

**MOT-835-2.57 BRIDGE REPLACEMENT
PID 116922
MONTGOMERY COUNTY, OHIO**

STRUCTURE FOUNDATION EXPLORATION REPORT

Prepared For:
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Rii Project No. W-23-155

September 2026



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September 17, 2025 (Revised September 25, 2026)

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**Re: Structure Foundation Exploration Report
MOT-835-2.57
PID 116922
Montgomery County, Ohio
Rii Project No. W-23-155 (Rev. 5)**

Ms. Boehm:

Resource International, Inc. (Rii) is pleased to submit this revised draft 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 revised report includes geotechnical recommendations for the design and construction of the proposed replacement of the existing bridge carrying State Route 835 over Little Beaver Creek in Kettering, Montgomery County, Ohio. This revised report supersedes all previous submittals.

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.

Daniel E. Karch, P.E.
Director – Geotechnical Services

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Enclosure: Structure Foundation Exploration Report

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EXECUTIVE SUMMARY

Resource International, Inc. (Rii) has completed a structure foundation exploration performed for the design and construction of the proposed replacement of the existing bridge (MOT-835-2.57) carrying SR 835 over Little Beaver Creek approximately 0.15 miles west of County Line Road in Kettering, Montgomery County, Ohio.

Based on the available plan information, Rii understands the current bridge is to be replaced with a three-span structure with either concrete or steel beams. The proposed structure will roughly maintain the existing horizontal and vertical alignment. The length of the proposed bridge is 204.11 feet with a total out-to-out width of 96.96 feet and a skew of 15 degrees.

The investigation was carried out in two phases: the initial investigation, with a previously-submitted report dated August 13, 2024, and this final investigation. This report includes the results from both phases of the field and laboratory testing. The initial field exploration consisted of four (4) borings for scour analyses only. Rii utilized historic borings to prepare a preliminary evaluation of the bridge foundation elements. The results of the foundation analyses indicated that depths of the historic borings, upon which the analyses were based, were insufficient to provide the required geotechnical resistance per pile. Therefore, deeper borings to supplement the historic boring data was needed confirm the required pile design lengths and tip elevations.

Exploration and Findings

On January 4, 2024, a total of four (4) borings, designated as B-001-0-24 through B-004-0-24, were performed for the initial investigation of the project. The borings were performed for scour considerations for the proposed bridge replacement and were advanced to depths ranging from 6.0 to 11.8 feet below the existing grade. Subsequently, between November 4 and December 13, 2024, four (4) additional structure borings, designated as B-001-1-24 through B-004-1-24, were drilled for the final investigation and were advanced to depths ranging from 109.2 to 110.0 feet below the existing ground surface.

Borings B-001-0-24 and B-004-0-24 were drilled through the existing roadway surface of SR 835 and encountered 15.5 and 15.0 inches of asphalt, respectively. No aggregate base was encountered below the borings or the pavement cores. Borings B-002-0-24 and B-003-0-24 were drilled on the creek slopes near each existing pier, and no measurable surface material was encountered. Similarly, for the final investigation borings, Borings B-001-1-24 and B-004-1-24 were drilled through the existing roadway surface of SR 835 and encountered 18.0 and 12.0 inches of asphalt, respectively, overlying 6 inches of aggregate base. Borings B-002-1-24 and B-003-1-24 were drilled on the creek slopes near each existing pier, and encountered 12.0 and 3.0 inches of topsoil at the ground surface, as identified by the presence of vegetation and organic matter.



Below the asphalt in boring B-004-0-24, existing fill was encountered to a depth of 5.8 feet below the existing ground surface. The fill was described as sandy silt (ODOT A-4a) and contained traces of brick fragments. Underlying the fill and the surficial materials, natural cohesive and granular soils were encountered to the termination depths of the borings. The cohesive soils were described as sandy silt, silt and clay, silty clay, and clay (ODOT A-4a, A-6a, A-6b, A-7-6). The granular soils were described as gravel, gravel with sand, gravel with sand, silt, and clay, and silt (ODOT A-1-a, A-1-b, A-2-6, A-4b).

During drilling groundwater was encountered in borings B-002-0-24 and B-003-0-24 at depths of 3.5 and 2.0 feet below the existing ground surface, respectively. Groundwater measured upon completion of drilling at depths of 3.0 and 2.5 feet below the existing ground surface, respectively. In the final investigation, Groundwater was encountered during drilling in borings B-001-1-24, B-001-1-24 and B-003-1-24 at depths of 8.5, 3.5 and 3.0 feet below the existing ground surface, respectively. Groundwater could not be measured upon completion of drilling due to addition of mud to boreholes.

Records of four (4) historic borings, designated as B-012-0-84 through B-015-0-84, were obtained from the ODOT Transportation Information Mapping System (TIMS) and were utilized in the foundation analysis.

Historic borings B-012-0-84 and B-013-0-84 encountered 0.7 to 1.0 feet of topsoil at the ground surface. Typical surface materials were not encountered at the ground surface of borings B-014-0-84 and B-015-0-84.

Underlying the fill material and surface materials, natural cohesive and granular soils were encountered to the termination depths of the borings. The cohesive soils were described as silt, silt with fine sand, and silt and clay. HP values were not reported on the historic boring logs.

Groundwater was encountered in the historic borings at depths ranging from 4.0 to 6.0 feet below the existing ground surface. Groundwater measured upon completion of drilling in the historic borings at depths ranging from 3.0 to 6.5 feet below the existing ground surface.

Analyses and Recommendations

Data obtained from the current and historic geotechnical explorations have been used to determine the foundation support capabilities and the settlement potential for the soil encountered at the site. These parameters have been used to provide guidelines for the design of foundation systems for the subject bridge.



Driven Pile Recommendations

Driven Pile Recommendations – Closed End CIP Piles

Substructure Reference	Bottom of Footing ¹ (feet)	Pile Size / Type ²	Min. Req. Pile Wall Thickness (inch)	Pile Elevation (feet)		Est. Pile Length ⁴ (feet)	Scour Friction Loss (kips/pile) ⁵	UB6 (kips/pile) ⁷	Φ_{dyn} ⁷
				Top ³	Tip				
Rear Abutment (B-001-1-24)	873.25	14" CIP	0.5	875.29	817.75	60.0	N/A	266.0	0.7
Pier 1 (B-002-1-24)	866.80	14" CIP	0.5	868.30	793.55	80.0	7.08	289.0	0.7
Pier 2 (B-003-1-24)	866.20	14" CIP	0.5	867.70	810.28	60.0	1.85	289.0	0.7
Forward Abutment (B-004-1-24)	872.35	14" CIP	0.5	874.38	808.82	70.0	N/A	266.0	0.7

1. Bottom of footing elevation determined from design plans provided by Korda.
2. Minimum of Grade 3 steel w/ conical points.
3. The top of pile elevation corresponds to the pile cutoff elevation, which is considered to be 1.5 feet above the bottom of footing elevation for piers and 2.0 feet above the bottom of footing elevation for abutments.
4. Per Section 305.3.5.2 of the 2023 ODOT BDM, the estimated pile length was determined as the pile cutoff elevation (top) minus the pile tip elevation, rounded up to the nearest 5.0 feet. Order (furnished) length for each pile should be calculated by adding 5 feet on estimated pile length.
5. Scour friction loss is the additional driving resistance to be overcome during pile installation.
6. UB6 is the resistance that an individual pile is expected to provide based on the structural loading and accounting for the applicable geotechnical resistance factor. Values are determined based on the design maximum factored structural loads provided by Korda and scour friction loss, as per Section 606.2 of the ODOT BDM.
7. The resistance factor listed assumes dynamic testing of the pile elements per Section 305.7.1 of the 2023 ODOT BDM.

Scour Recommendations

Soil borings performed for the proposed bridge replacement encountered granular and cohesive soils consisting of gravel, gravel with sand, gravel with sand, silt, and clay, sandy silt, silt, silt and clay, and silty clay (ODOT A-1-a, A-1-b, A-2-6, A-4a, A-4b, A-6a, A-6b) at or near the existing creek bed elevations. Classification tests were performed on the soil samples recovered from near the creek bed elevations for the scour considerations. A summary of soil parameters for scour analysis are tabulated below.



Parameters for Scour Analysis

Boring Number	Sample	Elevation, (feet)	Soil Type	D ₅₀ (mm)
B-001-0-24	SS-3	879.2-877.7	A-2-6	0.5140
	SS-4	877.7-876.2	A-2-6	0.7880
	SS-5	876.2-874.7	A-6b	0.0770
	SS-6	874.7-873.2	A-6a	0.0500
B-002-0-24	SS-1 & 2S-1A	871.5-869.5	A-1-b	1.1320
	SS-2 & 2S-2A	869.5-867.5	A-1-a	8.6030
	SS-3	867.5-866	A-1-a	2.0730
	SS-4	866-864.5	A-1-a	2.2830
B-003-0-24	SS-1	873-871.5	A-4b	0.0320
	SS-2	871.5-870	A-1-b	3.5730
	SS-3	870-868.5	A-1-a	7.9330
	SS-4	868.5-867	A-1-a	11.0120
B-004-0-24	SS-4A	877.2-876.2	A-1-b	0.5850
	SS-4B	876.2-875.7	A-4a	0.2290
	SS-5	875.7-874.2	A-6a	0.3890
	SS-6	874.2-872.7	A-2-6	0.4630
	SS-7 & 2S-7A	872.7-870.7	A-4a	0.0920

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



1.0 INTRODUCTION

This report is a presentation of the structure foundation exploration performed for the design and construction of the proposed replacement of the existing bridge (MOT-835-2.57) carrying SR 835 over Little Beaver Creek approximately 0.15 miles west of County Line Road in Kettering, Montgomery County, Ohio.

Based on the available plan information, Rii understands the current bridge is to be replaced with a three-span structure with composite prestressed concrete box beams with integral abutments and cap and column piers on cast-in-place concrete pile foundations. The proposed structure will roughly maintain the existing horizontal and vertical alignment. The length of the proposed bridge is 204.11 feet with a total out-to-out width of 96.96 feet and a skew of 15 degrees.

The investigation was carried out in two phases: the initial investigation, with a previously-submitted report dated August 13, 2024, and this final investigation. This report includes the results from both phases of the field and laboratory testing. The initial field exploration consisted of four (4) borings for scour analyses only. Rii utilized historic borings to prepare a preliminary evaluation of the bridge foundation elements. The results of the foundation analyses indicated that depths of the historic borings, upon which the analyses were based, were insufficient to provide the required geotechnical resistance per pile. Therefore, deeper borings to supplement the historic boring data was needed confirm the required pile design lengths and tip elevations.

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 Site Geology

Physiographically, this site lies within the Southern Ohio Loamy Till Plain Region. This region is characterized by relatively flat-lying silty loam till ground moraine, interspersed with end and recessional moraines, outwash and alluvial deposits. Ground moraines are deposited during the retreat of a glacier, resulting in an undifferentiated mixture of clay, silt, sand and gravel. End moraines are normally associated with ice melting that is neither advancing nor retreating for a period of time. Recessional moraines are deposited when the ice sheet is retreating. Both end and recessional moraines are commonly associated with boulder belts. 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 from silty clay to cobble sized deposits, usually deposited in present and former floodplain areas.

Based on bedrock geology and topography maps of the area from the Ohio Department of Natural Resources (ODNR), the bedrock at the project site consists of the Ordovician-aged Grant Lake Formation. This unit is comprised of gray to bluish gray interbedded shale and limestone. The unit features deposition of multiple sedimentary cycles of shale



and limestone displaying planar to irregular bedding, and limestone and shale exhibiting wavy to nodular bedding, and ranges between 60 to 130 feet thick. According to ODNr bedrock topography mapping, the bedrock surface in the vicinity of the site is at an approximate elevation of 580 feet, which is approximately 300 feet below the existing surface grade.

2.2 Existing Conditions

The site of the proposed structure replacement is located along SR 835 approximately 0.15 miles west of County Line Road in Kettering, Montgomery County, Ohio. Rii understands the existing bridge is a three-span structure approximately 193 feet long with center-to-center bearings of 64 feet at each span. The existing structure consists of a precast box beam system with abutments supported on 12-inch diameter CIP concrete piles and piers supported on conventional continuous shallow spread footings. In the vicinity of the project area, the existing roadway is a four-lane, bidirectional, asphalt surfaced roadway with an approximate width of 36.0 feet that is aligned east to west. Within the project limits, the roadway traverses primarily along commercial properties.

3.0 EXPLORATION

On January 4, 2024, a total of four (4) borings, designated as B-001-0-24 through B-004-0-24, were performed for the initial investigation of the project. The borings were performed for scour considerations for the proposed bridge replacement and were advanced to depths ranging from 6.0 to 11.8 feet below the existing grade. Records of four (4) historic borings, designated as B-012-0-84 through B-015-0-84, were obtained from the ODOT Transportation Information Mapping System (TIMS) and were utilized in the foundation analysis. Subsequently, between November 4 and December 13, 2024, four (4) additional structure borings, designated as B-001-1-24 through B-004-1-24, were drilled for the final investigation and were advanced to depths ranging from 109.2 to 110.0 feet below the existing ground surface.

The soil borings were performed at the locations shown on the boring plan provided in Appendix I of this report. A summary of soil borings information is provided in Table 1.



Table 1. Test Boring Summary

Boring Number	Station ¹	Offset ¹	Latitude	Longitude	Ground Elevation ¹ (feet)	Boring Depth (feet)
B-001-0-24	134+83	30' RT	39.717205	-84.108170	883.0	11.8
B-002-0-24	135+96	54' LT	39.717410	-84.107744	872.0	7.0
B-003-0-24	136+29	5' RT	39.717116	-84.107658	872.9	6.0
B-004-0-24	137+55	30' LT	39.717307	-84.107189	882.4	11.3
B-012-0-84 ²	135+28	45' LT	39.717400	-84.107987	877.3 ³	40.0
B-013-0-84 ²	135+75	44' RT	39.717145	-84.107847	876.9 ³	40.0
B-014-0-84 ²	136+66	44' LT	39.717365	-84.107499	876.6 ³	40.0
B-015-0-84 ²	137+15	43' RT	39.717118	-84.107352	876.7 ³	40.0
B-001-1-24	134+91	25' RT	39.717220	-84.108139	882.7	109.2
B-002-1-24	136+08	55' LT	39.717411	-84.107702	871.5	110.0
B-003-1-24	136+35	49' RT	39.717121	-84.107637	872.3	110.0
B-004-1-24	137+48	31' LT	39.717313	-84.107214	882.1	109.2

1. Station, offset and ground surface elevations were interpolated from basemaps provided by Korda.

2. Historic boring station, offset, and ground surface elevations obtained from ODOT Transportation Information Mapping System (TIMS).

3. Ground surface elevation adjusted from NGVD 29 to NAVD 88.

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

The borings performed for the initial and final investigations were drilled using either a Diedrich D-50 or Mobile-57 rotary drilling machine, utilizing either 4.5-inch outside diameter continuous flight augers or 3.25-inch inside diameter augers to advance the holes. In borings B-002-1-24, B-003-1-24, and B-004-1-24, open hole mud rotary drilling was utilized to counteract heaving conditions. Standard penetration testing (SPT) and split spoon sampling were performed at 1.5-foot intervals to depths of 6.0 to 11.8 feet below the existing ground surface for scour considerations, or at 2.5-foot increments to a depth of 25.0 to 30.0 feet and at 5.0-foot increments thereafter to the boring termination depth for the structure borings.

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. A calibrated automatic drop hammer was utilized to generate consistent energy transfer to the sampler. Driving resistance is recorded on the boring logs in terms of blows per 6.0-inch interval of the driving distance. The second and third intervals are added to obtain the number of blows per foot (N).

Standard penetration blow counts aid in determining soil properties applicable in foundation design. Measured blow count (N) values are corrected to an equivalent (60%) energy ratio, N_{60} , by the following equation. Both values are represented on boring logs in Appendix III.

$$N_{60} = N \cdot (ER/60)$$

Where:

N = measured N value

ER = drill rod energy ratio, expressed as a percent, for the system used

The Diedrich D-50 drill rig was utilized for the initial investigation and both the Diedrich D-50 and Mobile B-57 drill rigs were utilized for the final investigation. The hammer for the Diedrich D-50 drill rig was calibrated on March 21, 2022 and the hammer for the Mobile B-57 drill rig was calibrated on August 21, 2023, and had drill rod energy ratios of 86.4 and 80.4 percent for the Diedrich D-50 and Mobile B-57, respectively.

At the completion of drilling in borings, borings B-001-0-24 and B-004-0-24 were backfilled with a mixture of soil cuttings and bentonite chips in accordance with ODOT Specifications for Geotechnical Explorations (SGE) policy for sealing boreholes. The pavement surface at boring locations B-001-0-24 and B-004-0-24 were patched with an equivalent thickness of cold patch asphalt. Further, structure borings B-001-1-24 and B-004-1-24 were backfilled with cement-bentonite grout upon completion, and were patched with an equivalent thickness of quick set concrete.

In general, for instances of no recovery from standard split spoon sampling, a 2.5-inch outside diameter split spoon sampler was driven the full length of the standard split spoon interval plus an additional 6.0 inches to obtain a representative sample. These samples are designated with a "2S" preceding the sample number on the boring logs. Only the final 6.0 inches of sample were retained for classification.

Hand penetrometer readings, which provide a rough estimate of the unconfined compressive strength of the cohesive soils, 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 sample 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.

During drilling, Rii personnel prepared field logs detailing 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	134
Plastic and Liquid Limits	AASHTO T89, T90	15
Gradation – Sieve/Hydrometer	AASHTO T88	36
Gradation – Sieve Only	AASHTO T88	2

The tests performed are necessary to classify the existing soil according to the Ohio Department of Transportation (ODOT) classification system and to estimate engineering properties of importance for foundation design and construction recommendations. Results of the laboratory testing are presented on the boring logs in Appendix III.

4.0 FINDINGS

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

4.1 Initial Investigation Borings

4.1.1 Surface Materials

Borings B-001-0-24 and B-004-0-24 were drilled through the existing roadway surface of SR 835 and encountered 15.5 and 15.0 inches of asphalt, respectively. No aggregate base was encountered below the borings or the pavement cores. Borings B-002-0-24 and B-003-0-24 were drilled on the creek slopes near each existing pier, and no measurable surface material was encountered.

4.1.2 Subsurface Soils

Below the asphalt in boring B-004-0-24, existing fill was encountered to a depth of 5.8 feet below the existing ground surface. The fill was described as sandy silt (ODOT A-4a) and contained traces of brick fragments.

Underlying the fill in boring B-004-0-24, the asphalt in B-001-0-24, and from the ground surface in the remaining borings, natural cohesive and granular soils were encountered to the termination depths of the borings. The cohesive soils were described as sandy silt, silt and clay, silty clay, and clay (ODOT A-4a, A-6a, A-6b, A-7-6). The shear strength and consistency of cohesive soils are primarily derived from the hand penetrometer values



(HP). The HP values ranged from stiff ($1.0 < \text{HP} \leq 2.0$ tsf) to very stiff ($2.0 < \text{HP} \leq 4.0$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 1.25 tsf to 3.25 tsf (limit of the instrument). The N_{60} values recorded within these natural cohesive soils ranged from 13 to 30 blows per foot (bpf).

The granular soils were described as gravel, gravel with sand, gravel with sand, silt, and clay, and silt (ODOT A-1-a, A-1-b, A-2-6, A-4b). The relative density of granular soils is primarily derived from SPT blow counts (N_{60}). Based on the SPT blow counts obtained, the relative density of the granular soils encountered ranged from medium dense ($10 \leq N_{60} \leq 30$ bpf) to dense ($30 \leq N_{60} \leq 50$ bpf). SPT blow counts (N_{60}) of the granular deposits ranged from 17 bpf to 39 bpf.

Moisture contents of the natural cohesive soil samples tested ranged from 9 to 38 percent. The moisture contents of the natural cohesive soil samples tested for plasticity index ranged from 6 percent below to 1 percent above their corresponding plastic limits. In general, the soils exhibited natural moisture contents ranging from moderately below to near their estimated optimum moisture levels.

4.1.3 Bedrock

Bedrock was not encountered in the borings performed for this investigation.

4.1.4 Groundwater

Groundwater was encountered in the borings as shown in Table 3 below.

Table 3. Groundwater Levels – Initial Investigation Borings

Boring Number	Ground Elevation (feet)	During Drilling		Upon Completion	
		Depth (feet)	Elevation (feet)	Depth (feet)	Elevation (feet)
B-002-0-24	871.5	3.5	868.0	2.0	869.5
B-003-0-24	873.0	3.0	870.0	2.5	870.5

During drilling groundwater was encountered in borings B-002-0-24 and B-003-0-24 at depths of 3.5 and 2.0 feet below the existing ground surface, respectively. Groundwater measured upon completion of drilling at depths of 2.0 and 2.5 feet below the existing ground surface, respectively.

Please note that short-term water level readings 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.

4.2 Final Investigation Borings

4.2.1 Surface Materials

Borings B-001-1-24 and B-004-1-24 were drilled through the existing roadway surface of SR 835 and encountered 18.0 and 12.0 inches of asphalt, respectively, overlying 6 inches of aggregate base. Borings B-002-1-24 and B-003-1-24 were drilled on the creek slopes near each existing pier and encountered 12.0 and 3.0 inches of topsoil at the ground surface, as identified by the presence of vegetation and organic matter.

4.2.2 Subsurface Soils

Underlying the surficial materials, natural cohesive and granular soils were encountered to the termination depths of the borings. The cohesive soils were described as sandy silt, silt and clay, and silty clay (ODOT A-4a, A-6a, A-6b). The shear strength and consistency of cohesive soils are primarily derived from the hand penetrometer values (HP). The HP values ranged from medium stiff ($0.5 < \text{HP} \leq 1.0$ tsf) to hard ($\text{HP} > 4.0$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 0.75 tsf to 4.5 tsf (limit of the instrument). The N_{60} values recorded within the natural cohesive soils ranged from 8 to 53 blows per foot (bpf).

The granular soils were described as gravel, gravel with sand, gravel with sand, silt, and clay, as well as silt (ODOT A-1-a, A-1-b, A-2-6, A-4b). The relative density of granular soils is primarily derived from SPT blow counts (N_{60}). Based on the SPT blow counts obtained, the relative density of the granular soils encountered ranged from very loose ($N_{60} \leq 4$ bpf) to very dense ($N_{60} > 50$ bpf). SPT blow counts (N_{60}) of the granular deposits ranged from 0 bpf to 112 bpf.

Moisture contents of the natural cohesive soil samples tested ranged from 4 to 26 percent. The moisture contents of the natural cohesive soil samples tested for plasticity index ranged from values similar to 8 percent above their corresponding plastic limits. In general, the soils exhibited natural moisture contents ranging from moderately below to significantly above their estimated optimum moisture levels.

4.2.3 Bedrock

Bedrock was not encountered in the borings performed for this investigation.

4.2.4 Groundwater

Groundwater was encountered in the borings as shown in Table 4 below.

Table 4. Groundwater Levels – Final Investigation Borings

Boring Number	Ground Elevation (feet)	During Drilling	
		Depth (feet)	Elevation (feet)
B-001-1-24	882.7	8.5	874.2
B-002-1-24	871.5	3.5	868.0
B-003-1-24	872.3	3.0	869.3

Groundwater was encountered during drilling in borings B-001-1-24, B-001-1-24 and B-003-1-24 at depths of 8.5, 3.5 and 3.0 feet below the existing ground surface, respectively. As previously stated, open hole mud rotary drilling techniques were utilized to counteract heaving conditions in borings B-002-1-24, B-003-1-24, and B-004-1-24. Drilling mud displaces groundwater to the outside of the borehole to stabilize the borehole walls. Short-term groundwater measurements in boreholes drilled with mud rotary techniques are not practical or reliable. Therefore, groundwater could not be measured upon completion of drilling of these borings due to addition of drilling mud to boreholes.

Please note that short-term water level readings 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 III.

4.3 Historic Borings

4.3.1 Surface Materials

Historic borings B-012-0-84 and B-013-0-84 encountered 0.7 to 1.0 feet of topsoil at the ground surface. Typical surface materials were not encountered at the ground surface of borings B-014-0-84 and B-015-0-84.

4.3.2 Subsurface Soils

Historic borings B-014-0-84 and B-015-0-84 encountered existing fill to a depth of 4.0 feet each below the ground surface. The fill was described as silt and silt and clay (ODOT A-4b, A-6a) with traces of organics, wood, asphalt, and cobbles.

Underlying the fill material and surface materials, natural cohesive and granular soils were encountered to the termination depths of the borings. The cohesive soils were described as silt, silt with fine sand, and silt and clay. HP values were not reported on the historic boring logs. The N values recorded within these natural cohesive soils ranged from 5 to 79 bpf.

The granular soils were described as sand and gravel and sand. Blow counts (N) of the granular soil deposits ranged from 21 to 105 bpf.

4.3.3 Bedrock

Bedrock was not encountered in the borings performed for this investigation.

4.3.4 Groundwater

Groundwater was encountered in the historic borings as shown in Table 5 below.

Table 5. Groundwater Levels – Historic Borings

Boring Number	Ground Elevation (feet)	During Drilling		Upon Completion	
		Depth (feet)	Elevation (feet)	Depth (feet)	Elevation (feet)
B-012-0-84	877.3	5.4	871.3	5.9	870.8
B-013-0-84	876.9	3.4	872.9	3.4	872.9
B-014-0-84	876.6	3.4	872.6	2.4	873.6
B-015-0-84	876.7	3.4	872.7	2.9	873.2

Groundwater was encountered in the historic borings at depths ranging from 4.0 to 6.0 feet below the existing ground surface. Groundwater measured upon completion of drilling in the historic borings at depths ranging from 3.0 to 6.5 feet below the existing ground surface.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the current and historic geotechnical explorations have been used to determine the foundation support capabilities and the settlement potential for the soil encountered at the site. These parameters have been used to provide guidelines for the design of foundation systems for the subject bridge which are discussed in the following paragraphs.

Design details of the proposed structure were provided by Korda and are summarized in Table 6. Based on the information provided, it is understood that the proposed bridge will be a three-span composite prestressed box beam superstructure with reinforced concrete piers and capped pile abutments. The length of the proposed bridge, measured between center to center of the bearings, will be 200.1 feet.

Table 6. Bridge Design Details

Substructure Unit (Boring)	Bottom of Footing Elevation (feet) ¹	Maximum Factored Design Load (kips) ¹	Scour Elevation ¹ (feet)
Rear Abutment (B-001-1-24)	873.25	186.0	NA
Pier 1 (B-002-1-24)	866.80	202.0	865.92
Pier 2 (B-003-1-24)	866.20	202.0	865.75
Forward Abutment (B-004-1-24)	872.35	186.0	NA

1. Bottom of footing elevation, structural loading, and scour depth information provided by Korda.

5.1 Driven Pile Recommendations

Given the subsurface conditions encountered, Rii recommends that closed end steel CIP pipe piles (ODOT Item 507.06) driven to the depth of the ultimate bearing value (UBV) be employed for foundation support. The geotechnical resistance recommendations for CIP pipe piles are provided in Table 7. Rii recommends the use of conical points to protect the piles due to very dense granular soils encountered in the borings.

Table 7. Driven Pile Recommendations – Closed End CIP Piles

Substructure Reference	Bottom of Footing ¹ (feet)	Pile Size / Type ²	Min. Req. Pile Wall Thickness (inch)	Pile Elevation (feet)		Est. Pile Length ⁴ (feet)	Scour Friction Loss (kips/pile) ⁵	UBV (kips/pile) ⁶	Φ_{dyn} ⁷
				Top ³	Tip				
Rear Abutment (B-001-1-24)	873.25	14" CIP	0.5	875.29	817.75	60.0	N/A	266.0	0.7
Pier 1 (B-002-1-24)	866.80	14" CIP	0.5	868.30	793.55	80.0	7.08	289.0	0.7
Pier 2 (B-003-1-24)	866.20	14" CIP	0.5	867.70	810.28	60.0	1.85	289.0	0.7
Forward Abutment (B-004-1-24)	872.35	14" CIP	0.5	874.38	808.82	70.0	N/A	266.0	0.7

1. Bottom of footing elevation determined from design plans provided by Korda.
2. Minimum of Grade 3 steel w/ conical points.
3. The top of pile elevation corresponds to the pile cutoff elevation, which is considered to be 1.5 feet above the bottom of footing elevation for piers and 2.0 feet above the bottom of footing elevation for abutments.
4. Per Section 305.3.5.2 of the 2023 ODOT BDM, the estimated pile length was determined as the pile cutoff elevation (top) minus the pile tip elevation, rounded up to the nearest 5.0 feet. Order (furnished) length for each pile should be calculated by adding 5 feet on estimated pile length.
5. Scour friction loss is the additional driving resistance to be overcome during pile installation.
6. UBV is the resistance that an individual pile is expected to provide based on the structural loading and accounting for the applicable geotechnical resistance factor. Values are determined based on the design maximum factored structural loads provided by Korda and scour friction loss, as per Section 606.2 of the ODOT BDM.
7. The resistance factor listed assumes dynamic testing of the pile elements per Section 305.7.1 of the 2023 ODOT BDM.

The UBVs listed in Table 7 consider an axially loaded pile with negligible moment, no appreciable loss of section due to deterioration throughout the life of the structure. The piles were analyzed using the APILE software program. The UBVs listed in Table 7 were calculated in accordance with Section 305.3.2 and 305.3.4 of the ODOT BDM and Section 1304.1 of the ODOT GDM.

The UBV is the ultimate resistance achieved by the pile in the long-term after pile set-up has occurred. Pile restrike testing should be performed to verify that the pile has achieved UBV as recommended in Table 7.

The wait period of 7 days is recommended for the pile restrike. The wait period before restrike testing was determined in accordance with GDM Section 1304.3.1 and BDM Sections 305.3.2.4 and 305.3.5.9, and is summarized in Table 8.

Table 8. Comparison of Pile Length at EOID and Nominal Conditions

Substructure Reference	Est. Length at Nominal	UBV (kips/pile)	Resistance at EOID	Setup Factor ¹ (f_{su})	Percent Setup (%)	Wait Period
Rear Abutment (B-001-1-24)	55.5	266.0	193.48	1.375	37.5	7 days
Pier 1 (B-002-1-24)	73.25	289.0	207.55	1.392	39.2	7 days
Pier 2 (B-003-1-24)	55.92	289.0	236.75	1.221	22.1	7 days
Forward Abutment (B-004-1-24)	64.64	266.0	199.69	1.332	33.2	7 days

1. Setup factor calculated as UBV at nominal condition divided by geotechnical resistance at EOID.

It should be noted that the pile lengths presented in Table 7 are estimates using empirical equations based on the derived characteristics of the soils encountered in the current and historic borings drilled. The actual pile capacities should be verified using static or dynamic pile load testing as detailed in Sections 305.7.1 of the ODOT BDM. Dynamic pile load testing should be performed in accordance with ASTM D4945.

5.1.1 Drivability

Drivability analyses were performed in accordance with GDM Section 1304.2 and BDM Section 305.3.1.2 using the GRLWEAP software program, and the results are provided in Appendix VI. In the drivability analysis, a **Delmag 19-42** hammer with a rated energy of approximately 44,000 ft-lbs was used in conjunction with the CIP pipe pile sections. Driving stresses induced on the CIP-piles **would not exceed** 90 percent of the yield stress of the steel ($f_y = 45$ ksi, $0.9f_y = 40.5$ ksi) if driven to the elevations provided in Table 7. Care should be taken during pile driving operations 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 UBV based on dynamic pile load testing.

5.1.2 Driven Pile Considerations

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

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

5.1.3 Lateral Design

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

Table 9. Subsurface Strata Description

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

5.2 Scour Data

Soil borings performed for the proposed bridge replacement encountered granular and cohesive soils consisting of gravel, gravel with sand, gravel with sand, silt, and clay, sandy silt, silt, silt and clay, and silty clay (ODOT A-1-a, A-1-b, A-2-6, A-4a, A-4b, A-6a, A-6b) at or near the existing creek bed elevations. Classification tests were performed on the soil samples recovered from near the creek bed elevations for the scour considerations. A summary of soil parameters for scour analysis are tabulated in Table 10.

Table 10. Parameters for Scour Analysis

Boring Number	Sample	Elevation, (feet)	Soil Type	D ₅₀ (mm)
B-001-0-24	SS-3	879.2-877.7	A-2-6	0.5140
	SS-4	877.7-876.2	A-2-6	0.7880
	SS-5	876.2-874.7	A-6b	0.0770
	SS-6	874.7-873.2	A-6a	0.0500
B-002-0-24	SS-1 & 2S-1A	871.5-869.5	A-1-b	1.1320
	SS-2 & 2S-2A	869.5-867.5	A-1-a	8.6030
	SS-3	867.5-866	A-1-a	2.0730
	SS-4	866-864.5	A-1-a	2.2830
B-003-0-24	SS-1	873-871.5	A-4b	0.0320
	SS-2	871.5-870	A-1-b	3.5730
	SS-3	870-868.5	A-1-a	7.9330
	SS-4	868.5-867	A-1-a	11.0120
B-004-0-24	SS-4A	877.2-876.2	A-1-b	0.5850
	SS-4B	876.2-875.7	A-4a	0.2290
	SS-5	875.7-874.2	A-6a	0.3890
	SS-6	874.2-872.7	A-2-6	0.4630
	SS-7 & 2S-7A	872.7-870.7	A-4a	0.0920

5.3 Lateral Earth Pressure

For the soil types encountered in the borings, the “in-situ” unit weight (γ), cohesion (c), effective angle of friction (ϕ'), and lateral earth pressure coefficients for at-rest conditions (k_o), active conditions (k_a), and passive conditions (k_p) have been estimated and are provided in Table 11 and Table 12.

