650.09 psf	60.59 Kips
22.01 ft	Cohesive	N/A	N/A	1110.98 psf	60.63 Kips
31.01 ft	Cohesive	N/A	N/A	1163.85 psf	82.57 Kips
33.49 ft	Cohesive	N/A	N/A	1178.42 psf	88.96 Kips
33.51 ft	Cohesionless	2692.17 psf	21.97	N/A	89.03 Kips
42.51 ft	Cohesionless	2973.87 psf	21.97	N/A	119.20 Kips
43.49 ft	Cohesionless	3004.55 psf	21.97	N/A	122.83 Kips
43.51 ft	Cohesive	N/A	N/A	1139.66 psf	122.90 Kips
52.51 ft	Cohesive	N/A	N/A	1249.91 psf	154.47 Kips
58.49 ft	Cohesive	N/A	N/A	1260.00 psf	175.87 Kips
58.51 ft	Cohesionless	4257.17 psf	21.97	N/A	175.96 Kips
63.49 ft	Cohesionless	4413.05 psf	21.97	N/A	200.73 Kips
63.51 ft	Cohesive	N/A	N/A	1122.50 psf	200.81 Kips
67.99 ft	Cohesive	N/A	N/A	1122.50 psf	214.93 Kips
68.01 ft	Cohesive	N/A	N/A	1260.00 psf	215.00 Kips
73.99 ft	Cohesive	N/A	N/A	1260.00 psf	236.14 Kips
74.01 ft	Cohesive	N/A	N/A	1260.00 psf	236.21 Kips
77.99 ft	Cohesive	N/A	N/A	1260.00 psf	250.29 Kips
78.01 ft	Cohesionless	5382.87 psf	21.97	N/A	250.41 Kips
82.99 ft	Cohesionless	5538.75 psf	21.97	N/A	288.92 Kips
83.01 ft	Cohesionless	5695.90 psf	24.17	N/A	289.12 Kips
88.49 ft	Cohesionless	5881.12 psf	24.17	N/A	352.66 Kips
88.51 ft	Cohesive	N/A	N/A	1515.00 psf	352.80 Kips
97.51 ft	Cohesive	N/A	N/A	1515.00 psf	391.07 Kips
99.49 ft	Cohesive	N/A	N/A	1515.00 psf	399.48 Kips
99.51 ft	Cohesionless	6701.27 psf	22.70	N/A	399.68 Kips
104.99 ft	Cohesionless	6872.80 psf	22.70	N/A	471.49 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
15.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
21.99 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
22.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
31.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
33.51 ft	Cohesionless	2692.49 psf	30.00	18.60 Kips	18.60 Kips
42.51 ft	Cohesionless	3255.89 psf	30.00	18.60 Kips	18.60 Kips
43.49 ft	Cohesionless	3317.23 psf	30.00	18.60 Kips	18.60 Kips
43.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
52.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
58.49 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
58.51 ft	Cohesionless	4257.49 psf	30.00	18.60 Kips	18.60 Kips
63.49 ft	Cohesionless	4569.23 psf	30.00	18.60 Kips	18.60 Kips
63.51 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
67.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
73.99 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
74.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
78.01 ft	Cohesionless	5383.19 psf	30.00	18.60 Kips	18.60 Kips
82.99 ft	Cohesionless	5694.93 psf	30.00	18.60 Kips	18.60 Kips
83.01 ft	Cohesionless	5696.24 psf	47.20	69.81 Kips	69.81 Kips
88.49 ft	Cohesionless	6066.68 psf	47.20	69.81 Kips	69.81 Kips
88.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
97.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
99.49 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
99.51 ft	Cohesionless	6701.59 psf	35.20	28.85 Kips	28.85 Kips
104.99 ft	Cohesionless	7044.63 psf	35.20	28.85 Kips	28.85 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.03 Kips	15.71 Kips	15.74 Kips
9.01 ft	29.13 Kips	15.71 Kips	44.84 Kips
15.99 ft	52.41 Kips	15.71 Kips	68.12 Kips
16.01 ft	52.45 Kips	9.42 Kips	61.87 Kips
21.99 ft	60.59 Kips	9.42 Kips	70.01 Kips
22.01 ft	60.63 Kips	18.85 Kips	79.48 Kips
31.01 ft	82.57 Kips	18.85 Kips	101.41 Kips
33.49 ft	88.96 Kips	18.85 Kips	107.81 Kips
33.51 ft	89.03 Kips	18.60 Kips	107.62 Kips
42.51 ft	119.20 Kips	18.60 Kips	137.80 Kips
43.49 ft	122.83 Kips	18.60 Kips	141.43 Kips
43.51 ft	122.90 Kips	47.12 Kips	170.02 Kips
52.51 ft	154.47 Kips	47.12 Kips	201.60 Kips
58.49 ft	175.87 Kips	47.12 Kips	223.00 Kips
58.51 ft	175.96 Kips	18.60 Kips	194.56 Kips
63.49 ft	200.73 Kips	18.60 Kips	219.33 Kips
63.51 ft	200.81 Kips	15.71 Kips	216.52 Kips
67.99 ft	214.93 Kips	15.71 Kips	230.64 Kips
68.01 ft	215.00 Kips	40.84 Kips	255.84 Kips
73.99 ft	236.14 Kips	40.84 Kips	276.98 Kips
74.01 ft	236.21 Kips	40.84 Kips	277.05 Kips
77.99 ft	250.29 Kips	40.84 Kips	291.13 Kips
78.01 ft	250.41 Kips	18.60 Kips	269.00 Kips
82.99 ft	288.92 Kips	18.60 Kips	307.52 Kips
83.01 ft	289.12 Kips	69.81 Kips	358.93 Kips
88.49 ft	352.66 Kips	69.81 Kips	422.47 Kips
88.51 ft	352.80 Kips	25.13 Kips	377.93 Kips
97.51 ft	391.07 Kips	25.13 Kips	416.20 Kips
99.49 ft	399.48 Kips	25.13 Kips	424.62 Kips
99.51 ft	399.68 Kips	28.85 Kips	428.53 Kips
104.99 ft	471.49 Kips	28.85 Kips	500.34 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	930.00 psf	0.04 Kips
9.01 ft	Cohesive	N/A	N/A	930.00 psf	35.10 Kips
15.99 ft	Cohesive	N/A	N/A	942.79 psf	63.15 Kips
16.01 ft	Cohesive	N/A	N/A	631.03 psf	63.22 Kips
21.99 ft	Cohesive	N/A	N/A	650.09 psf	79.50 Kips
22.01 ft	Cohesive	N/A	N/A	1110.98 psf	79.58 Kips
31.01 ft	Cohesive	N/A	N/A	1163.85 psf	123.45 Kips
33.49 ft	Cohesive	N/A	N/A	1178.42 psf	136.25 Kips
33.51 ft	Cohesionless	2692.17 psf	21.97	N/A	136.34 Kips
42.51 ft	Cohesionless	2973.87 psf	21.97	N/A	181.38 Kips
43.49 ft	Cohesionless	3004.55 psf	21.97	N/A	186.80 Kips
43.51 ft	Cohesive	N/A	N/A	1139.66 psf	186.90 Kips
52.51 ft	Cohesive	N/A	N/A	1249.91 psf	234.02 Kips
58.49 ft	Cohesive	N/A	N/A	1260.00 psf	265.97 Kips
58.51 ft	Cohesionless	4257.17 psf	21.97	N/A	266.09 Kips
63.49 ft	Cohesionless	4413.05 psf	21.97	N/A	303.07 Kips
63.51 ft	Cohesive	N/A	N/A	1122.50 psf	303.19 Kips
67.99 ft	Cohesive	N/A	N/A	1122.50 psf	324.26 Kips
68.01 ft	Cohesive	N/A	N/A	1260.00 psf	324.36 Kips
73.99 ft	Cohesive	N/A	N/A	1260.00 psf	355.92 Kips
74.01 ft	Cohesive	N/A	N/A	1260.00 psf	356.02 Kips
77.99 ft	Cohesive	N/A	N/A	1260.00 psf	377.03 Kips
78.01 ft	Cohesionless	5382.87 psf	21.97	N/A	377.17 Kips
82.99 ft	Cohesionless	5538.75 psf	21.97	N/A	423.58 Kips
83.01 ft	Cohesionless	5695.90 psf	24.17	N/A	423.81 Kips
88.49 ft	Cohesionless	5881.12 psf	24.17	N/A	500.37 Kips
88.51 ft	Cohesive	N/A	N/A	1515.00 psf	500.58 Kips
97.51 ft	Cohesive	N/A	N/A	1515.00 psf	557.69 Kips
99.49 ft	Cohesive	N/A	N/A	1515.00 psf	570.26 Kips
99.51 ft	Cohesionless	6701.27 psf	22.70	N/A	570.45 Kips
104.99 ft	Cohesionless	6872.80 psf	22.70	N/A	642.26 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
15.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
21.99 ft	Cohesive	N/A	N/A	N/A	9.42 Kips
22.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
31.01 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
33.51 ft	Cohesionless	2692.49 psf	30.00	18.60 Kips	18.60 Kips
42.51 ft	Cohesionless	3255.89 psf	30.00	18.60 Kips	18.60 Kips
43.49 ft	Cohesionless	3317.23 psf	30.00	18.60 Kips	18.60 Kips
43.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
52.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
58.49 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
58.51 ft	Cohesionless	4257.49 psf	30.00	18.60 Kips	18.60 Kips
63.49 ft	Cohesionless	4569.23 psf	30.00	18.60 Kips	18.60 Kips
63.51 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
67.99 ft	Cohesive	N/A	N/A	N/A	15.71 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
73.99 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
74.01 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	40.84 Kips
78.01 ft	Cohesionless	5383.19 psf	30.00	18.60 Kips	18.60 Kips
82.99 ft	Cohesionless	5694.93 psf	30.00	18.60 Kips	18.60 Kips
83.01 ft	Cohesionless	5696.24 psf	47.20	69.81 Kips	69.81 Kips
88.49 ft	Cohesionless	6066.68 psf	47.20	69.81 Kips	69.81 Kips
88.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
97.51 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
99.49 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
99.51 ft	Cohesionless	6701.59 psf	35.20	28.85 Kips	28.85 Kips
104.99 ft	Cohesionless	7044.63 psf	35.20	28.85 Kips	28.85 Kips

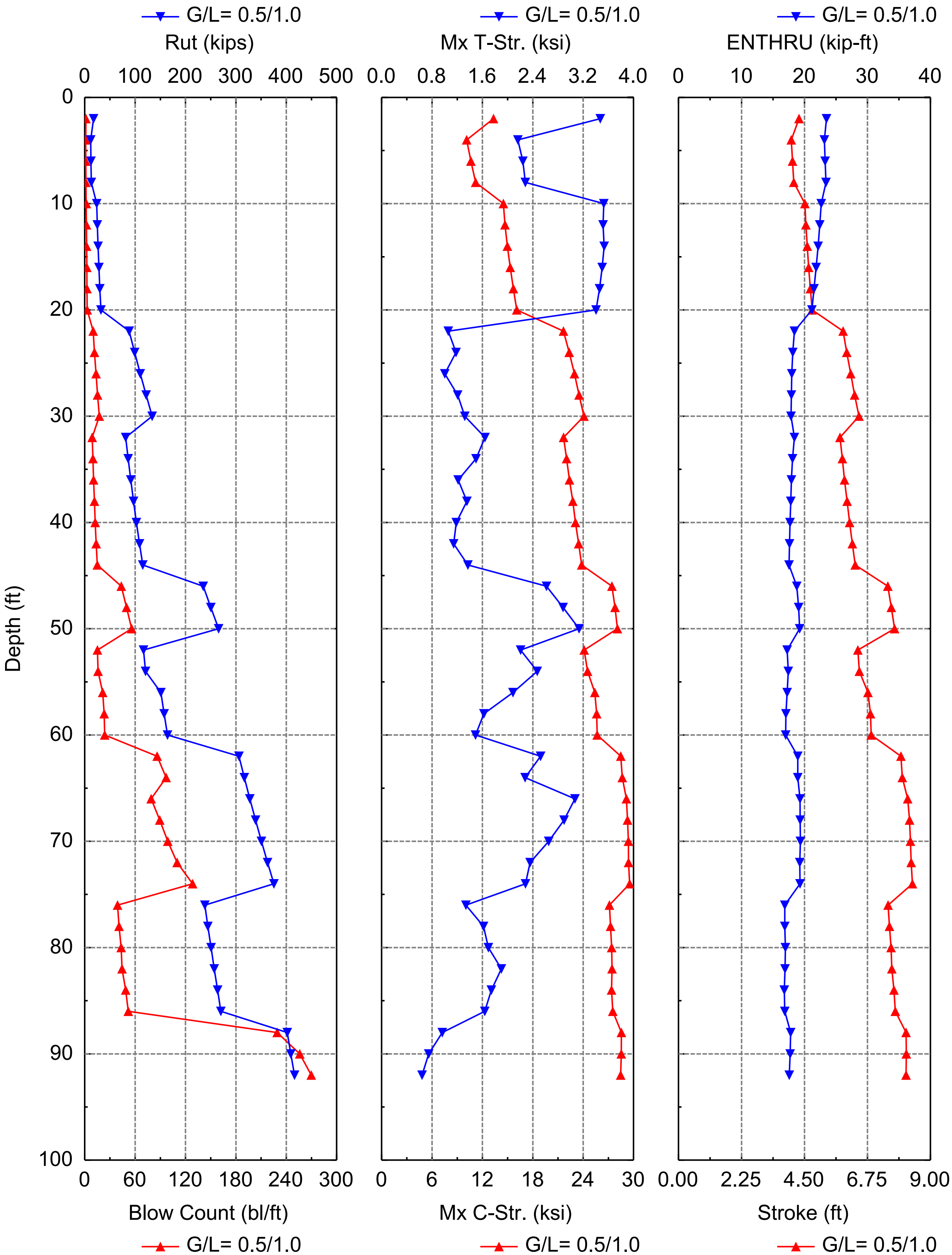
ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	15.71 Kips	15.75 Kips
9.01 ft	35.10 Kips	15.71 Kips	50.81 Kips
15.99 ft	63.15 Kips	15.71 Kips	78.85 Kips
16.01 ft	63.22 Kips	9.42 Kips	72.64 Kips
21.99 ft	79.50 Kips	9.42 Kips	88.93 Kips
22.01 ft	79.58 Kips	18.85 Kips	98.42 Kips
31.01 ft	123.45 Kips	18.85 Kips	142.30 Kips
33.49 ft	136.25 Kips	18.85 Kips	155.09 Kips
33.51 ft	136.34 Kips	18.60 Kips	154.94 Kips
42.51 ft	181.38 Kips	18.60 Kips	199.97 Kips
43.49 ft	186.80 Kips	18.60 Kips	205.39 Kips
43.51 ft	186.90 Kips	47.12 Kips	234.02 Kips
52.51 ft	234.02 Kips	47.12 Kips	281.15 Kips
58.49 ft	265.97 Kips	47.12 Kips	313.09 Kips
58.51 ft	266.09 Kips	18.60 Kips	284.69 Kips
63.49 ft	303.07 Kips	18.60 Kips	321.67 Kips
63.51 ft	303.19 Kips	15.71 Kips	318.90 Kips
67.99 ft	324.26 Kips	15.71 Kips	339.96 Kips
68.01 ft	324.36 Kips	40.84 Kips	365.20 Kips
73.99 ft	355.92 Kips	40.84 Kips	396.76 Kips
74.01 ft	356.02 Kips	40.84 Kips	396.86 Kips
77.99 ft	377.03 Kips	40.84 Kips	417.87 Kips
78.01 ft	377.17 Kips	18.60 Kips	395.77 Kips
82.99 ft	423.58 Kips	18.60 Kips	442.18 Kips
83.01 ft	423.81 Kips	69.81 Kips	493.62 Kips
88.49 ft	500.37 Kips	69.81 Kips	570.18 Kips
88.51 ft	500.58 Kips	25.13 Kips	525.71 Kips
97.51 ft	557.69 Kips	25.13 Kips	582.83 Kips
99.49 ft	570.26 Kips	25.13 Kips	595.39 Kips
99.51 ft	570.45 Kips	28.85 Kips	599.30 Kips
104.99 ft	642.26 Kips	28.85 Kips	671.11 Kips

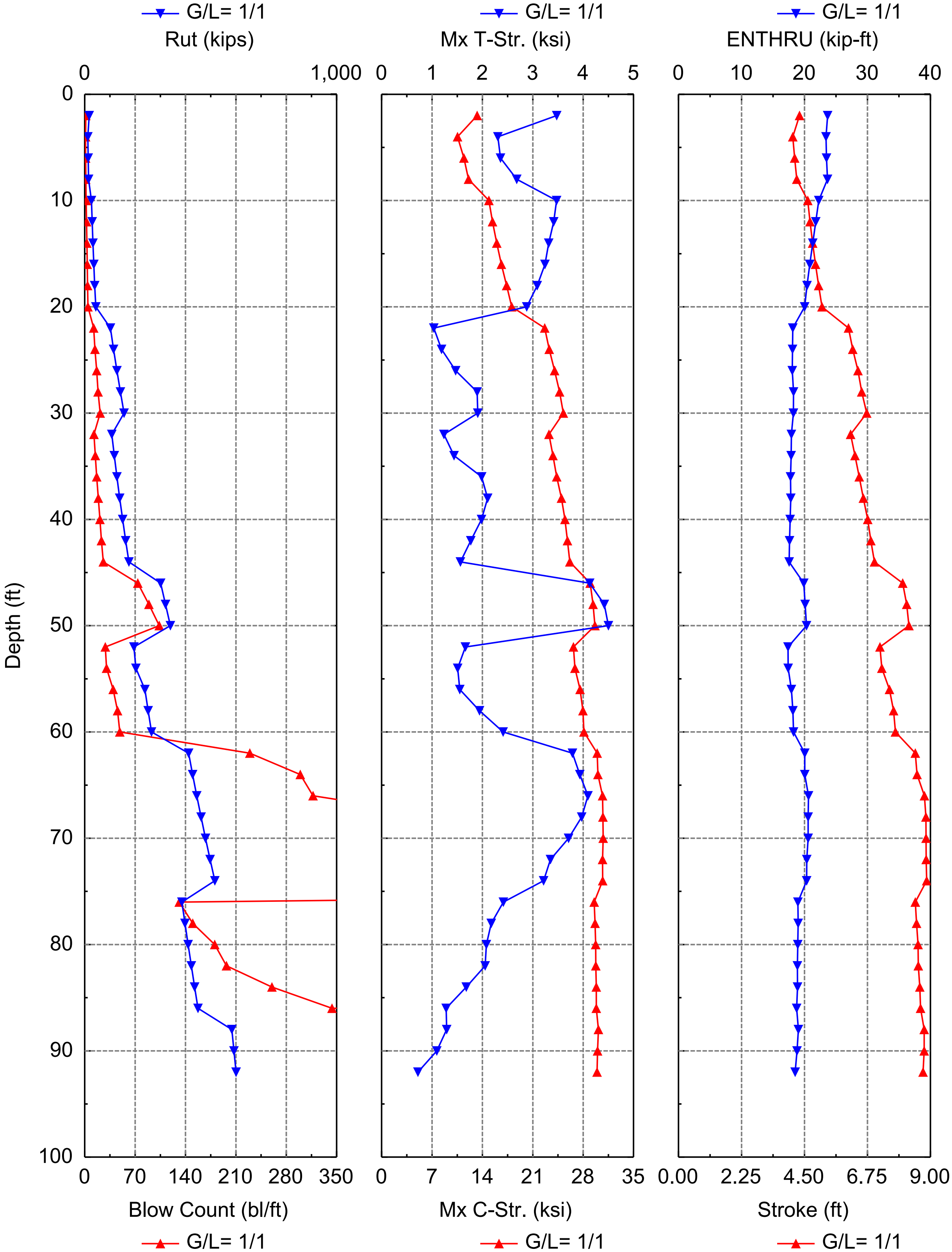
APPENDIX VI

GRLWEAP DRIVEABILITY ANALYSIS

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.500/1.000

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	-
2.0	17.5	0.2	17.3	1.4	13.324	3.471	4.30	23.5	D 19-42
4.0	11.7	0.6	11.0	1.1	10.118	2.162	4.03	23.1	D 19-42
6.0	12.3	1.3	11.0	1.1	10.625	2.241	4.07	23.3	D 19-42
8.0	13.1	2.1	11.0	1.2	11.193	2.282	4.12	23.4	D 19-42
10.0	23.6	3.1	20.5	1.9	14.498	3.527	4.51	22.7	D 19-42
12.0	24.9	4.4	20.5	2.0	14.691	3.514	4.55	22.4	D 19-42
14.0	26.4	6.0	20.5	2.2	14.971	3.533	4.60	22.2	D 19-42
16.0	28.1	7.7	20.5	2.4	15.310	3.501	4.65	21.8	D 19-42
18.0	30.0	9.5	20.5	2.6	15.682	3.459	4.71	21.5	D 19-42
20.0	32.1	11.6	20.5	2.9	16.094	3.405	4.77	21.2	D 19-42
22.0	88.3	14.8	73.4	10.1	21.645	1.058	5.88	18.4	D 19-42
24.0	99.1	18.7	80.4	11.6	22.329	1.180	6.01	18.1	D 19-42
26.0	110.3	22.9	87.4	13.4	22.954	1.002	6.15	18.0	D 19-42
28.0	121.8	27.4	94.4	15.2	23.505	1.206	6.29	17.9	D 19-42
30.0	133.7	32.3	101.4	17.3	24.087	1.320	6.44	17.9	D 19-42
32.0	81.1	37.1	44.1	8.9	21.663	1.642	5.77	18.4	D 19-42
34.0	86.0	42.0	44.1	9.7	22.027	1.498	5.85	18.1	D 19-42
36.0	91.2	47.2	44.1	10.5	22.370	1.214	5.93	17.9	D 19-42
38.0	96.8	52.7	44.1	11.5	22.761	1.353	6.02	17.8	D 19-42
40.0	102.6	58.5	44.1	12.5	23.081	1.185	6.11	17.7	D 19-42
42.0	108.7	64.6	44.1	13.6	23.459	1.144	6.21	17.6	D 19-42
44.0	115.1	71.0	44.1	14.9	23.816	1.370	6.31	17.5	D 19-42
46.0	235.2	77.9	157.3	43.5	27.425	2.617	7.48	18.8	D 19-42
48.0	250.2	85.9	164.3	49.7	27.798	2.880	7.60	19.1	D 19-42
50.0	265.6	94.3	171.2	55.8	28.069	3.135	7.72	19.2	D 19-42
52.0	116.7	99.3	17.3	15.1	24.124	2.206	6.41	17.3	D 19-42
54.0	120.6	103.3	17.3	15.8	24.516	2.469	6.46	17.4	D 19-42
56.0	151.1	108.5	42.5	21.4	25.382	2.085	6.77	17.2	D 19-42
58.0	157.6	115.1	42.5	23.2	25.604	1.624	6.86	17.0	D 19-42
60.0	164.2	121.7	42.5	23.7	25.665	1.490	6.88	17.0	D 19-42
62.0	306.0	131.1	175.0	86.2	28.479	2.523	7.94	18.9	D 19-42
64.0	316.7	141.7	175.0	96.9	28.656	2.278	8.00	18.9	D 19-42
66.0	327.6	152.7	175.0	79.1	29.144	3.069	8.19	19.3	D 19-42
68.0	339.0	164.0	175.0	89.3	29.279	2.897	8.25	19.3	D 19-42
70.0	350.7	175.8	175.0	98.8	29.388	2.652	8.28	19.3	D 19-42
72.0	362.8	187.9	175.0	110.0	29.394	2.358	8.31	19.3	D 19-42
74.0	375.3	200.4	175.0	128.5	29.532	2.284	8.36	19.3	D 19-42
76.0	238.3	211.5	26.8	39.1	27.120	1.338	7.49	16.9	D 19-42

