Resource International, Inc.

FRA-71-14.36 PHASE 6R
FRA-71-1503L
I-71 SB OVER THE SCIOTO RIVER
PID NO. 105588
FRANKLIN COUNTY, OHIO

STRUCTURE FOUNDATION EXPLORATION REPORT (REV. 1)

Prepared For:
ms consultants, inc.
2221 Schrock Road
Columbus, OH 43229-1547

Prepared By:
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Rii Project No. W-13-072

April 2020

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July 19, 2019 (Revised April 6, 2020)

Mr. Walid Antonios, P.E.
ms consultants, inc.
2221 Schrock Road
Columbus, OH 43229-1547

Re: Structure Foundation Exploration Report (Rev. 1)
FRA-71-14.36 Phase 6R
FRA-71-1503L – I-71 SB over the Scioto River
PID No. 105588
Rii Project No. W-13-072

Mr. Antonios:

Resource International, Inc. (Rii) is pleased to submit this revised structure foundation exploration report for the above referenced project. Engineering logs have been prepared and are attached to this report along with the results of laboratory testing. This report includes recommendations for the design and construction of the proposed FRA-71-1503L bridge structure carrying I-71 southbound over the Scioto River as part of the FRA-71-14.36 Phase 6R project in Columbus, 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.
Director – Geotechnical Services

Jonathan P. Sterenberg, P.E.
Vice President – Geotechnical Services

Enclosure: Structure Foundation Exploration Report (Rev. 1)

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APPENDICIES

EXECUTIVE SUMMARY

Resource International, Inc. (Rii) has completed a structure foundation exploration for the design and construction of the proposed FRA-71-1503L bridge structure carrying the southbound lanes of I-71 over the Scioto River, as shown on the vicinity map and boring plan presented in Appendix I. The structure begins at Sta. 230+85, where the I-71 alignment merges with proposed Ramp C3, and continues north and east over SR-315 and the proposed Ramp C5. The structure alignment turns east as it crosses I-70 and the Scioto River and continues along the elevated bridge structure, crossing the CSX and Norfolk Southern Railroads, and terminates at the east side of Short Street. Based on information provided by ms consultants, it is understood that the proposed bridge will consist of a three (3) unit composite hybrid steel girder structure with a reinforced concrete deck. The structure will be comprised of a 9-span and two (2) 7-span units, resulting in a total of twenty-two (22) intermediate piers across the structures roughly 4,680-foot length. It is understood that the intermediate piers are to be supported on drilled shafts, and the abutments are to be supported on driven piles behind mechanically stabilized earth (MSE) walls. The proposed structure is anticipated to vary in width from a minimum of approximately 45.0 feet at the beginning of the structure alignment to a maximum of approximately 98.5 feet where future Ramp D4 splits off from the structure. Additionally, the roadway profile will be elevated up to approximately 100 feet above the existing ground surface grade along the proposed alignment.

Exploration and Findings

Between February 4, 2014, and January 22, 2015, a total of twenty four (24) borings, designated as B-104-1-13, B-105-2-13, B-107-1-13, B-108-4-13 through B-108-6-13, B-113-2-13 through B-113-9-13, B-114-1-13 through B-114-9-13, B-115-1-13 and B-115-2-13 were drilled along the proposed bridge alignment at the locations illustrated on the boring plan provided in Appendix I of the full report. In addition to the borings performed as part of the current exploration, five (5) historic borings performed in 1957 by the Department of Highways as part of the FRA-40-12.30 project, and seven (7) historic borings performed in 1968 by the Department of Highways as part of the FRA-70-12.30S project were obtained from the construction documents on record. The historic borings were extended to depths ranging from 36.0 to 75.0 feet below existing grades at the time of the exploration.

Borings B-113-2-13 and B-113-3-13 were performed within the existing pavement of I-70 westbound and encountered 8.0 and 6.0 inches of asphalt overlying 6.0 and 12.0 inches of aggregate base material, respectively. Boring B-114-2-13 was extended through the pavement of the existing Lower Scioto Greenway bike trail and encountered 6.0 inches of asphalt at the ground surface. With the exception of borings B-113-6-13 through B-113-8-13, which were performed within the Scioto River, the remaining borings encountered 1.0 to 9.0 inches of topsoil at the ground surface, as identified by the significant presence of organics and vegetation. Surficial materials were not noted on the historic boring logs.

Beneath the surface materials, existing fill was encountered in eight (8) of the borings performed west of the Scioto River extending to elevations ranging from 677.5 to 719.7 feet msl, and in ten (10) of the borings performed east of the Scioto River extending to elevations ranging from 685.8 to 708.5 feet msl. The existing fill material encountered west of the Scioto River consisted of brown, dark brown, gray, dark gray and black gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay, coarse and fine sand, sandy silt, silt and clay and silty clay (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a, A-4a, A-6a, A-6b). The existing fill material encountered east of the Scioto River is comprised of dark brown, brown, gray, dark gray and black gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay, coarse and fine sand, sandy silt, silt, silt and clay and silty clay (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a, A-4a, A-4b, A-6a, A-6b). Asphalt, brick, cinder, coal, concrete, rock, slag, and wood fragments were observed to be present within the majority of the fill material east of the Scioto River in addition to organic material including grass and root fibers. Based on available historic records, the fill material encountered in the vicinity of Short Street was likely placed within an old canal.

Underlying the surface materials and existing fill, where encountered, the natural soils encountered west of the Scioto River were predominantly granular with intermittent seams of cohesive material, and the natural soils encountered east of the Scioto River consisted generally of granular overlying cohesive soils. The granular soils were generally described as black, brown, dark brown, gray, and dark gray gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay, coarse and fine sand and sandy silt (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a, A-4a). The cohesive soils were generally described as brown, light brown, dark brown, reddish brown, gray and dark gray sandy silt, silt, silt and clay, silty clay and clay (ODOT A-4a, A-4b, A-6a, A-6b, A-7-6).

Cobbles and boulders were encountered in a total of sixteen (16) of the borings performed for this structure. The cobbles and boulders, which generally increased in intensity with depth and near the bedrock surface, were initially encountered at elevations ranging from 663.6 to 743.3 feet msl. Additionally, a boulder zone was also encountered in historic boring B-001-S-57 between elevations 661.0 and 667.0 feet msl.

The bedrock surface was encountered in the historic borings at depths ranging from 29.0 to 86.7 feet below the ground surface, corresponding to elevations ranging from 646.4 to 660.8 feet msl. Within the borings performed as part of the current exploration, the bedrock surface was encountered at depths ranging from 30.9 to 89.2 feet beneath the ground surface, corresponding to elevations ranging from 644.0 to 661.1 feet msl. Augerable bedrock was encountered in several of the borings performed along the east side of the project. The cored bedrock encountered across the proposed alignment generally consists of shale, mudstone, claystone, limestone and dolomite.

Seven (7) borings performed along the west end of the structure alignment to just west of the Scioto River encountered limestone at the bedrock surface. Sixteen (16) borings performed from just west of the Scioto River to the end of the structure alignment encountered shale, claystone or mudstone at the bedrock surface overlying limestone. In thirteen (13) of the borings where shale, mudstone and claystone bedrock were encountered, the upper portion of the bedrock was able to be augered and sampled using the SPT and split spoon sampler. In general, the shale, mudstone and claystone bedrock overlying the limestone increased in thickness along the proposed alignment starting just west of the Scioto River to the end of the structure alignment. Limestone bedrock was encountered in eight (8) of the borings at the bedrock surface, and, with the exception of boring B-115-1-13, was encountered in the remaining borings below the shale, mudstone and claystone bedrock. The shale bedrock was encountered at elevations ranging from 648.4 to 661.1 feet msl, and the limestone bedrock was encountered at elevations ranging from 629.0 to 657.0 feet msl.

Analyses and Recommendations

Design details of the proposed structure were provided by ms consultants. Based on the information provided, it is understood that the proposed FRA-71-1503L bridge will consist of a twenty three (23) span, three-unit, composite hybrid steel girder structure with a reinforced concrete deck. The rear and forward abutments will be supported on driven piles behind mechanically stabilized earth (MSE) walls, and the twenty two (22) intermediate piers are to be supported on drilled shaft foundations. The roadway profile will be elevated up to 100 feet above the existing ground surface grade along its proposed 4,680-foot long alignment, with the rear abutment elevated approximately 38 feet above existing grade and the forward abutment elevated approximately 45 feet above existing grade.

Drilled Shaft Recommendations

Given the proposed loading per shaft at each of the pier locations, friction bearing drilled shafts within the overburden soils and drilled shafts bearing within the weak surficial shale, mudstone and claystone bedrock are not economically feasible foundation options due to the size and number of shafts that would be required to support the proposed loading. Therefore, it is recommended that the drilled shafts be extended through the surficial soils and weak surficial shale, mudstone and claystone bedrock to bear on or within the underlying limestone bedrock at all twenty-two (22) pier substructure units.

Per Section 10.8.3.5.4c of the 2018 AASHTO LRDF Bridge Design Specifications (BDS), a minimum rock socket length of 1.5 times the diameter of the drilled shaft within the rock socket ($1.5B_{RS}$) is required to utilize the full end bearing resistance within the bedrock unit that the shafts are end bearing in/on. However, based on discussions with the ODOT Office of Geotechnical Engineering (OGE), a reduced tip resistance can be utilized for shafts not extended to the required minimum socket length of $1.5B_{RS}$ into bedrock.

Based on unconfined compression tests performed on limestone rock cores obtained from the borings performed at the subject piers, the unconfined compressive strength ranges from 4,898 to 14,395 psi. Using equation 10.8.3.5.4c-1 from the 2014 AASHTO LRFD BDS and the limiting unconfined compressive strength from the given range for the limestone bedrock, it is recommended that drilled shaft foundations socketed a minimum of $1.5B_{RS}$ into the bedrock to bear on or within the competent limestone bedrock be proportioned for a nominal end bearing resistance of 1,760 ksf at the strength limit state.

Where shafts are not socketed a minimum of $1.5B_{RS}$ into the bedrock due to the absence or insufficient thickness of the overlying shale, mudstone and claystone bedrock, or where lateral load demands do not require a rock socket length of $1.5B_{RS}$, a reduced nominal end bearing resistance should be utilized based on equation 10.8.3.5.4c-2 of the 2014 AASHTO LRFD BDS. Using equation 10.8.3.5.4c-2 and the limiting unconfined compressive strength from the given range for the limestone bedrock, it is recommended that drilled shaft foundations bearing on or within the competent limestone bedrock with a socket length less than $1.5B_{RS}$ into the bedrock be proportioned for a nominal end bearing resistance of 760 ksf at the strength limit state. A resistance factor of φ_{qp}=0.5 at the strength limit state should be utilized for design regardless of the embedment length into the underlying bedrock.

Given the factored end bearing resistances noted above for drilled shafts extended to bear on or within the limestone bedrock, it is anticipated that the axial resistance will be governed by structural resistance of the drilled shaft.

The following table lists the estimated elevation of the top of bedrock, top of limestone bedrock and the required rock socket length to end bear on top of the limestone bedrock at each pier substructure location, as well as the proposed rock sock diameter and length from the design plans and corresponding nominal end bearing resistance to be utilized for the design of the drilled shaft foundations.

Drilled Shaft Recommendations Bearing in Limestone Bedrock

Substructure Unit (Boring)	Top of Bedrock Elevation (feet msl)	Top of Limestone Elevation (feet msl)	Rock Socket Diameter [1] (feet)	Required Socket Length to Top of Limestone (feet)	Proposed Socket Length [1] (feet)	Nominal End Bearing Resistance [2] (ksf)
Pier 1 (B-105-2-13)	651.0	651.0	3.5	0.0	3.5	760
Pier 2 (B-107-1-13)	650.2	650.2	3.5	0.0	4.0	760
Pier 3 (B-108-4-13)	653.2	653.2	4.0	0.0	4.0	760

Substructure Unit (Boring)	Top of Bedrock Elevation (feet msl)	Top of Limestone Elevation (feet msl)	Rock Socket Diameter [1] (feet)	Required Socket Length to Top of Limestone (feet)	Proposed Socket Length [1] (feet)	Nominal End Bearing Resistance [2] (ksf)
Pier 4 (B-108-5-13)	645.8	645.8	4.0	0.0	4.0	760
Pier 5 (B-108-6-13)	657.0	657.0	4.0	0.0	4.0	760
Pier 6 (B-113-2-13)	654.1	654.1	4.0	0.0	4.0	760
Pier 7 (B-113-3-13)	658.3	653.3	3.5	5.0	8.5	1,760
Pier 8 (B-113-4-13)	652.7	649.2	3.5	3.5	7.0	1,760
Pier 9R/L (B-113-5-13)	652.2	650.8	3.5	1.4	5.0	760
Pier 10 (B-113-6-13)	652.2	647.6	7.5	4.6	14.6	1,760
Pier 11 (B-113-7-13)	659.4	648.8	7.5	10.6	20.6	1,760
Pier 12 (B-113-8-13)	644.0	644.0	7.5	0.0	10.0	760
Pier 13 (B-113-9-13)	656.3	645.6	7.5	10.7	20.7	1,760
Pier 14 (B-114-1-13)	655.3	634.8	7.5	20.5	30.5	1,760
Pier 15 (B-114-2-13)	660.0	643.0	4.0	17.0	17.0	1,760
Pier 16 (B-114-3-13)	661.1	645.2	4.0	15.9	15.9	1,760
Pier 17 (B-114-4-13)	660.6	644.3	4.0	16.3	16.3	1,760
Pier 18 (B-114-5-13)	651.8	635.7	4.0	16.1	16.1	1,760
Pier 19 (B-114-7-13)	648.4	639.3	4.0	9.1	9.2	1,760
Pier 20 (B-114-8-13)	650.5	637.0	4.0	13.5	13.5	1,760
Pier 21 (B-114-9-13)	655.0	629.0	4.0	26.0	26.0	1,760
Pier 22 (B-115-1-13)	651.1	630.0	4.0	21.1	21.2	1,760

1. *Proposed rock socket diameter and length at each substructure unit determined from proposed plan information provided by ms consultants and CH2M HILL.*
2. *Nominal end bearing resistance provided is the value that should be utilized in the determination of the end bearing resistance per drilled shaft based on the proposed rock socket length and diameter.*

Based on information provided by ms consultants, embankment fill will be placed over the proposed foundations for the FRA-71-1503L structure at various areas where embankment widening is associated with future work following construction of the FRA-71-1503L bridge structure. Fill heights ranging from 5.5 to 12.0 feet are anticipated at piers 1, 3 and 5, where future embankment will be constructed along Ramp C3, Future Ramp A4 and I-70 westbound, and fill heights ranging from 14.0 to 32.0 feet are anticipated at piers 19 through 22 where future embankment will be constructed along I-70 westbound and Ramp D7. Given the disturbance to the sidewalls of the excavation during construction of the footings, downdrag loads are not anticipated to develop along the side of the footings. Therefore, downdrag loads were only considered along the lengths of the drilled shafts supporting the proposed footings.

The unfactored downdrag load induced on the shafts was calculated using static analysis and is equal to the magnitude of the side resistance over the length of the shaft within the downdrag zone at the respective substructure location. The side resistance values provided in Appendix VII for the respective substructure units were utilized in the calculation of the downdrag loads. Considering a 4.5-foot shaft diameter within the overburden soils, as indicated in the proposed plan information, the unfactored downdrag loads range from 0 to 886 kips per shaft. A load factor of 1.25 was utilized in the determination of the factored downdrag load. The factored downdrag loads should be considered in addition to the factored structural loads per shaft when verifying the end bearing and structural resistances of the drilled shaft foundations. Results of the settlement and downdrag analysis at the proposed pier substructure units are presented in the following table.

Downdrag Analysis Results

Substructure Unit (Boring)	Anticipated Embankment Height [1] (ft)	Total Settlement (in)		Depth of Downdrag (ft)	Downdrag Load (kips/shaft)	
		Below Existing Grade Elevation	Below Bottom of Footing Elevation		Unfactored	Factored [2]
Pier 1 (B-105-2-13)	5.5	0.91	0.32	0.0	0	0
Pier 3 (B-108-4-13)	12.0	1.60	0.65	8.0	124	156
Pier 5 (B-108-6-13)	11.0	1.27	0.69	7.0	60	75
Pier 19 (B-114-7-13)	14.0	2.74	1.19	12.0	192	240
Pier 20 (B-114-8-13)	32.0	9.09	3.67	34.0	886	1,107
Pier 21 (B-114-9-13)	28.5	4.18	2.85	21.0	345	432
Pier 22 (B-115-1-13)	14.0	2.38	0.92	8.0	86	108

1. *Anticipated embankment fill heights at the proposed pier substructure units provided by ms consultant.*
2. *A load factor of 1.25 was considered in calculating factored downdrag load.*

It is understood that significant uplift forces are anticipated at the majority of the substructure units due to the high overturning moments and location of the drilled shaft elements from the center of the footings. The nominal side resistance within the overburden soils was calculated in accordance with sections 10.8.3.5.1b and 10.8.3.5.2b for cohesive and granular soil types, respectively. A boring-by-boring tabulation of nominal side resistance and associated resistance factor within the overburden soil that should be used for uplift resistance is provided in Appendix VII. Please note that the contribution of the side resistance within the upper 5.0 feet of the shaft length below the bottom of footing elevation should be neglected where cohesive soils (ODOT A-4a, A-4b, A-6a, A-6b, A-7-6) are present below the bottom of footing/top of shaft elevation.

In addition to the uplift resistance within the overburden soils, uplift resistance within the bedrock socket should also be considered in the overall determination of the uplift resistance of the drilled shafts. The nominal side resistance, q_s, for drilled shafts socketed into rock was calculated using equation 10.8.3.5.4b-1 of the 2018 AASHTO LRFD BDS. Based on the unconfined compression testing performed on the claystone and shale rock cores obtained from borings B-114-1-13, B-114-3-13 and B-114-9-13, the unconfined compressive strength of the shale, mudstone and claystone stratum ranges from 259 to 520 psi. Using a regression coefficient of 0.8 and the limiting unconfined compressive strength from the given range for the shale, mudstone and claystone bedrock, a nominal side resistance of 7.1 ksf at the strength limit state should be utilized for uplift resistance within this bedrock unit. Using a regression coefficient of 1.0 and the limiting unconfined compressive strength from the given range for the limestone bedrock, a nominal side resistance of 38.7 ksf at the strength limit state should be utilized for uplift resistance within this bedrock unit. A resistance factor of φ_{qs}=0.40 at the strength limit state should be utilized in the determination of the factored uplift resistance for the portion of the shafts that are socketed into the shale, mudstone, claystone and limestone bedrock.

For determination of the overall uplift resistance, the design should consider 100 percent contribution of the side resistance within the overburden soil as well as the shale, mudstone and claystone bedrock. Given the disturbance that will occur to the limestone bedrock at the top of the socket within this bedrock unit, side resistance should be neglected for the upper 1.0 diameter length of socket within the limestone, and can be included below this depth within the limestone if additional resistance is required. Please note that self-weight of the drilled shafts should be considered in the determination of the overall uplift resistance at each substructure unit.

Driven Pile Recommendations

It is understood that driven piles are to be utilized at rear and forward abutment substructures. Given the depth of bedrock encountered and the anticipated loading at the abutments, it is recommended that steel H-piles (ODOT Item 507.06) driven to refusal on bedrock be employed for foundation support. Friction bearing piles will not be a feasible foundation option as the maximum factored load per pile exceeds the maximum factored resistance allowed per Section 202.2.3.2.b of the 2007 ODOT BDM for all pile types and sizes. The following table shows the recommended pile lengths and the corresponding factored structural axial resistance ($R_{R\ max}$) of steel H-piles. For H-piles driven to refusal on bedrock, no geotechnical resistance factor should be applied to the factored structural axial resistance values presented, as the values presented account for the structural resistance factor, φ_c = 0.50, for H-piles subject to damage due to severe driving conditions.

Driven Pile Recommendations

Substructure Unit (Boring)	Ground Elevation [1]	Pile Size [2]	Pile Elevation		Pile Length [4] (feet)	$R_{R\ max}$ [5] (kips/pile)	Sleeve Length [6]	φ [7]
			Top [3]	Tip				
Rear Abutment (B-104-1-13)	714.5	HP 10x42	738.4	654.0	85.0	310	23.4 / 33.4	N/A
Forward Abutment (B-115-2-13)	716.1	HP 12x53	749.0	648.6 [8]	105.0	380	37.5 / 38.5	N/A

1. *Ground elevation listed is the ground elevation at the respective boring location.*
2. *A steel pile point is recommended to protect the tips of the piles during pile installation.*
3. *The top of pile elevation corresponds to the pile cutoff elevation, which is assumed to be 1.0-foot above the proposed bottom of footing elevation.*
4. *Per ODOT BDM Section 202.3.2, the estimated pile length was determined as the pile cutoff elevation (top) minus the pile tip elevation, rounded up to the nearest 5.0 feet.*
5. *The factored structural axial resistance for H-piles is based on the structural limit state of the steel H-pile section per Section 202.2.3.2.a of the 2007 ODOT BDM.*
6. *Sleeve length represents the required length of pile that should be sleeved within the MSE wall backfill.*
7. *For H-piles driven to refusal on bedrock, no geotechnical resistance factor should be applied to the factored structural axial resistance values presented, as the values presented account for the structural resistance factor, φ_c = 0.50, for H-piles subject to damage due to severe driving conditions.*
8. *The pile tip elevation is based on a penetration of 4.0 feet into the weathered shale bedrock.*

The anticipated total settlement along the facing of Retaining Wall W5 at the rear abutment is approximately 2.71 inches, and total settlement along the facing of Retaining Wall E7 at the forward abutment is approximately 3.20 inches. Results of the settlement analysis indicate that approximately 90 percent of the primary consolidation of the cohesive layers at the rear and forward abutments will be complete within 15 and 0 days, respectively, following the placement of the surcharge load. Therefore, if the above noted waiting period is specified following completion of construction of the retaining walls at the rear and forward abutments, downdrag forces along the piles will be eliminated.

MSE Wall Recommendations

It is proposed to construct an MSE wall at the rear abutment (Retaining Wall W5 between Sta. 509+85 and 510+30, BL Wall W5) of the proposed bridge structure. Based on proposed plan information provided by ms consultants and the Rii design team, the maximum wall height at the rear e abutment (Retaining Wall W5) is anticipated to be 50.0 feet, as measured from the top of the leveling pad to the proposed crown elevation of the roadway profile.

The anticipated bearing material at the rear abutment consists of existing embankment fill comprised of very stiff to hard silt and clay (ODOT A-6a) overlying natural medium dense to very dense gravel and coarse and find sand (ODOT A-1-a, A-3a). MSE wall foundations bearing on these soils may be proportioned for a factored bearing resistance as indicated in the following table. A geotechnical resistance factor of φ_b=0.65 was considered in calculating the factored bearing resistances at the strength limit state.

FRA-71-1503L (Retaining Wall W5) MSE Wall Design Parameters

Substructure Unit (Boring)	Wall Height Analyzed (feet)	Backslope Behind Wall	Minimum Required Reinforcement Length [1] (feet)	Bearing Resistance at Strength Limit (ksf)		Strength Limit Equivalent Bearing Pressure [3] (ksf)
				Nominal	Factored [2]	
Rear Abutment / Retaining Wall W5 (Sta. 509+85 to 510+30) (B-104-1-13)	50.0	Level	35.0 [(4)] (0.70H to 0.88H)	17.73	11.52	11.26

1. *The minimum reinforcement length is based on the maximum wall height analyzed. The value in parentheses represent the required reinforcement length expressed as a percentage of the wall height, H.*
2. *A geotechnical resistance factor of φ_b=0.65 was utilized in calculating the factored nominal bearing resistance at the strength limit state.*
3. *The strength limit equivalent bearing pressure is the uniformly distributed pressure asserted by the wall over an effective base width based on the eccentricity of the wall system at the strength limit state.*
4. *Based on the results of all stability analyses for the minimum and maximum wall height along the section of wall alignment in front of the rear abutment, it is recommended to utilize the required wall width for the maximum wall height for the entire length of this segment of wall.*

Total settlements of up to 5.06 inches at the center of the reinforced soil mass and 2.71 inches at the facing of the wall are anticipated at the rear abutment. Based on the results of the analysis, 90 percent of the total settlement at the rear abutment is anticipated to occur over a period of approximately 1 to 15 days.

Based on the results of the external and global stability analyses performed for the MSE wall at the rear abutment (Retaining Wall W5), the recommended controlling strap length is 0.70 times the maximum height of the MSE wall (measured from the top of the leveling pad to the proposed roadway profile grade). All of the external and global stability calculations indicate that adequate resistance is available for support of the MSE wall at the rear abutment for a strap length equal to 70 percent of the maximum wall height. However, it should be noted that a strap length of 35.0 feet (88 percent of the wall height) is required for the minimum wall height of 40.0 feet along this segment of the wall in order to meet global stability requirements. **Therefore, the required width of 35.0 feet should be used for the entire alignment of the wall at the rear abutment.**

Lightweight (Cellular Concrete) Wall Recommendations

Existing fill material consisting of very loose to loose gravel with sand, gravel with sand and silt, coarse and fine sand and silt (ODOT A-1-b, A-2-4, A-3a, A-4b) was encountered at the proposed bearing elevation at the forward abutment (boring B-115-2-13), which extends to a depth of 18.0 feet below the proposed bearing elevation to an elevation of 693.1 feet msl. It is understood that lightweight fill material consisting of cellular concrete is being considered to be utilized as the backfill along the length of Retaining Wall E7 where it crosses in front of the forward abutment (between Sta. 704+21 to 705+61, BL Wall E7). Based on information provided by the Rii design team, two types of lightweight cellular concrete will be utilized in lieu of typical embankment fill and select granular fill, which is typically used for MSE wall applications. The wall facing will be connected to geosynthetic straps that are embedded into the cellular concrete and supported on a leveling pad, similar to traditional MSE walls. It is recommended that the reinforcement extend the minimum length of 70 percent of the wall height into the cellular concrete backfill, similar to traditional MSE walls.

Since the wall is located within an existing floodplain, the analysis was performed using a design groundwater level at the ground surface.

Provided that all backslopes cut into the existing I-70 embankment are graded no steeper than 2H:1V, external and global stability calculations will not be required for this section of Retaining Wall E7. However, if bearing resistance must be checked, then a factored bearing resistance of 4.23 ksf should be utilized for design at the strength limit state.

A total settlement of 4.43 inches at the center of the wall mass and 3.50 inches at the facing of the wall is anticipated along Retaining Wall E7 where is crosses in front of the forward abutment. Based on the results of the analysis, 90 percent of the total settlement is anticipated to occur during and immediately following construction of the wall.

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 FRA-70/71-13.10/14.36 (Projects 6A/6R) project in Columbus, Ohio. The projects represent the central portion of FRA-70-8.93 (PID 77369) I-70/71 south innerbelt improvements project, which includes all improvements along I-70 westbound from the I-71/SR-315 interchange to Front Street and along I-71 southbound from I-70 to Greenlawn Avenue. The FRA-71-14.36 (Project 6R) phase will consist of all work associated with the reconfiguration and construction of I-71 southbound from downtown (Front Street) to Greenlawn Avenue, including Ramps C3, D6 and D7. This project includes the construction of two (2) new bridge structures, one (1) for I-71 southbound over Short Street, NS/CXS Railroad and the Scioto River (FRA-71-1503L) and one (1) for Ramp D7 over Short Street (FRA-70-1373B), as well as the construction of five (5) new retaining walls (Walls E4, E5, E7, W2 and W5) to accommodate the new configuration.

This report is a presentation of the structure foundation exploration performed for the design and construction of the proposed FRA-71-1503L bridge structure carrying the southbound lanes of I-71 over the Scioto River, as shown on the vicinity map and boring plan presented in Appendix I. The structure begins at Sta. 230+85, where the I-71 alignment merges with proposed Ramp C3, and continues north and east over SR-315 and the proposed Ramp C5. The structure alignment turns east as it crosses I-70 and the Scioto River and continues along the elevated bridge structure, crossing the CSX and Norfolk Southern Railroads, and terminates at the east side of Short Street.

Based on information provided by ms consultants, it is understood that the proposed bridge will consist of a three (3) unit composite hybrid steel girder structure with a reinforced concrete deck. The structure will be comprised of a 9-span and two (2) 7-span units, resulting in a total of twenty-two (22) intermediate piers across the structures roughly 4,680-foot length. It is understood that the intermediate piers are to be supported on drilled shafts, and the abutments are to be supported on driven piles behind mechanically stabilized earth (MSE) walls. The proposed structure is anticipated to vary in width from a minimum of approximately 45.0 feet at the beginning of the structure alignment to a maximum of approximately 98.5 feet where future Ramp D4 splits off from the structure. Additionally, the roadway profile will be elevated up to approximately 100 feet above the existing ground surface grade along the proposed alignment. Please note that the analysis and recommendations for the portions of Retaining Wall W5, between Sta. 509+85 and 510+30 (BL Wall W5), at the rear abutment, and Retaining Wall E7, between Sta. 704+21 and 705+61 (BL Wall E7), at the forward abutment are presented under this report cover. Design recommendations for the remaining alignments of Retaining Walls W5 and E7 are presented under separate covers.

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 based on geological age, depositional process and geomorphic occurrence (physical features or landforms). The project area lies within the Columbus Lowland District of the Till Plains Section. This area is characterized by flat to gently rolling ground moraine deposits from the Late Wisconsinan age. The site topography exhibits moderate to high relief. The ground moraine deposits are composed primarily of silty loam till (Darby, Bellefontaine, Centerburg, Grand Lake, Arcanum, Knightstown Tills), with smaller alluvium and outwash deposits bordering the Scioto River, its tributaries and floodplain areas. A ground moraine is the sheet of debris left after the steady retreat of glacial ice. The debris left behind ranges in composition from clay size particles to boulders (including silt, sand, and gravel). 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.

According to the bedrock geology and topography maps obtained from the Ohio Department of Natural Resources (ODNR), the underlying bedrock consists predominantly of the Middle to Lower Devonian-aged Columbus Limestone Formation. This formation is further subdivided into two members in the central portion of the state, known as the Delhi and Bellepoint Members. The Delhi Member consists of light gray, finely to coarsely crystalline, irregularly bedded, fossiliferous limestone. The Bellepoint Member consists of variable brown, finely crystalline, massively bedded limy dolomite. Both of these members contain chert nodules. Just east of Scioto River, the Upper Devonian Ohio Shale Formation overlies the Columbus Limestone Formation. The Ohio Shale formation consists of brownish black to greenish gray, thinly bedded, fissile, carbonaceous shale. Regionally, the bedrock surface forms a broad valley aligned roughly north-to-south beneath the Scioto River. According to bedrock topography mapping, the elevation of the bedrock surface ranges from roughly 600 feet mean sea level (msl) in the valley to roughly 625 feet msl near the project limits. Bedrock consisting primarily of shale overlying limestone was encountered in the borings performed for this structure at elevations ranging from 644.0 to 661.1 feet msl.

2.2 Existing Conditions

The project alignment is along the I-70/71 south innerbelt, primarily along I-70 westbound between the I-71/SR-315 interchange and Front Street, and along I-71 southbound between I-70 and Greenlawn Avenue. The I-71/SR-315 and I-70 interchange is a major interchange with many entrance and exit ramps that connect the various alignments. I-70 crosses over the Scioto River just east of the I-71 and SR-315 interchange, with three existing bridges that cross the river and converge at the eastern bank into an eight-lane roadway. The roadway then reduces to a six-lane expressway which continues into downtown Columbus and crosses under Front Street and High Street. The existing I-70 is elevated from the surrounding terrain from east of the Scioto River to just west of Front Street and there are existing overpass bridges where the roadway crosses the existing CSX and Norfolk Southern Railroads and Short Street. The roadway profile is lowered from the surrounding terrain where the alignment enters into downtown from just west of Front Street to the end of the project alignment. There is also an entrance ramp from Mound Street to I-70 westbound and an exit ramp from I-70 eastbound to Fulton Street and Livingston Avenue, which is where the existing eight-lane alignment transitions to six lanes. The daily traffic volume along the project alignment is very high. The alignment traverses primarily commercial and government properties. The surrounding terrain across the site is relatively flat-lying, with general slope toward the Scioto River.

3.0 EXPLORATION

Between February 4, 2014, and January 22, 2015, a total of twenty four (24) borings, designated as B-104-1-13, B-105-2-13, B-107-1-13, B-108-4-13 through B-108-6-13, B-113-2-13 through B-113-9-13, B-114-1-13 through B-114-9-13, B-115-1-13 and B-115-2-13 were drilled along the proposed bridge alignment at the locations illustrated on the boring plan provided in Appendix I of this report and summarized in Table 1. The borings were advanced to completion depths ranging from 55.7 to 99.2 feet below the existing ground surface. One (1) boring was performed at each of the proposed substructure units, in accordance with ODOT Specification for Geotechnical Exploration (SGE) requirements. Borings B-113-6-13 through B-113-8-13 were performed from a barge within the Scioto River at the proposed pier substructure locations that will be located within the river channel. On January 9 and 10, 2020, an offset boring, designated as B-115-1A-19, which was extended to a completion depth of 96.0 feet below grade, was performed adjacent to boring B-115-1-13 in order to identify the depth to the top of limestone bedrock.

Table 1. Test Boring Summary

Boring Number	Station [1]	Offset [1]	Latitude	Longitude	Ground Elevation (feet msl)	Boring Depth (feet)
B-104-1-13	230+95.90	17.5’ Rt.	39.947937268	-83.015727886	714.5	70.5
B-105-2-13	232+68.59	24.4’ Rt.	39.948370122	-83.015953098	707.0	66.0
B-107-1-13	235+33.88	0.3’ Lt.	39.949053857	-83.016255140	704.0	65.8
B-108-4-13	237+31.12	23.7’ Rt.	39.949590983	-83.016192327	702.7	62.5
B-108-5-13	239+69.30	18.7’ Rt.	39.950225756	-83.016078985	700.3	63.0

Boring Number	Station [1]	Offset [1]	Latitude	Longitude	Ground Elevation (feet msl)	Boring Depth (feet)
B-108-6-13	242+23.02	20.7’ Rt.	39.950860104	-83.015749519	714.5	67.1
B-113-2-13	245+03.67	17.9’ Lt.	39.951551161	-83.015294380	743.3	99.2
B-113-3-13	247+30.17	35.7’ Rt.	39.951860441	-83.014576519	735.3	91.0
B-113-4-13	249+37.84	28.1’ Rt.	39.952169637	-83.013979325	725.2	88.3
B-113-5-13	250+13.44	36.0’ Rt.	39.952235986	-83.013728661	725.7	85.7
B-113-6-13	251+93.56	37.3’ Rt.	39.952409438	-83.013136525	691.5	63.7
B-113-7-13	254+41.19	36.0’ Rt.	39.952639679	-83.012306009	690.3	55.7
B-113-8-13	256+62.64	36.0’ Rt.	39.952842559	-83.011561408	691.0	66.2
B-113-9-13	258+77.50	36.0’ Rt.	39.953039408	-83.010838937	706.3	73.0
B-114-1-13	260+75.33	40.2’ Rt.	39.953209751	-83.010168725	709.8	81.0
B-114-2-13	263+18.38	9.4’ Lt.	39.953552395	-83.009405161	723.5	82.0
B-114-3-13	264+64.99	20.3’ Lt.	39.953687787	-83.008908335	724.6	84.0
B-114-4-13	265+98.19	41.6’ Lt.	39.953824760	-83.008455876	724.1	86.2
B-114-5-13	268+86.79	10.9’ Lt.	39.953855853	-83.007412457	715.3	89.6
B-114-7-13	271+12.84	28.4’ Rt.	39.953781634	-83.006602443	713.3	84.0
B-114-8-13	273+13.25	16.5’ Lt.	39.953893690	-83.005886092	714.0	82.0
B-114-9-13	275+07.50	4.7’ Rt.	39.953788084	-83.005201418	714.0	90.0
B-115-1-13	276+68.11	2.0’ Rt.	39.953729246	-83.004634304	714.6	75.5
B-115-1A-19	276+71.11	2.0’ Rt.	39.953727779	-83.004623774	714.3	96.0
B-115-2-13	277+71.50	20.2' Lt.	39.953734364	-83.004256897	716.1	90.7

1. *Station and offset referenced to the proposed baseline of I-71 Southbound.*

The boring locations were determined and located in the field by Rii representatives. Rii utilized a handheld GPS unit to obtain northing and easting coordinates of the boring locations. Ground surface elevations at the boring locations were interpolated using topographic mapping information provided by ms consultants.

The borings were sampled with either a truck or all-terrain vehicle (ATV) mounted rotary drilling machine, utilizing 3.25 or 4.25-inch inside diameter, continuous hollow-stem augers to advance the holes between sampling attempts. In general, standard penetration test (SPT) and split spoon sampling were performed in the borings at 2.5-foot increments of depth to 30.0 feet and at 5.0-foot increments thereafter to the top of bedrock. Borings B-113-2-13 and B-113-3-13 were sampled at 5.0-foot increments to a depth of 35.0 and 20.0 feet, respectively, at 2.5-foot increments to a depth of 55.0 and 40.0 feet, and at 5.0-foot intervals thereafter to the top of bedrock. Sampling was performed continuously to a depth of 6.0 feet below the riverbed elevation in borings B-113-6-13 through B-113-8-13. No SPT testing was performed within the overburden soils in boring B-115-1A-19.

The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted using a 140-pound hammer falling 30.0 inches to drive a 2.0-inch outside diameter split spoon sampler 18.0 inches. Rii utilized a calibrated automatic drop hammer to generate consistent energy transfer to the sampler. Driving resistance is recorded on the boring logs in terms of blow 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 the boring logs in Appendix III.

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

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

The hammers for the Mobile B-53, CME 750 and CME 750X drill rigs were calibrated on April 26, 2013, and have drill rod energy ratios of 77.7, 82.6 and 86.8 percent, respectively. The hammers for the CME 750X and CME 55 drill rigs were calibrated again on October 20, 2014, and have drill rod energy ratios of 85.7 and 92.0 percent, respectively. The updated energy ratio for the CME 750X drill rig was utilized for borings performed after the recalibration date for that rig.

In general, for instances of no recovery from standard split spoon sampling, a 3.0-inch outside diameter split spoon sampler was driven the full length of the standard split spoon interval plus an additional 6.0 inches to obtain a representative sample. Only the final 6.0 inches of sample were retained for classification. Blow counts from the 3S sampling are not correlated with N_{60} values.

In addition to the SPT samples, two (2) undisturbed (Shelby tube) samples were attempted within borings B-113-9-13, and B-114-1-13. These samples were obtained by hydraulically pushing a 2.75-inch outer diameter thin-walled seamless steel (Shelby) tube into the soil at a constant rate of penetration. No material was recovered during the Shelby tube sampling attempt in boring B-114-1-13. The recovered Shelby tube sample from boring B-113-9-13 was cleaned of soil cuttings and preserved within the tube by sealing the ends with wax.

During drilling, heaving sands were encountered in several of the borings conducted for this investigation. Where these conditions were encountered, drilling fluid, consisting of either water or a mixture of bentonite gel and water, was introduced to the borings to counteract the water pressure and prevent the sands from heaving into the augers. Drilling fluid was introduced to the borings at depths ranging from 6.4 to 48.5 feet beneath the existing ground surface, and is noted on the boring logs presented in Appendix III.

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 2.

Table 2. Laboratory Test Schedule

Laboratory Test	Test Designation	Number of Tests Performed
Natural Moisture Content	ASTM D 2216	433
Plastic and Liquid Limits	AASHTO T89, T90	171
Gradation – Sieve/Hydrometer	AASHTO T88	179
Unconfined Compressive Strength of Cohesive Soil	ASTM D2166	1
One-Dimensional Consolidation	ASTM D2435	1
Loss by Ignition	ASTM D2974	1
Point Load Strength Index of Rock Specimens	ASTM D5731	3
Unconfined Compressive Strength of Intact Rock	ASTM D7012	31

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 III and also in Appendix V. A description of the soil terms used throughout this report is presented in Appendix II.

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

The depth to competent bedrock was determined by auger and/or split spoon sampler refusal. Auger refusal is defined as no or insignificant observable advancement of the augers with the weight of the drill rig driving the augers. Split spoon sampler refusal is defined as exceeding 50 blows with less than 6.0 inches of penetration by the split spoon sampler.

Where the borings were extended into the competent bedrock or upon encountering auger refusal on large boulders, an NQ or HQ-sized double-tube diamond bit core barrel (utilizing wire line equipment) was used to core the bedrock. Coring produced 1.8 or 2.5 inch diameter cores, for NQ and HQ-sized cores, respectively, from which the type of rock and its geological characteristics were determined.

Rock cores were logged in the field and visually classified in the laboratory. They were analyzed to identify the type of rock, color, mineral content, bedding planes and other geological and mechanical features of interest in this project. The Rock Quality Designation (RQD) for each rock core run was calculated according to the following equation:

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

The RQD value aids in estimating the general quality of the rock and is used in conjunction with other parameters to designate the quality of the rock mass.

Upon completion of drilling, the borings were backfilled in accordance with the ODOT policy for sealing boreholes, utilizing either soil cuttings generated during the drilling process, or a cement-bentonite grout. Where borings penetrated the existing pavement, an equivalent thickness of quickset concrete was used to repair the pavement surface.

3.1 Historic Explorations

Historic borings performed in 1957 by the Department of Highways as part of the FRA-40-12.30 project were obtained from the construction documents on record. Five (5) borings, designated as B-001-S-57, B-005-S-57, B-009-S-57, B-013-S-57 and B-020-S-57, were obtained along the entire length of the existing bridge alignments carrying I-70 eastbound and westbound over the Scioto River. The borings were extended to depths ranging from 36.0 to 63.0 feet below the existing grade at the time of the exploration. Additionally, historic borings performed in 1968 by the Department of Highways as part of the FRA-70-12.30S project were obtained from the construction documents on record. Seven (7) borings, designated as B-006-D-68, B-009-D-68, B-015-D-57, B-012-E-68, B-018-E-68 and B-015-W-68, were obtained for various structures at the I-71/SR-315 and I-70 interchange, west of the Scioto River. The borings were extended to depths ranging from 43.0 to 75.0 feet below the existing grade at the time of the exploration. Please note that the elevations provided on the historic boring logs are referenced to the North American Datum (NAD) 27. The current design survey is referenced to NAD 83. The NAD 27 datum is 0.6 feet lower than the NAD 83 datum. **Therefore, all elevations noted in this report with respect to the historic borings are adjusted to the current NAD 83 datum.** The historic boring locations are shown on the boring plan provided in Appendix I, and the historic boring logs are provided in Appendix IV.

4.0 FINDINGS

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

4.1 Surface Materials

Borings B-113-2-13 and B-113-3-13 were performed within the existing pavement of I-70 westbound and encountered 8.0 and 6.0 inches of asphalt overlying 6.0 and 12.0 inches of aggregate base material, respectively. Boring B-114-2-13 was extended through the pavement of the existing Lower Scioto Greenway bike trail and encountered 6.0 inches of asphalt at the ground surface. With the exception of borings B-113-6-13 through B-113-8-13, which were performed within the Scioto River, the remaining borings encountered 1.0 to 9.0 inches of topsoil at the ground surface, as identified by the significant presence of organics and vegetation. Surficial materials were not noted on the historic boring logs.

4.2 Subsurface Soils

Beneath the surface materials, existing fill was encountered in eight (8) of the borings performed west of the Scioto River extending to elevations ranging from 677.5 to 719.7 feet msl, and in ten (10) of the borings performed east of the Scioto River extending to elevations ranging from 685.8 to 708.5 feet msl. The existing fill material encountered west of the Scioto River consisted of brown, dark brown, gray, dark gray and black gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay, coarse and fine sand, sandy silt, silt and clay and silty clay (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a, A-4a, A-6a, A-6b). The existing fill material encountered east of the Scioto River is comprised of dark brown, brown, gray, dark gray and black gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay, coarse and fine sand, sandy silt, silt, silt and clay and silty clay (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a, A-4a, A-4b, A-6a, A-6b). Asphalt, brick, cinder, coal, concrete, rock, slag, and wood fragments were observed to be present within the majority of the fill material east of the Scioto River in addition to organic material including grass and root fibers. Based on available historic records, the fill material encountered in the vicinity of Short Street was likely placed within an old canal.

Underlying the surface materials and existing fill, where encountered, the natural soils encountered west of the Scioto River were predominantly granular with intermittent seams of cohesive material, and the natural soils encountered east of the Scioto River consisted generally of granular overlying cohesive soils. The granular soils were generally described as black, brown, dark brown, gray, and dark gray gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay, coarse and fine sand and sandy silt (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a, A-4a). The cohesive soils were generally described as brown, light brown, dark brown, reddish brown, gray and dark gray sandy silt, silt, silt and clay, silty clay and clay (ODOT A-4a, A-4b, A-6a, A-6b, A-7-6).

Cobbles and boulders were encountered in a total of sixteen (16) of the borings performed for this structure. The cobbles and boulders, which generally increased in intensity with depth and near the bedrock surface, were initially encountered at depths ranging from 5.5 to 38.0 feet beneath the ground surface, corresponding to elevations ranging from 663.6 to 743.3 feet msl. In several instances, mud rotary drilling techniques with casing advancer or a tri-cone bit were necessary to penetrate the cobbles and boulders until bedrock was encountered. Due to the significant presence of large boulders in borings B-104-1-13, B-105-2-13, B-113-5-13, B-113-7-13, and B-113-8-13, rock coring techniques were utilized to advance the borings through these boulder zones. Additionally, a boulder zone was also encountered in historic boring B-001-S-57 between elevations 661.0 and 667.0 feet msl.

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 3 bpf to split spoon sampler refusal. The shear strength and consistency of the cohesive soils are primarily derived from the hand penetrometer values (HP). The cohesive soil encountered ranged from very soft (HP $\leq$ 0.25 tsf) to hard (HP > 4.0 tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 0.25 to over 4.5 tsf (limit of instrument).

Natural moisture contents of the soil samples tested ranged from 2 to 68 percent. The moisture contents at the higher end of the range were likely due to the presence of organic matter within the existing fill material or the saturated soils located within the riverbed. The natural moisture content of the cohesive soil samples tested for plasticity index ranged from 11 percent below to 18 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

A summary of the depths at which bedrock was encountered in the historic borings is presented in Table 3. Bedrock was encountered in the borings performed as part of the current exploration as presented in Table 4. The bedrock surface was encountered in the historic borings at depths ranging from 29.0 to 86.7 feet below the ground surface, corresponding to elevations ranging from 646.4 to 660.8 feet msl. Within the borings performed as part of the current exploration, the bedrock surface was encountered at depths ranging from 30.9 to 89.2 feet beneath the ground surface, corresponding to elevations ranging from 644.0 to 661.1 feet msl. Augerable bedrock was encountered in several of the borings performed along the east side of the project. The cored bedrock encountered across the proposed alignment generally consists of shale, mudstone, claystone, limestone and dolomite.

Table 3. Top of Bedrock Elevations – Historic Borings

Boring Number	Ground Surface Elevation (feet msl)	Top of Bedrock		Top of Bedrock Core (Auger Refusal)	
		Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-006-D-68	701.4	48.0	653.4	48.0	653.4
B-009-D-68	703.2	53.0	650.2	53.0	650.2
B-012-E-68	704.4	58.0	646.4	58.0	646.4
B-018-E-68	722.9	66.5	656.4	66.5	656.4
B-015-W-68	708.4	48.0	660.4	48.0	660.4
B-005-S-57	681.1	29.0	652.1	29.6	651.5
B-009-S-57	685.5	34.7	650.8	34.7	650.8
B-013-S-57	690.8	30.0	660.8	30.5	660.3

Table 4. Top of Bedrock Elevations – Current Borings

Boring Number	Ground Surface Elevation (feet msl)	Top of Bedrock		Top of Bedrock Core (Auger Refusal)	
		Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-104-1-13	714.5	60.5	654.0	60.5	654.0
B-105-2-13	707.0	56.0	651.0	56.0	651.0
B-107-1-13	704.0	53.8	650.2	53.8	650.2
B-108-4-13	702.7	49.5	653.2	49.5	653.2
B-108-5-13	700.3	54.5	645.8	54.5	645.8
B-108-6-13	714.5	57.5	657.0	57.5	657.0

Boring Number	Ground Surface Elevation (feet msl)	Top of Bedrock		Top of Bedrock Core (Auger Refusal)	
		Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-113-2-13	743.3	89.2	654.1	89.2	654.1
B-113-3-13	735.3	77.0	658.3	81.0	654.3
B-113-4-13	725.2	72.5	652.7	73.4	651.8
B-113-5-13	725.7	73.5	652.2	73.7	652.0
B-113-6-13	691.5	39.3	652.2	43.9	647.6
B-113-7-13	690.3	30.9	659.4	30.9	659.4
B-113-8-13	691.0	47.0	644.0	46.2	644.8
B-113-9-13	706.3	50.0	656.3	55.5	650.8
B-114-1-13	709.8	54.5	655.3	61.0	648.8
B-114-2-13	723.5	63.5	660.0	70.0	653.5
B-114-3-13	724.6	63.5	661.1	69.4	655.2
B-114-4-13	724.1	63.5	660.6	63.5	660.6
B-114-5-13	715.3	63.5	651.8	79.6	635.7
B-114-7-13	713.3	64.9	648.4	74.0	639.3
B-114-8-13	714.0	63.5	650.5	67.0	647.0
B-114-9-13	714.0	59.0	655.0	65.0	649.0
B-115-1-13	714.6	63.5	651.1	63.5	651.1
B-115-1A-19	714.3	65.0	649.3	66.0	648.3
B-115-2-13	716.1	63.5	652.6	64.2	651.9

Seven (7) borings performed along the west end of the structure alignment to just west of the Scioto River encountered limestone at the bedrock surface. Sixteen (16) borings performed from just west of the Scioto River to the end of the structure alignment encountered shale, claystone or mudstone at the bedrock surface overlying limestone. In thirteen (13) of the borings where shale, mudstone and claystone bedrock were encountered, the upper portion of the bedrock was able to be augered and sampled using the SPT and split spoon sampler. In general, the shale, mudstone and claystone bedrock overlying the limestone increased in thickness along the proposed alignment starting just west of the Scioto River to the end of the structure alignment. Limestone bedrock was encountered in eight (8) of the borings at the bedrock surface, and, with the exception of boring B-115-1-13, was encountered in the remaining borings below the shale, mudstone and claystone bedrock. The shale bedrock was encountered at elevations ranging from 648.4 to 661.1 feet msl, and the limestone bedrock was encountered at elevations ranging from 629.0 to 657.0 feet msl. Table 5 tabulates the depth and elevation that the surficial shale, mudstone and claystone bedrock were encountered, as well as the top of competent limestone bedrock.

Table 5. Bedrock Types

Boring Number	Ground Surface Elevation (feet msl)	Top of Shale, Mudstone and Claystone		Top of Limestone	
		Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-104-1-13	714.5	--	--	60.5	654.0
B-105-2-13	707.0	--	--	56.0	651.0
B-107-1-13	704.0	--	--	53.8	650.2
B-108-4-13	702.7	--	--	49.5	653.2
B-108-5-13	700.3	--	--	54.5	645.8
B-108-6-13	714.5	--	--	57.5	657.0
B-113-2-13	743.3	--	--	89.2	654.1
B-113-3-13	735.3	77.0	658.3	82.0	653.3
B-113-4-13	725.2	72.5	652.7	76.0	649.2
B-113-5-13	725.7	73.5	652.2	74.9	650.8
B-113-6-13	691.5	39.3	652.2	43.9	647.6
B-113-7-13	690.3	30.9	659.4	41.5	648.8
B-113-8-13	691.0	--	--	47.0	644.0
B-113-9-13	706.3	50.0	656.3	60.7	645.6
B-114-1-13	709.8	54.5	655.3	75.0	634.8
B-114-2-13	723.5	63.5	660.0	80.5	643.0
B-114-3-13	724.6	63.5	661.1	79.4	645.2
B-114-4-13	724.1	63.5	660.6	79.8	644.3
B-114-5-13	715.3	63.5	651.8	79.6	635.7
B-114-7-13	713.3	64.9	648.4	74.0	639.3
B-114-8-13	714.0	63.5	650.5	77.0	637.0
B-114-9-13	714.0	59.0	655.0	85.0	629.0
B-115-1-13	714.6	63.5	651.1	--	--
B-115-1A-19	714.3	65.0	649.3	82.5	631.8
B-115-2-13	716.1	63.5	652.6	83.2	632.9

The percent recovery, RQD values and unconfined compressive strengths of the bedrock core runs from the current exploration borings are summarized in Appendix VI. It should be noted that bedrock experiences mechanical breaks during the drilling and coring processes. Rii attempted to account for fresh, manmade breaks during tabulation of the RQD analysis. The zones within borings B-104-1-13, B-105-2-13, B-113-5-13, B-113-7-13 and B-113-8-13 where boulders were encountered that required rock coring techniques to advance through these zones are not included in the RQD tabulation above. The quality of the cored bedrock, according to the RQD values, ranged from very poor (RQD ≤ 25%) to excellent (RQD > 90%). Please note that core run RC-4 in boring B-113-7-13 did not have any recovery due to a piece of rock that become stuck in the core barrel during the coring process. This resulted in the bedrock becoming pulverized and washing out with the circulation fluid. Additionally, the first core run in boring B-113-9-13 was only 2.5-feet in length and resulted in an RQD of 0 percent. Due to the short length of the core run, this RQD value is likely not representative of this bedrock stratum.

The shale bedrock was described as gray and dark gray, unweathered to highly weathered, very weak to slightly strong, thinly laminated to very thickly bedded, and moderately to highly fractured, with tight to open apertures and a slickensided to very rough surface. Percent recoveries within the cored shale bedrock ranged from 0 to 100 percent, and RQD values ranged from 0 to 90 percent. One (1) unconfined compression test was performed on the recovered shale in boring B-114-3-13, with a resulting unconfined compressive strength of 259 psi. Additionally, due to the relatively low RQD values in the shale, a total of three (3) point load strength index tests were performed on portions of the recovered shale bedrock. Results of the point load strength testing indicated correlated unconfined compressive strengths ranging from 36 to 255 psi.

The mudstone encountered in borings B-113-4-13, 113-5-13, 113-9-13 and 1151-1-13 was generally described as gray, unweathered to highly weathered, very weak to weak, laminated to thickly bedded, friable, and moderately to highly fractured with tight apertures and a slightly to very rough surface. Percent recovery values within the mudstone ranged from 7 to 100 percent, and RQD values ranged from 0 to 100 percent. No unconfined compressive strength testing was performed on the recovered mudstone bedrock.

Claystone bedrock was encountered in borings B-114-8-13, B-115-1A-13 and B-115-2-13, and was described as gray and dark gray, unweathered to severely weathered, very weak to slightly strong, thinly laminated to medium bedded, and moderately to highly fractured with tight to open, slightly rough to rough apertures. Percent recovery values within the claystone ranged from 37 to 100 percent, and RQD values ranged from 0 to 86 percent. One (1) unconfined compressive strength test was performed on the recovered claystone in boring B-114-8-13, with a resulting unconfined compressive strength of 92 psi.

The limestone bedrock encountered across the proposed alignment was generally described as black, brown, light brown, brownish gray, gray, light gray, bluish gray and dark gray, unweathered to slightly weathered, slightly to very strong, thinly to very thickly bedded, and slightly to highly fractured with intact to open, slightly to very rough apertures. Percent recovery values within the limestone and dolomite ranged from 48 to 100 percent, and RQD values ranged from 36 to 100 percent. A total of twenty-nine (29) unconfined compression tests were performed on the recovered limestone, with resulting unconfined compressive strengths ranging from 4,898 to 14,395 psi.

4.4 Groundwater

Groundwater was encountered in a total of twenty (20) of the borings performed for this investigation. A summary of the depths at which groundwater was encountered in the borings is presented in Table 6. Please note that groundwater levels were not noted in the historic borings performed in the vicinity of the subject structure.

Table 6. Groundwater Levels

Boring Number	Ground Elevation (feet msl)	Groundwater Seepage		Initial Groundwater		Upon Completion [1]	
		Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-104-1-13	714.5	18.5	696.0	21.0	693.5	N/A	N/A
B-105-2-13	707.0	--	--	16.0	691.0	N/A	N/A
B-107-1-13	704.0	13.5	690.5	16.0	688.0	N/A	N/A
B-108-4-13	702.7	11.5	691.2	13.0	689.7	N/A	N/A
B-108-5-13	700.3	--	--	11.5	688.8	N/A	N/A
B-108-6-13	714.5	12.5	702.0	38.5	676.0	N/A	N/A
B-113-2-13	743.3	--	--	55.0	688.3	N/A	N/A
B-113-3-13	735.3	44.5	690.8	60.0	675.3	N/A	N/A
B-113-4-13	725.2	--	--	38.5	686.7	N/A	N/A
B-113-5-13	725.7	--	--	38.5	686.2	N/A	N/A
B-113-6-13	691.5	In Scioto River – Water Surface El. is at 699.2					
B-113-7-13	690.3	In Scioto River – Water Surface El. is at 700.7					
B-113-8-13	691.0	In Scioto River – Water Surface El. is at 699.8					
B-113-9-13	706.3	--	--	21.0	685.3	N/A	N/A
B-114-1-13	709.8	--	--	28.5	681.3	N/A	N/A

Boring Number	Ground Elevation (feet msl)	Groundwater Seepage		Initial Groundwater		Upon Completion [1]	
		Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-114-2-13	723.5	--	--	30.0	693.5	N/A	N/A
B-114-3-13	724.6	--	--	29.0	695.6	N/A	N/A
B-114-4-13	724.1	--	--	30.0	694.1	N/A	N/A
B-114-5-13	715.3	--	--	18.0	697.3	N/A	N/A
B-114-7-13	713.3	16.0	697.3	17.0	696.3	N/A	N/A
B-114-8-13	714.0	16.0	698.0	18.5	695.5	N/A	N/A
B-114-9-13	714.0	--	--	23.0	691.0	N/A	N/A
B-115-1-13	714.6	24.0	690.6	29.0	685.6	N/A	N/A
B-115-2-13	716.1	--	--	8.5	707.6	N/A	N/A

1. *The groundwater level at completion could not be obtained due to the addition of fluids during the drilling process.*

Groundwater seepage was initially encountered in eight (8) borings at depths ranging from 11.5 to 44.5 feet below the ground surface, corresponding to elevations ranging from 690.5 to 702.0 feet msl. More significant groundwater flow was encountered in twenty-one (21) of the borings performed, at depths ranging from 8.5 to 60.0 feet below the ground surface, corresponding to elevations ranging from 675.3 to 707.6 feet msl. As stated previously, borings B-113-6-13 through B-113-8-13 were performed within the Scioto River, which ranged in elevation from 699.2 to 700.7 feet msl at the time of drilling. At the completion of drilling, accurate groundwater levels could not be obtained due to the addition of mud to counteract heaving sands in several of the borings, as well as the addition of water as a circulating fluid during the rock coring process.

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

A 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 subsurface exploration has 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 bridge, 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 structure were provided by ms consultants. Based on the information provided, it is understood that the proposed FRA-71-1503L bridge will consist of a twenty three (23) span, three-unit, composite hybrid steel girder structure with a reinforced concrete deck. The rear and forward abutments will be supported on driven piles behind mechanically stabilized earth (MSE) walls, and the twenty two (22) intermediate piers are to be supported on drilled shaft foundations. The roadway profile will be elevated up to 100 feet above the existing ground surface grade along its proposed 4,680-foot long alignment, with the rear abutment elevated approximately 38 feet above existing grade and the forward abutment elevated approximately 45 feet above existing grade.

A portion of Retaining Wall W5, between Sta. 509+85 and 510+30 (BL Wall W5), will be located along the rear abutment of the proposed structure to provide the required grade separation to support the configuration. The wall height along the rear abutment ranges from 40.0 to 50.0 feet, and the total wall length along the abutment is approximately 45 lineal feet. The wall alignment will turn south on the east side of the rear abutment and turn north on the west side of the rear abutment. It is understood that a mechanically stabilized earth (MSE) wall type is being considered as the preferred wall type for Retaining Wall W5. Design recommendations for the remaining alignment of Retaining Wall W5 is presented under a separate cover.

Additionally, a portion of Retaining Wall E7, between Sta. 704+21 and 705+61 (BL Wall E7), will be located along the forward abutment of the proposed structure to provide the required grade separation to support the configuration. The maximum wall height at the forward abutment is 52.7 feet, and the total wall length along the abutment is approximately 140 lineal feet, which includes a short segment along the east side of the abutment. The wall alignment will turn north on the west side of the forward abutment. It is understood that a mechanically stabilized earth (MSE) wall type was being considered as the preferred wall type for Retaining Wall E7. However, given the presence of existing fill material to significant depths, as well as the significant amount of existing utilities within the footprint of this segment of the wall, it is understood that lightweight fill material consisting of cellular concrete will be utilized along the length of the wall that crosses in front of the forward abutment. Design recommendations for the remaining alignment of Retaining Wall E7 is presented under a separate cover.

Proposed structural data was obtained from the design details provided by ms consultants and is summarized in Table 7.

Table 7. Structure and Bridge Design Elevations

Substructure Unit (Boring)	Structure Component	Elevation [1,2] (feet msl)	Design Maximum Factored Load [1]
Rear Abutment / Retaining Wall W5 (Sta. 509+85 to 510+30) (B-104-1-13)	Profile Grade	716.5 / 754.0	302 kips/pile
	Bottom of Footing	737.4	
	Bottom of Wall (Top of Leveling Pad)	704.0 / 714.0 [3]	
Pier 1 (B-105-2-13)	Profile Grade	713.9 / 763.4	2,808 kips/shaft
	Bottom of Footing	698.0	
Pier 2 (B-107-1-13)	Profile Grade	704.7 / 774.7	2,861 kips/shaft
	Bottom of Footing	693.0	
Pier 3 (B-108-4-13)	Profile Grade	706.6 / 785.9	3,406 kips/shaft
	Bottom of Footing	692.8	
Pier 4 (B-108-5-13)	Profile Grade	699.7 / 795.5	2,644 kips/shaft
	Top of Shaft	699.0	
Pier 5 (B-108-6-13)	Profile Grade	721.3 / 799.1	3,347 kips/shaft
	Bottom of Footing	704.8	
Pier 6 (B-113-2-13)	Profile Grade	743.6 / 797.1	3,567 kips/shaft
	Bottom of Footing	709.5	
Pier 7 (B-113-3-13)	Profile Grade	724.0 / 790.8	2,962 kips/shaft
	Bottom of Footing	714.0	
Pier 8 (B-113-4-13)	Profile Grade	719.0 / 787.8	2,272 kips/shaft
	Bottom of Footing	710.0	
Pier 9R/L (B-113-5-13)	Profile Grade	726.0 / 787.2	2,083 / 1,974 kips/shaft
	Bottom of Footing	718.3	
Pier 10 (B-113-6-13)	Profile Grade	691.3 / 788.1	5,120 kips/shaft
	Bottom of Footing	695.6	
Pier 11 (B-113-7-13)	Profile Grade	689.4 / 789.6	3,951 kips/shaft
	Bottom of Footing	695.6	
Pier 12 (B-113-8-13)	Profile Grade	687.9 / 791.0	3,715 kips/shaft
	Bottom of Footing	695.6	

Substructure Unit (Boring)	Structure Component	Elevation [1,2] (feet msl)	Design Maximum Factored Load [1]
Pier 13 (B-113-9-13)	Profile Grade	693.8 / 792.2	3,546 kips/shaft
	Bottom of Footing	695.6	
Pier 14 (B-114-1-13)	Profile Grade	706.3 / 793.5	3,500 kips/shaft
	Bottom of Footing	695.6	
Pier 15 (B-114-2-13)	Profile Grade	725.5 / 794.1	4,188 kips/shaft
	Bottom of Footing	712.3	
Pier 16 (B-114-3-13)	Profile Grade	732.5 / 793.7	2,321 kips/shaft
	Bottom of Footing	718.5	
Pier 17 (B-114-4-13)	Profile Grade	729.3 / 792.1	3,890 kips/shaft
	Bottom of Footing	716.0	
Pier 18 (B-114-5-13)	Profile Grade	714.8 / 790.2	3,625 kips/shaft
	Bottom of Footing	706.5	
Pier 19 (B-114-7-13)	Profile Grade	713.9 / 786.3	3,632 kips/shaft
	Bottom of Footing	705.0	
Pier 20 (B-114-8-13)	Profile Grade	714.0 / 780.0	3,351 kips/shaft
	Bottom of Footing	705.0	
Pier 21 (B-114-9-13)	Profile Grade	713.9 / 771.2	3,199 kips/shaft
	Bottom of Footing	706.0	
Pier 22 (B-115-1-13)	Profile Grade	714.7 / 767.2	1,954 kips/shaft
	Bottom of Footing	706.5	
Forward Abutment / Retaining Wall E7 (Sta. 704+21 to 705+61) (B-115-2-13)	Profile Grade	716.0 / 762.2	342 kips/pile
	Bottom of Footing	748.0	
	Bottom of Wall	709.5 / 710.5	

1. *Proposed foundation elevations and structural loading based on information provided by ms consultants.*
2. *Where two (2) elevations are provided, the first represents existing grade and the second represents proposed grade.*
3. *The first value represents the minimum bottom of wall (top of leveling pad for MSE wall) elevation, and the second value represents the maximum bottom of wall elevation.*

Driven pile foundations were evaluated at the proposed pier locations; however, due to the footing sizes and thicknesses required to incorporate the number of piles to support the proposed loading, this foundation type was dismissed as a viable alternative. Therefore, all recommendations and analyses pertaining to driven piles at the proposed pier locations have been removed from this report.

5.1 Drilled Shaft Recommendations

Given the proposed loading per shaft at each of the pier locations, friction bearing drilled shafts within the overburden soils and drilled shafts bearing within the weak surficial shale, mudstone and claystone bedrock are not economically feasible foundation options due to the size and number of shafts that would be required to support the proposed loading. Therefore, it is recommended that the drilled shafts be extended through the surficial soils and weak surficial shale, mudstone and claystone bedrock to bear on or within the underlying limestone bedrock at all twenty-two (22) pier substructure units.

Per Section 10.8.3.5.4c of the 2018 AASHTO LRDF Bridge Design Specifications (BDS), a minimum rock socket length of 1.5 times the diameter of the drilled shaft within the rock socket ($1.5B_{RS}$) is required to utilize the full end bearing resistance within the bedrock unit that the shafts are end bearing in/on. However, based on discussions with the ODOT Office of Geotechnical Engineering (OGE), a reduced tip resistance can be utilized for shafts not extended to the required minimum socket length of $1.5B_{RS}$ into bedrock. Please note that the socket length to be considered for utilization of the full end bearing resistance includes the length of shaft within the overlying shale, mudstone and claystone bedrock as well as the limestone bedrock.

Using equation 10.8.3.5.4c-1 of the 2018 AASHTO LRFD BDS, the nominal end bearing resistance for drilled shafts socketed a minimum of $1.5B_{RS}$ into intact rock is 2.5 times the unconfined compressive strength of the bedrock unit that the shaft tip is bearing on or within. Based on unconfined compression tests performed on limestone rock cores obtained from the borings performed at the subject piers, the unconfined compressive strength ranges from 4,898 to 14,395 psi. Using equation 10.8.3.5.4c-1 and the limiting unconfined compressive strength from the given range for the limestone bedrock, it is recommended that drilled shaft foundations socketed a minimum of $1.5B_{RS}$ into the bedrock to bear on or within the competent limestone bedrock be proportioned for a nominal end bearing resistance of 1,760 ksf at the strength limit state.

Where shafts are not socketed a minimum of $1.5B_{RS}$ into the bedrock due to the absence or insufficient thickness of the overlying shale, mudstone and claystone bedrock, or where lateral load demands do not require a rock socket length of $1.5B_{RS}$, a reduced nominal end bearing resistance should be utilized based on equation 10.8.3.5.4c-2 of the 2018 AASHTO LRFD BDS, which is as follows:

$$q_p = A + q_u \left[m_b \left(\frac{A}{q_u} \right) + s \right]^a$$

In which:

$$A = \sigma'_{vb} + q_u \left[m_b \left(\frac{\sigma'_{vb}}{q_u} \right) + s \right]^a$$

Where:
σ'_{vb} = vertical effective stress at the socket bearing (tip) elevation (ksf)
s, a and m_b = Hoek-Brown strength parameters for fractured rock mass determined from GSI in accordance with Section 10.4.6.4 of the AASHTO LRFD BDS
q_u = unconfined compressive strength of intact rock (ksf)

Based on discussions with ODOT OGE, the condition of the rock mass for the determination of the GSI rating should consider the limestone to have a "closed" joint condition, a "blocky" structure and a "good" joint surface condition. Using this description for the structure and surface conditions of the rock mass, a GSI rating of 70 was determined from Figure 10.4.6.4-1 of the 2018 AASHTO LRFD BDS, and the Hoek-Brown strength parameters s, a and m_b were calculated as 0.036, 0.50 and 3.08, respectively. The vertical effective stress was estimated considering 55 feet of soil overburden with a buoyant unit weight of 57.6 pcf. Using the above noted equations and the limiting unconfined compressive strength from the given range for the limestone bedrock, it is recommended that drilled shaft foundations bearing on or within the competent limestone bedrock with a socket length less than $1.5B_{RS}$ into the bedrock be proportioned for a nominal end bearing resistance of 760 ksf at the strength limit state.

Based on the plan information provided by ms consultants, the proposed shaft diameter at piers 1, 2, 7, 8 and 9R/L will be 4.0 feet within the overburden soils and 3.5 feet within the bedrock socket. At piers 10 through 14, where the structure crosses the Scioto River, the proposed shaft diameter will be 8.0 feet within the overburden soils and 7.5 feet within the bedrock socket. The remaining pier locations will have a shaft diameter of 4.5 feet within the overburden soils and 4.0 feet within the bedrock socket. Table 8 lists the estimated elevation of the top of bedrock, top of limestone bedrock and the required rock socket length to end bear on top of the limestone bedrock at each pier substructure location, as well as the proposed rock sock diameter and length from the design plans and corresponding nominal end bearing resistance to be utilized for the design of the drilled shaft foundations. A resistance factor of φ_{qp}=0.5 at the strength limit state should be utilized for design.

Table 8. Drilled Shaft Recommendations Bearing in Limestone Bedrock

Substructure Unit (Boring)	Top of Bedrock Elevation (feet msl)	Top of Limestone Elevation (feet msl)	Rock Socket Diameter [1] (feet)	Required Socket Length to Top of Limestone (feet)	Proposed Socket Length [1] (feet)	Nominal End Bearing Resistance [2] (ksf)
Pier 1 (B-105-2-13)	651.0	651.0	3.5	0.0	3.5	760
Pier 2 (B-107-1-13)	650.2	650.2	3.5	0.0	4.0	760
Pier 3 (B-108-4-13)	653.2	653.2	4.0	0.0	4.0	760
Pier 4 (B-108-5-13)	645.8	645.8	4.0	0.0	4.0	760
Pier 5 (B-108-6-13)	657.0	657.0	4.0	0.0	4.0	760
Pier 6 (B-113-2-13)	654.1	654.1	4.0	0.0	4.0	760
Pier 7 (B-113-3-13)	658.3	653.3	3.5	5.0	8.5	1,760
Pier 8 (B-113-4-13)	652.7	649.2	3.5	3.5	7.0	1,760
Pier 9R/L (B-113-5-13)	652.2	650.8	3.5	1.4	5.0	760
Pier 10 (B-113-6-13)	652.2	647.6	7.5	4.6	14.6	1,760
Pier 11 (B-113-7-13)	659.4	648.8	7.5	10.6	20.6	1,760
Pier 12 (B-113-8-13)	644.0	644.0	7.5	0.0	10.0	760
Pier 13 (B-113-9-13)	656.3	645.6	7.5	10.7	20.7	1,760
Pier 14 (B-114-1-13)	655.3	634.8	7.5	20.5	30.5	1,760
Pier 15 (B-114-2-13)	660.0	643.0	4.0	17.0	17.0	1,760
Pier 16 (B-114-3-13)	661.1	645.2	4.0	15.9	15.9	1,760
Pier 17 (B-114-4-13)	660.6	644.3	4.0	16.3	16.3	1,760
Pier 18 (B-114-5-13)	651.8	635.7	4.0	16.1	16.1	1,760

Substructure Unit (Boring)	Top of Bedrock Elevation (feet msl)	Top of Limestone Elevation (feet msl)	Rock Socket Diameter [1] (feet)	Required Socket Length to Top of Limestone (feet)	Proposed Socket Length [1] (feet)	Nominal End Bearing Resistance [2] (ksf)
Pier 19 (B-114-7-13)	648.4	639.3	4.0	9.1	9.2	1,760
Pier 20 (B-114-8-13)	650.5	637.0	4.0	13.5	13.5	1,760
Pier 21 (B-114-9-13)	655.0	629.0	4.0	26.0	26.0	1,760
Pier 22 (B-115-1-13)	651.1	631.8	4.0	21.1	21.2	1,760

1. *Proposed rock socket diameter and length at each substructure unit determined from proposed plan information provided by ms consultants and CH2M HILL.*
2. *Nominal end bearing resistance provided is the value that should be utilized in the determination of the end bearing resistance per drilled shaft based on the proposed rock socket length and diameter.*

Given the factored end bearing resistances noted above for drilled shafts extended to bear on or within the limestone bedrock, it is anticipated that the axial resistance will be governed by structural resistance of the drilled shaft. The factored resistance per shaft provided in the design sheets should be the limiting value between the factored geotechnical resistance and the factored axial compressive resistance of the shaft.

Drilled shafts designed in accordance with the requirements presented above should experience a maximum settlement estimated to be less than 0.5 inches. Group settlement of the shafts, socketed into bedrock, is considered negligible for a minimum spacing of 2.0 shaft diameters center-to-center. Drilled shaft calculations are provided in Appendix VII.

5.1.1 Downdrag Considerations

Based on information provided by ms consultants, it is understood that the FRA-71-1503L bridge structure and associated improvements along I-71 southbound, Ramp C3 and Ramp D6 will be constructed prior to the construction of the improvements along I-70 westbound and Ramp D7. Therefore, embankment fill will be placed over the proposed foundations for the FRA-71-1503L structure at various areas where embankment widening is associated with future work following construction of the FRA-71-1503L bridge structure. Based on the proposed plan information, the proposed grade following construction of the FRA-71-1503L structure will closely match the existing ground surface grade at the proposed pier substructure locations.

Fill heights ranging from 5.5 to 12.0 feet are anticipated at piers 1, 3 and 5, where future embankment will be constructed along Ramp C3, Future Ramp A4 and I-70 westbound, and fill heights ranging from 14.0 to 32.0 feet are anticipated at piers 19 through 22 where future embankment will be constructed along I-70 westbound and Ramp D7. In general, the top of footing elevation at the pier substructure locations noted above is within the upper 3.0 to 5.0 feet below the existing ground surface grade, and the thickness of the footing is approximately 7.0 feet at each location. Given the disturbance to the sidewalls of the excavation during construction of the footings, downdrag loads are not anticipated to develop along the side of the footings. Therefore, downdrag loads were only considered along the lengths of the drilled shafts supporting the proposed footings.

Downdrag was evaluated using the traditional method to determine the depth of downdrag. Per the traditional method for calculating the depth of downdrag, downdrag loads will develop along the portion of the shaft above the interface where the relative soil movement from settlement with respect to the shaft is greater than 0.40 inches. For the purposes of the downdrag analysis, settlement within the underlying shale, mudstone, claystone and limestone bedrock was considered negligible, and only the settlement within the overburden soils was considered in the analysis. The total anticipated settlement below the existing ground surface grade at piers 1, 3 and 5 ranges from 0.91 to 1.60 inches, with the anticipated settlement below the bottom of footing elevation ranging from 0.32 to 0.69 inches. The total anticipated settlement below the existing ground surface grade at piers 19 through 22 ranges from 2.38 to 9.09 inches, with the anticipated settlement below the bottom of footing elevation ranging from 0.92 to 3.67 inches. Based on the results of the settlement analysis, downdrag loads will develop along the drilled shafts supporting the proposed pier substructures units. Using the traditional method criterion, the depth of downdrag for 100 percent of primary consolidation ranges from 0.0 to 34.0 feet below the bottom of footing elevation.

The unfactored downdrag load induced on the shafts was calculated using static analysis and is equal to the magnitude of the side resistance over the length of the shaft within the downdrag zone at the respective substructure location. The side resistance values provided in Appendix VII for the respective substructure units were utilized in the calculation of the downdrag loads. Considering a 4.5-foot shaft diameter within the overburden soils, as indicated in the proposed plan information, the unfactored downdrag loads range from 0 to 886 kips per shaft. A load factor of 1.25 was utilized in the determination of the factored downdrag load. The factored downdrag loads should be considered in addition to the factored structural loads per shaft when verifying the end bearing and structural resistances of the drilled shaft foundations. Results of the settlement and downdrag analysis at the proposed pier substructure units are presented in Table 9.

Table 9. Downdrag Analysis Results

Substructure Unit (Boring)	Anticipated Embankment Height [1] (ft)	Total Settlement (in)		Depth of Downdrag (ft)	Downdrag Load (kips/shaft)	
		Below Existing Grade Elevation	Below Bottom of Footing Elevation		Unfactored	Factored [1]
Pier 1 (B-105-2-13)	5.5	0.91	0.32	0.0	0	0
Pier 3 (B-108-4-13)	12.0	1.60	0.65	8.0	124	156
Pier 5 (B-108-6-13)	11.0	1.27	0.69	7.0	60	75
Pier 19 (B-114-7-13)	14.0	2.74	1.19	12.0	192	240
Pier 20 (B-114-8-13)	32.0	9.09	3.67	34.0	886	1,107
Pier 21 (B-114-9-13)	28.5	4.18	2.85	21.0	345	432
Pier 22 (B-115-1-13)	14.0	2.38	0.92	8.0	86	108

1. *Anticipated embankment fill heights at the proposed pier substructure units provided by ms consultant.*
2. *A load factor of 1.25 was considered in calculating factored downdrag load.*

It should be noted that the anticipated settlement and corresponding depth of downdrag and downdrag loads for Piers 19 through 22 assume no improvement for the existing fill soils encountered within this area, which were encountered in borings B-114-7-13 through B-115-1-13. If ground improvement is performed to stabilize the existing fill soils prior to placement of the embankment for Ramp D7 and subsequent construction of Retaining Wall E4, as recommended in the report for Retaining Wall E4, then total anticipated settlements below the footing elevations will likely be reduced, which would result in a reduced depth of downdrag and downdrag loads. The reduced settlement and depth of downdrag cannot be quantified at this time, and would need to be determined by the specialty contractor that is responsible for the design of the ground improvement system. For preliminary design, however, it is recommended to utilize the values provided above.

5.1.2 Uplift Resistance

It is understood that significant uplift forces are anticipated at the majority of the substructure units due to the high overturning moments and location of the drilled shaft elements from the center of the footings. Uplift resistance will be provided by side resistance along the embedment length of the shaft through the overburden soils and underlying bedrock. The nominal side resistance within the overburden soils was calculated in accordance with sections 10.8.3.5.1b and 10.8.3.5.2b of the 2018 AASHTO LRFD BDS for cohesive and granular soil types, respectively. A boring-by-boring tabulation of nominal side resistance and associated resistance factor within the overburden soil that should be used for uplift resistance is provided in Appendix VII. Please note that the contribution of the side resistance within the upper 5.0 feet of the shaft length below the bottom of footing elevation should be neglected where cohesive soils (ODOT A-4a, A-4b, A-6a, A-6b, A-7-6) are present below the bottom of footing/top of shaft elevation.

In addition to the uplift resistance within the overburden soils, uplift resistance within the bedrock socket should also be considered in the overall determination of the uplift resistance of the drilled shafts. The nominal side resistance, q_s, for drilled shafts socketed into rock was calculated using equation 10.8.3.5.4b-1 of the 2018 AASHTO LRFD BDS, which is as follows:

$$\frac{q_s}{p_a} = C\sqrt{\frac{q_u}{p_a}}$$

Where:
p_a = atmospheric pressure (2.12 ksf)
C = regression coefficient (taken as 1.0 for normal conditions)
q_u = unconfined compressive strength of rock (ksf)

Given the weak nature of the shale, mudstone and claystone bedrock, and also given the susceptibility of these types of bedrock to smearing and deterioration during the coring process, a regression coefficient of 0.8 was utilized for design within this bedrock unit. For the limestone bedrock, a regression coefficient of 1.0 was utilized for design within this bedrock unit.

Based on the unconfined compression testing performed on the claystone and shale rock cores obtained from borings B-114-1-13, B-114-3-13 and B-114-9-13, the unconfined compressive strength of the shale, mudstone and claystone stratum ranges from 259 to 520 psi. Point load testing was also performed on the recovered shale, mudstone and claystone bedrock where samples could not be trimmed to the required length for unconfined compression testing; however, the correlated unconfined compressive strengths determined from the point load tests were significantly lower than the strengths determined from the unconfined compression tests. Therefore, these strengths are not considered representative of the unconfined compressive strength of the shale, mudstone and claystone bedrock unit.

Using equation 10.8.3.5.4b-1 and the regression coefficient of 0.8 and limiting unconfined compressive strength from the given range above for the shale, mudstone and claystone bedrock, a nominal side resistance of 7.1 ksf at the strength limit state should be utilized for uplift resistance within this bedrock unit. Using the regression coefficient of 1.0 and limiting unconfined compressive strength from the given range for the limestone bedrock, a nominal side resistance of 38.7 ksf at the strength limit state should be utilized for uplift resistance within this bedrock unit. A resistance factor of

φ_{qs}=0.40 at the strength limit state should be utilized in the determination of the factored uplift resistance for the portion of the shafts that are socketed into the shale, mudstone, claystone and limestone bedrock.

For determination of the overall uplift resistance, the design should consider 100 percent contribution of the side resistance within the overburden soil as well as the shale, mudstone and claystone bedrock. Given the disturbance that will occur to the limestone bedrock at the top of the socket within this bedrock unit, side resistance should be neglected for the upper 1.0 diameter length of socket within the limestone, and can be included below this depth within the limestone if additional resistance is required. Please note that self-weight of the drilled shafts should be considered in the determination of the overall uplift resistance at each substructure unit.

5.1.3 Drilled Shaft Considerations

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

- A qualified inspector should record the material types being removed from the hole as excavation proceeds.
- When the bearing material has been encountered and identified and/or the design tip elevation has been reached, the shaft walls and base should be observed for anomalies, unexpected soft soil conditions, obstructions or caving.
- Concrete placed freefall should not be allowed to hit the sidewalls of the excavation or the rebar cage and should not pass through any water.
- Structural stability of the rebar cage should be maintained during the concrete pour to prevent buckling.
- The volume of concrete should be checked to ensure voids did not result during extraction of the casing (if utilized).
- The placement of all concrete for the drilled shafts shall follow the American Concrete Institute's Design and Construction of Drilled Piers (ACI 336.3R-93).
- If concrete is placed by tremie method, it must be done so with an adequate head to displace water or slurry if groundwater has entered the caisson (all tremie procedures shall follow applicable ACI specifications).
- Pulling casing with insufficient concrete inside should be restricted.
- The bottom of drilled shaft excavation should be clean and free of loose material. Any loose material observed should be removed using a clean-out bucket (muck bucket).