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

Soil Type	γ (pcf) ¹	c (psf)	ϕ	k_a	k_o	k_p
Medium Stiff to Stiff Cohesive Soil	115	1,000	0°	N/A	N/A	N/A
Very Stiff to Hard Cohesive Soil	120	2,500	0°	N/A	N/A	N/A
Very Loose to Loose Granular Soil	120	0	28°	0.36	0.53	2.77
Medium Dense to Very Dense Granular Soil	125	0	32°	0.31	0.47	3.25
Compacted Cohesive Engineered Fill	120	2,000	0°	N/A	N/A	N/A
Compacted Granular Engineered Fill	130	0	32°	0.31	0.47	3.25

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

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

Soil Type	γ (pcf) ¹	c' (psf)	ϕ'	k_a	k_o	k_p
Medium Stiff to Stiff Cohesive Soil	115	0	25°	0.41	0.58	2.46
Very Stiff to Hard Cohesive Soil	120	0	27°	0.38	0.55	2.66
Very Loose to Loose Granular Soil	120	0	28°	0.36	0.53	2.77
Medium Dense to Very Dense Granular Soil	125	0	32°	0.31	0.47	3.25
Compacted Cohesive Engineered Fill	120	0	28°	0.36	0.53	2.77
Compacted Granular Engineered Fill	130	0	32°	0.31	0.47	3.25

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.

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

Where necessary, temporary retaining structures, such as sheet pile system, should be designed using the undrained soil parameters provided in Table 11, and the design should follow all applicable guidelines for the type of retaining structure utilized.

Permanent retaining and subsurface structures should be designed using the drained soil parameters provided in Table 12. Regardless of whether the retaining structure is temporary or permanent, the effective unit weight ($\gamma' = \gamma - 62.4$ pcf) plus the hydrostatic water pressure ($\gamma_w * h_w$, where h_w is the height of water behind the wall above the base of the wall) should be utilized below the design groundwater level. The lateral earth pressure coefficients should only be applied to the horizontal pressure resulting from the effective overburden pressure, and should not be applied to the hydrostatic water pressure.

5.4 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).

5.4.1 Excavation Considerations

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

Table 13. Excavation Back Slopes

Soil	Maximum Back Slope	Notes
Soft to Medium Stiff Cohesive	1.5 : 1.0	Above Ground Water Table and No Seepage
Stiff Cohesive	1.0 : 1.0	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

5.4.2 Groundwater Considerations

Groundwater should be anticipated at or near the elevations as indicated in Table 3, Table 4 and Table 5. Groundwater should be anticipated within the upper cohesive and granular soils at the normal pool elevation and above the normal pool elevation during and after storm events. Additionally, groundwater conditions affecting construction may be encountered within the trapped/perched zones. These trapped/perched zones are generally the layer(s) of granular soils that are isolated within the fine-grained soil layers and may not be identified in boring logs. If excavation encounter such layers, temporary

dewatering may be accomplished by placing localized sumps and pumps within and beyond the excavation. Seepage rates from these layers are difficult to predict and flow rate could be significant.

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

5.5 Geotechnical Plan Notes

Below are the geotechnical plan notes that are recommended to be included in the project plans.

- 606.2-2 PILE DESIGN LOADS (ULTIMATE BEARING VALUE)

The Ultimate Bearing Values (UBV) is 266 kips per pile for the abutment piles. The UBV is 289 kips per pile for the pier piles. The UBV for the Pier 1 piles includes an additional 7.08 kips per pile due to the possibility of losing 0.88 feet of friction resistance due to scour, and the UBV for the Pier 2 piles includes an additional 1.85 kips per pile due to the possibility of losing 0.45 feet of friction resistance due to scour. Drive the Pier 1 piles to the UBV or a tip elevation of 793.55, whichever is deeper. Drive the Pier 2 piles to the UBV or a tip elevation of 810.28, whichever is deeper.

Rear Abutment Piles:

- 14" Dia. Concrete Piles 65 feet long, Order Length
- 1 Dynamic Load Testing Item
- 1 Restrike Item

Pier 1 Piles:

- 14" Dia. Concrete Piles 85 feet long, Order Length
- 1 Dynamic Load Testing Item
- 1 Restrike Item

Pier 2 Piles:

- 14" Dia. Concrete Piles 65 feet long, Order Length
- 1 Dynamic Load Testing Item
- 1 Restrike Item

Forward Abutment Piles:

- 14" Dia. Concrete Piles 75 feet long, Order Length
- 1 Dynamic Load Testing Item
- 1 Restrike Item

Provide plain cylindrical casings with a minimum pile wall thickness of 0.5 inch for the cast-in-place reinforced concrete piles.

- 606.3-2 STEEL PILE POINTS

Use conical steel pile points to protect the tips of the proposed steel CIP reinforced concrete pipe piles each substructure.

- 606.7-3 PILES DRIVEN TO FULL ESTIMATED LENGTH WITH PILE/SOIL SETUP

The Ultimate Bearing Values is 266 kips per pile for the abutment piles. The UBV is 289 kips for the pier piles. Part of the UBV will be achieved through pile/soil setup, which is a time dependent increase in resistance that occurs in some soils. Notify the Engineer at least 5 days before driving piles so that the Engineer can notify the District Geotechnical Engineer, the Office of Construction Administration, and the Office of Geotechnical Engineering.

Drive the first two piles at the Rear Abutment, Pier 1, Pier 2, and Forward Abutment to the full estimated lengths of 60, 80, 60, and 70 feet, respectively. Perform dynamic load testing on both piles while driving. If the dynamic load testing during the initial driving (before the waiting period) indicates a pile has achieved the required UBV prior to driving the full estimated length, stop driving and notify the Engineer. After driving and testing the first two piles, drive the remaining piles in the substructure to the same depth as the first two piles. After driving all piles to the estimated length, cease all driving operations at the substructure for a period of 7 days. Include the waiting period as a separate activity in the progress schedule. After the waiting period, perform pile restrikes on both of the first two piles (one restrike item). Submit all test results to the Engineer. If the restrike test results indicate that the both piles have achieved the required UBV, all piles in the substructure may be accepted by the Engineer.

If the restrike test results indicate that either of the two piles did not achieve the required UBV, immediately notify the Engineer so that the Engineer can notify the District Geotechnical Engineer, the Office of Construction Administration, and the Office of Geotechnical Engineering. The Engineer will review the test results and establish additional restrike testing or driving criteria for the piling in the substructure with the assistance of the District Geotechnical Engineer, the Office of Construction Administration, and the Office of Geotechnical Engineering.

If directed by the Engineer, perform additional restrike testing or drive all piles in the substructure to the established driving criteria. The Department will pay for splicing of the piles beyond the estimated length provided in the plans under C&MS 109.05 with a negotiated price per splice.

This plan note includes a quantity of one each ITEM 523 DYNAMIC LOAD TESTING, AS PER PLAN and a quantity of one each ITEM 523 RESTRIKE, AS PER PLAN per for each substructure unit.

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 subsurface information obtained from the test borings that were made at the proposed site for the current investigation. Resource International is not responsible for the data, conclusions, opinions or recommendations made by others during previous investigations at this site. At this time we would like to point out that soil borings only depict the subsurface 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.

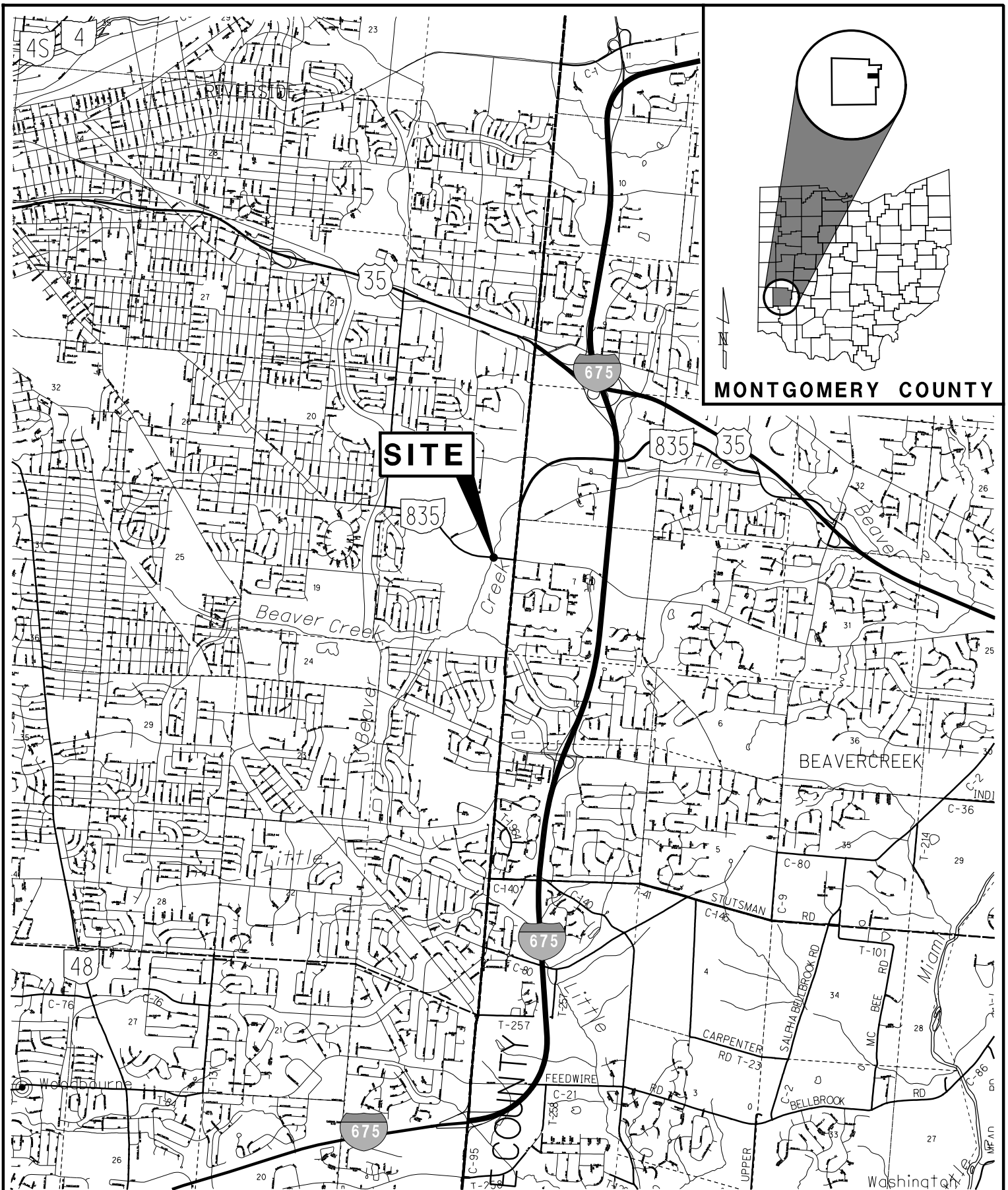
The conclusions and recommendations herein have been based upon the available soil and bedrock information and the design details furnished by a representative of the owner of the proposed project. Any revision in the plans for the proposed construction from those anticipated in this report should be 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
BORING PLAN



VICINITY MAP
MOT-SR 835-2.57
BRIDGE REPLACEMENT
MONTGOMERY COUNTY, OHIO

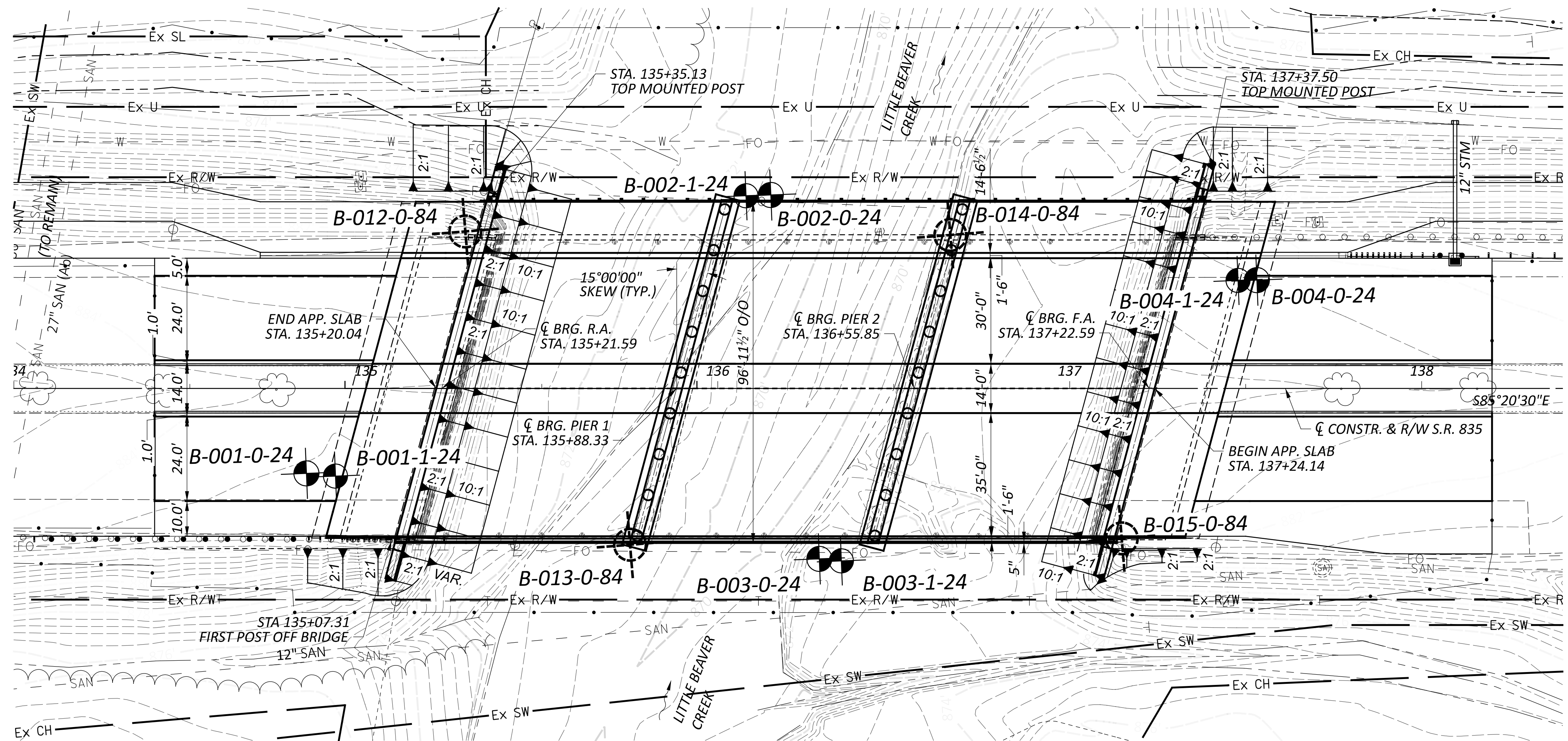
RII PROJECT NO.
W-23-155

SCALE: 1"=5000'

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DATE
3/1/2024



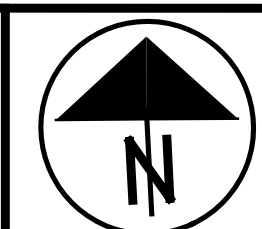


BORING PLAN **MOT-835-2.57 BRIDGE REPLACEMENT** **MONTGOMERY COUNTY, OHIO**

RII PROJECT NO.
W-23-155

SCALE: 1" = 40'

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APPENDIX II

DESCRIPTION OF SOIL TERMS

DESCRIPTION OF SOIL TERMS

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

Granular Soils – ODOT A-1, A-2, A-3, A-4 (non-plastic)

The relative compactness of granular soils is described as:

<u>Description</u>	<u>Blows per foot – SPT (N₆₀)</u>		
Very Loose	Below		5
Loose	5	-	10
Medium Dense	11	-	30
Dense	31	-	50
Very Dense	Over		50

Cohesive Soils – ODOT A-4, A-5, A-6, A-7, A-8

The relative consistency of cohesive soils is described as:

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

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

<u>Soil Fraction</u>	<u>Size</u>
Boulders	Larger than 12"
Cobbles	12" to 3"
Gravel coarse	3" to ¾"
fine	¾" to 2.0 mm (¾" to #10 Sieve)
Sand coarse	2.0 mm to 0.42 mm (#10 to #40 Sieve)
fine	0.42 mm to 0.074 mm (#40 to #200 Sieve)
Silt	0.074 mm to 0.005 mm (#200 to 0.005 mm)
Clay	Smaller than 0.005 mm

Modifiers of Components - The following modifiers indicate the range of percentages of the minor soil components:

<u>Term</u>	<u>Range</u>		
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:

<u>Term</u>	<u>Range - ODOT</u>
Dry	Well below Plastic Limit
Damp	Below Plastic Limit
Moist	Above PL to 3% below LL
Wet	3% below LL to above LL

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

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

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

<u>Description</u>	<u>Field Parameter</u>
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.



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	Classification		LL _O /LL × 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
		AASHTO	OHIO							
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	76 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	76 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		76 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	76 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	76 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		76 Min.		36 Min.	41 Min.	≤ LL-30	20	
	Clay	A-7-6		76 Min.		36 Min.	41 Min.	> LL-30	20	
	Organic Silt	A-8	A-8a	75 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	75 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6
MATERIAL CLASSIFIED BY VISUAL INSPECTION										
	Sod and Topsoil									
	Pavement or Base	Uncontrolled Fill (Describe)		Bouldery Zone		Peat				

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

APPENDIX III

BORING LOGS:

B-001-0-24 TO B-004-0-24

B-001-1-24 TO B-004-1-24

B-012-0-84 TO B-015-0-84

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 (%)

	PROJECT: MOT-835-2.57	DRILLING FIRM / OPERATOR: RII / TG	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 134+83 / 30' RT.	EXPLORATION ID B-001-0-24
	TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: RII / BG	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 835	
	PID: 116922 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 883.0 (MSL) EOB: 11.8 ft.	PAGE 1 OF 1
	START: 1/4/24 END: 1/4/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.4	LAT / LONG: 39.717205, -84.108170	

MATERIAL DESCRIPTION AND NOTES		ELEV. 883.0	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	BACK FILL		
									GR	CS	FS	SI	CL	LL	PL	PI					
1.3' - ASPHALT (15.5")																					
		881.7		1																	
VERY STIFF, BROWN SILT AND CLAY , LITTLE GRAVEL AND SAND, MOIST.		880.2		2	4	3	13	78	SS-1	3.00	-	-	-	-	-	-	13	A-6a (V)			
DENSE TO MEDIUM DENSE, BROWN GRAVEL WITH SAND, SILT, AND CLAY , DAMP.				3	13	15	33	39	SS-2	-	-	-	-	-	-	-	9	A-2-6 (V)			
				4	8																
				5	8	12	36	100	SS-3	-	26	27	15	18	14	25	14	11	9	A-2-6 (0)	
				6	13	13															
				7	8	4	17	56	SS-4	-	39	18	13	18	12	-	-	-	9	A-2-6 (V)	
STIFF, BROWN SILTY CLAY , LITTLE FINE TO COARSE SAND, LITTLE GRAVEL, DAMP TO MOIST.		874.2		8	11	9	30	100	SS-5	1.25	17	17	16	25	25	36	15	21	16	A-6b (7)	
VERY STIFF, BROWN SILT AND CLAY , "AND" COARSE TO FINE SAND, TRACE TO LITTLE FINE GRAVEL, MOIST.		872.7		9	6	6	20	78	SS-6	2.50	9	13	22	35	21	28	15	13	16	A-6a (5)	
VERY STIFF, BROWN TO GRAY CLAY , SOME SILT, TRACE SAND, VERY MOIST.		871.2		11	5	8	22	89	SS-7	2.25	-	-	-	-	-	-	-	-	38	A-7-6 (V)	

EOB

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH 12.5 LBS. BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH COLD PATCH ASPHALT .

	PROJECT: MOT-835-2.57	DRILLING FIRM / OPERATOR: RII / TG	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 135+96 / 54' LT.	EXPLORATION ID B-002-0-24
	TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: RII / BG	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 835	
	PID: 116922 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 872.0 (MSL) EOB: 7.0 ft.	PAGE 1 OF 1
	START: 1/4/24 END: 1/4/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.4	LAT / LONG: 39.717410, -84.107744	

MATERIAL DESCRIPTION AND NOTES	ELEV. 872.0	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI			
MEDIUM DENSE, BROWN TO GRAY GRAVEL WITH SAND, LITTLE SILT, TRACE CLAY, MOIST.	870.0	▽ 870.0	6	8	27	0	SS-1	-	-	-	-	-	-	-	-	-		<V>
			11	9	-	100	2S-1A	-	42	23	16	14	5	NP	NP	NP	8	A-1-b (0)
MEDIUM DENSE TO DENSE, BROWN GRAVEL, SOME SAND, TRACE SILT, TRACE CLAY, WET.	868.5	W 868.5	7	6	22	0	SS-2	-	-	-	-	-	-	-	-	-		<V>
			9	7	-	50	2S-2A	-	67	15	8	-	10	-	-	-	11	A-1-a (V)
	865.0	EOB	10	11	36	64	SS-3	-	50	25	12	9	4	NP	NP	NP	11	A-1-a (0)
			14	15	39	100	SS-4	-	52	26	11	8	3	NP	NP	NP	9	A-1-a (0)
			13	7														<V>

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 3.5' AND UPON COMPLETION @2.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH 12.5 LBS. BENTONITE CHIPS AND SOIL CUTTINGS .

	PROJECT: MOT-835-2.57	DRILLING FIRM / OPERATOR: RII / TG	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 136+29 / 5' RT.	EXPLORATION ID B-003-0-24
	TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: RII / BG	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 835	
	PID: 116922 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 872.9 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
	START: 1/4/24 END: 1/4/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.4	LAT / LONG: 39.717116, -84.107658	

MATERIAL DESCRIPTION AND NOTES	ELEV. 872.9	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI			
MEDIUM DENSE, DARK BROWN SILT, SOME COARSE TO FINE SAND, LITTLE CLAY, TRACE FINE GRAVEL, WET. -TRACE ORGANICS IN SS-1	871.4	1	1 3	13	50	SS-1	-	7	7	16	55	15	NP	NP	NP	37	A-4b (7)	<V> >V<
MEDIUM DENSE, DARK BROWN GRAVEL WITH SAND, LITTLE SILT, MOIST. -TRACE ORGANICS IN SS-2	869.9	2 3	2 4	17	50	SS-2	-	55	10	10	19	6	-	-	-	11	A-1-b (V)	<V> >V<
MEDIUM DENSE, BROWN TO GRAY GRAVEL, SOME TO LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, WET.	866.9	4 5	3 8	22	33	SS-3	-	64	17	9	7	3	-	-	-	15	A-1-a (V)	<V> >V<
		6	11 8	22	75	SS-4	-	72	10	8	8	2	NP	NP	NP	13	A-1-a (0)	<V> >V<
	866.9	EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 3.0' AND UPON COMPLETION @2.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH 12.5 LBS. BENTONITE CHIPS AND SOIL CUTTINGS .

	PROJECT: MOT-835-2.57	DRILLING FIRM / OPERATOR: RII / TG	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 137+55 / 30' LT.	EXPLORATION ID B-004-0-24
	TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: RII / BG	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 835	
	PID: 116922 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 882.4 (MSL) EOB: 11.3 ft.	PAGE 1 OF 1
	START: 1/4/24 END: 1/4/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.4	LAT / LONG: 39.717307, -84.107189	

MATERIAL DESCRIPTION AND NOTES	ELEV. 882.4	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI			
1.3' - ASPHALT (15.0")	881.1	1	5															
FILL: VERY STIFF, BROWN SANDY SILT , LITTLE FINE GRAVEL, LITTLE CLAY, MOIST.		2	7	20	83	SS-1	3.25	-	-	-	-	-	-	-	-	20	A-4a (V)	
-TRACE BRICKS IN SS-2		3	6															
	877.6	4	5	17	61	SS-2	3.75	-	-	-	-	-	-	-	-	18	A-4a (V)	
					100	ST-3	2.00	-	-	-	-	-	-	-	-	11	A-4a (V)	
MEDIUM DENSE, BROWN GRAVEL WITH SAND , LITTLE SILT, TRACE CLAY, MOIST.	876.6	5	7			SS-4A	-	26	31	18	17	8	NP	NP	NP	8	A-1-b (0)	
MEDIUM DENSE, BLACK SANDY SILT , SOME FINE GRAVEL, LITTLE CLAY, MOIST.	876.1	6	9	22	83	SS-4B	-	24	19	20	26	11	NP	NP	NP	14	A-4a (0)	
-TRACE ORGANICS IN SS-4B		7	4	24	44	SS-5	3.50	23	26	13	26	12	27	15	12	9	A-6a (1)	
VERY STIFF, BROWN SILT AND CLAY , AND COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP.	874.6	8	6															
		9	8	22	78	SS-6	-	25	26	15	23	11	29	16	13	14	A-2-6 (1)	
MEDIUM DENSE, BLACK TO BROWN GRAVEL WITH SAND, SILT, AND CLAY , MOIST.	871.9	10	5															
-TRACE ASPHALT IN SS-4B - SS-7B		11	7	23	0	SS-7	-	-	-	-	-	-	-	-	-	-		
STIFF, BLACK SANDY SILT , LITTLE FINE GRAVEL, TRACE CLAY, MOIST.	871.1		10	-	83	2S-7A	1.50	13	14	26	38	9	NP	NP	NP	12	A-4a (V)	
EOB																		

NOTES: GROUNDWATER NOT ENCOUNTERED ABOVE THE DEPTH WHERE MUD WAS ADDED TO BOREHOLE. GROUNDWATER WAS NOT RECORDED AFTER MUD WAS ADDED TO BOREHOLE.
 ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH 12.5 LBS. BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH COLD PATCH ASPHALT .

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT GDT - 9/17/25 14:57 - C:\USERS\KAYLEE\DESKTOP\PIW-23-155.GPJ

	PROJECT: MOT-835-2.57	DRILLING FIRM / OPERATOR: RII / SB	DRILL RIG: MOBLE B57 (2015023)	STATION / OFFSET: 134+91 / 25' RT.	EXPLORATION ID B-001-1-24														
	TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: RII / DB	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 835															
	PID: 116922 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 8/21/23	ELEVATION: 882.7 (MSL) EOB: 109.2 ft.	PAGE 1 OF 4														
	START: 11/6/24 END: 11/8/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 80.4	LAT / LONG: 39.717220, -84.108139															
	MATERIAL DESCRIPTION AND NOTES		ELEV. 882.7	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG				ODOT CLASS (GI)
									GR	CS	FS	SI	CL	LL	PL	PI	WC		
1.5' - ASPHALT (18.0")																			
0.5' - AGGREGATE BASE (6.0")																			
VERY STIFF, BROWN SILT AND CLAY , LITTLE FINE GRAVEL, TRACE COARSE TO FINE SAND, MOIST.																			
STIFF TO VERY STIFF, BROWN SILTY CLAY , TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. -SWITCHED TO MUD ROTARY DRILLING @ 10.0'																			
MEDIUM DENSE, BROWN TO BLACK TO RED GRAVEL , LITTLE COARSE TO FINE SAND, TRACE SILT, WET.																			

[illegible]

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 9/17/25 14:33 - C:\USERS\KAYLEW\DESKTOP\W-23-155.GPJ

MATERIAL DESCRIPTION AND NOTES		ELEV. 820.6	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED		
									GR	CS	FS	SI	CL	LL	PL	PI					
MEDIUM DENSE, GRAY SILT , SOME FINE SAND, TRACE CLAY, MOIST. (continued)	+++++	811.7	63	10	21	92	SS-19	-	-	-	-	-	-	-	-	21	A-4b (V)				
	64		9	7																	
	65																				
	66																				
	67																				
	68		6	28	89	SS-20	-	-	-	-	-	-	-	18	A-4b (V)						
	69		8													13					
	70																				
	71																				
	72																				
VERY STIFF, GRAY SILT AND CLAY , TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	//////	801.7	73	5	32	100	SS-21	3.50	-	-	-	-	-	-	-	18	A-6a (V)				
	74		9	15																	
	75																				
	76																				
	77																				
	78		4	19	100	SS-22	2.50	-	-	-	-	-	-	-	20	A-6a (V)					
	79		6														8				
	80																				
	81																				
	82																				
MEDIUM DENSE TO VERY DENSE, GRAY SILT , TRACE CLAY, TRACE COARSE TO FINE SAND, WET.	+++++	801.7	83	8	21	100	SS-23	-	-	-	-	-	-	-	-	26	A-4b (V)				
	84		8	8																	
	85																				
	86																				
	87																				
	88		18	43	100	SS-24	-	-	-	-	-	-	-	21	A-4b (V)						
	89		19													13					
	90																				
	91																				
	92																				
	93		14	56	78	SS-25	-	-	-	-	-	-	-	-	24	A-4b (V)					
	94		20														22				

	PROJECT: MOT-835-2.57	DRILLING FIRM / OPERATOR: RII / IS	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 136+08 / 55' LT.		EXPLORATION ID B-002-1-24														
	TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: RII / DB	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 835																
	PID: 116922 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/21/22	ELEVATION: 871.5 (MSL) EOB: 110.0 ft.		PAGE 1 OF 4														
	START: 12/13/24 END: 12/13/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.4	LAT / LONG: 39.717411, -84.107702																
	MATERIAL DESCRIPTION AND NOTES		ELEV. 871.5	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG				ODOT CLASS (GI)	HOLE SEALED
									GR	CS	FS	SI	CL	LL	PL	PI	WC			
1.0' - TOPSOIL (12.0")		870.5	W 868.0	1	5															
DENSE, GRAYISH BROWN GRAVEL WITH SAND, TRACE SILT, WET.				2	9	22	72	SS-1A	-	-	-	-	-	-	-	-	-	16	A-1-b (V)	
				3																
				4	11	33	61	SS-2	-	-	-	-	-	-	-	9	A-1-b (V)			
				5	10															
				6	11															
				7	20	55	50	SS-3	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
				8	18															
HARD, BROWNISH GRAY SANDY SILT, SOME CLAY, LITTLE FINE GRAVEL, MOIST.		863.5		9	6															
				10	7	23	56	SS-4	4.50	13	14	22	30	21	14	6	8	9	A-4a (3)	
				11	5															
				12	6	33	67	SS-5	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
				13	17															
DENSE TO VERY DENSE, BROWN GRAVEL WITH SAND, TRACE SILT, TRACE CLAY, WET.		858.5		14	9															
				15	13	52	56	SS-6	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
				16	23															
				17	14															
				18	18	50	100	SS-7	-	48	22	19	8	3	NP	NP	NP	11	A-1-b (0)	
				19	17															
				20	10															
				21	11	35	56	SS-8	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	
				22	13															
HARD, BROWNISH GRAY SILT AND CLAY, TRACE COARSE TO FINE SAND, DAMP TO MOIST.		851.0		23	7															
				24	9	49	67	SS-9	-	0	1	1	46	52	31	16	15	18	A-6a (10)	
				25	25															
				26	10															
				27	12	33	17	SS-10	-	-	-	-	-	-	-	-	-	14	A-6a (V)	
				28	14	-	100	2S-10A	-	-	-	-	-	-	-	-	-	10	A-6a (V)	
				29	11															
				30	13															
				31	12	36	39	SS-11	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	
				32																
				33	5	27	42	SS-12	3.50	12	4	6	35	43	31	15	16	18	A-6b (10)	
				34	9															
				35	10															
VERY STIFF TO HARD, BROWNISH GRAY SILTY CLAY, LITTLE COARSE TO FINE SAND, LITTLE GRAVEL, MOIST.		845.5																		
									</											

[illegible]

[illegible]

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH BENTONITE CHIPS. PUMPED WITH 94LBS. OF CEMENT/ 25LBS. BENTONITE POWDER/ 40 GAL. WATER. .

	PROJECT: MOT-835-2.57		DRILLING FIRM / OPERATOR: RII / IS		DRILL RIG: DIEDRICH D-50 (# 313)		STATION / OFFSET: 136+35 / 49' RT.		EXPLORATION ID B-003-1-24												
	TYPE: BRIDGE REPLACEMENT		SAMPLING FIRM / LOGGER: RII / DB		HAMMER: AUTOMATIC		ALIGNMENT: CL SR 835														
	PID: 116922 SFN: NA		DRILLING METHOD: 4.5" CFA		CALIBRATION DATE: 3/21/22		ELEVATION: 872.3 (MSL) EOB: 110.0 ft.		PAGE 1 OF 4												
	START: 12/9/24 END: 12/13/24		SAMPLING METHOD: SPT		ENERGY RATIO (%): 86.4		LAT / LONG: 39.717121, -84.107637														
MATERIAL DESCRIPTION AND NOTES			ELEV. 872.3	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG				ODOT CLASS (GI)	HOLE SEALED	
										GR	CS	FS	SI	CL	LL	PL	PI	WC			
0.3' - TOPSOIL (3.0")			872.0																		
DENSE, BROWN GRAVEL WITH SAND, SILT, AND CLAY, MOIST.																					
-COBBLE ENCOUNTERED @ 3.0'			868.8	W 869.3														4	A-2-6 (V)		
MEDIUM DENSE, BROWN SANDY SILT, TRACE FINE GRAVEL, MOIST.																		12	A-2-6 (V)		
-SWITCHED TO MUD ROTARY @ 5.0'			866.8															19	A-4a (V)		
MEDIUM DENSE TO VERY DENSE, BROWN GRAVEL, SOME FINE TO COARSE SAND, TRACE SILT, TRACE CLAY, MOIST.																					