78.0	244.4	217.6	26.8	40.9	27.260	1.618	7.54	16.9	D 19-42
80.0	250.6	223.9	26.8	43.3	27.395	1.695	7.59	17.0	D 19-42
82.0	257.0	230.3	26.8	44.4	27.442	1.900	7.62	16.9	D 19-42
84.0	263.6	236.8	26.8	48.7	27.380	1.743	7.69	16.8	D 19-42
86.0	270.2	243.4	26.8	51.8	27.517	1.637	7.74	16.9	D 19-42
88.0	401.9	250.2	151.6	229.1	28.552	0.964	8.13	17.8	D 19-42
90.0	409.0	257.3	151.6	256.0	28.536	0.747	8.14	17.7	D 19-42
92.0	416.3	264.6	151.6	269.8	28.461	0.641	8.13	17.6	D 19-42

Summary_Total driving time: 94 minutes; Total Number of Blows: 3985 (starting at penetration 2.0 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	-
2.0	17.7	0.3	17.3	1.4	13.262	3.475	4.32	23.7	D 19-42
4.0	12.3	1.3	11.0	1.1	10.538	2.306	4.08	23.4	D 19-42
6.0	13.6	2.6	11.0	1.2	11.427	2.358	4.15	23.5	D 19-42
8.0	15.2	4.2	11.0	1.3	12.074	2.680	4.22	23.7	D 19-42
10.0	26.7	6.3	20.5	2.2	14.890	3.472	4.62	22.3	D 19-42
12.0	29.4	8.9	20.5	2.5	15.404	3.415	4.70	21.8	D 19-42
14.0	32.4	11.9	20.5	2.9	15.992	3.317	4.79	21.3	D 19-42
16.0	35.8	15.3	20.5	3.4	16.640	3.242	4.89	20.8	D 19-42
18.0	39.6	19.1	20.5	3.9	17.359	3.087	5.00	20.4	D 19-42
20.0	43.7	23.2	20.5	4.4	18.074	2.880	5.13	20.0	D 19-42
22.0	101.8	28.3	73.4	12.4	22.660	1.035	6.07	18.1	D 19-42
24.0	114.5	34.1	80.4	14.1	23.280	1.189	6.22	18.1	D 19-42
26.0	127.8	40.4	87.4	16.5	24.028	1.468	6.41	18.1	D 19-42
28.0	141.6	47.2	94.4	18.5	24.720	1.895	6.54	18.3	D 19-42
30.0	155.9	54.5	101.4	21.4	25.249	1.909	6.72	18.2	D 19-42
32.0	107.5	63.4	44.1	12.8	23.240	1.236	6.15	17.9	D 19-42
34.0	117.3	73.2	44.1	14.7	23.801	1.438	6.30	17.9	D 19-42
36.0	127.7	83.6	44.1	16.5	24.313	1.985	6.45	17.8	D 19-42
38.0	138.7	94.6	44.1	18.8	24.987	2.104	6.60	17.8	D 19-42
40.0	150.3	106.3	44.1	21.1	25.468	1.982	6.76	17.7	D 19-42
42.0	162.6	118.5	44.1	23.2	25.811	1.769	6.87	17.6	D 19-42
44.0	175.4	131.3	44.1	25.8	26.142	1.564	7.00	17.6	D 19-42
46.0	301.4	144.1	157.3	73.7	28.967	4.129	8.01	19.9	D 19-42
48.0	320.4	156.2	164.3	89.1	29.372	4.418	8.15	20.1	D 19-42
50.0	340.0	168.8	171.2	103.5	29.622	4.501	8.23	20.3	D 19-42
52.0	195.0	177.7	17.3	28.6	26.651	1.662	7.20	17.4	D 19-42
54.0	202.9	185.5	17.3	30.3	26.850	1.509	7.26	17.4	D 19-42

56.0	238.6	196.1	42.5	39.5	27.573	1.550	7.53	17.9	D 19-42
58.0	251.8	209.2	42.5	45.6	27.960	1.942	7.68	18.2	D 19-42
60.0	264.9	222.4	42.5	48.6	28.099	2.410	7.75	18.3	D 19-42
62.0	412.2	237.3	175.0	229.3	29.947	3.788	8.46	20.0	D 19-42
64.0	428.2	253.2	175.0	299.4	30.053	3.932	8.52	20.0	D 19-42
66.0	444.7	269.7	175.0	317.2	30.696	4.093	8.78	20.6	D 19-42
68.0	461.7	286.7	175.0	506.3	30.744	3.970	8.84	20.6	D 19-42
70.0	479.3	304.3	175.0	724.9	30.778	3.710	8.84	20.6	D 19-42
72.0	497.5	322.5	175.0	1051.6	30.686	3.351	8.85	20.3	D 19-42
74.0	516.2	341.2	175.0	2794.7	30.707	3.214	8.86	20.3	D 19-42
76.0	385.4	358.7	26.8	131.2	29.530	2.417	8.46	19.0	D 19-42
78.0	397.7	370.9	26.8	150.1	29.639	2.176	8.50	19.0	D 19-42
80.0	410.2	383.4	26.8	180.5	29.729	2.078	8.56	18.9	D 19-42
82.0	423.0	396.3	26.8	196.9	29.746	2.053	8.56	18.9	D 19-42
84.0	436.1	409.3	26.8	260.1	29.829	1.680	8.62	18.9	D 19-42
86.0	449.2	422.5	26.8	343.5	29.818	1.281	8.65	18.7	D 19-42
88.0	583.6	432.0	151.6	9999.0	30.117	1.291	8.77	19.0	D 19-42
90.0	592.2	440.5	151.6	9999.0	30.000	1.094	8.77	18.8	D 19-42
92.0	600.9	449.2	151.6	9999.0	29.927	0.721	8.73	18.5	D 19-42

Summary_Refusal occurred; no driving time output possible.

GRLWEAP: Wave Equation Analysis of Pile Foundations

HAM-75-0791 - B-162-Rear Abut - 16" CIP 6/20/2023
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.15.0

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	Clay	115.0	0.0	22.5	0.00	12.41
3.0	Clay	115.0	0.0	22.5	0.12	12.41
3.0	Clay	115.0	0.0	20.5	0.11	7.89
9.0	Clay	115.0	0.0	20.5	0.23	7.89
9.0	Clay	115.0	0.0	23.5	0.27	14.66
20.5	Clay	115.0	0.0	23.5	0.53	14.66
20.5	Silt	125.0	0.0	44.5	0.61	48.84
30.5	Silt	125.0	0.0	44.0	0.92	73.86
30.5	Clay	125.0	0.0	31.0	1.08	31.58
45.5	Clay	125.0	0.0	31.0	1.57	31.58
45.5	Silt	125.0	0.0	43.4	1.39	111.39
50.5	Silt	125.0	0.0	43.2	1.55	123.90
50.5	Clay	115.0	0.0	22.5	0.90	12.41
55.0	Clay	115.0	0.0	22.5	0.97	12.41
55.0	Clay	120.0	0.0	30.5	1.57	30.45
60.5	Clay	120.0	0.0	30.5	1.57	30.45
60.5	Silt	125.0	0.0	43.2	1.83	125.31
65.0	Silt	125.0	0.0	43.1	1.97	125.31
65.0	Silt	130.0	0.0	44.5	1.97	125.31
75.5	Silt	130.0	0.0	44.2	2.32	125.31
75.5	Clay	120.0	0.0	25.5	1.43	19.17
86.5	Clay	120.0	0.0	25.5	1.57	19.17
86.5	Sand	125.0	0.0	37.0	0.99	108.60
92.0	Sand	125.0	0.0	36.9	1.05	108.60

PILE INPUT

Uniform Pile		Pile Type:	Pipe
Pile Length: (ft)	92.000	Pile Penetration: (ft)	92.000
Pile Size: (ft)	1.33	Toe Area: (in²)	201.06

Pile Profile

Lb Top ft	X-Area in²	E-Modulus ksi	Spec. Wt lb/ft³	Perim. ft	Crit. Index -
0.0	18.4	30,000.0	492.0	4.2	0
92.0	18.4	30,000.0	492.0	4.2	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

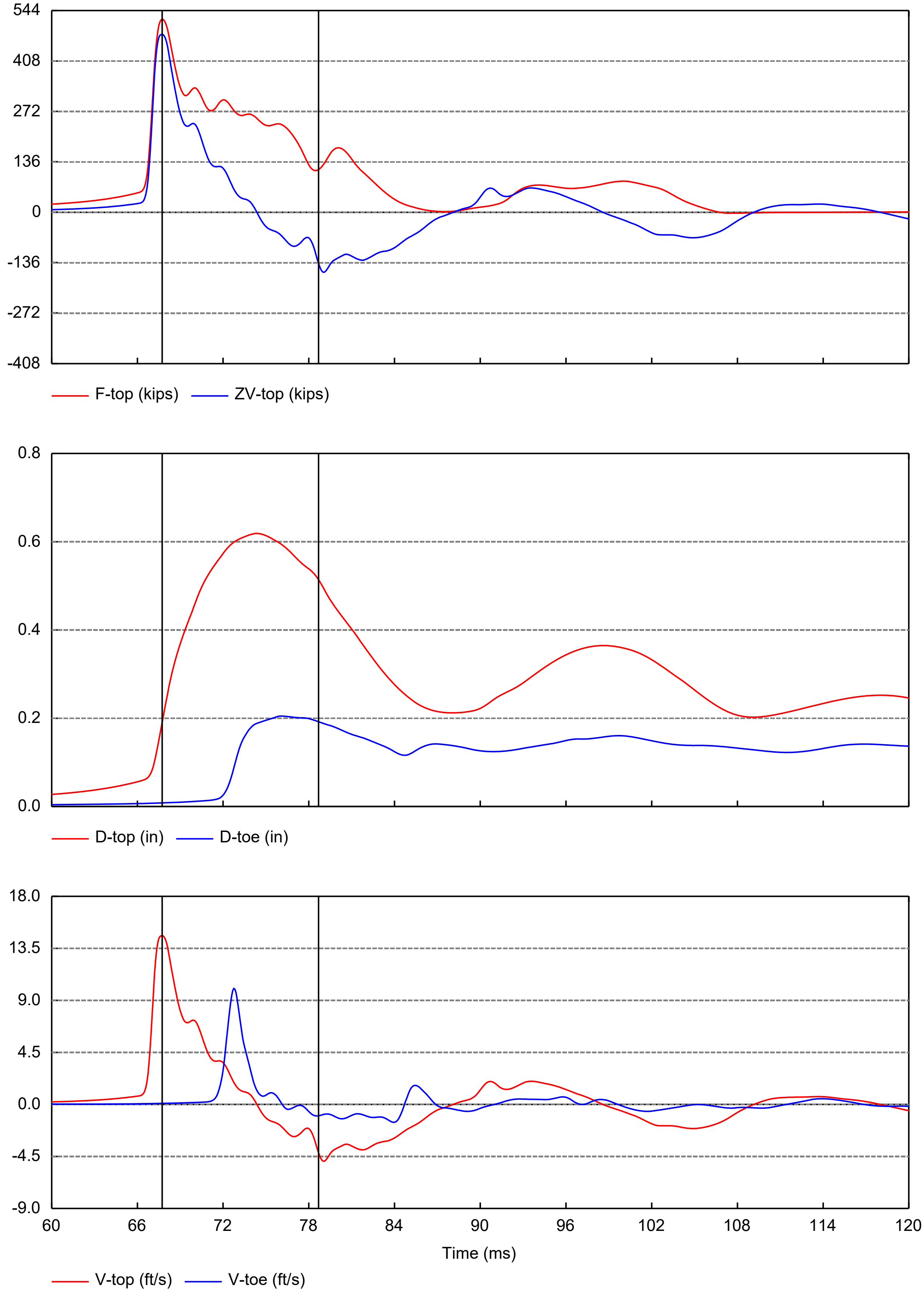
Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.563
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

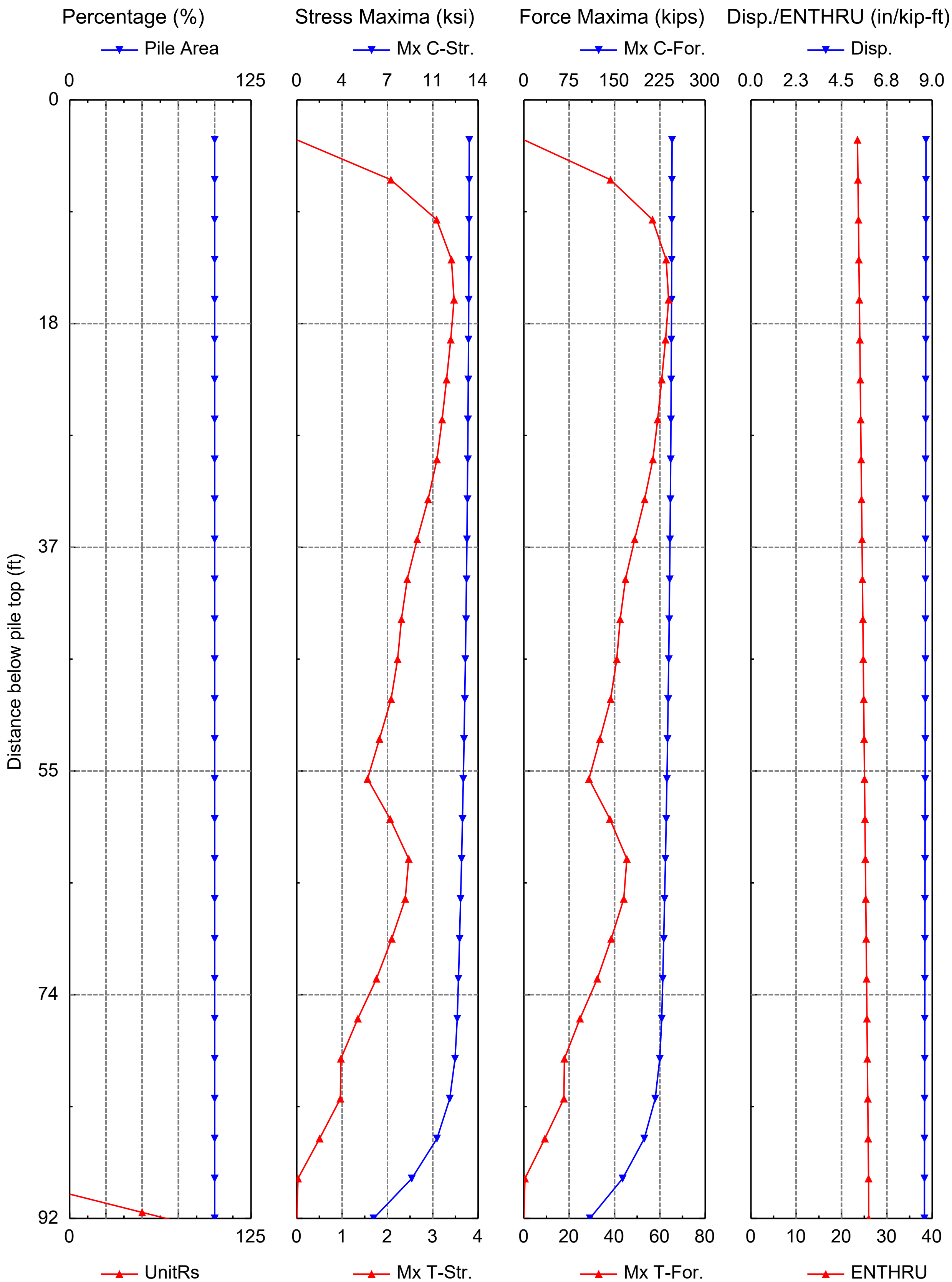
Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.0	0.0	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
1.5	0.1	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
3.0	0.1	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
3.0	0.1	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
5.0	0.2	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
7.0	0.2	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
9.0	0.2	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
9.0	0.3	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
10.6	0.3	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
12.3	0.3	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
13.9	0.4	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
15.6	0.4	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
17.2	0.5	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
18.9	0.5	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
20.5	0.5	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
20.5	0.6	48.8	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
22.2	0.7	53.0	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
23.8	0.7	57.2	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
25.5	0.8	61.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
27.2	0.8	65.5	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
28.8	0.9	69.7	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
30.5	0.9	73.9	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
30.5	1.1	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
32.2	1.1	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
33.8	1.2	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1

35.5	1.3	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
37.2	1.3	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
38.8	1.4	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
40.5	1.4	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
42.2	1.5	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
43.8	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
45.5	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
45.5	1.4	111.4	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
47.2	1.4	115.6	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
48.8	1.5	119.7	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
50.5	1.5	123.9	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
50.5	0.9	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
52.7	0.9	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
55.0	1.0	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
55.0	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
56.8	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
58.7	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
60.5	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
60.5	1.8	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
62.8	1.9	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
65.0	2.0	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
65.0	2.0	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
66.8	2.0	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
68.5	2.1	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
70.3	2.1	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
72.0	2.2	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
73.8	2.3	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
75.5	2.3	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
75.5	1.4	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
77.3	1.5	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
79.2	1.5	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
81.0	1.5	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
82.8	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
84.7	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
86.5	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
86.5	1.0	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1
88.3	1.0	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1
90.2	1.0	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1
92.0	1.1	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1