The use of casing for drilled shafts is recommended under any of the following conditions:

- Caving material is encountered at any time during the drilling of the shaft.
- Groundwater is encountered at any time during the drilling of the shaft, or groundwater seepage occurs in the drilled shaft.
- Down hole inspection is planned (casing is required for this instance).

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

It is anticipated that conventional drilled shaft equipment (with a standard soil bit) will be able to penetrate the surficial soils to the bedrock depths provided in Table 4. However, depending on the conditions encountered, additional effort may be needed at or above this depth. Below the depths noted, it will likely be necessary to employ more specialized drilling techniques, such as the use of rock teeth or a rock bit. The ability to penetrate the bedrock will be entirely dependent on the drilled shaft contractor and the equipment employed. It is the responsibility of the contractor to determine the most effective excavation procedures. The elevation and hardness of bedrock is subject to change within the project area.

As noted in Section 4.2, cobbles and boulders were encountered in a total of sixteen (16) of the borings performed for this structure. The cobbles and boulders, which generally increased in intensity with depth and near the bedrock surface, were first encountered at depths ranging from 5.5 to 38.0 feet beneath the ground surface, corresponding to elevations ranging from 663.6 to 743.3 feet msl. Special drilling techniques were required in several instances to advance the borings through the cobbles and boulders. Therefore, cobbles and boulders should be anticipated to be encountered during installation of the drilled shafts. If cobbles and boulders are encountered during installation of the drilled shafts, specialized drilling/coring equipment may be required to advance the drilled shaft excavation beyond the obstruction.

5.2 Driven Pile Recommendations

It is understood that driven piles are to be utilized at rear and forward abutment substructures. Given the depth of bedrock encountered and the anticipated loading at the abutments, it is recommended that steel H-piles (ODOT Item 507.06) driven to refusal on bedrock be employed for foundation support. Friction bearing piles will not be a feasible foundation option as the maximum factored load per pile exceeds the maximum factored resistance allowed per Section 202.2.3.2.b of the 2007 ODOT BDM for all pile types and sizes. Per Section 202.2.3.2a of the 2007 ODOT Bridge Design Manual, refusal is met during driving when the pile penetration is an inch or less after receiving at least 20 blows from the pile hammer. Table 10 shows the recommended pile lengths and the corresponding factored structural axial resistance ($R_{R\ max}$) of steel H-piles. For H-piles driven to refusal on bedrock, no geotechnical resistance factor should be applied to the factored structural axial resistance values presented, as the values presented account for the structural resistance factor, φ_c = 0.50, for H-piles subject to damage due to severe driving conditions.

Table 10. Driven Pile Recommendations

Substructure Unit (Boring)	Ground Elevation [1]	Pile Size [2]	Pile Elevation		Pile Length [4] (feet)	$R_{R\ max}$ [5] (kips/pile)	Sleeve Length [6]	φ [7]
			Top [3]	Tip				
Rear Abutment (B-104-1-13)	714.5	HP 10x42	738.4	654.0	85.0	310	23.4 / 33.4	N/A
Forward Abutment (B-115-2-13)	716.1	HP 12x53	749.0	648.6 [8]	105.0	380	37.5 / 38.5	N/A

1. *Ground elevation listed is the ground elevation at the respective boring location.*
2. *A steel pile point is recommended to protect the tips of the piles during pile installation.*
3. *The top of pile elevation corresponds to the pile cutoff elevation, which is assumed to be 1.0-foot above the proposed bottom of footing elevation.*
4. *Per ODOT BDM Section 202.3.2, the estimated pile length was determined as the pile cutoff elevation (top) minus the pile tip elevation, rounded up to the nearest 5.0 feet.*
5. *The factored structural axial resistance for H-piles is based on the structural limit state of the steel H-pile section per Section 202.2.3.2.a of the 2007 ODOT BDM.*
6. *Sleeve length represents the required length of pile that should be sleeved within the MSE wall backfill.*
7. *For H-piles driven to refusal on bedrock, no geotechnical resistance factor should be applied to the factored structural axial resistance values presented, as the values presented account for the structural resistance factor, φ_c = 0.50, for H-piles subject to damage due to severe driving conditions.*
8. *The pile tip elevation is based on a penetration of 4.0 feet into the weathered shale bedrock.*

Per Section 202.2.3.2.a of the 2019 ODOT BDM, the factored resistance of H-piles driven to refusal on bedrock is typically governed by the structural resistance of the pile element. The factored structural axial resistances listed in Table 10 consider an axially loaded pile with negligible moment, no appreciable loss of section due to deterioration throughout the life of the structure, a steel yield strength of 50 ksi, a structural resistance factor for H-piles subject to damage due to severe driving conditions (LRFD 6.5.4.2: φ_c = 0.50) and a pile fully braced along its length. **These bearing values should not be used for piles that are subjected to bending moments or are not supported by soil for their entire length.** Static or dynamic load testing is not required for H-piles driven to refusal on bedrock. It is anticipated that the piles will be able to be driven a short distance into the surficial bedrock before satisfying the driving conditions that meet the refusal criterion. Due to the weathered, variable nature of the upper portion of the shale bedrock encountered at the forward abutment, it is estimated that refusal will be met within the upper 3.0 to 5.0 feet of the surficial bedrock at this substructure location. Therefore, the recommended pile tip elevation at the forward abutment is based on a penetration of 4.0 feet into the weathered shale bedrock. Settlement is estimated to be less than 1.0 inch for H-piles driven to refusal on bedrock.

Consideration was given to the use of friction piles using cast-in-place (CIP) pipe piles; however, given the required pile reactions provided by ms consultants, additional piles would be required to support the proposed substructure units, which would result in additional costs.

5.2.1 Downdrag Considerations

The anticipated total settlement along the facing of Retaining Wall W5 at the rear abutment is approximately 2.71 inches, and total settlement along the facing of Retaining Wall E7 at the forward abutment is approximately 3.20 inches. Given the anticipated amount of settlement following construction of the embankment, downdrag loads may be induced on the pile elements if installed to the final tip elevation prior to placement of the embankment fill. To reduce the amount of downdrag induced on the piles, it is recommended that the piles be pre-driven into the soil only as far as necessary to remain vertical and that the retaining walls should be constructed around the piles and then allowed to sit for a specified holding period such that a percentage of the consolidation can occur prior to driving the piles the to the design tip elevation and reduce the amount of downdrag on the piles.

In order to consolidate the underlying soil to the required settlement, consideration should be given to the placement of a surcharge load in order to preload the site under the full weight of the retaining wall heights (from the bottom of wall elevation to the profile grade). The surcharge should remain in place until approximately 90 percent of consolidation of the subsurface soils has occurred to prevent downdrag loads from developing along the pile elements. Results of the settlement analysis indicate that approximately 90 percent of the primary consolidation of the cohesive layers at the rear and forward abutments will be complete within 15 and 0 days, respectively, following the placement of the surcharge load. Therefore, if the above noted waiting period is specified following completion of construction of the retaining walls at the rear and forward abutments, downdrag forces along the piles will be eliminated.

Settlement platforms should be installed once the embankment surcharges have been placed to monitor the settlement of the embankment over time. A shorter or longer hold period than specified may be required based on the settlement platform readings as directed by the geotechnical engineer. The required hold period may be considered complete when survey monitoring of the settlement platforms indicate that the above noted settlement has occurred for the hold period or until the survey shows less than ⅛-inch of total movement per week over a two week period **following placement of the final lifts of surcharge loading.**

5.2.2 Driveability

A drivability analysis was performed in accordance with Section 10.7.8 of the 2018 AASHTO LRFD BDS using the GRLWEAP software program, and the results are provided in Appendix VIII. In the driveability analysis, a Delmag 19-42 hammer with a rated energy of approximately 43,000 ft-lbs was used in conjunction with the H-pile sections. Based on the results of this analysis, driving stresses induced on the H-piles **would not exceed** 90 percent of the yield stress of the steel (f_y = 50 ksi, 0.9f_y = 45 ksi) if driven through the overburden soils to the bedrock elevations provided in Table 10. Care should be taken during pile driving operations when approaching the bedrock, and when extending the piles into the surficial bedrock material, to ensure that the driving stresses induced on the pile elements do not exceed the maximum allowable value of 90 percent of the yield stress of the steel, subsequently damaging the pile elements. Pile driving should be terminated upon achieving the required 20 blows from the pile hammer with an inch or less of penetration to reduce the possibility of damaging the pile element.

Per Section 202.2.3.2.a of the 2019 ODOT BDM, steel pile points should be used when the piles are driven to bear on strong bedrock (limestone or dolomite), and steel pile points should not be used when the piles are driven to bear on shale bedrock. However, given the dense granular soils and cobbles and boulders were encountered below an elevation of 693.1 feet msl in boring B-115-2-13 at the forward abutment, it is recommended that pile points be utilized to minimize the damage to the pile tip and aid in maintaining the alignment of the pile during pile driving. With the use of pile points at the forward abutment, then the piles will likely penetrate further into the weathered shale bedrock than the anticipated 4.0 feet recommended in Table 10 prior to satisfying the refusal criterion. Given the condition of the shale bedrock, it is estimated that the piles will be able to penetrate an additional 4.0 feet into the shale bedrock (4.0 feet below the pile tip elevation provided in Table 10) prior to satisfying the refusal criterion if steel pile points are utilized.

5.3 Lateral Design

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

Table 11. Subsurface Strata Description

Strata	Description
1	Soft Clay
2	Stiff Clay with Water
3	Stiff Clay without Free Water
4	Sand (Reese)
5	User Defined
6	Vuggy Limestone (Strong Rock)
7	Silt (with cohesion and internal friction angle)
8	API Sand
9	Weak Rock
10	Liquefiable Sand (Rollins)
11	Stiff Clay without free water with a specified initial K (Brown)

5.4 MSE Wall Recommendations

It is proposed to construct an MSE wall at the rear abutment (Retaining Wall W5 between Sta. 509+85 and 510+30, BL Wall W5) and forward abutment (Retaining Wall E7 between Sta. 704+21 and 705+60, BL Wall E7) of the proposed bridge structure. As previously discussed, given the presence of existing fill material to significant depths, as well as the significant amount and critical nature of existing utilities within the footprint of Retaining Wall E7, it is understood that lightweight fill material consisting of cellular concrete will be utilized along the length of the wall that crosses in front of the forward abutment. While it is understood that the wall facing will be connected to geosynthetic straps that will be embedded in the cellular concrete backfill, the analysis approach for this type of system differs from that of a traditional MSE wall. Therefore, the recommendations for this system are presented in Section 5.5.

MSE walls are constructed on earthen foundations at a minimum depth of 3.0 feet below grade, as defined by the top of the leveling pad to the ground surface located 4.0 feet from the face of the wall. Per Section 204.6.2.1 of the 2019 ODOT BDM, the height of the MSE wall is defined as the elevation difference between the profile grade at the face of the wall and the top of the leveling pad. However, it is noted that the reinforced soil mass only extends from the foundation bearing elevation (top of leveling pad) to the bottom of footing elevation. Additionally, per Section 303.5.1 of the 2019 ODOT BDM, a minimum of one row of soil reinforcement straps should be attached to the backside of the abutment footing to resist horizontal forces from the bridge structure and lateral pressures along the backwall of the abutment footing, and prevent any load transfer from these forces to the coping and facing panels. The width of the MSE wall foundation (B) is defined by the length of the reinforced soil mass. Per the Section 204.6.2.1 of the 2019 ODOT BDM and Supplemental Specification (SS) 840, the minimum length of the reinforced soil mass is equal to 70 percent of the height of the MSE wall or 8.0 feet, whichever is greater. A non-structural bearing leveling pad consisting of a minimum of 6.0-inches of unreinforced concrete should be placed at the base of the wall facing for constructability purposes. Please note that the leveling pad is not a structural foundation.

Based on proposed plan information provided by ms consultants and the Rii design team, the maximum wall height at the rear abutment (Retaining Wall W5) is anticipated to be 50.0 feet, as measured from the top of the leveling pad to the proposed crown elevation of the roadway profile. For the analyses, the foundation width was set at 70 percent of the wall height and the foundation width was increased, if required, until external and global stability requirements were satisfied.

Per Section 840.06.D of ODOT SS 840, the foundation subgrade should be inspected to verify that the subsurface conditions are the same as those anticipated in this report. Existing embankment fill comprised of very stiff to hard silt and clay (ODOT A-6a) overlying natural medium dense to very dense gravel and coarse and find sand (ODOT A-1-a, A-3a) was encountered at the proposed bearing elevation at the rear abutment (boring B-104-1-13). The existing embankment fill extends to an elevation of 701.5 feet msl, which is 2.5 to 12.5 feet below the proposed bearing elevation. Based on the SPT blow counts and hand penetrometer values obtained within this existing embankment fill, this material is considered suitable for foundation support.

Per ODOT SS 840, following foundation subgrade inspection and acceptance, a minimum of 12.0 inches of ODOT Item 703.16.C, Granular Material Type C, should be placed and compacted in accordance with ODOT Item 204.07.

5.4.1 Strength Parameters Utilized in External and Global Stability Analyses

The shear strength parameters utilized in the external and global stability analyses for the MSE wall at the rear abutment are provided in Table 12.

Table 12. Shear Strength Parameters Utilized in MSE Wall Stability Analyses

Material Type	γ (pcf)	φ' [1] (°)	c' [2] (psf)	S_u [3] (psf)
MSE Wall Backfill (Select granular fill)	120	34	0	N/A
Item 203 Embankment Fill (Retained soil)	120	30	0	2,000
Ex. Emb. Fill: Very Stiff to Hard Silt and Clay (ODOT A-6a)	120	27	0	3,000
Medium Dense to Very Dense Granular Soils (ODOT A-1-a, A-1-b, A-3a)	120 to 135	34 to 42	0	N/A
Hard Silt and Clay (ODOT A-6a)	130	28	50	8,000

1. *Per Figure 7-45, Section 7.6.9 of FHWA GEC 5 for cohesive soils and Table 10.4.6.2.4-1 of the 2018 AASHTO LRFS BDS for granular soils.*
2. *Estimated based on overconsolidated nature of soil.*
3. *$S_u = 125(N_{60})$, Terzaghi and Peck (1967).*

Shear strength parameters for the reinforced soil backfill and retained embankment are provided in ODOT SS 840. Per SS 840, the select granular backfill in the reinforced zone and the retained embankment must meet the shear strength requirements provided in Table 12. The shear strength parameters for the natural soils were assigned using correlations provided in FHWA Geotechnical Engineering Circular (GEC) No. 5 (FHWA-NHI-16-072) Evaluation of Soil and Rock Properties, the 2018 AASHTO LRFD BDS and based on past experience in the vicinity of the site with projects performed in similar subsurface profiles.

5.4.2 Bearing Stability

The anticipated bearing material at the rear abutment consists of existing embankment fill comprised of very stiff to hard silt and clay (ODOT A-6a) overlying natural medium dense to very dense gravel and coarse and find sand (ODOT A-1-a, A-3a). MSE wall foundations bearing on these soils may be proportioned for a factored bearing resistance as indicated in Table 13. A geotechnical resistance factor of φ_b=0.65 was considered in calculating the factored bearing resistance at the strength limit state. The reinforcement length presented in the following table represents the minimum foundation width required to satisfy external and global stability requirements based on the maximum height of the wall at the rear abutment (Retaining Wall W5).

Table 13. FRA-71-1503L (Retaining Wall W5) MSE Wall Design Parameters

Substructure Unit (Boring)	Wall Height Analyzed (feet)	Backslope Behind Wall	Minimum Required Reinforcement Length [1] (feet)	Bearing Resistance at Strength Limit (ksf)		Strength Limit Equivalent Bearing Pressure [3] (ksf)
				Nominal	Factored [2]	
Rear Abutment / Retaining Wall W5 (Sta. 509+85 to 510+30) (B-104-1-13)	50.0	Level	35.0 [(4)] (0.70H to 0.88H)	17.73	11.52	11.26

1. *The minimum reinforcement length is based on the maximum wall height analyzed. The value in parentheses represent the required reinforcement length expressed as a percentage of the wall height, H.*
2. *A geotechnical resistance factor of φ_b=0.65 was utilized in calculating the factored nominal bearing resistance at the strength limit state.*
3. *The strength limit equivalent bearing pressure is the uniformly distributed pressure asserted by the wall over an effective base width based on the eccentricity of the wall system at the strength limit state.*
4. *Based on the results of all stability analyses for the minimum and maximum wall height along the section of wall alignment in front of the rear abutment, it is recommended to utilize the required wall width for the maximum wall height for the entire length of this segment of wall.*

Rii performed a verification of the bearing pressure exerted on the subgrade soil for the maximum specified wall heights indicated in Table 13. Based on the minimum length of reinforced soil mass presented, the factored equivalent bearing pressure exerted below the wall **will not exceed** the factored bearing resistance at the strength limit state under drained or undrained conditions.

5.4.3 Settlement Evaluation

The compressibility parameters utilized in the settlement analyses of the proposed MSE walls are provided in Table 14.

Table 14. Compressibility Parameters Utilized in Settlement Analysis

Material Type	γ (pcf)	LL (%)	C_c [(1)]	C_r [(2)]	e_o [(3)]	C_v [(4)] (ft^2/yr)	N_{60}	C' [(5)]
Ex. Emb. Fill: Very Stiff to Hard Silt and Clay (ODOT A-6a)	120	25 to 28	0.135 to 0.189	0.014 to 0.019	0.467 to 0.514	600	N/A	N/A
Very Loose to Medium Dense Granular Soils (ODOT A-1-b, A-3a)	115 to 130	N/A	N/A	N/A	N/A	N/A	3 to 28	47 to 79
Dense to Very Dense Granular Soils (ODOT A-1-a, A-1-b)	130 to 135	N/A	N/A	N/A	N/A	N/A	35 to 120	107 to 410
Hard Silt and Clay (ODOT A-6a)	130	30	0.180	0.018	0.507	600	N/A	N/A

1. *Per Table 6-9, Section 6.14.1 of FHWA GEC 5.*
2. *Estimated at 10% of C_c per Section 8.11 of Holtz and Kovacs (1981).*
3. *Per Table 8-2 of Holtz and Kovacs (1981).*
4. *Per Figure 6-37, Section 6.14.2 of FHWA GEC 5.*
5. *Per Figure 10.6.2.4.2-1 of 2018 AASHTO LRFD BDS.*

Results of the settlement analysis are tabulated in Table 15. Total settlements of up to 5.06 inches at the center of the reinforced soil mass and 2.71 inches at the facing of the wall are anticipated at the rear abutment. Based on the results of the analysis, 90 percent of the total settlement at the rear abutment is anticipated to occur over a period of approximately 1 to 15 days. Please note that the consolidation settlement and time rate of consolidation are based on estimates using correlated compressibility parameters provided in Table 14 for the underlying soils. Actual settlement and time rate of consolidation should be determined by monitoring the settlement of the wall using settlement platforms.

Table 15. MSE Wall Settlement Values

Substructure Unit (Boring)	Service Limit Equivalent Bearing Pressure [1] (ksf)	Total Settlement Values (inches)		Time for 90% Consolidation (Days)
		Center of Wall Mass	Facing of Wall	
Rear Abutment / Retaining Wall W5 (Sta. 509+85 to 510+30) (B-104-1-13)	5.89 to 8.00	4.32 to 5.06	2.51 to 2.71	1 to 15

1. *The service limit equivalent bearing pressure is the uniformly distributed pressure asserted by the wall over an effective base width based on the eccentricity of the wall system at the service limit state.*

Per Section 204.6.2.1 of the ODOT BDM, "the maximum allowable differential settlement in the longitudinal direction (regardless of the size of panels) is one (1) percent." Based on the total anticipated settlement at the facing of the wall at the rear abutment, maximum differential settlement in the longitudinal direction is anticipated to be less than 1/1,000, which is within the tolerable limit of 1/100. If the total or differential settlement values predicted for the proposed wall present an issue with respect to the deformation tolerances that the wall can withstand, then measures should be taken to minimize the amount of settlement that will occur. This can be achieved by preloading the site and consolidating the underlying soils prior to constructing the walls. If preloading the site is not a desired option, then consideration could be given to ground improvement through the use of stone columns. Settlement calculations are provided in Appendix X.

5.4.4 Eccentricity (Overturning Stability)

The resistance of the MSE wall to overturning will be dependent on the location of the resultant force at the bottom of the wall due to the overturning and resisting moments acting on the wall. For MSE walls, overturning stability is determined by calculating the eccentricity of the resultant force from the midpoint of the base of the wall and comparing this value to a limiting eccentricity value. Per Section 11.10.5.5 of the 2018 AASHTO LRFD BDS, for foundations bearing on soil, the location of the resultant of the reaction forces shall be within the middle two-thirds ($^2/_3$) of the base width. Therefore, the limiting eccentricity is one-third ($^1/_3$) of the base width of the wall. Rii performed a verification of the eccentricity of the resultant force for the maximum specified wall heights indicated in Table 13. Based on the minimum reinforced soil mass length presented in Table 13 and utilizing the soil parameters listed in Section 5.4.1 for the retained embankment material, the calculated eccentricity of the resultant force **will not exceed** the limiting eccentricity at the strength limit state for the MSE wall at the rear abutment.

5.4.5 Sliding Stability

The resistance of the MSE wall to sliding was evaluated per Section 11.10.5.3 of the 2018 AASHTO LRFD BDS. For drained conditions, the sliding resistance is determined by multiplying a coefficient of sliding friction "f" times the total vertical force at the base of the wall. The coefficient of sliding friction is determined based on the limiting friction angle between the foundation soil and the reinforced soil backfill. Based on the soil parameters listed in Section 5.4.1 for the foundation and reinforced soil backfill material, a coefficient of sliding friction of 0.51 was utilized for design. For undrained conditions, the sliding resistance is taken as the limiting value between the undrained shear strength of the bearing soil and half of the vertical stress applied by the wall multiplied by the width of the MSE wall. Based on the soil parameters listed in Section 5.4.1, the undrained shear strength of the existing silt and clay embankment material encountered at the proposed bearing elevation at the rear abutment is estimated to be 3.0 ksf.

A geotechnical resistance factor of φ_τ=1.0 was considered when calculating the factored shear resistance. Based on the minimum length of reinforced soil mass presented in Table 13 and utilizing the soil parameters listed in Section 5.4.1 for the retained embankment material, the resultant horizontal forces on the back of the MSE wall **will not exceed** the factored shear resistance at the strength limit state under drained and undrained conditions at the rear abutment.

5.4.6 Overall (Global) Stability

A slope stability analysis was performed to check the global stability of each wall. As per the AASHTO LRFD BDS, safety against soil failure shall be evaluated at the service limit state by assuming the reinforced soil mass to be a rigid body. Soil parameters utilized in the global stability analyses are presented in Section 5.4.1. For the global stability condition, it was considered that the failure plane will not cross through the reinforced soil mass. The computer software program Slide 2018, manufactured by Rocscience Inc., was utilized to perform the analyses.

Per Section 11.6.2.3 of the 2018 AASHTO LRFD BDS, overall (global) stability for MSE walls that are integrated with or supporting structural foundations or elements is satisfied if the product of the factor of safety from the slope stability output multiplied by the resistance factor φ=0.65 is greater than 1.0. Therefore, global stability is satisfied when a minimum factor of safety of 1.5 is obtained. For MSE walls designed with the minimum reinforcement lengths listed in Table 13, the resulting factors of safety under drained conditions (long-term stability) and undrained conditions (short-term stability) using the Spencer's analysis method was greater than 1.5 at the rear abutment.

5.4.7 Final MSE Wall Considerations

Based on the results of the external and global stability analyses performed for the MSE wall at the rear abutment (Retaining Wall W5), the recommended controlling strap length is 0.70 times the maximum height of the MSE wall (measured from the top of the leveling pad to the proposed roadway profile grade). All of the external and global stability calculations indicate that adequate resistance is available for support of the MSE wall at the rear abutment for a strap length equal to 70 percent of the maximum wall height. However, it should be noted that a strap length of 35.0 feet (88 percent of the wall height) is required for the minimum wall height of 40.0 feet along this segment of the wall in order to meet global stability requirements. **Therefore, the required width of 35.0 feet should be used for the entire alignment of the wall at the rear abutment.**

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

5.5 Lightweight (Cellular Concrete) Wall Recommendations

Existing fill material consisting of very loose to loose gravel with sand, gravel with sand and silt, coarse and fine sand and silt (ODOT A-1-b, A-2-4, A-3a, A-4b) was encountered at the proposed bearing elevation at the forward abutment (boring B-115-2-13), which extends to a depth of 18.0 feet below the proposed bearing elevation to an elevation of 693.1 feet msl. As noted in Sections 5.0 and 5.4, given the presence of existing fill material to significant depths, as well as the significant amount of existing utilities present along the east side of Short Street, it is understood that lightweight fill material consisting of cellular concrete is being considered to be utilized as the backfill along the length of Retaining Wall E7 where it crosses in front of the forward abutment (between Sta. 704+21 to 705+61, BL Wall E7). The use of the lightweight cellular concrete will eliminate the need for undercut or ground improvement to stabilize the underlying existing fill material and control settlement to tolerable limits. Based on information provided by the Rii design group, two types of lightweight cellular concrete will be utilized in lieu of typical embankment fill and select granular fill, which is typically used for MSE wall applications. The wall facing will be connected to geosynthetic straps that are embedded into the cellular concrete and supported on a leveling pad, similar to traditional MSE walls.

A typical section of the proposed cellular concrete wall system was provided by the Rii design team. Based on the information provided, the typical section will consist of an approximate 3.0-foot thick pavement section, including asphalt and/or concrete and aggregate base, overlying 2.0 feet of Class III cellular concrete, followed by Class II cellular concrete to the bottom of the embankment/wall elevation. A composite unit weight of 130 pcf was considered for the entire pavement section, and the unit weight of the Class III cellular concrete is 36 pcf and the Class II cellular concrete is 30 pcf. The pressure at the bottom of the embankment was calculated as follows:

$$\Delta\sigma = (130 \text{ pcf})(3.0 \text{ ft}) + (36 \text{ pcf})(2.0 \text{ ft}) + (H - 5 \text{ ft})(30 \text{ pcf})$$

Where,

$\Delta\sigma$ = induced pressure at the bottom of embankment/wall (psf)

H = height of embankment/wall from existing ground surface to profile grade of roadway (ft)

Since the wall is located within an existing floodplain, the analysis was performed using a design groundwater level at the ground surface.

Following placement of the cellular concrete, the material will cure and harden similar to concrete and will become a rigid mass. The concept of active earth pressure within this mass is not valid, as it cannot substantially deform, develop an active wedge, and mobilize active earth pressure. Therefore, the entire cellular concrete mass must be treated as a solid block. The “reinforced zone” is not the same as a traditional MSE wall reinforced zone, as the reinforcement straps only need to extend back into the cellular mass far enough to fully develop resistance in tension as if it were a reinforcing bar embedded in reinforced concrete. However, it is recommended that the reinforcement extend the minimum length of 70 percent of the wall height into the cellular concrete backfill, similar to traditional MSE walls.

Considering the above commentary in regards to the external stability of the cellular concrete backfilled MSE walls, sliding, overturning, bearing and overall (global) stability of the wall must be performed for the entire mass as a single block. Therefore, consideration must be given to the effect of the backfill material behind the cellular concrete if it is only utilized within the reinforced zone of the wall.

The active earth pressure coefficient, and consequently the active pressure on the back of the cellular concrete mass, will greatly reduce as the slope of the backfill soil flattens. Once the slope of the backfill flattens more than the internal friction angle of the backfill soil, the active earth pressure coefficient will go to zero. Therefore, if the backslope of any backfill is reduced to the internal friction angle of the backfill material, analysis of external stability is not required, with the exception of bearing and overall (global) stability. Based on the plan information provided, it is understood that the cellular concrete fill will be placed the full height of the embankment within the limits of I-71 southbound to the west side of the Franklin main, which is approximately 150 feet east of Short Street. Provided that all backslopes cut into the existing I-70 embankment are graded no steeper than 2H:1V, external and global stability calculations will not be required for this section of Retaining Wall E7. However, if bearing resistance must be checked, then a factored bearing resistance of 4.23 ksf should be utilized for design at the strength limit state.

The compressibility parameters utilized in the settlement analysis of the proposed cellular concrete backfilled MSE wall along Retaining Wall E7 at the forward abutment are provided in Table 14.

Table 16. Compressibility Parameters Utilized in Settlement Analysis

Material Type	γ (pcf)	LL (%)	C_c (1)	C_r (2)	e_o (3)	C_v (4) (ft^2/yr)	N_{60}	C' (5)
Existing Fill: Loose Sandy Silt (ODOT A-4a)	115	N/A	N/A	N/A	N/A	N/A	6	22
Existing Fill: Very Loose to Medium Dense Granular Soils (ODOT A-1-b, A-2-4, A-3a)	115 to 125	N/A	N/A	N/A	N/A	N/A	5 to 13	50 to 88
Dense to Very Dense Granular Soils (ODOT A-1-a, A-2-4)	130 to 135	N/A	N/A	N/A	N/A	N/A	32 to 92	105 to 424
Hard Silty Clay (ODOT A-6b)	130	35 to 40	0.225 to 0.270	0.023 to 0.027	0.546 to 0.585	600	N/A	N/A

1. *Per Table 6-9, Section 6.14.1 of FHWA GEC 5.*
2. *Estimated at 10% of C_c for natural soils and 15% C_c for existing fill per Section 8.11 of Holtz and Kovacs (1981).*
3. *Per Table 8-2 of Holtz and Kovacs (1981).*
4. *Per Figure 6-37, Section 6.14.2 of FHWA GEC 5.*
5. *Per Figure 10.6.2.4.2-1 of 2018 AASHTO LRFD BDS.*

Results of the settlement analysis are tabulated in Table 15. A total settlement of 4.43 inches at the center of the wall mass and 3.50 inches at the facing of the wall is anticipated along Retaining Wall E7 where is crosses in front of the forward abutment. Based on the results of the analysis, 90 percent of the total settlement is anticipated to occur during and immediately following construction of the wall. Please note that the consolidation settlement and time rate of consolidation are based on estimates using correlated compressibility parameters provided in Table 14 for the underlying soils. Actual settlement and time rate of consolidation should be determined by monitoring the settlement of the wall using settlement platforms.

Table 17. Retaining Wall E7 Settlement Results

Structure Reference / Substructure Unit (Boring)	Wall / Embankment Height (feet)	Pressure at Bottom of Wall / Embankment [1] (ksf)	Total Settlement Values (inches)		Time for 90% Consolidation (Days)
			Center of Wall Mass	Facing of Wall	
Forward Abutment / Retaining Wall E7 (Sta. 704+21 to 705+61) (B-115-2-13)	52.7	1.95	4.43	3.20	0

1. *Δσ = (130 pcf)(3.0 ft) + (36 pcf)(2.0 ft) + (H - 5 ft)(30 pcf).*

Per Section 204.6.2.1 of the ODOT BDM, for traditional MSE walls "the maximum allowable differential settlement in the longitudinal direction (regardless of the size of panels) is one (1) percent." Based on the total anticipated settlement at the facing of the walls, maximum differential settlements in the longitudinal directions are anticipated to be less than 1/1,000, which is within the tolerable limit of 1/100. If localized bearing pressures exerted on the leveling pad from the wall facing panels will be higher than the pressure exerted by the wall mass, then there is a potential for differential settlement to occur given the variability in the fill material.

Results of the settlement analysis and bearing resistance for the cellular concrete MSE wall are provided in Appendix XI.

5.6 Lateral Earth Pressure

For the soil types encountered in the borings, the "in-situ" unit weight (γ), cohesion (c), effective angle of friction (φ'), and lateral earth pressure coefficients for at-rest conditions (k_o), active conditions (k_a), and passive conditions (k_p) have been estimated and are provided in Table 18 and Table 19.

Table 18. Estimated Undrained (Short-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ	k_a	k_o	k_p
Soft to Stiff Cohesive Soil	115	1,500	0°	N/A	N/A	N/A
Very Stiff to Hard Cohesive Soil	125	3,000	0°	N/A	N/A	N/A
Very Loose to Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense Granular Soil	125	0	32°	0.27	0.47	6.82
Dense to Very Dense Granular Soil	130	0	36°	0.23	0.41	9.09
Compacted Cohesive Engineered Fill	120	2,000	0°	N/A	N/A	N/A
Compacted Granular Engineered Fill	120	0	32°	0.27	0.47	6.82

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

Table 19. Estimated Drained (Long-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ'	k_a	k_o	k_p
Soft to Stiff Cohesive Soil	115	0	26°	0.35	0.56	4.53
Very Stiff to Hard Cohesive Soil	125	50	28°	0.32	0.53	5.07
Very Loose to Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense Granular Soil	125	0	32°	0.27	0.47	6.82
Dense to Very Dense Granular Soil	130	0	36°	0.23	0.41	9.09
Compacted Cohesive Engineered Fill	120	0	30°	0.30	0.50	5.58
Compacted Granular Engineered Fill	120	0	32°	0.27	0.47	6.82

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

These parameters are considered appropriate for the design of all subsurface structures and any excavation support systems. Subsurface structures (where the top of the structure is restrained from movement) should be designed based on at-rest conditions (k_o). For proposed temporary retaining structures (where the top of the structure is allowed to move), earth pressure distributions should be based on active (k_a) and passive (k_p) conditions. The values in this table have been estimated from correlation charts based on minimum standards specified for compacted engineered fill materials. These recommendations do not take into consideration the effect of any surcharge loading or a sloped ground surface (a flat surface is considered). Earth pressures on excavation support systems will be dependent on the type of sheeting and method of bracing or anchorage.

5.7 Scour Data

Continuous sampling was performed starting at the top of the riverbed elevation in borings B-113-6-13 through B-113-8-13, which were performed at piers 10 through 12, for a minimum 6.0-foot interval to determine the D_{50} and D_{95} grain sizes of the riverbed soils. The riverbed soils encountered at piers 10 through 12 consisted of very loose to medium dense black, brown, gray and dark gray gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay and sandy silt (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-4a). Based upon the grain size analyses performed, the D_{50} of the soils encountered ranged from 0.121 to 5.836 millimeters, and the D_{95} ranged from 2.300 to 33.179 millimeters. The results of the grain size analyses are summarized in Table 20.

Table 20. Scour Sampling Summary

Boring	Substructure Unit	Sample No.	Depth (feet)	ODOT Classification	D_{50} Value (mm)	D_{95} Value (mm)
B-113-6-13	Pier 10	SS-1	0.0 – 1.5	A-2-6	0.905	19.378
		SS-2	1.5 – 3.0	A-2-6	1.073	22.019
		SS-3	3.0 – 4.5	A-2-6	0.902	28.814
		3S-4A	6.0 – 6.5	A-2-6	2.424	18.153
B-113-7-13	Pier 11	SS-1	0.0 – 1.5	A-2-4	0.253	14.739
		SS-2	1.5 – 3.0	A-1-b	0.494	3.176
		SS-3	3.0 – 4.5	A-1-b	0.466	5.646
		SS-4	4.5 – 6.0	A-1-b	0.463	2.300
		SS-5	6.0 – 7.5	A-4a	0.121	2.880
B-113-8-13	Pier 12	SS-1	0.0 – 1.5	A-1-b	1.471	16.993
		SS-2	1.5 – 3.0	A-1-a	3.333	30.734
		SS-3	3.0 – 4.5	A-1-a	3.264	33.179
		SS-4	4.5 – 6.0	A-1-a	5.836	30.561

5.8 Construction Considerations

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

5.8.1 Excavation Considerations

All excavations should be shored / braced or laid back at a safe angle in accordance to Occupational Safety and Health Administration (OSHA) guidelines. During excavation, if slopes cannot be laid back to OSHA Standards due to adjacent structures or other obstructions, temporary shoring may be required. The following table should be utilized as a general guide for implementing OSHA guidelines when estimating excavation back slopes at the various boring locations. Actual excavation back slopes must be field verified by qualified personnel at the time of excavation in strict accordance with OSHA guidelines.

Table 21. 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

5.8.2 Groundwater Considerations

Based on the groundwater observations made during drilling, groundwater is anticipated during construction of the drilled shafts. Where groundwater is encountered, proper groundwater control should be employed and maintained to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or "boiling" condition where soft silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 36 inches below the deepest excavation. In the case of drilled shafts, the utilization of casing will be required below the water table to maintain an open hole and prevent the sidewalls from collapse. In addition, concrete placed below the water table should be placed by tremie method using a rigid tremie pipe. Note that mitigating the water during construction and protecting the excavation is the responsibility of the contractor.

6.0 LIMITATIONS OF STUDY

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

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

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

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

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

APPENDIX I

VICINITY MAP AND BORING PLAN

BORINGS B-104-1-13, B-105-2-13, B-107-1-13, B-108-4-13, B-108-5-13, B-108-6-13 AND B-113-2-13 WERE PERFORMED FOR FRA-71-1503L STRUCTURE.

BORINGS B-103-1-14, B-105-4-14 AND B-105-6-14 WERE PERFORMED FOR WALL W2.

BORINGS B-105-3-14, B-105-5-13, B-107-2-14, B-108-7-14 AND B-108-8-13 WERE PERFORMED FOR WALL W5.

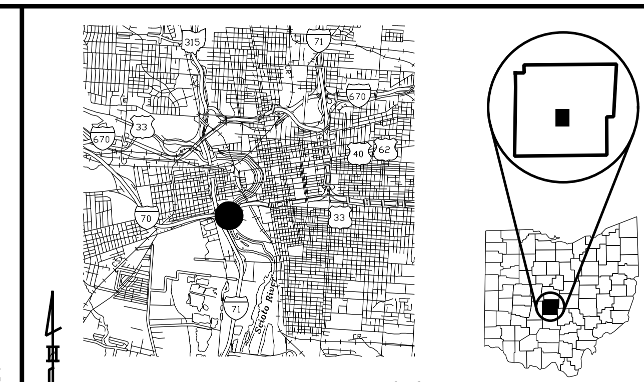
BORINGS B-015-1-13, B-015-4-13, B-015-5-13, B-015-6-13, B-015-7-13, B-102-1-13, B-105-1-13, B-106-1-13, B-108-1-13, B-108-3-13 AND B-108-9-15 WERE PERFORMED AS PART OF THE FRA-70-12.68 PROJECT 4A/4R.

BORINGS B-103-0-09, B-104-0-09, B-105-0-09, B-106-0-09, B-107-0-09, B-108-0-09 AND B-113-1-09 WERE DRILLED AS PART OF THE FRA-70-8.93 PRELIMINARY EXPLORATION.

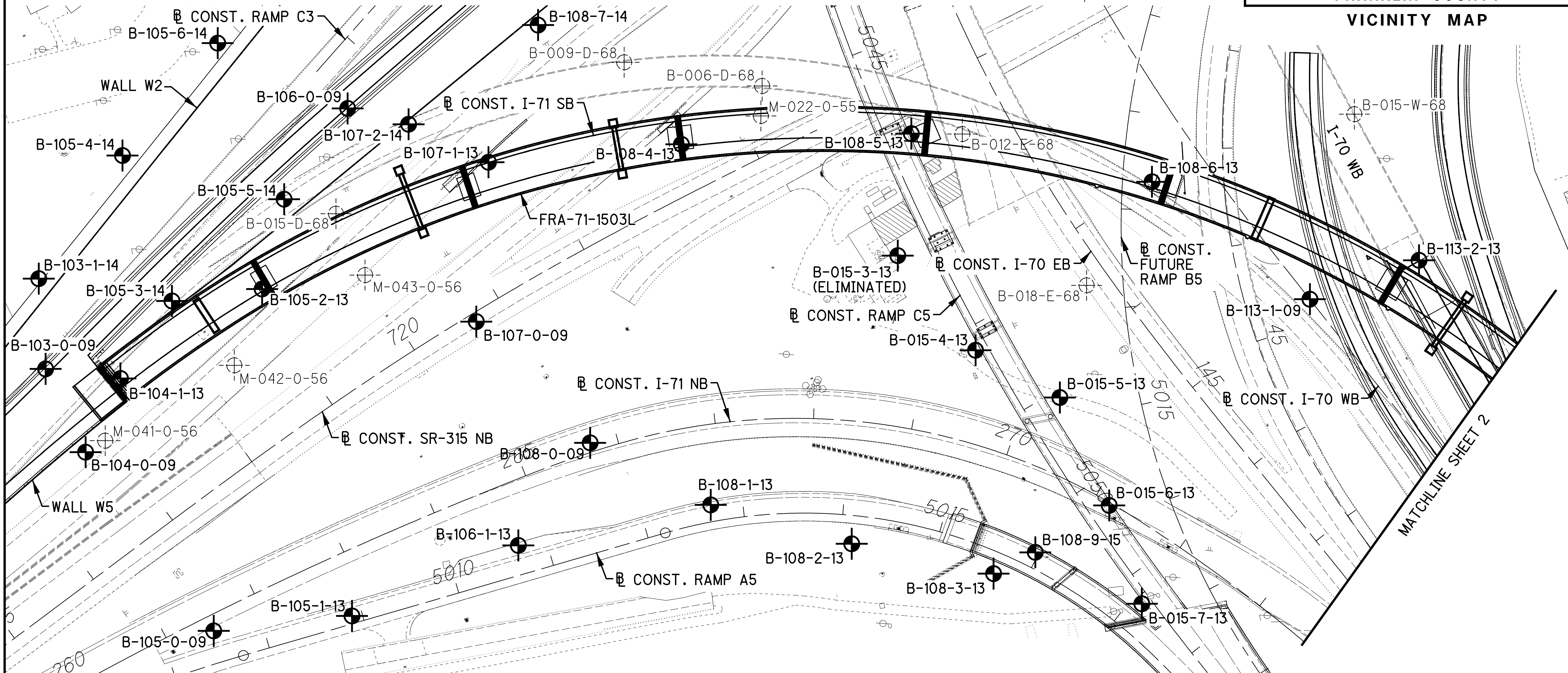
LEGEND

PROJECT BORING

HISTORIC BORING



VICINITY MAP



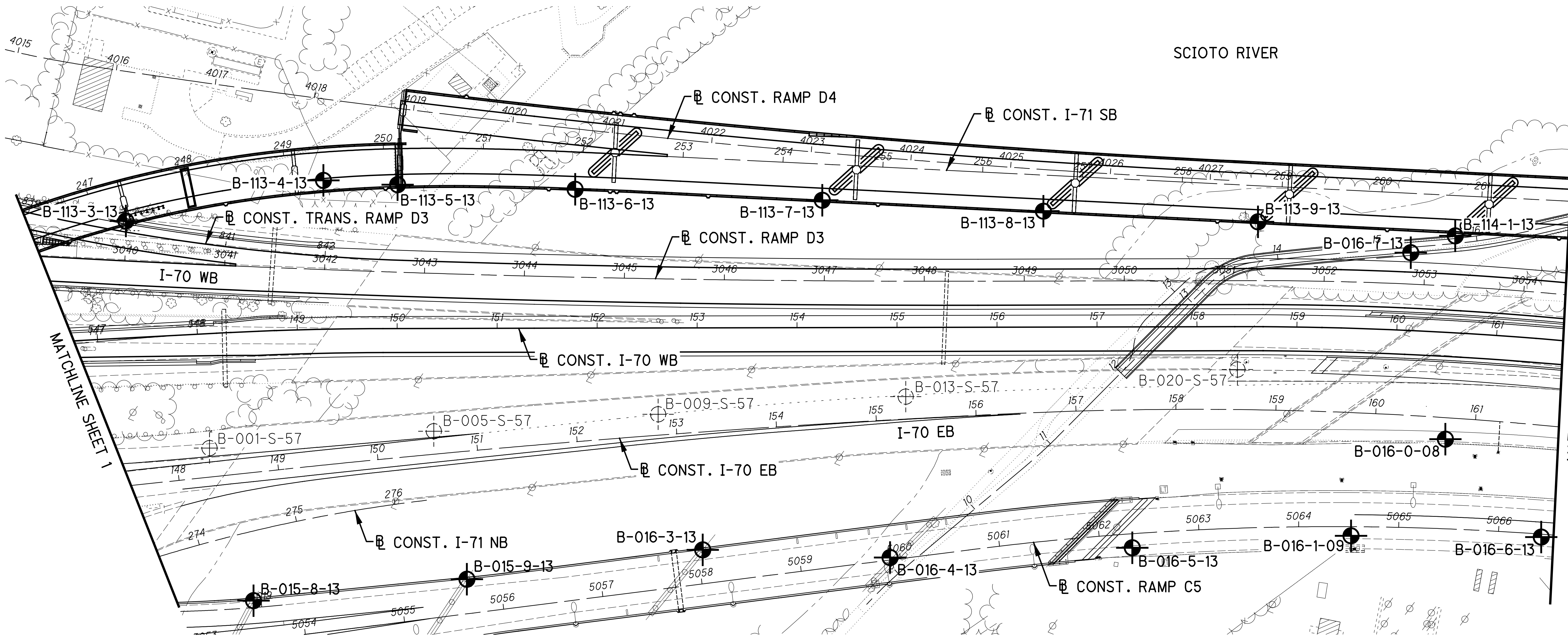
BORING PLAN - SHEET 1

FRA-71-1503L

FRANKLIN COUNTY, OHIO

PROJECT NO. Rii W-13-072	DRAWN RRM
SCALE: 1"=100' (0, 50, 100)	REVIEWED BRT
	DATE 7-17-19

RESOURCE INTERNATIONAL



BORINGS B-113-3-13, B-113-4-13, B-113-5-13, B-113-6-13, B-113-7-13, B-113-8-13, B-113-9-13 AND B-114-1-13 WERE PERFORMED FOR THE FRA-71-1503L STRUCTURE.

BORING B-016-7-13 WAS PERFORMED FOR THE FRA-70-1323C STRUCTURE.

BORINGS B-015-8-13, B-015-9-13, B-016-3-13, B-016-4-13, B-016-5-13, B-016-6-13 AND B-108-9-15 WERE PERFORMED AS PART OF THE FRA-70-12.68 PROJECT 4A/4R.

BORINGS B-016-0-08 AND B-016-1-09 WERE DRILLED AS PART OF THE FRA-70-8.93 PREMININARY EXPLORATION.

LEGEND

PROJECT BORING

HISTORIC BORING

BORING PLAN - SHEET 2

FRA-71-1503L

FRANKLIN COUNTY, OHIO

PROJECT NO. Rii W-13-072

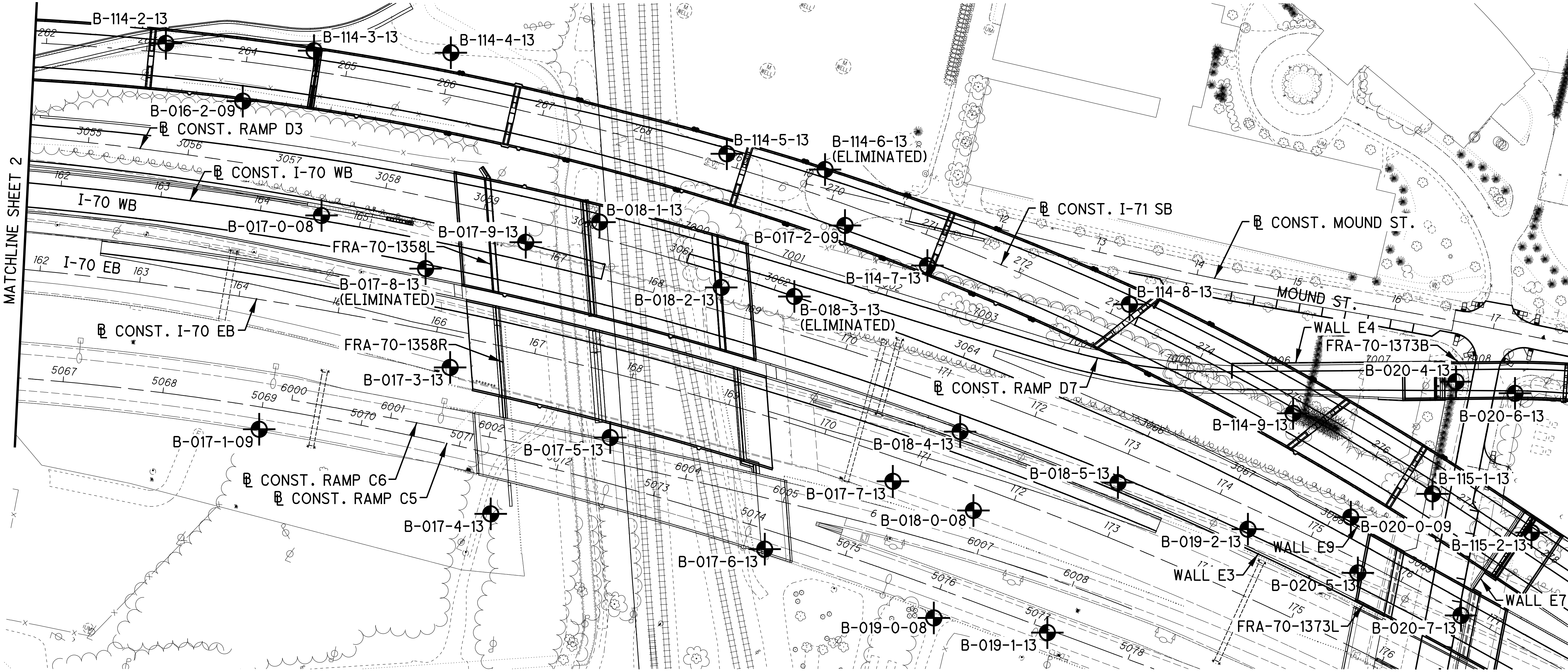
SCALE: 1"=100'

0 50 100

DRAWN RRM

REVIEWED BRT

DATE 7-17-19



BORINGS B-017-3-13, B-017-4-13, B-017-5-13, B-017-6-13, B-017-7-13 AND B-019-1-13 WERE PERFORMED AS PART OF THE FRA-70-12.68 PROJECT 4A/4R.

BORINGS B-017-0-08, B-017-1-09, B-017-2-09, B-018-0-08, B-019-0-08 AND B-020-0-08 WERE DRILLED AS PART OF THE FRA-70-8.93 PRELIMINARY EXPLORATION.

BORINGS B-114-2-13, B-114-3-13, B-114-4-13, B-114-5-13, B-114-7-13, B-114-8-13, B-114-9-13, B-115-1-13 AND B-115-2-13 WERE PERFORMED FOR THE FRA-71-1503L STRUCTURE.

BORINGS B-017-9-13, B-018-1-13 AND B-018-2-13 WERE PERFORMED FOR THE FRA-70-1358L STRUCTURE.

BORINGS B-018-4-13, B-018-5-13 AND B-019-2-13 WERE PERFORMED FOR WALL E3.

BORINGS B-020-4-13 AND B-020-6-13 WERE PERFORMED FOR THE FRA-70-1373B STRUCTURE.

BORINGS B-020-5-13 AND B-020-7-13 WERE PERFORMED FOR THE FRA-70-1373L STRUCTURE.

LEGEND

PROJECT BORING

HISTORIC BORING

BORING PLAN - SHEET 3

FRA-71-1503L

FRANKLIN COUNTY, OHIO

PROJECT NO. Rii W-13-072	DRAWN RRM
SCALE: 1"=100' (0 50 100)	REVIEWED BRT
	DATE 7-17-19

APPENDIX II

DESCRIPTION OF SOIL AND ROCK 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	^{3} 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”		

DESCRIPTION OF ROCK TERMS

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

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

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

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

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

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

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

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

Degree of Fracturing

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

Condition of Fractures

Aperature Width

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

Surface Roughness

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

RQD – Rock Quality Designation:

RQD %	Rock Index Property Classification
0 – 25%	Very Poor
26 – 50%	Poor
51 – 70%	Fair
71 – 85%	Good
86 – 100%	Very Good

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_O/LL x 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 III

PROJECT BORING LOGS:

B-104-1-13 through B-115-2-13

BORING LOGS

Definitions of Abbreviations

AS	=	Auger sample
GI	=	Group index as determined from the Ohio Department of Transportation classification system
HP	=	Unconfined compressive strength as determined by a hand penetrometer (tons per square foot)
LL_o	=	Oven-dried liquid limit as determined by ASTM D4318. Per ASTM D2487, if LL_o/LL is less than 75 percent, soil is classified as “organic”.
LOI	=	Percent organic content (by weight) as determined by ASTM D2974 (loss on ignition test)
PID	=	Photo-ionization detector reading (parts per million)
QR	=	Unconfined compressive strength of intact rock core sample as determined by ASTM D2938 (pounds per square inch)
QU	=	Unconfined compressive strength of soil sample as determined by ASTM D2166 (pounds per square foot)
RC	=	Rock core sample
REC	=	Ratio of total length of recovered soil or rock to the total sample length, expressed as a percentage
RQD	=	Rock quality designation – estimate of the degree of jointing or fracture in a rock mass, expressed as a percentage:

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

S	=	Sulfate content (parts per million)
SPT	=	Standard penetration test blow counts, per ASTM D1586. Driving resistance recorded in terms of blows per 6-inch interval while letting a 140-pound hammer free fall 30 inches to drive a 2-inch outer diameter (O.D.) split spoon sampler a total of 18 inches. The second and third intervals are added to obtain the number of blows per foot (N_m).
N_{60}	=	Measured blow counts corrected to an equivalent (60 percent) energy ratio (ER) by the following equation: $N_{60} = N_m$*(ER/60)
SS	=	Split spoon sample
2S	=	For instances of no recovery from standard SS interval, a 2.5 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 2S sampling are not correlated with N_{60} values.
3S	=	Same as 2S, but using a 3.0 inch O.D. split spoon sampler.
TR	=	Top of rock
W	=	Initial water level measured during drilling
▼	=	Water level measured at completion of drilling

Classification Test Data

Gradation (as defined on Description of Soil Terms):

GR	=	% Gravel
SA	=	% Sand
SI	=	% Silt
CL	=	% Clay

Atterberg Limits:

LL	=	Liquid limit
PL	=	Plastic limit
PI	=	Plasticity Index

WC	=	Water content (%)

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 230+95.90 / 17.5' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B./J.P.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 714.5 (MSL) EOB: 70.5 ft.
START: 6/4/14 END: 6/26/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.947937, -83.015728

EXPLORATION ID **B-104-1-13**

MATERIAL DESCRIPTION AND NOTES	ELEV. 714.5
0.3' - TOPSOIL (4.0")	714.2
FILL: VERY STIFF TO HARD, DARK BROWN TO GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE TO SOME FINE GRAVEL, DAMP TO MOIST. -ROCK FRAGMENTS PRESENT IN SS-4 -ORGANIC ODOR PRESENT IN SS-5	701.5
MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, SOME SILT, TRACE CLAY, MOIST.	699.0
MEDIUM DENSE TO VERY DENSE, BROWN TO BROWNISH GRAY **GRAVEL**, TRACE TO SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.	

DEPTHS: 1–29 (W at 18, W at 20.5)

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
5 9 13	28	67	SS-1	4.25	-	-	-	-	-	-	-	-	11	A-6a (V)
11 9 10	25	67	SS-2	4.25	16	12	14	29	29	25	14	11	15	A-6a (5)
3 5 25	39	78	SS-3	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)
6 6 9	19	33	SS-4	3.00	-	-	-	-	-	-	-	-	18	A-6a (V)
4 3 5	10	44	SS-5	3.50	32	18	10	19	21	31	16	15	18	A-6a (2)
3 4 5	12	67	SS-6	-	0	10	59	21	10	NP	NP	NP	14	A-3a (0)
14 21 17	49	67	SS-7	-	-	-	-	-	-	-	-	-	7	A-1-a (V)
9 11 14	32	100	SS-8	-	97	1	1	1	0	NP	NP	NP	8	A-1-a (0)
5 12 13	32	89	SS-9	-	-	-	-	-	-	-	-	-	9	A-1-a (V)
10 11 11	28	100	SS-10	-	-	-	-	-	-	-	-	-	7	A-1-a (V)
15 25 21	60	78	SS-11	-	68	12	10	6	4	NP	NP	NP	8	A-1-a (0)
13 17 21	49	100	SS-12	-	-	-	-	-	-	-	-	-	7	A-1-a (V)

GRADATION (%): GR, CS, FS, SI, CL; ATTERBERG: LL, PL, PI; HOLE SEALED

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:00 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 230+95.90 / 17.5 RT	START: 6/4/14	END: 6/26/14	PG 2 OF 3	B-104-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 684.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE TO VERY DENSE, BROWN TO BROWNISH GRAY **GRAVEL**, TRACE TO SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. *(same as above)*	682.5	31 – 32																
MEDIUM DENSE TO VERY DENSE, DARK BROWNISH GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		34 – 35	10 11 11	28	100	SS-13	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
-COBBLES PRESENT FROM 35.0' TO 38.5'		38.5 – 39	50/2"	-	0	SS-14	-	-	-	-	-	-	-	-	-	-		
	672.5	42																
VERY LOOSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		44 – 45	3 1 1	3	100	SS-15	-	39	43	6	2	10	NP	NP	NP	12	A-1-b (0)	
	667.5	47																
VERY DENSE, GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST. -HEAVING SANDS ENCOUNTERED @ 48.5' -INTRODUCED MUD @ 48.5'		48.5 – 49.7	16 25 50/2"	-	100	SS-16	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
AUGER REFUSAL @ 51.0'	663.5	51																
GRANITE AND LIMESTONE BOULDERS. -BORING TERMINATED @ 54.0' ON 6-5-14. OFFSET BORING 5.0' NORTH AND CONTINUED SAMPLING @ 58.5' ON 6-26-14.	660.5	51 – 54	0		25	RC-1											CORE	
HARD, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP. -COBBLES PRESENT THROUGHOUT		58.5 – 59	50/3"	-	33	SS-17	-	-	-	-	-	-	-	-	-	-	A-6a (V)	
		59	50/4"	-	50	3S-17A	-	-	-	-	-	-	-	-	-	11	A-6a (V)	
	654.0	TR 60																
		61																

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 230+95.90 / 17.5 RT	START: 6/4/14	END: 6/26/14	PG 3 OF 3	B-104-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 652.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, SILICEOUS, CHERTY, DOLOMITIC, CRYSTALLINE, SLIGHTLY TO MODERATELY FRACTURED, OPEN APERTURES, SLIGHTLY TO VERY ROUGH; RQD 73%, REC 95%. *(same as above)* -QU @ 65.5' = 8,783 PSI		63	75		100	RC-2											CORE	
		64																
		65																
		66																
		67																
		68	70		90	RC-3											CORE	
		69																
	644.0	EOB 70																

NOTES: SEEPAGE ENCOUNTERED @ 18.5'; GROUNDWATER ENCOUNTERED INITIALLY @ 21.0'; CAVE-IN DEPTH @ 45.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

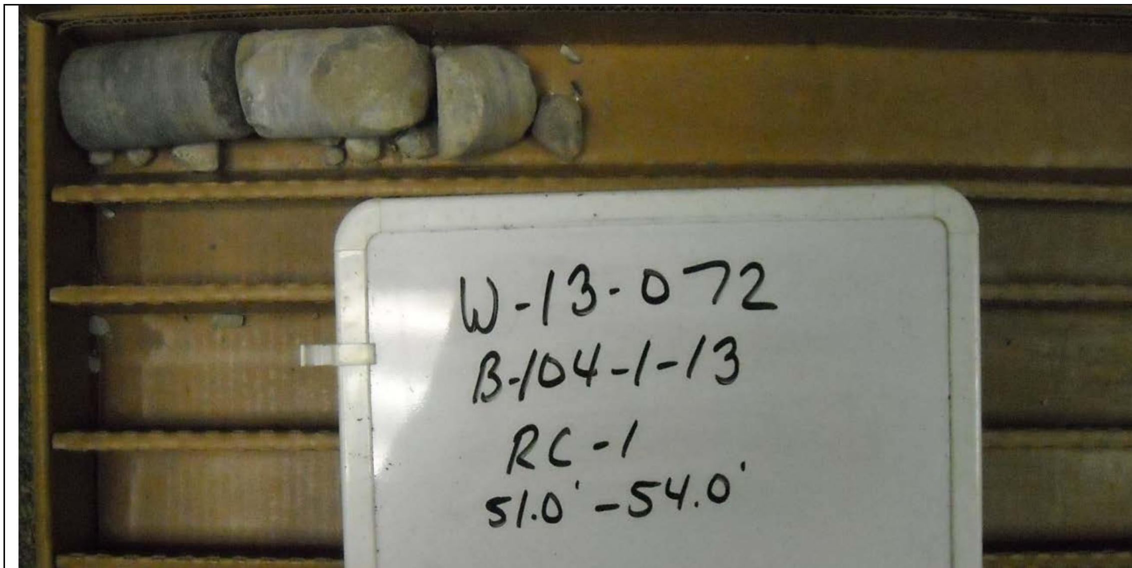


Photo No.	**Project:** FRA-70-13.10	**Depth:** 51.0’ to 54.0’
1	**Boring:** B-104-1-13	**Runs:** RC-1

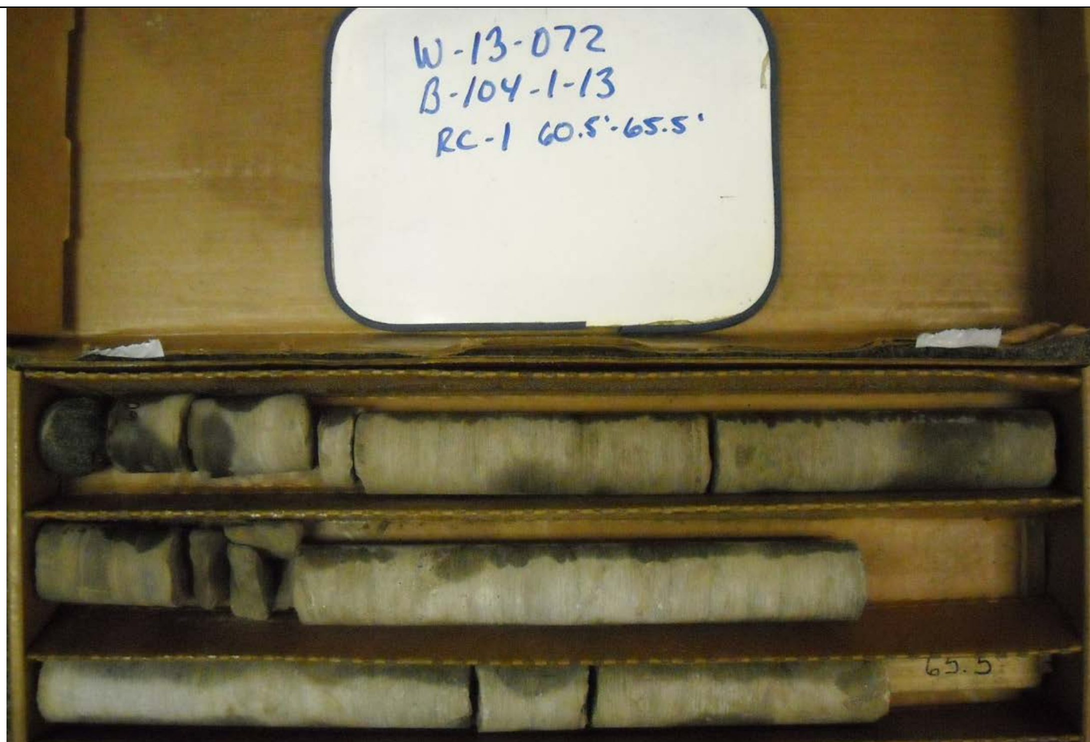


Photo No.	**Project:** FRA-70-13.10	**Depth:** 60.5’ to 65.5’
2	**Boring:** B-104-1-13	**Runs:** RC-2

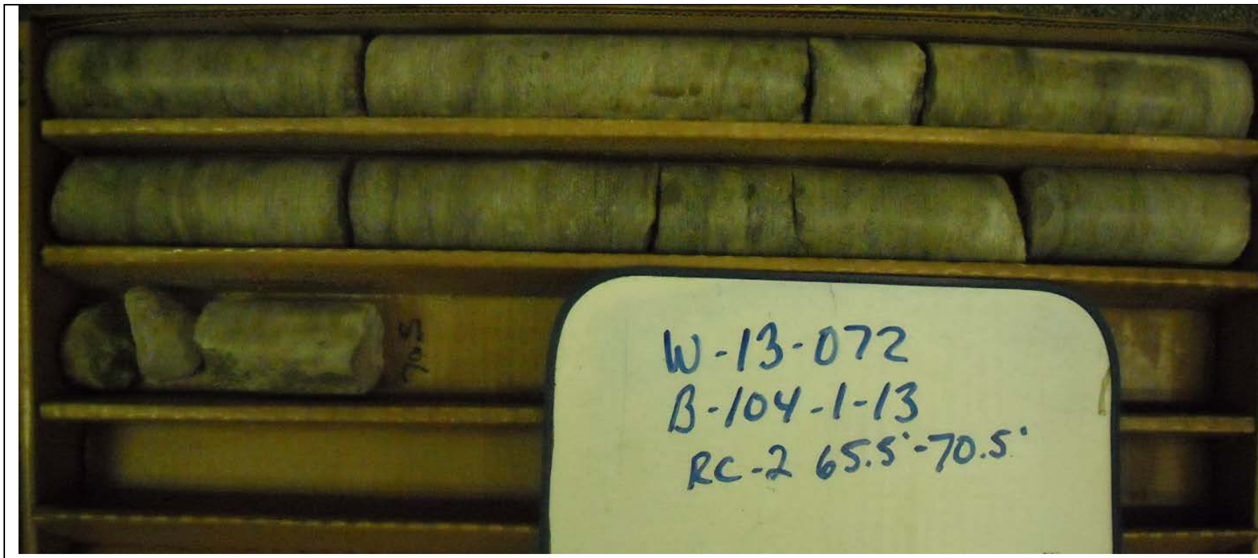


Photo No.	**Project:** FRA-70-13.10	**Depth:** 65.5' to 70.5'
3	**Boring:** B-104-1-13	**Runs:** RC-3

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 232+68.59 / 24.4' RT	EXPLORATION ID **B-105-2-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	PAGE
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 707.0 (MSL) EOB: 66.0 ft.	1 OF 3
START: 6/30/14 END: 7/2/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.948370, -83.015953	

MATERIAL DESCRIPTION AND NOTES	ELEV. 707.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.3' - TOPSOIL (4.0")	706.7																	
FILL: VERY STIFF, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP. -BRICK FRAGMENTS PRESENT IN SS-1	704.0	1, 2, 3	3 5 10	19	100	SS-1	3.00	-	-	-	-	-	-	-	-	13	A-6a (V)	
FILL: VERY DENSE, BLACK **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP. -ASPHALT FRAGMENTS PRESENT IN SS-2	701.5	4, 5	23 42 17	76	89	SS-2	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
STIFF TO VERY STIFF, BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		6, 7, 8	5 5 6	14	89	SS-3	2.00	3	11	24	30	32	36	17	19	18	A-6b (9)	
	696.5	9, 10	6 8 9	22	83	SS-4	3.00	-	-	-	-	-	-	-	-	15	A-6b (V)	
STIFF, LIGHT BROWN **SILT**, SOME CLAY, LITTLE COARSE TO FINE SAND, MOIST.	694.0	11, 12, 13	3 3 5	10	67	SS-5	1.50	0	1	10	68	21	23	18	5	19	A-4b (8)	
MEDIUM DENSE TO DENSE, BROWN TO MOTTLED BROWN AND GRAY **GRAVEL**, TRACE TO SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-6		14, 15	6 6 5	14	61	SS-6	-	-	-	-	-	-	-	-	-	10	A-1-a (V)	
		W 16, 17, 18	6 9 10	25	67	SS-7	-	91	4	2	3	0	NP	NP	NP	12	A-1-a (0)	
		19, 20	10 10 14	31	100	SS-8	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
		21, 22, 23	10 10 20	39	83	SS-9	-	67	16	7	7	3	NP	NP	NP	12	A-1-a (0)	
		24, 25	15 15 20	45	78	SS-10	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
-ROCK FRAGMENTS PRESENT IN SS-11		26, 27, 28	20 19 14	43	89	SS-11	-	-	-	-	-	-	-	-	-	15	A-1-a (V)	
		29	15 9 7	21	100	SS-12	-	63	21	7	7	2	NP	NP	NP	7	A-1-a (0)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 232+68.59 / 24.4 RT	START: 6/30/14	END: 7/2/14	PG 2 OF 3	B-105-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 677.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	676.0																	
-**GRANITE BOULDER.**	675.5	31	0		50	RC-1											CORE	
DENSE TO VERY DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST. -ENCOUNTERED GRANITE BOULDER @ 31.0' ON 6-30-14. CORED THROUGH BOULDER TO 31.5' ON 7-1-14 AND TERMINATED BORING. OFFSET HOLE 5.0' NORTH AND RESUMED SAMPLING @ 33.5' ON 7-2-14.		34	8 19 15	44	100	SS-13	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		39	18 19 20	51	89	SS-14	-	47	23	11	14	5	NP	NP	NP	13	A-1-b (0)	
		44	9 16 40	73	67	SS-15	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
	660.0																	
VERY DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, MOIST.		49	50/3"	-	100	SS-16	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
	655.0																	
HARD, BROWN **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.		54	35 50/4"	-	100	SS-17	4.5+	23	20	15	22	20	23	14	9	7	A-4a (1)	
AUGER REFUSAL @ 56.0'	651.0	TR 56																
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, CRYSTALLINE, SILICEOUS, MODERATELY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 56%, REC 95%. -QU @ 56.3' = 11,854 PSI		56–61	36		90	RC-2											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 232+68.59 / 24.4 RT	START: 6/30/14	END: 7/2/14	PG 3 OF 3	B-105-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 644.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, CRYSTALLINE, SILICEOUS, MODERATELY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 56%, REC 95%. *(same as above)*	641.0	63 64 65 EOB 66	77		100	RC-3											CORE	

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 16.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:00 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

Photo No.	**Project:** FRA-70-13.10	**Depth:** 56.0' to 61.0'
4	**Boring:** B-105-2-13	**Runs:** RC-2

Photo No.	**Project:** FRA-70-13.10	**Depth:** 61.0' to 66.0'
5	**Boring:** B-105-2-13	**Runs:** RC-3

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 235+33.88 / 0.3' LT	EXPLORATION ID **B-107-1-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / N.A.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 704.0 (MSL) EOB: 65.8 ft.	PAGE 1 OF 3
START: 12/22/14 END: 1/2/15	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.949054, -83.016255	

MATERIAL DESCRIPTION AND NOTES	ELEV. 704.0
0.6' - TOPSOIL (7.0")	703.4
FILL: VERY STIFF, DARK GRAY AND BLACK **SILTY CLAY**, LITTLE COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST.	701.0
LOOSE, BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST. -ROOT FIBERS PRESENT IN SS-2	698.5
LOOSE, DARK BROWN **COARSE AND FINE SAND**, LITTLE CLAY, LITTLE SILT, MOIST.	696.0
DENSE TO VERY DENSE, GRAY TO BROWN **GRAVEL**, TRACE TO SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-7	678.5
DENSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST. -BORING TERMINATED @ 27.5' ON 12-22-14. OFFSET 5.0' NORTH AND CONTINUED SAMPLING @ 28.5' ON 12-30-14.	676.0
MEDIUM DENSE TO DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, WET.	

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
4-3-5	10	50	SS-1	2.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
2-4-3	9	44	SS-2	-	-	-	-	-	-	-	-	-	14	A-2-4 (V)	
6-4-3	9	78	SS-3	-	2	28	39	14	17	NP	NP	NP	10	A-3a (0)	
8-14-16	39	106	SS-4	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
16-19-20	51	100	SS-5	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
7-20-21	53	100	SS-6	-	94	3	1	1	1	19	17	2	9	A-1-a (0)	
16-20-20	52	100	SS-7	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
9-15-11	34	100	SS-8	-	-	-	-	-	-	-	-	-	13	A-1-a (V)	
17-26-26	67	100	SS-9	-	57	29	6	7	1	NP	NP	NP	12	A-1-a (0)	
12-14-16	39	100	SS-10	-	-	-	-	-	-	-	-	-	10	A-1-a (V)	
13-11-14	32	100	SS-11	-	43	43	7	6	1	NP	NP	NP	17	A-1-b (0)	
15-13-12	32	100	SS-12	-	-	-	-	-	-	-	-	-	21	A-1-a (V)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 235+33.88 / 0.3 LT	START: 12/22/14	END: 1/2/15	PG 2 OF 3	B-107-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 674.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE TO DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, WET. *(same as above)*		31–36	5 6 7	17	83	SS-13	-	69	22	7	2	0	NP	NP	NP	21	A-1-a (0)	
	667.5																	
VERY DENSE, GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		37–41	50/3"	-	100	SS-14	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
	662.0																	
HARD, GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.		42–43	30 50/4"	-	100	SS-15	4.5+	20	14	16	32	18	20	13	7	9	A-4a (3)	
	659.9	44					-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
VERY DENSE, GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		45–53	50/5"	-	100	SS-16	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
	650.2	TR	50/1"	-	0	SS-17	-	-	-	-	-	-	-	-	-	-		
LIMESTONE : LIGHT GRAY TO BLUISH GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG, THIN TO THICK BEDDED, CRYSTALLINE, FOSSILIFEROUS, STYOLITIC, SLIGHTLY TO MODERATELY FRACTURED, NARROW APERTURES, SLIGHTLY ROUGH; RQD 83%, REC 100%.		54–56	100		100	RC-1											CORE	
-QU @ 59.6' = 4,898 PSI		56–61	80		100	RC-2											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 235+33.88 / 0.3 LT	START: 12/22/14	END: 1/2/15	PG 3 OF 3	B-107-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 641.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LIMESTONE : LIGHT GRAY TO BLUISH GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG, THIN TO THICK BEDDED, CRYSTALLINE, FOSSILIFEROUS, STYOLITIC, SLIGHTLY TO MODERATELY FRACTURED, NARROW APERTURES, SLIGHTLY ROUGH; RQD 83%, REC 100%. *(same as above)*	638.2	63 64 65 EOB	80		100	RC-3											CORE	

NOTES: SEEPAGE ENCOUNTERED @ 13.5'; GROUNDWATER ENCOUNTERED INITIALLY @ 16.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	**Project:** FRA-70-13.10	**Depth:** 53.8’ to 60.8’
6	**Boring:** B-107-1-13	**Runs:** RC-1 and RC-2

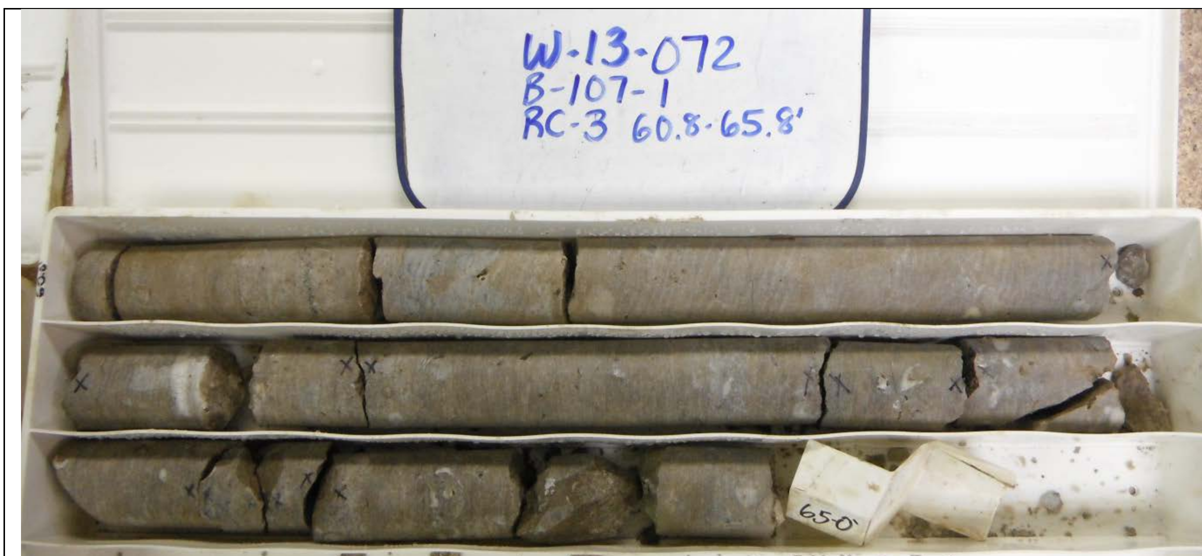


Photo No.	**Project:** FRA-70-13.10	**Depth:** 60.8’ to 65.8’
7	**Boring:** B-107-1-13	**Runs:** RC-3

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / R.B.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 237+31.12 / 23.7' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 702.7 (MSL) EOB: 62.5 ft.
START: 6/29/14 END: 6/30/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.949591, -83.016192

EXPLORATION ID B-108-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.7	DEPTHS
0.3' - TOPSOIL (4.0")	702.4	
FILL: MEDIUM DENSE, BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, DAMP. -BRICK FRAMENTS PRESENT IN IN SS-1	699.7	3
FILL: VERY STIFF, DARK BROWN **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DRY. -BRICK FRAGMENTS PRESENT IN SS-2	697.2	5.5
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, TRACE TO LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -COBBLES PRESENT @ 12.0'	684.7	18
LOOSE TO MEDIUM DENSE, BROWN AND GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET. -INTRODUCED MUD @ 20.0'		

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
7 13 8	30	44	SS-1	-	-	-	-	-	-	-	-	-	9	A-2-6 (V)
3 2 2	6	44	SS-2	3.00	19	16	17	27	21	35	26	9	15	A-4a (3)
7 10 11	30	39	SS-3	-	67	13	7	9	4	22	17	5	9	A-1-a (0)
13 12 3	22	33	SS-4	-	-	-	-	-	-	-	-	-	9	A-1-a (V)
13 15 19	49	67	SS-5	-	-	-	-	-	-	-	-	-	10	A-1-a (V)
7 10 9	27	72	SS-6	-	97	1	1	1	0	21	16	5	8	A-1-a (0)
8 9 10	27	50	SS-7	-	-	-	-	-	-	-	-	-	12	A-1-a (V)
5 5 7	17	67	SS-8	-	33	50	9	5	3	NP	NP	NP	20	A-1-b (0)
6 6 10	23	67	SS-9	-	-	-	-	-	-	-	-	-	18	A-1-b (V)
3 4 5	13	83	SS-10	-	-	-	-	-	-	-	-	-	19	A-1-b (V)
2 3 4	10	67	SS-11	-	24	53	14	6	3	NP	NP	NP	22	A-1-b (0)
1 2 4	9	50	SS-12	-	-	-	-	-	-	-	-	-	25	A-1-b (V)

HOLE SEALED

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 237+31.12 / 23.7 RT	START: 6/29/14	END: 6/30/14	PG 2 OF 3	B-108-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 672.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE TO MEDIUM DENSE, BROWN AND GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET. *(same as above)*	670.7	31–32																
STIFF, BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, WET.	668.9	32–34																
VERY DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -COBBLES PRESENT THROUGHOUT	662.7	34	28 50/6"	-	25	SS-13	1.50 -	- 65	- 17	- 7	- 7	- 4	- NP	- NP	- NP	27 9	A-6a (V) A-1-a (0)	
		39	12 24 31	80	0	SS-14	-	-	-	-	-	-	-	-	-	-		
STIFF TO VERY STIFF, BROWNISH GRAY **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, DAMP TO MOIST.		40	15	-	100	3S-14A	3.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		44	WOH 3 5	12	67	SS-15	1.50	11	14	17	38	20	20	13	7	15	A-4a (5)	
AUGER REFUSAL @ 49.5'	653.2	49	15 50/3"	-	100	SS-16	2.75	-	-	-	-	-	-	-	-	16	A-4a (V)	
		TR																
LIMESTONE : GRAY, SLIGHTLY WEATHERED TO UNWEATHERED, VERY STRONG, THICK BEDDED, CALCAREOUS, SILICEOUS, CHERTY, DOLOMITIC, SLIGHTLY TO MODERATELY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 81%, REC 92%. -QU @ 52.5' = 9,541 PSI		51	43		78	RC-1											CORE	
		55	93		100	RC-2											CORE	
		60	93		93	RC-3											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 237+31.12 / 23.7 RT	START: 6/29/14	END: 6/30/14	PG 3 OF 3	B-108-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 640.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	640.2	EOB																

NOTES: SEEPAGE ENCOUNTERED @ 11.5'; GROUNDWATER ENCOUNTERED INITIALLY @ 13.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	Project: FRA-70-13.10	Depth: 49.5' to 57.5'
8	Boring: B-108-4-13	Runs: RC-1 and RC-2

Photo No.	Project: FRA-70-13.10	Depth: 57.5' to 62.5'
9	Boring: B-108-4-13	Runs: RC-3

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 239+69.30 / 18.7' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 700.3 (MSL) EOB: 63.0 ft.
START: 6/30/14 END: 7/1/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.950226, -83.016079

EXPLORATION ID B-108-5-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 700.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.5' - TOPSOIL (6.0")	699.8																	
MEDIUM DENSE, BROWN AND GRAY **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP.		1, 2	3 5 12	25	33	SS-1	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
	697.3	3																
STIFF, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST. -ROCK FRAGMENTS AND ORGANICS PRESENT IN SS-2		4, 5	6 4 4	12	33	SS-2	2.00	20	16	15	30	19	30	17	13	18	A-6a (4)	
	694.8																	
MEDIUM DENSE, BROWN TO DARK BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST.		6, 7	2 5 6	16	0	SS-3	-	-	-	-	-	-	-	-	-	-		
		8	5	-	100	3S-3A	-	-	-	-	-	-	-	-	-	13	A-2-6 (V)	
-COBBLES PRESENT THROUGHOUT		9	3 5 9	20	0	SS-4	-	-	-	-	-	-	-	-	-	-		
-ROCK FRAGMENTS PRESENT IN 3S-4A	689.8	10	9	-	100	3S-4A	-	43	17	10	17	13	30	18	12	15	A-2-6 (0)	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		11, W, 12	8 7 7	20	39	SS-5	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
-COBBLES PRESENT THROUGHOUT		13, 14, 15	20 20 8	41	33	SS-6	-	-	-	-	-	-	-	-	-	12	A-1-a (V)	
		16, 17	11 9 10	27	100	SS-7	-	67	17	7	6	3	NP	NP	NP	13	A-1-a (0)	
	682.3	18																
MEDIUM DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, WET.		19, 20	3 5 6	16	100	SS-8	-	3	61	20	11	5	NP	NP	NP	24	A-1-b (0)	
-ROCK FRAGMENTS PRESENT IN SS-9		21, 22	3 6 9	22	78	SS-9	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	
	677.3	23																
DENSE TO VERY DENSE, GRAY TO BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP TO MOIST.		24, 25	9 12 13	36	67	SS-10	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
		26, 27	11 14 15	42	89	SS-11	-	67	15	7	8	3	17	14	3	10	A-1-a (0)	
-COBBLES PRESENT THROUGHOUT		28, 29	50/3"	-	100	SS-12	-	-	-	-	-	-	-	-	-	11	A-1-a (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV. 670.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DENSE TO VERY DENSE, GRAY TO BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP TO MOIST. *(same as above)*	668.3	31–32																
DENSE, BROWN AND BLACK **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-13	663.3	34	7 10 13	33	61	SS-13	-	43	43	8	4	2	NP	NP	NP	12	A-1-b (0)	
VERY STIFF TO HARD, GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.		39	19 9 12	30	67	SS-14	4.00	-	-	-	-	-	-	-	-	11	A-4a (V)	
		44	11 9 12	30	83	SS-15	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		49	8 9 10	27	67	SS-16	4.00	21	12	16	32	19	20	12	8	11	A-4a (3)	
-ROCK FRAGMENTS PRESENT IN SS-17 AUGER REFUSAL @ 54.5 FEET	645.8	54 TR	22 50/5"	-	100	SS-17	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)	
LIMESTONE : BLUISH GRAY TO LIGHT BROWN AND GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, SILICEOUS, FOSSILIFEROUS, VUGGY, SLIGHTLY FRACTURED TO FRACTURED, TIGHT TO OPEN APERTURES, SLIGHTLY TO VERY ROUGH; RQD 79%, REC 95%. -QU @ 56.8' = 11,933 PSI		57	79		100	RC-1											CORE	
-DOLOMITIC AND SLIGHTLY TO HIGHLY FRACTURED FROM 59.5' TO 63.0'		61	79		87	RC-2											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 239+69.30 / 18.7 RT	START: 6/30/14	END: 7/1/14	PG 3 OF 3	B-108-5-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	637.3	EOB 63																

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 11.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	**Project:** FRA-70-13.10	**Depth:** 54.5' to 63.0'
10	**Boring:** B-108-5-13	**Runs:** RC-1 and RC-2

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / R.B.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 242+23.02 / 20.7' RT	EXPLORATION ID **B-108-6-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 714.5 (MSL) EOB: 67.1 ft.	PAGE 1 OF 3
START: 7/7/14 END: 7/8/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.950860, -83.015750	

MATERIAL DESCRIPTION AND NOTES	ELEV. 714.5
0.2' - TOPSOIL (2.0")	714.3
FILL: MEDIUM DENSE TO DENSE, BROWN **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP. -BRICK AND CONCRETE FRAGMENTS PRESENT THROUGHOUT	709.0
FILL: MEDIUM STIFF, BLACK **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	706.5
FILL: MEDIUM DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP TO MOIST.	704.0
FILL: MEDIUM STIFF TO STIFF, GRAY TO BROWNISH GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE TO SOME FINE GRAVEL, DAMP TO MOIST. -ASPHALT AND COAL FRAGMENTS PRESENT IN SS-6 -BRICK FRAGMENTS PRESENT THROUGHOUT	689.0
FILL: MEDIUM STIFF TO STIFF, BROWNISH GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.	

