FINAL REPORT
STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. CUY-90-1678
RETAINING WALL AE & AG
CUY-90-16.28 (CCG3A)
CUYAHOGA COUNTY, OHIO
PID#: 82382

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NEAS PROJECT 21-0011

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National Engineering & Architectural Services Inc.

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1. INTRODUCTION

1.1. General

National Engineering & Architectural Services, Inc. (NEAS) presents our Structure Foundation Exploration Report for the proposed Bridge CUY-90-1678 (Bridge 13) structure and associated retaining walls, Retaining Walls AE & AG (RW-AE and RW-AG), as part of the proposed Ohio Department of Transportation (ODOT) project CCG3A (CUY-90-16.28, PID 82382) in the City of Cleveland, Cuyahoga County, Ohio. The overall project objective is to reconstruct and improve the IR-77/IR-90 interchange, IR-90 and associated surface streets within the project limits. As part of the planned improvements, IR-90 is proposed to be widened and to facilitate the widening, the existing Bridge CUY-90-1678 carrying East 22nd Street (St) over IR-90 is required to be replaced with a lengthened structure. Furthermore, the construction of two associated retaining walls (RW-AE and RW-AG) are also required. This report presents a summary of the encountered surficial and subsurface conditions and our recommendations for bridge and retaining wall foundation design and construction in accordance with Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication *LRFD Bridge Design Specifications, 9th Edition* (BDS) (AASHTO, 2020) and the 2021 revision of *ODOT's Bridge Design Manual 2020 Edition* (BDM) (ODOT [1], 2021).

The exploration was conducted in general accordance with Barr Engineering, Inc. DBA National Engineering & Architectural Services, Inc.'s (formerly Barr & Prevost) proposal to Michael Baker International (Baker) dated June 11, 2014, subsequent Modification 7 (MOD 7) proposal to Baker dated October 12, 2020 and with the provisions of the July 2014 (ODOT, 2014) and January 2021 (ODOT, 2021) revisions of ODOT's *Specifications for Geotechnical Explorations* (SGE) for the initial project exploration and the MOD 7 exploration, respectively.

The scope of work performed by NEAS as part of the CCG3A project included: 1) a review of published geotechnical information; 2) performing 182 total test soil borings (10 utilized within this report as a part of the indicated structure foundation exploration); 3) performing 30 total cone penetration test (CPT) sounding (3 utilized within this report as a part of the indicated structure foundation exploration); 4) laboratory testing of soil samples in accordance with the SGE; 5) performing geotechnical engineering analysis to assess foundation design and construction considerations; and, 6) development of this summary report.

1.2. Proposed Construction

The existing Bridge CUY-90-1678 consists of a two-span, continuous steel beam bridge originally built in 1958. The referenced bridge carries East 22nd St over IR-90 and is about 122 ft in length (abutment to abutment) with an approximate roadway width of 74 ft (curb to curb). The structure carries six lanes of traffic on a reinforced concrete bridge deck supported by concrete abutments. As IR-90 is planned to be widened as part of the CCG3A project, Bridge CUY-90-1678 is planned to be replaced with a lengthened structure to traverse the new IR-90 alignment. Based on the available Stage 2 Plan developed by Baker dated December 15, 2023, the new structure will be a two span, continuous steel plate girder bridge with wall type abutments and a cap and column type pier. The proposed bridge will be approximately 261 ft in length (abutment to abutment) and with a variable width. The proposed abutments and piers are planned to be supported by a driven, cast-in-place pile foundation system.

Each of the referenced retaining walls (RW-AE and RW-AG) are either near Bridge CUY-90-1678 or adjoin the proposed bridge's abutments or wing walls. Due to the proposed widening and realignment (horizontal and vertical) of IR-90, retaining walls RW-AE and RW-AG are required to provide the necessary grade separation between IR-90 roadway grades and the surrounding East 22nd St grades as well as other nearby surface street grades including Ramp A1 and the Midtown Connector. RW-AE is proposed to be a cast-in-place wall that is anticipated to extended along the southern edge of Ramp A1 which provides grade separation between IR-90 grades and Ramp A1. RW-AG is about 610 ft in length with maximum heights on the order of 30 ft. RW-AG is a driven pile supported cast-in-place wall that will function as the east rear abutment wing wall for Bridge CUY-90-1678 and provide grade separation between IR-90 grades and the Midtown Connector.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The project site is located within the Erie Lake Plain, part of the Huron-Erie Lake Plains. This area is characterized as the edge of the very low-relief (10 ft), Ice-Age lake basin separated from the modern Lake Erie by shoreline cliffs with major streams in deep gorges being characteristic. The geology in this region is described as Pleistocene-age lacustrine sand, silt, clay and wave-planed glacial till over Devonian- and Mississippi-age shales and sandstones (ODGS, 1998).

