Resource International, Inc.

HAM-75-7.85
RETAINING WALL V
PID NO. 77889
HAMILTON COUNTY, OHIO

DRAFT STRUCTURE FOUNDATION EXPLORATION REPORT

Prepared For:
EMH&T
5500 New Albany Road
Columbus, Ohio 43054

Prepared By:
Resource International, Inc.
4480 Lake Forest Drive, Suite 308
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Rii Project No. B-10-020

August, 2013

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June 28, 2012 (Revised August 8, 2013)

Mr. Edward D. Kagel, P.E.
Director of Transportation
EMH&T
5500 New Albany Road
Columbus, Ohio 43054

Re: Draft Structure Foundation Exploration
HAM-75-7.85
Retaining Wall V
PID No. 77889
Rii Project No. B-10-020

Dear Mr. Kagel:

Resource International, Inc. (Rii) is pleased to submit this DRAFT 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 design and construction of proposed Retaining Wall V as part of the HAM-75-7.85 project. The proposed wall will be located between Summit Road and Interstate 75 northbound, extending from north of Paddock Road to Mill Creek, 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 R. Trenner, P.E.
Project Engineer

Jonathan P. Sterenberg, P.E.
Director of Geotechnical Services

Enclosure: DRAFT Structure Foundation Exploration Report

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APPENDICIES

EXECUTIVE SUMMARY

Resource International, Inc. (Rii) has completed a DRAFT structure foundation exploration for the design and construction of proposed Retaining Wall V as part of the HAM-75-7.85 project. It is understood that a soldier pile and lagging wall type is being considered as the preferred wall type for the entire alignment of Retaining Wall V. Due to the varying wall height along the alignment, it is anticipated that portions of the wall will require tiebacks to control deflection and reduce the stresses within the pile section where greater wall heights are expected. The total wall length is approximately 2,780 lineal feet. There is an existing four-span pedestrian bridge (designated as HAM-75-0992) that crosses over I-75 near the intersection of Summit Road and Section Road. It is understood that this bridge will be replaced with a new two-span structure. Currently, it is proposed to support the forward abutment of the proposed structure on a stub abutment on a deep foundation consisting of driven piles which will allow sufficient clearance for Retaining Wall V to maintain its alignment as one continuous structure underneath the bridge.

Exploration and Findings

Between November 4 and December 7, 2011, a total of eighteen (18) structural borings, designated as B-044-0-11 through B-061-0-11, were drilled to completion depths ranging from 20.0 to 50.0 feet below the ground surface at the locations illustrated on the boring plan presented in Appendix II of the full report. In addition to the aforementioned borings, eighteen (18) structural borings, designated as B-001-0-07 through B-018-0-07, were drilled to depths ranging from 30.0 to 50.0 feet below the ground surface.

Boring B-044 was drilled in the grass between Summit Road and the entrance ramp from Paddock Road to I-75 northbound, and borings B-045 through B-056 were drilled in the grass along the east side of Summit Road and encountered 3.0 to 12.0 inches of topsoil at the ground surface, identified by the presence of organics and vegetation. The remaining borings were drilled in the northbound lane or shoulder of Summit Road and encountered 3.0 to 5.0 inches of asphalt overlying 5.0 to 10.0 inches of concrete at the ground surface. Underlying the asphalt and concrete in boring B-058, 7.0 inches of aggregate base material was also encountered. Boring B-002 was drilled in the southbound lane of Summit Road and encountered 4.0 inches of asphalt overlying 10.0 inches of concrete followed by 8.0 inches of aggregate base at the ground surface. The remaining 2007 borings were drilled along the west side of Summit Road, between I-75 and Summit Road. Borings B-001, B-003 through B-010 and B-015 encountered 3.0 to 9.0 inches of topsoil at the ground surface

Beneath the surface materials in borings B-002, B-013, B-044 and B-055, material identified as existing fill was encountered to a depths ranging from 3.0 and 16.0 feet below the ground surface, respectively. The fill material consisted of brown, dark brown and black gravel, gravel and sand, gravel with sand and silt, sandy silt, silt and clay and clay (ODOT A-1-b, A-2-4, A-4a, A-6a, A-7-6) and contained brick, asphalt, concrete and clay tile fragments.

Underlying the surface materials and existing fill in borings B-002, B-013, B-044 and B-055, natural soils were encountered consisting of both granular and cohesive soils. The granular soils were generally described as brown, gray, brownish gray and light brown gravel, gravel and sand, gravel with sand and silt, gravel with sand, silt and clay, fine sand, coarse and fine sand, sandy silt and silt (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3, A-3a, A-4a, A-4b). The cohesive soils were generally described as gray, brown, brownish gray, grayish brown, dark brown, light brown and black sandy silt, silt, elastic silt, silt and clay, silty clay and clay (ODOT A-4a, A-4b, A-5, A-6a, A-6b, A-7-6) with lesser percentages of gravel and/or sand.

Bedrock was not encountered in any of the borings performed for the 2007 or 2011 explorations.

Analyses and Recommendations

Design details of the proposed retaining wall were provided by the Rii design team. It is understood that the proposed retaining wall will be a soldier pile and lagging wall type that will be constructed adjacent to the east side of the widened portion of the I-75 northbound lanes. To accommodate the widened alignment, it is understood that the existing slope will have to be cut and the retaining wall constructed to avoid regrading the slope which would require the relocation of Summit Road behind the existing building. The backslope behind the wall will be regraded, where necessary, to a maximum backslope of 2:1 (H:V). Due to the height of the retaining wall required to accommodate the widened alignment, tieback anchors will be required for a majority of the alignment.

Based upon proposed plan and cross section information provided by the Rii design team, wall heights along the alignment are anticipated to range from 5.7 to 27.7 feet. Based on the subsurface conditions encountered and the proposed geometry of the slope behind the wall, steel H-Piles should be installed inside drilled shafts extending from the excavation bottom to the full wall height at each shaft location, and oriented with the web perpendicular to the wall alignment. Shafts and soldier piles employed for use in the retaining wall foundations may be proportioned based on the recommendations in the following table. Where greater exposed wall heights are present, tieback anchors will be required to resist the lateral loading and limit the deflection of the wall, as presented in the following table.

Drilled Shaft with Soldier Pile Foundation Recommendations

Wall Height [1] (ft)	Shaft Spacing (ft)	Shaft Diameter (in)	Embedment Depth [2] (ft)	Pile Section	Number of Anchor Rows	Depth to Anchor(s) [3] (ft)	Anchor Inclination [4]
H > 22	6.0	24	25.0	HP 12x53	2	7.0 / 16.0	20°
18 < H ≤ 22	6.0	24	25.0	HP 12x53	2	6.0 / 13.0	20°
14 < H ≤ 18	6.0	24	20.0	HP 12x53	1	5.0	20°
10 < H ≤ 14	6.0	24	15.0	HP 12x53	1	4.0	20°
H ≤ 10	6.0	24	15.0	HP 12x53	0	N/A	N/A

1. *Wall height is measured from the bottom of the wall lagging to the bottom of the paved gutter behind the back of the wall.*
2. *Embedment depth represents the length of the shaft required below the base of the wall.*
3. *Depth to anchor(s) along soldier pile measured from the top of the wall (bottom of the paved gutter behind the wall). Where multiple values are listed, the first value is the depth to the top row of anchors, and the second value is the depth to the bottom row of anchors.*
4. *Anchor inclination is with respect to a horizontal plane intersecting the wall.*

Provided drilled shafts are proportioned as outlined above, a nominal end bearing resistance of q_n = 18.0 ksf at the strength limit state may be utilized for design. A geotechnical resistance factor of φ_n = 0.50 should be considered when calculating the factored end bearing resistance. If additional resistance beyond the factored end bearing resistance is required, a nominal side resistance of q_s = 1.5 ksf and geotechnical resistance factor of φ_s = 0.55 should be considered for these shafts. Please note that side friction resistance should be neglected in the top 5.0 feet of shaft length.

As noted in the table above, tieback anchors will be required for wall heights greater than 10.0 feet to provide adequate lateral resistance and limit the overall deflection of the wall. Based on the subsurface conditions encountered in the 2007 and 2011 borings, the soils that the bonded length of anchors will be installed in are anticipated to consist of cohesive and granular material comprise of stiff to very stiff silt and clay, silty clay and clay (ODOT A-6a, A-6b, A-7-6) and loose to dense fine sand and coarse and fine sand (ODOT A-3, A-3a). A nominal anchor bond stress of 3.0 ksf was utilized in the analysis, and a geotechnical resistance factor of φ_n=0.70 was considered in calculating the factored anchor pullout resistance for the determination of the required anchor bond length.

Anchor Configurations and Dimensions

Wall Height [1] (ft)	Number of Anchor Rows	Row	Depth to Anchor [2] (ft)	Anchor Load (kips)	Anchor Diameter (in)	Unbonded Length (ft)	Bonded Length (ft)	Total Length (ft)
H > 22	2	Top	7.0	153.4	6.0	16.4	49.5	65.9
		Bottom	16.0	169.2	6.0	15.0	54.6	69.6
18 < H ≤ 22	2	Top	6.0	100.0	6.0	15.0	32.3	47.3
		Bottom	13.0	104.2	6.0	15.0	33.6	48.6
14 < H ≤ 18	1	N/A	5.0	120.9	6.0	15.0	36.7	51.7
10 < H ≤ 14	1	N/A	4.0	73.3	6.0	15.0	22.2	37.2

1. *Wall height is measured from the bottom of the wall lagging to the bottom of the paved gutter behind the back of the wall.*
2. *Depth to anchor(s) measured from the bottom of the paved gutter.*

An analysis of the lateral deflection and reactions was performed for the wall heights and anchor configurations listed in the previous tables. For walls that are restrained from movement due to the incorporation of tieback anchors along the cantilevered portion of the wall, the deflection at the top of the wall will be less than 1.0 percent of the wall height provided that tieback anchors are installed as noted in Section 5.1.1 of the full report to provide adequate resistance for the anticipated loading. For the center to center spacing, embedment depth and section type specified, the deflection determined from the LPILE analysis met the criteria of less than 1.0 percent of the wall height for portions of the wall that did not incorporate tieback anchors, and the section utilized met the structural capacity requirements in all circumstances.

Per Section 11.6.2.3 of the 2010 AASHTO LRFD BDS, overall (global) stability for walls not supporting structural foundations on spread footings is satisfied when a minimum factor of safety of 1.33 is obtained. Using the parameters provided in Section 5.1.3 of the full report in the section analyzed, a resulting factor of safety of 1.67 was determined for the maximum wall height of 27.7 feet, satisfying the minimum requirement of 1.33.

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 overall 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 DRAFT report is a presentation of the structure foundation exploration performed for the design and construction of proposed Retaining Wall V as part of the HAM-75-7.85 project, as shown on the vicinity map and boring plan presented in Appendix II. It is understood that a soldier pile and lagging wall type is being considered as the preferred wall type for the entire alignment of Retaining Wall V. Due to the varying wall height along the alignment, it is anticipated that portions of the wall will require tiebacks to control deflection and reduce the stresses within the pile section where greater wall heights are expected. The total wall length is approximately 2,780 lineal feet. There is an existing four-span pedestrian bridge (designated as HAM-75-0992) that crosses over I-75 near the intersection of Summit Road and Section Road. It is understood that this bridge will be replaced with a new two-span structure. Currently, it is proposed to support the forward abutment of the proposed structure on a stub abutment on a deep foundation consisting of driven piles which will allow sufficient clearance for Retaining Wall V to maintain its alignment as one continuous structure underneath the bridge.

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 size 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 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 valley roughly beneath, and following, the alignment of Mill Creek which is aligned northeast-to-southwest. I-75 is aligned roughly parallel to this main bedrock valley from the approximate intersection with State Route 126 to the approximate intersection with Regina Graeter Way, and lies just east of the bottom of the bedrock valley. Along the project alignment, the bedrock surface directly beneath I-75 lies along the slope of the bedrock valley and the bedrock surface ranges between approximate elevations of 385 to 425 feet msl. A smaller bedrock valley branches off to the southeast of the bedrock valley that follows Mill Creek just south of the interchange with State Route 562, and runs roughly parallel with Ross Run and generally beneath the SR 562 alignment. Overall, the bedrock surface along the majority of the project alignment slopes downward to the northwest. According to bedrock topography mapping, the depth to top of bedrock in the vicinity of the project ranges from approximately 120 to 170 feet below the existing ground surface. An illustration of the general geology of Ohio is presented in Appendix I.

2.2 Existing Conditions

The site for the proposed Retaining Wall V is located along the east side of I-75, starting approximately 725 feet north of the Paddock Road interchange with I-75 and extending north to just south of the I-75 bridge structure over Mill Creek. Overall, the project is located approximately 0.6 miles south of the Lockland split. The proposed wall begins at Station 505+00 and continues north to Station 532+82 along the east side of I-75. The wall will be located along the east side of I-75 and will be constructed along the slope between the I-75 northbound lanes and Summit Road which is aligned parallel along the east side of I-75 in this area. The existing I-75 roadway that runs adjacent to the proposed structure is currently a six-lane, asphalt paved roadway. There is also an existing four-span pedestrian bridge that crosses over I-75 and is located near the intersection of Summit Road and Section Road.

The terrain along Summit Road is elevated above I-75, with Summit Road increasing in elevation northward. Between Summit Road and I-75, the slope is approximately 2:1 with guardrail on top of the slope and guardrail / concrete barrier near the toe at the I-75 shoulder. The local terrain slopes gently to moderately upward to the east of Summit Road. The area between I-75 and Summit Road is covered with dense brush and trees, and overhead utilities on timber poles are present. The east side of Summit Road is developed with both residential and commercial properties.

3.0 EXPLORATION

Between November 4 and December 7, 2011, a total of eighteen (18) structural borings, designated as B-044-0-11 through B-061-0-11, were drilled to completion depths ranging from 20.0 to 50.0 feet below the ground surface at the locations illustrated on the boring plan presented in Appendix II. In addition to the aforementioned borings, eighteen (18) structural borings, designated as B-001-0-07 through B-018-0-07, were drilled as part of the 2007 Structure Foundation Exploration (HAM-75-10.10, PID No. 76256). Between June 3 and 14, 2007, borings B-001 through B-018 were drilled to depths ranging from 30.0 to 50.0 feet below the ground surface. The 2007 structure borings were drilled along the proposed alignment of Retaining Wall V. Upon determination of the proposed alignment of I-75 during the detailed design, the anticipated height of the wall indicated that tie-backs would be required for the majority of the wall alignment. Therefore, the borings performed during the 2011 exploration were drilled approximately 30 to 40 feet east of the proposed wall alignment to determine the soil conditions within the tie-back zone.

Table 1. 2011 Test Boring Summary

Boring Number	Station	Offset	Latitude	Longitude	Ground Elevation (feet)	Boring Depth
B-044-0-11	503+96.72	150.2' Rt.	39.195249413 °N	84.473852731 °W	543.4	20.0
B-045-0-11	506+49.18	188.1' Rt.	39.195680732 °N	84.473145925 °W	555.5	50.0
B-046-0-11	507+90.55	156.3' Rt.	39.196032716 °N	84.472894673 °W	555.7	50.0
B-047-0-11	510+26.50	147.4' Rt.	39.196525283 °N	84.472353115 °W	557.0	50.0
B-048-0-11	511+46.78	143.7' Rt.	39.196774772 °N	84.472074775 °W	558.1	50.0
B-049-0-11	512+93.35	140.5' Rt.	39.197076426 °N	84.471732333 °W	559.8	50.0
B-050-0-11	514+49.40	146.4' Rt.	39.197372662 °N	84.471338961 °W	560.0	50.0
B-051-0-11	515+95.19	136.2' Rt.	39.197685782 °N	84.471016526 °W	561.7	50.0
B-052-0-11	517+40.29	142.0' Rt.	39.197980553 °N	84.470655243 °W	562.8	50.0
B-053-0-11	518+83.68	146.4' Rt.	39.198277606 °N	84.470301951 °W	564.2	50.0
B-054-0-11	520+22.83	156.4' Rt.	39.198563487 °N	84.469953404 °W	565.0	50.0
B-055-0-11	521+64.10	164.9' Rt.	39.198864156 °N	84.469613398 °W	565.2	50.0
B-056-0-11	523+33.46	148.5' Rt.	39.199277070 °N	84.469296170 °W	566.0	50.0
B-057-0-11	524+76.23	140.3' Rt.	39.199621604 °N	84.469026372 °W	565.7	50.0
B-058-0-11	526+17.22	124.2' Rt.	39.199970997 °N	84.468791636 °W	566.8	50.0
B-059-0-11	527+50.52	135.9' Rt.	39.200281574 °N	84.468509172 °W	570.5	50.0
B-060-0-11	528+76.00	183.5' Rt.	39.200523523 °N	84.468135429 °W	575.9	50.0
B-061-0-11	530+23.82	195.3' Rt.	39.200869910 °N	84.467835916 °W	586.9	50.0

Table 2. 2007 Test Boring Summary

Boring Number	Station	Offset	Northing	Easting	Ground Elevation (feet)	Boring Depth
B-001-0-07	506+72.15	141.7' Rt.	441680.317	1409443.918	557.0	35.0
B-002-0-07	508+28.58	108.3' Rt.	441687.423	1409445.217	556.2	35.0
B-003-0-07	509+78.58	108.4' Rt.	441924.063	1409632.595	558.1	30.0
B-004-0-07	511+29.53	108.2' Rt.	442032.819	1409737.272	558.9	30.0
B-005-0-07	512+67.70	109.1' Rt.	442131.701	1409833.791	559.6	35.0
B-006-0-07	514+20.52	107.7' Rt.	442242.658	1409938.882	560.2	35.0
B-007-0-07	515+70.95	107.9' Rt.	442350.803	1410043.441	560.8	35.0
B-008-0-07	517+14.40	106.9' Rt.	442455.695	1410142.852	562.1	30.0
B-009-0-07	518+67.26	108.2' Rt.	442569.721	1410249.330	563.1	30.0
B-010-0-07	520+14.30	107.0' Rt.	442683.915	1410346.713	563.7	30.0
B-011-0-07	521+61.74	105.6' Rt.	442801.265	1410440.871	564.7	35.0
B-012-0-07	523+08.85	107.7' Rt.	443006.626	1410593.059	566.0	35.0
B-013-0-07	524+58.22	108.4' Rt.	443041.709	1410624.496	564.5	35.0
B-014-0-07	526+02.18	113.9' Rt.	443159.904	1410712.118	566.8	35.0
B-015-0-07	527+52.83	124.8' Rt.	443283.492	1410804.810	570.4	50.0
B-016-0-07	528+98.01	138.8' Rt.	443403.644	1410893.760	577.0	45.0
B-017-0-07	530+43.78	133.5' Rt.	443536.358	1410962.961	572.1	45.0
B-018-0-07	531+88.96	129.7' Rt.	443667.865	1411029.089	569.8	45.0

The boring locations were determined and located in the field by Rii representatives. Surveyed coordinates and elevations for the 2007 boring locations were obtained during the 2007 exploration, and a handheld GPS unit was utilized to obtain Geographic latitude and longitude coordinates for the 2011 boring locations. Ground surface elevations at the 2011 boring locations were interpolated using topographic mapping information provided by EMH&T.

The borings were advanced using either a truck-mounted or an all terrain vehicle (ATV) mounted rotary drilling machine, utilizing either a 2.25-inch, 3.25-inch, 3.75-inch or 4.25-inch inside diameter (I.D.), hollow-stem auger or a 4.5-inch outside diameter (O.D.), solid flight auger to advance the holes. Standard penetration testing (SPT) and split spoon sampling were performed in the borings at 2.5-foot increments of depth in the top 10.0 feet of existing grade in the 2007 borings and the top 30.0 feet of existing grade in the 2011 borings, and at 5.0-foot increments thereafter to the boring termination depth. The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted by letting a 140-pound hammer falling 30.0 inches to drive a 2.0-

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

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

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

No calibration data is available for the hammer used during the SPT testing for the 2007 exploration. Therefore, an estimated drill rod energy ratio of 80 percent was utilized to determine the energy corrected blow counts, where required for analysis. The hammers for the truck-mounted and ATV-mounted drill rigs used for the 2011 borings were calibrated on May 6, 2011, and have a drill rod energy ratio of 78.4 percent and 77.1 percent, respectively.

During drilling, Rii personnel prepared field logs showing the encountered subsurface conditions. Soil samples obtained from the drilling operation were preserved and sealed in glass jars and delivered to the soil laboratory. In the laboratory, the soil samples were visually classified and select samples were tested, as noted in Table 3**Error! Reference source not found.**.

Table 3. Laboratory Test Schedule

Laboratory Test	Test Designation	Number of Tests Performed	
		2007 Exploration	2011 Exploration
Natural Moisture Content	ASTM D2216	94	283
Plastic and Liquid Limits	AASHTO T89, T90	34	66
Gradation – Sieve/Hydrometer	AASHTO T88	34	66
Gradation – Sieve Only	AASHTO T88	16	-
Unconfined Compression Test	ASTM D2166	-	5
One-Dimensional Consolidation	ASTM D2435	-	1
Consolidated Undrained (CU) Triaxial Test (2-Points)	ASTM D4767	-	1

The tests performed are necessary to classify existing soil according to the Ohio Department of Transportation (ODOT) classification system and to estimate engineering properties of importance in determining foundation design and construction recommendations. Results of the laboratory testing are presented, in part, on the boring logs in Appendix IV, and also in Appendix V. A description of the soil terms used throughout this report is presented in Appendix III.

Hand penetrometer readings, which provide a rough estimate of the unconfined compressive strength of the soil, were reported on the boring logs in units of tons per square foot (tsf) and were utilized to classify the consistency of the cohesive soil in each layer of the borings performed in 2011. An indirect estimate of the unconfined compressive strength of the cohesive split spoon samples can also be made from a correlation with the blow counts (N_{60}). Please note that split-spoon samples are considered to be disturbed and the laboratory determination of their shear strengths may vary from undisturbed conditions

4.0 FINDINGS

Interpreted engineering logs have been prepared from field logs, visual examination of samples, and laboratory testing. Classification follows the respective version of the ODOT Specifications for Geotechnical Explorations (SGE) at the time the exploration was performed. The following is a generalization of what was found in the test borings and what is represented on the boring logs.

4.1 Surficial Material

Boring B-044 was drilled in the grass between Summit Road and the entrance ramp from Paddock Road to I-75 northbound, and borings B-045 through B-056 were drilled in the grass along the east side of Summit Road and encountered 3.0 to 12.0 inches of topsoil at the ground surface, identified by the presence of organics and vegetation. The remaining 2011 borings were drilled in the northbound lane or shoulder of Summit Road and encountered 3.0 to 5.0 inches of asphalt overlying 5.0 to 10.0 inches of concrete at the ground surface. Underlying the asphalt and concrete in boring B-058, 7.0 inches of aggregate base material was also encountered.

Boring B-002 was drilled in the southbound lane of Summit Road and encountered 4.0 inches of asphalt overlying 10.0 inches of concrete followed by 8.0 inches of aggregate base at the ground surface. The remaining 2007 borings were drilled along the west side of Summit Road, between I-75 and Summit Road. Borings B-001, B-003 through B-010 and B-015 encountered 3.0 to 9.0 inches of topsoil at the ground surface.

4.2 Subsurface Soils

4.2.1 2011 Exploration Borings

Beneath the surface materials in borings B-044 and B-055, material identified as existing fill was encountered to a depth of 8.0 and 5.5 feet below the ground surface, respectively. The fill material consisted of brown, dark brown and black gravel, gravel and sand and gravel with sand and silt (ODOT A-1-b, A-2-4) and contained brick, asphalt, concrete and clay tile fragments.

Underlying the surface materials and existing fill in borings B-044 and B-055, natural soils were encountered consisting of both granular and cohesive soils. The granular soils were generally described as brown, gray, brownish gray and light brown gravel, gravel and sand, gravel with sand and silt, gravel with sand, silt and clay, fine sand, coarse and fine sand, sandy silt and silt (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3, A-3a, A-4a, A-4b). The cohesive soils were generally described as gray, brown, brownish gray, grayish brown, dark brown, light brown and black sandy silt, silt, elastic silt, silt and clay, silty clay and clay (ODOT A-4a, A-4b, A-5, A-6a, A-6b, A-7-6) with lesser percentages of gravel and/or sand.

The relative density of granular soils is primarily derived from SPT blow counts (N_{60}). Based on the SPT blow counts obtained, the granular soil encountered ranged from very loose (N_{60} < 5 blows per foot [bpf]) to very dense (N_{60} > 50 bpf). Overall blow counts recorded from the SPT sampling ranged from 0 bpf (split spoon advanced under the weight of the hammer [WOH] alone without requiring the hammer to lift and drop) to 68 bpf. The shear strength and consistency of the cohesive soils are primarily derived from the hand penetrometer values (HP). The cohesive soil encountered ranged from soft (0.25 < HP £ 0.5 tsf) to hard (HP > 4.0 tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 0.5 tsf to over 4.5 tsf (limit of the instrument).

Natural moisture contents of the soil samples tested ranged from 0 to 35 percent. The natural moisture contents of the cohesive soil samples tested for plasticity index ranged from 7 percent below to 10 percent above their corresponding plastic limits. The moisture contents of the native soils are generally considered to be significantly below to significantly above their corresponding optimum moisture levels.

4.2.2 2007 Exploration Borings

Beneath the surface materials in borings B-002 and B-013, material identified as existing fill was encountered to a depth of 16.0 and 3.0 feet below the ground surface, respectively. The fill material consisted of brown and dark brown sandy silt, silt and clay and clay (ODOT A-4a, A-6a, A-7-6).

Beneath the surface materials and existing fill in borings B-002 and B-013, natural cohesive and granular soils were encountered. The cohesive soils were generally described as brown, gray, reddish brown or reddish gray sandy silt, silt and clay, silty clay and clay (ODOT A-4a, A-6a, A-6b, A-7-6). The granular soils were generally described as brown and gray gravel and sand, gravel with sand, silt and clay, fine sand, coarse to fine sand, sandy silt and silt (ODOT A-1-b, A-2-6, A-3, A-3a, A-4a, A-4b).

The blow counts indicate that the relative consistency of the cohesive soil ranges from soft ($2 \leq N \leq 4$ bpf) to hard ($N > 30$ bpf), and the relative density of the granular soils ranges from very loose ($N < 5$ bpf) to dense ($31 \leq N \leq 50$ bpf). The standard penetration blow counts, N, ranged from 4 bpf to split spoon sampler refusal, generally increasing with depth. Split spoon sampler refusal is defined as exceeding 50 blows with less than 6 inches of penetration by the split spoon sampler. The unconfined compressive strength of the cohesive soil samples tested ranged from 1.0 to over 4.5 tsf.

Moisture contents of the soil samples tested ranged from 2 to 37 percent. The natural moisture content of the cohesive soil samples tested for plasticity index ranged from 19 percent below to 16 percent above their corresponding plastic limits. In general, the soil exhibited natural moisture contents considered to be significantly below to significantly above optimum moisture levels.

4.3 Bedrock

Bedrock was not encountered in any of the borings performed for the 2007 or 2011 explorations.

4.4 Groundwater

Groundwater was encountered initially during the drilling process in borings B-002, B-047, B-051 and B-058 at depths ranging from of 2.0 to 22.0 feet below the ground surface. The remaining borings were observed to be dry, meaning no measureable amount of water had accumulated within the boreholes during or at the completion of drilling. Please note that short-term water level readings, especially in cohesive soils, are not necessarily an accurate indication of the actual groundwater level. In addition, groundwater levels or the presence of groundwater are considered to be dependent on seasonal fluctuations in precipitation.

A more comprehensive description of what was encountered during the drilling process may be found on the boring logs in Appendix IV.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the drilling and testing program have been used to determine the 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 foundation systems for the subject retaining wall, 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 proposed retaining wall were provided by the Rii design team. It is understood that the proposed retaining wall will be a soldier pile and lagging wall type that will be constructed adjacent to the east side of the widened portion of the I-75 northbound lanes. To accommodate the widened alignment, it is understood that the existing slope will have to be cut and the retaining wall constructed to avoid regrading the slope which would require the relocation of Summit Road behind the existing building. The backslope behind the wall will be regraded, where necessary, to a maximum backslope of 2:1 (H:V). Due to the height of the retaining wall required to accommodate the widened alignment, tieback anchors will be required for a majority of the alignment.

It should be noted that the 2007 borings were located just off the west shoulder of Summit Road, and the 2011 borings were located primarily in the grass adjacent to the roadway east of Summit Road. The 2011 borings were performed primarily to characterize the soils in which the tieback anchors will be installed; however, they were also utilized as verification of the subsurface soils below the termination depth of the 2007 borings as those were only advanced to a typical completion depth of 35 feet along a majority of the alignment.

5.1 Retaining Wall Recommendations

Based upon proposed plan and cross section information provided by the Rii design team, wall heights along the alignment are anticipated to range from 5.7 to 27.7 feet. Based on the subsurface conditions encountered and the proposed geometry of the slope behind the wall, steel H-Piles should be installed inside drilled shafts extending from the excavation bottom to the full wall height at each shaft location, and oriented with the web perpendicular to the wall alignment. Shafts and soldier piles employed for use in the retaining wall foundations may be proportioned based on the recommendations in Table 4. Where greater exposed wall heights are present, tieback anchors will be required to resist the lateral loading and limit the deflection of the wall, as presented in Table 4.

Table 4. Drilled Shaft with Soldier Pile Foundation Recommendations

Wall Height [1] (ft)	Shaft Spacing (ft)	Shaft Diameter (in)	Embedment Depth [2] (ft)	Pile Section	Number of Anchor Rows	Depth to Anchor(s) [3] (ft)	Anchor Inclination [4]
H > 22	6.0	24	25.0	HP 12x53	2	7.0 / 16.0	20°
18 < H ≤ 22	6.0	24	25.0	HP 12x53	2	6.0 / 13.0	20°
14 < H ≤ 18	6.0	24	20.0	HP 12x53	1	5.0	20°
10 < H ≤ 14	6.0	24	15.0	HP 12x53	1	4.0	20°
H ≤ 10	6.0	24	15.0	HP 12x53	0	N/A	N/A

1. *Wall height is measured from the bottom of the wall lagging to the bottom of the paved gutter behind the back of the wall.*
2. *Embedment depth represents the length of the shaft required below the base of the wall.*
3. *Depth to anchor(s) along soldier pile measured from the top of the wall (bottom of the paved gutter behind the wall). Where multiple values are listed, the first value is the depth to the top row of anchors, and the second value is the depth to the bottom row of anchors.*
4. *Anchor inclination is with respect to a horizontal plane intersecting the wall.*

The wall height listed in Table 4 is measured from the bottom of the wall lagging to the bottom of the paved gutter behind the back of the wall, and the embedment depth reflects exclusively the length of the shaft in contact with the soil. The wall was evaluated to determine the required embedment depth based on the maximum exposed wall height along the alignment as well as the incorporation of the tieback anchors. For analysis, it was considered that a 2:1 backslope was present along the entire wall alignment and that no traffic surcharge is present.

Provided drilled shafts are proportioned as outlined above, a nominal end bearing resistance of q_n = 18.0 ksf at the strength limit state may be utilized for design. A geotechnical resistance factor of φ_n = 0.50 should be considered when calculating the factored end bearing resistance. If additional resistance beyond the factored end bearing resistance is required, a nominal side resistance of q_s = 1.5 ksf and geotechnical resistance factor of φ_s = 0.55 should be considered for these shafts. Please note that side friction resistance should be neglected in the top 5.0 feet of shaft length. Based on the above noted bearing resistance, a maximum settlement of the foundation is estimated to be 1.0-inch.

5.1.1 Tieback Anchor Design

As noted in Table 4, tieback anchors will be required for wall heights greater than 10.0 feet to provide adequate lateral resistance and limit the overall deflection of the wall. The required configuration and dimensions of the tieback anchors were determined such that the reaction loading along the pile section was minimized. Per Section 11.9.1 of the 2010 AASHTO LRFD Bridge Design Specifications (BDS), tieback anchors must have a minimum unbounded length equal to the greater of:

- a minimum length to start of bonded segment behind the active failure wedge (see Figure 1) of 5.0 feet or H/5;
- a minimum overburden cover of 15.0 feet above the start of the bonded segment;
- and, must be a minimum of 15.0 feet.

Figure 1. AASHTO Anchored Wall Schematic

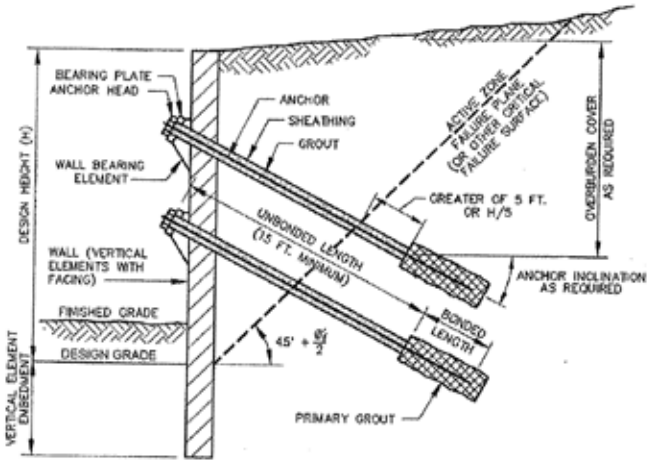


Figure 11.9.1-1—Anchored Wall Nomenclature and Anchor Embedment Guidelines

Based on the subsurface conditions encountered in the 2007 and 2011 borings, the soils that the bonded length of anchors will be installed in are anticipated to consist of cohesive and granular material comprise of stiff to very stiff silt and clay, silty clay and clay (ODOT A-6a, A-6b, A-7-6) and loose to dense fine sand and coarse and fine sand (ODOT A-3, A-3a). A nominal anchor bond stress of 3.0 ksf was utilized in the analysis per Table C11.9.4.2-1 of the 2010 AASHTO LRFD BDS for stiff to very stiff, medium to high plasticity cohesive soil. A geotechnical resistance factor of φ_n=0.70 was considered in calculating the factored anchor pullout resistance for the determination of the required anchor bond length.

Table 5. Anchor Configurations and Dimensions

Wall Height [1] (ft)	Number of Anchor Rows	Row	Depth to Anchor [2] (ft)	Anchor Load (kips)	Anchor Diameter (in)	Unbonded Length (ft)	Bonded Length (ft)	Total Length (ft)
H > 22	2	Top	7.0	153.4	6.0	16.4	49.5	65.9
		Bottom	16.0	169.2	6.0	15.0	54.6	69.6
18 < H ≤ 22	2	Top	6.0	100.0	6.0	15.0	32.3	47.3
		Bottom	13.0	104.2	6.0	15.0	33.6	48.6
14 < H ≤ 18	1	N/A	5.0	120.9	6.0	15.0	36.7	51.7
10 < H ≤ 14	1	N/A	4.0	73.3	6.0	15.0	22.2	37.2

1. *Wall height is measured from the bottom of the wall lagging to the bottom of the paved gutter behind the back of the wall.*
2. *Depth to anchor(s) measured from the bottom of the paved gutter.*

5.1.2 Lateral Design

The foundation elements for the soldier pile and lagging retaining wall were analyzed to verify that the pile section utilized has enough lateral and bending resistance to support the lateral load applied from the retained soil. Due to the length of the wall and the somewhat uniform subsurface conditions present along the alignment, the limiting soil conditions encountered along the alignment were utilized in the analysis. For walls that are not restrained from movement due to the incorporation of tieback anchors along the cantilevered portion of the wall, it is understood that the maximum allowable lateral deflection is 1.0 percent of the wall height. Table 6 was used for lateral loading design:

Table 6. Lateral Design Parameters

Boring No.	Depth (feet)	Strata	Effective Unit Weight	Strength Parameter	k (soil)	ε_{50} (soil)
B-012-0-11	0-7.0	3	115 pcf	C_u = 1,500 psf	500 pci	0.007
	Below 7.0	4	125 pcf	$\varphi = 29^o$	90 pci	N/A

1. *Depth listed represents the depth below the ground surface at the base of the wall (embedment depth). Loading above the wall was modeled using a triangular load distribution for portions of the wall that did not incorporate tieback anchors, and the calculated reaction loads were applied to the top of the shaft for portions of the wall that did incorporate tieback anchors.*

In order to evaluate the lateral capacity, the LPILE Plus 5.0 program was utilized to determine the proper embedment depth and pile section required to resist the lateral load for the given end condition and deflection criteria. Note that the table was prepared with a design groundwater elevation as indicated on the boring logs. The following table lists the eleven different soil types internal to the LPILE Plus 5.0 program. These strata were utilized in Table 6 for evaluating the soil layers. For portions of the wall that

incorporates tieback anchors, the exposed cantilever portion of the wall was evaluated separately and the reaction loads were applied to the top of the shaft for the embedded section in the LPILE analysis.

Table 7. 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)

Using the conditions and parameters in the previous tables, an analysis of the lateral deflection and reactions was performed for the wall heights and anchor configurations listed in Table 4. For walls that are restrained from movement due to the incorporation of tieback anchors along the cantilevered portion of the wall, the deflection at the top of the wall will be less than 1.0 percent of the wall height provided that tieback anchors are installed as noted in Section 5.1.1 to provide adequate resistance for the anticipated loading. For the center to center spacing, embedment depth and section type specified, the deflection determined from the LPILE analysis met the criteria of less than 1.0 percent of the wall height for portions of the wall that did not incorporate tieback anchors, and the section utilized met the structural capacity requirements in all circumstances.

5.1.3 Overall (Global) Stability

A slope stability analysis was performed to evaluate the global stability of the soldier pile and lagging retaining wall system. Global stability was checked at the maximum wall height of 27.7 feet. Soil parameters utilized in external stability analyses are presented below. For the global stability condition, it was considered that the failure plane will not cross through the lagging, and that an increase in shear strength will occur due to soil arching between adjacent shafts where the soldier piles are embedded below the ground surface. The following long term strength parameters were utilized for the soil:

Table 8. Shear Strength Parameters Utilized in Stability Analyses

Material Type	Unit Weight, γ (pcf)	Long Term (Effective Stress) Parameters	
		φ' (°)	c' (psf)
Stiff to Very Stiff Clay (ODOT A-7-6) [1]	115	28	238
Medium Dense Fine Sand and Coarse and Fine Sand (ODOT A-3, A-3a) [2]	125	29	0

1. *Based on laboratory consolidated undrained triaxial testing performed on an undisturbed sample from boring B-061-0-11.*
2. *Based on correlations with the energy corrected blow counts (N_{60}) within this zone.*

The soldier piles were modeled in the slope stability analysis by incorporating a soil layer with a width and depth equal to the diameter and embedment depth of the shafts, respectively. The following shear strength parameters were assigned to this layer to model the shear strength increase due to soil arching between the shafts.

- φ = 40°
- c = 10,000 psf
- γ = 140 pcf

Per Section 11.6.2.3 of the 2010 AASHTO LRFD BDS, overall (global) stability for walls not supporting structural foundations on spread footings is satisfied if the product of the factor of safety from the slope stability output multiplied by the resistance factor φ=0.75 is greater than 1.0. Therefore, global stability is satisfied when a minimum factor of safety of 1.33 is obtained. Using the parameters above in the section analyzed, a resulting factor of safety of 1.67 was determined for the maximum wall height of 27.7 feet, satisfying the minimum requirement of 1.33.

Calculations for wall deflection, structural capacity and overall (global) stability of the soldier pile and lagging retaining wall system are provided in Appendix VI.

5.2 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 9 and Table 10.

Table 9. Estimated Undrained (Short-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ'	k_a [2]	k_o	k_p [2]
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
Very Loose Granular Soil	120	0	27°	0.38 / 0.75	0.55	2.66 / 1.07
Loose to Medium Dense Granular Soil	125	0	29°	0.35 / 0.59	0.52	2.88 / 1.37
Dense Granular Soil	130	0	32°	0.31 / 0.46	0.47	3.26 / 1.73
Very Dense Granular Soil	135	0	34°	0.28 / 0.41	0.44	3.54 / 1.97
Compacted Cohesive Engineered Fill	125	1,500	0°	1.0	1.0	1.0
Compacted Granular Engineered Fill	135	0	33°	0.30 / 0.34	0.46	3.39 / 2.61

1. *When below groundwater table, use effective unit weight, γ' = γ - 62.4 pcf and add hydrostatic water pressure.*
2. *Where multiple values are listed, the first value is the earth pressure coefficient where the surface of the backfill is level, and the second value is the earth pressure coefficient where the surface of the backfill is sloped. Values listed for a sloped backfill are valid for slopes that are no steeper than 2:1 (H:V).*

Table 10. Estimated Drained (Long-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ'	k_a [2]	k_o	k_p [2]
Natural Cohesive Soil	115	0	28°	0.36 / 0.65	0.53	2.77 / 1.23
Very Loose Granular Soil	120	0	27°	0.38 / 0.75	0.55	2.66 / 1.07
Loose to Medium Dense Granular Soil	125	0	29°	0.35 / 0.59	0.52	2.88 / 1.37
Dense Granular Soil	130	0	32°	0.31 / 0.46	0.47	3.26 / 1.73
Very Dense Granular Soil	135	0	34°	0.28 / 0.41	0.44	3.54 / 1.97
Compacted Cohesive Engineered Fill	125	0	28°	0.36 / 0.44	0.53	2.77 / 2.04
Compacted Granular Engineered Fill	135	0	33°	0.30 / 0.34	0.46	3.39 / 2.61

1. *When below groundwater table, use effective unit weight, γ' = γ - 62.4 pcf and add hydrostatic water pressure.*
2. *Where multiple values are listed, the first value is the earth pressure coefficient where the surface of the backfill is level, and the second value is the earth pressure coefficient where the surface of the backfill is sloped. Values listed for a sloped backfill are valid for slopes that are no steeper than 2:1 (H:V).*

These parameters are considered appropriate for the design of subsurface walls and excavation support systems. It is recommended that the retaining wall structure be designed based on active conditions. The values in this table have been estimated from correlation charts based on minimum standards specified for compacted engineered fill materials. The first values listed in the columns for active and passive earth pressure do not take into account the effect of any surcharge loading or a sloped ground surface (a level surface is considered). The second values listed in these columns take into account a sloped ground surface along the surface of the backfill with a maximum slope angle of 2:1 (H:V). Earth pressures on excavation support systems will be dependent on the type of sheeting and method of bracing or anchorage.

5.3 Construction Considerations

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

Fill soil placed for foundation support should be placed in loose lifts not to exceed 8.0 inches. Fill soil placed under structures shall be compacted to not less than 100 percent of the maximum dry density obtained by the Standard Proctor Test (ASTM D698). Fill soil containing excess moisture shall be required to dry prior to or during compaction to a moisture content not greater than 3.0 percent above or below optimum. However, for material that displays pronounced elasticity or deformation under the action of loaded rubber tire construction equipment, the moisture content shall be reduced to optimum if necessary to secure stability. Drying of wet soil shall be expedited by the use of plows, discs, or by other approved methods when so ordered by the site geotechnical engineer.

Generally, materials utilized for engineered fill should free of waste construction debris and other deleterious materials and meet the following requirements:

- Maximum Dry Density per ASTM D698 > 110 pcf
- Liquid Limit < 40
- Plasticity Index < 15
- Organic Matter < 3 percent
- Maximum Particle Size < 3 inches
- Silt Content (between 0.075 and 0.005 mm) < 45 percent

Compacted granular fill shall meet the above specification and additionally shall have a maximum 35 percent passing the No. 200 sieve.

5.3.1 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, sheeting boxes 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 11. 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	Above Ground Water Table and No Seepage
Very Stiff to Hard Cohesive	0.75 : 1.0	Above Ground Water Table and No Seepage
All Granular & Cohesive Soil Below Ground Water Table or with Seepage	1.5 : 1.0	None
Rock to 3.0' +/- below Auger Refusal	0.75 : 1.0	Above Ground Water Table and No Seepage
Stable Rock	Vertical	Above Ground Water Table and No Seepage

5.3.2 Groundwater Considerations

Based on the groundwater observations made during drilling, little to no groundwater seepage is anticipated during construction. However, where/if 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. 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. At this time we would like to point out that soil borings only depict the soil and bedrock conditions at the specific locations and time at which they were made. The conditions at other locations on the site may differ from those occurring at the boring locations.

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

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

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

APPENDIX I

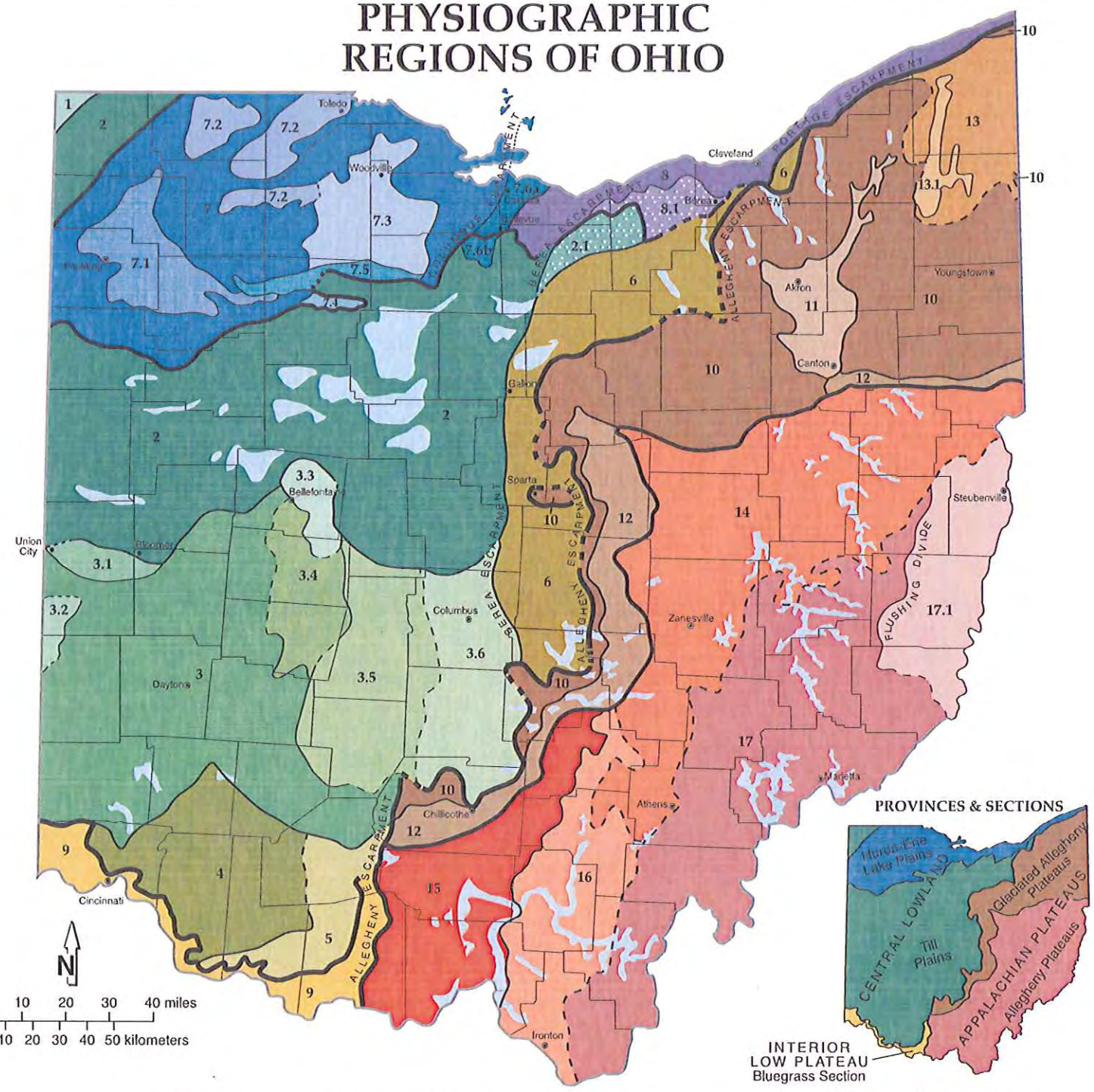
STATE GEOLOGY

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

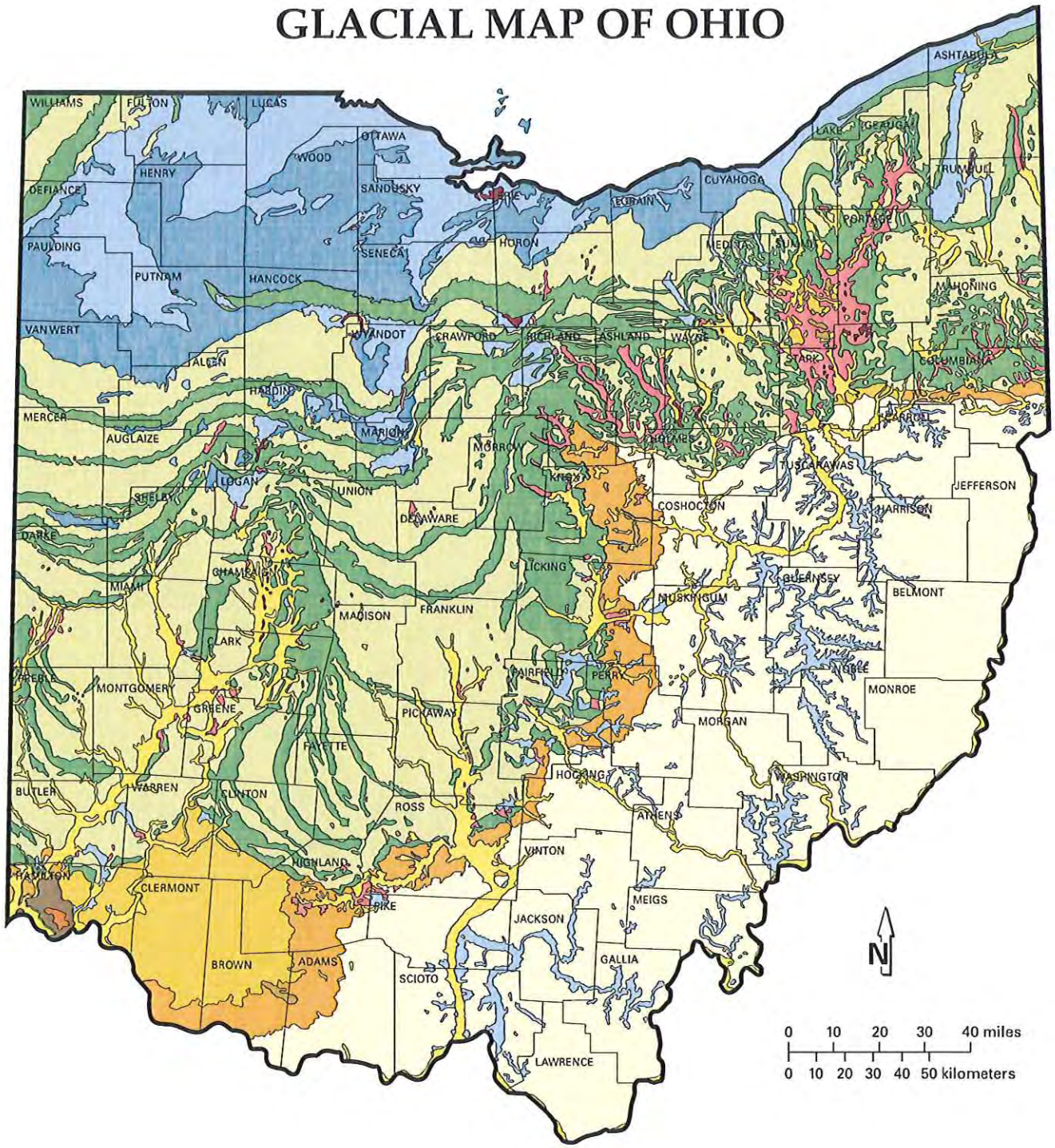
Recommended citation: Ohio Division of Geological Survey, 1998, Physiographic regions of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map with text, 2 p., scale 1:2,100,00.