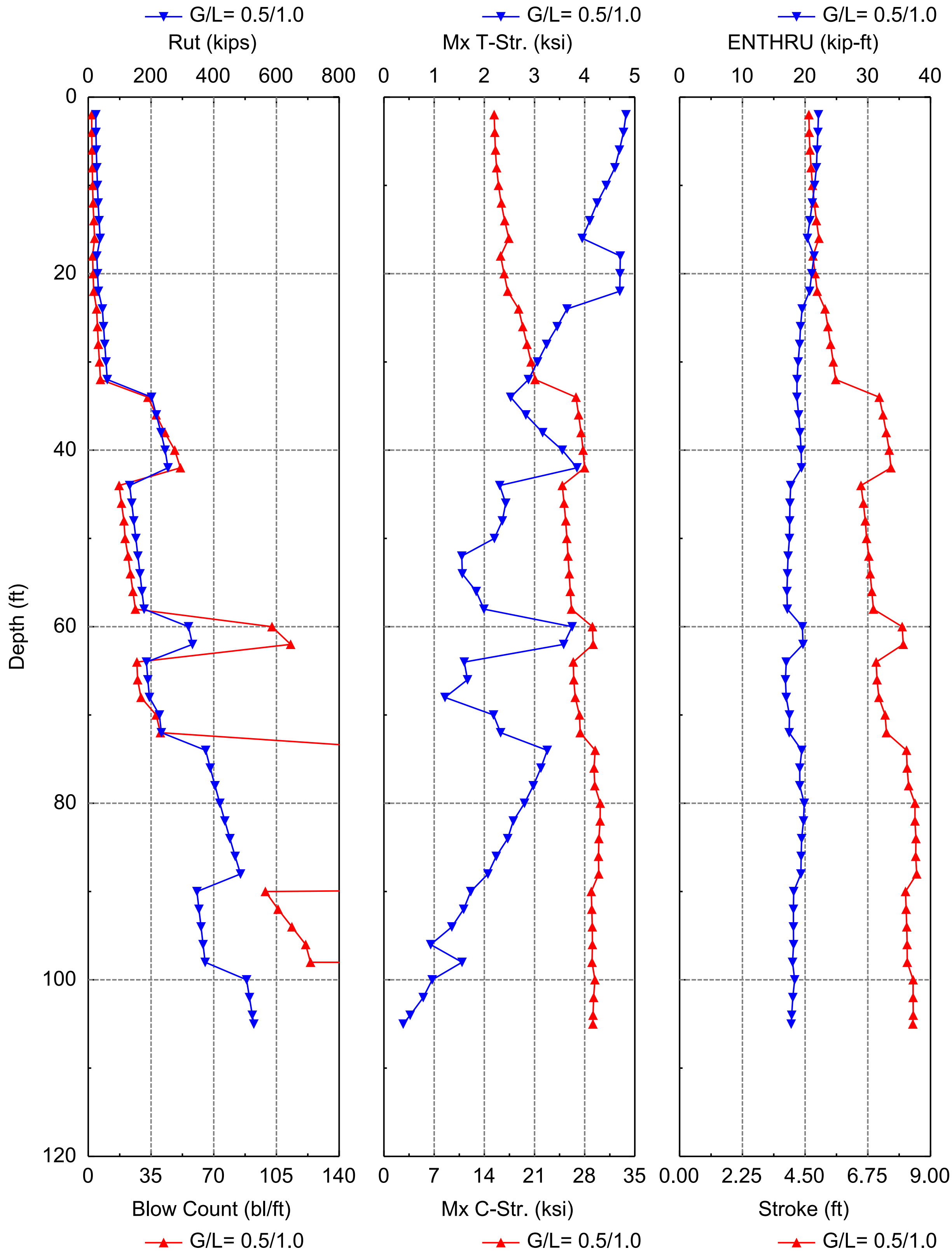
Variable Time Hisotry with DELMAG D 19-42; Depth = 92.00ft; Shaft/Toe G/L = 0.500/1.000



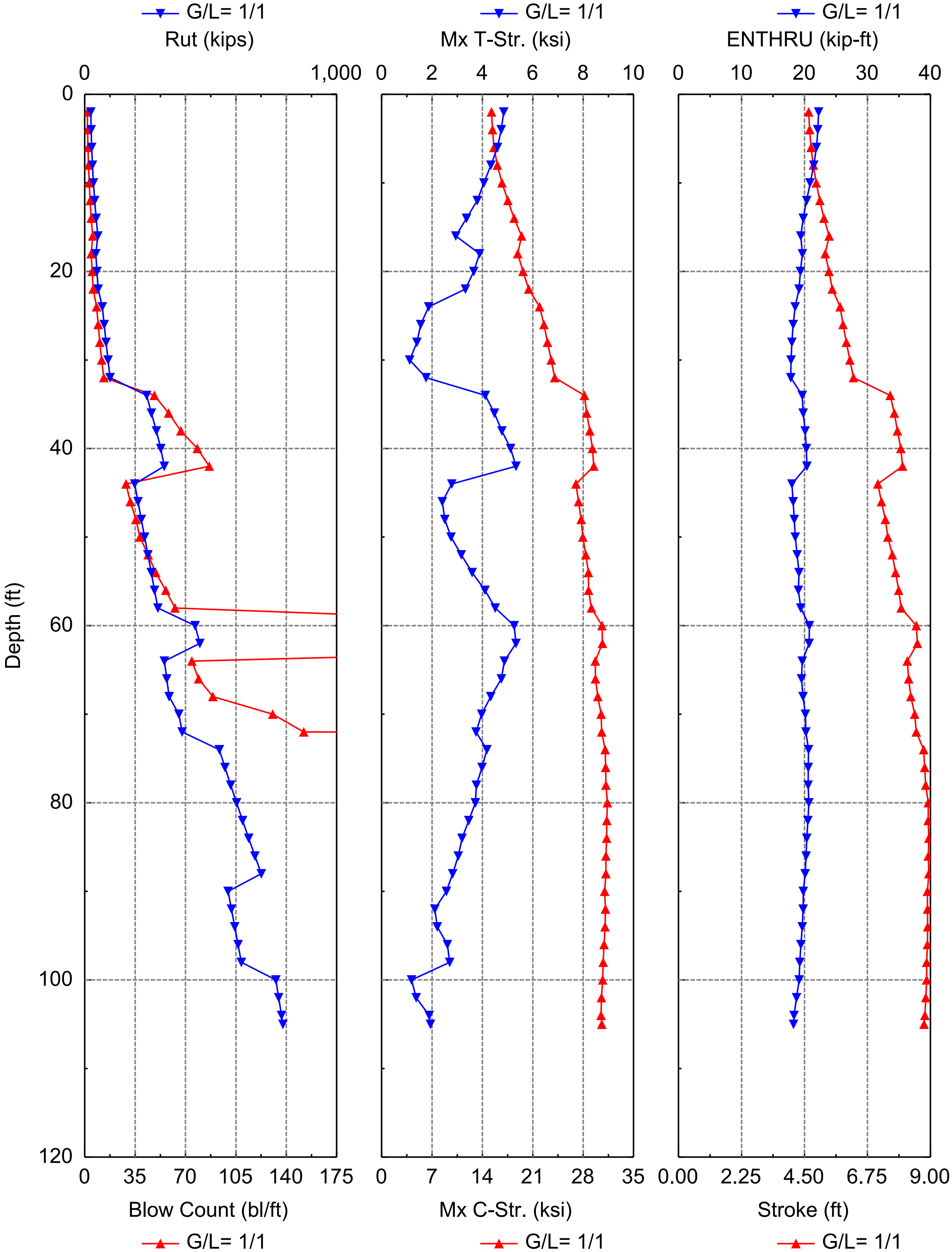
Extrema Results of Gain/Loss at Shaft/Toe = 0.500/1.000 and Depth = 2.00 ft



Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.500/1.000

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	-
2.0	23.8	0.2	23.6	1.9	15.373	4.824	4.63	22.1	D 19-42
4.0	24.5	0.9	23.6	1.9	15.449	4.774	4.65	22.0	D 19-42
6.0	25.6	2.0	23.6	2.1	15.556	4.690	4.68	21.9	D 19-42
8.0	27.2	3.5	23.6	2.2	15.709	4.603	4.71	21.8	D 19-42
10.0	29.1	5.5	23.6	2.4	15.971	4.429	4.76	21.5	D 19-42
12.0	31.6	8.0	23.6	2.7	16.370	4.247	4.83	21.2	D 19-42
14.0	34.4	10.8	23.6	3.1	16.843	4.101	4.90	20.8	D 19-42
16.0	37.8	14.1	23.6	3.5	17.417	3.950	4.99	20.4	D 19-42
18.0	27.4	16.4	11.0	2.4	16.264	4.709	4.78	21.4	D 19-42
20.0	29.7	18.7	11.0	2.7	16.758	4.705	4.86	21.0	D 19-42
22.0	32.2	21.2	11.0	3.0	17.260	4.699	4.93	20.7	D 19-42
24.0	45.1	24.6	20.5	4.6	18.787	3.648	5.21	19.5	D 19-42
26.0	48.7	28.2	20.5	5.1	19.366	3.452	5.32	19.3	D 19-42
28.0	52.4	32.0	20.5	5.6	19.944	3.242	5.42	19.1	D 19-42
30.0	56.4	35.9	20.5	6.2	20.520	3.060	5.51	18.9	D 19-42
32.0	60.5	40.0	20.5	6.8	21.069	2.879	5.60	18.7	D 19-42
34.0	201.6	45.1	156.5	33.3	26.776	2.526	7.16	18.7	D 19-42
36.0	216.6	53.1	163.5	37.9	27.155	2.828	7.29	19.0	D 19-42
38.0	231.9	61.5	170.5	42.7	27.494	3.162	7.41	19.2	D 19-42
40.0	244.9	70.2	174.7	48.2	27.773	3.553	7.52	19.4	D 19-42
42.0	254.2	79.2	175.0	51.4	27.982	3.847	7.58	19.4	D 19-42
44.0	132.0	87.9	44.1	17.2	24.875	2.307	6.50	17.7	D 19-42
46.0	138.5	94.4	44.1	18.5	25.121	2.425	6.59	17.6	D 19-42
48.0	145.1	101.0	44.1	19.9	25.362	2.360	6.66	17.5	D 19-42
50.0	151.6	107.5	44.1	20.5	25.498	2.201	6.70	17.5	D 19-42
52.0	158.2	114.1	44.1	22.2	25.677	1.552	6.78	17.3	D 19-42
54.0	164.8	120.7	44.1	23.5	25.840	1.560	6.83	17.2	D 19-42
56.0	171.3	127.2	44.1	24.9	25.990	1.837	6.89	17.1	D 19-42
58.0	177.9	133.8	44.1	26.3	26.156	1.992	6.95	17.2	D 19-42
60.0	319.6	144.6	175.0	102.5	29.068	3.749	7.98	19.6	D 19-42
62.0	332.1	157.2	175.0	112.9	29.185	3.582	8.02	19.7	D 19-42
64.0	185.3	168.0	17.3	27.1	26.403	1.600	7.05	17.0	D 19-42
66.0	190.0	172.7	17.3	27.5	26.464	1.665	7.08	16.9	D 19-42
68.0	194.8	177.5	17.3	29.4	26.684	1.217	7.15	17.0	D 19-42
70.0	226.6	184.1	42.5	37.9	27.269	2.182	7.37	17.5	D 19-42
72.0	233.1	190.6	42.5	40.2	27.372	2.325	7.42	17.5	D 19-42
74.0	374.1	199.2	175.0	187.5	29.460	3.253	8.14	19.5	D 19-42
76.0	388.9	214.0	175.0	224.5	29.292	3.126	8.16	19.2	D 19-42

78.0	404.1	229.1	175.0	284.3	29.405	2.975	8.21	19.2	D 19-42
80.0	419.6	244.6	175.0	299.5	30.170	2.799	8.44	19.9	D 19-42
82.0	435.4	260.5	175.0	367.0	30.152	2.577	8.44	19.7	D 19-42
84.0	451.7	276.7	175.0	582.8	29.980	2.465	8.48	19.4	D 19-42
86.0	468.3	293.3	175.0	694.4	29.933	2.237	8.47	19.4	D 19-42
88.0	485.3	310.4	175.0	1308.9	29.958	2.072	8.50	19.3	D 19-42
90.0	346.4	319.6	26.8	98.8	28.924	1.730	8.10	18.2	D 19-42
92.0	352.9	326.1	26.8	105.9	28.981	1.588	8.12	18.1	D 19-42
94.0	359.5	332.7	26.8	113.6	29.051	1.352	8.14	18.1	D 19-42
96.0	366.0	339.3	26.8	121.3	29.080	0.931	8.16	18.2	D 19-42
98.0	372.6	345.8	26.8	124.0	29.028	1.556	8.16	18.0	D 19-42
100.0	504.6	353.0	151.6	9999.0	29.418	0.960	8.37	18.3	D 19-42
102.0	513.7	362.1	151.6	9999.0	29.242	0.783	8.37	18.0	D 19-42
104.0	523.0	371.3	151.6	9999.0	29.168	0.521	8.38	17.8	D 19-42
105.0	527.7	376.0	151.6	9999.0	29.141	0.384	8.37	17.8	D 19-42

Summary_Refusal occurred; no driving time output possible.

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

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow Ct bl/ft	Mx C-Str ksi	Mx T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
2.0	24.1	0.4	23.6	1.9	15.266	4.846	4.65	22.2	D 19-42
4.0	25.4	1.8	23.6	2.0	15.397	4.746	4.68	22.1	D 19-42
6.0	27.6	4.0	23.6	2.3	15.617	4.599	4.73	21.9	D 19-42
8.0	30.7	7.1	23.6	2.6	16.077	4.338	4.82	21.5	D 19-42
10.0	34.7	11.0	23.6	3.1	16.718	4.060	4.92	20.9	D 19-42
12.0	39.5	15.9	23.6	3.8	17.537	3.797	5.05	20.4	D 19-42
14.0	45.3	21.6	23.6	4.5	18.396	3.370	5.20	19.8	D 19-42
16.0	51.9	28.3	23.6	5.5	19.436	2.944	5.38	19.4	D 19-42
18.0	43.7	32.7	11.0	4.5	18.910	3.887	5.24	19.7	D 19-42
20.0	48.4	37.4	11.0	5.2	19.632	3.657	5.37	19.4	D 19-42
22.0	53.4	42.3	11.0	5.9	20.428	3.326	5.49	19.1	D 19-42
24.0	69.7	49.2	20.5	8.2	21.951	1.866	5.77	18.5	D 19-42
26.0	76.9	56.4	20.5	9.3	22.545	1.549	5.88	18.2	D 19-42
28.0	84.4	64.0	20.5	10.5	23.028	1.402	6.00	18.0	D 19-42
30.0	92.3	71.8	20.5	11.8	23.558	1.113	6.12	17.9	D 19-42
32.0	100.5	80.0	20.5	13.2	24.035	1.761	6.25	17.8	D 19-42
34.0	245.8	89.3	156.5	48.4	28.175	4.115	7.56	19.6	D 19-42
36.0	264.7	101.3	163.5	58.3	28.481	4.474	7.71	19.8	D 19-42
38.0	284.3	113.8	170.5	66.8	28.918	4.771	7.82	20.1	D 19-42
40.0	301.5	126.8	174.7	78.2	29.279	5.117	7.94	20.3	D 19-42

42.0	315.4	140.4	175.0	86.5	29.469	5.332	8.00	20.4	D 19-42
44.0	198.3	154.2	44.1	28.7	26.989	2.784	7.12	18.0	D 19-42
46.0	211.4	167.3	44.1	31.6	27.362	2.408	7.25	18.2	D 19-42
48.0	224.5	180.4	44.1	35.5	27.723	2.509	7.39	18.4	D 19-42
50.0	237.7	193.6	44.1	38.3	27.943	2.753	7.47	18.5	D 19-42
52.0	250.8	206.7	44.1	44.0	28.372	3.161	7.64	18.8	D 19-42
54.0	263.9	219.8	44.1	49.2	28.726	3.593	7.75	19.1	D 19-42
56.0	277.0	232.9	44.1	56.3	28.751	4.103	7.87	19.0	D 19-42
58.0	290.2	246.1	44.1	62.7	29.140	4.510	7.95	19.4	D 19-42
60.0	438.1	263.1	175.0	393.8	30.621	5.258	8.49	20.8	D 19-42
62.0	456.9	281.9	175.0	548.5	30.665	5.334	8.53	20.7	D 19-42
64.0	316.0	298.7	17.3	74.4	29.689	4.870	8.17	19.6	D 19-42
66.0	325.5	308.1	17.3	79.1	29.703	4.752	8.22	19.5	D 19-42
68.0	335.1	317.8	17.3	89.0	30.027	4.329	8.30	19.8	D 19-42
70.0	373.4	330.9	42.5	130.5	30.500	3.969	8.44	20.1	D 19-42
72.0	386.5	344.0	42.5	152.1	30.566	3.744	8.49	20.2	D 19-42
74.0	534.3	359.3	175.0	9999.0	31.045	4.177	8.76	20.6	D 19-42
76.0	556.5	381.5	175.0	9999.0	31.116	3.982	8.79	20.6	D 19-42
78.0	579.2	404.2	175.0	9999.0	31.154	3.762	8.83	20.6	D 19-42
80.0	602.4	427.4	175.0	9999.0	31.361	3.723	8.92	20.7	D 19-42
82.0	626.2	451.3	175.0	9999.0	31.274	3.458	8.92	20.5	D 19-42
84.0	650.6	475.6	175.0	9999.0	31.267	3.193	8.94	20.4	D 19-42
86.0	675.5	500.6	175.0	9999.0	31.157	3.040	8.92	20.3	D 19-42
88.0	701.1	526.1	175.0	9999.0	31.164	2.818	8.94	20.1	D 19-42
90.0	569.2	542.4	26.8	9999.0	30.982	2.571	8.89	19.8	D 19-42
92.0	582.3	555.5	26.8	9999.0	31.083	2.110	8.90	19.8	D 19-42
94.0	595.4	568.6	26.8	9999.0	31.027	2.207	8.90	19.6	D 19-42
96.0	608.5	581.8	26.8	9999.0	30.904	2.611	8.89	19.4	D 19-42
98.0	621.7	594.9	26.8	9999.0	30.776	2.699	8.87	19.2	D 19-42
100.0	759.1	607.4	151.6	9999.0	30.707	1.187	8.87	19.1	D 19-42
102.0	770.0	618.3	151.6	9999.0	30.537	1.372	8.83	18.7	D 19-42
104.0	781.1	629.4	151.6	9999.0	30.477	1.884	8.80	18.3	D 19-42
105.0	786.7	635.1	151.6	9999.0	30.576	1.934	8.77	18.3	D 19-42

Summary_Refusal occurred; no driving time output possible.

GRLWEAP: Wave Equation Analysis of Pile Foundations

HAM-75-0791 - B-162-For Abut - 16" CIP 6/20/2023
RESOURCE INTERNATIONAL INC GRLWEAP 14.1.15.0

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	Clay	120.0	0.0	24.5	0.00	16.92
16.0	Clay	120.0	0.0	24.5	0.84	16.92
16.0	Clay	115.0	0.0	20.5	0.52	7.89
22.0	Clay	115.0	0.0	20.5	0.60	7.89
22.0	Clay	115.0	0.0	23.5	0.80	14.66
33.5	Clay	115.0	0.0	23.5	1.03	14.66
33.5	Silt	125.0	0.0	43.5	1.39	110.84
43.5	Silt	125.0	0.0	43.2	1.70	125.31
43.5	Clay	125.0	0.0	31.0	1.57	31.58
58.5	Clay	125.0	0.0	31.0	1.57	31.58
58.5	Silt	125.0	0.0	42.8	2.17	125.31
63.5	Silt	125.0	0.0	42.7	2.32	125.31
63.5	Clay	115.0	0.0	22.5	1.11	12.41
68.0	Clay	115.0	0.0	22.5	1.16	12.41
68.0	Clay	120.0	0.0	30.5	1.57	30.45
73.5	Clay	120.0	0.0	30.5	1.57	30.45
73.5	Silt	125.0	0.0	42.8	2.60	125.31
78.0	Silt	125.0	0.0	42.7	2.74	125.31
78.0	Silt	130.0	0.0	43.9	2.74	125.31
88.5	Silt	130.0	0.0	43.7	3.10	125.31
88.5	Clay	120.0	0.0	25.5	1.57	19.17
99.5	Clay	120.0	0.0	25.5	1.57	19.17
99.5	Sand	125.0	0.0	36.4	1.28	108.60
105.0	Sand	125.0	0.0	36.3	1.35	108.60

PILE INPUT

Uniform Pile		Pile Type:	Pipe
Pile Length: (ft)	105.000	Pile Penetration: (ft)	105.000
Pile Size: (ft)	1.33	Toe Area: (in²)	201.06

Pile Profile

Lb Top ft	X-Area in²	E-Modulus ksi	Spec. Wt lb/ft³	Perim. ft	Crit. Index -
0.0	18.4	30,000.0	492.0	4.2	0
105.0	18.4	30,000.0	492.0	4.2	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	60155.563
Helmet Wt.	1.900	kips				