The geology underlying the bridge site is mapped as an average of 20 ft of Wisconsinan-age sand atop a maximum of 290 ft of Wisconsinan-age lacustrine silt and clays all over Devonian-age Ohio Shale. The Wisconsinan-age sand mapped at the site is characterized as well to moderately sorted, moderately to well rounded, finely stratified to massive and contains minor amounts of disseminated gravel or thin lenses of silt or clay. The lacustrine soils at the site is described as laminated silts and clays that may contain fine sand or gravel layers.

Bedrock beneath the proposed bridge has been mapped as sedimentary Devonian-age Ohio shale with carbonate and/or siderite concretions in the lowermost 50 ft. This brownish black to greenish gray shale is carbonaceous to clayey, laminated to thin bedded, and can have a petroliferous odor (USGS & ODGS, 2005). Based on the ODNR bedrock topography map of Ohio, bedrock elevations near the proposed structure sites can be expected to be between elevations of 450 and 400 ft above mean sea level (amsl), putting bedrock at a depth ranging from about 200 to 270 ft below ground surface (bgs).

The soils at the bridge site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service as Udorthents, loamy (Ua) and Urban Land (Ub). These are soils that have been disturbed by cutting or filling and are not rated for local roads (USDA, 2019).

2.2. Hydrology/Hydrogeology

The local hydro-geologic system is dominated by the valley of the Cuyahoga River, located approximately 0.8 to 1.0 miles to the southwest of the proposed bridge structure and flows northwest discharging into Lake Erie. The elevation of the Cuyahoga River and Lake Erie is about 570 to 575 ft amsl in this region and is likely to be representative of the regional groundwater table. As mentioned previously, the surficial geology consists of primarily granular soils underlain by a relatively impermeable lacustrine layer. It is possible for groundwater to become trapped in granular soils above the regional groundwater level by an underlying impermeable layer forming a perched water table. The project site follows a similar geological model and

therefore, could result in a groundwater elevation within the project limits that is likely above the regional groundwater table elevation.

The proposed bridge site is not located within a special flood hazard area based on available mapping by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2016).

2.3. Mining and Oil/Gas Production

No abandoned mines are noted on ODNR's Abandoned Underground Mine Locator within the immediate vicinity of the proposed structure locations (ODNR [1], 2016).

No oil or gas wells are noted on ODNR's Ohio Oil & Gas Locator within the immediate vicinity of the proposed structure locations (ODNR [2], 2016).

2.4. Historical Records and Previous Phases of Project Exploration

A historic record search was performed through ODOT's Transportation Information Mapping System (TIMS). Two historical soil boring (B-008-C-57 & B-002-T-58) were reviewed and considered in our evaluation of the proposed structure subsurface conditions. A summary of the historic boring information (location, elevation, etc.) is provided in Table 1, and the location is depicted on the Soil Profile Sheets provided in Appendix A. The historic boring log of the boring utilized within this report is provided in Appendix B.

ODOT District 12 provided NEAS with "Report of Subsurface Exploration for CUY-INNERBELT, Innerbelt Corridor Project – Retaining Walls, PID 77510 & 25795" dated March 16, 2007, submitted by DLZ Ohio, Inc. (DLZ). Two soil borings performed as part of the DLZ exploration were reviewed and were considered in our evaluation of the proposed structures subsurface conditions. It should be noted that the location information regarding these borings was assumed based on Figure 1 provided with the referenced report. Boring coordinate information for the referenced logs was not provided in the report or on the logs. A summary of the boring information (location, elevation, etc.) is provided in Table 1, and their locations are depicted on the Soil Profile Sheets provided in Appendix A. The historic boring logs of the borings utilized within this report are provided in Appendix B.