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

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Samuel W. Speck, Director

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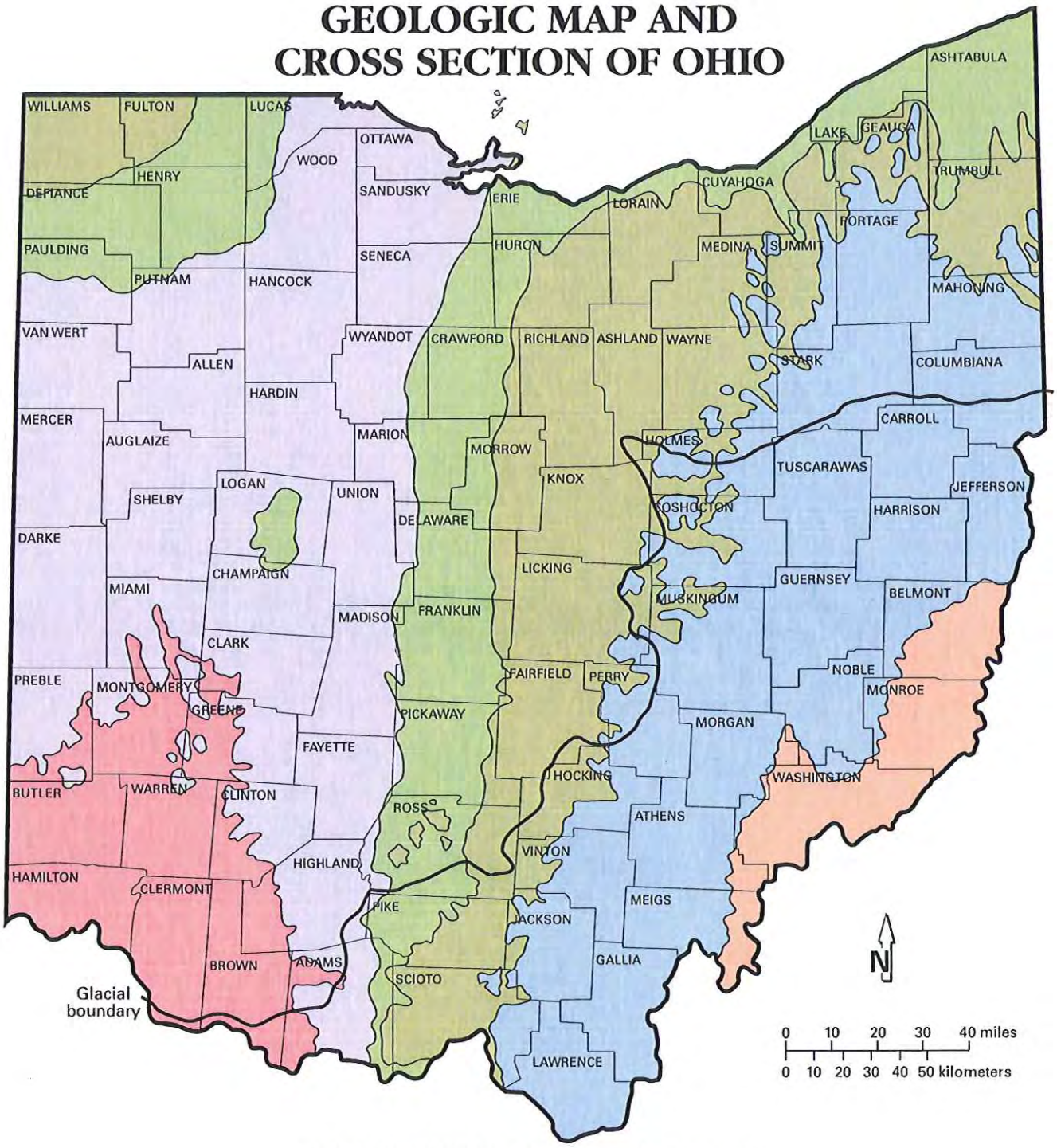
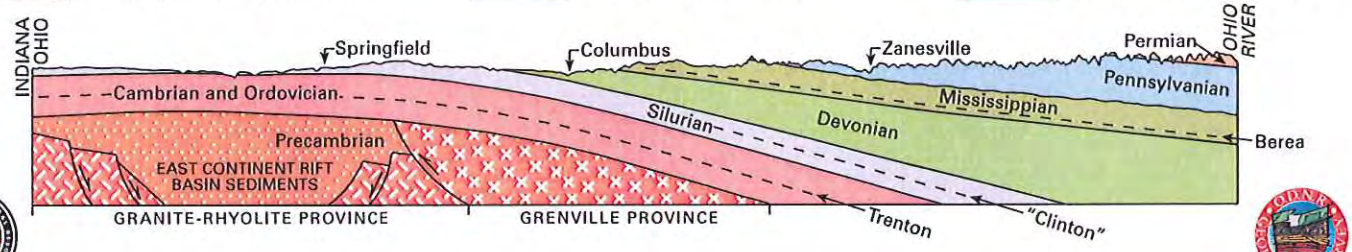
Thomas M. Berg, Chief

GEOLOGIC MAP AND CROSS SECTION OF OHIO



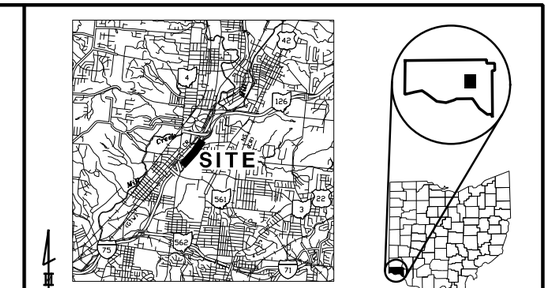
GEOLOGIC SYSTEM (million years before present)

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



APPENDIX II

VICINITY MAP AND BORING PLAN



VICINITY MAP

MILL CREEK

505

520

5254

530

I-75

I-75

B-001-0-07
B-002-0-07
B-003-0-07
B-004-0-07 (9012)
B-005-0-07
B-006-0-07
B-007-0-07
B-008-0-07
B-009-0-07
B-010-0-07
B-011-0-07
B-012-0-07
B-013-0-07
B-014-0-07
B-015-0-07
B-016-0-07
B-017-0-07
B-018-0-07

B-044-0-11
B-045-0-11
B-046-0-1
B-047-0-11
B-048-0-11
B-049-0-11
B-050-0-11
B-051-0-11
B-052-0-11
B-053-0-11
B-054-0-11
B-055-0-11
B-056-0-11
B-057-0-11
B-058-0-11
B-059-0-11
B-060-0-11
B-061-0-11

RETAINING WALL V

2011 RETAINING WALL BORINGS

2007 RII HISTORIC BORINGS

BORING PLAN

HAM-75-7.85 RETAINING WALL V
HAMILTON COUNTY, OHIO

PROJECT NO. Rii B-10-020	DRAWN RRM
SCALE: 1"=60' (0 30 60)	REVIEWED BRT
	DATE 6-28-12

RESOURCE INTERNATIONAL, INC.

APPENDIX III

DESCRIPTION OF SOIL TERMS

DESCRIPTION OF SOIL TERMS

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

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

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

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

Description	Blows per foot – SPT (N_{60})			Unconfined Compression (tsf)
Very Soft	Below		2	UCS ≤ 0.25
Soft	2	-	4	0.25 < UCS ≤ 0.5
Medium Stiff	5	-	8	0.5 < UCS ≤ 1.0
Stiff	9	-	15	1.0 < UCS ≤ 2.0
Very Stiff	16	-	30	2.0 < UCS ≤ 4.0
Hard	Over		30	UCS > 4.0

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

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

Modifiers of Components - Modifiers of components are as follows:

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

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

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

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

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

Bedrock – The following terms are used to describe bedrock hardness:

Term		Blows per foot – SPT (N)		
Very Soft		Below		50
Soft		50/5”	–	50/6”
Medium Hard		50/3”	–	50/4”
Hard		50/1”	–	50/2”
Very Hard	50/0”			

CLASSIFICATION OF SOILS

Ohio Department of Transportation

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

SYMBOL	DESCRIPTION	Classifcation AASHTO	Classifcation OHIO	$LL_0/LL \times 100$*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
F S	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	76 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	76 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		76 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	76 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	76 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		76 Min.		36 Min.	41 Min.	$\leq$LL-30	20	
	Clay	A-7-6		76 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	75 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	75 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6

MATERIAL CLASSIFIED BY VISUAL INSPECTION

- Sod and Topsoil
- Pavement or Base
- Uncontrolled Fill (Describe)
- Bouldery Zone
- Peat, S-Sedimentary W-Woody F-Fibrous L-Loamy & etc

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

APPENDIX IV

BORING LOGS:

B-044-0-11 through B-061-0-11
B-001-0-07 through B-018-0-07

Definitions of Abbreviations for Boring Logs

A	=	Adhesion (pounds per square foot)
AS	=	Auger Sample
BCP	=	Bentonite Chips or Pellets
C	=	Cohesion (pounds per square foot)
CB	=	Cased (Concentric) Boring
C/B	=	Neat Cement/Bentonite Grout
Cl^-	=	Chloride Ion Concentration (parts per million)
FA	=	Angle of Internal Friction (degrees)
FF	=	Friction Factor
GS	=	Geoprobe Sample
HSA	=	Hollow Stem Auger
HSB	=	High Solids Content Bentonite Grout
K	=	Modulus of Horizontal Subgrade Reaction (kips per cubic foot)
LOI	=	Percent Organic Content (by weight) as determined by ASTM D-2974 (loss on ignition test)
MD	=	Rotary Mud Drilling
NQ	=	Wireline Method (1.875-inch diameter rock core)
NX	=	Conventional Method (2.126-inch diameter rock core)
PC	=	Neat Portland Cement Grout
PID	=	Photo-Ionization Detector Reading (parts per million)
qh	=	Unconfined Compressive Strength of Soil as determined by a hand penetrometer (tons per square foot)
qr	=	Unconfined Compressive Strength of Intact Rock Core as determined by ASTM D-2938 (pounds per square inch)
qu	=	Unconfined Compressive Strength of Soil as determined by ASTM D-2166 (tons per square foot)
quu	=	Unconsolidated-Undrained Triaxial Compressive Strength as determined by ASTM D-2850 (pounds per square foot)
RC	=	Rock Coring
SO^{4-}	=	Sulfate Concentration
SFA	=	Solid Flight Auger
SS	=	Split Spoon Sample
3S	=	For instances of no recovery from standard SS interval, a 3.0 inch O.D. split spoon is driven the full length of the standard SS interval plus an additional 6.0 inches to obtain a representative sample. Only the final 6.0 inches of sample is retained. Blow counts from 3S sampling are not correlated with N_{60} values.
ss	=	Soluble Salts (conductivity)
ST	=	Thin-walled (Shelby) Tube Sample
uw	=	“In-Situ” Unit Weight of Soil (pounds per cubic foot)
VIS	=	Visual classification only, no testing performed
WOH	=	Weight of Hammer and Drill Rods “pushed” split spoon sampler 6-inches.
WD	=	Rotary Wash Drilling

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 503+96.72 / 150.2' Rt	**EXPLORATION ID B-044-0-11**
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / S.M.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 5/6/11	ELEVATION: 543.4 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 11/22/11 END: 11/22/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.195249413 ° N / 84.473852731 ° W	

MATERIAL DESCRIPTION AND NOTES	ELEV. 543.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1.0' - TOPSOIL (12.0")	542.4																	
FILL: VERY LOOSE TO MEDIUM DENSE, DARK BROWN, BLACK AND REDDISH BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST TO WET.		1	10 14 7	27	72	SS-1	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
-BRICK, ASPHALT AND CONCRETE FRAGMENTS PRESENT THROUGHOUT		4	2 1 1	3	33	SS-2	-	42	20	21	14	3	NP	NP	NP	21	A-1-b (0)	
	535.4	7	3 2 2	5	39	SS-3	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, SOME FINE TO COARSE SAND, TRACE SILT, TRACE CLAY, DRY TO DAMP.		9	2 3 7	13	28	SS-4	-	-	-	-	-	-	-	-	-	3	A-1-a (V)	
		12	14 16 16	41	72	SS-5	-	59	20	14	6	1	NP	NP	NP	4	A-1-a (0)	
		14	15 8 6	18	78	SS-6	-	-	-	-	-	-	-	-	-	3	A-1-a (V)	
		17	9 11 15	33	83	SS-7	-	-	-	-	-	-	-	-	-	3	A-1-a (V)	
	525.4																	
MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE FINE GRAVEL, DRY.	523.4	19	3 9 12	27	67	SS-8	-	-	-	-	-	-	-	-	-	4	A-3a (V)	
		EOB 20																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 16.3'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 506+49.18 / 188.1' Rt	**EXPLORATION ID B-045-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 555.5 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 11/15/11 END: 11/15/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.195680732 ° N / 84.473145925 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV. 555.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5' - TOPSOIL (6.0")	555.0																	
VERY STIFF, BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, DAMP.		1	5 4 5	12	56	SS-1	2.50	0	4	32	27	37	39	17	22	19	A-6b (11)	
	552.0	2																
MEDIUM DENSE, BROWN **FINE SAND**, LITTLE COARSE SAND, TRACE SILT, TRACE CLAY, DAMP.		3																
		4	4 6 9	19	50	SS-2	-	-	-	-	-	-	-	-	-	7	A-3 (V)	
		5																
		6	6 7 7	18	61	SS-3	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
		7																
		8																
		9	4 4 8	15	56	SS-4	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
		10																
		11	6 6 7	17	67	SS-5	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
		12																
		13																
		14	3 7 7	18	61	SS-6	-	0	17	73	9	1	NP	NP	NP	8	A-3 (0)	
		15																
		16																
		17	5 6 6	15	61	SS-7	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
		18																
		19	3 4 5	12	56	SS-8	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
		20																
		21																
		22	8 5 6	14	61	SS-9	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
	532.5	23																
DENSE, BROWN **FINE SAND**, SOME COARSE SAND, SOME FINE GRAVEL, TRACE SILT, DRY TO DAMP.		24	7 20 18	49	67	SS-10	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		25																
		26																
		27	12 12 17	37	67	SS-11	-	23	26	44	7	0	NP	NP	NP	6	A-3 (0)	

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:10 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 506+49.18 / 188.1' Rt	START: 11/15/11	END: 11/15/11	PG 2 OF 2	B-045-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
DENSE, BROWN **FINE SAND**, SOME COARSE SAND, SOME FINE GRAVEL, TRACE SILT, DRY TO DAMP. *(same as above)*	527.5	29	7 11 14	32	56	SS-12	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		30																
		31																
		32																
		33																
		34	4 11 16	35	67	SS-13	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		35																
	518.5	36																
VERY STIFF, GRAY **SILTY CLAY**, MOIST.		37																
		38																
		39	WOH 4 4	10	72	SS-14	1.50	-	-	-	-	-	-	-	-	27	A-6b (V)	
		40																
		41																
		42																
		43																
		44			96	ST-15	1.50	0	0	0	48	52	35	19	16	27	A-6b (10)	
-qu @ 44.9' = 0.97 tsf		45																
		46																
		47																
		48																
		49	3 5 4	12	94	SS-16	3.00	-	-	-	-	-	-	-	-	26	A-6b (V)	
	505.5	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 19.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 100 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 507+90.55 / 156.3' Rt	**EXPLORATION ID B-046-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 555.7 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 11/15/11 END: 11/15/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.196032716 ° N / 84.472894673 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV. 555.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - TOPSOIL (4.0")	555.4																	
STIFF, BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. -TRACE ORGANICS PRESENT IN SS-1	552.7	1 2 3	4 3 4	9	56	SS-1	2.00	-	-	-	-	-	-	-	-	24	A-6b (V)	
STIFF, DARK BROWN **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, DAMP.	550.2	4 5	4 7 8	19	44	SS-2	2.00	1	12	29	41	17	22	13	9	12	A-4a (5)	
LOOSE TO MEDIUM DENSE, BROWN **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE CLAY, TRACE FINE GRAVEL, DAMP.		6 7 8	9 9 10	24	56	SS-3	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
		9 10	3 5 7	15	61	SS-4	-	-	-	-	-	-	-	-	-	8	A-3 (V)	
		11 12 13	5 7 8	19	56	SS-5	-	3	34	53	9	1	NP	NP	NP	6	A-3 (0)	
		14 15	3 3 4	9	61	SS-6	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
		16 17 18	5 5 5	13	56	SS-7	-	-	-	-	-	-	-	-	-	7	A-3 (V)	
		19 20 21	4 5 8	17	56	SS-8	-	-	-	-	-	-	-	-	-	9	A-3 (V)	
		22 23	9 8 9	22	61	SS-9	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
	532.2	24 25	5 11 11	28	50	SS-10	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, AND FINE TO COARSE SAND, TRACE SILT, DAMP TO MOIST.		26 27	20 19 18	48	56	SS-11	-	54	25	14	7	0	NP	NP	NP	4	A-1-a (0)	

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 507+90.55 / 156.3' Rt	START: 11/15/11	END: 11/15/11	PG 2 OF 2	B-046-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, AND FINE TO COARSE SAND, TRACE SILT, DAMP TO MOIST. *(same as above)*	527.7	29	6 18 20	49	50	SS-12	-	-	-	-	-	-	-	-	-	7	A-1-a (V)	
		30																
		31																
		32																
		33																
		34	7 17 18	45	56	SS-13	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
		35																
	518.7	36																
STIFF TO VERY STIFF, GRAY **CLAY**, SOME SILT, MOIST.		37																
		38																
		39	3 5 7	15	61	SS-14	1.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		40																
		41			92	ST-15	2.25	0	0	0	29	71	51	21	30	24	A-7-6 (18)	
		42																
		43																
		44	3 4 5	12	67	SS-16	2.25	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		45																
		46																
		47																
		48																
		49	4 4 8	15	67	SS-17	2.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
	505.7	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 17.3'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 100 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 510+26.50 / 147.4' Rt	**EXPLORATION ID B-047-0-11**
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 557.0 (MSL) EOB: 50.0 ft.	PAGE 1 OF 2
START: 11/10/11 END: 11/11/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.196525283 ° N / 84.472353115 ° W	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1.0' - TOPSOIL (12.0")	557.0																	
	556.0																	
STIFF TO VERY STIFF, BROWN TO MOTTLED BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, MOIST.		1	WOH															
		2	1 4	6	56	SS-1	2.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
-TRACE ORGANICS PRESENT IN SS-1		3																
		4	4															
		5	4 5	12	67	SS-2	2.25	0	2	16	37	45	36	18	18	20	A-6b (11)	
	551.5																	
STIFF TO VERY STIFF, MOTTLED BROWN AND GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		6																
		7	5 8 8	21	56	SS-3	2.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
-SAND LENSES PRESENT THROUGHOUT		8																
		9			79	ST-4	2.00	-	-	-	-	-	-	-	-	21	A-6a (V)	
	547.5	10					-	-	-	-	-	-	-	-	-	17	A-3a (V)	
MEDIUM DENSE TO LOOSE, BROWN **COARSE TO FINE SAND**, LITTLE SILT, TRACE CLAY, MOIST TO WET.		11																
		12	2 5 7	15	72	SS-5	-	-	-	-	-	-	-	-	-	4	A-3a (V)	
		13																
		14	2															
		15	4 4	10	67	SS-6	-	-	-	-	-	-	-	-	-	6	A-3a (V)	
		16																
		17	4 4 4	10	61	SS-7	-	0	16	69	15	0	NP	NP	NP	6	A-3a (0)	
	538.5	18	W															
LOOSE, BROWN TO GRAY **SILT**, SOME COARSE TO FINE SAND, TRACE CLAY, MOIST TO WET.		19	2															
		20	1 3	5	61	SS-8	-	-	-	-	-	-	-	-	-	20	A-4b (V)	
		21																
		22	1 2 4	8	56	SS-9	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
		23																
		24	2															
		25	2 2	5	61	SS-10	-	-	-	-	-	-	-	-	-	26	A-4b (V)	
		26																
		27	1 2 4	8	72	SS-11	-	0	1	23	67	9	NP	NP	NP	23	A-4b (8)	

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:10 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 510+26.50 / 147.4' Rt	START: 11/10/11	END: 11/11/11	PG 2 OF 2	B-047-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
LOOSE, BROWN TO GRAY **SILT**, SOME COARSE TO FINE SAND, TRACE CLAY, MOIST TO WET. *(same as above)*	529.0	29	4 4 3	9	56	SS-12	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
		30																
		31																
		32																
		33																
		34	1 2 4	8	61	SS-13	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
-COBBLE PRESENT @ 34.7'		35																
	520.0	36																
LOOSE TO MEDIUM DENSE, GRAY **COARSE TO FINE SAND**, LITTLE SILT, TRACE CLAY, DAMP.		37																
		38																
		39	7 4 7	14	44	SS-15	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
		40																
		41																
		42																
		43																
		44	3 3 3	8	56	SS-16	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
		45																
		46																
		47																
		48																
		49	4 4 4	10	61	SS-17	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
	507.0	EOB 50																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 18.5'; CAVE-IN DEPTH @ 13.3'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 25 LBS. BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 511+46.78 / 143.7' Rt	**EXPLORATION ID B-048-0-11**
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 558.1 (MSL) EOB: 50.0 ft.	PAGE 1 OF 2
START: 11/10/11 END: 11/10/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.196774772 ° N / 84.472074775 ° W	

MATERIAL DESCRIPTION AND NOTES	ELEV. 558.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.8' - TOPSOIL (9.0")	557.3																	
VERY STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, MOIST. -TRACE ORGANICS PRESENT IN SS-1	554.6	1 2 3	2 2 4	8	72	SS-1	2.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
VERY STIFF TO HARD, MOTTLED BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		4 5	3 4 6	13	67	SS-2	4.5+	1	2	10	34	53	39	18	21	20	A-6b (12)	
		6 7	6 9 10	24	67	SS-3	4.50	-	-	-	-	-	-	-	-	23	A- 6b (V)	
-qu @ 9.9' = 3.51 tsf		8 9 10			75	ST-4	4.00	6	5	9	25	55	34	18	16	15	A-6b (10)	
-COBBLE PRESENT @ 13.0'	545.1	11 12	11 9 8	22	67	SS-5	3.00	-	-	-	-	-	-	-	-	13	A- 6b (V)	
HARD, GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP.		13 14	6 10 16	33	56	SS-6	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
	540.1	15 16 17	3 18 18	46	56	SS-7	4.5+	13	9	15	39	24	24	14	10	10	A-4a (6)	
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, TRACE SILT, TRACE COARSE SAND, TRACE CLAY, DRY TO DAMP.		18 19	2 12 18	39	39	SS-8	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		20 21 22	7 10 12	28	67	SS-9	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		23 24 25	8 6 9	19	67	SS-10	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		26 27	8 8 10	23	61	SS-11	-	0	1	92	7	0	NP	NP	NP	3	A-3 (0)	

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:10 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 511+46.78 / 143.7' Rt	START: 11/10/11	END: 11/10/11	PG 2 OF 2	B-048-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, TRACE SILT, TRACE COARSE SAND, TRACE CLAY, DRY TO DAMP. *(same as above)*	530.1	29	5 6 8	18	67	SS-12	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		30																
		31																
		32																
		33																
		34	7 12 18	39	78	SS-13	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		35																
		36																
		37																
		38																
	F S	39	5 10 15	32	72	SS-14	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		40																
		41																
		42																
		43																
		44	8 13 15	36	61	SS-15	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
		45																
		46																
		47																
		48																
		49	3 15 15	39	67	SS-16	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
	508.1	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 22.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS. BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 512+93.35 / 140.5' Rt	**EXPLORATION ID**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	**B-049-0-11**	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 559.8 (MSL) EOB: 50.0 ft.	PAGE	
START: 11/10/11 END: 11/10/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.197076426 ° N / 84.471732333 ° W	1 OF 2	

MATERIAL DESCRIPTION AND NOTES	ELEV. 559.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.8' - TOPSOIL (10.0")	559.0																	
MEDIUM STIFF, GRAYISH BROWN **CLAY**, SOME SILT, TRACE FINE SAND, MOIST.		1	2 2 2	5	67	SS-1	0.75	0	0	1	32	67	46	22	24	30	A-7-6 (15)	
		2																
		3	3 2 2	5	67	SS-2	0.75	-	-	-	-	-	-	-	-	28	A-7-6 (V)	
		4																
		5																
		6	3 3 3	8	67	SS-3	1.00	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
		7																
	551.3	8																
STIFF TO HARD, GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE TO SOME FINE GRAVEL, DAMP TO MOIST.		9			65	ST-4	2.00	20	10	13	29	28	25	14	11	16	A-6a (5)	
		10																
		11	3 5 6	14	56	SS-5	2.00	-	-	-	-	-	-	-	-	14	A-6a (V)	
		12																
		13																
		14	6 7 5	15	61	SS-6	2.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
		15																
		16	20 16 20	46	56	SS-7	4.5+	13	10	16	37	24	26	14	12	11	A-6a (6)	
		17																
	541.3	18																
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, TRACE SILT, TRACE COARSE SAND, TRACE CLAY, DRY.		19	6 7 9	21	50	SS-8	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		20																
		21	7 8 9	22	56	SS-9	-	-	-	-	-	-	-	-	-	2	A-3 (V)	
		22																
		23																
		24	7 6 10	21	61	SS-10	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		25																
		26	6 8 11	24	61	SS-11	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		27																

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 512+93.35 / 140.5' Rt	START: 11/10/11	END: 11/10/11	PG 2 OF 2	B-049-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, TRACE SILT, TRACE COARSE SAND, TRACE CLAY, DRY. *(same as above)*	531.8	29	5 8 12	26	67	SS-12	-	0	0	90	10	0	NP	NP	NP	3	A-3 (0)	
		30–33																
		34	8 8 9	22	67	SS-13	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		35–38																
F S		39	11 10 17	35	67	SS-14	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		40–43																
		44	9 10 12	28	67	SS-15	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		45–48																
	509.8	49	12 12 9	27	67	SS-16	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 22.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 514+49.40 / 146.4' Rt	**EXPLORATION ID**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	**B-050-0-11**	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 560.0 (MSL) EOB: 50.0 ft.	PAGE	
START: 11/9/11 END: 11/9/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.197372662 ° N / 84.471338961 ° W	1 OF 2	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1.0' - TOPSOIL (12.0")	560.0																	
	559.0																	
MEDIUM STIFF TO STIFF, BROWN AND GRAY **CLAY**, SOME SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		1	2 2 2	5	61	SS-1	1.25	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
		2																
		3																
		4	3 1 2	4	33	SS-2	1.50	6	5	6	28	55	46	22	24	25	A-7-6 (15)	
		5																
		6																
		7	2 2 3	6	67	SS-3	1.00	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
	552.0	8																
STIFF TO VERY STIFF, BROWNISH GRAY **SANDY SILT**, SOME FINE GRAVEL, SOME CLAY, DAMP TO MOIST.		9			88	ST-4	1.50	23	12	20	25	20	20	13	7	9	A-4a (2)	
-qu @ 9.8' = 1.42 tsf		10																
		11																
		12	3 8 7	19	56	SS-5	2.50	-	-	-	-	-	-	-	-	13	A-4a (V)	
		13																
-COBBLES PRESENT @ 14.0'		14	3 6 4	13	50	SS-6	2.75	-	-	-	-	-	-	-	-	11	A-4a (V)	
	544.5	15																
HARD, BROWNISH GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, MOIST.		16																
		17	5 18 16	44	56	SS-7	4.5+	21	12	16	34	17	25	12	13	11	A-6a (4)	
		18																
		19	14 15 12	35	33	SS-8	4.25	-	-	-	-	-	-	-	-	10	A-6a (V)	
	539.5	20																
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE CLAY, TRACE FINE GRAVEL, DRY TO DAMP.		21																
		22	9 14 15	37	56	SS-9	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		23																
F S		24	5 7 10	22	56	SS-10	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		25																
		26																
		27	9 11 15	33	61	SS-11	-	-	-	-	-	-	-	-	-	4	A-3 (V)	

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:10 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 514+49.40 / 146.4' Rt	START: 11/9/11	END: 11/9/11	PG 2 OF 2	B-050-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE CLAY, TRACE FINE GRAVEL, DRY TO DAMP. *(same as above)*	532.0	29	3 5 9	18	61	SS-12	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		30																
		31																
		32																
		33																
		34	4 6 11	22	67	SS-13	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		35																
		36																
		37																
		38																
F S		39	5 11 10	27	56	SS-14	-	1	33	56	9	1	NP	NP	NP	3	A-3 (0)	
		40																
		41																
		42																
		43																
		44	6 9 10	24	56	SS-15	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		45																
		46																
		47																
		48																
		49	9 11 13	31	56	SS-16	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
	510.0	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 23.1'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 515+95.19 / 136.2' Rt	**EXPLORATION ID B-051-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 561.7 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 11/9/11 END: 11/9/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.197685782 ° N / 84.471016526 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV. 561.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - TOPSOIL (3.0")	561.4																	
MEDIUM STIFF TO VERY STIFF, GRAYISH BROWN **ELASTIC SILT AND CLAY**, DAMP.		1	3 2 3	6	67	SS-1	2.50	-	-	-	-	-	-	-	-	29	A-5 (V)	
		2																
		3																
		4	2 1 3	5	56	SS-2	1.00	0	0	0	32	68	45	36	9	29	A-5 (9)	
	556.2	5																
STIFF TO VERY STIFF, BROWN **CLAY**, LITTLE SILT, TRACE FINE SAND, MOIST.		6																
		7	4 4 5	12	61	SS-3	1.25	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		8																
		9			88	ST-4	4.00	0	0	1	10	89	52	21	31	23	A-7-6 (18)	
	550.7	10																
VERY STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		11	7 10 13	30	67	SS-5	4.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
	548.7	12																
DENSE, BROWNISH GRAY **GRAVEL WITH SAND AND SILT**, MOIST.		13																
	546.2	14	5 13 14	35	44	SS-6	-	-	-	-	-	-	-	-	-	14	A-2-4 (V)	
VERY STIFF TO HARD, GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP.		15																
		16	10 7 10	22	67	SS-7	3.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
-COBBLES PRESENT @ 16.0'		17																
		18																
		19	4 12 14	33	39	SS-8	3.00	21	11	15	32	21	25	13	12	10	A-6a (4)	
		20																
		21																
		22	10 12 16	36	50	SS-9	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
	538.2	23																
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE FINE GRAVEL, TRACE CLAY, DRY TO DAMP.		24	13 13 14	35	67	SS-10	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		25																
		26																
		27	10 13 15	36	56	SS-11	-	-	-	-	-	-	-	-	-	3	A-3 (V)	

F S

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:10 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 515+95.19 / 136.2' Rt	START: 11/9/11	END: 11/9/11	PG 2 OF 2	B-051-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE FINE GRAVEL, TRACE CLAY, DRY TO DAMP. *(same as above)*	533.7	29	5 8 10	23	56	SS-12	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		30																
		31																
		32																
		33																
		34	4 6 8	18	61	SS-13	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		35																
		36																
		37																
		38																
		39	5 12 18	39	67	SS-14	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		40																
		41																
		42																
		43																
		44	14 15 18	42	50	SS-15	-	4	22	66	7	1	NP	NP	NP	3	A-3 (0)	
		45																
		46																
		47																
		48																
		49	10 12 17	37	56	SS-16	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
	511.7	EOB 50																

F S

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 15.5'; CAVE-IN DEPTH @ 23.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LB. BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 517+40.29 / 142.0' Rt	**EXPLORATION ID B-052-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 562.8 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 11/8/11 END: 11/8/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.197980553 ° N / 84.470655243 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV. 562.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.6' - TOPSOIL (7.0")	562.2																	
VERY STIFF, MOTTLED BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	559.8	1	5 5 4	12	67	SS-1	2.50	4	5	10	35	46	34	17	17	17	A-6b (11)	
STIFF, MOTTLED BROWN AND GRAY **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, MOIST.	554.8	4	2 3 4	9	50	SS-2	1.50	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
		7	3 3 4	9	56	SS-3	1.50	-	-	-	-	-	-	-	-	31	A-7-6 (V)	
VERY STIFF, BROWN TO GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE TO SOME FINE GRAVEL, DAMP TO MOIST.		10			75	ST-4	3.75	32	9	14	13	32	29	15	14	19	A-6a (3)	
		12	5 7 12	24	61	SS-5	3.25	-	-	-	-	-	-	-	-	14	A-6a (V)	
		15	6 4 4	10	67	SS-6	3.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
-COBBLES PRESENT @ 17.0'		17	4 13 11	31	61	SS-7	3.50	17	12	14	34	23	24	13	11	10	A-6a (5)	
		20	7 7 10	22	56	SS-8	3.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
	539.8	22	11 24 24	62	56	SS-9	4.00	-	-	-	-	-	-	-	-	12	A-6a (V)	
MEDIUM DENSE, BROWN **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE FINE GRAVEL, DRY TO DAMP.		25	7 9 13	28	44	SS-10	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
F S		27	13 12 11	30	67	SS-11	-	-	-	-	-	-	-	-	-	3	A-3 (V)	

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 517+40.29 / 142.0' Rt	START: 11/8/11	END: 11/8/11	PG 2 OF 2	B-052-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE, BROWN **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE FINE GRAVEL, DRY TO DAMP. *(same as above)*	534.8	29	4 6 10	21	56	SS-12	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		30																
		31																
		32																
		33																
		34	4 7 8	19	67	SS-13	-	1	2	89	7	1	NP	NP	NP	4	A-3 (0)	
		35																
		36																
		37																
		38																
F S		39	6 7 10	22	67	SS-14	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		40																
		41																
		42																
		43																
		44	6 9 11	26	67	SS-15	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
		45																
		46																
		47																
-BLOW COUNTS NOT RECORDED ON FIELD LOGS FOR SS-16		48																
		49			67	SS-16	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
	512.8	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 23.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 518+83.68 / 146.4' Rt	**EXPLORATION ID B-053-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / S.M.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 564.2 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 11/4/11 END: 11/4/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.198277606 ° N / 84.470301951 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV. 564.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - TOPSOIL (4.0")	563.9																	
DENSE, BROWN **GRAVEL AND SAND**, TRACE SILT, DAMP.	561.7	1	15 8 32	51	44	SS-1	-	-	-	-	-	-	-	-	-	5	A-1-b (V)	
MEDIUM STIFF TO STIFF, BROWN **SILTY CLAY**, SOME TO AND COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		3																
-SAMPLE INTERVAL FOR STANDARD SPLIT SPOON MISSED FROM 3.5' TO 5.0', SAMPLE 3S-2 OBTAINED TO GET REPRESENTATIVE SAMPLE FROM THIS AREA		5	8	-	100	3S-2A	0.75	1	4	32	28	35	30	13	17	19	A-6b (8)	
		7	4 5 6	14	78	SS-3	2.00	-	-	-	-	-	-	-	-	22	A-6b (V)	
-CONSOLIDATION TEST PERFORMED @ 8.5'		9			100	ST-4	-	1	3	17	37	42	35	16	19	14	A-6b (12)	
	553.2	11																
MEDIUM STIFF, GRAY **CLAY**, LITTLE SILT, TRACE FINE SAND, MOIST.	551.2	12	1 2 5	9	89	SS-5	1.00	0	0	1	19	80	48	21	27	29	A-7-6 (16)	
VERY STIFF, BROWN, BLACK AND GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DRY.	548.7	14	13 12 14	33	78	SS-6	3.00	-	-	-	-	-	-	-	-	8	A-4a (V)	
STIFF, BROWN AND GRAY **CLAY**, SOME SILT, LITTLE COARSE TO FINE SAND, MOIST.	546.2	17	3 4 3	9	89	SS-7	1.25	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
HARD, BROWN AND GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.	541.2	19	2 8 11	24	67	SS-8	4.5+	-	-	-	-	-	-	-	-	11	A-6a (V)	
		22	4 4 6	13	89	SS-9	4.5+	15	9	19	32	25	25	13	12	12	A-6a (5)	
MEDIUM DENSE, BROWN **SILT**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	538.7	24	11 10 12	28	89	SS-10	-	-	-	-	-	-	-	-	-	16	A-4b (V)	
VERY STIFF, BROWN **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, DRY.		27	8 10 13	30	33	SS-11	3.50	-	-	-	-	-	-	-	-	8	A-4a (V)	

ELI - OH DOT.GDT - 6/21/12 10:55 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 518+83.68 / 146.4' Rt	START: 11/4/11	END: 11/4/11	PG 2 OF 2	B-053-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE, BROWN **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE CLAY, TRACE FINE GRAVEL, DRY TO DAMP.	536.2	29	6 9 8	22	72	SS-12	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		30																
		31																
		32																
		33																
		34	7 6 9	19	78	SS-13	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		35																
		36																
		37																
		38																
F S		39	5 8 12	26	83	SS-14	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
		40																
		41																
		42																
		43																
		44	6 8 9	22	89	SS-15	-	3	26	63	5	3	NP	NP	NP	2	A-3 (0)	
		45																
		46																
		47																
		48																
		49	5 9 11	26	89	SS-16	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
	514.2	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 27.2'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS. BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 520+22.83 / 156.4' Rt	**EXPLORATION ID**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	**B-054-0-11**	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 565.0 (MSL) EOB: 50.0 ft.	PAGE	
START: 11/7/11 END: 11/7/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.198563487 ° N / 84.469953404 ° W	1 OF 2	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.7' - TOPSOIL (8.0")	564.3																	
STIFF TO VERY STIFF, BROWN AND BLACK TO MOTTLED BROWN AND GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST. -TRACE ORGANICS PRESENT IN SS-1		1	2 3 5	10	56	SS-1	2.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
		2																
		3	3 4 5	12	44	SS-2	2.50	-	-	-	-	-	-	-	-	20	A-6a (V)	
		4																
		5																
		6	3 5 7	15	72	SS-3	2.50	19	7	10	31	33	29	17	12	17	A-6a (7)	
		7																
		8																
		9			0	ST-4	-	-	-	-	-	-	-	-	-	-		
	554.0	10																
VERY STIFF, GRAY **CLAY**, SOME SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		11	5 9 16	32	0	SS-5	-	-	-	-	-	-	-	-	-	-		
		12	23	-	100	3S-5A	-	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
	551.5	13																
STIFF, GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		14	5 4 5	12	56	SS-6	1.50	-	-	-	-	-	-	-	-	15	A-6b (V)	
	549.5	15																
VERY STIFF TO HARD, GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP.		16	6 8 9	22	0	SS-7	-	-	-	-	-	-	-	-	-	-		
-COBBLES PRESENT @ 17.5'		17	12	-	100	3S-7	3.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
		18																
		19	4 5 8	17	56	SS-8	2.50	22	11	14	29	24	24	15	9	11	A-4a (4)	
		20																
-COBBLES PRESENT @ 21.0'		21	8 15 25	51	83	SS-9	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)	
	542.0	22																
VERY STIFF, GRAY **SILT**, SOME COARSE TO FINE SAND, LITTLE CLAY, TRACE FINE GRAVEL, WET.		23																
		24	13 6 13	24	56	SS-10	3.50	-	-	-	-	-	-	-	-	24	A-4b (V)	
	539.5	25																
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, LITTLE COARSE SAND, LITTLE SILT, DRY TO DAMP.		26	18 16 15	40	67	SS-11	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		27																

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 520+22.83 / 156.4' Rt	START: 11/7/11	END: 11/7/11	PG 2 OF 2	B-054-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN **FINE SAND**, LITTLE COARSE SAND, LITTLE SILT, DRY TO DAMP. *(same as above)*	537.0	29	4 8 10	23	50	SS-12	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		30																
		31																
		32																
		33																
		34	17 22 16	49	39	SS-13	-	-	-	-	-	-	-	-	-	2	A-3 (V)	
		35																
		36																
		37																
		38																
F S		39	4 9 11	26	67	SS-14	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		40																
		41																
		42																
		43																
		44	5 11 11	28	61	SS-15	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		45																
		46																
		47																
		48																
	515.0	49	7 9 11	26	67	SS-16	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
	EOB	50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 23.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 521+64.10 / 164.9' Rt	**EXPLORATION ID**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	**B-055-0-11**	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 565.2 (MSL) EOB: 50.0 ft.	PAGE	
START: 11/8/11 END: 11/8/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.198864156 ° N / 84.469613398 ° W	1 OF 2	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.8' - TOPSOIL (10.0")	565.2 / 564.4																	
FILL: LOOSE TO MEDIUM DENSE, BROWN AND BLACK **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP TO MOIST. -CLAY TILE FRAGMENTS PRESENT THROUGHOUT		1	4 6 4	13	50	SS-1	-	27	12	30	18	13	23	15	8	12	A-2-4 (0)	
		2																
		3																
		4	3 2 2	5	67	SS-2	-	-	-	-	-	-	-	-	-	18	A-2-4 (V)	
		5																
	559.7	6																
MEDIUM DENSE, BROWN **FINE SAND**, TRACE SILT, DAMP.		7	4 7 4	14	67	SS-3	-	-	-	-	-	-	-	-	-	9	A-3 (V)	
	557.2	8																
VERY LOOSE TO LOOSE, BROWN **SANDY SILT**, LITTLE CLAY, MOIST TO WET.		9	3 3 3	8	61	SS-4	-	-	-	-	-	-	-	-	-	14	A-4a (V)	
		10																
		11	3 2 3	6	67	SS-5	-	0	0	56	25	19	NP	NP	NP	14	A-4a (2)	
		12																
		13																
		14	2 1 1	3	61	SS-6	-	-	-	-	-	-	-	-	-	26	A-4a (V)	
		15																
		16																
		17	1 2 2	5	67	SS-7	-	-	-	-	-	-	-	-	-	30	A-4a (V)	
	547.2	18																
VERY STIFF TO HARD, GRAY **SANDY SILT**, SOME CLAY, SOME FINE GRAVEL, DAMP.		19	3 6 5	14	56	SS-8	3.75	-	-	-	-	-	-	-	-	10	A-4a (V)	
		20																
		21																
		22	7 9 10	24	67	SS-9	4.5+	22	12	14	27	25	24	15	9	12	A-4a (3)	
	542.2	23																
VERY STIFF, BROWN **SILT**, SOME FINE SAND, LITTLE CLAY, WET.		24	9 7 15	28	72	SS-10	4.00	-	-	-	-	-	-	-	-	23	A-4b (V)	
	539.7	25																
MEDIUM DENSE, BROWN **FINE SAND**, LITTLE COARSE SAND, TRACE SILT, DRY TO DAMP.		26																
		27	14 11 11	28	56	SS-11	-	-	-	-	-	-	-	-	-	4	A-3 (V)	

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:10 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 521+64.10 / 164.9' Rt	START: 11/8/11	END: 11/8/11	PG 2 OF 2	B-055-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV. 537.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE, BROWN **FINE SAND**, LITTLE COARSE SAND, TRACE SILT, DRY TO DAMP. *(same as above)*		29	9 6 7	17	67	SS-12	-	-	-	-	-	-	-	-	-	3	A-3 (V)	
		30–33																
		34	10 6 5	14	61	SS-13	-	-	-	-	-	-	-	-	-	7	A-3 (V)	
		35–38																
FS		39	4 5 6	14	72	SS-14	-	-	-	-	-	-	-	-	-	8	A-3 (V)	
		40–43																
		44	8 8 9	22	56	SS-15	-	-	-	-	-	-	-	-	-	7	A-3 (V)	
		45–48																
	515.2	49 EOB 50	5 5 8	17	61	SS-16	-	-	-	-	-	-	-	-	-	5	A-3 (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 22.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LB. BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / A.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 523+33.46 / 148.5' Rt	**EXPLORATION ID**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	**B-056-0-11**	
PID: 77889 BR ID: NA	DRILLING METHOD: 3.25" - HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 566.0 (MSL) EOB: 50.0 ft.	PAGE	
START: 11/29/11 END: 11/29/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.4	LAT / LONG : 39.19927707 ° N / 84.46929617 ° W	1 OF 2	

MATERIAL DESCRIPTION AND NOTES	ELEV. 566.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1.0' - TOPSOIL (12.0")	565.0																	
VERY LOOSE, BROWN **GRAVEL AND SAND**, TRACE SILT, MOIST.	563.0	1	1 2 1	4	44	SS-1	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
SOFT, BROWN **SANDY SILT**, SOME CLAY, MOIST.	560.5	4	2 3 3	8	39	SS-2	0.50	0	8	33	39	20	22	16	6	18	A-4a (5)	
STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, MOIST.	556.4	7	2 4 5	12	56	SS-3	1.50	-	-	-	-	-	-	-	-	20	A-6a (V)	
		9			58	ST-4	1.25	-	-	-	-	-	-	-	-	-	A-6a (V)	
VERY LOOSE TO MEDIUM DENSE, LIGHT BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE FINE GRAVEL, DAMP TO MOIST.		10					-	-	-	-	-	-	-	-	-	11	A-3 (V)	
		12	2 3 2	7	61	SS-5	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
		14	2 1 2	4	56	SS-6	-	-	-	-	-	-	-	-	-	10	A-3a (V)	
		17	7 5 5	13	44	SS-7	-	1	21	58	18	2	NP	NP	NP	5	A-3a (0)	
		19	4 5 5	13	61	SS-8	-	-	-	-	-	-	-	-	-	6	A-3a (V)	
		22	5 3 3	8	50	SS-9	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
	543.0																	
STIFF, LIGHT BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.	540.5	24	7 6 8	18	11	SS-10	1.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
VERY LOOSE TO LOOSE, LIGHT BROWN **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, DAMP TO WET.		27	2 2 2	5	61	SS-11	-	-	-	-	-	-	-	-	-	13	A-3 (V)	

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:11 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 523+33.46 / 148.5' Rt	START: 11/29/11	END: 11/29/11	PG 2 OF 2	B-056-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY LOOSE TO LOOSE, LIGHT BROWN **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, DAMP TO WET. *(same as above)*	538.0	29	1 2 1	4	67	SS-12	-	-	-	-	-	-	-	-	-	12	A-3 (V)	
		30–38																
		34	WOH WOH 1	1	61	SS-13	-	-	-	-	-	-	-	-	-	34	A-3 (V)	
		35–38																
		39	2 2 2	5	56	SS-14	-	0	6	86	7	1	NP	NP	NP	8	A-3 (0)	
		40–43																
		44	3 2 3	7	61	SS-15	-	-	-	-	-	-	-	-	-	11	A-3 (V)	
		45–48																
	519.0	49	5 6 7	17	61	SS-16	-	-	-	-	-	-	-	-	-	8	A-3 (V)	
MEDIUM DENSE, LIGHT BROWN **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, DAMP.	516.0	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 30.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LB. BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / A.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 524+76.23 / 140.3' Rt	**EXPLORATION ID B-057-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 3.25" - HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 565.7 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 11/21/11 END: 11/21/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.4	LAT / LONG : 39.199621604 ° N / 84.469026372 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV. 565.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - ASPHALT (3.0")	565.4																	
0.7' - CONCRETE (8.0")	564.7																	
LOOSE, GRAY **GRAVEL WITH SAND, SILT, AND CLAY**, DAMP.	562.7	1	5 4 1	7	33	SS-1	-	-	-	-	-	-	-	-	-	6	A-2-6 (V)	
VERY LOOSE TO MEDIUM DENSE, GRAY **SANDY SILT**, TRACE TO SOME CLAY, TRACE FINE GRAVEL, MOIST.		2																
		3	2 3 5	10	33	SS-2	-	-	-	-	-	-	-	-	-	16	A-4a (V)	
		4																
		5																
		6	2 2 2	5	33	SS-3	-	5	10	30	29	26	NP	NP	NP	17	A-4a (4)	
		7																
		8																
		9	WOH WOH WOH	0	39	SS-4	-	-	-	-	-	-	-	-	-	21	A-4a (V)	
		10																
		11																
		12	2 2 3	7	39	SS-5	-	-	-	-	-	-	-	-	-	20	A-4a (V)	
		13																
		14	WOH 2 1	4	33	SS-6	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
		15																
		16																
		17	3 2 4	8	56	SS-7	-	0	16	45	38	1	NP	NP	NP	13	A-4a (1)	
		18																
		19	3 4 5	12	50	SS-8	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
	545.2	20																
MEDIUM DENSE, GRAY **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, DAMP.		21																
		22	5 6 4	13	61	SS-9	-	-	-	-	-	-	-	-	-	6	A-3a (V)	
	542.7	23																
STIFF, GRAY **CLAY**, AND SILT, TRACE COARSE TO FINE SAND, MOIST.		24	2 1 2	4	61	SS-10	1.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		25																
		26																
		27	WOH 2 1	4	67	SS-11	1.25	0	1	2	49	48	42	19	23	22	A-7-6 (14)	