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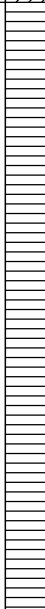
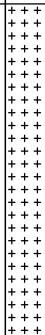
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000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT GDT - 9/17/25 14:33 - C:\USERS\KAYLEE\DESKTOP\PW-23-155.GPJ

PID: 116922	SFN: NA	PROJECT: MOT-835-2.57	STATION / OFFSET: 13635, 49' RT.	START: 12/9/24	END: 12/13/24	PG 4 OF 4	B-003-1-24														
MATERIAL DESCRIPTION AND NOTES		ELEV. 778.0	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED		
MEDIUM DENSE TO VERY DENSE, BROWNISH GRAY SILT, SOME CLAY, TRACE COARSE TO FINE SAND, MOIST. (continued)		++++ ++++ ++++ ++++ ++++	775.6	95	7	22	100	SS-25	-	-	-	-	-	-	-	-	-	24	A-4b (V)		
				96	8																
				97																	
				98																	
				99	16																
				100	15	52	100	SS-26	1.50	-	-	-	-	-	-	-	-	22	A-6a (V)		
				101	21																
				102																	
				103																	
				104	8																
				105	9	32	100	SS-27	2.50	0	0	1	58	41	25	14	11	21	A-6a (8)		
			106	13																	
			107																		
			108																		
			109	6																	
			110	7	24	100	SS-28	2.00	-	-	-	-	-	-	-	-	24	A-6a (V)			
			762.3	10																	
			EOB																		
NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 3.0' BUT COULD NOT BE DETERMINED UPON COMPLETION DUE TO ADDITION OF MUD TO BOREHOLE.																					
ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LB. CEMENT / 50 LB. BENTONITE POWDER / 80 GAL WATER. PAVEMENT PATCHED WITH CONCRETE.																					

	PROJECT: MOT-835-2.57	DRILLING FIRM / OPERATOR: RII / SB/IS	DRILL RIG: MOBLE B57 (2015023)	STATION / OFFSET: 137+48 / 31' LT.	EXPLORATION ID B-004-1-24															
	TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: RII / DB	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 835																
	PID: 116922 SFN: NA	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 8/21/23	ELEVATION: 882.1 (MSL) EOB: 109.2 ft.	PAGE 1 OF 4															
	START: 11/4/24 END: 11/6/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 80.4	LAT / LONG: 39.717313, -84.107214																
	MATERIAL DESCRIPTION AND NOTES		ELEV. 882.1	DEPTHS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG				ODOT CLASS (GI)	HOLE SEALED
1.0' - ASPHALT (12.0")		881.1																		
AGGREGATE BASE (6.0")		880.6																		
STIFF TO HARD, BROWN TO DARK BROWN SILT AND CLAY , LITTLE COARSE FINE SAND, LITTLE FINE GRAVEL, MOIST.			1																	
			2	4	6	7	17	72	SS-1	4.5+	-	-	-	-	-	-	-	15	A-6a (V)	
			3																	
			4	2	5	9	19	83	SS-2	1.50	-	-	-	-	-	-	-	15	A-6a (V)	
			5																	
			6	7	9	13	29	100	SS-3	1.25	-	-	-	-	-	-	-	13	A-6a (V)	
			7																	
			8																	
			9	3	2	4	8	28	SS-4	1.00	-	-	-	-	-	-	-	17	A-6a (V)	
			10	10			-	100	2S-4A	-	-	-	-	-	-	-	-	17	A-4a (V)	
MEDIUM DENSE TO DENSE, LIGHT BROWN GRAVEL WITH SAND , LITTLE SILT, TRACE CLAY, WET. -MUD ROTARY DRILLING STARTED @ 11.5'			11																	
			12	7	15	18	44	50	SS-5	-	-	-	-	-	-	-	9	A-1-b (V)		
			13																	
			14	6	15	14	39	44	SS-6	-	31	30	23	11	5	NP	NP	NP	14	A-1-b (0)
			15																	
			16	2	10	14	32	22	SS-7	-	-	-	-	-	-	-	-	14	A-1-b (V)	
			17																	
			18	13			-	0	2S-7A	-	-	-	-	-	-	-	-	-		
			19	8	10	17	36	44	SS-8	-	-	-	-	-	-	-	-	10	A-1-b (V)	
			20																	
VERY LOOSE, BROWN TO LIGHT BROWN GRAVEL , TRACE COARSE TO FINE SAND, TRACE SILT, WET.			21	1	0	0	0	SS-9	-	-	-	-	-	-	-	-	-			
			22																	
			23	3			-	100	SS-9A	-	90	8	1	-	1	-	-	-	15	A-1-a (V)
			24	3	14	19	44	50	SS-10	-	-	-	-	-	-	-	-	14	A-1-a (V)	
			25																	
			26																	
			27																	
			28																	
			29	10	18	20	51	67	SS-11	-	-	-	-	-	-	-	-	25	A-4a (V)	
VERY DENSE, BROWN SANDY SILT , WET.																				

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT GDT - 3/12/26 14:59 - U:\GIS\PROJECTS\2023\W-23-155.GPJ

PID: 116922	SFN: NA	PROJECT: MOT-835-2.57	STATION / OFFSET: 13748, 31' LT.		START: 11/4/24	END: 11/6/24	PG 3 OF 4		B-004-1-24												
MATERIAL DESCRIPTION AND NOTES		ELEV. 820.0	DEPTHS		SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG				ODOT CLASS (GI)	HOLE SEALED	
VERY STIFF, LIGHT BROWN SILTY CLAY , TRACE FINE SAND, MOIST. (continued)				63	4	21	100	SS-18	3.00	-	-	-	-	-	-	-	-	20	A-6a (V)		
				64	7																9
				65																	
				66																	
				67																	
				68	4																
				69	9																11
				70																	
				71																	
				72																	
STIFF TO VERY STIFF, BROWN SILTY CLAY , LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.				73	3	24	100	SS-20	2.75	2	4	6	40	48	31	15	16	19	A-6b (10)		
				74	8																10
				75																	
				76																	
				77																	
				78	3																
				79	6																7
				80																	
				81																	
				82																	
MEDIUM DENSE TO VERY DENSE, LIGHT BROWN SANDY SILT , TRACE CLAY, MOIST.				83	6	17	100	SS-21	1.75	-	-	-	-	-	-	-	22	A-6b (V)			
				84	13															12	
				85																	
				86																	
				87																	
				88	6																
				89	6															7	
				90																	
				91																	
				92																	
				93	10	71	78	SS-24	-	-	-	-	-	-	-	-	25	A-4b (V)			
				94	26															27	

[illegible]

000-23 RII STA ODOT BORING LOG (8.5X11) - OH DOT.GDT - 3/12/26 14:59 - U:\G18\PROJECTS\2023\W-23-155.GPJ

NOTES: DRILLING MUD INTRODUCED @ 11.5' TO COMBAT HEAVE. THEREFORE, GROUNDWATER WAS NOT MEASURED TO THE INTRODUCTION OF DRILLING MUD.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LB. CEMENT / 50 LB. BENTONITE POWDER / 80 GAL WATER. PAVEMENT PATCHED WITH CONCRETE. .

LOG OF BORING NO. 12

SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD,
KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)

BORING LOCATION: Sta. 48+34.2'; 44.6' Lt.

DATE STARTED: 7/18/84

SURFACE ELEVATION: 877.9'

DATE COMPLETED: 7/18/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Soft brown silt, some sand, trace of clay - damp	1A	1.0-2.5	6- 3- 2	5
5'	(Becomes stiff at 4.0')	2A	4.0-5.5	10- 8- 6	14
7.0'	Medium dense gray sand and gravel, trace of silt - wet	3A	6.5-8.0	14-11-10 ²¹	21
9.5'	Hard gray silt and fine sand, trace of gravel - moist	4A	9.0-10.5	9-17-18	35
11.0'	Very stiff gray silt, some clay, some sand, trace of gravel - moist	5A	11.5-13.0	13-11-17	28
14.5'	Very dense gray sand and gravel, trace of silt - wet	6A	14.0-15.5	20-38-25	63
19.5'		7A	16.5-18.0	17-31-28	59
20'	Very dense brown sand and gravel, trace of silt - wet	8A	19.0-20.5	39-37-40	77
25'		9A	24.0-25.5	13-32-35	67
29.5'	Hard gray silt and fine sand, trace of clay - damp (Continued on next page)	10A	29.0-30.5	40-33-35	68

METHOD: HOLLOW STEM AUGER

WATER OBSERVATIONS

TYPE SAMPLER:

TECHNICIAN: KB-DD

INITIAL DEPTH: 6.0'

☒ A. SPLIT SPOON

JOB NO.: 28129 (bw)

COMPLETION DEPTH: 6.5'

☐ B.

DEPTH AFTER: HRS.

☐ C. SHELBY TUBE

BOWSER - MORNER

LOG OF BORING NO. 12 (Second page)					
SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD, KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)					
BORING LOCATION: Sta. 48+34.2'; 44.6' Lt.			DATE STARTED: 7/18/84		
SURFACE ELEVATION: 877.9'			DATE COMPLETED: 7/18/84		
STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS / FT. OR CORE REC.
30'	(Continued)				
35'		11A	34.0-35.5	25-30-28	58
40'		12A	38.5-40.0	41-37-42	79
45'	Bottom of boring at 40.0'				
50'					
55'					
60'					
METHOD: HOLLOW STEM AUGER		WATER OBSERVATIONS		TYPE SAMPLER:	
TECHNICIAN: KB-DD		INITIAL DEPTH: 6.0'		X A. SPLIT SPOON	
JOB NO.: 28129 (bw)		COMPLETION DEPTH: 6.5'		B.	
		DEPTH AFTER: _____ HRS. _____		C. SHELBY TUBE	

BOWSER - MORNER

LOG OF BORING NO. 13					
SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD, KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)					
BORING LOCATION: Sta. 48+81.0'; 44.4' Rt.			DATE STARTED: 7/18/84		
SURFACE ELEVATION: 877.5'			DATE COMPLETED: 7/18/84		
STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.7'					
2.5'	Stiff dark brown silt, some clay, some sand, trace of gravel, trace of organic material - moist	1A	1.0-2.5	4- 5- 7	12
5'	Dense brown sand and gravel, trace of silt, trace of cobbles - wet	2A	3.5-5.0	15-16-22	38
		3A	6.0-7.5	17-17-23	40
10'	(Becomes very dense at 9.0')	4A	8.5-10.0	20-29-34	63
		5A	11.0-12.5	29-37-41	78
		6A	13.5-15.0	17-23-30	53
15'					
16.5'		1C	16.0-16.5		0"
18.5'	Medium dense gray sand, some silt, trace of gravel, trace of cobbles - wet	7A	16.5-18.0	13-13-13	26
20'					
23.5'	Hard gray silt, some clay, some sand, trace of gravel, trace of cobbles - wet	8A	18.5-20.0	17-12-19	31
25'	(With 1' to 3' sand and gravel seams at 19.0')				
	Very dense gray sand, some gravel, trace of cobbles - wet	9A	23.5-24.5	52-53	105
30'	(Becomes dense at 29.0') (Continued on next page)	10A	28.5-30.0	16-17-23	40

METHOD: HOLLOW STEM AUGER	WATER OBSERVATIONS	TYPE SAMPLER:
TECHNICIAN: DH	INITIAL DEPTH: 4.0' (heavy)	☒ A. SPLIT SPOON
JOB NO.: 28129 (bw)	COMPLETION DEPTH: 4.0'	☐ B.
	DEPTH AFTER: _____ HRS. _____	☒ C. SHELBY TUBE

BOWSER - MORNER

LOG OF BORING NO. 13 (Second page)					
SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD, KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)					
BORING LOCATION: Sta. 48+81.0'; 44.4' Rt.			DATE STARTED: 7/18/84		
SURFACE ELEVATION: 877.5'			DATE COMPLETED: 7/18/84		
STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'	(Continued)				
35'	(With 1' to 2' gray silt lenses at 34.0')	11A	33.5-35.0	15-16-30 37	46
40'	(Becomes very dense at 39.0') Bottom of boring at 40.0'	12A	38.5-40.0	23-25-28	53
45'					
50'					
55'					
60'					

METHOD: HOLLOW STEM AUGER TECHNICIAN: DH JOB NO.: 28129 (bw)	WATER OBSERVATIONS INITIAL DEPTH: 4.0' (heavy) COMPLETION DEPTH: 4.0' DEPTH AFTER: _____ HRS. _____	TYPE SAMPLER: ☒ A. SPLIT SPOON ☐ B. _____ ☒ C. SHELBY TUBE
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BOWSER - MORNER

LOG OF BORING NO. 14

SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD,
KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)

BORING LOCATION: Sta. 49+72'; 43.6' Lt.

DATE STARTED: 7/18/84

SURFACE ELEVATION: 877.2'

DATE COMPLETED: 7/18/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS / FT. OR CORE REC.
0.0'	(FILL) Hard brown silt and clay, some sand, trace of organic material, trace of cobbles, trace of asphalt, trace of wood - damp	1A	1.0-2.5	30-33-51	84
4.0'	(ORIGINAL) Medium dense brown sand and gravel, some cobbles, trace of organic material - wet	2A	3.5-5.0	16- 8- 8	16
7.0'	Medium dense brown sand and gravel, trace of cobbles, trace of silt - wet	3A	6.0-7.5	4- 7-12	19
10'	(Becomes very dense at 9.0')	4A	8.5-10.0	35-22-29	51
	(Becomes dense at 11.5')	5A	11.0-12.5	11-15-20	35
15'	(Becomes <u>very dense</u> at 14.0')	6A	13.5-15.0	15-25-34	59
		7A	16.0-17.5	15-25-30	55
20'	(Becomes dense at 18.5')	8A	18.5-20.0	17-17-18	35
25'	(Becomes very dense at 24.0')	9A	23.5-25.0	15-22-30	52
28.5'	Dense gray sand and silt, trace of gravel - wet	10A	28.5-30.0	20-22-25	47
30'	(Continued on next page)				

METHOD: HOLLOW STEM AUGER

WATER OBSERVATIONS

TYPE SAMPLER:

TECHNICIAN: DH

INITIAL DEPTH: 4.0' (heavy)

☒ A. SPLIT SPOON

JOB NO.: 28129 (bw)

COMPLETION DEPTH: 3.0'

☐ B.

DEPTH AFTER: _____ HRS. _____

☐ C. SHELBY TUBE

BOWSER - MORNER

LOG OF BORING NO. 14 (Second page)					
SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD, KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)					
BORING LOCATION: Sta. 49+72'; 43.6' Lt.			DATE STARTED: 7/18/84		
SURFACE ELEVATION: 877.2'			DATE COMPLETED: 7/18/84		
STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 8" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'	(Continued)				
35'		11A	33.5-35.0	14-22-23	45
37.0'	Hard gray silt and fine sand, some clay - moist	12A	38.5-40.0	10-14-22	36
40'	Bottom of boring at 40.0'				
45'					
50'					
55'					
60'					

METHOD: HOLLOW STEM AUGER TECHNICIAN: DH JOB NO.: 28129 (bw)	WATER OBSERVATIONS INITIAL DEPTH: <u>4.0' (heavy)</u> COMPLETION DEPTH: <u>3.0'</u> DEPTH AFTER: _____ HRS. _____	TYPE SAMPLER: ☒ A. SPLIT SPOON ☐ B. ☐ C. SHELBY TUBE
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BOWSER - MORNER

LOG OF BORING NO. 15

SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD,
KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)

BORING LOCATION: Sta. 50+20.7'; 42.6' Rt.

DATE STARTED: 7/18/84

SURFACE ELEVATION: 877.3'

DATE COMPLETED: 7/18/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 8" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
877.3 0.0'	(FILL) Stiff brown silt, some clay, some sand, trace of gravel, trace of asphalt, trace of cobbles - moist	1A	1.0-2.5	5- 5- 6	11
4.0'	(ORIGINAL) Stiff brown silt, some clay, some sand, trace of roots, trace of gravel - wet	2A	3.5-5.0	7- 7- 4	11
6.0'	Medium dense brown sand and gravel, trace of silt, trace of cobbles - wet	1C	6.0-7.0		6"
868.3 367.3 10'	(Becomes dense at 9.0')	3A 4A	7.0-8.5 8.5-10.0	15- 9- 8 8-12-20	17 32
	(Becomes medium dense at 11.5')	5A	11.0-12.5	6- 4-12	16
	(Becomes dense at 14.0')	6A	13.5-15.0	15-18-23	41
15'	(With 6" gray silt lenses at 16.5')	7A	16.0-17.5	15-12-20	32
20'	(Becomes very dense at 18.5')	8A	18.5-20.0	16-26-34	60
23.5'					
25'	Very stiff gray silt and clay, some sand, trace of gravel, trace of cobbles - moist (With 1' to 3' gray wet sand seams from 24.0')	9A	23.5-25.0	6-12-14	26
30'	(Continued on next page)	10A	28.5-30.0	9-14-16	30

METHOD: HOLLOW STEM AUGER

WATER OBSERVATIONS

TYPE SAMPLER:

TECHNICIAN: DH

INITIAL DEPTH: 4.0' (heavy)

☒ X

A. SPLIT SPOON

JOB NO.: 28129 (bw)

COMPLETION DEPTH: 3.5'

☐

B.

DEPTH AFTER: _____ HRS. _____

☒ X

C. SHELBY TUBE

BOWSER - MORNER

LOG OF BORING NO. 15 (Second page)					
SOIL STUDY FOR MOT/GRE RESEARCH BOULEVARD, KETTERING & BEAVERCREEK, OHIO (ACCORDING TO ODOT SPECIFICATIONS)					
BORING LOCATION: Sta. 50+20.7'; 42.6' Rt.			DATE STARTED: 7/18/84		
SURFACE ELEVATION: 877.3'			DATE COMPLETED: 7/18/84		
STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 8" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'	(Continued)				
35'	(Becomes hard at 34.0')	12A	33.5-35.0	12-17-22	39
37.0'	Hard gray silt and fine sand, some clay - moist	13A	38.5-40.0	14-26-22	48
40'	Bottom of boring at 40.0'				
45'					
50'					
55'					
60'					

METHOD: HOLLOW STEM AUGER TECHNICIAN: DH JOB NO.: 28129 (bw)	WATER OBSERVATIONS INITIAL DEPTH: 4.0' (heavy) COMPLETION DEPTH: 3.5' DEPTH AFTER: _____ HRS. _____	TYPE SAMPLER: ☒ A. SPLIT SPOON ☐ B. ☒ C. SHELBY TUBE
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BOWSER - MORNER

APPENDIX IV

PAVEMENT CORE DATA SHEETS



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

Pavement Core Data Summary

PROJECT MOT-835-2.57 Bridge Replacement
LOCATION Montgomery County, Ohio
JOB No. W-23-155

BORING/CORE No. B-001-0-24
DATE CORE OBTAINED 1/4/2024
CORE OBTAINED BY TG & BG

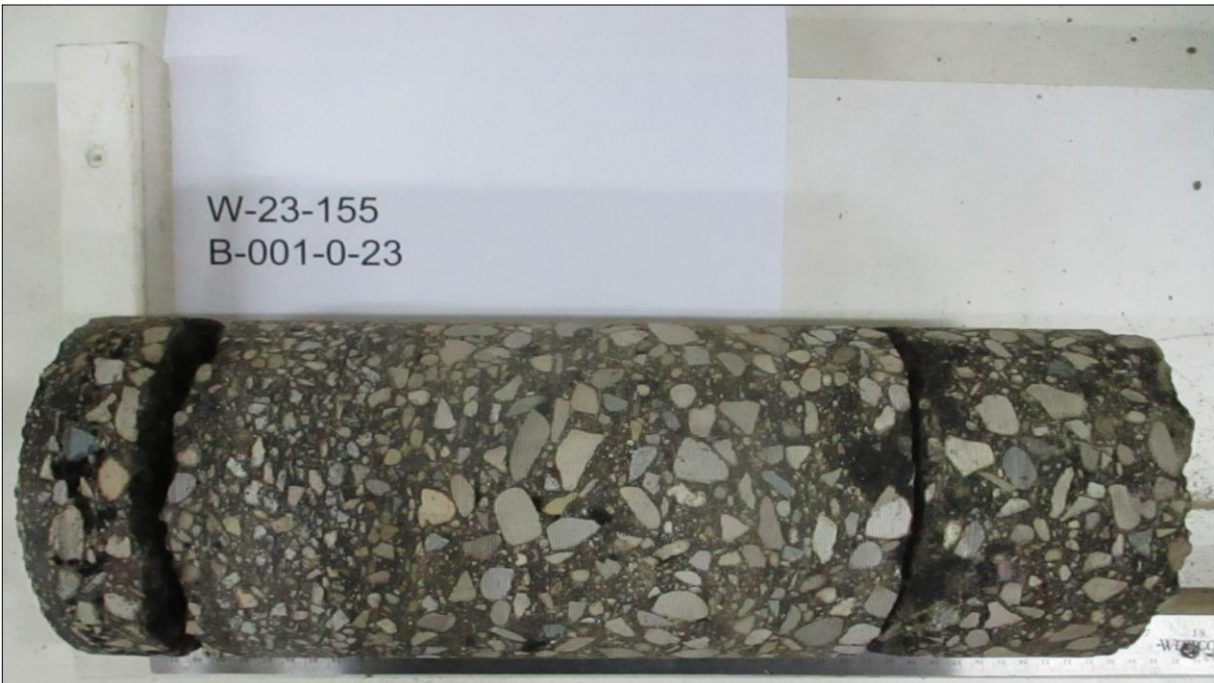
Core Composition

Comments/Remarks

Core Number	Layer Thickness (in.)	Pavement Layer Number	Asphalt			Concrete	Aggregate/Granular Base	Other		
			Surface Binder	Intermediate Binder	Base Binder					
B-001-0-24	0.25	8	✓							
	1.25	7		✓						
	0.75	6	✓							
	1.25	5	✓							
	1.25	4	✓							
	1.75	3		✓						
	4.75	2		✓						
	4.25	1		✓						

- Layer 8 is a sand mix.
- Layer 7 has voids.
- The core separated between layers 6 & 7.
- Layer 3 has some voids.
- The core separated between layers 1 & 2.

Total Pavement Thickness = 15.50 in. Total Asphalt Thickness = 15.50 in. Total Concrete Thickness = 0.00 in. Total Base Thickness = 0.00 in.





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

Pavement Core Data Summary

PROJECT MOT-835-2.57 Bridge Replacement
LOCATION Montgomery County, Ohio
JOB No. W-23-155

BORING/CORE No. B-004-0-24
DATE CORE OBTAINED 1/4/2024
CORE OBTAINED BY TG & BG

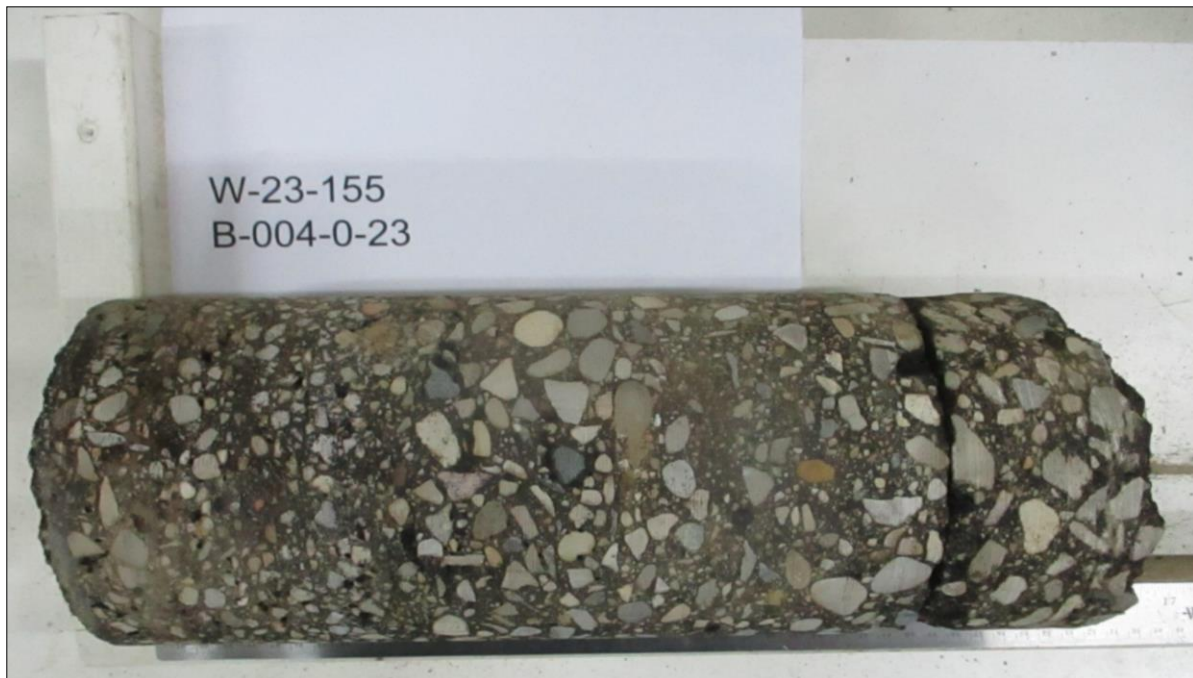
Core Composition

Comments/Remarks

Core Number	Layer Thickness (in.)	Pavement Layer Number	Asphalt			Concrete	Aggregate/Granular Base		Other	
			Surface Binder	Intermediate Binder	Base Binder					
B-004-0-24	0.25	7	✓							
	1.25	6		✓						
	1.75	5	✓							
	1.25	4	✓							
	2.75	3		✓						
	4.25	2		✓						
	3.50	1		✓						

- Layer 7 is a sand mix.
- Layers 3 - 6 have some voids.
- The core separated between layers 1 & 2.
- Layer 1 is deteriorating.

Total Pavement Thickness = 15.00 in. Total Asphalt Thickness = 15.00 in. Total Concrete Thickness = 0.00 in. Total Base Thickness = 0.00 in.



APPENDIX V

LATERAL DESIGN PARAMETERS

Soil Parameters for Lateral Load Analysis
MOT-835-2.57 Bridge Replacement; PID 116922
Montgomery County, Ohio
Rii Project Number: W-23-155

Substructure Unit (Boring)	Elevation (feet)	Soil Class.	Soil Type	Strata	N ₆₀	N ₁₆₀	γ (pcf)	γ' (pcf)	Strength Parameter	k (soil) k _{rm} (rock)	ε ₅₀ (soil) E _r (rock)	RQD (rock)
B-001-1-24 (Rear Abutment)	873.3 to 872.7	A-6a	C	2	11	22	120	57.6	Su = 1,375 psf	435 pci	0.0075	-
	872.7 to 870.2	A-1-a	G	4	16	32	125	62.6	φ = 38°	165 pci	18,000 psi	-
	870.2 to 865.2	A-6a	C	2	16	25	125	62.6	Su = 2,000 psf	665 pci	0.0063	-
	865.2 to 855.2	A-1-b	G	4	43	56	130	67.6	φ = 39°	190 pci	18,000 psi	-
	855.2 to 848.2	A-4b	G	4	42	47	130	67.6	φ = 34°	90 pci	18,000 psi	-
	848.2 to 842.2	A-4b	G	4	23	24	125	62.6	φ = 31°	50 pci	18,000 psi	-
	842.2 to 827.2	A-6b	C	2	12	11	125	62.6	Su = 1,500 psf	500 pci	0.0070	-
	827.2 to 812.2	A-4b	G	4	28	23	130	67.6	φ = 31°	50 pci	18,000 psi	-
	812.2 to 802.2	A-6a	C	2	25	19	125	62.6	Su = 3,125 psf	1,040 pci	0.0050	-
	802.2 to 797.2	A-4b	G	4	21	15	125	62.6	φ = 29°	30 pci	18,000 psi	-
	797.2 to 792.2	A-4b	G	4	43	30	130	67.6	φ = 32°	60 pci	18,000 psi	-
	792.2 to 778.2	A-4b	G	4	60	39	135	72.6	φ = 33°	75 pci	18,000 psi	-
	778.2 to 774.2	A-4b	G	4	24	15	125	62.6	φ = 29°	30 pci	18,000 psi	-
B-002-1-24 (Pier 1)	866.8 to 863.5	A-1-b	G	4	55	107	135	72.6	φ = 40°	215 pci	18,000 psi	-
	863.5 to 858.5	A-4a	C	2	28	43	125	62.6	Su = 3,500 psf	1,165 pci	0.0048	-
	858.5 to 851.0	A-1-b	G	4	45	59	130	67.6	φ = 40°	215 pci	18,000 psi	-
	851.0 to 845.5	A-6a	C	2	40	46	130	67.6	Su = 4,000 psf	1,335 pci	0.0047	-
	845.5 to 834.5	A-6b	C	2	29	30	125	62.6	Su = 3,625 psf	1,210 pci	0.0048	-
	834.5 to 829.5	A-4b	G	4	20	19	125	62.6	φ = 30°	35 pci	18,000 psi	-
	829.5 to 819.5	A-4b	G	4	31	28	130	67.6	φ = 32°	60 pci	18,000 psi	-
	819.5 to 799.5	A-6a	C	2	25	20	125	62.6	Su = 3,125 psf	1,040 pci	0.0050	-
	799.5 to 794.5	A-6a	C	2	23	17	125	62.6	Su = 2,000 psf	665 pci	0.0063	-
	794.5 to 784.5	A-4b	G	4	23	16	125	62.6	φ = 29°	30 pci	18,000 psi	-
	784.5 to 774.5	A-4b	G	4	30	20	130	67.6	φ = 30°	35 pci	18,000 psi	-
	774.5 to 766.5	A-4b	G	4	48	30	135	72.6	φ = 32°	60 pci	18,000 psi	-
	766.5 to 761.5	A-4b	G	4	65	39	135	72.6	φ = 33°	75 pci	18,000 psi	-
B-003-1-24 (Pier 2)	866.2 to 864.2	A-1-a	G	4	112	224	135	72.6	φ = 41°	240 pci	18,000 psi	-
	864.2 to 861.7	A-1-a	G	4	71	122	135	72.6	φ = 41°	240 pci	18,000 psi	-
	861.7 to 859.7	A-1-a	G	4	23	36	125	62.6	φ = 38°	165 pci	18,000 psi	-
	859.7 to 857.2	A-1-a	G	4	36	52	130	67.6	φ = 40°	215 pci	18,000 psi	-
	857.2 to 854.7	A-6a	C	2	19	26	125	62.6	Su = 2,375 psf	790 pci	0.0058	-
	854.7 to 849.7	A-1-a	G	4	28	35	130	67.6	φ = 38°	165 pci	18,000 psi	-
	849.7 to 844.7	A-1-a	G	4	37	43	130	67.6	φ = 39°	190 pci	18,000 psi	-
	844.7 to 841.2	A-1-a	G	4	48	52	135	72.6	φ = 40°	215 pci	18,000 psi	-
	841.2 to 801.2	A-6a	C	2	41	35	130	67.6	Su = 5,125 psf	1,710 pci	0.0043	-
	801.2 to 791.2	A-4b	G	4	28	20	130	67.6	φ = 30°	35 pci	18,000 psi	-
	791.2 to 781.2	A-4b	G	4	62	41	135	72.6	φ = 34°	90 pci	18,000 psi	-
	781.2 to 771.2	A-4b	G	4	22	14	125	62.6	φ = 29°	30 pci	18,000 psi	-
	771.2 to 761.2	A-6a	C	2	52	31	130	67.6	Su = 6,500 psf	2,165 pci	0.0038	-
	761.2 to 758.2	A-6a	C	2	24	14	125	62.6	Su = 3,000 psf	1,000 pci	0.0050	-
B-004-1-24 (Forward Abutment)	872.4 to 872.2	A-6a	C	3	8	16	120	120	Su = 1,000 psf	235 pci	0.0090	-
	872.2 to 861.7	A-1-b	G	4	37	56	130	67.6	φ = 39°	190 pci	18,000 psi	-
	861.7 to 859.2	A-1-a	G	4	0	0	115	52.6	φ = 28°	20 pci	18,000 psi	-
	859.2 to 854.2	A-1-a	G	4	44	53	130	67.6	φ = 40°	215 pci	18,000 psi	-
	854.2 to 851.2	A-4a	G	4	51	57	135	72.6	φ = 35°	105 pci	18,000 psi	-
	851.2 to 836.2	A-4b	G	4	41	41	130	67.6	φ = 34°	90 pci	18,000 psi	-
	836.2 to 831.2	A-6a	C	2	15	14	125	62.6	Su = 1,875 psf	625 pci	0.0065	-
	831.2 to 811.2	A-6a	C	2	24	20	125	62.6	Su = 3,000 psf	1,000 pci	0.0050	-
	811.2 to 796.2	A-6b	C	2	25	18	125	62.6	Su = 3,125 psf	1,040 pci	0.0050	-
	796.2 to 791.2	A-4a	G	4	17	12	125	62.6	φ = 28°	20 pci	18,000 psi	-
	791.2 to 786.2	A-4a	G	4	71	47	135	72.6	φ = 34°	90 pci	18,000 psi	-
	786.2 to 776.2	A-6a	C	2	20	13	125	62.6	Su = 2,500 psf	835 pci	0.0057	-
	776.2 to 773.2	A-6a	C	2	11	7	120	57.6	Su = 1,375 psf	435 pci	0.0075	-