Table 1: Historic Boring Summary

Boring Number	Latitude	Longitude	Elevation (NAVD 88) (ft)	Depth (ft)	Proposed Substructure
B-002-T-58	41.497953	-81.673918	669.8	81.0	Rear Abutment
B-008-C-57	41.498238	-81.672849	671.0	81.0	RW-AG
B-001-D-06[(2)]	41.498178	-81.673424	671.0	130.0	RW-AG
B-002-D-06[(2)]	41.498676	-81.671768	668.0	130.0	RW-AG

Notes:
1. *Based on locations as mapped in ODOT's Transportation Information Mapping System (TIMS).*
2. *Based on Figure 1 provided with the referenced March 16, 2007, DLZ Ohio, Inc. report.*

2.5. Site Reconnaissance

Field reconnaissance visits for the proposed Bridge CUY-90-1678 and retaining walls RW-AE and RW-AG were conducted on July 9, 2015, along the existing IR-90 alignment at this location. Site conditions were noted and photographed during the visit. A summary of our observations are provided below.

2.5.1. Bridge No. CUY 90-1678

The existing bridge carrying East 22nd St over IR-90 is a two span, continuous steel beam bridge with a reinforced concrete deck supported by wall type abutments and a cap and column type pier. On the east side of the rear abutment is a full height wing wall which extended to the existing Cedar Avenue Bridge (Photograph 1). The west side of the rear abutment consists of a short wing wall and an existing embankment slope which supports IR-90 exist ramp pavement (Photograph 2). Similar to the rear abutment location, on the east side of the forward abutment is a full height wing wall which extended to the existing Cedar Avenue Bridge while the west side consists of a short wing wall and an existing embankment slope which supports an upslope parking lot (Photograph 3). The existing wing walls were observed to be in good condition. The embankment slopes at the bridge site were observed to be approximately two horizontal to one vertical (2H:1V) and generally appeared to be in good condition with no visible slope instability. The embankment slopes near the abutments were heavily vegetated primarily with various grasses and brush, however, some trees were present.

Overall, the bridge appeared to be in good condition with no signs of distress observed. No apparent signs of structural distress due to geotechnical concerns were noted during our field reconnaissance visit. The deck surface of the bridge was observed to be in good condition showing minor signs of distress including one small area of low to medium severity joint alligator transverse cracking. minor joint cracking near the abutments, and some longitudinal cracking. Surface water drains to either side of the bridge which is directed to storm drains along the curbs. Small amounts of ponding and standing water were observed in the roadway on the east side of the bridge, however, the reconnaissance was conducted on a rainy day.

2.5.2. Retaining Wall AE

The location of the proposed RW-AE encompasses the area located along the proposed northern limits of IR-90 from about East 19th St to East 22nd St. This area generally includes current private parking lot property as well as pavement and embankments of the existing IR-90 westbound entrance ramp from Carnegie Ave. At the time of our site visit, the area located adjacent to the existing Bridge CUY-90-1678 and within the limits of the proposed walls were observed to be a grassy area with a few small trees were the terrain slopes downward from north to south with a maximum slope of about 2H:1V. The remainder of the proposed RW-AE site traverses two parking lots and the referenced IR-90 entrance ramp. This area was observed to consist of asphalt pavement at the ramp with grass covered slopes ranging from relatively flat to 3H:1V (Photograph 4). Each area generally appeared to be in good condition with no visible sign of instability. In the pavement areas (parking lot or ramp), no significant sign of pavement distress within the length of the proposed walls was observed. In general, the site appeared to be well-drained with no apparent signs of ponding observed at the time of our visit.

2.5.3. Retaining Wall AG

The location of the proposed RW-AG encompasses the area located along the southeast limits of IR-90 from the existing Bridge CUY-90-1678 and extending east for about 600 ft along the Cedar Ave. This area includes the property which is currently the IR-90 EB exist ramp to Carnegie Ave as well as the property immediately adjacent to the existing parking lot located off Cedar Ave. At the time of our site visit, the area located adjacent to the existing Cedar Ave Bridge and within the limits of the proposed walls was observed to be a grassy area with various mature trees were the terrain slopes downward from south to north with a maximum slope of about 2H:1V (Photograph 5). This area generally appeared to be in good condition with no visible sign of instability. In the pavement areas, no significant sign of pavement distress within the length of the proposed walls was observed. In general, the site appeared to be well-drained with no apparent signs of ponding observed at the time of our visit on or near the referenced roadways.