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 524+76.23 / 140.3' Rt	START: 11/21/11	END: 11/21/11	PG 2 OF 2	B-057-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
STIFF TO VERY STIFF, GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	537.7	29	3 4 6	13	61	SS-12	2.25	-	-	-	-	-	-	-	-	19	A-6a (V)	
		30																
		31			88	ST-13	1.50	7	4	15	46	28	27	16	11	19	A-6a (8)	
	533.2	32																
MEDIUM DENSE, BROWN **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, DRY TO DAMP.		33																
		34	10 11 6	22	61	SS-14	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
		35																
		36																
		37																
		38																
		39	6 5 4	12	67	SS-15	-	-	-	-	-	-	-	-	-	8	A-3 (V)	
F S		40																
		41																
		42																
		43																
		44	5 7 8	20	67	SS-16	-	-	-	-	-	-	-	-	-	6	A-3 (V)	
		45																
		46																
		47																
		48																
		49	10 11 10	27	67	SS-17	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
	515.7	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 44.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / A.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 526+17.22 / 124.2' Rt	**EXPLORATION ID B-058-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 3.25" - HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 566.8 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 11/23/11 END: 11/23/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.4	LAT / LONG : 39.199970997 ° N / 84.468791636 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - ASPHALT (3.0")	566.8																	
0.8' - CONCRETE (8.0")	566.5																	
0.6' - AGGREGATE BASE (7.0")	565.7																	
VERY STIFF, BROWNISH GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, DAMP.	565.1	1	11 13 7	26	33	SS-1	3.75	-	-	-	-	-	-	-	-	13	A-6a (V)	
STIFF TO VERY STIFF, BROWNISH GRAY **CLAY**, AND COARSE TO FINE SAND, SOME SILT, MOIST.	563.8	2																
		3																
		4	3 4 5	12	33	SS-2	2.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		5																
		6																
		7	2 3 3	8	56	SS-3	1.50	0	2	36	30	32	47	18	29	21	A-7-6 (14)	
		8																
		9			42	ST-4	1.50	0	2	36	28	34	43	17	26	21	A-7-6 (12)	
	556.3	10																
VERY STIFF TO HARD, BROWNISH GRAY TO BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST.		11																
		12	3 5 7	16	56	SS-5	3.00	-	-	-	-	-	-	-	-	22	A-6b (V)	
		13																
		14	3 4 6	13	67	SS-6	4.50	-	-	-	-	-	-	-	-	23	A-6b (V)	
	551.3	15																
HARD, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.		16																
		17	6 9 12	27	67	SS-7	4.5+	16	11	16	34	23	30	15	15	12	A-6a (6)	
	548.8	18																
MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, LITTLE SILT, TRACE CLAY, MOIST.		19	8 9 10	25	56	SS-8	-	-	-	-	-	-	-	-	-	14	A-3a (V)	
	546.3	20																
HARD, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.		21																
W		22	11 24 21	59	56	SS-9	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
	543.8	23																
VERY STIFF, BROWN **SILT**, LITTLE CLAY, LITTLE COARSE TO FINE SAND, WET.		24	9 9 16	33	67	SS-10	4.00	-	-	-	-	-	-	-	-	21	A-4b (V)	
	541.3	25																
MEDIUM DENSE TO VERY DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, DAMP.		26																
		27	8 10 13	30	61	SS-11	-	-	-	-	-	-	-	-	-	6	A-3a (V)	

2010 ODOT BORING LOG-RII-WITH LAT/LONG - OH DOT.GDT - 6/21/12 11:11 - G:\GINT8\PROJECTS\2010\B-10-020\B-10-020 B-044 TO B-061.GPJ

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 526+17.22 / 124.2' Rt	START: 11/23/11	END: 11/23/11	PG 2 OF 2	B-058-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO VERY DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, DAMP. *(same as above)*	538.8	29	8 11 13	31	67	SS-12	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
		30																
		31																
		32																
		33																
		34	13 21 23	57	56	SS-13	-	-	-	-	-	-	-	-	-	5	A-3a (V)	
		35																
		36																
		37																
		38																
		39	9 11 13	31	56	SS-14	-	0	1	78	18	3	NP	NP	NP	8	A-3a (0)	
		40																
		41																
		42																
		43																
		44	7 11 11	29	56	SS-15	-	-	-	-	-	-	-	-	-	5	A-3a (V)	
		45																
		46																
		47																
		48																
		49	11 11 10	27	61	SS-16	-	-	-	-	-	-	-	-	-	6	A-3a (V)	
	516.8	EOB 50																

NOTES: GROUNDWATER INITIALY ENCOUNTERED @ 22.0'; CAVE-IN DEPTH @ 21.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / A.B.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 527+50.52 / 135.9' Rt	**EXPLORATION ID**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / T.F.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	**B-059-0-11**	
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 570.5 (MSL) EOB: 50.0 ft.	PAGE	
START: 12/6/11 END: 12/6/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.200281574 ° N / 84.468509172 ° W	1 OF 2	

MATERIAL DESCRIPTION AND NOTES	ELEV. 570.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.4' - ASPHALT (5.0")	570.1																	
0.8' - CONCRETE (9.0")	569.3																	
VERY STIFF TO HARD, BROWN TO BROWNISH GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		1																
		2	10 7 5	15	39	SS-1	2.75	-	-	-	-	-	-	-	-	18	A-6b (V)	
		3																
		4	2 4 6	13	44	SS-2	4.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
	565.0	5																
MEDIUM STIFF TO STIFF, GRAY **CLAY**, SOME SILT, MOIST.		6																
		7	3 3 6	12	89	SS-3	2.50	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
		8																
		9	2 3 3	8	83	SS-4	2.00	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
		10																
		11																
		12	2 2 3	6	67	SS-5	1.00	0	0	0	29	71	52	22	30	31	A-7-6 (18)	
		13																
		14	2 2 3	6	100	SS-6	1.25	-	-	-	-	-	-	-	-	31	A-7-6 (V)	
		15																
		16																
		17	1 2 2	5	100	SS-7	1.25	-	-	-	-	-	-	-	-	35	A-7-6 (V)	
		18																
		19	3 4 5	12	89	SS-8	1.50	-	-	-	-	-	-	-	-	27	A-7-6 (17)	
	550.0	20																
VERY STIFF TO HARD, GRAY TO BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP TO MOIST.		21																
		22	3 5 7	15	100	SS-9	3.75	-	-	-	-	-	-	-	-	10	A-6a (V)	
		23																
		24	4 6 8	18	72	SS-10	3.50	12	8	16	38	26	26	13	13	12	A-6a (7)	
		25																
		26																
		27	4 21 28	63	67	SS-11	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 527+50.52 / 135.9' Rt	START: 12/6/11	END: 12/6/11	PG 2 OF 2	B-059-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY DENSE, GRAY **GRAVEL**, LITTLE COARSE TO FINE SAND, DRY.	542.5	29	13 16 26	54	17	SS-12	-	-	-	-	-	-	-	-	-	0	A-1-a (V)	
	538.5	30																
MEDIUM DENSE TO DENSE, GRAYISH BROWN **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, DRY.		31																
		32																
		33																
		34	7 9 13	28	67	SS-13	-	-	-	-	-	-	-	-	-	2	A-3a (V)	
		35																
		36																
		37																
		38																
		39	7 8 10	23	83	SS-14	-	0	1	88	9	2	NP	NP	NP	3	A-3a (0)	
		40																
		41																
		42																
		43																
		44	7 10 15	32	94	SS-15	-	-	-	-	-	-	-	-	-	3	A-3a (V)	
		45																
		46																
		47																
		48																
		49	7 3 9	15	78	SS-16	-	-	-	-	-	-	-	-	-	3	A-3a (V)	
	520.5	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 29.6'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / A.B.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 528+76.00 / 183.5' Rt	**EXPLORATION ID B-060-0-11**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / T.F.	HAMMER: CME AUTOMATIC	ALIGNMENT: PROPOSED CL I-75		
PID: 77889 BR ID: NA	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 575.9 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 12/7/11 END: 12/7/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.1	LAT / LONG : 39.200523523 ° N / 84.468135429 ° W		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - ASPHALT (4.0")	575.9																	
0.4' - CONCRETE (5.0")	575.6																	
SOFT TO STIFF, DARK BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	575.2	1	1 2 2	5	50	SS-1	1.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
		2																
		3																
		4	1 1 1	3	78	SS-2	0.50	5	2	25	37	31	33	15	18	20	A-6b (10)	
		5																
	570.4	6																
STIFF TO VERY STIFF, MOTTLED BROWN AND GRAY **CLAY**, AND SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		7	3 7 9	21	89	SS-3	3.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
		8																
		9			96	ST-4	2.50	2	2	5	39	52	43	20	23	20	A-7-6 (14)	
-qu @ 9.8' = 3.3 tsf		10																
		11																
	562.9	12	1 3 3	8	61	SS-5	2.00	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
SOFT TO MEDIUM STIFF, GRAY **CLAY**, SOME SILT, MOIST.		13																
		14	1 1 1	3	100	SS-6	0.50	-	-	-	-	-	-	-	-	34	A-7-6 (V)	
		15																
		16																
		17	2 2 4	8	100	SS-7	1.00	0	0	0	23	77	55	22	33	32	A-7-6 (V)	
		18																
		19	2 3 4	9	100	SS-8	1.00	-	-	-	-	-	-	-	-	34	A-7-6 (V)	
		20																
		21																
		22	2 4 3	9	100	SS-9	1.00	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
	552.9	23																
VERY STIFF TO HARD, GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY TO MOIST.		24	5 9 10	24	89	SS-10	3.25	-	-	-	-	-	-	-	-	14	A-6a (V)	
		25																
		26																
		27	9 12 14	33	100	SS-11	3.00	-	-	-	-	-	-	-	-	12	A-6a (V)	

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 528+76.00 / 183.5' Rt	START: 12/7/11	END: 12/7/11	PG 2 OF 2	B-060-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY TO MOIST. *(same as above)*	547.9	29	6 9 10	24	94	SS-12	3.25	-	-	-	-	-	-	-	-	9	A-6a (V)	
		30																
		31																
		32																
		33																
		34	13 13 22	45	67	SS-13	4.25	-	-	-	-	-	-	-	-	20	A-6a (V)	
		35																
	538.9	36																
MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, DAMP.		37																
		38																
		39	6 8 11	24	67	SS-14	-	0	1	86	10	3	NP	NP	NP	5	A-3a (0)	
		40																
		41																
		42																
		43																
		44	12 8 12	26	83	SS-15	-	-	-	-	-	-	-	-	-	4	A-3a (V)	
		45																
	528.9	46																
VERY DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, DAMP.		47																
		48																
		49	7 23 23	59	100	SS-16	-	-	-	-	-	-	-	-	-	5	A-3a (V)	
	525.9	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 41.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: HAM-75-7.85	DRILLING FIRM / OPERATOR: RII / A.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 530+23.82 / 195.3' Rt	**EXPLORATION ID**	
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: AUTOMATIC	ALIGNMENT: PROPOSED CL I-75	**B-061-0-11**	
PID: 77889 BR ID: NA	DRILLING METHOD: 3.25" - HSA	CALIBRATION DATE: 5/6/11	ELEVATION: 586.9 (MSL) EOB: 50.0 ft.	PAGE	
START: 11/30/11 END: 11/30/11	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.4	LAT / LONG : 39.20086991 ° N / 84.467835916 ° W	1 OF 2	

MATERIAL DESCRIPTION AND NOTES	ELEV. 586.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.3' - ASPHALT (4.0")	586.6																	
0.8' - CONCRETE (9.0")	585.8																	
STIFF TO VERY STIFF, DARK BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		1	3 3 3	8	56	SS-1	1.50	-	-	-	-	-	-	-	-	16	A-6b (V)	
		2																
		3																
		4	3 5 5	13	50	SS-2	2.75	1	2	25	41	31	37	16	21	19	A-6b (12)	
		5																
		6	1 2 2	5	11	SS-3	3.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
		7																
	578.9	8																
VERY STIFF TO HARD, BROWNISH GRAY TO GRAY **CLAY**, SOME TO AND SILT, TRACE TO LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		9			60	ST-4	4.00	6	4	10	33	47	46	20	26	22	A-7-6 (16)	
		10																
-CU TRIAXIAL TEST PERFORMED @ 9.5'		11	5 6 8	18	61	SS-5	4.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		12																
		13																
		14	5 5 6	14	61	SS-6	4.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		15																
		16																
		17	3 5 8	17	61	SS-7	3.50	0	1	0	42	57	42	20	22	26	A-7-6 (13)	
		18																
		19	2 5 4	12	72	SS-8	2.50	-	-	-	-	-	-	-	-	33	A-7-6 (V)	
	566.4	20																
STIFF, GRAY **CLAY**, SOME SILT, MOIST.		21																
		22	3 5 7	16	56	SS-9	2.00	-	-	-	-	-	-	-	-	33	A-7-6 (V)	
		23																
		24	3 5 6	14	61	SS-10	2.00	-	-	-	-	-	-	-	-	32	A-7-6 (V)	
		25																
		26																
		27	3 3 5	10	67	SS-11	1.25	0	0	0	26	74	52	24	28	33	A-7-6 (18)	

PID: 77889	BR ID: NA	PROJECT: HAM-75-7.85	STATION / OFFSET: 530+23.82 / 195.3' Rt	START: 11/30/11	END: 11/30/11	PG 2 OF 2	B-061-0-11

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
STIFF, GRAY **CLAY**, SOME SILT, MOIST. *(same as above)*	558.9	29	3 4 4	10	78	SS-12	1.25	-	-	-	-	-	-	-	-	33	A-7-6 (V)	
	554.9	30																
VERY STIFF TO HARD, GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		31																
		32																
		33																
		34	4 8 11	25	83	SS-13	4.00	-	-	-	-	-	-	-	-	10	A-6a (V)	
		35																
		36																
		37																
		38																
		39	6 11 13	31	67	SS-14	4.00	19	12	15	33	21	29	14	15	10	A-6a (6)	
-COBBLES PRESENT @ 40.5'		40																
		41																
		42																
		43																
		44	17 23 30	69	61	SS-15	4.5+	-	-	-	-	-	-	-	-	14	A-6a (V)	
		45																
	539.9	46																
DENSE, LIGHT BROWN **FINE SAND**, TRACE SILT, DRY.		47																
F S		48																
		49	14 17 20	48	50	SS-16	-	-	-	-	-	-	-	-	-	4	A-3 (V)	
	536.9 EOB	50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 12.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LB. BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-001-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/6/07
Date Finished: 6/6/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 61+47
Offset: 141.9 R
Elevation: 557.01 ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				4" - Topsoil (0.4)			
SS-1	4 6 8	83	2.5	Stiff to medium stiff, brown SANDY SILT, some to trace fine gravel, dry to moist. -SS-1: ODOT A-4A; qh = 4.5 tsf	6	26	16
AS-2	4 5 6	0	5.0	-AS-2: *Visual ODOT A-4a; qh = 2.5 tsf	13		
SS-3	3 3 4	83	7.5	-SS-3: *Visual ODOT A-4a; qh = 4.0 tsf			
SS-4A	3 4 5	89		-SS-4A: ODOT A-4a; qh = 3.5 tsf (9.5)	15	25	15
SS-4B			10.0	Medium stiff, dark brown SILT and CLAY, some coarse to fine sand, trace fine gravel, damp. -SS-4B: *Visual ODOT A-6a; qh = 2.0 tsf			
			12.5				
SS-5	4 3 2	67	15.0	-SS-5: *Visual ODOT A-6a; qh = 2.0 tsf (15.0)			

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE
- SS - Split Spoon Sample
- GS - Geoprobe Sample
- ST - Shelby Tube
- RC - Rock Core
- AS - Auger Sample
- BS - Bag Sample

GROUND WATER READING
- Initial: Dry ft
- At Completion: Dry *** ft
- Extended: NA ft

***Cave-in depth @ 27.1'

BORING METHOD
- HSA - Hollow Stem Augers
- SFA - Solid Flight Augers
- MD - Mud Drilling
- WD - Wash Drilling
- RC - Rock Coring

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-001-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Loose to very loose, dark brown fine GRAVEL and fine to coarse sand, some silt, trace glass fragments, damp.			
SS-6	1 2 1	44	20.0	-SS-6: *Visual ODOT A-1-b	12		
			22.5	Loose to medium dense, dark brown fine GRAVEL and fine to coarse sand, some silt, dry.			
SS-7	3 4 4	89	25.0	-SS-7: *Visual A-1-b			
			27.5				
SS-8	5 7 8	89	30.0	-SS-8: ODOT A-1-b	3		
			32.5				
SS-9	5 6 7	94	35.0	-SS-9: *Visual ODOT A-1-b			
				Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-002-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/6/07
Date Finished: 6/6/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 63+03
Offset: 108.4 R
Elevation: 556.0 ± ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				4.0" - Asphalt (0.4)			
				10.0" - Concrete (1.2)			
				8' - Base material (1.8)			
SS-1	7 5 4	56	2.5	FILL: Stiff, brown CLAY, trace coarse to fine sand, trace fine gravel, damp to moist. -SS-1: *Visual ODOT A-7-6; qh = 4.5 tsf	15		
SS-2	3 5 6	100	5.0	-SS-2: ODOT A-7-6; qh = 4.0 tsf	24	44	22
SS-3	3 6 8	89	7.5	-SS-3: *Visual ODOT A-7-6; qh = 3.0 tsf (8.0)			
SS-4	2 3 4	100	10.0	FILL: Medium stiff, brown SILT and CLAY, little coarse to fine sand, trace coarse to fine gravel, damp. -SS-4: *Visual ODOT A-6a; qh = 4.0 tsf	17		
			12.5	(13.5)			
SS-5	5 5 5	89	15.0	FILL: Loose, brown SANDY SILT, trace coarse to fine gravel, trace glass fragments, damp. -SS-5: *Visual ODOT A-4a			

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial: Dry ft
At Completion: Dry ft
Extended: NA ft

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-002-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
			16.0				
				Loose to medium dense, brown fine SAND, trace fine gravel, trace silt, dry.			
			17.5				
SS-6	2 3 5	94		-SS-6: ODOT A-3	2		
			20.0				
			22.5				
SS-7	4 6 8	100		-SS-7: *Visual ODOT A-3			
			25.0				
			27.5				
SS-8	10 11 12	78		-SS-8: *Visual ODOT A-3	4		
			30.0				
				Medium dense, brown fine GRAVEL, and coarse to fine sand, trace silt, damp.			
			32.5				
SS-9	8 11 13	94		-SS-9: *Visual ODOT A-1-b			
			35.0				
				Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-003-0-07
Sheet: 1 of 2
Completion Depth: 30.0'

Date Started: 6/6/07
Date Finished: 6/6/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 64+53
Offset: 108.4 R
Elevation: 558.1 ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				6" - Topsoil (0.5)			
SS-1	6 7 9	100	2.5	Medium dense, brown coarse to fine GRAVELY coarse to fine SAND, little silt, dry. -SS-1: *Visual ODOT A-2-6 (3.0)	5		
SS-2	4 5 6	78	5.0	Stiff, brown SILT and CLAY, little coarse to fine sand, trace fine gravel, damp. -SS-2: ODOT A-6a; qh = 4.5 tsf	13	32	17
SS-3	4 5 5	100	7.5	-SS-3: *Visual ODOT A-6a; qh = 4.25 tsf (8.0)			
SS-4	5 6 7	100	10.0	Stiff, brown SANDY SILT, trace fine gravel, moist. -SS-4: *Visual ODOT A-4a; qh = 2.0 tsf	15		
			12.5	(12.5)			
SS-5	6 6 7	56	15.0	Medium dense, brown fine SAND, trace silt, dry. -SS-5: *Visual ODOT A-3			

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE
- SS - Split Spoon Sample
- GS - Geoprobe Sample
- ST - Shelby Tube
- RC - Rock Core
- AS - Auger Sample
- BS - Bag Sample

GROUND WATER READING
- Initial: Dry ft
- At Completion: Dry *** ft
- Extended: NA ft

***Cave-in depth @ 26.2'

BORING METHOD
- HSA - Hollow Stem Augers
- SFA - Solid Flight Augers
- MD - Mud Drilling
- WD - Wash Drilling
- RC - Rock Coring

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
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(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-003-0-07
Sheet: 2 of 2
Completion Depth: 30.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
			17.5				
SS-6	5 7 8	100		-SS-6: ODOT A-3			
			20.0				
			22.5				
SS-7	6 10 13	83		-SS-7: *Visual ODOT A-3			
			25.0				
			27.5				
SS-8	7 10 10	78		-SS-8: *Visual ODOT A-3			
			30.0	30.0			
				Bottom of Boring = 30.0 feet			
			32.5				
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-004-0-07
Sheet: 1 of 2
Completion Depth: 30.0'

Date Started: 6/6/07
Date Finished: 6/6/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 66+04
Offset: 108.2 R
Elevation: 558.89 ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				5" - Topsoil (0.5)			
SS-1	8 8 7	89	2.5	Stiff, brown SANDY SILT, trace fine gravel, dry. -SS-1: ODOT A-4a; qh = 4.0 tsf (3.0)	4	22	13
SS-2	3 3 4	100	5.0	Medium stiff to stiff, brown changing to brownish gray CLAY, trace coarse to fine sand, trace fine gravel, damp to moist. -SS-2: *Visual ODOT A-7-6; qh = 4.0 tsf	20		
SS-3	3 4 6	100	7.5	-SS-3: *Visual ODOT A-7-6; qh = 3.5 tsf			
SS-4	5 6 8	100	10.0	-SS-4: ODOT A-7-6; qh = 4.25 tsf	29	49	22
			12.5				
SS-5	5 13 11	89	15.0	Very stiff, brownish gray CLAY, trace coarse to fine sand, trace fine gravel, damp to moist. -SS-5: *Visual ODOT A-7-6; qh = 2.25 tsf (13.5)			

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 24.6'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-004-0-07
Sheet: 2 of 2
Completion Depth: 30.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Same as above			
				18.0			
SS-6	4 8 8	100	20.0	Medium dense to loose, brown fine SAND, trace fine gravel, dry. -SS-6: *Visual ODOT A-3	3		
			22.5				
SS-7	2 3 3	100	25.0	-SS-7: ODOT A-3	7	NP	NP
			27.5				
SS-8	5 6 9	100	30.0	-SS-8: *Visual ODOT A-3			
				30.0			
				Bottom of Boring = 30.0 feet			
			32.5				
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-005-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/6/07
Date Finished: 6/6/07
Drilled By: I.C.

DRILLING AND SAMPLING INFORMATION

Station: 67+43
Offset: 109.0 R
Elevation: 559.64 ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				5" - Topsoil (0.4)			
SS-1	4 5 5	67	2.5	Stiff, brown SILTY CLAY, little fine to coarse sand, little fine gravel, damp. -SS-1: ODOT A-6b; qh = 4.5 tsf (3.0)	13	37	21
SS-2	3 2 3	100	5.0	Medium stiff, brown CLAY, trace coarse to fine sand, trace fine gravel, moist. -SS-2: *Visual ODOT A-7-6; qh = 2.25 tsf			
SS-3	2 3 3	100	7.5	-SS-3: ODOT A-7-6; qh = 4.0 tsf	34	50	25
SS-4	2 3 3	100	10.0	-SS-4: ODOT A-7-6; qh = 2.0 tsf (12.0)			
SS-5	5 7 10	100	12.5 15.0	Very stiff, grayish brown CLAY, trace coarse to fine sand, trace fine gravel, damp. -drillers noted cobbles in SS-5 -SS-5: *Visual ODOT A-7-6; qh = 3.0 tsf	11		

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 22.0'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-005-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
			17.5	17.5			
			17.5	Medium dense, brown fine SAND, trace fine gravel, trace silt, dry.			
SS-6	5 8 11	100		-SS-6: *Visual ODOT A-3			
			20.0				
			22.5				
SS-7	5 6 10	100		-SS-7: ODOT A-3	6		
			25.0				
			27.5				
SS-8	5 6 10	100		-SS-8: *Visual ODOT A-3			
			30.0	30.0			
				Bottom of Boring = 30.0 feet			
			32.5				
SS-9	6 10 13	100					
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-006-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/6/07
Date Finished: 6/6/07
Drilled By: I.C.

DRILLING AND SAMPLING INFORMATION

Station: 68+95
Offset: 107.6 R
Elevation: 560.21 ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				9" - Topsoil (0.8)			
SS-1	2 2 3	56	2.5	Medium stiff, brown SILT and CLAY, and fine to coarse sand, little fine gravel, moist. (3.0) -SS-1: ODOT A-6a; qh = 3.0 tsf	17	28	16
SS-2	3 4 6	78	5.0	Stiff to medium stiff, brown changing to gray CLAY, trace fine sand, moist. -SS-2: *Visual ODOT A-7-6; qh = 4.5 tsf			
SS-3	4 5 7	100	7.5	-SS-3: *Visual ODOT A-7-6; qh = 4.0 tsf	29		
SS-4	2 3 3	89	10.0	-SS-4: ODOT A-7-6; qh = 2.0 tsf	37	45	21
			12.5				
AS-5	3 4 5	0	15.0	-SS-5: *Visual ODOT A-7-6; qh = 1.75 tsf (15.0)			

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion ▽ Dry *** ft
Extended ▼ NA ft
****Cave-in depth @ 31.5'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-006-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Hard to very stiff, gray CLAY, little coarse to fine sand, trace coarse to fine gravel (limestone), damp.			
SS-6	10 14 23	83	20.0	-SS-6: *Visual ODOT A-7-6; qh = 3.5 tsf	10		
			22.5				
SS-7	6 10 18	100	25.0	-SS-7: *Visual ODOT A-7-6; qh = 4.25 tsf			
				25.5			
			27.5	Medium dense, brown fine SAND, trace fine gravel, trace silt, dry.			
SS-8	4 7 10	100	30.0	-SS-8: *Visual ODOT A-3	3		
			32.5				
SS-9	5 6 10	89	35.0	-SS-9: *Visual ODOT A-3			
				35.0			
				Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-007-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/5/07
Date Finished: 6/5/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 70+46
Offset: 107.7 R
Elevation: 560.83 ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				6" - Topsoil (0.5)			
SS-1	2 2 2	83	2.5	Soft, dark brown SILT and CLAY, and fine to coarse sand, little fine gravel, damp. -SS-1: ODOT A-6a; qh = 2.25 tsf (3.0)	13	27	16
SS-2	2 2 3	89	5.0	Medium stiff to soft, brown changing to gray CLAY, trace fine sand, trace fine gravel, moist. -SS-2: *Visual ODOT A-7-6; qh = 2.0 tsf	28		
SS-3	2 1 2	100	7.5	-SS-3: ODOT A-7-6; qh = 1.25 tsf (8.5)	34	46	22
SS-4	3 8 10	89	10.0	Very stiff, dark brown SILT and CLAY, little coarse to fine sand, trace fine gravel, damp. -SS-4: *Visual ODOT A-6a; qh = 4.5 tsf (12.0)			
SS-5	6 7 9	89	12.5 15.0	Very stiff to hard, gray SILTY CLAY, trace coarse to fine sand, trace fine gravel, dry. -SS-5: *Visual ODOT A-6b; qh = 3.25 tsf	9		

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE
- SS - Split Spoon Sample
- GS - Geoprobe Sample
- ST - Shelby Tube
- RC - Rock Core
- AS - Auger Sample
- BS - Bag Sample

GROUND WATER READING
- Initial: 2.0 ft
- At Completion: Dry *** ft
- Extended: NA ft

***Cave-in depth @ 27.1'

BORING METHOD
- HSA - Hollow Stem Augers
- SFA - Solid Flight Augers
- MD - Mud Drilling
- WD - Wash Drilling
- RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-007-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
			17.5				
SS-6	9 11 15	94		-SS-6: *Visual ODOT A-6b; qh = 4.5+ tsf			
			20.0				
			22.5				
SS-7	11 13 17	83		-SS-7: *Visual ODOT A-6b; qh = 4.5+ tsf	10		
			25.0				
			27.5				
SS-8	10 13 18	89		-SS-8: *Visual ODOT A-6b; qh = 4.5 tsf			
			30.0				
				30.5 Medium dense, brown coarse to fine SAND, little silt, trace fine gravel, dry.			
			32.5				
SS-9	6 9 10	78		-SS-9: ODOT A-3a	9		
			35.0	35.0 Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-008-0-07
Sheet: 1 of 2
Completion Depth: 30.0'

Date Started: 6/5/07
Date Finished: 6/5/07
Drilled By: I.C.

DRILLING AND SAMPLING INFORMATION

Station: 71+89
Offset: 106.7 R
Elevation: 562.08 ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				4" - Topsoil (0.4)			
SS-1	9 8 7	89	2.5	Medium stiff, brown SANDY SILT, little fine gravel, moist. -SS-1: ODOT A-4a; qh = 4.0 tsf (3.0)	6	25	15
SS-2	2 3 3	89	5.0	Medium stiff to stiff, brown changing to brownish gray SILT and CLAY, and coarse to fine sand,little fine gravel, wet. -SS-2: *Visual ODOT A-6a; qh = 3.25 tsf	20		
SS-3	3 3 4	100	7.5	-SS-3: ODOT A-6a; qh = 1.0 tsf		22	8
SS-4	4 5 7	83	10.0	-SS-4: *Visual ODOT A-6a; qh = 1.5 tsf (12.0)			
SS-5	5 7 9	100	12.5	Very stiff, brownish gray SILT and CLAY, and coarse to fine sand, little fine gravel, moist. -SS-5: *Visual ODOT A-6a; qh = 2.75 tsf -drillers noted cobbles @ 13.0'-22.5'	13		
			15.0				

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 21.0'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-008-0-07
Sheet: 2 of 2
Completion Depth: 30.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Same as above			
SS-6	5 8 9	11	20.0	-SS-6: *Visual ODOT A-6a			
			22.5	22.5			
				Medium dense, brown fine SAND, trace silt, dry.			
SS-7	7 9 11	100	25.0	-SS-7: *Visual ODOT A-3	3		
			27.5				
SS-8	5 6 8	100		-SS-8: ODOT A-3			
			30.0	30.0			
				Bottom of Boring = 30.0 feet			
			32.5				
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-009-0-07
Sheet: 1 of 2
Completion Depth: 30.0'

Date Started: 6/5/07
Date Finished: 6/5/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 73+42
Offset: 108.0 R
Elevation: 563.08 ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				3" - Topsoil (0.3)			
SS-1	4 6 7	83	2.5	Medium dense, brownish gray coarse to fine GRAVELY coarse to fine SAND, some silt, damp. -SS-1: *Visual ODOT A-2-6 (3.0)	10		
SS-2	5 5 6	0	5.0	Stiff to medium stiff, brown CLAY, trace coarse to fine sand, trace fine gravel, damp. -SS-2: *Visual ODOT A-7-6; qh = 3.75 tsf			
SS-3	3 2 5	83	7.5	-SS-3: ODOT A-7-6; qh = 3.25 tsf	21	44	23
SS-4	6 3 7	89	10.0	-SS-4: *Visual ODOT A-7-6; qh = 3.5 tsf (11.5)			
			12.5	Very stiff to hard, brown CLAY, trace coarse to fine sand, trace fine gravel, damp.			
SS-5	6 8 12	67	15.0	-SS-5: *Visual ODOT A-7-6; qh = 4.5 tsf	12		

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE
- SS - Split Spoon Sample
- GS - Geoprobe Sample
- ST - Shelby Tube
- RC - Rock Core
- AS - Auger Sample
- BS - Bag Sample

GROUND WATER READING
- Initial: Dry ft
- At Completion: Dry *** ft
- Extended: NA ft

***Cave-in depth @ 27.0'

BORING METHOD
- HSA - Hollow Stem Augers
- SFA - Solid Flight Augers
- MD - Mud Drilling
- WD - Wash Drilling
- RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-009-0-07
Sheet: 2 of 2
Completion Depth: 30.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
			17.5				
SS-6	10 13 15	44		-SS-6: *Visual ODOT A-7-6; qh = 4.5 tsf			
			20.0				
			22.5				
SS-7	10 37 50/2"	89		-SS-7: *Visual ODOT A-7-6; qh = 3.25 tsf			
			25.0				
				26.5			
				Medium dense, brown fine SAND, trace silt, dry.			
			27.5				
SS-8	6 9 11	89		-SS-8: ODOT A-3	6		
			30.0	30.0			
				Bottom of Boring = 30.0 feet			
			32.5				
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-010-0-07
Sheet: 1 of 2
Completion Depth: 30.0'

Date Started: 6/5/07
Date Finished: 6/5/07
Drilled By: I.C.

DRILLING AND SAMPLING INFORMATION

Station: 74+89
Offset: 106.9 R
Elevation: 563.73 ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				3" - Topsoil (0.3)			
SS-1	3 4 5	100	2.5	Medium dense, brownish gray coarse to fine GRAVELY coarse to fine SAND, some silt, moist. -SS-1: *Visual ODOT A-2-6 (3.0)	9		
SS-2	2 3 3	100	5.0	Medium stiff, brownish gray SILTY CLAY, trace coarse to fine sand, trace fine gravel, moist. -SS-2: ODOT A-6b; qh = 2.0 tsf	27	39	21
SS-3	2 3 4	100	7.5	-SS-3: *Visual ODOT A-6b; qh = 2.75 tsf (8.0)			
SS-4	8 5 6	100	10.0	Stiff, dark brown SILT and CLAY, little coarse to fine sand, trace fine gravel, damp. -SS-4: *Visual ODOT A-6a; qh = 2.0 tsf	16		
			12.5	(12.5)			
SS-5	2 3 3	100	15.0	Medium stiff to stiff, brown CLAY, trace coarse to fine sand, moist. -SS-5: ODOT A-7-6; qh = 2.25 tsf	28	52	25

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 21.0'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-010-0-07
Sheet: 2 of 2
Completion Depth: 30.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
			17.5				
SS-6A	6 8 5	100		-SS-6A: *Visual ODOT A-7-6; qh = 3.0 tsf	17		
				19.5			
SS-6B			20.0	Stiff to very stiff, brown SILTY CLAY, little coarse to fine sand, trace fine gravel, damp to moist. -SS-6B: *Visual ODOT A-6b			
				-drillers noted cobbles @ 19.5'-26.0'			
			22.5				
SS-7	5 10 15	11		-SS-7: *Visual ODOT A-6b			
			25.0				
				26.0			
				Medium dense, brown fine SAND, trace silt, dry.			
			27.5				
SS-8	5 7 9	100		-SS-8: ODOT A-3			
			30.0	30.0			
				Bottom of Boring = 30.0 feet			
			32.5				
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-011-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/5/07
Date Finished: 6/5/07
Drilled By: I.C.

DRILLING AND SAMPLING INFORMATION

Station: 76+37
Offset: 105.5 R
Elevation: 564.65 ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Stiff to medium stiff, SILT and CLAY, and coarse to fine sand, trace fine gravel, dry.			
SS-1	5 6 7	83	2.5	-SS-1: *Visual ODOT A-6a; qh = 2.25 tsf	8		
SS-2	2 3 4	0	5.0	-SS-2: ODOT A-6a; qh = 1.25 tsf	21	27	14
SS-3	2 3 3	83	7.5	-SS-3: ODOT A-6a; qh = 1.25 tsf			
			8.0	Soft to medium stiff, brown SILT and CLAY, some coarse to fine sand, little fine gravel, damp.			
SS-4	2 2 2	89	10.0	-SS-4: *Visual ODOT A-6a; qh = 1.25 tsf	11	28	16
			12.5				
SS-5	2 4 3	67	15.0	-SS-5: *Visual ODOT A-6a; qh = 2.0 tsf			
			15.0				

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 23.0'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-011-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Loose, brown coarse to fine GRAVEL, some coarse to fine sand, little silt, moist.			
SS-6	2 3 3	44	20.0	-SS-6: ODOT A-1-b	12		
			22.5	Very loose, brown fine SAND, trace silt, dry.			
SS-7	1 2 2	89	25.0	-SS-7: *Visual ODOT A-3			
			27.5	Medium dense, brown fine SAND, trace silt, dry.			
SS-8	5 10 17	89	30.0	-SS-8: *Visual ODOT A-3	4		
			32.5				
SS-9	5 6 8	94	35.0	-SS-9: *Visual ODOT A-3a			
				Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-012-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/5/07
Date Finished: 6/5/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 77+84
Offset: 107.6 R
Elevation: 565.9 ± ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Loose, brown coarse to fine GRAVEL, some coarse to fine sand, trace silt, dry.	5		
SS-1	10 7 3	33	2.5	-SS-1: *Visual ODOT A-1-b			
				Medium stiff, brown SANDY SILT, trace fine gravel, damp.			
SS-2	3 3 3	83	5.0	-SS-2: ODOT A-4a; qh = 2.0 tsf	14	25	15
SS-3	2 3 3	89	7.5	-SS-3: *Visual ODOT A-4a; qh = 2.25 tsf			
			8.0				
				Very loose to loose, brown coarse to fine SAND, some silt, trace fine gravel, wet.			
SS-4	2 2 3	94		-SS-4: ODOT A-3a	16	NP	NP
			10.0				
			12.5				
SS-5	2 2 2	94		-SS-5: *Visual ODOT A-3a	13		
			15.0				

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 30.7'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-012-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Medium dense, brown coarse to fine SAND, little silt, dry.			
			17.5				
SS-6	4 5 6	89		-SS-6: *Visual ODOT A-3a			
			20.0				
			22.5				
SS-7	5 5 6	100		-SS-7: *Visual ODOT A-3a	5		
			25.0				
			27.5				
SS-8	4 5 6	89		-SS-8: *Visual ODOT A-3a			
			30.0				
			32.5				
SS-9	3 5 7	67		-SS-9: *Visual ODOT A-3a	3		
			35.0	35.0			
				Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-013-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/4/07
Date Finished: 6/4/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 79+33
Offset: 108.3 R
Elevation: 565.7 ± ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
SS-1	3 6 4	56	2.5	FILL: Stiff, dark brown SILT and CLAY, little coarse to fine sand, trace fine gravel, damp. -SS-1: *Visual ODOT A-6a; qh = 4.5+ tsf	11		
SS-2	3 3 4	89	5.0	Medium stiff to stiff, reddish brown changing to dark brown SILT and CLAY, some coarse to fine sand, trace fine gravel, moist. -SS-2: ODOT A-6a; qh = 2.0 tsf	19	29	15
SS-3	3 4 8	100	7.5	-SS-3: *Visual ODOT A-6a; qh = 4.0 tsf			
SS-4	2 3 4	89	10.0	Medium stiff to soft, reddish brown SANDY SILT, moist. -SS-4: ODOT A-4a; qh = 1.0 tsf	19	23	14
SS-5	3 2 2	83	12.5 15.0	-SS-5: *Visual ODOT A-4a; qh = 1.0 tsf			

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE
- SS - Split Spoon Sample
- GS - Geoprobe Sample
- ST - Shelby Tube
- RC - Rock Core
- AS - Auger Sample
- BS - Bag Sample

GROUND WATER READING
- Initial: Dry ft
- At Completion: Dry *** ft
- Extended: NA ft

***Cave-in depth @ 29.0'

BORING METHOD
- HSA - Hollow Stem Augers
- SFA - Solid Flight Augers
- MD - Mud Drilling
- WD - Wash Drilling
- RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-013-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Same as above			
				18.0			
SS-6	3 3 4	89	20.0	Loose to medium dense, brown coarse to fine SAND, little silt, trace fine gravel, dry. -SS-6: ODOT A-3a	5		
			22.5				
SS-7	4 4 5	94	25.0	-SS-7: *Visual ODOT A-3a			
			27.5				
SS-8	6 10 13	83	30.0	-SS-8: *Visual ODOT A-3a	9		
			32.5				
SS-9	6 6 7	50	35.0	-SS-9: *Visual ODOT A-3a			
				35.0			
				Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-014-0-07
Sheet: 1 of 2
Completion Depth: 35.0'

Date Started: 6/4/07
Date Finished: 6/4/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 80+77
Offset: 113.8 R
Elevation: 566.1 ± ft

Boring Method: 2.25" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Stiff, brown SILT and CLAY, little coarse to fine sand, trace fine gravel, dry to damp.	8		
SS-1	4 5 6	83	2.5	-SS-1: *Visual ODOT A-6a; qh = 4.5 tsf			
SS-2	4 4 5	89	5.0	-SS-2: *Visual ODOT A-6a; qh = 3.5 tsf			
			6.0				
SS-3	4 3 3	89	7.5	Medium stiff to stiff, brown CLAY, some to trace fine sand, trace fine gravel, damp to moist. -SS-3: ODOT A-7-6; qh = 2.0 tsf	17	42	19
SS-4	2 3 3	94	10.0	-SS-4: *Visual ODOT A-7-6; qh = 2.0 tsf			
			12.5				
SS-5	4 5 6	100	15.0	-SS-5: ODOT A-7-6; qh = 2.75 tsf	25	48	22

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 31.9'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-014-0-07
Sheet: 2 of 2
Completion Depth: 35.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Same as above			
				18.5			
SS-6	5 9 13	89	20.0	Medium dense, brown coarse to fine SAND, little silt, damp. -SS-6: *Visual ODOT A-3a			
				21.0			
			22.5	Dense to medium dense, brown fine SAND, trace silt, damp to dry.			
SS-7	10 17 18	89		-SS-7: *Visual ODOT A-3	19		
			25.0				
			27.5				
SS-8	7 9 9	83		-SS-8: ODOT A-3	2		
			30.0				
			32.5				
SS-9	6 7 9	78		-SS-9: *Visual ODOT A-3a			
			35.0	35.0			
				Bottom of Boring = 35.0 feet			
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-015-0-07
Sheet: 1 of 3
Completion Depth: 50.0'

Date Started: 6/3/07
Date Finished: 6/3/07
Drilled By: I.C.

DRILLING AND SAMPLING INFORMATION

Station: 82+28
Offset: 124.8 R
Elevation: 570.41 ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				4" - Topsoil (0.4)			
AS-1	8 6 4	0	2.5	Stiff, brown SANDY SILT, some coarse to fine gravel, dry. -AS-1: *Visual ODOT A-4a (3.0)	8		
SS-2	3 4 5	100	5.0	Stiff, brown SILT and CLAY, trace coarse to fine sand, trace fine gravel, moist. -SS-2: ODOT A-6a; qh = 3.5 tsf	25	34	21
SS-3	4 5 7	100	7.5	-SS-3: *Visual ODOT A-6a; qh = 4.25 tsf (8.0)			
SS-4	2 2 3	100	10.0	Medium stiff to soft, gray CLAY, trace coarse to fine sand, moist. -SS-4: ODOT A-7-6; qh = 3.0 tsf	33	46	25
			12.5				
SS-5	1 2 2	100	15.0	-SS-5: ODOT A-7-6; qh = 1.25 tsf	34	43	22

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 40.0'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-015-0-07
Sheet: 2 of 3
Completion Depth: 50.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Same as above			
SS-6	2 3 4	100	20.0	-SS-6: *Visual ODOT A-7-6; qh = 1.75 tsf			
			22.5				
SS-7	3 5 8	100	25.0	Stiff to very stiff, gray SILTY CLAY, little coarse to fine sand, trace fine gravel, damp. -SS-7: *Visual ODOT A-6b; qh = 4.5+ tsf	16		
			27.5				
SS-8A	7 15 18	89		-SS-8A: *Visual ODOT A-6b; qh = 4.5 tsf			
			29.5				
SS-8B			30.0	Dense to medium dense, brown fine SAND, trace silt, dry. -SS-8B: ODOT A-3	2		
			32.5				
SS-9	5 8 9	94		-SS-9: *Visual ODOT A-3	2		
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-015-0-07
Sheet: 3 of 3
Completion Depth: 50.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
SS-10	8 13 15	89		-SS-10: *Visual ODOT A-3			
			40.0				
			42.5				
SS-11	9 15 16	100		-SS-11: *Visual ODOT A-3	3		
			45.0				
			47.5				
SS-12	10 15 20	94		-SS-12: *Visual ODOT A-3			
			50.0	50.0			
				Bottom of Boring = 50.0 feet			
			52.5				
			55.0				
			57.5				
			60.0				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-016-0-07
Sheet: 1 of 3
Completion Depth: 45.0'

Date Started: 6/3/07
Date Finished: 6/3/07
Drilled By: I.C.

DRILLING AND SAMPLING INFORMATION

Station: 83+73
Offset: 138.7 R
Elevation: 577.6 ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Medium stiff, dark brown SILTY CLAY, and coarse to fine sand, trace fine gravel, damp.	15		
SS-1	7 5 3	0	2.5	-SS-1: *Visual ODOT A-6b; qh = 4.5+ tsf			
SS-2	4 4 4	100	5.0	-SS-2: *Visual ODOT A-6b; qh = 3.5 tsf			
AS-3	3 4 4	100	7.5	-AS-3: *Visual ODOT A-6b	15	35	18
				Loose, brown coarse to fine SAND, little silt, little clay, damp.			
SS-4	4 2 4	100	10.0	-SS-4: ODOT A-3a	13		
				Very stiff, brown SILTY CLAY, trace coarse to fine sand, damp.			
SS-5	5 8 10	100	12.5 15.0	-SS-5: *Visual ODOT A-6b; qh = 4.5 tsf			

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 38.0'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-016-0-07
Sheet: 2 of 3
Completion Depth: 45.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Same as above			
				18.0			
SS-6	2 2 4	100	20.0	Medium stiff to stiff, gray CLAY, trace coarse to fine sand, moist. -SS-6: ODOT A-7-6; qh = 3.0 tsf	33	52	23
			22.5				
SS-7	5 6 9	100	25.0	-SS-7: *Visual ODOT A-7-6; qh = 4.0 tsf			
			27.5				
SS-8	4 6 7	89	30.0	-SS-8: *Visual ODOT A-7-6; qh = 4.25 tsf	9		
			32.5	32.5			
				Medium dense, brown fine SAND, trace silt, dry.			
SS-9	5 9 13	94	35.0	-SS-9: *Visual ODOT A-3			
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-016-0-07
Sheet: 3 of 3
Completion Depth: 45.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
SS-10	5 11 9	89	40.0	-SS-10: *Visual ODOT A-3	3		
			42.5				
SS-11	6 8 13	100		-SS-11: *Visual ODOT A-3			
			45.0	45.0 Bottom of Boring = 45.0 feet			
			47.5				
			50.0				
			52.5				
			55.0				
			57.5				
			60.0				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-017-0-07
Sheet: 1 of 3
Completion Depth: 45.0'

Date Started: 6/10/07
Date Finished: 6/10/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 85+18
Offset: 133.4 R
Elevation: 572.0 ± ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Stiff to very stiff, brown changing to mottled brown and gray SILTY CLAY, little fine to coarse sand, little fine gravel, dry to damp.			
AS-1	3 6 7	0	2.5	-AS-1: ODOT A-6b	7	36	20
SS-2	4 6 7	100	5.0	-SS-2: *Visual ODOT A-6b; qh = 4.5 tsf			
SS-3	5 9 14	100	7.5	-SS-3: *Visual ODOT A-6b; qh = 4.5+ tsf	14		
SS-4	6 8 12	100	10.0	-SS-4: *Visual ODOT A-6b; qh = 4.5+ tsf			
			12.0				
			12.5	Dense, gray fine to coarse GRAVEL, some silt, little fine to coarse sand, dry.			
SS-5	19 27 21	100	15.0	-SS-5: ODOT A-1-b	1		

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 44.5'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-017-0-07
Sheet: 2 of 3
Completion Depth: 45.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
			17.5	Same as above			
				18.0			
SS-6	6 10 12	100	20.0	Very stiff to stiff, brown SILTY CLAY, little coarse to fine sand, trace fine gravel, damp. -SS-6: *Visual ODOT A-6b; qh = 2.5 tsf			
			22.5				
SS-7	6 7 8	100	25.0	-SS-7; *Visual ODOT A-6b; qh = 4.5+ tsf			
			27.5				
SS-8	5 6 8	89	30.0	-SS-8: *Visual ODOT A-6b; qh = 3.0 tsf	16		
				30.5			
			32.5	Stiff, gray CLAY, trace coarse to fine sand, moist.			
SS-9	3 4 8	94	35.0	-SS-9: ODOT A-7-6; qh = 1.0 tsf	31	45	26
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-017-0-07
Sheet: 3 of 3
Completion Depth: 45.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
SS-10	5 6 7	89	40.0	-SS-10: *Visual ODOT A-7-6; qh = 1.5 tsf			
				41.0 Medium dense, light brown fine SAND, trace silt, dry.			
			42.5				
SS-11	7 11 13	100		-SS-11: *Visual ODOT A-3			
			45.0	45.0 Bottom of Boring = 45.0 feet			
			47.5				
			50.0				
			52.5				
			55.0				
			57.5				
			60.0				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)

Boring Number: B-018-0-07
Sheet: 1 of 3
Completion Depth: 45.0'

Date Started: 6/14/07
Date Finished: 6/14/07
Drilled By: C.M.