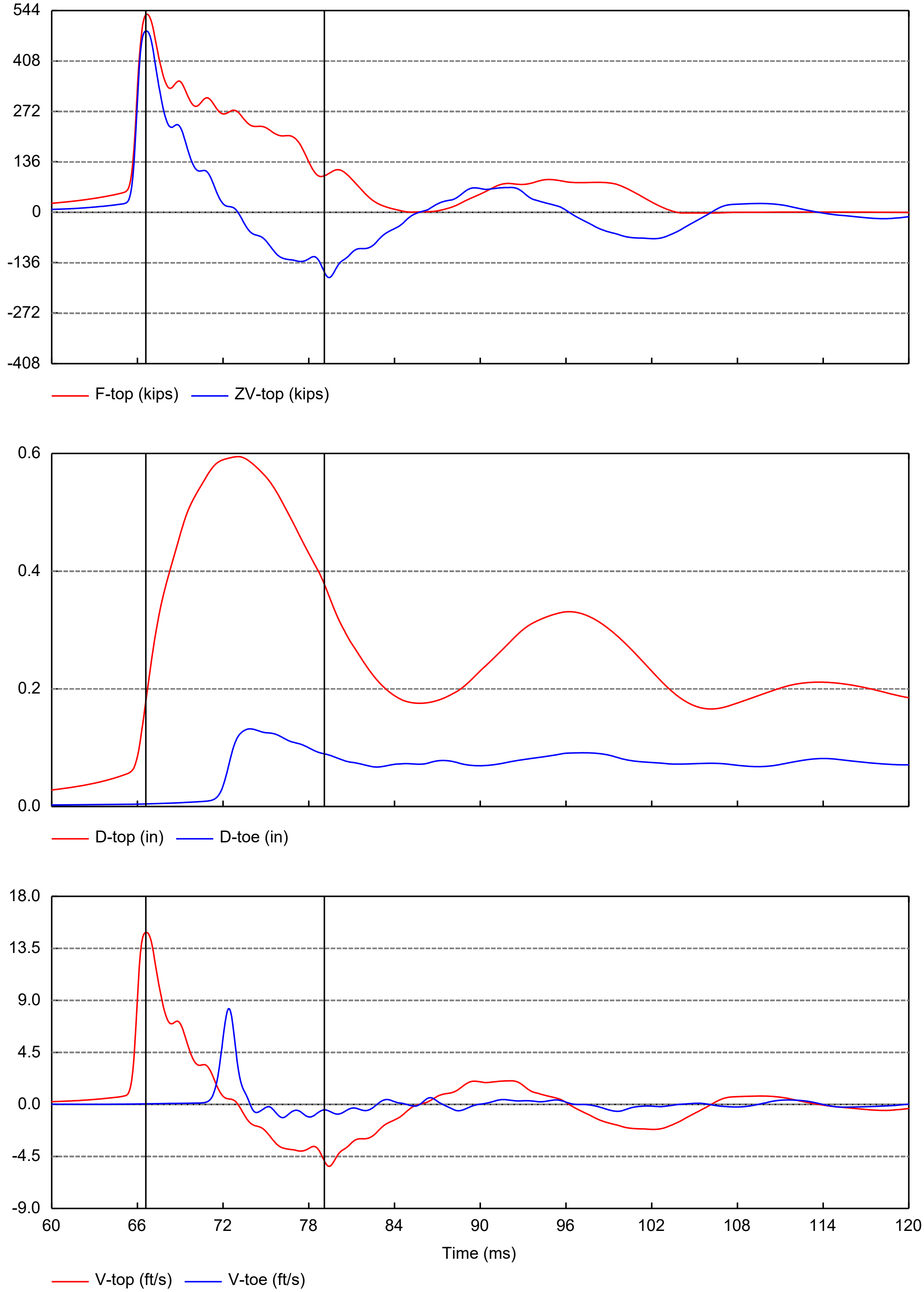
SOIL RESISTANCE DISTRIBUTION

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	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
1.8	0.1	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
3.6	0.2	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
5.3	0.3	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
7.1	0.4	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
8.9	0.5	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
10.7	0.6	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
12.4	0.7	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
14.2	0.7	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
16.0	0.8	16.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
16.0	0.5	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
18.0	0.5	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
20.0	0.6	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
22.0	0.6	7.9	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
22.0	0.8	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
23.6	0.8	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
25.3	0.9	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
26.9	0.9	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
28.6	0.9	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
30.2	1.0	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
31.9	1.0	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
33.5	1.0	14.7	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
33.5	1.4	110.8	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
35.2	1.4	115.0	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
36.8	1.5	119.2	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1

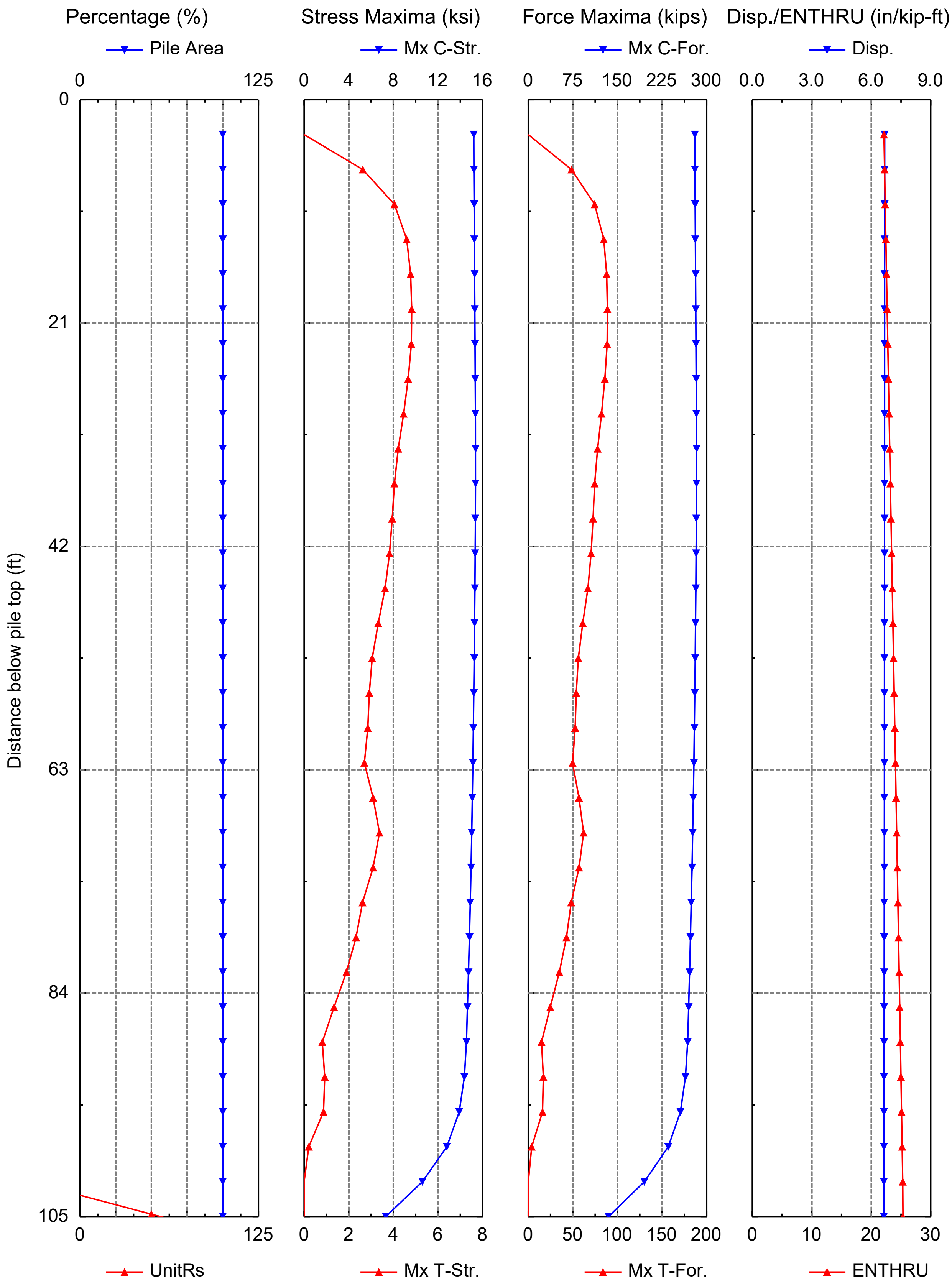
38.5	1.5	123.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
40.2	1.6	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
41.8	1.6	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
43.5	1.7	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
43.5	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
45.2	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
46.8	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
48.5	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
50.2	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
51.8	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
53.5	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
55.2	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
56.8	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
58.5	1.6	31.6	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
58.5	2.2	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
60.2	2.2	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
61.8	2.3	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
63.5	2.3	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
63.5	1.1	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
65.7	1.1	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
68.0	1.2	12.4	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
68.0	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
69.8	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
71.7	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
73.5	1.6	30.5	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
73.5	2.6	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
75.8	2.7	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
78.0	2.7	125.3	0.10	0.27	0.10	0.15	1.5	6.6	24.0	201.1
78.0	2.7	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
79.8	2.8	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
81.5	2.9	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
83.3	2.9	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
85.0	3.0	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
86.8	3.0	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
88.5	3.1	125.3	0.10	0.13	0.10	0.15	1.5	6.6	24.0	201.1
88.5	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
90.3	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
92.2	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
94.0	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
95.8	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
97.7	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1

99.5	1.6	19.2	0.10	0.27	0.20	0.15	2.0	6.6	168.0	201.1
99.5	1.3	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1
101.3	1.3	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1
103.2	1.3	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1
105.0	1.3	108.6	0.10	0.27	0.05	0.15	1.2	6.6	1.0	201.1

Variable Time Hisotry with DELMAG D 19-42; Depth = 105.00ft; Shaft/Toe G/L = 0.500/1.000



Extrema Results of Gain/Loss at Shaft/Toe = 0.500/1.000 and Depth = 2.00 ft



APPENDIX VII

LATERAL DESIGN PARAMETERS

HAM-75-0791
Lateral Design Parameters

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-160-0-07	520.6 to 509.6	A-6a	C	3	16	16	120	57.6	Su = 2,000 psf	750 pci	0.0060	-
	509.6 to 507.6	A-4a	C	3	8	8	115	52.6	Su = 1,000 psf	500 pci	0.0070	-
	507.6 to 499.6	A-6a	C	1	3	3	110	47.6	Su = 375 psf	100 pci	0.0100	-
	499.6 to 492.1	A-4b	C	1	5	5	115	52.6	Su = 625 psf	100 pci	0.0100	-
	492.1 to 487.6	A-4b	C	2	11	11	115	52.6	Su = 1,375 psf	500 pci	0.0070	-
	487.6 to 482.1	A-1-b	G	4	33	28	130	67.6	φ = 33°	60 pci	-	-
	482.1 to 467.1	A-1-b	G	4	11	9	120	57.6	φ = 29°	30 pci	-	-
	467.1 to 452.1	A-1-b	G	4	15	11	125	62.6	φ = 30°	30 pci	-	-
	452.1 to 443.6	A-3	G	4	19	13	125	62.6	φ = 31°	30 pci	-	-
	443.6 to 437.1	A-3a	G	4	24	15	125	62.6	φ = 32°	60 pci	-	-
	437.1 to 407.1	A-3	G	4	28	16	130	67.6	φ = 32°	60 pci	-	-
	407.1 to 405.6	A-3A	G	4	33	17	130	67.6	φ = 33°	60 pci	-	-
B-162-0-07	516.2 to 512.7	A-3a	G	4	13	23	125	125	φ = 29°	30 pci	-	-
	512.7 to 505.2	A-7-6	C	1	5	5	115	52.6	Su = 750 psf	100 pci	0.0100	-
	505.2 to 492.7	A-7-6	C	2	9	9	115	52.6	Su = 1,500 psf	500 pci	0.0070	-
	492.7 to 482.7	A-4b	C	2	16	16	125	62.6	Su = 3,000 psf	1,000 pci	0.0050	-
	482.7 to 467.7	A-6b	C	2	21	21	125	62.6	Su = 3,000 psf	1,000 pci	0.0050	-
	467.7 to 462.7	A-4b	C	2	14	14	125	62.6	Su = 3,000 psf	1,000 pci	0.0050	-
	462.7 to 458.2	A-6b	C	2	8	8	115	52.6	Su = 1,250 psf	500 pci	0.0070	-
	458.2 to 452.7	A-6b	C	2	20	20	120	57.6	Su = 3,250 psf	1,000 pci	0.0050	-
	452.7 to 448.2	A-4a	G	4	16	12	125	62.6	φ = 30°	30 pci	-	-
	448.2 to 437.7	A-4a	G	4	28	20	130	67.6	φ = 33°	60 pci	-	-
	437.7 to 426.7	A-6a	C	2	13	13	120	57.6	Su = 2,000 psf	750 pci	0.0060	-
	426.7 to 421.2	A-3a	G	4	19	12	125	62.6	φ = 31°	30 pci	-	-

APPENDIX VIII

SETTLEMENT CALCULATIONS

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment

MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023

Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120	pcf	Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall

																						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)	Z_f/B	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-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.500	1,680	1,759	0.019	0.226
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279	0.499	1,676	1,926	0.018	0.215
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	0.495	1,662	2,070	0.068	0.813
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936	0.489	1,642	2,181	0.058	0.699
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816	0.480	1,613	2,284	0.051	0.613
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716	0.469	1,577	2,379	0.045	0.544
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.456	1,534	2,480	0.012	0.150
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170	0.442	1,486	2,589	0.011	0.133
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279	0.420	1,410	2,747	0.019	0.224
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	0.389	1,306	2,957	0.035	0.414
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399	0.359	1,207	3,170	0.028	0.341
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324	0.332	1,115	3,391	0.024	0.283
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.301	1,012	3,679	0.010	0.116
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.270	906	4,024	0.023	0.272
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.247	831	4,309	0.004	0.051
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.224	754	4,714	0.007	0.083
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.199	669	5,256	0.007	0.089
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.181	607	5,732	0.007	0.083
																						Total Settlement:				6.771 in	Total Settlement:				5.348 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 26, FHWA GEC 5
3. C_r = 0.15(C_c) for medium stiff to stiff natural soil deposits and existing fill material, 0.075 to 0.10(C_c) for very stiff to hard natural soil deposits, and 0.05(Cc) for new embankment fill; Ref. Section 5.4.2.5 of FHWA GEC 5
4. e_o = (C_c/1.15)+0.35; Ref. Table 8-2, Holtz and Kovacs 1981
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 continuous 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 $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ 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)

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	0	days	Time following completion of construction

Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	Total Settlement at Facing of Wall: S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	Settlement Complete at 10% of Primary Consolidation: c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.500	1,680	1,759	0.019	0.226	0.441				100	0.226	0.441
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.499	1,676	1,926	0.018	0.215					100	0.215	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.495	1,662	2,070	0.068	0.813	2.669	150	2.5	0.000	0	0.000	0.000
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.489	1,642	2,181	0.058	0.699		150	5.0	0.000	0	0.000	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.480	1,613	2,284	0.051	0.613		150	7.5	0.000	0	0.000	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.469	1,577	2,379	0.045	0.544		150	10.0	0.000	0	0.000	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.456	1,534	2,480	0.012	0.150	0.507	1000	12.5	0.000	0	0.000	0.000
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.442	1,486	2,589	0.011	0.133		1000	15.0	0.000	0	0.000	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.420	1,410	2,747	0.019	0.224		1000	20.0	0.000	0	0.000	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.389	1,306	2,957	0.035	0.414	1.038	400	25.0	0.000	0	0.000	0.000
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.359	1,207	3,170	0.028	0.341		400	30.0	0.000	0	0.000	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.332	1,115	3,391	0.024	0.283		400	35.0	0.000	0	0.000	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.301	1,012	3,679	0.010	0.116	0.116	1000	37.5	0.000	0	0.000	0.000
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.270	906	4,024	0.023	0.272	0.272	400	32.5	0.000	0	0.000	0.000
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.247	831	4,309	0.004	0.051	0.051	1000	25.0	0.000	0	0.000	0.000
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.224	754	4,714	0.007	0.083	0.083	1000	20.0	0.000	0	0.000	0.000
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.199	669	5,256	0.007	0.089	0.089	800	10.0	0.000	0	0.000	0.000
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.181	607	5,732	0.007	0.083	0.083				100	0.083	0.083

$(S_c)_t$ = 0.524 in

Settlement Remaining After Hold Period: 4.824 in

Depth of Neutral Plane: 31 ft

Remaining Settlement within Depth of Neutral Plane: 3.590 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5
3. C_r = 0.10(C_c); Ref. Chapter 8.11, Holtz and Kovacs 1981
4. e_o = (C_c/0.54)+0.35; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	30	days	Time following completion of construction

Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	Total Settlement at Facing of Wall: S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	Settlement Complete at 59% of Primary Consolidation: c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.500	1,680	1,759	0.019	0.226	0.441				100	0.226	0.441
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.499	1,676	1,926	0.018	0.215					100	0.215	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.495	1,662	2,070	0.068	0.813	2.669	150	2.5	1.973	99	0.805	1.879
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.489	1,642	2,181	0.058	0.699		150	5.0	0.493	76	0.531	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.480	1,613	2,284	0.051	0.613		150	7.5	0.219	53	0.325	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.469	1,577	2,379	0.045	0.544		150	10.0	0.123	40	0.218	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.456	1,534	2,480	0.012	0.150	0.507	1000	12.5	0.526	78	0.117	0.320
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.442	1,486	2,589	0.011	0.133		1000	15.0	0.365	67	0.089	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.420	1,410	2,747	0.019	0.224		1000	20.0	0.205	51	0.114	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.389	1,306	2,957	0.035	0.414	1.038	400	25.0	0.053	26	0.108	0.234
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.359	1,207	3,170	0.028	0.341		400	30.0	0.037	22	0.075	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.332	1,115	3,391	0.024	0.283		400	35.0	0.027	18	0.051	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.301	1,012	3,679	0.010	0.116	0.116	1000	37.5	0.058	27	0.031	0.031
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.270	906	4,024	0.023	0.272	0.272	400	32.5	0.031	20	0.054	0.054
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.247	831	4,309	0.004	0.051	0.051	1000	25.0	0.132	41	0.021	0.021
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.224	754	4,714	0.007	0.083	0.083	1000	20.0	0.205	51	0.042	0.042
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.199	669	5,256	0.007	0.089	0.089	800	10.0	0.658	84	0.074	0.074
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.181	607	5,732	0.007	0.083	0.083				100	0.083	0.083

$(S_c)_t$ = 3.180 in

Settlement Remaining After Hold Period: 2.168 in

Depth of Neutral Plane: 31 ft

Remaining Settlement within Depth of Neutral Plane: 1.284 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment

MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023

Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	45	days	Time following completion of construction

																									Total Settlement at Facing of Wall			Settlement Complete at 66% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.500	1,680	1,759	0.019	0.226	0.441				100	0.226	0.441
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.499	1,676	1,926	0.018	0.215					100	0.215	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.495	1,662	2,070	0.068	0.813	2.669	150	2.5	2.959	100	0.813	2.080
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.489	1,642	2,181	0.058	0.699		150	5.0	0.740	87	0.608	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.480	1,613	2,284	0.051	0.613		150	7.5	0.329	64	0.392	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.469	1,577	2,379	0.045	0.544		150	10.0	0.185	49	0.266	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.456	1,534	2,480	0.012	0.150	0.507	1000	12.5	0.789	88	0.132	0.376
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.442	1,486	2,589	0.011	0.133		1000	15.0	0.548	79	0.105	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.420	1,410	2,747	0.019	0.224		1000	20.0	0.308	62	0.139	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.389	1,306	2,957	0.035	0.414	1.038	400	25.0	0.079	32	0.133	0.286
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.359	1,207	3,170	0.028	0.341		400	30.0	0.055	26	0.089	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.332	1,115	3,391	0.024	0.283		400	35.0	0.040	23	0.065	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.301	1,012	3,679	0.010	0.116	0.116	1000	37.5	0.088	33	0.038	0.038
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.270	906	4,024	0.023	0.272	0.272	400	32.5	0.047	24	0.065	0.065
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.247	831	4,309	0.004	0.051	0.051	1000	25.0	0.197	50	0.025	0.025
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.224	754	4,714	0.007	0.083	0.083	1000	20.0	0.308	62	0.051	0.051
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.199	669	5,256	0.007	0.089	0.089	800	10.0	0.986	93	0.082	0.082
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.181	607	5,732	0.007	0.083	0.083				100	0.083	0.083

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 3.529 in

Settlement Remaining After Hold Period: 1.819 in

Depth of Neutral Plane: 31 ft

Remaining Settlement within Depth of Neutral Plane: 1.002 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment

MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023

Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	60	days	Time following completion of construction

Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	Total Settlement at Facing of Wall: S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	Settlement Complete at 71% of Primary Consolidation: c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.500	1,680	1,759	0.019	0.226	0.441				100	0.226	0.441
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.499	1,676	1,926	0.018	0.215					100	0.215	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.495	1,662	2,070	0.068	0.813	2.669	150	2.5	3.945	100	0.813	2.215
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.489	1,642	2,181	0.058	0.699		150	5.0	0.986	93	0.650	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.480	1,613	2,284	0.051	0.613		150	7.5	0.438	73	0.448	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.469	1,577	2,379	0.045	0.544		150	10.0	0.247	56	0.305	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.456	1,534	2,480	0.012	0.150	0.507	1000	12.5	1.052	94	0.141	0.416
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.442	1,486	2,589	0.011	0.133		1000	15.0	0.731	87	0.116	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.420	1,410	2,747	0.019	0.224		1000	20.0	0.411	71	0.159	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.389	1,306	2,957	0.035	0.414	1.038	400	25.0	0.105	37	0.153	0.329
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.359	1,207	3,170	0.028	0.341		400	30.0	0.073	30	0.102	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.332	1,115	3,391	0.024	0.283		400	35.0	0.054	26	0.074	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.301	1,012	3,679	0.010	0.116	0.116	1000	37.5	0.117	39	0.045	0.045
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.270	906	4,024	0.023	0.272	0.272	400	32.5	0.062	28	0.076	0.076
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.247	831	4,309	0.004	0.051	0.051	1000	25.0	0.263	58	0.030	0.030
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.224	754	4,714	0.007	0.083	0.083	1000	20.0	0.411	71	0.059	0.059
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.199	669	5,256	0.007	0.089	0.089	800	10.0	1.315	97	0.086	0.086
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.181	607	5,732	0.007	0.083	0.083				100	0.083	0.083

1. $\sigma_p' = \sigma_{vo}'+\sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 3.780 in

Settlement Remaining After Hold Period: 1.569 in

Depth of Neutral Plane: 31 ft

Remaining Settlement within Depth of Neutral Plane: 0.806 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	75	days	Time following completion of construction