DEPTHS: 1 – 29; W

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
9 13 10	33	67	SS-1	-	-	-	-	-	-	-	-	-	7	A-2-4 (V)
5 6 7	19	72	SS-2	-	50	16	5	15	14	NP	NP	NP	6	A-2-4 (0)
3 2 3	7	78	SS-3	-	-	-	-	-	-	-	-	-	19	A-6a (V)
7 7 4	16	11	SS-4	-	-	-	-	-	-	-	-	-	5	A-1-a (V)
5	-	100	3S-4A	-	-	-	-	-	-	-	-	-	9	A-1-a (V)
2 3 3	9	44	SS-5	1.50	22	24	11	25	18	26	15	11	12	A-6a (2)
4 3 5	12	33	SS-6	1.75	-	-	-	-	-	-	-	-	21	A-6a (V)
1 2 3	7	94	SS-7	1.00	16	12	11	28	33	31	19	12	24	A-6a (6)
2 2 3	7	67	SS-8	0.75	-	-	-	-	-	-	-	-	21	A-6a (V)
1 10 22	46	72	SS-9	1.75	-	-	-	-	-	-	-	-	24	A-6a (V)
12 5 3	12	61	SS-10	1.50	12	16	12	30	30	31	20	11	20	A-6a (5)
4 5 3	12	67	SS-11	1.75	-	-	-	-	-	-	-	-	15	A-4a (V)
4 2 4	9	44	SS-12	1.25	33	20	10	18	19	25	19	6	17	A-4a (0)

HOLE SEALED

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 242+23.02 / 20.7 RT	START: 7/7/14	END: 7/8/14	PG 2 OF 3	B-108-6-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 684.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
FILL: MEDIUM STIFF TO STIFF, BROWNISH GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP. *(same as above)* -BRICK, ASPHALT AND COAL FRAGMENTS PRESENT THROUGHOUT		31–33																
		34–35	3 3 3	9	44	SS-13	1.00	-	-	-	-	-	-	-	-	18	A-4a (V)	
	677.5	36–37																
MEDIUM DENSE TO VERY DENSE, BROWN TO GRAYISH BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		W 38																
		39–40	1 11 7	26	83	SS-14	-	-	-	-	-	-	-	-	-	11	A-1-a (V)	
-HEAVING SANDS ENCOUNTERED @ 40.0' -INTRODUCED MUD @ 40.0' -ROCK FRAGMENTS PRESENT THROUGHOUT		41–43																
		44–45	13 15 22	54	100	SS-15	-	81	9	3	4	3	NP	NP	NP	9	A-1-a (0)	
	667.5	46–47																
HARD, GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.		48																
		49–50	15 23 35	84	50	SS-16	4.50	26	14	10	29	21	20	15	5	10	A-4a (3)	
		51–53																
		54	50/5"	-	0	SS-17	-	-	-	-	-	-	-	-	-	-		
AUGER REFUSAL @ 57.5'	657.0	55–57 TR																
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, SILICEOUS, CHERTY, DOLOMITIC, PYRITIC, MODERATELY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 73%, REC 99%. -QU @ 59.6' = 8,033 PSI		58–61	55		100	RC-1											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 242+23.02 / 20.7 RT	START: 7/7/14	END: 7/8/14	PG 3 OF 3	B-108-6-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 652.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, SILICEOUS, CHERTY, DOLOMITIC, PYRITIC, MODERATELY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 73%, REC 99%. *(same as above)*	647.4	63 64 65 66 EOB 67	90		98	RC-2											CORE	

NOTES: SEEPAGE ENCOUNTERED @ 12.5'; GROUNDWATER ENCOUNTERED INITIALLY @ 38.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	**Project:** FRA-70-13.10	**Depth:** 57.5' to 67.1'
11	**Boring:** B-108-6-13	**Runs:** RC-1 and RC-2

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: CME-55 (SN 386345)	STATION / OFFSET: 245+03.67 / 17.9' LT	EXPLORATION ID B-113-2-13
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / N.A.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 10/20/14	ELEVATION: 743.3 (MSL) EOB: 99.2 ft.	PAGE 1 OF 4
START: 1/15/15 END: 1/22/15	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 92	LAT / LONG: 39.951551, -83.015294	

MATERIAL DESCRIPTION AND NOTES	ELEV. 743.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.7' - ASPHALT (8.0")	742.6																	
0.5' - AGGREGATE BASE (6.0")	742.1	1																
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST.		4 - 5	4 19 13	48	83	SS-1	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		9 - 10	30 15 50/2"	-	57	SS-2	-	54	17	10	11	8	21	15	6	7	A-1-b (0)	
		14 - 15	24 26 23	74	100	SS-3	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		19 - 20	14 4 6	15	0	SS-4	-	-	-	-	-	-	-	-	-	-		
	721.3	22																
DENSE, BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, DAMP.		24 - 25	31 15 17	48	50	SS-5	-	40	22	14	14	10	22	15	7	8	A-2-4 (0)	
	716.3	27																
VERY STIFF TO HARD, BROWN AND GRAY TO REDDISH BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY TO MOIST. -ROCK FRAGMENTS PRESENT IN SS-6		29 - 30	9 9 15	36	100	SS-6	4.5+	-	-	-	-	-	-	-	-	10	A-6a (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV. 713.3	DEPTHS	SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, BROWN AND GRAY TO REDDISH BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY TO MOIST. *(same as above)*		31–33																
		34	50/3"	-	0	SS-7	-	-	-	-	-	-	-	-	-	-		
		36–37	34 7 8	23	67	SS-8	2.50	6	16	14	32	32	30	18	12	20	A-6a (7)	
	702.8	39–40	34 17 7	36	56	SS-9	3.25	-	-	-	-	-	-	-	-	20	A-6a (V)	
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP TO WET. -ROCK FRAGMENTS PRESENT IN SS-10		41–42	14 19 23	63	89	SS-10	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		44–45	17 7 10	26	100	SS-11	-	33	27	18	14	8	NP	NP	NP	7	A-1-b (0)	
-ROCK FRAGMENTS PRESENT IN SS-12		46–47	28 26 22	72	100	SS-12	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		49–50	17 19 29	72	100	SS-13	-	46	20	10	19	5	22	19	3	9	A-1-b (0)	
		51–52	27 28 31	89	100	SS-14	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		54–55 (W at 55)	8 9 21	45	100	SS-15	-	-	-	-	-	-	-	-	-	20	A-1-b (V)	
	686.3	56–57																
VERY DENSE, GRAYISH BROWN **GRAVEL**, SOME COARSE TO FINE SAND, LITTLE SILT, TRACE CLAY, MOIST.		59–60	26 41 37	117	100	SS-16	-	60	19	8	11	2	17	15	2	7	A-1-a (0)	
	681.3	61																

PID: 89464 | BR ID: FRA-71-1503L | PROJECT: FRA-70-13.10 - PHASE 6A | STATION / OFFSET: 245+03.67 / 17.9 LT | START: 1/15/15 | END: 1/22/15 | PG 3 OF 4 | B-113-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 681.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY DENSE, GRAYISH BROWN **COARSE AND FINE SAND**, SOME SILT, LITTLE CLAY, MOIST. *(same as above)*		63																
		64	27 50/5"	-	100	SS-17	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
	676.3	65–67																
HARD, BROWNISH GRAY **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, DAMP.		68																
		69–70	29 41 48	134	100	SS-18	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)	
		71–73																
		74–75	13 14 23	56	100	SS-19	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)	
-ROCK FRAGMENTS PRESENT THROUGHOUT		76–78																
		79–80	17 23 44	101	50	SS-20	4.5+	13	13	17	40	17	20	13	7	11	A-4a (4)	
		81–83																
		84	30 50/3"	-	78	SS-21	4.5+	-	-	-	-	-	-	-	-	8	A-4a (V)	
		85–88																
	654.1	TR 89	35 50/2"	-	88	SS-22	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)	
LIMESTONE : BROWNISH GRAY, UNWEATHERED, SLIGHTLY STRONG TO STRONG, MEDIUM TO THICK BEDDED, CHERTY, DOLOMITIC, CRYSTALLINE, SLIGHTLY FRACTURED, NARROW APERTURES, SLIGHTLY ROUGH; RQD 90%, REC 91%. -QU @ 91.5' = 14,395 PSI		90–94	84		85	RC-1											CORE	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:01 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 245+03.67 / 17.9 LT	START: 1/15/15	END: 1/22/15	PG 4 OF 4	B-113-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 649.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LIMESTONE : BROWNISH GRAY, UNWEATHERED, SLIGHTLY STRONG TO STRONG, MEDIUM TO THICK BEDDED, CHERTY, DOLOMITIC, CRYSTALLINE, SLIGHTLY FRACTURED, NARROW APERTURES, SLIGHTLY ROUGH; RQD 90%, REC 91%. *(same as above)* -CHERTY FROM @ 95.5' TO 99.2'	644.1	95 96 97 98 EOB 99	97		97	RC-2											CORE	

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 55.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 376 LBS CEMENT / 100 LBS BENTONITE CHIPS / 80 GAL WATER

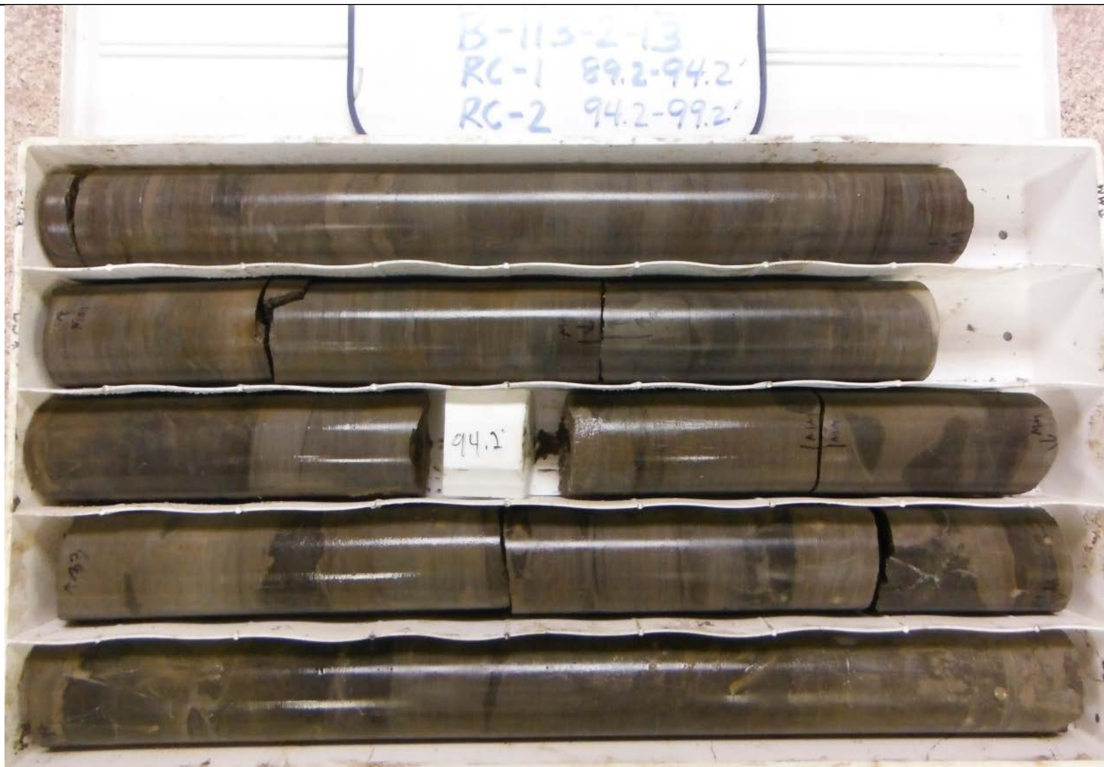


Photo No.	Project: FRA-70-13.10	Depth: 89.2' to 99.2'
12	**Boring:** B-113-2-13	**Runs:** RC-1 and RC-2

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME 750X (SN 310218)	STATION / OFFSET: 247+30.17 / 35.7' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / C.D.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 10/20/14	ELEVATION: 735.3 (MSL) EOB: 91.0 ft.
START: 1/15/15 END: 1/16/15	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 85.7	LAT / LONG: 39.951860, -83.014577

EXPLORATION ID **B-113-3-13**

MATERIAL DESCRIPTION AND NOTES	ELEV. 735.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)
0.5' - ASPHALT (6.0")	734.8																
1.0' - AGGREGATE BASE (12.0")	733.8																
FILL: MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, LITTLE SILT, TRACE CLAY, MOIST.	732.3	1–2	9 4 4	11	78	SS-1	-	-	-	-	-	-	-	-	-	11	A-3a (V)
FILL: VERY STIFF, GRAY **SANDY SILT**, SOME FINE GRVEL, LITTLE CLAY, DAMP.	728.3	3.5–5	2 5 9	20	72	SS-2	2.50	27	15	15	25	18	26	17	9	13	A-4a (2)
FILL: DENSE TO VERY DENSE, BROWN **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP.		8.5–10	12 19 16	50	89	SS-3	-	-	-	-	-	-	-	-	-	7	A-2-4 (V)
	718.3	13.5–15	14 16 14	43	83	SS-4	-	43	21	10	13	13	24	15	9	7	A-2-4 (0)
FILL: VERY STIFF, BROWN AND GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.		18.5–20	4 5 8	19	67	SS-5	2.50	-	-	-	-	-	-	-	-	14	A-6a (V)
-CINDERS AND ORGANICS PRESENT IN SS-6	712.3	21–22.5	10 10 11	30	78	SS-6	4.00	-	-	-	-	-	-	-	-	13	A-6a (V)
FILL: STIFF TO VERY STIFF, BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP. -SLAG AND COAL FRAGMENTS PRESENT IN SS-7		23.5–25	3 3 5	11	67	SS-7	2.00	9	4	24	29	34	36	20	16	16	A-6b (8)
-SHELLS PRESENT IN SS-8	707.3	26–27.5	5 6 9	21	67	SS-8	3.00	-	-	-	-	-	-	-	-	19	A-6b (V)
VERY DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, DRY.		28.5–29	50/3"	-	67	SS-9	-	-	-	-	-	-	-	-	-	3	A-1-a (V)

HOLE SEALED

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:01 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

MATERIAL DESCRIPTION AND NOTES	ELEV. 705.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	704.8																	
STIFF TO HARD, DARK BROWNISH GRAY TO BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, MOIST.		31–32	2 2 7	13	89	SS-10	2.00	-	-	-	-	-	-	-	-	28	A-6a (V)	
		34–35	8 11 13	34	89	SS-11	4.5+	0	2	18	37	43	34	19	15	21	A-6a (10)	
	697.3	36–37	9 12 12	34	67	SS-12	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
DENSE TO VERY DENSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		39–40	11 16 9	36	28	SS-13	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
	688.3	W 44–45	10 16 20	51	44	SS-14	-	29	47	13	6	5	NP	NP	NP	18	A-1-b (0)	
LOOSE TO MEDIUM DENSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET.		49–50	2 5 6	16	56	SS-15	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
	678.3	54–55	WOH 1 5	9	89	SS-16	-	23	52	15	6	4	NP	NP	NP	36	A-1-b (0)	
STIFF TO HARD, GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, MOIST.		59–60	5 7 9	23	0	SS-17	-	-	-	-	-	-	-	-	-	-		
		W 60	14	-	100	3S-17A	1.50	-	-	-	-	-	-	-	-	12	A-4a (V)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 247+30.17 / 35.7 RT	START: 1/15/15	END: 1/16/15	PG 3 OF 3	B-113-3-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 673.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
STIFF TO HARD, GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, MOIST. *(same as above)*		63																
		64	14 23 19	60	0	SS-18	-	-	-	-	-	-	-	-	-	-		
		65	37	-	100	3S-18A	2.00	-	-	-	-	-	-	-	-	13	A-4a (V)	
		69	50/5"	-	100	SS-19	-	29	15	19	21	16	19	12	7	15	A-4a (0)	
	663.3	72																
VERY DENSE, GRAY **COARSE AND FINE SAND**, SOME FINE GRAVEL, LITTLE SILT, TRACE CLAY, MOIST.		74	27 50/2"	-	100	SS-20	-	-	-	-	-	-	-	-	-	12	A-3a (V)	
	658.3	TR 77																
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.		79	28 29 50/3"	-	80	SS-21	-	-	-	-	-	-	-	-	-	13	Rock (V)	
	653.3	82																
LIMESTONE : BROWNISH GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG, THICK TO VERY THICK BEDDED, CHERTY, DOLOMITIC, PYRITIC, CRYSTALLINE, SLIGHTLY FRACTURED, NARROW APERTURES, SLIGHTLY ROUGH; RQD 93%, REC 95%.		81–86	98		98	RC-1											CORE	
-QU @ 87.8' = 5,882 PSI		86–91	87		92	RC-2											CORE	
	644.3	EOB 91																

NOTES: SEEPAGE ENCOUNTERED @ 44.5'; GROUNDWATER ENCOUNTERED INITIALLY @ 60.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER; PLACED CONCRETE

Photo No.	Project: FRA-70-13.10	Depth: 81.0' to 91.0'
13	Boring: B-113-3-13	Runs: RC-1 and RC-2

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: CME-55 (SN 386345)	STATION / OFFSET: 249+37.84 / 28.1' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 10/20/14	ELEVATION: 725.2 (MSL) EOB: 88.3 ft.
START: 5/29/14 END: 6/3/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 92	LAT / LONG: 39.952170, -83.013979

EXPLORATION ID **B-113-4-13**

MATERIAL DESCRIPTION AND NOTES	ELEV. 725.2
0.5' - TOPSOIL (6.0")	724.7
POSSIBLE FILL: VERY STIFF TO HARD, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP. -ROCK, COAL AND BRICK FRAGMENTS PRESENT TROUGHOUT	719.7
DENSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, DAMP. -ROCK FRAGMENTS PRESENT THROUGHOUT	714.7
VERY STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP.	712.2
LOOSE, BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST.	709.7
LOOSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, DAMP.	707.9
MEDIUM STIFF TO STIFF, DARK BROWN **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, MOIST. -TRACE ORGANICS PRESENT THROUGHOUT	704.7
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST. -COBBLES PRESENT THROUGHOUT -BOULDER PRESENT FROM 25.0' TO 25.5'	699.7
VERY DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP.	

DEPTHS: 1 – 29

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
6-11-6	26	78	SS-1	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	
2-6-6	18	61	SS-2	2.75	32	14	13	21	20	35	20	15	12	A-6a (3)	
11-6-7	20	44	SS-3	-	-	-	-	-	-	-	-	-	5	A-1-b (V)	
6-6-7	20	33	SS-4	-	-	-	-	-	-	-	-	-	4	A-1-b (V)	
3-3-6	14	67	SS-5	2.50	25	14	14	27	20	28	17	11	16	A-6a (3)	
5-4-3	11	83	SS-6	-	54	13	7	15	11	30	18	12	13	A-2-6 (0)	
8-4-3	11	56	SS-7	-	-	-	-	-	-	-	-	-	4	A-1-b (V)	
				1.50	-	-	-	-	-	-	-	-	16	A-4a (V)	
2-2-2	6	72	SS-8	1.00	6	13	20	41	20	32	24	8	23	A-4a (5)	
11-8-12	30	0	SS-9	-	-	-	-	-	-	-	-	-	-		
12	-	67	2S-9A	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
15-17-50/3"	-	80	SS-10	-	57	18	6	13	6	23	18	5	8	A-1-b (0)	
50/3"	-	100	SS-11	-	-	-	-	-	-	-	-	-	-	A-1-a (V)	
33-25-22	71	100	SS-12	-	63	17	7	9	4	NP	NP	NP	4	A-1-a (0)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 249+37.84 / 28.1 RT	START: 5/29/14	END: 6/3/14	PG 2 OF 3	B-113-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 695.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP. *(same as above)* -COBBLES PRESENT THROUGHOUT		31–33																
		34	50 50/0"	-	100	SS-13	-	-	-	-	-	-	-	-	-	4	A-1-a (V)	
	688.2	35–37																
DENSE TO VERY DENSE, GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST. -BOULDER PRESENT FROM 37.0' TO 38.0'		38 W																
		39	50 25 35	90	56	SS-14	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
		40–43																
		44	19 19 12	47	83	SS-15	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
-COBBLES PRESENT THROUGHOUT		45–48																
		49	10 18 13	47	100	SS-16	-	32	43	10	10	5	NP	NP	NP	17	A-1-b (0)	
		50–53																
		54	18 19 20	59	67	SS-17	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
	668.2	55–56																
VERY DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		57–58																
	665.2	59	50/3"	-	0	SS-18	-	-	-	-	-	-	-	-	-	-		
-COBBLES AND BOULDERS PRESENT THROUGHOUT		60	50/3"	-	0	2S-18A	-	-	-	-	-	-	-	-	-	-		
		61																

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:01 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 249+37.84 / 28.1 RT	START: 5/29/14	END: 6/3/14	PG 3 OF 3	B-113-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 663.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
-COBBLES AND BOULDERS PRESENT THROUGHOUT *(same as above)*		63																
		64–65	10 24 47	107	78	SS-19	-	56	18	13	9	4	NP	NP	NP	9	A-1-a (0)	
		69	50/2"	-	0	SS-20	-	-	-	-	-	-	-	-	-	-		
AUGER REFUSAL @ 72.5'	652.7	TR																
MUDSTONE : GRAY, HIGHLY WEATHERED; RQD 0%, REC 96%.	649.9	73	50 50/4"	-	100	SS-21	-	-	-	-	-	-	-	-	-	11	Rock (V)	
SHALE : GRAY, HIGHLY WEATHERED; RQD 0%, REC 100%.	649.2	76	34		98	RC-1											CORE	
LIMESTONE : GRAY TO BROWN, UNWEATHERED, STRONG TO VERY STRONG, THICK BEDDED, DOLOMITIC, CALCAREOUS, SILICEOUS, CHERTY, HIGHLY TO SLIGHTLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 77%, REC 99%. -QU @ 78.3' = 7,676 PSI		81	97		100	RC-2											CORE	
	636.9	86 / EOB 88	100		100	RC-3											CORE	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 38.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:01 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

Photo No.	Project: FRA-70-13.10	Depth: 73.3' to 83.3'
14	Boring: B-113-4-13	Runs: RC-1 and RC-2

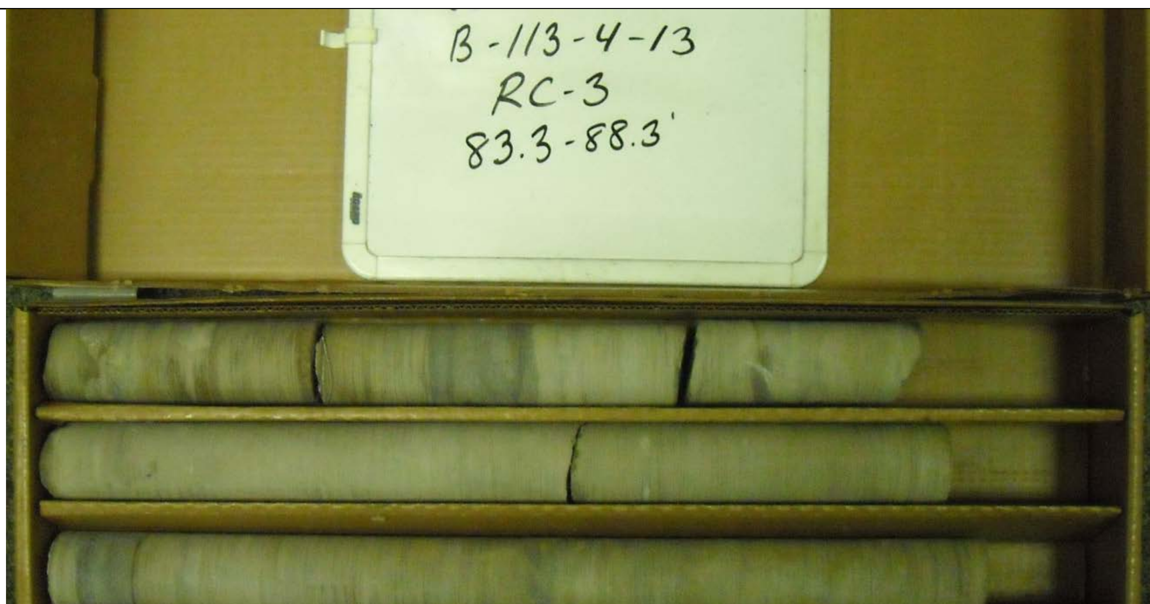


Photo No.	Project: FRA-70-13.10	Depth: 83.3' to 88.3'
15	Boring: B-113-4-13	Runs: RC-3

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 250+13.44 / 36.0' RT	EXPLORATION ID B-113-5-13
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 725.7 (MSL) EOB: 85.7 ft.	PAGE 1 OF 3
START: 5/27/14 END: 5/28/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.952236, -83.013729	

MATERIAL DESCRIPTION AND NOTES	ELEV. 725.7	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
0.5' - TOPSOIL (6.0")	725.2																	
FILL: HARD, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DRY TO DAMP.		1, 2	8 9 10	25	44	SS-1	4.25	20	13	14	30	23	33	19	14	14	A-6a (5)	
-BRICK FRAGMENTS PRESENT THROUGHOUT	720.2	3, 4, 5	8 7 6	17	67	SS-2	4.25	-	-	-	-	-	-	-	-	11	A-6a (V)	
FILL: LOOSE TO MEDIUM DENSE, BROWN TO DARK BROWN **GRAVEL WITH SAND**, LITTLE SILT, LITTLE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-3		6, 7, 8	7 3 7	13	44	SS-3	-	39	12	24	13	12	22	16	6	11	A-1-b (0)	
	715.2	9, 10	3 3 4	9	39	SS-4	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
MEDIUM DENSE, DARK BROWN TO GRAY **GRAVEL**, TRACE COARSE TO FINE SAND, TRACE SILT, DAMP TO MOIST.		11, 12, 13	7 9 9	23	33	SS-5	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
		14	9 8 8	21	0	SS-6	-	-	-	-	-	-	-	-	-	-		
		15	5	-	83	2S-6A	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
	707.7	16, 17, 18	14 11 7	23	33	SS-7	-	-	-	-	-	-	-	-	-	3	A-1-a (V)	
MEDIUM DENSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, DAMP.		19	10 11 12	30	0	SS-8	-	-	-	-	-	-	-	-	-	-		
-ROCK FRAGMENTS PRESENT IN 2S-8A	705.2	20	9	-	100	2S-8A	-	63	15	6	9	7	23	17	6	6	A-1-b (0)	
VERY STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.	702.7	21, 22, 23	7 8 9	22	94	SS-9	3.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
MEDIUM DENSE TO VERY DENSE, BROWNISH GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP TO MOIST.		24	6 5 5	13	0	SS-10	-	-	-	-	-	-	-	-	-	-		
		25	6	-	0	2S-10A	-	-	-	-	-	-	-	-	-	-		
		26, 27, 28	6 8 12	26	44	SS-11	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
-COBBLES PRESENT THROUGHOUT		29	9 15 30	58	89	SS-12	-	64	16	5	10	5	22	16	6	6	A-1-a (0)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 250+13.44 / 36.0 RT	START: 5/27/14	END: 5/28/14	PG 2 OF 3	B-113-5-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 695.7
MEDIUM DENSE TO VERY DENSE, BROWNISH GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP TO MOIST. *(same as above)* -ROCK FRAGMENTS PRESENT THROUGHOUT	688.7
MEDIUM DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST. -HEAVING SANDS ENCOUNTERED @ 38.5' -INTRODUCED MUD @ 38.5'	683.7
VERY DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, MOIST TO WET. -COBBLES AND BOULDERS PRESENT THROUGHOUT	674.7
LIMESTONE AND DOLOMITE BOULDERS -SWITCHED TO MUD ROTARY DRILLING WITH TRICONE BIT @ 57.0'	668.7
VERY DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE FINE GRAVEL, WET.	663.7

DEPTHS: 31 – 61 (W at 38.5)

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
20 17 18	45	33	SS-13	-	-	-	-	-	-	-	-	-	3	A-1-a (V)	
4 4 6	13	100	SS-14	-	14	50	12	17	7	NP	NP	NP	14	A-1-b (0)	
50/3"	-	0	SS-15	-	-	-	-	-	-	-	-	-	-		
35	-	100	2S-15A	-	73	12	4	7	4	NP	NP	NP	11	A-1-a (0)	
30 50/3"	-	67	SS-16	-	-	-	-	-	-	-	-	-	16	A-1-a (V)	
0		50	RC-1											CORE	
0		20	RC-2											CORE	
25 32 34	85	100	SS-17	-	1	31	44	19	5	NP	NP	NP	19	A-3a (0)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 250+13.44 / 36.0 RT	START: 5/27/14	END: 5/28/14	PG 3 OF 3	B-113-5-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 663.6	DEPTHS
VERY DENSE, BROWN **GRAVEL**, TRACE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. *(same as above)* -COBBLES AND BOULDERS PRESENT THROUGHOUT		
AUGER REFUSAL @ 73.7'	652.2	TR
MUDSTONE : GRAY, WEATHERED; RQD 0%, REC 86%. -0.2' LIMESTONE SEAM FROM 74.2' TO 74.4'	650.8	
LIMESTONE : GRAY, UNWEATHERED, STRONG, THIN BEDDED, CALCAREOUS, CHERTY, MODERATELY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY TO VERY ROUGH; RQD 100%, REC 100%.	650.0	
DOLOMITE : BROWN TO GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, CRYSTALLINE, CHERTY, PYRITIC, SILICEOUS, SLIGHTLY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 77%, REC 89%. -QU @ 75.7' = 8,702 PSI -QU @ 80.7' = 7,992 PSI	640.0	EOB

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
43 44 45	115	100	SS-18	-	-	-	-	-	-	-	-	-	10	A-1-a (V)	
50/2"	-	50	SS-19	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
50/2"	-	100	SS-20	-	-	-	-	-	-	-	-	-	16	Rock (V)	
21		92	RC-3											CORE	
94		100	RC-4											CORE	
60		78	RC-5											CORE	

Depth scale: 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 38.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

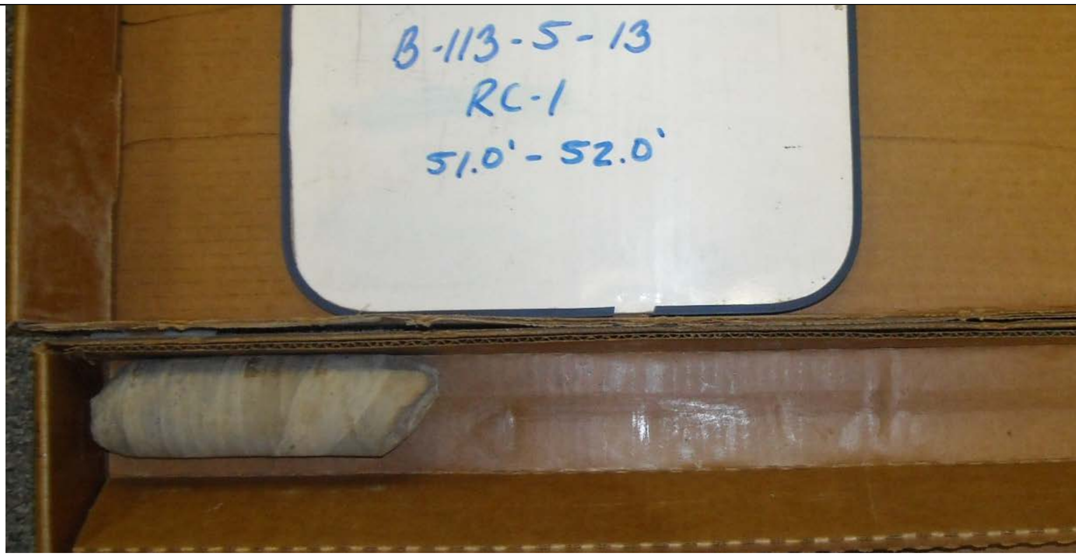


Photo No.	**Project:** FRA-70-13.10	**Depth:** 51.0 to 52.0’
16	**Boring:** B-113-5-13	**Runs:** RC-1

Photo No.	**Project:** FRA-70-13.10	**Depth:** 52.0’ to 80.7’’
17	**Boring:** B-113-5-13	**Runs:** RC-2 through RC-4

Photo No.	Project: FRA-70-13.10	Depth: 80.7' to 85.7'
18	Boring: B-113-5-13	Runs: RC-5

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 251+93.56 / 37.3' RT	EXPLORATION ID **B-113-6-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB	PAGE
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 691.5 (MSL) EOB: 63.7 ft.	1 OF 3
START: 4/23/14 END: 4/23/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.952409, -83.013137	

MATERIAL DESCRIPTION AND NOTES	ELEV. 691.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY LOOSE TO LOOSE, BLACK TO BROWN AND GRAY **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST. -ORGANICS AND PLANT MATERIAL PRESENT IN SS-1		1	1 1 2	4	33	SS-1	-	42	17	18	14	9	-	-	-	26	A-2-6 (V)	
		2, 3	1 2 2	6	56	SS-2	1.50	45	12	11	19	13	31	19	12	17	A-2-6 (0)	
		4	2 2 2	6	61	SS-3	1.50	43	14	11	19	13	32	19	13	18	A-2-6 (1)	
		5	1 2 3	7	0	SS-4	-	-	-	-	-	-	-	-	-	-		
		6	6	-	100	3S-4A	2.00	53	17	9	13	8	-	-	-	18	A-2-6 (V)	
		7, 8																
	681.7	9	2 1 1	3	0	SS-5	-	-	-	-	-	-	-	-	-	-		
LOOSE TO MEDIUM DENSE, BLACK AND GRAY **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		10	6	-	50	3S-5A	-	-	-	-	-	-	-	-	-	13	A-1-a (V)	
-INTRODUCED MUD @ 12.0'	678.7	11, 12	8 6 4	14	33	SS-6	-	72	13	6	5	4	NP	NP	NP	14	A-1-a (0)	
DENSE TO VERY DENSE, BROWN AND GRAY TO BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		13																
		14	13 32 37	100	0	SS-7	-	-	-	-	-	-	-	-	-	-		
		15	50	-	100	3S-7A	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
		16, 17	10 17 17	49	78	SS-8	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
		18																
		19	18 24 24	69	89	SS-9	-	66	17	6	7	4	NP	NP	NP	9	A-1-a (0)	
		20																
		21, 22	20 40 25	94	67	SS-10	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
		23																
		24	45 47 41	127	100	SS-11	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
		25																
		26, 27	6 37 48	123	89	SS-12	-	64	16	6	10	4	NP	NP	NP	9	A-1-a (0)	
		28																
		29	20 36 38	107	61	SS-13	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	

PID: 89464 | BR ID: FRA-71-1503L | PROJECT: FRA-70-13.10 - PHASE 6A | STATION / OFFSET: 251+93.56 / 37.3 RT | START: 4/23/14 | END: 4/23/14 | | B-113-6-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 661.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST.	661.2	31–32	8 28 39	97	100	SS-14	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		36–37	6 36 27	91	100	SS-15	-	26	32	22	13	7	NP	NP	NP	15	A-1-b (0)	
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.	652.2	TR																
		41	50/4"	-	100	SS-16	4.5+	-	-	-	-	-	-	-	-	12	Rock (V)	
AUGER REFUSAL @ 43.9 FEET	647.6																	
LIMESTONE : GRAY TO BROWN, UNWEATHERED, MODERATELY STRONG TO STRONG, VERY THICK BEDDED, CALCAREOUS, DOLOMITIC, PYRITIC, SLIGHTLY TO HIGHLY FRACTURED, TIGHT TO OPEN APERTURES, SLIGHTLY TO VERY ROUGH; RQD 88%, REC 95%. -QU @ 45.9' = 9,906 PSI		44–49	79		79	RC-1											CORE	
-QU @ 50.7' = 11,448 PSI		49–54	88		100	RC-2											CORE	
-QU @ 54.8' = 5,140 PSI		54–59	93		100	RC-3											CORE	
-RC-4 IS ARENACEOUS, FOSSILIFEROUS, STYLOLITIC, AND CONTAINS THINLY LAMINATED BLACK LENSES.		59–	90		100	RC-4											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 251+93.56 / 37.3 RT	START: 4/23/14	END: 4/23/14	PG 3 OF 3	B-113-6-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 629.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	627.8	63 EOB																

NOTES: ELEVATION OF SCIOTO RIVER SURFACE @ 699.2

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	Project: FRA-70-13.10	Depth: 43.9' to 53.7'
19	Boring: B-113-6-13	Runs: RC-1 and RC-2

Photo No.	Project: FRA-70-13.10	Depth: 53.7' to 63.7'
20	Boring: B-113-6-13	Runs: RC-3 and RC-4

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 254+41.19 / 36.0' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 690.3 (MSL) EOB: 55.7 ft.
START: 4/24/14 END: 4/25/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.952640, -83.012306

EXPLORATION ID **B-113-7-13**

MATERIAL DESCRIPTION AND NOTES	ELEV. 690.3
VERY LOOSE, GRAYISH BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, WET.	688.8
VERY LOOSE TO LOOSE, DARK GRAYISH BROWN TO BLACK **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, WET.	684.3
VERY LOOSE TO LOOSE, DARK GRAY **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, WET. -INTRODUCED MUD @ 6.4'	680.2
DENSE, GRAYISH BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -COBBLES PRESENT @ 10.6'	675.2
VERY DENSE, GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, DAMP TO MOIST. -AUGER REFUSAL @ 19.8', SWITCHED TO ROCK CORING AND CORED THROUGH 0.8' THICK LIMESTONE BOULDER, CONTINUTED SAMPLING @ 20.8'.	670.5
LIMESTONE BOULDER	669.5
VERY DENSE, GRAY **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST.	664.7
VERY DENSE, BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST.	662.7
HARD, BROWN AND GRAY **SILTY CLAY**, SOME FINE GRAVEL, LITTLE COARSE TO FINE SAND, DAMP.	
AUGER REFUSAL @ 29.8 FEET	660.5

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
WOH WOH 2	3	33	SS-1	-	24	17	29	20	10	NP	NP	NP	22	A-2-4 (0)
2 2 2	6	44	SS-2	-	8	47	34	8	3	-	-	-	31	A-1-b (V)
1 1 1	3	44	SS-3	-	12	40	37	8	3	NP	NP	NP	32	A-1-b (0)
1 2 1	4	100	SS-4	-	5	47	36	10	2	-	-	-	28	A-1-b (V)
1 1 1	3	67	SS-5	-	6	9	48	26	11	NP	NP	NP	53	A-4a (0)
2 1 3	6	33	SS-6	-	-	-	-	-	-	-	-	-	45	A-4a (V)
8 10 15	36	89	SS-7	-	56	24	7	10	3	NP	NP	NP	12	A-1-a (0)
5 8 16	35	100	SS-8	-	-	-	-	-	-	-	-	-	13	A-1-a (V)
4 35 35	101	89	SS-9	-	38	38	12	8	4	NP	NP	NP	11	A-1-b (0)
50/3"	-	100	SS-10	-	-	-	-	-	-	-	-	-	8	A-1-b (V)
0		75	RC-1											CORE
35 50/3"	-	100	SS-11	-	60	13	11	12	4	NP	NP	NP	5	A-1-b (0)
50/2"	-	100	SS-12	-	-	-	-	-	-	-	-	-	9	A-1-b (V)
28 30 35	94	67	SS-13	-	-	-	-	-	-	-	-	-	11	A-2-4 (V)
48 50 50/3"	-	80	SS-14	4.50	25	8	11	20	36	36	17	19	13	A-6b (8)

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 254+41.19 / 36.0 RT	START: 4/24/14	END: 4/25/14	PG 2 OF 2	B-113-7-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 660.3	DEPTHS
GRANITE, LIMESTONE AND DOLOMITE BOULDERS *(same as above)*	659.4	TR
SHALE : DARK GRAY, HIGHLY WEATHERED, WEAK, THIN BEDDED, MODERATELY FRACTURED, OPEN APERTURES, ROUGH; RQD 21%, REC 31%. -POINT LOAD STRENGTH @ 30.9' TO 35.7' -MEAN QU = 36 PSI -RC-4: COBBLE STUCK IN CORE BARREL PREVENTED CORE FROM ENTERING INNER BARREL. SHALE WASHED OUT DURING CORING PROCESS.	648.8	
LIMESTONE : BROWN, SLIGHTLY WEATHERED, STRONG, THICK BEDDED, DOLOMITIC, SILICEOUS, CHERTY, PYRITIC, SLIGHTLY FRACTURED, NARROW APERTURES, SLIGHTLY ROUGH; RQD 81%, REC 91%. -QU @ 42.2' = 11,119 PSI -CALCITE LENS PRESENT @ 47.6' -RC-6 AND RC-7 CONTAIN CHERT NODULES AND LENSES THROUGHOUT -QU @ 50.2' = 9,850 PSI -QU @ 51.2' = 10,087 PSI	634.6	EOB

Depth scale: 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0		93	RC-2											CORE	
45		53	RC-3											CORE	
0		0	RC-4											CORE	
58		76	RC-5											CORE	
90		100	RC-6											CORE	
100		100	RC-7											CORE	

NOTES: ELEVATION OF SCIOTO RIVER SURFACE @ 700.7

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	Project: FRA-70-13.10	Depth: 19.8' to 20.8'
21	Boring: B-113-7-13	Runs: RC-1

Photo No.	Project: FRA-70-13.10	Depth: 29.8' to 30.7'
22	Boring: B-113-7-13	Runs: RC-2

Photo No.	Project: FRA-70-13.10	Depth: 29.8' to 35.7'
23	Boring: B-113-7-13	Runs: RC-2 and RC-3

Photo No.	Project: FRA-70-13.10	Depth: 40.7' to 50.7'
24	Boring: B-113-7-13	Runs: RC-5 and RC-6

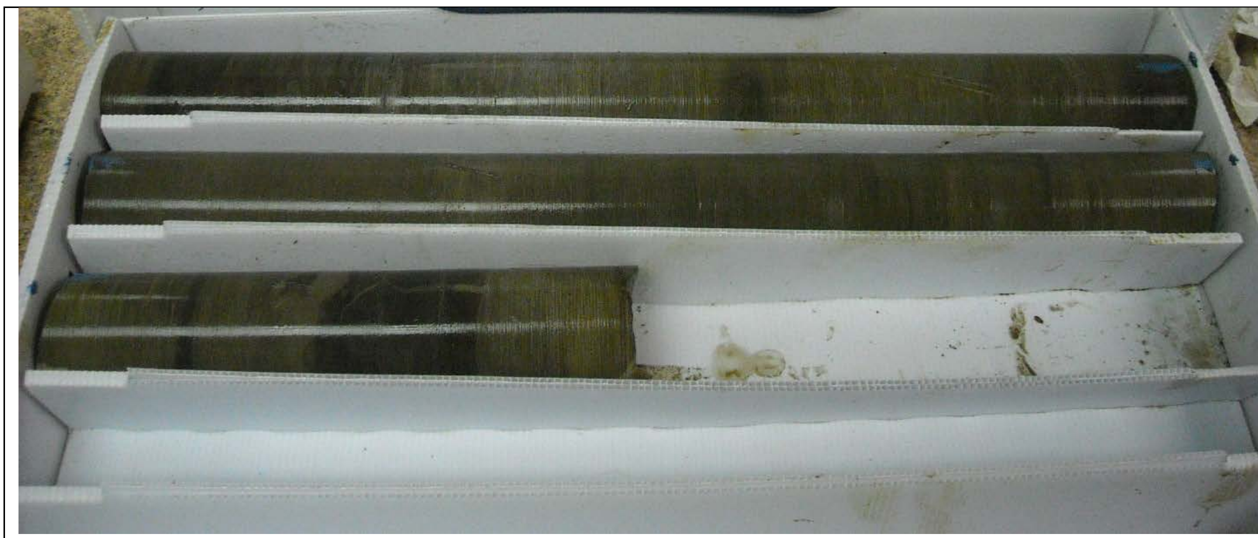


Photo No.	Project: FRA-70-13.10	Depth: 50.7' to 55.7'
25	Boring: B-113-7-13	Runs: RC-7

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 256+62.64 / 36.0' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 691.0 (MSL) EOB: 66.2 ft.
START: 4/28/14 END: 4/29/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.952843, -83.011561

EXPLORATION ID **B-113-8-13**

DEPTHS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

MATERIAL DESCRIPTION AND NOTES	ELEV. 691.0	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE, BROWNISH GRAY **GRAVEL WITH SAND**, TRACE CLAY, TRACE SILT, WET.	689.5	4 6 6	17	33	SS-1	-	43	33	19	2	3	-	-	-	20	A-1-b (V)	
LOOSE TO MEDIUM DENSE, BROWNISH GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		5 6 5	16	33	SS-2	-	57	19	11	8	5	NP	NP	NP	14	A-1-a (0)	
		5 4 2	9	44	SS-3	3.00	56	18	11	9	6	-	-	-	14	A-1-a (V)	
		3 6 6	17	44	SS-4	-	60	17	10	8	5	NP	NP	NP	15	A-1-a (0)	
-INTRODUCED MUD @ 7.2'		7 7 8	22	11	SS-5	-	-	-	-	-	-	-	-	-	17	A-1-a (V)	
	681.8	10	-	100	SS-5A	-	70	16	6	6	2	NP	NP	NP	13	A-1-a (0)	
MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, TRACE SILT, WET.	679.8	2 7 10	25	100	SS-6	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		9 6 7	19	44	SS-7	-	-	-	-	-	-	-	-	-	13	A-1-a (V)	
		7 9 17	38	67	SS-8	-	79	11	3	5	2	NP	NP	NP	14	A-1-a (0)	
	671.8	11 15 16	45	50	SS-9	-	-	-	-	-	-	-	-	-	15	A-1-a (V)	
VERY DENSE, BROWN AND GRAY **SANDY SILT**, LITTLE CLAY, TRACE TO LITTLE FINE GRAVEL, MOIST TO WET.		22 22 29	74	94	SS-10	-	6	3	27	47	17	NP	NP	NP	15	A-4a (6)	
		19 20 39	85	56	SS-11	-	-	-	-	-	-	-	-	-	19	A-4a (V)	
		18 20 50/5"	-	100	SS-12	-	16	10	25	34	15	NP	NP	NP	15	A-4a (3)	
AUGER REFUSAL @ 27.4 FEET	663.6	50/3"	-	0	SS-13	-	-	-	-	-	-	-	-	-	-		
GRANITE, LIMESTONE AND DOLOMITE BOULDERS		0		14	RC-1											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 256+62.64 / 36.0 RT	START: 4/28/14	END: 4/29/14	PG 2 OF 3	B-113-8-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 661.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
GRANITE, LIMESTONE AND DOLOMITE BOULDERS *(same as above)*		31–33																
		32–37	0		13	RC-2											CORE	
-SWITCHED TO MUD ROTARY DRILLING WITH TRICONE BIT @ 41.7'.	649.3	37–42	0		3	RC-3											CORE	
VERY DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, DAMP.	646.8	42–43.5	7 40 20	87	89	SS-14	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
HARD, GRAY **SILTY CLAY**, SOME FINE GRAVEL, LITTLE COARSE TO FINE SAND, DAMP.	644.0	45–46.5	29 32 50	119	67	SS-15	-	34	7	8	23	28	35	19	16	11	A-6b (5)	
DOLOMITE : BROWN, SLIGHTLY WEATHERED, STRONG, MEDIUM BEDDED, LIMY, SILICEOUS, PYRITIC, CHERTY, SLIGHTLY FRACTURED, TIGHT TO NARROW APERTURES, SLIGHTLY ROUGH; RQD 40%, REC 48%. -QU @ 47.1' = 12,942 PSI		TR 47–52	30		46	RC-4											CORE	
-QU @ 52.3' = 9,438 PSI	634.4	52–57	99		100	RC-5											CORE	
LIMESTONE : BROWN, SLIGHTLY WEATHERED, MODERATELY STRONG, THIN TO MEDIUM BEDDED, DOLOMITIC, SILICEOUS, CHERTY, MODERATELY TO SLIGHTLY FRACTURED, TIGHT TO NARROW APERTURES, ROUGH; RQD 90%, REC 92%. -QU @ 56.8' = 9,657 PSI		57–62	97		100	RC-6											CORE	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:02 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 256+62.64 / 36.0 RT	START: 4/28/14	END: 4/29/14	PG 3 OF 3	B-113-8-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 628.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LIMESTONE : BROWN, SLIGHTLY WEATHERED, MODERATELY STRONG, THIN TO MEDIUM BEDDED, DOLOMITIC, SILICEOUS, CHERTY, MODERATELY TO SLIGHTLY FRACTURED, TIGHT TO NARROW APERTURES, ROUGH; RQD 90%, REC 92%. *(same as above)*	624.8	63 64 65 66 EOB	83		97	RC-7											CORE	

NOTES: ELEVATION OF SCIOTO RIVER SURFACE @ 699.8

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	**Project:** FRA-70-13.10	**Depth:** 27.4' to 41.7'
26	**Boring:** B-113-8-13	**Runs:** RC-1 through RC-3

Photo No.	**Project:** FRA-70-13.10	**Depth:** 46.2' to 56.2'
27	**Boring:** B-113-8-13	**Runs:** RC-4 and RC-5

Photo No.	**Project:** FRA-70-13.10	**Depth:** 56.2' to 66.2'
28	**Boring:** B-113-8-13	**Runs:** RC-6 and RC-7

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 258+77.50 / 36.0' RT	EXPLORATION ID **B-113-9-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 706.3 (MSL) EOB: 73.0 ft.	PAGE
START: 4/1/14 END: 4/3/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.953039, -83.010839	1 OF 3

MATERIAL DESCRIPTION AND NOTES	ELEV. 706.3	DEPTHS
0.5' - TOPSOIL (6.0")	705.8	
FILL: VERY STIFF, DARK BROWN **SILT AND CLAY**, SOME FINE GRAVEL, SOME COARSE TO FINE SAND, DAMP. -ROOT FIBER AND WOOD FRAGMENTS PRESENT IN SS-1 -ROCK FRAGMENTS PRESENT THROUGHOUT -SLAG FRAGMENTS PRESENT IN SS-2	700.8	
FILL: VERY DENSE, BROWN AND GRAY **GRAVEL WITH SAND**, TRACE SILT, MOIST. -ROCK AND SLAG FRAGMENTS PRESENT IN SS-3	698.3	
FILL: MEDIUM STIFF TO STIFF, GRAY **SILTY CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST. -BRICK AND CONCRETE FRAGMENTS PRESENT IN SS-4 -TRACE ROCK FRAGMENTS PRESENT THROUGHOUT	691.3	
FILL: MEDIUM STIFF TO STIFF, DARK BROWN TO GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST TO WET. -CONSOLIDATION TEST PERFORMED @ 16.3' -QU @ 16.4' = 1,531 PSF (0.77 TSF) -CONCRETE AND SLAG FRAGMENTS PRESENT IN SS-8	685.8	W
STIFF, BROWN AND BLACK **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, MOIST TO WET. -SS-9: LL (OVEN DRIED) = 23%; LOI = 5.6%	683.3	
MEDIUM DENSE, BROWN **SANDY SILT**, LITTLE FINE GRAVEL, TRACE CLAY, MOIST. -ORGANICS PRESENT THROUGHOUT -ROCK FRAGMENTS PRESENT IN SS-10	680.8	
VERY DENSE, GRAY **SANDY SILT**, LITTLE FINE GRAVEL, TRACE CLAY, DAMP TO MOIST.		

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)
5 3 3	8	61	SS-1	3.50	-	-	-	-	-	-	-	-	12	A-6a (V)
5 4 5	12	44	SS-2	3.25	33	14	13	23	17	34	21	13	16	A-6a (2)
18 34 8	54	67	SS-3	-	-	-	-	-	-	-	-	-	12	A-1-b (V)
5 8 9	22	50	SS-4	1.25	-	-	-	-	-	-	-	-	18	A-6b (V)
4 4 9	17	67	SS-5	0.75	19	12	14	31	24	34	18	16	19	A-6b (6)
6 3 3	8	67	SS-6	1.00	-	-	-	-	-	-	-	-	19	A-6b (V)
		69	ST-7	1.50	19	10	13	31	27	32	18	14	18	A-6a (6)
3 2 2	5	39	SS-8	0.75	-	-	-	-	-	-	-	-	26	A-6a (V)
2 4 4	10	100	SS-9	-	10	4	19	46	21	32	22	10	40	A-4a (6)
7 8 10	23	56	SS-10	-	-	-	-	-	-	-	-	-	12	A-4a (V)
10 17 26	56	61	SS-11	-	13	15	30	32	10	NP	NP	NP	12	A-4a (1)
8 22 25	61	78	SS-12	-	-	-	-	-	-	-	-	-	9	A-4a (V)

PID: 89464 | BR ID: FRA-71-1503L | PROJECT: FRA-70-13.10 - PHASE 6A | STATION / OFFSET: 258+77.50 / 36.0 RT | START: 4/1/14 | END: 4/3/14 | | B-113-9-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 676.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY DENSE, GRAY **SANDY SILT**, LITTLE FINE GRAVEL, TRACE CLAY, DAMP TO MOIST. *(same as above)*	674.3	31–32																
DENSE TO VERY DENSE, GRAY TO BROWN **GRAVEL WITH SAND AND SILT**, TRACE TO LITTLE CLAY, DAMP TO MOIST. -ROCK FRAGMENTS PRESENT IN SS-13		34–35	10 15 20	45	56	SS-13	-	59	15	8	11	7	21	14	7	9	A-2-4 (0)	
-INTRODUCED MUD @ 38.5'		39–40	6 22 22	57	83	SS-14	4.50	-	-	-	-	-	-	-	-	11	A-2-4 (V)	
		44–45	9 23 30	69	67	SS-15	4.50	35	17	16	18	14	22	12	10	8	A-2-4 (0)	
	656.3	49–50	10 30 50/5"	-	0	SS-16	-	-	-	-	-	-	-	-	-	-		
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.		TR 50	30	-	100	2S-16A	-	-	-	-	-	-	-	-	-	13	Rock (V)	
		54	30 50/3"	-	100	SS-17	4.5+	-	-	-	-	-	-	-	-	10	Rock (V)	
AUGER REFUSAL @ 55.5 FEET	650.8	55																
MUDSTONE : GRAY, HIGHLY WEATHERED, VERY WEAK, MEDIUM BEDDED, FRIABLE, PYRITIC, HIGHLY FRACTURED, VERY ROUGH; RQD 0%, REC 23%. -RC-1: 0.2' LIMESTONE PIECE RECOVERED; MUDSTONE WASHED OUT DURING CORING PROCESS		56–58	0		7	RC-1											CORE	
	645.6	58–61	40		70	RC-2											CORE	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 258+77.50 / 36.0 RT	START: 4/1/14	END: 4/3/14	PG 3 OF 3	B-113-9-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 644.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LIMESTONE : GRAY TO BLACK, UNWEATHERED, VERY STRONG, THICK TO VERY THICK BEDDED, CALCAREOUS, CRYSTALLINE, CHERTY, ARENACEOUS, DOLOMITIC, PYRITIC, CALCITE DEPOSITS, STYLOLITIC, JOINTED, FRACTURED TO INTACT, OPEN APERTURES, SLIGHTLY ROUGH TO ROUGH; RQD 95%, REC 100%. *(same as above)* -QU @ 61.8' = 11,594 PSI -QU @ 64.5' = 5,086 PSI		63 – 68	100		100	RC-3											CORE	
	633.3	68 – 73 EOB	94		100	RC-4											CORE	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 21.0'; CAVE-IN DEPTH @ 20.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	**Project:** FRA-70-13.10	**Depth:** 55.5' to 68.0'
29	**Boring:** B-113-9-13	**Runs:** RC-1 through RC-3

Photo No.	**Project:** FRA-70-13.10	**Depth:** 68.0' to 73.0'
30	**Boring:** B-113-9-13	**Runs:** RC-4

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 260+75.33 / 40.2' RT	EXPLORATION ID B-114-1-13
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 709.8 (MSL) EOB: 81.0 ft.	PAGE
START: 5/13/14 END: 5/14/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.953210, -83.010169	1 OF 3

MATERIAL DESCRIPTION AND NOTES	ELEV. 709.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.3' - TOPSOIL (4.0")	709.5																	
FILL: STIFF, BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST. -ROOT FIBERS PRESENT IN SS-1	706.8	1–2	3 4 3	10	61	SS-1	2.00	-	-	-	-	-	-	-	-	15	A-6b (V)	
FILL: VERY DENSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-2	704.3	3.5	50/1"	-	100	SS-2	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
FILL: STIFF, BROWN TO DARK BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP TO MOIST. -ROOT FIBERS AND ROCK FRAGMENTS PRESENT IN SS-3		6–7	8 4 4	12	22	SS-3	1.50	14	10	12	39	25	35	19	16	18	A-6b (8)	
	699.3	9–10	4 6 3	13	56	SS-4	1.50	-	-	-	-	-	-	-	-	21	A-6b (V)	
FILL: STIFF TO VERY STIFF, DARK BROWN TO BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME TO AND FINE GRAVEL, DAMP. -CONCRETE FRAGMENTS PRESENT IN SS-5		11–12	5 3 2	7	33	SS-5	1.50	33	15	13	24	15	33	20	13	13	A-6a (2)	
		14–15	4 3 5	12	56	SS-6	4.00	-	-	-	-	-	-	-	-	13	A-6a (V)	
		16–17	5 7 8	22	39	SS-7	2.00	38	11	13	24	14	33	20	13	13	A-6a (1)	
-BRICK FRAGMENTS AND ROOT FIBERS PRESENT IN SS-8	689.3	19–20	6 7 6	19	56	SS-8	2.75	-	-	-	-	-	-	-	-	17	A-6a (V)	
VERY SOFT TO MEDIUM STIFF, BROWN TO DARK BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, MOIST.		21–22	3 2 3	7	89	SS-9	1.00	0	1	10	60	29	37	21	16	29	A-6b (10)	
	684.8	24–25	4 3 3	9	89	SS-10	0.25	-	-	-	-	-	-	-	-	25	A-6b (V)	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, LITTLE SILT, TRACE CLAY, MOIST.		25–27			0	ST-11	-	-	-	-	-	-	-	-	-	-		
		W 28.5–30	3 4 8	17	67	SS-12	-	55	23	9	10	3	22	18	4	14	A-1-a (0)	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:02 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 260+75.33 / 40.2 RT	START: 5/13/14	END: 5/14/14	PG 2 OF 3	B-114-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 679.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, LITTLE SILT, TRACE CLAY, MOIST. *(same as above)*		31 - 34																
	675.3	34 - 35	8 16 12	41	50	SS-13	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
HARD, DARK GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.							4.5+	31	13	13	26	17	23	14	9	8	A-4a (2)	
-COBBLES PRESENT FROM 36.5' TO 38.5'	672.8	35 - 37																
VERY DENSE, GRAY **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, MOIST.		37 - 38.5																
		38.5 - 39.5	18 50/6"	-	75	SS-14	-	-	-	-	-	-	-	-	-	10	A-2-4 (V)	
-BOULDER PRESENT FROM 39.5' TO 41.0'	667.8	39.5 - 42																
VERY STIFF TO HARD, GRAY TO LIGHT BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST.		42 - 43.5																
		43.5 - 45	14 17 8	36	50	SS-15	3.00	19	12	9	18	42	35	16	19	23	A-6b (9)	
		48.5 - 50	4 12 15	39	83	SS-16	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
	657.8	50 - 52																
HARD, LIGHT BROWN **CLAY**, SOME SILT, TRACE FINE SAND, TRACE FINE GRAVEL, DAMP.		52 - 53.5																
	655.3	53.5 - 54.5	20 50/6"	-	83	SS-17	4.5+	5	0	1	32	62	46	22	24	15	A-7-6 (15)	
SHALE : GRAY, WEATHERED.		TR																
		58.5 - 58.8	50/3"	-	100	SS-18	-	-	-	-	-	-	-	-	-	17	Rock (V)	
AUGER REFUSAL @ 61.0'	648.8	61																

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:02 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 260+75.33 / 40.2 RT	START: 5/13/14	END: 5/14/14	PG 3 OF 3	B-114-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 647.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SHALE : GRAY, UNWEATHERED TO SLIGHTLY WEATHERED, VERY WEAK TO WEAK, VERY THICK BEDDED, CALCAREOUS, ARGILLACEOUS, FRIABLE, MICACEOUS, FISSILE, MODERATELY TO HIGHLY FRACTURED, TIGHT TO OPEN APERTURES, SLICKENSIDED TO SLIGHTLY ROUGH; RQD 37%, REC 89%. *(same as above)*		63 – 66	76		95	RC-1											CORE	
		66 – 71	23		100	RC-2											CORE	
-POINT LOAD STRENGTH @ 73.0' TO 74.0' -MEAN QU = 255 PSI	634.8	71 – 76	23		75	RC-3											CORE	
LIMESTONE : GRAY AND BROWN, UNWEATHERED TO SLIGHTLY WEATHERED, VERY STRONG, VERY THICK BEDDED, DOLOMITIC, CALCAREOUS, CRYSTALLINE, CHERTY, PYRITIC, SILICEOUS, SLIGHTLY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 95%, REC 96%. -QU @ 76.0' = 11,340 PSI	628.8	EOB 76 – 81	94		96	RC-4											CORE	

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 28.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	Project:	Depth:
Photo No.	**Project:** FRA-70-13.10	**Depth:** 61.0’ to 71.0’
31	**Boring:** B-114-1-13	**Runs:** RC-1 and RC-2

Photo No.	**Project:** FRA-70-13.10	**Depth:** 71.0’ to 81.0’
32	**Boring:** B-114-1-13	**Runs:** RC-3 and RC-4

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 263+18.38 / 9.4' LT	EXPLORATION ID B-114-2-13
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 723.5 (MSL) EOB: 82.0 ft.	PAGE
START: 6/4/14 END: 6/5/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.953552, -83.009405	1 OF 3

MATERIAL DESCRIPTION AND NOTES	ELEV. 723.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.5' - ASPHALT (6.0")	723.0																	
FILL: MEDIUM STIFF, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP. -ROOT FIBERS AND ORGANIC ODOR PREENT IN SS-1	720.5	1 2 3	2 3 3	9	33	SS-1	1.00	-	-	-	-	-	-	-	-	14	A-6a (V)	
FILL: LOOSE, BROWN **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, MOIST. -ROOT FIBERS PRESENT IN SS-2	718.0	4 5	3 2 3	7	33	SS-2	-	-	-	-	-	-	-	-	-	7	A-2-4 (V)	
FILL: STIFF TO VERY STIFF, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP TO MOIST. -ROOT FIBERS AND SHALE FRAGMENTS PRESENT IN SS-3		6 7 8	2 4 5	13	50	SS-3	1.75	24	18	11	27	20	30	19	11	19	A-6a (3)	
		9 10	2 3 1	6	50	SS-4	1.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
	710.5	11 12 13	2 4 5	13	67	SS-5	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
FILL: LOOSE, DARK BROWN **SANDY SILT**, LITTLE FINE GRAVEL, LITTLE CLAY, WET. -BRICK AND CLAY TILE FRAGMENTS PRESENT IN SS-6	708.0	14 15	2 2 2	6	89	SS-6	-	17	33	13	22	15	NP	NP	NP	22	A-4a (0)	
VERY STIFF TO HARD, BROWN **SILT AND CLAY**, LITTLE FINE SAND, DAMP TO MOIST.		16 17 18	8 12 13	36	83	SS-7	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		19 20	5 6 7	19	100	SS-8	2.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
	700.5	21 22 23	5 8 7	22	100	SS-9	2.75	0	0	13	51	36	33	18	15	22	A-6a (10)	
SOFT, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, MOIST TO WET.		24 25	1 2 1	4	100	SS-10	0.50	-	-	-	-	-	-	-	-	28	A-6a (V)	
	695.5	26 27 28	WOH 1 1	3	100	SS-11	0.50	0	5	28	37	30	29	17	12	23	A-6a (7)	
LOOSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, WET.		W 29	2 2 3	7	78	SS-12	-	38	29	12	13	8	25	20	5	20	A-1-b (0)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 263+18.38 / 9.4 LT	START: 6/4/14	END: 6/5/14	PG 2 OF 3	B-114-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 693.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, WET. *(same as above)*	691.5	31–32																
VERY DENSE, BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		34–35	6 20 18	55	100	SS-13	-	-	-	-	-	-	-	-	-	17	A-1-b (V)	
	686.5																	
HARD, GRAY **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP. -COBBLES PRESENT @ 38.0'		39–40	20 18 20	55	39	SS-14	4.5+	11	19	12	23	35	25	16	9	13	A-4a (5)	
	681.5																	
DENSE TO VERY DENSE, BROWNISH GRAY TO GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		44–45	12 30 42	104	100	SS-15	-	-	-	-	-	-	-	-	-	16	A-1-b (V)	
		49–50	4 15 9	35	100	SS-16	-	36	36	15	6	7	NP	NP	NP	11	A-1-b (0)	
	671.5																	
HARD, BROWN TO GRAY **SILTY CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		54–55	10 18 30	69	50	SS-17	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
		59–60	18 33 19	75	78	SS-18	4.5+	9	6	4	39	42	38	20	18	12	A-6b (11)	

Depth scale: 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 263+18.38 / 9.4 LT	START: 6/4/14	END: 6/5/14	PG 3 OF 3	B-114-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 661.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
HARD, BROWN TO GRAY **SILTY CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST. *(same as above)*	660.0	63 TR																
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.		64	21 50/4"	-	90	SS-19	-	-	-	-	-	-	-	-	-	12	Rock (V)	
		65–68																
		69	50/2"	-	0	SS-20	-	-	-	-	-	-	-	-	-	-		
-0.2' CLAY SEAM @ 70.0' -LIMESTONE FRAGMENTS RECOVERED IN RC-1	651.5	70–72	0		33	RC-1											CORE	
SHALE : GRAY, MODERATELY WEATHERED TO UNWEATHERED, VERY WEAK TO WEAK, VERY THICK BEDDED, CALCAREOUS, FRIABLE, FISSILE, PYRITIC, MODERATELY TO HIGHLY FRACTURED, THIGHT TO OPEN APERTURES, SLIGHTLY TO VERY ROUGH; RQD 35%, REC 58%.		72–77	50		85	RC-2											CORE	
	643.0	77–82	43		50	RC-3											CORE	
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, THICK BEDDED, CALCAREOUS, SILICEOUS, CHERTY, DOLOMITIC, PYRITIC, MODERATELY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 100%, REC 100%.	641.5	82 EOB																

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 30.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	Project: FRA-70-13.10	Depth: 70.0 to 82.0’
33	Boring: B-114-2-13	Runs: RC-1 through RC-3

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 264+64.99 / 20.3' LT	EXPLORATION ID **B-114-3-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 724.6 (MSL) EOB: 84.0 ft.	PAGE 1 OF 3
START: 5/28/14 END: 5/29/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.953688, -83.008908	

MATERIAL DESCRIPTION AND NOTES	ELEV. 724.6
0.5' - TOPSOIL (6.0")	724.1
FILL: STIFF TO VERY STIFF, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP. -BRICK FRAGMENTS PRESENT IN SS-1 -ROOT FIBERS PRESENT IN SS-2 -BRICK AND COAL FRAGMENTS PRESENT IN SS-7 -ROOT FIBERS PRESENT IN SS-8	704.1
VERY STIFF, DARK BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP.	699.1
DENSE TO VERY DENSE, BROWNISH GRAY **GRAVEL WITH SAND, SILT, AND CLAY**, DAMP TO MOIST.	

DEPTHS: 1 – 29; W (at approx. 29)

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4 4 3	10	44	SS-1	2.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
2 3 3	9	39	SS-2	2.25	23	13	14	26	24	34	20	14	16	A-6a (4)	
3 4 4	12	44	SS-3	1.50	-	-	-	-	-	-	-	-	15	A-6a (V)	
6 6 4	14	56	SS-4	2.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
3 7 3	14	78	SS-5	1.50	21	13	15	26	25	34	20	14	17	A-6a (5)	
3 7 13	29	72	SS-6	1.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
30 45 28	106	33	SS-7	2.00	-	-	-	-	-	-	-	-	19	A-6a (V)	
12 12 17	42	33	SS-8	4.00	-	-	-	-	-	-	-	-	16	A-6a (V)	
7 7 10	25	67	SS-9	3.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
12 10 11	30	56	SS-10	3.00	22	12	14	26	26	35	19	16	15	A-6b (6)	
20 22 26	69	78	SS-11	-	-	-	-	-	-	-	-	-	7	A-2-6 (V)	
6 8 17	36	67	SS-12	1.00	45	14	11	17	13	28	17	11	14	A-2-6 (0)	

PID: 89464 | BR ID: FRA-71-1503L | PROJECT: FRA-70-13.10 - PHASE 6A | STATION / OFFSET: 264+64.99 / 20.3 LT | START: 5/28/14 | END: 5/29/14 | | B-114-3-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 694.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
								GRADATION (%)					ATTERBERG					
DENSE TO VERY DENSE, BROWNISH GRAY **GRAVEL WITH SAND, SILT, AND CLAY**, DAMP TO MOIST. *(same as above)*	692.6	31–32																
MEDIUM DENSE, BROWN TO DARK BROWNISH GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, WET.		34	4 4 4	12	33	SS-13	-	-	-	-	-	-	-	-	-	19	A-1-b (V)	
	682.6	39	5 5 11	23	89	SS-14	-	31	37	21	6	5	NP	NP	NP	19	A-1-b (0)	
VERY DENSE, BROWNISH GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, WET.	677.6	44	50/4"	-	100	SS-15	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	
VERY DENSE, BROWNISH GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST.	672.6	49	40 50/5"	-	100	SS-16	-	20	31	15	25	9	NP	NP	NP	10	A-2-4 (0)	
VERY DENSE, BROWNISH GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.	667.6	54	45 50/3"	-	100	SS-17	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
HARD, BROWN **CLAY**, AND SILT, LITTLE COARSE TO FINE SAND, DAMP.		59	5 15 30	65	67	SS-18	4.5+	0	3	10	38	49	41	21	20	19	A-7-6 (12)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 264+64.99 / 20.3 LT	START: 5/28/14	END: 5/29/14	PG 3 OF 3	B-114-3-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 662.5	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
HARD, BROWN **CLAY**, AND SILT, LITTLE COARSE TO FINE SAND, DAMP. *(same as above)*	661.1	TR — 63																
SHALE : BROWN TO GRAY, HIGHLY WEATHERED, VERY WEAK.		64	50/5"	-	100	SS-19	-	-	-	-	-	-	-	-	-	-	Rock (V)	
AUGER REFUSAL @ 69.0'	655.2	69	35 50/5"	-	100	SS-20	-	-	-	-	-	-	-	-	-	-	Rock (V)	
SHALE : GRAY, SLIGHTLY TO HIGHLY WEATHERED, VERY WEAK TO WEAK, MEDIUM BEDDED, CALCAREOUS, FRIABLE, MICACEOUS, FISSILE, FRACTURED TO HIGHLY FRACTURED, TIGHT TO OPEN APERTURES, SLIGHTLY TO VERY ROUGH; RQD 19%, REC 62%. -0.5' LIMESTONE SEAM @ 69.4'		70–74	10		44	RC-1	-	-	-	-	-	-	-	-	-	-	CORE	
-QU @ 77.5' = 259 PSI	645.2	74–79	27		80	RC-2											CORE	
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, DOLOMITIC, CALCAREOUS, SILICEOUS, CRYSTALLINE, PYRITIC, SLIGHTLY FRACTURED TO FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 91%, REC 100%.	640.6	79–84 EOB	83		92	RC-3											CORE	

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 29.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER SOIL CUTTINGS

Photo No.	**Project:** FRA-70-13.10	**Depth:** 69.0' to 79.0'
34	**Boring:** B-114-3-13	**Runs:** RC-1 and RC-2

Photo No.	**Project:** FRA-70-13.10	**Depth:** 79.0' to 84.0'
35	**Boring:** B-114-3-13	**Runs:** RC-3

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 265+98.19 / 41.6' LT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / T.P.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 724.1 (MSL) EOB: 86.2 ft.
START: 5/5/14 END: 5/20/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.953825, -83.008456

EXPLORATION ID B-114-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 724.1
0.4' - TOPSOIL (5.0")	723.7
FILL: LOOSE TO MEDIUM DENSE, BROWN TO DARK BROWN **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, MOIST TO WET. -BRICK FRAGMENTS, WOOD AND ROOT FIBERS PRESENT THROUGHOUT	718.6
FILL: STIFF TO VERY STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP TO MOIST. -ORGANICS PRESENT IN SS-4 -BRICK FRAGMENTS PRESENT IN SS-5	711.1
FILL: VERY LOOSE TO LOOSE, BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, WET. -BRICK FRAGMENTS, CINDERS AND WOOD FIBERS PRESENT THROUGHOUT	706.1
STIFF, DARK BROWN **SILT**, AND CLAY, LITTLE COARSE TO FINE SAND, MOIST.	703.6
LOOSE, DARK BROWN AND BLACK **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, MOIST.	701.1
MEDIUM DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP.	696.1
MEDIUM DENSE TO DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST.	