DRILLING AND SAMPLING INFORMATION

Station: 86+64
Offset: 129.7 R
Elevation: 570.0 ± ft

Boring Method: 3.75" HSA
Hammer Weight: 140 lbs.
Hammer Drop: 30 inches

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Medium stiff, brown SILT and CLAY, some coarse to fine gravel, little fine to coarse sand, dry to moist.			
SS-1	2 3 5	83	2.5	-SS-1: ODOT A-6a	8	34	21
			3.5				
SS-2	6 7 6	0	5.0	Stiff, brown SILTY CLAY, little coarse to fine sand, damp. -AS-2: *Visual ODOT A-6b; qh = 4.5+ tsf			
			6.0				
SS-3	6 5 4	83	7.5	Stiff to medium stiff, gray CLAY, trace coarse to fine sand, damp to moist. -SS-3: *Visual ODOT A-7-6; qh = 2.0 tsf	26		
SS-4	3 3 4	89	10.0	-SS-4: *Visual ODOT A-7-6; qh = 1.0 tsf			
			12.5				
SS-5	2 3 3	67	15.0	-SS-5: ODOT A-7-6; qh = 1.0 tsf	30	48	27

NOTES: *Visual only; **Visual with partial testing

SAMPLE TYPE

SS - Split Spoon Sample
GS - Geoprobe Sample
ST - Shelby Tube
RC - Rock Core
AS - Auger Sample
BS - Bag Sample

GROUND WATER READING

Initial Dry ft
At Completion Dry *** ft
Extended NA ft
****Cave-in depth @ 41.7'*

BORING METHOD

HSA - Hollow Stem Augers
SFA - Solid Flight Augers
MD - Mud Drilling
WD - Wash Drilling
RC - Rock Coring

RESOURCE INTERNATIONAL, INC.
4480 LAKE FOREST DRIVE
SUITE 308
CINCINNATI, OHIO 45242
(513) 769-6998

REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-018-0-07
Sheet: 2 of 3
Completion Depth: 45.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
			17.5				
SS-6	3 5 6	44		-SS-6: *Visual ODOT A-7-6; qh = 1.25 tsf			
			20.0				
				Very stiff, brownish gray SILTY CLAY, little coarse to fine sand, trace fine gravel, moist.			
			22.5				
SS-7	5 7 9	89		-SS-7; *Visual ODOT A-6b; qh = 2.0 tsf	28		
			25.0				
			27.0				
			27.5	Medium dense, brown SILT, some coarse to fine sand, moist to dry.			
SS-8	11 13 14	89		-SS-8: **Visual ODOT A-4b	18		
			30.0				
			32.5				
SS-9	9 10 12	94		-SS-9: *Visual ODOT A-4b			
			35.0				
			37.5				

NOTES: *Visual only; **Visual with partial testing

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REPORT OF SOIL EXPLORATION

Client: ME Companies
Project: HAMILTON 75-10.10 RETAINING WALL 1
Project Number: B-06-020 (1)
Boring Number: B-018-0-07
Sheet: 3 of 3
Completion Depth: 45.0'

SAMPLE NO	BLOWS PER 6"	PERCENT RECOVERY	DEPTH	SOIL DESCRIPTION	MOISTURE CONTENT	ATTERBERG LL	ATTERBERG PL
				Same as above			
SS-10	7 10 15	89	40.0	-SS-10: *Visual ODOT A-4b	2		
			42.5				
SS-11	9 9 10	83	45.0	-SS-11: *Visual ODOT A-4b			
				Bottom of Boring = 45.0 feet			
			47.5				
			50.0				
			52.5				
			55.0				
			57.5				
			60.0				

NOTES: *Visual only; **Visual with partial testing

APPENDIX V

LABORATORY TEST RESULTS

One-Dimensional Consolidation Test Report (ASTM D2435)

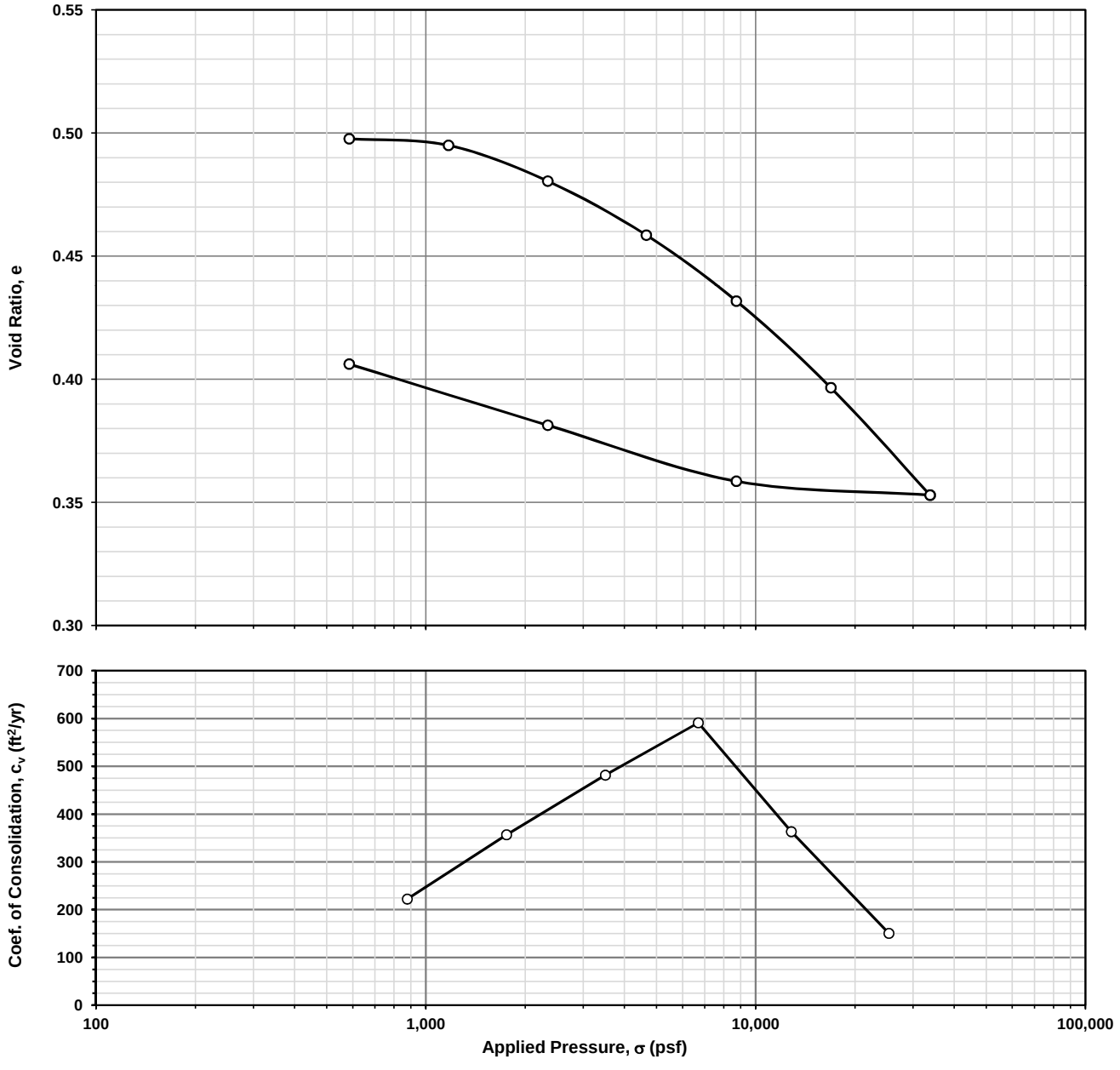
Project Number:	B-10-020	Boring Number:	B-053-0-11
Project Name:	HAM-75-7.85	Sample No. / Depth:	ST-4 / 8.5 ft
Project Location:	Hamilton County, Ohio	Date of Testing:	11/18/2011 to 12/2/2011
Client:	EMH&T	Technician:	JJH

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



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CONSOLIDATED, UNDRAINED TRIAXIAL

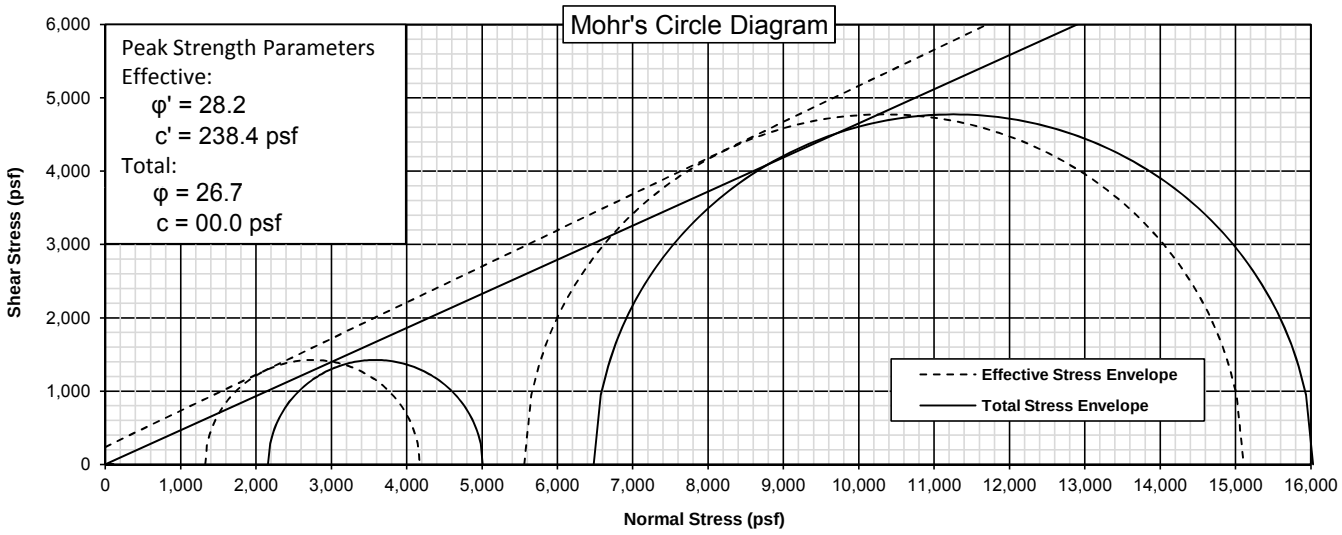
ASTM D-4767

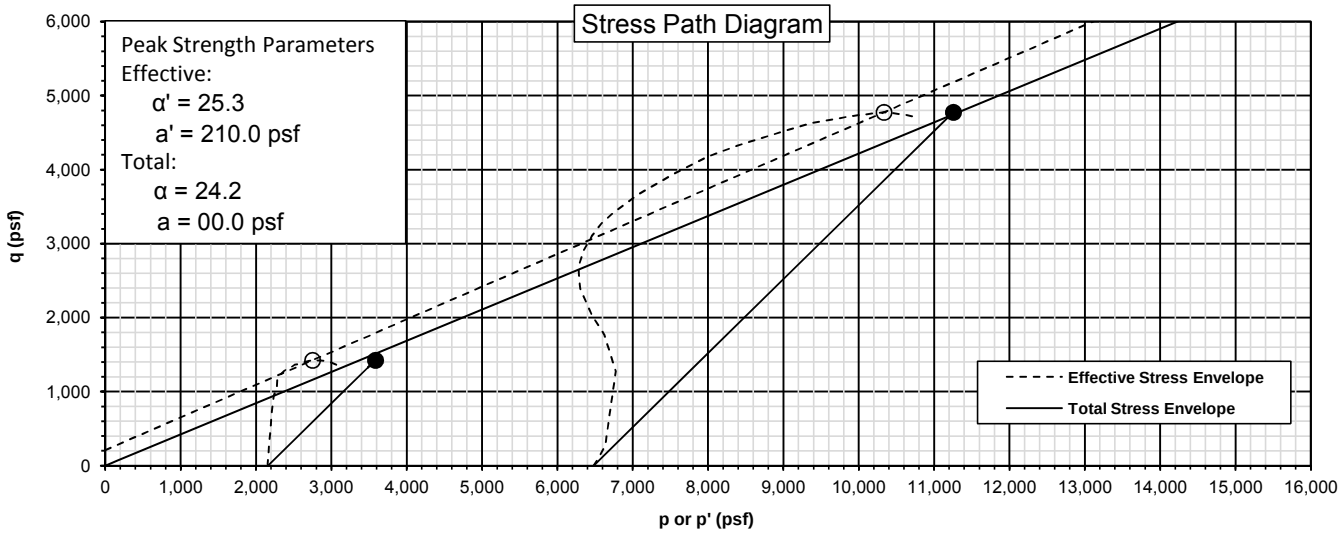
PROJECT NAME:	HAM-75-7.85
JOB NUMBER:	B-10-020
BORING NUMBER:	B-061-0-11
SAMPLE NUMBER:	ST-4
SAMPLE DEPTH:	9.5 to 10.0 ft
DATE OF TESTING:	12/13/2011-12/15/2011
TESTED BY:	Hoyt

Soil Description: Brownish gray CLAY, and silt, little coarse to fine sand, trace fine gravel.
Soil Classification: ODOT A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	46	20	26	6	4	10	33	47

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-061-0-11	ST-4	9.5	2,160	5,009	1,325	4,174	2,749	1,425
2	B-061-0-11	ST-4	10.0	6,480	16,030	5,558	15,108	10,333	4,775
3									





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CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

PROJECT NAME:	HAM-75-7.85
JOB NUMBER:	B-10-020
BORING NUMBER:	B-061-0-11
SAMPLE NUMBER:	ST-4
SAMPLE DEPTH:	9.5
DATE OF TESTING:	12/13/2011
TESTED BY:	Hoyt

Data for Specimen No. 1

Soil Description: Brownish gray CLAY, and silt, little coarse to fine sand, trace fine gravel.
Soil Classification: ODOT A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C.Sand%	F.Sand%	Silt%	Clay%
	46	20	26.0	6	4	10	33	47

Diameter, D_0	2.860	in	Volume of Solids , V_s :	24.298	in^3
Area, A_0	6.424	in^2	Initial Volume of Voids, V_v :	13.766	in^3
Height, L_0	5.925	in	Initial Void Ratio, e_o :	0.567	
Volume, V_0	38.064	in^3	Initial Degree of Saturation, S_0 :	105.91	%

Water Content BEFORE Test

Tin No.:	M-15	g
Wet Soil + Tin :	121.71	g
Dry Soil + Tin :	104.99	g
Tin Weight :	30.59	g
Dry Mass :	74.4	g
Weight of water :	16.72	g
Moisture :	22.47	%

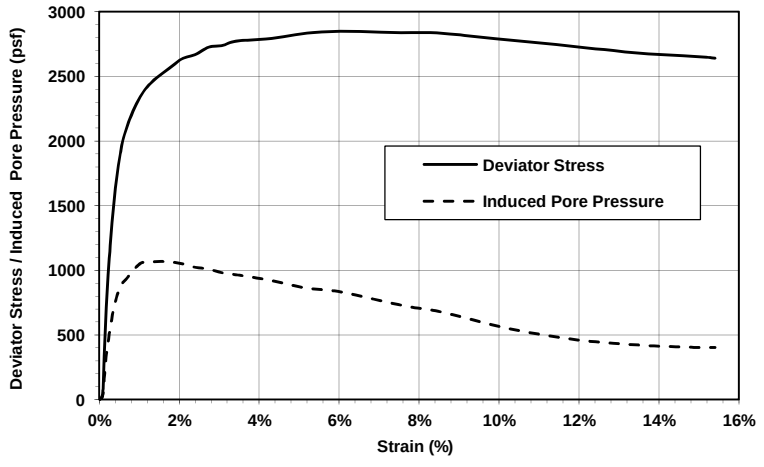
Water Content AFTER Test (Total Specimen)

Tin No.:	Ohio	g
Wet Soil + Tin :	1397.00	g
Dry Soil + Tin :	1190.10	g
Tin Weight :	127.00	g
Dry Mass :	1063.10	g
Weight of water :	206.90	g
Moisture :	19.46	%
Wet Density :	127.11	pcf
Dry Density :	106.40	pcf

Consolidation Cell Pressure:	140.0	psi	Deviator Stress @ Failure, Ds:	2,849.20	psf
Consolidation Back Pressure:	125.0	psi	Axial Strain @ Failure:	5.99	%
Effective Confining Stress, σ_3:	15.0	psi	Major Principal Stress @ Failure, σ_1:	5,009.20	psf
	2,160.00	psf	Induced Pore Pressure @ Failure:	835.20	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress,σ'_3:	1,324.80	psf
			Effective Major Principal Stress, σ'_1:	4,174.00	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



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CONSOLIDATED, UNDRAINED TRIAXIAL

ASTM D-4767

PROJECT NAME:	HAM-75-7.85
JOB NUMBER:	B-10-020
BORING NUMBER:	B-061-0-11
SAMPLE NUMBER:	ST-4
SAMPLE DEPTH:	10.0
DATE OF TESTING:	12/15/2011
TESTED BY:	Hoyt

Data for Specimen No. 2

Soil Description: Brownish gray CLAY, and silt, little coarse to fine sand, trace fine gravel.
Soil Classification: ODOT A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	46	20	26	6	4	10	33	47

Diameter, D_0	2.850	in	Volume of Solids , V_s :	24.729	in^3
Area, A_0	6.378	in^2	Initial Volume of Voids, V_v :	13.211	in^3
Height, L_0	5.949	in	Initial Void Ratio, e_o :	0.534	
Volume, V_0	37.940	in^3	Initial Degree of Saturation, S_0 :	112.32	%

Water Content BEFORE Test

Tin No.:	M-15	g
Wet Soil + Tin :	121.71	g
Dry Soil + Tin :	104.99	g
Tin Weight :	30.59	g
Dry Mass :	74.4	g
Weight of water :	16.72	g
Moisture :	22.47	%

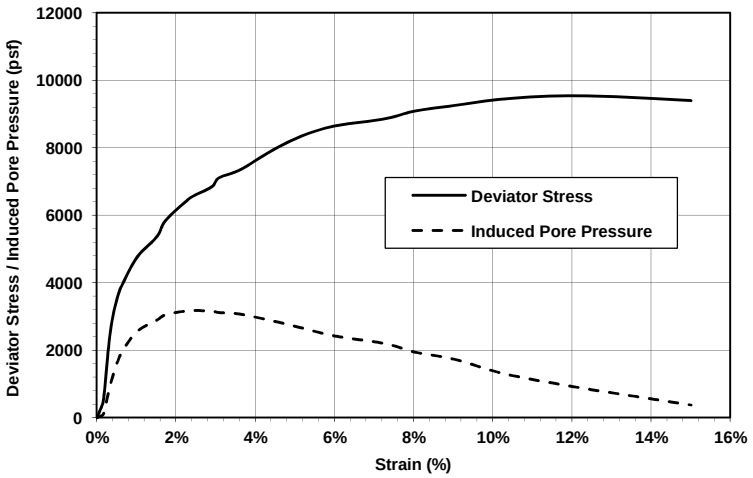
Water Content AFTER Test (Total Specimen)

Tin No.:	Funky	g
Wet Soil + Tin :	1339.50	g
Dry Soil + Tin :	1138.30	g
Tin Weight :	56.30	g
Dry Mass :	1082.00	g
Weight of water :	201.20	g
Moisture :	18.60	%
Wet Density :	128.84	pcf
Dry Density :	108.64	pcf

Consolidation Cell Pressure:	140.0	psi	Deviator Stress @ Failure, Ds:	9,549.70	psf
Consolidation Back Pressure:	95.0	psi	Axial Strain @ Failure:	12.02	%
Effective Confining Stress, σ_3:	45.0	psi	Major Principal Stress @ Failure, σ_1:	16,029.70	psf
	6,480.00	psf	Induced Pore Pressure @ Failure:	921.60	psf
Strain Rate:	0.0030	in/min	Effective Minor Principal Stress,σ'_3:	5,558.40	psf
			Effective Major Principal Stress, σ'_1:	15,108.10	psf

Failure Sketch

CU Compressive Strength and Induced Pore Pressure



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UNCONFINED COMPRESSION

ASTM D -2166

PROJECT	HAM-75-7.85
JOB No.	B-10-020
BORING / SAMPLE No.	B-045-0-11 / ST-15
SAMPLE DEPTH	44.9 ft
DATE OF TESTING	12/2/2011
TESTED BY	J.H.

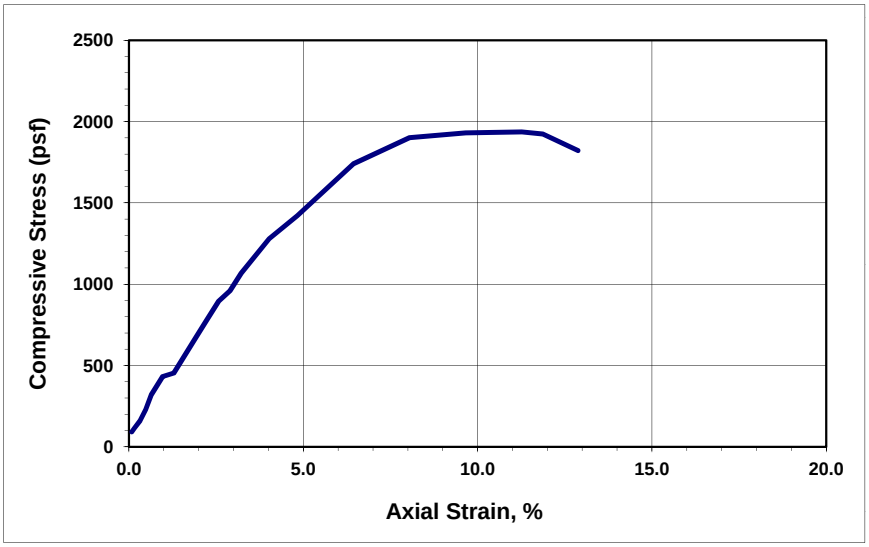
SOIL DESCRIPTION: Gray SILTY CLAY.
SOIL CLASSIFICATION: ODOT A-6b

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	35	19	16	0	0	0	48	52

DIAMETER, D_0	2.825 in	71.755 mm	STRAIN RATE	1	%/min	
AREA, A_0	6.268 in^2	40.439 cm^2	WET SOIL + PAN MASS	1434.4	g	
HEIGHT, L_0	6.211 in	157.76 mm	PAN MASS	127	g	
VOLUME, V_0	38.93 in^3	637.96 cm^3	DRY SOIL + PAN MASS	1162.4	g	
MACH. RATE	0.621	in/min	WET DENSITY	127.94	lb/ft^3	
WATER CONT.	26.27	%	DRY DENSITY	101.32	lb/ft^3	
UNCONFINED COMPRESSION STRESS, q_u			**1936** psf	0.97	tsf	
HAND PENETROMETER				1.50	tsf	

Failure Sketch

Unconfined Compression Test



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UNCONFINED COMPRESSION

ASTM D -2166

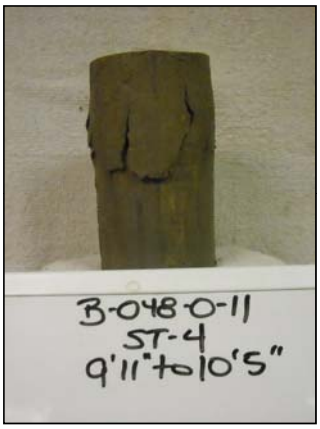
PROJECT	HAM-75-7.85
JOB No.	B-10-020
BORING / SAMPLE No.	B-048-0-11 / ST-4
SAMPLE DEPTH	9.9 ft
DATE OF TESTING	11/21/2011
TESTED BY	J.H.

SOIL DESCRIPTION: Mottled brown and gray SILTY CLAY, little coarse to fine sand, trace fine gavel.
SOIL CLASSIFICATION: ODOT A-6b

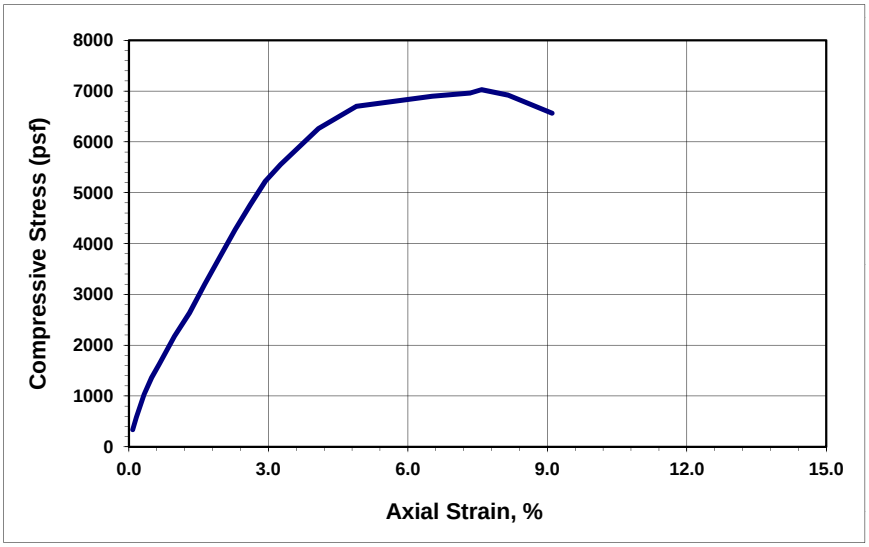
Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	34	18	16	6	5	9	25	55

DIAMETER, D_0	2.859 in	72.619 mm	STRAIN RATE	1	%/min	
AREA, A_0	6.4198 in^2	41.418 cm^2	WET SOIL + PAN MASS	1512.1	g	
HEIGHT, L_0	6.13 in	155.7 mm	PAN MASS	89.1	g	
VOLUME, V_0	39.353 in^3	644.88 cm^3	DRY SOIL + PAN MASS	1313.6	g	
MACH. RATE	0.613	in/min	WET DENSITY	137.75	lb/ft^3	
WATER CONT.	16.21	%	DRY DENSITY	118.54	lb/ft^3	
UNCONFINED COMPRESSION STRESS, q_u			**7027** psf	3.51	tsf	
HAND PENETROMETER				4.00	tsf	

Failure Sketch



Unconfined Compression Test



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UNCONFINED COMPRESSION

ASTM D -2166

PROJECT	HAM-75-7.85
JOB No.	B-10-020
BORING / SAMPLE No.	B-050-0-11 / ST-4
SAMPLE DEPTH	9.8 ft
DATE OF TESTING	11/21/2011
TESTED BY	J.H.

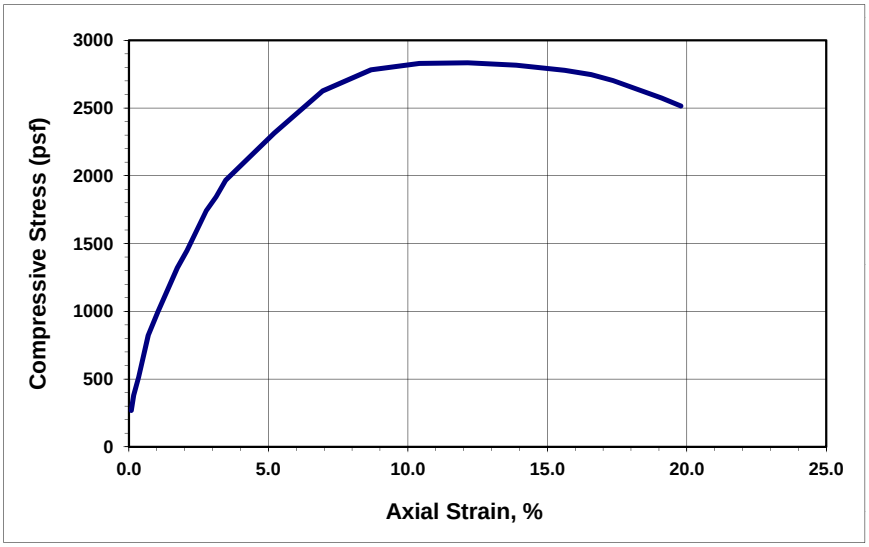
SOIL DESCRIPTION: Brownish gray SANDY SILT, some fine gavel, some clay.
SOIL CLASSIFICATION: ODOT A-4a

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	20	13	7	23	12	20	25	20

DIAMETER, D_0	2.861 in	72.669 mm	STRAIN RATE	1	%/min	
AREA, A_0	6.4288 in^2	41.476 cm^2	WET SOIL + PAN MASS	1366	g	
HEIGHT, L_0	5.761 in	146.33 mm	PAN MASS	77.9	g	
VOLUME, V_0	37.036 in^3	606.91 cm^3	DRY SOIL + PAN MASS	1149.7	g	
MACH. RATE	0.635	in/min	WET DENSITY	132.49	lb/ft^3	
WATER CONT.	20.18	%	DRY DENSITY	110.25	lb/ft^3	
UNCONFINED COMPRESSION STRESS, q_u			**2833** psf	1.42	tsf	
HAND PENETROMETER				1.50	tsf	

Failure Sketch

Unconfined Compression Test



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UNCONFINED COMPRESSION

ASTM D -2166

PROJECT	HAM-75-7.85
JOB No.	B-10-020
BORING / SAMPLE No.	B-051-0-11 / ST-4
SAMPLE DEPTH	9.8 ft
DATE OF TESTING	11/21/2011
TESTED BY	J.H.

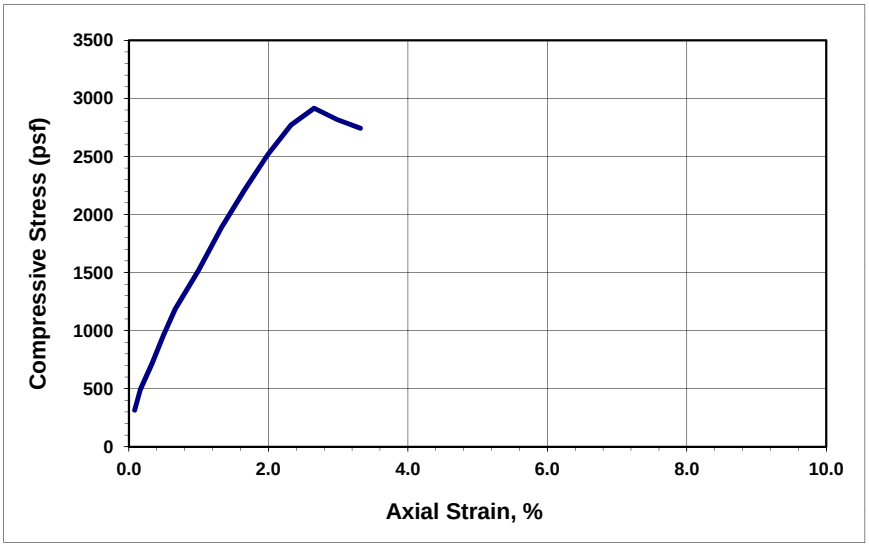
SOIL DESCRIPTION: Brown CLAY, little silt, trace fine sand.
SOIL CLASSIFICATION: ODOT A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	52	21	31	0	0	1	10	89

DIAMETER, D_0	2.854 in	72.492 mm	STRAIN RATE	1	%/min
AREA, A_0	6.3973 in^2	41.273 cm^2	WET SOIL + PAN MASS	1303.6	g
HEIGHT, L_0	6.025 in	153.04 mm	PAN MASS	56.2	g
VOLUME, V_0	38.544 in^3	631.62 cm^3	DRY SOIL + PAN MASS	1032.8	g
MACH. RATE	0.603	in/min	WET DENSITY	123.29	lb/ft^3
WATER CONT.	27.73	%	DRY DENSITY	96.52	lb/ft^3
UNCONFINED COMPRESSION STRESS, q_u			**2914** psf	1.46	tsf
HAND PENETROMETER				4.00	tsf

Failure Sketch

Unconfined Compression Test



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UNCONFINED COMPRESSION

ASTM D -2166

PROJECT	HAM-75-7.85
JOB No.	B-10-020
BORING / SAMPLE No.	B-060-0-11 / ST-4
SAMPLE DEPTH	9.8 ft
DATE OF TESTING	12/13/2011
TESTED BY	J.H.

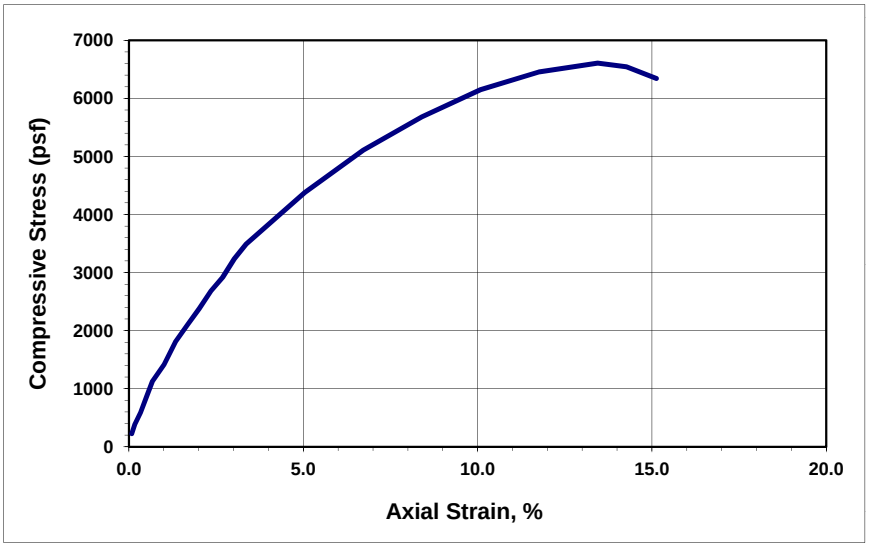
SOIL DESCRIPTION: Mottled brown and gray CLAY, and silt, trace coarse to fine sand, trace fine gavel.
SOIL CLASSIFICATION: ODOT A-7-6

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	43	20	23	2	2	5	39	52

DIAMETER, D_0	2.841 in	72.161 mm	STRAIN RATE	1	%/min	
AREA, A_0	6.3392 in^2	40.898 cm^2	WET SOIL + PAN MASS	1386.1	g	
HEIGHT, L_0	5.95 in	151.13 mm	PAN MASS	56.2	g	
VOLUME, V_0	37.718 in^3	618.09 cm^3	DRY SOIL + PAN MASS	1178.3	g	
MACH. RATE	0.595	in/min	WET DENSITY	134.32	lb/ft^3	
WATER CONT.	18.52	%	DRY DENSITY	113.33	lb/ft^3	
UNCONFINED COMPRESSION STRESS, q_u			**6606** psf	3.30	tsf	
HAND PENETROMETER				2.50	tsf	

Failure Sketch

Unconfined Compression Test



APPENDIX VI

PILE AND LAGGING RETAINING WALL CALCULATIONS

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COLUMBUS, OHIO 43231
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FAX: (614) 823-4990
WWW.RESOURCEINTERATIONAL.COM

JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	1	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 2 Tiebacks - 27.7' Max Ht

Retaining Wall and Soil Parameters

Retaining Wall Height, (H) =	27.7	ft
Soil Friction Angle, (φ') =	28	°
Soil Total Unit Weight, (γ) =	120	pcf
Backslope Angle, (β) =	26.6	°
Live Surcharge Load, (σ_{LS}) =	0	psf
Shaft Spacing, (S) =	6.0	ft O.C.
Shaft Diameter, (b) =	24	in

Rankine Active Earth Pressures

$$K_a = \cos\beta\left(\frac{\cos\beta-\sqrt{\cos^2\beta-\cos^2\varphi}}{\cos\beta+\sqrt{\cos^2\beta-\cos^2\varphi}}\right)$$

k_a = 0.65

$$P_a = \frac{k_a\gamma H^2}{1.5H-0.5H_1-0.5H_3}$$

P_a = 1860 psf

LRFD Load Factors

	EH	LS
Strength I	1.50	1.75
Service I	1.00	1.00

p-y Reduction Factor

$$\beta_a = 0.5292\left(S/b\right)^{0.5659}$$

β_a = 0.9854

Stuructural Element Properties

Section Type: HP 12x53

E =	29,000	ksi	d =	11.8	in	I_x =	393	in^4	Z_x =	74	in^3
A_s =	15.5	in^2	t_w =	0.435	in	I_x =	65.5	in^4 per ft	Z_x =	12.3	in^3 per ft
f_y =	50	ksi	t_f =	0.435	in	r_s =	5.03	in	T =	9.5	in
									S =	66.8	in^3

Anchor Tieback Setup

2		=	Row(s) of Anchors
7.0	ft	=	Distance Between Top of Wall and Top Row of Anchors, (H_1)
9.0	ft	=	Distance Between Top and Bottom Row of Anchors, (H_2)
11.7	ft	=	Distance Between Bottom Row of Anchors and Bottom of Excavation, (H_3)
20	°	=	Inclination of Anchors, (θ)

Factored Horizontal Tieback and Resultant Loads by Tributary Area Method

$$T_1 = \gamma_{LS}\left[k_a\sigma_{LS}\left(H_1+\tfrac{1}{2}H_2\right)S\right]+\gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}H_1\right)P_aS+\left(H_1+H_2/2-\tfrac{2}{3}H_1\right)P_aS\right]$$

T_1 = 153,430 lb

$$T_2 = \gamma_{LS}\left[k_a\sigma_{LS}\left(\tfrac{1}{2}H_2+\tfrac{1}{2}H_3\right)S\right]+\gamma_{EH}\left[\left(\tfrac{1}{2}H_2+H_3-\tfrac{2}{3}H_3\right)P_aS+\left(\tfrac{2}{3}H_3-\tfrac{1}{2}H_3\right)\left(\tfrac{7}{8}\right)P_aS\right]$$

T_2 = 169,156 lb

$$R = \gamma_{LS}\left[k_a\sigma_{LS}\left(\tfrac{1}{2}H_3\right)S\right]+\gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{1}{2}H_3\right)\left(\tfrac{3}{4}\right)P_aS\right]$$

R = **36,718** lb

$V_{max(from\ embedded,\ LPILE)}$ = **36,718** lb

$V_{max(from\ cantilever,\ calculated)}$ = **93,836** lb

Factored Moment at Ground Surface

$$M = \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}\right)H_1\left(H-\tfrac{2}{3}\left(\tfrac{2}{3}\right)H_1\right)+\left(H-\tfrac{2}{3}H_1-\tfrac{2}{3}H_3\right)\left(\tfrac{2}{3}H_3+\tfrac{1}{2}\left(H-\tfrac{2}{3}H_1-\tfrac{2}{3}H_3\right)\right)\right.$$
$$\left.+\tfrac{1}{2}\left(\tfrac{2}{3}H_3\right)\left(\tfrac{2}{3}\left(\tfrac{2}{3}\right)H_3\right)\right]P_aS+\gamma_{LS}k_a\sigma_{LS}HS-T_1\left(H_2+H_3\right)-T_2H_3$$

M = **75,457** lb-ft

905,480 lb-in

$M_{max(from\ embedded,\ LPILE)}$ = **206,891** lb-ft

$M_{max(from\ cantilever,\ calculated)}$ = **197,444** lb-ft

Factored Vertical Component from Anchor and Structural Loads

$$P_{max} = \left(\frac{T_1+T_2}{\cos\theta}\right)\sin\theta$$

P_{max} = **117,412** lb

Factored Axial Load from Structure

P_{SL} = **0** lb

Capacity Verification

φ_f = 1.00 φ_c = 0.70 φ_v = 1.00, C= 1.0

Maximum Factored Bending Moment, M_u =	206.9	kip-ft per section	
Maximum Factored Axial Force, P_u =	117.4	kip per section	(Anchor and Structural Axial Load)
Maximum Factored Shear Force, V_u =	93.8	kip per section	

Check

Factored Flexural Resistance, $\varphi_f M_n$ =	308.3	kip-ft per section	M_u	less than	$\varphi_f M_n$	OK
Factored Axial Resistance, $\varphi_c P_n$ =	524.6	kip per section	P_u	less than	$\varphi_c P_n$	OK
Factored Shear Resistance, $\varphi_v V_n$ =	137.6	kip per section	V_u	less than	$\varphi_v V_n$	OK
Required Section Modulus, S_{Req} =	49.7	in^3	S_{Req}	less than	$S_{Section}$	OK

RESOURCE INTERNATIONAL, INC.
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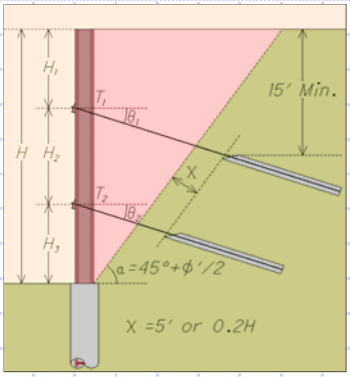
WWW.RESOURCEINTERATIONAL.COM

JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	2	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 2 Tiebacks - 27.7' Max Ht

Anchor Diagram



Per AASHTO Bridge Design Specification 11.9:

Anchor tiebacks must have an unbonded length of the greater of:

1) Length to bonded segment equal to a distance x beyond the active wedge angle.
2) Overburden cover must be a minimum of 15 ft before bonding.
3) Must be a minimum of 15 ft.

Anchor tiebacks must have the capacity to resist pullout of the bonded length.

Active Wedge Angle, (α) = 59.0 °

Min. Length Behind Active Wedge, (x) = 5.5 ft

Unbonded Anchor Length

Top Row of Anchors:

$$L_{u,T1} = (15 - H_1)\left(\frac{\sin(90-\beta)}{\sin(\beta+\theta)}\right) = 9.845 \text{ ft}$$ For min. overburden

$$L_{u,T1} = (H_2 + H_3)\left(\frac{\sin(90-\alpha)}{\sin(\alpha+\theta)}\right) + x = 16.4 \text{ ft}$$ For min. x behind active wedge

$L_{u,T1}$ = **16.40** ft

Bottom Row of Anchors:

$$L_{u,T2} = (15 - H_1 - H_2)\left(\frac{\sin(90-\beta)}{\sin(\beta+\theta)}\right) = 0 \text{ ft}$$ For min. overburden

$$L_{u,T2} = (H_3)\left(\frac{\sin(90-\alpha)}{\sin(\alpha+\theta)}\right) + x = 11.68 \text{ ft}$$ For min. x behind active wedge

$L_{u,T1}$ = **15.00** ft

Bonded Anchor Length

Anchor Pullout Capacity (AASHTO 11.9.4.2)

$$Q_R = \phi Q_n = \phi \pi d \tau_n L_b$$

φ	= 0.7		Per table 11.5.6-1
d	= 6.0	in	
τ_n	= 3.0	ksf	Per Table C11.9.4.2-1 for stiff to very stiff, medium to high plasticity cohesive soil (q_u = 1.25 to 4.0 tsf)
ϕQ_n	= T		

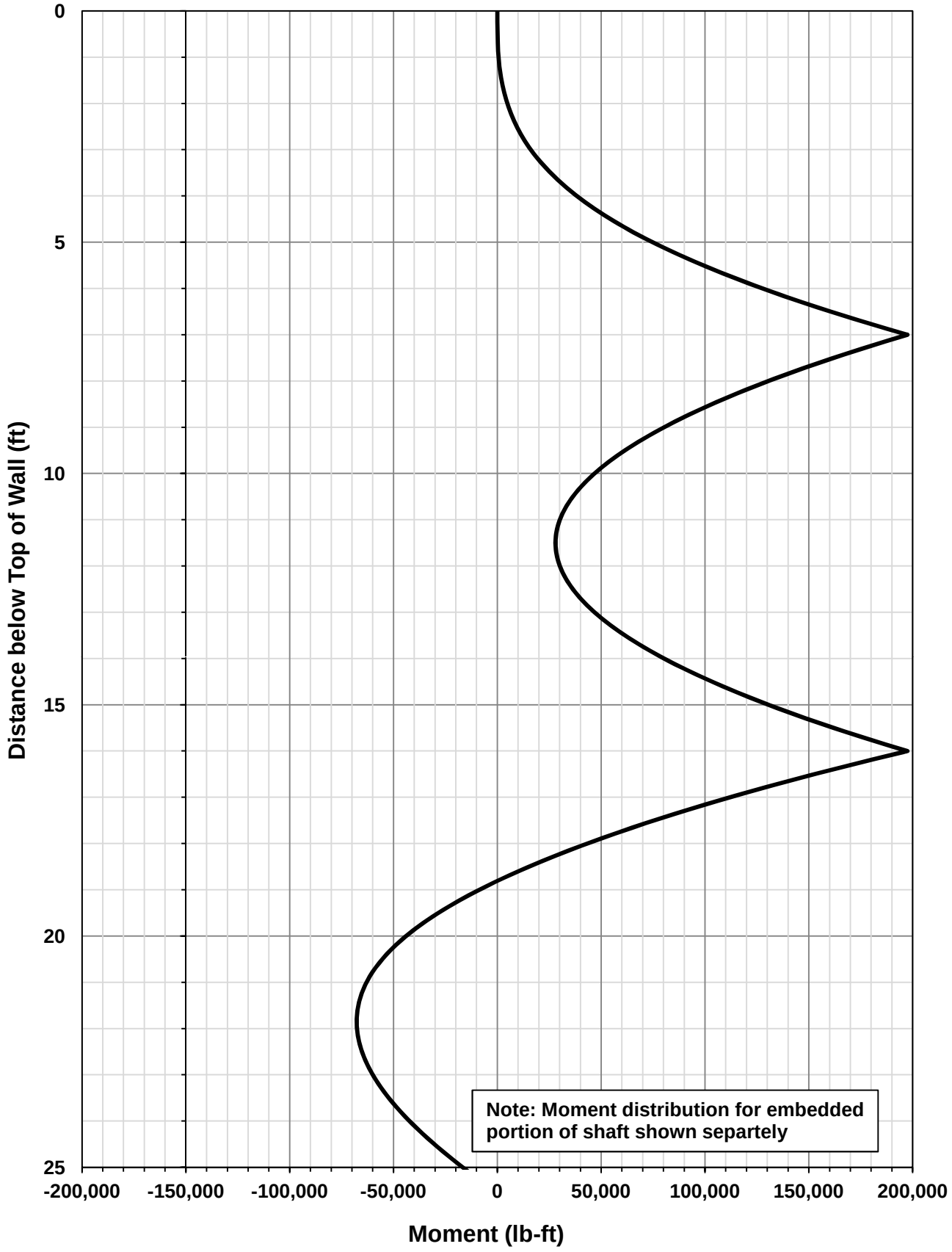
Top Row of Anchors: T_1 = 163,276 lb

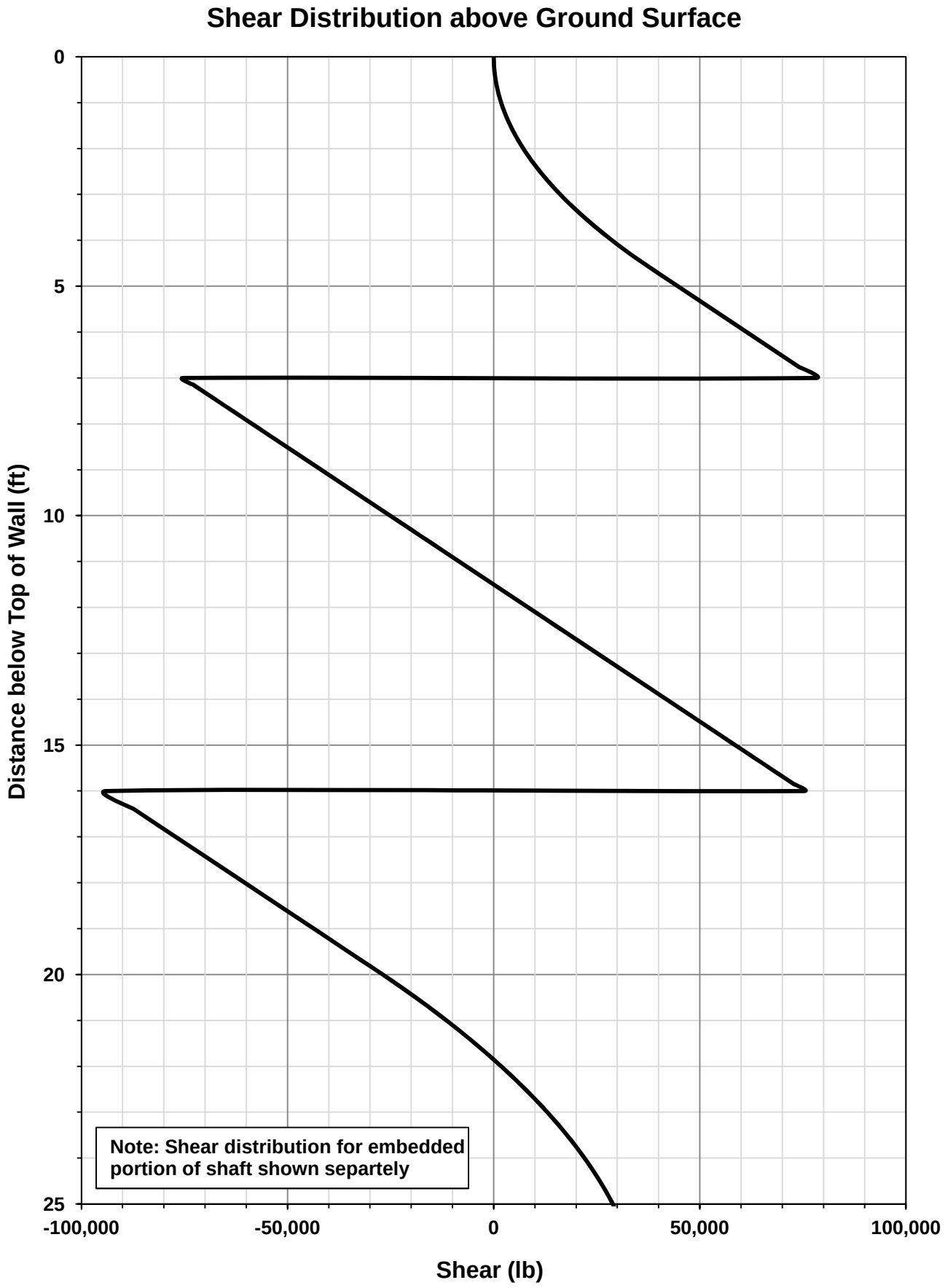
$$L_{b,T1} = \frac{T_1}{\phi \pi d \tau_n}$$ $L_{b,T1}$ = **49.50** ft

Bottom Row of Anchors: T_2 = 180,012 lb

$$L_{b,T2} = \frac{T_2}{\phi \pi d \tau_n}$$ $L_{b,T2}$ = **54.57** ft

Moment Distribution above Ground Surface




Shear Distribution above Ground Surface
Distance below Top of Wall (ft)
0
5
10
15
20
25
-100,000
-50,000
0
50,000
100,000
Shear (lb)
Note: Shear distribution for embedded portion of shaft shown separtely

LPILE Plus for Windows, Version 5.0 (5.0.39)

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

This program is licensed to:

Path to file locations: J:\GEOTECH\Projects\2010\B-10-020 HAM-75-7.85\HAM-75-7.85 PID 77889 - Mainline\Analysis\Retaining Wall V\Pile and Lagging - 2-Tiebacks\22' to 26' Wall Height\
Name of input data file: 22' to 26' Wall Height - 2-Tiebacks.lpd
Name of output file: 22' to 26' Wall Height - 2-Tiebacks.lpo
Name of plot output file: 22' to 26' Wall Height - 2-Tiebacks.lpp
Name of runtime file: 22' to 26' Wall Height - 2-Tiebacks.lpr

Time and Date of Analysis

Date: August 10, 2013 Time: 21:29:45

Problem Title

HAM-75-7.85 - Retaining Wall V - Pile and Lagging - 2-Tiebacks - 27.7 ft Wall Ht

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 300.00 in

Depth of ground surface below top of pile = .00 in

Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point No.	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.0000	3604997.
2	300.0000	24.00000000	16286.0000	452.0000	3604997.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 430.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 130.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06660
2	84.00	.06660
3	84.00	.07230
4	430.00	.07230

Shear Strength of Soils

Shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.42000	.00	.00700	.0
2	84.000	10.42000	.00	.00700	.0
3	84.000	.00000	29.00	------	------
4	430.000	.00000	29.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.9854	1.0000
2	360.000	.9854	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 36718.000 lbs
Bending moment at pile head = 905480.000 in-lbs
Axial load at pile head = 117412.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 36718.000 lbs
Specified moment at pile head = 905480.000 in-lbs
Specified axial load at pile head = 117412.000 lbs

Non-zero moment for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment)condition.