1. C = cohesive soil stratum; G = granular soil stratum

2. γ = total unit weight

3. γ' = effective unit weight

4. S_u = average undrained shear strength (cohesive soil layers); φ = internal angle of friction (granular layers)

5. k = soil modulus parameter (static loading)

6. ε₅₀ = strain factor

7. E_r = Initial modulus of rock mass

APPENDIX VI

GRLWEAP DRIVABILITY & DRIVENPILES ANLAYSIS OUTPUTS

DrivenPiles - Report

General Project Information

Filename: C:\Users\Legacy\Documents\W-23-155\Rear Abutment\Rear Abutment (B-001-1-24).dvn
Project Name: MOT-835-2.57 (Rear Abutment/B-001-1-24)
Project Client: Korda
Prepared By: DEK
Project Manager: DEK

Pile Information

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 14.00 in

Nominal Considerations

Water Table Depth At Time Of:

Drilling: 0.00 ft
Driving/Restrike: 0.00 ft
Nominal: 0.00 ft

Nominal Considations:

Local Scour: 0.00 ft
Long Term Scour: 0.00 ft
Soft Soil: 0.00 ft

Nominal Profile

Layer	Soil Type	Thickness	Setup Factor	Unit Weight	Strength	Nominal Curve
1	Cohesive	1.10 ft	1.750	120.00 pcf	1375.00 psf	T-80 Same
2	Cohesionless	2.50 ft	1.000	125.00 pcf	40.0/40.0	Nordlund
3	Cohesive	5.50 ft	1.500	125.00 pcf	2000.00 psf	T-80 Same
4	Cohesionless	9.50 ft	1.000	130.00 pcf	42.0/42.0	Nordlund
5	Cohesionless	8.00 ft	1.500	130.00 pcf	37.0/37.0	Nordlund
6	Cohesionless	5.00 ft	1.500	125.00 pcf	33.0/33.0	Nordlund
7	Cohesive	15.00 ft	1.750	125.00 pcf	1500.00 psf	T-80 Same
8	Cohesionless	15.00 ft	1.500	130.00 pcf	32.0/32.0	Nordlund
9	Cohesive	10.00 ft	1.500	125.00 pcf	3125.00 psf	T-80 Same
10	Cohesionless	5.00 ft	1.500	125.00 pcf	31.0/31.0	Nordlund
11	Cohesionless	10.00 ft	1.500	130.00 pcf	34.0/34.0	Nordlund
12	Cohesionless	10.00 ft	1.500	135.00 pcf	37.0/37.0	Nordlund
13	Cohesionless	3.20 ft	1.500	125.00 pcf	31.0/31.0	Nordlund

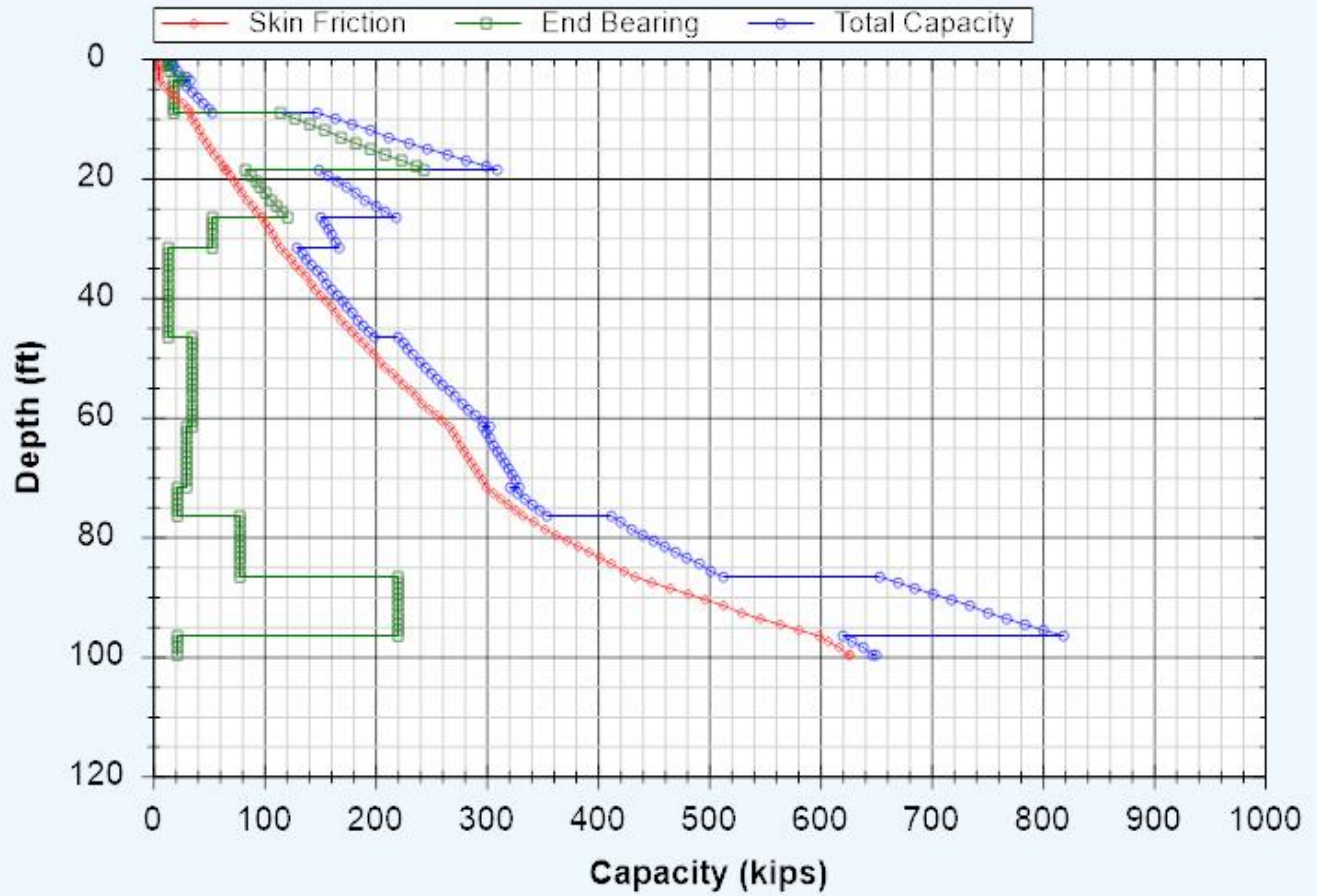
Restrike - Summary of Capacities

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 kips	13.23 kips	13.27 kips
1.00 ft	4.32 kips	13.23 kips	17.55 kips
1.09 ft	4.71 kips	13.23 kips	17.94 kips
1.11 ft	4.76 kips	8.21 kips	12.97 kips
2.10 ft	5.11 kips	16.16 kips	21.27 kips
3.10 ft	5.71 kips	24.19 kips	29.90 kips
3.59 ft	6.08 kips	28.12 kips	34.21 kips
3.61 ft	6.14 kips	19.24 kips	25.38 kips
4.60 ft	11.13 kips	19.24 kips	30.37 kips
5.60 ft	16.17 kips	19.24 kips	35.41 kips
6.60 ft	21.21 kips	19.24 kips	40.45 kips
7.60 ft	26.25 kips	19.24 kips	45.49 kips
8.60 ft	31.29 kips	19.24 kips	50.53 kips
9.09 ft	33.76 kips	19.24 kips	53.00 kips
9.11 ft	33.83 kips	114.03 kips	147.87 kips
10.10 ft	36.09 kips	127.55 kips	163.64 kips
11.10 ft	38.63 kips	141.19 kips	179.83 kips
12.10 ft	41.43 kips	154.84 kips	196.27 kips
13.10 ft	44.48 kips	168.49 kips	212.97 kips
14.10 ft	47.79 kips	182.14 kips	229.93 kips
15.10 ft	51.36 kips	195.78 kips	247.15 kips
16.10 ft	55.19 kips	209.43 kips	264.62 kips
17.10 ft	59.28 kips	223.08 kips	282.36 kips
18.10 ft	63.62 kips	236.73 kips	300.35 kips
18.59 ft	65.84 kips	243.42 kips	309.26 kips
18.61 ft	65.92 kips	83.26 kips	149.18 kips
19.60 ft	69.30 kips	87.87 kips	157.17 kips
20.60 ft	72.89 kips	92.54 kips	165.43 kips
21.60 ft	76.67 kips	97.20 kips	173.87 kips
22.60 ft	80.64 kips	101.86 kips	182.50 kips
23.60 ft	84.79 kips	106.53 kips	191.31 kips
24.60 ft	89.13 kips	111.19 kips	200.31 kips
25.60 ft	93.65 kips	115.85 kips	209.50 kips
26.59 ft	98.31 kips	120.47 kips	218.78 kips
26.61 ft	98.39 kips	53.45 kips	151.84 kips
27.60 ft	101.45 kips	53.45 kips	154.90 kips
28.60 ft	104.64 kips	53.45 kips	158.09 kips
29.60 ft	107.95 kips	53.45 kips	161.40 kips
30.60 ft	111.36 kips	53.45 kips	164.81 kips
31.59 ft	114.85 kips	53.45 kips	168.30 kips
31.61 ft	114.93 kips	14.43 kips	129.36 kips
32.60 ft	119.44 kips	14.43 kips	133.87 kips

Depth	Skin Friction	End Bearing	Total Capacity
33.60 ft	123.99 kips	14.43 kips	138.42 kips
34.60 ft	128.55 kips	14.43 kips	142.98 kips
35.60 ft	133.10 kips	14.43 kips	147.54 kips
36.60 ft	137.66 kips	14.43 kips	152.09 kips
37.60 ft	142.22 kips	14.43 kips	156.65 kips
38.60 ft	146.77 kips	14.43 kips	161.20 kips
39.60 ft	151.33 kips	14.43 kips	165.76 kips
40.60 ft	155.88 kips	14.43 kips	170.31 kips
41.60 ft	160.44 kips	14.43 kips	174.87 kips
42.60 ft	164.99 kips	14.43 kips	179.43 kips
43.60 ft	169.66 kips	14.43 kips	184.09 kips
44.60 ft	174.57 kips	14.43 kips	189.00 kips
45.60 ft	179.54 kips	14.43 kips	193.97 kips
46.59 ft	184.51 kips	14.43 kips	198.94 kips
46.61 ft	184.61 kips	35.28 kips	219.89 kips
47.60 ft	189.32 kips	35.28 kips	224.60 kips
48.60 ft	194.19 kips	35.28 kips	229.47 kips
49.60 ft	199.17 kips	35.28 kips	234.44 kips
50.60 ft	204.25 kips	35.28 kips	239.52 kips
51.60 ft	209.43 kips	35.28 kips	244.71 kips
52.60 ft	214.72 kips	35.28 kips	250.00 kips
53.60 ft	220.12 kips	35.28 kips	255.40 kips
54.60 ft	225.63 kips	35.28 kips	260.90 kips
55.60 ft	231.24 kips	35.28 kips	266.51 kips
56.60 ft	236.95 kips	35.28 kips	272.23 kips
57.60 ft	242.77 kips	35.28 kips	278.05 kips
58.60 ft	248.70 kips	35.28 kips	283.98 kips
59.60 ft	254.74 kips	35.28 kips	290.02 kips
60.60 ft	260.88 kips	35.28 kips	296.16 kips
61.59 ft	267.06 kips	35.28 kips	302.34 kips
61.61 ft	267.16 kips	30.07 kips	297.22 kips
62.60 ft	270.34 kips	30.07 kips	300.41 kips
63.60 ft	273.56 kips	30.07 kips	303.62 kips
64.60 ft	276.77 kips	30.07 kips	306.84 kips
65.60 ft	279.99 kips	30.07 kips	310.05 kips
66.60 ft	283.20 kips	30.07 kips	313.27 kips
67.60 ft	286.42 kips	30.07 kips	316.49 kips
68.60 ft	289.63 kips	30.07 kips	319.70 kips
69.60 ft	292.85 kips	30.07 kips	322.92 kips
70.60 ft	296.07 kips	30.07 kips	326.13 kips
71.59 ft	299.25 kips	30.07 kips	329.31 kips
71.61 ft	299.35 kips	22.09 kips	321.44 kips

Depth	Skin Friction	End Bearing	Total Capacity
72.60 ft	305.85 kips	22.09 kips	327.94 kips
73.60 ft	312.51 kips	22.09 kips	334.60 kips
74.60 ft	319.26 kips	22.09 kips	341.35 kips
75.60 ft	326.10 kips	22.09 kips	348.19 kips
76.59 ft	332.96 kips	22.09 kips	355.05 kips
76.61 ft	333.12 kips	78.59 kips	411.71 kips
77.60 ft	342.53 kips	78.59 kips	421.12 kips
78.60 ft	352.15 kips	78.59 kips	430.75 kips
79.60 ft	361.91 kips	78.59 kips	440.51 kips
80.60 ft	371.80 kips	78.59 kips	450.39 kips
81.60 ft	381.81 kips	78.59 kips	460.41 kips
82.60 ft	391.95 kips	78.59 kips	470.55 kips
83.60 ft	402.23 kips	78.59 kips	480.82 kips
84.60 ft	412.63 kips	78.59 kips	491.22 kips
85.60 ft	423.16 kips	78.59 kips	501.75 kips
86.59 ft	433.71 kips	78.59 kips	512.30 kips
86.61 ft	433.97 kips	220.26 kips	654.23 kips
87.60 ft	449.39 kips	220.26 kips	669.65 kips
88.60 ft	465.15 kips	220.26 kips	685.41 kips
89.60 ft	481.12 kips	220.26 kips	701.38 kips
90.60 ft	497.29 kips	220.26 kips	717.55 kips
91.60 ft	513.66 kips	220.26 kips	733.92 kips
92.60 ft	530.22 kips	220.26 kips	750.48 kips
93.60 ft	546.99 kips	220.26 kips	767.25 kips
94.60 ft	563.96 kips	220.26 kips	784.22 kips
95.60 ft	581.12 kips	220.26 kips	801.38 kips
96.59 ft	598.31 kips	220.26 kips	818.57 kips
96.61 ft	598.58 kips	22.09 kips	620.67 kips
97.60 ft	607.47 kips	22.09 kips	629.56 kips
98.60 ft	616.55 kips	22.09 kips	638.64 kips
99.60 ft	625.71 kips	22.09 kips	647.80 kips
99.79 ft	627.46 kips	22.09 kips	649.55 kips

Bearing Capacity - Restrike



Driving - Summary of Capacities

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.02 kips	13.23 kips	13.25 kips
1.00 ft	2.47 kips	13.23 kips	15.70 kips
1.09 ft	2.69 kips	13.23 kips	15.92 kips
1.11 ft	2.72 kips	8.21 kips	10.93 kips
2.10 ft	3.07 kips	16.16 kips	19.23 kips
3.10 ft	3.67 kips	24.19 kips	27.86 kips
3.59 ft	4.04 kips	28.12 kips	32.17 kips
3.61 ft	4.09 kips	19.24 kips	23.33 kips
4.60 ft	7.41 kips	19.24 kips	26.66 kips
5.60 ft	10.77 kips	19.24 kips	30.02 kips
6.60 ft	14.13 kips	19.24 kips	33.38 kips
7.60 ft	17.49 kips	19.24 kips	36.74 kips
8.60 ft	20.85 kips	19.24 kips	40.10 kips
9.09 ft	22.50 kips	19.24 kips	41.74 kips
9.11 ft	22.56 kips	114.03 kips	136.59 kips
10.10 ft	24.81 kips	127.55 kips	152.36 kips
11.10 ft	27.35 kips	141.19 kips	168.55 kips
12.10 ft	30.15 kips	154.84 kips	184.99 kips
13.10 ft	33.20 kips	168.49 kips	201.69 kips
14.10 ft	36.51 kips	182.14 kips	218.65 kips
15.10 ft	40.08 kips	195.78 kips	235.87 kips
16.10 ft	43.91 kips	209.43 kips	253.34 kips
17.10 ft	48.00 kips	223.08 kips	271.08 kips
18.10 ft	52.34 kips	236.73 kips	289.07 kips
18.59 ft	54.56 kips	243.42 kips	297.98 kips
18.61 ft	54.63 kips	83.26 kips	137.89 kips
19.60 ft	56.88 kips	87.87 kips	144.75 kips
20.60 ft	59.28 kips	92.54 kips	151.81 kips
21.60 ft	61.80 kips	97.20 kips	159.00 kips
22.60 ft	64.44 kips	101.86 kips	166.30 kips
23.60 ft	67.21 kips	106.53 kips	173.73 kips
24.60 ft	70.10 kips	111.19 kips	181.29 kips
25.60 ft	73.12 kips	115.85 kips	188.97 kips
26.59 ft	76.22 kips	120.47 kips	196.69 kips
26.61 ft	76.28 kips	53.45 kips	129.73 kips
27.60 ft	78.31 kips	53.45 kips	131.76 kips
28.60 ft	80.44 kips	53.45 kips	133.90 kips
29.60 ft	82.65 kips	53.45 kips	136.10 kips
30.60 ft	84.92 kips	53.45 kips	138.37 kips
31.59 ft	87.25 kips	53.45 kips	140.70 kips
31.61 ft	87.30 kips	14.43 kips	101.73 kips
32.60 ft	89.87 kips	14.43 kips	104.31 kips

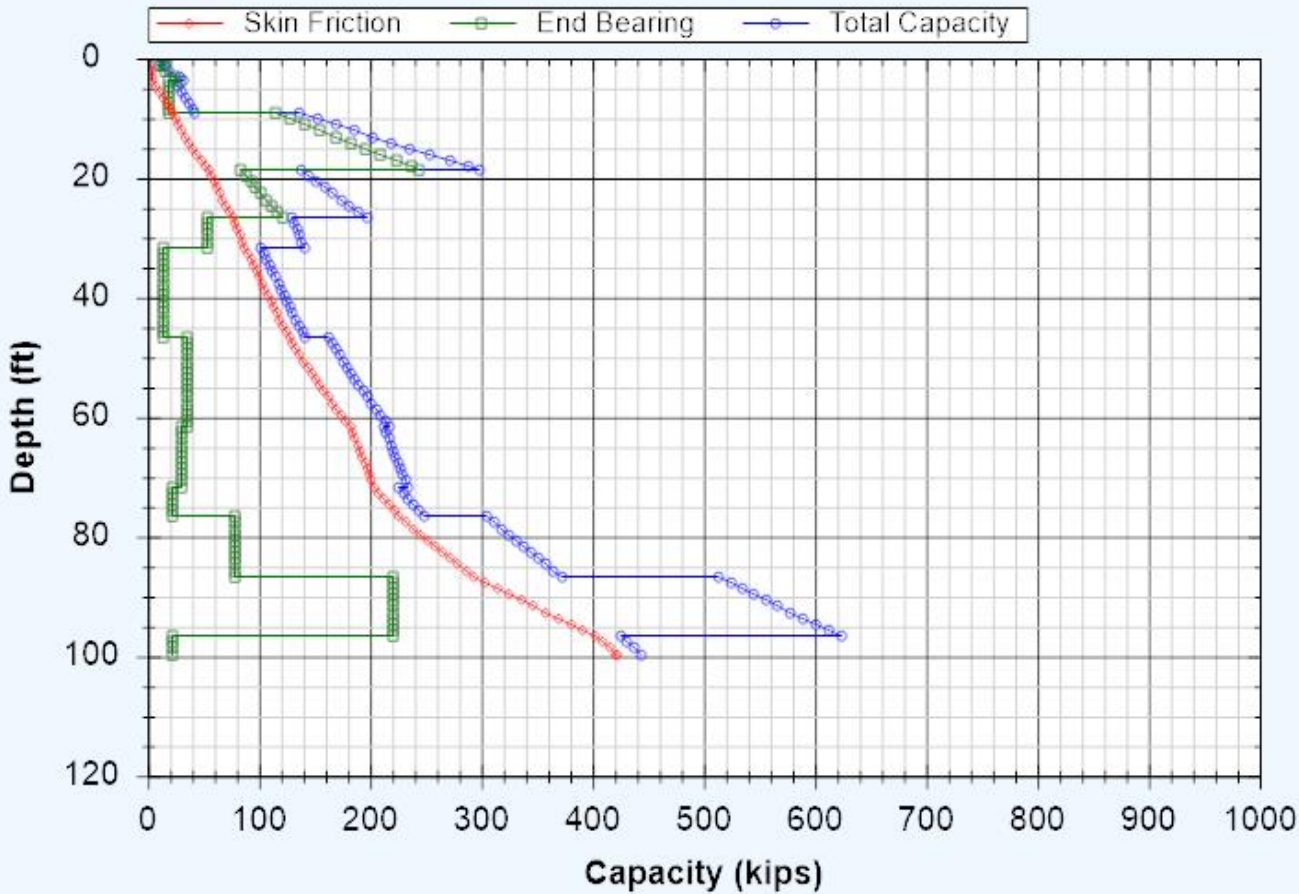
Depth	Skin Friction	End Bearing	Total Capacity
33.60 ft	92.48 kips	14.43 kips	106.91 kips
34.60 ft	95.08 kips	14.43 kips	109.51 kips
35.60 ft	97.68 kips	14.43 kips	112.12 kips
36.60 ft	100.29 kips	14.43 kips	114.72 kips
37.60 ft	102.89 kips	14.43 kips	117.32 kips
38.60 ft	105.49 kips	14.43 kips	119.92 kips
39.60 ft	108.10 kips	14.43 kips	122.53 kips
40.60 ft	110.70 kips	14.43 kips	125.13 kips
41.60 ft	113.30 kips	14.43 kips	127.73 kips
42.60 ft	115.91 kips	14.43 kips	130.34 kips
43.60 ft	118.57 kips	14.43 kips	133.00 kips
44.60 ft	121.38 kips	14.43 kips	135.81 kips
45.60 ft	124.22 kips	14.43 kips	138.65 kips
46.59 ft	127.06 kips	14.43 kips	141.49 kips
46.61 ft	127.12 kips	35.28 kips	162.40 kips
47.60 ft	130.26 kips	35.28 kips	165.54 kips
48.60 ft	133.51 kips	35.28 kips	168.78 kips
49.60 ft	136.82 kips	35.28 kips	172.10 kips
50.60 ft	140.21 kips	35.28 kips	175.49 kips
51.60 ft	143.67 kips	35.28 kips	178.94 kips
52.60 ft	147.19 kips	35.28 kips	182.47 kips
53.60 ft	150.79 kips	35.28 kips	186.07 kips
54.60 ft	154.46 kips	35.28 kips	189.74 kips
55.60 ft	158.20 kips	35.28 kips	193.48 kips
56.60 ft	162.01 kips	35.28 kips	197.29 kips
57.60 ft	165.90 kips	35.28 kips	201.17 kips
58.60 ft	169.85 kips	35.28 kips	205.13 kips
59.60 ft	173.87 kips	35.28 kips	209.15 kips
60.60 ft	177.97 kips	35.28 kips	213.24 kips
61.59 ft	182.09 kips	35.28 kips	217.37 kips
61.61 ft	182.15 kips	30.07 kips	212.22 kips
62.60 ft	184.28 kips	30.07 kips	214.34 kips
63.60 ft	186.42 kips	30.07 kips	216.49 kips
64.60 ft	188.56 kips	30.07 kips	218.63 kips
65.60 ft	190.71 kips	30.07 kips	220.77 kips
66.60 ft	192.85 kips	30.07 kips	222.92 kips
67.60 ft	194.99 kips	30.07 kips	225.06 kips
68.60 ft	197.14 kips	30.07 kips	227.20 kips
69.60 ft	199.28 kips	30.07 kips	229.35 kips
70.60 ft	201.42 kips	30.07 kips	231.49 kips
71.59 ft	203.55 kips	30.07 kips	233.61 kips
71.61 ft	203.61 kips	22.09 kips	225.70 kips

Depth	Skin Friction	End Bearing	Total Capacity
72.60 ft	207.95 kips	22.09 kips	230.04 kips
73.60 ft	212.39 kips	22.09 kips	234.48 kips
74.60 ft	216.89 kips	22.09 kips	238.98 kips
75.60 ft	221.45 kips	22.09 kips	243.54 kips
76.59 ft	226.02 kips	22.09 kips	248.11 kips
76.61 ft	226.13 kips	78.59 kips	304.72 kips
77.60 ft	232.40 kips	78.59 kips	311.00 kips
78.60 ft	238.82 kips	78.59 kips	317.41 kips
79.60 ft	245.32 kips	78.59 kips	323.92 kips
80.60 ft	251.91 kips	78.59 kips	330.51 kips
81.60 ft	258.59 kips	78.59 kips	337.18 kips
82.60 ft	265.35 kips	78.59 kips	343.94 kips
83.60 ft	272.20 kips	78.59 kips	350.79 kips
84.60 ft	279.13 kips	78.59 kips	357.73 kips
85.60 ft	286.15 kips	78.59 kips	364.75 kips
86.59 ft	293.19 kips	78.59 kips	371.78 kips
86.61 ft	293.36 kips	220.26 kips	513.62 kips
87.60 ft	303.64 kips	220.26 kips	523.90 kips
88.60 ft	314.15 kips	220.26 kips	534.41 kips
89.60 ft	324.80 kips	220.26 kips	545.06 kips
90.60 ft	335.57 kips	220.26 kips	555.83 kips
91.60 ft	346.49 kips	220.26 kips	566.75 kips
92.60 ft	357.53 kips	220.26 kips	577.79 kips
93.60 ft	368.71 kips	220.26 kips	588.97 kips
94.60 ft	380.02 kips	220.26 kips	600.28 kips
95.60 ft	391.46 kips	220.26 kips	611.72 kips
96.59 ft	402.92 kips	220.26 kips	623.18 kips
96.61 ft	403.10 kips	22.09 kips	425.19 kips
97.60 ft	409.03 kips	22.09 kips	431.12 kips
98.60 ft	415.08 kips	22.09 kips	437.17 kips
99.60 ft	421.19 kips	22.09 kips	443.28 kips
99.79 ft	422.35 kips	22.09 kips	444.44 kips

76.6 feet at 266 kips

At EOID, there would be an additional 21.1 feet of driving (76.6 - 55.5) required to meet the UBV compared to nominal. Since this is greater than 10 feet, setup should be included.

Bearing Capacity - Driving



Nominal - Summary of Capacities

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 kips	13.23 kips	13.27 kips
1.00 ft	4.32 kips	13.23 kips	17.55 kips
1.09 ft	4.71 kips	13.23 kips	17.94 kips
1.11 ft	4.76 kips	8.21 kips	12.97 kips
2.10 ft	5.11 kips	16.16 kips	21.27 kips
3.10 ft	5.71 kips	24.19 kips	29.90 kips
3.59 ft	6.08 kips	28.12 kips	34.21 kips
3.61 ft	6.14 kips	19.24 kips	25.38 kips
4.60 ft	11.13 kips	19.24 kips	30.37 kips
5.60 ft	16.17 kips	19.24 kips	35.41 kips
6.60 ft	21.21 kips	19.24 kips	40.45 kips
7.60 ft	26.25 kips	19.24 kips	45.49 kips
8.60 ft	31.29 kips	19.24 kips	50.53 kips
9.09 ft	33.76 kips	19.24 kips	53.00 kips
9.11 ft	33.83 kips	114.03 kips	147.87 kips
10.10 ft	36.09 kips	127.55 kips	163.64 kips
11.10 ft	38.63 kips	141.19 kips	179.83 kips
12.10 ft	41.43 kips	154.84 kips	196.27 kips
13.10 ft	44.48 kips	168.49 kips	212.97 kips
14.10 ft	47.79 kips	182.14 kips	229.93 kips
15.10 ft	51.36 kips	195.78 kips	247.15 kips
16.10 ft	55.19 kips	209.43 kips	264.62 kips
17.10 ft	59.28 kips	223.08 kips	282.36 kips
18.10 ft	63.62 kips	236.73 kips	300.35 kips
18.59 ft	65.84 kips	243.42 kips	309.26 kips
18.61 ft	65.92 kips	83.26 kips	149.18 kips
19.60 ft	69.30 kips	87.87 kips	157.17 kips
20.60 ft	72.89 kips	92.54 kips	165.43 kips
21.60 ft	76.67 kips	97.20 kips	173.87 kips
22.60 ft	80.64 kips	101.86 kips	182.50 kips
23.60 ft	84.79 kips	106.53 kips	191.31 kips
24.60 ft	89.13 kips	111.19 kips	200.31 kips
25.60 ft	93.65 kips	115.85 kips	209.50 kips
26.59 ft	98.31 kips	120.47 kips	218.78 kips
26.61 ft	98.39 kips	53.45 kips	151.84 kips
27.60 ft	101.45 kips	53.45 kips	154.90 kips
28.60 ft	104.64 kips	53.45 kips	158.09 kips
29.60 ft	107.95 kips	53.45 kips	161.40 kips
30.60 ft	111.36 kips	53.45 kips	164.81 kips
31.59 ft	114.85 kips	53.45 kips	168.30 kips
31.61 ft	114.93 kips	14.43 kips	129.36 kips
32.60 ft	119.44 kips	14.43 kips	133.87 kips

Depth	Skin Friction	End Bearing	Total Capacity
33.60 ft	123.99 kips	14.43 kips	138.42 kips
34.60 ft	128.55 kips	14.43 kips	142.98 kips
35.60 ft	133.10 kips	14.43 kips	147.54 kips
36.60 ft	137.66 kips	14.43 kips	152.09 kips
37.60 ft	142.22 kips	14.43 kips	156.65 kips
38.60 ft	146.77 kips	14.43 kips	161.20 kips
39.60 ft	151.33 kips	14.43 kips	165.76 kips
40.60 ft	155.88 kips	14.43 kips	170.31 kips
41.60 ft	160.44 kips	14.43 kips	174.87 kips
42.60 ft	164.99 kips	14.43 kips	179.43 kips
43.60 ft	169.66 kips	14.43 kips	184.09 kips
44.60 ft	174.57 kips	14.43 kips	189.00 kips
45.60 ft	179.54 kips	14.43 kips	193.97 kips
46.59 ft	184.51 kips	14.43 kips	198.94 kips
46.61 ft	184.61 kips	35.28 kips	219.89 kips
47.60 ft	189.32 kips	35.28 kips	224.60 kips
48.60 ft	194.19 kips	35.28 kips	229.47 kips
49.60 ft	199.17 kips	35.28 kips	234.44 kips
50.60 ft	204.25 kips	35.28 kips	239.52 kips
51.60 ft	209.43 kips	35.28 kips	244.71 kips
52.60 ft	214.72 kips	35.28 kips	250.00 kips
53.60 ft	220.12 kips	35.28 kips	255.40 kips
54.60 ft	225.63 kips	35.28 kips	260.90 kips
55.60 ft	231.24 kips	35.28 kips	266.51 kips
56.60 ft	236.95 kips	35.28 kips	272.23 kips
57.60 ft	242.77 kips	35.28 kips	278.05 kips
58.60 ft	248.70 kips	35.28 kips	283.98 kips
59.60 ft	254.74 kips	35.28 kips	290.02 kips
60.60 ft	260.88 kips	35.28 kips	296.16 kips
61.59 ft	267.06 kips	35.28 kips	302.34 kips
61.61 ft	267.16 kips	30.07 kips	297.22 kips
62.60 ft	270.34 kips	30.07 kips	300.41 kips
63.60 ft	273.56 kips	30.07 kips	303.62 kips
64.60 ft	276.77 kips	30.07 kips	306.84 kips
65.60 ft	279.99 kips	30.07 kips	310.05 kips
66.60 ft	283.20 kips	30.07 kips	313.27 kips
67.60 ft	286.42 kips	30.07 kips	316.49 kips
68.60 ft	289.63 kips	30.07 kips	319.70 kips
69.60 ft	292.85 kips	30.07 kips	322.92 kips
70.60 ft	296.07 kips	30.07 kips	326.13 kips
71.59 ft	299.25 kips	30.07 kips	329.31 kips
71.61 ft	299.35 kips	22.09 kips	321.44 kips