DEPTHS: 1 – 29

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
3 3 4	9	50	SS-1	-	-	-	-	-	-	-	-	-	22	A-2-4 (V)
4 5 6	14	39	SS-2	-	43	19	9	15	14	NP	NP	NP	20	A-2-4 (0)
3 4 9	17	61	SS-3	2.50	-	-	-	-	-	-	-	-	15	A-6a (V)
2 3 3	8	72	SS-4	2.00	12	14	7	27	40	32	20	12	21	A-6a (7)
5 9 4	17	28	SS-5	1.25	-	-	-	-	-	-	-	-	18	A-6a (V)
2 2 1	4	33	SS-6	-	42	17	13	19	9	NP	NP	NP	45	A-2-4 (0)
1 1 3	5	33	SS-7	-	-	-	-	-	-	-	-	-	36	A-2-4 (V)
2 4 6	13	67	SS-8	1.50	0	5	8	50	37	32	24	8	27	A-4b (8)
4 3 4	9	56	SS-9	-	-	-	-	-	-	-	-	-	20	A-2-4 (V)
10 12 10	28	67	SS-10	-	-	-	-	-	-	-	-	-	8	A-1-a (V)
10 13 9	28	67	SS-11	-	-	-	-	-	-	-	-	-	8	A-1-a (V)
8 11 10	27	67	SS-12	-	52	19	7	15	7	NP	NP	NP	14	A-1-b (0)

GRADATION (%): GR, CS, FS, SI, CL; ATTERBERG: LL, PL, PI; HOLE SEALED

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 265+98.19 / 41.6 LT	START: 5/5/14	END: 5/20/14	PG 2 OF 3	B-114-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 694.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE TO DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST. *(same as above)*		34 - 35	8 / 10 / 20	39	28	SS-13	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	
	687.1	37																
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		39 - 40	15 / 19 / 14	43	28	SS-14	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
-COBBLES PRESENT THROUGHOUT																		
	680.1	44																
VERY STIFF TO HARD, BROWN TO GRAY **CLAY**, LITTLE SILT, LITTLE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP TO MOIST.		44 - 45	5 / 6 / 5	14	44	SS-15	-	64	17	6	8	5	NP	NP	NP	9	A-1-a (0)	
							3.00	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		49 - 50	6 / 9 / 16	32	56	SS-16	3.75	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
		54 - 55	9 / 16 / 20	47	72	SS-17	4.5+	14	5	2	16	63	52	21	31	21	A-7-6 (18)	
		59 - 60	10 / 13 / 16	38	67	SS-18	4.5+	-	-	-	-	-	-	-	-	24	A-7-6 (V)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 265+98.19 / 41.6 LT	START: 5/5/14	END: 5/20/14	PG 3 OF 3	B-114-4-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 662.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
AUGER REFUSAL @ 63.8'	660.6	TR 63																
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK. -0.3' LIMESTONE PIECE RECOVERED IN RC-1; REMAINDER OF ROCK IN CORE RUN WASHED OUT DUE TO BARREL BEING BLOCKED BY LIMESTONE.		64	50/3"	-	100	SS-19	-	-	-	-	-	-	-	-	-	8	Rock (V)	
		65–68	0		5	RC-1											CORE	
	650.6	69–73	0		0	RC-2											CORE	
SHALE : GRAY, SLIGHTLY WEATHERED, WEAK, THIN BEDDED, CALCAREOUS, FISSILE, FRACTURED, NARROW TO OPEN APERTURES, SLIGHTLY ROUGH; RQD 26%, REC 73%.		74–76	25		43	RC-3											CORE	
-0.2' LIMESTONE SEAM @ 78.1'	644.3	77–81	63		98	RC-4											CORE	
LIMESTONE : GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, THIN TO THICK BEDDED, CHERTY, PYRITIC, DOLOMITIC, SLIGHTLY FRACTURED, OPEN APERTURES, VERY ROUGH; RQD 87%, REC 99%. -0.1' CHERT SEAM @ 84.4'	637.9	82–86 EOB	83		100	RC-5											CORE	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 30.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE CHIPS / 40 GAL WATER

Photo No.	Project: FRA-70-13.10	Depth: 73.5' to 81.2'
36	**Boring:** B-114-4-13	**Runs:** RC-3 and RC-4

Photo No.	Project: FRA-70-13.10	Depth: 81.2' to 86.2'
37	**Boring:** B-114-4-13	**Runs:** RC-5

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME-750X (SN 310218)	STATION / OFFSET: 268+86.79 / 10.9' LT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.M.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 715.3 (MSL) EOB: 89.6 ft.
START: 3/4/14 END: 3/5/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 86.8	LAT / LONG: 39.953856, -83.007412

EXPLORATION ID B-114-5-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 715.3
0.1' - TOPSOIL (1.0")	715.2
FILL: MEDIUM DENSE, DARK BROWN **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-1	712.3
FILL: STIFF, DARK BROWN TO BROWNISH GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST. -BRICK FRAGMENTS AND CINDERS PRESENT IN SS-2 -BRICK FRAGMENTS AND ROOT FIBERS PRESENT IN SS-5	702.3
MEDIUM DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-6	699.8
MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE FINE GRAVEL, DAMP. -ROCK FRAGMENTS PRESENT IN SS-7	697.3 W
DENSE TO VERY DENSE, BROWN **GRAVEL**, LITTLE TO SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-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)
1–2.5	7 6 5	16	78	SS-1	-	36	17	13	20	14	30	19	11	11	A-2-6 (0)
3.5–5	3 3 3	9	33	SS-2	2.00	-	-	-	-	-	-	-	-	14	A-6b (V)
6–7.5	2 3 4	10	44	SS-3	1.75	-	-	-	-	-	-	-	-	21	A-6b (V)
8.5–10	2 3 4	10	50	SS-4	1.75	7	7	13	39	34	38	18	20	21	A-6b (12)
11–12.5	3 3 4	10	33	SS-5	2.00	-	-	-	-	-	-	-	-	13	A-6b (V)
13.5–15	5 4 7	16	33	SS-6	-	-	-	-	-	-	-	-	-	18	A-1-b (V)
16–17.5	4 6 8	20	39	SS-7	-	10	29	33	19	9	NP	NP	NP	9	A-3a (0)
18.5–20	7 34 28	90	33	SS-8	-	-	-	-	-	-	-	-	-	9	A-1-a (V)
21–22.5	14 28 32	87	33	SS-9	-	67	13	6	10	4	NP	NP	NP	9	A-1-a (0)
23.5–25	9 13 14	39	61	SS-10	-	-	-	-	-	-	-	-	-	6	A-1-a (V)
26–27.5	12 14 14	41	50	SS-11	-	-	-	-	-	-	-	-	-	11	A-1-a (V)
28.5–30	22 13 15	41	39	SS-12	-	65	18	7	8	2	NP	NP	NP	10	A-1-a (0)

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 268+86.79 / 10.9 LT	START: 3/4/14	END: 3/5/14	PG 2 OF 3	B-114-5-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 685.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
DENSE TO VERY DENSE, BROWN **GRAVEL**, LITTLE TO SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. *(same as above)* -INTRODUCED MUD @ 30.0'	683.3	31–32																
DENSE, GRAY **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, TRACE SILT, TRACE CLAY, MOIST.		32–34																
		34–35	10 16 16	46	44	SS-13	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
	678.3	35–37																
VERY STIFF, BROWN **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, DRY.		37–38.5																
		38.5–40	6 7 9	23	50	SS-14	3.00	0	2	1	28	69	44	20	24	10	A-7-6 (14)	
	673.3	40–42																
HARD, BROWN **SILT**, "AND" CLAY, TRACE COARSE TO FINE SAND, MOIST TO WET.		42–43.5																
		43.5–45	18 23 19	61	67	SS-15	4.5+	-	-	-	-	-	-	-	-	24	A-4b (V)	
		45–48.5																
		48.5–50	14 18 20	55	44	SS-16	4.5+	0	1	1	59	39	25	15	10	17	A-4b (8)	
	661.7	50–53.5																
HARD, GRAY **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY TO DAMP.		53.5–54.4	48 50/5"	-	73	SS-17	4.5+ / 4.5+	- / -	- / -	- / -	- / -	- / -	- / -	- / -	- / -	16 / 9	A-4b (V) / A-7-6 (V)	
-SHALE AND LIMESTONE FRAGMENTS PRESENT THROUGHOUT		54.4–58.5																
		58.5–60	20 22 26	69	61	SS-18	4.5+	1	1	1	31	66	53	22	31	17	A-7-6 (19)	
		60–62																

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 268+86.79 / 10.9 LT	START: 3/4/14	END: 3/5/14	PG 3 OF 3	B-114-5-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 653.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
HARD, GRAY **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY TO DAMP. *(same as above)*	651.8	TR 63																
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.		64	50/5"	-	100	SS-19	-	-	-	-	-	-	-	-	-	20	Rock (V)	
		69	50/3"	-	100	SS-20	-	-	-	-	-	-	-	-	-	10	Rock (V)	
		74	48 50/5"	-	64	SS-21	-	-	-	-	-	-	-	-	-	10	Rock (V)	
AUGER REFUSAL @ 79.6	635.7	79	50/1"	-	0	SS-22	-	-	-	-	-	-	-	-	-	-		
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, VERY THICK BEDDED, CALCAREOUS, SILICEOUS, CRYSTALLINE, CHERT INCLUSIONS, SLIGHTLY DOLOMITIC, JOINTED, INTACT TO FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH TO ROUGH; RQD 91%, REC 98%. -QU @ 80.5' = 8,154 PSI -0.1' CALCITE DEPOSIT @ 83.1' -QU @ 84.6' = 12,237 PSI		80–84	98		100	RC-1											CORE	
	625.7	85–89 EOB	83		97	RC-2											CORE	

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 18.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER SOIL CUTTINGS

Photo No.	Project: FRA-70-13.10	Depth: 79.6' to 89.6'
38	Boring: B-114-5-13	Runs: RC-1 and RC-2

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.B.	DRILL RIG: CME-750 (SN 98048)	STATION / OFFSET: 271+12.84 / 28.4' RT	EXPLORATION ID **B-114-7-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / T.F./K.S	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-71 SB	PAGE 1 OF 3
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 4.25" HSA / HQ	CALIBRATION DATE: 4/26/13	ELEVATION: 713.3 (MSL) EOB: 84.0 ft.	
START: 2/4/14 END: 2/14/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 82.6	LAT / LONG: 39.953782, -83.006602	

MATERIAL DESCRIPTION AND NOTES	ELEV. 713.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.2' - TOPSOIL (2.0")	713.1																	
VERY STIFF, BROWN **SILT AND CLAY**, SOME FINE GRAVEL, SOME COARSE TO FINE SAND, DAMP. -ROCK FRAGMENTS PRESENT THROUGHOUT		1, 2	5-7-30	51	83	SS-1	3.25	32	14	13	22	19	33	19	14	12	A-6a (2)	
		3																
-IRON STAINING PRESENT IN SS-2	707.8	4, 5	9-11-4	21	61	SS-2	3.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
VERY STIFF, BROWN **CLAY**, AND SILT, TRACE FINE SAND, TRACE FINE GRAVEL, MOIST.		6, 7	1-4-4	11	44	SS-3	3.00	2	0	8	43	47	41	20	21	22	A-7-6 (13)	
		8																
-IRON STAINING PRESENT THROUGHOUT		9, 10	3-5-8	18	67	SS-4	3.25	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
	700.3	11, 12	8-9-9	25	89	SS-5	2.75	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
LOOSE, BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST.		13																
-COBBLES PRESENT @ 15.0'	697.8	14, 15	3-3-3	8	94	SS-6	-	30	19	21	12	18	34	17	17	14	A-2-6 (1)	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		W 16, W 17	5-9-13	30	56	SS-7	-	-	-	-	-	-	-	-	-	7	A-1-a (V)	
		18																
		19, 20	6-8-8	22	67	SS-8	-	-	-	-	-	-	-	-	-	12	A-1-a (V)	
-ROCK FRAGMENTS PRESENT THROUGHOUT		21, 22	7-8-7	21	78	SS-9	-	-	-	-	-	-	-	-	-	11	A-1-a (V)	
		23																
		24, 25	8-10-12	30	72	SS-10	-	69	12	6	8	5	NP	NP	NP	14	A-1-a (0)	
	685.3	26, 27	7-10-18	39	83	SS-11	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
VERY DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		28, 29	41-50/4"	-	60	SS-12	-	-	-	-	-	-	-	-	-	8	A-1a (V)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 271+12.84 / 28.4 RT	START: 2/4/14	END: 2/14/14	PG 2 OF 3	B-114-7-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 683.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. *(same as above)*	681.3	31–32																
VERY DENSE, GRAY **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP.		34	33 21 19	55	56	SS-13	-	58	17	8	10	7	18	14	4	8	A-1-b (0)	
	676.3																	
MEDIUM DENSE, GRAY **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST.		39	6 6 9	21	33	SS-14	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
-COBBLES PRESENT @ 40.0'	671.3																	
HARD, BROWN TO GRAY **SILTY CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. -INTRODUCED MUD @ 43.5'		44	14 14 16	41	72	SS-15	4.50	4	1	3	46	46	31	15	16	20	A-6b (10)	
		49	11 11 11	30	83	SS-16	4.25	-	-	-	-	-	-	-	-	19	A-6b (V)	
	661.3																	
HARD, GRAY **CLAY**, SOME TO "AND" SILT, TRACE TO LITTLE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP. -ROCK FRAGMENTS PRESENT IN SS-17		54	21 32 50/3"	-	100	SS-17	-	9	3	3	38	47	41	18	23	14	A-7-6 (13)	
		59	31 50/5"	-	100	SS-18	-	-	-	-	-	-	-	-	-	15	A-7-6 (V)	

Depth scale: 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 271+12.84 / 28.4 RT	START: 2/4/14	END: 2/14/14	PG 3 OF 3	B-114-7-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 651.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
HARD, GRAY **CLAY**, SOME TO "AND" SILT, TRACE TO LITTLE FINE GRAVEL, TRACE COARSE TO FINE SAND, DAMP. *(same as above)*	648.4	63–64.6	21 21 50/5"	-	59	SS-19	-	15	0	1	32	52	50	24	26	17	A-7-6 (16)	
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.		TR																
		69	18 24 50/3"	-	67	SS-20	-	-	-	-	-	-	-	-	-	12	Rock (V)	
AUGER REFUSAL @ 74.0'	639.3																	
LIMESTONE : DARK GRAY, UNWEATHERED TO SLIGHTLY WEATHERED, STRONG TO VERY STRONG, VERY THICK BEDDED, CALCAREOUS, DOLOMITIC, ARGILLACEOUS, CALCITE VEINS, CHERT INCLUSIONS, JOINTED, MODERATELY TO HIGHLY FRACTURED, OPEN APERATURES, ROUGH; RQD 50%, REC 87%. -QU @ 75.1' = 8,488 PSI		74–79	48		92	RC-1											CORE	
-QU @ 81.5' = 9,141 PSI	629.3	79–84 EOB	52		83	RC-2											CORE	

NOTES: SEEPAGE ENCOUNTERED @ 16.0'; GROUNDWATER ENCOUNTERED INITIALLY @ 17.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT 100 LBS BENTONITE 70 GALLONS WATER; COMPACTED WITH THE AUGER 300 LBS BENTONITE CHIPS AND SOIL CUTTINGS

Photo No.	Project: FRA-70-13.10	Depth: 74.0' to 84.0'
39	Boring: B-114-7-13	Runs: RC-1 and RC-2

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 273+13.25 / 16.5' LT	EXPLORATION ID **B-114-8-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	PAGE
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 714.0 (MSL) EOB: 82.0 ft.	1 OF 3
START: 3/11/14 END: 3/13/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.953894, -83.005886	

MATERIAL DESCRIPTION AND NOTES	ELEV. 714.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.3' - TOPSOIL (3.0")	713.7																	
FILL: VERY STIFF TO HARD, DARK BROWN **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.		1 – 2	7 8 8	21	50	SS-1	4.50	-	-	-	-	-	-	-	-	14	A-4a (V)	
		4 – 5	6 7 9	21	61	SS-2	3.00	21	22	14	25	18	32	22	10	17	A-4a (2)	
	708.5																	
STIFF TO VERY STIFF, BROWN TO DARK BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		6.5 – 8	3 2 1	4	33	SS-3	1.75	-	-	-	-	-	-	-	-	24	A-6b (V)	
		9 – 10	5 5 8	17	50	SS-4	2.25	-	-	-	-	-	-	-	-	21	A-6b (V)	
		11 – 12.5	2 3 4	9	89	SS-5	1.25	1	2	12	36	49	38	16	22	22	A-6b (13)	
		14 – 15	4 4 4	10	72	SS-6	1.25	-	-	-	-	-	-	-	-	22	A-6b (V)	
	698.5																	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		16 – 17.5	14 16 10	34	72	SS-7	-	64	13	9	10	4	20	19	1	10	A-1-a (0)	
		19 – 20	8 7 8	19	83	SS-8	-	-	-	-	-	-	-	-	-	11	A-1-a (V)	
	693.5																	
MEDIUM DENSE TO DENSE, DARK BROWN TO BROWN **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.		21 – 22.5	4 8 16	31	56	SS-9	-	35	42	9	10	4	NP	NP	NP	16	A-1-b (0)	
-COBBLES PRESENT THROUGHOUT		24 – 25	12 16 18	44	72	SS-10	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
-INTRODUCED MUD @ 25.0'		26 – 27.5	5 3 8	14	33	SS-11	-	-	-	-	-	-	-	-	-	30	A-1-b (V)	
	686.0																	
VERY DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DRY TO MOIST.		29 – 30	19 27 28	71	72	SS-12	-	63	18	7	9	3	NP	NP	NP	12	A-1-a (0)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 273+13.25 / 16.5 LT	START: 3/11/14	END: 3/13/14	PG 2 OF 3	B-114-8-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 684.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DRY TO MOIST. *(same as above)* -COBBLES PRESENT THROUGHOUT	677.0	31–37	50/5"	-	20	SS-13	-	-	-	-	-	-	-	-	-	3	A-1-a (V)	
HARD, GRAY **SILTY CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	672.0	37–42	5 6 8	18	33	SS-14	4.25	3	2	2	38	55	36	18	18	21	A-6b (11)	
MEDIUM DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, MOIST.	669.2	42–44.8	4 8 6	18	100	SS-15	-	-	-	-	-	-	-	-	-	14	A-1-a (V)	
VERY STIFF TO HARD, BROWN **CLAY**, SOME SILT, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.		44.8–61					3.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
			8 10 13	30	67	SS-16	3.50	15	11	10	30	34	42	20	22	18	A-7-6 (11)	
			6 42 50/5"	-	65	SS-17	4.5+	-	-	-	-	-	-	-	-	12	A-7-6 (V)	
			10 49 50/3"	-	100	SS-18	4.5+	-	-	-	-	-	-	-	-	15	A-7-6 (V)	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:03 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 273+13.25 / 16.5 LT	START: 3/11/14	END: 3/13/14	PG 3 OF 3	B-114-8-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 651.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	650.5	TR																
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK. AUGER REFUSAL @ 67.0'	647.0	64	37 50/4"	-	100	SS-19	-	-	-	-	-	-	-	-	-	15	Rock (V)	
SHALE : DARK GRAY, SLIGHTLY WEATHERED, VERY WEAK TO WEAK, THINLY LAMINATED TO LAMINATED, ARGILLACEOUS, FRACTURED TO HIGHLY FRACTURED, NARROW TO OPEN APERTURES, SLICKENSIDED TO SLIGHTLY ROUGH; RQD 19%, REC 82%. -0.5' CLAYSTONE SEAM @ 67.7' -CLAYSTONE SEAMS PRESENT FROM 69.5' TO 72.0'	642.0	67–72	19		82	RC-1											CORE	
CLAYSTONE : DARK GRAY, SLIGHTLY WEATHERED, VERY WEAK TO WEAK, THINLY LAMINATED BEDDING TO VERY THIN BEDDED, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURES, ROUGH; RQD 12%, REC 97%. -QU @ 74.8' = 92 PSI	637.0	72–77	12		97	RC-2											CORE	
LIMESTONE : GRAY, UNWEATHERED, STRONG, VERY THICK BEDDED, CALCAREOUS, CHERTY, PYRITIC, JOINTED, SLIGHTLY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURES, SLIGHTLY ROUGH; RQD 92%, REC 98%. -QU @ 78.4' = 12,567 PSI	632.0	77–82 EOB	92		98	RC-3											CORE	

NOTES: SEEPAGE ENCOUNTERED @ 16.0'; GROUNDWATER ENCOUNTERED INITIALLY @ 18.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT 50 LBS BENTONITE 40 GALLONS WATER AND SOIL CUTTINGS

Photo No.	Project: FRA-70-13.10	Depth: 67.0' to 77.0'
40	**Boring:** B-114-8-13	**Runs:** RC-1 and RC-2

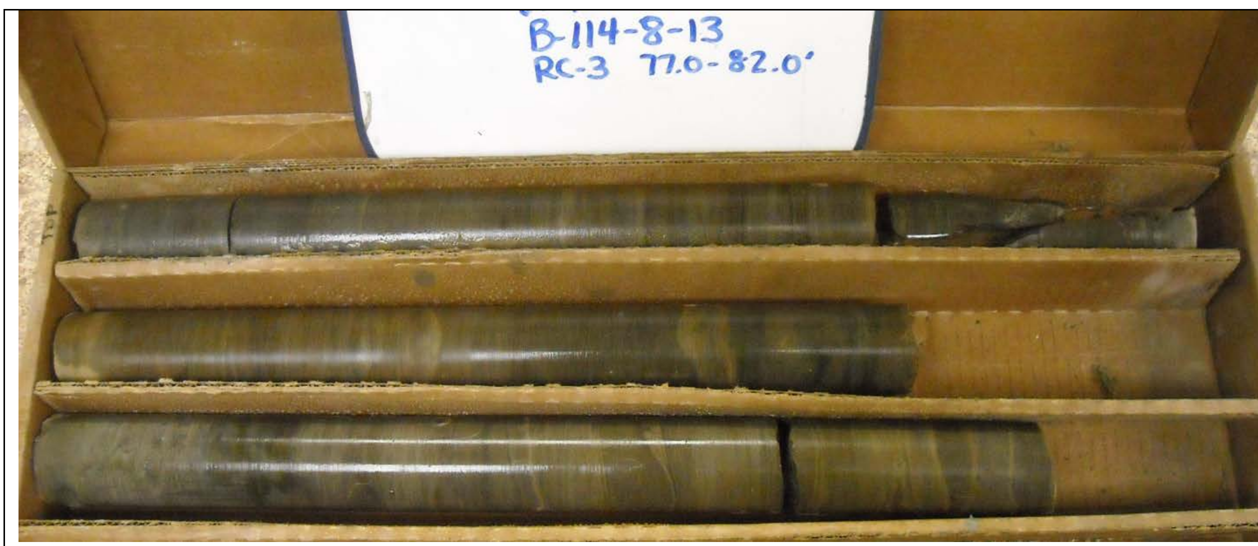


Photo No.	Project: FRA-70-13.10	Depth: 77.0' to 82.0'
41	**Boring:** B-114-8-13	**Runs:** RC-3

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 275+07.50 / 4.7' RT	EXPLORATION ID B-114-9-13
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / B.Z.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 714.0 (MSL) EOB: 90.0 ft.	PAGE 1 OF 3
START: 5/9/14 END: 5/13/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.953788, -83.005201	

MATERIAL DESCRIPTION AND NOTES	ELEV. 714.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.4' - TOPSOIL (4.5")	713.6																	
FILL: LOOSE TO MEDIUM DENSE, BROWN AND BLACK **GRAVEL WITH SAND AND SILT**, TRACE CLAY, DAMP TO MOIST. -ROOT FIBERS PRESENT IN SS-1		1–2	2 9 9	23	33	SS-1	-	56	15	10	13	6	-	-	-	8	A-2-4 (V)	
-BRICK FRAGMENTS PRESENT IN SS-2 AND SS-3		4–5	3 4 5	12	33	SS-2	-	60	10	7	15	8	33	23	10	23	A-2-4 (0)	
-CINDERS PRESENT IN SS-3	706.0	6–7	2 2 2	5	67	SS-3	-	-	-	-	-	-	-	-	-	28	A-2-4 (V)	
STIFF, DARK BROWN **SILTY CLAY**, TRACE COARSE TO FINE SAND, MOIST.		9–10	1 2 4	8	67	SS-4	1.75	-	-	-	-	-	-	-	-	29	A-6b (V)	
-COBBLE PRESENT @ 13.5'	701.0	11–12	2 3 4	9	89	SS-5	2.00	0	1	7	53	39	37	20	17	22	A-6b (11)	
MEDIUM DENSE TO DENSE, BROWN **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST TO WET. -LARGE PIECE OF ROCK RECOVERED IN SS-6		14–15	3 4 7	14	44	SS-6	-	-	-	-	-	-	-	-	-	-		
		16–17	3 5 7	16	61	SS-7	-	49	11	17	19	4	NP	NP	NP	11	A-1-b (0)	
-COBBLES PRESENT THROUGHOUT		19–20	16 14 17	40	67	SS-8	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		21–22	3 4 7	14	61	SS-9	-	33	31	16	14	6	26	20	6	18	A-1-b (0)	
		W 23																
		24–25	21 17 20	48	0	SS-10	-	-	-	-	-	-	-	-	-	-		
	688.5	25	15	-	100	3S-10A	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		26–27	12 9 9	23	44	SS-11	-	82	10	3	4	1	NP	NP	NP	10	A-1-a (V)	
		29	16 21 21	54	39	SS-12	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 275+07.50 / 4.7 RT	START: 5/9/14	END: 5/13/14	PG 2 OF 3	B-114-9-13

MATERIAL DESCRIPTION AND NOTES	ELEV. (684.0)
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. *(same as above)* -INTRODUCED MUD @ 30.0'	682.0
VERY DENSE, BROWN **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, LITTLE SILT, TRACE CLAY, WET.	677.0
HARD, BROWN **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, DAMP.	672.0
VERY DENSE, GRAY **COARSE AND FINE SAND**, LITTLE SILT, TRACE FINE GRAVEL, MOIST.	667.0
VERY STIFF TO HARD, GRAY **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, MOIST.	655.0
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.	

DEPTHS: 31 – 61 (TR at 59)

DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
34	30 50/3"	-	100	SS-13	-	11	18	51	15	5	NP	NP	NP	24	A-3a (0)	
38.5	50/5"	-	100	SS-14	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
44	17 19 20	51	67	SS-15	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
49	2 9 12	27	72	SS-16	3.50	0	1	2	28	69	42	19	23	21	A-7-6 (14)	
54	9 11 16	35	78	SS-17	4.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
59	18 50/4"	-	100	SS-18	4.5+	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
					-	-	-	-	-	-	-	-	-	10	Rock (V)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 275+07.50 / 4.7 RT	START: 5/9/14	END: 5/13/14	PG 3 OF 3	B-114-9-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 651.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK. *(same as above)*		63 – 64	50/5"	-	100	SS-19	-	-	-	-	-	-	-	-	-	16	Rock (V)	
AUGER REFUSAL @ 65.0'	649.0	65																
SHALE : DARK GRAY, SLIGHTLY WEATHERED, VERY WEAK TO WEAK, VERY THIN TO THIN BEDDED, CALCAREOUS, FISSILE, PYRITIC, MODERATELY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURES, SLIGHTLY ROUGH; RQD 64%, REC 79%. -ARGILLACEOUS FROM 65.6' TO 75.0'		65 – 70	26		33	RC-1											CORE	
-0.3' LIMESTONE SEAM @ 71.5'		70 – 75	58		88	RC-2											CORE	
-ARGILLACEOUS FROM 78.6' TO 85.0'		75 – 80	83		100	RC-3											CORE	
-POINT LOAD STRENGTH @ 78.8' TO 81.3' -MEAN QU = 176 PSI	629.0	80 – 85	90		93	RC-4											CORE	
LIMESTONE : GRAY, UNWEATHERED, VERY STRONG, MEDIUM TO THICK BEDDED, CALCAREOUS, DOLOMITIC, PYRITIC, MODERATELY FRACTURED TO FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 89%, REC 93%.	624.0	85 – 90 EOB	89		93	RC-5											CORE	

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 23.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	**Project:** FRA-70-13.10	**Depth:** 65.0' to 75.0'
42	**Boring:** B-114-9-13	**Runs:** RC-1 and RC-2

Photo No.	**Project:** FRA-70-13.10	**Depth:** 75.0' to 85.0'
43	**Boring:** B-114-9-13	**Runs:** RC-3 and RC-4

Photo No.	Project: FRA-70-13.10	Depth: 85.0' to 90.0'
44	Boring: B-114-9-13	Runs: RC-5

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: CME 750X (SN 310218)	STATION / OFFSET: 276+68.11 / 2.0' RT
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / C.D.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 10/20/14	ELEVATION: 714.6 (MSL) EOB: 75.5 ft.
START: 1/13/15 END: 1/14/15	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 85.7	LAT / LONG: 39.953729, -83.004634

EXPLORATION ID **B-115-1-13**

MATERIAL DESCRIPTION AND NOTES	ELEV. 714.6
0.8' - TOPSOIL (9.0")	713.8
FILL: VERY STIFF, DARK BROWN **SANDY SILT**, SOME CLAY, LITTLE FINE GRAVEL, DAMP. -ORGANICS PRESENT IN SS-1 -BRICK AND ROCK FRAGMENTS PRESENT IN SS-2	709.1
FILL: HARD, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP. -ROCK FRAGMENTS PRESENT THROUGHOUT	704.1
FILL: LOOSE TO MEDIUM DENSE, BROWN **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP.	699.1
FILL: STIFF TO VERY STIFF, BROWN **SANDY SILT**, LITTLE FINE GRAVEL, LITTLE CLAY, DAMP. -IRON STAINING PRESENT IN SS-8	695.6
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT THROUGHOUT -COBBLES PRESENT @ 26.0'	686.6
DENSE TO VERY DENSE, BROWN TO DARK GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST.	

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
2 7 6	19	61	SS-1	4.00	-	-	-	-	-	-	-	-	19	A-4a (V)
3 4 5	13	67	SS-2	3.50	13	14	10	42	21	32	22	10	21	A-4a (6)
4 6 7	19	50	SS-3	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)
6 5 6	16	61	SS-4	4.5+	14	10	15	33	28	33	22	11	16	A-6a (6)
5 5 5	14	61	SS-5	-	-	-	-	-	-	-	-	-	2	A-1-a (V)
2 3 3	9	56	SS-6	-	73	12	5	7	3	NP	NP	NP	2	A-1-a (0)
2 4 4	11	78	SS-7	2.00	14	13	31	29	13	25	18	7	13	A-4a (1)
11 14 13	39	83	SS-8	4.00	-	-	-	-	-	-	-	-	15	A-4a (V)
				-	-	-	-	-	-	-	-	-	10	A-1-a (V)
3 7 4	16	33	SS-9	-	-	-	-	-	-	-	-	-	13	A-1-a (V)
4 10 11	30	78	SS-10	-	64	11	15	7	3	NP	NP	NP	9	A-1-a (0)
10 49 49	140	50	SS-11	-	-	-	-	-	-	-	-	-	9	A-1-a (V)
11 10 11	30	100	SS-12	-	58	5	28	5	4	23	18	5	16	A-1-b (0)

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 7/12/19 13:04 - U:\GI8\PROJECTS\2013\W-13-072.GPJ

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 276+68.11 / 2.0 RT	START: 1/13/15	END: 1/14/15	PG 2 OF 3	B-115-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 684.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DENSE TO VERY DENSE, BROWN TO DARK GRAY **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST. *(same as above)* -ROCK FRAGMENTS PRESENT THROUGHOUT		31, 32, 33																
		34–35	7 24 27	73	78	SS-13	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
	677.6	36, 37																
VERY STIFF, GRAY **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, DAMP.		38																
		39–40	15 16 28	63	78	SS-14	4.00	2	6	12	47	33	26	16	10	15	A-4a (8)	
		41, 42, 43																
-ROCK FRAGMENTS PRESENT IN SS-15		44–45	18 32 48	114	89	SS-15	3.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
	667.6	46, 47																
VERY DENSE, GRAY **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST.		48																
		49–50	6 35 44	113	78	SS-16	-	-	-	-	-	-	-	-	-	10	A-2-6 (V)	
	662.6	51, 52																
VERY DENSE, GRAY **GRAVEL**, TRACE COARSE TO FINE SAND, TRACE SILT, MOIST.		53																
		54–55	12 36 50/5"	-	71	SS-17	-	89	1	9	1	0	NP	NP	NP	8	A-1-a (0)	
		56, 57, 58																
		59–60	36 44 28	103	44	SS-18	-	-	-	-	-	-	-	-	-	16	A-1-a (V)	
		61																

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 276+68.11 / 2.0 RT	START: 1/13/15	END: 1/14/15	PG 3 OF 3	B-115-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 652.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY DENSE, GRAY **GRAVEL**, TRACE COARSE TO FINE SAND, TRACE SILT, MOIST. *(same as above)*	651.1	63																
MUDSTONE : GRAY, HIGHLY WEATHERED TO UNWEATHERED, VERY WEAK TO WEAK, LAMINATED TO THICK BEDDED, FRIABLE, FISSILE, CALCAREOUS, SLIGHTLY TO HIGHLY WEATHERED, MODERATELY TO HIGHLY FRACTURED, THIGHT APERTURES, SLIGHTLY TO VERY ROUGH; RQD 69%, REC 97%.		TR 64 65	100		100	RC-1											CORE	
-0.3' LIMESTONE SEAM @ 68.5' -0.3' LIMESTONE SEAM @ 70.1"		66 67 68 69 70	40		95	RC-2											CORE	
-0.3' LIMESTONE SEAM @ 73.5'	639.1	71 72 73 74 75 EOB	87		96	RC-3											CORE	

NOTES: SEEPAGE ENCOUNTERED @ 24.0'; GROUNDWATER INITIALLY ENCOUNTERED @ 29.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	Project: FRA-70-13.10	Depth: 63.5' to 70.5'
45	**Boring:** B-115-1-13	**Runs:** RC-1 and RC-2

Photo No.	Project: FRA-70-13.10	Depth: 70.5' to 75.5'
46	**Boring:** B-115-1-13	**Runs:** RC-3

PROJECT: FRA-70-13.10 PHASE 6A	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55-LC (SN 360485)	STATION / OFFSET: 276+71.11 / 2' RT	EXPLORATION ID B-115-1A-19
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	
PID: 89464 SFN: NA	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 3/28/13	ELEVATION: 714.3 (MSL) EOB: 96.0 ft.	PAGE 1 OF 4
START: 1/9/20 END: 1/10/20	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 73.2	LAT / LONG: 39.953728, -83.004624	

MATERIAL DESCRIPTION AND NOTES	ELEV. 714.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
NO SAMPLING DOWN TO 66.0'		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29																

PID: 89464	SFN: NA	PROJECT: FRA-70-13.10 PHASE 6A	STATION / OFFSET: 27671.11, 2' RT.	START: 1/9/20	END: 1/10/20	PG 2 OF 4	B-115-1A-19

MATERIAL DESCRIPTION AND NOTES	ELEV. 684.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
NO SAMPLING DOWN TO 66.0' *(continued)*		31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61																

PID: 89464	SFN: NA	PROJECT: FRA-70-13.10 PHASE 6A	STATION / OFFSET: 27671.11, 2' RT.	START: 1/9/20	END: 1/10/20	PG 3 OF 4	B-115-1A-19

MATERIAL DESCRIPTION AND NOTES	ELEV. 652.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
NO SAMPLING DOWN TO 66.0' *(continued)*	648.3	TR 63–66																
CLAYSTONE : GRAY, HIGHLY TO SEVERELY WEATHERED, VERY WEAK TO WEAK, VERY THIN TO THIN BEDDED, MODERATELY FRACTURED, TIGHT TO NARROW, ROUGH, BLOCKY/DISTURBED/SEAMY, VERY POOR.	643.3	66–71	35		37	NQ-1											CORE	
SHALE : GRAY TO DARK GRAY, MODERATELY TO HIGHLY WEATHERED, WEAK TO SLIGHTLY STRONG, LAMINATED TO THIN, FISSILE, HIGHLY TO MODERATELY FRACTURED, TIGHT TO NARROW, VERY ROUGH, BLOCKY/DISTURBED/SEAMY, VERY POOR.		71–76	60		97	NQ-2											CORE	
-HIGHLY FRACTURED FROM 79.5'-82.8'		76–81	50		95	NQ-3											CORE	
-PYRITE NODULES PRESENT @ 81.5'	631.8																	
LIMESTONE : GRAY AND BROWN, SLIGHTLY WEATHERED, STRONG TO VERY STRONG, CRYSTALLINE, THIN TO MEDIUM BEDDED, MODERATELY TO SLIGHTLY FRACTURED, TIGHT TO NARROW, SLIGHTLY ROUGH, BLOCKY/DISTURBED/SEAMY, FAIR. -PYRITE NODULES/VEINS AND DISSEMINATED PYRITE OBSERVED FROM 83.0-86.0' -BOTH PARALLEL PLANAR LAMINATIONS AND BIOTURBATED ZONES FROM 82.5'-90.3'		81–86	73		93	NQ-4											CORE	
-CHERT INCLUSIONS AND NODULES PRESENT FROM 86.0'-90.3'		86–91	62		97	NQ-5											CORE	
-FOSSILIFEROUS BELOW 93.5', LIGHT GRAY AND GRAY		91–94	93		95	NQ-6											CORE	

02019 NEW STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 4/6/20 12:52 - U:\GI8\PROJECTS\2013\W-13-072 -2020.GPJ

PID: 89464	SFN: NA	PROJECT: FRA-70-13.10 PHASE 6A	STATION / OFFSET: 27671.11, 2' RT.	START: 1/9/20	END: 1/10/20	PG 4 OF 4	B-115-1A-19

MATERIAL DESCRIPTION AND NOTES	ELEV. 620.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	618.3	95 EOB 96																

NOTES: GROUNDWATER NOT OBSERVED DUE TO ADDITION OF WATER FOR ROCK CORING PROCESS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 100 GAL WATER

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-13.10 - PHASE 6A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 277+71.50 / 20.2' LT	EXPLORATION ID B-115-2-13
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-71 SB	PAGE 1 OF 3
PID: 89464 BR ID: FRA-71-1503L	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/26/13	ELEVATION: 716.1 (MSL) EOB: 90.7 ft.	
START: 5/13/14 END: 5/16/14	SAMPLING METHOD: SPT / RC	ENERGY RATIO (%): 77.7	LAT / LONG: 39.953734, -83.004257	

MATERIAL DESCRIPTION AND NOTES	ELEV. 716.1
0.6' - TOPSOIL (7.0")	715.5
FILL: MEDIUM DENSE, BROWN AND BLACK **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS AND ROOT FIBERS PRESENT IN SS-1	713.1
FILL: MEDIUM DENSE, BROWN TO DARK BROWN **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, MOIST. -CINDERS, BRICK AND SLAG FRAGMENTS PRESENT THROUGHOUT	708.1
FILL: VERY LOOSE TO LOOSE, GRAY AND BLACK **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, WET. -ORGANICS PRESENT THROUGHOUT	703.1
FILL: VERY LOOSE TO LOOSE, GRAY AND BLACK **COARSE AND FINE SAND**, SOME SILT, TRACE CLAY, TRACE FINE GRAVEL, WET. -ROCK FRAGMENTS AND ORGANICS PRESENT IN SS-6 -PETROLEUM ODOR AND WOOD FRAGMENTS PRESENT IN SS-7	698.1
FILL: VERY LOOSE TO LOOSE, BLACK **SILT**, SOME COARSE TO FINE SAND, SOME CLAY, TRACE FINE GRAVEL, WET. -ORGANICS PRESENT THROUGHOUT	693.1
MEDIUM DENSE TO DENSE, BROWNISH GRAY TO BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -CERAMIC TILE FRAGMENTS PRESENT IN SS-10 -ROCK FRAGMENTS PRESENT IN SS-11	

W (water level at ~8.5 ft)

DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
1–2.5	7 8 9	22	67	SS-1	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
3.5–5	4 5 4	12	72	SS-2	-	29	26	11	18	16	NP	NP	NP	17	A-2-4 (0)	
6–7.5	4 5 6	14	56	SS-3	-	-	-	-	-	-	-	-	-	13	A-2-4 (V)	
8.5–10	2 2 3	6	100	SS-4	-	30	33	13	15	9	NP	NP	NP	21	A-1-b (0)	
11–12.5	3 1 2	4	56	SS-5	-	-	-	-	-	-	-	-	-	34	A-1-b (V)	
13.5–15	WOH 1 1	3	100	SS-6	-	4	33	29	24	10	NP	NP	NP	49	A-3a (0)	
16–17.5	2 2 6	10	78	SS-7	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
18.5–20	3 2 1	4	56	SS-8	-	1	11	14	53	21	NP	NP	NP	68	A-4b (8)	
21–22.5	2 3 3	8	83	SS-9	-	-	-	-	-	-	-	-	-	41	A-4b (V)	
23.5–25	6 9 13	28	44	SS-10	-	-	-	-	-	-	-	-	-	13	A-1-a (V)	
26–27.5	11 11 13	31	44	SS-11	-	61	21	6	7	5	NP	NP	NP	13	A-1-a (0)	
28.5–30	10 13 15	36	11	SS-12	-	-	-	-	-	-	-	-	-	-	A-1-a (V)	

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 277+71.50 / 20.2 LT	START: 5/13/14	END: 5/16/14	PG 2 OF 3	B-115-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 686.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE TO DENSE, BROWNISH GRAY TO BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. *(same as above)*	684.1	31	25	-	0	3S-12A	-	-	-	-	-	-	-	-	-	-		
VERY DENSE, DARK BROWN TO GRAY **GRAVEL**, "AND" COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -COBBLES PRESENT @ 33.5'		34	10 30 35	84	72	SS-13	-	50	32	5	7	6	NP	NP	NP	12	A-1-a (0)	
-ROCK FRAGMENTS PRESENT THROUGHOUT -HEAVING SANDS ENCOUNTERED @ 38.5' -INTRODUCED MUD @ 38.5'	674.1	39	22 32 48	104	94	SS-14	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
HARD, GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, MOIST.	669.1	44	10 12 45	74	78	SS-15	4.50	0	5	5	32	58	40	19	21	24	A-6b (12)	
DENSE, GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, WET.	664.1	49	12 12 18	39	94	SS-16	-	-	-	-	-	-	-	-	-	23	A-2-4 (V)	
GRAY **SILTY CLAY.**		53.5	50/2"	-	0	SS-17	-	-	-	-	-	-	-	-	-	-		
-BOULDER ENCOUNTERED @ 55.0' -SOIL TYPE DETERMINED FROM FIELD OBSERVATION OF AUGER CUTTINGS		58.5	50/3"	-	0	SS-18	-	-	-	-	-	-	-	-	-	-		

PID: 89464	BR ID: FRA-71-1503L	PROJECT: FRA-70-13.10 - PHASE 6A	STATION / OFFSET: 277+71.50 / 20.2 LT	START: 5/13/14	END: 5/16/14	PG 3 OF 3	B-115-2-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 654.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
GRAY **SILTY CLAY.** *(same as above)*	652.6	TR 63																
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK. AUGER REFUSAL @ 64.2'	651.9	64	45 50/2"	-	100	SS-19	-	-	-	-	-	-	-	-	-	9	Rock (V)	
CLAYSTONE : GRAY, UNWEATHERED, VERY WEAK TO SLIGHTLY STRONG, MEDIUM BEDDED, MODERATELY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 45%, REC 95%.		65	58		100	RC-1											CORE	
		66–70	0		88	RC-2											CORE	
	640.4	71–75	86		100	RC-3											CORE	
SHALE : GRAY, HIGHLY WEATHERED, WEAK, MEDIUM BEDDED, CALCAREOUS, FISSILE, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH; RQD 0%, REC 37%.		76–80	0		30	RC-4											CORE	
	632.9	81–85	45		75	RC-5											CORE	
LIMESTONE : GRAYISH BROWN, SLIGHTLY WEATHERED, MODERATELY STRONG, THIN TO MEDIUM BEDDED, CHERTY, PYRITIC,, MODERATELY FRACTURED, OPEN APERTURES, SLIGHTLY TO VERY ROUGH; RQD 91%, REC 100%. -QU @ 83.2' = 8,867 PSI		86–90	92		100	RC-6											CORE	
	625.4	EOB																

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 8.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE POWDER / 40 GAL WATER

Photo No.	Project: FRA-70-13.10	Depth: 64.2' to 70.7'
47	Boring: B-115-2-13	Runs: RC-1 and RC-2

Photo No.	Project: FRA-70-13.10	Depth: 70.7' to 80.7'
48	Boring: B-115-2-13	Runs: RC-3 and RC-4

Photo No.	**Project:** FRA-70-13.10	**Depth:** 80.7' to 85.7'
49	**Boring:** B-115-2-13	**Runs:** RC-5 and RC-6

APPENDIX IV

HISTORIC BORING LOGS

B-001-S-57

SHEET 3

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

LOG OF BORING

CO., RT. NO., SEC. FRA-40-12.30 REAR ABUTMENT BRIDGE NO. FRA-40-1230 OVER SCIOTO RIVER

LOCATION: T.H. 1 STA. 21+75 OFFSET C.L. FED. NO.

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
724.0	0			
	2			
	4			
	6			
	8			
714.0	10			
	12	18	67403	GRAY AND BROWN SILTY GRAVEL
	14			
709.0	16	45	67404	GRAVEL
	18			
704.0	20	30	67405	BROWN CLAY
	22			
	24			
699.0	26	70	67406	GRAY AND BROWN SILTY SANDY GRAVEL
	28			
694.0	30			
	32	52	67407	GRAVEL
	34			
689.0	36	33	67408	GRAVEL

7-24-57

B-001-S-57

SHEET 7

LOG OF BORING (CONTINUED)

BRIDGE NO. FRA-40-1230 T.H. 1

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
	38			
684.0	40	74	67409	SANDY GRAVEL
	42			
680.0	44	90	67410	SILTY SANDY GRAVEL
	46			
	48			
674.0	50	155	67411	GRAY GRAVELLY SANDY CLAY
	52			
	54			
	56			BOULDERS
667.0	58			
	60			
	62			
661.0	64			LARGE BOULDERS
				BOTTOM OF HOLE
	66			
	68			
	70			
	72			
	74			
	76			
	78			
	80			
	82			

B-005-S-57

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

LOG OF BORING

CO., RT. NO., SEC. FRA-40-12.30 BRIDGE NO. FRA-40-1230
SECOND PIER OVER SCIOTO RIVER

LOCATION: T.H. 5 STA. 24+00 OFFSET C.L. FED. NO.

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
681.7	0			
	2			
	4			
676.4	6	24	66517	GRAY SANDY GRAVEL
	8			
671.4	10			
	12	73	66518	GRAY SILTY GRAVELLY SAND
	14			
666.4	16	180	66519	GRAY SILTY SANDY GRAVEL
663.4	18	--	---	COARSE SAND
661.4	20			
	22	117	66520	GRAY SILTY GRAVEL
	24			
656.4	26	20	----	FINE SAND, SILT AND SMALL GRAVEL
	28			
652.7 652.1	30	600	66521	WEATHERED SHALE
				TOP OF ROCK
	32			
				HARD DENSE GRAY LIMESTONE
	34			
645.7	36			BOTTOM OF HOLE

98
7-24-57

B-006-D-68

LOG OF BORING

Date Started 7-17-68
Date Completed 7-18-68
Boring No. B-6

Sampler Type SS Dia 1 3/8"
Casing: Length 48' Dia. 3 1/2"
Station & Offset 523+90, 04' Lt. (2nd Pier)

Water Elev. ______
Surface Elev. 702.0'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
702.0	0														
	2														
	4														
697.0	6	10/14			Brown Silty Sandy Gravel	1	70	11	6	-13	-	NP	NP	12	A-1-a
694.5	8				No Sample Recovered (Hole Caved in)		V	I		S	U		A	L	
692.0	10	15/18			Gray Silty Gravel	2	78	6	6	-10	-	NP	NP	25	A-1-a
	12														
	14														
687.0	16	13/19			Brown Silty Sandy Gravel	3	55	23	8	-14	-	NP	NP	12	A-1-a
	18														
682.0	20	12/9			Gray Silty Gravelly Sand	4	37	35	18	-10	-	NP	NP	13	A-1-b
	22														
	24														
677.0	26	10/10			Gray Silty Sand	5	14	25	42	-19	-	NP	NP	20	A-3a
	28														
672.0	30	50/*			Gray Sandy Gravel	6	53	39	5	- 3	-	NP	NP	5	A-1-a
	32														
	34														
667.0	36	10/13			Gray Gravelly Sandy Silt	7	24	14	16	21	25	19	7	11	A-4a
	38														
662.0	40	8/10			Gray Gravelly Sandy Silt	8	23	12	14	27	24	19	6	12	A-4a
	42														
	44														
657.0	46	9/9			Gray Gravelly Sandy Silt	9	21	11	14	30	24	19	7	15	A-4a
654.0	48				TOP OF ROCK										
	50		1.9	0.1											
	52		5.0	0.0	Limestone, light-gray, hard, dense, chert seams, crystalline, few fossils. Core Loss 1%.										
647.0	54				BOTTOM OF BORING										

*Refusal

B-009-D-68

LOG OF BORING

Date Started 7-23-68
Date Completed 7-25-68
Boring No. B-9

Sampler Type SS   Dia 1 3/8"
Casing: Length 50'   Dia. 3 1/2"
Station & Offset 525+26, 24' Rt. (4th Pier)

Water Elev. ______
Surface Elev. 703.8'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
703.8	0														
701.3	2														
698.8	4				No Sample Recovered		V	I		S		U	A	L	
	6	7/8			Brown Silty Gravelly Sand	1	24	20	19	22	15	NP	NP	10	A-4a
696.3	8				No Sample Recovered		V	I		S		U	A	L	
693.8	10														
691.3	12				Brownish-Gray Gravelly Sand (Wash Sample) (Heaved in Casing 0.3')	2	37	44	9	-10	-	NP	NP	20	A-1-b
	14				No Sample Recovered		V	I		S		U	A	L	
688.8	16	50* (0.6')			Brownish-Gray Silty Sandy Gravel	3	61	14	8	8	9	NP	NP	9	A-1-b
	18														
683.8	20	22/28			Brownish-Gray Silty Sandy Gravel	4	68	13	6	7	6	NP	NP	23	A-4a
	22														
	24														
678.8	26	16/18			Brownish-Gray Gravel	5	V	I S	U	A	L	NP	NP	2	-
	28														
673.8	30	11/11			Gray Gravelly Sand	6	44	46	6	- 4	-	NP	NP	6	A-1-b
	32														
	34														
668.8	36	4/9			Brown and Gray Clayey Silt	7	13	2	4	34	47	26	8	24	A-4a
	38														
663.8	40														
	42	50* (0.6')			Gray Sandy Gravel	8	67	16	7	5	5	-	-	8	-
	44														
658.8	46	13/15			Gray Silty Sand	9	0	3	72	- 25	-	NP	NP	17	A-3a
	48														
653.8	50														
	52	50* (0.7')			Brown Sandy Gravel	10	V	I	S	U		A	L	5	
650.8	54				TOP OF ROCK										
	56		4.7	0.3	Limestone, gray, hard, dense. Core Loss 6%.										
645.8	58				BOTTOM OF BORING										

*Refusal

B-009-S-57

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

LOG OF BORING

CO., RT. NO., SEC. FRA-40-12.30 FOURTH PIER BRIDGE NO. FRA-40-1230 OVER SCIOTO RIVER

LOCATION: T.H. 9 STA. 26+25 OFFSET C.L. FED. NO.

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
686.1	0			
	2			
	4			
	6			
	8			
677.4	10	39	67412	GRAY SILTY GRAVELLY SAND
	12			
672.4	14	171	67413	GRAY AND BROWN SILTY GRAVELLY SAND
	16			
669.4	18		67414	GRAVEL AND STONE FRAGMENTS
	20			
	22			
	24			
662.4	26	39	67415	SANDY GRAVEL
660.4	28	190	67416	SANDY GRAVEL
	30			
654.4	32			
	34	70	67417	GRAVEL TOP OF ROCK
651.4	36			FIRM GRAY CLAY SHALE

AE
7-24-67

LOG OF BORING (CONTINUED)

BRIDGE NO. FRA-45-1230 T.H. 9

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
648.7	38			FIRM GRAY CLAY SHALE
646.0	40			DENSE GRAY LIMESTONE WITH DARK WAVY PARTINGS
	42			BOTTOM OF HOLE
	44			
	46			
	48			
	50			
	52			
	54			
	56			
	58			
	60			
	62			
	64			
	66			
	68			
	70			
	72			
	74			
	76			
	78			
	80			
	82			

RS
7-24-57

LOG OF BORING

Date Started 7-11-68
Date Completed 7-17-68
Boring No B-12

Sampler Type SS Dia 1 3/8"
Casing Length 58' Dia 3 1/2"
Station & Offset 498+62, 65' Rt. (5th Pier)

Water Elev
Surface Elev 705.0'

Elev.	Depth	Std Pen (N)	Rec ft	Loss ft	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class
705.0	0														
702.5	2														
	4				No Sample Recovered (Hole Caved in)		V	I		S	U		A	L	
700.0	6	9/9			Brown Sandy Gravel	1	51	43	3	-3	-	NP	NP	13	A-1-a
697.5	8				No Sample Recovered (Hole Caved in)		V	I		S	U		A	L	
695.0	10	6/3			Brown Silty Sandy Gravel	2	49	27	9	-15	-	NP	NP	18	A-1-b
	12														
	14														
690.0	16	3/1			Brown Sandy Gravel	3	67	24	3	-6	-	NP	NP	10	A-1-a
	18														
685.0	20	23/24			Brown Silty Sandy Gravel	4	68	12	8	-12	-	NP	NP	8	A-1-a
	22														
	24														
680.0	26	15/12			Brown Sandy Gravel	5	70	16	6	-8	-	NP	NP	12	A-1-a
	28														
675.0	30														
	32	50*/ (0.4')			Gray Gravel	6	90	8	1	-1	-	NP	NP	4	A-1-a
	34														
670.0	36	50* (0.9')			Gray Silty Sandy Gravel	7	38	23	11	17	11	16	4	14	A-2-4
	38														
665.0	40	11/15			Gray Sandy Gravelly Silt	8	35	9	13	23	20	NP	NP	12	A-4a
	42														
	44														
660.0	46	50* (0.6')			Gray Gravelly Sandy Silt	9	25	17	16	19	23	19	6	15	A-4a
	48														
655.0	50	11/12			Gray Silty Sandy Gravel	10	44	11	12	15	18	-	-	10	A-2-4
	52														
	54														
650.0	56	23/27			Gray Silty Sandy Gravel	11	52	15	13	-20	-	NP	NP	10	A-1-b
647.0	58				TOP OF ROCK										
645.0	60		2.0	0.0	Limestone, light-gray, hard, dense, crystalline, few small fossils. No Core Loss.										

BOTTOM OF BORING

*Refusal

B-013-S-57

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

LOG OF BORING

CO., RT. NO., SEC. FRA -40-12.30 BRIDGE NO. FRA-40-1230
SIXTH PIER OVER SCIOTO RIVER

LOCATION: T.H. 13 STA. 28+73 OFFSET C.L. FED. NO.

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
691.4	0			
	2			
	4			
686.9	6	15	66522	GRAVEL
682.9	8	90	66523	BROWN SANDY GRAVEL
	10			
	12			
	14			
676.9	16	27	66524	GRAY AND BROWN GRAVELLY SAND
	18			
672.9	20	30	66525	BROWN AND GRAY SANDY GRAVEL
	22			
	24			
666.9				
665.9	26	200	66526	BROWN AND GRAY SANDY GRAVEL
			66527	STONE FRAGMENTS
	28			
661.4	30	200	66528	GRAY SOFT SHALE TOP OF ROCK
660.9				
	32		66529	SHALE
	34			
	36			

AS
7-29-57

B-013-S-57

LOG OF BORING (CONTINUED)

BRIDGE NO. FRA-40-1230 T.H. 13

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
	38			SHALE
652.4	40			BOTTOM OF HOLE
	42			
	44			
	46			
	48			
	50			
	52			
	54			
	56			
	58			
	60			
	62			
	64			
	66			
	68			
	70			
	72			
	74			
	76			
	78			
	80			
	82			

BB
7-24-57

B-015-D-68

LOG OF BORING

Date Started 7-19-68 Sampler Type SS Dia 1 3/8" Water Elev. ______

Date Completed 7-23-68 Casing: Length 43' Dia. 3 1/2"

Boring No. B-15 Station & Offset 528+57, 28' Lt. (Wingwall) Surface Elev. 704.2'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
704.2	0														
	2														
	4														
699.2	6	12/6			Brown Silty Gravelly Sand	1	37	26	15	10	12	NP	NP	11	A-1-b
696.7	8	5/7			Brown Sand (Wash Sample)	2	0	4	86	-10	-	NP	NP	23	A-3
694.2	10	9/10			Brown Silty Sandy Gravel	3	42	15	11	25	7	NP	NP	12	A-2-4
	12														
	14														
689.2	16	13/8			Brown Sandy Gravel	4	78	14	4	- 4	-	NP	NP	9	A-1-a
	18														
684.2	20														
	22	16/12			Gray Gravel	5	85	10	2	- 3	-	NP	NP	5	A-1-a
	24														
679.2	26	11/12			Gray Sandy Gravel	6	80	10	5	- 5	-	NP	NP	8	A-1-a
	28														
674.2	30														
	32				Gray Sand with Boulders (Wash Sample)	7	0	76	15	- 9	-	NP	NP	21	A-1-b
	34														
669.2	36	13/16			Gray Sandy Gravelly Silt	8	32	11	14	19	24	18	6	11	A-4a
	38														
664.2	40														
	42	9/9			Brownish-Gray Silty Gravelly Sand	9	29	19	20	10	22	17	3	12	A-2-4
661.2															

BOTTOM OF BORING

B-018-E-68

SDUCTION

5 1978

LOG OF BORING

Date Started 7-10-68
Date Completed 7-12-68
Boring No B-18

Sampler Type SS Dia 1 3/8"
Casing Length 55' Dia 3 1/2"
Station & Offset 500+61, 35' Rt. (Forward Abutment)

Water Elev ______
Surface Elev 723.5'

Elev.	Depth	Std Pen (N)	Rec ft.	Loss ft.	Description	Sample No	% Agg	% C S	% F S	% Silt	% Clay	L L	P I	W C	SHT Class
723.5	0														
	2														
	4														
718.5	6	50* (0.8')			Brown Gravel and Sand	1	-	-	-	-	-	-	-	17	Visual
	8														
713.5	10	19/14			Brown Sand (Wash Sample)	2	0	72	12	-16	-	NP	NP	23	A-1-b
	12														
	14														
708.5	16	12/28			Brown Silty Sandy Gravel	3	40	8	13	23	16	NP	NP	13	A-4a
	18														
703.5	20	7/12			Brown Gravel and Sand	4	-	-	-	-	-	-	-	12	Visual
	22														
	24														
698.5	26	4/5			Brown Sandy Gravelly Clay	5	29	11	14	22	24	24	11	14	A-6a
	28														
693.5	30	3/5			Brown Gravelly Sandy Silt	6	19	14	19	23	25	24	7	16	A-4a
	32														
	34														
688.5	36	6/4			Brown Sandy Clay	7	10	12	18	28	32	26	11	16	A-6a
	38														
683.5	40	8/7			Brown Sandy Clay	8	11	14	15	29	31	26	11	18	A-6a
	42														
	44														
678.5	46	50* (0.6')			No Sample Recovered - Boulders(Driller's Des.)		V	I		S		U	A	L	
	48														
673.5	50														
	52	50*/ (0.4')			Gray Sandy Gravelly Silt	9	24	8	13	30	25	22	9	10	A-4a
	54														
668.5	56	50* (0.6')			Gray Sandy Silt	10	9	6	12	46	27	21	6	11	A-4a
	58														
663.5	60														
	62	50* (0.6')			Brownish-Gray Sandy Gravelly Silt	11	23	9	14	29	25	23	9	11	A-4a
	64														
658.5	66	50/*			Gray Silty Sandy Gravel	12	42	5	11	25	17	NP	NP	10	A-4a
657.0					TOP OF ROCK										
	68		3.5	0.0	Limestone, medium-gray, hard, dense, cherty. Core Loss 2%.										
	70														
	72		4.8	0.2											
	74														
648.5					BOTTOM OF BORING										

*Refusal

B-015-W-68

LOG OF BORING

Date Started 7-30-68
Date Completed 7-30-68
Boring No. B-15

Sampler Type SS Dia 1 3/8"
Casing: Length 42' Dia. 3 1/2"
Station & Offset 499+97, 36' Lt. (7th Pier)

Water Elev. ____
Surface Elev. 709.0'

Elev.	Depth	Std. Pen (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
709.0	0														
	2														
	4														
704.0	6	24/31			Brown Silty Sandy Gravel	1	35	14	16	19	16	NP	NP	7	A-2-4
701.5	8	19/35			Brownish-Gray Silty Sandy Gravel	2	42	17	9	21	11	NP	NP	7	A-2-4
699.0	10	24/22			Brownish-Gray Silty Sandy Gravel	3	48	15	16	13	8	NP	NP	12	A-1-b
	12														
	14														
694.0	16	28/34			Brownish-Gray Silty Sandy Gravel	4	47	17	11	12	13	NP	NP	9	A-1-b
	18														
689.0	20	26/36			Brownish-Gray Silty Sandy Gravel with Boulders	5	39	21	13	15	12	NP	NP	9	A-2-4
	22														
	24														
684.0	26	50*/ (0.4')			Brownish-Gray Gravelly Sand with Boulders	6	V	I		S	U	A	L	12	-
	28														
679.0	30	14/18			Brown Silty Sandy Gravel	7	61	12	9	10	8	NP	NP	12	A-1-b
	32														
	34														
674.0	36	24/22			Brown Sandy Gravel with Boulders	8	72	15	8	2	3	NP	NP	5	A-1-a
	38														
669.0	40	26/37			Gray Silty Gravel with Boulders	9	60	8	6	13	13	NP	NP	8	A-2-4
666.0	42														
	44														
	46		3.7	1.3	Limestone Boulders and Clay with Pebbles										
661.0	48				TOP OF ROCK										
	50														
	52		5.0	0.0	Limestone, gray, thinly-bedded, hard, dense, few cherty zones, pyritiferous. No Core Loss.										
656.0					BOTTOM OF BORING										

*Refusal

B-020-S-57

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

LOG OF BORING

CO., RT. NO., SEC. FRA-40-12.30 BRIDGE NO. FRA-40-1230
FORWARD ABUTMENT OVER SCIOTO RIVER

LOCATION: T.H. 20 STA. 32+05 OFFSET 19' LT FED. NO.

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
726.0	0			
	2			
	4			
721.0	6	----	-----	SAND & SMALL GRAVEL
	8			
	10			
715.0	12	10	67937	SANDY GRAVEL
	14			
	16			
709.0	18	17	-----	SANDY GRAVELLY SILT
	20			
705.0	22	25	67938	SANDY GRAVELLY SILT
	24			
700.0	26			
	28	15	67939	BROWN CLAY
	30			
695.0	32	23	67940	BROWN SILTY GRAVEL
	34			
690.0	36	25	67941	GRAVEL

AB
7-24-57

B-020-S-57

SHEET 11

LOG OF BORING (CONTINUED)

BRIDGE NO. FRA-40-1230 T.H. 20

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
	38			
	40			
658.5		75	67942	SILTY GRAVEL
	42			BOTTOM OF HOLE
	44			
	46			
	48			
	50			
	52			
	54			
	56			
	58			
	60			
	62			
	64			
	66			
	68			
	70			
	72			
	74			
	76			
	78			
	80			
	82			

APPENDIX V

LABORATORY TEST RESULTS

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

UNCONFINED COMPRESSION

ASTM D -2166

PROJECT	FRA-70-13.10
JOB No.	W-13-072
BORING	B-113-9-13
STATION / OFFSET	258+77.50, 36.0' Rt.
SAMPLE No. / DEPTH	ST-7 / 16.4 ft
DATE OF TESTING	4/15/2014
TESTED BY	T.P.

Soil Description: Dark brown SILT AND CLAY, little coarse to fine sand, little fine gravel.
Soil Classification: ODOT A-6a

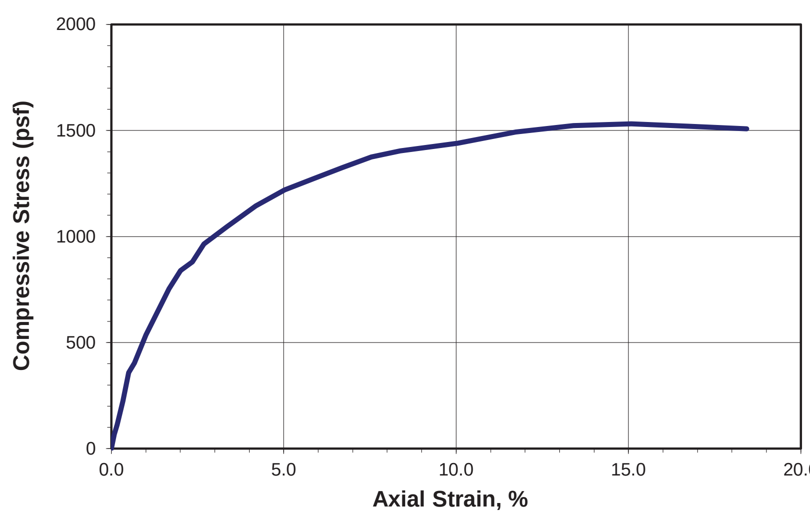
Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	32	18	14	19	10	13	31	27

DIAMETER, D_0	2.852 in	72.4 mm	STRAIN RATE	1.00 %/min
AREA, A_0	6.388 in^2	41.2 cm^2	WET SOIL + PAN MASS	1367.7 g
HEIGHT, L_0	5.969 in	151.61 mm	PAN MASS	89 g
VOLUME, V_0	38.132 in^3	624.87 cm^3	DRY SOIL + PAN MASS	1149.7 g
MACH. RATE	0.597 in/min		WET DENSITY	127.75 lb/ft^3
WATER CONT.	20.55 %		DRY DENSITY	105.97 lb/ft^3

UNCONFINED COMPRESSION STRESS, q_u	**1,531 psf**	0.77 tsf
AXIAL STRAIN @ FAILURE		15.08 %
HAND PENETROMETER		1.50 tsf

Failure Sketch

Unconfined Compression Test



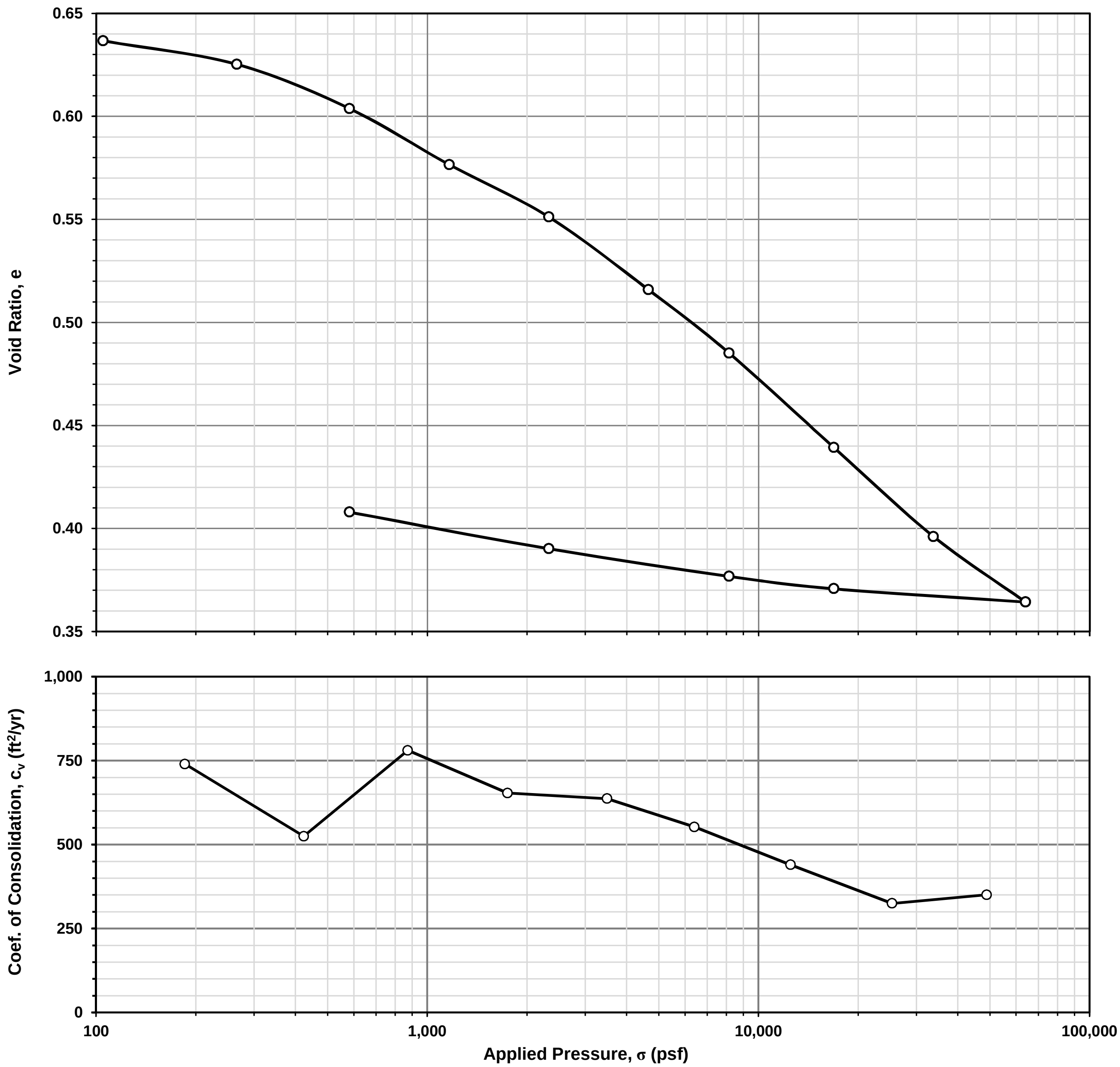
One-Dimensional Consolidation Test Report (ASTM D2435)

Project Number:	W-13-072	Boring Number:	B-113-9-13
Project Name:	FRA-70-13.10	Station / Offset:	258+77.50, 36.0' Rt.
Project Location:	Columbus, Ohio	Sample No. / Depth:	ST-7 / 16.3
Client:	ms consultants, inc.	Date of Testing:	04/07/2014 to 04/25/2014

Soil Description: Dark brown SILT AND CLAY, little coarse to fine sand, little fine gravel.
Soil Classification: ODOT A-6a

Physical Characteristics	L.L.	P.L.	P.I.	Gravel%	C. Sand%	F. Sand%	Silt%	Clay%
	32	18	14	19	10	13	31	27

Natural		γ_d (pcf)	γ_{sat} (pcf)	σ_{vo}' (psf)	S_G	e_o	σ_p' (psf)	c_c	c_r
S_o	w_o								
91.2%	18.3%	101.7	123.9	1,793	2.67	0.638	1,973	0.165	0.022



RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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

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

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

Point Load Strength Index of Rock Specimens
(ASTM D 5731-08)

Project: FRA-70-13.10
Project No.: W-13-072
Date of Testing: 5/2/2014
Test Performed by: E.M.

Rock Description: Gray Shale

Boring No.: B-113-7-13
Station / Offset: 254+41.19, 36.0' Rt.
Sample No. / Depth: RC-3 / 30.9' to 35.7'

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 8/10/2013

Sample No.	Test Type	Depth (ft)	Width (mm)	Diameter (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (MPa)	$Is_{(50)}$ (MPa)	σ_c (MPa)
1	a ⊥	30.9-35.7	35.4	57.3	50	2,583	50.8	1.01	0.02	0.02	0.23
2	a ⊥	30.9-35.7	42.5	63.0	50	3,409	58.4	1.07	0.01	0.02	0.18
3	a ⊥	30.9-35.7	46.4	62.8	70	3,711	60.9	1.09	0.02	0.02	0.23
4	a ⊥	30.9-35.7	48.0	64.9	90	3,967	63.0	1.11	0.02	0.03	0.27
5	a ⊥	30.9-35.7	46.6	63.1	100	3,747	61.2	1.10	0.03	0.03	0.32
6											
7											
8											
9											
10											

STATISTICS	
Mean $Is_{(50)}$ ⊥	0.02 MPa (3 psi)
Mean $Is_{(50)}$ ∥	
$Ia_{(50)}$	

Specific Specimen Shape:

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

Estimated Unaxial Compression, σ_c = K*Is

K = 12
*Per Section 206.1.3 of 2011 ODOT Rock Slope Design Guide

Mean σ_c = 0.25 MPa (36 psi)

Remarks:

RESOURCE INTERNATIONAL, INC.

Engineering Consultants

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Cleveland, OH 44125
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4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: FRA-70-13.10
Project No.: W-13-072
Date of Testing: 6/19/2014
Test Performed by: E.M.

Rock Description: Gray Shale

Boring No.: B-114-1-13
Station / Offset: 260+75.33, 40.2' Rt.
Sample No. / Depth: RC-3 / 73.0' to 74.0'

Test Apparatus: Forney-LA 0080
Serial Number: A125/AZ/0014
Date of Calibration: 8/10/2013

Sample No.	Test Type	Depth (ft)	Width (mm)	Diameter (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (MPa)	$Is_{(50)}$ (MPa)	σ_c (MPa)
1	a ⊥	73.0-74.0	26.6	61.0	350	2,066	45.5	0.96	0.17	0.16	2.03
2	a ⊥	73.0-74.0	28.0	61.0	290	2,177	46.7	0.97	0.13	0.13	1.60
3	a ⊥	73.0-74.0	25.0	61.0	275	1,941	44.1	0.94	0.14	0.13	1.70
4	a ⊥	73.0-74.0	27.0	60.7	295	2,086	45.7	0.96	0.14	0.14	1.70
6											
7											
8											
9											
10											

STATISTICS	
Mean $Is_{(50)}$ ⊥	**0.14 MPa (20 psi)**
Mean $Is_{(50)}$ ∥	
$Ia_{(50)}$	

Specific Specimen Shape:

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

Estimated Unaxial Compression, σ_c = K*Is

K = 12

*Per Section 206.1.3 of 2011 ODOT Rock Slope Design Guide

Mean σ_c = 1.76 MPa (255 psi)

Remarks:

RESOURCE INTERNATIONAL, INC.

Engineering Consultants

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

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

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

Point Load Strength Index of Rock Specimens

(ASTM D 5731-08)

Project: FRA-70-13.10

Project No.: W-13-072

Date of Testing: 6/19/2014

Test Performed by: E.M.

Rock Description: SHALE

Boring No.: B-114-9-13

Station / Offset: 275+07.50, 4.7' Rt.

Sample No. / Depth: RC-3/4 / 78.8' to 81.3'

Test Apparatus: Forney-LA 0080

Serial Number: A125/AZ/0014

Date of Calibration: 8/12/2013

Sample No.	Test Type	Depth (ft)	Width (mm)	Diameter (mm)	Load (N)	D_e^2 (mm^2)	D_e (mm)	F	Is (MPa)	$Is_{(50)}$ (MPa)	σ_c (MPa)
1	a ⊥	78.8'-81.3'	36.1	46.9	330	2,159	46.5	0.97	0.15	0.15	1.83
2	a ⊥	78.8'-81.3'	33.5	50.5	35	2,157	46.4	0.97	0.02	0.02	0.19
3	a ⊥	78.8'-81.3'	33.4	47.8	25	2,032	45.1	0.95	0.01	0.01	0.15
4	a ⊥	78.8'-81.3'	35.1	47.9	330	2,143	46.3	0.97	0.15	0.15	1.85
5	a ⊥	78.8'-81.3'	35.1	47.9	310	1,808	42.5	0.93	0.17	0.16	2.06

STATISTICS

Mean $Is_{(50)}$ ⊥	**0.10 MPa (14 psi)**
Mean $Is_{(50)}$ ‖	
$Ia_{(50)}$	

Specific Specimen Shape:

d = diametrical

a = axial

b = block

i = irregular lump

⊥ = perpendicular to bedding plane

‖ = parallel to bedding plane

Estimated Unaxial Compression, σ_c = K*Is

K = 12

*Per Section 206.1.3 of 2011 ODOT Rock Slope Design Guide

Mean σ_c = 1.22 MPa (176 psi)

Remarks:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.	9885 Rockside Road	4480 Lake Forest Drive
Columbus, OH 43231	Cleveland, OH 44125	Cincinnati, Ohio 45242
Phone (614) 823-4949	Phone (216) 573-0955	Phone (513) 769-6998

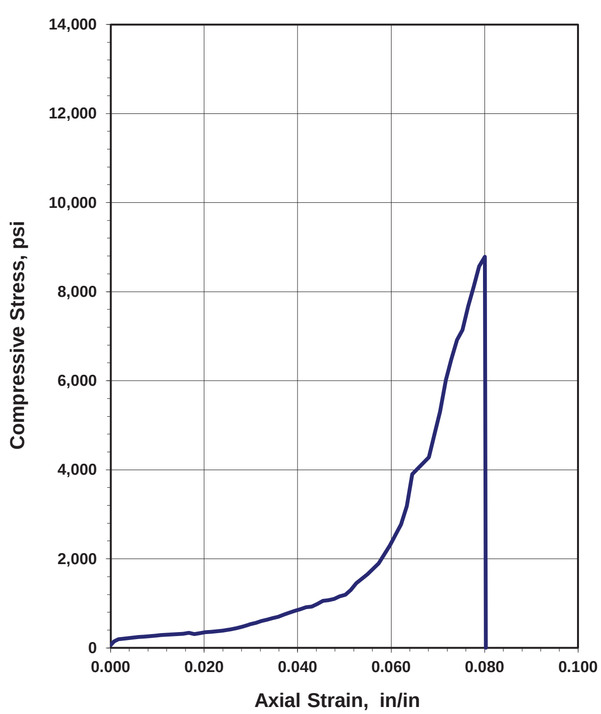
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 7/3/2014
Test Performed by: K.R./T.K.

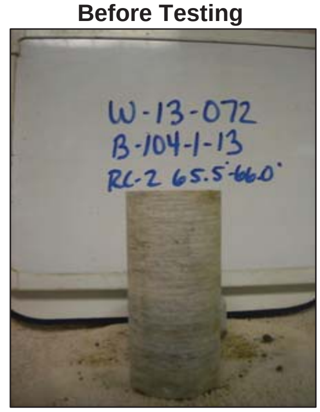
Rock Description: Dolomitic Limestone

Boring No.:	B-104-1-13	Average Length:	4.185 in
Station / Offset:	230+95.90, 17.5' Rt.	Average Diameter:	1.858 in
Sample No. / Depth:	RC-2 / 65.5 ft	Length to diameter ratio:	2.252
Moisture condition:	As received	Cross Sectional Area:	2.710 in^2
Rate of Loading:	55.1 lbs/sec	Failure Load:	23,820 lbs
Testing Time:	432 sec	Axial Strain at Failure:	0.0800 in/in
(Rate 2-15 minutes to failure)		Stress:	8,783 psi

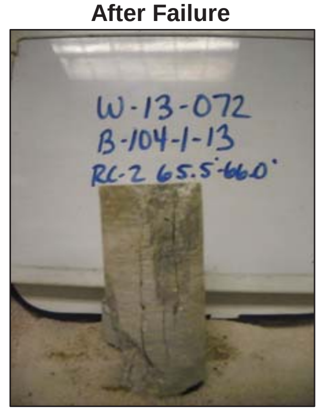
Unconfined Compression Test



Before Testing



After Failure



REMARKS: ______

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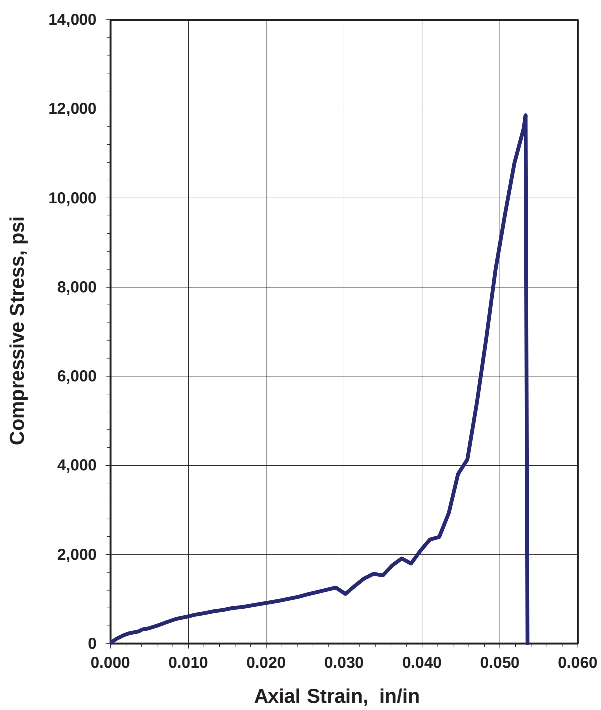
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 7/9/2014
Test Performed by: K.R./T.K.

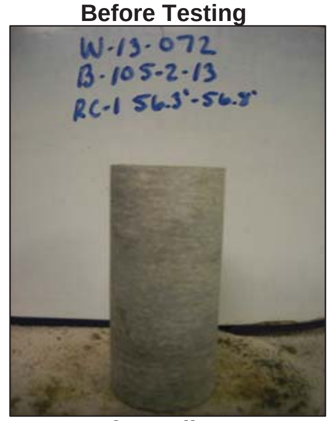
Rock Description: Dolomitic Limestone

Boring No.:	B-105-2-13	Average Length:	4.146 in
Station / Offset:	232+68.59, 24.4' Rt.	Average Diameter:	1.864 in
Sample No. / Depth:	RC-1 / 56.3 ft	Length to diameter ratio:	2.224
Moisture condition:	As received	Cross Sectional Area:	2.727 in^2
Rate of Loading:	55.6 lbs/sec	Failure Load:	32,350 lbs
Testing Time:	582 sec	Axial Strain at Failure:	0.0533 in/in
(Rate 2-15 minutes to failure)		Stress:	11,854 psi

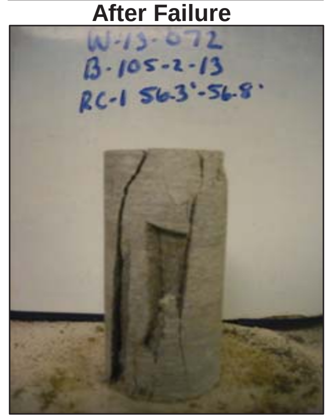
Unconfined Compression Test



Before Testing



After Failure



REMARKS:

RESOURCE INTERNATIONAL, INC.

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Unconfined Compressive Strength
of Intact Rock Core Specimens (ASTM D 7012-04)

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Project: FRA-70-13.10 - Project 6A

Project No.: W-13-072

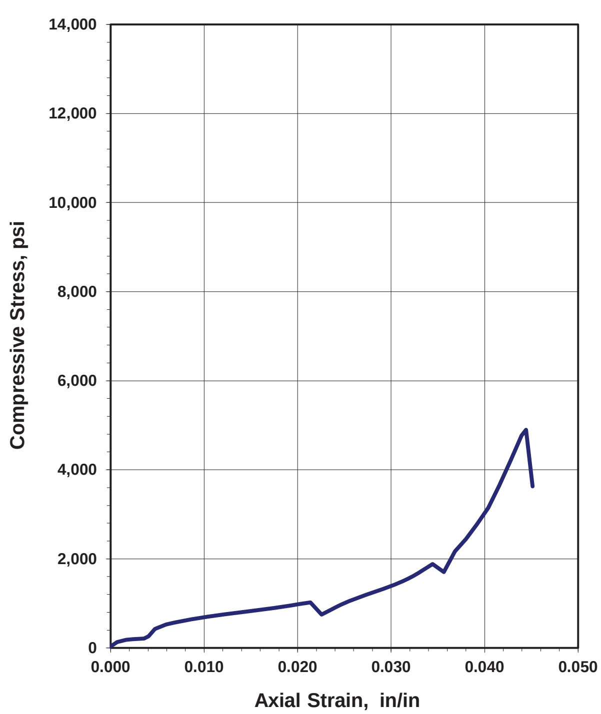
Date of Testing: 1/6/2015

Test Performed by: C.S./T.K.

Rock Description: Limestone

Boring No.:	B-107-1	Average Length:	4.21 in
Station / Offset:	#N/A	Average Diameter:	1.856 in
Sample No. / Depth:	RC-2 / 59.6-60.0' ft	Length to diameter ratio:	2.268
Moisture condition:	As received	Cross Sectional Area:	2.704 in^2
Rate of Loading:	37.9 lbs/sec	Failure Load:	13,250 lbs
Testing Time:	350 sec	Axial Strain at Failure:	0.0444 in/in
	(Rate 2-15 minutes to failure)	Stress:	4,898 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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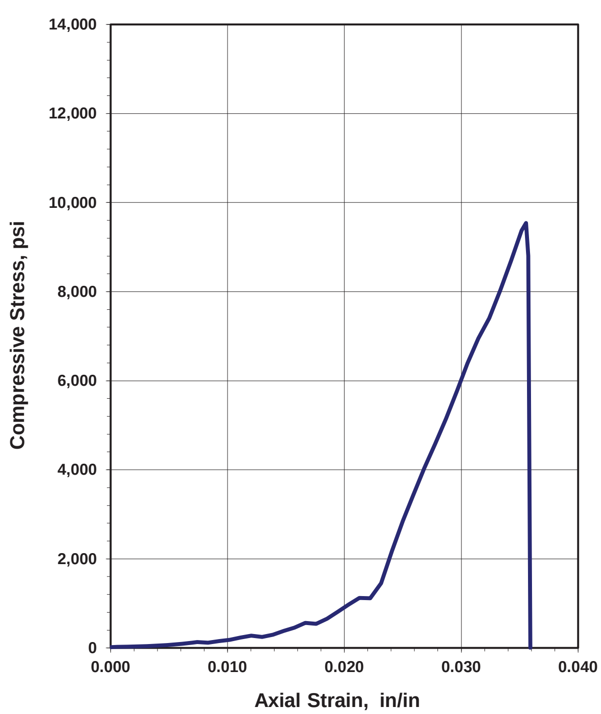
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 7/3/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-108-4-13	Average Length:	5.402 in
Station / Offset:	237+31.12, 23.7' Rt.	Average Diameter:	2.481 in
Sample No. / Depth:	RC-2 / 52.5 ft	Length to diameter ratio:	2.177
Moisture condition:	As received	Cross Sectional Area:	4.832 in^2
Rate of Loading:	68.2 lbs/sec	Failure Load:	46,120 lbs
Testing Time:	676 sec	Axial Strain at Failure:	0.0355 in/in
(Rate 2-15 minutes to failure)		Stress:	9,541 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.

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Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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Project: FRA-70-13.10 - Project 6A

Project No.: W-13-072

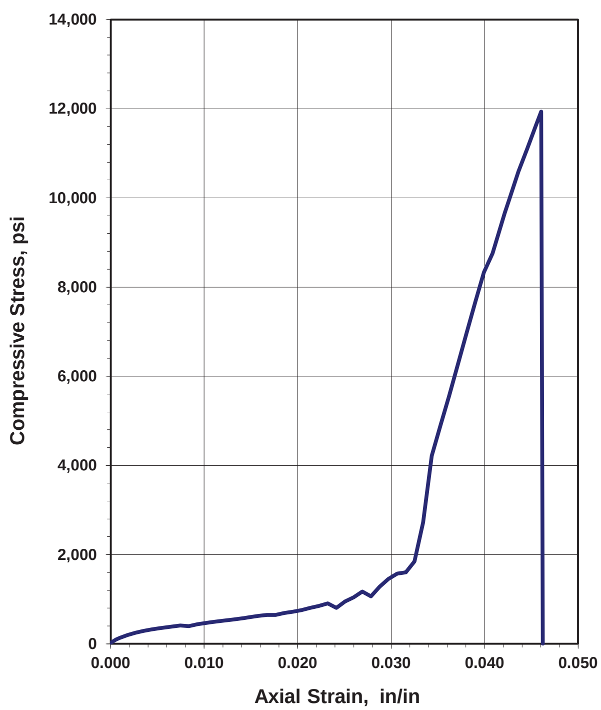
Date of Testing: 7/3/2014

Test Performed by: K.R./T.K.

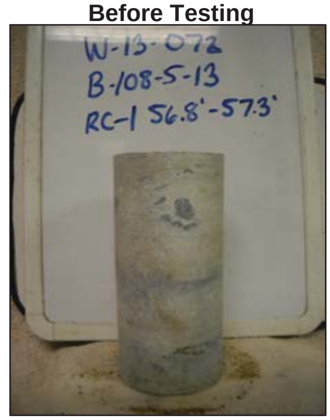
Rock Description: Dolomitic Limestone

Boring No.:	B-108-5-13	Average Length:	5.386 in
Station / Offset:	239+69.30, 18.7' Rt.	Average Diameter:	2.408 in
Sample No. / Depth:	RC-1 / 56.8 ft	Length to diameter ratio:	2.237
Moisture condition:	As received	Cross Sectional Area:	4.552 in^2
Rate of Loading:	72.6 lbs/sec	Failure Load:	54,340 lbs
Testing Time:	749 sec	Axial Strain at Failure:	0.0460 in/in
	(Rate 2-15 minutes to failure)	Stress:	11,933 psi

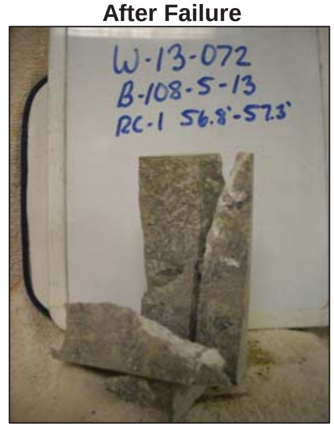
Unconfined Compression Test



Before Testing



After Failure



REMARKS:

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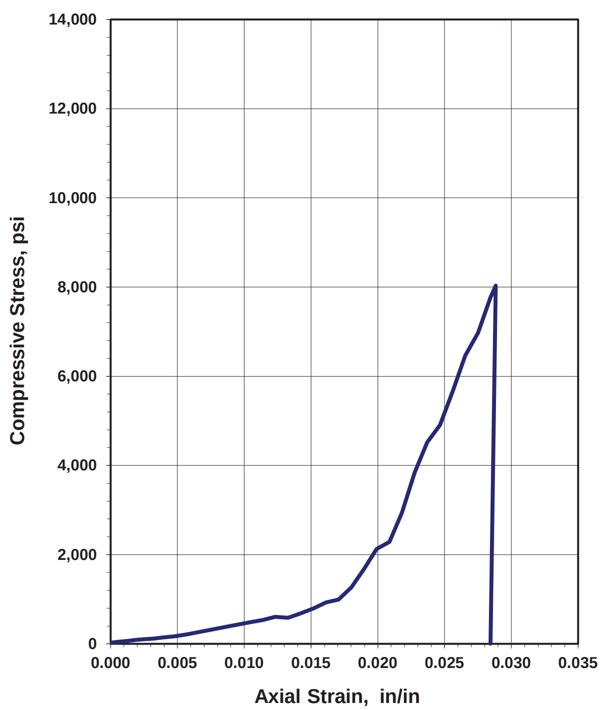
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 7/9/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-108-6-13	Average Length:	5.272 in
Station / Offset:	242+23.02, 20.7' Rt.	Average Diameter:	2.398 in
Sample No. / Depth:	RC-1 / 59.6 ft	Length to diameter ratio:	2.198
Moisture condition:	As received	Cross Sectional Area:	4.514 in^2
Rate of Loading:	63.5 lbs/sec	Failure Load:	36,270 lbs
Testing Time:	571 sec	Axial Strain at Failure:	0.0288 in/in
	(Rate 2-15 minutes to failure)	Stress:	8,033 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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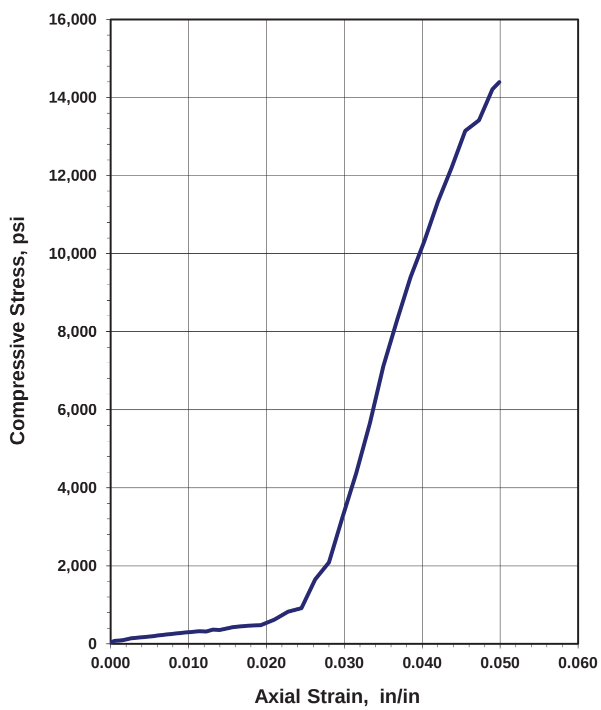
Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 1/22/2015
Test Performed by: C.S./T.K.