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	.523273	905480.	36718.0000	-.0059659	926.9451	-390.5324	1119.4889
3.000	.505445	1015970.	35535.6468	-.0059168	1008.3573	-397.7031	2360.5133
6.000	.487772	1122862.	34332.1512	-.0058622	1087.1186	-404.6273	2488.6248
9.000	.470272	1226093.	33108.2598	-.0058022	1163.1818	-411.3003	2623.8041
12.000	.452959	1325599.	31864.7340	-.0057370	1236.5012	-417.7170	2766.5873
15.000	.435850	1421322.	30602.3496	-.0056668	1307.0329	-423.8726	2917.5599
18.000	.418958	1513205.	29321.8974	-.0055918	1374.7349	-429.7622	3077.3622
21.000	.402299	1601193.	28024.1833	-.0055123	1439.5669	-435.3806	3246.6956
24.000	.385885	1685234.	26710.0282	-.0054283	1501.4904	-440.7228	3426.3299
27.000	.369729	1765277.	25380.2685	-.0053401	1560.4690	-445.7837	3617.1114
30.000	.353844	1841277.	24035.7561	-.0052480	1616.4679	-450.5579	3819.9722
33.000	.338241	1913189.	22677.3587	-.0051521	1669.4545	-455.0403	4035.9408
36.000	.322931	1980971.	21305.9605	-.0050526	1719.3982	-459.2252	4266.1549
39.000	.307926	2044584.	19922.4620	-.0049497	1766.2703	-463.1072	4511.8749
42.000	.293233	2103993.	18527.7805	-.0048437	1810.0442	-466.6805	4774.5007
45.000	.278863	2159163.	17122.8510	-.0047348	1850.6955	-469.9392	5055.5909
48.000	.264824	2210065.	15708.6261	-.0046232	1888.2017	-472.8774	5356.8846
51.000	.251124	2256672.	14286.0769	-.0045091	1922.5427	-475.4887	5680.3278
54.000	.237770	2298958.	12856.1938	-.0043927	1953.7006	-477.7667	6028.1035
57.000	.224768	2336903.	11419.9869	-.0042742	1981.6597	-479.7046	6402.6683
60.000	.212124	2370489.	9978.4870	-.0041540	2006.4067	-481.2953	6806.7948
63.000	.199844	2399701.	8532.7469	-.0040321	2027.9306	-482.5314	7243.6226
66.000	.187932	2424526.	7083.8421	-.0039088	2046.2228	-483.4051	7716.7193
69.000	.176391	2444957.	5632.8722	-.0037844	2061.2771	-483.9081	8230.1546
72.000	.165225	2460990.	4180.9629	-.0036591	2073.0900	-484.0315	8788.5887
75.000	.154436	2472621.	2729.2672	-.0035330	2081.6604	-483.7657	9397.3823

78.000	.144027	2479854.	1278.9678	-.0034065	2086.9899	-483.1006	10062.7299
81.000	.133997	2482695.	-168.7204	-.0032797	2089.0829	-482.0249	10791.8265
84.000	.124348	2481152.	-1612.4333	-.0031529	2087.9464	-480.4504	11591.2408
87.000	.115080	2475241.	-3045.7506	-.0030263	2083.5910	-475.0945	12385.1791
90.000	.106191	2465010.	-4460.1219	-.0029001	2076.0521	-467.8197	13216.4114
93.000	.097679	2450523.	-5852.1142	-.0027745	2065.3782	-460.1752	14133.2323
96.000	.089544	2431852.	-7227.9726	-.0026497	2051.6202	-457.0638	15313.0801
99.000	.081781	2409022.	-8592.2439	-.0025261	2034.7989	-452.4504	16597.3955
102.000	.074387	2382078.	-9940.3837	-.0024036	2014.9453	-446.3094	17999.3829
105.000	.067359	2351073.	-11267.7703	-.0022827	1992.1004	-438.6150	19534.7819
108.000	.060691	2316079.	-12569.7036	-.0021635	1966.3157	-429.3405	21222.5671
111.000	.054378	2277179.	-13841.3994	-.0020461	1937.6531	-418.4568	23085.9125
114.000	.048414	2234472.	-15077.9808	-.0019309	1906.1853	-405.9308	25153.5455
117.000	.042793	2188071.	-16274.4616	-.0018179	1871.9960	-391.7231	27461.7009
120.000	.037507	2138106.	-17425.7225	-.0017073	1835.1799	-375.7841	30057.0207
123.000	.032549	2084720.	-18526.4732	-.0015995	1795.8435	-358.0497	33001.0069
126.000	.027910	2028074.	-19571.1981	-.0014944	1754.1051	-338.4336	36377.1381
129.000	.023583	1968345.	-20554.0734	-.0013923	1710.0955	-316.8166	40302.8022
132.000	.019557	1905730.	-21444.5038	-.0012933	1663.9587	-276.8037	42461.5538
135.000	.015823	1840590.	-22201.9580	-.0011976	1615.9612	-228.1657	43259.7278
138.000	.012371	1773362.	-22816.7333	-.0011052	1566.4261	-181.6845	44057.9018
141.000	.009191	1704468.	-23295.4071	-.0010164	1515.6627	-137.4313	44856.0758
144.000	.006273	1634306.	-23644.7475	-.0009311	1463.9652	-95.4623	45654.2498
147.000	.003605	1563255.	-23871.6701	-.0008494	1411.6131	-55.8195	46452.4238
150.000	.001177	1491674.	-23983.1963	-.0007713	1358.8701	-18.5313	47250.5978
153.000	-.001023	1419899.	-23986.4132	-.0006970	1305.9844	16.3867	48048.7718
156.000	-.003005	1348247.	-23888.4363	-.0006262	1253.1885	48.9312	48846.9458
159.000	-.004781	1277010.	-23696.3742	-.0005592	1200.6993	79.1102	49645.1198
162.000	-.006360	1206462.	-23417.2954	-.0004957	1148.7177	106.9423	50443.2938
165.000	-.007755	1136855.	-23058.1977	-.0004358	1097.4293	132.4561	51241.4678
168.000	-.008975	1068420.	-22625.9800	-.0003795	1047.0042	155.6890	52039.6418
171.000	-.010032	1001367.	-22127.4165	-.0003266	997.5974	176.6867	52837.8158
174.000	-.010935	935886.	-21569.1333	-.0002771	949.3490	195.5021	53635.9898
177.000	-.011695	872147.	-20957.5876	-.0002309	902.3847	212.1950	54434.1638
180.000	-.012321	810303.	-20299.0491	-.0001879	856.8159	226.8307	55232.3378
183.000	-.012822	750485.	-19599.5837	-.0001481	812.7406	239.4796	56030.5118
186.000	-.013209	692810.	-18865.0402	-.0001112	770.2435	250.2161	56828.6858
189.000	-.013489	637374.	-18101.0384	-7.7213E-05	729.3965	259.1184	57626.8598
192.000	-.013672	584258.	-17312.9602	-4.6001E-05	690.2593	266.2671	58425.0338
195.000	-.013765	533528.	-16505.9420	-1.7443E-05	652.8802	271.7450	59223.2078
198.000	-.013777	485235.	-15684.8701	8.5852E-06	617.2960	275.6362	60021.3818
201.000	-.013714	439413.	-14854.3774	3.2209E-05	583.5333	278.0255	60819.5558
204.000	-.013584	396086.	-14018.8423	5.3555E-05	551.6085	278.9979	61617.7298
207.000	-.013393	355262.	-13182.3891	7.2751E-05	521.5286	278.6376	62415.9038
210.000	-.013147	316940.	-12348.8905	8.9925E-05	493.2917	277.0282	63214.0778
213.000	-.012853	281105.	-11521.9712	.0001052	466.8877	274.2514	64012.2518
216.000	-.012516	247734.	-10705.0132	.0001187	442.2987	270.3873	64810.4258
219.000	-.012141	216792.	-9901.1625	.0001306	419.4995	265.5132	65608.5998
222.000	-.011732	188235.	-9113.3369	.0001409	398.4582	259.7039	66406.7738
225.000	-.011295	162012.	-8344.2348	.0001499	379.1365	253.0309	67204.9478
228.000	-.010833	138064.	-7596.3452	.0001575	361.4907	245.5622	68003.1218
231.000	-.010350	116323.	-6871.9584	.0001640	345.4715	237.3623	68801.2958
234.000	-.009849	96716.7730	-6173.1774	.0001695	331.0248	228.4916	69599.4698
237.000	-.009333	79164.8827	-5501.9303	.0001740	318.0921	219.0064	70397.6438
240.000	-.008805	63582.6254	-4859.9826	.0001776	306.6106	208.9587	71195.8178
243.000	-.008267	49879.8520	-4248.9504	.0001805	296.5140	198.3961	71993.9918
246.000	-.007722	37961.7456	-3670.3135	.0001828	287.7324	187.3618	72792.1658
249.000	-.007171	27729.2123	-3125.4290	.0001845	280.1928	175.8946	73590.3398
252.000	-.006615	19079.2310	-2615.5442	.0001856	273.8192	164.0286	74388.5138
255.000	-.006057	11905.1638	-2141.8107	.0001864	268.5331	151.7938	75186.6878
258.000	-.005496	6097.0260	-1705.2967	.0001869	264.2535	139.2155	75984.8618
261.000	-.004935	1541.7184	-1307.0005	.0001871	260.8970	126.3153	76783.0358
264.000	-.004374	-1876.7791	-947.8619	.0001871	261.1439	113.1104	77581.2098
267.000	-.003813	-4277.2495	-628.7751	.0001869	262.9127	99.6142	78379.3838
270.000	-.003252	-5781.1150	-350.5986	.0001867	264.0208	85.8368	79177.5578
273.000	-.002693	-6512.3456	-114.1663	.0001864	264.5595	71.7847	79975.7318
276.000	-.002134	-6597.3964	79.7035	.0001860	264.6222	57.4618	80773.9058
279.000	-.001577	-6165.1720	230.2000	.0001857	264.3037	42.8692	81572.0798
282.000	-.001020	-5347.0141	336.5125	.0001854	263.7009	28.0058	82370.2538
285.000	-.000464	-4276.7077	397.8246	.0001852	262.9123	12.8690	83168.4278
288.000	9.09E-05	-3090.5036	413.3102	.0001850	262.0382	-2.5453	83966.6018
291.000	.000646	-1927.1513	382.1300	.0001848	261.1810	-18.2415	84764.7758
294.000	.001200	-927.9381	303.4309	.0001848	260.4448	-34.2245	85562.9498
297.000	.001754	-236.7285	176.3467	.0001847	259.9355	-50.4984	86361.1238
300.000	.002308	0.0000	0.0000	.0001847	259.7611	-67.0661	43579.6489

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.52327321 in
Computed slope at pile head	=	-.00596593
Maximum bending moment	=	2482695. lbs-in
Maximum shear force	=	36718.00000 lbs
Depth of maximum bending moment	=	81.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	20
Number of zero deflection points	=	2

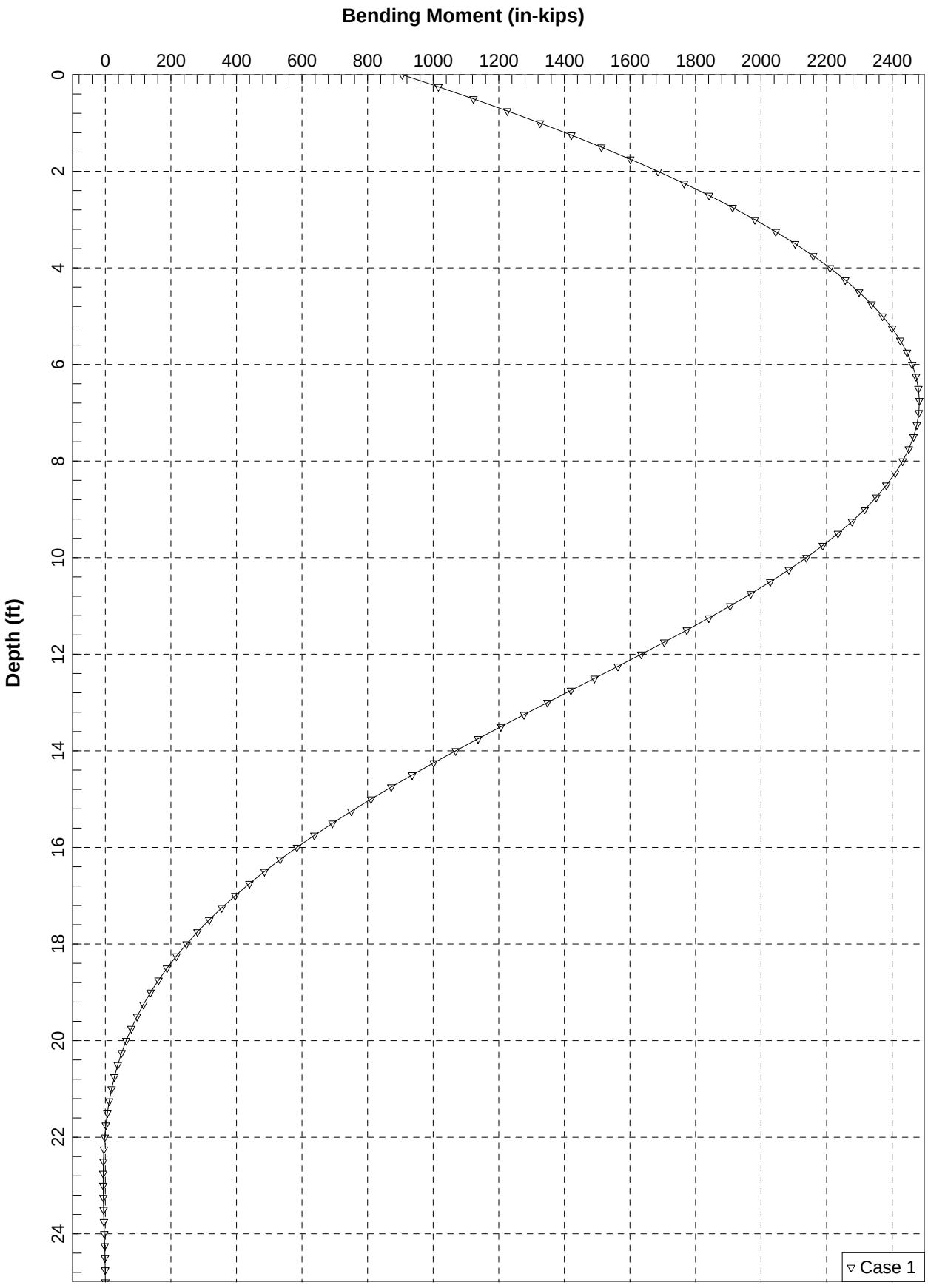
Summary of Pile Response(s)

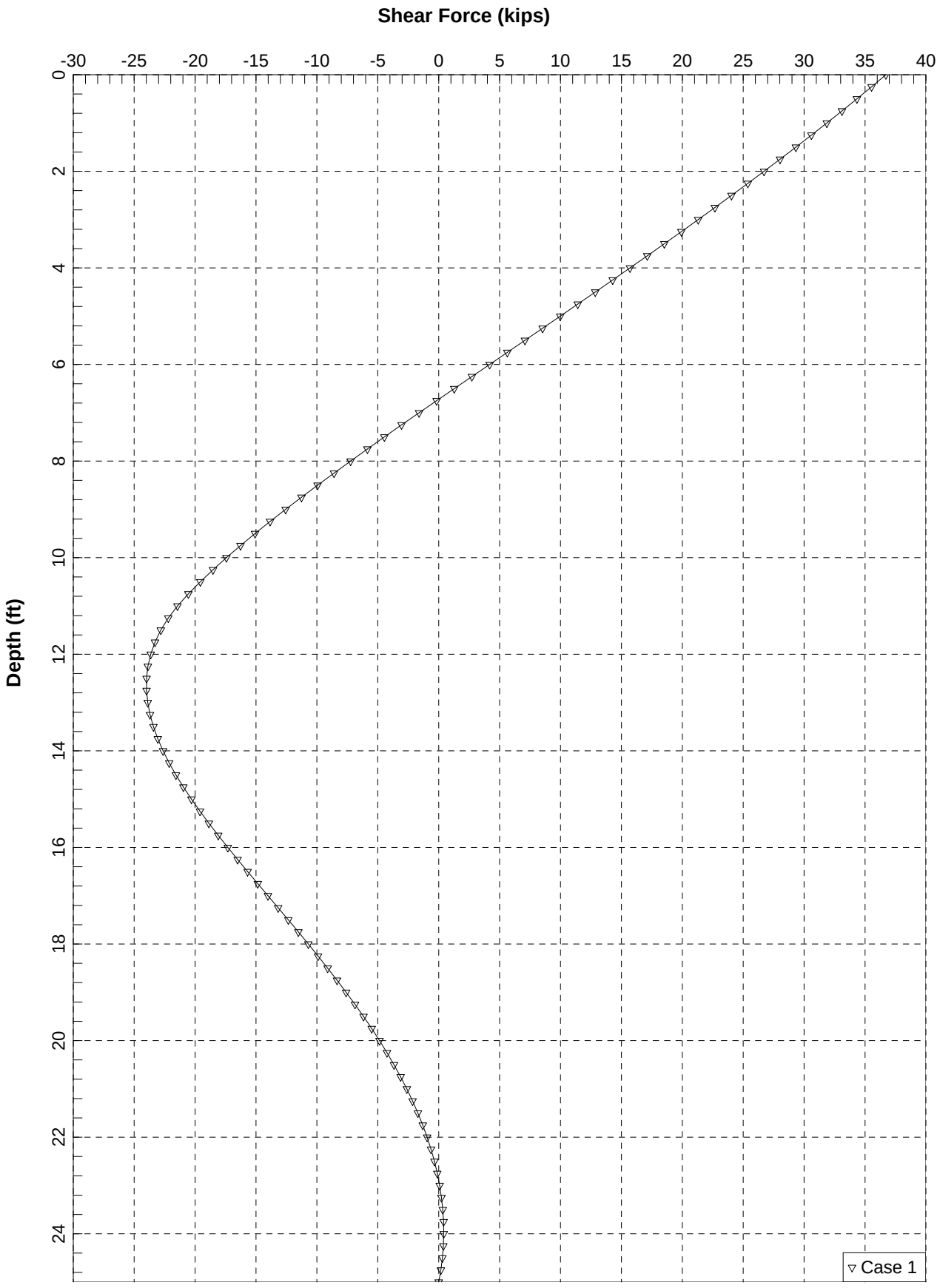
Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

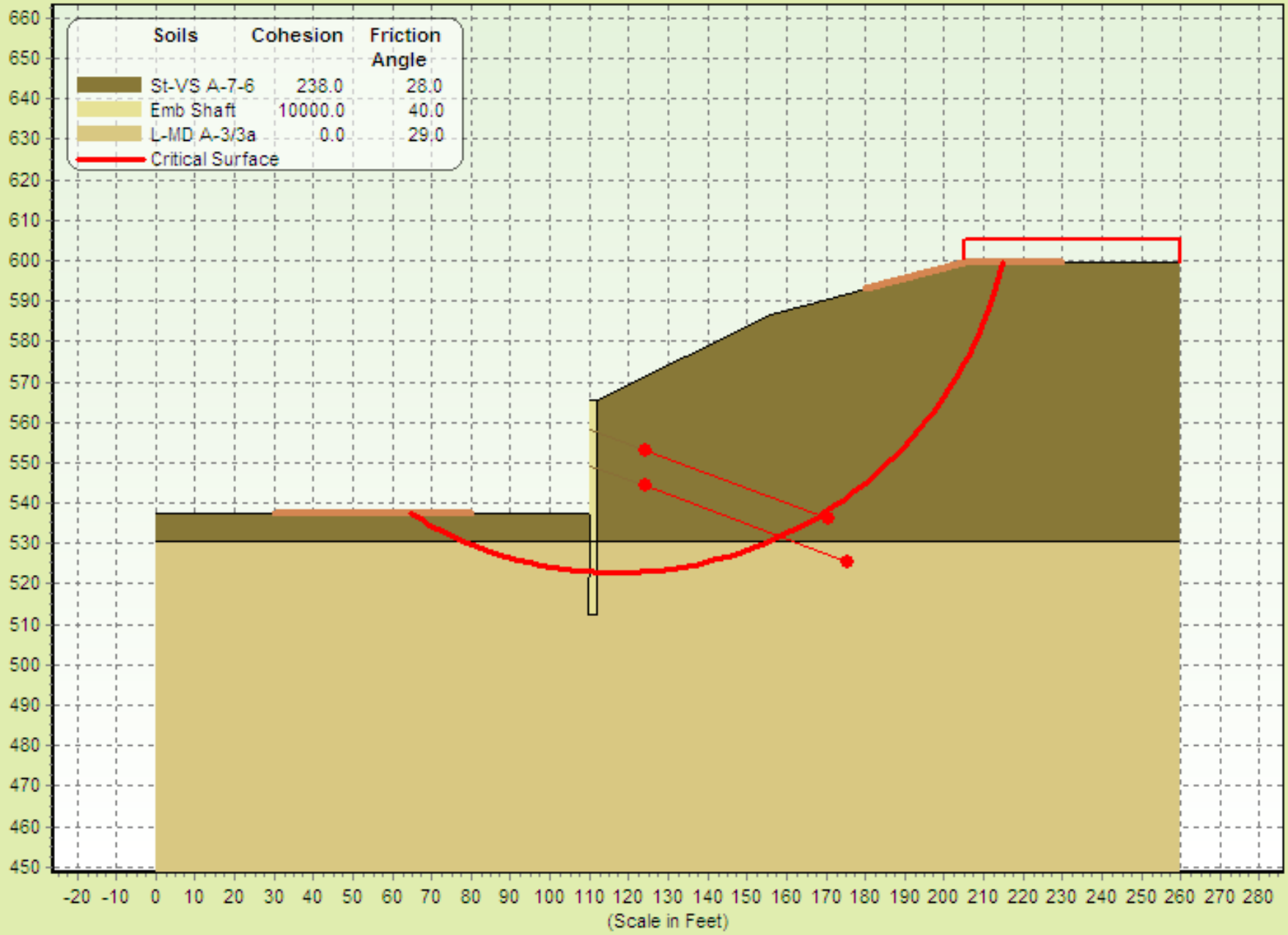
Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 36718.	M= 9.05E+05	117412.	.5232732	2482695.	36718.0000

The analysis ended normally.


Bending Moment (in-kips)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1


Shear Force (kips)
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1

Problem: B-10-020 - HAM-75-7.85 - Wall V - Pile and Lagging - 27.7 ft Wall Ht - FS Min- Janbu = 1.666



** 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 - Wall V - Pile and Lagging - 27.7 ft Wall Ht

BOUNDARY COORDINATES

6 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	537.60	110.00	537.60	1
2	110.00	537.60	110.10	565.30	3
3	110.10	565.30	112.10	565.30	3
4	112.10	565.30	156.00	586.80	1
5	156.00	586.80	205.00	599.40	1
6	205.00	599.40	260.00	599.40	1
7	0.00	530.60	109.90	530.60	2
8	109.90	530.60	110.00	537.60	3
9	109.90	530.60	111.90	530.60	3
10	111.90	530.60	112.10	565.30	1
11	111.90	530.60	260.00	530.60	2
12	109.80	512.60	109.90	530.60	3
13	109.80	512.60	111.80	512.60	2
14	111.80	512.60	111.90	530.60	2

1

ISOTROPIC SOIL PARAMETERS

3 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	115.0	125.0	238.0	28.0	0.00	0.0	1
2	125.0	130.0	0.0	29.0	0.00	0.0	1
3	140.0	140.0	10000.0	40.0	0.00	0.0	0

1

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	205.00	260.00	240.0	0.0

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

1

TIEBACK LOAD(S)

2 Tieback Load(s) Specified

Tieback No.	X-Pos (ft)	Y-Pos (ft)	Load (lbs)	Spacing (ft)	Inclination (deg)	Length (ft) free	Length (ft) fixed
1	110.07	558.30	153400.0	6.0	20.00	15.0	49.5
2	110.04	549.30	169200.0	6.0	20.00	15.0	54.6

NOTE - An Equivalent Line Load Is Calculated For Each Row Of Tiebacks
Assuming A Uniform Distribution Of Load Horizontally Between
Individual Tiebacks.

1

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

750 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 75 Points Equally Spaced
Along The Ground Surface Between X = 30.00 ft.
and X = 80.00 ft.

Each Surface Terminates Between X = 180.00 ft.
and X = 230.00 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 65 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	64.46	537.60
2	67.04	536.07
3	69.67	534.62
4	72.34	533.25
5	75.04	531.96
6	77.79	530.75
7	80.57	529.62
8	83.38	528.58
9	86.23	527.62
10	89.09	526.75
11	91.99	525.96
12	94.91	525.25
13	97.84	524.64

14	100.80	524.11
15	103.76	523.67
16	106.74	523.32
17	109.73	523.06
18	112.73	522.89
19	115.72	522.80
20	118.72	522.81
21	121.72	522.90
22	124.72	523.09
23	127.71	523.36
24	130.68	523.73
25	133.65	524.18
26	136.60	524.72
27	139.53	525.34
28	142.45	526.06
29	145.34	526.86
30	148.21	527.74
31	151.04	528.71
32	153.85	529.77
33	156.63	530.91
34	159.37	532.13
35	162.07	533.43
36	164.73	534.81
37	167.36	536.27
38	169.93	537.81
39	172.46	539.42
40	174.94	541.11
41	177.37	542.87
42	179.74	544.70
43	182.06	546.61
44	184.33	548.58
45	186.53	550.61
46	188.67	552.72
47	190.75	554.88
48	192.76	557.11
49	194.70	559.39
50	196.58	561.73
51	198.38	564.13
52	200.11	566.58
53	201.77	569.08
54	203.36	571.63
55	204.86	574.22
56	206.29	576.86
57	207.64	579.54
58	208.91	582.25
59	210.10	585.01
60	211.21	587.80
61	212.23	590.62
62	213.17	593.47
63	214.02	596.34
64	214.79	599.24
65	214.82	599.40

*** 1.666 ***

Individual data on the 75 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	2.6	226.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.6	680.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	2.7	1123.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	2.7	1555.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	2.7	1971.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.4	297.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	2.4	2083.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.8	2790.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	2.8	3176.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	2.9	3535.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	2.9	3867.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	2.9	4168.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	2.9	4438.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

14	3.0	4675.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	3.0	4877.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	3.0	5043.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	3.0	5173.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.1	222.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	75.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.1	195.0	0.0	0.0	7.1	0.4	0.0	0.0	0.0
21	0.1	397.7	0.0	0.0	7.1	0.4	0.0	0.0	0.0
22	1.8	10410.5	0.0	0.0	136.7	12.7	0.0	0.0	0.0
23	0.0	250.0	0.0	0.0	3.6	0.4	0.0	0.0	0.0
24	0.2	1076.6	0.0	0.0	16.9	2.2	0.0	0.0	0.0
25	0.6	3111.8	0.0	0.0	54.3	7.9	0.0	0.0	0.0
26	3.0	15232.7	0.0	0.0	291.1	53.3	0.0	0.0	0.0
27	3.0	15759.9	0.0	0.0	331.5	87.2	0.0	0.0	0.0
28	3.0	16239.5	0.0	0.0	358.5	122.1	0.0	0.0	0.0
29	3.0	16670.0	0.0	0.0	373.1	154.9	0.0	0.0	0.0
30	3.0	17049.7	0.0	0.0	377.3	183.5	0.0	0.0	0.0
31	3.0	17377.6	0.0	0.0	373.6	207.0	0.0	0.0	0.0
32	3.0	17652.6	0.0	0.0	364.3	224.9	0.0	0.0	0.0
33	3.0	17874.0	0.0	0.0	351.4	237.7	0.0	0.0	0.0
34	2.9	18041.2	0.0	0.0	336.4	245.9	0.0	0.0	0.0
35	2.9	18154.2	0.0	0.0	320.4	250.2	0.0	0.0	0.0
36	2.9	18212.7	0.0	0.0	304.3	251.5	0.0	0.0	0.0
37	2.9	18217.2	0.0	0.0	288.6	250.3	0.0	0.0	0.0
38	2.8	18168.0	0.0	0.0	273.5	247.2	0.0	0.0	0.0
39	2.8	18065.8	0.0	0.0	259.3	242.7	0.0	0.0	0.0
40	2.0	13088.3	0.0	0.0	181.7	173.2	0.0	0.0	0.0
41	0.1	767.0	0.0	0.0	10.3	10.2	0.0	0.0	0.0
42	0.6	4052.3	0.0	0.0	53.9	53.7	0.0	0.0	0.0
43	2.7	17585.4	0.0	0.0	233.6	230.8	0.0	0.0	0.0
44	2.7	17170.0	0.0	0.0	222.1	224.0	0.0	0.0	0.0
45	2.7	16716.7	0.0	0.0	211.5	217.0	0.0	0.0	0.0
46	2.6	16227.6	0.0	0.0	201.8	209.7	0.0	0.0	0.0
47	2.6	15705.1	0.0	0.0	192.7	202.4	0.0	0.0	0.0
48	2.5	15151.7	0.0	0.0	184.4	195.1	0.0	0.0	0.0
49	2.5	14570.0	0.0	0.0	176.7	187.8	0.0	0.0	0.0
50	2.4	13962.8	0.0	0.0	169.5	180.7	0.0	0.0	0.0
51	2.4	13332.9	0.0	0.0	162.9	173.8	0.0	0.0	0.0
52	2.3	12683.4	0.0	0.0	156.8	167.0	0.0	0.0	0.0
53	2.3	12017.5	0.0	0.0	151.0	160.4	0.0	0.0	0.0
54	2.2	11338.0	0.0	0.0	145.6	154.0	0.0	0.0	0.0
55	2.1	10648.6	0.0	0.0	140.6	147.8	0.0	0.0	0.0
56	2.1	9952.5	0.0	0.0	135.9	141.9	0.0	0.0	0.0
57	2.0	9252.8	0.0	0.0	131.4	136.1	0.0	0.0	0.0
58	1.9	8553.3	0.0	0.0	127.2	130.5	0.0	0.0	0.0
59	1.9	7857.3	0.0	0.0	123.2	125.1	0.0	0.0	0.0
60	1.8	7168.1	0.0	0.0	119.4	119.9	0.0	0.0	0.0
61	1.7	6489.4	0.0	0.0	115.8	114.9	0.0	0.0	0.0
62	1.7	5824.6	0.0	0.0	112.4	110.0	0.0	0.0	0.0
63	1.6	5176.9	0.0	0.0	109.1	105.3	0.0	0.0	0.0
64	1.5	4549.9	0.0	0.0	106.0	100.8	0.0	0.0	0.0
65	0.1	391.9	0.0	0.0	10.1	9.2	0.0	0.0	0.0
66	1.3	3530.2	0.0	0.0	92.9	87.3	0.0	0.0	310.4
67	1.4	3292.3	0.0	0.0	100.0	92.3	0.0	0.0	324.0
68	1.3	2702.2	0.0	0.0	97.2	88.3	0.0	0.0	304.7
69	1.2	2154.9	0.0	0.0	94.5	84.4	0.0	0.0	285.2
70	1.1	1652.7	0.0	0.0	91.9	80.6	0.0	0.0	265.4
71	1.0	1198.2	0.0	0.0	89.3	77.0	0.0	0.0	245.3
72	0.9	793.4	0.0	0.0	86.8	73.5	0.0	0.0	225.1
73	0.9	440.6	0.0	0.0	84.4	70.1	0.0	0.0	204.6
74	0.8	141.6	0.0	0.0	82.0	66.8	0.0	0.0	183.9
75	0.0	0.3	0.0	0.0	4.4	3.4	0.0	0.0	8.7

Individual data on the 2 ties

No	Bnd	Slice	Head Coordinates (ft)		End Coordinates (ft)		T (lbs)	Length(ft) free	fixed
1	2	47	110.1	558.3	170.7	536.2	5988.0	15.0	49.5
2	2	43	110.0	549.3	175.4	525.5	******	15.0	54.6

Failure Surface Specified By 66 Coordinate Points

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

1	55.68	537.60
2	58.30	536.14
3	60.96	534.76
4	63.66	533.45
5	66.40	532.22
6	69.17	531.07
7	71.97	529.99
8	74.80	529.00
9	77.65	528.08
10	80.53	527.24
11	83.44	526.48
12	86.36	525.81
13	89.30	525.21
14	92.26	524.70
15	95.22	524.27
16	98.20	523.93
17	101.19	523.67
18	104.19	523.49
19	107.19	523.39
20	110.19	523.38
21	113.19	523.46
22	116.18	523.61
23	119.17	523.85
24	122.15	524.18
25	125.13	524.59
26	128.09	525.08
27	131.03	525.65
28	133.96	526.30
29	136.87	527.04
30	139.75	527.86
31	142.62	528.76
32	145.45	529.74
33	148.26	530.79
34	151.04	531.93
35	153.78	533.14
36	156.49	534.43
37	159.16	535.79
38	161.80	537.23
39	164.39	538.74
40	166.94	540.32
41	169.44	541.97
42	171.90	543.70
43	174.30	545.49
44	176.66	547.34
45	178.96	549.27
46	181.21	551.25
47	183.40	553.30
48	185.54	555.41
49	187.61	557.58
50	189.63	559.80
51	191.58	562.08
52	193.46	564.41
53	195.28	566.80
54	197.03	569.23
55	198.72	571.72
56	200.33	574.25
57	201.87	576.82
58	203.34	579.43
59	204.74	582.09
60	206.06	584.78
61	207.30	587.51
62	208.47	590.28
63	209.56	593.07
64	210.57	595.90
65	211.51	598.75
66	211.70	599.40

*** 1.667 ***

1

Failure Surface Specified By 63 Coordinate Points

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

1	63.11	537.60
2	65.77	536.21
3	68.46	534.90
4	71.20	533.66
5	73.97	532.51
6	76.77	531.43
7	79.60	530.44
8	82.46	529.53
9	85.34	528.70
10	88.25	527.96
11	91.17	527.30
12	94.12	526.72
13	97.08	526.23
14	100.05	525.83
15	103.03	525.51
16	106.02	525.28
17	109.02	525.13
18	112.02	525.07
19	115.02	525.10
20	118.02	525.21
21	121.01	525.41
22	124.00	525.70
23	126.97	526.07
24	129.94	526.53
25	132.89	527.08
26	135.82	527.71
27	138.74	528.42
28	141.63	529.22
29	144.50	530.10
30	147.34	531.06
31	150.15	532.11
32	152.93	533.24
33	155.68	534.44
34	158.39	535.73
35	161.06	537.09
36	163.69	538.53
37	166.28	540.04
38	168.83	541.63
39	171.33	543.29
40	173.77	545.02
41	176.17	546.83
42	178.52	548.70
43	180.81	550.64
44	183.04	552.64
45	185.21	554.71
46	187.33	556.84
47	189.38	559.03
48	191.37	561.27
49	193.29	563.58
50	195.14	565.94
51	196.93	568.35
52	198.64	570.81
53	200.28	573.32
54	201.85	575.88
55	203.35	578.48
56	204.77	581.12
57	206.11	583.80
58	207.37	586.52
59	208.56	589.28
60	209.66	592.07
61	210.69	594.89
62	211.63	597.74
63	212.13	599.40

*** 1.668 ***

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.65	537.60
2	56.24	536.08

3	58.87	534.64
4	61.53	533.26
5	64.24	531.96
6	66.97	530.74
7	69.75	529.59
8	72.55	528.51
9	75.38	527.52
10	78.23	526.60
11	81.11	525.76
12	84.01	524.99
13	86.93	524.31
14	89.87	523.71
15	92.83	523.19
16	95.79	522.74
17	98.77	522.38
18	101.76	522.11
19	104.75	521.91
20	107.75	521.80
21	110.75	521.76
22	113.75	521.81
23	116.75	521.94
24	119.74	522.16
25	122.73	522.45
26	125.70	522.83
27	128.67	523.28
28	131.62	523.82
29	134.55	524.44
30	137.47	525.14
31	140.37	525.92
32	143.24	526.78
33	146.09	527.71
34	148.92	528.72
35	151.71	529.81
36	154.48	530.98
37	157.21	532.22
38	159.91	533.53
39	162.57	534.92
40	165.19	536.38
41	167.77	537.91
42	170.30	539.51
43	172.79	541.18
44	175.24	542.92
45	177.64	544.73
46	179.98	546.59
47	182.28	548.53
48	184.52	550.52
49	186.71	552.57
50	188.84	554.69
51	190.91	556.86
52	192.92	559.08
53	194.87	561.37
54	196.75	563.70
55	198.57	566.08
56	200.33	568.52
57	202.02	570.99
58	203.64	573.52
59	205.19	576.09
60	206.67	578.70
61	208.08	581.35
62	209.41	584.03
63	210.67	586.76
64	211.86	589.51
65	212.97	592.30
66	214.00	595.11
67	214.96	597.96
68	215.40	599.40

*** 1.668 ***

1

Failure Surface Specified By 67 Coordinate Points

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

1	56.35	537.60
2	58.86	535.95
3	61.41	534.37
4	64.01	532.87
5	66.65	531.45
6	69.33	530.11
7	72.06	528.85
8	74.81	527.67
9	77.61	526.57
10	80.43	525.56
11	83.28	524.63
12	86.16	523.79
13	89.06	523.03
14	91.99	522.36
15	94.93	521.77
16	97.89	521.27
17	100.86	520.86
18	103.84	520.54
19	106.83	520.31
20	109.83	520.17
21	112.83	520.12
22	115.83	520.15
23	118.83	520.28
24	121.82	520.49
25	124.80	520.80
26	127.78	521.19
27	130.74	521.67
28	133.69	522.24
29	136.61	522.89
30	139.52	523.63
31	142.40	524.46
32	145.26	525.37
33	148.09	526.37
34	150.89	527.45
35	153.65	528.62
36	156.38	529.86
37	159.07	531.19
38	161.72	532.59
39	164.33	534.08
40	166.89	535.64
41	169.41	537.28
42	171.87	538.99
43	174.29	540.77
44	176.64	542.62
45	178.95	544.55
46	181.19	546.54
47	183.38	548.59
48	185.50	550.71
49	187.56	552.90
50	189.55	555.14
51	191.47	557.44
52	193.33	559.80
53	195.11	562.21
54	196.82	564.67
55	198.46	567.19
56	200.03	569.75
57	201.51	572.35
58	202.92	575.00
59	204.25	577.69
60	205.50	580.42
61	206.66	583.18
62	207.75	585.98
63	208.75	588.81
64	209.66	591.67
65	210.49	594.55
66	211.24	597.46
67	211.67	599.40

*** 1.669 ***

Failure Surface Specified By 61 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	64.46	537.60
2	67.08	536.14
3	69.74	534.75
4	72.45	533.46
5	75.19	532.24
6	77.97	531.11
7	80.78	530.07
8	83.63	529.12
9	86.50	528.26
10	89.40	527.49
11	92.32	526.81
12	95.26	526.22
13	98.22	525.72
14	101.19	525.31
15	104.18	525.00
16	107.17	524.78
17	110.17	524.66
18	113.17	524.62
19	116.17	524.69
20	119.16	524.84
21	122.15	525.09
22	125.13	525.43
23	128.10	525.87
24	131.05	526.39
25	133.99	527.01
26	136.90	527.72
27	139.80	528.52
28	142.66	529.41
29	145.50	530.39
30	148.30	531.46
31	151.07	532.61
32	153.80	533.85
33	156.49	535.18
34	159.14	536.59
35	161.75	538.08
36	164.30	539.65
37	166.81	541.30
38	169.26	543.02
39	171.66	544.82
40	174.00	546.70
41	176.28	548.65
42	178.50	550.67
43	180.65	552.76
44	182.74	554.91
45	184.76	557.13
46	186.71	559.41
47	188.59	561.74
48	190.40	564.14
49	192.13	566.59
50	193.78	569.10
51	195.35	571.65
52	196.84	574.26
53	198.25	576.90
54	199.58	579.59
55	200.82	582.32
56	201.98	585.09
57	203.05	587.90
58	204.03	590.73
59	204.92	593.59
60	205.73	596.48
61	206.44	599.40

*** 1.673 ***

1

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.30	537.60
2	54.95	536.19

3	57.63	534.86
4	60.35	533.59
5	63.10	532.39
6	65.89	531.27
7	68.70	530.22
8	71.53	529.25
9	74.39	528.34
10	77.28	527.52
11	80.18	526.77
12	83.11	526.09
13	86.05	525.49
14	89.00	524.97
15	91.97	524.53
16	94.94	524.16
17	97.93	523.87
18	100.92	523.66
19	103.92	523.53
20	106.92	523.48
21	109.92	523.50
22	112.92	523.60
23	115.91	523.79
24	118.90	524.04
25	121.88	524.38
26	124.85	524.80
27	127.81	525.29
28	130.76	525.86
29	133.69	526.51
30	136.60	527.23
31	139.49	528.03
32	142.36	528.90
33	145.21	529.85
34	148.03	530.87
35	150.82	531.97
36	153.58	533.13
37	156.32	534.37
38	159.01	535.68
39	161.68	537.07
40	164.30	538.52
41	166.89	540.03
42	169.44	541.62
43	171.94	543.27
44	174.40	544.99
45	176.82	546.76
46	179.19	548.61
47	181.51	550.51
48	183.78	552.47
49	185.99	554.49
50	188.15	556.57
51	190.26	558.71
52	192.31	560.90
53	194.31	563.14
54	196.24	565.43
55	198.12	567.78
56	199.93	570.17
57	201.68	572.60
58	203.36	575.09
59	204.98	577.61
60	206.53	580.18
61	208.02	582.79
62	209.43	585.43
63	210.78	588.11
64	212.06	590.83
65	213.26	593.57
66	214.40	596.35
67	215.46	599.16
68	215.54	599.40

*** 1.674 ***

Failure Surface Specified By 62 Coordinate Points

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

1	67.84	537.60
2	70.38	536.00
3	72.97	534.49
4	75.60	533.06
5	78.29	531.72
6	81.01	530.46
7	83.78	529.30
8	86.58	528.23
9	89.42	527.25
10	92.28	526.36
11	95.17	525.57
12	98.09	524.87
13	101.03	524.27
14	103.99	523.76
15	106.96	523.35
16	109.94	523.04
17	112.94	522.83
18	115.93	522.71
19	118.93	522.69
20	121.93	522.77
21	124.93	522.95
22	127.91	523.23
23	130.89	523.60
24	133.85	524.07
25	136.80	524.64
26	139.73	525.30
27	142.63	526.06
28	145.50	526.91
29	148.35	527.86
30	151.17	528.90
31	153.94	530.03
32	156.68	531.25
33	159.38	532.56
34	162.04	533.96
35	164.65	535.44
36	167.20	537.01
37	169.71	538.66
38	172.16	540.39
39	174.55	542.21
40	176.88	544.09
41	179.15	546.06
42	181.35	548.09
43	183.49	550.20
44	185.55	552.38
45	187.54	554.62
46	189.46	556.93
47	191.30	559.29
48	193.07	561.72
49	194.75	564.21
50	196.35	566.74
51	197.87	569.33
52	199.30	571.97
53	200.65	574.65
54	201.90	577.37
55	203.07	580.14
56	204.14	582.94
57	205.13	585.77
58	206.02	588.64
59	206.81	591.53
60	207.52	594.45
61	208.12	597.38
62	208.47	599.40

*** 1.674 ***

1

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.95	537.60
2	53.47	535.98
3	56.05	534.44

4	58.66	532.97
5	61.32	531.58
6	64.01	530.26
7	66.75	529.02
8	69.51	527.86
9	72.31	526.78
10	75.14	525.78
11	78.00	524.86
12	80.88	524.03
13	83.78	523.28
14	86.71	522.61
15	89.65	522.02
16	92.61	521.52
17	95.58	521.11
18	98.56	520.78
19	101.55	520.53
20	104.55	520.37
21	107.54	520.30
22	110.54	520.31
23	113.54	520.41
24	116.54	520.60
25	119.52	520.87
26	122.50	521.22
27	125.47	521.66
28	128.42	522.19
29	131.36	522.80
30	134.28	523.50
31	137.18	524.28
32	140.05	525.14
33	142.90	526.08
34	145.72	527.10
35	148.51	528.21
36	151.26	529.39
37	153.99	530.65
38	156.67	532.00
39	159.31	533.41
40	161.92	534.90
41	164.48	536.47
42	166.99	538.11
43	169.45	539.82
44	171.87	541.60
45	174.23	543.45
46	176.54	545.36
47	178.79	547.34
48	180.99	549.39
49	183.13	551.49
50	185.20	553.66
51	187.21	555.88
52	189.16	558.17
53	191.04	560.50
54	192.85	562.89
55	194.60	565.34
56	196.27	567.83
57	197.87	570.36
58	199.40	572.94
59	200.85	575.57
60	202.23	578.23
61	203.53	580.94
62	204.75	583.68
63	205.90	586.45
64	206.96	589.26
65	207.94	592.09
66	208.84	594.95
67	209.66	597.84
68	210.06	599.40

*** 1.675 ***

Failure Surface Specified By 63 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	58.38	537.60

2	61.02	536.18
3	63.70	534.83
4	66.42	533.57
5	69.18	532.38
6	71.97	531.28
7	74.79	530.26
8	77.64	529.32
9	80.51	528.46
10	83.41	527.69
11	86.33	527.01
12	89.27	526.40
13	92.23	525.89
14	95.20	525.46
15	98.18	525.12
16	101.17	524.87
17	104.16	524.70
18	107.16	524.63
19	110.16	524.64
20	113.16	524.73
21	116.15	524.92
22	119.14	525.19
23	122.12	525.55
24	125.09	526.00
25	128.04	526.53
26	130.97	527.15
27	133.89	527.86
28	136.78	528.65
29	139.65	529.52
30	142.50	530.48
31	145.31	531.52
32	148.09	532.64
33	150.84	533.85
34	153.55	535.13
35	156.23	536.49
36	158.86	537.93
37	161.45	539.45
38	163.99	541.04
39	166.49	542.70
40	168.93	544.44
41	171.33	546.25
42	173.67	548.12
43	175.95	550.07
44	178.18	552.08
45	180.34	554.15
46	182.45	556.29
47	184.49	558.49
48	186.47	560.74
49	188.38	563.06
50	190.22	565.43
51	191.99	567.85
52	193.69	570.32
53	195.32	572.84
54	196.87	575.41
55	198.35	578.02
56	199.75	580.67
57	201.07	583.37
58	202.31	586.10
59	203.47	588.86
60	204.55	591.66
61	205.55	594.49
62	206.47	597.35
63	207.06	599.40