Photograph 1: Existing rear abutment east wing wall

Photograph 2: Existing rear abutment west wing wall and slope

Photograph 3: Existing forward abutment west embankment slope

Photograph 4: Existing IR-90 entrance ramp along proposed RW-AE

Photograph 5: Existing IR-90 exit ramp along proposed RW-AG

3. GEOTECHNICAL EXPLORATION

3.1. Field Exploration Program

The exploration for the proposed Bridge CUY-90-1678 and associated retaining walls (RW-AE & RW-AG) structures was conducted by NEAS between October 22, 2014, and April 7, 2021. The exploration for the referenced structures included 10 borings drilled to depths ranging from of 51.5 to 141.5 ft bgs and 3 CPT soundings that were extended to depths ranging from 64.0 and 117 ft bgs. The exploration locations were selected by NEAS in general accordance with the guidelines contained in the SGE with the intent to evaluate subsurface soil and groundwater conditions. Borings were typically located at/near proposed substructure locations and along wall alignments that were not restricted by maintenance of traffic, underground utilities or dictated by terrain (i.e., steep embankment slopes). Project exploration locations were located and surveyed in the field by NEAS after the completion of drilling/sounding. Each individual project boring/CPT log (included within Appendix B) includes the recorded boring latitude and longitude location (based on the surveyed Ohio State Plane North, NAD83, location) and the corresponding ground surface

elevation. A summary of the exploration locations including stationing, offsets, location information and elevations of the indicated CUY-90-1678 structure foundation explorations are shown in Table 1 below, while the locations are depicted on the Soil Profile Sheets provided within Appendix A.

Table 2: Project Boring Summary

Boring Number	Latitude	Longitude	Elevation (NAVD 88) (ft)	Depth (ft)	Structure
B-085-1-20	41.498493	-81.674299	672.4	66.5	CUY-90-1678 Forward Abutment
B-085-2-20	41.498410	-81.674225	672.0	131.5	CUY-90-1678 Pier 1
B-085-4-20	41.497956	-81.673732	670.8	51.5	CUY-90-1678 Rear Abutment
C-086-0-14	41.497963	-81.673711	670.3	115.2	CUY-90-1678 Rear Abutment
B-086-1-20	41.498510	-81.673720	670.4	141.5	CUY-90-1678 Pier 1
C-087-0-14	41.498719	-81.673844	671.4	117.0	CUY-90-1678 Forward Abutment
B-087-1-20	41.498184	-81.673420	670.7	136.5	RW-AG
B-087-3-20	41.498318	-81.673037	670.1	141.5	RW-AG
B-148-0-14	41.497523	-81.676575	667.3	61.5	RW-AE
B-149-0-14	41.497763	-81.676127	669.8	61.5	RW-AE
C-150-0-14	41.498442	-81.674889	670.1	64.0	RW-AE
B-151-0-14	41.498073	-81.675354	665.4	61.5	RW-AE
B-169-1-20	41.498665	-81.672360	645.2	85.0	RW-AG

Notes:
1. As-drilled boring location and corresponding ground surface elevation was surveyed in the field by NEAS Inc.

The boring was drilled using a either a CME 55, MOBILE B-58, CME 75 or CME 45B truck mounted drilling rig utilizing 3.25-inch diameter hollow stem augers. Soil samples were generally recovered at 2.5-ft intervals to depths ranging from 30 ft to 61.5 bgs and at 5.0-ft intervals thereafter using a split spoon sampler (AASHTO T-206 “Standard Method for Penetration Test and Split Barrel Sampling of Soils”). The soil samples obtained from the exploration program were visually observed in the field by the NEAS field representative and preserved for review by a Geologist and possible laboratory testing. Standard penetration tests (SPT) were conducted using auto hammers that had been calibrated to be between 68.4% and 92.2% efficient as indicated on the boring log. Field boring logs were prepared by drilling personnel, and included lithological description, SPT results recorded as blows per 6-inch increment of penetration and estimated unconfined shear strength values on specimens exhibiting cohesion (using a hand penetrometer). Groundwater level observations were recorded both during and after the completion of drilling. These groundwater level observations are included on the individual boring log. After completing the boring, the borehole was backfilled with auger cuttings to the ground surface.