																									Total Settlement at Facing of Wall			Settlement Complete at 74% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.500	1,680	1,759	0.019	0.226	0.441				100	0.226	0.441
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.499	1,676	1,926	0.018	0.215					100	0.215	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.495	1,662	2,070	0.068	0.813	2.669	150	2.5	4.932	100	0.813	2.306
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.489	1,642	2,181	0.058	0.699		150	5.0	1.233	96	0.671	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.480	1,613	2,284	0.051	0.613		150	7.5	0.548	79	0.484	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.469	1,577	2,379	0.045	0.544		150	10.0	0.308	62	0.337	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.456	1,534	2,480	0.012	0.150	0.507	1000	12.5	1.315	97	0.145	0.439
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.442	1,486	2,589	0.011	0.133		1000	15.0	0.913	91	0.121	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.420	1,410	2,747	0.019	0.224		1000	20.0	0.514	77	0.173	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.389	1,306	2,957	0.035	0.414	1.038	400	25.0	0.132	41	0.170	0.368
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.359	1,207	3,170	0.028	0.341		400	30.0	0.091	34	0.116	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.332	1,115	3,391	0.024	0.283		400	35.0	0.067	29	0.082	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.301	1,012	3,679	0.010	0.116	0.116	1000	37.5	0.146	43	0.050	0.050
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.270	906	4,024	0.023	0.272	0.272	400	32.5	0.078	31	0.084	0.084
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.247	831	4,309	0.004	0.051	0.051	1000	25.0	0.329	64	0.033	0.033
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.224	754	4,714	0.007	0.083	0.083	1000	20.0	0.514	77	0.064	0.064
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.199	669	5,256	0.007	0.089	0.089	800	10.0	1.644	99	0.088	0.088
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.181	607	5,732	0.007	0.083	0.083				100	0.083	0.083

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 3.955 in

Settlement Remaining After Hold Period: 1.394 in

Depth of Neutral Plane: 31 ft

Remaining Settlement within Depth of Neutral Plane: 0.676 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	90	days	Time following completion of construction

																									Total Settlement at Facing of Wall			Settlement Complete at 77% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.500	1,680	1,759	0.019	0.226	0.441				100	0.226	0.441
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.499	1,676	1,926	0.018	0.215					100	0.215	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.495	1,662	2,070	0.068	0.813	2.669	150	2.5	5.918	100	0.813	2.377
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.489	1,642	2,181	0.058	0.699		150	5.0	1.479	98	0.685	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.480	1,613	2,284	0.051	0.613		150	7.5	0.658	84	0.515	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.469	1,577	2,379	0.045	0.544		150	10.0	0.370	67	0.364	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.456	1,534	2,480	0.012	0.150	0.507	1000	12.5	1.578	98	0.147	0.457
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.442	1,486	2,589	0.011	0.133		1000	15.0	1.096	95	0.126	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.420	1,410	2,747	0.019	0.224		1000	20.0	0.616	82	0.184	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.389	1,306	2,957	0.035	0.414	1.038	400	25.0	0.158	45	0.187	0.403
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.359	1,207	3,170	0.028	0.341		400	30.0	0.110	37	0.126	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.332	1,115	3,391	0.024	0.283		400	35.0	0.081	32	0.091	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.301	1,012	3,679	0.010	0.116	0.116	1000	37.5	0.175	47	0.054	0.054
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.270	906	4,024	0.023	0.272	0.272	400	32.5	0.093	34	0.092	0.092
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.247	831	4,309	0.004	0.051	0.051	1000	25.0	0.395	69	0.035	0.035
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.224	754	4,714	0.007	0.083	0.083	1000	20.0	0.616	82	0.068	0.068
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.199	669	5,256	0.007	0.089	0.089	800	10.0	1.973	99	0.088	0.088
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.181	607	5,732	0.007	0.083	0.083				100	0.083	0.083

$(S_c)_t$ = 4.099 in

Settlement Remaining After Hold Period: 1.249 in

Depth of Neutral Plane: 31 ft

Remaining Settlement within Depth of Neutral Plane: 0.569 in

1. $\sigma_p' = \sigma_{vo}'+\sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5
3. C_r = 0.10(C_c); Ref. Chapter 8.11, Holtz and Kovacs 1981
4. e_o = (C_c/0.54)+0.35; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment

MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023

Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	350	days	Time following completion of construction

																									Total Settlement at Facing of Wall			Settlement Complete at 93% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.500	1,680	1,759	0.019	0.226	0.441				100	0.226	0.441
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.499	1,676	1,926	0.018	0.215					100	0.215	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.495	1,662	2,070	0.068	0.813	2.669	150	2.5	23.014	100	0.813	2.658
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.489	1,642	2,181	0.058	0.699		150	5.0	5.753	100	0.699	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.480	1,613	2,284	0.051	0.613		150	7.5	2.557	100	0.613	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.469	1,577	2,379	0.045	0.544		150	10.0	1.438	98	0.533	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.456	1,534	2,480	0.012	0.150	0.507	1000	12.5	6.137	100	0.150	0.507
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.442	1,486	2,589	0.011	0.133		1000	15.0	4.262	100	0.133	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.420	1,410	2,747	0.019	0.224		1000	20.0	2.397	100	0.224	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.389	1,306	2,957	0.035	0.414	1.038	400	25.0	0.614	82	0.340	0.764
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.359	1,207	3,170	0.028	0.341		400	30.0	0.426	72	0.245	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.332	1,115	3,391	0.024	0.283		400	35.0	0.313	63	0.178	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.301	1,012	3,679	0.010	0.116	0.116	1000	37.5	0.682	85	0.098	0.098
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.270	906	4,024	0.023	0.272	0.272	400	32.5	0.363	67	0.182	0.182
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.247	831	4,309	0.004	0.051	0.051	1000	25.0	1.534	98	0.050	0.050
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.224	754	4,714	0.007	0.083	0.083	1000	20.0	2.397	100	0.083	0.083
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.199	669	5,256	0.007	0.089	0.089	800	10.0	7.671	100	0.089	0.089
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.181	607	5,732	0.007	0.083	0.083				100	0.083	0.083

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 4.954 in

Settlement Remaining After Hold Period: 0.394 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall

t = 0 days Time following completion of construction

Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	Total Settlement at Center of Reinforced Soil Mass: S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	Settlement Complete at 9% of Primary Consolidation: c_v (ft²/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.554				100	0.274	0.554
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279					100	0.279	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	3.601	150	2.5	0.000	0	0.000	0.000
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936		150	5.0	0.000	0	0.000	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816		150	7.5	0.000	0	0.000	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716		150	10.0	0.000	0	0.000	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.644	1000	12.5	0.000	0	0.000	0.000
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170		1000	15.0	0.000	0	0.000	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279		1000	20.0	0.000	0	0.000	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	1.224	400	25.0	0.000	0	0.000	0.000
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399		400	30.0	0.000	0	0.000	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324		400	35.0	0.000	0	0.000	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.129	1000	37.5	0.000	0	0.000	0.000
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.297	400	32.5	0.000	0	0.000	0.000
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.055	1000	25.0	0.000	0	0.000	0.000
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.088	1000	20.0	0.000	0	0.000	0.000
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.093	800	10.0	0.000	0	0.000	0.000
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.087				100	0.087	0.087

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 0.640 in

Settlement Remaining After Hold Period: 6.131 in

Depth of Neutral Plane: 28 ft

Remaining Settlement within Depth of Neutral Plane: 4.394 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	30	days	Time following completion of construction

																									Total Settlement at Center of Reinforced Soil Mass			Settlement Complete at 61% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.554				100	0.274	0.554
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279					100	0.279	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	3.601	150	2.5	1.973	99	1.121	2.552
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936		150	5.0	0.493	76	0.711	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816		150	7.5	0.219	53	0.433	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716		150	10.0	0.123	40	0.286	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.644	1000	12.5	0.526	78	0.152	0.408
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170		1000	15.0	0.365	67	0.114	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279		1000	20.0	0.205	51	0.142	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	1.224	400	25.0	0.053	26	0.130	0.276
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399		400	30.0	0.037	22	0.088	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324		400	35.0	0.027	18	0.058	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.129	1000	37.5	0.058	27	0.035	0.035
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.297	400	32.5	0.031	20	0.059	0.059
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.055	1000	25.0	0.132	41	0.022	0.022
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.088	1000	20.0	0.205	51	0.045	0.045
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.093	800	10.0	0.658	84	0.078	0.078
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.087				100	0.087	0.087

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 4.116 in

Settlement Remaining After Hold Period: 2.655 in

Depth of Neutral Plane: 28 ft

Remaining Settlement within Depth of Neutral Plane: 1.396 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment

MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023

Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	45	days	Time following completion of construction

																									Total Settlement at Center of Reinforced Soil Mass			Settlement Complete at 67% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.554				100	0.274	0.554
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279					100	0.279	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	3.601	150	2.5	2.959	100	1.133	2.820
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936		150	5.0	0.740	87	0.814	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816		150	7.5	0.329	64	0.522	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716		150	10.0	0.185	49	0.351	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.644	1000	12.5	0.789	88	0.171	0.478
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170		1000	15.0	0.548	79	0.134	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279		1000	20.0	0.308	62	0.173	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	1.224	400	25.0	0.079	32	0.160	0.338
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399		400	30.0	0.055	26	0.104	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324		400	35.0	0.040	23	0.075	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.129	1000	37.5	0.088	33	0.043	0.043
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.297	400	32.5	0.047	24	0.071	0.071
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.055	1000	25.0	0.197	50	0.027	0.027
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.088	1000	20.0	0.308	62	0.055	0.055
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.093	800	10.0	0.986	93	0.087	0.087
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.087				100	0.087	0.087

1. $\sigma_p' = \sigma_{vo}'+\sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
5. $(N1)_{60} = C_nN_{60}$, 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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 4.560 in

Settlement Remaining After Hold Period: 2.211 in

Depth of Neutral Plane: 28 ft

Remaining Settlement within Depth of Neutral Plane: 1.048 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment

MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023

Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	60	days	Time following completion of construction

																									Total Settlement at Center of Reinforced Soil Mass			Settlement Complete at 72% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.554				100	0.274	0.554
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279					100	0.279	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	3.601	150	2.5	3.945	100	1.133	3.000
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936		150	5.0	0.986	93	0.870	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816		150	7.5	0.438	73	0.596	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716		150	10.0	0.247	56	0.401	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.644	1000	12.5	1.052	94	0.183	0.529
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170		1000	15.0	0.731	87	0.148	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279		1000	20.0	0.411	71	0.198	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	1.224	400	25.0	0.105	37	0.185	0.389
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399		400	30.0	0.073	30	0.120	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324		400	35.0	0.054	26	0.084	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.129	1000	37.5	0.117	39	0.050	0.050
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.297	400	32.5	0.062	28	0.083	0.083
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.055	1000	25.0	0.263	58	0.032	0.032
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.088	1000	20.0	0.411	71	0.063	0.063
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.093	800	10.0	1.315	97	0.090	0.090
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.087				100	0.087	0.087

$(S_c)_t$ = 4.877 in

Settlement Remaining After Hold Period: 1.894 in

Depth of Neutral Plane: 28 ft

Remaining Settlement within Depth of Neutral Plane: 0.810 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	75	days	Time following completion of construction

																									Total Settlement at Center of Reinforced Soil Mass			Settlement Complete at 75% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.554				100	0.274	0.554
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279					100	0.279	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	3.601	150	2.5	4.932	100	1.133	3.120
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936		150	5.0	1.233	96	0.899	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816		150	7.5	0.548	79	0.645	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716		150	10.0	0.308	62	0.444	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.644	1000	12.5	1.315	97	0.189	0.558
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170		1000	15.0	0.913	91	0.154	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279		1000	20.0	0.514	77	0.215	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	1.224	400	25.0	0.132	41	0.205	0.435
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399		400	30.0	0.091	34	0.136	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324		400	35.0	0.067	29	0.094	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.129	1000	37.5	0.146	43	0.056	0.056
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.297	400	32.5	0.078	31	0.092	0.092
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.055	1000	25.0	0.329	64	0.035	0.035
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.088	1000	20.0	0.514	77	0.068	0.068
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.093	800	10.0	1.644	99	0.092	0.092
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.087				100	0.087	0.087

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 5.096 in

Settlement Remaining After Hold Period: 1.675 in

Depth of Neutral Plane: 28 ft

Remaining Settlement within Depth of Neutral Plane: 0.655 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment

MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023

Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall
t =	90	days	Time following completion of construction

																							Total Settlement at Center of Reinforced Soil Mass			Settlement Complete at 78% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.554				100	0.274	0.554
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279					100	0.279	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	3.601	150	2.5	5.918	100	1.133	3.215
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936		150	5.0	1.479	98	0.917	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816		150	7.5	0.658	84	0.686	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716		150	10.0	0.370	67	0.479	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.644	1000	12.5	1.578	98	0.191	0.581
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170		1000	15.0	1.096	95	0.161	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279		1000	20.0	0.616	82	0.229	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	1.224	400	25.0	0.158	45	0.225	0.477
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399		400	30.0	0.110	37	0.148	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324		400	35.0	0.081	32	0.104	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.129	1000	37.5	0.175	47	0.061	0.061
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.297	400	32.5	0.093	34	0.101	0.101
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.055	1000	25.0	0.395	69	0.038	0.038
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.088	1000	20.0	0.616	82	0.072	0.072
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.093	800	10.0	1.973	99	0.092	0.092
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.087				100	0.087	0.087

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

$(S_c)_t$ = 5.277 in

Settlement Remaining After Hold Period: 1.494 in

Depth of Neutral Plane: 28 ft

Remaining Settlement within Depth of Neutral Plane: 0.531 in

HAM-75-7.85 - HAM-75-0791 I-75 over SR-562 Ramp J - Rear Abutment
MSE Wall Settlement

Calculated By: BRT Date: 5/7/2023
Checked By: JPS Date: 5/7/2023

Boring B-162-0-07

H =	28.0	ft	Wall height
B =	25.7	ft	Width of wall
D_w =	0.0	ft	Depth below bottom of wall
γ_{BF} =	120		Unit weight of backfill
q =	3,360	psf	Bearing pressure at bottom of wall

t = 395 days Time following completion of construction

																									Total Settlement at Center of Reinforced Soil Mass			Settlement Complete at 94% of Primary Consolidation					
Layer	Soil Class.	Soil Type	Layer Depth (ft)		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)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	c_v (ft^2/yr)	H_{dr} (ft)	T_v	U (%)	$(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-1-b	G	0.0	3.0	510.7	507.7	3.0	1.5	115	345	173	79	3,079					30	60	215	0.06	0.999	3,358	3,437	0.023	0.274	0.554				100	0.274	0.554
	A-1-b	G	3.0	6.5	507.7	504.2	3.5	4.8	115	748	546	250	3,250					30	51	173	0.18	0.982	3,298	3,548	0.023	0.279					100	0.279	
2	A-7-6	C	6.5	9.0	504.2	501.7	2.5	7.8	115	1,035	891	408	3,408	49	0.230	0.068	0.771				0.30	0.936	3,145	3,553	0.094	1.133	3.601	150	2.5	25.973	100	1.133	3.594
	A-7-6	C	9.0	11.5	501.7	499.2	2.5	10.3	115	1,323	1,179	539	3,539	49	0.230	0.068	0.771				0.40	0.882	2,963	3,502	0.078	0.936		150	5.0	6.493	100	0.936	
	A-7-6	C	11.5	14.0	499.2	496.7	2.5	12.8	115	1,610	1,466	671	3,671	49	0.230	0.068	0.771				0.50	0.821	2,758	3,428	0.068	0.816		150	7.5	2.886	100	0.816	
	A-7-6	C	14.0	16.5	496.7	494.2	2.5	15.3	115	1,898	1,754	802	3,802	49	0.230	0.068	0.771				0.59	0.759	2,552	3,354	0.060	0.716		150	10.0	1.623	99	0.709	
3	A-4b	C	16.5	19.0	494.2	491.7	2.5	17.8	125	2,210	2,054	946	3,946	30	0.180	0.018	0.507				0.69	0.701	2,356	3,303	0.016	0.195	0.644	1000	12.5	6.926	100	0.195	0.644
	A-4b	C	19.0	21.5	491.7	489.2	2.5	20.3	125	2,523	2,366	1,103	4,103	30	0.180	0.018	0.507				0.79	0.648	2,177	3,280	0.014	0.170		1000	15.0	4.810	100	0.170	
	A-4b	C	21.5	26.5	489.2	484.2	5.0	24.0	125	3,148	2,835	1,337	4,337	30	0.180	0.018	0.507				0.93	0.578	1,942	3,279	0.023	0.279		1000	20.0	2.705	100	0.279	
5	A-6b	C	26.5	31.5	484.2	479.2	5.0	29.0	125	3,773	3,460	1,650	4,650	40	0.145	0.041	0.503				1.13	0.501	1,684	3,335	0.042	0.500	1.224	400	25.0	0.693	85	0.425	0.939
	A-6b	C	31.5	36.5	479.2	474.2	5.0	34.0	125	4,398	4,085	1,963	4,963	40	0.145	0.041	0.503				1.32	0.441	1,480	3,444	0.033	0.399		400	30.0	0.481	75	0.300	
	A-6b	C	36.5	41.5	474.2	469.2	5.0	39.0	125	5,023	4,710	2,276	5,276	40	0.145	0.041	0.503				1.52	0.392	1,317	3,593	0.027	0.324		400	35.0	0.353	66	0.214	
6	A-4b	C	41.5	49.0	469.2	461.7	7.5	45.3	125	5,960	5,491	2,668	5,668	25	0.135	0.014	0.467				1.76	0.343	1,154	3,822	0.011	0.129	0.129	1000	37.5	0.770	88	0.114	0.114
7	A-6b	C	49.0	56.5	461.7	454.2	7.5	52.8	120	6,860	6,410	3,118	6,118	38	0.145	0.041	0.503				2.05	0.299	1,003	4,121	0.025	0.297	0.297	400	32.5	0.410	71	0.211	0.211
8	A-4a	C	56.5	61.5	454.2	449.2	5.0	59.0	120	7,460	7,160	3,478	6,478	18	0.134	0.014	0.535				2.30	0.269	903	4,382	0.005	0.055	0.055	1000	25.0	1.732	99	0.054	0.054
9	A-4a	C	61.5	71.5	449.2	439.2	10.0	66.5	130	8,760	8,110	3,960	6,960	18	0.134	0.014	0.535				2.59	0.240	807	4,767	0.007	0.088	0.088	1000	20.0	2.705	100	0.088	0.088
10	A-6a	C	71.5	81.5	439.2	429.2	10.0	76.5	120	9,960	9,360	4,586	7,586	31	0.189	0.019	0.514				2.98	0.210	705	5,292	0.008	0.093	0.093	800	10.0	8.658	100	0.093	0.093
11	A-3a	G	81.5	89.5	429.2	421.2	8.0	85.5	125	10,960	10,460	5,125	8,125					19	13	56	3.33	0.189	633	5,758	0.007	0.087	0.087				100	0.087	0.087

$(S_c)_t$ = 6.377 in

Settlement Remaining After Hold Period: 0.395 in

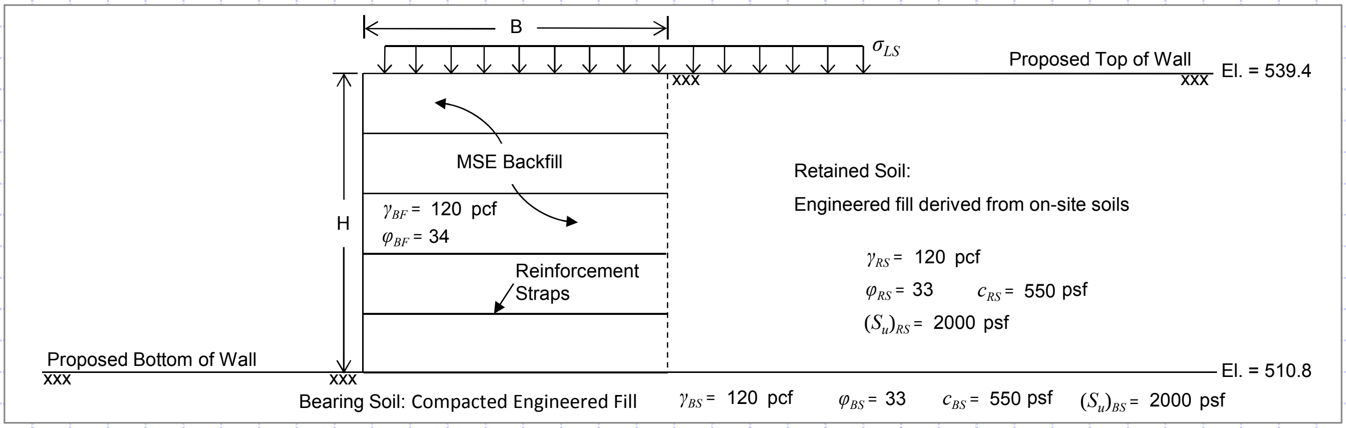
1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 3,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(C_c)$; Ref. Chapter 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/0.54)+0.35$; Ref. Table 6-11, FHWA GEC 5
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; $I = [\beta+\sin(\beta)\cos(\beta+2\delta)]/\pi$, where $\beta = \tan^{-1}[(x+B/2)/Z_f]-\delta$, $\delta = \tan^{-1}[(x-B/2)/Z_f]$ and x = horizontal distance from center of footing; Ref. Figure 6.13 and Equation 6.24, Das 2005
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. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