*** 1.675 ***

1

```
          Y           A     X     I     S           F     T

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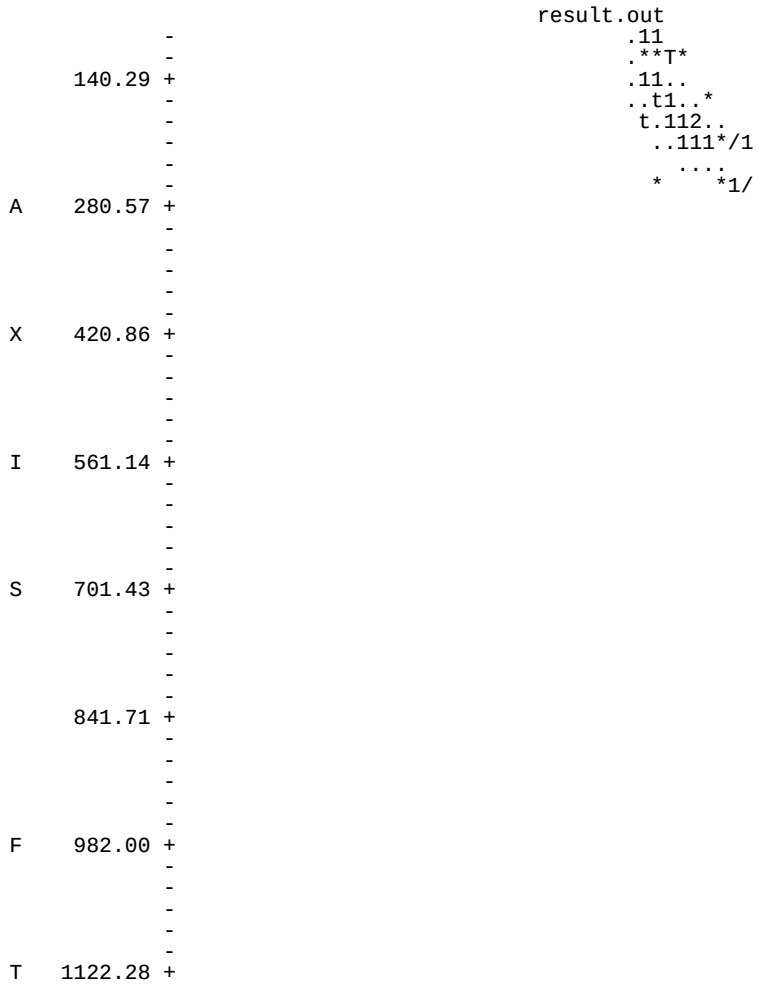
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T 1122.28

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JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	1	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 2 Tiebacks - 18 to 22 Ft Ht

Retaining Wall and Soil Parameters

Retaining Wall Height, (H) =	22.0	ft
Soil Friction Angle, (φ') =	28	°
Soil Total Unit Weight, (γ) =	120	pcf
Backslope Angle, (β) =	26.6	°
Live Surcharge Load, (σ_{LS}) =	0	psf
Shaft Spacing, (S) =	6.0	ft O.C.
Shaft Diameter, (b) =	24	in

Rankine Active Earth Pressures

$$K_a = \cos\beta\left(\frac{\cos\beta-\sqrt{\cos^2\beta-\cos^2\varphi}}{\cos\beta+\sqrt{\cos^2\beta-\cos^2\varphi}}\right)$$

k_a = 0.65

$$P_a = \frac{k_a\gamma H^2}{1.5H-0.5H_1-0.5H_3}$$

P_a = 1481 psf

LRFD Load Factors

	EH	LS
Strength I	1.50	1.75
Service I	1.00	1.00

p-y Reduction Factor

$$\beta_a = 0.5292\left(S/b\right)^{0.5659}$$

β_a = 0.9854

Stuructural Element Properties

Section Type: HP 12x53

E =	29,000	ksi	d =	11.8	in	I_x =	393	in^4	Z_x =	74	in^3
A_s =	15.5	in^2	t_w =	0.435	in	I_x =	65.5	in^4 per ft	Z_x =	12.3	in^3 per ft
f_y =	50	ksi	t_f =	0.435	in	r_s =	5.03	in	T =	9.5	in
									S =	66.8	in^3

Anchor Tieback Setup

2		=	Row(s) of Anchors
6.0	ft	=	Distance Between Top of Wall and Top Row of Anchors, (H_1)
7.0	ft	=	Distance Between Top and Bottom Row of Anchors, (H_2)
9.0	ft	=	Distance Between Bottom Row of Anchors and Bottom of Excavation, (H_3)
20	°	=	Inclination of Anchors, (θ)

Factored Horizontal Tieback and Resultant Loads by Tributary Area Method

$$T_1 = \gamma_{LS}\left[k_a\sigma_{LS}\left(H_1+\tfrac{1}{2}H_2\right)S\right]+\gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}H_1\right)P_aS+\left(H_1+H_2/2-\tfrac{2}{3}H_1\right)P_aS\right]$$

T_1 = 99,991 lb

$$T_2 = \gamma_{LS}\left[k_a\sigma_{LS}\left(\tfrac{1}{2}H_2+\tfrac{1}{2}H_3\right)S\right]+\gamma_{EH}\left[\left(\tfrac{1}{2}H_2+H_3-\tfrac{2}{3}H_3\right)P_aS+\left(\tfrac{2}{3}H_3-\tfrac{1}{2}H_3\right)\left(\tfrac{7}{8}\right)P_aS\right]$$

T_2 = 104,157 lb

$$R = \gamma_{LS}\left[k_a\sigma_{LS}\left(\tfrac{1}{2}H_3\right)S\right]+\gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{1}{2}H_3\right)\left(\tfrac{3}{4}\right)P_aS\right]$$

R = **22,498** lb

$V_{max(from\ embedded,\ LPILE)}$ = **22,498** lb

$V_{max(from\ cantilever,\ calculated)}$ = **57,495** lb

Factored Moment at Ground Surface

$$M = \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}\right)H_1\left(H-\tfrac{2}{3}\left(\tfrac{2}{3}\right)H_1\right)+\left(H-\tfrac{2}{3}H_1-\tfrac{2}{3}H_3\right)\left(\tfrac{2}{3}H_3+\tfrac{1}{2}\left(H-\tfrac{2}{3}H_1-\tfrac{2}{3}H_3\right)\right)\right.$$
$$\left.+\tfrac{1}{2}\left(\tfrac{2}{3}H_3\right)\left(\tfrac{2}{3}\left(\tfrac{2}{3}\right)H_3\right)\right]P_aS+\gamma_{LS}k_a\sigma_{LS}HS-T_1\left(H_2+H_3\right)-T_2H_3$$

M = **58,050** lb-ft

696,603 lb-in

$M_{max(from\ embedded,\ LPILE)}$ = **119,930** lb-ft

$M_{max(from\ cantilever,\ calculated)}$ = **115,545** lb-ft

Factored Vertical Component from Anchor and Structural Loads

$$P_{max} = \left(\frac{T_1+T_2}{\cos\theta}\right)\sin\theta$$

P_{max} = **74,304** lb

Factored Axial Load from Structure

P_{SL} = **0** lb

Capacity Verification

φ_f = 1.00 φ_c = 0.70 φ_v = 1.00 , C= 1.0

Maximum Factored Bending Moment, M_u =	119.9	kip-ft per section	
Maximum Factored Axial Force, P_u =	74.3	kip per section	(Anchor and Structural Axial Load)
Maximum Factored Shear Force, V_u =	57.5	kip per section	

Check				
Factored Flexural Resistance, φ_fM_n =	308.3	kip-ft per section	M_u less than φ_fM_n	OK
Factored Axial Resistance, φ_cP_n =	531.6	kip per section	P_u less than φ_cP_n	OK
Factored Shear Resistance, φ_vV_n =	137.6	kip per section	V_u less than φ_vV_n	OK
Required Section Modulus, S_{Req} =	28.8	in^3	S_{Req} less than $S_{Section}$	OK

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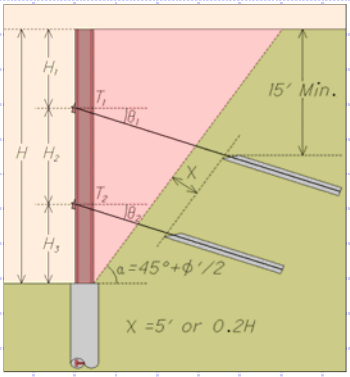
JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	2	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 2 Tiebacks - 18 to 22 Ft Ht

Anchor Diagram



Per AASHTO Bridge Design Specification 11.9:

Anchor tiebacks must have an unbonded length of the greater of:

1) Length to bonded segment equal to a distance x beyond the active wedge angle.
2) Overburden cover must be a minimum of 15 ft before bonding.
3) Must be a minimum of 15 ft.

Anchor tiebacks must have the capacity to resist pullout of the bonded length.

Active Wedge Angle, (α) = 59.0 °

Min. Length Behind Active Wedge, (x) = 5.0 ft

Unbonded Anchor Length

Top Row of Anchors:

$$L_{u,T1} = (15 - H_1)\left(\frac{\sin(90-\beta)}{\sin(\beta+\theta)}\right) = 11.08 \text{ ft}$$ For min. overburden

$$L_{u,T1} = (H_2 + H_3)\left(\frac{\sin(90-\alpha)}{\sin(\alpha+\theta)}\right) + x = 13.39 \text{ ft}$$ For min. x behind active wedge

$L_{u,T1}$ = **15.00** ft

Bottom Row of Anchors:

$$L_{u,T2} = (15 - H_1 - H_2)\left(\frac{\sin(90-\beta)}{\sin(\beta+\theta)}\right) = 2.461 \text{ ft}$$ For min. overburden

$$L_{u,T2} = (H_3)\left(\frac{\sin(90-\alpha)}{\sin(\alpha+\theta)}\right) + x = 9.722 \text{ ft}$$ For min. x behind active wedge

$L_{u,T1}$ = **15.00** ft

Bonded Anchor Length

Anchor Pullout Capacity (AASHTO 11.9.4.2)

$$Q_R = \phi Q_n = \phi \pi d \tau_n L_b$$

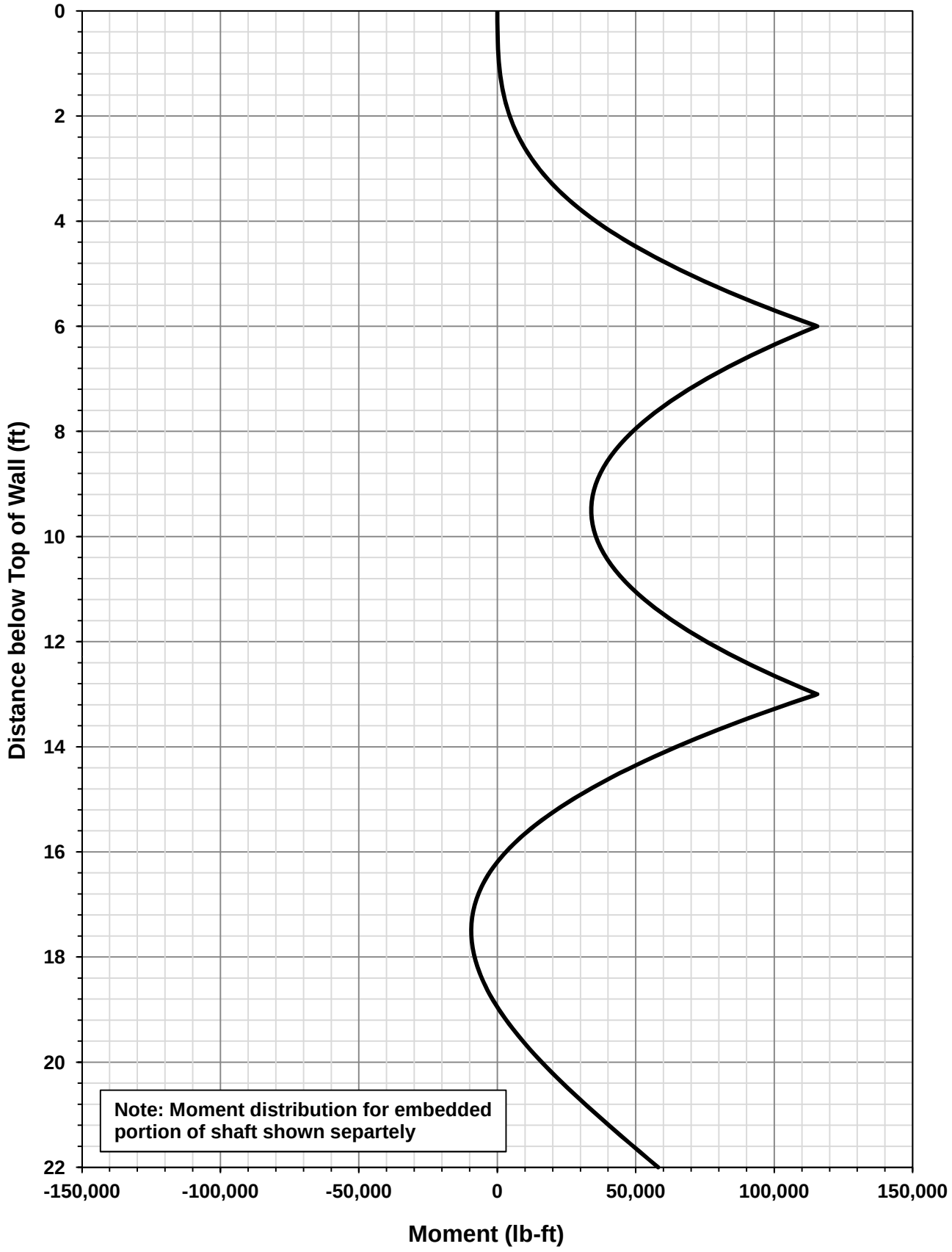
φ	= 0.7		Per table 11.5.6-1
d	= 6.0	in	
τ_n	= 3.0	ksf	Per Table C11.9.4.2-1 for stiff to very stiff, medium to high plasticity cohesive soil (q_u = 1.25 to 4.0 tsf)
ϕQ_n	= T		

Top Row of Anchors: T_1 = 106,408 lb

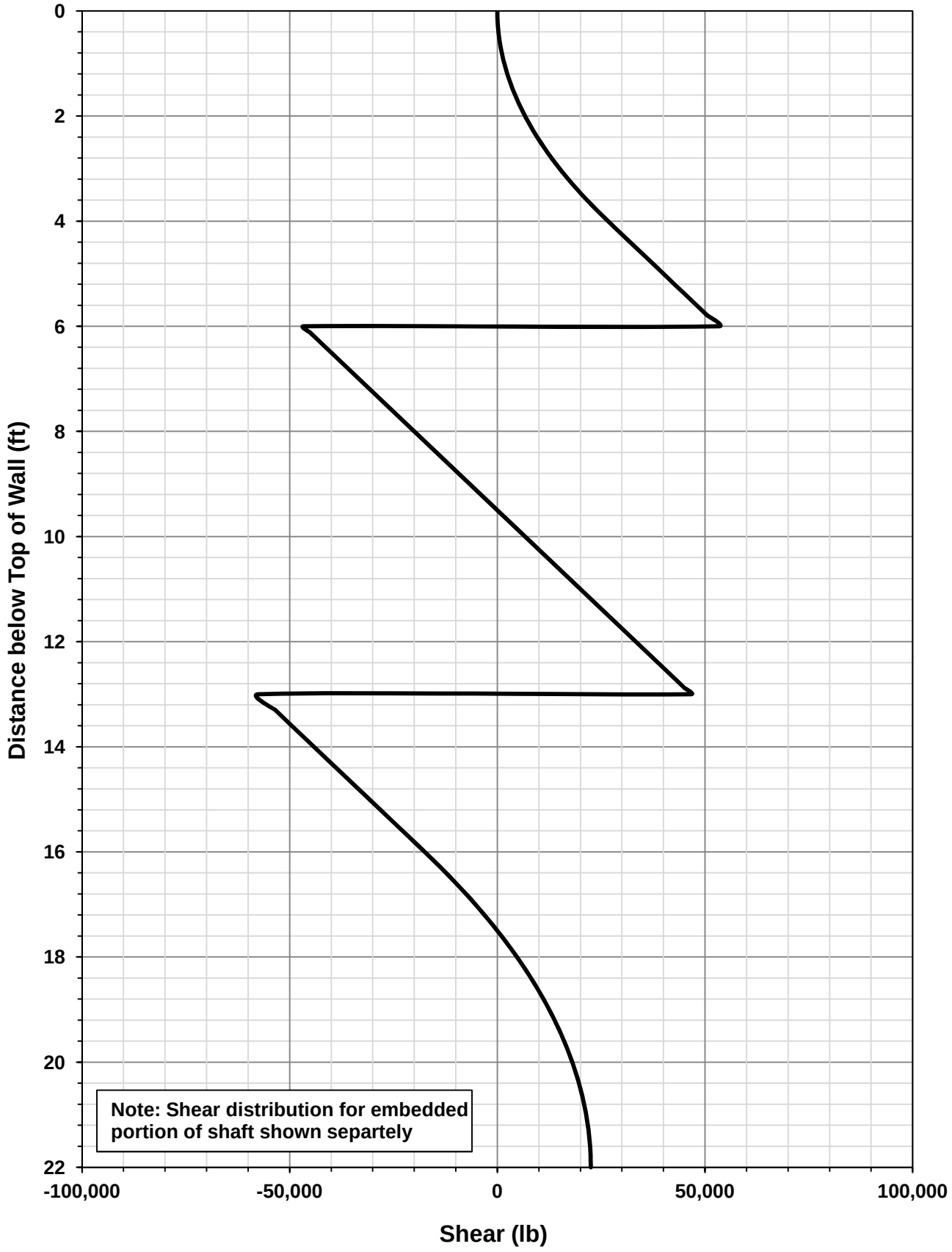
$$L_{b,T1} = \frac{T_1}{\phi \pi d \tau_n}$$ $L_{b,T1}$ = **32.26** ft

Bottom Row of Anchors: T_2 = 110,842 lb

$$L_{b,T2} = \frac{T_2}{\phi \pi d \tau_n}$$ $L_{b,T2}$ = **33.60** ft


Moment Distribution above Ground Surface
Distance below Top of Wall (ft)
0
2
4
6
8
10
12
14
16
18
20
22
-150,000
-100,000
-50,000
0
50,000
100,000
150,000
Moment (lb-ft)
Note: Moment distribution for embedded portion of shaft shown separtely

Shear Distribution above Ground Surface



LPILE Plus for Windows, Version 5.0 (5.0.39)

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

This program is licensed to:

Path to file locations: J:\GEOTECH\Projects\2010\B-10-020 HAM-75-7.85\HAM-75-7.85 PID 77889 - Mainline\Analysis\Retaining Wall V\Pile and Lagging - 2-Tiebacks\18' to 22' Wall Height\
Name of input data file: 18' to 22' Wall Height - 2-Tiebacks.lpd
Name of output file: 18' to 22' Wall Height - 2-Tiebacks.lpo
Name of plot output file: 18' to 22' Wall Height - 2-Tiebacks.lpp
Name of runtime file: 18' to 22' Wall Height - 2-Tiebacks.lpr

Time and Date of Analysis

Date: August 10, 2013 Time: 21:45:28

Problem Title

HAM-75-7.85 - Retaining Wall V - Pile and Lagging - 2-Tiebacks - 18 to 22 ft Ht

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 300.00 in

Depth of ground surface below top of pile = .00 in

Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.0000	3604997.
2	300.0000	24.00000000	16286.0000	452.0000	3604997.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 430.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 130.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06660
2	84.00	.06660
3	84.00	.07230
4	430.00	.07230

Shear Strength of Soils

Shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.42000	.00	.00700	.0
2	84.000	10.42000	.00	.00700	.0
3	84.000	.00000	29.00	------	------
4	430.000	.00000	29.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.9854	1.0000
2	430.000	.9854	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 22498.000 lbs
Bending moment at pile head = 696603.000 in-lbs
Axial load at pile head = 74304.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 22498.000 lbs
Specified moment at pile head = 696603.000 in-lbs
Specified axial load at pile head = 74304.000 lbs

Non-zero moment for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment)condition.

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	.228421	696603.	22498.0000	-.0030810	677.6668	-317.4412	2084.5828
3.000	.219231	763351.	21537.7083	-.0030437	726.8489	-322.7533	4416.6169
6.000	.210159	827186.	20561.8405	-.0030030	773.8843	-327.8253	4679.6841
9.000	.201213	888061.	19571.1241	-.0029592	818.7388	-332.6523	4959.7070
12.000	.192403	945932.	18566.3016	-.0029124	861.3798	-337.2294	5258.1650
15.000	.183739	1000757.	17548.1300	-.0028626	901.7766	-341.5516	5576.6961
18.000	.175228	1052497.	16517.3816	-.0028102	939.9001	-345.6139	5917.1169
21.000	.166878	1101115.	15474.8440	-.0027551	975.7227	-349.4112	6281.4474
24.000	.158697	1146575.	14421.3201	-.0026977	1009.2190	-352.9381	6671.9382
27.000	.150691	1188845.	13357.6287	-.0026381	1040.3652	-356.1894	7091.1040
30.000	.142868	1227896.	12284.6051	-.0025763	1069.1393	-359.1597	7541.7609
33.000	.135234	1263701.	11203.1008	-.0025126	1095.5214	-361.8432	8027.0721
36.000	.127792	1296235.	10113.9849	-.0024472	1119.4934	-364.2341	8550.6008
39.000	.120550	1325476.	9018.1440	-.0023803	1141.0390	-366.3265	9116.3731
42.000	.113511	1351405.	7916.4831	-.0023119	1160.1443	-368.1140	9728.9535
45.000	.106679	1374006.	6809.9269	-.0022422	1176.7970	-369.5901	10393.5353
48.000	.100057	1393265.	5699.4199	-.0021715	1190.9873	-370.7478	11116.0497
51.000	.093650	1409171.	4585.9285	-.0020999	1202.7074	-371.5798	11903.2988
54.000	.087458	1421716.	3470.4418	-.0020276	1211.9514	-372.0780	12763.1179
57.000	.081484	1430897.	2353.9735	-.0019547	1218.7162	-372.2342	13704.5766
60.000	.075729	1436712.	1237.5636	-.0018815	1223.0004	-372.0390	14738.2280
63.000	.070195	1439161.	122.2816	-.0018080	1224.8055	-371.4824	15876.4228
66.000	.064881	1438251.	-990.7716	-.0017345	1224.1349	-370.5531	17133.7067
69.000	.059788	1433990.	-2100.4593	-.0016611	1220.9951	-369.2387	18527.3307
72.000	.054915	1426389.	-3205.6051	-.0015880	1215.3945	-367.5251	20077.9128
75.000	.050260	1415464.	-4304.9871	-.0015154	1207.3448	-365.3962	21810.3091

78.000	.045822	1401235.	-5397.3314	-.0014434	1196.8601	-362.8334	23754.7750
81.000	.041599	1383724.	-6481.3037	-.0013723	1183.9575	-359.8148	25948.5410
84.000	.037589	1362959.	-7376.8149	-.0013021	1168.6572	-237.1926	18930.6837
87.000	.033787	1340044.	-8075.7468	-.0012331	1151.7725	-228.7620	20312.3101
90.000	.030190	1315054.	-8747.6890	-.0011652	1133.3596	-219.1995	21781.8365
93.000	.026795	1288077.	-9390.8881	-.0010987	1113.4820	-209.5999	23466.7539
96.000	.023598	1259199.	-10010.0397	-.0010336	1092.2036	-203.1678	25828.7120
99.000	.020593	1228477.	-10608.2367	-.0009701	1069.5674	-195.6302	28498.8241
102.000	.017777	1195982.	-11182.0871	-.0009081	1045.6236	-186.9368	31546.2381
105.000	.015145	1161790.	-11728.0258	-.0008479	1020.4300	-177.0223	35066.3027
108.000	.012690	1125992.	-12222.4624	-.0007895	994.0528	-152.6021	36076.1618
111.000	.010408	1088807.	-12643.2586	-.0007329	966.6541	-127.9287	36874.3358
114.000	.008293	1050459.	-12991.3568	-.0006782	938.3980	-104.1368	37672.5098
117.000	.006339	1011161.	-13269.4887	-.0006255	909.4425	-81.2845	38470.6838
120.000	.004540	971121.	-13480.5472	-.0005749	879.9394	-59.4212	39268.8578
123.000	.002889	930534.	-13627.5623	-.0005263	850.0341	-38.5888	40067.0318
126.000	.001382	889590.	-13713.6777	-.0004798	819.8652	-18.8214	40865.2058
129.000	1.05E-05	848466.	-13742.1282	-.0004354	789.5639	-.1456140	41663.3798
132.000	-.001231	807331.	-13716.2182	-.0003931	759.2546	17.4189	42461.5538
135.000	-.002348	766344.	-13639.3008	-.0003529	729.0540	33.8593	43259.7278
138.000	-.003348	725653.	-13514.7582	-.0003148	699.0715	49.1691	44057.9018
141.000	-.004237	685396.	-13345.9831	-.0002787	669.4090	63.3477	44856.0758
144.000	-.005020	645701.	-13136.3611	-.0002447	640.1608	76.4003	45654.2498
147.000	-.005705	606687.	-12889.2550	-.0002127	611.4139	88.3372	46452.4238
150.000	-.006297	568460.	-12607.9887	-.0001827	583.2476	99.1736	47250.5978
153.000	-.006801	531120.	-12295.8344	-.0001546	555.7343	108.9292	48048.7718
156.000	-.007224	494754.	-11955.9990	-.0001284	528.9388	117.6276	48846.9458
159.000	-.007572	459441.	-11591.6134	-.0001040	502.9193	125.2961	49645.1198
162.000	-.007848	425251.	-11205.7216	-8.1408E-05	477.7268	131.9651	50443.2938
165.000	-.008060	392243.	-10801.2720	-6.0522E-05	453.4058	137.6680	51241.4678
168.000	-.008211	360470.	-10381.1094	-4.1291E-05	429.9945	142.4404	52039.6418
171.000	-.008308	329975.	-9947.9684	-2.3651E-05	407.5247	146.3203	52837.8158
174.000	-.008353	300793.	-9504.4676	-7.5356E-06	386.0225	149.3470	53635.9898
177.000	-.008353	272952.	-9053.1051	7.1230E-06	365.5082	151.5613	54434.1638
180.000	-.008311	246471.	-8596.2556	2.0394E-05	345.9966	153.0051	55232.3378
183.000	-.008231	221365.	-8136.1669	3.2346E-05	327.4977	153.7207	56030.5118
186.000	-.008117	197640.	-7674.9595	4.3051E-05	310.0162	153.7509	56828.6858
189.000	-.007972	175296.	-7214.6254	5.2580E-05	293.5527	153.1385	57626.8598
192.000	-.007801	154329.	-6757.0289	6.1001E-05	278.1033	151.9259	58425.0338
195.000	-.007606	134727.	-6303.9071	6.8386E-05	263.6600	150.1553	59223.2078
198.000	-.007391	116475.	-5856.8726	7.4804E-05	250.2114	147.8677	60021.3818
201.000	-.007157	99552.2205	-5417.4157	8.0323E-05	237.7424	145.1036	60819.5558
204.000	-.006909	83934.4675	-4986.9076	8.5011E-05	226.2347	141.9018	61617.7298
207.000	-.006647	69592.8746	-4566.6049	8.8934E-05	215.6674	138.3000	62415.9038
210.000	-.006375	56495.1893	-4157.6533	9.2155E-05	206.0167	134.3344	63214.0778
213.000	-.006094	44605.8697	-3761.0931	9.4738E-05	197.2563	130.0391	64012.2518
216.000	-.005807	33886.3939	-3377.8645	9.6743E-05	189.3579	125.4467	64810.4258
219.000	-.005514	24295.5522	-3008.8130	9.8230E-05	182.2911	120.5876	65608.5998
222.000	-.005217	15789.7224	-2654.6962	9.9254E-05	176.0237	115.4903	66406.7738
225.000	-.004918	8323.1254	-2316.1893	9.9870E-05	170.5221	110.1810	67204.9478
228.000	-.004618	1848.0621	-1993.8925	.0001001	165.7511	104.6836	68003.1218
231.000	-.004318	-3684.8699	-1688.3371	.0001001	167.1045	99.0200	68801.2958
234.000	-.004018	-8326.5801	-1399.9928	9.9776E-05	170.5246	93.2095	69599.4698
237.000	-.003719	-12129.3095	-1129.2743	9.9254E-05	173.3266	87.2695	70397.6438
240.000	-.003422	-15146.4757	-876.5483	9.8557E-05	175.5497	81.2145	71195.8178
243.000	-.003128	-17432.5385	-642.1404	9.7724E-05	177.2342	75.0574	71993.9918
246.000	-.002836	-19042.8861	-426.3417	9.6792E-05	178.4207	68.8084	72792.1658
249.000	-.002547	-20033.7413	-229.4156	9.5794E-05	179.1508	62.4757	73590.3398
252.000	-.002261	-20462.0869	-51.6039	9.4759E-05	179.4664	56.0654	74388.5138
255.000	-.001978	-20385.6107	106.8667	9.3716E-05	179.4101	49.5816	75186.6878
258.000	-.001699	-19862.6674	245.7791	9.2688E-05	179.0248	43.0266	75984.8618
261.000	-.001422	-18952.2585	364.9200	9.1696E-05	178.3540	36.4007	76783.0358
264.000	-.001149	-17714.0276	464.0752	9.0759E-05	177.4416	29.7028	77581.2098
267.000	-.000878	-16208.2699	543.0247	8.9892E-05	176.3321	22.9302	78379.3838
270.000	-.000609	-14495.9558	601.5385	8.9108E-05	175.0704	16.0790	79177.5578
273.000	-.000343	-12638.7653	639.3735	8.8415E-05	173.7020	9.1443	79975.7318
276.000	-7.87E-05	-10699.1324	656.2699	8.7818E-05	172.2728	2.1200	80773.9058
279.000	.000184	-8740.2976	651.9495	8.7322E-05	170.8295	-5.0003	81572.0798
282.000	.000445	-6826.3656	626.1138	8.6924E-05	169.4192	-12.2235	82370.2538
285.000	.000705	-5022.3676	578.4433	8.6621E-05	168.0900	-19.5568	83168.4278
288.000	.000965	-3394.3236	508.5976	8.6406E-05	166.8904	-27.0070	83966.6018
291.000	.001224	-2009.3040	416.2162	8.6268E-05	165.8699	-34.5806	84764.7758
294.000	.001483	-935.4870	300.9205	8.6193E-05	165.0787	-42.2832	85562.9498
297.000	.001741	-242.2081	162.3167	8.6163E-05	164.5678	-50.1193	86361.1238
300.000	.002000	0.0000	0.0000	8.6157E-05	164.3894	-58.0919	43579.6489

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.22842065 in
Computed slope at pile head	=	-.00308098
Maximum bending moment	=	1439161. lbs-in
Maximum shear force	=	22498.00000 lbs
Depth of maximum bending moment	=	63.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	21
Number of zero deflection points	=	2

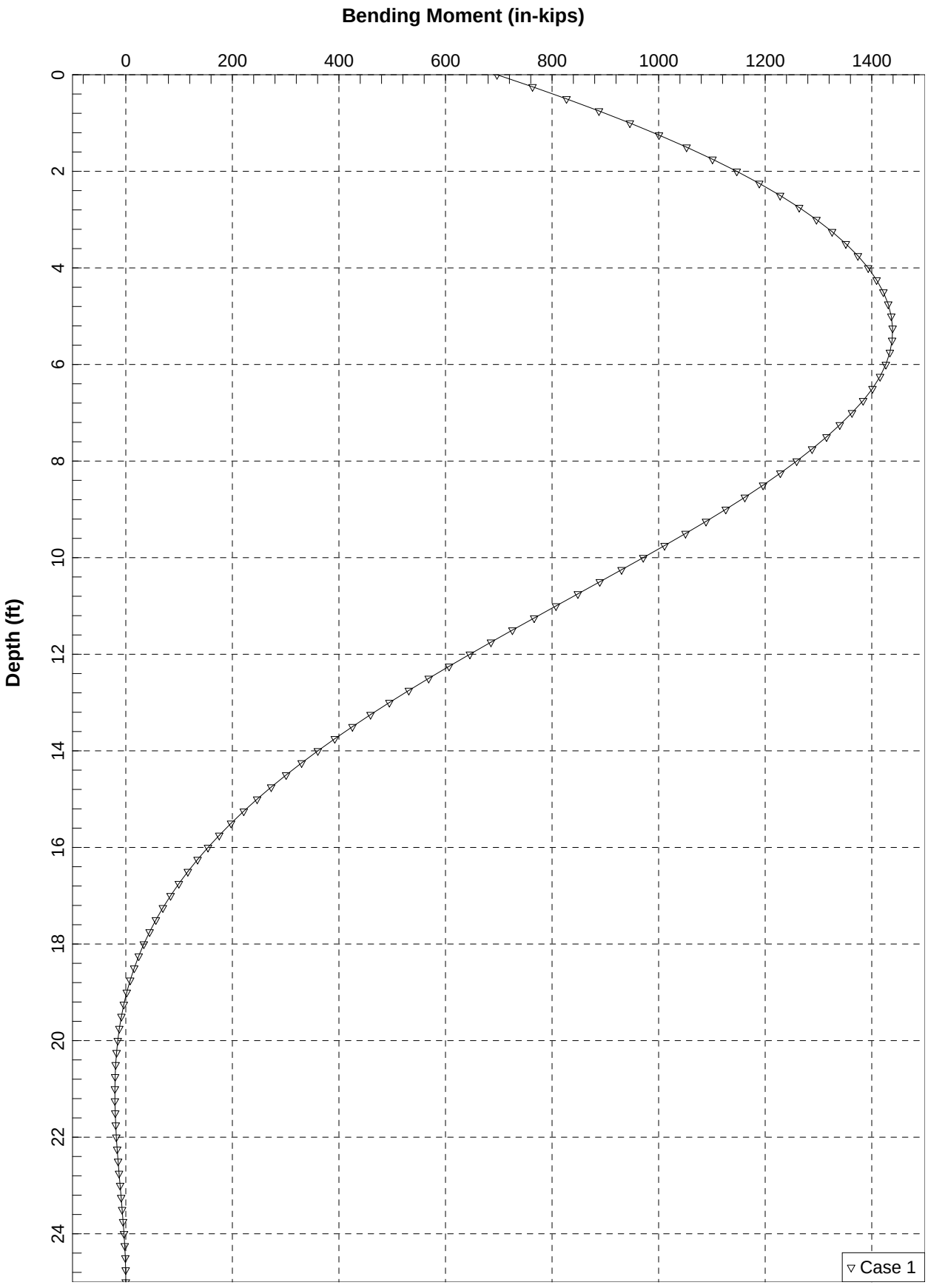
Summary of Pile Response(s)

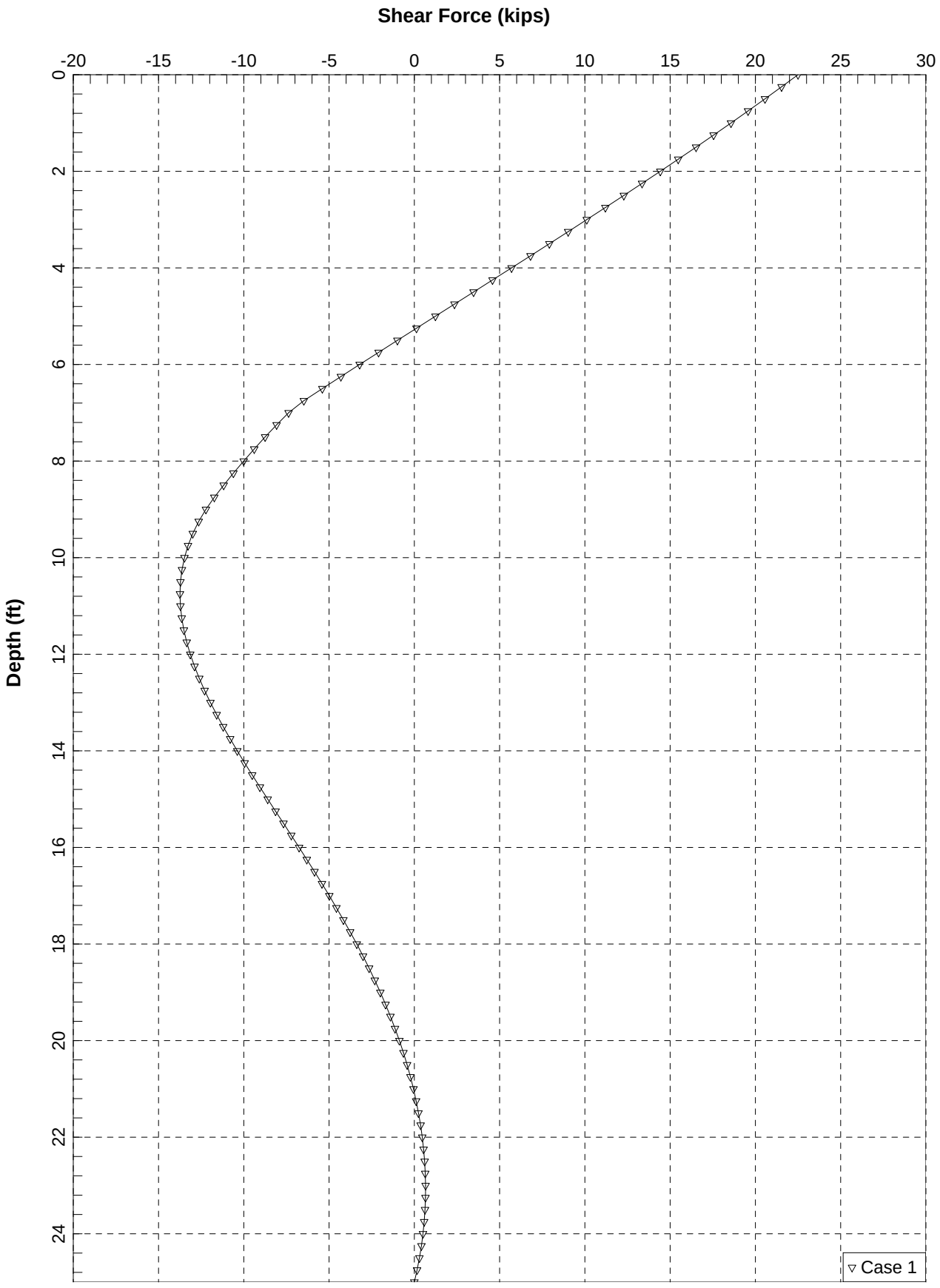
Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 22498.	M= 6.97E+05	74304.0000	.2284207	1439161.	22498.0000

The analysis ended normally.


Bending Moment (in-kips)
0
200
400
600
800
1000
1200
1400
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1


Shear Force (kips)
-20
-15
-10
-5
0
5
10
15
20
25
30
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1

RESOURCE INTERNATIONAL, INC.
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JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	1	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 1 Tieback - 14 to 18 ft Ht

Retaining Wall and Soil Parameters

Retaining Wall Height, (H) =	18.0	ft
Soil Friction Angle, (φ') =	28	°
Soil Total Unit Weight, (γ) =	120	pcf
Backslope Angle, (β) =	26.6	°
Live Surcharge Load, (σ_{LS}) =	0	psf
Shaft Spacing, (S) =	6.0	ft O.C.
Shaft diameter, (b) =	24	in

Rankine Active Earth Pressures

$$K_a = \cos\beta\left(\frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\varphi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\varphi}}\right)$$

k_a = 0.65

$$P_a = k_a \gamma H$$

P_a = 1405 psf

LRFD Load Factors

	EH	LS
Strength I	1.50	1.75
Service I	1.00	1.00

(AASHTO LRFD BDM Tab. 3.4.1-1, 3.4.1-2 - Active Earth Pressure)

p-y Reduction Factor

$$\beta_a = 0.5292\left(S/b\right)^{0.5659}$$

β_a = 0.9854

Stuructural Element Properties

Section Type: HP 12x53

E =	29,000	ksi	d =	11.8	in	I_x =	393	in^4	Z_x =	74.0	in^3
A_s =	15.5	in^2	t_w =	0.435	in	I_x =	65.5	in^4 per ft	Z_x =	12.3	in^3 per ft
f_y =	50	ksi	t_f =	0.435	in	r_s =	5.03	in	T =	9.5	in
									S =	66.8	in^3

Anchor Tieback Setup

1		=	Row(s) of Anchors
5.0	ft	=	Distance Between Top of Wall Row of Anchors, (H_1)
13.0	ft	=	Distance Row of Anchors and Bottom of Excavation, (H_2)
20	°	=	Inclination of Anchors, (θ)

Factored Horizontal Tieback and Resultant Loads by Tributary Area Method

$$T_1 = \gamma_{LS}\left[k_a\sigma_{LS}\left(H_1 + \tfrac{1}{2}H_2\right)S\right] + \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}H_1\right)P_aS + \left(H_1 - \tfrac{2}{3}H_1 - \tfrac{2}{3}H_2\right)P_aS + \left(\tfrac{2}{3}H_2 - \tfrac{1}{2}H_1\right)\tfrac{7}{8}P_aS\right]$$

T_1 = 120,903 lb

$$R = \gamma_{LS}\left[k_a\sigma_{LS}\left(\tfrac{1}{2}H_2\right)S\right] + \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{1}{2}H_2\right)\tfrac{3}{4}P_aS\right]$$

R = **30,818** lb

$V_{max(from\ embedded,\ LPILE)}$ = **30,818** lb

$V_{max(from\ cantilever,\ calculated)}$ = **78,758** lb

Factored Moment at Ground Surface

$$M = \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}\right)H_1\left(H - \tfrac{2}{3}\left(\tfrac{2}{3}\right)H_1\right) + \left(H - \tfrac{2}{3}H_1 - \tfrac{2}{3}H_2\right)\left(\tfrac{2}{3}H_2 + \tfrac{1}{2}\left(H - \tfrac{2}{3}H_1 - \tfrac{2}{3}H_2\right)\right) + \tfrac{1}{2}\left(\tfrac{2}{3}H_2\right)\left(\tfrac{2}{3}\left(\tfrac{2}{3}\right)H_2\right)\right]P_aS + \gamma_{LS}k_a\sigma_{LS}HS - T_1\left(H_2\right)$$

M = **-37,667** lb-ft

-452,004 lb-in

$M_{max(from\ embedded,\ LPILE)}$ = **77,925** lb-ft

$M_{max(from\ cantilever,\ calculated)}$ = **171,214** lb-ft

Factored Vertical Component from Anchor and Structural Loads

$$P_{max} = \left(\frac{T_1}{\cos\theta}\right)\sin\theta$$

P_{max} = **44,005** lb

Factored Axial Load from Structure

P_{SL} = **0** lb

Capacity Verification

φ_f = 1.00 φ_c = 0.70 φ_v = 1.00, C= 1.0

Maximum Factored Bending Moment, M_u =	171.2	kip-ft per section	
Maximum Factored Axial Force, P_u =	44.0	kip per section	(Anchor and Structural Axial Load)
Maximum Factored Shear Force, V_u =	78.8	kip per section	

Check

Factored Flexural Resistance, $\varphi_f M_n$ =	308.3	kip-ft per section	M_u	less than	$\varphi_f M_n$	OK
Factored Axial Resistance, $\varphi_c P_n$ =	505.9	kip per section	P_u	less than	$\varphi_c P_n$	OK
Factored Shear Resistance, $\varphi_v V_n$ =	137.6	kip per section	V_u	less than	$\varphi_v V_n$	OK
Required Section Modulus, S_{Req} =	41.1	in^3	S_{Req}	less than	$S_{Section}$	OK

RESOURCE INTERNATIONAL, INC.
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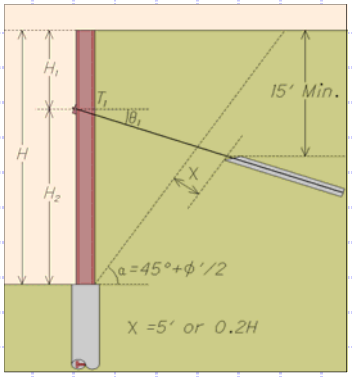
JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	2	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 1 Tieback - 14 to 18 ft Ht

Anchor Diagram



Per AASHTO Bridge Design Specification 11.9:

Anchor tiebacks must have an unbonded length of the greater of:

1) Length to bonded segment equal to a distance x beyond the active wedge angle.
2) Overburden cover must be a minimum of 15 ft before bonding.
3) Must be a minimum of 15 ft.

Anchor tiebacks must have the capacity to resist pullout of the bonded length.

Active Wedge Angle, (α) = 59.0 °

Min. Length Behind Active Wedge, (x) = 5.0 ft

Unbonded Anchor Length

$$L_{u,T1} = (15 - H_1)\left(\frac{\sin(90-\beta)}{\sin(\beta+\theta)}\right) = 12.31 \text{ ft}$$ For min. overburden

$$L_{u,T1} = (H_2)\left(\frac{\sin(90-\alpha)}{\sin(\alpha+\theta)}\right) + x = 11.82 \text{ ft}$$ For min. x behind active wedge

$L_{u,T1}$ = **15.00** ft

Bonded Anchor Length

Anchor Pullout Capacity (AASHTO 11.9.4.2)

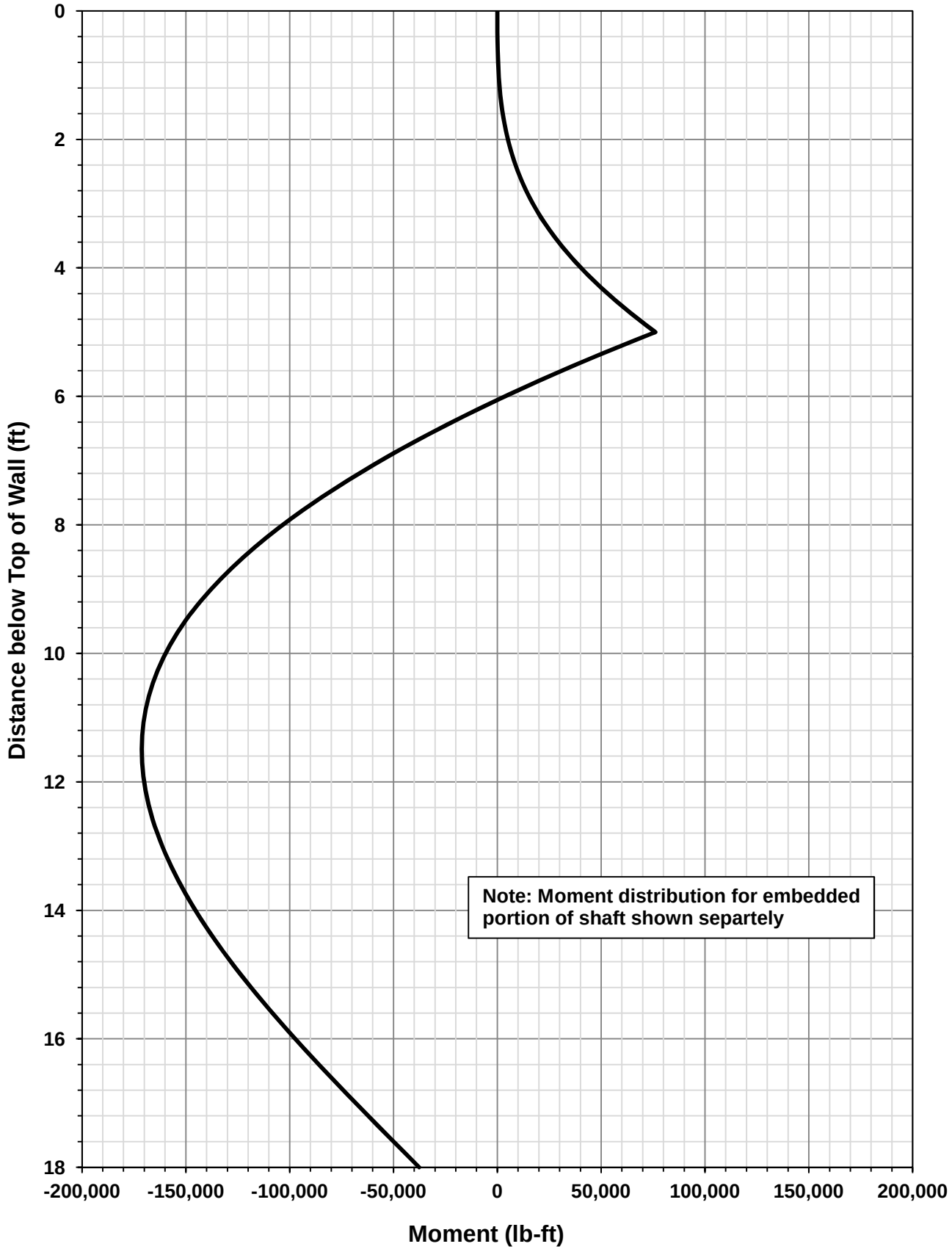
$$Q_R = \phi Q_n = \phi \pi d \tau_n L_b$$

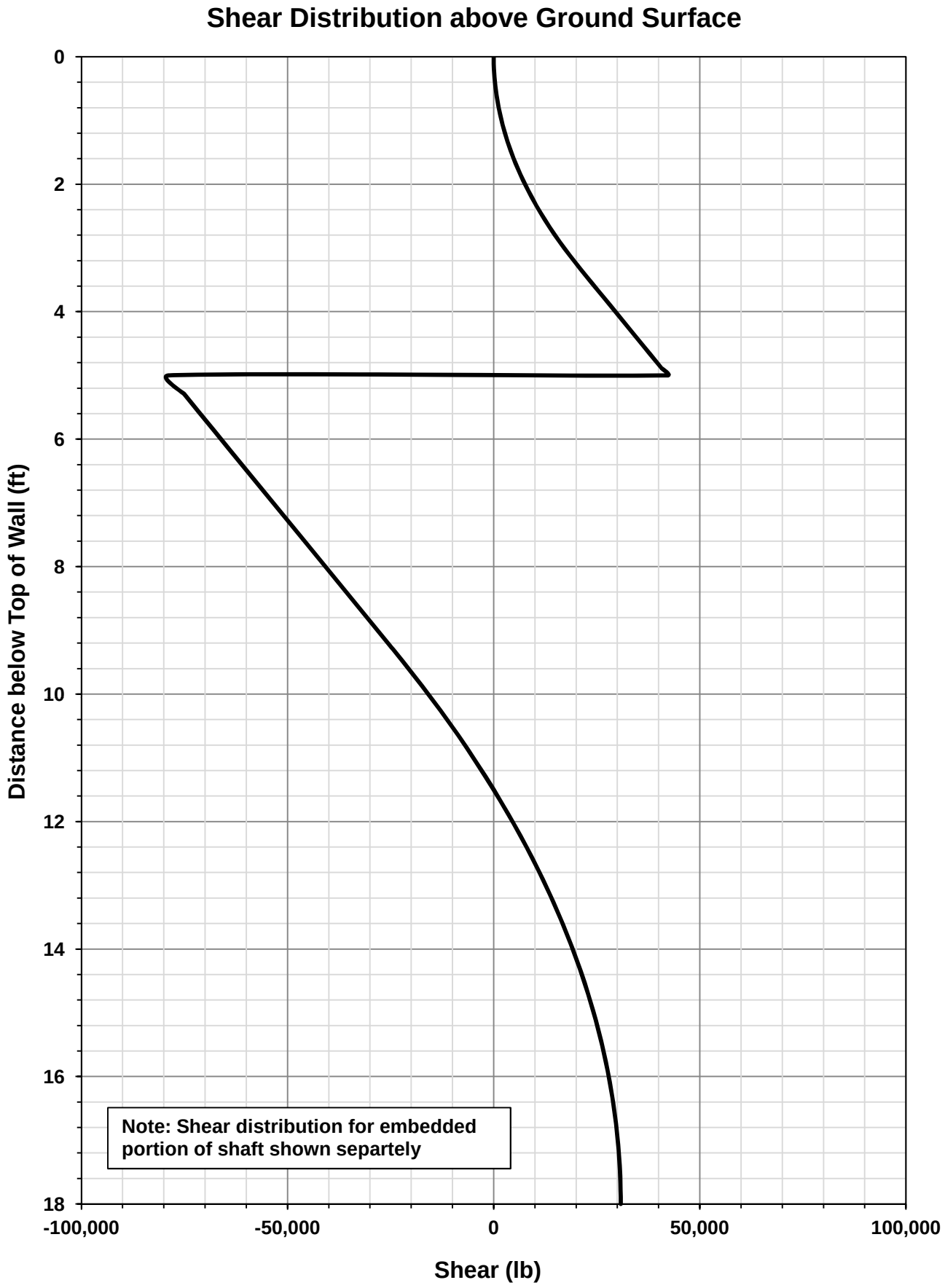
φ	=	0.7		Per table 11.5.6-1
d	=	6.0	in	
τ_n	=	3.0	ksf	Per Table C11.9.4.2-1 for stiff to very stiff, medium to high plasticity cohesive soil (q_u = 1.25 to 4.0 tsf)
ϕQ_n	=	T		

$$L_{b,T1} = \frac{T_1}{\phi \pi d \tau_n}$$

T_1 = 128,662 lb

$L_{b,T1}$ = **36.65** ft


Moment Distribution above Ground Surface
Distance below Top of Wall (ft)
0
2
4
6
8
10
12
14
16
18
-200,000
-150,000
-100,000
-50,000
0
50,000
100,000
150,000
200,000
Moment (lb-ft)
Note: Moment distribution for embedded portion of shaft shown separtely


Shear Distribution above Ground Surface
Distance below Top of Wall (ft)
0
2
4
6
8
10
12
14
16
18
-100,000
-50,000
0
50,000
100,000
Shear (lb)
Note: Shear distribution for embedded portion of shaft shown separtely

LPILE Plus for Windows, Version 5.0 (5.0.39)

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

This program is licensed to:

Path to file locations: J:\GEOTECH\Projects\2010\B-10-020 HAM-75-7.85\HAM-75-7.85 PID 77889 - Mainline\Analysis\Retaining Wall V\Pile and Lagging - 1-Tieback\14' to 18' Wall Height\
Name of input data file: 14' to 18' Wall Height - 1-Tieback.lpd
Name of output file: 14' to 18' Wall Height - 1-Tieback.lpo
Name of plot output file: 14' to 18' Wall Height - 1-Tieback.lpp
Name of runtime file: 14' to 18' Wall Height - 1-Tieback.lpr

Time and Date of Analysis

Date: August 10, 2013 Time: 22:06:10

Problem Title

HAM-75-7.85 - Retaining Wall V - Pile and Lagging - 1-Tieback - 14 to 18 ft Ht

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 240.00 in

Depth of ground surface below top of pile = .00 in

Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point No.	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.0000	3604997.
2	240.0000	24.00000000	16286.0000	452.0000	3604997.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 430.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 190.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06660
2	84.00	.06660
3	84.00	.07230
4	430.00	.07230

Shear Strength of Soils

Shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.41000	.00	.00700	.0
2	84.000	10.41000	.00	.00700	.0
3	84.000	.00000	29.00	------	------
4	430.000	.00000	29.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.9854	1.0000
2	430.000	.9854	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 30818.000 lbs
Bending moment at pile head = -452004.000 in-lbs
Axial load at pile head = 44005.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 30818.000 lbs
Specified moment at pile head = -452004.000 in-lbs
Specified axial load at pile head = 44005.000 lbs

Non-zero moment for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment)condition.

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	.187172	-452004.	30818.0000	-.0018353	430.4059	-301.7365	1934.5023
2.400	.182745	-378715.	30088.1517	-.0018523	376.4045	-306.4704	4024.9012
4.800	.178281	-307190.	29347.0969	-.0018663	323.7025	-311.0752	4187.6736
7.200	.173786	-237455.	28595.1484	-.0018774	272.3198	-315.5485	4357.7459
9.600	.169269	-169536.	27832.6249	-.0018858	222.2755	-319.8878	4535.5723
12.000	.164735	-103460.	27059.8509	-.0018913	173.5884	-324.0906	4721.6395
14.400	.160190	-39249.5647	26277.1568	-.0018943	126.2764	-328.1545	4916.4703
16.800	.155642	23070.6686	25484.8789	-.0018946	114.3553	-332.0771	5120.6262
19.200	.151096	83478.0380	24683.3590	-.0018924	158.8652	-335.8561	5334.7112
21.600	.146559	141951.	23872.9447	-.0018878	201.9495	-339.4891	5559.3758
24.000	.142035	198467.	23053.9893	-.0018809	243.5924	-342.9737	5795.3213
26.400	.137530	253007.	22226.8517	-.0018716	283.7791	-346.3076	6043.3047
28.800	.133051	305551.	21391.8965	-.0018602	322.4952	-349.4884	6304.1440
31.200	.128601	356081.	20549.4937	-.0018467	359.7270	-352.5139	6578.7244
33.600	.124187	404579.	19700.0191	-.0018311	395.4616	-355.3816	6868.0050
36.000	.119812	451028.	18843.8541	-.0018137	429.6867	-358.0893	7173.0261
38.400	.115481	495412.	17981.3854	-.0017943	462.3905	-360.6346	7494.9178
40.800	.111199	537717.	17113.0057	-.0017732	493.5621	-363.0152	7834.9095
43.200	.106970	577929.	16239.1132	-.0017504	523.1914	-365.2286	8194.3405
45.600	.102797	616035.	15360.1116	-.0017260	551.2687	-367.2726	8574.6723
48.000	.098685	652022.	14476.4108	-.0017001	577.7854	-369.1448	8977.5019
50.400	.094637	685881.	13588.4260	-.0016727	602.7332	-370.8426	9404.5776
52.800	.090656	717600.	12696.5786	-.0016440	626.1050	-372.3636	9857.8167
55.200	.086746	747172.	11801.2960	-.0016141	647.8941	-373.7053	10339.3256
57.600	.082909	774587.	10903.0116	-.0015830	668.0948	-374.8651	10851.4232
60.000	.079147	799840.	10002.1652	-.0015508	686.7020	-375.8402	11396.6674

62.400	.075465	822925.	9099.2032	-.0015176	703.7116	-376.6281	11977.8864
64.800	.071863	843837.	8194.5785	-.0014836	719.1201	-377.2258	12598.2145
67.200	.068344	862573.	7288.7514	-.0014487	732.9249	-377.6302	13261.1334
69.600	.064909	879129.	6382.1891	-.0014131	745.1243	-377.8383	13970.5223
72.000	.061561	893506.	5475.3670	-.0013769	755.7172	-377.8467	14730.7148
74.400	.058300	905702.	4568.7686	-.0013401	764.7037	-377.6519	15546.5678
76.800	.055128	915719.	3662.8863	-.0013029	772.0845	-377.2500	16423.5430
79.200	.052046	923559.	2758.2220	-.0012653	777.8613	-376.6369	17367.8045
81.600	.049055	929226.	1855.2881	-.0012274	782.0367	-375.8080	18386.3369
84.000	.046155	932724.	1083.1507	-.0011893	784.6141	-267.6398	13917.0213
86.400	.043346	934676.	445.3604	-.0011512	786.0526	-263.8521	14609.0761
88.800	.040629	935104.	-182.5262	-.0011130	786.3684	-259.3867	15322.2570
91.200	.038004	934035.	-798.9027	-.0010748	785.5803	-254.2603	16056.9545
93.600	.035470	931497.	-1404.9087	-.0010366	783.7101	-250.7447	16966.0098
96.000	.033028	927510.	-2004.7219	-.0009986	780.7728	-249.0997	18101.0125
98.400	.030677	922085.	-2599.9386	-.0009608	776.7753	-246.9142	19317.3824
100.800	.028416	915233.	-3189.2528	-.0009233	771.7269	-244.1810	20623.4214
103.200	.026245	906972.	-3771.3418	-.0008860	765.6393	-240.8931	22028.7080
105.600	.024163	897318.	-4344.8650	-.0008492	758.5264	-237.0429	23544.3772
108.000	.022169	886296.	-4908.4636	-.0008127	750.4046	-232.6226	25183.4855
110.400	.020262	873929.	-5460.7584	-.0007767	741.2927	-227.6230	26961.4885
112.800	.018441	860248.	-6000.3468	-.0007413	731.2120	-222.0340	28896.8800
115.200	.016704	845284.	-6520.5601	-.0007064	720.1862	-211.4771	30384.7613
117.600	.015050	829099.	-7006.8219	-.0006722	708.2602	-193.7411	30895.5927
120.000	.013477	811793.	-7450.9498	-.0006387	695.5092	-176.3654	31406.4240
122.400	.011984	793469.	-7853.8437	-.0006058	682.0072	-159.3795	31917.2554
124.800	.010569	774223.	-8216.4710	-.0005738	667.8262	-142.8099	32428.0868
127.200	.009230	754151.	-8539.8593	-.0005426	653.0366	-126.6803	32938.9181
129.600	.007965	733346.	-8825.0899	-.0005122	637.7070	-111.0119	33449.7495
132.000	.006772	711899.	-9073.2917	-.0004826	621.9040	-95.8230	33960.5808
134.400	.005648	689896.	-9285.6344	-.0004540	605.6919	-81.1292	34471.4122
136.800	.004593	667424.	-9463.3222	-.0004262	589.1334	-66.9439	34982.2436
139.200	.003603	644562.	-9607.5878	-.0003994	572.2886	-53.2775	35493.0749
141.600	.002676	621392.	-9719.6866	-.0003735	555.2156	-40.1382	36003.9063
144.000	.001810	597987.	-9800.8907	-.0003486	537.9703	-27.5318	36514.7376
146.400	.001002	574421.	-9852.4832	-.0003247	520.6063	-15.4619	37025.5690
148.800	.000251	550763.	-9875.7531	-.0003017	503.1748	-3.9297	37536.4004
151.200	-.000446	527081.	-9871.9900	-.0002796	485.7248	7.0656	38047.2317
153.600	-.001091	503437.	-9842.4792	-.0002586	468.3032	17.5268	38558.0631
156.000	-.001687	479892.	-9788.4966	-.0002385	450.9544	27.4587	39068.8944
158.400	-.002236	456503.	-9711.3050	-.0002193	433.7206	36.8677	39579.7258
160.800	-.002740	433324.	-9612.1490	-.0002011	416.6418	45.7623	40090.5572
163.200	-.003201	410407.	-9492.2517	-.0001839	399.7558	54.1521	40601.3885
165.600	-.003622	387800.	-9352.8107	-.0001676	383.0984	62.0488	41112.2199
168.000	-.004005	365549.	-9194.9944	-.0001522	366.7031	69.4648	41623.0512
170.400	-.004353	343696.	-9019.9393	-.0001377	350.6014	76.4144	42133.8826
172.800	-.004666	322282.	-8828.7467	-.0001241	334.8230	82.9127	42644.7140
175.200	-.004948	301344.	-8622.4804	-.0001113	319.3954	88.9759	43155.5453
177.600	-.005201	280918.	-8402.1638	-9.9423E-05	304.3445	94.6213	43666.3767
180.000	-.005425	261035.	-8168.7782	-8.8346E-05	289.6943	99.8667	44177.2080
182.400	-.005625	241726.	-7923.2607	-7.8070E-05	275.4671	104.7311	44688.0394
184.800	-.005800	223020.	-7666.5031	-6.8571E-05	261.6836	109.2336	45198.8708
187.200	-.005954	204941.	-7399.3497	-5.9823E-05	248.3630	113.3941	45709.7021
189.600	-.006087	187515.	-7122.5973	-5.1802E-05	235.5230	117.2329	46220.5335
192.000	-.006202	170764.	-6836.9937	-4.4479E-05	223.1800	120.7702	46731.3648
194.400	-.006301	154707.	-6543.2374	-3.7827E-05	211.3490	124.0268	47242.1962
196.800	-.006384	139364.	-6241.9774	-3.1816E-05	200.0439	127.0232	47753.0276
199.200	-.006454	124752.	-5933.8135	-2.6418E-05	189.2774	129.7801	48263.8589
201.600	-.006511	110888.	-5619.2959	-2.1602E-05	179.0614	132.3179	48774.6903
204.000	-.006557	97784.3976	-5298.9265	-1.7336E-05	169.4066	134.6566	49285.5216
206.400	-.006594	85456.4049	-4973.1593	-1.3591E-05	160.3230	136.8161	49796.3530
208.800	-.006622	73916.1039	-4642.4015	-1.0334E-05	151.8197	138.8154	50307.1844
211.200	-.006644	63175.0606	-4307.0149	-7.5318E-06	143.9054	140.6734	50818.0157
213.600	-.006659	53244.0234	-3967.3175	-5.1523E-06	136.5879	142.4078	51328.8471
216.000	-.006668	44133.0250	-3623.5853	-3.1620E-06	129.8747	144.0357	51839.6784
218.400	-.006674	35851.4818	-3276.0544	-1.5272E-06	123.7726	145.5734	52350.5098
220.800	-.006676	28408.2863	-2924.9234	-2.1374E-07	118.2882	147.0358	52861.3412
223.200	-.006675	21811.8946	-2570.3558	8.1271E-07	113.4278	148.4372	53372.1725
225.600	-.006672	16070.4068	-2212.4832	1.5870E-06	109.1973	149.7900	53883.0039
228.000	-.006667	11191.6402	-1851.4080	2.1442E-06	105.6025	151.1059	54393.8352
230.400	-.006661	7183.1955	-1487.2072	2.5198E-06	102.6490	152.3947	54904.6666
232.800	-.006655	4052.5134	-1119.9357	2.7494E-06	100.3422	153.6648	55415.4980
235.200	-.006648	1806.9232	-749.6304	2.8692E-06	98.6876	154.9230	55926.3293
237.600	-.006641	453.6815	-376.3140	2.9154E-06	97.6905	156.1740	56437.1607
240.000	-.006634	0.0000	0.0000	2.9247E-06	97.3562	157.4210	28473.9960

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      .18717154 in
Computed slope at pile head      =     -.00183532
Maximum bending moment           =   935104.39559 lbs-in
Maximum shear force              =    30818.00000 lbs
Depth of maximum bending moment  =    88.80000000 in
Depth of maximum shear force     =        0.00000 in
Number of iterations             =             21
Number of zero deflection points =              1
```