Rock Description: Limestone, dolomitic

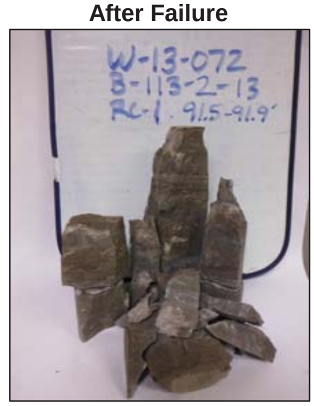
Boring No.:	B-113-2-13	Average Length:	5.713 in
Station / Offset:	245+03.67, 17.9' Lt.	Average Diameter:	2.484 in
Sample No. / Depth:	RC-1 / 91.5 ft	Length to diameter ratio:	2.300
Moisture condition:	As received	Cross Sectional Area:	4.844 in^2
Rate of Loading:	90.0 lbs/sec	Failure Load:	69,760 lbs
Testing Time:	775 sec	Axial Strain at Failure:	0.0499 in/in
	(Rate 2-15 minutes to failure)	Stress:	14,395 psi

Unconfined Compression Test



Before Testing

After Failure



REMARKS:

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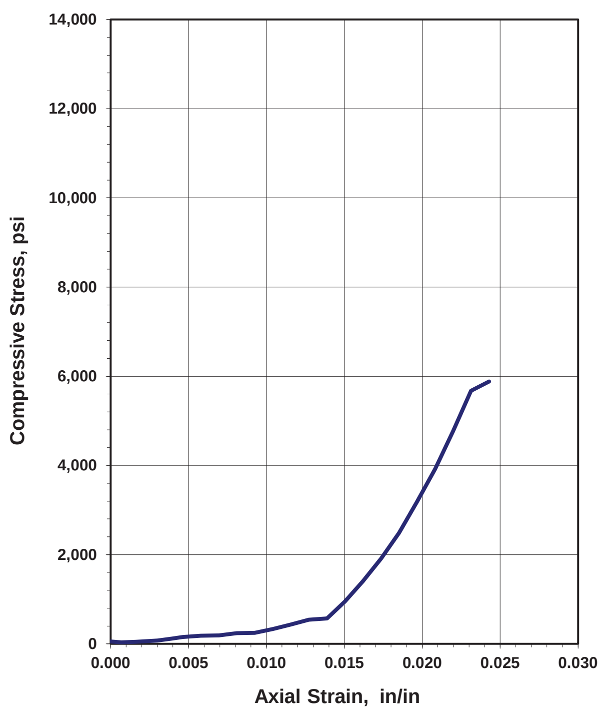
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 1/22/2015
Test Performed by: C.S./T.K.

Rock Description: Limestone with chert nodules

Boring No.:	B-113-3-13	Average Length:	4.323 in
Station / Offset:	247+30.17, 35.7' Rt.	Average Diameter:	1.856 in
Sample No. / Depth:	RC-2 / 87.8 ft	Length to diameter ratio:	2.329
Moisture condition:	As received	Cross Sectional Area:	2.704 in^2
Rate of Loading:	55.8 lbs/sec	Failure Load:	15,910 lbs
Testing Time:	285 sec	Axial Strain at Failure:	0.0243 in/in
(Rate 2-15 minutes to failure)		Stress:	5,882 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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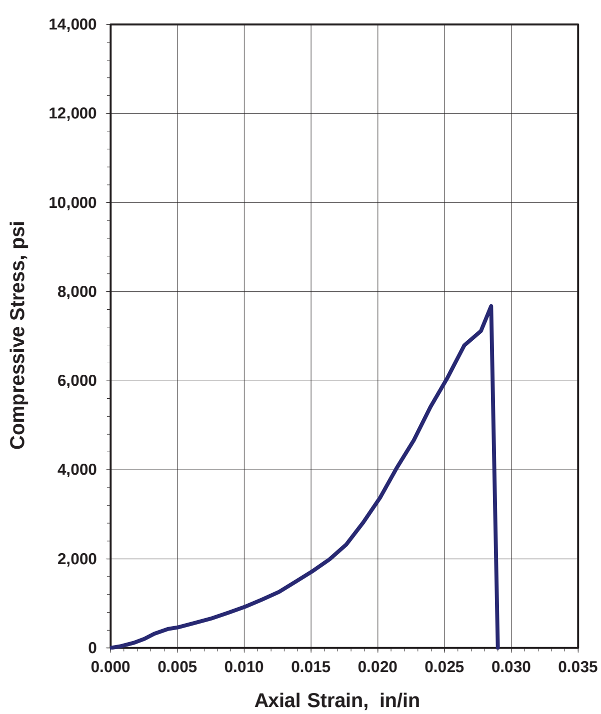
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 6/23/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-4-13	Average Length:	3.967 in
Station / Offset:	249+37.84, 28.1' Rt.	Average Diameter:	1.859 in
Sample No. / Depth:	RC-2 / 78.3 ft	Length to diameter ratio:	2.134
Moisture condition:	As received	Cross Sectional Area:	2.713 in^2
Rate of Loading:	56.3 lbs/sec	Failure Load:	20,830 lbs
Testing Time:	370 sec	Axial Strain at Failure:	0.0285 in/in
	(Rate 2-15 minutes to failure)	Stress:	7,676 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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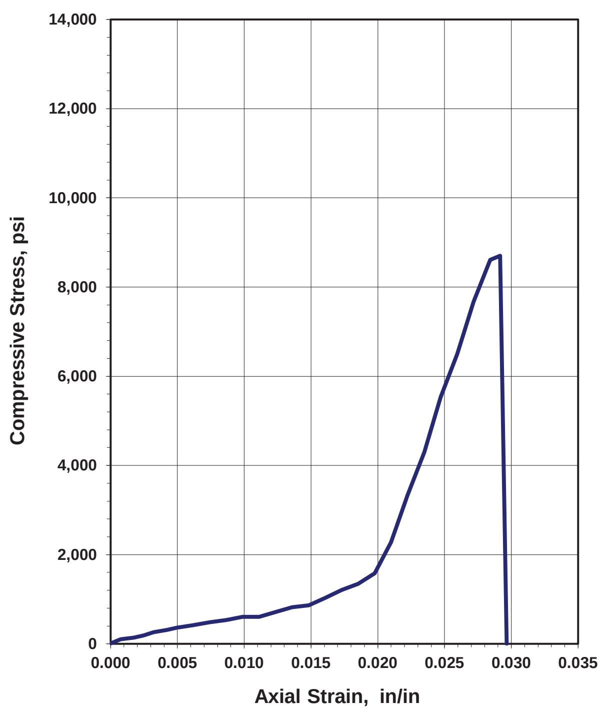
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 6/20/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-5-13	Average Length:	4.047 in
Station / Offset:	250+13.44, 36.0' Rt.	Average Diameter:	1.849 in
Sample No. / Depth:	RC-4 / 75.7 ft	Length to diameter ratio:	2.189
Moisture condition:	As received	Cross Sectional Area:	2.684 in^2
Rate of Loading:	49.5 lbs/sec	Failure Load:	23,360 lbs
Testing Time:	472 sec	Axial Strain at Failure:	0.0292 in/in
(Rate 2-15 minutes to failure)		Stress:	8,702 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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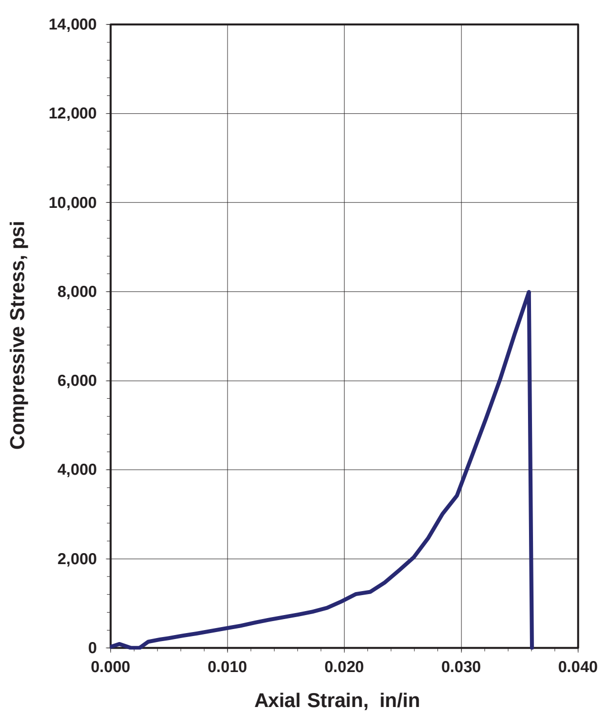
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 6/20/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-5-13	Average Length:	4.05 in
Station / Offset:	250+13.44, 36.0' Rt.	Average Diameter:	1.862 in
Sample No. / Depth:	RC-5 / 80.7 ft	Length to diameter ratio:	2.175
Moisture condition:	As received	Cross Sectional Area:	2.722 in^2
Rate of Loading:	49.1 lbs/sec	Failure Load:	21,760 lbs
Testing Time:	443 sec	Axial Strain at Failure:	0.0358 in/in
(Rate 2-15 minutes to failure)		Stress:	7,992 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

Unconfined Compressive Strength
of Intact Rock Core Specimens (ASTM D 7012-04)

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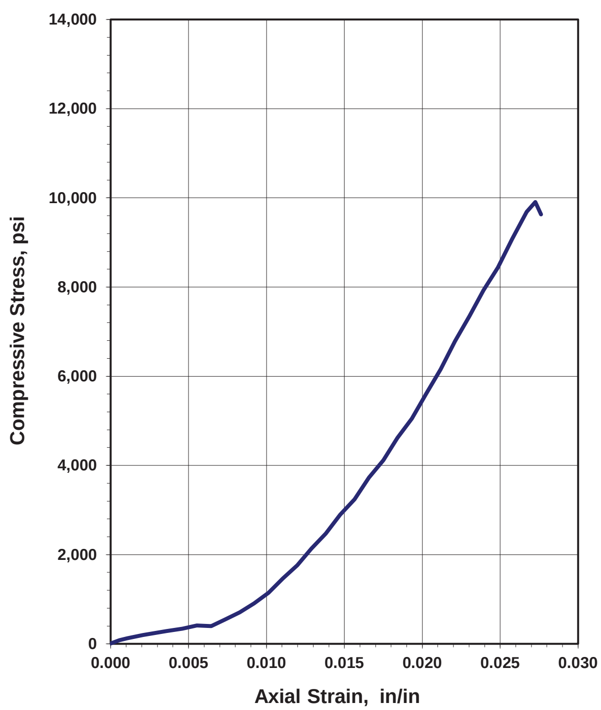
Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/7/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-6-13	Average Length:	5.431 in
Station / Offset:	251+93.56, 37.3' Rt.	Average Diameter:	2.468 in
Sample No. / Depth:	RC-1 / 45.9 ft	Length to diameter ratio:	2.201
Moisture condition:	As received	Cross Sectional Area:	4.781 in^2
Rate of Loading:	76.1 lbs/sec	Failure Load:	47,380 lbs
Testing Time:	623 sec	Axial Strain at Failure:	0.0273 in/in
	(Rate 2-15 minutes to failure)	Stress:	9,906 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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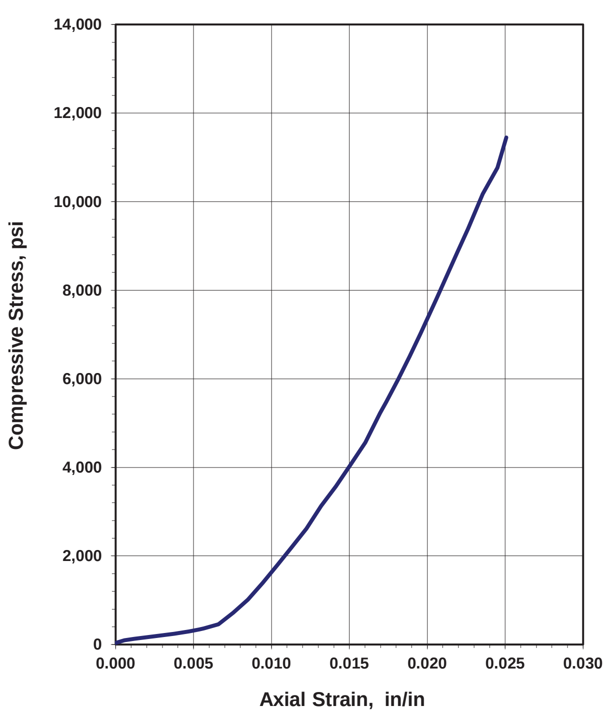
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/7/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-6-13	Average Length:	5.305 in
Station / Offset:	251+93.56, 37.3' Rt.	Average Diameter:	2.485 in
Sample No. / Depth:	RC-2 / 50.7 ft	Length to diameter ratio:	2.135
Moisture condition:	As received	Cross Sectional Area:	4.848 in^2
Rate of Loading:	79.3 lbs/sec	Failure Load:	55,510 lbs
Testing Time:	700 sec	Axial Strain at Failure:	0.0251 in/in
	(Rate 2-15 minutes to failure)	Stress:	11,448 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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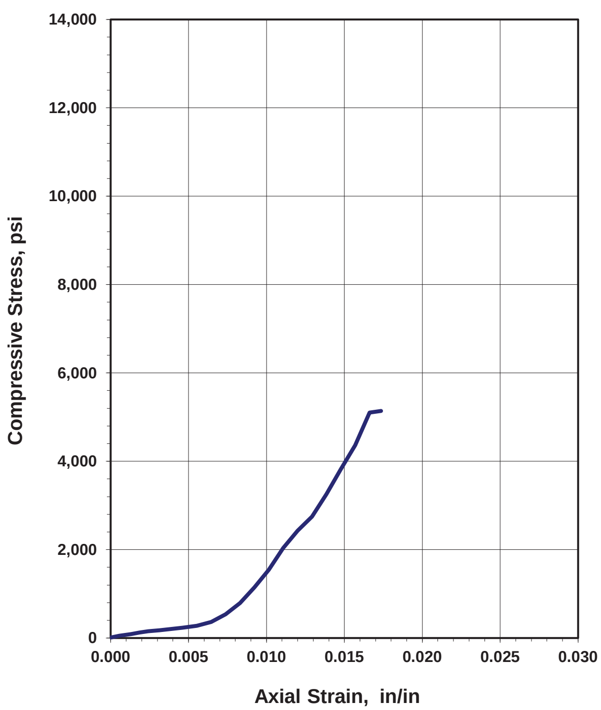
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/7/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-6-13	Average Length:	5.417 in
Station / Offset:	251+93.56, 37.3' Rt.	Average Diameter:	2.493 in
Sample No. / Depth:	RC-3 / 54.8 ft	Length to diameter ratio:	2.173
Moisture condition:	As received	Cross Sectional Area:	4.879 in^2
Rate of Loading:	69.7 lbs/sec	Failure Load:	25,080 lbs
Testing Time:	360 sec	Axial Strain at Failure:	0.0174 in/in
	(Rate 2-15 minutes to failure)	Stress:	5,140 psi

Unconfined Compression Test



Before Testing

Photo Not Available

After Failure

REMARKS:

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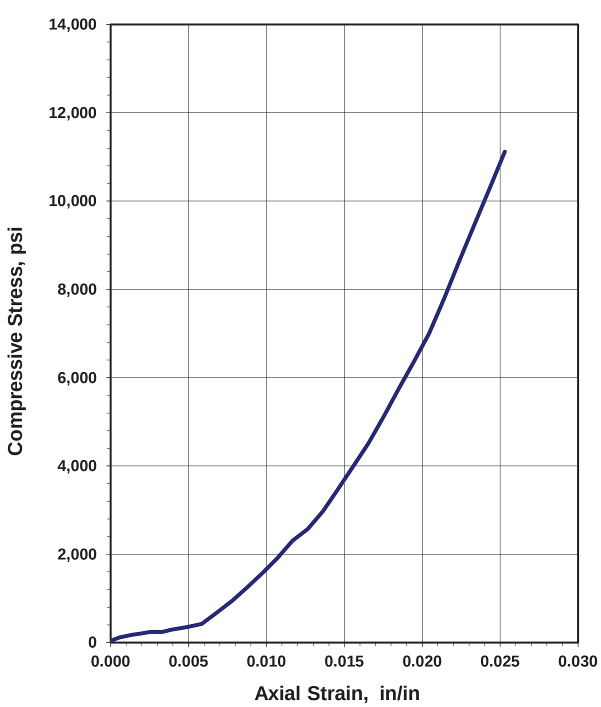
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/7/2014
Test Performed by: K.R./T.K.

Rock Description: Limestone

Boring No.:	B-113-7-13	Average Length:	5.139 in
Station / Offset:	254+41.19, 36.0' Rt.	Average Diameter:	2.478 in
Sample No. / Depth:	RC-5 / 42.2 ft	Length to diameter ratio:	2.074
Moisture condition:	As received	Cross Sectional Area:	4.820 in^2
Rate of Loading:	82.5 lbs/sec	Failure Load:	53,610 lbs
Testing Time:	650 sec	Axial Strain at Failure:	0.0253 in/in
(Rate 2-15 minutes to failure)		Stress:	11,119 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.

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Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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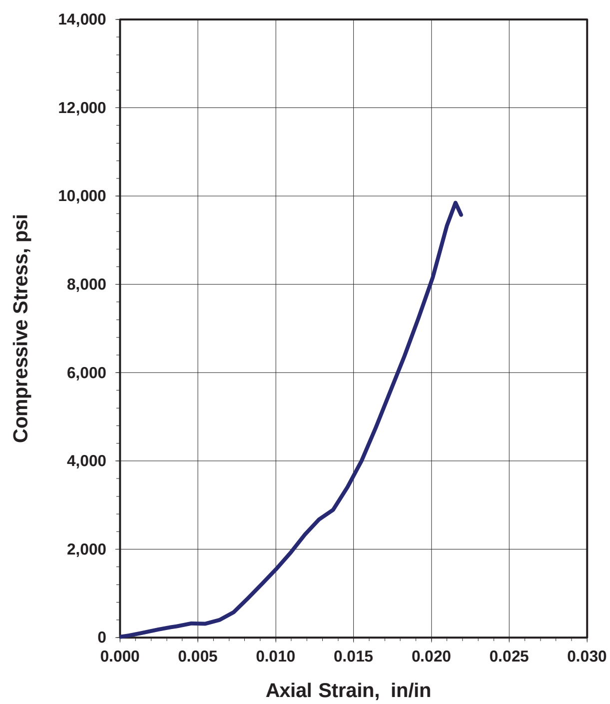
Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/7/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-7-13	Average Length:	5.478 in
Station / Offset:	254+41.19, 36.0' Rt.	Average Diameter:	2.483 in
Sample No. / Depth:	RC-6 / 50.2 ft	Length to diameter ratio:	2.206
Moisture condition:	As received	Cross Sectional Area:	4.840 in^2
Rate of Loading:	72.5 lbs/sec	Failure Load:	47,680 lbs
Testing Time:	658 sec	Axial Strain at Failure:	0.0215 in/in
	(Rate 2-15 minutes to failure)	Stress:	9,850 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.

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Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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Project: FRA-70-13.10 - Project 6A

Project No.: W-13-072

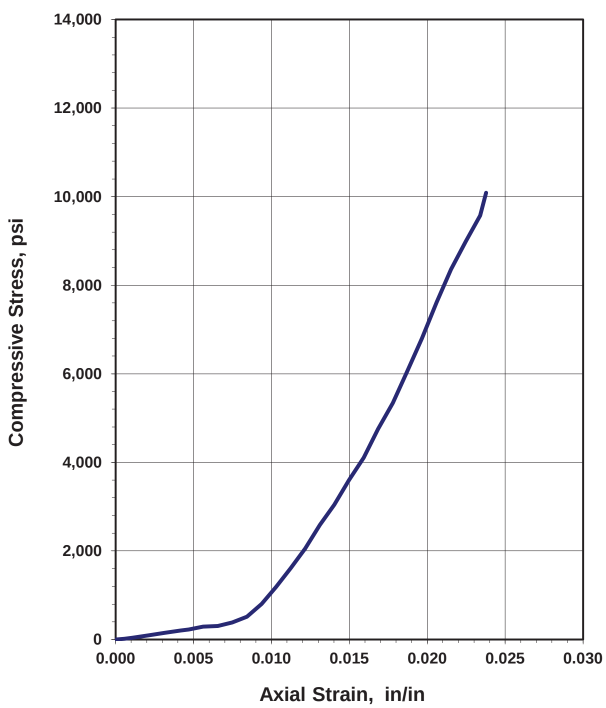
Date of Testing: 5/7/2014

Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-7-13	Average Length:	5.342 in
Station / Offset:	254+41.19, 36.0' Rt.	Average Diameter:	2.483 in
Sample No. / Depth:	RC-7 / 51.2 ft	Length to diameter ratio:	2.151
Moisture condition:	As received	Cross Sectional Area:	4.840 in^2
Rate of Loading:	73.5 lbs/sec	Failure Load:	48,830 lbs
Testing Time:	664 sec	Axial Strain at Failure:	0.0238 in/in
	(Rate 2-15 minutes to failure)	Stress:	10,087 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.	9885 Rockside Road	4480 Lake Forest Drive
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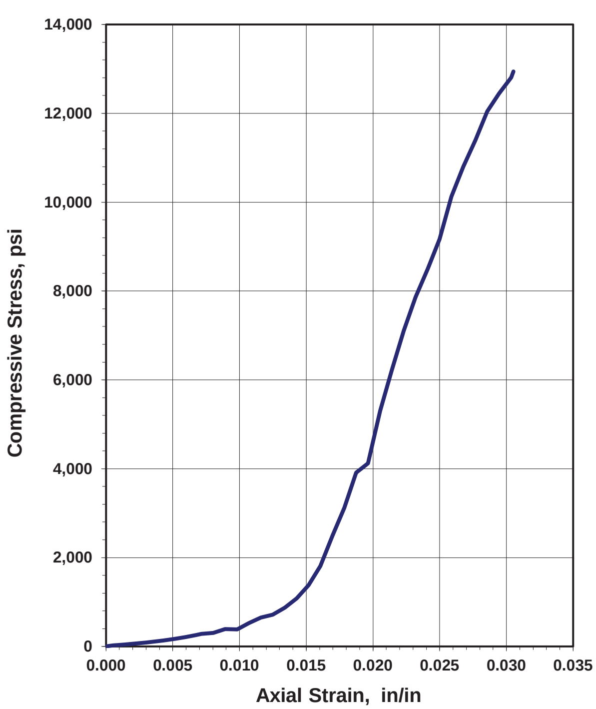
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/15/2014
Test Performed by: C.S./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-8-13	Average Length:	5.602 in
Station / Offset:	256+62.64, 36.0' Rt.	Average Diameter:	2.475 in
Sample No. / Depth:	RC-4 / 47.1 ft	Length to diameter ratio:	2.263
Moisture condition:	Dry	Cross Sectional Area:	4.809 in^2
Rate of Loading:	75.2 lbs/sec	Failure Load:	62,250 lbs
Testing Time:	828 sec	Axial Strain at Failure:	0.0305 in/in
(Rate 2-15 minutes to failure)		Stress:	12,942 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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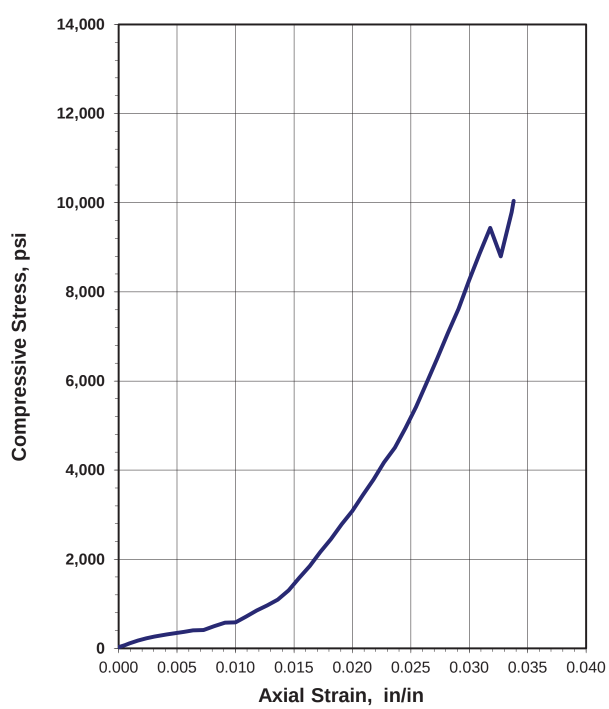
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/15/2014
Test Performed by: C.S./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-8-13	Average Length:	5.503 in
Station / Offset:	256+62.64, 36.0' Rt.	Average Diameter:	2.481 in
Sample No. / Depth:	RC-5 / 52.3 ft	Length to diameter ratio:	2.218
Moisture condition:	Dry	Cross Sectional Area:	4.832 in^2
Rate of Loading:	60.3 lbs/sec	Failure Load:	45,620 lbs
Testing Time:	757 sec	Axial Strain at Failure:	0.0318 in/in
(Rate 2-15 minutes to failure)		Stress:	9,438 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS: ______________________

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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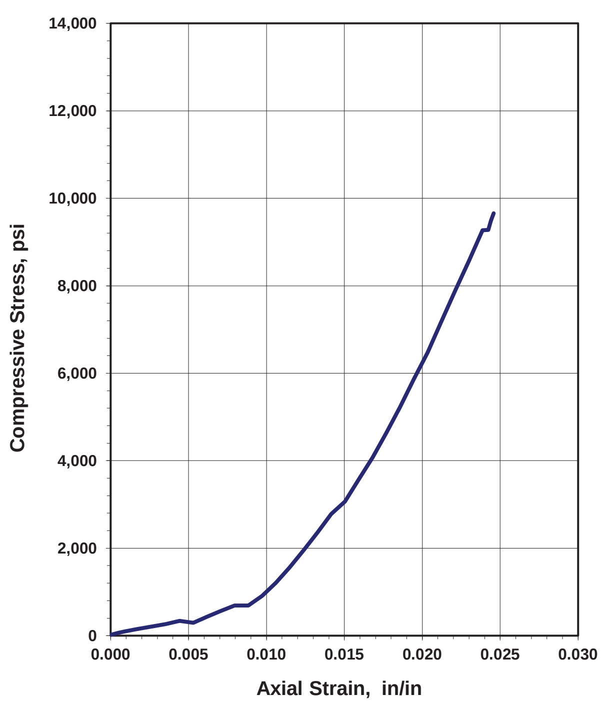
Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 5/15/2014
Test Performed by: C.S./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-113-8-13	Average Length:	5.655 in
Station / Offset:	256+62.64, 36.0' Rt.	Average Diameter:	2.486 in
Sample No. / Depth:	RC-6 / 56.8 ft	Length to diameter ratio:	2.275
Moisture condition:	Dry	Cross Sectional Area:	4.851 in^2
Rate of Loading:	73.6 lbs/sec	Failure Load:	46,860 lbs
Testing Time:	637 sec	Axial Strain at Failure:	0.0246 in/in
(Rate 2-15 minutes to failure)		Stress:	9,657 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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Project: FRA-70-13.10 - Project 6A

Project No.: W-13-072

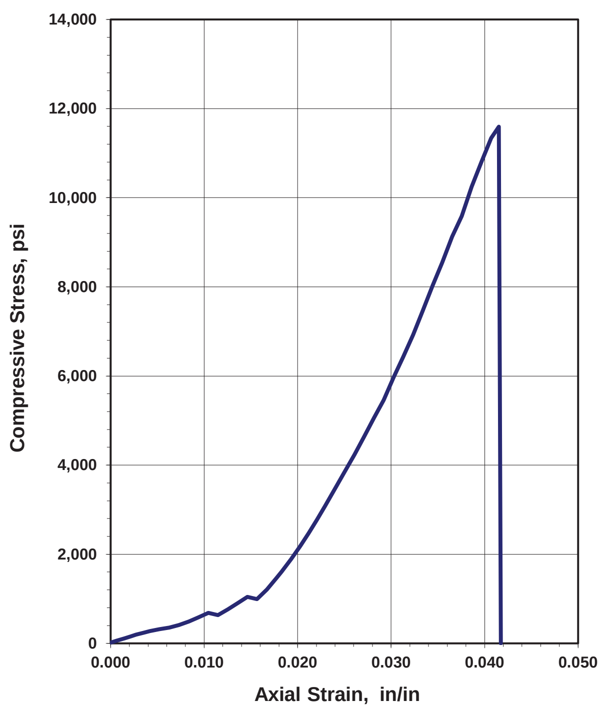
Date of Testing: 4/7/2014

Test Performed by: K.R./T.K.

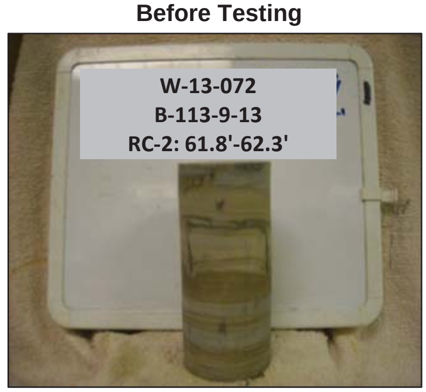
Rock Description: Dolomitic Limestone

Boring No.:	B-113-9-13	Average Length:	4.792 in
Station / Offset:	258+77.50, 36.0' Rt.	Average Diameter:	2.396 in
Sample No. / Depth:	RC-2 / 61.8 ft	Length to diameter ratio:	2.000
Moisture condition:	As received	Cross Sectional Area:	4.507 in^2
Rate of Loading:	106.7 lbs/sec	Failure Load:	52,270 lbs
Testing Time:	490 sec	Axial Strain at Failure:	0.0415 in/in
(Rate 2-15 minutes to failure)		Stress:	11,594 psi

Unconfined Compression Test



Before Testing



After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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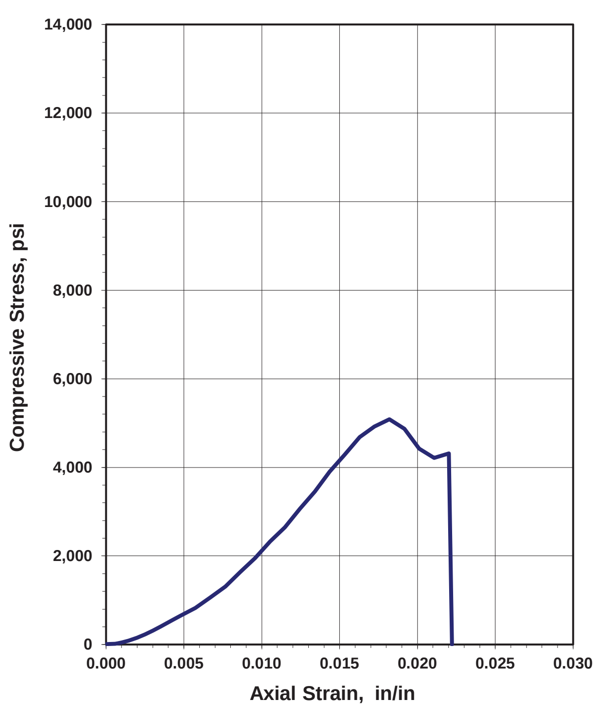
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 4/7/2014
Test Performed by: K.R./T.K.

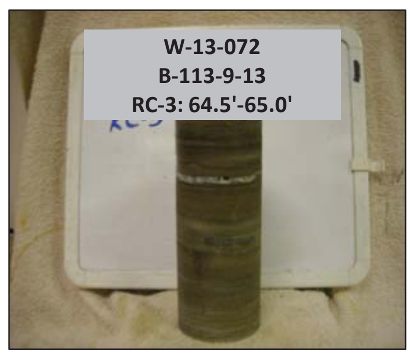
Rock Description: Dolomitic Limestone

Boring No.:	B-113-9-13	Average Length:	5.221 in
Station / Offset:	258+77.50, 36.0' Rt.	Average Diameter:	2.399 in
Sample No. / Depth:	RC-3 / 64.5 ft	Length to diameter ratio:	2.176
Moisture condition:	As received	Cross Sectional Area:	4.518 in^2
Rate of Loading:	70.5 lbs/sec	Failure Load:	22,980 lbs
Testing Time:	326 sec	Axial Strain at Failure:	0.0182 in/in
(Rate 2-15 minutes to failure)		Stress:	5,086 psi

Unconfined Compression Test



Before Testing



After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
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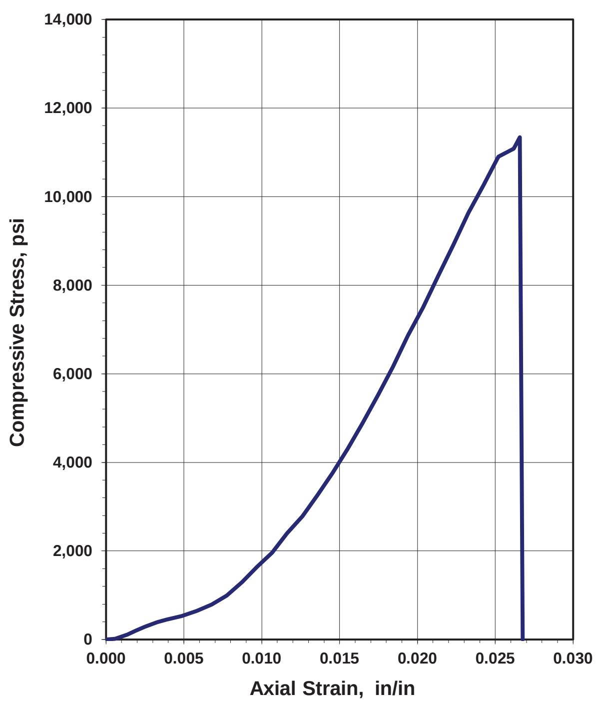
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 6/20/2014
Test Performed by: K.R./T.K.

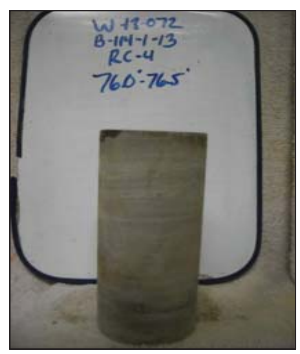
Rock Description: Dolomitic Limestone

Boring No.:	B-114-1-13	Average Length:	5.157 in
Station / Offset:	260+75.33, 40.2' Rt.	Average Diameter:	2.4 in
Sample No. / Depth:	RC-4 / 76 ft	Length to diameter ratio:	2.149
Moisture condition:	As received	Cross Sectional Area:	4.522 in^2
Rate of Loading:	88.3 lbs/sec	Failure Load:	51,290 lbs
Testing Time:	581 sec	Axial Strain at Failure:	0.0266 in/in
(Rate 2-15 minutes to failure)		Stress:	11,340 psi

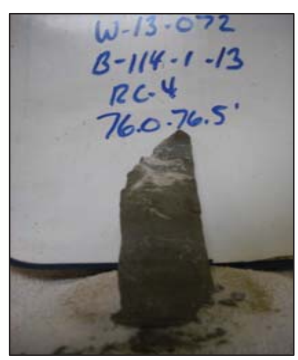
Unconfined Compression Test



Before Testing



After Failure



REMARKS: ______

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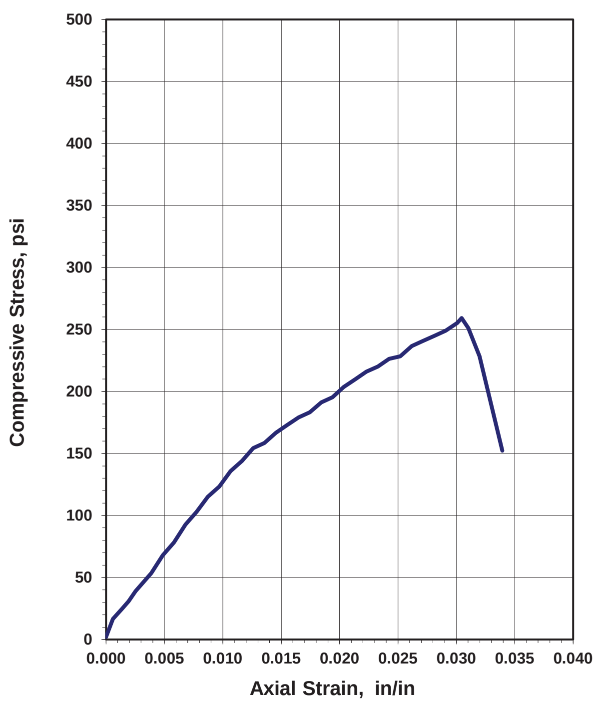
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 6/19/2014
Test Performed by: C.S./T.K.

Rock Description: Shale

Boring No.:	B-114-3-13	Average Length:	5.157 in
Station / Offset:	264+64.99, 20.3' Lt.	Average Diameter:	2.488 in
Sample No. / Depth:	RC-2 / 77.5 ft	Length to diameter ratio:	2.073
Moisture condition:	Dry	Cross Sectional Area:	4.859 in^2
Rate of Loading:	3.0 lbs/sec	Failure Load:	1,260 lbs
Testing Time:	424 sec	Axial Strain at Failure:	0.0304 in/in
(Rate 2-15 minutes to failure)		Stress:	259 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.

Engineering Consultants

Unconfined Compressive Strength
of Intact Rock Core Specimens (ASTM D 7012-04)

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Project: FRA-70-13.10 - Project 6A

Project No.: W-13-072

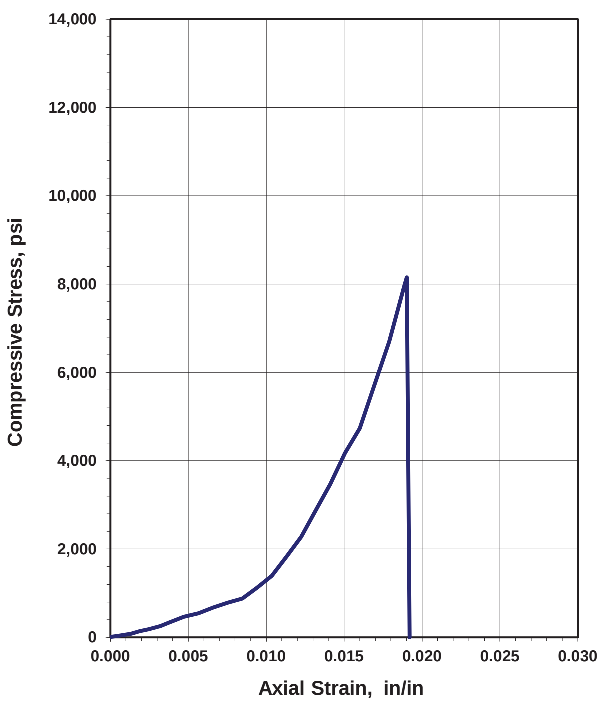
Date of Testing: 3/7/2014

Test Performed by: K.R./T.K.

Rock Description: Gray Limestone

Boring No.:	B-114-5-13	Average Length:	5.312 in
Station / Offset:	268+86.79, 10.9' Lt.	Average Diameter:	2.493 in
Sample No. / Depth:	RC-1 / 80.5 ft	Length to diameter ratio:	2.131
Moisture condition:	As received	Cross Sectional Area:	4.879 in^2
Rate of Loading:	99.7 lbs/sec	Failure Load:	39,790 lbs
Testing Time:	399 sec	Axial Strain at Failure:	0.0190 in/in
	(Rate 2-15 minutes to failure)	Stress:	8,154 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.

Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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Phone (614) 823-4949	Phone (216) 573-0955	Phone (513) 769-6998

Project: FRA-70-13.10 - Project 6A

Project No.: W-13-072

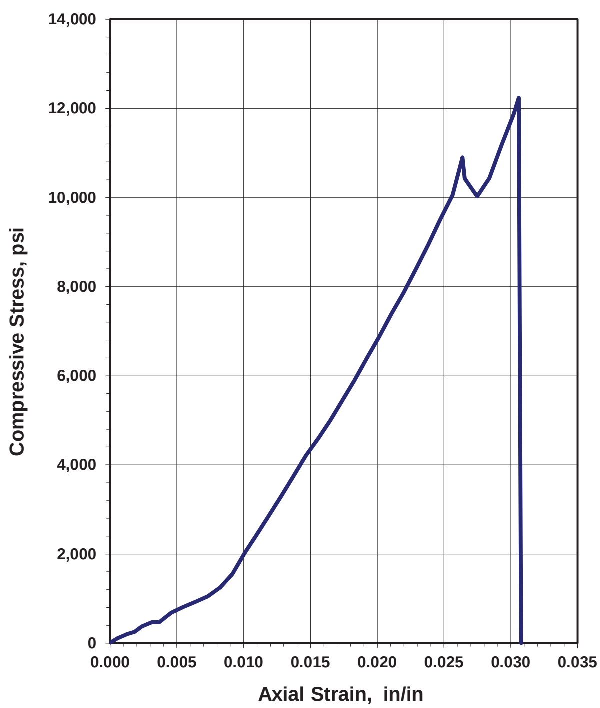
Date of Testing: 3/7/2014

Test Performed by: K.R./T.K.

Rock Description: Gray Limestone

Boring No.:	B-114-5-13	Average Length:	5.459 in
Station / Offset:	268+86.79, 10.9' Lt.	Average Diameter:	2.499 in
Sample No. / Depth:	RC-2 / 84.6 ft	Length to diameter ratio:	2.184
Moisture condition:	As received	Cross Sectional Area:	4.902 in^2
Rate of Loading:	78.7 lbs/sec	Failure Load:	53,450 lbs
Testing Time:	679 sec	Axial Strain at Failure:	0.0264 in/in
	(Rate 2-15 minutes to failure)	Stress:	10,900 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.

Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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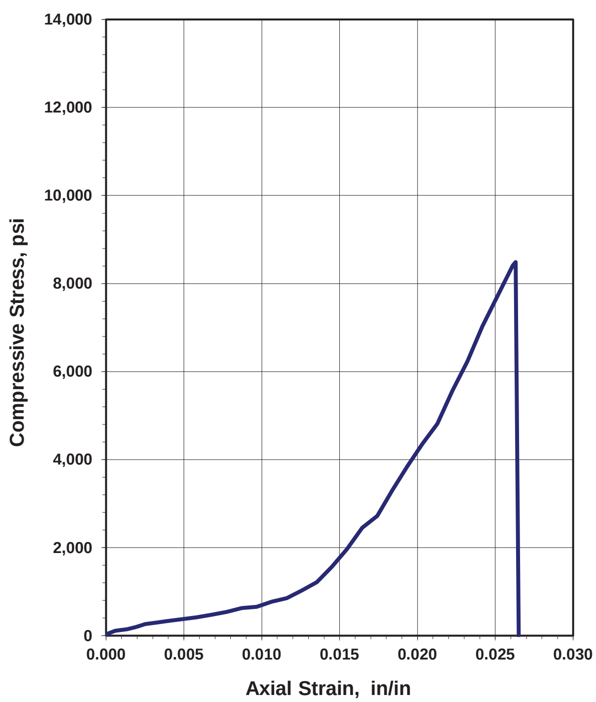
Cincinnati, Ohio 45242
Phone (513) 769-6998

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 2/20/2014
Test Performed by: K.R./T.K.

Rock Description: Gray Limestone

Boring No.:	B-114-7-13	Average Length:	5.169 in
Station / Offset:	271+12.84, 28.4' Rt.	Average Diameter:	2.4 in
Sample No. / Depth:	RC-1 / 75.1 ft	Length to diameter ratio:	2.154
Moisture condition:	As received	Cross Sectional Area:	4.522 in^2
Rate of Loading:	67.1 lbs/sec	Failure Load:	38,390 lbs
Testing Time:	572 sec	Axial Strain at Failure:	0.0263 in/in
	(Rate 2-15 minutes to failure)	Stress:	8,488 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 2/20/2014
Test Performed by: K.R./T.K.

Rock Description: Gray Limestone

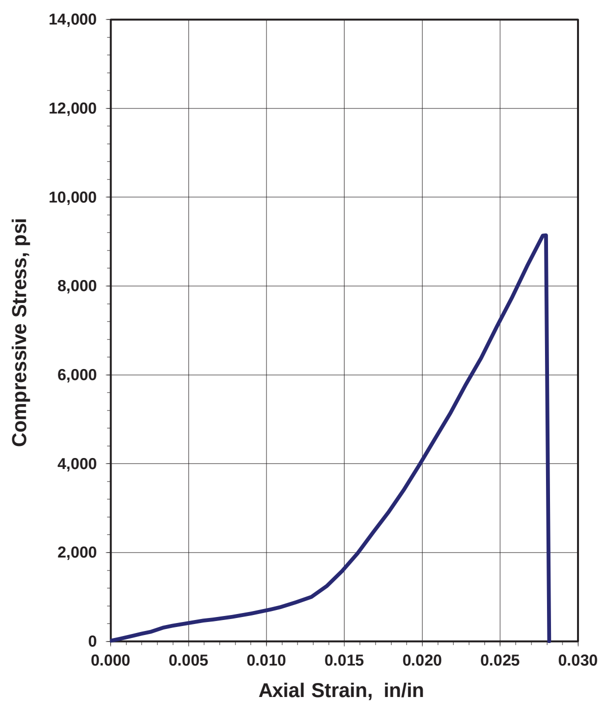
Boring No.: B-114-7-13
Station / Offset: 271+12.84, 28.4' Rt.
Sample No. / Depth: RC-2 / 81.5 ft
Moisture condition: As received

Average Length: 5.047 in
Average Diameter: 2.397 in
Length to diameter ratio: 2.106
Cross Sectional Area: 4.510 in^2

Rate of Loading: 59.8 lbs/sec
Testing Time: 690 sec
(Rate 2-15 minutes to failure)

Failure Load: 41,240 lbs
Axial Strain at Failure: 0.0279 in/in
Stress: 9,141 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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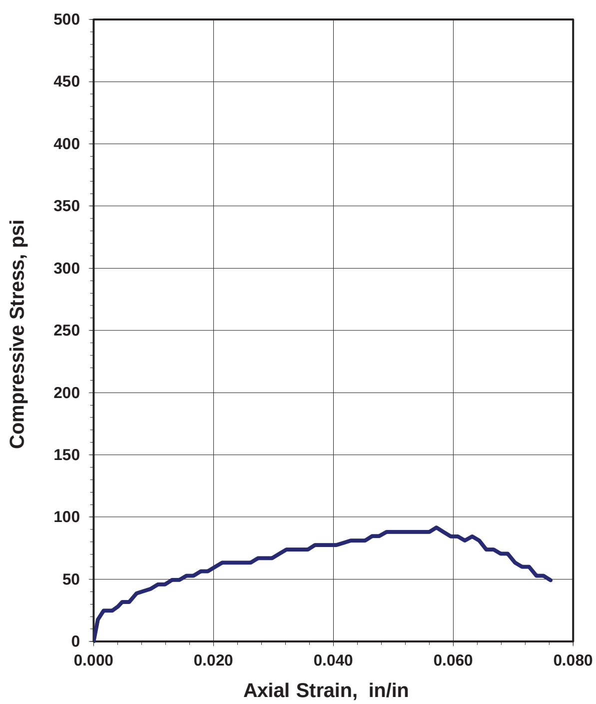
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 3/17/2014
Test Performed by: K.R./T.K.

Rock Description: Gray Claystone

Boring No.:	B-114-8-13	Average Length:	4.197 in
Station / Offset:	273+13.25, 16.5' Lt.	Average Diameter:	1.901 in
Sample No. / Depth:	RC-2 / 74.8 ft	Length to diameter ratio:	2.208
Moisture condition:	As received	Cross Sectional Area:	2.837 in^2
Rate of Loading:	0.3 lbs/sec	Failure Load:	260 lbs
Testing Time:	821 sec	Axial Strain at Failure:	0.0572 in/in
	(Rate 2-15 minutes to failure)	Stress:	92 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

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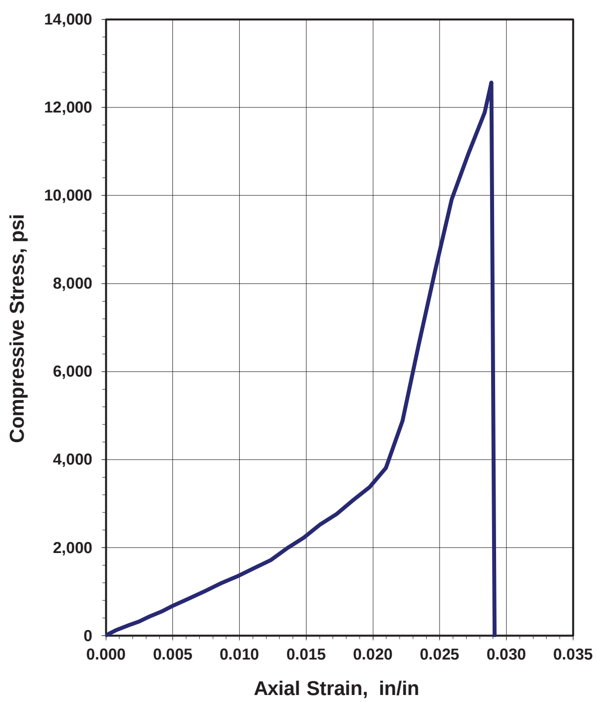
Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 4/1/2014
Test Performed by: K.R./T.K.

Rock Description: Limestone

Boring No.:	B-114-8-13	Average Length:	4.053 in
Station / Offset:	273+13.25, 16.5' Lt.	Average Diameter:	1.869 in
Sample No. / Depth:	RC-3 / 78.4 ft	Length to diameter ratio:	2.169
Moisture condition:	As received	Cross Sectional Area:	2.742 in^2
Rate of Loading:	127.7 lbs/sec	Failure Load:	34,470 lbs
Testing Time:	270 sec	Axial Strain at Failure:	0.0289 in/in
(Rate 2-15 minutes to failure)		Stress:	12,567 psi

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

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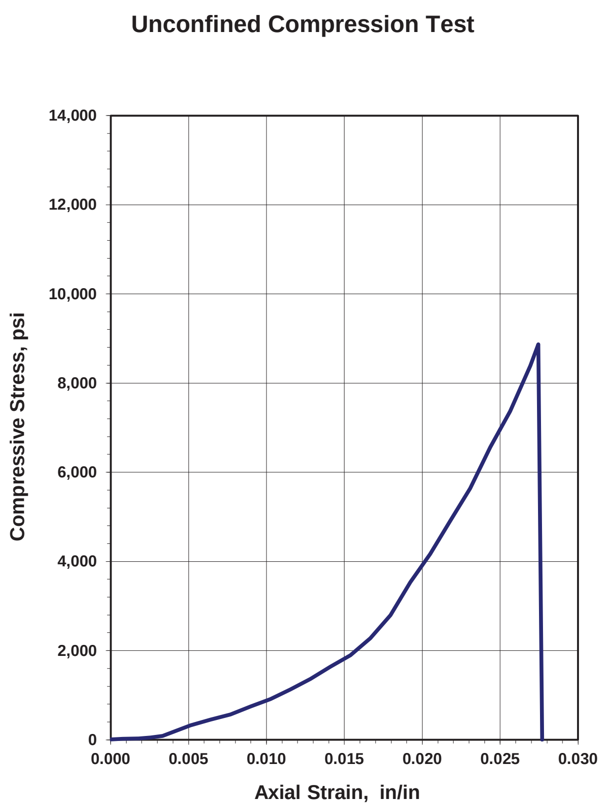
Project: FRA-70-13.10 - Project 6A
Project No.: W-13-072
Date of Testing: 6/23/2014
Test Performed by: K.R./T.K.

Rock Description: Dolomitic Limestone

Boring No.:	B-115-2-13	Average Length:	3.9 in
Station / Offset:	277+71.50, 20.2' Lt.	Average Diameter:	1.778 in
Sample No. / Depth:	RC-5 / 83.2 ft	Length to diameter ratio:	2.193
Moisture condition:	As received	Cross Sectional Area:	2.482 in^2
Rate of Loading:	56.9 lbs/sec	Failure Load:	22,010 lbs
Testing Time:	387 sec	Axial Strain at Failure:	0.0274 in/in
(Rate 2-15 minutes to failure)		Stress:	8,867 psi



Before Testing

After Failure

REMARKS:

APPENDIX VI

ROCK CORE SUMMARY

Rock Core Summary

Boring	Core No.	Depth (feet)	Recovery (%)	RQD (%)	Unconfined Compressive Strength
B-104-1-13	RC-2	60.5 to 65.5	100	75	N/A
	RC-3	65.5 to 70.5	90	70	q_u @ 65.5' = 8,783 psi
B-105-2-13	RC-2	56.0 to 61.0	90	36	q_u @ 56.3' = 11,854 psi
	RC-3	61.0 to 66.0	100	77	N/A
B-107-1-13	RC-1	53.8 to 55.8	100	100	N/A
	RC-2	55.8 to 60.8	100	80	q_u @ 59.6' = 4,898 psi
	RC-3	60.8 to 65.8	100	80	N/A
B-108-4-13	RC-1	49.5 to 52.5	78	43	N/A
	RC-2	52.5 to 57.5	100	93	q_u @ 52.5' = 9,541 psi
	RC-3	57.5 to 62.5	93	93	N/A
B-108-5-13	RC-1	54.5 to 59.5	100	79	q_u @ 56.8' = 11,933 psi
	RC-2	59.5 to 63.0	87	79	N/A
B-108-6-13	RC-1	57.5 to 62.1	100	55	q_u @ 59.6' = 8,033 psi
	RC-2	62.1 to 67.1	98	90	N/A
B-113-2-13	RC-1	89.2 to 94.2	85	84	q_u @ 91.5' = 14,395 psi
	RC-2	94.2 to 99.2	97	97	N/A
B-113-3-13	RC-1	81.0 to 86.0	98	98	N/A
	RC-2	86.0 to 91.0	92	87	q_u @ 87.8' = 5,882 psi
B-113-4-13	RC-1	73.4 to 78.3	98	34	N/A
	RC-2	78.3 to 83.3	100	97	q_u @ 78.3' = 7,676 psi
	RC-3	83.3 to 88.3	100	100	N/A
B-113-5-13	RC-3	73.7 to 75.7	92	21	N/A
	RC-4	75.7 to 80.7	100	94	q_u @ 75.7' = 8,702 psi
	RC-5	80.7 to 85.7	78	60	q_u @ 80.7' = 7,992 psi
B-113-6-13	RC-1	43.9 to 48.7	79	79	q_u @ 45.9' = 9,906 psi
	RC-2	48.7 to 53.7	100	88	q_u @ 50.7' = 11,448 psi
	RC-3	53.7 to 58.7	100	93	q_u @ 54.8' = 5,140 psi
	RC-4	58.7 to 63.7	100	90	N/A

Boring	Core No.	Depth (feet)	Recovery (%)	RQD (%)	Unconfined Compressive Strength
B-113-7-13	RC-3	30.7 to 35.7	53	45	q_u @ 30.9’ = 73 psi [1]
	RC-4	35.7 to 40.7	0	0	N/A
	RC-5	40.7 to 45.7	76	58	q_u @ 42.2’ = 11,119 psi
	RC-6	45.7 to 50.7	100	90	N/A
	RC-7	50.7 to 55.7	100	100	q_u @ 50.2’ = 9,850 psi q_u @ 51.2’ = 10,087 psi
B-113-8-13	RC-4	46.2 to 51.2	46	30	N/A
	RC-5	51.2 to 56.2	100	99	q_u @ 42.2’ = 9,438 psi
	RC-6	56.2 to 61.2	100	97	q_u @ 56.8’ = 9,657 psi
	RC-7	61.2 to 66.2	97	83	N/A
B-113-9-13	RC-1	55.5 to 58.0	7	0	N/A
	RC-2	58.0 to 63.0	70	40	q_u @ 61.8’ = 11,594 psi
	RC-3	63.0 to 68.0	100	100	q_u @ 56.8’ = 5,086 psi
	RC-4	68.0 to 73.0	100	94	N/A
B-114-1-13	RC-1	61.0 to 66.0	95	76	N/A
	RC-2	66.0 to 71.0	100	23	N/A
	RC-3	71.0 to 76.0	75	23	q_u @ 73.0’ = 520 psi [1]
	RC-4	76.0 to 81.0	96	94	q_u @ 76.0’ = 11,340 psi
B-114-2-13	RC-1	70.0 to 72.0	33	0	N/A
	RC-2	72.0 to 77.0	85	50	N/A
	RC-3	77.0 to 82.0	50	43	N/A
B-114-3-13	RC-1	69.0 to 74.0	44	10	N/A
	RC-2	74.0 to 79.0	80	27	q_u @ 77.5’ = 259 psi
	RC-3	79.0 to 84.0	92	83	N/A
B-114-4-13	RC-1	63.8 to 68.5	5	0	N/A
	RC-2	68.5 to 73.5	0	0	N/A
	RC-3	73.5 to 76.2	43	25	N/A
	RC-4	76.2 to 81.2	98	63	N/A
	RC-5	81.2 to 86.2	100	83	N/A

Boring	Core No.	Depth (feet)	Recovery (%)	RQD (%)	Unconfined Compressive Strength
B-114-5-13	RC-1	79.6 to 84.6	100	98	q_u @ 80.5' = 8,154 psi
	RC-2	84.6 to 89.6	97	83	q_u @ 84.6' = 12,237 psi
B-114-7-13	RC-1	74.0 to 79.0	92	48	q_u @ 75.1' = 8,488 psi
	RC-2	79.0 to 84.0	83	52	q_u @ 81.5' = 9,141 psi
B-114-8-13	RC-1	67.0 to 72.0	82	19	N/A
	RC-2	72.0 to 77.0	97	12	q_u @ 74.8' = 92 psi
	RC-3	77.0 to 82.0	98	92	q_u @ 78.4' = 12,567 psi
B-114-9-13	RC-1	65.0 to 70.0	33	26	N/A
	RC-2	70.0 to 75.0	88	58	N/A
	RC-3	75.0 to 80.0	100	83	q_u @ 75.7' = 338 psi [1]
	RC-4	80.0 to 85.0	93	90	N/A
	RC-5	85.0 to 90.0	93	89	N/A
B-115-1-13	RC-1	63.5 to 65.5	100	100	N/A
	RC-2	65.5 to 70.5	95	40	N/A
	RC-3	70.5 to 75.5	96	87	N/A
B-115-1A-19	NQ-1	66.0 to 71.0	37	35	N/A
	NQ-2	71.0 to 76.0	97	60	N/A
	NQ-3	76.0 to 81.0	95	50	N/A
	NQ-4	81.0 to 86.0	93	73	N/A
	NQ-5	86.0 to 91.0	97	62	N/A
	NQ-6	91.0 to 96.0	95	93	N/A
B-115-2-13	RC-1	64.2 to 65.7	100	58	N/A
	RC-2	65.7 to 70.7	88	0	N/A
	RC-3	70.7 to 75.7	100	86	N/A
	RC-4	75.7 to 80.7	30	0	N/A
	RC-5	80.7 to 85.7	75	45	q_u @ 83.2' = 8,867 psi
	RC-6	85.7 to 90.7	100	92	N/A

1. Indicates unconfined compressive strength determined from point load testing.

APPENDIX VII

DRILLED SHAFT CALCULATIONS

Substructure Unit (Boring)	Proposed Top of Shaft Elevation (ft msl)	D_w (ft)	Shaft Diameter, D (ft)	Soil Class.	Material Type [1]	Stratum Depth, z (ft)	Stratum Thickness (ft)	Bottom Elevation (ft msl)	γ (pcf)	σ_v' (Midpoint) (psf)	σ_v (Bottom) (psf)	S_u [2] (psf)	N_c [3]	α [4]	N_{60} [5]	$(N_1)_{60}$ [6]	φ'_f [7]	σ_p' [8] (psf)	β [9]	Substructure Unit (Boring)	Elevation (ft msl)	Shaft Length (ft)	Nominal Tip Resistance, q_p [10,11] (ksf)	Nominal Side Resistance, q_s [12,13] (ksf)	φ_{qp} [14]	φ_{qs} [15]	φ_{up} [16]
Pier 1 (B-105-2-13)	698.0	7.0	4.0	A-6a	C	4.0	4.0	694.0	120	240	480	2,000	7.2	0.55						Pier 1 (B-105-2-13)	698.0-694.0	0.0-4.0	14	1.10	0.40	0.45	0.35
				A-1-a	G	11.5	7.5	686.5	125	902	1,418				20	25	40	6,360	1.05		694.0-686.5	4.0-11.5	24	0.94	0.50	0.55	0.45
				A-1-a	G	19.0	7.5	679.0	130	1,390	2,393				42	47	43	13,356	1.39		686.5-679.0	11.5-19.0	50	1.92	0.50	0.55	0.45
				A-1-a	G	22.0	3.0	676.0	125	1,738	2,768				21	22	40	6,678	0.71		679.0-676.0	19.0-22.0	25	1.23	0.50	0.55	0.45
				A-1-b	G	33.0	11.0	665.0	135	2,231	4,253				48	46	43	15,264	1.10		676.0-665.0	22.0-33.0	57	2.45	0.50	0.55	0.45
				A-1-b	G	38.0	5.0	660.0	135	2,812	4,928				73	65	44	23,214	1.28		665.0-660.0	33.0-38.0	60	3.59	0.50	0.55	0.45
				A-1-a	G	43.0	5.0	655.0	135	3,175	5,603				100	85	45	31,800	1.49		660.0-655.0	38.0-43.0	60	4.74	0.50	0.55	0.45
				A-4a	C	47.0	4.0	651.0	130	3,491	6,123	8,000	9.0	0.45							655.0-651.0	43.0-47.0	72	3.60	0.40	0.45	0.35
Pier 2 (B-107-1-13)	693.0	5.0	4.0	A-1-a	G	7.0	7.0	686.0	135	473	945				52	77	45	16,536	3.62	Pier 2 (B-107-1-13)	693.0-686.0	0.0-7.0	60	1.70	0.50	0.55	0.45
				A-1-a	G	21.0	14.0	672.0	130	1,293	2,765				34	39	42	10,812	1.23		686.0-672.0	7.0-21.0	40	1.59	0.50	0.55	0.45
				A-1-a	G	26.0	5.0	667.0	125	1,923	3,390				17	17	39	5,406	0.58		672.0-667.0	21.0-26.0	20	1.10	0.50	0.55	0.45
				A-1-b	G	42.8	16.8	650.2	135	2,689	5,658				100	90	45	31,800	1.68		667.0-650.2	26.0-42.8	60	4.51	0.50	0.55	0.45
Pier 3 (B-108-4-13)	692.8	3.1	4.5	A-1-a	G	8.1	8.1	684.7	130	467	1,053				31	46	43	9,858	2.37	Pier 3 (B-108-4-13)	692.8-684.7	0.0-8.1	37	1.10	0.50	0.55	0.45
				A-1-b	G	13.1	5.0	679.7	125	897	1,678				20	25	40	6,360	1.06		684.7-679.7	8.1-13.1	24	0.94	0.50	0.55	0.45
				A-1-b	G	24.1	11.0	668.7	120	1,371	2,998				11	12	37	3,498	0.53		679.7-668.7	13.1-24.1	13	0.72	0.50	0.55	0.45
				A-1-a	G	30.1	6.0	662.7	135	1,905	3,808				90	92	46	28,620	2.04		668.7-662.7	24.1-30.1	60	3.88	0.50	0.55	0.45
				A-4a	C	39.6	9.5	653.2	120	2,397	4,948	1,500	9.0	0.55							662.7-653.2	30.1-39.6	13	0.82	0.40	0.45	0.35
Pier 4 (B-108-5-13)	699.0	10.2	4.5	A-6a	C	4.2	4.2	694.8	120	252	504	2,250	7.1	0.55						Pier 4 (B-108-5-13)	699.0-694.8	0.0-4.2	16	1.23	0.40	0.45	0.35
				A-2-6	G	9.2	5.0	689.8	125	817	1,129				18	23	40	5,724	1.05		694.8-689.8	4.2-9.2	21	0.85	0.50	0.55	0.45
				A-1-a	G	16.7	7.5	682.3	130	1,445	2,104				29	32	41	9,222	1.01		689.8-682.3	9.2-16.7	34	1.45	0.50	0.55	0.45
				A-1-b	G	21.7	5.0	677.3	125	1,855	2,729				19	20	39	6,042	0.63		682.3-677.3	16.7-21.7	22	1.17	0.50	0.55	0.45
				A-1-a	G	35.7	14.0	663.3	130	2,485	4,549				37	34	42	11,766	0.84		677.3-663.3	21.7-35.7	44	2.09	0.50	0.55	0.45
				A-4a	C	53.2	17.5	645.8	125	3,506	6,737	3,625	9.0	0.53							663.3-645.8	35.7-53.2	32	1.91	0.40	0.45	0.35
Pier 5 (B-108-6-13)	704.8	2.8	4.5	A-6a	C	15.8	15.8	689.0	115	590	1,817	1,125	9.0	0.55						Pier 5 (B-108-6-13)	704.8-689.0	0.0-15.8	10	0.61	0.40	0.45	0.35
				A-4a	C	27.3	11.5	677.5	115	1,308	3,139	1,250	9.0	0.55							689.0-677.5	15.8-27.3	11	0.68	0.40	0.45	0.35
				A-1-a	G	32.3	5.0	672.5	125	1,767	3,764				26	27	41	8,268	0.82		677.5-672.5	27.3-32.3	31	1.45	0.50	0.55	0.45
				A-1-a	G	37.3	5.0	667.5	135	2,105	4,439				54	53	43	17,172	1.24		672.5-667.5	32.3-37.3	60	2.61	0.50	0.55	0.45
				A-4a	C	47.8	10.5	657.0	130	2,642	5,804	8,000	9.0	0.45							667.5-657.0	37.3-47.8	72	3.60	0.40	0.45	0.35
Pier 6 (B-113-2-13)	709.5	21.2	4.5	A-6a	C	6.7	6.7	702.8	125	419	838	4,000	7.8	0.51						Pier 6 (B-113-2-13)	709.5-702.8	0.0-6.7	31	2.04	0.40	0.45	0.35
				A-1-b	G	23.2	16.5	686.3	135	1,951	3,065				62	63	44	19,716	1.47		702.8-686.3	6.7-23.2	60	2.86	0.50	0.55	0.45
				A-1-a	G	28.2	5.0	681.3	135	3,122	3,740				100	85	45	31,800	1.51		686.3-681.3	23.2-28.2	60	4.71	0.50	0.55	0.45
				A-3a	G	33.2	5.0	676.3	135	3,485	4,415				100	82	45	15,792	0.85		681.3-676.3	28.2-33.2	60	2.97	0.50	0.55	0.45
				A-4a	C	55.4	22.2	654.1	130	4,417	7,301	8,000	9.0	0.45							676.3-654.1	33.2-55.4	72	3.60	0.40	0.45	0.35
Pier 7 (B-113-3-13)	714.0	38.7	4.0	A-6b	C	11.7	11.7	702.3	120	702	1,404	2,375	9.0	0.55						Pier 7 (B-113-3-13)	714.0-702.3	0.0-11.7	21	1.30	0.40	0.45	0.35
				A-6a	C	16.7	5.0	697.3	125	1,717	2,029	4,250	9.0	0.50							702.3-697.3	11.7-16.7	38	2.12	0.40	0.45	0.35
				A-1-b	G	25.7	9.0	688.3	130	2,614	3,199				44	40	42	13,992	0.92		697.3-688.3	16.7-25.7	52	2.39	0.50	0.55	0.45
				A-1-b	G	35.7	10.0	678.3	125	3,824	4,449				13	10	37	4,134	0.31		688.3-678.3	25.7-35.7	15	1.20	0.50	0.55	0.45
				A-4a	C	40.7	5.0	673.3	120	4,749	5,049	2,875	9.0	0.55							678.3-673.3	35.7-40.7	25	1.58	0.40	0.45	0.35
				A-4a	C	50.7	10.0	663.3	130	5,262	6,349	8,000	9.0	0.45							673.3-663.3	40.7-50.7	72	3.60	0.40	0.45	0.35
				A-3a	G	55.7	5.0	658.3	135	5,782	7,024				100	65	44	15,792	0.59		663.3-658.3	50.7-55.7	60	3.42	0.50	0.55	0.45
Pier 8 (B-113-4-13)	710.0	23.3	4.0	A-2-6	G	2.1	2.1	707.9	125	131	262				12	23	40	3,816	2.61	Pier 8 (B-113-4-13)	710.0-707.9	0.0-2.1	14	0.34	0.50	0.55	0.45
				A-4a	C	5.3	3.2	704.7	110	438	614	750	7.6	0.55							707.9-704.7	2.1-5.3	5	0.41	0.40	0.45	0.35
				A-1-b	G	10.3	5.0	699.7	135	952	1,289				65	81	45	20,670	2.58		704.7-699.7	5.3-10.3	60	2.45	0.50	0.55	0.45
				A-1-a	G	21.8	11.5	688.2	135	2,066	2,842				91	90	45	28,938	1.89		699.7-688.2	10.3-21.8	60	3.91	0.50	0.55	0.45
				A-1-b	G	26.8	5.0	683.2	135	3,117	3,517				92	79	45	29,256	1.43		688.2-683.2	21.8-26.8	60	4.44	0.50	0.55	0.45
				A-1-b	G	41.8	15.0	668.2	135	3,843	5,542				52	41	42	16,536	0.79		683.2-668.2	26.8-41.8	60	3.03	0.50	0.55	0.45
				A-1-a	G	57.3	15.5	652.7	135	4,950	7,634				100	70	44	31,800	1.07		668.2-652.7	41.8-57.3	60	5.31	0.50	0.55	0.45
Pier 9 (B-113-5-13)	717.0	29.8	4.0	A-1-b	G	1.8	1.8	715.2	120	108	216				11	22	40	3,498	2.80	Pier 9 (B-113-5-13)	717.0-715.2	0.0-1.8	13	0.30	0.50	0.55	0.45
				A-1-a	G	19.3	17.5	697.7	125	1,310	2,403				22	25	40	6,996	0.88		715.2-697.7	1.8-19.3	26	1.15	0.50	0.55	0.45
				A-1-a	G	28.3	9.0	688.7	135	3,011	3,618				52	45	43	16,536	0.95		697.7-688.7	19.3-28.3	60	2.85	0.50	0.55	0.45
				A-1-b	G	33.3	5.0	683.7	120	3,856	4,218				13	10	37	4,134	0.31		688.7-683.7	28.3-33.3	15	1.20	0.50	0.55	0.45
				A-1-a	G	42.3	9.0	674.7	135	4,327	5,433				100	74	45	31,800	1.20		683.7-674.7	33.3-42.3	60	5.19	0.50	0.55	0.45
				Boulders	G	48.3	6.0	668.7	140	4,886	6,273				100	70	44	31,800	1.08		674.7-668.7	42.3-48.3	60	5.29	0.50	0.55	0.45
				A-3a	G	53.3	5.0	663.7	135	5,301	6,948				85	57	44	14,325	0.59		668.7-663.7	48.3-53.3	60	3.11	0.50	0.55	0.45
				A-1-a	G	64.8	11.5	652.2	135	5,900	8,501				100	64	44	31,800	0.95		663.7-652.2	53.3-64.8	60	5.60	0.50	0.55	0.45
Pier 10 (B-113-6-13)	691.5	0.0	8.0	A-2-6	G	12.8	12.8	678.7	120	369	1,536				5	8	36	1,590	0.71	Pier 10 (B-113-6-13)	691.5-678.7	0.0-12.8	6	0.26	0.50	0.55	0.45
				A-1-a	G	39.3	26.5	652.2	135	1,699	5,114				89	94	46	28,302	2.20		678.7-652.2	12.8-39.3	60	3.73	0.50	0.55	0.45

Substructure Unit (Boring)	Proposed Top of Shaft Elevation (ft msl)	D_w (ft)	Shaft Diameter, D (ft)	Soil Class.	Material Type [1]	Stratum Depth, z (ft)	Stratum Thickness (ft)	Bottom Elevation (ft msl)	γ (pcf)	σ_v' (Midpoint) (psf)	σ_v (Bottom) (psf)	S_u [2] (psf)	N_c [3]	α [4]	N_{60} [5]	$(N_1)_{60}$ [6]	φ'_f [7]	σ_p' [8] (psf)	β [9]	Substructure Unit (Boring)	Elevation (ft msl)	Shaft Length (ft)	Nominal Tip Resistance, q_p [10,11] (ksf)	Nominal Side Resistance, q_s [12,13] (ksf)	φ_{qp} [14]	φ_{qs} [15]	φ_{up} [16]
Pier 11 (B-113-7-13)	690.3	0.0	8.0	A-1-b	G	6.0	6.0	684.3	120	173	720				4	7	35	1,272	0.94	Pier 11 (B-113-7-13)	690.3-684.3	0.0-6.0	4	0.16	0.50	0.55	0.45
				A-4a	G	10.1	4.1	680.2	120	464	1,212				4	6	35	3,021	0.87		684.3-680.2	6.0-10.1	4	0.40	0.50	0.55	0.45
				A-1-a	G	15.1	5.0	675.2	130	751	1,862				35	47	43	11,130	1.87		680.2-675.2	10.1-15.1	42	1.40	0.50	0.55	0.45
				A-1-b	G	30.9	15.8	659.4	135	1,493	3,995				100	110	46	31,800	2.62		675.2-659.4	15.1-30.9	60	3.91	0.50	0.55	0.45
Pier 12 (B-113-8-13)	691.0	0.0	8.0	A-1-a	G	14.2	14.2	676.8	125	444	1,775				18	27	41	5,724	1.60	Pier 12 (B-113-8-13)	691.0-676.8	0.0-14.2	21	0.71	0.50	0.55	0.45
				A-1-a	G	19.2	5.0	671.8	130	1,058	2,425				42	51	43	13,356	1.67		676.8-671.8	14.2-19.2	50	1.76	0.50	0.55	0.45
				A-4a	G	27.4	8.2	663.6	135	1,525	3,532				86	94	46	35,159	2.78		671.8-663.6	19.2-27.4	60	4.23	0.50	0.55	0.45
				Boulders	G	44.2	16.8	646.8	140	2,474	5,884				100	93	46	31,800	1.82		663.6-646.8	27.4-44.2	60	4.51	0.50	0.55	0.45
				A-6b	C	47.0	2.8	644.0	130	3,221	6,248	8,000	9.0	0.45							646.8-644.0	44.2-47.0	72	3.60	0.40	0.45	0.35
Pier 13 (B-113-9-13)	695.6	9.3	8.0	A-6b	C	2.3	2.3	693.3	120	138	276	2,375	6.3	0.55						Pier 13 (B-113-9-13)	695.6-693.3	0.0-2.3	15	1.30	0.40	0.45	0.35
				A-6a	C	12.3	10.0	683.3	115	851	1,426	1,000	7.8	0.55							693.3-683.3	2.3-12.3	7	0.55	0.40	0.45	0.35
				A-4a	G	21.3	9.0	674.3	130	1,543	2,596				47	51	43	21,683	1.80		683.3-674.3	12.3-21.3	56	2.77	0.50	0.55	0.45
				A-2-4	G	39.3	18.0	656.3	135	2,501	5,026				57	53	43	18,126	1.14		674.3-656.3	21.3-39.3	60	2.86	0.50	0.55	0.45
Pier 14 (B-114-1-13)	695.6	14.3	8.0	A-6a	C	6.3	10.0	689.3	120	600	1,200	1,875	6.9	0.55						Pier 14 (B-114-1-13)	695.6-689.3	0.0-6.3	13	1.03	0.40	0.45	0.35
				A-6b	C	10.8	4.5	684.8	115	1,459	1,718	1,000	7.6	0.55							689.3-684.8	6.3-10.8	7	0.55	0.40	0.45	0.35
				A-1-a	G	17.8	7.0	677.8	125	2,155	2,593				17	17	39	5,406	0.54		684.8-677.8	10.8-17.8	20	1.15	0.50	0.55	0.45
				A-1-a	G	22.8	5.0	672.8	130	2,543	3,243				41	38	42	13,038	0.89		677.8-672.8	17.8-22.8	49	2.26	0.50	0.55	0.45
				A-2-4	G	27.8	5.0	667.8	135	2,894	3,918				100	88	45	31,800	1.60		672.8-667.8	22.8-27.8	60	4.61	0.50	0.55	0.45
				A-6b	C	40.3	12.5	655.3	125	3,466	5,480	4,750	9.0	0.48							667.8-655.3	27.8-40.3	42	2.26	0.40	0.45	0.35
Pier 15 (B-114-2-13)	718.5	25.0	4.5	A-6a	C	15.5	15.5	703.0	115	891	1,783	1,250	9.0	0.55						Pier 15 (B-114-2-13)	718.5-703.0	0.0-15.5	11	0.68	0.40	0.45	0.35
				A-6a	C	23.0	7.5	695.5	120	2,233	2,683	3,125	9.0	0.55							703.0-695.5	15.5-23.0	28	1.71	0.40	0.45	0.35
				A-6a	C	28.0	5.0	690.5	110	2,926	3,233	375	9.0	0.55							695.5-690.5	23.0-28.0	3	0.20	0.40	0.45	0.35
				A-1-b	G	32.0	4.0	686.5	120	3,161	3,713				7	6	35	2,226	0.24		690.5-686.5	28.0-32.0	8	0.77	0.50	0.55	0.45
				A-1-b	G	37.0	5.0	681.5	135	3,457	4,388				55	45	43	17,490	0.90		686.5-681.5	32.0-37.0	60	3.09	0.50	0.55	0.45
				A-4a	C	42.0	5.0	676.5	125	3,795	5,013	6,875	9.0	0.45							681.5-676.5	37.0-42.0	61	3.09	0.40	0.45	0.35
				A-1-b	G	47.0	5.0	671.5	135	4,133	5,688				104	79	45	33,072	1.27		676.5-671.5	42.0-47.0	60	5.26	0.50	0.55	0.45
				A-1-b	G	52.0	5.0	666.5	130	4,484	6,338				35	26	41	11,130	0.54		671.5-666.5	47.0-52.0	42	2.43	0.50	0.55	0.45
				A-6b	C	63.5	11.5	655.0	130	5,041	7,833	8,000	9.0	0.45							666.5-655.0	52.0-63.5	72	3.60	0.40	0.45	0.35
Pier 16 (B-114-3-13)	718.5	22.9	4.5	A-6a	C	6.9	6.9	711.6	115	397	793	1,500	7.8	0.55						Pier 16 (B-114-3-13)	718.5-711.6	0.0-6.9	11	0.82	0.40	0.45	0.35
				A-6a	C	19.4	12.5	699.1	125	1,575	2,356	3,875	9.0	0.52							711.6-699.1	6.9-19.4	34	2.00	0.40	0.45	0.35
				A-2-6	G	25.9	6.5	692.6	135	2,795	3,234				52	46	43	16,536	1.00		699.1-692.6	19.4-25.9	60	2.78	0.50	0.55	0.45
				A-1-b	G	35.9	10.0	682.6	125	3,359	4,484				17	14	38	5,406	0.40		692.6-682.6	25.9-35.9	20	1.35	0.50	0.55	0.45
				A-1-b	G	50.9	15.0	667.6	135	4,217	6,509				100	75	45	31,800	1.22		682.6-667.6	35.9-50.9	60	5.15	0.50	0.55	0.45
				A-7-6	C	57.4	6.5	661.1	130	4,981	7,354	8,000	9.0	0.45							667.6-661.1	50.9-57.4	72	3.60	0.40	0.45	0.35
Pier 17 (B-114-4-13)	716.0	21.9	4.5	A-6a	C	4.9	4.9	711.1	120	294	588	1,750	7.3	0.55						Pier 17 (B-114-4-13)	716.0-711.1	0.0-4.9	12	0.96	0.40	0.45	0.35
				A-2-4	G	14.9	10.0	701.1	120	1,188	1,788				8	9	36	2,544	0.47		711.1-701.1	4.9-14.9	9	0.55	0.50	0.55	0.45
				A-1-b	G	23.9	9.0	692.1	130	2,373	2,958				28	26	41	8,904	0.71		701.1-692.1	14.9-23.9	33	1.68	0.50	0.55	0.45
				A-1-b	G	35.9	12.0	680.1	130	3,239	4,518				41	34	42	13,038	0.76		692.1-680.1	23.9-35.9	49	2.45	0.50	0.55	0.45
				A-7-6	C	55.4	19.5	660.6	125	4,255	6,956	4,875	9.0	0.47							680.1-660.6	35.9-55.4	43	2.29	0.40	0.45	0.35
Pier 18 (B-114-5-13)	706.5	9.2	4.5	A-6b	C	4.2	4.2	702.3	115	242	483	1,250	7.1	0.55						Pier 18 (B-114-5-13)	706.5-702.3	0.0-4.2	8	0.68	0.40	0.45	0.35
				A-3a	G	9.2	5.0	697.3	125	796	1,108				18	24	40	5,644	1.06		702.3-697.3	4.2-9.2	21	0.84	0.50	0.55	0.45
				A-1-a	G	14.2	5.0	692.3	135	1,290	1,783				88	101	46	27,984	2.66		697.3-692.3	9.2-14.2	60	3.42	0.50	0.55	0.45
				A-1-a	G	23.2	9.0	683.3	130	1,775	2,953				40	42	42	12,720	1.11		692.3-683.3	14.2-23.2	48	1.97	0.50	0.55	0.45
				A-3a	G	28.2	5.0	678.3	130	2,248	3,603				46	44	43	9,910	0.82		683.3-678.3	23.2-28.2	55	1.83	0.50	0.55	0.45
				A-7-6	C	33.2	5.0	673.3	120	2,561	4,203	2,875	9.0	0.55							678.3-673.3	28.2-33.2	25	1.58	0.40	0.45	0.35
				A-4b	C	44.8	11.6	661.7	130	3,097	5,711	7,250	9.0	0.45							673.3-661.7	33.2-44.8	65	3.26	0.40	0.45	0.35
				A-7-6	C	54.7	9.9	651.8	130	3,824	6,998	8,000	9.0	0.45							661.7-651.8	44.8-54.7	72	3.60	0.40	0.45	0.35
Pier 19 (B-114-7-13)	705.0	8.7	4.5	A-7-6	C	4.7	4.7	700.3	120	282	564	2,250	7.3	0.55						Pier 19 (B-114-7-13)	705.0-700.3	0.0-4.7	16	1.23	0.40	0.45	0.35
				A-2-6	G	7.2	2.5	697.8	120	714	864				8	11	37	2,544	0.64		700.3-697.8	4.7-7.2	9	0.46	0.50	0.55	0.45
				A-1-a	G	19.7	12.5	685.3	125	1,349	2,427				28	32	41	8,904	1.03		697.8-685.3	7.2-19.7	33	1.39	0.50	0.55	0.45
				A-1-b	G	28.7	9.0	676.3	135	2,067	3,642				77	76	45	24,486	1.68		685.3-676.3	19.7-28.7	60	3.47	0.50	0.55	0.45
				A-1-b	G	33.7	5.0	671.3	125	2,550	4,267				21	19	39	6,678	0.55		676.3-671.3	28.7-33.7	25	1.40	0.50	0.55	0.45
				A-6b	C	43.7	10.0	661.3	125	3,020	5,517	4,375	9.0	0.49							671.3-661.3	33.7-43.7	39	2.15	0.40	0.45	0.35
				A-7-6	C	56.6	12.9	648.4	130	3,769	7,194	8,000	9.0	0.45							661.3-648.4	43.7-56.6	72	3.60	0.40	0.45	0.35