The CPT soundings were performed by ODOT utilizing a A.P. van den Berg twin-cylinder H-form HYSON 200-kN (45-kip) track mounted penetrometer with a model ELCI-CFXYP20-15 seismic piezocone. During testing, data was collected continuously by a GOnsite! Data acquisition system. The CPT soundings were conducted in accordance with ASTM D5778 “Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils”. In general, the 15-cm^2 (2.3-in^2) seismic piezocone was advanced at a rate of 20 mm/sec (0.8 in/sec) utilizing 1-m (3.3-ft) long connector rods extending to the target termination depth. After the completion of the CPT soundings, a CPT log was generating by ODOT utilizing the software entitled CPeT-IT by GeoLogismiki. It should be noted that in instances where the

angle of inclination of the cone deviated from vertical and/or cone tip pressures increased to tolerances that may result in damaging of the equipment, the CPT soundings was stopped prior to target termination depth. The continuously recorded sounding data can be found on the individual log included within Appendix B.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing and moisture content determinations. Data from the laboratory testing program was incorporated onto the final boring logs included within Appendix B. Soil samples are retained at the laboratory for 60 days following report submittal, after which time they will be discarded.

3.2.1. Classification Testing

Representative soil samples were selected for index properties (Atterberg Limits) and gradation testing for classification purposes on approximately 33% of the samples. At the boring location, samples were selected for testing with the intent of identification and classification of all significant soil units. Soils not selected for testing were compared to laboratory tested samples/strata and classified visually. Moisture content testing was conducted on all samples. The laboratory testing was performed in general accordance with applicable AASHTO specifications.

A final classification of the soil strata was made in accordance with AASHTO M-145 “Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes,” as modified by ODOT “Classification of Soils” once laboratory test results became available. The results of the soil classification are presented on the boring log in Appendix B.

3.2.2. Standard Penetration Test Results

Standard Penetration Tests (SPT) and split-barrel (commonly known as split-spoon) sampling of soils were performed at varying intervals (i.e., continuous, 2.5-ft and 5.0-ft) in the project borings performed. To account for the high efficiency (automatic) hammers used during SPT sampling, field SPT N-values were converted based on the calibrated efficiency (energy ratio) of the specific drill rig's hammer. Field N-values were converted to an equivalent rod energy of 60% (N_{60}) for use in analysis or for correlation purposes. The resulting N_{60} values are presented on the boring logs provided in Appendix B.

4. GEOTECHNICAL FINDINGS

The subsurface conditions encountered during NEAS’s explorations are described in the following subsections and on each boring log presented in Appendix B. The boring logs represent NEAS’s interpretation of the subsurface conditions encountered at each exploration location based on our site observations, field logs, visual review of the soil samples by NEAS's geologist, and laboratory test results. The lines designating the interfaces between various soil strata on the logs represent the approximate interface location; the actual transition between strata may be gradual and indistinct. The subsurface and groundwater characterizations included herein, including summary test data, are based on the subsurface findings from the geotechnical explorations performed by NEAS as part of the referenced project, results of historical explorations, and consideration of the geological history of the site.

4.1. Subsurface Conditions

The general subsurface profile is relatively uniform and consistent with the geological model for the project. The subsurface profile at the site of proposed Bridge CUY-90-1678 and associated retaining walls generally consists of surficial materials (i.e., topsoil or pavement) underlain by existing embankment or historical fill soils followed by natural sands and gravels underlain by natural lacustrine and/or till soils. Where encountered, the embankment fill at the site can generally be described as very loose to very dense non-cohesive, granular soils. The natural sands and gravels encountered at the site were generally comprised of loose to very dense non-cohesive, granular material. The lacustrine/till soils at the site were highly variable though can generally as loose to dense coarse- and fined-grained, non-cohesive material in the upper portion of the stratum and medium stiff to hard fine-grained, cohesive material in the lower portion of the stratum. Bedrock was not encountered within the depths of the explorations performed.