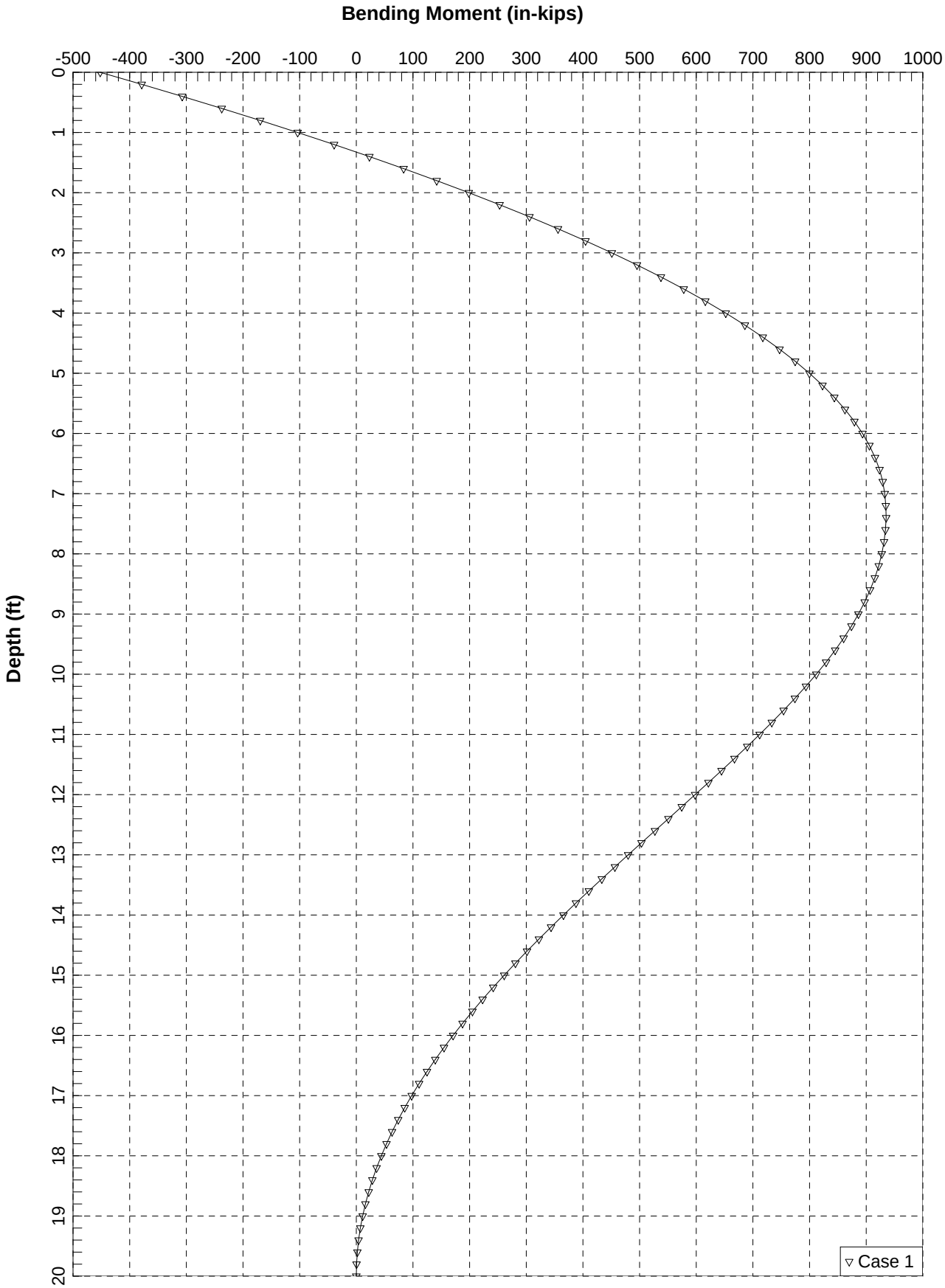
Summary of Pile Response(s)

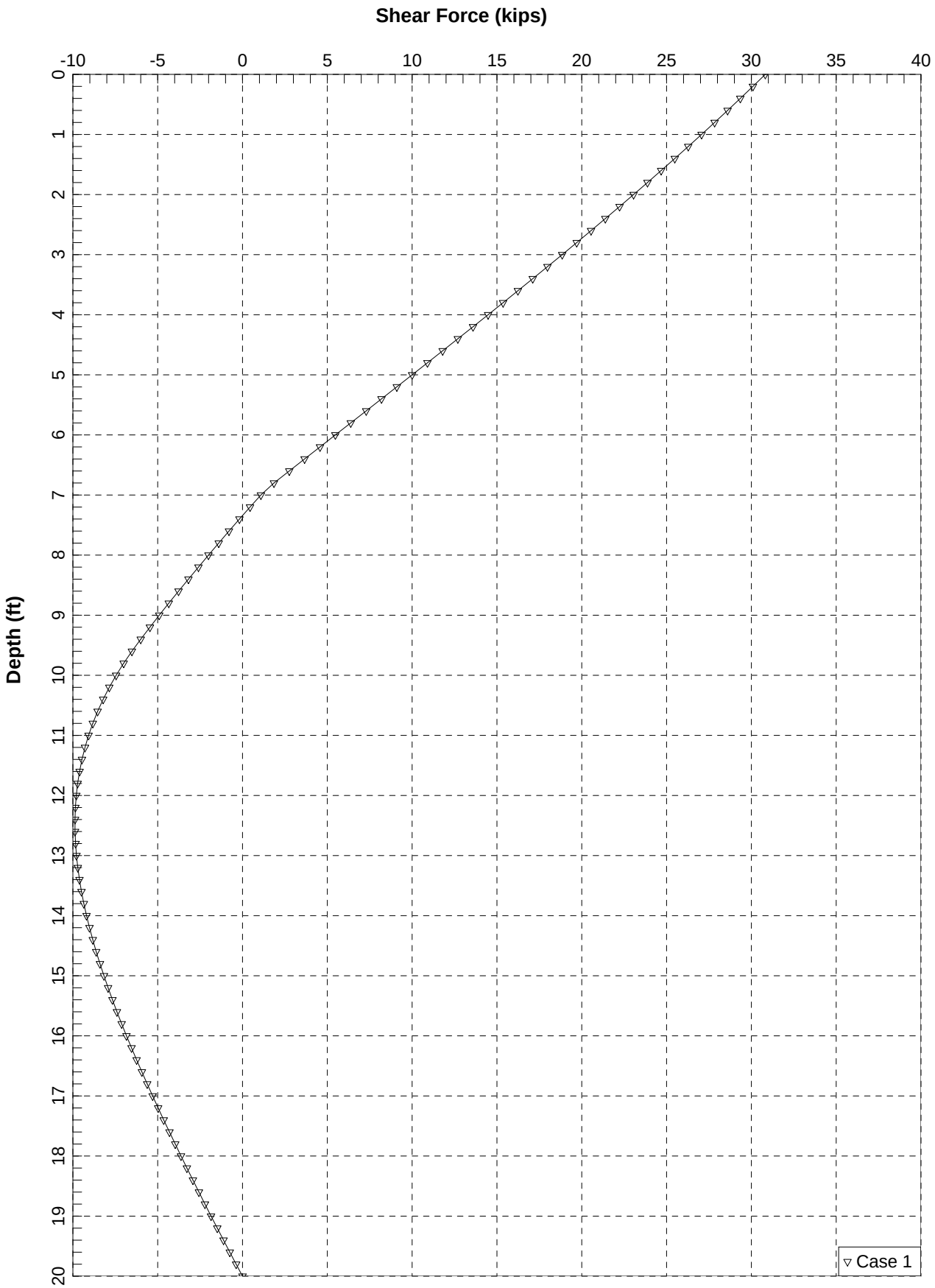
Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 30818.	M= -4.52E+05	44005.0000	.1871715	935104.	30818.0000

The analysis ended normally.


Bending Moment (in-kips)
-500
-400
-300
-200
-100
0
100
200
300
400
500
600
700
800
900
1000
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Shear Force (kips)
-10
-5
0
5
10
15
20
25
30
35
40
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1

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JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	1	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 1 Tieback - 10 to 14 ft Ht

Retaining Wall and Soil Parameters

Retaining Wall Height, (H) =	14.0	ft
Soil Friction Angle, (φ') =	28	°
Soil Total Unit Weight, (γ) =	120	pcf
Backslope Angle, (β) =	26.6	°
Live Surcharge Load, (σ_{LS}) =	0	psf
Shaft Spacing, (S) =	6.0	ft O.C.
Shaft diameter, (b) =	24	in

Rankine Active Earth Pressures

$$K_a = \cos\beta\left(\frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\varphi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\varphi}}\right)$$

k_a = 0.65

$$P_a = k_a \gamma H$$

P_a = 1093 psf

LRFD Load Factors

	EH	LS
Strength I	1.50	1.75
Service I	1.00	1.00

(AASHTO LRFD BDM Tab. 3.4.1-1, 3.4.1-2 - Active Earth Pressure)

p-y Reduction Factor

$$\beta_a = 0.5292\left(S/b\right)^{0.5659}$$

β_a = 0.9854

Stuructural Element Properties

Section Type: HP 12x53

E =	29,000	ksi	d =	11.8	in	I_x =	393	in^4	Z_x =	74.0	in^3
A_s =	15.5	in^2	t_w =	0.435	in	I_x =	65.5	in^4 per ft	Z_x =	12.3	in^3 per ft
f_y =	50	ksi	t_f =	0.435	in	r_s =	5.03	in	T =	9.5	in
									S =	66.8	in^3

Anchor Tieback Setup

1		=	Row(s) of Anchors
4.0	ft	=	Distance Between Top of Wall Row of Anchors, (H_1)
10.0	ft	=	Distance Row of Anchors and Bottom of Excavation, (H_2)
20	°	=	Inclination of Anchors, (θ)

Factored Horizontal Tieback and Resultant Loads by Tributary Area Method

$$T_1 = \gamma_{LS}\left[k_a\sigma_{LS}\left(H_1 + \tfrac{1}{2}H_2\right)S\right] + \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}H_1\right)P_aS + \left(H_1 - \tfrac{2}{3}H_1 - \tfrac{2}{3}H_2\right)P_aS + \left(\tfrac{2}{3}H_2 - \tfrac{1}{2}H_1\right)\tfrac{7}{8}P_aS\right]$$

T_1 = 73,344 lb

$$R = \gamma_{LS}\left[k_a\sigma_{LS}\left(\tfrac{1}{2}H_2\right)S\right] + \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{1}{2}H_2\right)\tfrac{3}{4}P_aS\right]$$

R = **18,438** lb

$V_{max(from\ embedded,\ LPILE)}$ = **18,438** lb

$V_{max(from\ cantilever,\ calculated)}$ = **47,120** lb

Factored Moment at Ground Surface

$$M = \gamma_{EH}\left[\tfrac{1}{2}\left(\tfrac{2}{3}\right)H_1\left(H - \tfrac{2}{3}\left(\tfrac{2}{3}\right)H_1\right) + \left(H - \tfrac{2}{3}H_1 - \tfrac{2}{3}H_2\right)\left(\tfrac{2}{3}H_2 + \tfrac{1}{2}\left(H - \tfrac{2}{3}H_1 - \tfrac{2}{3}H_2\right)\right) + \tfrac{1}{2}\left(\tfrac{2}{3}H_2\right)\left(\tfrac{2}{3}\left(\tfrac{2}{3}\right)H_2\right)\right]P_aS + \gamma_{LS}k_a\sigma_{LS}HS - T_1\left(H_2\right)$$

M = **-14,478** lb-ft

-173,731 lb-in

$M_{max(from\ embedded,\ LPILE)}$ = **39,492** lb-ft

$M_{max(from\ cantilever,\ calculated)}$ = **75,939** lb-ft

Factored Vertical Component from Anchor and Structural Loads

$$P_{max} = \left(\frac{T_1}{\cos\theta}\right)\sin\theta$$

P_{max} = **26,695** lb

Factored Axial Load from Structure

P_{SL} = **0** lb

Capacity Verification

φ_f = 1.00 φ_c = 0.70 φ_v = 1.00, C= 1.0

Maximum Factored Bending Moment, M_u =	75.9	kip-ft per section	
Maximum Factored Axial Force, P_u =	26.7	kip per section	(Anchor and Structural Axial Load)
Maximum Factored Shear Force, V_u =	47.1	kip per section	

Check

Factored Flexural Resistance, $\varphi_f M_n$ =	308.3	kip-ft per section	M_u	less than	$\varphi_f M_n$	OK
Factored Axial Resistance, $\varphi_c P_n$ =	520.5	kip per section	P_u	less than	$\varphi_c P_n$	OK
Factored Shear Resistance, $\varphi_v V_n$ =	137.6	kip per section	V_u	less than	$\varphi_v V_n$	OK
Required Section Modulus, S_{Req} =	18.2	in^3	S_{Req}	less than	$S_{Section}$	OK

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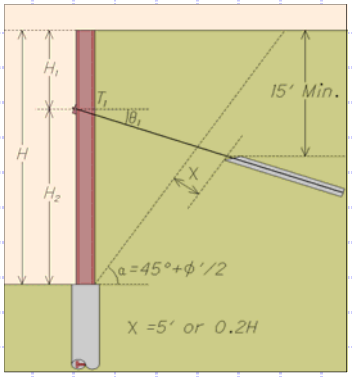
JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	2	OF	2
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - 1 Tieback - 10 to 14 ft Ht

Anchor Diagram



Per AASHTO Bridge Design Specification 11.9:

Anchor tiebacks must have an unbonded length of the greater of:

1) Length to bonded segment equal to a distance x beyond the active wedge angle.
2) Overburden cover must be a minimum of 15 ft before bonding.
3) Must be a minimum of 15 ft.

Anchor tiebacks must have the capacity to resist pullout of the bonded length.

Active Wedge Angle, (α) = 59.0 °

Min. Length Behind Active Wedge, (x) = 5.0 ft

Unbonded Anchor Length

$$L_{u,T1} = (15 - H_1)\left(\frac{\sin(90-\beta)}{\sin(\beta+\theta)}\right) = 13.54 \text{ ft}$$ For min. overburden

$$L_{u,T1} = (H_2)\left(\frac{\sin(90-\alpha)}{\sin(\alpha+\theta)}\right) + x = 10.25 \text{ ft}$$ For min. x behind active wedge

$L_{u,T1}$ = **15.00** ft

Bonded Anchor Length

Anchor Pullout Capacity (AASHTO 11.9.4.2)

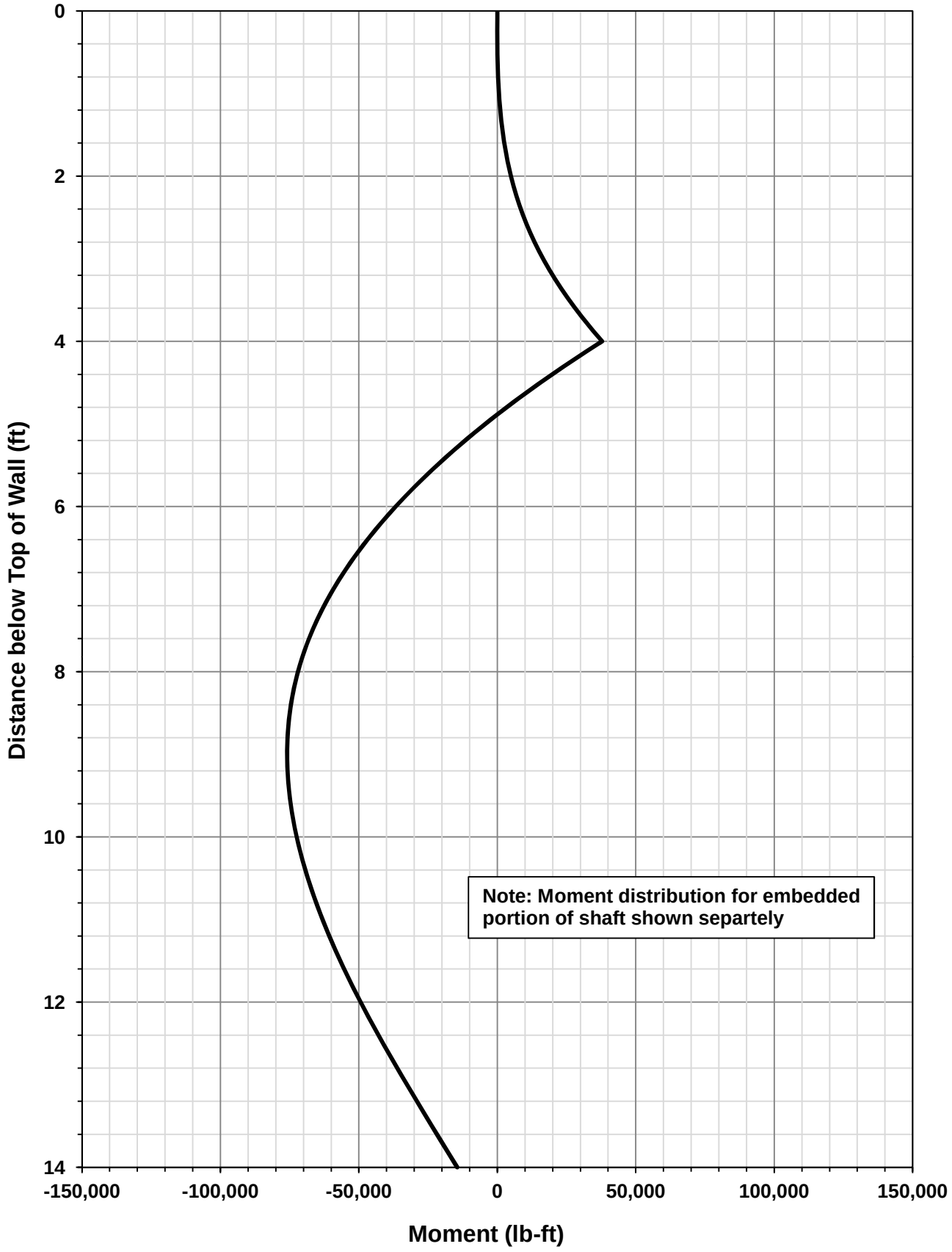
$$Q_R = \phi Q_n = \phi \pi d \tau_n L_b$$

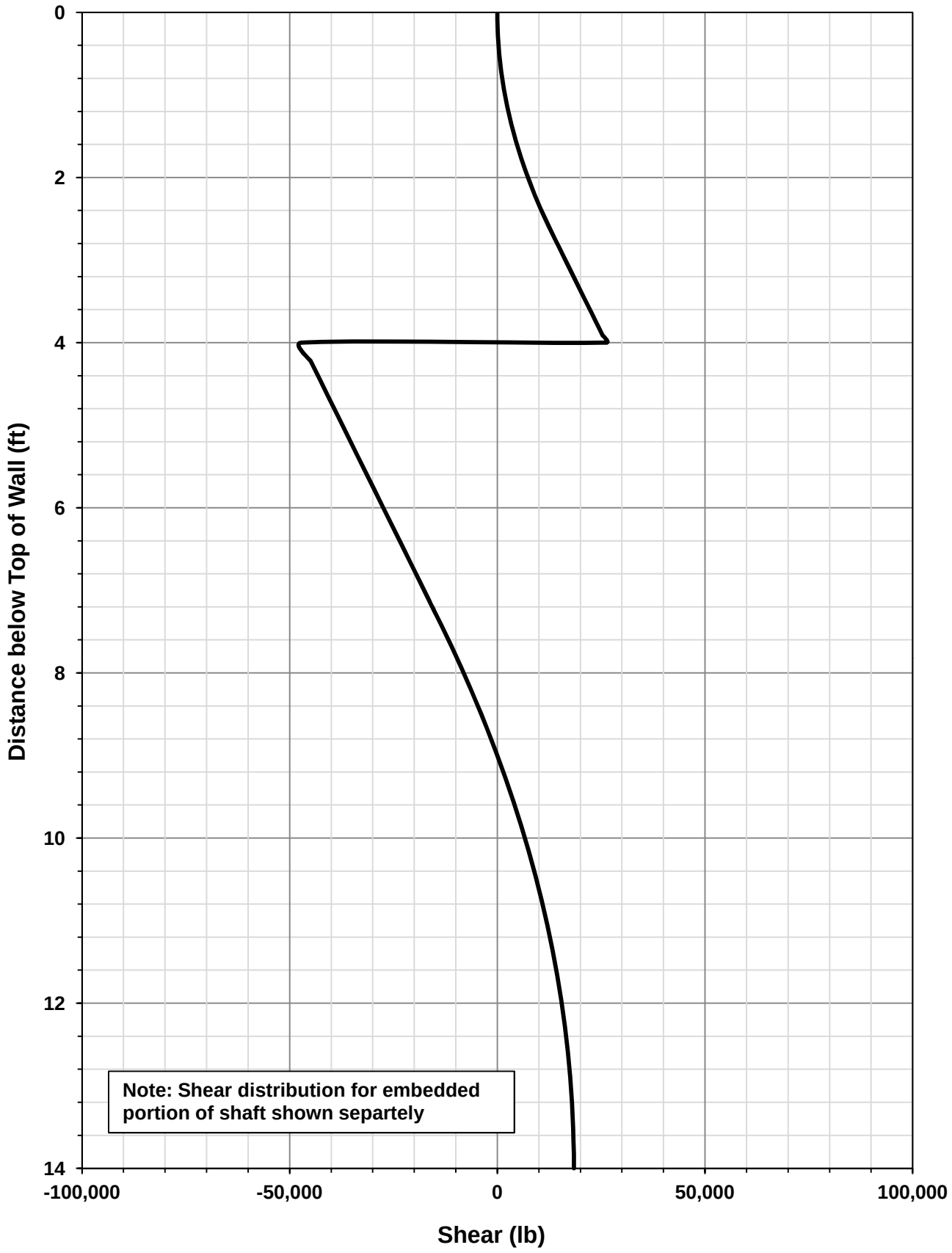
φ	=	0.7		Per table 11.5.6-1
d	=	6.0	in	
τ_n	=	3.0	ksf	Per Table C11.9.4.2-1 for stiff to very stiff, medium to high plasticity cohesive soil (q_u = 1.25 to 4.0 tsf)
ϕQ_n	=	T		

$$L_{b,T1} = \frac{T_1}{\phi \pi d \tau_n}$$

T_1 = 78,051 lb

$L_{b,T1}$ = **22.23** ft


Moment Distribution above Ground Surface
Distance below Top of Wall (ft)
0
2
4
6
8
10
12
14
-150,000
-100,000
-50,000
0
50,000
100,000
150,000
Moment (lb-ft)
Note: Moment distribution for embedded portion of shaft shown separtely


Shear Distribution above Ground Surface
Distance below Top of Wall (ft)
0
2
4
6
8
10
12
14
-100,000
-50,000
0
50,000
100,000
Shear (lb)
Note: Shear distribution for embedded portion of shaft shown separtely

LPILE Plus for Windows, Version 5.0 (5.0.39)

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

This program is licensed to:

Path to file locations: J:\GEOTECH\Projects\2010\B-10-020 HAM-75-7.85\HAM-75-7.85 PID 77889 - Mainline\Analysis\Retaining Wall V\Pile and Lagging - 1-Tieback\10' to 14' Wall Height\
Name of input data file: 10' to 14' Wall Height - 1-Tieback.lpd
Name of output file: 10' to 14' Wall Height - 1-Tieback.lpo
Name of plot output file: 10' to 14' Wall Height - 1-Tieback.lpp
Name of runtime file: 10' to 14' Wall Height - 1-Tieback.lpr

Time and Date of Analysis

Date: August 10, 2013 Time: 22:50:23

Problem Title

HAM-75-7.85 - Retaining Wall V - Pile and Lagging - 1-Tieback - 10 to 14 ft Ht

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 180.00 in

Depth of ground surface below top of pile = .00 in

Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point No.	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.0000	3604997.
2	180.0000	24.00000000	16286.0000	452.0000	3604997.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 430.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 250.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06660
2	84.00	.06660
3	84.00	.07230
4	430.00	.07230

Shear Strength of Soils

Shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.41000	.00	.00700	.0
2	84.000	10.41000	.00	.00700	.0
3	84.000	.00000	29.00	------	------
4	430.000	.00000	29.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.9854	1.0000
2	430.000	.9854	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 18438.000 lbs
Bending moment at pile head = -173731.000 in-lbs
Axial load at pile head = 26695.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 18438.000 lbs
Specified moment at pile head = -173731.000 in-lbs
Specified axial load at pile head = 26695.000 lbs

Non-zero moment for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment)condition.

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	.073666	-173731.	18438.0000	-.0008756	187.0698	-239.0066	2920.0226
1.800	.072085	-140888.	18005.4558	-.0008804	162.8698	-241.5980	6032.8293
3.600	.070496	-108827.	17568.3113	-.0008843	139.2465	-244.1182	6233.1310
5.400	.068902	-77556.6899	17126.6951	-.0008871	116.2058	-246.5663	6441.3457
7.200	.067303	-47085.3923	16680.7383	-.0008890	93.7536	-248.9413	6657.8935
9.000	.065701	-17420.5951	16230.5733	-.0008900	71.8957	-251.2421	6883.2211
10.800	.064099	11430.2035	15776.3346	-.0008901	67.4818	-253.4676	7117.8035
12.600	.062497	39459.7501	15318.1584	-.0008893	88.1348	-255.6170	7362.1470
14.400	.060897	66661.0394	14856.1828	-.0008877	108.1775	-257.6892	7616.7910
16.200	.059301	93027.3176	14390.5477	-.0008852	127.6050	-259.6831	7882.3107
18.000	.057710	118552.	13921.3949	-.0008820	146.4124	-261.5978	8159.3207
19.800	.056126	143229.	13448.8677	-.0008780	164.5951	-263.4323	8448.4777
21.600	.054549	167052.	12973.1117	-.0008732	182.1488	-265.1855	8750.4841
23.400	.052982	190016.	12494.2739	-.0008678	199.0692	-266.8565	9066.0923
25.200	.051425	212115.	12012.5033	-.0008616	215.3524	-268.4441	9396.1088
27.000	.049880	233344.	11527.9508	-.0008548	230.9944	-269.9475	9741.3991
28.800	.048348	253698.	11040.7692	-.0008473	245.9918	-271.3655	10102.8930
30.600	.046830	273172.	10551.1129	-.0008392	260.3410	-272.6970	10481.5908
32.400	.045327	291763.	10059.1386	-.0008306	274.0389	-273.9411	10878.5699
34.200	.043840	309465.	9565.0046	-.0008214	287.0825	-275.0966	11294.9918
36.000	.042370	326276.	9068.8716	-.0008116	299.4691	-276.1624	11732.1112
37.800	.040918	342191.	8570.9018	-.0008014	311.1960	-277.1373	12191.2844
39.600	.039485	357208.	8071.2600	-.0007906	322.2609	-278.0203	12673.9808
41.400	.038072	371323.	7570.1127	-.0007795	332.6617	-278.8100	13181.7941
43.200	.036679	384535.	7067.6291	-.0007679	342.3964	-279.5052	13716.4559
45.000	.035308	396841.	6563.9802	-.0007559	351.4635	-280.1047	14279.8511

46.800	.033958	408238.	6059.3397	-.0007436	359.8615	-280.6069	14874.0353
48.600	.032631	418726.	5553.8839	-.0007309	367.5891	-281.0106	15501.2548
50.400	.031327	428302.	5047.7916	-.0007179	374.6454	-281.3142	16163.9691
52.200	.030046	436967.	4541.2443	-.0007046	381.0296	-281.5161	16864.8779
54.000	.028790	444719.	4034.4268	-.0006911	386.7413	-281.6145	17606.9514
55.800	.027558	451557.	3527.5268	-.0006774	391.7802	-281.6077	18393.4658
57.600	.026352	457483.	3020.7356	-.0006634	396.1463	-281.4936	19228.0448
59.400	.025170	462496.	2514.2482	-.0006493	399.8399	-281.2702	20114.7088
61.200	.024014	466596.	2008.2636	-.0006351	402.8616	-280.9350	21057.9321
63.000	.022884	469786.	1502.9852	-.0006207	405.2120	-280.4855	22062.7112
64.800	.021779	472067.	998.6212	-.0006063	406.8923	-279.9189	23134.6469
66.600	.020701	473440.	495.3853	-.0005918	407.9039	-279.2321	24280.0416
68.400	.019649	473907.	-6.5031	-.0005773	408.2483	-278.4217	25506.0184
70.200	.018623	473472.	-506.8179	-.0005628	407.9275	-277.4837	26820.6646
72.000	.017623	472137.	-1005.3256	-.0005483	406.9438	-276.4138	28233.2092
73.800	.016649	469905.	-1501.7843	-.0005338	405.2996	-275.2070	29754.2407
75.600	.015701	466781.	-1995.9427	-.0005195	402.9979	-273.8579	31395.9798
77.400	.014779	462770.	-2487.5388	-.0005052	400.0420	-272.3600	33172.6221
79.200	.013882	457875.	-2976.2982	-.0004911	396.4353	-270.7060	35100.7724
81.000	.013011	452102.	-3461.9323	-.0004772	392.1819	-268.8874	37200.0040
82.800	.012164	445458.	-3944.1360	-.0004634	387.2860	-266.8945	39493.5831
84.600	.011342	437948.	-4285.8561	-.0004499	381.7525	-112.7944	17900.0603
86.400	.010545	430072.	-4483.2618	-.0004366	375.9493	-106.5453	18187.4029
88.200	.009771	421850.	-4669.4092	-.0004235	369.8912	-100.2851	18474.7456
90.000	.009020	413303.	-4844.2843	-.0004107	363.5933	-94.0205	18762.0882
91.800	.008292	404450.	-5007.8846	-.0003982	357.0704	-87.7576	19049.4308
93.600	.007587	395313.	-5160.2183	-.0003859	350.3376	-81.5021	19336.7735
95.400	.006903	385910.	-5301.3034	-.0003739	343.4098	-75.2591	19624.1161
97.200	.006241	376264.	-5431.1668	-.0003622	336.3019	-69.0335	19911.4588
99.000	.005599	366393.	-5549.8434	-.0003509	329.0289	-62.8294	20198.8014
100.800	.004978	356318.	-5657.3753	-.0003398	321.6054	-56.6505	20486.1440
102.600	.004376	346059.	-5753.8110	-.0003290	314.0462	-50.5002	20773.4867
104.400	.003793	335636.	-5839.2043	-.0003186	306.3662	-44.3812	21060.8293
106.200	.003229	325069.	-5913.6137	-.0003084	298.5798	-38.2959	21348.1720
108.000	.002683	314377.	-5977.1014	-.0002986	290.7017	-32.2460	21635.5146
109.800	.002154	303580.	-6029.7326	-.0002892	282.7462	-26.2331	21922.8572
111.600	.001642	292697.	-6071.5746	-.0002800	274.7278	-20.2580	22210.1999
113.400	.001146	281749.	-6102.6960	-.0002712	266.6607	-14.3213	22497.5425
115.200	.000665	270754.	-6123.1660	-.0002627	258.5590	-8.4231	22784.8852
117.000	.000200	259731.	-6133.0536	-.0002546	250.4370	-2.5631	23072.2278
118.800	-.000251	248699.	-6132.4267	-.0002468	242.3086	3.2596	23359.5704
120.600	-.000689	237678.	-6121.3517	-.0002394	234.1877	9.0460	23646.9131
122.400	-.001113	226685.	-6099.8925	-.0002322	226.0882	14.7976	23934.2557
124.200	-.001525	215741.	-6068.1099	-.0002255	218.0237	20.5164	24221.5984
126.000	-.001925	204862.	-6026.0611	-.0002190	210.0080	26.2045	24508.9410
127.800	-.002313	194068.	-5973.7989	-.0002129	202.0546	31.8646	24796.2836
129.600	-.002691	183377.	-5911.3713	-.0002071	194.1770	37.4994	25083.6263
131.400	-.003059	172807.	-5838.8208	-.0002017	186.3888	43.1123	25370.9689
133.200	-.003417	162376.	-5756.1838	-.0001965	178.7033	48.7066	25658.3116
135.000	-.003766	152103.	-5663.4903	-.0001917	171.1340	54.2862	25945.6542
136.800	-.004107	142006.	-5560.7634	-.0001872	163.6940	59.8549	26232.9968
138.600	-.004440	132103.	-5448.0188	-.0001830	156.3968	65.4169	26520.3395
140.400	-.004766	122411.	-5325.2645	-.0001791	149.2556	70.9767	26807.6821
142.200	-.005085	112949.	-5192.5005	-.0001755	142.2838	76.5389	27095.0248
144.000	-.005397	103735.	-5049.7183	-.0001722	135.4945	82.1080	27382.3674
145.800	-.005704	94786.4597	-4896.9010	-.0001691	128.9012	87.6890	27669.7100
147.600	-.006006	86122.1499	-4734.0229	-.0001663	122.5170	93.2867	27957.0527
149.400	-.006303	77759.9623	-4561.0492	-.0001638	116.3555	98.9063	28244.3953
151.200	-.006596	69718.1164	-4377.9362	-.0001616	110.4301	104.5526	28531.7380
153.000	-.006885	62014.9183	-4184.6312	-.0001595	104.7541	110.2308	28819.0806
154.800	-.007170	54668.7766	-3981.0721	-.0001578	99.3413	115.9459	29106.4232
156.600	-.007453	47698.2190	-3767.1882	-.0001562	94.2052	121.7029	29393.7659
158.400	-.007733	41121.9085	-3542.8997	-.0001548	89.3596	127.5066	29681.1085
160.200	-.008010	34958.6589	-3308.1180	-.0001537	84.8183	133.3619	29968.4512
162.000	-.008286	29227.4503	-3062.7463	-.0001527	80.5954	139.2734	30255.7938
163.800	-.008560	23947.4444	-2806.6793	-.0001519	76.7049	145.2455	30543.1364
165.600	-.008832	19137.9986	-2539.8041	-.0001512	73.1612	151.2824	30830.4791
167.400	-.009104	14818.6798	-2262.0006	-.0001507	69.9786	157.3882	31117.8217
169.200	-.009375	11009.2769	-1973.1414	-.0001503	67.1717	163.5664	31405.1644
171.000	-.009645	7729.8130	-1673.0933	-.0001500	64.7553	169.8204	31692.5070
172.800	-.009915	5000.5557	-1361.7172	-.0001498	62.7443	176.1530	31979.8496
174.600	-.010184	2842.0269	-1038.8693	-.0001497	61.1538	182.5669	32267.1923
176.400	-.010454	1275.0105	-704.4016	-.0001496	59.9992	189.0639	32554.5349
178.200	-.010723	320.5595	-358.1629	-.0001496	59.2959	195.6457	32841.8776
180.000	-.010992	0.0000	0.0000	-.0001496	59.0597	202.3131	16564.6101