Substructure Unit (Boring)	Proposed Top of Shaft Elevation (ft msl)	D_w (ft)	Shaft Diameter, D (ft)	Soil Class.	Material Type [1]	Stratum Depth, z (ft)	Stratum Thickness (ft)	Bottom Elevation (ft msl)	γ (pcf)	σ_v' (Midpoint) (psf)	σ_v (Bottom) (psf)	S_u [2] (psf)	N_c [3]	α [4]	N_{60} [5]	$(N_1)_{60}$ [6]	φ'_f [7]	σ_p' [8] (psf)	β [9]
Pier 20 (B-114-8-13)	705.0	9.5	4.5	A-6b	C	6.5	6.5	698.5	115	374	748	1,250	7.7	0.55					
				A-1-a	G	11.5	5.0	693.5	125	1,060	1,373				26	32	41	8,268	1.15
				A-1-b	G	19.0	7.5	686.0	130	1,501	2,348				30	33	41	9,540	1.01
				A-1-a	G	28.0	9.0	677.0	135	2,081	3,563				85	84	45	27,030	1.80
				A-6b	C	35.8	7.8	669.2	120	2,633	4,499	2,250	9.0	0.55					
				A-7-6	C	43.0	7.2	662.0	125	3,083	5,399	3,750	9.0	0.52					
				A-7-6	C	54.5	11.5	650.5	130	3,697	6,894	8,000	9.0	0.45					
Pier 21 (B-114-9-13)	706.0	15.0	4.5	A-6b	C	5.0	5.0	701.0	115	288	575	1,000	7.3	0.55					
				A-1-b	G	15.0	10.0	691.0	125	1,200	1,825				16	19	39	5,088	0.75
				A-1-a	G	24.0	9.0	682.0	130	2,129	2,995				41	40	42	13,038	1.00
				A-3a	G	29.0	5.0	677.0	135	2,615	3,670				100	91	46	15,792	1.06
				A-4a	C	34.0	5.0	672.0	130	2,965	4,320	8,000	9.0	0.45					
				A-3a	G	39.0	5.0	667.0	135	3,316	4,995				51	42	42	10,543	0.65
				A-7-6	C	51.0	12.0	655.0	125	3,873	6,495	3,875	9.0	0.52					
Pier 22 (B-115-1-13)	706.5	20.9	4.5	A-6a	C	2.4	2.4	704.1	120	144	288	2,125	6.6	0.55					
				A-1-a	G	7.4	5.0	699.1	125	600	913				12	17	39	3,816	0.96
				A-4a	C	10.9	3.5	695.6	115	1,114	1,316	1,375	8.9	0.55					
				A-1-a	G	23.9	13.0	682.6	130	2,161	3,006				29	28	41	9,222	0.77
				A-1-b	G	28.9	5.0	677.6	135	3,000	3,681				73	63	44	23,214	1.22
				A-4a	C	38.9	10.0	667.6	130	3,519	4,981	8,000	9.0	0.45					
				A-2-6	G	43.9	5.0	662.6	135	4,039	5,656				100	77	45	31,800	1.26
				A-1-a	G	55.4	11.5	651.1	135	4,638	7,208				100	72	45	31,800	1.14

Substructure Unit (Boring)	Elevation (ft msl)	Shaft Length (ft)	Nominal Tip Resistance, q_p [10,11] (ksf)	Nominal Side Resistance, q_s [12,13] (ksf)	φ_{qp} [14]	φ_{qs} [15]	φ_{up} [16]
Pier 20 (B-114-8-13)	705.0-698.5	0.0-6.5	9	0.68	0.40	0.45	0.35
	698.5-693.5	6.5-11.5	31	1.21	0.50	0.55	0.45
	693.5-686.0	11.5-19.0	36	1.50	0.50	0.55	0.45
	686.0-677.0	19.0-28.0	60	3.73	0.50	0.55	0.45
	677.0-669.2	28.0-35.8	20	1.23	0.40	0.45	0.35
	669.2-662.0	35.8-43.0	33	1.96	0.40	0.45	0.35
	662.0-650.5	43.0-54.5	72	3.60	0.40	0.45	0.35
Pier 21 (B-114-9-13)	706.0-701.0	0.0-5.0	7	0.55	0.40	0.45	0.35
	701.0-691.0	5.0-15.0	19	0.89	0.50	0.55	0.45
	691.0-682.0	15.0-24.0	49	2.13	0.50	0.55	0.45
	682.0-677.0	24.0-29.0	60	2.77	0.50	0.55	0.45
	677.0-672.0	29.0-34.0	72	3.60	0.40	0.45	0.35
	672.0-667.0	34.0-39.0	60	2.14	0.50	0.55	0.45
	667.0-655.0	39.0-51.0	34	2.00	0.40	0.45	0.35
Pier 22 (B-115-1-13)	706.5-704.1	0.0-2.4	14	1.16	0.40	0.45	0.35
	704.1-699.1	2.4-7.4	14	0.57	0.50	0.55	0.45
	699.1-695.6	7.4-10.9	12	0.75	0.40	0.45	0.35
	695.6-682.6	10.9-23.9	34	1.67	0.50	0.55	0.45
	682.6-677.6	23.9-28.9	60	3.66	0.50	0.55	0.45
	677.6-667.6	28.9-38.9	72	3.60	0.40	0.45	0.35
	667.6-662.6	38.9-43.9	60	5.08	0.50	0.55	0.45
	662.6-651.1	43.9-55.4	60	5.29	0.50	0.55	0.45

1. C = cohesive soil stratum; G = granular soil stratum
2. S_u = average shear strength over stratum thickness (cohesive soil layers)
3. $N_C = 6[1+0.2(Z/D)] \leq 9$; Ref. Section 10.8.3.5.1c, AASHTO LRFD BDS (cohesive soil layers)
4. $\alpha = 0.55$ for $S_u/P_a \leq 1.5$; $\alpha = 0.55-0.1(S_u/P_a-1.5)$ for $1.5 \leq S_u/P_a \leq 2.5$, where P_a = 2.12 ksf = 2,120 psf; Ref. Section 10.8.3.5.1b AASHTO LRFD BDS (cohesive soil layers)
5. N_{60} = average energy corrected N-values over stratum thickness (granular soil layers)
6. $(N_1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_v')] \leq 2.0$ ksf, where σ_v' = vetical effective stress at midpoint of soil layer; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS (granular soil layers)
7. $\varphi'_f = 27.5+9.2\log[(N_1)_{60}]$; Ref. Section 10.8.3.5.2b, AASHTO LRFD BDS (granular soil layers)
8. $\sigma_p' = n(N_{60})^m(P_a)$, where n = 0.15 and m = 1.0 for A-1-a/1-b and A-2-4/2-6, n = 0.47 and m = 0.6 for A-3/3a, n = 0.47 and m = 0.8 for A-4a/4b soils, and P_a = 2.12 ksf = 2,120 psf; Ref. Section 10.8.3.5.2b, AASHTO LRFD BDS (granular soil layers)
9. $\beta = \tan\varphi'_f(1-\sin\varphi'_f)(\sigma_p'/\sigma_v')$^$(\sin\varphi'_f)$, where σ_v' = vetical effective stress at midpoint of soil layer; Ref. Section 10.8.3.5.2b, AASHTO LRFD BDS   (granular soil layers)
10. $q_p = N_C S_u \leq 80.0$ ksf; Ref. Section 10.8.3.5.1c, AASHTO LRFD BDS (cohesive soil layers)
11. $q_p = 1.2N_{60} \leq 60$ ksf; Ref. Section 10.8.3.5.2c, AASHTO LRFD BDS (granular soil layers)
12. $q_s = \alpha S_u$; Ref. Section 10.8.3.5.1b, AASHTO LRFD BDS (cohesive soil layers)
13. $q_s = \beta\sigma_v'$, where σ_v' = vetical effective stress at midpoint of soil layer; Ref. Section 10.8.3.5.2b, AASHTO LRFD BDS (granular soil layers)
14. φ_{qp} = 0.50 for granular soils layers and 0.40 for cohesive soil layers; Ref. Table 10.5.5.2.4-1, AASHTO LRFD BDS
15. φ_{qs} = 0.55 for granular soils layers and 0.45 for cohesive soil layers; Ref. Table 10.5.5.2.4-1, AASHTO LRFD BDS
16. φ_{up} = 0.45 for granular soils layers and 0.35 for cohesive soil layers; Ref. Table 10.5.5.2.4-1, AASHTO LRFD BDS

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Drilled Shaft Calculations

End Bearing Resistance in Bedrock: Limestone and Dolomite

Intact Rock (Minimum Rock Socket Length ≥ 1.5B):

$q_p = 2.5q_u$ Equation 10.8.3.5.4c-1

q_u = 705 ksf

q_p = 1,763 ksf

Jointed Rock (or Shafts with Rock Socket Length < 1.5B):

$$q_p = A + q_u\left[m_b\left(\frac{A}{q_u}\right) + s\right]^a$$ Equation 10.8.3.5.4c-2:

$$A = \sigma'_{vb} + q_u\left[m_b\frac{\sigma'_{vb}}{q_u} + s\right]^a$$ Equation 10.8.3.5.4c-3

q_u =	705	ksf	
GSI =	70	Per Figure 10.4.6.4-1	
D =	0.0	Per Section 10.4.6.4 for undisturbed foundation excavation	
m_i =	9	Per Table 10.4.6.4-1	
s =	0.036	Per Equation 10.4.6.4-2	
a =	0.50	Per Equation 10.4.6.4-3	
m_b =	3.08	Per Equation 10.4.6.4-4	
σ'_{vb} =	3.17	ksf	Considering overburden depth of 55 feet and bouyant unit weight of overburden of 57.6 pcf
A =	159	ksf	Per Equation 10.8.3.5.4c-3
q_p =	763	ksf	

Side Resistance in Bedrock (Minimum Rock Socket Length ≥ 1.0B): Limestone and Dolomite

$$q_s = C(p_a)\sqrt{\frac{q_u}{p_a}}$$ Equation 10.8.3.5.4b-1:

q_u =	705	ksf
p_a =	2.12	ksf
C =	1.00	
q_s =	38.7	ksf

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Drilled Shaft Calculations

End Bearing Resistance in Bedrock: Shale, Mudstone and Claystone

Intact Rock (Minimum Rock Socket Length ≥ 1.5B):

$q_p = 2.5q_u$ Equation 10.8.3.5.4c-1

q_u =	37	ksf
q_p =	93	ksf

Jointed Rock (or Shafts with Rock Socket Length < 1.5B):

$$q_p = A + q_u \left[m_b \left(\frac{A}{q_u} \right) + s \right]^a$$ Equation 10.8.3.5.4c-2:

$$A = \sigma'_{vb} + q_u \left[m_b \frac{\sigma'_{vb}}{q_u} + s \right]^a$$ Equation 10.8.3.5.4c-3

q_u =	ksf	
GSI =	Per Figure 10.4.6.4-1	
D =	Per Section 10.4.6.4 for undisturbed foundation excavation	
m_i =	Per Table 10.4.6.4-1	
s =	Per Equation 10.4.6.4-2	
a =	Per Equation 10.4.6.4-3	
m_b =	Per Equation 10.4.6.4-4	
σ'_{vb} =	ksf	Considering overburden depth of 55 feet and bouyant unit weight of overburden of 57.6 pcf
A =	ksf	Per Equation 10.8.3.5.4c-3
q_p =	ksf	

Side Resistance in Bedrock: Shale, Mudstone and Claystone

$$q_s = C(p_a)\sqrt{\frac{q_u}{p_a}}$$ Equation 10.8.3.5.4b-1:

q_u =	37	ksf
p_a =	2.12	ksf
C =	0.80	
q_s =	7.1	ksf

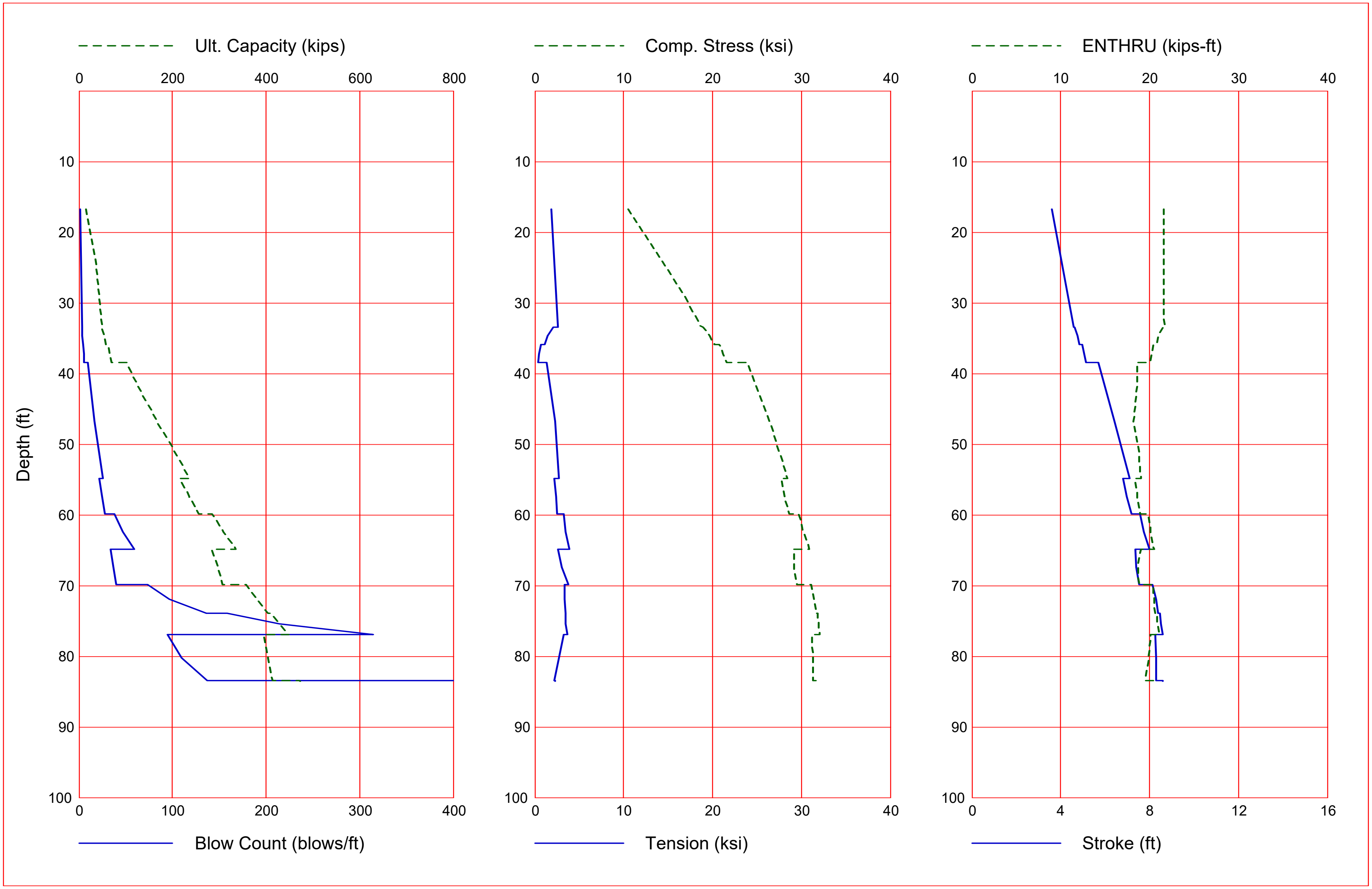
APPENDIX VIII

GRLWEAP DRIVEABILITY ANALYSIS OUTPUTS

Resource International Inc
FRA-71-1503L - RA - B-104-1-13 - HP10x42

Apr 06 2020
GRLWEAP Version 2010

Gain/Loss 3 at Shaft and Toe 0.670 / 1.000



Gain/Loss 3 at Shaft and Toe 0.670 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
16.7	15.8	14.7	1.1	1.3	10.478	-1.861	3.62	21.6
33.4	48.9	47.8	1.1	3.1	18.720	-2.586	4.58	21.7
33.4	50.2	47.9	2.3	3.2	18.939	-2.044	4.62	21.5
34.7	53.7	51.4	2.3	3.7	19.669	-1.471	4.75	21.0
35.9	57.3	54.9	2.3	4.2	20.249	-1.106	4.86	20.7
35.9	61.4	55.1	6.3	4.7	20.763	-0.713	4.96	20.4
37.2	65.9	59.5	6.3	5.1	21.194	-0.470	5.05	20.2
38.4	70.5	64.1	6.3	5.6	21.559	-0.320	5.13	20.0
38.4	102.4	64.3	38.0	9.8	23.898	-1.354	5.69	18.6
46.7	166.2	123.3	42.9	17.1	26.385	-2.281	6.40	18.2
54.9	236.0	192.6	43.4	26.2	28.459	-2.697	7.09	19.0
54.9	216.1	192.9	23.1	21.9	27.659	-2.169	6.82	18.4
57.4	235.4	212.3	23.1	24.8	28.137	-2.434	6.99	18.6
59.9	255.5	232.4	23.1	28.3	28.650	-2.514	7.17	18.9
59.9	283.8	232.8	51.0	37.6	29.741	-3.281	7.56	19.8
62.4	308.9	257.9	51.0	47.1	30.248	-3.458	7.76	20.1
64.9	335.1	284.0	51.0	59.4	30.862	-3.879	8.00	20.5
64.9	285.5	284.3	1.1	34.0	29.139	-2.661	7.37	19.0
67.4	295.9	294.8	1.1	37.2	29.179	-3.092	7.40	18.7
69.9	306.7	305.5	1.1	39.6	29.511	-3.818	7.54	18.8
69.9	356.9	305.8	51.0	73.2	31.110	-3.393	8.14	20.4
71.9	379.7	328.7	51.0	96.8	31.411	-3.372	8.28	20.5
73.9	403.2	352.1	51.0	136.1	31.610	-3.418	8.37	20.6
73.9	411.0	352.6	58.3	158.8	31.791	-3.445	8.45	20.8
75.4	429.1	370.8	58.3	214.0	31.963	-3.430	8.53	20.9
76.9	447.6	389.3	58.3	314.4	32.091	-3.647	8.61	21.1
76.9	395.8	389.6	6.2	94.4	31.215	-3.200	8.25	20.1
80.2	404.8	398.6	6.2	110.0	31.274	-2.711	8.30	19.9
83.4	413.8	407.6	6.2	136.8	31.293	-2.151	8.28	19.6
83.4	471.4	407.9	63.5	660.7	32.081	-2.312	8.60	20.5
83.4	471.7	408.2	63.5	669.4	32.076	-2.298	8.60	20.4
83.5	472.6	409.1	63.5	685.7	32.087	-2.296	8.60	20.4

Total Continuous Driving Time 66.00 minutes; Total Number of Blows 2788

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

```
 Input  File: J:\GEOTECH\PROJECTS\2013\W-13-072 FRA-70-13.10 PROJECT 6A\ANALYSIS\FRA-71-1503L\DRIVEABILITY\REAR
ABUTMENT\B-114-1.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2003.GW
 Hammer File Version:  2003 (2/22/2013)

                        Input File Contents
    FRA-71-1503L - RA - B-104-1-13 - HP10x42
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0   0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size          Pile Type
    32.170    32.170   144.000    10.000            Unknown
      W Cp      A Cp      E Cp      T Cp       CoR      ROut      StCp
     1.900   227.000     530.0     2.000     0.800     0.010       0.0
      A Cu      E Cu      T Cu       CoR      ROut      StCu
     0.000       0.0     0.000     0.000     0.000       0.0
      LPle      APle      EPle      WPle      Peri        CI       CoR      ROut
    83.500     12.40   29000.0   492.000     3.300         0     0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42         1       5
    Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
      4.00    129.10     12.60     11.86     10.81      0.80
    IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
      0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
     16.65    124.70    157.70     0.002     0.002     1.250      0.00      0.00
     P atm        P1        P2        P3        P4        P5
     14.70   1520.00   1368.00   1231.00   1108.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
```

10.8100	0.8000	1520.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Rtoe	Qs	Qt	Js	Jt	SU F	LimD	SU T
0.01	0.00	0.00	0.10	0.10	0.05	0.15	1.00	0.00	0.0
9.01	0.31	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
10.49	0.36	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
10.51	0.36	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
19.51	0.51	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
28.51	0.66	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
33.39	0.74	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
33.41	1.30	2.32	0.10	0.10	0.20	0.15	1.49	0.00	0.0
35.89	1.30	2.32	0.10	0.10	0.20	0.15	1.49	0.00	0.0
35.91	1.09	6.33	0.10	0.10	0.05	0.15	1.00	0.00	0.0
38.39	1.14	6.33	0.10	0.10	0.05	0.15	1.00	0.00	0.0
38.41	1.98	38.01	0.10	0.10	0.05	0.15	1.00	0.00	0.0
47.41	2.40	43.36	0.10	0.10	0.05	0.15	1.00	0.00	0.0
54.89	2.74	43.36	0.10	0.10	0.05	0.15	1.00	0.00	0.0
54.91	2.31	23.13	0.10	0.10	0.05	0.15	1.00	0.00	0.0
59.89	2.51	23.13	0.10	0.10	0.05	0.15	1.00	0.00	0.0
59.91	3.01	51.03	0.10	0.10	0.05	0.15	1.00	0.00	0.0
64.89	3.26	51.03	0.10	0.10	0.05	0.15	1.00	0.00	0.0
64.91	1.26	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
69.89	1.33	1.15	0.10	0.10	0.05	0.15	1.00	0.00	0.0
69.91	3.44	51.03	0.10	0.10	0.05	0.15	1.00	0.00	0.0
73.89	3.64	51.03	0.10	0.10	0.05	0.15	1.00	0.00	0.0
73.91	3.67	58.35	0.10	0.10	0.05	0.15	1.00	0.00	0.0
76.89	3.83	58.35	0.10	0.10	0.05	0.15	1.00	0.00	0.0
76.91	1.26	6.20	0.10	0.10	0.20	0.15	1.49	0.00	0.0
83.39	1.26	6.20	0.10	0.10	0.20	0.15	1.49	0.00	0.0
83.41	4.60	63.52	0.10	0.10	0.05	0.15	1.00	0.00	0.0
83.50	4.60	63.52	0.10	0.10	0.05	0.15	1.00	0.00	0.0

Gain/Loss factors: shaft and toe

0.60400	0.63700	0.67000	0.70300	0.73600
1.00000	1.00000	1.00000	1.00000	1.00000

Dpth	L	Wait	Strk	Pmx%	Eff.	Stff	CoR
16.70	0.00	0.00	0.000	0.000	0.000	0.000	0.000
33.38	0.00	0.00	0.000	0.000	0.000	0.000	0.000
33.42	0.00	0.00	0.000	0.000	0.000	0.000	0.000
34.65	0.00	0.00	0.000	0.000	0.000	0.000	0.000
35.88	0.00	0.00	0.000	0.000	0.000	0.000	0.000
35.92	0.00	0.00	0.000	0.000	0.000	0.000	0.000
37.15	0.00	0.00	0.000	0.000	0.000	0.000	0.000
38.38	0.00	0.00	0.000	0.000	0.000	0.000	0.000
38.42	0.00	0.00	0.000	0.000	0.000	0.000	0.000
46.65	0.00	0.00	0.000	0.000	0.000	0.000	0.000
54.88	0.00	0.00	0.000	0.000	0.000	0.000	0.000
54.92	0.00	0.00	0.000	0.000	0.000	0.000	0.000
57.40	0.00	0.00	0.000	0.000	0.000	0.000	0.000
59.88	0.00	0.00	0.000	0.000	0.000	0.000	0.000
59.92	0.00	0.00	0.000	0.000	0.000	0.000	0.000
62.40	0.00	0.00	0.000	0.000	0.000	0.000	0.000
64.88	0.00	0.00	0.000	0.000	0.000	0.000	0.000
64.92	0.00	0.00	0.000	0.000	0.000	0.000	0.000
67.40	0.00	0.00	0.000	0.000	0.000	0.000	0.000
69.88	0.00	0.00	0.000	0.000	0.000	0.000	0.000
69.92	0.00	0.00	0.000	0.000	0.000	0.000	0.000
71.90	0.00	0.00	0.000	0.000	0.000	0.000	0.000
73.88	0.00	0.00	0.000	0.000	0.000	0.000	0.000
73.92	0.00	0.00	0.000	0.000	0.000	0.000	0.000
75.40	0.00	0.00	0.000	0.000	0.000	0.000	0.000
76.88	0.00	0.00	0.000	0.000	0.000	0.000	0.000
76.92	0.00	0.00	0.000	0.000	0.000	0.000	0.000
80.15	0.00	0.00	0.000	0.000	0.000	0.000	0.000
83.38	0.00	0.00	0.000	0.000	0.000	0.000	0.000
83.42	0.00	0.00	0.000	0.000	0.000	0.000	0.000
83.44	0.00	0.00	0.000	0.000	0.000	0.000	0.000
83.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

1	0	10.81000	11.86000

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

FRA-71-1503L - RA - B-104-1-13 - HP10x42

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		8972.1			

HAMMER OPTIONS:

Hammer File ID No.	41	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1520.00	Actual Pressure	(psi)	1520.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

Depth	(ft)	16.7		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	10.000		

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 15.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	0.6	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	1.9	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	3.2	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	4.2	0.050	0.100	80.16	3.3	12.4

```
 25  0.142     8972 0.000 0.000 1.00     4.8   0.050 0.100  83.50   3.3    12.4
Toe                                      1.1   0.150 0.100

     3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.538 kips total reduced pile weight   (g= 32.17 ft/s2)

 PILE, SOIL, ANALYSIS OPTIONS:
 Uniform pile                          Pile Segments: Automatic
 No. of Slacks/Splices             0  Pile Damping          (%)         1
                                      Pile Damping Fact.(k/ft/s)     0.435
 Driveability Analysis
 Soil Damping Option            Smith
 Max No Analysis Iterations        0  Time Increment/Critical         160
 Output Time Interval              1  Analysis Time-Input   (ms)        0
 Output Level: Normal
 Gravity Mass, Pile, Hammer:   32.170    32.170    32.170
 Output Segment Generation: Automatic

    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    16.70     10.81      1.00     0.800
↑
FRA-71-1503L - RA - B-104-1-13 - HP10x42                           04/06/2020
Resource International Inc                                GRLWEAP Version 2010

    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi              ksi        kip-ft   b/min
   15.8     1.3   3.62   3.65   -1.86  10  15    10.48   1   7   21.6    62.1
   15.8     1.3   3.62   3.65   -1.86  10  15    10.48   1   7   21.6    62.1
   15.8     1.3   3.62   3.65   -1.86  10  15    10.48   1   7   21.6    62.1
   15.8     1.3   3.62   3.65   -1.86  10  15    10.48   1   7   21.6    62.1
   15.8     1.3   3.62   3.65   -1.86  10  15    10.48   1   7   21.6    62.1
         1          0   10.81000       11.86000
↑
FRA-71-1503L - RA - B-104-1-13 - HP10x42                           04/06/2020
Resource International Inc                                GRLWEAP Version 2010

 Depth                 (ft)      33.4
 Shaft Gain/Loss Factor         0.604  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area            (in2)   144.000  Pile Type                    Unknown
 Pile Size          (inch)    10.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
      ft      in2      ksi   lb/ft3       ft             ft/s    k/ft/s
     0.0    12.40   29000.    492.0      3.3        0    16524.     21.8
    83.5    12.40   29000.    492.0      3.3        0    16524.     21.8

 Wave Travel Time 2L/c (ms)    10.106

       Pile and Soil Model            Total Capacity Rut  (kips)      48.9
No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips     k/in    ft    ft        kips    s/ft  inch     ft    ft     in2
  1  0.142     8972 0.010 0.000 0.85     0.0   0.000 0.100   3.34   3.3    12.4
  2  0.142     8972 0.000 0.000 1.00     0.0   0.000 0.100   6.68   3.3    12.4
 16  0.142     8972 0.000 0.000 1.00     0.6   0.050 0.100  53.44   3.3    12.4
 17  0.142     8972 0.000 0.000 1.00     1.9   0.050 0.100  56.78   3.3    12.4
 18  0.142     8972 0.000 0.000 1.00     3.2   0.050 0.100  60.12   3.3    12.4
 19  0.142     8972 0.000 0.000 1.00     4.2   0.050 0.100  63.46   3.3    12.4
 20  0.142     8972 0.000 0.000 1.00     4.8   0.050 0.100  66.80   3.3    12.4
 21  0.142     8972 0.000 0.000 1.00     5.4   0.050 0.100  70.14   3.3    12.4
 22  0.142     8972 0.000 0.000 1.00     6.0   0.050 0.100  73.48   3.3    12.4
 23  0.142     8972 0.000 0.000 1.00     6.6   0.050 0.100  76.82   3.3    12.4
 24  0.142     8972 0.000 0.000 1.00     7.2   0.050 0.100  80.16   3.3    12.4
 25  0.142     8972 0.000 0.000 1.00     7.8   0.050 0.100  83.50   3.3    12.4
Toe                                      1.1   0.150 0.100

     3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.538 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    33.38     10.81      1.00     0.800
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FRA-71-1503L - RA - B-104-1-13 - HP10x42 04/06/2020
Resource International Inc GRLWEAP Version 2010

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
48.9	3.1	4.58	4.55	-2.59	15	79	18.72	16	5	21.7	55.4
48.9	3.1	4.58	4.55	-2.59	15	79	18.72	16	5	21.7	55.4
48.9	3.1	4.58	4.55	-2.59	15	79	18.72	16	5	21.7	55.4
48.9	3.1	4.58	4.55	-2.59	15	79	18.72	16	5	21.7	55.4
48.9	3.1	4.58	4.55	-2.59	15	79	18.72	16	5	21.7	55.4

1 0 10.81000 11.86000

FRA-71-1503L - RA - B-104-1-13 - HP10x42 04/06/2020
Resource International Inc GRLWEAP Version 2010

Depth (ft) 33.4
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 50.2

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	0.0	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	0.6	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	1.9	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	3.2	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	4.2	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	7.9	0.051	0.100	83.50	3.3	12.4
Toe						2.3	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
33.42	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
50.2	3.2	4.62	4.58	-2.05	3	12	18.95	16	5	21.5	55.2
50.2	3.2	4.61	4.58	-2.04	3	12	18.93	16	5	21.5	55.2
50.2	3.2	4.62	4.58	-2.04	3	12	18.94	16	5	21.5	55.2
50.2	3.2	4.61	4.58	-2.05	3	12	18.95	16	5	21.5	55.2
50.2	3.2	4.62	4.58	-2.05	3	12	18.94	16	5	21.5	55.2

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FRA-71-1503L - RA - B-104-1-13 - HP10x42 04/06/2020
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Depth (ft) 34.7
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	10.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 53.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	0.1	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	1.1	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	2.4	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	3.6	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	4.4	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	5.0	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	5.6	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	6.2	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	7.5	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	8.2	0.128	0.100	83.50	3.3	12.4
Toe						2.3	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
34.65	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
53.4	3.7	4.74	4.71	-1.53	3	12	19.65	16	5	21.1	54.5
53.5	3.7	4.74	4.71	-1.49	3	12	19.65	16	5	21.1	54.5
53.7	3.7	4.75	4.71	-1.47	3	12	19.67	16	5	21.0	54.4
53.9	3.8	4.75	4.72	-1.45	3	12	19.71	16	5	21.0	54.4
54.1	3.8	4.76	4.72	-1.45	3	12	19.74	16	5	21.0	54.3

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Depth	(ft)	35.9		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	10.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 56.6

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	0.3	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	1.6	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	2.8	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	4.0	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	4.6	0.050	0.100	63.46	3.3	12.4

20	0.142	8972	0.000	0.000	1.00	5.3	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	5.9	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	6.5	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	7.1	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	7.7	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	8.5	0.175	0.100	83.50	3.3	12.4
Toe						2.3	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
35.88	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
56.6	4.1	4.84	4.80	-1.18	2	12	20.15	16	5	20.8	53.9
56.9	4.2	4.85	4.81	-1.14	2	12	20.20	16	5	20.8	53.8
57.3	4.2	4.86	4.82	-1.11	2	12	20.25	16	5	20.7	53.8
57.6	4.2	4.87	4.83	-1.07	2	12	20.30	16	5	20.7	53.7
58.0	4.3	4.87	4.84	-1.03	2	12	20.33	16	5	20.7	53.7

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Resource International Inc GRLWEAP Version 2010

Depth (ft) 35.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 60.7

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	0.4	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	1.6	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	2.9	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	4.0	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	4.7	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	5.3	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	5.9	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	6.5	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	7.1	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	7.7	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	8.5	0.176	0.100	83.50	3.3	12.4
Toe						6.3	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
35.92	10.81	1.00	0.800

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Rut Bl Ct Stroke (ft) Ten Str i t Comp Str i t ENTHRU Bl Rt

kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
60.7	4.6	4.94	4.90	-0.79	2	12	20.67	16	5	20.5	53.2
61.0	4.6	4.95	4.92	-0.74	2	12	20.70	16	5	20.4	53.2
61.4	4.7	4.96	4.92	-0.71	2	12	20.76	16	5	20.4	53.1
61.8	4.7	4.97	4.93	-0.68	2	12	20.82	16	5	20.4	53.1
62.1	4.8	4.98	4.94	-0.62	2	12	20.85	16	5	20.4	53.0

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Depth (ft) 37.2
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 65.2

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	0.0	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	0.8	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	2.1	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	3.3	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	4.3	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	4.9	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	5.5	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	6.1	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	6.7	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	7.3	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	8.0	0.080	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	10.0	0.149	0.100	83.50	3.3	12.4
Toe						6.3	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
37.15	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
65.2	5.1	5.03	4.99	-0.54	2	12	21.10	16	5	20.2	52.7
65.5	5.1	5.04	5.00	-0.52	2	12	21.14	16	5	20.2	52.7
65.9	5.1	5.05	5.01	-0.47	2	12	21.19	16	5	20.2	52.6
66.2	5.2	5.05	5.02	-0.43	2	12	21.22	16	5	20.1	52.6
66.6	5.2	5.06	5.03	-0.40	2	12	21.25	16	5	20.1	52.5

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Resource International Inc GRLWEAP Version 2010

Depth (ft) 38.4
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top Area E-Mod Spec Wt Perim C Index Wave Sp EA/c

ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 69.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	0.2	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	1.3	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	2.5	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	3.7	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	4.5	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	5.1	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	5.7	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	6.3	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	7.5	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	8.3	0.145	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	11.4	0.093	0.100	83.50	3.3	12.4
Toe						6.3	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
38.38	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
69.8	5.5	5.11	5.07	-0.39	2	12	21.47	15	5	20.0	52.3
70.1	5.5	5.12	5.08	-0.34	2	12	21.51	16	5	20.0	52.2
70.5	5.6	5.13	5.09	-0.32	2	12	21.56	15	5	20.0	52.2
70.8	5.6	5.13	5.10	-0.29	3	14	21.59	15	5	19.9	52.1
71.2	5.7	5.14	5.11	-0.29	3	14	21.61	15	5	19.9	52.1

1 0 10.81000 11.86000

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Depth (ft) 38.4
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 101.6

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	0.2	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	1.3	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	2.5	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	3.8	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	4.5	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	5.1	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	5.7	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	6.3	0.050	0.100	70.14	3.3	12.4

22	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	7.5	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	8.3	0.146	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	11.5	0.091	0.100	83.50	3.3	12.4
Toe						38.0	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
38.42	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
101.6	9.7	5.67	5.73	-1.32	15	43	23.84	16	5	18.5	49.3
102.0	9.8	5.68	5.73	-1.34	15	43	23.86	16	5	18.5	49.2
102.4	9.8	5.69	5.74	-1.35	15	43	23.90	16	5	18.6	49.2
102.7	9.9	5.69	5.74	-1.37	15	43	23.93	16	5	18.6	49.2
103.1	9.9	5.70	5.75	-1.39	15	43	23.95	16	5	18.5	49.2

1 0 10.81000 11.86000

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Depth (ft) 46.7
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 165.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	0.6	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	1.9	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	3.1	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	4.2	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	9.4	0.168	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	17.0	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	23.5	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	25.2	0.050	0.100	83.50	3.3	12.4
Toe						42.9	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
46.65	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
165.5	17.0	6.39	6.40	-2.29	13	37	26.34	14	5	18.2	46.5
165.8	17.0	6.39	6.40	-2.28	14	35	26.39	14	5	18.2	46.5
166.2	17.1	6.40	6.41	-2.28	14	35	26.39	14	5	18.2	46.5
166.5	17.2	6.40	6.41	-2.28	14	34	26.38	14	5	18.1	46.5
166.9	17.2	6.40	6.41	-2.28	14	34	26.42	14	5	18.2	46.5

1 0 10.81000 11.86000

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Depth (ft) 54.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 235.3

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	0.1	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	1.2	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	2.4	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	3.7	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	4.5	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	5.1	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	5.7	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	6.3	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	7.5	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	8.3	0.136	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	11.1	0.103	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	21.9	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	24.2	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	26.0	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	27.7	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	29.4	0.050	0.100	83.50	3.3	12.4
Toe						43.4	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
54.88	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
235.3	26.1	7.07	7.02	-2.67	12	28	28.40	11	4	18.9	44.3
235.6	26.1	7.08	7.02	-2.69	12	28	28.41	12	4	18.9	44.3
236.0	26.2	7.09	7.02	-2.70	12	28	28.46	12	4	19.0	44.3
236.3	26.3	7.08	7.04	-2.71	12	28	28.44	11	4	18.9	44.2
236.7	26.4	7.10	7.04	-2.72	12	28	28.48	11	4	18.9	44.2

1 0 10.81000 11.86000

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Depth (ft) 54.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	10.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model   Total Capacity Rut (kips) 215.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	0.1	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	1.2	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	2.5	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	3.7	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	4.5	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	5.1	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	5.7	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	6.3	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	7.5	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	8.3	0.138	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	11.2	0.101	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	22.1	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	24.3	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	26.0	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	27.7	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	29.4	0.050	0.100	83.50	3.3	12.4
Toe						23.1	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
54.92	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	Stroke (ft) up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft			ksi			ksi			kip-ft	b/min
215.4	21.8	6.81	6.76	-2.16	11	30	27.62	11	4	18.3	45.2
215.7	21.8	6.82	6.76	-2.17	11	30	27.66	11	4	18.4	45.1
216.1	21.9	6.82	6.76	-2.17	11	30	27.66	11	4	18.4	45.1
216.4	21.9	6.83	6.77	-2.17	11	30	27.69	11	4	18.4	45.1
216.8	21.9	6.83	6.77	-2.17	11	30	27.68	11	4	18.4	45.1

1 0 10.81000 11.86000

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Depth	(ft)	57.4		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	10.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model   Total Capacity Rut (kips) 234.7

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	0.0	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	0.9	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	2.1	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	3.4	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	4.3	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	4.9	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	5.5	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	6.1	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	6.7	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	7.3	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	8.0	0.094	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	10.2	0.140	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	19.3	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	23.8	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	25.5	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	27.3	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	29.0	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	27.0	0.050	0.100	83.50	3.3	12.4
Toe						23.1	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
57.40	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
234.7	24.7	6.98	6.93	-2.40	11	28	28.10	11	4	18.6	44.6
235.0	24.9	6.92	6.93	-2.44	11	28	27.94	11	4	18.5	44.7
235.4	24.8	6.99	6.94	-2.43	11	28	28.14	11	4	18.6	44.6
235.7	24.8	7.00	6.93	-2.45	11	28	28.18	11	4	18.7	44.6
236.1	24.9	7.00	6.93	-2.46	11	28	28.16	11	4	18.7	44.6

1 0 10.81000 11.86000

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Depth (ft) 59.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 254.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	0.5	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	1.8	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	3.1	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	4.1	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	56.78	3.3	12.4

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 18  0.142     8972 0.000 0.000 1.00     9.2   0.169 0.100  60.12   3.3    12.4
 19  0.142     8972 0.000 0.000 1.00    16.6   0.050 0.100  63.46   3.3    12.4
 20  0.142     8972 0.000 0.000 1.00    23.4   0.050 0.100  66.80   3.3    12.4
 21  0.142     8972 0.000 0.000 1.00    25.1   0.050 0.100  70.14   3.3    12.4
 22  0.142     8972 0.000 0.000 1.00    26.8   0.050 0.100  73.48   3.3    12.4
 23  0.142     8972 0.000 0.000 1.00    28.5   0.050 0.100  76.82   3.3    12.4
 24  0.142     8972 0.000 0.000 1.00    27.9   0.050 0.100  80.16   3.3    12.4
 25  0.142     8972 0.000 0.000 1.00    26.9   0.050 0.100  83.50   3.3    12.4
Toe                                     23.1   0.150 0.100

     3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.538 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    59.88     10.81      1.00     0.800
```

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```
    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi             ksi          kip-ft   b/min
  254.8    28.2   7.16   7.09   -2.53  10  27    28.63  10   4   18.9    44.0
  255.2    28.6   7.10   7.11   -2.53  10  27    28.45  10   4   18.7    44.1
  255.5    28.3   7.17   7.10   -2.51  10  27    28.65  10   4   18.9    44.0
  255.9    28.5   7.18   7.12   -2.56  10  27    28.66  10   4   18.9    44.0
  256.2    28.6   7.18   7.12   -2.54  10  27    28.67  10   4   18.9    44.0
        1          0   10.81000       11.86000
```

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```
 Depth                 (ft)      59.9
 Shaft Gain/Loss Factor         0.604  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area            (in2)   144.000  Pile Type                   Unknown
 Pile Size           (inch)   10.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
      ft      in2      ksi   lb/ft3      ft             ft/s    k/ft/s
     0.0    12.40   29000.    492.0      3.3       0    16524.     21.8
    83.5    12.40   29000.    492.0      3.3       0    16524.     21.8

 Wave Travel Time 2L/c (ms)    10.106

        Pile and Soil Model           Total Capacity Rut  (kips)     283.1
No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
     kips     k/in    ft    ft         kips    s/ft  inch     ft    ft     in2
  1  0.142     8972 0.010 0.000 0.85     0.0   0.000 0.100   3.34   3.3    12.4
  2  0.142     8972 0.000 0.000 1.00     0.0   0.000 0.100   6.68   3.3    12.4
  8  0.142     8972 0.000 0.000 1.00     0.6   0.050 0.100  26.72   3.3    12.4
  9  0.142     8972 0.000 0.000 1.00     1.8   0.050 0.100  30.06   3.3    12.4
 10  0.142     8972 0.000 0.000 1.00     3.1   0.050 0.100  33.40   3.3    12.4
 11  0.142     8972 0.000 0.000 1.00     4.1   0.050 0.100  36.74   3.3    12.4
 12  0.142     8972 0.000 0.000 1.00     4.8   0.050 0.100  40.08   3.3    12.4
 13  0.142     8972 0.000 0.000 1.00     5.4   0.050 0.100  43.42   3.3    12.4
 14  0.142     8972 0.000 0.000 1.00     6.0   0.050 0.100  46.76   3.3    12.4
 15  0.142     8972 0.000 0.000 1.00     6.6   0.050 0.100  50.10   3.3    12.4
 16  0.142     8972 0.000 0.000 1.00     7.2   0.050 0.100  53.44   3.3    12.4
 17  0.142     8972 0.000 0.000 1.00     7.8   0.050 0.100  56.78   3.3    12.4
 18  0.142     8972 0.000 0.000 1.00     9.3   0.169 0.100  60.12   3.3    12.4
 19  0.142     8972 0.000 0.000 1.00    16.7   0.050 0.100  63.46   3.3    12.4
 20  0.142     8972 0.000 0.000 1.00    23.4   0.050 0.100  66.80   3.3    12.4
 21  0.142     8972 0.000 0.000 1.00    25.1   0.050 0.100  70.14   3.3    12.4
 22  0.142     8972 0.000 0.000 1.00    26.8   0.050 0.100  73.48   3.3    12.4
 23  0.142     8972 0.000 0.000 1.00    28.6   0.050 0.100  76.82   3.3    12.4
 24  0.142     8972 0.000 0.000 1.00    27.8   0.050 0.100  80.16   3.3    12.4
 25  0.142     8972 0.000 0.000 1.00    27.0   0.050 0.100  83.50   3.3    12.4
Toe                                     51.0   0.150 0.100

     3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.538 kips total reduced pile weight   (g= 32.17 ft/s2)
```

Depth ft	Stroke ft	Pressure Ratio	Efficy
59.92	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
283.1	37.1	7.55	7.50	-3.27	10	25	29.75	10	4	19.8	42.9
283.4	37.4	7.54	7.51	-3.28	10	25	29.71	10	4	19.8	42.9
283.8	37.6	7.56	7.52	-3.28	10	25	29.74	10	4	19.8	42.9
284.1	37.7	7.55	7.52	-3.29	10	25	29.73	10	4	19.8	42.9
284.5	37.7	7.57	7.52	-3.30	10	25	29.78	10	4	19.8	42.8

1 0 10.81000 11.86000

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Depth (ft) 62.4
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 308.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	0.3	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	1.5	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	2.8	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	3.9	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	4.6	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	5.2	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	5.8	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	6.4	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	7.0	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	7.6	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	8.5	0.169	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	13.9	0.060	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	23.0	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	24.7	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	26.4	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	28.1	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	28.6	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	26.6	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	32.2	0.050	0.100	83.50	3.3	12.4
Toe						51.0	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
62.40	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
308.2	46.6	7.76	7.74	-3.44	10	24	30.25	9	3	20.1	42.3
308.6	46.6	7.77	7.75	-3.45	10	24	30.29	9	3	20.1	42.3

308.9	47.1	7.76	7.76	-3.46	10	24	30.25	10	4	20.1	42.3
309.3	47.1	7.77	7.76	-3.47	10	24	30.28	9	3	20.1	42.3
309.6	47.0	7.79	7.76	-3.49	10	24	30.33	9	3	20.2	42.2

1 0 10.81000 11.86000

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Depth (ft) 64.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 334.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	0.1	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	1.2	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	2.4	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	3.7	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	4.5	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	5.1	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	5.7	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	6.3	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	7.5	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	8.3	0.135	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	11.1	0.104	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	21.9	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	24.2	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	26.0	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	27.7	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	29.4	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	26.3	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	30.4	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	35.0	0.050	0.100	83.50	3.3	12.4
Toe						51.0	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
64.88	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
334.4	58.9	7.99	7.97	-3.84	11	24	30.86	9	3	20.5	41.7
334.7	59.6	7.98	7.98	-3.86	11	24	30.82	9	3	20.5	41.7
335.1	59.4	8.00	7.98	-3.88	11	24	30.86	9	3	20.5	41.7
335.4	60.1	8.00	7.99	-3.87	11	24	30.85	9	3	20.5	41.7
335.8	59.8	8.01	7.99	-3.89	11	24	30.91	9	3	20.6	41.7

1 0 10.81000 11.86000

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Depth (ft) 64.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	10.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 284.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	0.1	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	1.2	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	2.5	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	3.7	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	4.5	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	5.1	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	5.7	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	6.3	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	7.5	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	8.3	0.137	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	11.2	0.102	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	22.0	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	24.3	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	26.0	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	27.7	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	29.4	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	26.2	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	30.5	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	34.9	0.050	0.100	83.50	3.3	12.4
Toe						1.1	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
64.92	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
284.8	33.6	7.35	7.30	-2.62	9	27	29.09	9	3	19.0	43.5
285.1	33.6	7.36	7.30	-2.62	9	27	29.13	9	3	19.0	43.5
285.5	34.0	7.37	7.31	-2.66	9	27	29.14	9	3	19.0	43.5
285.8	34.0	7.37	7.31	-2.64	9	27	29.14	9	3	19.0	43.5
286.2	34.0	7.38	7.31	-2.63	9	27	29.17	9	3	19.0	43.5

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Depth	(ft)	67.4		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	10.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 295.2

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	0.0	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	0.9	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	2.1	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	3.4	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	4.3	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	4.9	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	5.5	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	6.1	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	6.7	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	7.3	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	8.0	0.092	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	10.2	0.141	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	19.2	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	23.8	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	25.5	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	27.3	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	29.0	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	27.1	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	28.6	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	34.5	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	19.5	0.050	0.100	83.50	3.3	12.4
Toe						1.1	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
67.40	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
295.2	36.4	7.45	7.39	-3.07	7	23	29.33	8	3	18.9	43.2
295.6	36.4	7.46	7.39	-3.08	7	23	29.37	8	3	19.0	43.2
295.9	37.2	7.40	7.41	-3.09	6	23	29.18	8	3	18.7	43.3
296.3	36.9	7.47	7.41	-3.08	6	23	29.38	8	3	18.9	43.2
296.6	36.8	7.48	7.41	-3.12	7	23	29.41	8	3	19.0	43.2

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Depth (ft) 69.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 306.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	0.5	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	1.8	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	3.1	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	4.1	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	30.06	3.3	12.4

10	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	9.2	0.169	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	16.5	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	23.4	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	25.1	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	26.8	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	28.5	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	27.9	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	26.9	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	34.0	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	24.9	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	14.4	0.050	0.100	83.50	3.3	12.4
Toe						1.1	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
69.88	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
306.0	39.0	7.53	7.47	-3.83	6	23	29.49	7	3	18.9	43.0
306.3	39.4	7.54	7.49	-3.81	6	23	29.50	7	3	18.8	43.0
306.7	39.6	7.54	7.49	-3.82	6	23	29.51	7	3	18.8	43.0
307.0	39.6	7.55	7.50	-3.83	6	23	29.55	7	3	18.8	42.9
307.4	39.6	7.56	7.49	-3.86	6	23	29.57	7	3	18.9	42.9

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Depth (ft) 69.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 356.2

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	0.5	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	1.8	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	3.1	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	4.1	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	9.2	0.169	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	16.7	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	23.4	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	25.1	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	26.8	0.050	0.100	63.46	3.3	12.4

20	0.142	8972	0.000	0.000	1.00	28.5	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	27.9	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	26.9	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	34.1	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	24.7	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	14.5	0.050	0.100	83.50	3.3	12.4
Toe						51.0	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
69.92	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
356.2	72.2	8.14	8.12	-3.39	8	23	31.10	7	3	20.4	41.3
356.5	73.4	8.13	8.13	-3.39	8	23	31.07	7	3	20.4	41.3
356.9	73.2	8.14	8.13	-3.39	8	23	31.11	7	3	20.4	41.3
357.2	74.0	8.15	8.14	-3.38	8	23	31.13	7	3	20.4	41.3
357.6	73.7	8.15	8.14	-3.40	8	23	31.16	7	3	20.4	41.3

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Depth (ft) 71.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model						Total Capacity Rut (kips)				379.0	
No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
4	0.142	8972	0.000	0.000	1.00	0.2	0.050	0.100	13.36	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	1.3	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	2.6	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	3.8	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	4.5	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	5.1	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	5.7	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	6.3	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	6.9	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	7.6	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	8.3	0.150	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	11.8	0.086	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	22.7	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	24.4	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	26.1	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	27.8	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	29.1	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	26.3	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	31.1	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	33.1	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	14.2	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	28.9	0.050	0.100	83.50	3.3	12.4
Toe						51.0	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)

3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
71.90	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
379.0	95.3	8.28	8.28	-3.37	7	22	31.41	7	3	20.6	41.0
379.3	95.6	8.27	8.27	-3.39	7	22	31.40	7	3	20.6	41.0
379.7	96.8	8.28	8.29	-3.37	7	22	31.41	7	3	20.5	41.0
380.0	97.2	8.28	8.28	-3.39	7	22	31.41	7	3	20.5	41.0
380.4	97.1	8.29	8.29	-3.40	7	22	31.45	7	3	20.6	41.0

1 0 10.81000 11.86000

Depth (ft) 73.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 402.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
3	0.142	8972	0.000	0.000	1.00	0.0	0.050	0.100	10.02	3.3	12.4
4	0.142	8972	0.000	0.000	1.00	0.8	0.050	0.100	13.36	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	2.1	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	3.3	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	4.3	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	4.9	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	5.5	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	6.1	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	6.7	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	7.3	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	8.0	0.080	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	9.9	0.150	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	18.6	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	23.7	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	25.4	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	27.1	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	28.9	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	27.3	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	28.2	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	34.4	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	20.8	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	19.0	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	39.2	0.050	0.100	83.50	3.3	12.4
Toe						51.0	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
73.88	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
402.5	134.9	8.36	8.39	-3.41	7	22	31.55	6	3	20.6	40.8
402.8	136.2	8.36	8.39	-3.41	7	22	31.57	6	3	20.6	40.8
403.2	136.1	8.37	8.39	-3.42	7	22	31.61	6	3	20.6	40.7
403.5	136.2	8.36	8.39	-3.44	7	22	31.57	6	3	20.7	40.8
403.9	138.1	8.37	8.40	-3.43	7	22	31.59	6	3	20.7	40.7

1 0 10.81000 11.86000

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Depth (ft) 73.9
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 410.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.3	12.4
3	0.142	8972	0.000	0.000	1.00	0.0	0.050	0.100	10.02	3.3	12.4
4	0.142	8972	0.000	0.000	1.00	0.8	0.050	0.100	13.36	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	2.1	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	3.3	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	4.3	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	4.9	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	5.5	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	6.1	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	6.7	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	7.3	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	8.0	0.082	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	10.0	0.148	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	18.7	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	23.7	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	25.5	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	27.2	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	28.9	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	27.2	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	28.3	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	34.4	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	20.5	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	19.3	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	39.3	0.050	0.100	83.50	3.3	12.4
Toe						58.3	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
73.92	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
410.3	155.2	8.44	8.44	-3.45	7	22	31.78	6	3	20.8	40.6
410.6	156.8	8.44	8.44	-3.46	7	22	31.77	6	3	20.8	40.6
411.0	158.8	8.45	8.44	-3.45	7	22	31.79	6	3	20.8	40.6
411.3	157.3	8.45	8.44	-3.48	7	22	31.79	6	3	20.9	40.6

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  411.7   159.3   8.45   8.44   -3.48   7  22    31.81   6   3   20.9    40.6
          1           0   10.81000       11.86000
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 Depth                  (ft)      75.4
 Shaft Gain/Loss Factor         0.604  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area             (in2)   144.000  Pile Type                   Unknown
 Pile Size           (inch)    10.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s    k/ft/s
      0.0    12.40   29000.    492.0      3.3       0    16524.     21.8
     83.5    12.40   29000.    492.0      3.3       0    16524.     21.8

 Wave Travel Time 2L/c (ms)    10.106

        Pile and Soil Model           Total Capacity Rut  (kips)     428.4
No. Weight    Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips      k/in    ft    ft         kips    s/ft  inch     ft    ft     in2
  1  0.142      8972 0.010 0.000 0.85     0.0   0.000 0.100   3.34   3.3    12.4
  2  0.142      8972 0.000 0.000 1.00     0.0   0.000 0.100   6.68   3.3    12.4
  3  0.142      8972 0.000 0.000 1.00     0.2   0.050 0.100  10.02   3.3    12.4
  4  0.142      8972 0.000 0.000 1.00     1.4   0.050 0.100  13.36   3.3    12.4
  5  0.142      8972 0.000 0.000 1.00     2.6   0.050 0.100  16.70   3.3    12.4
  6  0.142      8972 0.000 0.000 1.00     3.8   0.050 0.100  20.04   3.3    12.4
  7  0.142      8972 0.000 0.000 1.00     4.5   0.050 0.100  23.38   3.3    12.4
  8  0.142      8972 0.000 0.000 1.00     5.2   0.050 0.100  26.72   3.3    12.4
  9  0.142      8972 0.000 0.000 1.00     5.8   0.050 0.100  30.06   3.3    12.4
 10  0.142      8972 0.000 0.000 1.00     6.4   0.050 0.100  33.40   3.3    12.4
 11  0.142      8972 0.000 0.000 1.00     7.0   0.050 0.100  36.74   3.3    12.4
 12  0.142      8972 0.000 0.000 1.00     7.6   0.050 0.100  40.08   3.3    12.4
 13  0.142      8972 0.000 0.000 1.00     8.4   0.156 0.100  43.42   3.3    12.4
 14  0.142      8972 0.000 0.000 1.00    12.4   0.078 0.100  46.76   3.3    12.4
 15  0.142      8972 0.000 0.000 1.00    22.8   0.050 0.100  50.10   3.3    12.4
 16  0.142      8972 0.000 0.000 1.00    24.5   0.050 0.100  53.44   3.3    12.4
 17  0.142      8972 0.000 0.000 1.00    26.2   0.050 0.100  56.78   3.3    12.4
 18  0.142      8972 0.000 0.000 1.00    27.9   0.050 0.100  60.12   3.3    12.4
 19  0.142      8972 0.000 0.000 1.00    29.0   0.050 0.100  63.46   3.3    12.4
 20  0.142      8972 0.000 0.000 1.00    26.4   0.050 0.100  66.80   3.3    12.4
 21  0.142      8972 0.000 0.000 1.00    31.5   0.050 0.100  70.14   3.3    12.4
 22  0.142      8972 0.000 0.000 1.00    32.1   0.050 0.100  73.48   3.3    12.4
 23  0.142      8972 0.000 0.000 1.00    14.2   0.050 0.100  76.82   3.3    12.4
 24  0.142      8972 0.000 0.000 1.00    30.1   0.050 0.100  80.16   3.3    12.4
 25  0.142      8972 0.000 0.000 1.00    40.2   0.050 0.100  83.50   3.3    12.4
Toe                                      58.3   0.150 0.100

     3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.538 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
      ft        ft     Ratio
    75.40     10.81      1.00     0.800
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    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi              ksi         kip-ft   b/min
  428.4   206.7   8.54   8.50   -3.43   7  22    32.00   6   3   21.0    40.4
  428.8   208.7   8.54   8.50   -3.44   8  21    31.98   6   3   21.0    40.4
  429.1   214.0   8.53   8.50   -3.43   8  21    31.96   6   3   20.9    40.4
  429.5   214.6   8.55   8.51   -3.42   8  21    32.01   6   3   21.0    40.4
  429.8   220.0   8.53   8.51   -3.42   8  21    31.97   6   3   20.9    40.4
          1           0   10.81000       11.86000
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 Depth                  (ft)      76.9
 Shaft Gain/Loss Factor         0.604  Toe Gain/Loss Factor          1.000
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 PILE PROFILE:
 Toe Area            (in2)   144.000  Pile Type                    Unknown
 Pile Size          (inch)    10.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
      ft      in2      ksi   lb/ft3       ft              ft/s    k/ft/s
     0.0    12.40   29000.    492.0      3.3        0    16524.     21.8
    83.5    12.40   29000.    492.0      3.3        0    16524.     21.8

 Wave Travel Time 2L/c (ms)    10.106

       Pile and Soil Model            Total Capacity Rut  (kips)     446.9
No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch     ft    ft     in2
  1  0.142     8972 0.010 0.000 0.85     0.0   0.000 0.100   3.34   3.3    12.4
  2  0.142     8972 0.000 0.000 1.00     0.0   0.050 0.100   6.68   3.3    12.4
  3  0.142     8972 0.000 0.000 1.00     0.7   0.050 0.100  10.02   3.3    12.4
  4  0.142     8972 0.000 0.000 1.00     1.9   0.050 0.100  13.36   3.3    12.4
  5  0.142     8972 0.000 0.000 1.00     3.2   0.050 0.100  16.70   3.3    12.4
  6  0.142     8972 0.000 0.000 1.00     4.2   0.050 0.100  20.04   3.3    12.4
  7  0.142     8972 0.000 0.000 1.00     4.8   0.050 0.100  23.38   3.3    12.4
  8  0.142     8972 0.000 0.000 1.00     5.4   0.050 0.100  26.72   3.3    12.4
  9  0.142     8972 0.000 0.000 1.00     6.0   0.050 0.100  30.06   3.3    12.4
 10  0.142     8972 0.000 0.000 1.00     6.6   0.050 0.100  33.40   3.3    12.4
 11  0.142     8972 0.000 0.000 1.00     7.2   0.050 0.100  36.74   3.3    12.4
 12  0.142     8972 0.000 0.000 1.00     7.9   0.055 0.100  40.08   3.3    12.4
 13  0.142     8972 0.000 0.000 1.00     9.6   0.164 0.100  43.42   3.3    12.4
 14  0.142     8972 0.000 0.000 1.00    17.5   0.050 0.100  46.76   3.3    12.4
 15  0.142     8972 0.000 0.000 1.00    23.5   0.050 0.100  50.10   3.3    12.4
 16  0.142     8972 0.000 0.000 1.00    25.3   0.050 0.100  53.44   3.3    12.4
 17  0.142     8972 0.000 0.000 1.00    27.0   0.050 0.100  56.78   3.3    12.4
 18  0.142     8972 0.000 0.000 1.00    28.7   0.050 0.100  60.12   3.3    12.4
 19  0.142     8972 0.000 0.000 1.00    27.6   0.050 0.100  63.46   3.3    12.4
 20  0.142     8972 0.000 0.000 1.00    27.5   0.050 0.100  66.80   3.3    12.4
 21  0.142     8972 0.000 0.000 1.00    34.2   0.050 0.100  70.14   3.3    12.4
 22  0.142     8972 0.000 0.000 1.00    22.9   0.050 0.100  73.48   3.3    12.4
 23  0.142     8972 0.000 0.000 1.00    16.5   0.050 0.100  76.82   3.3    12.4
 24  0.142     8972 0.000 0.000 1.00    39.0   0.050 0.100  80.16   3.3    12.4
 25  0.142     8972 0.000 0.000 1.00    41.2   0.050 0.100  83.50   3.3    12.4
Toe                                     58.3   0.150 0.100

    3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
    3.538 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    76.88     10.81      1.00     0.800
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    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi             ksi          kip-ft   b/min
  446.9   311.2   8.61   8.54   -3.57   8  50    32.09   5   3   21.0    40.3
  447.3   303.7   8.63   8.55   -3.66   9  50    32.12   6   3   21.1    40.3
  447.6   314.4   8.61   8.54   -3.65   9  50    32.09   6   3   21.1    40.3
  448.0   320.0   8.62   8.56   -3.61   8  50    32.12   6   3   21.0    40.3
  448.3   325.7   8.62   8.55   -3.60   8  50    32.12   5   3   21.0    40.3
          1          0   10.81000       11.86000
```

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 Depth                  (ft)      76.9
 Shaft Gain/Loss Factor         0.604  Toe Gain/Loss Factor           1.000

 PILE PROFILE:
 Toe Area            (in2)   144.000  Pile Type                    Unknown
 Pile Size          (inch)    10.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
      ft      in2      ksi   lb/ft3       ft              ft/s    k/ft/s
     0.0    12.40   29000.    492.0      3.3        0    16524.     21.8
```

83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 395.1

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	0.0	0.050	0.100	6.68	3.3	12.4
3	0.142	8972	0.000	0.000	1.00	0.7	0.050	0.100	10.02	3.3	12.4
4	0.142	8972	0.000	0.000	1.00	1.9	0.050	0.100	13.36	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	3.2	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	4.2	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	7.9	0.058	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	9.6	0.163	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	17.7	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	23.6	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	25.3	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	27.0	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	28.7	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	27.5	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	27.6	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	34.2	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	22.7	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	16.8	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	39.1	0.050	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	41.0	0.050	0.100	83.50	3.3	12.4
Toe						6.2	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
76.92	10.81	1.00	0.800

↑

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
395.1	94.1	8.23	8.23	-3.19	9	21	31.16	5	3	20.1	41.1
395.4	95.1	8.24	8.23	-3.19	9	21	31.20	5	3	20.0	41.1
395.8	94.4	8.25	8.23	-3.20	9	21	31.22	5	3	20.1	41.1
396.1	96.2	8.24	8.24	-3.21	9	21	31.16	5	3	20.0	41.1
396.5	95.5	8.24	8.24	-3.22	9	21	31.22	5	3	20.1	41.1

1 0 10.81000 11.86000

↑

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Depth (ft) 80.2
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 403.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.3	12.4

```
  2  0.142     8972 0.000 0.000 1.00     0.6    0.050 0.100   6.68   3.3     12.4
  3  0.142     8972 0.000 0.000 1.00     1.9    0.050 0.100  10.02   3.3     12.4
  4  0.142     8972 0.000 0.000 1.00     3.2    0.050 0.100  13.36   3.3     12.4
  5  0.142     8972 0.000 0.000 1.00     4.2    0.050 0.100  16.70   3.3     12.4
  6  0.142     8972 0.000 0.000 1.00     4.8    0.050 0.100  20.04   3.3     12.4
  7  0.142     8972 0.000 0.000 1.00     5.4    0.050 0.100  23.38   3.3     12.4
  8  0.142     8972 0.000 0.000 1.00     6.0    0.050 0.100  26.72   3.3     12.4
  9  0.142     8972 0.000 0.000 1.00     6.6    0.050 0.100  30.06   3.3     12.4
 10  0.142     8972 0.000 0.000 1.00     7.2    0.050 0.100  33.40   3.3     12.4
 11  0.142     8972 0.000 0.000 1.00     7.8    0.050 0.100  36.74   3.3     12.4
 12  0.142     8972 0.000 0.000 1.00     9.5    0.167 0.100  40.08   3.3     12.4
 13  0.142     8972 0.000 0.000 1.00    17.3    0.050 0.100  43.42   3.3     12.4
 14  0.142     8972 0.000 0.000 1.00    23.5    0.050 0.100  46.76   3.3     12.4
 15  0.142     8972 0.000 0.000 1.00    25.2    0.050 0.100  50.10   3.3     12.4
 16  0.142     8972 0.000 0.000 1.00    26.9    0.050 0.100  53.44   3.3     12.4
 17  0.142     8972 0.000 0.000 1.00    28.7    0.050 0.100  56.78   3.3     12.4
 18  0.142     8972 0.000 0.000 1.00    27.7    0.050 0.100  60.12   3.3     12.4
 19  0.142     8972 0.000 0.000 1.00    27.4    0.050 0.100  63.46   3.3     12.4
 20  0.142     8972 0.000 0.000 1.00    34.2    0.050 0.100  66.80   3.3     12.4
 21  0.142     8972 0.000 0.000 1.00    23.4    0.050 0.100  70.14   3.3     12.4
 22  0.142     8972 0.000 0.000 1.00    16.0    0.050 0.100  73.48   3.3     12.4
 23  0.142     8972 0.000 0.000 1.00    39.0    0.050 0.100  76.82   3.3     12.4
 24  0.142     8972 0.000 0.000 1.00    41.2    0.050 0.100  80.16   3.3     12.4
 25  0.142     8972 0.000 0.000 1.00     9.3    0.189 0.100  83.50   3.3     12.4
Toe                                      6.2    0.150 0.100

     3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.538 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    80.15     10.81      1.00     0.800
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    Rut   Bl Ct   Stroke (ft) Ten Str   i    t Comp Str   i    t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi             ksi          kip-ft   b/min
  403.2   106.9   8.29   8.29   -2.75   5  22    31.23   4   2   19.9    41.0
  404.0   107.8   8.30   8.29   -2.73   5  22    31.28   4   2   19.9    41.0
  404.8   110.0   8.30   8.30   -2.71   5  22    31.27   4   2   19.9    40.9
  405.6   110.5   8.31   8.30   -2.68   5  22    31.30   4   2   20.0    40.9
  406.4   113.2   8.32   8.31   -2.67   5  22    31.31   4   2   20.0    40.9
          1           0   10.81000       11.86000
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 Depth                 (ft)      83.4
 Shaft Gain/Loss Factor         0.604  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area            (in2)   144.000  Pile Type                    Unknown
 Pile Size          (inch)    10.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
      ft      in2      ksi   lb/ft3       ft             ft/s     k/ft/s
     0.0    12.40   29000.    492.0      3.3        0    16524.     21.8
    83.5    12.40   29000.    492.0      3.3        0    16524.     21.8

 Wave Travel Time 2L/c (ms)    10.106

        Pile and Soil Model           Total Capacity Rut  (kips)     411.3
No. Weight    Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips      k/in    ft    ft         kips    s/ft  inch     ft    ft     in2
  1  0.142     8972 0.010 0.000 0.85     0.6    0.050 0.100   3.34   3.3     12.4
  2  0.142     8972 0.000 0.000 1.00     1.9    0.050 0.100   6.68   3.3     12.4
  3  0.142     8972 0.000 0.000 1.00     3.1    0.050 0.100  10.02   3.3     12.4
  4  0.142     8972 0.000 0.000 1.00     4.2    0.050 0.100  13.36   3.3     12.4
  5  0.142     8972 0.000 0.000 1.00     4.8    0.050 0.100  16.70   3.3     12.4
  6  0.142     8972 0.000 0.000 1.00     5.4    0.050 0.100  20.04   3.3     12.4
  7  0.142     8972 0.000 0.000 1.00     6.0    0.050 0.100  23.38   3.3     12.4
  8  0.142     8972 0.000 0.000 1.00     6.6    0.050 0.100  26.72   3.3     12.4
  9  0.142     8972 0.000 0.000 1.00     7.2    0.050 0.100  30.06   3.3     12.4
```

10	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	9.4	0.168	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	17.0	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	23.4	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	25.2	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	26.9	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	28.6	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	27.8	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	27.1	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	34.1	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	24.0	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	15.2	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	38.9	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	41.1	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	10.4	0.176	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	8.4	0.200	0.100	83.50	3.3	12.4
Toe						6.2	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
83.38	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
411.3	128.6	8.26	8.34	-2.22	5	22	31.24	2	2	19.6	41.0
412.5	128.6	8.36	8.35	-2.18	5	22	31.46	2	2	19.7	40.8
413.8	136.8	8.28	8.36	-2.15	5	22	31.29	2	2	19.6	40.9
415.0	139.1	8.30	8.36	-2.11	5	22	31.32	2	2	19.6	40.9
416.3	142.0	8.31	8.37	-2.07	5	22	31.36	2	2	19.7	40.9

1 0 10.81000 11.86000

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Depth (ft) 83.4
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 468.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.6	0.050	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	1.9	0.050	0.100	6.68	3.3	12.4
3	0.142	8972	0.000	0.000	1.00	3.1	0.050	0.100	10.02	3.3	12.4
4	0.142	8972	0.000	0.000	1.00	4.2	0.050	0.100	13.36	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	9.4	0.168	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	17.1	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	23.5	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	25.2	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	26.9	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	28.6	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	27.7	0.050	0.100	56.78	3.3	12.4

18	0.142	8972	0.000	0.000	1.00	27.2	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	34.1	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	23.8	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	15.5	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	39.0	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	41.1	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	10.0	0.181	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	8.6	0.197	0.100	83.50	3.3	12.4
Toe						63.5	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
83.42	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
468.9	593.5	8.59	8.58	-2.32	9	21	32.05	2	2	20.4	40.3
470.2	630.8	8.59	8.59	-2.31	9	21	32.04	2	2	20.4	40.3
471.4	660.7	8.60	8.59	-2.31	9	21	32.08	2	2	20.5	40.3
472.7	696.5	8.61	8.60	-2.30	9	21	32.09	2	2	20.4	40.3
473.9	744.4	8.61	8.60	-2.29	9	21	32.08	2	2	20.4	40.2

1 0 10.81000 11.86000

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Depth (ft) 83.4
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model Total Capacity Rut (kips) 469.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.142	8972	0.010	0.000	0.85	0.6	0.050	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	1.9	0.050	0.100	6.68	3.3	12.4
3	0.142	8972	0.000	0.000	1.00	3.1	0.050	0.100	10.02	3.3	12.4
4	0.142	8972	0.000	0.000	1.00	4.2	0.050	0.100	13.36	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	9.4	0.167	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	17.2	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	23.5	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	25.2	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	26.9	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	28.6	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	27.7	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	27.3	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	34.2	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	23.7	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	15.7	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	39.0	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	41.1	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	9.8	0.183	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	8.9	0.194	0.100	83.50	3.3	12.4

Toe	63.5	0.150	0.100

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
83.44	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
469.2	602.3	8.59	8.58	-2.32	9	21	32.04	2	2	20.4	40.3
470.5	632.8	8.60	8.59	-2.31	9	21	32.06	2	2	20.4	40.3
471.7	669.4	8.60	8.60	-2.30	9	21	32.08	2	2	20.4	40.3
473.0	711.4	8.60	8.60	-2.29	9	21	32.07	2	2	20.4	40.3
474.2	749.5	8.61	8.60	-2.29	9	21	32.09	2	2	20.4	40.2
	1	0	10.81000			11.86000					

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Depth (ft) 83.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 10.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	12.40	29000.	492.0	3.3	0	16524.	21.8
83.5	12.40	29000.	492.0	3.3	0	16524.	21.8

Wave Travel Time 2L/c (ms) 10.106

Pile and Soil Model — Total Capacity Rut (kips) 470.2

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.142	8972	0.010	0.000	0.85	0.6	0.050	0.100	3.34	3.3	12.4
2	0.142	8972	0.000	0.000	1.00	1.9	0.050	0.100	6.68	3.3	12.4
3	0.142	8972	0.000	0.000	1.00	3.2	0.050	0.100	10.02	3.3	12.4
4	0.142	8972	0.000	0.000	1.00	4.2	0.050	0.100	13.36	3.3	12.4
5	0.142	8972	0.000	0.000	1.00	4.8	0.050	0.100	16.70	3.3	12.4
6	0.142	8972	0.000	0.000	1.00	5.4	0.050	0.100	20.04	3.3	12.4
7	0.142	8972	0.000	0.000	1.00	6.0	0.050	0.100	23.38	3.3	12.4
8	0.142	8972	0.000	0.000	1.00	6.6	0.050	0.100	26.72	3.3	12.4
9	0.142	8972	0.000	0.000	1.00	7.2	0.050	0.100	30.06	3.3	12.4
10	0.142	8972	0.000	0.000	1.00	7.8	0.050	0.100	33.40	3.3	12.4
11	0.142	8972	0.000	0.000	1.00	9.5	0.167	0.100	36.74	3.3	12.4
12	0.142	8972	0.000	0.000	1.00	17.3	0.050	0.100	40.08	3.3	12.4
13	0.142	8972	0.000	0.000	1.00	23.5	0.050	0.100	43.42	3.3	12.4
14	0.142	8972	0.000	0.000	1.00	25.2	0.050	0.100	46.76	3.3	12.4
15	0.142	8972	0.000	0.000	1.00	26.9	0.050	0.100	50.10	3.3	12.4
16	0.142	8972	0.000	0.000	1.00	28.7	0.050	0.100	53.44	3.3	12.4
17	0.142	8972	0.000	0.000	1.00	27.6	0.050	0.100	56.78	3.3	12.4
18	0.142	8972	0.000	0.000	1.00	27.4	0.050	0.100	60.12	3.3	12.4
19	0.142	8972	0.000	0.000	1.00	34.2	0.050	0.100	63.46	3.3	12.4
20	0.142	8972	0.000	0.000	1.00	23.3	0.050	0.100	66.80	3.3	12.4
21	0.142	8972	0.000	0.000	1.00	16.1	0.050	0.100	70.14	3.3	12.4
22	0.142	8972	0.000	0.000	1.00	39.0	0.050	0.100	73.48	3.3	12.4
23	0.142	8972	0.000	0.000	1.00	41.2	0.050	0.100	76.82	3.3	12.4
24	0.142	8972	0.000	0.000	1.00	9.2	0.190	0.100	80.16	3.3	12.4
25	0.142	8972	0.000	0.000	1.00	9.6	0.185	0.100	83.50	3.3	12.4
Toe						63.5	0.150	0.100			

3.538 kips total unreduced pile weight (g= 32.17 ft/s2)
3.538 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	

83.50	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
470.2	613.8	8.60	8.59	-2.31	9	21	32.07	2	2	20.4	40.3
471.4	650.4	8.60	8.59	-2.30	9	21	32.06	2	2	20.4	40.3
472.6	685.7	8.60	8.59	-2.30	9	21	32.09	2	2	20.4	40.3
473.9	729.1	8.60	8.59	-2.29	9	21	32.09	2	2	20.5	40.3
475.1	770.7	8.61	8.60	-2.28	9	21	32.10	2	2	20.4	40.2

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.604 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
16.7	15.8	14.7	1.1	1.3	10.478	-1.861	3.62	21.6
33.4	48.9	47.8	1.1	3.1	18.720	-2.586	4.58	21.7
33.4	50.2	47.9	2.3	3.2	18.950	-2.052	4.62	21.5
34.7	53.4	51.1	2.3	3.7	19.648	-1.527	4.74	21.1
35.9	56.6	54.2	2.3	4.1	20.149	-1.184	4.84	20.8
35.9	60.7	54.4	6.3	4.6	20.672	-0.789	4.94	20.5
37.2	65.2	58.8	6.3	5.1	21.100	-0.541	5.03	20.2
38.4	69.8	63.4	6.3	5.5	21.475	-0.392	5.11	20.0
38.4	101.6	63.6	38.0	9.7	23.836	-1.320	5.67	18.5
46.7	165.5	122.6	42.9	17.0	26.343	-2.291	6.39	18.2
54.9	235.3	191.9	43.4	26.1	28.403	-2.673	7.07	18.9
54.9	215.4	192.2	23.1	21.8	27.618	-2.163	6.81	18.3
57.4	234.7	211.6	23.1	24.7	28.102	-2.403	6.98	18.6
59.9	254.8	231.7	23.1	28.2	28.633	-2.529	7.16	18.9
59.9	283.1	232.1	51.0	37.1	29.746	-3.268	7.55	19.8
62.4	308.2	257.2	51.0	46.6	30.245	-3.441	7.76	20.1
64.9	334.4	283.3	51.0	58.9	30.863	-3.843	7.99	20.5
64.9	284.8	283.6	1.1	33.6	29.094	-2.622	7.35	19.0
67.4	295.2	294.1	1.1	36.4	29.332	-3.067	7.45	18.9
69.9	306.0	304.8	1.1	39.0	29.493	-3.833	7.53	18.9
69.9	356.2	305.1	51.0	72.2	31.100	-3.387	8.14	20.4
71.9	379.0	328.0	51.0	95.3	31.408	-3.371	8.28	20.6
73.9	402.5	351.4	51.0	134.9	31.548	-3.413	8.36	20.6
73.9	410.3	351.9	58.3	155.2	31.784	-3.450	8.44	20.8
75.4	428.4	370.1	58.3	206.7	32.000	-3.428	8.54	21.0
76.9	446.9	388.6	58.3	311.2	32.087	-3.573	8.61	21.0
76.9	395.1	388.9	6.2	94.1	31.162	-3.185	8.23	20.1
80.2	403.2	397.0	6.2	106.9	31.233	-2.753	8.29	19.9
83.4	411.3	405.1	6.2	128.6	31.236	-2.219	8.26	19.6
83.4	468.9	405.4	63.5	593.5	32.051	-2.322	8.59	20.4
83.4	469.2	405.7	63.5	602.3	32.043	-2.321	8.59	20.4
83.5	470.2	406.6	63.5	613.8	32.074	-2.305	8.60	20.4

Total Driving Time 65 minutes; Total No. of Blows 2727

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Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.637 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
16.7	15.8	14.7	1.1	1.3	10.478	-1.861	3.62	21.6
33.4	48.9	47.8	1.1	3.1	18.720	-2.586	4.58	21.7
33.4	50.2	47.9	2.3	3.2	18.931	-2.039	4.61	21.5
34.7	53.5	51.2	2.3	3.7	19.651	-1.494	4.74	21.1
35.9	56.9	54.6	2.3	4.2	20.204	-1.144	4.85	20.8
35.9	61.0	54.7	6.3	4.6	20.704	-0.741	4.95	20.4
37.2	65.5	59.2	6.3	5.1	21.135	-0.516	5.04	20.2
38.4	70.1	63.8	6.3	5.5	21.513	-0.342	5.12	20.0
38.4	102.0	64.0	38.0	9.8	23.860	-1.340	5.68	18.5
46.7	165.8	122.9	42.9	17.0	26.388	-2.280	6.39	18.2
54.9	235.6	192.2	43.4	26.1	28.414	-2.688	7.08	18.9

54.9	215.7	192.6	23.1	21.8	27.657	-2.167	6.82	18.4
57.4	235.0	211.9	23.1	24.9	27.936	-2.435	6.92	18.5
59.9	255.2	232.0	23.1	28.6	28.454	-2.535	7.10	18.7
59.9	283.4	232.4	51.0	37.4	29.708	-3.281	7.54	19.8
62.4	308.6	257.5	51.0	46.6	30.286	-3.449	7.77	20.1
64.9	334.7	283.7	51.0	59.6	30.816	-3.855	7.98	20.5
64.9	285.1	284.0	1.1	33.6	29.130	-2.623	7.36	19.0
67.4	295.6	294.4	1.1	36.4	29.373	-3.079	7.46	19.0
69.9	306.3	305.2	1.1	39.4	29.503	-3.814	7.54	18.8
69.9	356.5	305.5	51.0	73.4	31.067	-3.386	8.13	20.4
71.9	379.3	328.3	51.0	95.6	31.400	-3.391	8.27	20.6
73.9	402.8	351.8	51.0	136.2	31.575	-3.411	8.36	20.6
73.9	410.6	352.3	58.3	156.8	31.775	-3.457	8.44	20.8
75.4	428.8	370.4	58.3	208.7	31.975	-3.439	8.54	21.0
76.9	447.3	388.9	58.3	303.7	32.122	-3.656	8.63	21.1
76.9	395.4	389.2	6.2	95.1	31.196	-3.187	8.24	20.0
80.2	404.0	397.8	6.2	107.8	31.276	-2.729	8.30	19.9
83.4	412.5	406.3	6.2	128.6	31.456	-2.180	8.36	19.7
83.4	470.2	406.7	63.5	630.8	32.042	-2.315	8.59	20.4
83.4	470.5	407.0	63.5	632.8	32.057	-2.309	8.60	20.4
83.5	471.4	407.9	63.5	650.4	32.059	-2.300	8.60	20.4