4.1.1. Overburden Soil

At the site of proposed structures, three different materials were encountered below the surficial material. In general, the three different overburden materials consisted of historical or embankment "man-made" fill soils, natural sands and gravels, and natural lacustrine and/or till soils. These materials and the general profile underlying the site is further described below.

Fill soils were encountered in 8 of the 10 borings utilized for the proposed structures with the exceptions of B-085-1-20 and B-085-2-20. These fill soils were encountered immediately below the topsoil, pavement section or at the ground surface and extended to depths ranging from 2.0 to 24.5 ft bgs (approximate elevations 645.9 to 667.6 ft amsl). Based on laboratory testing results and a visual review of the soil samples obtained, the fill within the borings is comprised of granular material and is classified on the boring logs as Gravel with Sand (A-1-b), Fine Sand (A-3), Coarse and Fine Sand (A-3a) and non-cohesive Sandy Silt (A-4a). The exceptions being an approximately 2.5-ft thick layer of cohesive fill encountered within B-086-1-20 at a depth of 14.5 ft bgs (elevation 655.9 ft amsl) and an approximately 4.5-ft thick layer of cohesive fill encountered within B-148-014 at a depth of 2.5 ft bgs (elevation 664.8 ft amsl). The cohesive fill soils encountered within the indicated boring both classified on the boring logs as cohesive Sandy Silt (A-4a). With respect to the soil strength, the granular fill soils can be described having a relative compactness of very loose to very dense correlating to converted SPT-N values (N_{60}) between 3 and 89 blows per foot (bpf). Natural moisture contents of the granular fill ranged from 7 to 18 percent. With respect to the soil strength of the fine-grained cohesive fill, these soils can be described as having a consistency of medium stiff to very stiff correlating to N_{60} values of 9 and 12 bpf and unconfined compressive strengths (estimated by means of hand penetrometer) between approximately 0.7 and 2.5 tons per square foot (tsf). Natural moisture contents of the cohesive fill ranged from 14 to 18 percent. Based on a Atterberg Limits test performed on representative samples of the cohesive fill material, the liquid limits ranged from 20 to 24 while the plastic limit was 14 percent.

The stratum encountered either immediately beneath the fill, topsoil or at the ground surface consisted of a natural sand layer extending to depths between 32.0 and 55.5 ft bgs (approximate elevations 616.9 and 639.9 ft amsl). Based on laboratory testing results and a visual review of the soil samples obtained within this stratum, these soils are comprised of granular material and are classified on the boring logs as Gravel (A-1-a), Gravel and/or Stone Fragments with Sand (A-1-b), Fine Sand (A-3), Coarse and Fine Sand (A-3a) and non-cohesive Sandy Silt (A-4a) or non-cohesive Silt (A-4b). With respect to the soil strength, the natural sand can be described having a relative compactness of loose to very dense correlating to converted N_{60} values between 6 and 51 bpf. Natural moisture contents of the natural sand ranged from 4 to 45 percent. With respect to the soil strength of the cohesive soil encountered within this stratum, these soils can be

described as having a consistency of stiff to very stiff correlating to an N_{60} value of 13 bpf and an unconfined compressive strength (estimated by means of hand penetrometer) of 2.25 tsf. The natural moisture content of the cohesive soils was determined to be 12 percent.

The soils encountered directly underlying the natural sand layer encountered at the site consisted of highly variable lacustrine/till soils which consisted of an upper stratum comprised predominantly of non-cohesive, coarse- and fine-grained soils and a lower stratum comprised of predominantly cohesive, fine-grained soils. The upper stratum of non-cohesive soils was encountered in 7 of the 10 borings utilized within this report with the exceptions being borings B-085-1-20 and B-085-2-20. Where encountered, the upper stratum of the lacustrine soils extended to depths between 43.0 and 52.0 ft bgs (approximate elevations 618.4 and 626.8 ft amsl) and are classified on the boring logs as Coarse and Fine Sand (A-3a), non-cohesive Sandy Silt (A-4a), and non-cohesive Silt (A-4b). With respect to the soil strength, the upper lacustrine/till soils can be described having a relative compactness of medium dense to dense correlating to converted N_{60} values between 14 and 38 bpf. Natural moisture contents of the upper lacustrine/till soils ranged from 20 to 28 percent. The lower cohesive portion of the lacustrine/till stratum extended to termination depths ranging from 61.0 to 141.5 ft bgs (approximate elevations 528.9 and 610.9 ft amsl) and are classified on the boring logs as cohesive Silt (A-4b), Silt and Clay (A-6a) and Silty Clay (A-6b). The exception being boring B-085-4-20 in which the non-cohesive lacustrine/till soils extended to the borehole termination depth of 51.5 ft bgs (elevation 619.3 ft amsl). With respect to the soil strength, the lower lacustrine soils can be described having a consistency of medium stiff to hard correlating to N_{60} values between 9 and 57 bpf and unconfined compressive strengths (estimated by means of hand penetrometer and laboratory test results) between 0.5 and 4.5 tsf. Natural moisture contents of the lower cohesive lacustrine soils ranged from 18 to 31 percent. Based on Atterberg Limits tests performed on representative samples of the lower lacustrine material, the liquid and plastic limits ranged from 25 to 43 percent and from 17 to 22 percent, respectively.