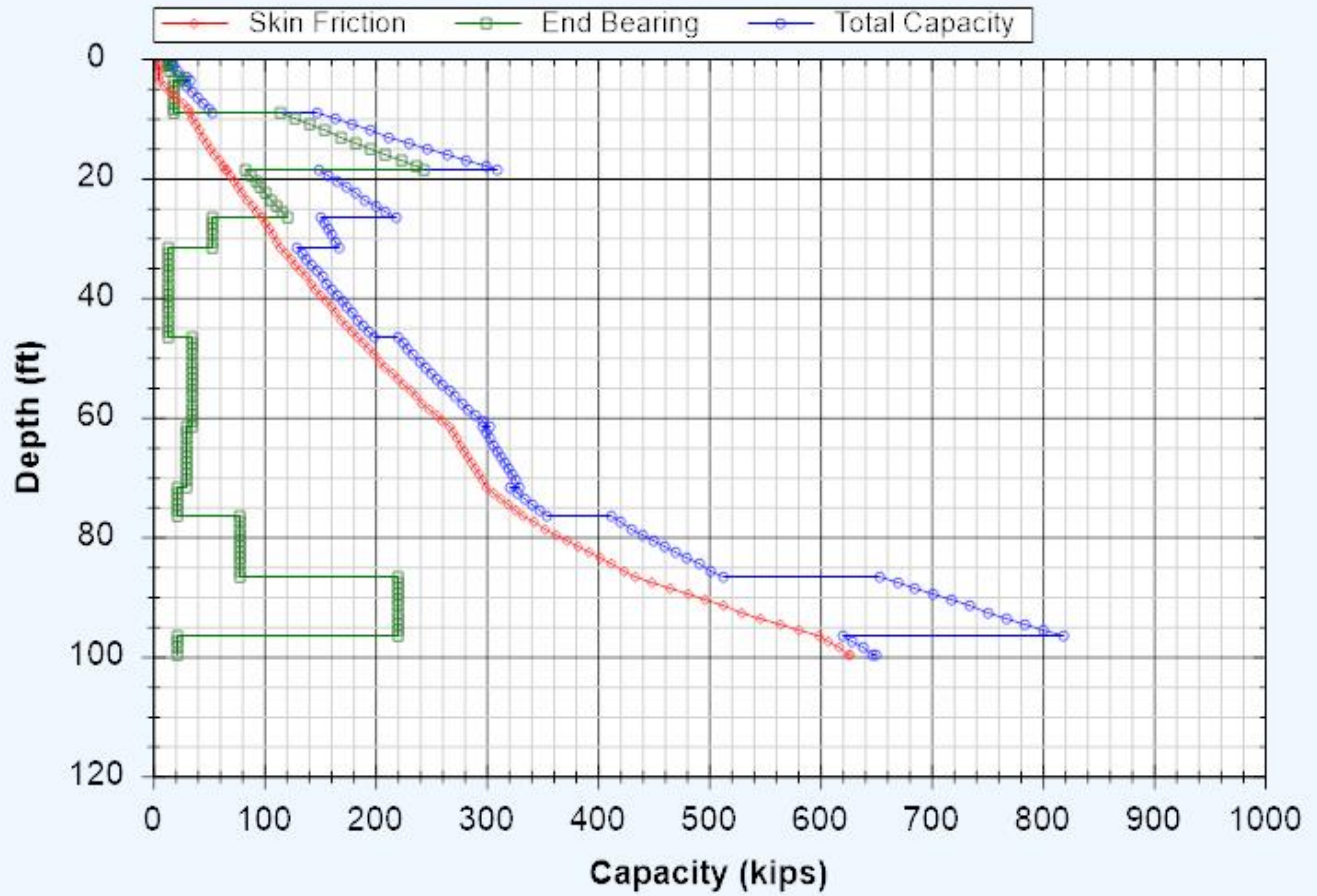
Setup:

$266.0/193.48 = 1.375$

$1.2 < fsu < 1.4 = 7 \text{ days to restrike}$

Depth	Skin Friction	End Bearing	Total Capacity
72.60 ft	305.85 kips	22.09 kips	327.94 kips
73.60 ft	312.51 kips	22.09 kips	334.60 kips
74.60 ft	319.26 kips	22.09 kips	341.35 kips
75.60 ft	326.10 kips	22.09 kips	348.19 kips
76.59 ft	332.96 kips	22.09 kips	355.05 kips
76.61 ft	333.12 kips	78.59 kips	411.71 kips
77.60 ft	342.53 kips	78.59 kips	421.12 kips
78.60 ft	352.15 kips	78.59 kips	430.75 kips
79.60 ft	361.91 kips	78.59 kips	440.51 kips
80.60 ft	371.80 kips	78.59 kips	450.39 kips
81.60 ft	381.81 kips	78.59 kips	460.41 kips
82.60 ft	391.95 kips	78.59 kips	470.55 kips
83.60 ft	402.23 kips	78.59 kips	480.82 kips
84.60 ft	412.63 kips	78.59 kips	491.22 kips
85.60 ft	423.16 kips	78.59 kips	501.75 kips
86.59 ft	433.71 kips	78.59 kips	512.30 kips
86.61 ft	433.97 kips	220.26 kips	654.23 kips
87.60 ft	449.39 kips	220.26 kips	669.65 kips
88.60 ft	465.15 kips	220.26 kips	685.41 kips
89.60 ft	481.12 kips	220.26 kips	701.38 kips
90.60 ft	497.29 kips	220.26 kips	717.55 kips
91.60 ft	513.66 kips	220.26 kips	733.92 kips
92.60 ft	530.22 kips	220.26 kips	750.48 kips
93.60 ft	546.99 kips	220.26 kips	767.25 kips
94.60 ft	563.96 kips	220.26 kips	784.22 kips
95.60 ft	581.12 kips	220.26 kips	801.38 kips
96.59 ft	598.31 kips	220.26 kips	818.57 kips
96.61 ft	598.58 kips	22.09 kips	620.67 kips
97.60 ft	607.47 kips	22.09 kips	629.56 kips
98.60 ft	616.55 kips	22.09 kips	638.64 kips
99.60 ft	625.71 kips	22.09 kips	647.80 kips
99.79 ft	627.46 kips	22.09 kips	649.55 kips

Bearing Capacity - Nominal



DrivenPiles - Report

General Project Information

Filename: C:\Users\Legacy\Documents\W-23-155\Pier 1\Pier 1 (B-002-1-24).dvn
Project Name: MOT-835-2.57 (Pier 1/B-002-1-24)
Project Client: Korda
Prepared By: DEK
Project Manager: DEK

Pile Information

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 14.00 in

Nominal Considerations

Water Table Depth At Time Of:

Drilling: 0.00 ft
Driving/Restrike: 0.00 ft
Nominal: 0.00 ft

Nominal Considations:

Local Scour: 0.00 ft
Long Term Scour: 0.88 ft
Soft Soil: 0.00 ft

Nominal Profile

Layer	Soil Type	Thickness	Setup Factor	Unit Weight	Strength	Nominal Curve
1	Cohesionless	0.80 ft	1.000	130.00 pcf	42.0/42.0	Nordlund
2	Cohesionless	2.50 ft	1.000	135.00 pcf	43.0/43.0	Nordlund
3	Cohesive	5.00 ft	1.500	125.00 pcf	3500.00 psf	T-80 Same
4	Cohesionless	7.50 ft	1.000	130.00 pcf	42.0/42.0	Nordlund
5	Cohesive	5.50 ft	1.500	130.00 pcf	4000.00 psf	T-80 Same
6	Cohesive	11.00 ft	1.750	125.00 pcf	3625.00 psf	T-80 Same
7	Cohesionless	5.00 ft	1.500	125.00 pcf	32.0/32.0	Nordlund
8	Cohesionless	9.70 ft	1.500	130.00 pcf	34.0/34.0	Nordlund
9	Cohesive	20.30 ft	1.500	125.00 pcf	3125.00 psf	T-80 Same
10	Cohesive	4.70 ft	1.500	125.00 pcf	2000.00 psf	T-80 Same
11	Cohesionless	10.30 ft	1.500	125.00 pcf	31.0/31.0	Nordlund
12	Cohesionless	5.00 ft	1.500	130.00 pcf	33.0/33.0	Nordlund
13	Cohesionless	5.00 ft	1.500	135.00 pcf	36.0/36.0	Nordlund
14	Cohesionless	23.00 ft	1.500	135.00 pcf	36.0/36.0	Nordlund

Restrike - Summary of Capacities

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 kips	0.14 kips	0.14 kips
0.79 ft	0.08 kips	10.78 kips	10.86 kips
0.81 ft	0.08 kips	14.10 kips	14.19 kips
0.87 ft	0.10 kips	15.22 kips	15.32 kips
0.89 ft	0.10 kips	15.60 kips	15.70 kips
1.88 ft	0.47 kips	34.09 kips	34.56 kips
2.88 ft	1.12 kips	52.77 kips	53.88 kips
3.29 ft	1.46 kips	60.43 kips	61.89 kips
3.31 ft	1.50 kips	33.67 kips	35.18 kips
4.30 ft	4.61 kips	33.67 kips	38.28 kips
5.30 ft	7.75 kips	33.67 kips	41.42 kips
6.30 ft	10.89 kips	33.67 kips	44.56 kips
7.30 ft	14.03 kips	33.67 kips	47.70 kips
8.29 ft	17.13 kips	33.67 kips	50.81 kips
8.31 ft	17.19 kips	110.89 kips	128.07 kips
9.30 ft	19.39 kips	124.40 kips	143.79 kips
10.30 ft	21.86 kips	138.05 kips	159.91 kips
11.30 ft	24.60 kips	151.70 kips	176.30 kips
12.30 ft	27.60 kips	165.34 kips	192.94 kips
13.30 ft	30.85 kips	178.99 kips	209.84 kips
14.30 ft	34.36 kips	192.64 kips	227.00 kips
15.30 ft	38.13 kips	206.29 kips	244.41 kips
15.79 ft	40.07 kips	212.97 kips	253.04 kips
15.81 ft	40.14 kips	38.48 kips	78.63 kips
16.80 ft	43.60 kips	38.48 kips	82.08 kips
17.80 ft	47.09 kips	38.48 kips	85.57 kips
18.80 ft	50.57 kips	38.48 kips	89.06 kips
19.80 ft	54.06 kips	38.48 kips	92.55 kips
20.80 ft	57.55 kips	38.48 kips	96.04 kips
21.29 ft	59.26 kips	38.48 kips	97.75 kips
21.31 ft	59.33 kips	34.88 kips	94.21 kips
22.30 ft	62.49 kips	34.88 kips	97.36 kips
23.30 ft	65.67 kips	34.88 kips	100.55 kips
24.30 ft	68.86 kips	34.88 kips	103.74 kips
25.30 ft	72.05 kips	34.88 kips	106.92 kips
26.30 ft	75.23 kips	34.88 kips	110.11 kips
27.30 ft	78.42 kips	34.88 kips	113.30 kips
28.30 ft	81.61 kips	34.88 kips	116.49 kips
29.30 ft	84.80 kips	34.88 kips	119.67 kips
30.30 ft	87.98 kips	34.88 kips	122.86 kips
31.30 ft	91.17 kips	34.88 kips	126.05 kips
32.29 ft	94.33 kips	34.88 kips	129.20 kips

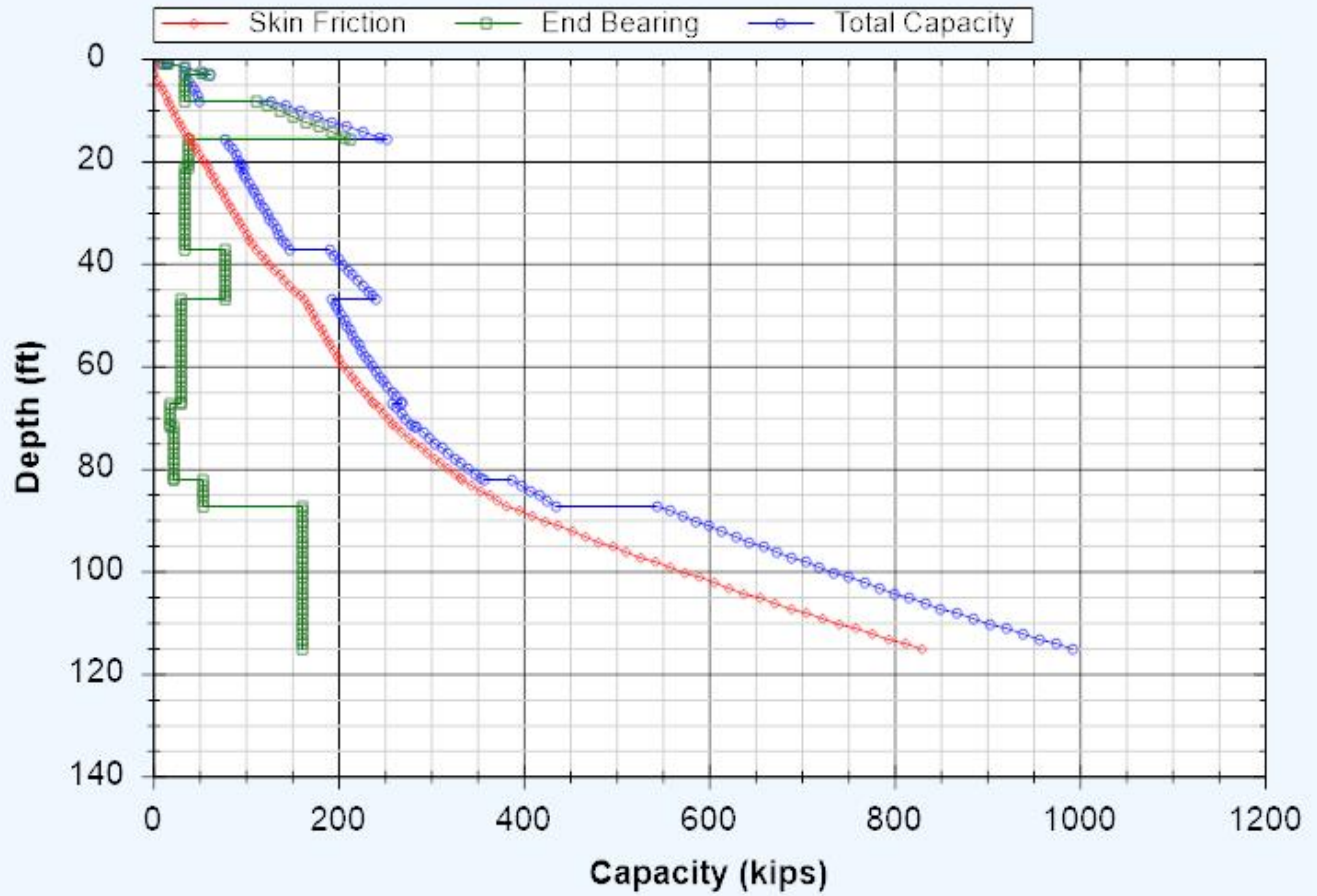
Depth	Skin Friction	End Bearing	Total Capacity
32.31 ft	94.39 kips	35.28 kips	129.67 kips
33.30 ft	97.73 kips	35.28 kips	133.01 kips
34.30 ft	101.20 kips	35.28 kips	136.48 kips
35.30 ft	104.77 kips	35.28 kips	140.04 kips
36.30 ft	108.43 kips	35.28 kips	143.71 kips
37.29 ft	112.16 kips	35.28 kips	147.44 kips
37.31 ft	112.24 kips	78.59 kips	190.84 kips
38.30 ft	116.89 kips	78.59 kips	195.48 kips
39.30 ft	121.71 kips	78.59 kips	200.30 kips
40.30 ft	126.66 kips	78.59 kips	205.25 kips
41.30 ft	131.74 kips	78.59 kips	210.33 kips
42.30 ft	136.95 kips	78.59 kips	215.54 kips
43.30 ft	142.28 kips	78.59 kips	220.88 kips
44.30 ft	147.75 kips	78.59 kips	226.34 kips
45.30 ft	153.34 kips	78.59 kips	231.93 kips
46.30 ft	159.06 kips	78.59 kips	237.66 kips
46.99 ft	163.09 kips	78.59 kips	241.68 kips
47.01 ft	163.18 kips	30.07 kips	193.24 kips
48.00 ft	166.36 kips	30.07 kips	196.43 kips
49.00 ft	169.58 kips	30.07 kips	199.64 kips
50.00 ft	172.79 kips	30.07 kips	202.86 kips
51.00 ft	176.01 kips	30.07 kips	206.07 kips
52.00 ft	179.22 kips	30.07 kips	209.29 kips
53.00 ft	182.44 kips	30.07 kips	212.50 kips
54.00 ft	185.65 kips	30.07 kips	215.72 kips
55.00 ft	188.87 kips	30.07 kips	218.93 kips
56.00 ft	192.08 kips	30.07 kips	222.15 kips
57.00 ft	195.30 kips	30.07 kips	225.37 kips
58.00 ft	198.52 kips	30.07 kips	228.58 kips
59.00 ft	201.97 kips	30.07 kips	232.04 kips
60.00 ft	206.00 kips	30.07 kips	236.06 kips
61.00 ft	210.14 kips	30.07 kips	240.21 kips
62.00 ft	214.41 kips	30.07 kips	244.47 kips
63.00 ft	218.80 kips	30.07 kips	248.86 kips
64.00 ft	223.30 kips	30.07 kips	253.37 kips
65.00 ft	227.93 kips	30.07 kips	258.00 kips
66.00 ft	232.69 kips	30.07 kips	262.75 kips
67.00 ft	237.56 kips	30.07 kips	267.62 kips
67.29 ft	238.99 kips	30.07 kips	269.06 kips
67.31 ft	239.09 kips	19.24 kips	258.34 kips
68.30 ft	244.08 kips	19.24 kips	263.33 kips
69.30 ft	249.12 kips	19.24 kips	268.37 kips

Depth	Skin Friction	End Bearing	Total Capacity
70.30 ft	254.16 kips	19.24 kips	273.41 kips
71.30 ft	259.21 kips	19.24 kips	278.45 kips
71.99 ft	262.68 kips	19.24 kips	281.93 kips
72.01 ft	262.80 kips	22.09 kips	284.89 kips
73.00 ft	269.32 kips	22.09 kips	291.41 kips
74.00 ft	276.00 kips	22.09 kips	298.09 kips
75.00 ft	282.76 kips	22.09 kips	73.25 feet at 293.08 kips
76.00 ft	289.61 kips	22.09 kips	311.70 kips
77.00 ft	296.55 kips	22.09 kips	318.64 kips
78.00 ft	303.58 kips	22.09 kips	325.67 kips
79.00 ft	310.70 kips	22.09 kips	332.79 kips
80.00 ft	317.90 kips	22.09 kips	339.99 kips
81.00 ft	325.19 kips	22.09 kips	347.28 kips
82.00 ft	332.57 kips	22.09 kips	354.67 kips
82.29 ft	334.73 kips	22.09 kips	356.82 kips
82.31 ft	334.90 kips	53.45 kips	388.35 kips
83.30 ft	344.06 kips	53.45 kips	397.51 kips
84.30 ft	353.42 kips	53.45 kips	406.87 kips
85.30 ft	362.91 kips	53.45 kips	416.36 kips
86.30 ft	372.51 kips	53.45 kips	425.96 kips
87.29 ft	382.13 kips	53.45 kips	435.58 kips
87.31 ft	382.36 kips	162.06 kips	544.43 kips
88.30 ft	395.89 kips	162.06 kips	557.95 kips
89.30 ft	409.72 kips	162.06 kips	571.79 kips
90.30 ft	423.73 kips	162.06 kips	585.80 kips
91.30 ft	437.92 kips	162.06 kips	599.98 kips
92.29 ft	452.14 kips	162.06 kips	614.20 kips
92.31 ft	452.42 kips	162.06 kips	614.49 kips
93.30 ft	466.82 kips	162.06 kips	628.88 kips
94.30 ft	481.53 kips	162.06 kips	643.59 kips
95.30 ft	496.41 kips	162.06 kips	658.47 kips
96.30 ft	511.47 kips	162.06 kips	673.53 kips
97.30 ft	526.71 kips	162.06 kips	688.77 kips
98.30 ft	542.12 kips	162.06 kips	704.18 kips
99.30 ft	557.70 kips	162.06 kips	719.76 kips
100.30 ft	573.46 kips	162.06 kips	735.52 kips
101.30 ft	589.40 kips	162.06 kips	751.46 kips
102.30 ft	605.51 kips	162.06 kips	767.57 kips
103.30 ft	621.79 kips	162.06 kips	783.85 kips
104.30 ft	638.25 kips	162.06 kips	800.31 kips
105.30 ft	654.89 kips	162.06 kips	816.95 kips
106.30 ft	671.69 kips	162.06 kips	833.76 kips

At scour condition, 289.0 kips.
At non-scour condition, 293.08 kips. Therefore, additional 7.08 kips of resistance to overcome during pile installation.

Depth	Skin Friction	End Bearing	Total Capacity
107.30 ft	688.68 kips	162.06 kips	850.74 kips
108.30 ft	705.84 kips	162.06 kips	867.90 kips
109.30 ft	723.17 kips	162.06 kips	885.24 kips
110.30 ft	740.68 kips	162.06 kips	902.75 kips
111.30 ft	758.37 kips	162.06 kips	920.43 kips
112.30 ft	776.23 kips	162.06 kips	938.29 kips
113.30 ft	794.26 kips	162.06 kips	956.32 kips
114.30 ft	812.47 kips	162.06 kips	974.53 kips
115.29 ft	830.67 kips	162.06 kips	992.73 kips

Bearing Capacity - Restrike



Driving - Summary of Capacities

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 kips	0.14 kips	0.14 kips
0.79 ft	0.08 kips	10.78 kips	10.86 kips
0.81 ft	0.08 kips	14.10 kips	14.19 kips
0.87 ft	0.10 kips	15.22 kips	15.32 kips
0.89 ft	0.10 kips	15.60 kips	15.70 kips
1.88 ft	0.47 kips	34.09 kips	34.56 kips
2.88 ft	1.12 kips	52.77 kips	53.88 kips
3.29 ft	1.46 kips	60.43 kips	61.89 kips
3.31 ft	1.49 kips	33.67 kips	35.16 kips
4.30 ft	3.56 kips	33.67 kips	37.24 kips
5.30 ft	5.66 kips	33.67 kips	39.33 kips
6.30 ft	7.75 kips	33.67 kips	41.42 kips
7.30 ft	9.84 kips	33.67 kips	43.51 kips
8.29 ft	11.91 kips	33.67 kips	45.59 kips
8.31 ft	11.95 kips	110.89 kips	122.84 kips
9.30 ft	14.15 kips	124.40 kips	138.55 kips
10.30 ft	16.63 kips	138.05 kips	154.68 kips
11.30 ft	19.37 kips	151.70 kips	171.07 kips
12.30 ft	22.36 kips	165.34 kips	187.71 kips
13.30 ft	25.62 kips	178.99 kips	204.61 kips
14.30 ft	29.13 kips	192.64 kips	221.77 kips
15.30 ft	32.90 kips	206.29 kips	239.18 kips
15.79 ft	34.84 kips	212.97 kips	247.81 kips
15.81 ft	34.90 kips	38.48 kips	73.38 kips
16.80 ft	37.20 kips	38.48 kips	75.69 kips
17.80 ft	39.53 kips	38.48 kips	78.01 kips
18.80 ft	41.85 kips	38.48 kips	80.34 kips
19.80 ft	44.18 kips	38.48 kips	82.66 kips
20.80 ft	46.51 kips	38.48 kips	84.99 kips
21.29 ft	47.65 kips	38.48 kips	86.13 kips
21.31 ft	47.69 kips	34.88 kips	82.56 kips
22.30 ft	49.49 kips	34.88 kips	84.37 kips
23.30 ft	51.31 kips	34.88 kips	86.19 kips
24.30 ft	53.13 kips	34.88 kips	88.01 kips
25.30 ft	54.95 kips	34.88 kips	89.83 kips
26.30 ft	56.78 kips	34.88 kips	91.65 kips
27.30 ft	58.60 kips	34.88 kips	93.47 kips
28.30 ft	60.42 kips	34.88 kips	95.30 kips
29.30 ft	62.24 kips	34.88 kips	97.12 kips
30.30 ft	64.06 kips	34.88 kips	98.94 kips
31.30 ft	65.88 kips	34.88 kips	100.76 kips
32.29 ft	67.69 kips	34.88 kips	102.56 kips

Depth	Skin Friction	End Bearing	Total Capacity
32.31 ft	67.73 kips	35.28 kips	103.00 kips
33.30 ft	69.95 kips	35.28 kips	105.23 kips
34.30 ft	72.26 kips	35.28 kips	107.54 kips
35.30 ft	74.64 kips	35.28 kips	109.92 kips
36.30 ft	77.09 kips	35.28 kips	112.36 kips
37.29 ft	79.57 kips	35.28 kips	114.85 kips
37.31 ft	79.63 kips	78.59 kips	158.22 kips
38.30 ft	82.72 kips	78.59 kips	161.32 kips
39.30 ft	85.94 kips	78.59 kips	164.53 kips
40.30 ft	89.24 kips	78.59 kips	167.83 kips
41.30 ft	92.62 kips	78.59 kips	171.22 kips
42.30 ft	96.09 kips	78.59 kips	174.69 kips
43.30 ft	99.65 kips	78.59 kips	178.25 kips
44.30 ft	103.30 kips	78.59 kips	181.89 kips
45.30 ft	107.02 kips	78.59 kips	185.62 kips
46.30 ft	110.84 kips	78.59 kips	189.43 kips
46.99 ft	113.52 kips	78.59 kips	192.12 kips
47.01 ft	113.58 kips	30.07 kips	143.65 kips
48.00 ft	115.70 kips	30.07 kips	145.77 kips
49.00 ft	117.85 kips	30.07 kips	147.91 kips
50.00 ft	119.99 kips	30.07 kips	150.06 kips
51.00 ft	122.14 kips	30.07 kips	152.20 kips
52.00 ft	124.28 kips	30.07 kips	154.35 kips
53.00 ft	126.42 kips	30.07 kips	156.49 kips
54.00 ft	128.57 kips	30.07 kips	158.63 kips
55.00 ft	130.71 kips	30.07 kips	160.78 kips
56.00 ft	132.85 kips	30.07 kips	162.92 kips
57.00 ft	135.00 kips	30.07 kips	165.06 kips
58.00 ft	137.14 kips	30.07 kips	167.21 kips
59.00 ft	139.45 kips	30.07 kips	169.51 kips
60.00 ft	142.13 kips	30.07 kips	172.20 kips
61.00 ft	144.89 kips	30.07 kips	174.96 kips
62.00 ft	147.74 kips	30.07 kips	177.80 kips
63.00 ft	150.66 kips	30.07 kips	180.73 kips
64.00 ft	153.67 kips	30.07 kips	183.74 kips
65.00 ft	156.76 kips	30.07 kips	186.82 kips
66.00 ft	159.92 kips	30.07 kips	189.99 kips
67.00 ft	163.17 kips	30.07 kips	193.24 kips
67.29 ft	164.13 kips	30.07 kips	194.20 kips
67.31 ft	164.20 kips	19.24 kips	183.44 kips
68.30 ft	167.52 kips	19.24 kips	186.77 kips
69.30 ft	170.88 kips	19.24 kips	190.13 kips

Depth	Skin Friction	End Bearing	Total Capacity
70.30 ft	174.24 kips	19.24 kips	193.49 kips
71.30 ft	177.60 kips	19.24 kips	196.85 kips
71.99 ft	179.92 kips	19.24 kips	199.17 kips
72.01 ft	180.00 kips	22.09 kips	202.09 kips
73.00 ft	184.35 kips	22.09 kips	206.44 kips
74.00 ft	188.80 kips	22.09 kips	210.89 kips
75.00 ft	193.31 kips	22.09 kips	215.40 kips
76.00 ft	197.88 kips	22.09 kips	219.97 kips
77.00 ft	202.50 kips	22.09 kips	224.59 kips
78.00 ft	207.19 kips	22.09 kips	229.28 kips
79.00 ft	211.93 kips	22.09 kips	234.02 kips
80.00 ft	216.74 kips	22.09 kips	238.83 kips
81.00 ft	221.60 kips	22.09 kips	243.69 kips
82.00 ft	226.52 kips	22.09 kips	248.61 kips
82.29 ft	227.96 kips	22.09 kips	250.05 kips
82.31 ft	228.07 kips	53.45 kips	281.52 kips
83.30 ft	234.17 kips	53.45 kips	287.62 kips
84.30 ft	240.42 kips	53.45 kips	293.87 kips
85.30 ft	246.74 kips	53.45 kips	300.19 kips
86.30 ft	253.14 kips	53.45 kips	306.59 kips
87.30 ft	259.55 kips	53.45 kips	313.01 kips
88.30 ft	259.71 kips	162.06 kips	421.77 kips
89.30 ft	268.73 kips	162.06 kips	430.79 kips
90.30 ft	277.95 kips	162.06 kips	440.01 kips
91.30 ft	287.29 kips	162.06 kips	449.35 kips
92.29 ft	306.22 kips	162.06 kips	468.29 kips
92.31 ft	306.42 kips	162.06 kips	468.48 kips
93.30 ft	316.01 kips	162.06 kips	478.07 kips
94.30 ft	325.82 kips	162.06 kips	487.88 kips
95.30 ft	335.74 kips	162.06 kips	497.81 kips
96.30 ft	345.78 kips	162.06 kips	507.85 kips
97.30 ft	355.94 kips	162.06 kips	518.00 kips
98.30 ft	366.21 kips	162.06 kips	528.28 kips
99.30 ft	376.61 kips	162.06 kips	538.67 kips
100.30 ft	387.11 kips	162.06 kips	549.18 kips
101.30 ft	397.74 kips	162.06 kips	559.80 kips
102.30 ft	408.48 kips	162.06 kips	570.54 kips
103.30 ft	419.33 kips	162.06 kips	581.40 kips
104.30 ft	430.31 kips	162.06 kips	592.37 kips
105.30 ft	441.40 kips	162.06 kips	603.46 kips
106.30 ft	452.60 kips	162.06 kips	614.67 kips

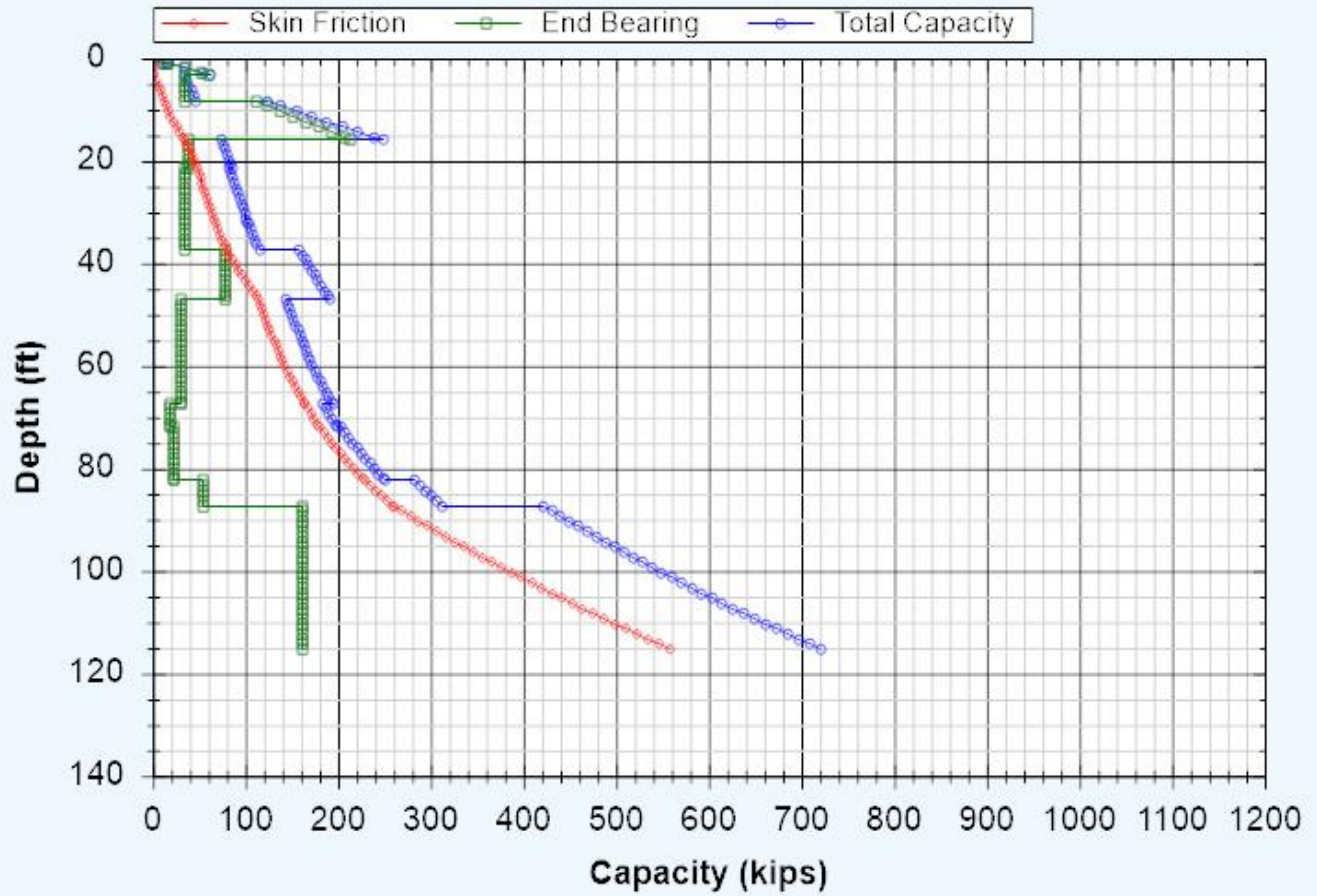
At EOID, there would be an additional 10.27 feet of driving (83.52 - 73.25) required to meet the UBV compared to nominal. Since this is greater than 10 feet, setup should be included.