Total Driving Time 65 minutes; Total No. of Blows 2742

FRA-71-1503L - RA - B-104-1-13 - HP10x42 04/06/2020
Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.670 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
16.7	15.8	14.7	1.1	1.3	10.478	-1.861	3.62	21.6
33.4	48.9	47.8	1.1	3.1	18.720	-2.586	4.58	21.7
33.4	50.2	47.9	2.3	3.2	18.939	-2.044	4.62	21.5
34.7	53.7	51.4	2.3	3.7	19.669	-1.471	4.75	21.0
35.9	57.3	54.9	2.3	4.2	20.249	-1.106	4.86	20.7
35.9	61.4	55.1	6.3	4.7	20.763	-0.713	4.96	20.4
37.2	65.9	59.5	6.3	5.1	21.194	-0.470	5.05	20.2
38.4	70.5	64.1	6.3	5.6	21.559	-0.320	5.13	20.0
38.4	102.4	64.3	38.0	9.8	23.898	-1.354	5.69	18.6
46.7	166.2	123.3	42.9	17.1	26.385	-2.281	6.40	18.2
54.9	236.0	192.6	43.4	26.2	28.459	-2.697	7.09	19.0
54.9	216.1	192.9	23.1	21.9	27.659	-2.169	6.82	18.4
57.4	235.4	212.3	23.1	24.8	28.137	-2.434	6.99	18.6
59.9	255.5	232.4	23.1	28.3	28.650	-2.514	7.17	18.9
59.9	283.8	232.8	51.0	37.6	29.741	-3.281	7.56	19.8
62.4	308.9	257.9	51.0	47.1	30.248	-3.458	7.76	20.1
64.9	335.1	284.0	51.0	59.4	30.862	-3.879	8.00	20.5
64.9	285.5	284.3	1.1	34.0	29.139	-2.661	7.37	19.0
67.4	295.9	294.8	1.1	37.2	29.179	-3.092	7.40	18.7
69.9	306.7	305.5	1.1	39.6	29.511	-3.818	7.54	18.8
69.9	356.9	305.8	51.0	73.2	31.110	-3.393	8.14	20.4
71.9	379.7	328.7	51.0	96.8	31.411	-3.372	8.28	20.5
73.9	403.2	352.1	51.0	136.1	31.610	-3.418	8.37	20.6
73.9	411.0	352.6	58.3	158.8	31.791	-3.445	8.45	20.8
75.4	429.1	370.8	58.3	214.0	31.963	-3.430	8.53	20.9
76.9	447.6	389.3	58.3	314.4	32.091	-3.647	8.61	21.1
76.9	395.8	389.6	6.2	94.4	31.215	-3.200	8.25	20.1
80.2	404.8	398.6	6.2	110.0	31.274	-2.711	8.30	19.9
83.4	413.8	407.6	6.2	136.8	31.293	-2.151	8.28	19.6
83.4	471.4	407.9	63.5	660.7	32.081	-2.312	8.60	20.5
83.4	471.7	408.2	63.5	669.4	32.076	-2.298	8.60	20.4
83.5	472.6	409.1	63.5	685.7	32.087	-2.296	8.60	20.4

Total Driving Time 66 minutes; Total No. of Blows 2788

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Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.703 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft

16.7	15.8	14.7	1.1	1.3	10.478	-1.861	3.62	21.6
33.4	48.9	47.8	1.1	3.1	18.720	-2.586	4.58	21.7
33.4	50.2	47.9	2.3	3.2	18.946	-2.050	4.61	21.5
34.7	53.9	51.6	2.3	3.8	19.706	-1.453	4.75	21.0
35.9	57.6	55.3	2.3	4.2	20.300	-1.073	4.87	20.7
35.9	61.8	55.4	6.3	4.7	20.820	-0.677	4.97	20.4
37.2	66.2	59.9	6.3	5.2	21.219	-0.430	5.05	20.1
38.4	70.8	64.5	6.3	5.6	21.589	-0.287	5.13	19.9
38.4	102.7	64.7	38.0	9.9	23.934	-1.366	5.69	18.6
46.7	166.5	123.6	42.9	17.2	26.382	-2.276	6.40	18.1
54.9	236.3	193.0	43.4	26.3	28.444	-2.712	7.08	18.9
54.9	216.4	193.3	23.1	21.9	27.691	-2.168	6.83	18.4
57.4	235.7	212.6	23.1	24.8	28.178	-2.448	7.00	18.7
59.9	255.9	232.7	23.1	28.5	28.664	-2.556	7.18	18.9
59.9	284.1	233.1	51.0	37.7	29.733	-3.291	7.55	19.8
62.4	309.3	258.2	51.0	47.1	30.280	-3.472	7.77	20.1
64.9	335.4	284.4	51.0	60.1	30.845	-3.868	8.00	20.5
64.9	285.8	284.7	1.1	34.0	29.145	-2.635	7.37	19.0
67.4	296.3	295.1	1.1	36.9	29.381	-3.076	7.47	18.9
69.9	307.0	305.9	1.1	39.6	29.547	-3.831	7.55	18.8
69.9	357.2	306.2	51.0	74.0	31.128	-3.381	8.15	20.4
71.9	380.0	329.0	51.0	97.2	31.408	-3.394	8.28	20.5
73.9	403.5	352.5	51.0	136.2	31.572	-3.438	8.36	20.7
73.9	411.3	353.0	58.3	157.3	31.794	-3.479	8.45	20.9
75.4	429.5	371.1	58.3	214.6	32.013	-3.423	8.55	21.0
76.9	448.0	389.6	58.3	320.0	32.118	-3.613	8.62	21.0
76.9	396.1	389.9	6.2	96.2	31.163	-3.206	8.24	20.0
80.2	405.6	399.4	6.2	110.5	31.296	-2.683	8.31	20.0
83.4	415.0	408.8	6.2	139.1	31.316	-2.112	8.30	19.6
83.4	472.7	409.2	63.5	696.5	32.087	-2.297	8.61	20.4
83.4	473.0	409.5	63.5	711.4	32.067	-2.292	8.60	20.4
83.5	473.9	410.4	63.5	729.1	32.085	-2.289	8.60	20.5

Total Driving Time 67 minutes; Total No. of Blows 2808

FRA-71-1503L - RA - B-104-1-13 - HP10x42 04/06/2020
Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.736 1.000

Depth	Rut	Frictn	End Bg	Bl Ct	Com Str	Ten Str	Stroke	ENTHRU
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft
16.7	15.8	14.7	1.1	1.3	10.478	-1.861	3.62	21.6
33.4	48.9	47.8	1.1	3.1	18.720	-2.586	4.58	21.7
33.4	50.2	47.9	2.3	3.2	18.942	-2.047	4.62	21.5
34.7	54.1	51.8	2.3	3.8	19.744	-1.447	4.76	21.0
35.9	58.0	55.6	2.3	4.3	20.332	-1.028	4.87	20.7
35.9	62.1	55.8	6.3	4.8	20.846	-0.617	4.98	20.4
37.2	66.6	60.2	6.3	5.2	21.253	-0.396	5.06	20.1
38.4	71.2	64.8	6.3	5.7	21.611	-0.286	5.14	19.9
38.4	103.1	65.0	38.0	9.9	23.947	-1.391	5.70	18.5
46.7	166.9	124.0	42.9	17.2	26.425	-2.283	6.40	18.2
54.9	236.7	193.3	43.4	26.4	28.482	-2.723	7.10	18.9
54.9	216.8	193.6	23.1	21.9	27.677	-2.169	6.83	18.4
57.4	236.1	213.0	23.1	24.9	28.159	-2.464	7.00	18.7
59.9	256.2	233.1	23.1	28.6	28.670	-2.542	7.18	18.9
59.9	284.5	233.5	51.0	37.7	29.784	-3.296	7.57	19.8
62.4	309.6	258.6	51.0	47.0	30.335	-3.489	7.79	20.2
64.9	335.8	284.7	51.0	59.8	30.908	-3.890	8.01	20.6
64.9	286.2	285.0	1.1	34.0	29.167	-2.629	7.38	19.0
67.4	296.6	295.5	1.1	36.8	29.412	-3.121	7.48	19.0
69.9	307.4	306.2	1.1	39.6	29.570	-3.856	7.56	18.9
69.9	357.6	306.5	51.0	73.7	31.157	-3.399	8.15	20.4
71.9	380.4	329.4	51.0	97.1	31.454	-3.400	8.29	20.6
73.9	403.9	352.8	51.0	138.1	31.589	-3.435	8.37	20.7
73.9	411.7	353.3	58.3	159.3	31.806	-3.476	8.45	20.9
75.4	429.8	371.5	58.3	220.0	31.968	-3.422	8.53	20.9
76.9	448.3	390.0	58.3	325.7	32.124	-3.603	8.62	21.0
76.9	396.5	390.3	6.2	95.5	31.215	-3.218	8.24	20.1
80.2	406.4	400.2	6.2	113.2	31.310	-2.668	8.32	20.0
83.4	416.3	410.1	6.2	142.0	31.358	-2.075	8.31	19.7
83.4	473.9	410.4	63.5	744.4	32.084	-2.291	8.61	20.4
83.4	474.2	410.7	63.5	749.5	32.089	-2.287	8.61	20.4
83.5	475.1	411.6	63.5	770.7	32.096	-2.276	8.61	20.4

Total Driving Time 68 minutes; Total No. of Blows 2841

FRA-71-1503L - RA - B-104-1-13 - HP10x42 04/06/2020
Resource International Inc GRLWEAP Version 2010

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
16.70	83.50	0.00	10.81	1.00	0.80	1.00	1.00
33.38	83.50	0.00	10.81	1.00	0.80	1.00	1.00
33.42	83.50	0.00	10.81	1.00	0.80	1.00	1.00
34.65	83.50	0.00	10.81	1.00	0.80	1.00	1.00
35.88	83.50	0.00	10.81	1.00	0.80	1.00	1.00
35.92	83.50	0.00	10.81	1.00	0.80	1.00	1.00
37.15	83.50	0.00	10.81	1.00	0.80	1.00	1.00
38.38	83.50	0.00	10.81	1.00	0.80	1.00	1.00
38.42	83.50	0.00	10.81	1.00	0.80	1.00	1.00
46.65	83.50	0.00	10.81	1.00	0.80	1.00	1.00
54.88	83.50	0.00	10.81	1.00	0.80	1.00	1.00
54.92	83.50	0.00	10.81	1.00	0.80	1.00	1.00
57.40	83.50	0.00	10.81	1.00	0.80	1.00	1.00
59.88	83.50	0.00	10.81	1.00	0.80	1.00	1.00
59.92	83.50	0.00	10.81	1.00	0.80	1.00	1.00
62.40	83.50	0.00	10.81	1.00	0.80	1.00	1.00
64.88	83.50	0.00	10.81	1.00	0.80	1.00	1.00
64.92	83.50	0.00	10.81	1.00	0.80	1.00	1.00
67.40	83.50	0.00	10.81	1.00	0.80	1.00	1.00
69.88	83.50	0.00	10.81	1.00	0.80	1.00	1.00
69.92	83.50	0.00	10.81	1.00	0.80	1.00	1.00
71.90	83.50	0.00	10.81	1.00	0.80	1.00	1.00
73.88	83.50	0.00	10.81	1.00	0.80	1.00	1.00
73.92	83.50	0.00	10.81	1.00	0.80	1.00	1.00
75.40	83.50	0.00	10.81	1.00	0.80	1.00	1.00
76.88	83.50	0.00	10.81	1.00	0.80	1.00	1.00
76.92	83.50	0.00	10.81	1.00	0.80	1.00	1.00
80.15	83.50	0.00	10.81	1.00	0.80	1.00	1.00
83.38	83.50	0.00	10.81	1.00	0.80	1.00	1.00
83.42	83.50	0.00	10.81	1.00	0.80	1.00	1.00
83.44	83.50	0.00	10.81	1.00	0.80	1.00	1.00
83.50	83.50	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

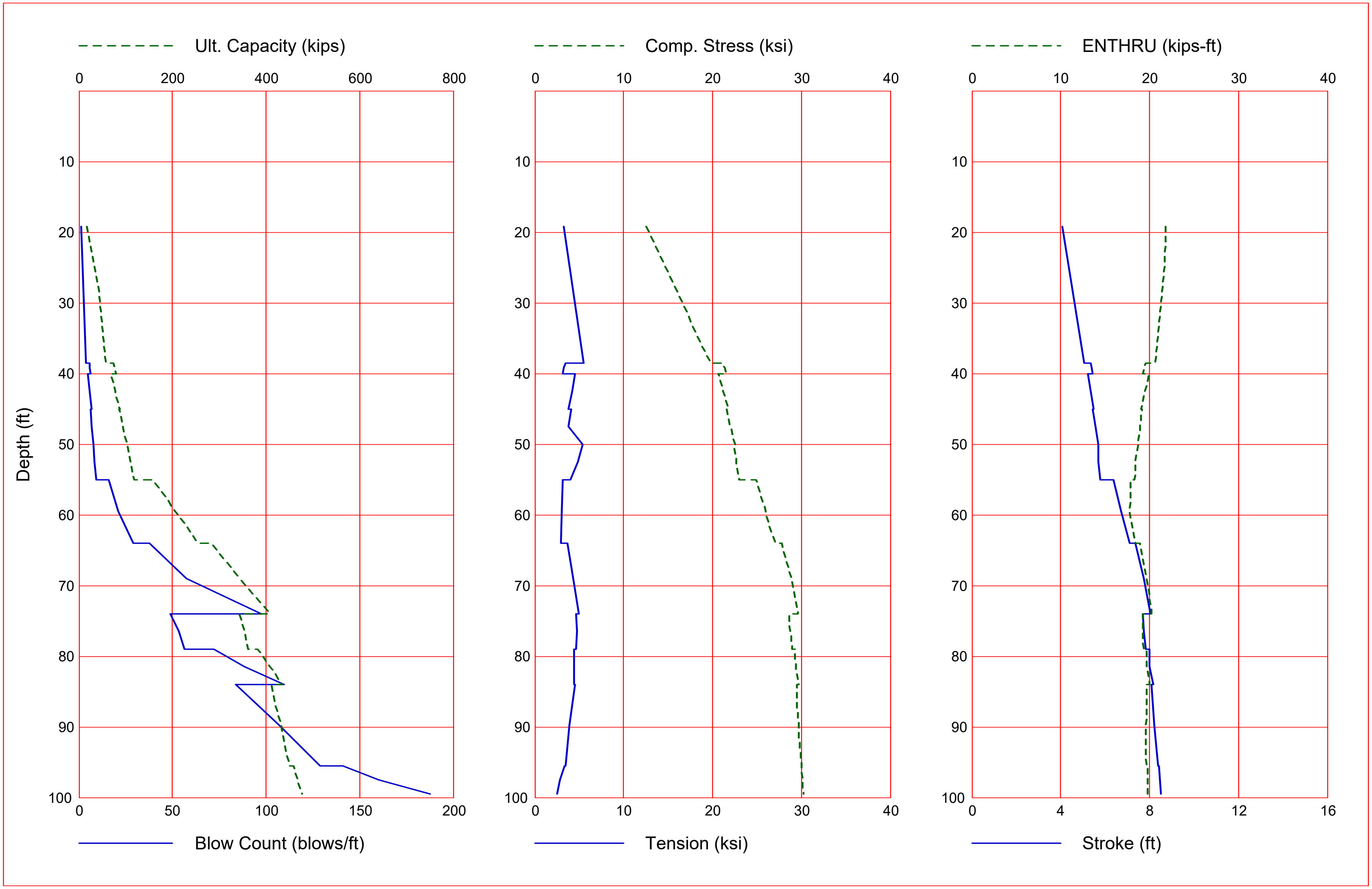
Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.00	0.100	0.100	0.050	0.150	0.000	0.000	0.000
9.01	0.31	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
10.49	0.36	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
10.51	0.36	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
19.51	0.51	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
28.51	0.66	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
33.39	0.74	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
33.41	1.30	2.32	0.100	0.100	0.200	0.150	1.000	0.000	0.000
35.89	1.30	2.32	0.100	0.100	0.200	0.150	1.000	0.000	0.000
35.91	1.09	6.33	0.100	0.100	0.050	0.150	0.000	0.000	0.000
38.39	1.14	6.33	0.100	0.100	0.050	0.150	0.000	0.000	0.000
38.41	1.98	38.01	0.100	0.100	0.050	0.150	0.000	0.000	0.000
47.41	2.40	43.36	0.100	0.100	0.050	0.150	0.000	0.000	0.000
54.89	2.74	43.36	0.100	0.100	0.050	0.150	0.000	0.000	0.000
54.91	2.31	23.13	0.100	0.100	0.050	0.150	0.000	0.000	0.000
59.89	2.51	23.13	0.100	0.100	0.050	0.150	0.000	0.000	0.000
59.91	3.01	51.03	0.100	0.100	0.050	0.150	0.000	0.000	0.000
64.89	3.26	51.03	0.100	0.100	0.050	0.150	0.000	0.000	0.000
64.91	1.26	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
69.89	1.33	1.15	0.100	0.100	0.050	0.150	0.000	0.000	0.000
69.91	3.44	51.03	0.100	0.100	0.050	0.150	0.000	0.000	0.000
73.89	3.64	51.03	0.100	0.100	0.050	0.150	0.000	0.000	0.000
73.91	3.67	58.35	0.100	0.100	0.050	0.150	0.000	0.000	0.000
76.89	3.83	58.35	0.100	0.100	0.050	0.150	0.000	0.000	0.000
76.91	1.26	6.20	0.100	0.100	0.200	0.150	1.000	0.000	0.000

83.39	1.26	6.20	0.100	0.100	0.200	0.150	1.000	0.000	0.000
83.41	4.60	63.52	0.100	0.100	0.050	0.150	0.000	0.000	0.000
83.50	4.60	63.52	0.100	0.100	0.050	0.150	0.000	0.000	0.000

Resource International Inc
FRA-71-1503L - FA - B-115-2-13 - HP12x52

Apr 06 2020
GRLWEAP Version 2010

Gain/Loss 3 at Shaft and Toe 0.670 / 1.000



Gain/Loss 3 at Shaft and Toe 0.670 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
19.2	16.9	15.5	1.4	1.5	12.527	-3.218	4.09	21.8
38.5	58.0	56.6	1.4	3.7	19.800	-5.468	5.06	20.6
38.5	73.0	56.7	16.3	5.6	21.129	-3.463	5.35	19.6
39.2	76.6	60.0	16.6	5.9	21.344	-3.290	5.40	19.4
40.0	80.2	63.2	16.9	6.3	21.550	-3.120	5.45	19.3
40.0	68.8	63.4	5.4	4.9	20.617	-4.538	5.22	19.9
42.5	78.5	73.1	5.4	5.6	21.212	-4.162	5.36	19.5
45.0	88.7	83.3	5.4	6.6	21.815	-3.769	5.50	19.0
45.0	85.7	83.5	2.2	6.1	21.569	-4.150	5.44	19.1
47.5	94.8	92.6	2.2	7.0	22.058	-3.834	5.56	18.9
50.0	104.3	102.1	2.2	7.9	22.533	-5.428	5.69	18.7
50.0	103.6	102.2	1.4	7.8	22.487	-5.366	5.68	18.7
52.5	110.7	109.2	1.4	8.5	22.631	-4.853	5.71	18.4
55.0	118.0	116.6	1.4	9.2	22.960	-3.971	5.80	18.3
55.0	158.8	116.8	42.0	15.8	24.951	-3.138	6.39	17.9
59.5	204.7	161.2	43.5	21.0	26.012	-3.041	6.73	17.8
64.0	254.5	209.6	44.9	29.3	27.058	-2.969	7.09	18.4
64.0	283.0	210.0	72.9	37.8	27.800	-3.714	7.35	18.9
69.0	343.3	270.4	72.9	57.5	28.813	-4.346	7.74	19.7
74.0	409.1	336.2	72.9	97.6	29.595	-4.937	8.06	20.2
74.0	344.2	336.5	7.8	49.1	28.605	-4.682	7.68	19.2
76.5	352.6	344.8	7.8	53.2	28.793	-4.717	7.76	19.3
79.0	360.9	353.1	7.8	56.4	28.958	-4.591	7.84	19.4
79.0	382.3	353.4	28.9	71.9	29.327	-4.453	7.98	19.7
81.5	407.7	378.8	28.9	88.2	29.369	-4.459	8.02	19.7
84.0	434.0	405.1	28.9	109.8	29.696	-4.479	8.16	20.0
84.0	413.1	405.4	7.8	83.8	29.534	-4.500	8.09	19.7
89.8	432.3	424.6	7.8	107.3	29.682	-3.921	8.21	19.6
95.5	451.5	443.8	7.8	128.8	29.980	-3.464	8.38	19.7
95.5	457.9	443.9	13.9	141.2	30.040	-3.321	8.41	19.8
97.5	467.8	453.8	13.9	160.1	30.153	-2.784	8.48	19.8
99.5	477.8	463.9	13.9	187.4	30.222	-2.520	8.53	19.8

Total Continuous Driving Time 86.00 minutes; Total Number of Blows 3589

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

```
 Input  File: J:\GEOTECH\PROJECTS\2013\W-13-072 FRA-70-13.10 PROJECT 6A\ANALYSIS\FRA-71-1503L\DRIVEABILITY\FORWARD
ABUTMENT\B-115-2.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2003.GW
 Hammer File Version:  2003 (2/22/2013)

                     Input File Contents
     FRA-71-1503L - FA - B-115-2-13 - HP12x52
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0   0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size          Pile Type
    32.170    32.170   144.000    12.000            Unknown
      W Cp      A Cp      E Cp      T Cp       CoR      ROut      StCp
     1.900   227.000     530.0     2.000     0.800     0.010       0.0
      A Cu      E Cu      T Cu       CoR      ROut      StCu
     0.000       0.0     0.000     0.000     0.000       0.0
      LPle      APle      EPle      WPle      Peri        CI       CoR      ROut
    99.500     15.50   29000.0   492.000     3.970         0     0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42         1       5
    Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
      4.00    129.10     12.60     11.86     10.81      0.80
    IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
      0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
     16.65    124.70    157.70     0.002     0.002     1.250      0.00      0.00
     P atm        P1        P2        P3        P4        P5
     14.70   1520.00   1368.00   1231.00   1108.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
```

10.8100	0.8000	1520.0000	0.0000	0.0000	0.0000	0.0100	0.0000
Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Rtoe	Qs	Qt	Js	Jt	SU F	LimD	SU T
0.01	0.00	0.00	0.10	0.10	0.05	0.15	1.00	0.00	0.0
1.99	0.07	0.45	0.10	0.10	0.05	0.15	1.00	0.00	0.0
2.01	0.07	0.45	0.10	0.10	0.05	0.15	1.00	0.00	0.0
11.01	0.23	1.42	0.10	0.10	0.05	0.15	1.00	0.00	0.0
20.01	0.38	1.43	0.10	0.10	0.05	0.15	1.00	0.00	0.0
29.01	0.54	1.43	0.10	0.10	0.05	0.15	1.00	0.00	0.0
38.01	0.70	1.43	0.10	0.10	0.05	0.15	1.00	0.00	0.0
38.49	0.70	1.43	0.10	0.10	0.05	0.15	1.00	0.00	0.0
38.51	1.32	16.27	0.10	0.10	0.05	0.15	1.21	0.00	0.0
39.99	1.38	16.92	0.10	0.10	0.05	0.15	1.21	0.00	0.0
40.01	0.95	5.38	0.10	0.10	0.05	0.15	1.00	0.00	0.0
44.99	1.07	5.38	0.10	0.10	0.05	0.15	1.00	0.00	0.0
45.01	0.90	2.22	0.10	0.10	0.05	0.15	1.00	0.00	0.0
49.99	0.99	2.22	0.10	0.10	0.05	0.15	1.00	0.00	0.0
50.01	0.84	1.43	0.10	0.10	0.05	0.15	1.21	0.00	0.0
54.99	0.92	1.43	0.10	0.10	0.05	0.15	1.21	0.00	0.0
55.01	2.38	41.99	0.10	0.10	0.05	0.15	1.00	0.00	0.0
63.99	2.83	44.95	0.10	0.10	0.05	0.15	1.00	0.00	0.0
64.01	2.92	72.94	0.10	0.10	0.05	0.15	1.00	0.00	0.0
73.01	3.41	72.94	0.10	0.10	0.05	0.15	1.00	0.00	0.0
73.99	3.46	72.94	0.10	0.10	0.05	0.15	1.00	0.00	0.0
74.01	1.26	7.75	0.10	0.10	0.20	0.15	1.49	0.00	0.0
78.99	1.26	7.75	0.10	0.10	0.20	0.15	1.49	0.00	0.0
79.01	3.06	28.91	0.10	0.10	0.05	0.15	1.21	0.00	0.0
83.99	3.27	28.91	0.10	0.10	0.05	0.15	1.21	0.00	0.0
84.01	1.26	7.75	0.10	0.10	0.20	0.15	1.49	0.00	0.0
93.01	1.26	7.75	0.10	0.10	0.20	0.15	1.49	0.00	0.0
95.49	1.26	7.75	0.10	0.10	0.20	0.15	1.49	0.00	0.0
95.51	1.26	13.95	0.10	0.10	0.20	0.15	1.00	0.00	0.0
99.50	1.26	13.95	0.10	0.10	0.20	0.15	1.00	0.00	0.0

Gain/Loss factors: shaft and toe

0.60400	0.63700	0.67000	0.70300	0.73600
1.00000	1.00000	1.00000	1.00000	1.00000

Dpth	L	Wait	Strk	Pmx%	Eff.	Stff	CoR
19.25	0.00	0.00	0.000	0.000	0.000	0.000	0.000
38.48	0.00	0.00	0.000	0.000	0.000	0.000	0.000
38.52	0.00	0.00	0.000	0.000	0.000	0.000	0.000
39.25	0.00	0.00	0.000	0.000	0.000	0.000	0.000
39.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
40.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
42.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000
44.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
45.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
47.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000
49.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
50.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
52.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000
54.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
55.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
59.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000
63.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
64.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
69.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
73.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
74.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
76.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000
78.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
79.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
81.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000
83.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
84.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
89.75	0.00	0.00	0.000	0.000	0.000	0.000	0.000
95.48	0.00	0.00	0.000	0.000	0.000	0.000	0.000
95.52	0.00	0.00	0.000	0.000	0.000	0.000	0.000
97.49	0.00	0.00	0.000	0.000	0.000	0.000	0.000
99.50	0.00	0.00	0.000	0.000	0.000	0.000	0.000

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     0.00      0.00      0.00     0.000     0.000     0.000     0.000     0.000
          1          0   10.81000       11.86000
```

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

FRA-71-1503L - FA - B-115-2-13 - HP12x52

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		11294.0			

HAMMER OPTIONS:

Hammer File ID No.	41	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1520.00	Actual Pressure	(psi)	1520.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

Depth	(ft)	19.2		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 16.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	86.23	4.0	15.5

```
 27  0.176    11294 0.000 0.000 1.00     2.2   0.050 0.100  89.55   4.0    15.5
 28  0.176    11294 0.000 0.000 1.00     3.0   0.050 0.100  92.87   4.0    15.5
 29  0.176    11294 0.000 0.000 1.00     3.8   0.050 0.100  96.18   4.0    15.5
 30  0.176    11294 0.000 0.000 1.00     4.5   0.050 0.100  99.50   4.0    15.5
Toe                                      1.4   0.150 0.100

     5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
     5.269 kips total reduced pile weight   (g= 32.17 ft/s2)

 PILE, SOIL, ANALYSIS OPTIONS:
 Uniform pile                          Pile Segments: Automatic
 No. of Slacks/Splices             0  Pile Damping           (%)         1
                                       Pile Damping Fact.(k/ft/s)     0.544
 Driveability Analysis
 Soil Damping Option            Smith
 Max No Analysis Iterations         0  Time Increment/Critical          160
 Output Time Interval               1  Analysis Time-Input   (ms)         0
 Output Level: Normal
 Gravity Mass, Pile, Hammer:   32.170    32.170    32.170
 Output Segment Generation: Automatic

    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    19.25     10.81      1.00     0.800
↑
FRA-71-1503L - FA - B-115-2-13 - HP12x52                          04/06/2020
Resource International Inc                                  GRLWEAP Version 2010

    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi            ksi          kip-ft   b/min
   16.9     1.5   4.09   4.11   -3.22   6  37    12.53   1   2   21.8    58.7
   16.9     1.5   4.09   4.11   -3.22   6  37    12.53   1   2   21.8    58.7
   16.9     1.5   4.09   4.11   -3.22   6  37    12.53   1   2   21.8    58.7
   16.9     1.5   4.09   4.11   -3.22   6  37    12.53   1   2   21.8    58.7
   16.9     1.5   4.09   4.11   -3.22   6  37    12.53   1   2   21.8    58.7
         1          0   10.81000       11.86000
↑
FRA-71-1503L - FA - B-115-2-13 - HP12x52                          04/06/2020
Resource International Inc                                  GRLWEAP Version 2010

 Depth                (ft)      38.5
 Shaft Gain/Loss Factor         0.604  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area            (in2)   144.000  Pile Type                    Unknown
 Pile Size          (inch)    12.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
      ft      in2      ksi   lb/ft3       ft             ft/s    k/ft/s
     0.0    15.50   29000.    492.0      4.0       0    16524.     27.2
    99.5    15.50   29000.    492.0      4.0       0    16524.     27.2

 Wave Travel Time 2L/c (ms)    12.043

       Pile and Soil Model            Total Capacity Rut  (kips)      58.0
No. Weight    Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips      k/in    ft    ft         kips    s/ft  inch     ft    ft     in2
  1  0.176    11294 0.010 0.000 0.85     0.0   0.000 0.100   3.32   4.0    15.5
  2  0.176    11294 0.000 0.000 1.00     0.0   0.000 0.100   6.63   4.0    15.5
 19  0.176    11294 0.000 0.000 1.00     0.3   0.050 0.100  63.02   4.0    15.5
 20  0.176    11294 0.000 0.000 1.00     1.3   0.050 0.100  66.33   4.0    15.5
 21  0.176    11294 0.000 0.000 1.00     2.1   0.050 0.100  69.65   4.0    15.5
 22  0.176    11294 0.000 0.000 1.00     2.8   0.050 0.100  72.97   4.0    15.5
 23  0.176    11294 0.000 0.000 1.00     3.6   0.050 0.100  76.28   4.0    15.5
 24  0.176    11294 0.000 0.000 1.00     4.4   0.050 0.100  79.60   4.0    15.5
 25  0.176    11294 0.000 0.000 1.00     5.1   0.050 0.100  82.92   4.0    15.5
 26  0.176    11294 0.000 0.000 1.00     5.9   0.050 0.100  86.23   4.0    15.5
 27  0.176    11294 0.000 0.000 1.00     6.6   0.050 0.100  89.55   4.0    15.5
 28  0.176    11294 0.000 0.000 1.00     7.4   0.050 0.100  92.87   4.0    15.5
 29  0.176    11294 0.000 0.000 1.00     8.1   0.050 0.100  96.18   4.0    15.5
 30  0.176    11294 0.000 0.000 1.00     8.9   0.050 0.100  99.50   4.0    15.5
Toe                                      1.4   0.150 0.100