4.1.2. Groundwater

Groundwater measurements were taken during the boring drilling procedures and immediately following the completion of the boring performed. Groundwater was observed during drilling in each of the borings performed at the bridge and retaining wall sites at depths ranging from 16.0 to 33.4 ft bgs (elevations 638.5 to 651.9 ft amsl).

Pore pressure readings collected from CPT sounding data can also indicate groundwater levels at the site. However, it should be noted that pore pressure readings may suggest a groundwater level that is higher or lower than the static groundwater table when performed on specific soil types (i.e., contractive or dilative soils). Therefore, during a CPT sounding, a more accurate interpretation of the groundwater level can be made by performing a dissipation test in which the pushing of the cone is paused temporarily, and pore pressure readings are allowed to stabilize to the hydrostatic pressure at that depth. Six (6) total dissipation tests were performed within the soundings utilized within this report including three (3) within sounding C-086-0-14 at depths ranging from 49.8 to 102.8 ft bgs (approximate elevations 567.5 to 620.5 ft amsl) and three (3) within sounding C-150-0-14 at depths ranging from 46.3 to 59.5 ft bgs (approximate elevations 610.6 to 623.8 ft amsl). However, the dissipation test performed was not performed long enough to stabilize and therefore does not provide an accurate static groundwater level reading. Piezometers were installed in borings B-085-1-20 and B-085-4-20, the results of the piezometer readings is summarized in the Roadway Exploration Report for this project.

It should be noted that groundwater is affected by many hydrologic characteristics in the area and may vary from those measured at the time of the exploration. The specific groundwater and pore pressure readings are included on the logs located within Appendix B.

5. ANALYSES AND RECOMMENDATIONS

5.1. Retaining Walls AE and AG Analysis and Recommendations

5.1.1. Cast-in-Place Wall Design Assumptions

As RW-AE is planned as a cast-in-place (CIP) wall founded on the existing soil at the site, ODOT's BDM, AASHTO's LRFD BDS, and the project conditions dictate analysis parameters and design minimums/constraints to be used in the analysis and design process. The referenced parameters and design minimums/constraints that where significant to our analyses consist of the following:

- Porous backfill is to be placed from back of the wall extending from top of footing elevation to top of earth backfill with a width not less than 2 feet.
- Retained soils behind the porous backfill are to consist of material placed and compacted in accordance with Item 203, Roadway Excavation and Embankment, of the ODOT Construction and Material Specifications (CMS);
- Retained fill soils will meet the minimum design soil parameters per Table 307-1 of ODOT's BDM as shown in Table 3 below;

Table 3: Design Soil Parameters for Fill Materials

Fill Zone	Type of Soil	Soil Unit Weight (pcf)	Friction Angle (°)	Cohesion (psf)
Retained Soil (Soil behind the wall heel or behind the MSE Reinforced Soil Zone)	On-site soil varying from sandy lean clay to silty sand, per 703.16.A	120	30	0
CIP or Precast Semigravity Wall Infill	Granular Embankment, per 703.16.B	120	32	0

Notes:
1. Table reproduced from Section 307.1 of ODOT's BDM.

With respect to design constraints and assumptions specific to the RW-AE and RW-AG walls, the geometry of the proposed walls (i.e., exposed wall heights, existing ground elevations, proposed final grade behind/at the toe of the wall, etc.) is assumed to be consistent with the available Stage 2 Plan developed by Baker dated December 15, 2023.