APPENDIX IX

MSE WALL CALCULATIONS

RESOURCE INTERNATIONAL, INC.
6350 PRESIDENTIAL GATEWAY
COLUMBUS, OHIO 43231
PHONE: (614) 823-4949
FAX: (614) 823-4990
WWW.RESOURCEINTERATIONAL.COM

MSE Wall - Rear Abutment - B-162 - (25.7 ft. Wall Height)



MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	28.6	ft
MSE Wall Width (Reinforcement Length), (B) =	25.7	ft
Live Surcharge Load, (σ_{LS}) =	240	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	33	°
Retained Soil Drained Cohesion, (c_{BS}) =	550	psf
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.295	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	33	°
Bearing Soil Drained Cohesion, (c_{BS}) =	550	psf
Bearing Soil Undrained Shear Strength, $[(S_u)_{BS}]$ =	2000	psf
Embedment Depth, (D) =	3.0	ft

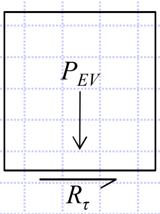
LRFD Load Factors

	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 Sections 11.6.3.6 and 11.10.5.3

Nominal Sliding Resistance: $R_\tau = P_{EV} \cdot \tan\delta$



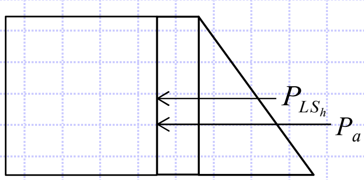
$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ = (120 pcf)(28.6 ft)(25.74 ft)(1.00) = 88.34 kip/ft

$\tan\delta = (\tan\varphi_{BS} \le \tan\varphi_{BF})$

$\tan\delta =$ tan(33) ≤ tan(34) ⟶ 0.65 ≤ 0.67 ⟶ $\tan\delta =$ 0.65

R_τ = (88.34 kip/ft)(0.65) = 57.42 kip/ft

Sliding Force: $P_H = P_{EH} + P_{LS_h}$



$P_{EH} = \frac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH}$ = ½(120 pcf)(28.6 ft)²(0.295)(1.5) = 21.72 kip/ft

$P_{LS_h} = \sigma_{LS} H K_a \gamma_{LS}$ = (240 psf)(28.6 ft)(0.295)(1.75) = 3.54 kip/ft

P_H = 21.72 kip/ft + 3.54 kip/ft = 25.26 kip/ft

Check Sliding Resistance

$P_H \le R_\tau \cdot \phi_\tau$ ⟶ 25.26 kip/ft ≤ (57.42 kip/ft)(1.0) = 57.42 kip/ft ⟶ 25.26 kip/ft ≤ 57.42 kip/ft **OK**

Use φ_τ = **1.0** *(Per AASHTO LRFD BDM Table 11.5.6-1)*

RESOURCE INTERNATIONAL, INC.
6350 PRESIDENTIAL GATEWAY
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MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	28.6	ft
MSE Wall Width (Reinforcement Length), (B) =	25.74	ft
Live Surcharge Load, (σ_{LS}) =	240	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	33	°
Retained Soil Drained Cohesion, (c_{BS}) =	550	psf
Retained Soil Undrained Shear Strength, [$(S_u)_{RS}$] =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.295	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

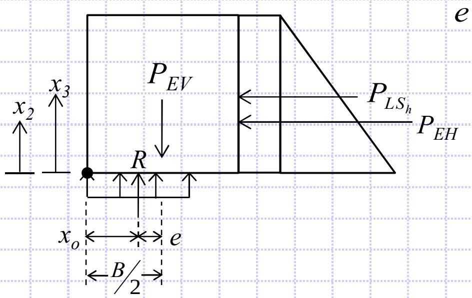
Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	33	°
Bearing Soil Drained Cohesion, (c_{BS}) =	550	psf
Bearing Soil Undrained Shear Strength, [$(s_u)_{BS}$] =	2000	psf
Embedment Depth, (D) =	3.0	ft

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 11.6.3.3



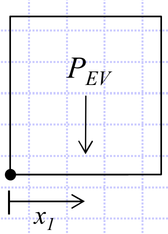
$$e = B/2 - x_o$$

$$x_o = \frac{M_{EV} - M_H}{P_{EV}}$$ = (1136.94 kip·ft/ft - 257.61 kip·ft/ft) / (88.34 kip/ft) = 9.95 ft

M_{EV} = 1136.94 kip·ft/ft
M_H = 257.61 kip·ft/ft
P_{EV} = 88.34 kip/ft
Defined below

$e =$ (25.74 ft)/2 - 9.95 ft = 2.92 ft

Resisting Moment, M_{EV}:



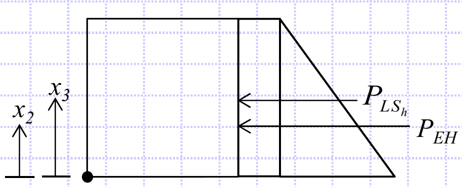
$$M_{EV} = P_{EV}(x_1)$$

$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ = (120 pcf)(28.6 ft)(25.74 ft)(1.00) = 88.34 kip/ft

$x_1 = B/2$ = (25.74 ft) / 2 = 12.87 ft

$M_{EV} =$ (88.34 kip/ft)(12.87 ft) = 1136.94 kip·ft/ft

Overturning Moment, M_H:



$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3)$$

$P_{EH} = ½\gamma_{RS} H^2 K_a \gamma_{EH}$ = ½(120 pcf)(28.6 ft)²(0.295)(1.5) = 21.72 kip/ft

$P_{LS_h} = \sigma_{LS} H K_a \gamma_{LS}$ = (240 psf)(28.6 ft)(0.295)(1.75) = 3.54 kip/ft

$x_2 = H/3$ = (28.6 ft) / 3 = 9.53 ft

$x_3 = H/2$ = (28.6 ft) / 2 = 14.30 ft

$M_H =$ (21.72 kip/ft)(9.53 ft) + (3.54 kip/ft)(14.3 ft) = 257.61 kip·ft/ft

Limiting Eccentricity:

$e_{max} = B/4 \longrightarrow e_{max} =$ (25.74 ft) / 4 = 6.44 ft

Check Eccentricity

$e < e_{max} \longrightarrow$ 2.92 ft ≤ 6.44 ft **OK**

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	28.6	ft
MSE Wall Width (Reinforcement Length), (B) =	25.74	ft
Live Surcharge Load, (σ_{LS}) =	240	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	33	°
Retained Soil Drained Cohesion, (c_{BS}) =	550	psf
Retained Soil Undrained Shear Strength, [$(S_u)_{RS}$] =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.295	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

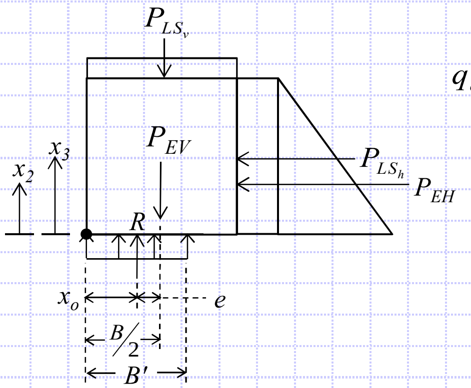
Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	33	°
Bearing Soil Drained Cohesion, (c_{BS}) =	550	psf
Bearing Soil Undrained Shear Strength, [$(s_u)_{BS}$] =	2000	psf
Embedment Depth, (D) =	3.0	ft

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 11.6.3.2



$$q_{eq} = P_V / B'$$

$$B' = B - 2e \quad = \quad 25.7 \text{ ft} - 2(1.98 \text{ ft}) \quad = \quad 21.78 \text{ ft}$$

$$e = B/2 - x_o \quad = \quad (25.7 \text{ ft}) / 2 - 10.89 \text{ ft} \quad = \quad 1.98 \text{ ft}$$

$$x_o = \frac{M_V - M_H}{P_V} \quad = \quad (1673.99 \text{ kip·ft/ft} - 257.63 \text{ kip·ft/ft}) / 130.07 \text{ kip/ft} \quad = \quad 10.89 \text{ ft}$$

$$q_{eq} = (130.07 \text{ kip/ft}) / (21.78 \text{ ft}) \quad = \quad 5.97 \text{ ksf}$$

$$M_V = P_{EV}(x_1) + P_{LS_v}(x_1) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_1) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_1)$$

$$M_V = [(120 \text{ pcf})(28.6 \text{ ft})(25.74 \text{ ft})(1.35)](12.87 \text{ ft}) + [(240 \text{ psf})(25.74 \text{ ft})(1.75)](12.87 \text{ ft}) \quad = \quad 1673.99 \text{ kip·ft/ft}$$

$$M_H = P_{EH}(x_2) + P_{LS_h}(x_3) = (\tfrac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH})(x_2) + (\sigma_{LS} H K_a \gamma_{LS})(x_3)$$

$$M_H = [\tfrac{1}{2}(120 \text{ pcf})(28.6 \text{ ft})^2(0.295)(1.5)](9.53 \text{ ft}) + [(240 \text{ psf})(28.6 \text{ ft})(0.295)(1.75)](14.3 \text{ ft}) \quad = \quad 257.63 \text{ kip·ft/ft}$$

$$P_V = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$$

$$P_V = (120 \text{ pcf})(28.6 \text{ ft})(25.7 \text{ ft})(1.35) + (240 \text{ psf})(25.7 \text{ ft})(1.75) \quad = \quad 130.07 \text{ kip/ft}$$

Nominal Bearing Resistance:

$$q_n = cN_c + \gamma D N_q + \tfrac{1}{2}\gamma B N_\gamma \quad = \quad (2000 \text{ psf})(5.7) + (120 \text{ pcf})(3.0 \text{ ft})(1.0) + \tfrac{1}{2}(120 \text{ pcf})(25.74 \text{ ft})(0.0) \quad = \quad 11.8 \text{ ksf}$$

N_c = 5.7 $\quad N_q$ = 1.0 $\quad N_\gamma$ = 0.0

Check Bearing Capacity

$$q_{eq} \le q_n \cdot \phi_b \quad \longrightarrow \quad 5.97 \text{ ksf} \le (11.8 \text{ ksf})(0.65) = 7.67 \text{ ksf} \quad \longrightarrow \quad 5.97 \text{ ksf} \le 7.67 \text{ ksf}$$

OK

Use φ_b = **0.65** *(Per AASHTO LRFD BDM Table 11.5.6-1)*

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Retained Soil Drained Cohesion, (c_{BS}) =	550	psf
Retained Soil Undrained Shear Strength, [$(S_u)_{RS}$] =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.295	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	33	°
Bearing Soil Drained Cohesion, (c_{BS}) =	550	psf
Bearing Soil Undrained Shear Strength, [$(s_u)_{BS}$] =	2000	psf
Embedment Depth, (D) =	3.0	ft

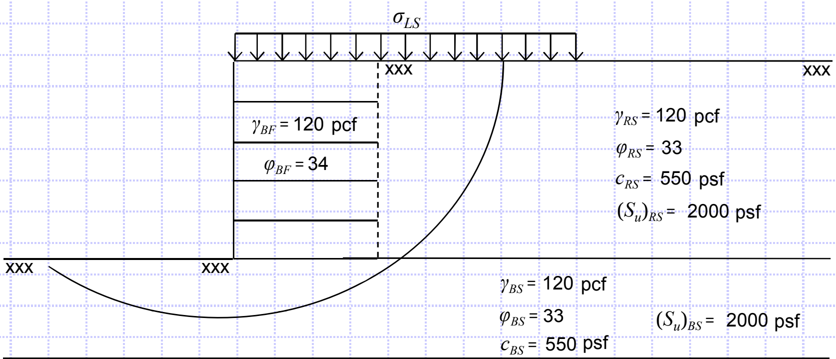
LRFD Load Factors

	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)

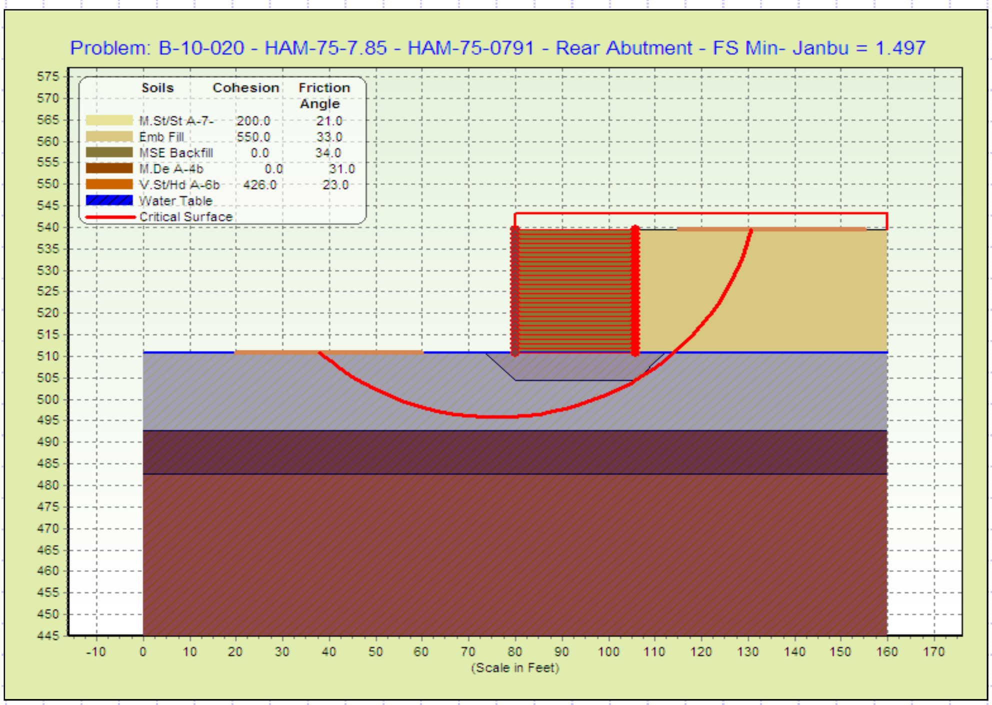
Check Overall (Global) Stability (Loading Case - Service I) - AASHTO LRFD BDM Sections 11.6.2.3 and 11.10.5.2

Long Term Stability - Drained Conditions



Loading scenario modeled as shown to the left and analyzed for slope stability using STABL for Windows software.

Graphical output shown below and tabular output results are provided as a separate attachment.



Check Overall (Global) Stability

$1.0 \le FS \cdot \phi_{GS}$ → 1.0 ≤ (1.497)(0.65) = 1.0 → 1.0 ≤ 1.0 **OK**

FS = **1.497** *(From STABL Slope Stability Analysis)*

Use φ_{GS} = **0.65** *(Per AASHTO LRFD BDM Section 11.6.2.3)*

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MSE Wall Width (Reinforcement Length), (B) =	25.74	ft
Live Surcharge Load, (σ_{LS}) =	240	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	33	°
Retained Soil Drained Cohesion, (c_{RS}) =	550	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.295	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	33	°
Bearing Soil Drained Cohesion, (c_{BS}) =	550	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	2000	psf
Embedment Depth, (D) =	3.0	ft

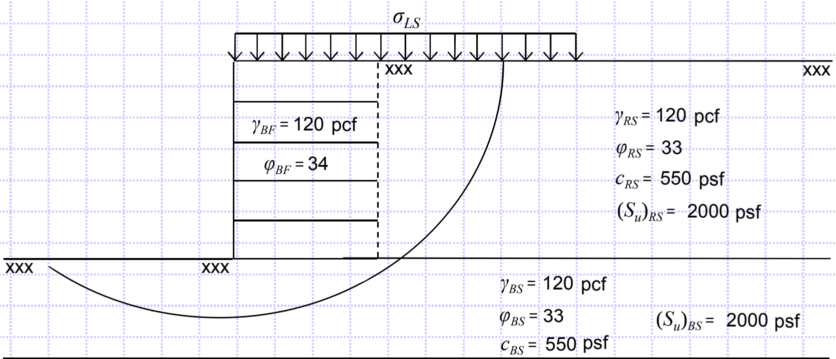
LRFD Load Factors

	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)

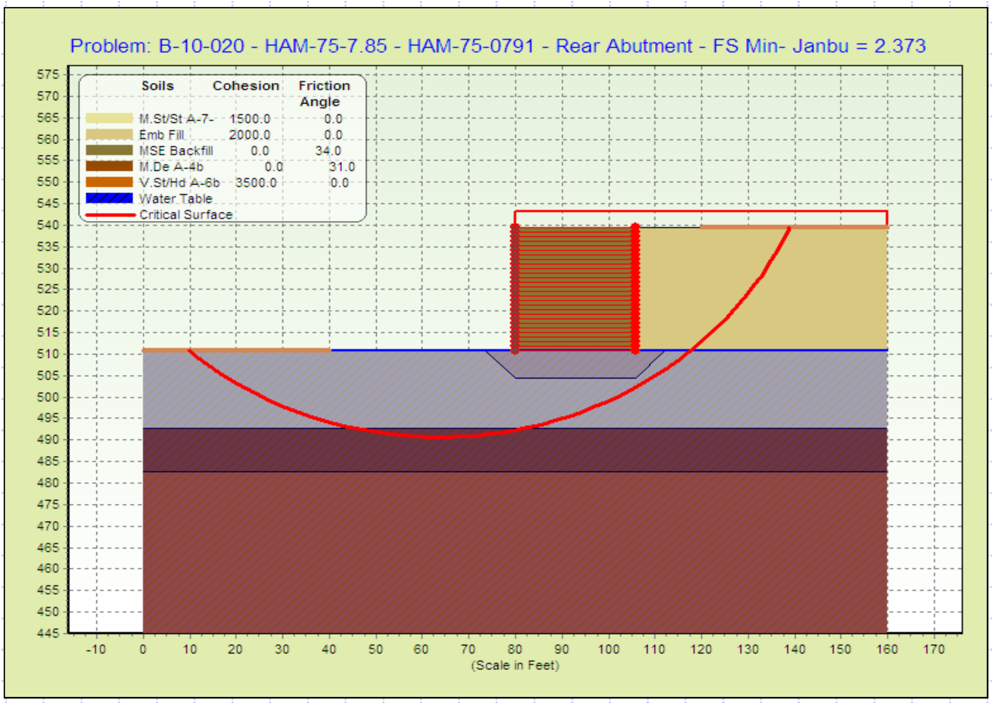
Check Overall (Global) Stability (Loading Case - Service I) - AASHTO LRFD BDM Sections 11.6.2.3 and 11.10.5.2 ***(Cont'd)***

Short Term Stability - Undrained Conditions



Loading scenario modeled as shown to the left and analyzed for slope stability using STABL for Windows software.

Graphical output shown below and tabular output results are provided as a separate attachment.