73.25 feet at 207.55 kips

83.52 feet at 289.0 kips

Depth	Skin Friction	End Bearing	Total Capacity
107.30 ft	463.93 kips	162.06 kips	625.99 kips
108.30 ft	475.37 kips	162.06 kips	637.43 kips
109.30 ft	486.93 kips	162.06 kips	648.99 kips
110.30 ft	498.60 kips	162.06 kips	660.66 kips
111.30 ft	510.39 kips	162.06 kips	672.45 kips
112.30 ft	522.30 kips	162.06 kips	684.36 kips
113.30 ft	534.32 kips	162.06 kips	696.38 kips
114.30 ft	546.46 kips	162.06 kips	708.52 kips
115.29 ft	558.59 kips	162.06 kips	720.66 kips

Bearing Capacity - Driving



Nominal - Summary of Capacities

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 kips	0.00 kips	0.00 kips
0.79 ft	0.00 kips	0.00 kips	0.00 kips
0.81 ft	0.00 kips	0.00 kips	0.00 kips
0.87 ft	0.00 kips	0.00 kips	0.00 kips
0.89 ft	0.00 kips	0.19 kips	0.19 kips
1.88 ft	0.14 kips	18.68 kips	18.82 kips
2.88 ft	0.56 kips	37.36 kips	37.92 kips
3.29 ft	0.81 kips	45.02 kips	45.83 kips
3.31 ft	0.85 kips	33.67 kips	34.52 kips
4.30 ft	3.95 kips	33.67 kips	37.63 kips
5.30 ft	7.09 kips	33.67 kips	40.77 kips
6.30 ft	10.23 kips	33.67 kips	43.91 kips
7.30 ft	13.37 kips	33.67 kips	47.04 kips
8.29 ft	16.48 kips	33.67 kips	50.15 kips
8.31 ft	16.53 kips	98.80 kips	115.33 kips
9.30 ft	18.50 kips	112.31 kips	130.81 kips
10.30 ft	20.75 kips	125.96 kips	146.71 kips
11.30 ft	23.26 kips	139.61 kips	162.87 kips
12.30 ft	26.03 kips	153.25 kips	179.28 kips
13.30 ft	29.05 kips	166.90 kips	195.95 kips
14.30 ft	32.33 kips	180.55 kips	212.88 kips
15.30 ft	35.87 kips	194.20 kips	230.07 kips
15.79 ft	37.70 kips	200.88 kips	238.58 kips
15.81 ft	37.77 kips	38.48 kips	76.26 kips
16.80 ft	41.23 kips	38.48 kips	79.71 kips
17.80 ft	44.72 kips	38.48 kips	83.20 kips
18.80 ft	48.21 kips	38.48 kips	86.69 kips
19.80 ft	51.70 kips	38.48 kips	90.18 kips
20.80 ft	55.18 kips	38.48 kips	93.67 kips
21.29 ft	56.89 kips	38.48 kips	95.38 kips
21.31 ft	56.96 kips	34.88 kips	91.84 kips
22.30 ft	60.12 kips	34.88 kips	94.99 kips
23.30 ft	63.30 kips	34.88 kips	98.18 kips
24.30 ft	66.49 kips	34.88 kips	101.37 kips
25.30 ft	69.68 kips	34.88 kips	104.56 kips
26.30 ft	72.87 kips	34.88 kips	107.74 kips
27.30 ft	76.05 kips	34.88 kips	110.93 kips
28.30 ft	79.24 kips	34.88 kips	114.12 kips
29.30 ft	82.43 kips	34.88 kips	117.31 kips
30.30 ft	85.62 kips	34.88 kips	120.49 kips
31.30 ft	88.80 kips	34.88 kips	123.68 kips
32.29 ft	91.96 kips	34.88 kips	126.84 kips

scour depth

Depth	Skin Friction	End Bearing	Total Capacity
32.31 ft	92.02 kips	35.28 kips	127.30 kips
33.30 ft	95.27 kips	35.28 kips	130.55 kips
34.30 ft	98.64 kips	35.28 kips	133.92 kips
35.30 ft	102.12 kips	35.28 kips	137.39 kips
36.30 ft	105.69 kips	35.28 kips	140.97 kips
37.29 ft	109.32 kips	35.28 kips	144.60 kips
37.31 ft	109.40 kips	78.59 kips	188.00 kips
38.30 ft	113.94 kips	78.59 kips	192.53 kips
39.30 ft	118.64 kips	78.59 kips	197.24 kips
40.30 ft	123.48 kips	78.59 kips	202.07 kips
41.30 ft	128.44 kips	78.59 kips	207.04 kips
42.30 ft	133.54 kips	78.59 kips	212.13 kips
43.30 ft	138.76 kips	78.59 kips	217.35 kips
44.30 ft	144.11 kips	78.59 kips	222.70 kips
45.30 ft	149.59 kips	78.59 kips	228.18 kips
46.30 ft	155.20 kips	78.59 kips	233.79 kips
46.99 ft	159.14 kips	78.59 kips	237.74 kips
47.01 ft	159.23 kips	30.07 kips	189.30 kips
48.00 ft	162.42 kips	30.07 kips	192.48 kips
49.00 ft	165.63 kips	30.07 kips	195.70 kips
50.00 ft	168.85 kips	30.07 kips	198.91 kips
51.00 ft	172.06 kips	30.07 kips	202.13 kips
52.00 ft	175.28 kips	30.07 kips	205.34 kips
53.00 ft	178.49 kips	30.07 kips	208.56 kips
54.00 ft	181.71 kips	30.07 kips	211.77 kips
55.00 ft	184.92 kips	30.07 kips	214.99 kips
56.00 ft	188.14 kips	30.07 kips	218.20 kips
57.00 ft	191.35 kips	30.07 kips	221.42 kips
58.00 ft	194.57 kips	30.07 kips	224.64 kips
59.00 ft	198.03 kips	30.07 kips	228.09 kips
60.00 ft	202.05 kips	30.07 kips	232.12 kips
61.00 ft	206.20 kips	30.07 kips	236.26 kips
62.00 ft	210.46 kips	30.07 kips	240.53 kips
63.00 ft	214.85 kips	30.07 kips	244.92 kips
64.00 ft	219.36 kips	30.07 kips	249.43 kips
65.00 ft	223.99 kips	30.07 kips	254.06 kips
66.00 ft	228.74 kips	30.07 kips	258.81 kips
67.00 ft	233.61 kips	30.07 kips	263.68 kips
67.29 ft	235.05 kips	30.07 kips	265.12 kips
67.31 ft	235.15 kips	19.24 kips	254.39 kips
68.30 ft	240.14 kips	19.24 kips	259.38 kips
69.30 ft	245.18 kips	19.24 kips	264.42 kips

Depth	Skin Friction	End Bearing	Total Capacity
70.30 ft	250.22 kips	19.24 kips	269.46 kips
71.30 ft	255.26 kips	19.24 kips	274.50 kips
71.99 ft	258.74 kips	19.24 kips	277.98 kips
72.01 ft	258.85 kips	22.09 kips	280.94 kips
73.00 ft	265.29 kips	22.09 kips	287.38 kips
74.00 ft	271.88 kips	22.09 kips	293.97 kips
75.00 ft	278.56 kips	22.09 kips	300.65 kips
76.00 ft	285.33 kips	22.09 kips	307.42 kips
77.00 ft	292.19 kips	22.09 kips	314.28 kips
78.00 ft	299.13 kips	22.09 kips	321.22 kips
79.00 ft	306.16 kips	22.09 kips	328.25 kips
80.00 ft	313.28 kips	22.09 kips	335.37 kips
81.00 ft	320.49 kips	22.09 kips	342.58 kips
82.00 ft	327.79 kips	22.09 kips	349.88 kips
82.29 ft	329.92 kips	22.09 kips	352.01 kips
82.31 ft	330.08 kips	53.45 kips	383.53 kips
83.30 ft	339.14 kips	53.45 kips	392.59 kips
84.30 ft	348.40 kips	53.45 kips	401.85 kips
85.30 ft	357.78 kips	53.45 kips	411.23 kips
86.30 ft	367.28 kips	53.45 kips	420.73 kips
87.29 ft	376.80 kips	53.45 kips	430.25 kips
87.31 ft	377.03 kips	162.06 kips	539.09 kips
88.30 ft	390.41 kips	162.06 kips	552.47 kips
89.30 ft	404.10 kips	162.06 kips	566.16 kips
90.30 ft	417.97 kips	162.06 kips	580.03 kips
91.30 ft	432.01 kips	162.06 kips	594.07 kips
92.29 ft	446.08 kips	162.06 kips	608.15 kips
92.31 ft	446.37 kips	162.06 kips	608.43 kips
93.30 ft	460.62 kips	162.06 kips	622.68 kips
94.30 ft	475.18 kips	162.06 kips	637.25 kips
95.30 ft	489.92 kips	162.06 kips	651.99 kips
96.30 ft	504.84 kips	162.06 kips	666.90 kips
97.30 ft	519.93 kips	162.06 kips	681.99 kips
98.30 ft	535.20 kips	162.06 kips	697.26 kips
99.30 ft	550.64 kips	162.06 kips	712.70 kips
100.30 ft	566.25 kips	162.06 kips	728.31 kips
101.30 ft	582.04 kips	162.06 kips	744.11 kips
102.30 ft	598.01 kips	162.06 kips	760.07 kips
103.30 ft	614.15 kips	162.06 kips	776.21 kips
104.30 ft	630.46 kips	162.06 kips	792.53 kips
105.30 ft	646.95 kips	162.06 kips	809.02 kips
106.30 ft	663.62 kips	162.06 kips	825.68 kips

73.25 feet at 289.0 kips

Includes scour losses

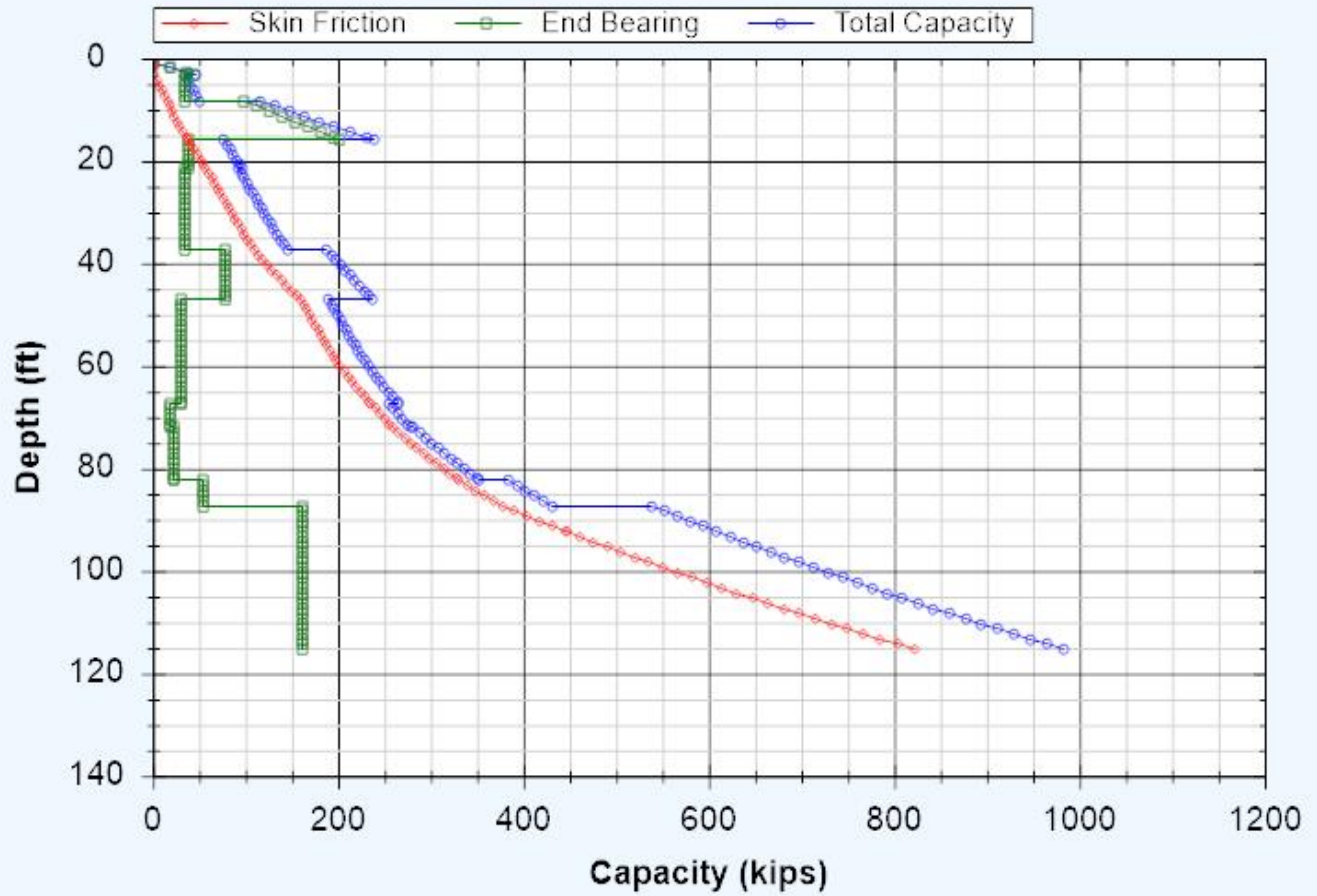
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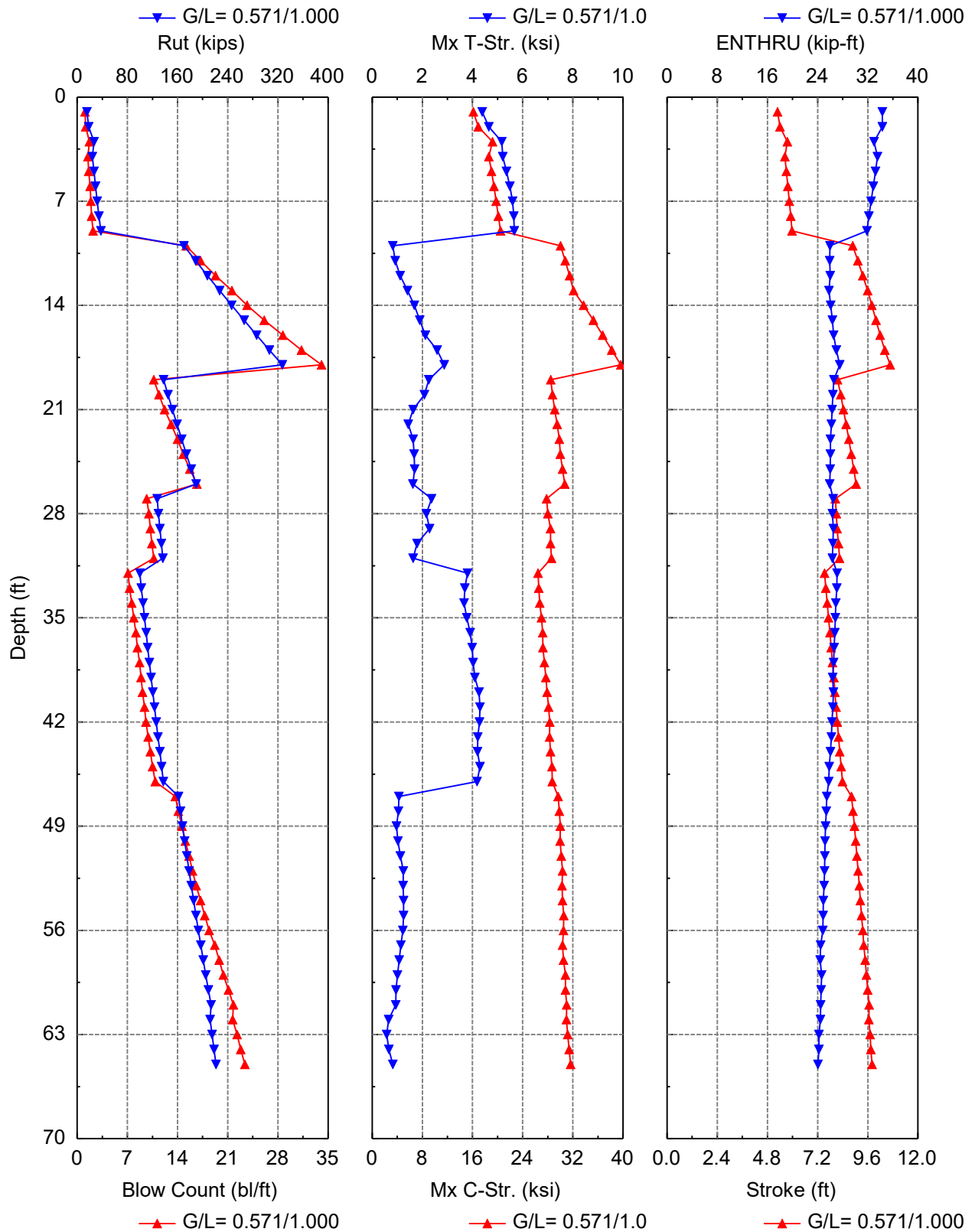
$1.2 < fsu < 1.4 = 7 \text{ days to restrike}$

Depth	Skin Friction	End Bearing	Total Capacity
107.30 ft	680.46 kips	162.06 kips	842.52 kips
108.30 ft	697.48 kips	162.06 kips	859.54 kips
109.30 ft	714.67 kips	162.06 kips	876.73 kips
110.30 ft	732.03 kips	162.06 kips	894.09 kips
111.30 ft	749.57 kips	162.06 kips	911.63 kips
112.30 ft	767.29 kips	162.06 kips	929.35 kips
113.30 ft	785.18 kips	162.06 kips	947.24 kips
114.30 ft	803.24 kips	162.06 kips	965.30 kips
115.29 ft	821.30 kips	162.06 kips	983.36 kips

Bearing Capacity - Nominal



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.571/1.000

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow CtMx bl/ft	C-StrMx ksi	T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
1.0	15.4	2.2	13.2	1.1	16.127	4.389	5.28	34.3	D 19-42
2.0	18.1	2.7	15.3	1.2	16.905	4.652	5.40	34.3	D 19-42
3.0	26.7	3.3	23.4	1.7	19.193	5.165	5.75	33.0	D 19-42
4.0	24.0	4.8	19.2	1.5	18.613	5.205	5.63	33.6	D 19-42
5.0	26.7	7.4	19.2	1.6	19.034	5.356	5.70	33.2	D 19-42
6.0	29.3	10.1	19.2	1.8	19.405	5.485	5.77	32.9	D 19-42
7.0	32.1	12.8	19.2	1.9	19.784	5.597	5.85	32.5	D 19-42
8.0	34.8	15.6	19.2	2.0	20.128	5.643	5.91	32.2	D 19-42
9.0	37.7	18.4	19.2	2.2	20.474	5.662	5.98	31.9	D 19-42
10.0	170.1	20.8	149.3	15.2	30.053	0.823	8.88	26.0	D 19-42
11.0	188.8	23.3	165.5	17.2	30.792	0.921	9.13	25.9	D 19-42
12.0	207.8	26.1	181.6	19.3	31.472	1.117	9.36	26.0	D 19-42
13.0	227.0	29.2	197.8	21.6	32.098	1.406	9.59	25.8	D 19-42
14.0	246.5	32.5	213.9	23.7	33.696	1.687	9.79	26.1	D 19-42
15.0	266.2	36.1	230.1	26.1	35.286	1.896	9.99	26.4	D 19-42
16.0	286.2	40.0	246.2	28.7	36.763	2.122	10.19	26.5	D 19-42
17.0	306.5	44.1	262.4	31.3	38.190	2.588	10.42	27.0	D 19-42
18.0	327.0	48.5	278.5	34.1	39.665	2.877	10.67	27.5	D 19-42
19.0	137.6	52.2	85.5	10.7	28.485	2.263	8.16	26.6	D 19-42
20.0	144.7	54.5	90.2	11.4	28.767	2.087	8.30	26.4	D 19-42
21.0	151.8	57.0	94.9	12.2	29.108	1.633	8.43	26.3	D 19-42
22.0	159.1	59.6	99.5	13.1	29.499	1.438	8.56	26.2	D 19-42
23.0	166.5	62.3	104.2	14.0	29.831	1.629	8.69	26.1	D 19-42
24.0	174.1	65.2	108.9	14.8	30.019	1.674	8.81	26.0	D 19-42
25.0	181.7	68.1	113.6	15.7	30.356	1.694	8.93	26.0	D 19-42
26.0	189.5	71.2	118.3	16.7	30.718	1.621	9.05	25.9	D 19-42
27.0	127.6	74.0	53.6	9.7	27.834	2.369	8.05	26.5	D 19-42
28.0	129.7	76.1	53.6	10.0	28.022	2.165	8.09	26.4	D 19-42
29.0	131.9	78.3	53.6	10.2	28.443	2.289	8.13	26.5	D 19-42
30.0	134.1	80.5	53.6	10.4	28.453	1.793	8.19	26.4	D 19-42
31.0	136.5	82.9	53.6	10.7	28.586	1.633	8.25	26.4	D 19-42
32.0	99.7	85.3	14.4	7.1	26.432	3.800	7.53	27.1	D 19-42
33.0	102.2	87.8	14.4	7.3	26.579	3.689	7.59	27.0	D 19-42
34.0	104.8	90.3	14.4	7.6	26.704	3.660	7.66	26.9	D 19-42
35.0	107.3	92.9	14.4	7.9	26.978	3.772	7.72	26.8	D 19-42
36.0	109.9	95.5	14.4	8.2	27.193	3.906	7.79	26.7	D 19-42
37.0	112.5	98.1	14.4	8.4	27.244	3.987	7.85	26.6	D 19-42
38.0	115.2	100.8	14.4	8.7	27.448	4.023	7.90	26.6	D 19-42

39.0	117.9	103.4	14.4	8.9	27.714	4.094	7.97	26.4	D 19-42
40.0	120.6	106.1	14.4	9.1	27.885	4.264	8.03	26.5	D 19-42
41.0	123.3	108.9	14.4	9.4	28.111	4.297	8.09	26.4	D 19-42
42.0	126.1	111.6	14.4	9.6	28.308	4.277	8.14	26.3	D 19-42
43.0	128.9	114.4	14.4	9.9	28.274	4.212	8.20	26.2	D 19-42
44.0	131.7	117.3	14.4	10.2	28.430	4.202	8.26	26.0	D 19-42
45.0	134.6	120.1	14.4	10.5	28.660	4.297	8.33	25.9	D 19-42
46.0	137.4	123.0	14.4	10.9	28.706	4.184	8.39	25.8	D 19-42
47.0	161.4	126.0	35.4	13.7	29.641	1.070	8.82	25.4	D 19-42
48.0	164.7	129.3	35.4	14.1	29.850	1.048	8.89	25.4	D 19-42
49.0	168.0	132.6	35.4	14.6	30.008	0.973	8.96	25.3	D 19-42
50.0	171.4	136.0	35.4	15.1	29.948	1.024	9.02	25.2	D 19-42
51.0	174.8	139.4	35.4	15.6	30.144	1.130	9.08	25.1	D 19-42
52.0	178.4	143.0	35.4	16.1	30.347	1.239	9.13	25.1	D 19-42
53.0	182.0	146.6	35.4	16.6	30.264	1.235	9.19	25.0	D 19-42
54.0	185.6	150.3	35.4	17.2	30.346	1.250	9.25	24.9	D 19-42
55.0	189.4	154.0	35.4	17.8	30.553	1.252	9.30	24.9	D 19-42
56.0	193.2	157.8	35.4	18.4	30.527	1.228	9.35	24.8	D 19-42
57.0	197.1	161.7	35.4	19.2	30.356	1.145	9.41	24.5	D 19-42
58.0	201.0	165.7	35.4	19.8	30.517	1.076	9.48	24.4	D 19-42
59.0	205.1	169.7	35.4	20.4	30.829	1.012	9.54	24.6	D 19-42
60.0	209.2	173.8	35.4	21.1	30.833	0.950	9.60	24.6	D 19-42
61.0	213.4	178.0	35.4	21.8	30.998	0.941	9.66	24.5	D 19-42
62.0	211.8	181.8	30.1	21.7	30.979	0.653	9.65	24.4	D 19-42
63.0	214.9	184.9	30.1	22.3	31.181	0.583	9.71	24.2	D 19-42
64.0	218.0	188.0	30.1	22.8	31.404	0.671	9.74	24.2	D 19-42
65.0	221.1	191.1	30.1	23.4	31.647	0.825	9.80	24.0	D 19-42

Total driving time: 22 minutes; Total Number of Blows: 865 (starting at penetration 1.0 ft)

GRLWEAP: Wave Equation Analysis of Pile Foundations

MOT-835-2.57 Rear Abutment B-001-1-24

4/30/2026

RESOURCE INTERNATIONAL INC

GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

SOIL PROFILE

Depth ft	Soil Type -	Spec. Wt lb/ft³	Su ksf	Phi °	Unit Rs ksf	Unit Rt ksf
0.0	Clay	120.0	1.4	0.0	0.90	12.37
1.1	Clay	120.0	1.4	0.0	0.90	12.37
1.1	Sand	125.0	0.0	40.0	0.07	7.60
3.6	Sand	125.0	0.0	40.0	0.23	26.36
3.6	Clay	125.0	2.0	0.0	1.11	18.00
9.1	Clay	125.0	2.0	0.0	1.11	18.00
9.1	Sand	130.0	0.0	42.0	0.60	126.09
18.6	Sand	130.0	0.0	42.0	1.27	269.63
18.6	Sand	130.0	0.0	37.0	0.92	78.21
26.6	Sand	130.0	0.0	37.0	1.33	113.28
26.6	Sand	125.0	0.0	33.0	0.84	50.11
31.6	Sand	125.0	0.0	33.0	0.99	50.11
31.6	Clay	125.0	1.5	0.0	1.29	13.50
46.6	Clay	125.0	1.5	0.0	1.29	13.50
46.6	Sand	130.0	0.0	32.0	1.30	33.09
61.6	Sand	130.0	0.0	32.0	1.74	33.09
61.6	Clay	125.0	3.1	0.0	1.27	28.12
71.6	Clay	125.0	3.1	0.0	1.27	28.12
71.6	Sand	125.0	0.0	31.0	1.81	20.71
76.6	Sand	125.0	0.0	31.0	1.93	20.71
76.6	Sand	130.0	0.0	34.0	2.60	73.64
86.6	Sand	130.0	0.0	34.0	2.96	73.64
86.6	Sand	135.0	0.0	37.0	4.27	203.27
96.6	Sand	135.0	0.0	37.0	4.82	203.27
96.6	Sand	125.0	0.0	31.0	2.47	20.71
99.8	Sand	125.0	0.0	31.0	2.55	20.71

PILE INPUT

Uniform Pile		Pile Type:	Closed-End Pipe
Pile Length: (ft)	65.000	Pile Penetration: (ft)	65.000
Pile Size: (ft)	1.17	Toe Area: (in²)	153.94

Pile Shell Thickness: (in) 0.5

Pile Profile

Lb Top ft	X-Area in²	E-Modulus ksi	Spec. Wt lb/ft³	Perim. ft	Crit. Index -
0.0	21.2	30,000.0	492.0	3.7	0
65.0	21.2	30,000.0	492.0	3.7	0

HAMMER INPUT

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

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in ²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

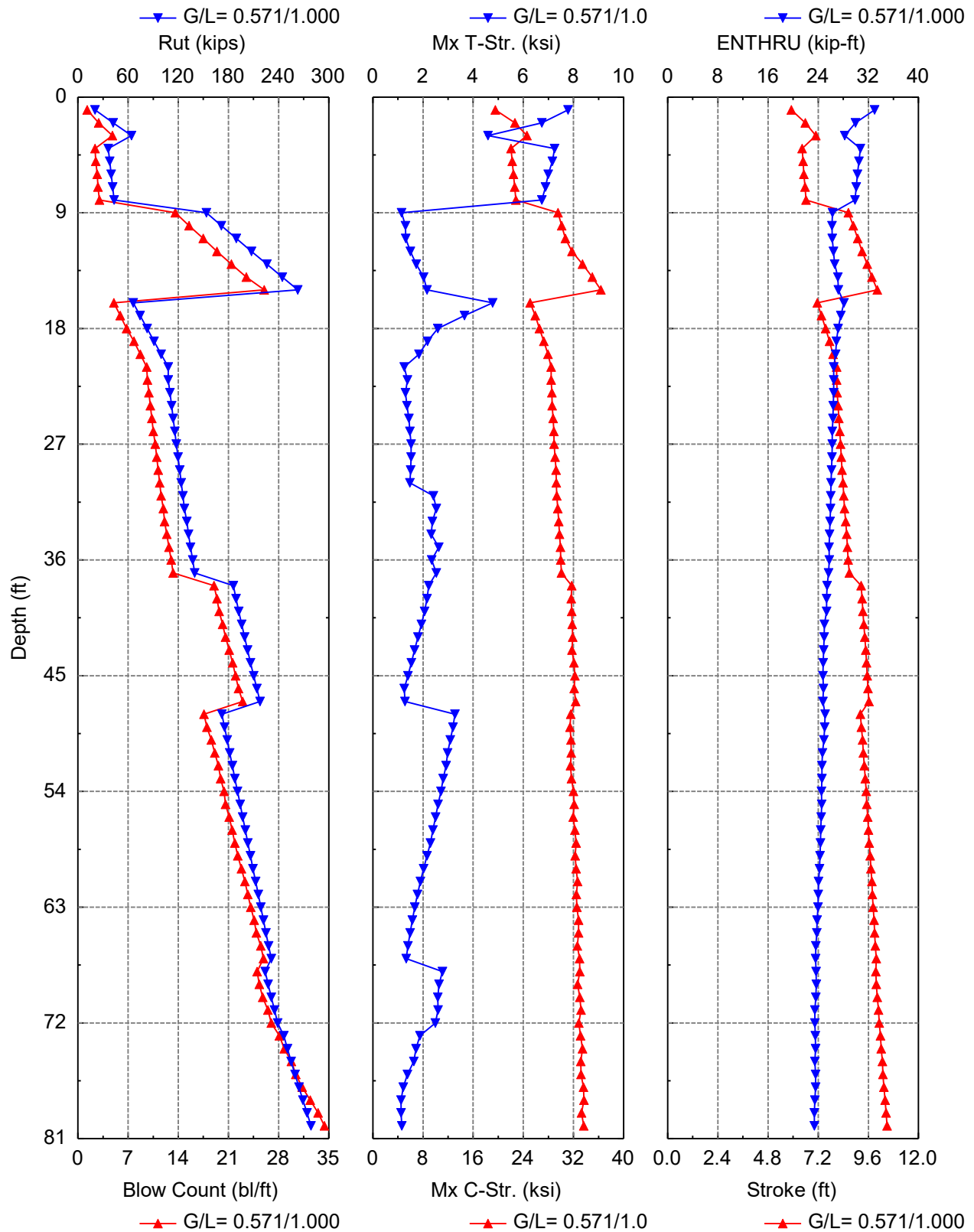
Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in ²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in ²
0.0	0.9	12.4	0.10	0.15	0.15	0.15	1.5	6.0	168.0	153.9
1.1	0.9	12.4	0.10	0.15	0.15	0.15	1.5	6.0	168.0	153.9
1.1	0.1	7.6	0.10	0.16	0.20	0.15	1.0	6.0	1.0	153.9
2.4	0.1	17.0	0.10	0.16	0.20	0.15	1.0	6.0	1.0	153.9
3.6	0.2	26.4	0.10	0.16	0.20	0.15	1.0	6.0	1.0	153.9
3.6	1.1	18.0	0.10	0.16	0.05	0.15	1.5	6.0	168.0	153.9
5.4	1.1	18.0	0.10	0.16	0.05	0.15	1.5	6.0	168.0	153.9
7.3	1.1	18.0	0.10	0.16	0.05	0.15	1.5	6.0	168.0	153.9
9.1	1.1	18.0	0.10	0.16	0.05	0.15	1.5	6.0	168.0	153.9
9.1	0.6	126.1	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
11.0	0.7	154.8	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
12.9	0.9	183.5	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
14.8	1.0	212.2	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
16.7	1.1	240.9	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
18.6	1.3	269.6	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
18.6	0.9	78.2	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
20.6	1.0	87.0	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
22.6	1.1	95.7	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
24.6	1.2	104.5	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
26.6	1.3	113.3	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
26.6	0.8	50.1	0.10	0.15	0.20	0.15	1.5	6.0	168.0	153.9
28.3	0.9	50.1	0.10	0.15	0.20	0.15	1.5	6.0	168.0	153.9
29.9	0.9	50.1	0.10	0.15	0.20	0.15	1.5	6.0	168.0	153.9

31.6	1.0	50.1	0.10	0.15	0.20	0.15	1.5	6.0	168.0	153.9
31.6	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
33.3	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
34.9	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
36.6	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
38.3	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
39.9	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
41.6	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
43.3	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
44.9	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
46.6	1.3	13.5	0.10	0.16	0.15	0.15	1.8	6.0	168.0	153.9
46.6	1.3	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
48.3	1.4	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
49.9	1.4	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
51.6	1.4	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
53.3	1.5	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
54.9	1.5	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
56.6	1.6	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
58.3	1.6	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
59.9	1.7	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
61.6	1.7	33.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
61.6	1.3	28.1	0.10	0.18	0.15	0.15	1.5	6.0	168.0	153.9
63.3	1.3	28.1	0.10	0.18	0.15	0.15	1.5	6.0	168.0	153.9
64.9	1.3	28.1	0.10	0.18	0.15	0.15	1.5	6.0	168.0	153.9
65.0	1.3	28.1	0.10	0.18	0.15	0.15	1.5	6.0	168.0	153.9

Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.571/1.000

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow CtMx bl/ft	C-StrMx ksi	T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
1.0	20.3	0.1	20.2	1.3	19.553	7.785	5.92	33.0	D 19-42
2.0	42.1	0.5	41.6	2.9	22.679	6.736	6.58	29.9	D 19-42
3.0	64.2	1.2	63.0	4.8	24.588	4.594	7.09	28.2	D 19-42
4.0	36.3	2.6	33.7	2.4	22.048	7.251	6.42	30.7	D 19-42
5.0	38.0	4.3	33.7	2.5	22.231	7.156	6.47	30.5	D 19-42
6.0	39.7	6.0	33.7	2.7	22.420	6.997	6.52	30.3	D 19-42
7.0	41.5	7.9	33.7	2.8	22.612	6.882	6.57	30.1	D 19-42
8.0	43.4	9.7	33.7	3.0	22.831	6.739	6.62	29.9	D 19-42
9.0	153.7	11.4	142.4	13.6	29.517	1.147	8.65	26.3	D 19-42
10.0	171.5	13.0	158.5	15.5	30.128	1.305	8.88	26.2	D 19-42
11.0	189.5	14.8	174.7	17.5	30.692	1.314	9.09	26.2	D 19-42
12.0	207.6	16.8	190.8	19.4	31.775	1.494	9.30	26.4	D 19-42
13.0	225.9	18.9	207.0	21.4	33.429	1.734	9.54	26.6	D 19-42
14.0	244.4	21.2	223.1	23.5	34.993	2.021	9.77	27.1	D 19-42
15.0	263.0	23.7	239.3	26.0	36.374	2.165	10.03	27.2	D 19-42
16.0	66.0	27.5	38.5	5.0	25.084	4.773	7.16	28.1	D 19-42
17.0	74.4	35.9	38.5	5.9	25.887	3.652	7.36	27.6	D 19-42
18.0	82.8	44.3	38.5	6.8	26.579	2.595	7.56	27.2	D 19-42
19.0	91.1	52.6	38.5	7.8	27.256	2.178	7.74	26.9	D 19-42
20.0	99.5	61.0	38.5	8.7	27.921	1.837	7.91	26.8	D 19-42
21.0	107.9	69.4	38.5	9.6	28.442	1.255	8.08	26.5	D 19-42
22.0	108.1	73.3	34.9	9.7	28.450	1.378	8.08	26.5	D 19-42
23.0	110.1	75.2	34.9	9.9	28.565	1.298	8.11	26.5	D 19-42
24.0	112.0	77.1	34.9	10.1	28.589	1.361	8.15	26.4	D 19-42
25.0	113.9	79.1	34.9	10.3	28.753	1.438	8.19	26.3	D 19-42
26.0	115.9	81.0	34.9	10.5	28.882	1.473	8.23	26.3	D 19-42
27.0	117.8	82.9	34.9	10.8	28.926	1.524	8.27	26.2	D 19-42
28.0	119.7	84.9	34.9	11.0	29.081	1.526	8.31	26.2	D 19-42
29.0	121.7	86.8	34.9	11.2	29.226	1.508	8.34	26.1	D 19-42
30.0	123.6	88.7	34.9	11.4	29.244	1.476	8.39	26.1	D 19-42
31.0	125.5	90.7	34.9	11.6	29.355	2.413	8.43	26.0	D 19-42
32.0	127.5	92.6	34.9	11.9	29.511	2.535	8.46	26.0	D 19-42
33.0	130.1	94.7	35.4	12.1	29.663	2.372	8.52	25.9	D 19-42
34.0	132.4	97.0	35.4	12.4	29.778	2.324	8.56	25.8	D 19-42
35.0	134.8	99.4	35.4	12.7	29.905	2.632	8.60	25.7	D 19-42
36.0	137.2	101.8	35.4	13.0	29.972	2.349	8.64	25.8	D 19-42
37.0	139.7	104.3	35.4	13.3	30.067	2.530	8.69	25.7	D 19-42
38.0	186.0	107.3	78.7	19.0	31.739	2.228	9.25	25.4	D 19-42

39.0	189.2	110.4	78.7	19.4	31.657	2.164	9.30	25.3	D 19-42
40.0	192.5	113.7	78.7	19.7	31.729	2.064	9.34	25.3	D 19-42
41.0	195.8	117.1	78.7	20.2	31.809	1.940	9.39	25.0	D 19-42
42.0	199.3	120.5	78.7	20.6	31.883	1.804	9.43	25.0	D 19-42
43.0	202.8	124.1	78.7	21.1	31.762	1.665	9.47	24.9	D 19-42
44.0	206.4	127.7	78.7	21.6	32.076	1.532	9.51	24.8	D 19-42
45.0	210.1	131.4	78.7	22.0	32.240	1.395	9.55	24.8	D 19-42
46.0	213.9	135.2	78.7	22.4	32.126	1.250	9.58	24.8	D 19-42
47.0	217.8	139.1	78.7	23.0	32.335	1.284	9.63	24.8	D 19-42
48.0	172.3	142.2	30.1	17.6	31.577	3.271	9.21	25.1	D 19-42
49.0	175.4	145.3	30.1	18.0	31.456	3.198	9.26	25.0	D 19-42
50.0	178.5	148.4	30.1	18.6	31.599	3.093	9.32	24.9	D 19-42
51.0	181.6	151.5	30.1	19.1	31.648	2.979	9.36	24.7	D 19-42
52.0	184.7	154.6	30.1	19.6	31.538	2.922	9.41	24.6	D 19-42
53.0	187.8	157.7	30.1	19.9	31.662	2.809	9.45	24.6	D 19-42
54.0	190.9	160.8	30.1	20.4	31.991	2.715	9.50	24.5	D 19-42
55.0	194.0	163.9	30.1	20.6	32.112	2.602	9.52	24.6	D 19-42
56.0	197.1	167.0	30.1	21.1	31.961	2.501	9.57	24.5	D 19-42
57.0	200.2	170.1	30.1	21.5	32.244	2.400	9.61	24.4	D 19-42
58.0	203.3	173.2	30.1	21.9	32.433	2.294	9.65	24.4	D 19-42
59.0	206.4	176.3	30.1	22.3	32.251	2.165	9.68	24.3	D 19-42
60.0	209.5	179.4	30.1	22.8	32.420	2.022	9.72	24.2	D 19-42
61.0	212.6	182.5	30.1	23.3	32.645	1.896	9.77	24.0	D 19-42
62.0	215.7	185.6	30.1	23.7	32.445	1.784	9.80	24.0	D 19-42
63.0	218.8	188.7	30.1	24.1	32.549	1.670	9.82	24.0	D 19-42
64.0	221.9	191.8	30.1	24.6	32.805	1.572	9.87	23.8	D 19-42
65.0	225.0	194.9	30.1	24.9	32.800	1.489	9.89	23.8	D 19-42
66.0	228.1	198.0	30.1	25.5	32.608	1.402	9.94	23.6	D 19-42
67.0	231.2	201.1	30.1	25.9	32.962	1.327	9.97	23.6	D 19-42
68.0	223.9	204.6	19.2	25.0	33.009	2.775	9.95	23.6	D 19-42
69.0	227.6	208.4	19.2	25.3	32.676	2.640	9.98	23.7	D 19-42
70.0	231.3	212.1	19.2	25.8	32.996	2.588	10.03	23.6	D 19-42
71.0	235.0	215.8	19.2	26.5	33.220	2.599	10.08	23.5	D 19-42
72.0	238.8	219.5	19.2	27.0	32.861	2.491	10.12	23.5	D 19-42
73.0	246.1	223.9	22.1	28.1	33.144	1.878	10.17	23.5	D 19-42
74.0	250.6	228.4	22.1	28.8	33.446	1.719	10.21	23.6	D 19-42
75.0	255.1	233.0	22.1	29.8	33.160	1.637	10.27	23.4	D 19-42
76.0	259.7	237.6	22.1	30.4	33.218	1.376	10.30	23.6	D 19-42
77.0	264.4	242.3	22.1	31.3	33.579	1.217	10.34	23.6	D 19-42
78.0	269.1	247.0	22.1	32.4	33.679	1.129	10.40	23.5	D 19-42
79.0	273.9	251.8	22.1	33.5	33.275	1.129	10.45	23.4	D 19-42

80.0	278.7	256.6	22.1	34.4	33.637	1.160	10.49	23.4	D 19-42
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Total driving time: 36 minutes; Total Number of Blows: 1390 (starting at penetration 1.0 ft)

GRLWEAP: Wave Equation Analysis of Pile Foundations

MOT-835-2.57 Pier 1 B-002-1-24

4/30/2026

RESOURCE INTERNATIONAL INC

GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

SOIL PROFILE

Depth ft	Soil Type -	Spec. Wt lb/ft ³	Su ksf	Phi °	Unit Rs ksf	Unit Rt ksf
0.0	Sand	130.0	0.0	42.0	0.00	0.00
0.8	Sand	130.0	0.0	42.0	0.06	12.09
0.8	Sand	135.0	0.0	43.0	0.06	14.90
3.3	Sand	135.0	0.0	43.0	0.25	64.90
3.3	Clay	125.0	3.5	0.0	0.72	31.50
8.3	Clay	125.0	3.5	0.0	0.72	31.50
8.3	Sand	130.0	0.0	42.0	0.58	122.61
15.8	Sand	130.0	0.0	42.0	1.11	235.93
15.8	Clay	125.0	4.0	0.0	4.00	36.00
21.3	Clay	125.0	4.0	0.0	4.00	36.00
21.3	Clay	125.0	3.6	30.0	0.79	32.62
32.3	Clay	125.0	3.6	30.0	0.79	32.62
32.3	Sand	125.0	0.0	32.0	0.91	33.09
37.3	Sand	125.0	0.0	32.0	1.04	33.09
37.3	Sand	130.0	3.1	34.0	1.26	73.64
47.0	Sand	130.0	3.1	34.0	1.61	73.64
47.0	Clay	125.0	3.1	0.0	1.27	28.12
67.3	Clay	125.0	3.1	0.0	1.27	28.12
67.3	Clay	125.0	2.0	29.0	1.52	18.00
72.0	Clay	125.0	2.0	29.0	1.52	18.00
72.0	Sand	125.0	0.0	31.0	1.80	20.71
82.3	Sand	125.0	0.0	31.0	2.05	20.71
82.3	Sand	130.0	0.0	33.0	2.53	50.11
87.3	Sand	130.0	0.0	33.0	2.69	50.11
87.3	Sand	135.0	0.0	36.0	3.73	151.75
92.3	Sand	135.0	0.0	36.0	3.97	151.75
92.3	Sand	135.0	0.0	36.0	3.97	151.75
115.3	Sand	135.0	0.0	36.0	5.08	151.75

PILE INPUT

Uniform Pile	Pile Type:	Closed-End Pipe
Pile Length: (ft)	85.000	Pile Penetration: (ft)
Pile Size: (ft)	1.17	Toe Area: (in ²)
		153.94

Pile Shell Thickness: (in) 0.5

Pile Profile

Lb Top ft	X-Area in ²	E-Modulus ksi	Spec. Wt lb/ft ³	Perim. ft	Crit. Index -
0.0	21.2	30,000.0	492.0	3.7	0

85.0	21.2	30,000.0	492.0	3.7	0
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HAMMER INPUT

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

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in ²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

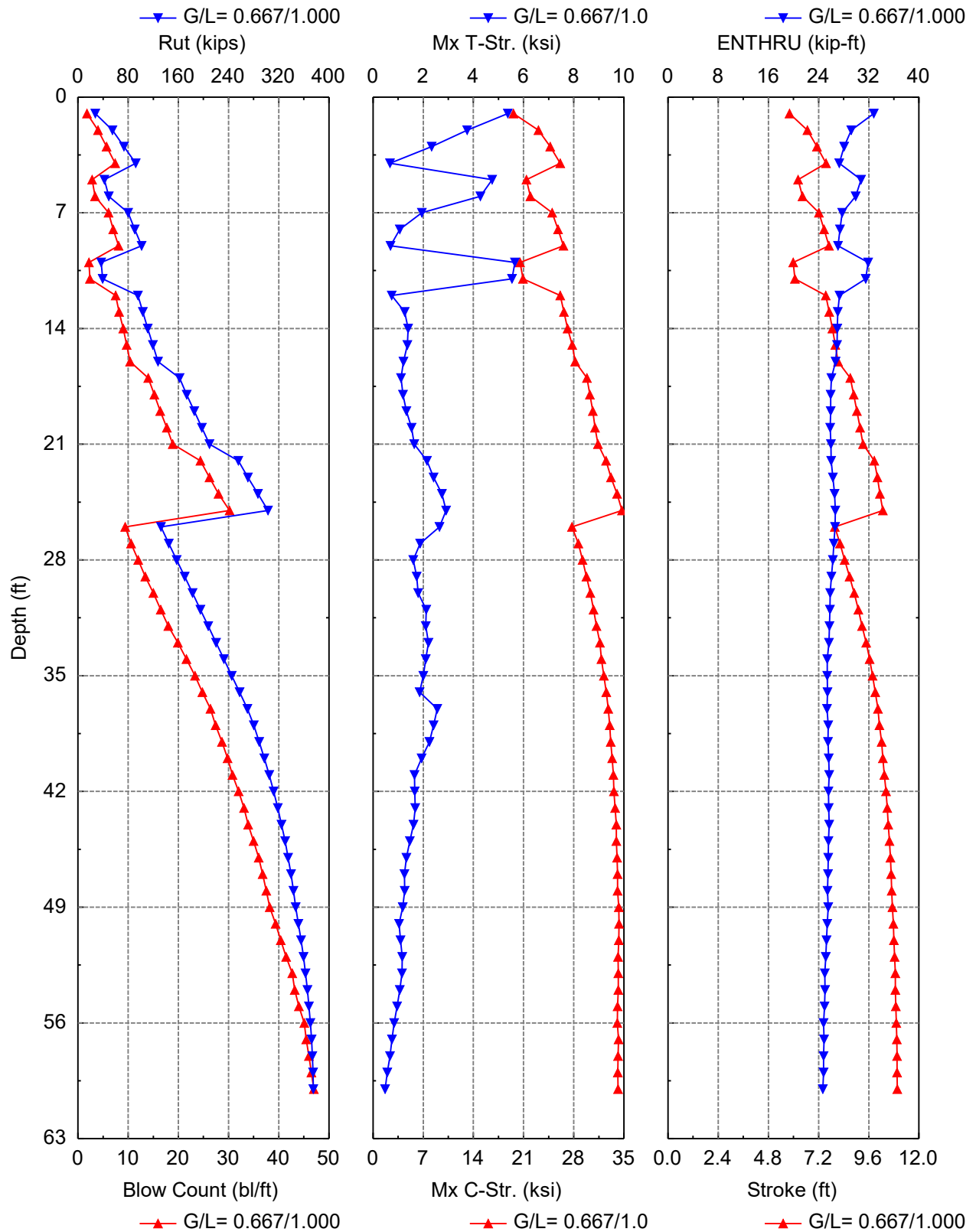
Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in ²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

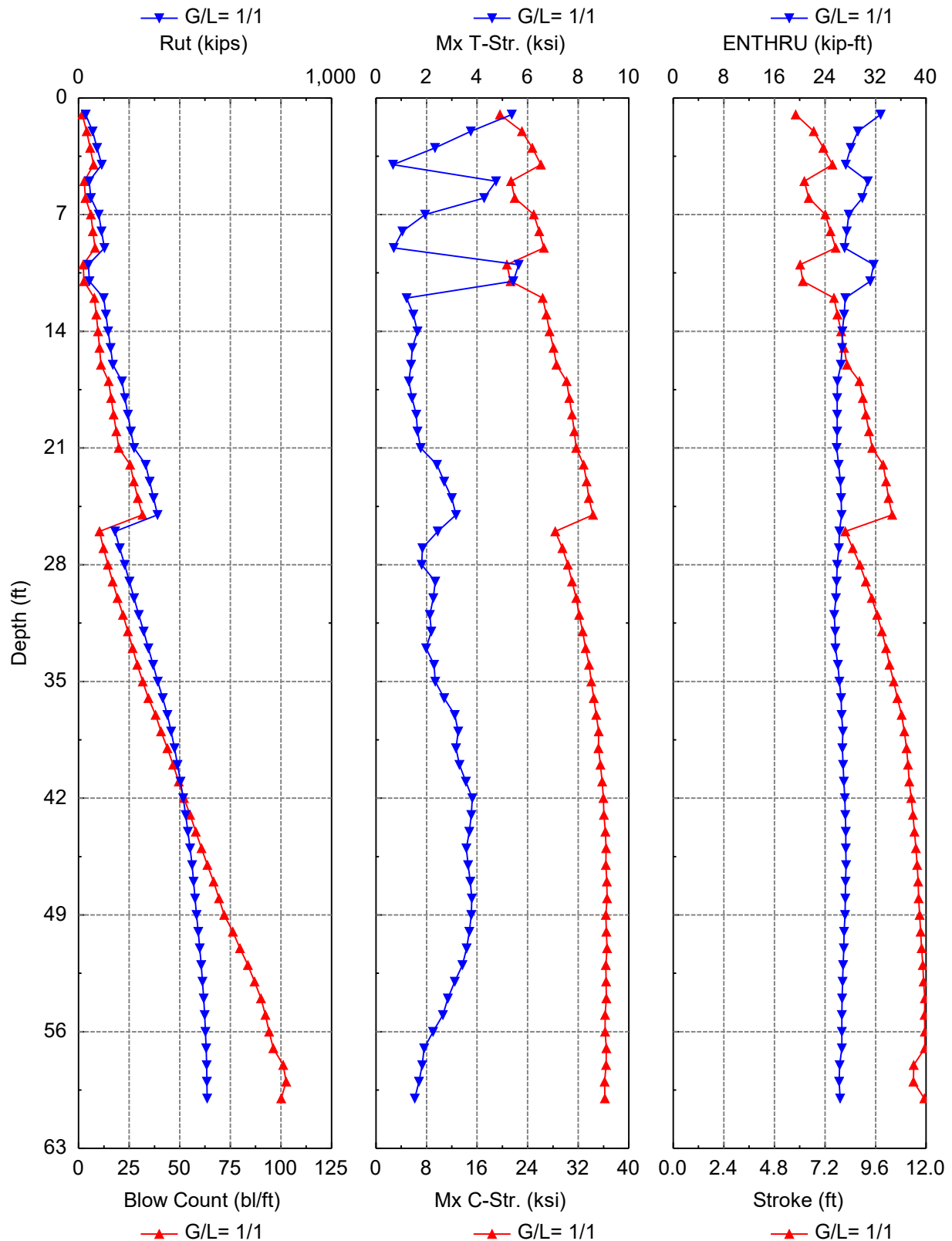
Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in ²
0.0	0.0	0.0	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
0.8	0.1	12.1	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
0.8	0.1	14.9	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
2.1	0.2	39.9	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
3.3	0.2	64.9	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
3.3	0.7	31.5	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
5.0	0.7	31.5	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
6.6	0.7	31.5	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
8.3	0.7	31.5	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
8.3	0.6	122.6	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
10.2	0.7	150.9	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
12.1	0.8	179.3	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
13.9	1.0	207.6	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
15.8	1.1	235.9	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
15.8	4.0	36.0	0.10	0.12	0.20	0.15	1.8	6.0	168.0	153.9
17.6	4.0	36.0	0.10	0.12	0.20	0.15	1.8	6.0	168.0	153.9
19.5	4.0	36.0	0.10	0.12	0.20	0.15	1.8	6.0	168.0	153.9
21.3	4.0	36.0	0.10	0.12	0.20	0.15	1.8	6.0	168.0	153.9
21.3	0.8	32.6	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
23.1	0.8	32.6	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
25.0	0.8	32.6	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9

26.8	0.8	32.6	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
28.6	0.8	32.6	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
30.5	0.8	32.6	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
32.3	0.8	32.6	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
32.3	0.9	33.1	0.10	0.15	0.15	0.15	1.5	6.0	168.0	153.9
34.0	1.0	33.1	0.10	0.15	0.15	0.15	1.5	6.0	168.0	153.9
35.6	1.0	33.1	0.10	0.15	0.15	0.15	1.5	6.0	168.0	153.9
37.3	1.0	33.1	0.10	0.15	0.15	0.15	1.5	6.0	168.0	153.9
37.3	1.3	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
39.2	1.3	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
41.2	1.4	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
43.1	1.5	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
45.1	1.5	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
47.0	1.6	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
47.0	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
48.7	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
50.4	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
52.1	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
53.8	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
55.5	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
57.2	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
58.8	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
60.5	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
62.2	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
63.9	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
65.6	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
67.3	1.3	28.1	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
67.3	1.5	18.0	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
69.7	1.5	18.0	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
72.0	1.5	18.0	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
72.0	1.8	20.7	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
73.7	1.8	20.7	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
75.4	1.9	20.7	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
77.2	1.9	20.7	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
78.9	2.0	20.7	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9
80.0	2.0	20.7	0.10	0.16	0.15	0.15	1.5	6.0	168.0	153.9

Driveability Analysis Summary



Driveability Analysis Summary



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

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow CtMx bl/ft	C-StrMx ksi	T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
1.0	27.8	0.2	27.6	1.8	19.602	5.375	5.81	32.8	D 19-42
2.0	55.0	0.9	54.1	4.0	23.074	3.755	6.67	29.2	D 19-42
3.0	73.4	1.9	71.5	5.7	24.716	2.334	7.12	28.1	D 19-42
4.0	92.0	3.2	88.8	7.4	26.100	0.673	7.55	27.3	D 19-42
5.0	42.2	4.6	37.6	2.8	21.390	4.745	6.22	30.8	D 19-42
6.0	49.1	6.1	43.0	3.4	21.946	4.283	6.43	29.9	D 19-42
7.0	80.0	7.7	72.3	6.1	24.981	1.949	7.22	27.8	D 19-42
8.0	90.6	9.6	81.0	7.0	25.792	1.069	7.46	27.4	D 19-42
9.0	101.4	11.8	89.6	8.1	26.562	0.698	7.69	27.1	D 19-42
10.0	37.0	14.1	22.9	2.2	20.515	5.660	5.98	31.9	D 19-42
11.0	39.5	16.6	22.9	2.4	20.919	5.535	6.07	31.5	D 19-42
12.0	95.6	19.2	76.5	7.5	26.114	0.743	7.54	27.3	D 19-42
13.0	103.4	21.1	82.3	8.2	26.618	1.265	7.71	27.1	D 19-42
14.0	111.2	23.2	88.1	9.0	27.135	1.400	7.85	27.0	D 19-42
15.0	119.3	25.4	93.9	9.7	27.806	1.370	7.99	26.9	D 19-42
16.0	127.4	27.7	99.7	10.4	28.187	1.210	8.13	26.7	D 19-42
17.0	161.8	30.4	131.4	14.0	29.847	1.119	8.72	26.0	D 19-42
18.0	173.4	34.8	138.6	15.2	30.253	1.190	8.88	25.9	D 19-42
19.0	185.3	39.4	145.9	16.4	30.647	1.331	9.03	25.9	D 19-42
20.0	197.4	44.3	153.1	17.7	30.982	1.541	9.19	25.8	D 19-42
21.0	209.7	49.4	160.3	18.9	31.360	1.640	9.32	26.0	D 19-42
22.0	255.6	54.7	200.9	24.4	32.503	2.149	9.87	26.0	D 19-42
23.0	271.0	60.9	210.2	26.2	33.187	2.410	10.02	26.3	D 19-42
24.0	286.8	67.3	219.5	28.0	34.045	2.743	10.13	26.6	D 19-42
25.0	302.7	74.0	228.8	30.2	34.737	2.916	10.28	26.7	D 19-42
26.0	132.4	83.1	49.3	9.4	27.741	2.649	7.98	26.6	D 19-42
27.0	144.9	95.6	49.3	10.6	28.632	1.880	8.23	26.4	D 19-42
28.0	157.5	108.2	49.3	12.0	29.218	1.600	8.45	26.3	D 19-42
29.0	170.0	120.7	49.3	13.4	29.786	1.741	8.68	26.0	D 19-42
30.0	182.5	133.2	49.3	15.0	30.306	1.802	8.91	25.9	D 19-42
31.0	195.0	145.7	49.3	16.5	30.748	2.121	9.10	25.8	D 19-42
32.0	207.6	158.2	49.3	18.0	31.155	2.105	9.28	25.7	D 19-42
33.0	220.1	170.8	49.3	19.9	31.662	2.211	9.48	25.6	D 19-42
34.0	232.6	183.3	49.3	21.6	31.870	2.101	9.64	25.4	D 19-42
35.0	245.1	195.8	49.3	23.3	32.202	2.009	9.78	25.4	D 19-42
36.0	257.6	208.3	49.3	24.8	32.540	1.858	9.92	25.4	D 19-42
37.0	270.2	220.9	49.3	26.4	32.820	2.564	10.04	25.3	D 19-42
38.0	280.3	230.9	49.3	27.4	33.015	2.410	10.11	25.6	D 19-42

39.0	289.0	239.7	49.3	28.7	33.168	2.252	10.21	25.5	D 19-42
40.0	297.2	247.9	49.3	29.8	33.362	1.939	10.28	25.6	D 19-42
41.0	304.8	255.5	49.3	30.8	33.533	1.657	10.34	25.7	D 19-42
42.0	312.0	262.6	49.3	32.0	33.593	1.667	10.42	25.6	D 19-42
43.0	318.5	269.2	49.3	33.1	33.776	1.679	10.49	25.6	D 19-42
44.0	324.6	275.3	49.3	33.9	33.938	1.610	10.53	25.7	D 19-42
45.0	330.1	280.8	49.3	35.0	33.954	1.470	10.59	25.6	D 19-42
46.0	335.1	285.8	49.3	36.0	34.028	1.333	10.64	25.5	D 19-42
47.0	339.5	290.2	49.3	36.8	34.115	1.253	10.67	25.5	D 19-42
48.0	343.4	294.1	49.3	37.5	34.108	1.264	10.70	25.4	D 19-42
49.0	346.9	297.6	49.3	38.2	34.274	1.180	10.73	25.5	D 19-42
50.0	351.4	302.1	49.3	39.4	34.298	1.038	10.77	25.4	D 19-42
51.0	355.6	306.3	49.3	40.4	34.282	1.093	10.80	25.2	D 19-42
52.0	359.3	310.0	49.3	41.5	34.179	1.167	10.84	25.1	D 19-42
53.0	362.7	313.4	49.3	42.7	34.212	1.154	10.88	25.0	D 19-42
54.0	365.7	316.4	49.3	43.2	34.212	1.070	10.87	25.0	D 19-42
55.0	368.3	319.0	49.3	44.0	34.105	0.964	10.89	24.9	D 19-42
56.0	370.4	321.1	49.3	45.1	34.064	0.846	10.92	24.8	D 19-42
57.0	372.2	322.9	49.3	45.5	34.249	0.755	10.94	24.9	D 19-42
58.0	373.6	324.3	49.3	46.0	34.185	0.674	10.95	24.8	D 19-42
59.0	374.6	325.3	49.3	46.5	34.144	0.568	10.95	24.8	D 19-42
60.0	375.2	325.9	49.3	47.0	34.164	0.479	10.97	24.7	D 19-42

UBV = 289.0 kips

Scour friction loss = 1.85 kips.

e: 36 minutes; Total Number of Blows: 1353 (starting at penetration 1.0 ft)

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

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow CtMx bl/ft	C-StrMx ksi	T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
1.0	27.8	0.2	27.6	1.8	19.602	5.375	5.81	32.8	D 19-42
2.0	55.0	0.9	54.1	4.0	23.074	3.755	6.67	29.2	D 19-42
3.0	73.4	1.9	71.5	5.7	24.716	2.334	7.12	28.1	D 19-42
4.0	92.0	3.2	88.8	7.4	26.100	0.673	7.55	27.3	D 19-42
5.0	42.2	4.6	37.6	2.8	21.390	4.745	6.22	30.8	D 19-42
6.0	49.1	6.1	43.0	3.4	21.946	4.283	6.43	29.9	D 19-42
7.0	80.1	7.8	72.3	6.1	24.982	1.942	7.22	27.7	D 19-42
8.0	91.0	10.1	81.0	7.1	25.840	1.053	7.46	27.4	D 19-42
9.0	102.2	12.6	89.6	8.1	26.566	0.702	7.71	27.1	D 19-42
10.0	38.6	15.7	22.9	2.3	20.714	5.641	6.02	31.7	D 19-42
11.0	42.4	19.5	22.9	2.6	21.278	5.430	6.15	31.2	D 19-42
12.0	99.8	23.3	76.5	7.8	26.380	1.216	7.62	27.2	D 19-42
13.0	108.5	26.2	82.3	8.7	26.940	1.475	7.79	27.0	D 19-42

14.0	117.4	29.3	88.1	9.6	27.460	1.642	7.96	26.7	D 19-42
15.0	126.5	32.6	93.9	10.3	28.094	1.440	8.10	26.7	D 19-42
16.0	135.8	36.2	99.7	11.1	28.558	1.392	8.25	26.5	D 19-42
17.0	171.3	39.9	131.4	14.9	30.177	1.307	8.84	26.0	D 19-42
18.0	183.0	44.3	138.6	16.1	30.606	1.432	8.99	25.9	D 19-42
19.0	194.8	49.0	145.9	17.3	31.008	1.593	9.14	25.9	D 19-42
20.0	206.9	53.8	153.1	18.6	31.368	1.648	9.29	25.9	D 19-42
21.0	219.2	58.9	160.3	19.9	31.666	1.775	9.44	25.9	D 19-42
22.0	265.1	64.3	200.9	25.5	32.845	2.413	9.96	26.2	D 19-42
23.0	280.6	70.4	210.2	27.3	33.330	2.694	10.10	26.4	D 19-42
24.0	296.3	76.8	219.5	29.3	33.667	3.004	10.21	26.6	D 19-42
25.0	312.3	83.5	228.8	31.6	34.350	3.162	10.39	26.6	D 19-42
26.0	144.5	95.2	49.3	10.3	28.376	2.448	8.17	26.3	D 19-42
27.0	163.2	113.9	49.3	12.3	29.493	1.837	8.51	26.2	D 19-42
28.0	182.0	132.7	49.3	14.5	30.369	1.809	8.85	25.9	D 19-42
29.0	200.8	151.5	49.3	16.8	31.004	2.342	9.14	25.8	D 19-42
30.0	219.6	170.3	49.3	19.3	31.680	2.264	9.42	25.7	D 19-42
31.0	238.4	189.1	49.3	21.9	32.150	2.128	9.67	25.5	D 19-42
32.0	257.2	207.9	49.3	24.4	32.709	2.190	9.90	25.6	D 19-42
33.0	276.0	226.6	49.3	26.7	33.169	1.985	10.09	25.7	D 19-42
34.0	294.7	245.4	49.3	29.0	33.693	2.296	10.26	26.0	D 19-42
35.0	313.5	264.2	49.3	31.7	34.075	2.343	10.46	26.3	D 19-42
36.0	332.3	283.0	49.3	34.5	34.470	2.696	10.64	26.5	D 19-42
37.0	351.1	301.8	49.3	38.0	34.860	3.113	10.84	26.6	D 19-42
38.0	366.2	316.9	49.3	40.7	35.241	3.253	10.97	26.8	D 19-42
39.0	379.3	330.0	49.3	43.9	35.194	3.171	11.07	26.8	D 19-42
40.0	391.6	342.3	49.3	46.7	35.499	3.299	11.14	26.9	D 19-42
41.0	403.1	353.8	49.3	49.5	35.790	3.561	11.20	27.0	D 19-42
42.0	413.8	364.5	49.3	52.1	35.982	3.806	11.29	27.2	D 19-42
43.0	423.6	374.3	49.3	55.1	36.054	3.768	11.38	27.2	D 19-42
44.0	432.7	383.4	49.3	57.9	36.287	3.696	11.45	27.3	D 19-42
45.0	441.0	391.7	49.3	60.8	36.389	3.577	11.52	27.3	D 19-42
46.0	448.4	399.1	49.3	63.7	36.348	3.648	11.57	27.3	D 19-42
47.0	455.1	405.8	49.3	66.7	36.516	3.730	11.61	27.3	D 19-42
48.0	460.9	411.6	49.3	69.4	36.550	3.786	11.65	27.2	D 19-42
49.0	466.1	416.8	49.3	72.0	36.376	3.768	11.68	27.2	D 19-42
50.0	473.0	423.7	49.3	76.2	36.448	3.691	11.74	27.0	D 19-42
51.0	479.2	429.9	49.3	79.8	36.547	3.589	11.78	27.0	D 19-42
52.0	484.9	435.6	49.3	83.7	36.356	3.415	11.84	26.9	D 19-42
53.0	489.9	440.6	49.3	87.0	36.395	3.122	11.88	26.8	D 19-42
54.0	494.4	445.1	49.3	90.1	36.440	2.842	11.94	26.7	D 19-42

55.0	498.2	448.9	49.3	92.3	36.269	2.648	11.93	26.7	D 19-42
56.0	501.5	452.2	49.3	94.2	36.231	2.254	11.94	26.7	D 19-42
57.0	504.2	454.9	49.3	96.2	36.455	1.906	11.94	26.7	D 19-42
58.0	506.3	457.0	49.3	101.1	36.398	1.828	11.41	26.3	D 19-42
59.0	507.8	458.4	49.3	102.6	36.168	1.705	11.39	26.2	D 19-42
60.0	508.7	459.3	49.3	100.2	36.200	1.533	11.91	26.4	D 19-42

UBV = 289.0 kips

Scour friction loss = 1.85 kips.