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      .07366586 in
Computed slope at pile head      =     -.00087560
Maximum bending moment           =   473907.06106 lbs-in
Maximum shear force              =    18438.00000 lbs
Depth of maximum bending moment  =    68.40000000 in
Depth of maximum shear force     =        0.00000 in
Number of iterations             =             23
Number of zero deflection points =              1
```

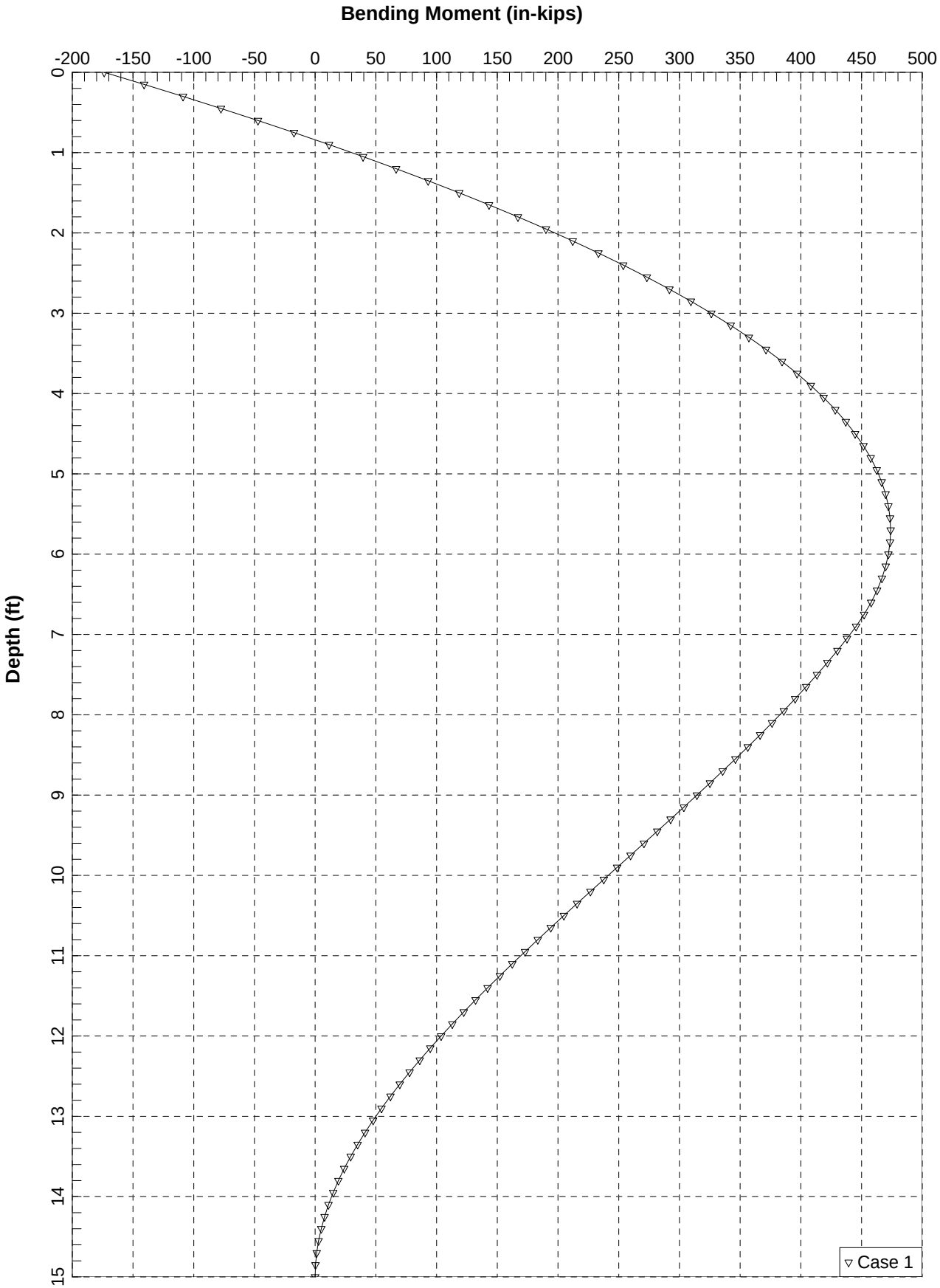
Summary of Pile Response(s)

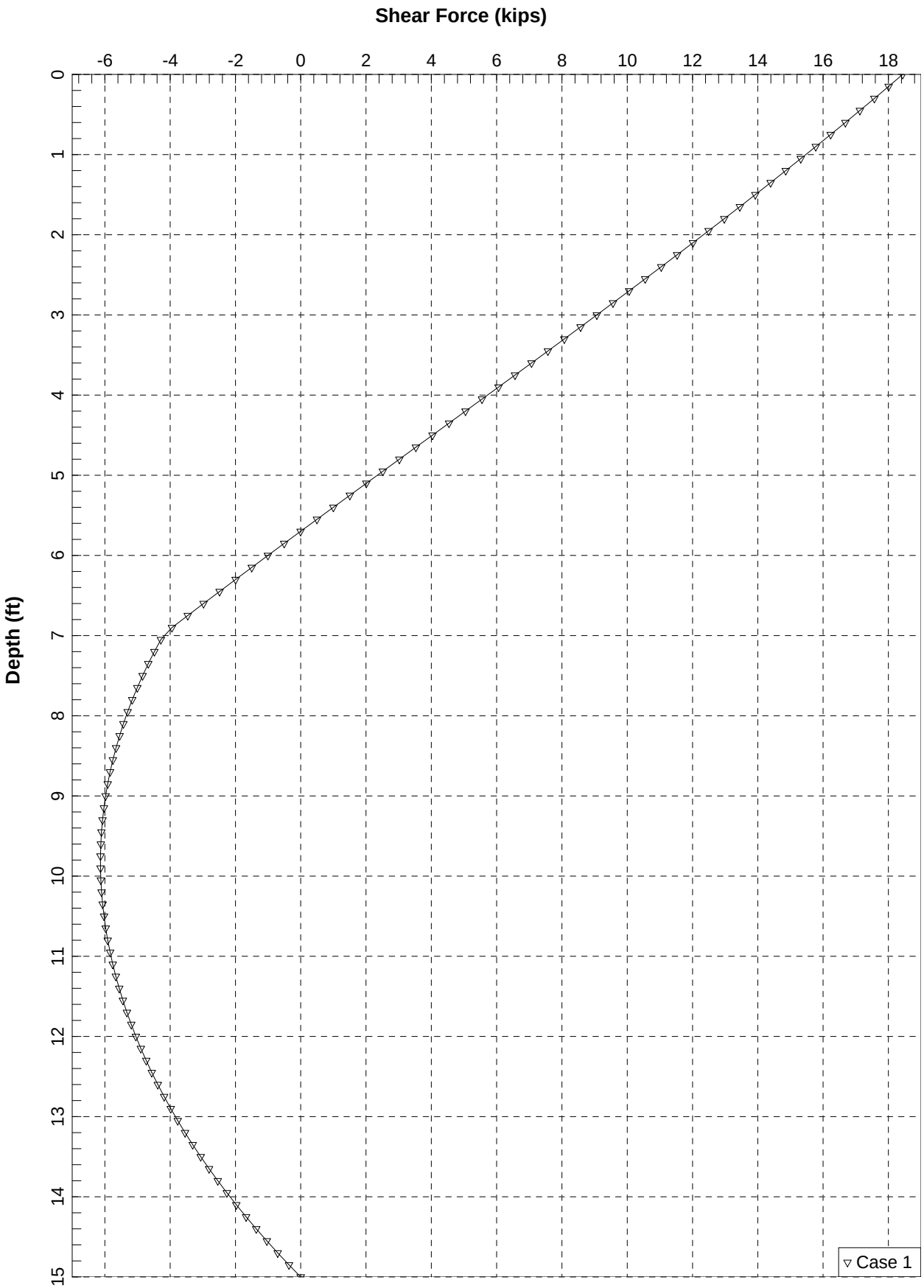
Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 18438.	M= -1.74E+05	26695.0000	.0736659	473907.	18438.0000

The analysis ended normally.


Bending Moment (in-kips)
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
450
500
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Case 1


Shear Force (kips)
-6
-4
-2
0
2
4
6
8
10
12
14
16
18
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Case 1

RESOURCE INTERNATIONAL, INC.
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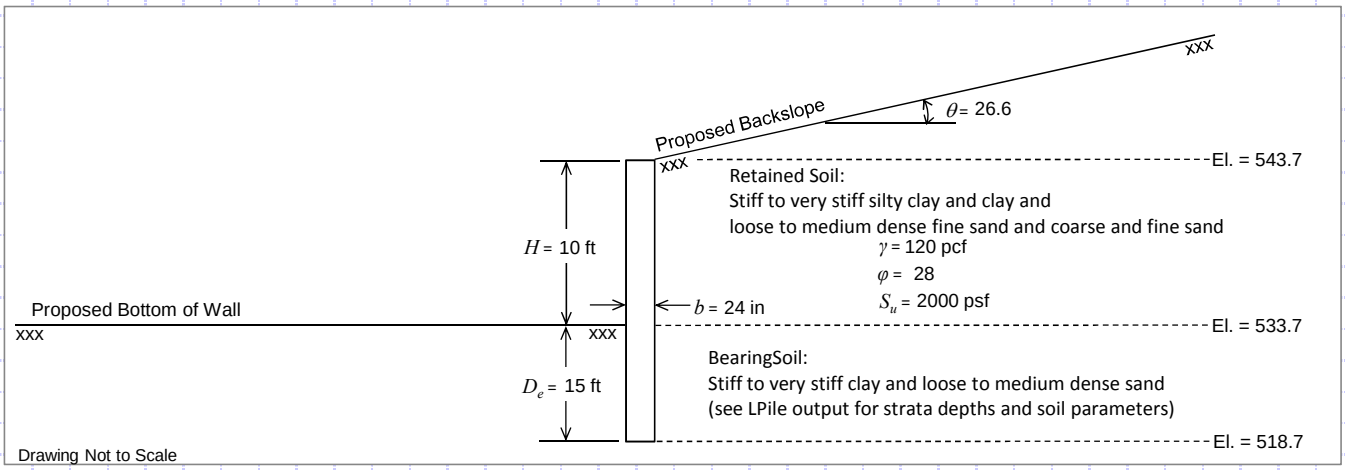
JOB	HAM-75-7.85	NO.	B-10-020
SHEET NO.	1	OF	1
CALCULATED BY	BRT	DATE	8/8/2013
CHECKED BY	NCK	DATE	8/8/2013

Retaining Wall V - Pile and Lagging - No Tiebacks - 10.0' Max Ht



Retaining Wall and Soil Parameters

Retaining Wall Height, (H) =	10.0	ft
Soil Friction Angle, (φ') =	28	°
Soil Total Unit Weight, (γ) =	120	pcf
Soil Undrained Shear Strength, (s_u) =	2000	psf
Backslope Angle, (θ) =	26.6	°
Embedment Depth, (D_e) =	15	ft
Shaft Spacing, (S) =	6.0	ft O.C.
Shaft Diameter, (b) =	24	in

Rankine Earth Pressures

$$K_a = \cos\beta\left(\frac{\cos\beta-\sqrt{\cos^2\beta-\cos^2\varphi}}{\cos\beta+\sqrt{\cos^2\beta-\cos^2\varphi}}\right)$$

K_a = 0.648

$$K_p = \cos\beta\left(\frac{\cos\beta+\sqrt{\cos^2\beta-\cos^2\varphi}}{\cos\beta-\sqrt{\cos^2\beta-\cos^2\varphi}}\right)$$

K_p = 1.234

LRFD Load Factors

	EH	LS
Strength I	1.50	1.75
Service I	1.00	1.00

(AASHTO LRFD BDM Tab. 3.4.1-1, 3.4.1-2 - Active Earth Pressure)

p-y Reduction Factor

S/b = 3.00

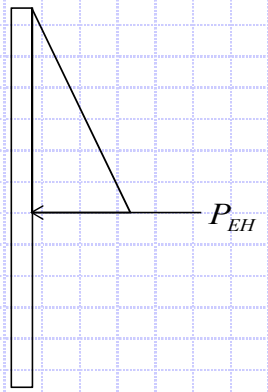
β_a = 0.9854

Stuructural Element Properties

Section Type: HP 12x53

E =	29,000	ksi	d =	11.8	in	I_x =	393	in^4	Z_x =	74	in^3
A_s =	15.5	in^2	t_w =	0.435	in	I_x =	65.5	in^4 per ft	Z_x =	12.3	in^3 per ft
f_y =	50	ksi	t_f =	0.435	in	r_s =	5.03	in	T =	9.5	in
									S =	66.8	in^3

Lateral Loading of Cantilever Portion of Wall Retaining Soil - (Loading Case - Service I and Strength I)



Note: Required embedment and determination of structural capacity and allowable deflection at the top of the wall determined usig LPile software. Loading conditions and material parameters used in the analysis are provided on this data page.

$$P_{EH} = \gamma H S K_a \gamma_{EH}$$

P_{EH} = (120 pcf)(10.0 ft)(6 ft O.C.)(0.648)(1.00) (Service I)
= (120 pcf)(10.0 ft)(6 ft O.C.)(0.648)(1.50) (Strength I)

P_{EH} = 4666.2 lb/ft (Service I)
= 6999.3 lb/ft (Strength I)

Check Deflection - (Loading Case - Service I)

$\left(\frac{\delta_h}{H}\right)\cdot 100\% < 1.0\%$ ⟶ δ_h = **1.036** in (Determined from LPile) ⟶ 0.86% < 1.0% **OK**

Capacity Verification - (Loading Case - Strength I)

φ_f = **1.00** φ_v = **1.00** C = **1.00**

Maximum Bending Moment, M_u = **216.0** kip-ft per section (Determined from LPile analysis)

Maximum Shear Force, V_u = **38.9** kip per section (Determined from LPile analysis)

Factored Flexural Resistance, $\varphi_f M_n$ = **308.3** kip-ft per section ⟶ $M_u < \varphi_f M_n$ ⟶ 216.0 kip-ft < 308.3 kip-ft **OK**

Factored Shear Resistance, $\varphi_v V_n$ = **148.6** kip per section ⟶ $V_u < \varphi_v V_n$ ⟶ 38.9 kip < 148.6 kip **OK**

$S_{Req} = M_u \times \left(\frac{12}{50ksi}\right)$ = (216.0 kip-ft)(12 in) / (50 ksi) = 51.8 in^3 ⟶ $S_{Req} < S_{Section}$ ⟶ 51.8 in^3 < 66.8 in^3 **OK**

LPILE Plus for Windows, Version 5.0 (5.0.39)

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

This program is licensed to:

Path to file locations: J:\GEOTECH\Projects\2010\B-10-020 HAM-75-7.85\HAM-75-7.85 PID 77889 - Mainline\Analysis\Retaining Wall V\Pile and Lagging - Without Tiebacks\
Name of input data file: Pile and Lagging - Without Tiebacks.lpd
Name of output file: Pile and Lagging - Without Tiebacks.lpo
Name of plot output file: Pile and Lagging - Without Tiebacks.lpp
Name of runtime file: Pile and Lagging - Without Tiebacks.lpr

Time and Date of Analysis

Date: August 10, 2013 Time: 23:05:40

Problem Title

HAM-75-7.85-Retaining Wall V - Pile and Lagging-No Tiebacks - 10 ft Ht - Service

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 300.00 in

Depth of ground surface below top of pile = 120.00 in

Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 4 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	12.00000000	393.0000	15.5000	29000000.
2	120.0000	12.00000000	393.0000	15.5000	29000000.
3	120.0000	24.00000000	16286.0000	452.0000	3604997.
4	300.0000	24.00000000	16286.0000	452.0000	3604997.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = 120.000 in
Distance from top of pile to bottom of layer = 204.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 204.000 in
Distance from top of pile to bottom of layer = 550.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 250.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	120.00	.06660
2	204.00	.06660
3	204.00	.07230
4	550.00	.07230

Shear Strength of Soils

Shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	120.000	10.41000	.00	.00700	.0
2	204.000	10.41000	.00	.00700	.0
3	204.000	.00000	29.00	------	------
4	550.000	.00000	29.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	120.000	.9854	1.0000
2	550.000	.9854	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves.

Distributed Lateral Loading

Distributed lateral load intensity defined using 2 points

Point No.	Depth X in	Dist. Load lbs/in
1	.000	.00000
2	120.000	388.90000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = .000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = .000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = .000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = .000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	1.036	3.6554E-06	2.3432E-08	-.0064050	5.5807E-08	0.0000	0.0000
3.000	1.017	5.4689	16.4067	-.0064050	.0834948	0.0000	0.0000
6.000	.997420	98.4403	60.1580	-.0064050	1.5029	0.0000	0.0000
9.000	.978206	366.4167	133.0767	-.0064049	5.5941	0.0000	0.0000
12.000	.958991	896.9006	235.1630	-.0064047	13.6931	0.0000	0.0000
15.000	.939777	1777.3945	366.4167	-.0064044	27.1358	0.0000	0.0000
18.000	.920565	3095.4009	526.8380	-.0064037	47.2580	0.0000	0.0000
21.000	.901355	4938.4223	716.4267	-.0064027	75.3958	0.0000	0.0000
24.000	.882149	7393.9612	935.1830	-.0064011	112.8849	0.0000	0.0000
27.000	.862948	10549.5202	1183.1067	-.0063987	161.0614	0.0000	0.0000
30.000	.843757	14492.6016	1460.1980	-.0063954	221.2611	0.0000	0.0000
33.000	.824576	19310.7080	1766.4567	-.0063909	294.8200	0.0000	0.0000

36.000	.805411	25091.3419	2101.8830	-.0063851	383.0739	0.0000	0.0000
39.000	.786266	31922.0058	2466.4767	-.0063776	487.3589	0.0000	0.0000
42.000	.767145	39890.2022	2860.2380	-.0063681	609.0107	0.0000	0.0000
45.000	.748057	49083.4336	3283.1667	-.0063564	749.3654	0.0000	0.0000
48.000	.729007	59589.2025	3735.2630	-.0063421	909.7588	0.0000	0.0000
51.000	.710004	71495.0114	4216.5267	-.0063249	1091.5269	0.0000	0.0000
54.000	.691057	84888.3628	4726.9580	-.0063043	1296.0055	0.0000	0.0000
57.000	.672178	99856.7592	5266.5567	-.0062800	1524.5307	0.0000	0.0000
60.000	.653378	116488.	5835.3230	-.0062515	1778.4382	0.0000	0.0000
63.000	.634669	134869.	6433.2567	-.0062184	2059.0641	0.0000	0.0000
66.000	.616067	155087.	7060.3580	-.0061803	2367.7442	0.0000	0.0000
69.000	.597587	177231.	7716.6267	-.0061365	2705.8144	0.0000	0.0000
72.000	.579248	201387.	8402.0630	-.0060867	3074.6107	0.0000	0.0000
75.000	.561067	227643.	9116.6667	-.0060302	3475.4690	0.0000	0.0000
78.000	.543066	256087.	9860.4380	-.0059666	3909.7253	0.0000	0.0000
81.000	.525268	286806.	10633.3767	-.0058951	4378.7153	0.0000	0.0000
84.000	.507696	319887.	11435.4830	-.0058153	4883.7750	0.0000	0.0000
87.000	.490376	355419.	12266.7567	-.0057264	5426.2404	0.0000	0.0000
90.000	.473338	393488.	13127.1980	-.0056278	6007.4474	0.0000	0.0000
93.000	.456609	434182.	14016.8067	-.0055189	6628.7318	0.0000	0.0000
96.000	.440224	477589.	14935.5830	-.0053989	7291.4297	0.0000	0.0000
99.000	.424216	523795.	15883.5267	-.0052671	7996.8769	0.0000	0.0000
102.000	.408622	572890.	16860.6380	-.0051227	8746.4092	0.0000	0.0000
105.000	.393480	624959.	17866.9167	-.0049651	9541.3628	0.0000	0.0000
108.000	.378831	680091.	18902.3630	-.0047933	10383.0734	0.0000	0.0000
111.000	.364720	738373.	19966.9767	-.0046066	11272.8769	0.0000	0.0000
114.000	.351191	799893.	21060.7580	-.0044042	12212.1094	0.0000	0.0000
117.000	.338295	864738.	22183.7067	-.0041851	13202.1067	0.0000	0.0000
120.000	.326081	932995.	22522.3531	-.0040475	687.4582	-346.6479	3189.2225
123.000	.314010	999872.	21763.1152	-.0039981	736.7349	-352.7454	3370.0734
126.000	.302092	1063574.	20696.0810	-.0039453	783.6724	-358.6108	3561.2707
129.000	.290338	1124049.	19611.8051	-.0038895	828.2318	-364.2398	3763.6154
132.000	.278756	1181245.	18511.0028	-.0038306	870.3757	-369.6284	3977.9845
135.000	.267354	1235115.	17394.4023	-.0037688	910.0685	-374.7720	4205.3399
138.000	.256143	1285611.	16262.7449	-.0037044	947.2759	-379.6663	4446.7384
141.000	.245128	1332691.	15116.7851	-.0036375	981.9657	-384.3068	4703.3442
144.000	.234317	1376312.	13957.2915	-.0035683	1014.1069	-388.6889	4976.4419
147.000	.223718	1416435.	12785.0463	-.0034970	1043.6705	-392.8079	5267.4527
150.000	.213336	1453022.	11600.8465	-.0034237	1070.6293	-396.6587	5577.9532
153.000	.203176	1486040.	10405.5042	-.0033486	1094.9576	-400.2362	5909.6967
156.000	.193244	1515455.	9199.8473	-.0032719	1116.6317	-403.5351	6264.6390
159.000	.183545	1541239.	7984.7202	-.0031938	1135.6299	-406.5496	6644.9683
162.000	.174082	1563364.	6760.9850	-.0031145	1151.9320	-409.2739	7053.1418
165.000	.164858	1581805.	5529.5222	-.0030341	1165.5200	-411.7013	7491.9283
168.000	.155877	1596541.	4291.2328	-.0029529	1176.3779	-413.8250	7964.4601
171.000	.147141	1607552.	3047.0391	-.0028710	1184.4914	-415.6375	8474.2969
174.000	.138651	1614823.	1797.8873	-.0027887	1189.8487	-417.1304	9025.5022
177.000	.130408	1618340.	544.7497	-.0027061	1192.4399	-418.2947	9622.7392
180.000	.122414	1618092.	-711.3729	-.0026234	1192.2571	-419.1203	10271.3897
183.000	.114668	1614071.	-1969.4471	-.0025408	1189.2949	-419.5958	10977.7027
186.000	.107169	1606275.	-3228.4032	-.0024586	1183.5502	-419.7083	11748.9846
189.000	.099916	1594701.	-4487.1303	-.0023768	1175.0222	-419.4431	12593.8420
192.000	.092908	1579352.	-5744.4695	-.0022957	1163.7127	-418.7831	13522.4982
195.000	.086142	1560234.	-6999.2074	-.0022155	1149.6260	-417.7088	14547.2094
198.000	.079615	1537357.	-8250.0659	-.0021363	1132.7694	-416.1969	15682.8208
201.000	.073324	1510734.	-9495.6911	-.0020585	1113.1527	-414.2199	16947.5213
204.000	.067264	1480383.	-10618.3209	-.0019820	1090.7892	-334.1999	14905.3616
207.000	.061432	1447024.	-11609.5356	-.0019073	1066.2094	-326.6099	15949.9041
210.000	.055821	1410725.	-12575.4973	-.0018342	1039.4637	-317.3646	17056.2464
213.000	.050426	1371571.	-13512.9957	-.0017632	1010.6134	-307.6343	18302.0422
216.000	.045242	1329648.	-14426.8262	-.0016941	979.7231	-301.5860	19998.2446
219.000	.040261	1285010.	-15320.0152	-.0016273	946.8328	-293.8733	21897.4310
222.000	.035478	1237727.	-16187.3508	-.0015629	911.9937	-284.3504	24044.6442
225.000	.030884	1187886.	-17023.1273	-.0015009	875.2689	-272.8339	26502.4593
228.000	.026472	1135589.	-17821.0094	-.0014416	836.7348	-259.0875	29361.3713
231.000	.022235	1080960.	-18573.8332	-.0013849	796.4827	-242.7951	32759.0197
234.000	.018163	1024146.	-19273.2997	-.0013311	754.6204	-223.5159	36918.9131
237.000	.014248	965320.	-19882.5445	-.0012803	711.2759	-182.6474	38458.0769
240.000	.010481	904850.	-20362.2344	-.0012325	666.7202	-137.1459	39256.2509
243.000	.006853	843147.	-20705.1910	-.0011879	621.2550	-91.4919	40054.4249
246.000	.003354	780619.	-20910.9296	-.0011464	575.1830	-45.6672	40852.5989
249.000	-2.58E-05	717681.	-20978.8936	-.0011081	528.8083	.3578900	41650.7729
252.000	-.003295	654746.	-20908.4200	-.0010730	482.4359	46.6245	42448.9469
255.000	-.006464	592230.	-20698.7072	-.0010412	436.3727	93.1840	43247.1209
258.000	-.009542	530554.	-20348.7862	-.0010125	390.9274	140.0968	44045.2949
261.000	-.012539	470138.	-19857.4933	-.0009869	346.4112	187.4318	44843.4689
264.000	-.015464	411409.	-19223.4481	-.0009644	303.1379	235.2650	45641.6429
267.000	-.018326	354797.	-18445.0330	-.0009448	261.4248	283.6783	46439.8169
270.000	-.021133	300738.	-17520.3785	-.0009281	221.5929	332.7580	47237.9909

273.000	-.023894	249675.	-16447.3515	-.0009140	183.9676	382.5933	48036.1649
276.000	-.026617	202054.	-15223.5491	-.0009025	148.8795	433.2749	48834.3389
279.000	-.029309	158333.	-13846.2972	-.0008933	116.6647	484.8930	49632.5129
282.000	-.031977	118977.	-12312.6545	-.0008862	87.6654	537.5355	50430.6869
285.000	-.034626	84457.5229	-10619.4222	-.0008810	62.2308	591.2861	51228.8609
288.000	-.037263	55260.0436	-8777.4011	-.0008774	40.7172	636.7280	51262.6819
291.000	-.039891	31793.1163	-6797.6356	-.0008752	23.4261	683.1157	51374.0497
294.000	-.042514	14474.2301	-4677.0770	-.0008740	10.6650	730.5901	51554.2351
297.000	-.045135	3730.6545	-2412.3717	-.0008736	2.7489	779.2135	51792.3928
300.000	-.047755	0.0000	0.0000	-.0008735	0.0000	829.0343	26040.1279

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 1.03585012 in
Computed slope at pile head = -.00640497
Maximum bending moment = 1618340. lbs-in
Maximum shear force = 22522.35312 lbs
Depth of maximum bending moment = 177.00000 in
Depth of maximum shear force = 120.00000 in
Number of iterations = 27
Number of zero deflection points = 1

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 0.000	M= 0.000	0.0000	1.0359	1618340.	22522.3531

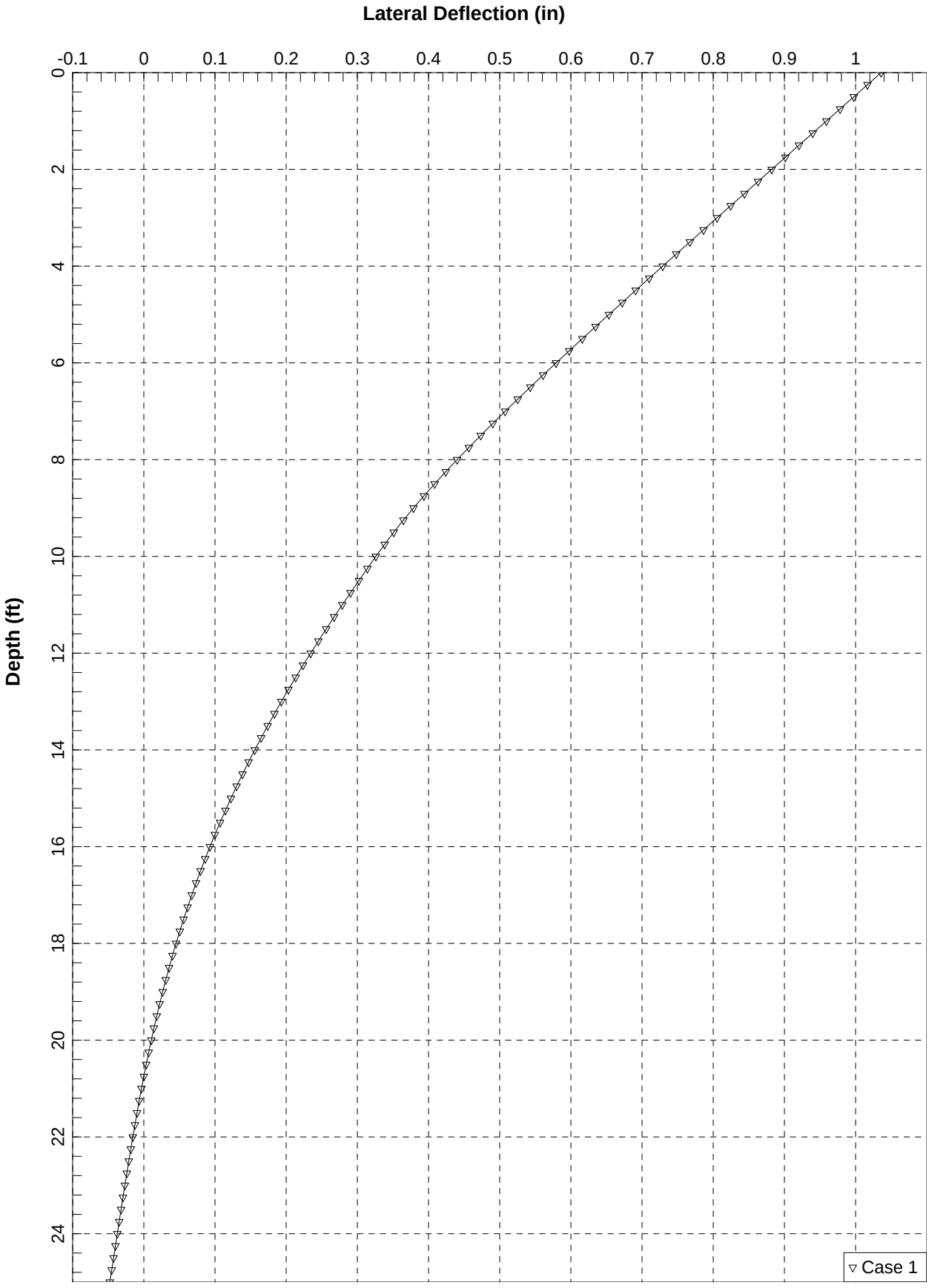
Pile-head Deflection vs. Pile Length

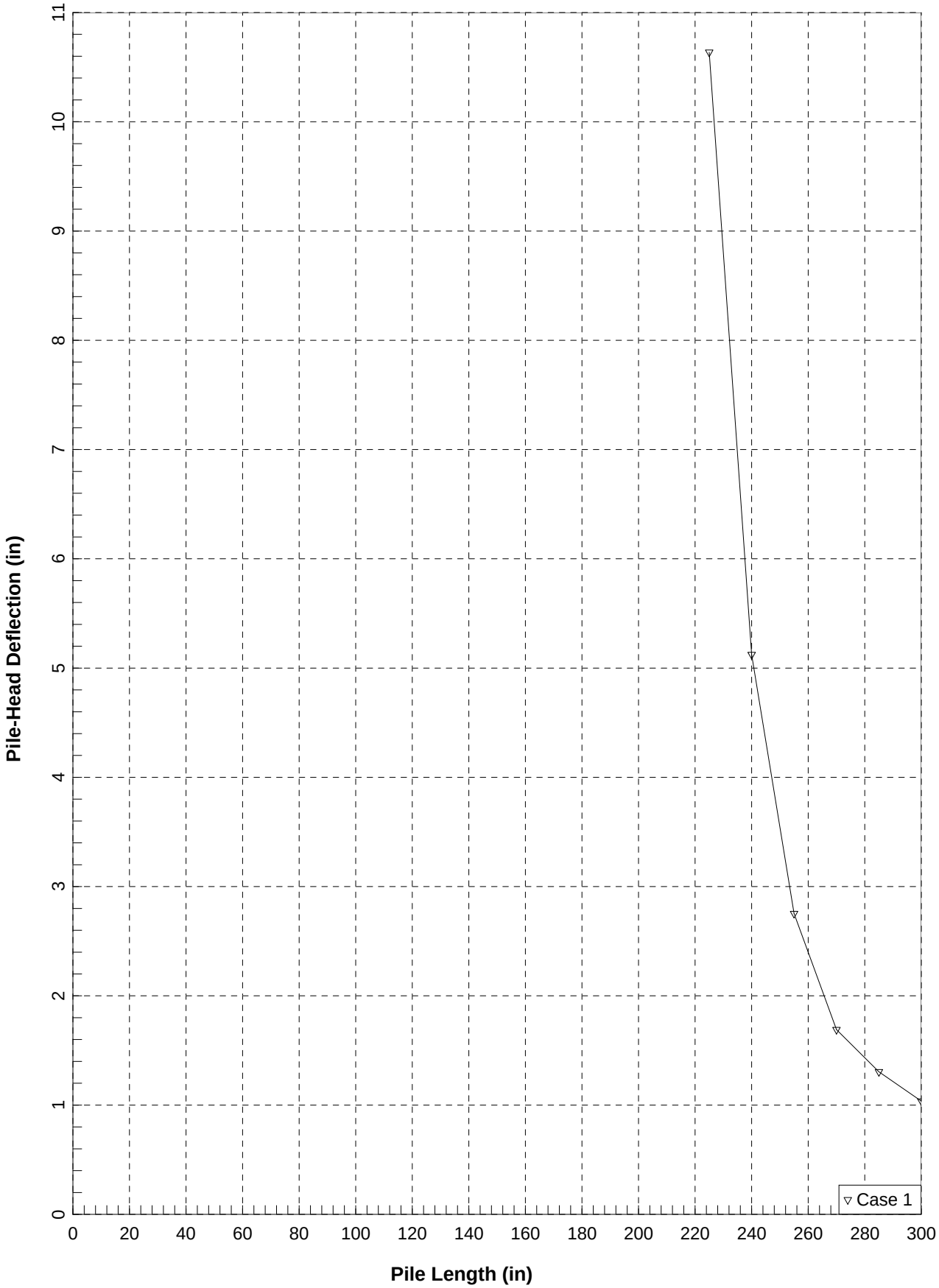
Boundary Condition Type 1, Shear and Moment

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

Pile Length in	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
300.000	1.03585012	1618340.	22522.35312
285.000	1.30532378	1617853.	-24308.67976
270.000	1.69091464	1546762.	-26142.05095
255.000	2.75333678	1493107.	-28534.35189
240.000	5.12370679	1420982.	-30511.33437
225.000	10.63633153	1334829.	-32514.97178

The analysis ended normally.


Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1


Pile-Head Deflection (in)
0
1
2
3
4
5
6
7
8
9
10
11
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Pile Length (in)
Case 1

LPILE Plus for Windows, Version 5.0 (5.0.39)

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

This program is licensed to:

Path to file locations: J:\GEOTECH\Projects\2010\B-10-020 HAM-75-7.85\HAM-75-7.85 PID 77889 - Mainline\Analysis\Retaining Wall V\Pile and Lagging - Without Tiebacks\
Name of input data file: Pile and Lagging - Without Tiebacks.lpd
Name of output file: Pile and Lagging - Without Tiebacks.lpo
Name of plot output file: Pile and Lagging - Without Tiebacks.lpp
Name of runtime file: Pile and Lagging - Without Tiebacks.lpr

Time and Date of Analysis

Date: August 10, 2013 Time: 23:14:17

Problem Title

HAM-75-7.85-Retaining Wall V - Pile and Lagging-No Tiebacks - 10 ft Ht -Strength

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 300.00 in

Depth of ground surface below top of pile = 120.00 in

Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 4 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	12.00000000	393.0000	15.5000	29000000.
2	120.0000	12.00000000	393.0000	15.5000	29000000.
3	120.0000	24.00000000	16286.0000	452.0000	3604997.
4	300.0000	24.00000000	16286.0000	452.0000	3604997.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = 120.000 in
Distance from top of pile to bottom of layer = 204.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 204.000 in
Distance from top of pile to bottom of layer = 550.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 250.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	120.00	.06660
2	204.00	.06660
3	204.00	.07230
4	550.00	.07230

Shear Strength of Soils

Shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	120.000	10.41000	.00	.00700	.0
2	204.000	10.41000	.00	.00700	.0
3	204.000	.00000	29.00	------	------
4	550.000	.00000	29.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	120.000	.9854	1.0000
2	550.000	.9854	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves.

Distributed Lateral Loading

Distributed lateral load intensity defined using 2 points

Point No.	Depth X in	Dist. Load lbs/in
1	.000	.00000
2	120.000	583.30000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = .000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = .000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = .000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = .000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	2.234	-7.3107E-06	0.0000	-.0122830	1.1161E-07	0.0000	0.0000
3.000	2.197	8.2026	24.6080	-.0122830	.1252313	0.0000	0.0000
6.000	2.160	147.6478	90.2292	-.0122829	2.2542	0.0000	0.0000
9.000	2.124	549.5780	199.5980	-.0122829	8.3905	0.0000	0.0000
12.000	2.087	1345.2356	352.7142	-.0122826	20.5379	0.0000	0.0000
15.000	2.050	2665.8633	549.5780	-.0122821	40.7002	0.0000	0.0000
18.000	2.013	4642.7034	790.1892	-.0122811	70.8810	0.0000	0.0000
21.000	1.976	7406.9986	1074.5480	-.0122795	113.0839	0.0000	0.0000
24.000	1.939	11089.9912	1402.6542	-.0122771	169.3128	0.0000	0.0000
27.000	1.903	15822.9239	1774.5080	-.0122736	241.5714	0.0000	0.0000
30.000	1.866	21737.0391	2190.1092	-.0122686	331.8632	0.0000	0.0000
33.000	1.829	28963.5792	2649.4580	-.0122619	442.1920	0.0000	0.0000

36.000	1.792	37633.7869	3152.5542	-.0122532	574.5616	0.0000	0.0000
39.000	1.755	47878.9045	3699.3980	-.0122419	730.9756	0.0000	0.0000
42.000	1.719	59830.1747	4289.9892	-.0122277	913.4378	0.0000	0.0000
45.000	1.682	73618.8398	4924.3280	-.0122102	1123.9518	0.0000	0.0000
48.000	1.645	89376.1425	5602.4142	-.0121887	1364.5213	0.0000	0.0000
51.000	1.609	107233.	6324.2480	-.0121628	1637.1500	0.0000	0.0000
54.000	1.572	127322.	7089.8292	-.0121320	1943.8417	0.0000	0.0000
57.000	1.536	149772.	7899.1580	-.0120955	2286.6000	0.0000	0.0000
60.000	1.500	174717.	8752.2342	-.0120528	2667.4287	0.0000	0.0000
63.000	1.464	202286.	9649.0580	-.0120032	3088.3314	0.0000	0.0000
66.000	1.428	232611.	10589.6292	-.0119459	3551.3118	0.0000	0.0000
69.000	1.392	265823.	11573.9480	-.0118803	4058.3738	0.0000	0.0000
72.000	1.357	302055.	12602.0142	-.0118056	4611.5208	0.0000	0.0000
75.000	1.321	341436.	13673.8280	-.0117209	5212.7567	0.0000	0.0000
78.000	1.286	384098.	14789.3892	-.0116254	5864.0852	0.0000	0.0000
81.000	1.252	430172.	15948.6980	-.0115183	6567.5099	0.0000	0.0000
84.000	1.217	479790.	17151.7542	-.0113985	7325.0346	0.0000	0.0000
87.000	1.183	533082.	18398.5580	-.0112652	8138.6630	0.0000	0.0000
90.000	1.150	590181.	19689.1092	-.0111173	9010.3987	0.0000	0.0000
93.000	1.116	651217.	21023.4080	-.0109540	9942.2455	0.0000	0.0000
96.000	1.084	716322.	22401.4542	-.0107740	10936.2071	0.0000	0.0000
99.000	1.052	785626.	23823.2480	-.0105763	11994.2871	0.0000	0.0000
102.000	1.020	859261.	25288.7892	-.0103598	13118.4894	0.0000	0.0000
105.000	.989618	937359.	26798.0780	-.0101233	14310.8174	0.0000	0.0000
108.000	.959618	1020050.	28351.1142	-.0098657	15573.2751	0.0000	0.0000
111.000	.930424	1107465.	29947.8980	-.0095857	16907.8661	0.0000	0.0000
114.000	.902104	1199737.	31588.4292	-.0092821	18316.5940	0.0000	0.0000
117.000	.874731	1296996.	33272.7080	-.0089535	19801.4626	0.0000	0.0000
120.000	.848383	1399373.	33900.1445	-.0087470	1031.0990	-440.2536	1556.7978
123.000	.822249	1500397.	33001.4271	-.0086729	1105.5360	-448.7185	1637.1622
126.000	.796346	1597382.	31642.9359	-.0085938	1176.9975	-456.9423	1721.3969
129.000	.770687	1690254.	30260.1420	-.0085098	1245.4287	-464.9203	1809.7638
132.000	.745287	1778943.	28853.7897	-.0084211	1310.7768	-472.6479	1902.5473
135.000	.720160	1863377.	27424.6376	-.0083281	1372.9906	-480.1201	2000.0563
138.000	.695318	1943490.	25973.4595	-.0082308	1432.0204	-487.3320	2102.6277
141.000	.670775	2019218.	24501.0443	-.0081296	1487.8186	-494.2782	2210.6288
144.000	.646541	2090497.	23008.1970	-.0080246	1540.3389	-500.9533	2324.4620
147.000	.622628	2157267.	21495.7394	-.0079161	1589.5372	-507.3518	2444.5680
150.000	.599045	2219471.	19964.5104	-.0078042	1635.3711	-513.4675	2571.4317
153.000	.575802	2277054.	18415.3677	-.0076894	1677.7998	-519.2943	2705.5872
156.000	.552909	2329963.	16849.1881	-.0075716	1716.7849	-524.8255	2847.6251
159.000	.530372	2378149.	15266.8689	-.0074514	1752.2897	-530.0540	2998.1999
162.000	.508200	2421565.	13669.3293	-.0073287	1784.2794	-534.9724	3158.0395
165.000	.486400	2460165.	12057.5120	-.0072040	1812.7215	-539.5725	3327.9561
168.000	.464976	2493910.	10432.3850	-.0070774	1837.5854	-543.8456	3508.8593
171.000	.443935	2522759.	8794.9432	-.0069493	1858.8428	-547.7823	3701.7716
174.000	.423281	2546679.	7146.2114	-.0068197	1876.4676	-551.3722	3907.8475
177.000	.403017	2565637.	5487.2467	-.0066891	1890.4360	-554.6042	4128.3961
180.000	.383146	2579603.	3819.1417	-.0065577	1900.7266	-557.4658	4364.9093
183.000	.363671	2588552.	2143.0282	-.0064256	1907.3203	-559.9432	4619.0959
186.000	.344592	2592461.	460.0817	-.0062933	1910.2008	-562.0211	4892.9248
189.000	.325911	2591312.	-1228.4736	-.0061608	1909.3543	-563.6824	5188.6778
192.000	.307627	2585090.	-2921.3590	-.0060286	1904.7698	-564.9078	5509.0176
195.000	.289740	2573784.	-4617.2335	-.0058968	1896.4391	-565.6753	5857.0736
198.000	.272246	2557387.	-6314.6863	-.0057657	1884.3571	-565.9599	6236.5534
201.000	.255145	2535896.	-8012.2256	-.0056356	1868.5220	-565.7330	6651.8878
204.000	.238433	2509313.	-9918.3560	-.0055067	1848.9353	-705.0206	8870.6691
207.000	.222106	2476386.	-12030.0747	-.0053793	1824.6732	-702.7919	9492.6748
210.000	.206158	2437133.	-14130.4359	-.0052537	1795.7506	-697.4490	10149.2629
213.000	.190583	2391603.	-16212.2263	-.0051304	1762.2029	-690.4112	10867.8774
216.000	.175375	2339859.	-18278.8542	-.0050095	1724.0768	-687.3407	11757.7688
219.000	.160526	2281930.	-20331.8581	-.0048914	1681.3925	-681.3285	12733.0357
222.000	.146027	2217868.	-22362.0419	-.0047764	1634.1901	-672.1274	13808.2956
225.000	.131868	2147758.	-24359.4044	-.0046649	1582.5305	-659.4476	15002.5021
228.000	.118037	2071712.	-26312.9915	-.0045571	1526.4978	-642.9438	16340.8445
231.000	.104525	1989880.	-28210.6995	-.0044533	1466.2014	-622.1948	17857.7936
234.000	.091317	1902448.	-30039.0042	-.0043539	1401.7790	-596.6749	19602.2222
237.000	.078402	1809646.	-31782.5779	-.0042590	1333.3997	-565.7075	21646.5303
240.000	.065763	1711752.	-33423.7217	-.0041691	1261.2690	-528.3883	24104.1477
243.000	.053387	1609103.	-34941.4743	-.0040842	1185.6343	-483.4468	27166.4831
246.000	.041258	1502103.	-36310.0975	-.0040047	1106.7936	-428.9687	31191.8702
249.000	.029359	1391243.	-37496.1759	-.0039308	1025.1083	-361.7502	36965.2953
252.000	.017673	1277126.	-38413.8968	-.0038627	941.0240	-250.0638	42448.9469
255.000	.006183	1160759.	-38922.6848	-.0038004	855.2814	-89.1283	43247.1209
258.000	-.005129	1043590.	-38943.4140	-.0037440	768.9477	75.3088	44045.2949
261.000	-.016282	927099.	-38465.3897	-.0036937	683.1135	243.3740	44843.4689
264.000	-.027292	812798.	-37483.4803	-.0036492	598.8932	411.2322	45204.2457
267.000	-.038177	702198.	-36084.9428	-.0036105	517.4000	521.1261	40950.7366
270.000	-.048955	596288.	-34364.2127	-.0035774	439.3626	626.0273	38363.5498

273.000	-.059641	496013.	-32332.2618	-.0035495	365.4767	728.6066	36649.4675
276.000	-.070252	402295.	-29993.7979	-.0035265	296.4225	830.3693	35459.7991
279.000	-.080800	316050.	-27349.8373	-.0035082	232.8748	932.2712	34613.9027
282.000	-.091301	238196.	-24398.9747	-.0034940	175.5095	1034.9706	34007.5969
285.000	-.101764	169656.	-21138.0974	-.0034836	125.0076	1138.9476	33576.0590
288.000	-.112202	111367.	-17562.8251	-.0034764	82.0585	1244.5673	33276.6121
291.000	-.122623	64279.1505	-13667.8014	-.0034719	47.3628	1352.1153	33079.9122
294.000	-.133033	29360.2650	-9446.8996	-.0034695	21.6335	1461.8193	32965.0835
297.000	-.143440	7597.7531	-4893.3775	-.0034686	5.5982	1573.8621	32916.8686
300.000	-.153845	0.0000	0.0000	-.0034684	0.0000	1688.3896	16461.9385

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 2.23410714 in
Computed slope at pile head = -.01228297
Maximum bending moment = 2592461. lbs-in
Maximum shear force = -38943.41400 lbs
Depth of maximum bending moment = 186.00000 in
Depth of maximum shear force = 258.00000 in
Number of iterations = 29
Number of zero deflection points = 1

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 0.000	M= 0.000	0.0000	2.2341	2592461.	-38943.4140

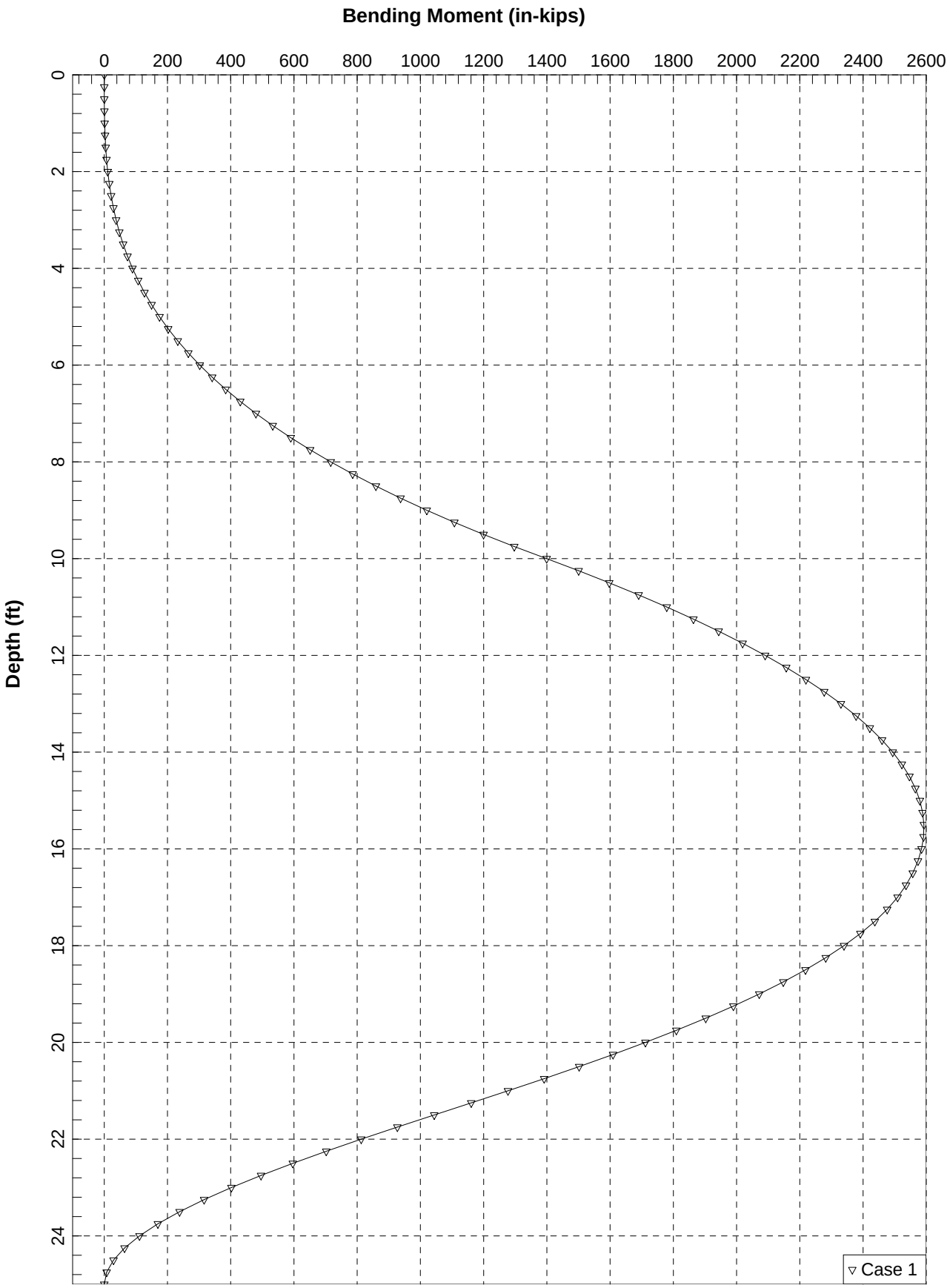
Pile-head Deflection vs. Pile Length

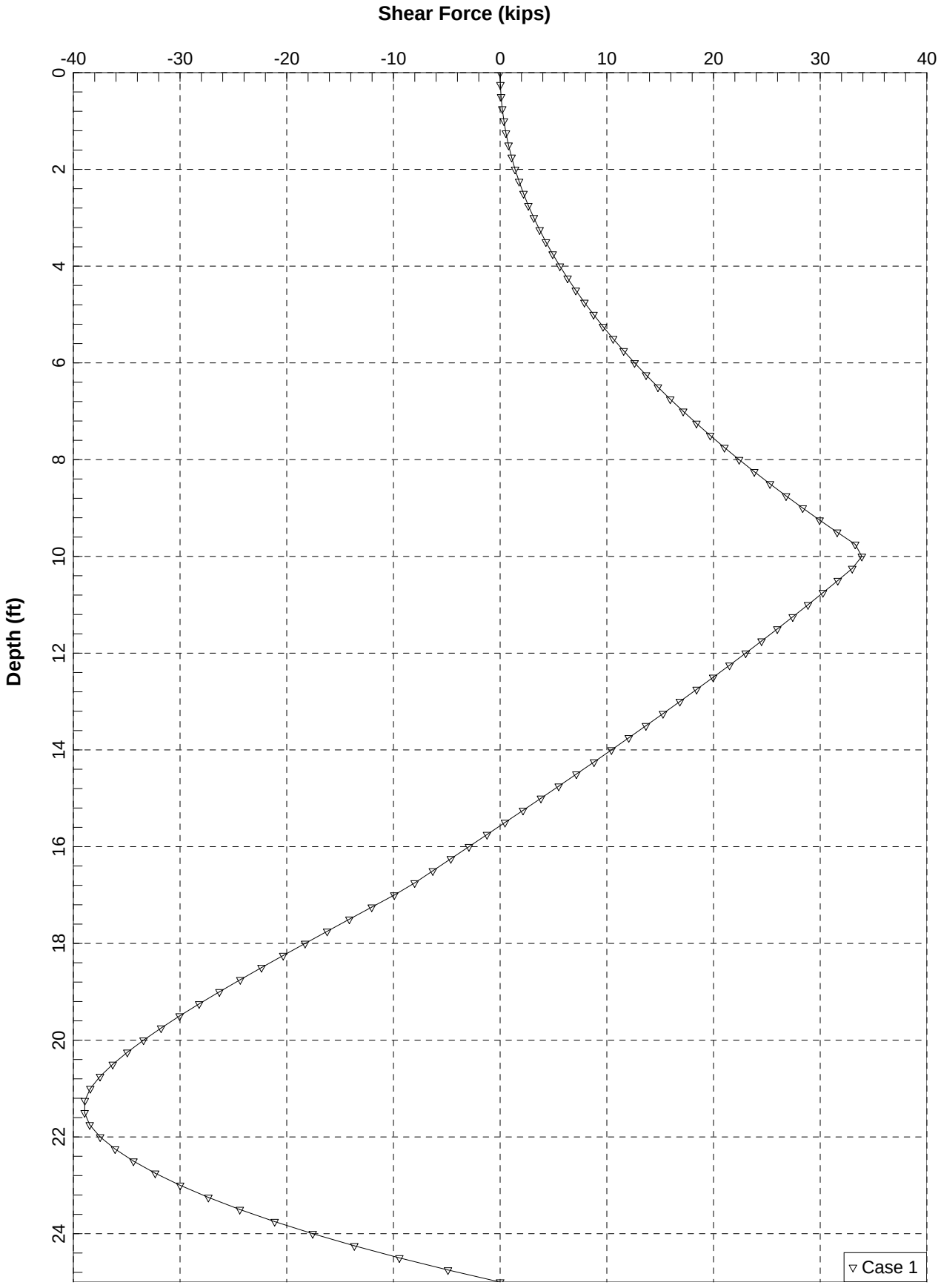
Boundary Condition Type 1, Shear and Moment

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

Pile Length in	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
300.000	2.23410714	2592461.	-38943.41400
285.000	3.15810629	2553470.	-43532.75186
270.000	4.66480498	2416974.	-46043.66986
255.000	8.61049102	2309177.	-49502.59706
240.000	23.60802539	2173713.	-51809.06326

The analysis ended normally.


Bending Moment (in-kips)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1


Shear Force (kips)
-40
-30
-20
-10
0
10
20
30
40
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1