Check Overall (Global) Stability

$$1.0 \leq FS \cdot \phi_{GS} \quad \longrightarrow \quad 1.0 \leq (2.373)(0.65) = 1.5 \quad \longrightarrow \quad 1.0 \leq 1.5$$

OK

FS = **2.373** *(From STABL Slope Stability Analysis)*

Use φ_{GS} = **0.65** *(Per AASHTO LRFD BDM Section 11.6.2.3)*

** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION B-10-020 - HAM-75-7.85 - HAM-75-0791 - R
ear Abutment

BOUNDARY COORDINATES

5 Top Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	510.80	73.50	510.80	3
2	73.50	510.80	80.00	510.80	2
3	80.00	510.80	80.10	539.40	1
4	80.10	539.40	105.80	539.40	1
5	105.80	539.40	160.00	539.40	2
6	80.00	510.80	105.70	510.80	2
7	105.70	510.80	105.80	539.40	2
8	105.70	510.80	112.20	510.80	2
9	112.20	510.80	160.00	510.80	3
10	73.50	510.80	80.00	504.30	3
11	80.00	504.30	105.70	504.30	3
12	105.70	504.30	112.20	510.80	3
13	0.00	492.70	160.00	492.70	4
14	0.00	482.70	160.00	482.70	5

1

ISOTROPIC SOIL PARAMETERS

5 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	0.0	34.0	0.00	0.0	1
2	120.0	130.0	550.0	33.0	0.00	0.0	1
3	115.0	125.0	200.0	21.0	0.00	0.0	1
4	125.0	130.0	0.0	31.0	0.00	0.0	1
5	120.0	130.0	426.0	23.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	510.80
2	160.00	510.80

1

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	80.10	160.00	240.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

GEOSYNTHETIC DATA

1 Geosynthetics(s) group(s) specified

Ngroup no	Bnr no	Y-top (ft)	Y-bot (ft)	Levels no	Length (ft)	Spacing (ft)	Efficiency	Tallow (lbs/ft)
1	3	539.4	510.8	28	25.7	1.06	1.0	7500.0

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

500 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 50 Points Equally Spaced
Along The Ground Surface Between X = 20.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between   X = 115.00 ft.
and   X = 155.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y =450.00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	37.96	510.80
2	40.21	508.82
3	42.57	506.96
4	45.02	505.23
5	47.56	503.63
6	50.18	502.18
7	52.88	500.86
8	55.64	499.69
9	58.46	498.68
10	61.33	497.81
11	64.25	497.10
12	67.20	496.54
13	70.17	496.15
14	73.16	495.92
15	76.16	495.84
16	79.16	495.93
17	82.15	496.17
18	85.12	496.58
19	88.07	497.15
20	90.98	497.87
21	93.85	498.75
22	96.67	499.78
23	99.42	500.96
24	102.12	502.28
25	104.73	503.75
26	107.27	505.36
27	109.71	507.10
28	112.06	508.96
29	114.30	510.96
30	116.44	513.06
31	118.45	515.28
32	120.35	517.61
33	122.12	520.03
34	123.75	522.55
35	125.25	525.14
36	126.61	527.82
37	127.82	530.56
38	128.89	533.37
39	129.80	536.23
40	130.56	539.13
41	130.61	539.40

*** 1.497 ***

Individual data on the 49 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.3	279.0	0.0	185.5	0.0	0.0	0.0	0.0	0.0
2	2.4	857.0	0.0	545.0	0.0	0.0	0.0	0.0	0.0
3	2.5	1441.7	0.0	880.8	0.0	0.0	0.0	0.0	0.0
4	2.5	2022.1	0.0	1192.1	0.0	0.0	0.0	0.0	0.0
5	2.6	2587.7	0.0	1477.8	0.0	0.0	0.0	0.0	0.0
6	2.7	3128.2	0.0	1737.3	0.0	0.0	0.0	0.0	0.0
7	2.8	3634.3	0.0	1969.7	0.0	0.0	0.0	0.0	0.0
8	2.8	4097.1	0.0	2174.4	0.0	0.0	0.0	0.0	0.0
9	2.9	4508.8	0.0	2350.8	0.0	0.0	0.0	0.0	0.0
10	2.9	4862.3	0.0	2498.4	0.0	0.0	0.0	0.0	0.0
11	2.9	5151.9	0.0	2616.8	0.0	0.0	0.0	0.0	0.0
12	3.0	5372.6	0.0	2705.5	0.0	0.0	0.0	0.0	0.0
13	3.0	5520.8	0.0	2764.5	0.0	0.0	0.0	0.0	0.0
14	0.3	628.9	0.0	314.0	0.0	0.0	0.0	0.0	0.0
15	2.7	4982.9	0.0	2479.4	0.0	0.0	0.0	0.0	0.0
16	3.0	5653.6	0.0	2792.3	0.0	0.0	0.0	0.0	0.0
17	0.8	1583.7	0.0	780.5	0.0	0.0	0.0	0.0	0.0
18	0.1	359.8	0.0	92.7	0.0	0.0	0.0	0.0	0.0
19	2.0	10870.4	0.0	1887.9	0.0	0.0	0.0	0.0	491.9
20	3.0	15655.8	0.0	2699.8	0.0	0.0	0.0	0.0	713.3
21	2.9	15339.4	0.0	2608.8	0.0	0.0	0.0	0.0	707.1
22	2.9	14925.1	0.0	2488.2	0.0	0.0	0.0	0.0	698.8
23	2.9	14418.2	0.0	2338.4	0.0	0.0	0.0	0.0	688.5

24	2.8	13825.2	0.0	2159.9	0.0	0.0	0.0	0.0	676.2
25	2.8	13153.5	0.0	1953.0	0.0	0.0	0.0	0.0	662.0
26	2.7	12411.8	0.0	1718.5	0.0	0.0	0.0	0.0	645.9
27	2.6	11609.5	0.0	1457.0	0.0	0.0	0.0	0.0	627.9
28	0.9	3736.3	0.0	433.8	0.0	0.0	0.0	0.0	208.0
29	0.1	433.0	0.0	48.4	0.0	0.0	0.0	0.0	24.3
30	0.1	426.5	0.0	47.3	0.0	0.0	0.0	0.0	24.0
31	0.1	321.2	0.0	35.4	0.0	0.0	0.0	0.0	18.1
32	1.4	5833.8	0.0	604.4	0.0	0.0	0.0	0.0	333.7
33	2.4	9831.0	0.0	856.1	0.0	0.0	0.0	0.0	586.6
34	2.3	8884.5	0.0	518.5	0.0	0.0	0.0	0.0	563.4
35	0.1	520.8	0.0	21.1	0.0	0.0	0.0	0.0	34.2
36	1.9	6816.2	0.0	137.3	0.0	0.0	0.0	0.0	462.3
37	0.2	600.0	0.0	0.0	0.0	0.0	0.0	0.0	42.1
38	2.1	7014.2	0.0	0.0	0.0	0.0	0.0	0.0	512.2
39	2.0	6108.7	0.0	0.0	0.0	0.0	0.0	0.0	484.3
40	1.9	5222.8	0.0	0.0	0.0	0.0	0.0	0.0	455.1
41	1.8	4368.3	0.0	0.0	0.0	0.0	0.0	0.0	424.5
42	1.6	3556.6	0.0	0.0	0.0	0.0	0.0	0.0	392.8
43	1.5	2798.7	0.0	0.0	0.0	0.0	0.0	0.0	359.8
44	1.4	2105.1	0.0	0.0	0.0	0.0	0.0	0.0	325.9
45	1.2	1485.6	0.0	0.0	0.0	0.0	0.0	0.0	291.0
46	1.1	949.1	0.0	0.0	0.0	0.0	0.0	0.0	255.3
47	0.9	503.7	0.0	0.0	0.0	0.0	0.0	0.0	218.9
48	0.8	156.6	0.0	0.0	0.0	0.0	0.0	0.0	181.8
49	0.1	0.9	0.0	0.0	0.0	0.0	0.0	0.0	13.3

Individual data on the 28 geosynthetics

Group	Level	Slice	Head Coordinates (ft)		End Coordinates (ft)		T (lbs)	Length (ft)	Tallow (lbs)	T/Tall %
1	1	0	80.0	510.8	105.7	510.8	0.0	25.7	7500.0	0.0
1	2	0	80.0	511.9	105.7	511.9	0.0	25.7	7500.0	0.0
1	3	0	80.0	512.9	105.7	512.9	0.0	25.7	7500.0	0.0
1	4	0	80.0	514.0	105.7	514.0	0.0	25.7	7500.0	0.0
1	5	0	80.0	515.0	105.7	515.0	0.0	25.7	7500.0	0.0
1	6	0	80.0	516.1	105.7	516.1	0.0	25.7	7500.0	0.0
1	7	0	80.0	517.2	105.7	517.2	0.0	25.7	7500.0	0.0
1	8	0	80.0	518.2	105.7	518.2	0.0	25.7	7500.0	0.0
1	9	0	80.0	519.3	105.7	519.3	0.0	25.7	7500.0	0.0
1	10	0	80.0	520.3	105.7	520.3	0.0	25.7	7500.0	0.0
1	11	0	80.0	521.4	105.7	521.4	0.0	25.7	7500.0	0.0
1	12	0	80.0	522.5	105.7	522.5	0.0	25.7	7500.0	0.0
1	13	0	80.0	523.5	105.7	523.5	0.0	25.7	7500.0	0.0
1	14	0	80.0	524.6	105.7	524.6	0.0	25.7	7500.0	0.0
1	15	0	80.1	525.6	105.8	525.6	0.0	25.7	7500.0	0.0
1	16	0	80.1	526.7	105.8	526.7	0.0	25.7	7500.0	0.0
1	17	0	80.1	527.7	105.8	527.7	0.0	25.7	7500.0	0.0
1	18	0	80.1	528.8	105.8	528.8	0.0	25.7	7500.0	0.0
1	19	0	80.1	529.9	105.8	529.9	0.0	25.7	7500.0	0.0
1	20	0	80.1	530.9	105.8	530.9	0.0	25.7	7500.0	0.0
1	21	0	80.1	532.0	105.8	532.0	0.0	25.7	7500.0	0.0
1	22	0	80.1	533.0	105.8	533.0	0.0	25.7	7500.0	0.0
1	23	0	80.1	534.1	105.8	534.1	0.0	25.7	7500.0	0.0
1	24	0	80.1	535.2	105.8	535.2	0.0	25.7	7500.0	0.0
1	25	0	80.1	536.2	105.8	536.2	0.0	25.7	7500.0	0.0
1	26	0	80.1	537.3	105.8	537.3	0.0	25.7	7500.0	0.0
1	27	0	80.1	538.3	105.8	538.3	0.0	25.7	7500.0	0.0
1	28	0	80.1	539.4	105.8	539.4	0.0	25.7	7500.0	0.0

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.16	510.80
2	30.40	508.80
3	32.73	506.91
4	35.14	505.12
5	37.63	503.46
6	40.20	501.91
7	42.85	500.49
8	45.55	499.19
9	48.31	498.02
10	51.13	496.98

11	53.99	496.08
12	56.89	495.32
13	59.82	494.69
14	62.78	494.20
15	65.76	493.85
16	68.76	493.64
17	71.75	493.57
18	74.75	493.64
19	77.75	493.86
20	80.72	494.21
21	83.68	494.71
22	86.62	495.35
23	89.51	496.12
24	92.37	497.03
25	95.19	498.07
26	97.95	499.24
27	100.65	500.55
28	103.29	501.98
29	105.85	503.53
30	108.35	505.20
31	110.76	506.99
32	113.08	508.88
33	115.31	510.89
34	117.44	513.00
35	119.47	515.21
36	121.40	517.51
37	123.21	519.90
38	124.91	522.37
39	126.50	524.92
40	127.96	527.54
41	129.29	530.23
42	130.50	532.97
43	131.57	535.77
44	132.51	538.62
45	132.73	539.40

*** 1.505 ***

1

Failure Surface Specified By 44 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.25	510.80
2	34.37	508.68
3	36.60	506.67
4	38.92	504.78
5	41.34	503.00
6	43.85	501.36
7	46.44	499.84
8	49.10	498.46
9	51.83	497.21
10	54.62	496.10
11	57.46	495.14
12	60.35	494.33
13	63.27	493.66
14	66.23	493.14
15	69.20	492.77
16	72.19	492.55
17	75.19	492.49
18	78.19	492.58
19	81.18	492.82
20	84.16	493.22
21	87.11	493.76
22	90.03	494.46
23	92.91	495.30
24	95.74	496.29
25	98.52	497.42
26	101.23	498.69
27	103.88	500.10
28	106.46	501.64
29	108.95	503.30
30	111.36	505.10

31	113.67	507.01
32	115.88	509.04
33	117.98	511.18
34	119.97	513.42
35	121.85	515.77
36	123.60	518.20
37	125.23	520.72
38	126.72	523.32
39	128.09	525.99
40	129.31	528.73
41	130.39	531.53
42	131.33	534.38
43	132.13	537.27
44	132.60	539.40

*** 1.510 ***

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	39.59	510.80
2	41.75	508.71
3	44.01	506.75
4	46.38	504.91
5	48.85	503.21
6	51.41	501.64
7	54.06	500.22
8	56.77	498.95
9	59.55	497.82
10	62.39	496.86
11	65.28	496.05
12	68.21	495.40
13	71.17	494.92
14	74.16	494.60
15	77.15	494.44
16	80.15	494.45
17	83.15	494.62
18	86.13	494.96
19	89.08	495.47
20	92.01	496.14
21	94.89	496.96
22	97.73	497.95
23	100.50	499.09
24	103.21	500.38
25	105.84	501.82
26	108.39	503.40
27	110.85	505.12
28	113.21	506.97
29	115.46	508.95
30	117.61	511.05
31	119.63	513.27
32	121.52	515.59
33	123.29	518.02
34	124.92	520.54
35	126.41	523.14
36	127.75	525.83
37	128.94	528.58
38	129.98	531.39
39	130.86	534.26
40	131.58	537.17
41	132.00	539.40

*** 1.513 ***

1

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.41	510.80
2	42.55	508.70
3	44.81	506.72
4	47.17	504.88
5	49.64	503.17
6	52.19	501.60
7	54.83	500.17
8	57.55	498.90
9	60.33	497.78
10	63.18	496.82
11	66.07	496.02
12	69.00	495.39
13	71.96	494.92
14	74.95	494.61
15	77.94	494.48
16	80.94	494.51
17	83.94	494.72
18	86.91	495.09
19	89.87	495.63
20	92.78	496.33
21	95.65	497.19
22	98.47	498.22
23	101.23	499.40
24	103.92	500.74
25	106.53	502.22
26	109.05	503.85
27	111.47	505.61
28	113.79	507.52
29	116.00	509.54
30	118.10	511.69
31	120.06	513.96
32	121.90	516.33
33	123.61	518.79
34	125.17	521.36
35	126.58	524.00
36	127.85	526.72
37	128.96	529.51
38	129.91	532.35
39	130.70	535.25
40	131.32	538.18
41	131.51	539.40

*** 1.515 ***

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.86	510.80
2	45.02	508.72
3	47.30	506.77
4	49.69	504.95
5	52.18	503.28
6	54.75	501.75
7	57.42	500.36
8	60.16	499.14
9	62.96	498.07
10	65.82	497.16
11	68.73	496.42
12	71.67	495.85
13	74.64	495.45
14	77.63	495.21
15	80.63	495.15
16	83.63	495.27
17	86.62	495.55
18	89.58	496.00
19	92.52	496.62
20	95.41	497.41
21	98.26	498.37
22	101.04	499.48

23	103.76	500.76
24	106.40	502.18
25	108.95	503.76
26	111.41	505.48
27	113.76	507.34
28	116.01	509.33
29	118.14	511.44
30	120.14	513.67
31	122.01	516.02
32	123.75	518.46
33	125.34	521.01
34	126.78	523.64
35	128.08	526.35
36	129.21	529.12
37	130.18	531.96
38	130.99	534.85
39	131.63	537.78
40	131.89	539.40

*** 1.529 ***

1

Failure Surface Specified By 44 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.35	510.80
2	29.52	508.73
3	31.79	506.77
4	34.16	504.93
5	36.61	503.20
6	39.15	501.60
7	41.76	500.13
8	44.45	498.79
9	47.20	497.59
10	50.00	496.53
11	52.86	495.60
12	55.75	494.82
13	58.69	494.19
14	61.65	493.70
15	64.63	493.36
16	67.62	493.17
17	70.62	493.13
18	73.62	493.24
19	76.61	493.50
20	79.58	493.90
21	82.53	494.46
22	85.44	495.16
23	88.32	496.00
24	91.16	496.99
25	93.94	498.12
26	96.66	499.38
27	99.31	500.78
28	101.89	502.31
29	104.39	503.97
30	106.81	505.75
31	109.13	507.65
32	111.36	509.66
33	113.48	511.78
34	115.50	514.00
35	117.40	516.32
36	119.18	518.73
37	120.84	521.23
38	122.38	523.81
39	123.78	526.46
40	125.05	529.18
41	126.18	531.95
42	127.18	534.78
43	128.03	537.66
44	128.45	539.40

*** 1.532 ***

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.53	510.80
2	28.84	508.88
3	31.23	507.07
4	33.69	505.36
5	36.23	503.76
6	38.84	502.28
7	41.51	500.91
8	44.24	499.66
9	47.02	498.54
10	49.85	497.53
11	52.72	496.66
12	55.62	495.91
13	58.56	495.28
14	61.51	494.79
15	64.49	494.43
16	67.48	494.20
17	70.48	494.11
18	73.48	494.14
19	76.48	494.31
20	79.46	494.61
21	82.43	495.04
22	85.38	495.60
23	88.30	496.29
24	91.18	497.11
25	94.03	498.06
26	96.83	499.13
27	99.59	500.32
28	102.29	501.63
29	104.92	503.06
30	107.49	504.60
31	110.00	506.26
32	112.42	508.03
33	114.77	509.90
34	117.03	511.87
35	119.20	513.94
36	121.28	516.10
37	123.26	518.35
38	125.14	520.69
39	126.91	523.11
40	128.58	525.61
41	130.13	528.17
42	131.57	530.80
43	132.90	533.50
44	134.10	536.24
45	135.18	539.04
46	135.30	539.40

*** 1.533 ***

1

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	49.39	510.80
2	51.55	508.72
3	53.85	506.79
4	56.27	505.01
5	58.80	503.40
6	61.43	501.96
7	64.15	500.70
8	66.95	499.62
9	69.81	498.72

10	72.72	498.02
11	75.68	497.51
12	78.66	497.19
13	81.66	497.08
14	84.66	497.16
15	87.65	497.44
16	90.61	497.92
17	93.53	498.59
18	96.41	499.45
19	99.22	500.50
20	101.95	501.74
21	104.60	503.15
22	107.15	504.74
23	109.58	506.48
24	111.90	508.39
25	114.09	510.44
26	116.13	512.64
27	118.03	514.96
28	119.77	517.41
29	121.34	519.96
30	122.74	522.62
31	123.96	525.36
32	125.00	528.17
33	125.85	531.05
34	126.51	533.97
35	126.98	536.94
36	127.20	539.40

*** 1.534 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	38.78	510.80
2	40.92	508.71
3	43.18	506.73
4	45.54	504.88
5	47.99	503.15
6	50.54	501.56
7	53.16	500.10
8	55.86	498.79
9	58.62	497.62
10	61.44	496.60
11	64.31	495.73
12	67.22	495.01
13	70.17	494.45
14	73.14	494.05
15	76.13	493.80
16	79.13	493.72
17	82.13	493.79
18	85.12	494.03
19	88.10	494.42
20	91.05	494.97
21	93.96	495.68
22	96.84	496.54
23	99.66	497.55
24	102.43	498.71
25	105.13	500.01
26	107.76	501.46
27	110.30	503.05
28	112.76	504.76
29	115.13	506.61
30	117.39	508.58
31	119.55	510.67
32	121.59	512.86
33	123.51	515.17
34	125.31	517.57
35	126.97	520.06
36	128.50	522.64
37	129.90	525.30
38	131.15	528.03
39	132.25	530.82

```
             40        133.20      533.66
             41        134.00      536.55
             42        134.63      539.40

                ***     1.538   ***


1
                     Y            A     X     I     S            F     T

                     0.00    126.24    252.49    378.73    504.97    631.21

          X      0.00 +---------+---------+---------+-------***---------+
                      -                                       2
                      -                                      21
                      -                                      1*
                      -                                      1G. G/1
                      -                                      2g7.g
               126.24 +                                      .3111
                      -                                       ....
                      -                                     ***  *1/
                      -
                      -
                      -
          A    252.49 +
                      -
                      -
                      -
                      -
                      -
          X    378.73 +
                      -
                      -
                      -
                      -
                      -
          I    504.97 +
                      -
                      -
                      -
                      -
                      -
          S    631.21 +
                      -
                      -
                      -
                      -
                      -
               757.46 +
                      -
                      -
                      -
                      -
                      -
          F    883.70 +
                      -
                      -
                      -
                      -
                      -
          T   1009.94 +
```

** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION B-10-020 - HAM-75-7.85 - HAM-75-0791 - R
ear Abutment

BOUNDARY COORDINATES

5 Top Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	510.80	73.50	510.80	3
2	73.50	510.80	80.00	510.80	2
3	80.00	510.80	80.10	539.40	1
4	80.10	539.40	105.80	539.40	1
5	105.80	539.40	160.00	539.40	2
6	80.00	510.80	105.70	510.80	2
7	105.70	510.80	105.80	539.40	2
8	105.70	510.80	112.20	510.80	2
9	112.20	510.80	160.00	510.80	3
10	73.50	510.80	80.00	504.30	3
11	80.00	504.30	105.70	504.30	3
12	105.70	504.30	112.20	510.80	3
13	0.00	492.70	160.00	492.70	4
14	0.00	482.70	160.00	482.70	5

1

ISOTROPIC SOIL PARAMETERS

5 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	0.0	34.0	0.00	0.0	1
2	120.0	130.0	2000.0	0.0	0.00	0.0	1
3	115.0	125.0	1500.0	0.0	0.00	0.0	1
4	125.0	130.0	0.0	31.0	0.00	0.0	1
5	120.0	130.0	3500.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	510.80
2	160.00	510.80

1

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	80.10	160.00	240.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

GEOSYNTHETIC DATA

1 Geosynthetics(s) group(s) specified

Ngroup no	Bnr no	Y-top (ft)	Y-bot (ft)	Levels no	Length (ft)	Spacing (ft)	Efficiency	Tallow (lbs/ft)
1	3	539.4	510.8	28	25.7	1.06	1.0	7500.0

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

500 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 50 Points Equally Spaced
Along The Ground Surface Between X = 0.00 ft.
and X = 40.00 ft.