Time: 62 minutes; Total Number of Blows: 2209 (starting at penetration 1.0 ft)

GRLWEAP: Wave Equation Analysis of Pile Foundations

MOT-835-2.57 Pier 2 B-003-1-24

9/24/2026

RESOURCE INTERNATIONAL INC

GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

SOIL PROFILE

Depth ft	Soil Type -	Spec. Wt lb/ft ³	Su ksf	Phi °	Unit Rs ksf	Unit Rt ksf
0.0	Sand	135.0	0.0	42.0	0.00	0.00
1.9	Sand	135.0	0.0	42.0	0.23	48.99
1.9	Sand	135.0	0.0	42.0	0.23	48.99
4.4	Sand	135.0	0.0	42.0	0.42	89.56
4.4	Sand	125.0	0.0	38.0	0.34	32.19
6.9	Sand	125.0	0.0	38.0	0.48	44.76
6.9	Sand	130.0	0.0	40.0	0.58	66.81
9.6	Sand	130.0	0.0	40.0	0.77	88.70
9.6	Clay	125.0	2.4	0.0	1.04	21.37
11.9	Clay	125.0	2.4	0.0	1.04	21.37
11.9	Sand	130.0	0.0	38.0	0.76	70.98
16.9	Sand	130.0	0.0	38.0	1.04	98.13
16.9	Sand	130.0	0.0	39.0	1.16	122.24
21.9	Sand	130.0	0.0	39.0	1.48	156.06
21.9	Sand	135.0	0.0	40.0	1.63	187.03
25.6	Sand	135.0	0.0	40.0	1.91	219.24
25.6	Clay	130.0	5.1	0.0	2.95	46.12
65.6	Clay	130.0	5.1	0.0	2.95	46.12
65.6	Sand	130.0	0.0	31.0	1.76	20.71
75.9	Sand	130.0	0.0	31.0	2.04	20.71
75.9	Sand	135.0	0.0	35.0	3.00	107.60
85.9	Sand	135.0	0.0	35.0	3.42	107.60
85.9	Sand	125.0	0.0	30.0	2.06	13.32
90.6	Sand	125.0	0.0	30.0	2.16	13.32
90.6	Clay	130.0	6.5	0.0	6.50	58.50
95.9	Clay	130.0	6.5	0.0	6.50	58.50
95.9	Clay	125.0	3.0	0.0	1.31	27.00
103.9	Clay	125.0	3.0	0.0	1.31	27.00

PILE INPUT

Uniform Pile	Pile Type:	Closed-End Pipe
Pile Length: (ft)	65.000	Pile Penetration: (ft) 60.000
Pile Size: (ft)	1.17	Toe Area: (in ²) 153.94

Pile Profile

Lb Top ft	X-Area in ²	E-Modulus ksi	Spec. Wt lb/ft ³	Perim. ft	Crit. Index -
0.0	21.2	30,000.0	492.0	3.7	0

65.0	21.2	30,000.0	492.0	3.7	0
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HAMMER INPUT

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

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in ²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

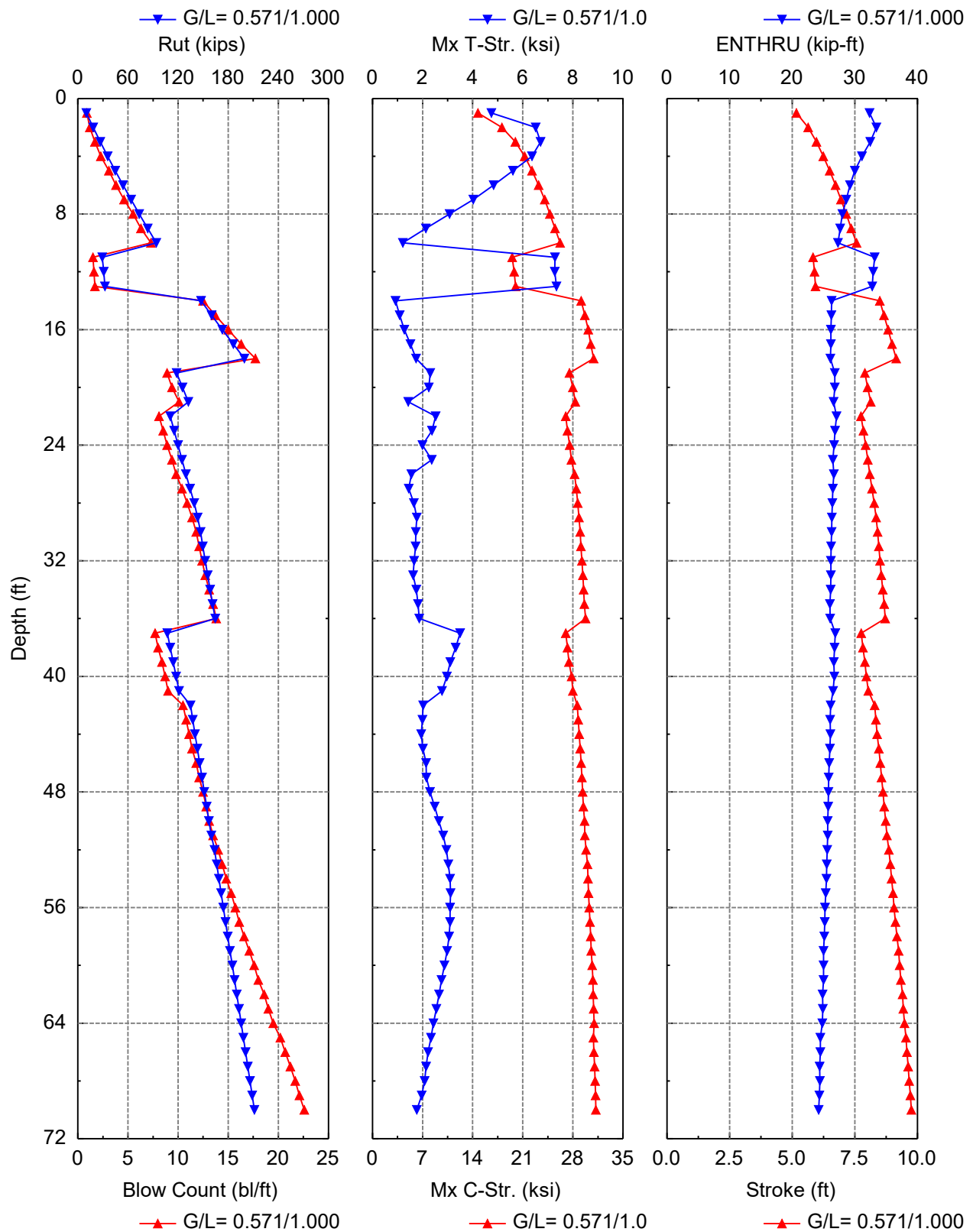
Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in ²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

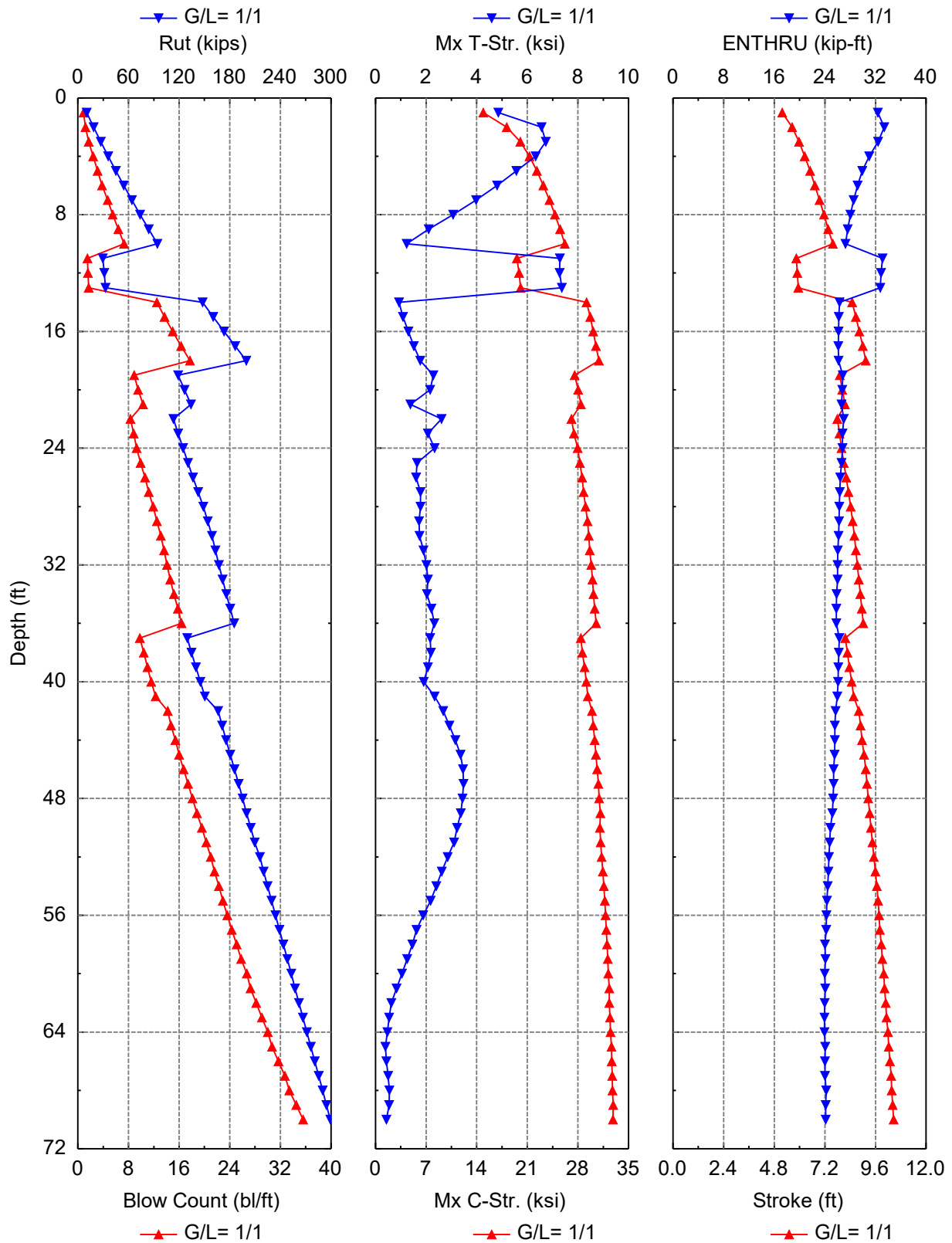
Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in ²
0.0	0.0	0.0	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
1.0	0.1	24.5	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
1.9	0.2	49.0	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
1.9	0.2	49.0	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
3.2	0.3	69.3	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
4.4	0.4	89.6	0.10	0.12	0.05	0.15	1.0	6.0	1.0	153.9
4.4	0.3	32.2	0.10	0.15	0.05	0.15	1.0	6.0	1.0	153.9
5.7	0.4	38.5	0.10	0.15	0.05	0.15	1.0	6.0	1.0	153.9
6.9	0.5	44.8	0.10	0.15	0.05	0.15	1.0	6.0	1.0	153.9
6.9	0.6	66.8	0.10	0.13	0.05	0.15	1.2	6.0	168.0	153.9
8.3	0.7	77.8	0.10	0.13	0.05	0.15	1.2	6.0	168.0	153.9
9.6	0.8	88.7	0.10	0.13	0.05	0.15	1.2	6.0	168.0	153.9
9.6	1.0	21.4	0.10	0.14	0.15	0.15	1.5	6.0	168.0	153.9
10.8	1.0	21.4	0.10	0.14	0.15	0.15	1.5	6.0	168.0	153.9
11.9	1.0	21.4	0.10	0.14	0.15	0.15	1.5	6.0	168.0	153.9
11.9	0.8	71.0	0.10	0.14	0.05	0.15	1.5	6.0	168.0	153.9
13.6	0.9	80.0	0.10	0.14	0.05	0.15	1.5	6.0	168.0	153.9
15.2	0.9	89.1	0.10	0.14	0.05	0.15	1.5	6.0	168.0	153.9
16.9	1.0	98.1	0.10	0.14	0.05	0.15	1.5	6.0	168.0	153.9
16.9	1.2	122.2	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
18.6	1.3	133.5	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9

20.2	1.4	144.8	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
21.9	1.5	156.1	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
21.9	1.6	187.0	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
23.8	1.8	203.1	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
25.6	1.9	219.2	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
25.6	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
27.3	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
28.9	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
30.6	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
32.3	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
33.9	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
35.6	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
37.3	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
38.9	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
40.6	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
42.3	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
43.9	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
45.6	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
47.3	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
48.9	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
50.6	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
52.3	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
53.9	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
55.6	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
57.3	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
58.9	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9
60.0	2.9	46.1	0.10	0.12	0.15	0.15	1.5	6.0	168.0	153.9

Driveability Analysis Summary



Driveability Analysis Summary



Gain/Loss Factor at Shaft/Toe = 0.571/1.000

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow CtMx bl/ft	C-StrMx ksi	T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
1.0	10.1	0.7	9.4	0.9	14.751	4.744	5.16	32.3	D 19-42
2.0	18.4	1.1	17.2	1.2	18.077	6.517	5.63	33.4	D 19-42
3.0	26.9	1.8	25.1	1.7	19.971	6.709	5.97	32.4	D 19-42
4.0	35.7	2.8	33.0	2.3	21.276	6.371	6.24	31.1	D 19-42
5.0	44.8	4.0	40.8	3.1	22.294	5.607	6.49	30.0	D 19-42
6.0	54.1	5.4	48.7	3.8	23.211	4.834	6.72	29.2	D 19-42
7.0	63.7	7.1	56.6	4.6	24.057	4.028	6.94	28.6	D 19-42
8.0	73.5	9.1	64.4	5.5	24.797	3.083	7.15	28.0	D 19-42
9.0	83.6	11.3	72.3	6.3	25.499	2.135	7.35	27.6	D 19-42
10.0	94.0	13.8	80.2	7.3	26.204	1.213	7.56	27.3	D 19-42
11.0	29.1	16.2	13.0	1.5	19.508	7.285	5.83	33.2	D 19-42
12.0	31.0	17.1	13.8	1.6	19.795	7.272	5.89	32.9	D 19-42
13.0	32.3	18.2	14.1	1.7	20.004	7.347	5.93	32.8	D 19-42
14.0	147.6	21.1	126.5	12.5	29.157	0.926	8.49	26.3	D 19-42
15.0	160.2	25.0	135.2	13.7	29.663	1.092	8.66	26.2	D 19-42
16.0	173.0	29.2	143.9	15.0	30.155	1.274	8.83	26.2	D 19-42
17.0	186.1	33.6	152.5	16.3	30.478	1.516	8.98	26.1	D 19-42
18.0	199.5	38.3	161.2	17.7	30.904	1.744	9.15	26.1	D 19-42
19.0	118.2	41.6	76.6	8.9	27.513	2.307	7.90	26.8	D 19-42
20.0	125.2	44.3	80.8	9.4	27.998	2.248	8.01	26.8	D 19-42
21.0	132.3	47.3	85.0	10.1	28.346	1.425	8.13	26.6	D 19-42
22.0	110.6	49.5	61.1	8.1	27.001	2.521	7.74	27.1	D 19-42
23.0	115.3	51.6	63.7	8.5	27.252	2.376	7.84	26.8	D 19-42
24.0	119.9	53.7	66.3	8.9	27.537	1.992	7.93	26.7	D 19-42
25.0	124.7	55.9	68.8	9.4	27.775	2.369	8.01	26.5	D 19-42
26.0	129.5	58.2	71.3	9.8	28.225	1.558	8.09	26.6	D 19-42
27.0	134.3	60.5	73.8	10.4	28.463	1.447	8.18	26.5	D 19-42
28.0	139.2	63.0	76.2	10.9	28.679	1.657	8.27	26.4	D 19-42
29.0	143.3	65.5	77.8	11.4	28.840	1.769	8.34	26.3	D 19-42
30.0	146.9	68.2	78.7	11.8	29.007	1.732	8.40	26.3	D 19-42
31.0	149.6	70.9	78.7	12.1	29.127	1.725	8.46	26.2	D 19-42
32.0	152.4	73.7	78.7	12.4	29.242	1.661	8.51	26.2	D 19-42
33.0	155.3	76.6	78.7	12.7	29.384	1.624	8.55	26.2	D 19-42
34.0	158.3	79.6	78.7	13.1	29.511	1.755	8.60	26.1	D 19-42
35.0	161.4	82.6	78.7	13.5	29.606	1.821	8.67	26.0	D 19-42
36.0	164.5	85.8	78.7	13.8	29.765	1.868	8.71	26.0	D 19-42
37.0	107.2	89.1	18.0	7.7	26.989	3.497	7.75	26.9	D 19-42
38.0	110.6	92.6	18.0	8.0	27.226	3.326	7.82	26.8	D 19-42

39.0	114.1	96.0	18.0	8.4	27.436	3.104	7.89	26.6	D 19-42
40.0	117.6	99.5	18.0	8.7	27.833	2.969	7.96	26.7	D 19-42
41.0	121.1	103.1	18.0	9.0	27.998	2.774	8.03	26.5	D 19-42
42.0	134.9	106.0	28.9	10.5	28.620	2.028	8.29	26.1	D 19-42
43.0	137.5	108.7	28.9	10.8	28.744	1.994	8.34	26.0	D 19-42
44.0	140.2	111.4	28.9	11.1	28.899	1.944	8.39	26.1	D 19-42
45.0	143.0	114.2	28.9	11.4	29.034	2.017	8.45	26.0	D 19-42
46.0	145.9	117.0	28.9	11.8	29.145	2.144	8.51	25.9	D 19-42
47.0	148.7	119.9	28.9	12.1	29.262	2.148	8.56	25.8	D 19-42
48.0	151.5	122.6	28.9	12.5	29.358	2.299	8.62	25.8	D 19-42
49.0	154.2	125.4	28.9	12.8	29.479	2.480	8.67	25.7	D 19-42
50.0	157.0	128.1	28.9	13.1	29.645	2.646	8.73	25.7	D 19-42
51.0	159.7	130.9	28.9	13.5	29.674	2.822	8.77	25.6	D 19-42
52.0	163.6	133.6	30.1	14.0	29.855	2.950	8.86	25.6	D 19-42
53.0	166.3	136.2	30.1	14.4	30.036	3.033	8.92	25.5	D 19-42
54.0	168.9	138.9	30.1	14.8	30.111	3.099	8.96	25.5	D 19-42
55.0	171.6	141.5	30.1	15.3	30.172	3.117	9.02	25.3	D 19-42
56.0	174.3	144.2	30.1	15.7	30.267	3.097	9.06	25.2	D 19-42
57.0	176.9	146.8	30.1	16.1	30.388	3.096	9.12	25.2	D 19-42
58.0	179.6	149.5	30.1	16.6	30.471	3.061	9.18	25.1	D 19-42
59.0	182.2	152.2	30.1	17.1	30.550	2.980	9.24	25.0	D 19-42
60.0	184.9	154.8	30.1	17.6	30.690	2.876	9.28	25.0	D 19-42
61.0	187.5	157.5	30.1	18.0	30.780	2.756	9.33	25.0	D 19-42
62.0	190.2	160.1	30.1	18.6	30.818	2.659	9.40	24.8	D 19-42
63.0	192.9	162.8	30.1	19.0	30.915	2.551	9.43	24.9	D 19-42
64.0	195.5	165.4	30.1	19.5	30.976	2.435	9.48	24.8	D 19-42
65.0	198.2	168.1	30.1	20.2	30.877	2.338	9.54	24.5	D 19-42
66.0	200.8	170.8	30.1	20.7	30.942	2.220	9.58	24.5	D 19-42
67.0	203.5	173.4	30.1	21.2	31.028	2.144	9.63	24.4	D 19-42
68.0	206.1	176.1	30.1	21.7	31.105	2.080	9.66	24.4	D 19-42
69.0	208.8	178.7	30.1	22.1	31.157	1.961	9.71	24.3	D 19-42
70.0	211.5	181.4	30.1	22.6	31.193	1.767	9.75	24.2	D 19-42

Total driving time: 20 minutes; Total Number of Blows: 806 (starting at penetration 1.0 ft)

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

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow CtMx bl/ft	C-StrMx ksi	T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
1.0	10.3	1.0	9.4	0.9	14.910	4.851	5.18	32.4	D 19-42
2.0	18.6	1.4	17.2	1.2	18.154	6.560	5.64	33.4	D 19-42
3.0	27.2	2.1	25.1	1.7	20.017	6.725	5.97	32.4	D 19-42

4.0	36.0	3.0	33.0	2.4	21.308	6.332	6.25	31.0	D 19-42
5.0	45.1	4.2	40.8	3.1	22.317	5.570	6.50	29.9	D 19-42
6.0	54.4	5.7	48.7	3.8	23.226	4.803	6.73	29.2	D 19-42
7.0	64.0	7.4	56.6	4.7	24.070	3.980	6.95	28.6	D 19-42
8.0	73.8	9.4	64.4	5.5	24.819	3.073	7.15	28.0	D 19-42
9.0	83.9	11.6	72.3	6.4	25.520	2.105	7.36	27.6	D 19-42
10.0	94.2	14.1	80.2	7.3	26.196	1.237	7.57	27.2	D 19-42
11.0	29.4	16.4	13.0	1.5	19.557	7.284	5.84	33.1	D 19-42
12.0	31.2	17.4	13.8	1.6	19.847	7.280	5.89	32.9	D 19-42
13.0	32.6	18.5	14.1	1.7	20.063	7.364	5.93	32.7	D 19-42
14.0	147.9	21.4	126.5	12.5	29.175	0.927	8.49	26.3	D 19-42
15.0	160.5	25.3	135.2	13.7	29.695	1.088	8.67	26.2	D 19-42
16.0	173.3	29.4	143.9	15.0	30.103	1.298	8.83	26.2	D 19-42
17.0	186.4	33.9	152.5	16.3	30.487	1.520	8.99	26.1	D 19-42
18.0	199.7	38.5	161.2	17.7	30.897	1.766	9.14	26.2	D 19-42
19.0	118.9	42.2	76.6	8.9	27.551	2.290	7.91	26.8	D 19-42
20.0	126.4	45.5	80.8	9.5	28.022	2.159	8.02	26.7	D 19-42
21.0	134.1	49.1	85.0	10.3	28.420	1.384	8.16	26.6	D 19-42
22.0	113.2	52.2	61.1	8.3	27.119	2.614	7.79	27.0	D 19-42
23.0	119.0	55.2	63.7	8.8	27.446	2.069	7.89	26.8	D 19-42
24.0	124.7	58.4	66.3	9.3	27.945	2.339	7.99	26.8	D 19-42
25.0	130.5	61.7	68.8	9.9	28.264	1.645	8.10	26.6	D 19-42
26.0	136.4	65.1	71.3	10.6	28.568	1.602	8.21	26.4	D 19-42
27.0	142.5	68.7	73.8	11.2	28.780	1.780	8.32	26.3	D 19-42
28.0	148.6	72.4	76.2	11.9	29.053	1.780	8.42	26.3	D 19-42
29.0	154.0	76.2	77.8	12.5	29.328	1.723	8.51	26.2	D 19-42
30.0	158.9	80.1	78.7	13.1	29.493	1.745	8.60	26.1	D 19-42
31.0	163.0	84.2	78.7	13.6	29.649	1.895	8.67	26.0	D 19-42
32.0	167.2	88.4	78.7	14.1	29.837	2.013	8.74	26.0	D 19-42
33.0	171.5	92.8	78.7	14.6	29.994	2.072	8.80	26.0	D 19-42
34.0	176.0	97.3	78.7	15.2	30.160	2.039	8.88	25.9	D 19-42
35.0	180.6	101.9	78.7	15.8	30.320	2.205	8.95	25.8	D 19-42
36.0	185.3	106.6	78.7	16.4	30.528	2.329	9.02	25.8	D 19-42
37.0	129.6	111.6	18.0	9.8	28.389	2.165	8.17	26.3	D 19-42
38.0	134.8	116.7	18.0	10.4	28.601	2.190	8.26	26.2	D 19-42
39.0	140.0	121.9	18.0	11.0	28.901	2.074	8.36	26.1	D 19-42
40.0	145.2	127.2	18.0	11.6	29.146	1.910	8.46	26.1	D 19-42
41.0	150.6	132.5	18.0	12.3	29.347	2.333	8.56	26.0	D 19-42
42.0	166.2	137.3	28.9	14.2	29.927	2.682	8.81	25.7	D 19-42
43.0	170.9	142.0	28.9	14.7	30.126	2.926	8.89	25.6	D 19-42
44.0	175.6	146.8	28.9	15.4	30.334	3.161	8.97	25.6	D 19-42

45.0	180.5	151.6	28.9	16.0	30.502	3.357	9.06	25.5	D 19-42
46.0	185.5	156.6	28.9	16.7	30.656	3.458	9.14	25.4	D 19-42
47.0	190.5	161.6	28.9	17.4	30.822	3.482	9.20	25.4	D 19-42
48.0	195.3	166.4	28.9	18.1	30.920	3.442	9.26	25.3	D 19-42
49.0	200.1	171.2	28.9	18.8	31.095	3.376	9.33	25.2	D 19-42
50.0	204.9	176.0	28.9	19.6	31.031	3.225	9.39	24.9	D 19-42
51.0	209.7	180.9	28.9	20.3	31.135	3.110	9.45	24.8	D 19-42
52.0	215.6	185.6	30.1	21.0	31.279	2.855	9.53	24.7	D 19-42
53.0	220.3	190.2	30.1	21.6	31.454	2.619	9.59	24.5	D 19-42
54.0	224.9	194.9	30.1	22.3	31.596	2.408	9.66	24.4	D 19-42
55.0	229.6	199.5	30.1	22.9	31.702	2.176	9.72	24.3	D 19-42
56.0	234.2	204.2	30.1	23.6	31.805	1.888	9.77	24.2	D 19-42
57.0	238.9	208.8	30.1	24.3	31.932	1.628	9.81	24.2	D 19-42
58.0	243.5	213.5	30.1	25.1	32.022	1.462	9.88	24.0	D 19-42
59.0	248.2	218.1	30.1	25.8	32.114	1.253	9.92	24.1	D 19-42
60.0	252.8	222.8	30.1	26.7	32.202	1.046	9.99	24.0	D 19-42
61.0	257.5	227.4	30.1	27.3	32.328	0.830	10.02	24.1	D 19-42
62.0	262.1	232.1	30.1	28.2	32.341	0.629	10.08	24.0	D 19-42
63.0	266.8	236.7	30.1	29.1	32.444	0.538	10.12	23.9	D 19-42
64.0	271.4	241.4	30.1	30.0	32.514	0.472	10.19	23.9	D 19-42
65.0	276.1	246.0	30.1	30.7	32.629	0.397	10.23	24.1	D 19-42
66.0	280.7	250.7	30.1	31.7	32.661	0.429	10.29	24.0	D 19-42
67.0	285.4	255.3	30.1	32.7	32.733	0.501	10.34	24.0	D 19-42
68.0	290.0	260.0	30.1	33.4	32.787	0.548	10.37	24.2	D 19-42
69.0	294.7	264.6	30.1	34.5	32.863	0.544	10.41	24.1	D 19-42
70.0	299.3	269.3	30.1	35.6	32.832	0.429	10.46	24.1	D 19-42

UBV = 266.0 kips driving time: 27 minutes; Total Number of Blows: 1065 (starting at penetration 1.0 ft)

GRLWEAP: Wave Equation Analysis of Pile Foundations

MOT-835-2.57 Fwd Abutment B-004-1-24

9/24/2026

RESOURCE INTERNATIONAL INC

GRLWEAP 14.1.20.1

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

SOIL PROFILE

Depth ft	Soil Type -	Spec. Wt lb/ft ³	Su ksf	Phi °	Unit Rs ksf	Unit Rt ksf
0.0	Clay	120.0	1.0	0.0	0.76	9.00
0.3	Clay	120.0	1.0	0.0	0.76	9.00
0.3	Sand	130.0	0.0	39.0	0.03	3.60
10.8	Sand	130.0	0.0	39.0	0.77	80.88
10.8	Sand	115.0	0.0	29.0	0.26	11.98
13.3	Sand	115.0	0.0	29.0	0.30	13.32
13.3	Sand	130.0	0.0	40.0	0.98	112.69
18.3	Sand	130.0	0.0	40.0	1.33	153.22
18.3	Sand	135.0	0.0	36.0	0.85	68.95
21.3	Sand	135.0	0.0	36.0	1.00	80.70
21.3	Sand	130.0	0.0	34.0	0.79	55.36
36.3	Sand	130.0	0.0	34.0	1.32	73.64
36.3	Clay	125.0	1.9	0.0	1.42	16.87
41.3	Clay	125.0	1.9	0.0	1.42	16.87
41.3	Clay	125.0	3.0	0.0	1.31	27.00
51.3	Clay	125.0	3.0	0.0	1.31	27.00
51.3	Clay	125.0	3.1	0.0	1.27	28.12
76.3	Clay	125.0	3.1	0.0	1.27	28.12
76.3	Sand	125.0	0.0	29.0	1.60	13.32
81.3	Sand	125.0	0.0	29.0	1.70	13.32
81.3	Sand	135.0	0.0	35.0	3.05	107.60
86.3	Sand	135.0	0.0	35.0	3.26	107.60
86.3	Clay	125.0	2.5	0.0	1.53	22.50
96.3	Clay	125.0	2.5	0.0	1.53	22.50
96.3	Clay	120.0	1.4	0.0	1.22	12.37
99.5	Clay	120.0	1.4	0.0	1.22	12.37

PILE INPUT

Uniform Pile		Pile Type:	Closed-End Pipe
Pile Length: (ft)	75.000	Pile Penetration: (ft)	70.000
Pile Size: (ft)	1.17	Toe Area: (in ²)	153.94

Pile Profile

Lb Top ft	X-Area in ²	E-Modulus ksi	Spec. Wt lb/ft ³	Perim. ft	Crit. Index -
0.0	21.2	30,000.0	492.0	3.7	0
75.0	21.2	30,000.0	492.0	3.7	0

HAMMER INPUT

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

Hammer Data

ID	Ram Wt	Ram L.	Ram Ar.	Rtd. Stk	Effic.	Rtd. Energy
-	kips	in	in ²	ft	-	kip-ft
41	4.000	129.1	124.7	10.8	0.80	43.2

DRIVE SYSTEM FOR DELMAG D 19-42-OED

Type	X-Area	E-Modulus	Thickness	COR	Round-out	Stiffness
-	in ²	ksi	in	-	in	kips/in
Hammer C.	227.000	530.000	2.000	0.800	0.120	60155.555
Helmet Wt.	1.900	kips				

SOIL RESISTANCE DISTRIBUTION

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Set. F.	Limit D.	Set. T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in ²
0.0	0.8	9.0	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
0.3	0.8	9.0	0.10	0.17	0.15	0.15	1.5	6.0	168.0	153.9
0.3	0.0	3.6	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
2.1	0.2	16.5	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
3.8	0.3	29.4	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
5.6	0.4	42.2	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
7.3	0.5	55.1	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
9.1	0.6	68.0	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
10.8	0.8	80.9	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
10.8	0.3	12.0	0.10	0.23	0.05	0.15	1.0	6.0	1.0	153.9
12.1	0.3	13.0	0.10	0.23	0.05	0.15	1.0	6.0	1.0	153.9
13.3	0.3	13.3	0.10	0.23	0.05	0.15	1.0	6.0	1.0	153.9
13.3	1.0	112.7	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
15.0	1.1	126.2	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
16.6	1.2	139.7	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
18.3	1.3	153.2	0.10	0.13	0.05	0.15	1.0	6.0	1.0	153.9
18.3	0.9	68.9	0.10	0.12	0.10	0.15	1.2	6.0	168.0	153.9
19.8	0.9	74.8	0.10	0.12	0.10	0.15	1.2	6.0	168.0	153.9
21.3	1.0	80.7	0.10	0.12	0.10	0.15	1.2	6.0	168.0	153.9
21.3	0.8	55.4	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
23.0	0.8	59.5	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
24.6	0.9	63.5	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
26.3	1.0	67.4	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9

28.0	1.0	71.3	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
29.6	1.1	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
31.3	1.1	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
33.0	1.2	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
34.6	1.3	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
36.3	1.3	73.6	0.10	0.13	0.15	0.15	1.5	6.0	168.0	153.9
36.3	1.4	16.9	0.10	0.14	0.15	0.15	1.5	6.0	168.0	153.9
38.0	1.4	16.9	0.10	0.14	0.15	0.15	1.5	6.0	168.0	153.9
39.6	1.4	16.9	0.10	0.14	0.15	0.15	1.5	6.0	168.0	153.9
41.3	1.4	16.9	0.10	0.14	0.15	0.15	1.5	6.0	168.0	153.9
41.3	1.3	27.0	0.10	0.13	0.15	0.15	1.8	6.0	168.0	153.9
43.0	1.3	27.0	0.10	0.13	0.15	0.15	1.8	6.0	168.0	153.9
44.6	1.3	27.0	0.10	0.13	0.15	0.15	1.8	6.0	168.0	153.9
46.3	1.3	27.0	0.10	0.13	0.15	0.15	1.8	6.0	168.0	153.9
48.0	1.3	27.0	0.10	0.13	0.15	0.15	1.8	6.0	168.0	153.9
49.6	1.3	27.0	0.10	0.13	0.15	0.15	1.8	6.0	168.0	153.9
51.3	1.3	27.0	0.10	0.13	0.15	0.15	1.8	6.0	168.0	153.9
51.3	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
53.0	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
54.6	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
56.3	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
58.0	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
59.6	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
61.3	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
63.0	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
64.6	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
66.3	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
68.0	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
69.6	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9
70.0	1.3	28.1	0.10	0.13	0.20	0.15	1.8	6.0	168.0	153.9