     5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
     5.269 kips total reduced pile weight   (g= 32.17 ft/s2)
```

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
38.48	10.81	1.00	0.800

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Resource International Inc GRLWEAP Version 2010

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
58.0	3.7	5.06	5.03	-5.47	4	14	19.80	20	6	20.6	52.8
58.0	3.7	5.06	5.03	-5.47	4	14	19.80	20	6	20.6	52.8
58.0	3.7	5.06	5.03	-5.47	4	14	19.80	20	6	20.6	52.8
58.0	3.7	5.06	5.03	-5.47	4	14	19.80	20	6	20.6	52.8
58.0	3.7	5.06	5.03	-5.47	4	14	19.80	20	6	20.6	52.8

1 0 10.81000 11.86000

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

Depth (ft) 38.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 73.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	0.3	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	1.3	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	2.1	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	2.9	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	3.6	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	4.4	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	5.1	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	5.9	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	6.6	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	7.4	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	8.2	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	8.9	0.050	0.100	99.50	4.0	15.5
Toe						16.3	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
38.52	10.81	1.00	0.800

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
73.0	5.6	5.35	5.33	-3.46	3	14	21.14	20	6	19.6	51.1
73.0	5.6	5.35	5.33	-3.46	3	14	21.13	20	6	19.6	51.1
73.0	5.6	5.35	5.33	-3.46	3	14	21.13	20	6	19.6	51.1
73.0	5.6	5.35	5.33	-3.46	3	14	21.15	20	6	19.6	51.1
73.0	5.6	5.35	5.33	-3.46	3	14	21.13	20	6	19.6	51.1

1 0 10.81000 11.86000

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020

Depth (ft) 39.2
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 76.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	2.3	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	3.8	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	6.1	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	7.6	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	10.1	0.050	0.100	99.50	4.0	15.5
Toe						16.6	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
39.25	10.81	1.00	0.800

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

Rut	Bl Ct	Stroke (ft) down	Stroke (ft) up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
76.4	5.9	5.40	5.37	-3.31	3	14	21.36	20	6	19.4	50.9
76.5	5.9	5.40	5.38	-3.29	3	14	21.35	20	6	19.4	50.9
76.6	5.9	5.40	5.38	-3.29	3	14	21.34	20	6	19.4	50.9
76.6	6.0	5.40	5.38	-3.28	3	14	21.36	20	6	19.4	50.9
76.7	6.0	5.40	5.38	-3.27	3	14	21.36	20	6	19.4	50.8

1 0 10.81000 11.86000

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
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Depth (ft) 40.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 79.9

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2

B-115-2

1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	0.0	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	0.8	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	1.7	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	2.4	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	3.2	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	3.9	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	4.7	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	5.5	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	6.2	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	7.0	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	7.7	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	8.5	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	11.3	0.050	0.100	99.50	4.0	15.5
Toe						16.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
39.98	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
79.9	6.3	5.45	5.42	-3.12	3	14	21.55	20	6	19.2	50.6
80.0	6.3	5.44	5.43	-3.12	3	14	21.55	20	6	19.2	50.6
80.2	6.3	5.45	5.42	-3.12	3	14	21.55	20	6	19.3	50.6
80.3	6.3	5.45	5.43	-3.12	3	14	21.58	20	6	19.2	50.6
80.4	6.3	5.45	5.43	-3.11	3	14	21.58	20	6	19.2	50.6

1 0 10.81000 11.86000

Depth (ft) 40.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 68.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	0.0	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	0.8	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	1.7	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	2.4	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	3.2	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	4.0	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	4.7	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	5.5	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	6.2	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	7.0	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	7.7	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	8.5	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	11.4	0.050	0.100	99.50	4.0	15.5
Toe						5.4	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)

5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
40.02	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
68.5	4.8	5.22	5.18	-4.54	4	14	20.61	20	6	19.8	51.9
68.7	4.8	5.23	5.18	-4.55	4	14	20.62	20	6	19.9	51.9
68.8	4.9	5.22	5.19	-4.54	4	14	20.62	20	6	19.9	51.9
68.9	4.9	5.23	5.19	-4.54	4	14	20.65	20	6	19.9	51.8
69.1	4.9	5.23	5.19	-4.52	4	14	20.64	20	6	19.9	51.8

1 0 10.81000 11.86000

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Depth (ft) 42.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 78.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	2.2	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	3.8	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	6.0	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	7.6	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	10.0	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	99.50	4.0	15.5
Toe						5.4	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
42.50	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
78.2	5.6	5.35	5.32	-4.17	3	14	21.20	19	6	19.5	51.2
78.3	5.6	5.36	5.33	-4.15	3	14	21.22	19	6	19.4	51.1
78.5	5.6	5.36	5.33	-4.16	3	14	21.21	19	6	19.5	51.1
78.6	5.6	5.36	5.33	-4.16	3	14	21.24	19	6	19.5	51.1
78.7	5.7	5.36	5.33	-4.16	3	14	21.24	19	6	19.4	51.1

1 0 10.81000 11.86000

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Depth (ft) 45.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 88.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	0.2	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	1.3	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	2.1	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	2.8	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	3.6	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	4.3	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	5.1	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	5.8	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	6.6	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	7.4	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	8.1	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	8.9	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	13.6	0.050	0.100	99.50	4.0	15.5
Toe						5.4	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
44.98	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
88.4	6.5	5.50	5.48	-3.80	3	14	21.80	19	6	19.0	50.3
88.6	6.6	5.50	5.48	-3.82	10	53	21.80	18	5	19.0	50.3
88.7	6.6	5.50	5.48	-3.77	3	14	21.81	19	6	19.0	50.3
88.8	6.6	5.51	5.48	-3.78	3	14	21.83	18	5	19.0	50.3
89.0	6.6	5.50	5.49	-3.75	3	14	21.80	19	6	19.0	50.3

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Depth (ft) 45.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 85.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	0.3	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	1.3	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	2.1	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	2.8	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	3.6	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	4.3	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	5.1	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	5.9	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	6.6	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	7.4	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	8.1	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	8.9	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	13.6	0.050	0.100	99.50	4.0	15.5
Toe						2.2	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
45.02	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
85.4	6.1	5.44	5.41	-4.19	3	14	21.56	18	5	19.2	50.7
85.6	6.1	5.44	5.42	-4.18	3	14	21.56	18	5	19.2	50.7
85.7	6.1	5.44	5.42	-4.15	3	14	21.57	19	6	19.1	50.6
85.8	6.2	5.45	5.42	-4.18	3	14	21.59	18	5	19.2	50.6
86.0	6.2	5.45	5.42	-4.17	3	14	21.59	18	5	19.1	50.6

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Depth (ft) 47.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 94.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	0.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	1.1	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	2.6	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	3.4	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	4.2	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	4.9	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	5.7	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	6.4	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	7.9	0.050	0.100	86.23	4.0	15.5

27	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	99.50	4.0	15.5
Toe						2.2	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
47.50	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
94.5	6.9	5.56	5.55	-3.82	3	14	22.04	18	5	18.8	50.1
94.6	6.9	5.56	5.54	-3.85	3	14	22.06	18	5	18.9	50.1
94.8	7.0	5.56	5.55	-3.83	3	14	22.06	18	5	18.9	50.1
94.9	7.0	5.56	5.55	-3.82	3	14	22.06	18	5	18.8	50.0
95.1	7.0	5.57	5.55	-3.80	3	14	22.07	18	5	18.8	50.0

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Depth (ft) 50.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 104.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	0.0	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	0.8	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	1.7	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	2.4	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	3.2	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	4.0	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	4.7	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	5.5	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	6.2	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	7.0	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	7.7	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	8.5	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	11.4	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	13.1	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	12.9	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	99.50	4.0	15.5
Toe						2.2	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
49.98	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
104.0	7.8	5.68	5.67	-5.42	16	49	22.50	17	5	18.7	49.5
104.1	7.8	5.69	5.67	-5.41	16	50	22.52	17	5	18.7	49.5
104.3	7.9	5.69	5.67	-5.43	16	50	22.53	17	5	18.7	49.5
104.4	7.9	5.69	5.67	-5.44	16	49	22.54	17	5	18.7	49.5
104.6	7.9	5.69	5.67	-5.44	16	50	22.56	17	5	18.7	49.5

1 0 10.81000 11.86000

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Depth (ft) 50.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 103.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	0.0	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	0.8	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	1.7	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	2.5	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	3.2	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	4.0	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	4.7	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	5.5	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	6.2	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	7.0	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	7.8	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	8.5	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	11.5	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	13.1	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	12.9	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	99.50	4.0	15.5
Toe						1.4	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
50.02	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
103.4	7.7	5.67	5.66	-5.37	16	50	22.48	17	5	18.7	49.5
103.5	7.7	5.67	5.66	-5.38	16	50	22.47	17	5	18.7	49.5
103.6	7.8	5.68	5.66	-5.37	16	50	22.49	17	5	18.7	49.5
103.8	7.8	5.67	5.66	-5.39	16	50	22.51	17	5	18.7	49.5
103.9	7.8	5.68	5.66	-5.42	16	50	22.51	17	5	18.7	49.5

1 0 10.81000 11.86000

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Depth (ft) 52.5

Shaft Gain/Loss Factor	0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model   Total Capacity Rut (kips) 110.1

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	2.3	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	3.8	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	6.1	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	7.6	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	10.1	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	13.2	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	10.0	0.050	0.100	99.50	4.0	15.5
Toe						1.4	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
52.50	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	Stroke (ft) up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
110.1	8.3	5.76	5.74	-5.09	16	49	22.80	17	5	18.6	49.1
110.4	8.4	5.76	5.75	-5.04	16	49	22.79	17	5	18.6	49.1
110.7	8.5	5.71	5.76	-4.85	16	49	22.63	17	5	18.4	49.2
110.9	8.4	5.77	5.75	-4.95	16	49	22.83	17	5	18.6	49.1
111.2	8.5	5.72	5.77	-4.75	16	49	22.65	17	5	18.4	49.1

1 0 10.81000 11.86000

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Depth	(ft)	55.0		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model   Total Capacity Rut (kips) 117.1

No. Weight Stiffn C-Slk T-Slk CoR Soil-S Soil-D Quake LbTop Perim Area

B-115-2

	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	0.3	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	1.3	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	2.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	2.8	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	3.6	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	4.3	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	5.1	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	5.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	6.6	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	7.4	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	8.1	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	8.9	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	13.6	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	12.2	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	10.9	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	9.4	0.050	0.100	99.50	4.0	15.5
Toe						1.4	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
54.98	10.81	1.00	0.800

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
117.1	9.1	5.79	5.84	-3.97	20	47	22.92	16	5	18.3	48.8
117.6	9.1	5.80	5.85	-3.96	20	47	22.96	16	5	18.4	48.8
118.0	9.2	5.80	5.86	-3.97	20	47	22.96	16	5	18.3	48.8
118.4	9.2	5.81	5.86	-3.99	19	47	22.99	16	5	18.3	48.8
118.9	9.2	5.81	5.86	-4.01	19	47	23.00	16	5	18.4	48.8

1 0 10.81000 11.86000

Depth (ft) 55.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 157.9

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	0.3	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	1.3	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	2.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	2.8	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	3.6	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	4.4	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	5.1	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	5.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	6.6	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	7.4	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	8.1	0.050	0.100	79.60	4.0	15.5

25	0.176	11294	0.000	0.000	1.00	8.9	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	13.4	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	13.5	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	12.3	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	10.8	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	9.5	0.050	0.100	99.50	4.0	15.5
Toe						42.0	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
55.02	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
157.9	15.7	6.39	6.40	-3.17	18	40	24.95	16	5	18.0	46.5
158.4	15.8	6.39	6.41	-3.15	18	40	24.95	16	5	17.9	46.5
158.8	15.8	6.39	6.41	-3.14	18	40	24.95	16	5	17.9	46.5
159.3	15.9	6.39	6.41	-3.12	18	40	24.94	16	5	17.9	46.5
159.7	15.9	6.40	6.42	-3.10	18	40	24.98	16	5	17.9	46.5
	1	0		10.81000			11.86000				

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Depth (ft) 59.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 203.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	0.6	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	1.6	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	2.3	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	3.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	3.9	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	4.6	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	5.4	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	6.1	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	6.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	7.6	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	8.4	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	10.7	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	13.2	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	13.1	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	12.5	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	9.6	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	17.4	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	33.3	0.050	0.100	99.50	4.0	15.5
Toe						43.5	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth Stroke Pressure Efficy

ft	ft	Ratio	
59.50	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
203.8	20.9	6.72	6.67	-3.00	16	33	25.98	15	5	17.8	45.5
204.3	21.0	6.72	6.68	-3.01	16	33	25.98	15	5	17.8	45.5
204.7	21.0	6.73	6.67	-3.04	16	33	26.01	15	5	17.8	45.5
205.1	21.2	6.72	6.68	-3.06	16	33	25.96	14	5	17.8	45.5
205.6	21.2	6.73	6.68	-3.08	16	33	26.01	15	5	17.8	45.5

1 0 10.81000 11.86000

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Depth (ft) 64.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 253.7

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	0.1	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	1.1	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	2.6	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	3.4	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	4.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	4.9	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	5.6	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	6.4	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	7.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	12.2	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	11.9	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	9.2	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	25.5	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	34.0	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	36.2	0.050	0.100	99.50	4.0	15.5
Toe						44.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
63.98	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
253.7	29.1	7.08	7.03	-2.95	14	32	27.02	14	5	18.4	44.3
254.1	29.3	7.08	7.04	-2.97	14	32	27.02	13	4	18.4	44.3
254.5	29.3	7.09	7.04	-2.97	14	32	27.06	13	4	18.4	44.3

255.0	29.4	7.09	7.04	-2.96	14	32	27.06	14	5	18.4	44.3
255.4	29.5	7.09	7.05	-2.97	14	32	27.06	13	4	18.4	44.3

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Depth (ft) 64.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 282.1

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	0.1	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	1.1	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	2.6	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	3.4	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	4.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	4.9	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	5.7	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	6.4	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	7.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	12.3	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	11.8	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	9.2	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	25.8	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	34.0	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	36.2	0.050	0.100	99.50	4.0	15.5
Toe						72.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
64.02	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
282.1	37.6	7.35	7.32	-3.68	16	29	27.79	14	4	18.9	43.5
282.5	37.6	7.34	7.32	-3.70	16	29	27.76	13	4	19.0	43.5
283.0	37.8	7.35	7.33	-3.71	16	29	27.80	14	4	18.9	43.4
283.4	37.8	7.36	7.33	-3.73	16	29	27.79	13	4	19.0	43.4
283.8	37.8	7.35	7.33	-3.74	16	29	27.81	14	5	19.0	43.4

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Depth (ft) 69.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model   Total Capacity Rut (kips) 342.5

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	2.2	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	3.8	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	6.0	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	7.5	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	10.0	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	10.1	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	14.3	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	33.0	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	35.1	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	37.9	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	40.8	0.050	0.100	99.50	4.0	15.5
Toe						72.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
69.00	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
342.5	57.4	7.73	7.74	-4.33	16	29	28.76	13	4	19.6	42.4
342.9	57.1	7.73	7.72	-4.33	16	29	28.82	12	4	19.7	42.4
343.3	57.5	7.74	7.74	-4.35	16	29	28.81	12	4	19.7	42.3
343.8	57.4	7.75	7.74	-4.35	16	29	28.86	12	4	19.7	42.3
344.2	57.9	7.76	7.75	-4.37	16	29	28.86	13	4	19.7	42.3

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Depth	(ft)	74.0		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 408.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	0.1	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	1.1	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	2.6	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	3.4	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	4.1	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	4.9	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	5.7	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	6.4	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	7.9	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	12.3	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	11.8	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	9.2	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	25.9	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	34.0	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	36.2	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	39.6	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	42.0	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	44.4	0.050	0.100	99.50	4.0	15.5
Toe						72.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
73.98	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
408.2	96.4	8.05	8.08	-4.93	14	28	29.62	11	4	20.3	41.5
408.7	97.1	8.06	8.09	-4.93	14	28	29.60	11	4	20.2	41.5
409.1	97.6	8.06	8.09	-4.94	14	28	29.60	11	4	20.2	41.5
409.5	98.1	8.06	8.09	-4.94	14	28	29.64	11	4	20.2	41.5
410.0	98.5	8.07	8.10	-4.94	14	28	29.64	11	4	20.2	41.5

1 0 10.81000 11.86000

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

Depth (ft) 74.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 343.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	0.1	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	1.1	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	33.17	4.0	15.5

11	0.176	11294	0.000	0.000	1.00	2.6	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	3.4	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	4.1	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	4.9	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	5.7	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	6.4	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	7.9	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	12.3	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	11.8	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	9.2	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	26.2	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	34.1	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	36.3	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	39.6	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	42.0	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	44.2	0.050	0.100	99.50	4.0	15.5
Toe						7.8	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
74.02	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
343.4	48.7	7.68	7.64	-4.67	12	25	28.60	11	4	19.2	42.6
343.8	49.0	7.68	7.65	-4.67	12	25	28.60	11	4	19.2	42.5
344.2	49.1	7.68	7.65	-4.68	12	25	28.61	11	4	19.2	42.5
344.7	48.9	7.69	7.65	-4.70	12	25	28.62	11	4	19.3	42.5
345.1	49.1	7.69	7.65	-4.71	12	25	28.63	11	4	19.3	42.5

1 0 10.81000 11.86000

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Depth (ft) 76.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 350.9

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	0.0	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	0.8	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	1.7	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	2.4	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	3.2	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	4.0	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	4.7	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	5.5	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	6.2	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	7.0	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	7.7	0.050	0.100	56.38	4.0	15.5

18	0.176	11294	0.000	0.000	1.00	8.5	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	11.4	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	13.1	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	12.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	9.1	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	20.3	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	33.5	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	35.7	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	38.8	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	41.4	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	43.8	0.050	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	18.7	0.130	0.100	99.50	4.0	15.5
Toe						7.8	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
76.50	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
350.9	52.5	7.75	7.73	-4.71	12	25	28.76	11	4	19.3	42.3
351.7	53.0	7.75	7.74	-4.71	12	25	28.76	10	4	19.3	42.3
352.6	53.2	7.76	7.74	-4.72	12	25	28.79	11	4	19.3	42.3
353.4	54.1	7.76	7.75	-4.71	12	25	28.76	10	4	19.3	42.3
354.2	53.7	7.78	7.75	-4.72	12	25	28.82	11	4	19.4	42.3

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Depth (ft) 79.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 358.3

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	2.2	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	3.8	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	6.0	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	7.6	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	10.0	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	10.0	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	14.5	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	33.0	0.050	0.100	79.60	4.0	15.5

25	0.176	11294	0.000	0.000	1.00	35.1	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	37.9	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	40.8	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	43.2	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	27.4	0.091	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	99.50	4.0	15.5
Toe						7.8	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
78.98	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
358.3	55.1	7.82	7.80	-4.60	13	25	28.92	10	4	19.3	42.2
359.6	56.1	7.83	7.82	-4.59	12	25	28.92	9	3	19.3	42.1
360.9	56.4	7.84	7.82	-4.59	12	25	28.96	10	4	19.4	42.1
362.1	56.8	7.85	7.83	-4.59	12	25	28.99	10	4	19.4	42.1
363.4	57.8	7.86	7.84	-4.59	12	25	29.01	10	4	19.4	42.1

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Depth (ft) 79.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 379.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	2.3	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	3.8	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	6.0	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	7.6	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	10.1	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	13.2	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	10.0	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	14.8	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	33.0	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	35.2	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	38.0	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	40.9	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	43.3	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	27.0	0.092	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	10.1	0.198	0.100	99.50	4.0	15.5
Toe						28.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
79.02	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
379.8	70.1	7.97	7.95	-4.45	12	25	29.28	10	4	19.7	41.8
381.0	71.1	7.96	7.97	-4.45	12	25	29.28	10	4	19.7	41.8
382.3	71.9	7.98	7.98	-4.45	12	25	29.33	10	4	19.7	41.7
383.6	72.0	7.99	7.97	-4.47	12	25	29.33	10	4	19.8	41.7
384.8	74.3	7.99	7.99	-4.45	12	25	29.33	10	4	19.7	41.7

1 0 10.81000 11.86000

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Depth (ft) 81.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 404.1

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	0.3	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	1.3	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	2.1	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	2.8	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	3.6	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	4.3	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	5.1	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	5.9	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	6.6	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	7.4	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	8.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	8.9	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	13.6	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	12.2	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	10.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	9.3	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	32.2	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	34.6	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	37.1	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	40.2	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	42.6	0.050	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	35.6	0.068	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	27.0	0.068	0.100	99.50	4.0	15.5
Toe						28.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth Stroke Pressure Efficy

ft	ft	Ratio	
81.50	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
404.1	85.9	7.99	8.07	-4.43	13	25	29.32	9	3	19.6	41.6
405.9	86.8	8.00	8.07	-4.45	13	25	29.32	10	4	19.7	41.6
407.7	88.2	8.02	8.08	-4.46	12	25	29.37	9	3	19.7	41.6
409.5	91.3	8.03	8.10	-4.47	12	25	29.42	9	3	19.7	41.5
411.3	92.6	8.04	8.11	-4.49	12	25	29.45	9	3	19.7	41.5

1 0 10.81000 11.86000

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Depth (ft) 84.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 429.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
5	0.176	11294	0.000	0.000	1.00	0.1	0.050	0.100	16.58	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	1.1	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	2.6	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	3.4	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	4.2	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	4.9	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	5.7	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	6.4	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	7.9	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	12.3	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	11.8	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	9.2	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	26.2	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	34.1	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	36.3	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	39.6	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	42.0	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	44.1	0.051	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	21.3	0.093	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	33.5	0.050	0.100	99.50	4.0	15.5
Toe						28.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
83.98	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
429.4	104.8	8.13	8.15	-4.44	14	24	29.62	8	3	19.9	41.3
431.7	109.0	8.14	8.17	-4.45	14	24	29.65	9	3	19.8	41.3
434.0	109.8	8.16	8.17	-4.48	14	24	29.70	8	3	20.0	41.3
436.3	112.5	8.18	8.18	-4.49	14	24	29.74	8	3	20.0	41.2
438.7	117.2	8.19	8.20	-4.49	14	24	29.77	9	3	19.9	41.2

1 0 10.81000 11.86000

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Depth (ft) 84.0
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 408.5

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
5	0.176	11294	0.000	0.000	1.00	0.1	0.050	0.100	16.58	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	1.1	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	2.6	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	3.4	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	4.2	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	4.9	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	5.7	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	6.4	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	7.9	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	11.7	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	9.2	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	26.5	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	34.1	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	36.3	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	39.7	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	42.1	0.050	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	43.7	0.051	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	21.5	0.092	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	33.4	0.050	0.100	99.50	4.0	15.5
Toe						7.8	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
84.02	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
408.5	79.6	8.07	8.07	-4.44	14	25	29.47	9	3	19.7	41.5
410.8	81.1	8.08	8.08	-4.47	14	25	29.50	9	3	19.7	41.5

413.1	83.8	8.09	8.09	-4.50	14	25	29.53	8	3	19.7	41.4
415.5	85.3	8.10	8.10	-4.52	14	25	29.55	9	3	19.7	41.4
417.8	86.7	8.12	8.11	-4.54	14	25	29.58	9	3	19.8	41.4

1 0 10.81000 11.86000

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Depth (ft) 89.8
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 425.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.0	0.000	0.100	6.63	4.0	15.5
3	0.176	11294	0.000	0.000	1.00	0.0	0.050	0.100	9.95	4.0	15.5
4	0.176	11294	0.000	0.000	1.00	0.8	0.050	0.100	13.27	4.0	15.5
5	0.176	11294	0.000	0.000	1.00	1.7	0.050	0.100	16.58	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	2.4	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	3.2	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	4.0	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	4.7	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	5.5	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	6.2	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	7.0	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	7.7	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	8.5	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	11.4	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	13.1	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	12.9	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	9.1	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	20.2	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	33.5	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	35.7	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	38.8	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	41.4	0.050	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	43.8	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	18.9	0.129	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	15.4	0.135	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	33.1	0.050	0.100	92.87	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	16.4	0.128	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	99.50	4.0	15.5
Toe						7.8	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
89.75	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	Stroke (ft) up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
425.8	100.6	8.16	8.20	-3.85	9	49	29.57	7	3	19.4	41.3
429.0	103.5	8.19	8.21	-3.89	9	49	29.65	7	3	19.5	41.2
432.3	107.3	8.21	8.22	-3.92	9	49	29.68	7	3	19.6	41.2
435.6	109.9	8.23	8.23	-3.94	9	49	29.74	7	3	19.7	41.1
438.9	114.8	8.25	8.25	-3.98	9	49	29.82	7	3	19.7	41.1

1	0	10.81000	11.86000

Depth	(ft)	95.5		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model — Total Capacity Rut (kips) 443.1

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	6.63	4.0	15.5
3	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	9.95	4.0	15.5
4	0.176	11294	0.000	0.000	1.00	2.2	0.050	0.100	13.27	4.0	15.5
5	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	16.58	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	3.7	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	6.0	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	7.5	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	9.9	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	10.1	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	14.0	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	32.9	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	35.1	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	37.8	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	40.8	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	43.2	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	28.3	0.088	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	32.1	0.052	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	22.9	0.088	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	92.87	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	99.50	4.0	15.5
Toe						7.8	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
95.48	10.81	1.00	0.800

Rut	Bl Ct	Stroke (ft) down	Stroke (ft) up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft			ksi			ksi			kip-ft	b/min
443.1	116.3	8.33	8.32	-3.59	9	46	29.85	6	3	19.5	40.9
447.3	121.3	8.36	8.33	-3.53	9	46	29.92	6	3	19.6	40.9
451.5	128.8	8.38	8.35	-3.46	9	46	29.98	6	3	19.7	40.8
455.8	136.4	8.40	8.38	-3.40	9	46	30.04	6	3	19.7	40.7
460.0	142.8	8.43	8.38	-3.34	9	46	30.08	6	3	19.8	40.7

1	0	10.81000	11.86000

Depth (ft) 95.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 449.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.0	0.000	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	0.5	0.050	0.100	6.63	4.0	15.5
3	0.176	11294	0.000	0.000	1.00	1.5	0.050	0.100	9.95	4.0	15.5
4	0.176	11294	0.000	0.000	1.00	2.2	0.050	0.100	13.27	4.0	15.5
5	0.176	11294	0.000	0.000	1.00	3.0	0.050	0.100	16.58	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	3.8	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	4.5	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	5.3	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	6.0	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	6.8	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	7.5	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	8.3	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	9.9	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	13.3	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	12.4	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	10.1	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	14.2	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	32.9	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	35.1	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	37.9	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	40.8	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	43.2	0.050	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	27.9	0.089	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	32.3	0.051	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	22.6	0.089	0.100	89.55	4.0	15.5
28	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	92.87	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	10.1	0.200	0.100	99.50	4.0	15.5
Toe						13.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
95.52	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
449.4	127.4	8.37	8.34	-3.44	9	46	29.94	6	3	19.6	40.8
453.7	132.8	8.39	8.36	-3.39	9	46	30.00	6	3	19.7	40.8
457.9	141.2	8.41	8.38	-3.32	9	46	30.04	6	3	19.8	40.7
462.1	150.0	8.43	8.39	-3.26	9	46	30.07	6	3	19.8	40.7
466.4	159.4	8.45	8.41	-3.20	9	46	30.12	6	3	19.8	40.7
	1	0	10.81000		11.86000						

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Depth (ft) 97.5
Shaft Gain/Loss Factor 0.604 Toe Gain/Loss Factor 1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 459.3

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.1	0.050	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	1.2	0.050	0.100	6.63	4.0	15.5
3	0.176	11294	0.000	0.000	1.00	1.9	0.050	0.100	9.95	4.0	15.5
4	0.176	11294	0.000	0.000	1.00	2.7	0.050	0.100	13.27	4.0	15.5
5	0.176	11294	0.000	0.000	1.00	3.5	0.050	0.100	16.58	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	4.2	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	5.0	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	5.7	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	6.5	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	7.2	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	8.0	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	8.7	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	13.4	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	12.5	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	11.5	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	9.3	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	28.0	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	34.2	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	36.5	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	39.8	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	42.2	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	41.7	0.055	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	22.9	0.085	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	32.0	0.054	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	89.55	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	14.0	0.200	0.100	99.50	4.0	15.5
Toe						13.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
97.49	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
459.3	143.0	8.43	8.39	-2.85	8	21	30.03	5	3	19.7	40.7
463.5	152.0	8.45	8.41	-2.81	8	21	30.07	5	3	19.7	40.7
467.8	160.1	8.48	8.42	-2.78	8	21	30.15	5	3	19.8	40.6
472.0	170.4	8.50	8.44	-2.75	8	21	30.19	5	3	19.8	40.6
476.2	179.2	8.52	8.46	-2.71	8	21	30.24	5	3	19.9	40.5

1 0 10.81000 11.86000

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Depth	(ft)	99.5		
Shaft Gain/Loss Factor		0.604	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type	Unknown
Pile Size	(inch)	12.000		

L b Top Area E-Mod Spec Wt Perim C Index Wave Sp EA/c

B-115-2

ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	29000.	492.0	4.0	0	16524.	27.2
99.5	15.50	29000.	492.0	4.0	0	16524.	27.2

Wave Travel Time 2L/c (ms) 12.043

Pile and Soil Model Total Capacity Rut (kips) 469.3

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.176	11294	0.010	0.000	0.85	0.7	0.050	0.100	3.32	4.0	15.5
2	0.176	11294	0.000	0.000	1.00	1.6	0.050	0.100	6.63	4.0	15.5
3	0.176	11294	0.000	0.000	1.00	2.4	0.050	0.100	9.95	4.0	15.5
4	0.176	11294	0.000	0.000	1.00	3.2	0.050	0.100	13.27	4.0	15.5
5	0.176	11294	0.000	0.000	1.00	3.9	0.050	0.100	16.58	4.0	15.5
6	0.176	11294	0.000	0.000	1.00	4.7	0.050	0.100	19.90	4.0	15.5
7	0.176	11294	0.000	0.000	1.00	5.4	0.050	0.100	23.22	4.0	15.5
8	0.176	11294	0.000	0.000	1.00	6.2	0.050	0.100	26.53	4.0	15.5
9	0.176	11294	0.000	0.000	1.00	6.9	0.050	0.100	29.85	4.0	15.5
10	0.176	11294	0.000	0.000	1.00	7.7	0.050	0.100	33.17	4.0	15.5
11	0.176	11294	0.000	0.000	1.00	8.5	0.050	0.100	36.48	4.0	15.5
12	0.176	11294	0.000	0.000	1.00	11.0	0.050	0.100	39.80	4.0	15.5
13	0.176	11294	0.000	0.000	1.00	13.1	0.050	0.100	43.12	4.0	15.5
14	0.176	11294	0.000	0.000	1.00	13.0	0.050	0.100	46.43	4.0	15.5
15	0.176	11294	0.000	0.000	1.00	12.6	0.050	0.100	49.75	4.0	15.5
16	0.176	11294	0.000	0.000	1.00	9.4	0.050	0.100	53.07	4.0	15.5
17	0.176	11294	0.000	0.000	1.00	18.8	0.050	0.100	56.38	4.0	15.5
18	0.176	11294	0.000	0.000	1.00	33.4	0.050	0.100	59.70	4.0	15.5
19	0.176	11294	0.000	0.000	1.00	35.5	0.050	0.100	63.02	4.0	15.5
20	0.176	11294	0.000	0.000	1.00	38.6	0.050	0.100	66.33	4.0	15.5
21	0.176	11294	0.000	0.000	1.00	41.3	0.050	0.100	69.65	4.0	15.5
22	0.176	11294	0.000	0.000	1.00	43.7	0.050	0.100	72.97	4.0	15.5
23	0.176	11294	0.000	0.000	1.00	21.0	0.117	0.100	76.28	4.0	15.5
24	0.176	11294	0.000	0.000	1.00	14.0	0.148	0.100	79.60	4.0	15.5
25	0.176	11294	0.000	0.000	1.00	33.1	0.050	0.100	82.92	4.0	15.5
26	0.176	11294	0.000	0.000	1.00	17.9	0.117	0.100	86.23	4.0	15.5
27	0.176	11294	0.000	0.000	1.00	10.0	0.200	0.100	89.55	4.0	15.5
29	0.176	11294	0.000	0.000	1.00	11.4	0.200	0.100	96.18	4.0	15.5
30	0.176	11294	0.000	0.000	1.00	16.6	0.200	0.100	99.50	4.0	15.5
Toe						13.9	0.150	0.100			

5.269 kips total unreduced pile weight (g= 32.17 ft/s2)
5.269 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
99.50	10.81	1.00	0.800

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
469.3	167.9	8.50	8.45	-2.57	8	21	30.15	5	3	19.7	40.6
473.6	178.7	8.51	8.46	-2.55	8	21	30.18	5	3	19.7	40.5
477.8	187.4	8.53	8.47	-2.52	8	21	30.22	5	3	19.8	40.5
482.0	196.6	8.55	8.48	-2.50	8	21	30.27	5	3	19.8	40.5
486.3	206.2	8.56	8.49	-2.47	8	21	30.31	5	3	19.8	40.4

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.604 1.000

Depth	Rut	Frictn	End Bg	Bl Ct	Com Str	Ten Str	Stroke	ENTHRU
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft
19.2	16.9	15.5	1.4	1.5	12.527	-3.218	4.09	21.8
38.5	58.0	56.6	1.4	3.7	19.800	-5.468	5.06	20.6
38.5	73.0	56.7	16.3	5.6	21.136	-3.465	5.35	19.6
39.2	76.4	59.8	16.6	5.9	21.364	-3.307	5.40	19.4
40.0	79.9	63.0	16.9	6.3	21.546	-3.123	5.45	19.2
40.0	68.5	63.1	5.4	4.8	20.608	-4.544	5.22	19.8
42.5	78.2	72.8	5.4	5.6	21.198	-4.172	5.35	19.5
45.0	88.4	83.0	5.4	6.5	21.802	-3.798	5.50	19.0

45.0	85.4	83.2	2.2	6.1	21.560	-4.191	5.44	19.2
47.5	94.5	92.3	2.2	6.9	22.045	-3.821	5.56	18.8
50.0	104.0	101.8	2.2	7.8	22.503	-5.423	5.68	18.7
50.0	103.4	101.9	1.4	7.7	22.478	-5.366	5.67	18.7
52.5	110.1	108.7	1.4	8.3	22.803	-5.088	5.76	18.6
55.0	117.1	115.7	1.4	9.1	22.921	-3.966	5.79	18.3
55.0	157.9	116.0	42.0	15.7	24.949	-3.175	6.39	18.0
59.5	203.8	160.4	43.5	20.9	25.980	-2.999	6.72	17.8
64.0	253.7	208.7	44.9	29.1	27.019	-2.948	7.08	18.4
64.0	282.1	209.2	72.9	37.6	27.795	-3.683	7.35	18.9
69.0	342.5	269.5	72.9	57.4	28.764	-4.330	7.73	19.6
74.0	408.2	335.3	72.9	96.4	29.616	-4.927	8.05	20.3
74.0	343.4	335.6	7.8	48.7	28.600	-4.670	7.68	19.2
76.5	350.9	343.1	7.8	52.5	28.755	-4.714	7.75	19.3
79.0	358.3	350.6	7.8	55.1	28.917	-4.597	7.82	19.3
79.0	379.8	350.8	28.9	70.1	29.283	-4.449	7.97	19.7
81.5	404.1	375.2	28.9	85.9	29.316	-4.429	7.99	19.6
84.0	429.4	400.4	28.9	104.8	29.617	-4.444	8.13	19.9
84.0	408.5	400.7	7.8	79.6	29.466	-4.440	8.07	19.7
89.8	425.8	418.0	7.8	100.6	29.569	-3.850	8.16	19.4
95.5	443.1	435.3	7.8	116.3	29.851	-3.587	8.33	19.5
95.5	449.4	435.5	13.9	127.4	29.935	-3.443	8.37	19.6
97.5	459.3	445.3	13.9	143.0	30.026	-2.853	8.43	19.7
99.5	469.3	455.4	13.9	167.9	30.148	-2.574	8.50	19.7

Total Driving Time 81 minutes; Total No. of Blows 3411

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.637 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
19.2	16.9	15.5	1.4	1.5	12.527	-3.218	4.09	21.8
38.5	58.0	56.6	1.4	3.7	19.800	-5.468	5.06	20.6
38.5	73.0	56.7	16.3	5.6	21.135	-3.462	5.35	19.6
39.2	76.5	59.9	16.6	5.9	21.352	-3.290	5.40	19.4
40.0	80.0	63.1	16.9	6.3	21.550	-3.122	5.44	19.2
40.0	68.7	63.3	5.4	4.8	20.618	-4.552	5.23	19.9
42.5	78.3	73.0	5.4	5.6	21.217	-4.149	5.36	19.4
45.0	88.6	83.2	5.4	6.6	21.805	-3.823	5.50	19.0
45.0	85.6	83.3	2.2	6.1	21.563	-4.183	5.44	19.2
47.5	94.6	92.4	2.2	6.9	22.059	-3.852	5.56	18.9
50.0	104.1	101.9	2.2	7.8	22.524	-5.410	5.69	18.7
50.0	103.5	102.1	1.4	7.7	22.472	-5.385	5.67	18.7
52.5	110.4	109.0	1.4	8.4	22.793	-5.041	5.76	18.6
55.0	117.6	116.1	1.4	9.1	22.958	-3.965	5.80	18.4
55.0	158.4	116.4	42.0	15.8	24.947	-3.154	6.39	17.9
59.5	204.3	160.8	43.5	21.0	25.976	-3.014	6.72	17.8
64.0	254.1	209.1	44.9	29.3	27.017	-2.966	7.08	18.4
64.0	282.5	209.6	72.9	37.6	27.760	-3.699	7.34	19.0
69.0	342.9	270.0	72.9	57.1	28.822	-4.331	7.73	19.7
74.0	408.7	335.7	72.9	97.1	29.599	-4.931	8.06	20.2
74.0	343.8	336.1	7.8	49.0	28.599	-4.675	7.68	19.2
76.5	351.7	344.0	7.8	53.0	28.757	-4.715	7.75	19.3
79.0	359.6	351.9	7.8	56.1	28.920	-4.594	7.83	19.3
79.0	381.0	352.1	28.9	71.1	29.284	-4.450	7.96	19.7
81.5	405.9	377.0	28.9	86.8	29.325	-4.446	8.00	19.7
84.0	431.7	402.8	28.9	109.0	29.650	-4.447	8.14	19.8
84.0	410.8	403.0	7.8	81.1	29.502	-4.467	8.08	19.7
89.8	429.0	421.3	7.8	103.5	29.647	-3.891	8.19	19.5
95.5	447.3	439.6	7.8	121.3	29.916	-3.529	8.36	19.6
95.5	453.7	439.7	13.9	132.8	29.997	-3.387	8.39	19.7
97.5	463.5	449.6	13.9	152.0	30.072	-2.812	8.45	19.7
99.5	473.6	459.6	13.9	178.7	30.183	-2.546	8.51	19.7

Total Driving Time 83 minutes; Total No. of Blows 3494

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.670 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
19.2	16.9	15.5	1.4	1.5	12.527	-3.218	4.09	21.8
38.5	58.0	56.6	1.4	3.7	19.800	-5.468	5.06	20.6
38.5	73.0	56.7	16.3	5.6	21.129	-3.463	5.35	19.6
39.2	76.6	60.0	16.6	5.9	21.344	-3.290	5.40	19.4
40.0	80.2	63.2	16.9	6.3	21.550	-3.120	5.45	19.3
40.0	68.8	63.4	5.4	4.9	20.617	-4.538	5.22	19.9
42.5	78.5	73.1	5.4	5.6	21.212	-4.162	5.36	19.5
45.0	88.7	83.3	5.4	6.6	21.815	-3.769	5.50	19.0
45.0	85.7	83.5	2.2	6.1	21.569	-4.150	5.44	19.1
47.5	94.8	92.6	2.2	7.0	22.058	-3.834	5.56	18.9
50.0	104.3	102.1	2.2	7.9	22.533	-5.428	5.69	18.7
50.0	103.6	102.2	1.4	7.8	22.487	-5.366	5.68	18.7
52.5	110.7	109.2	1.4	8.5	22.631	-4.853	5.71	18.4
55.0	118.0	116.6	1.4	9.2	22.960	-3.971	5.80	18.3
55.0	158.8	116.8	42.0	15.8	24.951	-3.138	6.39	17.9
59.5	204.7	161.2	43.5	21.0	26.012	-3.041	6.73	17.8
64.0	254.5	209.6	44.9	29.3	27.058	-2.969	7.09	18.4
64.0	283.0	210.0	72.9	37.8	27.800	-3.714	7.35	18.9
69.0	343.3	270.4	72.9	57.5	28.813	-4.346	7.74	19.7
74.0	409.1	336.2	72.9	97.6	29.595	-4.937	8.06	20.2
74.0	344.2	336.5	7.8	49.1	28.605	-4.682	7.68	19.2
76.5	352.6	344.8	7.8	53.2	28.793	-4.717	7.76	19.3
79.0	360.9	353.1	7.8	56.4	28.958	-4.591	7.84	19.4
79.0	382.3	353.4	28.9	71.9	29.327	-4.453	7.98	19.7
81.5	407.7	378.8	28.9	88.2	29.369	-4.459	8.02	19.7
84.0	434.0	405.1	28.9	109.8	29.696	-4.479	8.16	20.0
84.0	413.1	405.4	7.8	83.8	29.534	-4.500	8.09	19.7
89.8	432.3	424.6	7.8	107.3	29.682	-3.921	8.21	19.6
95.5	451.5	443.8	7.8	128.8	29.980	-3.464	8.38	19.7
95.5	457.9	443.9	13.9	141.2	30.040	-3.321	8.41	19.8
97.5	467.8	453.8	13.9	160.1	30.153	-2.784	8.48	19.8
99.5	477.8	463.9	13.9	187.4	30.222	-2.520	8.53	19.8

Total Driving Time 86 minutes; Total No. of Blows 3589

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.703 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
19.2	16.9	15.5	1.4	1.5	12.527	-3.218	4.09	21.8
38.5	58.0	56.6	1.4	3.7	19.800	-5.468	5.06	20.6
38.5	73.0	56.7	16.3	5.6	21.153	-3.463	5.35	19.6
39.2	76.6	60.0	16.6	6.0	21.359	-3.284	5.40	19.4
40.0	80.3	63.4	16.9	6.3	21.577	-3.120	5.45	19.2
40.0	68.9	63.5	5.4	4.9	20.647	-4.542	5.23	19.9
42.5	78.6	73.2	5.4	5.6	21.238	-4.163	5.36	19.5
45.0	88.8	83.5	5.4	6.6	21.828	-3.781	5.51	19.0
45.0	85.8	83.6	2.2	6.2	21.593	-4.180	5.45	19.2
47.5	94.9	92.7	2.2	7.0	22.058	-3.825	5.56	18.8
50.0	104.4	102.2	2.2	7.9	22.541	-5.437	5.69	18.7
50.0	103.8	102.3	1.4	7.8	22.505	-5.391	5.67	18.7
52.5	110.9	109.5	1.4	8.4	22.833	-4.949	5.77	18.6
55.0	118.4	117.0	1.4	9.2	22.989	-3.987	5.81	18.3
55.0	159.3	117.3	42.0	15.9	24.941	-3.120	6.39	17.9
59.5	205.1	161.7	43.5	21.2	25.965	-3.055	6.72	17.8
64.0	255.0	210.0	44.9	29.4	27.057	-2.956	7.09	18.4
64.0	283.4	210.5	72.9	37.8	27.794	-3.726	7.36	19.0
69.0	343.8	270.8	72.9	57.4	28.856	-4.353	7.75	19.7
74.0	409.5	336.6	72.9	98.1	29.642	-4.938	8.06	20.2
74.0	344.7	336.9	7.8	48.9	28.620	-4.699	7.69	19.3
76.5	353.4	345.6	7.8	54.1	28.760	-4.709	7.76	19.3
79.0	362.1	354.4	7.8	56.8	28.993	-4.588	7.85	19.4
79.0	383.6	354.6	28.9	72.0	29.334	-4.466	7.99	19.8
81.5	409.5	380.6	28.9	91.3	29.418	-4.473	8.03	19.7
84.0	436.3	407.4	28.9	112.5	29.737	-4.493	8.18	20.0
84.0	415.5	407.7	7.8	85.3	29.551	-4.521	8.10	19.7
89.8	435.6	427.9	7.8	109.9	29.739	-3.940	8.23	19.7
95.5	455.8	448.0	7.8	136.4	30.037	-3.401	8.40	19.7

95.5	462.1	448.2	13.9	150.0	30.075	-3.261	8.43	19.8
97.5	472.0	458.0	13.9	170.4	30.192	-2.751	8.50	19.8
99.5	482.0	468.1	13.9	196.6	30.266	-2.496	8.55	19.8

Total Driving Time 88 minutes; Total No. of Blows 3684

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.736 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
19.2	16.9	15.5	1.4	1.5	12.527	-3.218	4.09	21.8
38.5	58.0	56.6	1.4	3.7	19.800	-5.468	5.06	20.6
38.5	73.0	56.8	16.3	5.6	21.134	-3.460	5.35	19.6
39.2	76.7	60.1	16.6	6.0	21.361	-3.270	5.40	19.4
40.0	80.4	63.5	16.9	6.3	21.582	-3.109	5.45	19.2
40.0	69.1	63.7	5.4	4.9	20.644	-4.516	5.23	19.9
42.5	78.7	73.4	5.4	5.7	21.239	-4.156	5.36	19.4
45.0	89.0	83.6	5.4	6.6	21.801	-3.754	5.50	19.0
45.0	86.0	83.7	2.2	6.2	21.590	-4.172	5.45	19.1
47.5	95.1	92.8	2.2	7.0	22.075	-3.801	5.57	18.8
50.0	104.6	102.3	2.2	7.9	22.557	-5.440	5.69	18.7
50.0	103.9	102.5	1.4	7.8	22.508	-5.424	5.68	18.7
52.5	111.2	109.8	1.4	8.5	22.653	-4.747	5.72	18.4
55.0	118.9	117.4	1.4	9.2	22.999	-4.006	5.81	18.4
55.0	159.7	117.7	42.0	15.9	24.983	-3.104	6.40	17.9
59.5	205.6	162.1	43.5	21.2	26.015	-3.079	6.73	17.8
64.0	255.4	210.4	44.9	29.5	27.060	-2.970	7.09	18.4
64.0	283.8	210.9	72.9	37.8	27.807	-3.741	7.35	19.0
69.0	344.2	271.3	72.9	57.9	28.857	-4.370	7.76	19.7
74.0	410.0	337.0	72.9	98.5	29.635	-4.945	8.07	20.2
74.0	345.1	337.4	7.8	49.1	28.631	-4.707	7.69	19.3
76.5	354.2	346.5	7.8	53.7	28.825	-4.721	7.78	19.4
79.0	363.4	355.6	7.8	57.8	29.006	-4.586	7.86	19.4
79.0	384.8	355.9	28.9	74.3	29.331	-4.455	7.99	19.7
81.5	411.3	382.4	28.9	92.6	29.449	-4.488	8.04	19.7
84.0	438.7	409.7	28.9	117.2	29.773	-4.494	8.19	19.9
84.0	417.8	410.0	7.8	86.7	29.576	-4.543	8.12	19.8
89.8	438.9	431.1	7.8	114.8	29.825	-3.976	8.25	19.7
95.5	460.0	452.2	7.8	142.8	30.082	-3.343	8.43	19.8
95.5	466.4	452.4	13.9	159.4	30.115	-3.196	8.45	19.8
97.5	476.2	462.3	13.9	179.2	30.244	-2.713	8.52	19.9
99.5	486.3	472.3	13.9	206.2	30.305	-2.474	8.56	19.8

Total Driving Time 91 minutes; Total No. of Blows 3786

FRA-71-1503L - FA - B-115-2-13 - HP12x52 04/06/2020
Resource International Inc GRLWEAP Version 2010

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
19.25	99.50	0.00	10.81	1.00	0.80	1.00	1.00
38.48	99.50	0.00	10.81	1.00	0.80	1.00	1.00
38.52	99.50	0.00	10.81	1.00	0.80	1.00	1.00
39.25	99.50	0.00	10.81	1.00	0.80	1.00	1.00
39.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00
40.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
42.50	99.50	0.00	10.81	1.00	0.80	1.00	1.00
44.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00
45.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
47.50	99.50	0.00	10.81	1.00	0.80	1.00	1.00
49.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00
50.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
52.50	99.50	0.00	10.81	1.00	0.80	1.00	1.00
54.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00
55.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
59.50	99.50	0.00	10.81	1.00	0.80	1.00	1.00
63.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00

64.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
69.00	99.50	0.00	10.81	1.00	0.80	1.00	1.00
73.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00
74.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
76.50	99.50	0.00	10.81	1.00	0.80	1.00	1.00
78.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00
79.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
81.50	99.50	0.00	10.81	1.00	0.80	1.00	1.00
83.98	99.50	0.00	10.81	1.00	0.80	1.00	1.00
84.02	99.50	0.00	10.81	1.00	0.80	1.00	1.00
89.75	99.50	0.00	10.81	1.00	0.80	1.00	1.00
95.48	99.50	0.00	10.81	1.00	0.80	1.00	1.00
95.52	99.50	0.00	10.81	1.00	0.80	1.00	1.00
97.49	99.50	0.00	10.81	1.00	0.80	1.00	1.00
99.50	99.50	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.00	0.100	0.100	0.050	0.150	0.000	0.000	0.000
1.99	0.07	0.45	0.100	0.100	0.050	0.150	0.000	0.000	0.000
2.01	0.07	0.45	0.100	0.100	0.050	0.150	0.000	0.000	0.000
11.01	0.23	1.42	0.100	0.100	0.050	0.150	0.000	0.000	0.000
20.01	0.38	1.43	0.100	0.100	0.050	0.150	0.000	0.000	0.000
29.01	0.54	1.43	0.100	0.100	0.050	0.150	0.000	0.000	0.000
38.01	0.70	1.43	0.100	0.100	0.050	0.150	0.000	0.000	0.000
38.49	0.70	1.43	0.100	0.100	0.050	0.150	0.000	0.000	0.000
38.51	1.32	16.27	0.100	0.100	0.050	0.150	0.515	0.000	0.000
39.99	1.38	16.92	0.100	0.100	0.050	0.150	0.515	0.000	0.000
40.01	0.95	5.38	0.100	0.100	0.050	0.150	0.000	0.000	0.000
44.99	1.07	5.38	0.100	0.100	0.050	0.150	0.000	0.000	0.000
45.01	0.90	2.22	0.100	0.100	0.050	0.150	0.000	0.000	0.000
49.99	0.99	2.22	0.100	0.100	0.050	0.150	0.000	0.000	0.000
50.01	0.84	1.43	0.100	0.100	0.050	0.150	0.515	0.000	0.000
54.99	0.92	1.43	0.100	0.100	0.050	0.150	0.515	0.000	0.000
55.01	2.38	41.99	0.100	0.100	0.050	0.150	0.000	0.000	0.000
63.99	2.83	44.95	0.100	0.100	0.050	0.150	0.000	0.000	0.000
64.01	2.92	72.94	0.100	0.100	0.050	0.150	0.000	0.000	0.000
73.01	3.41	72.94	0.100	0.100	0.050	0.150	0.000	0.000	0.000
73.99	3.46	72.94	0.100	0.100	0.050	0.150	0.000	0.000	0.000
74.01	1.26	7.75	0.100	0.100	0.200	0.150	1.000	0.000	0.000
78.99	1.26	7.75	0.100	0.100	0.200	0.150	1.000	0.000	0.000
79.01	3.06	28.91	0.100	0.100	0.050	0.150	0.515	0.000	0.000
83.99	3.27	28.91	0.100	0.100	0.050	0.150	0.515	0.000	0.000
84.01	1.26	7.75	0.100	0.100	0.200	0.150	1.000	0.000	0.000
93.01	1.26	7.75	0.100	0.100	0.200	0.150	1.000	0.000	0.000
95.49	1.26	7.75	0.100	0.100	0.200	0.150	1.000	0.000	0.000
95.51	1.26	13.95	0.100	0.100	0.200	0.150	0.000	0.000	0.000
99.50	1.26	13.95	0.100	0.100	0.200	0.150	0.000	0.000	0.000

APPENDIX IX

LATERAL DESIGN PARAMETERS

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-104-1-13	714.5 to 701.5	A-6a	C	3	24	24	120 psf	120 psf	Su = 3,000 psf	1,000 pci	0.0050	-
	701.5 to 699.0	A-3a	G	4	12	13	120 psf	120 psf	φ = 34°	115 pci	-	-
	699.0 to 682.5	A-1-a	G	4	42	38	130 psf	67.6 psf	φ = 41°	175 pci	-	-
	682.5 to 677.5	A-1-b	G	4	28	23	130 psf	67.6 psf	φ = 38°	125 pci	-	-
	677.5 to 672.5	A-1-b	G	4	100	78	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	672.5 to 667.5	A-1-b	G	4	3	2	115 psf	52.6 psf	φ = 29°	25 pci	-	-
	667.5 to 663.5	A-1-b	G	4	100	74	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	663.5 to 660.5	Boulders	G	4	100	72	140 psf	77.6 psf	φ = 45°	255 pci	-	-
	660.5 to 654.0	A-6a	C	2	100	100	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	654.0 to 644.0	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	73
B-105-2-13	707.0 to 694.0	A-6a	C	3	16	16	120 psf	120 psf	Su = 2,000 psf	665 pci	0.0063	-
	694.0 to 686.5	A-1-a	G	4	20	20	125 psf	62.6 psf	φ = 38°	125 pci	-	-
	686.5 to 679.0	A-1-a	G	4	42	39	130 psf	67.6 psf	φ = 41°	175 pci	-	-
	679.0 to 676.0	A-1-a	G	4	21	19	125 psf	62.6 psf	φ = 38°	125 pci	-	-
	676.0 to 665.0	A-1-b	G	4	48	40	135 psf	72.6 psf	φ = 40°	155 pci	-	-
	665.0 to 660.0	A-1-b	G	4	73	57	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	660.0 to 655.0	A-1-a	G	4	100	75	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	655.0 to 651.0	A-4a	C	2	100	100	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	651.0 to 641.0	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	56
B-107-1-13	704.0 to 696.0	A-3a	G	4	9	13	120 psf	120 psf	φ = 34°	115 pci	-	-
	696.0 to 686.0	A-1-a	G	4	52	56	135 psf	135 psf	φ = 43°	395 pci	-	-
	686.0 to 672.0	A-1-a	G	4	34	31	130 psf	67.6 psf	φ = 40°	155 pci	-	-
	672.0 to 667.0	A-1-a	G	4	17	14	125 psf	62.6 psf	φ = 37°	110 pci	-	-
	667.0 to 650.2	A-1-b	G	4	100	77	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	650.2 to 638.2	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	83
B-108-4-13	702.7 to 697.2	A-4a	C	3	15	15	115 psf	115 psf	Su = 1,875 psf	625 pci	0.0065	-
	697.2 to 684.7	A-1-a	G	4	31	34	130 psf	130 psf	φ = 41°	315 pci	-	-
	684.7 to 679.7	A-1-b	G	4	20	20	125 psf	62.6 psf	φ = 37°	110 pci	-	-
	679.7 to 668.7	A-1-b	G	4	11	10	120 psf	57.6 psf	φ = 34°	70 pci	-	-
	668.7 to 662.7	A-1-a	G	4	90	77	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	662.7 to 653.2	A-4a	C	2	12	12	120 psf	57.6 psf	Su = 1,500 psf	500 pci	0.0070	-
	653.2 to 640.2	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	81

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-108-5-13	700.3 to 694.8	A-6a	C	3	18	18	120 psf	120 psf	Su = 2,250 psf	750 pci	0.0060	-
	694.8 to 689.8	A-2-6	G	4	18	22	125 psf	125 psf	φ = 37°	190 pci	-	-
	689.8 to 682.3	A-1-a	G	4	29	31	130 psf	67.6 psf	φ = 40°	155 pci	-	-
	682.3 to 677.3	A-1-b	G	4	19	19	125 psf	62.6 psf	φ = 37°	110 pci	-	-
	677.3 to 663.3	A-1-a	G	4	37	34	130 psf	67.6 psf	φ = 41°	175 pci	-	-
	663.3 to 645.8	A-4a	C	2	29	29	125 psf	62.6 psf	Su = 3,625 psf	1,210 pci	0.0048	-
	645.8 to 637.3	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	79
B-108-6-13	714.5 to 709.0	A-2-4	G	4	26	41	125 psf	125 psf	φ = 40°	280 pci	-	-
	709.0 to 689.0	A-6a	C	2	9	9	115 psf	52.6 psf	Su = 1,125 psf	300 pci	0.0085	-
	689.0 to 677.5	A-4a	C	2	10	10	115 psf	52.6 psf	Su = 1,250 psf	365 pci	0.0080	-
	677.5 to 672.5	A-1-a	G	4	26	23	125 psf	62.6 psf	φ = 39°	140 pci	-	-
	672.5 to 667.5	A-1-a	G	4	54	45	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	667.5 to 657.0	A-4a	C	2	92	92	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	657.0 to 647.4	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	73
B-113-2-13	743.3 to 736.3	A-1-b	G	4	49	73	130 psf	130 psf	φ = 42°	355 pci	-	-
	736.3 to 726.3	A-1-b	G	4	87	94	135 psf	135 psf	φ = 42°	355 pci	-	-
	726.3 to 721.3	A-1-b	G	4	15	14	125 psf	125 psf	φ = 36°	160 pci	-	-
	721.3 to 716.3	A-2-4	G	4	49	41	135 psf	135 psf	φ = 40°	280 pci	-	-
	716.3 to 702.8	A-6a	C	3	32	32	125 psf	125 psf	Su = 4,000 psf	1,335 pci	0.0047	-
	702.8 to 686.3	A-1-b	G	4	62	38	135 psf	135 psf	φ = 40°	280 pci	-	-
	686.3 to 681.3	A-1-a	G	4	100	56	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	681.3 to 676.3	A-3a	G	4	100	54	135 psf	72.6 psf	φ = 40°	155 pci	-	-
	676.3 to 654.1	A-4a	C	2	90	90	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	654.1 to 644.1	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	90
B-113-3-13	735.3 to 728.3	A-4a	C	3	15	15	120 psf	120 psf	Su = 1,875 psf	625 pci	0.0065	-
	728.3 to 718.3	A-2-4	G	4	47	52	130 psf	130 psf	φ = 41°	315 pci	-	-
	718.3 to 702.3	A-6b	C	3	19	19	120 psf	120 psf	Su = 2,375 psf	790 pci	0.0058	-
	702.3 to 697.3	A-6a	C	3	34	34	125 psf	125 psf	Su = 4,250 psf	1,415 pci	0.0046	-
	697.3 to 688.3	A-1-b	G	4	44	30	130 psf	130 psf	φ = 39°	250 pci	-	-
	688.3 to 678.3	A-1-b	G	4	13	8	125 psf	125 psf	φ = 34°	115 pci	-	-
	678.3 to 673.3	A-4a	C	3	23	23	120 psf	120 psf	Su = 2,875 psf	960 pci	0.0052	-
	673.3 to 663.3	A-4a	C	2	80	80	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	663.3 to 658.3	A-3a	G	4	100	52	135 psf	72.6 psf	φ = 40°	155 pci	-	-
	658.3 to 653.3	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	653.3 to 644.3	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	93

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-113-4-13	725.2 to 719.7	A-6a	C	3	22	22	120 psf	120 psf	Su = 2,750 psf	915 pci	0.0053	-
	719.7 to 714.7	A-1-b	G	4	20	25	125 psf	125 psf	φ = 38°	215 pci	-	-
	714.7 to 707.9	A-2-6	G	4	12	13	125 psf	125 psf	φ = 35°	135 pci	-	-
	707.9 to 704.7	A-4a	C	1	6	6	110 psf	110 psf	Su = 750 psf	100 pci	0.0100	-
	704.7 to 699.7	A-1-b	G	4	65	58	135 psf	135 psf	φ = 42°	355 pci	-	-
	699.7 to 688.2	A-1-a	G	4	91	71	135 psf	135 psf	φ = 43°	395 pci	-	-
	688.2 to 683.2	A-1-b	G	4	92	64	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	683.2 to 668.2	A-1-b	G	4	52	34	135 psf	72.6 psf	φ = 40°	155 pci	-	-
	668.2 to 652.7	A-1-a	G	4	100	59	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	652.7 to 649.2	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	0
	649.2 to 636.9	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	77
B-113-5-13	725.7 to 720.2	A-6a	C	3	21	21	120 psf	120 psf	Su = 2,625 psf	875 pci	0.0055	-
	720.2 to 715.2	A-1-b	G	4	11	14	120 psf	120 psf	φ = 36°	160 pci	-	-
	715.2 to 697.7	A-1-a	G	4	22	21	125 psf	125 psf	φ = 39°	250 pci	-	-
	697.7 to 688.7	A-1-a	G	4	52	40	135 psf	135 psf	φ = 41°	315 pci	-	-
	688.7 to 683.7	A-1-b	G	4	13	9	120 psf	57.6 psf	φ = 34°	70 pci	-	-
	683.7 to 674.7	A-1-a	G	4	100	67	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	674.7 to 668.7	Boulders	G	4	100	64	140 psf	77.6 psf	φ = 45°	255 pci	-	-
	668.7 to 663.7	A-3a	G	4	85	52	135 psf	72.6 psf	φ = 40°	155 pci	-	-
	663.7 to 652.2	A-1-a	G	4	100	59	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	652.2 to 650.8	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	650.8 to 640.0	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	77
B-113-6-13	691.5 to 678.7	A-2-6	G	4	5	8	120 psf	57.6 psf	φ = 33°	60 pci	-	-
	678.7 to 652.2	A-1-a	G	4	89	94	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	652.2 to 647.6	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	647.6 to 627.8	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	88
B-113-7-13	690.3 to 684.3	A-1-b	G	4	4	7	120 psf	57.6 psf	φ = 33°	60 pci	-	-
	684.3 to 680.2	A-4a	G	4	4	6	120 psf	57.6 psf	φ = 29°	25 pci	-	-
	680.2 to 675.2	A-1-a	G	4	35	47	130 psf	67.6 psf	φ = 42°	195 pci	-	-
	675.2 to 659.4	A-1-b	G	4	100	110	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	659.4 to 648.8	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 750 psi	0.00025	68,000 psi	21
	648.8 to 634.6	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	81

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-113-8-13	691.0 to 676.8	A-1-a	G	4	18	27	125 psf	62.6 psf	φ = 40°	155 pci	-	-
	676.8 to 671.8	A-1-a	G	4	42	51	130 psf	67.6 psf	φ = 43°	215 pci	-	-
	671.8 to 663.6	A-4a	G	4	86	94	135 psf	72.6 psf	φ = 38°	125 pci	-	-
	663.6 to 646.8	Boulders	G	4	100	93	140 psf	77.6 psf	φ = 45°	255 pci	-	-
	646.8 to 644.0	A-6b	C	2	100	100	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	644.0 to 624.8	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	80
B-113-9-13	706.3 to 700.8	A-6a	C	3	10	10	115 psf	115 psf	Su = 1,250 psf	365 pci	0.0080	-
	700.8 to 693.3	A-6b	C	3	19	19	120 psf	120 psf	Su = 2,375 psf	790 pci	0.0058	-
	693.3 to 683.3	A-6a	C	3	8	8	115 psf	115 psf	Su = 1,000 psf	235 pci	0.0090	-
	683.3 to 674.3	A-4a	G	4	47	42	130 psf	67.6 psf	φ = 37°	110 pci	-	-
	674.3 to 656.3	A-2-4	G	4	57	45	135 psf	72.6 psf	φ = 40°	155 pci	-	-
	656.3 to 645.6	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	10
	645.6 to 633.3	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	95
B-114-1-13	709.8 to 699.3	A-6b	C	3	12	12	115 psf	115 psf	Su = 1,500 psf	500 pci	0.0070	-
	699.3 to 689.3	A-6a	C	3	15	15	120 psf	120 psf	Su = 1,875 psf	625 pci	0.0065	-
	689.3 to 684.8	A-6b	C	3	8	8	115 psf	115 psf	Su = 1,000 psf	235 pci	0.0090	-
	684.8 to 677.8	A-1-a	G	4	17	14	125 psf	62.6 psf	φ = 37°	110 pci	-	-
	677.8 to 672.8	A-1-a	G	4	41	32	130 psf	67.6 psf	φ = 40°	155 pci	-	-
	672.8 to 667.8	A-2-4	G	4	100	76	135 psf	72.6 psf	φ = 41°	175 pci	-	-
	667.8 to 655.3	A-6b	C	2	38	38	125 psf	62.6 psf	Su = 4,750 psf	1,585 pci	0.0044	-
	655.3 to 648.8	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	648.8 to 634.8	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 360 psi	0.0005	32,000 psi	37
	634.8 to 628.8	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	95
B-114-2-13	723.5 to 708.0	A-6a	C	3	10	10	115 psf	115 psf	Su = 1,250 psf	365 pci	0.0080	-
	708.0 to 700.5	A-6a	C	3	25	25	120 psf	120 psf	Su = 3,125 psf	1,040 pci	0.0050	-
	700.5 to 695.5	A-6a	C	1	3	3	110 psf	110 psf	Su = 375 psf	50 pci	0.0175	-
	695.5 to 691.5	A-1-b	G	4	7	6	120 psf	57.6 psf	φ = 33°	60 pci	-	-
	691.5 to 686.5	A-1-b	G	4	55	43	135 psf	72.6 psf	φ = 41°	175 pci	-	-
	686.5 to 681.5	A-4a	C	2	55	55	125 psf	62.6 psf	Su = 6,875 psf	2,290 pci	0.0037	-
	681.5 to 676.5	A-1-b	G	4	104	76	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	676.5 to 671.5	A-1-b	G	4	35	25	130 psf	67.6 psf	φ = 38°	125 pci	-	-
	671.5 to 660.0	A-6b	C	2	72	72	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	660.0 to 651.5	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	15
	651.5 to 643.0	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 360 psi	0.0005	32,000 psi	35
	643.0 to 641.5	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	100

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-114-3-13	724.6 to 711.6	A-6a	C	3	12	12	115 psf	115 psf	Su = 1,500 psf	500 pci	0.0070	-
	711.6 to 699.1	A-6a	C	3	31	31	125 psf	125 psf	Su = 3,875 psf	1,290 pci	0.0047	-
	699.1 to 692.6	A-2-6	G	4	52	42	135 psf	135 psf	φ = 40°	280 pci	-	-
	692.6 to 682.6	A-1-b	G	4	17	13	125 psf	62.6 psf	φ = 36°	95 pci	-	-
	682.6 to 667.6	A-1-b	G	4	100	70	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	667.6 to 661.1	A-7-6	C	2	65	65	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	661.1 to 655.2	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	655.2 to 645.2	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 360 psi	0.0005	32,000 psi	19
	645.2 to 640.6	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	91
B-114-4-13	724.1 to 718.6	A-2-4	G	4	11	18	120 psf	120 psf	φ = 36°	160 pci	-	-
	718.6 to 711.1	A-6a	C	3	14	14	120 psf	120 psf	Su = 1,750 psf	585 pci	0.0067	-
	711.1 to 701.1	A-2-4	G	4	8	8	120 psf	120 psf	φ = 33°	95 pci	-	-
	701.1 to 692.1	A-1-b	G	4	28	23	130 psf	130 psf	φ = 38°	215 pci	-	-
	692.1 to 680.1	A-1-b	G	4	41	31	130 psf	67.6 psf	φ = 39°	140 pci	-	-
	680.1 to 660.6	A-7-6	C	2	39	39	125 psf	62.6 psf	Su = 4,875 psf	1,625 pci	0.0044	-
	660.6 to 650.6	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	0
	650.6 to 644.3	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 750 psi	0.00025	68,000 psi	26
	644.3 to 637.9	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	87
B-114-5-13	715.3 to 702.3	A-6b	C	3	10	10	115 psf	115 psf	Su = 1,250 psf	365 pci	0.0080	-
	702.3 to 697.3	A-3a	G	4	18	19	125 psf	125 psf	φ = 35°	135 pci	-	-
	697.3 to 692.3	A-1-a	G	4	88	84	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	692.3 to 683.3	A-1-a	G	4	40	36	130 psf	67.6 psf	φ = 41°	175 pci	-	-
	683.3 to 678.3	A-3a	G	4	46	39	130 psf	67.6 psf	φ = 38°	125 pci	-	-
	678.3 to 673.3	A-7-6	C	2	23	23	120 psf	57.6 psf	Su = 2,875 psf	960 pci	0.0052	-
	673.3 to 661.7	A-4b	C	2	58	58	130 psf	67.6 psf	Su = 7,250 psf	2,415 pci	0.0036	-
	661.7 to 651.8	A-7-6	C	2	85	85	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	651.8 to 635.7	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	635.7 to 625.7	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	91

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-114-7-13	713.3 to 707.8	A-6a	C	3	36	36	125 psf	125 psf	Su = 4,500 psf	1,500 pci	0.0045	-
	707.8 to 700.3	A-7-6	C	3	18	18	120 psf	120 psf	Su = 2,250 psf	750 pci	0.0060	-
	700.3 to 697.8	A-2-6	G	4	8	8	120 psf	120 psf	φ = 33°	95 pci	-	-
	697.8 to 685.3	A-1-a	G	4	28	26	125 psf	62.6 psf	φ = 39°	140 pci	-	-
	685.3 to 676.3	A-1-b	G	4	77	66	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	676.3 to 671.3	A-1-b	G	4	21	17	125 psf	62.6 psf	φ = 37°	110 pci	-	-
	671.3 to 661.3	A-6b	C	2	35	35	125 psf	62.6 psf	Su = 4,375 psf	1,460 pci	0.0045	-
	661.3 to 648.4	A-7-6	C	2	100	100	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	648.4 to 639.3	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	639.3 to 629.3	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	50
B-114-8-13	714.0 to 708.5	A-4a	C	3	12	12	120 psf	120 psf	Su = 1,500 psf	500 pci	0.0070	-
	708.5 to 698.5	A-6b	C	3	10	10	115 psf	115 psf	Su = 1,250 psf	365 pci	0.0080	-
	698.5 to 693.5	A-1-a	G	4	26	26	125 psf	125 psf	φ = 39°	250 pci	-	-
	693.5 to 686.0	A-1-b	G	4	30	28	130 psf	67.6 psf	φ = 39°	140 pci	-	-
	686.0 to 677.0	A-1-a	G	4	85	72	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	677.0 to 669.2	A-6b	C	2	18	18	120 psf	57.6 psf	Su = 2,250 psf	750 pci	0.0060	-
	669.2 to 662.0	A-7-6	C	2	30	30	125 psf	62.6 psf	Su = 3,750 psf	1,250 pci	0.0048	-
	662.0 to 650.5	A-7-6	C	2	100	100	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	650.5 to 647.0	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	647.0 to 637.0	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 360 psi	0.0005	32,000 psi	15
	637.0 to 632.0	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	92
B-114-9-13	714.0 to 706.0	A-2-4	G	4	13	19	125 psf	125 psf	φ = 36°	160 pci	-	-
	706.0 to 701.0	A-6b	C	3	8	8	115 psf	115 psf	Su = 1,000 psf	235 pci	0.0090	-
	701.0 to 691.0	A-1-b	G	4	16	16	125 psf	125 psf	φ = 36°	160 pci	-	-
	691.0 to 682.0	A-1-a	G	4	41	35	130 psf	67.6 psf	φ = 41°	175 pci	-	-
	682.0 to 677.0	A-3a	G	4	100	80	135 psf	72.6 psf	φ = 40°	155 pci	-	-
	677.0 to 672.0	A-4a	C	2	100	100	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	672.0 to 667.0	A-3a	G	4	51	38	135 psf	72.6 psf	φ = 38°	125 pci	-	-
	667.0 to 655.0	A-7-6	C	2	31	31	125 psf	62.6 psf	Su = 3,875 psf	1,290 pci	0.0047	-
	655.0 to 649.0	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 200 psi	0.0005	20,000 psi	20
	649.0 to 629.0	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 360 psi	0.0005	32,000 psi	64
	629.0 to 624.0	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	89

Boring No.	Elevation (feet msl)	Soil Class.	Soil Type	Strata	N_{60}	$N1_{60}$	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k_{rm} (rock)	ε_{50} (soil) E_r (rock)	RQD (rock)
B-115-1-13	714.6 to 709.1	A-4a	C	3	16	16	120 psf	120 psf	Su = 2,000 psf	665 pci	0.0063	-
	709.1 to 704.1	A-6a	C	3	17	17	120 psf	120 psf	Su = 2,125 psf	710 pci	0.0062	-
	704.1 to 699.1	A-1-a	G	4	12	13	125 psf	125 psf	φ = 37°	190 pci	-	-
	699.1 to 695.6	A-4a	C	3	11	11	115 psf	115 psf	Su = 1,375 psf	435 pci	0.0075	-
	695.6 to 682.6	A-1-a	G	4	29	25	130 psf	130 psf	φ = 39°	250 pci	-	-
	682.6 to 677.6	A-1-b	G	4	73	56	135 psf	72.6 psf	φ = 42°	195 pci	-	-
	677.6 to 667.6	A-4a	C	2	81	81	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	667.6 to 662.6	A-2-6	G	4	100	69	135 psf	72.6 psf	φ = 41°	175 pci	-	-
	662.6 to 651.1	A-1-a	G	4	100	66	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	651.1 to 639.1	Mudstone	R	9	-	-	150 psf	87.6 psf	Qu = 360 psi	0.0005	32,000 psi	69
B-115-2-13	716.1 to 708.1	A-2-4	G	4	16	23	125 psf	125 psf	φ = 37°	190 pci	-	-
	708.1 to 703.1	A-1-b	G	4	5	6	120 psf	57.6 psf	φ = 33°	60 pci	-	-
	703.1 to 698.1	A-3a	G	4	6	7	115 psf	52.6 psf	φ = 31°	40 pci	-	-
	698.1 to 693.1	A-4b	G	4	6	6	115 psf	52.6 psf	φ = 29°	25 pci	-	-
	693.1 to 684.1	A-1-a	G	4	32	31	130 psf	67.6 psf	φ = 40°	155 pci	-	-
	684.1 to 674.1	A-1-a	G	4	92	82	135 psf	72.6 psf	φ = 43°	215 pci	-	-
	674.1 to 669.1	A-6b	C	2	74	74	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	669.1 to 664.1	A-2-4	G	4	36	29	130 psf	67.6 psf	φ = 38°	125 pci	-	-
	664.1 to 652.6	A-6b	C	2	100	100	130 psf	67.6 psf	Su = 8,000 psf	2,665 pci	0.0033	-
	652.6 to 640.4	Claystone	R	9	-	-	150 psf	87.6 psf	Qu = 360 psi	0.0005	32,000 psi	45
	640.4 to 632.9	Shale	R	9	-	-	150 psf	87.6 psf	Qu = 750 psi	0.00025	68,000 psi	0
	632.9 to 625.4	Limestone	R	9	-	-	165 psf	102.6 psf	Qu = 10,000 psi	0.00005	1,000,000 psi	91

APPENDIX X

MSE WALL CALCULATIONS

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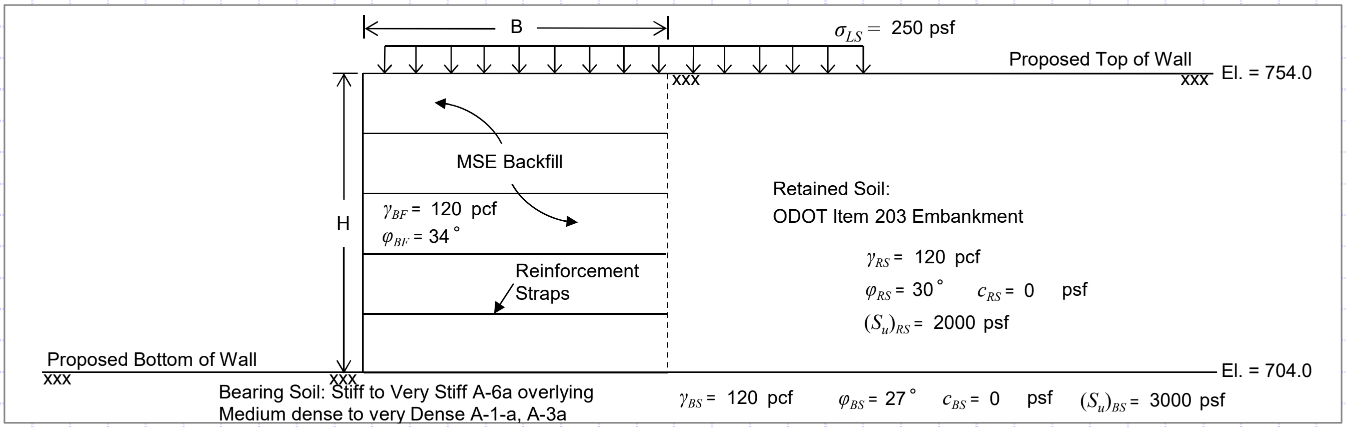
FRA-71-1503L - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30) - B-104-1-13 - 50.0 ft. Wall Height



MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	50.0	ft
MSE Wall Width (Reinforcement Length), (B) =	35.0	ft
MSE Wall Length, (L) =	45	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion [1], (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	psf
Bearing Soil Undrained Shear Strength, $[(S_u)_{BS}]$ =	3000	psf
Embedment Depth, (D_f) =	4.0	ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	10.0	ft

LRFD Load Factors

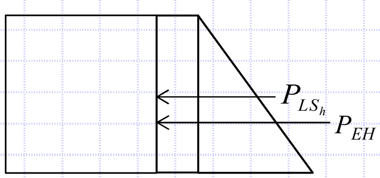
	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Sliding (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.3

Sliding Force:

$$P_H = P_{EH} + P_{LS_h}$$



$P_{EH} = \frac{1}{2}\gamma_{RS}H^2K_a\gamma_{EH}$ = ½(120 pcf)(50 ft)²(0.297)(1.5) = 66.83 kip/ft

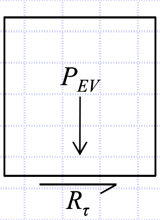
$P_{LS_h} = \sigma_{LS}HK_a\gamma_{LS}$ = (250 psf)(50 ft)(0.297)(1.75) = 6.5 kip/ft

P_H = 66.83 kip/ft + 6.5 kip/ft = 73.33 kip/ft

Check Sliding Resistance - Drained Condition

Nominal Sliding Resistance:

$$R_\tau = P_{EV} \cdot \tan\delta$$



$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ = (120 pcf)(50 ft)(35.0 ft)(1.00) = 210 kip/ft

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

$\tan\delta =$ tan(27) ≤ tan(34) ⟶ 0.51 ≤ 0.67 ⟶ $\tan\delta =$ 0.51

R_τ = (210 kip/ft)(0.51) = 107.10 kip/ft

Verify Sliding Force Less Than Factored Sliding Resistance - Drained Condition

$P_H \le R_\tau \cdot \phi_\tau$ ⟶ 73.33 kip/ft ≤ (107.10 kip/ft)(1.0) = 107.10 kip/ft ⟶ 73.33 kip/ft ≤ 107.10 kip/ft **OK**

Use φ_τ = **1.0** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	50.0	ft
MSE Wall Width (Reinforcement Length), (B) =	35.0	ft
MSE Wall Length, (L) =	45	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [$(S_u)_{RS}$] =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	psf
Bearing Soil Undrained Shear Strength, [$(s_u)_{BS}$] =	3000	psf
Embedment Depth, (D_f) =	4.0	ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	10.0	ft

LRFD Load Factors

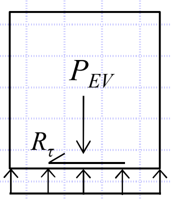
	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Sliding (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.3 ***(Continued)***

Check Sliding Resistance - Undrained Condition

Nominal Sliding Resisting: $$R_\tau = \left((S_u)_{BS} \leq q_s\right) \cdot B$$



$(S_u)_{BS} \leq q_s$

$(S_u)_{BS}$ = 3.00 ksf

$q_s = \sigma_v / 2$ = (6.00 ksf) / 2 = 3.00 ksf

$\sigma_v = P_{EV} / B$ = (210 kip/ft) / (35 ft) = 6.00 ksf

R_τ = (3.00 ksf ≤ 3.00 ksf)(35.0 ft) = 105.00 kip/ft

Verify Sliding Force Less Than Factored Sliding Resistance - Undrained Condition

$P_H \leq R_\tau \cdot \phi_\tau$ ⟶ 73.33 kip/ft ≤ (105.00 kip/ft)(1.0) = 105.00 kip/ft ⟶ 73.33 kip/ft ≤ 105.00 kip/ft **OK**

Use φ_τ = **1.0** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	50.0	ft
MSE Wall Width (Reinforcement Length), (B) =	35.0	ft
MSE Wall Length, (L) =	45	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

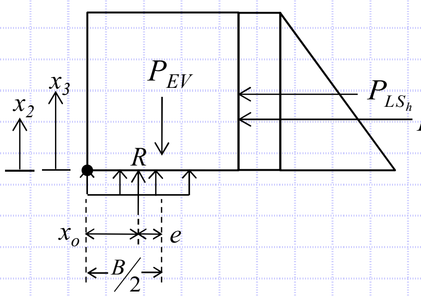
Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	psf
Bearing Soil Undrained Shear Strength, $[(s_u)_{BS}]$ =	3000	psf
Embedment Depth, (D_f) =	4.0	ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	10.0	ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Eccentricity (Loading Case - Strength Ia) - AASHTO LRFD BDM Section 11.10.5.5



$$e = B/2 - x_o$$

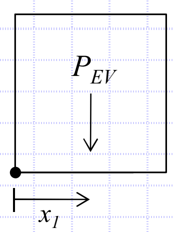
$$x_o = \frac{M_{EV} - M_H}{P_{EV}}$$ = (3675 kip·ft/ft - 1276.56 kip·ft/ft) / (210 kip/ft) = 11.42 ft

M_{EV}	=	3675.00	kip·ft/ft
M_H	=	1276.56	kip·ft/ft
P_{EV}	=	210.00	kip/ft

Defined below

$e =$ (35 ft)/2 - 11.42 ft = 6.08 ft

Resisting Moment, M_{EV}:



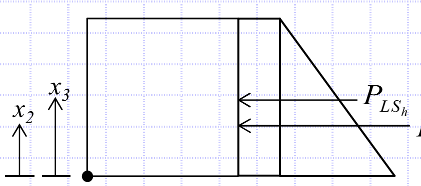
$$M_{EV} = P_{EV}(x_1)$$

$P_{EV} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ = (120 pcf)(50 ft)(35.0 ft)(1.00) = 210.00 kip/ft

$x_1 = B/2$ = (35.0 ft) / 2 = 17.50 ft

$M_{EV} =$ (210 kip/ft)(17.50 ft) = 3675.00 kip·ft/ft

Overturning Moment, M_H:



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

$P_{EH} = \frac{1}{2}\gamma_{RS} H^2 K_a \gamma_{EH}$ = ½(120 pcf)(50 ft)²(0.297)(1.5) = 66.83 kip/ft

$P_{LS_h} = \sigma_{LS} H K_a \gamma_{LS}$ = (250 psf)(50 ft)(0.297)(1.75) = 6.5 kip/ft

$x_2 = H/3$ = (50 ft) / 3 = 16.67 ft

$x_3 = H/2$ = (50 ft) / 2 = 25.00 ft

$M_H =$ (66.83 kip/ft)(16.67 ft) + (6.5 kip/ft)(25.00 ft) = 1276.56 kip·ft/ft

Check Eccentricity

$e < e_{max} \longrightarrow$ 6.08 ft < 11.67 ft **OK**

Limiting Eccentricity: $e_{max} = B/3 \longrightarrow e_{max} =$ (35.0 ft) / 3 = 11.67 ft

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JOB	FRA-70-13.10	NO.	W-13-072
SHEET NO.	4	OF	6
CALCULATED BY	BRT	DATE	7/7/2019
CHECKED BY	JPS	DATE	7/9/2019

FRA-71-1503L - Rear Abutment - Retaining Wall W5

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	50.0	ft
MSE Wall Width (Reinforcement Length), (B) =	35.0	ft
MSE Wall Length, (L) =	45	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, [(S_u)$_{RS}$] =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

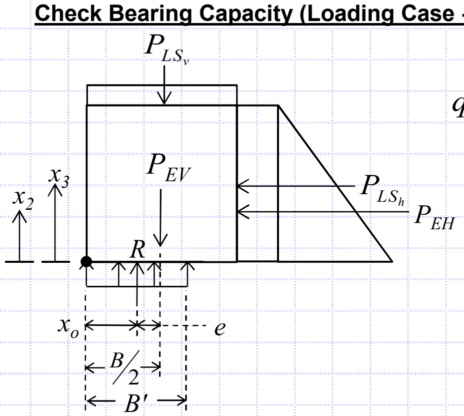
Bearing Soil Properties:

Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	psf
Bearing Soil Undrained Shear Strength, [(s_u)$_{BS}$] =	3000	psf
Embedment Depth, (D_f) =	4.0	ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	10.0	ft

LRFD Load Factors

	EV	EH	LS	
Strength Ia	1.00	1.50	1.75	*(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)*
Strength Ib	1.35	1.50	1.75	
Service I	1.00	1.00	1.00	

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4



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

$B' = B - 2e$ = 35.0 ft - 2(4.27 ft) = 26.46 ft

$e = B/2 - x_o$ = (35.0 ft) / 2 - 13.23 ft = 4.27 ft

$x_o = \dfrac{M_V - M_H}{P_V}$ = (5229.22 kip·ft/ft - 1276.39 kip·ft/ft) / 298.81 kip/ft = 13.23 ft

q_{eq} = (298.81 kip/ft) / (26.46 ft) = 11.29 ksf

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

M_V = [(120 pcf)(50 ft)(35.0 ft)(1.35)](17.5 ft) + [(250 psf)(35.0 ft)(1.75)](17.5 ft) = 5229.22 kip·ft/ft

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

M_H = [½(120 pcf)(50 ft)²(0.297)(1.5)](16.67 ft) + [(250 psf)(50 ft)(0.297)(1.75)](25 ft) = 1,276.39 kip·ft/ft

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

P_V = (120 pcf)(50 ft)(35.0 ft)(1.35) + (250 psf)(35.0 ft)(1.75) = 298.81 kip/ft

Check Bearing Resistance - Drained Condition

Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \tfrac{1}{2}\gamma B N_{\gamma m} C_{w\gamma}$

$N_{cm} = N_c s_c i_c$ = 31.70

- N_c = 23.94
- s_c = 1+(26.46 ft/45 ft)(13.2/23.94)
- = 1.324
- i_c = 1.000 (Assumed)

$N_{qm} = N_q s_q d_q i_q$ = 17.95

- N_q = 13.20
- s_q = 1.300
- d_q = 1+2tan(27°)[1-sin(27°)]²tan⁻¹(4.0 ft/26.46 ft)
- 1.046
- i_q = 1.000 (Assumed)
- C_{wq} = 10.0 ft > 4.0 ft = 1.000

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ = 11.07

- N_γ = 14.47
- s_γ = 0.765
- i_γ = 1.000 (Assumed)
- $C_{w\gamma}$ = 10.0 ft < 1.5(26.46 ft) + 4.0 ft = 0.626

q_n = (0 psf)(31.697) + (120 pcf)(4.0 ft)(17.949)(1.000) + ½(120 pcf)(26.5 ft)(11.070)(0.626) = 19.62 ksf

Verify Equivalent Pressure Less Than Factored Bearing Resistance

Use φ_b = **0.65** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

$q_{eq} \le q_n \cdot \phi_b$ ⟶ 11.29 ksf ≤ (19.62 ksf)(0.65) = 12.75 ksf ⟶ 11.29 ksf ≤ 12.75 ksf **OK**

MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	50.0	ft
MSE Wall Width (Reinforcement Length), (B) =	35.0	ft
MSE Wall Length, (L) =	45	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	psf
Bearing Soil Undrained Shear Strength, $[(s_u)_{BS}]$ =	3000	psf
Embedment Depth, (D_f) =	4.0	ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	10.0	ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 ***(Continued)***

Check Bearing Resistance - Undrained Condition

Nominal Bearing Resistance: $$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \tfrac{1}{2}\gamma B N_{\gamma m} C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$ = 5.750

- N_c = 5.140
- s_c = 1+(26.46 ft/[(5)(45 ft)]) = 1.118
- i_c = 1.000 (Assumed)

$N_{qm} = N_q s_q d_q i_q$ = 1.000

- N_q = 1.000
- s_q = 1.000
- d_q = 1+2tan(0°)[1-sin(0°)]²tan⁻¹(4.0 ft/26.46 ft) = 1.000
- i_q = 1.000 (Assumed)
- C_{wq} = 10.0 ft > 4.0 ft = 1.000

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ = 0.000

- N_γ = 0.000
- s_γ = 1.000
- i_γ = 1.000 (Assumed)
- $C_{w\gamma}$ = 10.0 ft < 1.5(26.46 ft) + 4.0 ft = 0.626

q_n = (3000 psf)(5.750) + (120 pcf)(4.0 ft)(1.000)(1.000) + ½(120 pcf)(26.5 ft)(0.000)(0.626) = 17.73 ksf

Verify Equivalent Pressure Less Than Factored Bearing Resistance

$q_{eq} \leq q_n \cdot \phi_b$ ⟶ 11.29 ksf ≤ (17.73 ksf)(0.65) = 11.52 ksf ⟶ 11.29 ksf ≤ 11.52 ksf **OK**

Use φ_b = **0.65** *(Per AASHTO LRFD BDM Table 11.5.7-1)*

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MSE Wall Dimensions and Retained Soil Parameters

MSE Wall Height, (H) =	50.0	ft
MSE Wall Width (Reinforcement Length), (B) =	35.0	ft
MSE Wall Length, (L) =	45	ft
Live Surcharge Load, (σ_{LS}) =	250	psf
Retained Soil Unit Weight, (γ_{RS}) =	120	pcf
Retained Soil Friction Angle, (φ_{RS}) =	30	°
Retained Soil Drained Cohesion, (c_{BS}) =	0	psf
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000	psf
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	
MSE Backfill Unit Weight, (γ_{BF}) =	120	pcf
MSE Backfill Friction Angle, (φ_{BF}) =	34	°

Bearing Soil Properties:

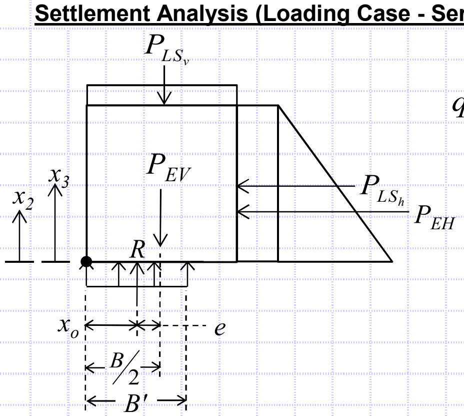
Bearing Soil Unit Weight, (γ_{BS}) =	120	pcf
Bearing Soil Friction Angle, (φ_{BS}) =	27	°
Bearing Soil Drained Cohesion, (c_{BS}) =	0	psf
Bearing Soil Undrained Shear Strength, $[(s_u)_{BS}]$ =	3000	psf
Embedment Depth, (D_f) =	4.0	ft
Depth to Grounwater (Below Bot. of Wall), (D_W) =	10.0	ft

LRFD Load Factors

	EV	EH	LS
Strength Ia	1.00	1.50	1.75
Strength Ib	1.35	1.50	1.75
Service I	1.00	1.00	1.00

(AASHTO LRFD BDM Tables 3.4.1-1 and 3.4.1-2 - Active Earth Pressure)

Settlement Analysis (Loading Case - Service I) - AASHTO LRFD BDM Section 11.10.4.1



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

$$B' = B - 2e \quad = \quad 35.0\text{ ft} - 2(3.82\text{ ft}) \quad = \quad 27.36 \quad \text{ft}$$

$$e = B/2 - x_o \quad = \quad (35.0\text{ ft}) / 2 - 13.68\text{ ft} \quad = \quad 3.82 \quad \text{ft}$$

$$x_o = \frac{M_V - M_H}{P_V} \quad = \quad (3828.13\text{ kip·ft/ft} - 835.46\text{ kip·ft/ft}) / 218.75\text{ kip/ft} \quad = \quad 13.68 \quad \text{ft}$$

$$q_{eq} = \quad (218.75\text{ kip/ft}) / (27.36\text{ ft}) \quad = \quad 8.00 \quad \text{ksf}$$

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

$$M_V = \quad [(120\text{ pcf})(50.0\text{ ft})(35.0\text{ ft})(1.00)](17.5\text{ ft}) + [(250\text{ psf})(35.0\text{ ft})(1.00)](17.5\text{ ft}) \quad = \quad 3828.13 \quad \text{kip·ft/ft}$$

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

$$M_H = \quad [\tfrac{1}{2}(120\text{ pcf})(50\text{ ft})^2(0.297)(1.00)](16.67\text{ ft}) + [(250\text{ psf})(50\text{ ft})(0.297)(1.00)](25\text{ ft}) \quad = \quad 835.46 \quad \text{kip·ft/ft}$$

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

$$P_V = \quad (120\text{ pcf})(50.0\text{ ft})(35.0\text{ ft})(1.00) + (250\text{ psf})(35.0\text{ ft})(1.00) \quad = \quad 218.75 \quad \text{kip/ft}$$

Settlement, Time Rate of Consolidation and Differential Settlement:

Boring	Total Settlement at Center of Reinforced Soil Mass	Total Settlement at Wall Facing	Time for 90% Consolidation	Distance Between Borings Along Wall Facing	Differential Settlement Along Wall Facing
B-104-1-13	4.324 in	2.706 in	1 days		
B-104-1-13	5.064 in	2.513 in	15 days	45 ft	1/2800

W-13-072 - FRA-70-13.10 - FRA-71-1503L

MSE Wall Settlement - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30)

Calculated By: BRT Date: 7/7/2019

Checked By: JPS Date: 7/9/2019

Boring B-104-1-13 @ Sta. 509+85 (BL Wall W5)

H=	50.0	ft	Total wall height
B'=	27.4	ft	Effective footing width due to eccentricity
D_w =	10.0	ft	Depth below bottom of footing
q_e =	8,000	psf	Equivalent bearing pressure at bottom of wall

																				Total Settlement at Center of Reinforced Soil Mass					Total Settlement at Facing of Wall				
Layer	Soil Class.	Soil Type	Layer Depth (ft)		Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)
1	A-6a	C	0.0	2.5	2.5	1.3	120	300	150	150	4,150	31	0.189	0.019	0.514				0.05	1.000	7,997	8,147	0.136	1.637	0.500	4,000	4,150	0.045	0.540
2	A-3a	G	2.5	5.0	2.5	3.8	120	600	450	450	4,450					12	18	64	0.14	0.992	7,936	8,386	0.050	0.599	0.499	3,996	4,446	0.039	0.469
3	A-1-a	G	5.0	7.5	2.5	6.3	130	925	763	763	4,763					35	46	154	0.23	0.968	7,743	8,506	0.017	0.204	0.498	3,981	4,744	0.013	0.154
	A-1-a	G	7.5	10.0	2.5	8.8	130	1,250	1,088	1,088	5,088					35	42	138	0.32	0.927	7,416	8,503	0.016	0.193	0.494	3,951	5,038	0.012	0.144
	A-1-a	G	10.0	12.5	2.5	11.3	130	1,575	1,413	1,335	5,335					35	40	130	0.41	0.875	6,996	8,331	0.015	0.184	0.488	3,903	5,237	0.011	0.137
	A-1-a	G	12.5	15.0	2.5	13.8	130	1,900	1,738	1,504	5,504					35	38	125	0.50	0.817	6,537	8,041	0.015	0.175	0.480	3,836	5,340	0.011	0.132
4	A-1-a	G	15.0	18.0	3.0	16.5	135	2,305	2,103	1,697	5,697					54	57	201	0.60	0.754	6,032	7,729	0.010	0.118	0.468	3,745	5,442	0.008	0.091
	A-1-a	G	18.0	21.5	3.5	19.8	135	2,778	2,541	1,933	5,933					54	55	190	0.72	0.684	5,474	7,407	0.011	0.129	0.452	3,618	5,550	0.008	0.101
5	A-1-b	G	21.5	26.5	5.0	24.0	130	3,428	3,103	2,229	6,229					28	27	91	0.88	0.604	4,834	7,063	0.028	0.331	0.429	3,430	5,659	0.022	0.267
6	A-1-b	G	26.5	31.5	5.0	29.0	135	4,103	3,765	2,579	6,579					120	110	550	1.06	0.527	4,215	6,794	0.004	0.046	0.400	3,199	5,778	0.003	0.038
7	A-1-b	G	31.5	36.5	5.0	34.0	115	4,678	4,390	2,892	6,892					3	3	48	1.24	0.465	3,716	6,609	0.037	0.447	0.371	2,971	5,864	0.032	0.382
8	A-1-b	G	36.5	40.5	4.0	38.5	135	5,218	4,948	3,169	7,169					120	102	482	1.41	0.419	3,350	6,519	0.003	0.031	0.347	2,778	5,947	0.002	0.027
9	A-1-a	G	40.5	43.5	3.0	42.0	140	5,638	5,428	3,431	7,431					120	99	457	1.53	0.388	3,107	6,538	0.002	0.022	0.330	2,637	6,068	0.002	0.019
10	A-6a	C	43.5	50.0	6.5	46.8	130	6,483	6,060	3,767	7,767	30	0.180	0.018	0.507				1.71	0.353	2,826	6,593	0.019	0.227	0.308	2,461	6,228	0.017	0.203
																						Total Settlement:		4.342 in			Total Settlement:		2.706 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_{m;}$ Estimate σ_m of 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5
3. C_r = 0.10(Cc) for natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for strip loaded footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

W-13-072 - FRA-70-13.10 - FRA-71-1503L

MSE Wall Settlement - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30)

Calculated By: BRT Date: 7/7/2019

Checked By: JPS Date: 7/9/2019

Boring B-104-1-13 @ Sta. 509+85 (BL Wall W5)

H=	50.0	ft	Total wall height
B'=	27.4	ft	Effective footing width due to eccentricity
D_w =	10.0	ft	Depth below bottom of footing
q_e =	8,000	psf	Equivalent bearing pressure at bottom of wall

	A-6a (Upper)	A-6a (Lower)			
c_v =	600	600		ft^2/yr	Coefficient of consolidation
t =	1	1		days	Time following completion of construction
H_{dr} =	1.3	6.5		ft	Length of longest drainage path considered
T_v =	1.052	0.039			Time factor
U =	94	22		%	Degree of consolidation

$(S_c)_t$ = 2.515 in Settlement complete at 93% of primary consolidation

Layer	Soil Type	Soil Type	Layer Depth (ft)		Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' [1] (psf)	LL	C_c [2]	C_r [3]	e_o [4]	N_{60}	$(N1)_{60}$ [5]	C' [6]	Z_f/B	I [7]	$\Delta\sigma_v$ [8] (psf)	σ_{vf}' Midpoint (psf)	S_c [9,10] (ft)	S_c (in)	Layer Settlement (in)	$(S_c)_t$ [11] (in)	Layer Settlement (in)
																							Total Settlement at Facing of Wall			Settlement Complete at 93% of Primary Consolidation	
1	A-6a	C	0.0	2.5	2.5	1.3	120	300	150	150	4,150	31	0.189	0.019	0.514				0.05	0.500	4,000	4,150	0.045	0.540	0.540	0.507	0.507
2	A-3a	G	2.5	5.0	2.5	3.8	120	600	450	450	4,450					12	18	64	0.14	0.499	3,996	4,446	0.039	0.469	1.127	0.469	1.127
3	A-1-a	G	5.0	7.5	2.5	6.3	130	925	763	763	4,763					35	46	154	0.23	0.498	3,981	4,744	0.013	0.154		0.154	
	A-1-a	G	7.5	10.0	2.5	8.8	130	1,250	1,088	1,088	5,088					35	42	138	0.32	0.494	3,951	5,038	0.012	0.144		0.144	
	A-1-a	G	10.0	12.5	2.5	11.3	130	1,575	1,413	1,335	5,335					35	40	130	0.41	0.488	3,903	5,237	0.011	0.137		0.137	
	A-1-a	G	12.5	15.0	2.5	13.8	130	1,900	1,738	1,504	5,504					35	38	125	0.50	0.480	3,836	5,340	0.011	0.132		0.132	
4	A-1-a	G	15.0	18.0	3.0	16.5	135	2,305	2,103	1,697	5,697					54	57	201	0.60	0.468	3,745	5,442	0.008	0.091		0.091	
	A-1-a	G	18.0	21.5	3.5	19.8	135	2,778	2,541	1,933	5,933					54	55	190	0.72	0.452	3,618	5,550	0.008	0.101	0.101	0.101	0.101
5	A-1-b	G	21.5	26.5	5.0	24.0	130	3,428	3,103	2,229	6,229					28	27	91	0.88	0.429	3,430	5,659	0.022	0.267	0.267	0.267	0.267
6	A-1-b	G	26.5	31.5	5.0	29.0	135	4,103	3,765	2,579	6,579					120	110	550	1.06	0.400	3,199	5,778	0.003	0.038	0.038	0.038	0.038
7	A-1-b	G	31.5	36.5	5.0	34.0	115	4,678	4,390	2,892	6,892					3	3	48	1.24	0.371	2,971	5,864	0.032	0.382	0.382	0.382	0.382
8	A-1-b	G	36.5	40.5	4.0	38.5	135	5,218	4,948	3,169	7,169					120	102	482	1.41	0.347	2,778	5,947	0.002	0.027	0.027	0.027	0.027
9	A-1-a	G	40.5	43.5	3.0	42.0	140	5,638	5,428	3,431	7,431					120	99	457	1.53	0.330	2,637	6,068	0.002	0.019	0.019	0.019	0.019
10	A-6a	C	43.5	50.0	6.5	46.8	130	6,483	6,060	3,767	7,767	30	0.180	0.018	0.507				1.71	0.308	2,461	6,228	0.017	0.203	0.203	0.045	0.045

Settlement Remaining After Hold Period: 0.191 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5
3. C_r = 0.10(Cc) for natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_N N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for strip loaded footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

W-13-072 - FRA-70-13.10 - FRA-71-1503L

MSE Wall Settlement - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30)

Calculated By: BRT Date: 7/7/2019

Checked By: JPS Date: 7/9/2019

Boring B-104-1-13 @ Sta. 510+30 (BL Wall W5)

H=	40.0	ft	Total wall height
B'=	30.0	ft	Effective footing width due to eccentricity
D_w =	24.0	ft	Depth below bottom of footing
q_e =	5,890	psf	Equivalent bearing pressure at bottom of wall

																				Total Settlement at Center of Reinforced Soil Mass					Total Settlement at Facing of Wall				
Layer	Soil Class.	Soil Type	Layer Depth (ft)		Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)
1	A-6a	C	0.0	1.5	1.5	0.8	120	180	90	90	4,090	25	0.135	0.014	0.467				0.03	1.000	5,890	5,980	0.046	0.548	0.500	2,945	3,035	0.021	0.253
	A-6a	C	1.5	4.5	3.0	3.0	120	540	360	360	4,360	25	0.135	0.014	0.467				0.10	0.997	5,871	6,231	0.073	0.872	0.500	2,944	3,304	0.027	0.319
	A-6a	C	4.5	7.5	3.0	6.0	120	900	720	720	4,720	25	0.135	0.014	0.467				0.20	0.977	5,756	6,476	0.060	0.725	0.498	2,935	3,655	0.019	0.234
2	A-6a	C	7.5	10.0	2.5	8.8	120	1,200	1,050	1,050	5,050	31	0.189	0.019	0.514				0.29	0.941	5,542	6,592	0.057	0.689	0.495	2,917	3,967	0.018	0.216
	A-6a	C	10.0	12.5	2.5	11.3	120	1,500	1,350	1,350	5,350	31	0.189	0.019	0.514				0.38	0.896	5,277	6,627	0.048	0.572	0.490	2,889	4,239	0.016	0.186
3	A-3	G	12.5	15.0	2.5	13.8	120	1,800	1,650	1,650	5,650					12	13	47	0.46	0.845	4,976	6,626	0.032	0.384	0.484	2,849	4,499	0.023	0.277
4	A-1-a	G	15.0	25.0	10.0	20.0	130	3,100	2,450	2,450	6,450					35	33	107	0.67	0.715	4,213	6,663	0.041	0.489	0.460	2,708	5,158	0.030	0.364
5	A-1-a	G	25.0	31.5	6.5	28.3	135	3,978	3,539	3,274	7,274					54	45	150	0.94	0.574	3,383	6,657	0.013	0.160	0.418	2,465	5,738	0.011	0.127
6	A-1-b	G	31.5	36.5	5.0	34.0	130	4,628	4,303	3,679	7,679					28	22	79	1.13	0.500	2,943	6,621	0.016	0.193	0.388	2,286	5,964	0.013	0.159
7	A-1-b	G	36.5	41.5	5.0	39.0	135	5,303	4,965	4,029	8,029					120	92	410	1.30	0.447	2,633	6,662	0.003	0.032	0.363	2,135	6,164	0.002	0.027
8	A-1-b	G	41.5	46.5	5.0	44.0	115	5,878	5,590	4,342	8,342					3	2	48	1.47	0.404	2,377	6,719	0.020	0.238	0.339	1,995	6,337	0.017	0.206
9	A-1-b	G	46.5	50.5	4.0	48.5	135	6,418	6,148	4,619	8,619					120	87	371	1.62	0.371	2,183	6,802	0.002	0.022	0.319	1,877	6,496	0.002	0.019
10	A-1-a	G	50.5	53.5	3.0	52.0	140	6,838	6,628	4,880	8,880					120	84	356	1.73	0.348	2,052	6,932	0.001	0.015	0.304	1,793	6,673	0.001	0.014
11	A-6a	C	53.5	60.0	6.5	56.8	130	7,683	7,260	5,216	9,216	30	0.180	0.018	0.507				1.89	0.322	1,895	7,112	0.010	0.125	0.286	1,686	6,903	0.009	0.113
																						Total Settlement:		5.064 in			Total Settlement:		2.513 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(Cc)$ for natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for strip loaded footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

W-13-072 - FRA-70-13.10 - FRA-71-1503L

MSE Wall Settlement - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30)

Calculated By: BRT Date: 7/7/2019

Checked By: JPS Date: 7/9/2019

Boring B-104-1-13 @ Sta. 510+30 (BL Wall W5)

H=	40.0	ft	Total wall height
B'=	30.0	ft	Effective footing width due to eccentricity
D_w =	24.0	ft	Depth below bottom of footing
q_e =	5,890	psf	Equivalent bearing pressure at bottom of wall

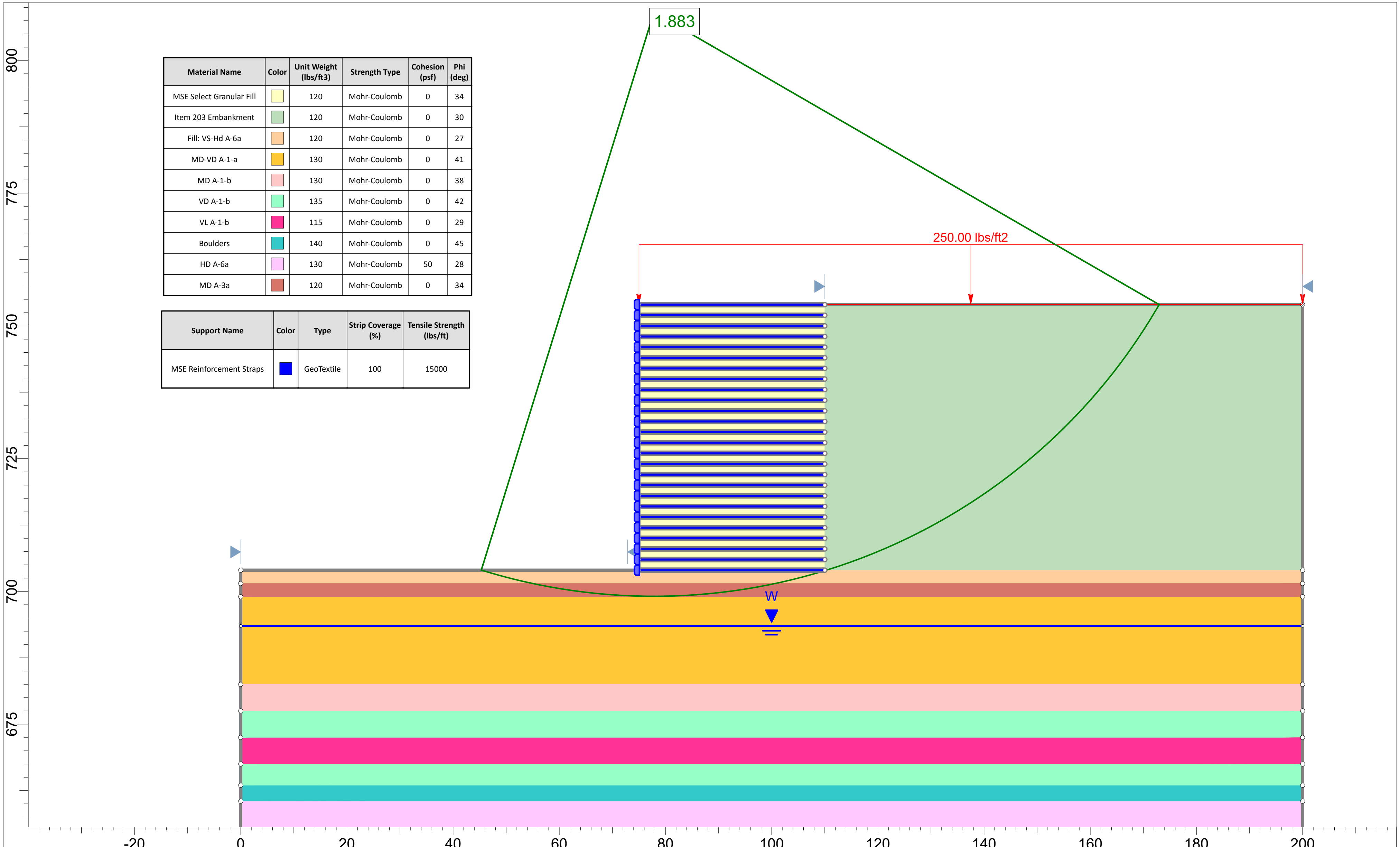
	A-6a		
c_v =	600	ft^2/yr	Coefficient of consolidation
t =	15	days	Time following completion of construction
H_{dr} =	6.5	ft	Length of longest drainage path considered
T_v =	0.584		Time factor
U =	81	%	Degree of consolidation

$(S_c)_t$ = 2.262 in Settlement complete at 90% of primary consolidation

Layer	Soil Type	Soil Type	Layer Depth (ft)		Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' [1] (psf)	LL	C_c [2]	C_r [3]	e_o [4]	N_{60}	$(N1)_{60}$ [5]	C' [6]	Z_f/B	I [7]	$\Delta\sigma_v$ [8] (psf)	σ_{vf}' Midpoint (psf)	Total Settlement at Facing of Wall: S_c [9,10] (ft)	S_c (in)	Layer Settlement (in)	Settlement Complete at 90% of Primary Consolidation: $(S_c)_t$ [11] (in)	Layer Settlement (in)
	A-6a	C	0.0	1.5	1.5	0.8	120	180	90	90	4,090	25	0.135	0.014	0.467				0.03	0.500	2,945	3,035	0.021	0.253		0.205	
1	A-6a	C	1.5	4.5	3.0	3.0	120	540	360	360	4,360	25	0.135	0.014	0.467				0.10	0.500	2,944	3,304	0.027	0.319	0.806	0.258	0.653
	A-6a	C	4.5	7.5	3.0	6.0	120	900	720	720	4,720	25	0.135	0.014	0.467				0.20	0.498	2,935	3,655	0.019	0.234		0.189	
2	A-6a	C	7.5	10.0	2.5	8.8	120	1,200	1,050	1,050	5,050	31	0.189	0.019	0.514				0.29	0.495	2,917	3,967	0.018	0.216	0.402	0.175	0.326
	A-6a	C	10.0	12.5	2.5	11.3	120	1,500	1,350	1,350	5,350	31	0.189	0.019	0.514				0.38	0.490	2,889	4,239	0.016	0.186		0.151	
3	A-3	G	12.5	15.0	2.5	13.8	120	1,800	1,650	1,650	5,650					12	13	47	0.46	0.484	2,849	4,499	0.023	0.277	0.277	0.277	0.277
4	A-1-a	G	15.0	25.0	10.0	20.0	130	3,100	2,450	2,450	6,450					35	33	107	0.67	0.460	2,708	5,158	0.030	0.364	0.364	0.364	0.364
5	A-1-a	G	25.0	31.5	6.5	28.3	135	3,978	3,539	3,274	7,274					54	45	150	0.94	0.418	2,465	5,738	0.011	0.127	0.127	0.127	0.127
6	A-1-b	G	31.5	36.5	5.0	34.0	130	4,628	4,303	3,679	7,679					28	22	79	1.13	0.388	2,286	5,964	0.013	0.159	0.159	0.159	0.159
7	A-1-b	G	36.5	41.5	5.0	39.0	135	5,303	4,965	4,029	8,029					120	92	410	1.30	0.363	2,135	6,164	0.002	0.027	0.027	0.027	0.027
8	A-1-b	G	41.5	46.5	5.0	44.0	115	5,878	5,590	4,342	8,342					3	2	48	1.47	0.339	1,995	6,337	0.017	0.206	0.206	0.206	0.206
9	A-1-b	G	46.5	50.5	4.0	48.5	135	6,418	6,148	4,619	8,619					120	87	371	1.62	0.319	1,877	6,496	0.002	0.019	0.019	0.019	0.019
10	A-1-a	G	50.5	53.5	3.0	52.0	140	6,838	6,628	4,880	8,880					120	84	356	1.73	0.304	1,793	6,673	0.001	0.014	0.014	0.014	0.014
11	A-6a	C	53.5	60.0	6.5	56.8	130	7,683	7,260	5,216	9,216	30	0.180	0.018	0.507				1.89	0.286	1,686	6,903	0.009	0.113	0.113	0.092	0.092

Settlement Remaining After Hold Period: 0.251 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.10(Cc)$ for natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_N N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for strip loaded footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Select Granular Fill		120	Mohr-Coulomb	0	34
Item 203 Embankment		120	Mohr-Coulomb	0	30
Fill: VS-Hd A-6a		120	Mohr-Coulomb	0	27
MD-VD A-1-a		130	Mohr-Coulomb	0	41
MD A-1-b		130	Mohr-Coulomb	0	38
VD A-1-b		135	Mohr-Coulomb	0	42
VL A-1-b		115	Mohr-Coulomb	0	29
Boulders		140	Mohr-Coulomb	0	45
HD A-6a		130	Mohr-Coulomb	50	28
MD A-3a		120	Mohr-Coulomb	0	34

Support Name	Color	Type	Strip Coverage (%)	Tensile Strength (lbs/ft)
MSE Reinforcement Straps		GeoTextile	100	15000

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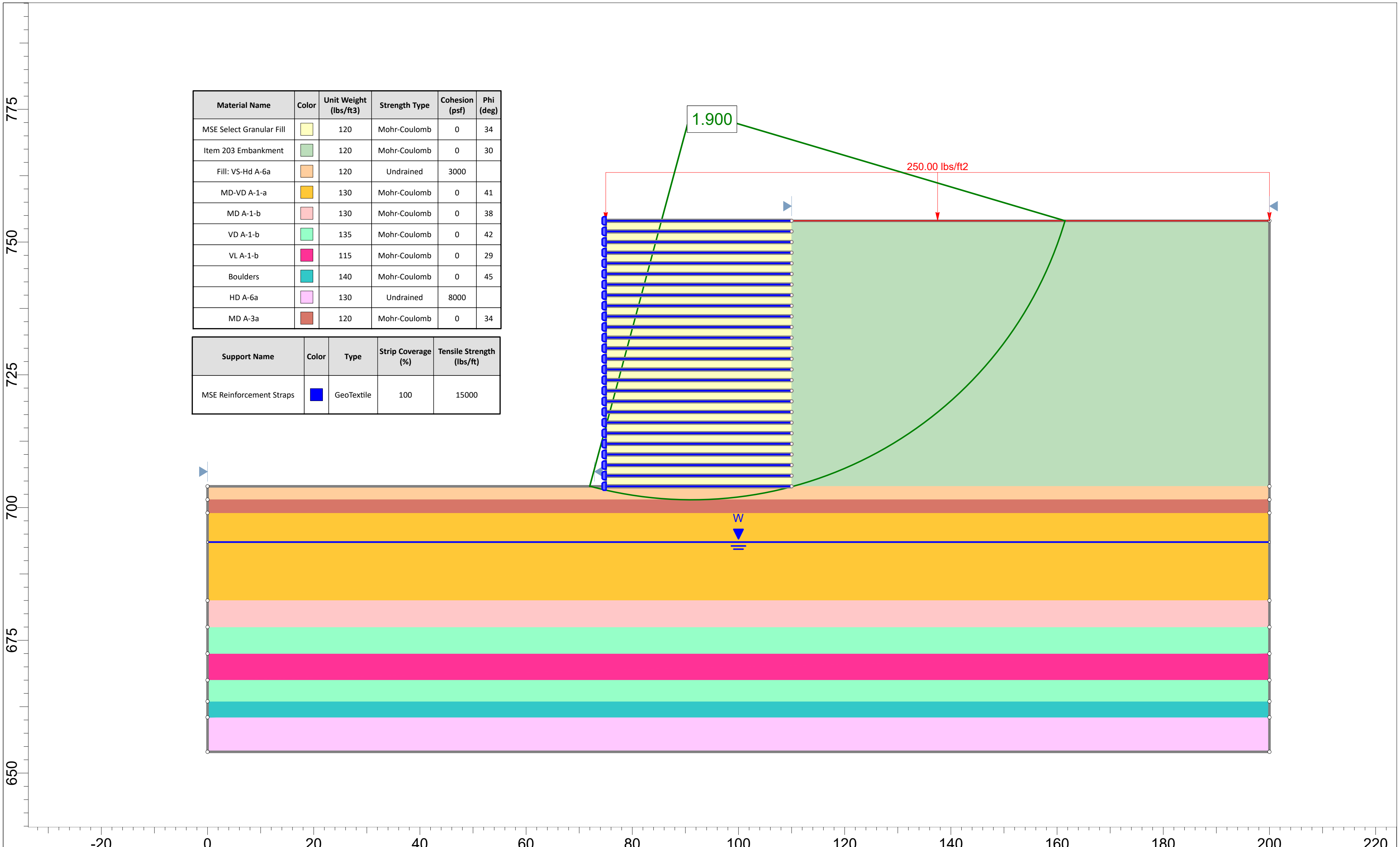
SLIDEINTERPRET 8.020

Project	FRA-70-13.10 - FRA-71-1503L - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30) - Global Stability		
Analysis Description	50.0 ft Wall Height - Drained - Circular - Spencer's		
Drawn By	BRT	*Scale* 1:300	*Company* Resource International, Inc.
Date	7/6/2019		*File Name* FRA-71-1503L - Rear Abutment - MSE Wall Global Stability.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Select Granular Fill		120	Mohr-Coulomb	0	34
Item 203 Embankment		120	Mohr-Coulomb	0	30
Fill: VS-Hd A-6a		120	Undrained	3000	
MD-VD A-1-a		130	Mohr-Coulomb	0	41
MD A-1-b		130	Mohr-Coulomb	0	38
VD A-1-b		135	Mohr-Coulomb	0	42
VL A-1-b		115	Mohr-Coulomb	0	29
Boulders		140	Mohr-Coulomb	0	45
HD A-6a		130	Undrained	8000	
MD A-3a		120	Mohr-Coulomb	0	34

Support Name	Color	Type	Strip Coverage (%)	Tensile Strength (lbs/ft)
MSE Reinforcement Straps		GeoTextile	100	15000

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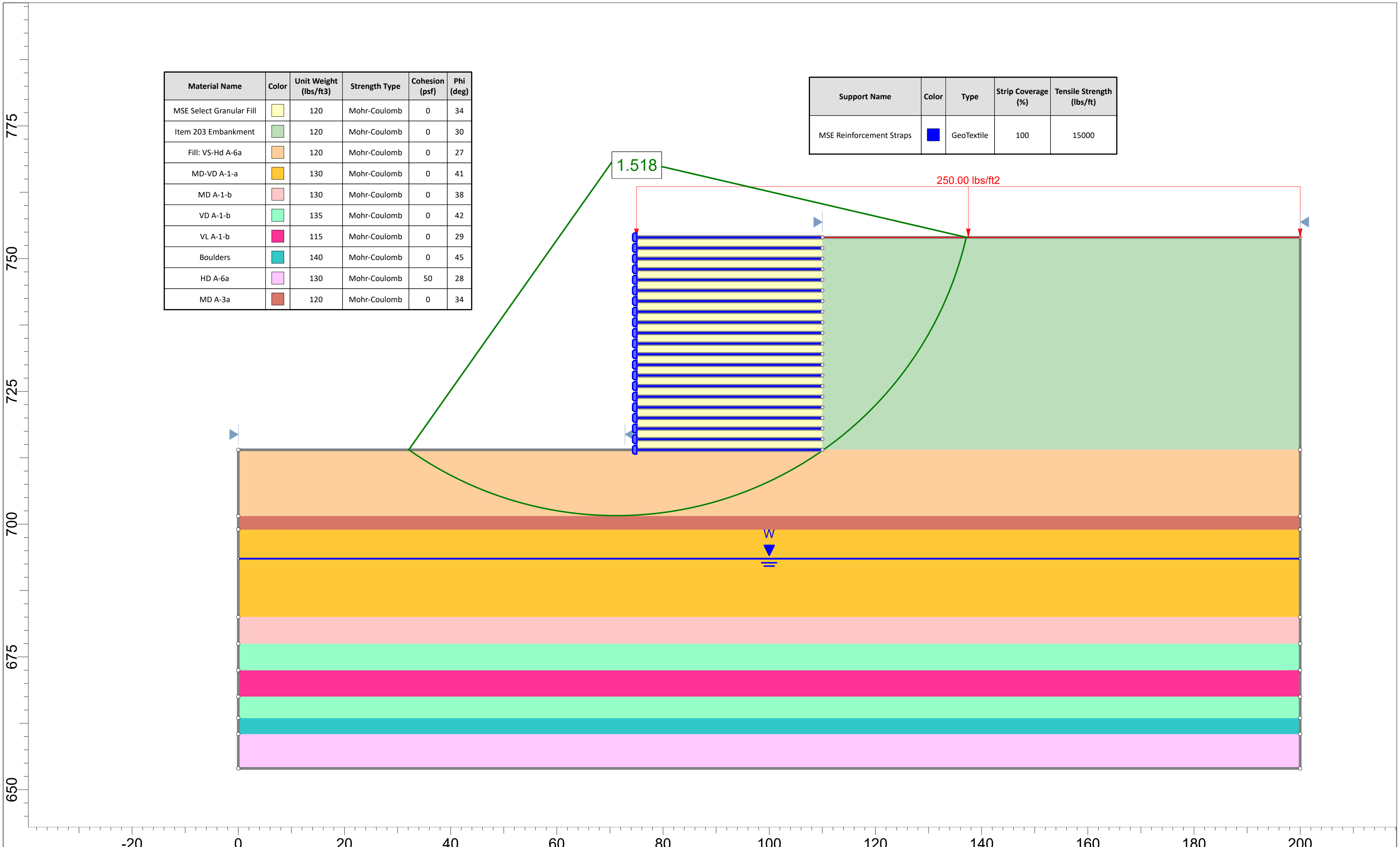
SLIDEINTERPRET 8.020

Project	FRA-70-13.10 - FRA-71-1503L - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30) - Global Stability
Analysis Description	50.0 ft Wall Height - Undrained - Circular - Spencer's
Drawn By	BRT
Scale	1:300
Company	Resource International, Inc.
Date	7/6/2019
File Name	FRA-71-1503L - Rear Abutment - MSE Wall Global Stability.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Select Granular Fill		120	Mohr-Coulomb	0	34
Item 203 Embankment		120	Mohr-Coulomb	0	30
Fill: VS-Hd A-6a		120	Mohr-Coulomb	0	27
MD-VD A-1-a		130	Mohr-Coulomb	0	41
MD A-1-b		130	Mohr-Coulomb	0	38
VD A-1-b		135	Mohr-Coulomb	0	42
VL A-1-b		115	Mohr-Coulomb	0	29
Boulders		140	Mohr-Coulomb	0	45
HD A-6a		130	Mohr-Coulomb	50	28
MD A-3a		120	Mohr-Coulomb	0	34

Support Name	Color	Type	Strip Coverage (%)	Tensile Strength (lbs/ft)
MSE Reinforcement Straps		GeoTextile	100	15000

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SLIDEINTERPRET 8.020

Project	FRA-70-13.10 - FRA-71-1503L - Rear Abutment - Retaining Wall W5 (Sta. 509+85 to 510+30) - Global Stability
Analysis Description	40.0 ft Wall Height - Drained - Circular - Spencer's
Drawn By	BRT
Scale	1:300
Company	Resource International, Inc.
Date	7/6/2019
File Name	FRA-71-1503L - Rear Abutment - MSE Wall Global Stability.slim

APPENDIX XI

CELLULAR CONCRETR WALL CALCULATIONS

W-13-075 - FRA-70-13.10 - FRA-71-1503L

MSE Wall with Cellular Concrete Backfill - Forward Abutment - Retaining Wall E7 (Sta. 704+21 to 705+61)

Boring	Boring Elevation	Profile Elevation (ft msl)	Bottom of Wall Elevation (ft msl)	Wall Height (ft)	Pressure at Bottom of Wall [1] (psf)	Total Settlement at Center of Wall (in)	Total Settlement at Wall Facing (in)
B-115-2-13	716.1	762.2	709.5	52.7	1,953	4.43	3.20

1. $\Delta\sigma$ = (130 pcf)(3.0 ft) + (36 pcf)(2.0 ft) + (H - 5 ft)(30 pcf)

W-13-075 - FRA-70-13.10 - FRA-71-1503L

MSE Wall with Cellular Concrete Backfill - Forward Abutment - Retaining Wall E7 (Sta. 704+21 to 705+61)

Calculated By: BRT Date: 7/7/2019

Checked By: JPS Date: 7/9/2019

Boring B-115-2-13

H =	52.7	ft	Total wall height from profile grade to top of leveling pad
B =	36.9	ft	Wall width considered in analysis, equal to 70% of the wall height
D_w =	0.0	ft	Depth below bottom of wall
q =	1,953	psf	Bearing pressure at bottom of wall (see summary sheet)

																				Total Settlement at Center of Reinforced Soil Mass					Total Settlement at Facing of Wall				
Layer	Soil Class.	Soil Type	Layer Depth (ft)		Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)
1	A-2-4	G	0.0	1.5	1.5	0.8	125	188	94	47	2,047					13	26	88	0.02	1.000	1,953	2,000	0.028	0.333	0.500	976	1,023	0.023	0.273
2	A-1-b	G	1.5	4.0	2.5	2.8	120	488	338	166	2,166					5	9	56	0.07	0.999	1,950	2,116	0.050	0.598	0.500	976	1,142	0.038	0.453
	A-1-b	G	4.0	6.5	2.5	5.3	120	788	638	310	2,310					5	8	54	0.14	0.991	1,936	2,246	0.040	0.477	0.499	975	1,285	0.029	0.342
3	A-3a	G	6.5	9.0	2.5	7.8	115	1,075	931	448	2,448					6	9	51	0.21	0.974	1,902	2,350	0.036	0.427	0.498	973	1,421	0.025	0.297
	A-3a	G	9.0	11.5	2.5	10.3	115	1,363	1,219	579	2,579					6	8	50	0.28	0.947	1,850	2,429	0.031	0.374	0.496	968	1,548	0.021	0.256
4	A-4b	G	11.5	14.0	2.5	12.8	115	1,650	1,506	711	2,711					6	8	22	0.35	0.913	1,783	2,493	0.062	0.742	0.492	962	1,672	0.042	0.506
	A-4b	G	14.0	16.5	2.5	15.3	115	1,938	1,794	842	2,842					6	8	22	0.41	0.873	1,705	2,547	0.056	0.670	0.488	952	1,794	0.038	0.458
5	A-1-a	G	16.5	21.0	4.5	18.8	130	2,523	2,230	1,060	5,060					32	39	127	0.51	0.813	1,588	2,648	0.014	0.170	0.479	935	1,995	0.010	0.117
	A-1-a	G	21.0	25.5	4.5	23.3	130	3,108	2,815	1,364	5,364					32	36	118	0.63	0.737	1,439	2,804	0.012	0.144	0.465	907	2,272	0.008	0.102
6	A-1-a	G	25.5	35.5	10.0	30.5	135	4,458	3,783	1,879	5,879					92	94	424	0.83	0.628	1,227	3,106	0.005	0.062	0.436	852	2,732	0.004	0.046
7	A-6b	C	35.5	40.5	5.0	38.0	130	5,108	4,783	2,411	6,411	40	0.270	0.027	0.585				1.03	0.538	1,050	3,462	0.013	0.161	0.404	790	3,201	0.010	0.126
8	A-2-4	G	40.5	45.5	5.0	43.0	130	5,758	5,433	2,749	6,749					36	32	105	1.17	0.489	954	3,704	0.006	0.074	0.383	748	3,497	0.005	0.060
9	A-6b	C	45.5	51.0	5.5	48.3	130	6,473	6,115	3,104	7,104	35	0.225	0.023	0.546				1.31	0.445	869	3,973	0.009	0.103	0.361	706	3,810	0.007	0.085
	A-6b	C	51.0	57.0	6.0	54.0	130	7,253	6,863	3,493	7,493	35	0.225	0.023	0.546				1.46	0.404	790	4,283	0.008	0.093	0.339	662	4,155	0.007	0.079
																					Total Settlement:			4.426 in		Total Settlement:			3.201 in

1. $\sigma_p' = \sigma_{vo}'+\sigma_m$; Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003
2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5
3. C_r = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_nN_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for strip loaded footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

W-13-075 - FRA-70-13.10 - FRA-71-1503L

MSE Wall with Cellular Concrete Backfill - Forward Abutment - Retaining Wall E7 (Sta. 704+21 to 705+61)

Calculated By: BRT Date: 7/7/2019

Checked By: JPS Date: 7/9/2019

Boring B-115-2-13

H =	52.7	ft	Total wall/embankment height from profile grade to top of leveling pad
B =	36.9	ft	Wall/embankment width considered in analysis, equal to 70% of the wall height
D_w =	0.0	ft	Depth below bottom of wall/embankment
q =	1,953	psf	Bearing pressure at bottom of wall/embankment (see summary sheet)

	A-6b (Upper)	A-6b (Lower)				
c_v =	300	300			ft^2/yr	Coefficient of consolidation
t =	0	0			days	Time following completion of construction
H_{dr} =	2.5	11.5			ft	Length of longest drainage path considered
T_v =	0.000	0.000				Time factor
U =	0	0			%	Degree of consolidation

$(S_c)_t$ = 2.911 in Settlement complete at 91% of primary consolidation

Layer	Soil Type	Soil Type	Layer Depth (ft)		Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	Total Settlement at Facing of Wall: S_c (9,10) (ft)	S_c (in)	Layer Settlement (in)	Settlement Complete at 91% of Primary Consolidation: $(S_c)_t$ (11) (in)	Layer Settlement (in)
1	A-2-4	G	0.0	1.5	1.5	0.8	125	188	94	47	2,047					13	26	88	0.02	0.500	976	1,023	0.023	0.273	0.273	0.273	0.273
2	A-1-b	G	1.5	4.0	2.5	2.8	120	488	338	166	2,166					5	9	56	0.07	0.500	976	1,142	0.038	0.453	0.795	0.453	0.795
	A-1-b	G	4.0	6.5	2.5	5.3	120	788	638	310	2,310					5	8	54	0.14	0.499	975	1,285	0.029	0.342		0.342	
3	A-3a	G	6.5	9.0	2.5	7.8	115	1,075	931	448	2,448					6	9	51	0.21	0.498	973	1,421	0.025	0.297	0.554	0.297	0.554
	A-3a	G	9.0	11.5	2.5	10.3	115	1,363	1,219	579	2,579					6	8	50	0.28	0.496	968	1,548	0.021	0.256		0.256	
4	A-4b	G	11.5	14.0	2.5	12.8	115	1,650	1,506	711	4,711					6	8	22	0.35	0.492	962	1,672	0.042	0.506	0.964	0.506	0.964
	A-4b	G	14.0	16.5	2.5	15.3	115	1,938	1,794	842	4,842					6	8	22	0.41	0.488	952	1,794	0.038	0.458		0.458	
5	A-1-a	G	16.5	21.0	4.5	18.8	130	2,523	2,230	1,060	5,060					32	39	127	0.51	0.479	935	1,995	0.010	0.117	0.219	0.117	0.219
	A-1-a	G	21.0	25.5	4.5	23.3	130	3,108	2,815	1,364	5,364					32	36	118	0.63	0.465	907	2,272	0.008	0.102		0.102	
6	A-1-a	G	25.5	35.5	10.0	30.5	135	4,458	3,783	1,879	5,879					92	94	424	0.83	0.436	852	2,732	0.004	0.046	0.046	0.046	0.046
7	A-6b	C	35.5	40.5	5.0	38.0	130	5,108	4,783	2,411	6,411	40	0.270	0.027	0.585				1.03	0.404	790	3,201	0.010	0.126	0.126	0.000	0.000
8	A-2-4	G	40.5	45.5	5.0	43.0	130	5,758	5,433	2,749	6,749					36	32	105	1.17	0.383	748	3,497	0.005	0.060	0.060	0.060	0.060
9	A-6b	C	45.5	51.0	5.5	48.3	130	6,473	6,115	3,104	7,104	35	0.225	0.023	0.546				1.31	0.361	706	3,810	0.007	0.085	0.165	0.000	0.000
	A-6b	C	51.0	57.0	6.0	54.0	130	7,253	6,863	3,493	7,493	35	0.225	0.023	0.546				1.46	0.339	662	4,155	0.007	0.079		0.000	

Settlement Remaining After Hold Period: 0.290 in

1. $\sigma_p' = \sigma_{vo}'+\sigma_m$; Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5
3. $C_r = 0.15(Cc)$ for the existing fill and $0.10(Cc)$ for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_nN_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for strip loaded footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)
11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Calculated By: BRT Date: 7/7/2019
Checked By: JPS Date: 7/9/2019

B =	36.9	ft	
L =	95	ft	
c =	0	psf	
γ =	115	pcf	
D_f =	0.0	ft	
φ =	24	deg	
D_w =	0.0	ft	Below ground surface

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \tfrac{1}{2}\gamma B N_{\gamma m} C_{w\gamma}$$ = 8.46 ksf

$$N_{cm} = N_c s_c i_c$$ = 23.05

$$N_{qm} = N_q s_q d_q i_q$$ = 11.26

$$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$$ = 7.97

N_c =	19.32	s_c =	1+(36.9 ft/95 ft)(9.6/19.32) =	1.193	i_c =	1.000	d_q =	1+2tan(24°)[1-sin(24°)]²tan⁻¹(0 ft/36.9 ft) =	1.000
N_q =	9.60	s_q =	1+(36.9 ft/95 ft)tan(24°) =	1.173	i_q =	1.000	C_{wq} =	0.0 ft > 0.0 ft =	1.000
N_γ =	9.44	s_γ =	1-0.4(36.9 ft/95 ft) =	0.845	i_γ =	1.000	$C_{w\gamma}$ =	0.0 ft < 1.5(36.9 ft) + 0 ft =	0.500

$$q_R = q_n \cdot \phi_b$$ = 4.23 ksf

φ_b = 0.5