Each Surface Terminates Between X = 120.00 ft.
and X = 160.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y =450.00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 53 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	9.80	510.80
2	12.10	508.87
3	14.47	507.03
4	16.90	505.28
5	19.40	503.62
6	21.95	502.05
7	24.57	500.57
8	27.23	499.19
9	29.94	497.91
10	32.70	496.73
11	35.50	495.65
12	38.33	494.67
13	41.20	493.80
14	44.10	493.03
15	47.03	492.36
16	49.98	491.81
17	52.94	491.36
18	55.93	491.02
19	58.92	490.79
20	61.91	490.67
21	64.91	490.66
22	67.91	490.76
23	70.90	490.97
24	73.89	491.28
25	76.86	491.71
26	79.81	492.24
27	82.74	492.88
28	85.65	493.63
29	88.52	494.48
30	91.37	495.44
31	94.17	496.50
32	96.94	497.66
33	99.66	498.92
34	102.33	500.28
35	104.96	501.74
36	107.52	503.29
37	110.03	504.94
38	112.48	506.67
39	114.86	508.49
40	117.18	510.40
41	119.42	512.39
42	121.59	514.46
43	123.68	516.61
44	125.70	518.84
45	127.63	521.14
46	129.47	523.50
47	131.23	525.93
48	132.90	528.43
49	134.47	530.98
50	135.96	533.59
51	137.34	536.25
52	138.63	538.96
53	138.82	539.40

*** 2.373 ***

Individual data on the 61 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.3	276.9	0.0	180.2	0.0	0.0	0.0	0.0	0.0
2	2.4	842.8	0.0	532.7	0.0	0.0	0.0	0.0	0.0
3	2.4	1412.8	0.0	869.0	0.0	0.0	0.0	0.0	0.0
4	2.5	1982.0	0.0	1188.7	0.0	0.0	0.0	0.0	0.0
5	2.6	2545.3	0.0	1491.3	0.0	0.0	0.0	0.0	0.0
6	2.6	3098.0	0.0	1776.5	0.0	0.0	0.0	0.0	0.0
7	2.7	3635.3	0.0	2043.8	0.0	0.0	0.0	0.0	0.0
8	2.7	4152.8	0.0	2293.0	0.0	0.0	0.0	0.0	0.0
9	2.8	4646.3	0.0	2523.6	0.0	0.0	0.0	0.0	0.0
10	2.8	5111.7	0.0	2735.4	0.0	0.0	0.0	0.0	0.0
11	2.8	5545.2	0.0	2928.1	0.0	0.0	0.0	0.0	0.0

12	2.9	5943.4	0.0	3101.4	0.0	0.0	0.0	0.0	0.0
13	2.9	6303.2	0.0	3255.2	0.0	0.0	0.0	0.0	0.0
14	1.4	3237.6	0.0	1657.1	0.0	0.0	0.0	0.0	0.0
15	1.5	3385.2	0.0	1732.0	0.0	0.0	0.0	0.0	0.0
16	2.9	6905.2	0.0	3503.1	0.0	0.0	0.0	0.0	0.0
17	3.0	7141.3	0.0	3596.9	0.0	0.0	0.0	0.0	0.0
18	3.0	7328.2	0.0	3670.5	0.0	0.0	0.0	0.0	0.0
19	3.0	7464.2	0.0	3723.7	0.0	0.0	0.0	0.0	0.0
20	3.0	7548.4	0.0	3756.5	0.0	0.0	0.0	0.0	0.0
21	3.0	7580.1	0.0	3768.8	0.0	0.0	0.0	0.0	0.0
22	3.0	7559.1	0.0	3760.7	0.0	0.0	0.0	0.0	0.0
23	3.0	7485.6	0.0	3732.0	0.0	0.0	0.0	0.0	0.0
24	2.6	6409.1	0.0	3207.0	0.0	0.0	0.0	0.0	0.0
25	0.4	951.3	0.0	476.0	0.0	0.0	0.0	0.0	0.0
26	3.0	7211.2	0.0	3613.5	0.0	0.0	0.0	0.0	0.0
27	3.0	7028.5	0.0	3523.8	0.0	0.0	0.0	0.0	0.0
28	0.2	446.3	0.0	224.7	0.0	0.0	0.0	0.0	0.0
29	0.1	406.4	0.0	118.2	0.0	0.0	0.0	0.0	0.0
30	1.8	10366.0	0.0	2105.9	0.0	0.0	0.0	0.0	432.5
31	0.8	4795.5	0.0	965.1	0.0	0.0	0.0	0.0	201.4
32	2.9	16437.5	0.0	3284.1	0.0	0.0	0.0	0.0	697.3
33	2.9	15984.9	0.0	3134.3	0.0	0.0	0.0	0.0	690.3
34	2.8	15479.9	0.0	2965.0	0.0	0.0	0.0	0.0	682.4
35	2.8	14925.8	0.0	2776.2	0.0	0.0	0.0	0.0	673.6
36	2.8	14326.2	0.0	2568.3	0.0	0.0	0.0	0.0	663.8
37	2.7	13685.0	0.0	2341.4	0.0	0.0	0.0	0.0	653.2
38	2.7	13006.3	0.0	2096.0	0.0	0.0	0.0	0.0	641.7
39	2.6	12294.6	0.0	1832.4	0.0	0.0	0.0	0.0	629.4
40	0.7	3395.3	0.0	478.7	0.0	0.0	0.0	0.0	178.4
41	0.1	453.7	0.0	62.6	0.0	0.0	0.0	0.0	24.0
42	1.7	7697.2	0.0	1009.5	0.0	0.0	0.0	0.0	413.9
43	2.5	10752.4	0.0	1251.7	0.0	0.0	0.0	0.0	602.2
44	2.2	8825.8	0.0	844.3	0.0	0.0	0.0	0.0	519.9
45	0.3	1115.5	0.0	91.1	0.0	0.0	0.0	0.0	67.6
46	2.4	9136.5	0.0	602.5	0.0	0.0	0.0	0.0	571.9
47	2.3	8335.8	0.0	253.3	0.0	0.0	0.0	0.0	555.5
48	0.4	1553.0	0.0	7.5	0.0	0.0	0.0	0.0	107.8
49	1.8	5986.8	0.0	0.0	0.0	0.0	0.0	0.0	430.6
50	2.2	6761.3	0.0	0.0	0.0	0.0	0.0	0.0	520.7
51	2.1	5991.2	0.0	0.0	0.0	0.0	0.0	0.0	502.2
52	2.0	5234.5	0.0	0.0	0.0	0.0	0.0	0.0	483.0
53	1.9	4496.4	0.0	0.0	0.0	0.0	0.0	0.0	463.2
54	1.8	3782.1	0.0	0.0	0.0	0.0	0.0	0.0	442.8
55	1.8	3096.9	0.0	0.0	0.0	0.0	0.0	0.0	421.8
56	1.7	2445.7	0.0	0.0	0.0	0.0	0.0	0.0	400.3
57	1.6	1833.6	0.0	0.0	0.0	0.0	0.0	0.0	378.2
58	1.5	1265.2	0.0	0.0	0.0	0.0	0.0	0.0	355.6
59	1.4	745.1	0.0	0.0	0.0	0.0	0.0	0.0	332.5
60	1.3	277.5	0.0	0.0	0.0	0.0	0.0	0.0	309.0
61	0.2	5.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7

Individual data on the 28 geosynthetics

Group	Level	Slice	Head Coordinates (ft)		End Coordinates (ft)		T (lbs)	Length (ft)	Tallow (lbs)	T/Tall %
1	1	0	80.0	510.8	105.7	510.8	0.0	25.7	7500.0	0.0
1	2	0	80.0	511.9	105.7	511.9	0.0	25.7	7500.0	0.0
1	3	0	80.0	512.9	105.7	512.9	0.0	25.7	7500.0	0.0
1	4	0	80.0	514.0	105.7	514.0	0.0	25.7	7500.0	0.0
1	5	0	80.0	515.0	105.7	515.0	0.0	25.7	7500.0	0.0
1	6	0	80.0	516.1	105.7	516.1	0.0	25.7	7500.0	0.0
1	7	0	80.0	517.2	105.7	517.2	0.0	25.7	7500.0	0.0
1	8	0	80.0	518.2	105.7	518.2	0.0	25.7	7500.0	0.0
1	9	0	80.0	519.3	105.7	519.3	0.0	25.7	7500.0	0.0
1	10	0	80.0	520.3	105.7	520.3	0.0	25.7	7500.0	0.0
1	11	0	80.0	521.4	105.7	521.4	0.0	25.7	7500.0	0.0
1	12	0	80.0	522.5	105.7	522.5	0.0	25.7	7500.0	0.0
1	13	0	80.0	523.5	105.7	523.5	0.0	25.7	7500.0	0.0
1	14	0	80.0	524.6	105.7	524.6	0.0	25.7	7500.0	0.0
1	15	0	80.1	525.6	105.8	525.6	0.0	25.7	7500.0	0.0
1	16	0	80.1	526.7	105.8	526.7	0.0	25.7	7500.0	0.0
1	17	0	80.1	527.7	105.8	527.7	0.0	25.7	7500.0	0.0
1	18	0	80.1	528.8	105.8	528.8	0.0	25.7	7500.0	0.0
1	19	0	80.1	529.9	105.8	529.9	0.0	25.7	7500.0	0.0
1	20	0	80.1	530.9	105.8	530.9	0.0	25.7	7500.0	0.0
1	21	0	80.1	532.0	105.8	532.0	0.0	25.7	7500.0	0.0

1	22	0	80.1	533.0	105.8	533.0	0.0	25.7	7500.0	0.0
1	23	0	80.1	534.1	105.8	534.1	0.0	25.7	7500.0	0.0
1	24	0	80.1	535.2	105.8	535.2	0.0	25.7	7500.0	0.0
1	25	0	80.1	536.2	105.8	536.2	0.0	25.7	7500.0	0.0
1	26	0	80.1	537.3	105.8	537.3	0.0	25.7	7500.0	0.0
1	27	0	80.1	538.3	105.8	538.3	0.0	25.7	7500.0	0.0
1	28	0	80.1	539.4	105.8	539.4	0.0	25.7	7500.0	0.0

Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.96	510.80
2	20.21	508.82
3	22.54	506.93
4	24.95	505.14
5	27.43	503.45
6	29.97	501.86
7	32.58	500.38
8	35.25	499.00
9	37.97	497.74
10	40.74	496.58
11	43.55	495.54
12	46.41	494.62
13	49.30	493.82
14	52.22	493.13
15	55.16	492.57
16	58.13	492.12
17	61.11	491.80
18	64.10	491.60
19	67.10	491.52
20	70.10	491.56
21	73.10	491.73
22	76.08	492.02
23	79.06	492.43
24	82.01	492.96
25	84.94	493.62
26	87.84	494.39
27	90.70	495.28
28	93.53	496.29
29	96.31	497.41
30	99.04	498.64
31	101.72	499.99
32	104.35	501.44
33	106.91	503.00
34	109.41	504.67
35	111.83	506.43
36	114.19	508.29
37	116.46	510.25
38	118.65	512.30
39	120.76	514.43
40	122.78	516.65
41	124.70	518.95
42	126.53	521.33
43	128.26	523.78
44	129.89	526.30
45	131.41	528.89
46	132.83	531.53
47	134.14	534.23
48	135.34	536.98
49	136.27	539.40

*** 2.378 ***

1

Failure Surface Specified By 53 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.43	510.80
2	13.80	508.96

3	16.22	507.19
4	18.71	505.52
5	21.26	503.93
6	23.86	502.43
7	26.51	501.02
8	29.20	499.71
9	31.94	498.49
10	34.72	497.37
11	37.54	496.34
12	40.40	495.41
13	43.28	494.58
14	46.19	493.85
15	49.12	493.22
16	52.08	492.70
17	55.05	492.28
18	58.03	491.96
19	61.02	491.75
20	64.02	491.63
21	67.02	491.63
22	70.02	491.73
23	73.01	491.93
24	76.00	492.23
25	78.97	492.64
26	81.92	493.15
27	84.86	493.77
28	87.77	494.48
29	90.66	495.30
30	93.52	496.22
31	96.34	497.23
32	99.13	498.34
33	101.87	499.55
34	104.57	500.86
35	107.23	502.25
36	109.83	503.74
37	112.39	505.32
38	114.88	506.98
39	117.32	508.73
40	119.69	510.57
41	122.00	512.48
42	124.24	514.48
43	126.41	516.55
44	128.51	518.69
45	130.53	520.91
46	132.48	523.19
47	134.34	525.55
48	136.12	527.96
49	137.81	530.44
50	139.42	532.97
51	140.94	535.56
52	142.37	538.19
53	142.97	539.40

*** 2.386 ***

Failure Surface Specified By 54 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.53	510.80
2	8.84	508.88
3	11.21	507.05
4	13.64	505.29
5	16.14	503.62
6	18.69	502.04
7	21.29	500.55
8	23.95	499.16
9	26.65	497.85
10	29.39	496.64
11	32.18	495.52
12	35.00	494.51
13	37.85	493.59
14	40.74	492.77
15	43.65	492.05

16	46.59	491.43
17	49.54	490.92
18	52.52	490.51
19	55.50	490.20
20	58.49	490.00
21	61.49	489.90
22	64.49	489.90
23	67.49	490.01
24	70.48	490.22
25	73.47	490.54
26	76.44	490.96
27	79.39	491.48
28	82.32	492.11
29	85.23	492.83
30	88.12	493.66
31	90.97	494.59
32	93.79	495.62
33	96.57	496.74
34	99.31	497.96
35	102.01	499.27
36	104.66	500.68
37	107.26	502.18
38	109.80	503.77
39	112.29	505.44
40	114.72	507.20
41	117.09	509.05
42	119.39	510.97
43	121.62	512.97
44	123.78	515.05
45	125.87	517.21
46	127.88	519.43
47	129.82	521.73
48	131.67	524.09
49	133.44	526.51
50	135.12	528.99
51	136.72	531.53
52	138.23	534.13
53	139.64	536.77
54	140.94	539.40

*** 2.389 ***

1

Failure Surface Specified By 55 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.90	510.80
2	7.25	508.93
3	9.66	507.15
4	12.13	505.44
5	14.65	503.82
6	17.23	502.28
7	19.85	500.83
8	22.52	499.47
9	25.24	498.20
10	28.00	497.02
11	30.79	495.93
12	33.62	494.93
13	36.48	494.03
14	39.37	493.22
15	42.29	492.51
16	45.23	491.90
17	48.18	491.39
18	51.15	490.97
19	54.14	490.65
20	57.13	490.44
21	60.13	490.32
22	63.13	490.30
23	66.12	490.38
24	69.12	490.56
25	72.11	490.84
26	75.08	491.22

27	78.04	491.70
28	80.99	492.28
29	83.91	492.95
30	86.81	493.73
31	89.68	494.59
32	92.52	495.56
33	95.33	496.61
34	98.10	497.76
35	100.83	499.00
36	103.52	500.33
37	106.17	501.75
38	108.76	503.26
39	111.30	504.85
40	113.79	506.52
41	116.22	508.28
42	118.59	510.12
43	120.90	512.03
44	123.15	514.02
45	125.33	516.09
46	127.43	518.22
47	129.47	520.43
48	131.43	522.70
49	133.31	525.03
50	135.12	527.43
51	136.84	529.88
52	138.48	532.39
53	140.04	534.96
54	141.51	537.57
55	142.46	539.40

*** 2.390 ***

Failure Surface Specified By 54 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.53	510.80
2	8.88	508.93
3	11.28	507.14
4	13.75	505.43
5	16.28	503.82
6	18.86	502.29
7	21.49	500.85
8	24.17	499.50
9	26.90	498.25
10	29.67	497.09
11	32.47	496.03
12	35.32	495.07
13	38.19	494.21
14	41.09	493.45
15	44.02	492.79
16	46.96	492.23
17	49.93	491.77
18	52.91	491.42
19	55.90	491.17
20	58.89	491.03
21	61.89	490.99
22	64.89	491.05
23	67.89	491.22
24	70.88	491.49
25	73.85	491.86
26	76.81	492.34
27	79.76	492.92
28	82.68	493.61
29	85.57	494.39
30	88.44	495.28
31	91.28	496.26
32	94.07	497.34
33	96.83	498.52
34	99.55	499.79
35	102.22	501.16
36	104.84	502.62
37	107.41	504.17

38	109.93	505.80
39	112.38	507.53
40	114.77	509.33
41	117.10	511.22
42	119.37	513.19
43	121.56	515.24
44	123.68	517.36
45	125.73	519.56
46	127.69	521.82
47	129.58	524.15
48	131.39	526.55
49	133.11	529.01
50	134.75	531.52
51	136.29	534.09
52	137.75	536.71
53	139.11	539.39
54	139.12	539.40

*** 2.391 ***

1

Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.14	510.80
2	19.36	508.78
3	21.66	506.85
4	24.04	505.02
5	26.49	503.30
6	29.02	501.68
7	31.61	500.16
8	34.26	498.76
9	36.97	497.47
10	39.73	496.29
11	42.53	495.23
12	45.38	494.29
13	48.27	493.48
14	51.19	492.78
15	54.13	492.20
16	57.10	491.76
17	60.08	491.43
18	63.07	491.23
19	66.07	491.16
20	69.07	491.21
21	72.07	491.39
22	75.05	491.70
23	78.02	492.13
24	80.97	492.68
25	83.89	493.36
26	86.78	494.16
27	89.64	495.09
28	92.45	496.13
29	95.22	497.29
30	97.93	498.56
31	100.59	499.95
32	103.19	501.44
33	105.73	503.05
34	108.19	504.76
35	110.58	506.57
36	112.89	508.48
37	115.12	510.49
38	117.27	512.59
39	119.32	514.78
40	121.28	517.05
41	123.14	519.40
42	124.90	521.83
43	126.56	524.33
44	128.11	526.90
45	129.55	529.53
46	130.88	532.22
47	132.10	534.96
48	133.20	537.75

49	133.77	539.40

*** 2.391 ***

Failure Surface Specified By 52 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.14	510.80
2	19.47	508.91
3	21.87	507.10
4	24.33	505.38
5	26.85	503.76
6	29.43	502.23
7	32.06	500.79
8	34.74	499.45
9	37.48	498.21
10	40.25	497.07
11	43.07	496.04
12	45.92	495.11
13	48.80	494.28
14	51.72	493.56
15	54.65	492.95
16	57.61	492.45
17	60.59	492.05
18	63.57	491.77
19	66.57	491.59
20	69.57	491.53
21	72.57	491.57
22	75.56	491.73
23	78.55	491.99
24	81.53	492.37
25	84.49	492.85
26	87.43	493.45
27	90.35	494.15
28	93.23	494.95
29	96.09	495.86
30	98.92	496.88
31	101.70	498.00
32	104.44	499.22
33	107.13	500.54
34	109.78	501.96
35	112.36	503.48
36	114.90	505.09
37	117.37	506.79
38	119.77	508.58
39	122.11	510.46
40	124.38	512.42
41	126.58	514.46
42	128.70	516.59
43	130.74	518.79
44	132.69	521.06
45	134.57	523.41
46	136.35	525.82
47	138.05	528.29
48	139.65	530.83
49	141.16	533.42
50	142.57	536.07
51	143.89	538.76
52	144.17	539.40

*** 2.395 ***

1

Failure Surface Specified By 54 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	10.61	510.80
2	12.91	508.87
3	15.27	507.01
4	17.69	505.25
5	20.18	503.57
6	22.72	501.98
7	25.33	500.49
8	27.98	499.09
9	30.68	497.78
10	33.42	496.57
11	36.21	495.46
12	39.04	494.45
13	41.89	493.54
14	44.78	492.74
15	47.70	492.03
16	50.64	491.44
17	53.60	490.94
18	56.58	490.56
19	59.56	490.28
20	62.56	490.10
21	65.56	490.04
22	68.56	490.08
23	71.55	490.23
24	74.54	490.48
25	77.52	490.85
26	80.48	491.31
27	83.43	491.89
28	86.35	492.57
29	89.25	493.35
30	92.11	494.23
31	94.95	495.22
32	97.74	496.31
33	100.50	497.50
34	103.21	498.78
35	105.87	500.16
36	108.48	501.64
37	111.04	503.20
38	113.54	504.86
39	115.98	506.61
40	118.36	508.44
41	120.67	510.35
42	122.90	512.35
43	125.07	514.43
44	127.16	516.58
45	129.17	518.80
46	131.11	521.10
47	132.95	523.46
48	134.72	525.89
49	136.39	528.38
50	137.98	530.92
51	139.47	533.53
52	140.87	536.18
53	142.17	538.88
54	142.40	539.40

*** 2.397 ***

Failure Surface Specified By 54 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.16	510.80
2	10.40	508.80
3	12.71	506.88
4	15.08	505.05
5	17.53	503.31
6	20.03	501.66
7	22.60	500.10
8	25.22	498.64
9	27.89	497.28
10	30.61	496.02
11	33.38	494.86

12	36.19	493.80
13	39.03	492.85
14	41.91	492.00
15	44.81	491.26
16	47.75	490.63
17	50.70	490.11
18	53.67	489.69
19	56.66	489.39
20	59.65	489.20
21	62.65	489.11
22	65.65	489.14
23	68.65	489.28
24	71.64	489.54
25	74.61	489.90
26	77.58	490.37
27	80.52	490.95
28	83.44	491.64
29	86.33	492.43
30	89.19	493.34
31	92.02	494.35
32	94.81	495.46
33	97.55	496.67
34	100.24	497.99
35	102.89	499.40
36	105.48	500.91
37	108.02	502.52
38	110.49	504.22
39	112.90	506.01
40	115.24	507.88
41	117.51	509.84
42	119.70	511.89
43	121.82	514.01
44	123.86	516.21
45	125.82	518.49
46	127.69	520.84
47	129.47	523.25
48	131.16	525.73
49	132.76	528.27
50	134.26	530.86
51	135.67	533.51
52	136.97	536.21
53	138.18	538.96
54	138.36	539.40

*** 2.400 ***

1

```
           Y            A     X     I     S            F     T


           0.00    126.24    252.49    378.73    504.97    631.21

X      0.00 +---------+---------+---------+-------***---------+
            -                                      11
            -                                     .12
            -                                     .1*
            -                                     .1G. G/1
            -                                     .1g..g
     126.24 +                                      .1112
            -                                       ..11
            -                                     *** .*1/
            -
            -
            -
A    252.49 +
            -
            -
            -
            -
            -
X    378.73 +
            -
            -
            -
            -
```

```
              -
I    504.97 +
              -
              -
              -
              -
              -
S    631.21 +
              -
              -
              -
              -
              -
     757.46 +
              -
              -
              -
              -
              -
F    883.70 +
              -
              -
              -
              -
              -
T   1009.94 +
```