5.1.2. Soil Profile for Analysis

For analysis purposes, each boring location was reviewed, and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties for each soil strata was estimated based on their field (i.e., SPT N_{60} Values, hand penetrometer values, etc.) and laboratory test (i.e., Atterberg Limits, grain size, etc.) results using correlations provided in published engineering manuals, research reports and guidance documents. Engineering soil properties were estimated for each individual classified layer per boring location. Soil layers from each of the borings with similar behavior (i.e., cohesive or non-cohesive/granular) and characteristics (i.e., relative compactness/consistency, moisture content, etc.) were grouped into generalized soil units (i.e., Soil Types) and weighted average values of the estimated engineering soil properties were assigned to each Soil Type to develop a generalized soil profile for analysis. The summary of the generalized soil profile including designated Soil Types, elevations, average engineering soil properties per boring location are presented in Tables 4 through 13 below.

Retaining Wall AE

Table 4: Soil Profile and Estimated Engineering Properties - At Boring B-085-1-20

Wall AE: Profile for Analysis, B-085-1-20							
Soil Description	Moist Unit Weight[1] (pcf)	Total Cohesion[2] (psf)	Total Friction Angle[2] (degrees)	Effective Cohesion[3] (psf)	Effective Friction Angle[3] (degrees)	Presumptive Ultimate Unit Bond Stress (ksf)	
						Gravity Grouted (<50 psi)	Pressure Grouted (50 psi - 400 psi)
Soil Type 1 Depth (672.4 ft - 650.4 ft)	112	-	31	-	31	1.61	2.19
Soil Type 2 Depth (650.4 ft - 616.9 ft)	128	-	34	-	34	-	-
Soil Type 3 Depth (616.9 ft - 605.9 ft)	125	2600	0	250	26	-	-

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 5: Soil Profile and Estimated Engineering Properties - At Boring B-085-2-20

Wall AE: Profile for Analysis, B-085-2-20							
Soil Description	Moist Unit Weight[1] (pcf)	Total Cohesion[2] (psf)	Total Friction Angle[2] (degrees)	Effective Cohesion[3] (psf)	Effective Friction Angle[3] (degrees)	Presumptive Ultimate Unit Bond Stress (ksf)	
						Gravity Grouted (<50 psi)	Pressure Grouted (50 psi - 400 psi)
Soil Type 1 Depth (670 ft - 650 ft)	112	-	31	-	31	1.61	2.19
Soil Type 2 Depth (650 ft - 624.5 ft)	128	-	34	-	34	-	-
Soil Type 3 Depth (624.5 ft - 540.5 ft)	125	2600	0	250	26	-	-

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 6: Soil Profile and Estimated Engineering Properties - At Boring B-148-0-14

Wall AE: Profile for Analysis, B-148-0-14							
Soil Description	Moist Unit Weight[1] (pcf)	Total Cohesion[2] (psf)	Total Friction Angle[2] (degrees)	Effective Cohesion[3] (psf)	Effective Friction Angle[3] (degrees)	Presumptive Ultimate Unit Bond Stress (ksf)	
						Gravity Grouted (<50 psi)	Pressure Grouted (50 psi - 400 psi)
Soil Type 1 Depth (667.3 ft - 650.3 ft)	112	-	31	-	31	1.61	2.19
Soil Type 2 Depth (650.3 ft - 623.8 ft)	128	-	34	-	34	-	-
Soil Type 3 Depth (623.8 ft - 605.8 ft)	125	2600	0	250	26	-	-

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 7: Soil Profile and Estimated Engineering Properties - At Boring B-149-0-14

Wall AE: Profile for Analysis, B-149-0-14							
Soil Description	Moist Unit Weight[1] (pcf)	Total Cohesion[2] (psf)	Total Friction Angle[2] (degrees)	Effective Cohesion[3] (psf)	Effective Friction Angle[3] (degrees)	Presumptive Ultimate Unit Bond Stress (ksf)	
						Gravity Grouted (<50 psi)	Pressure Grouted (50 psi - 400 psi)
Soil Type 1 Depth (669.8 ft - 658.3 ft)	112	-	31	-	31	1.61	2.19
Soil Type 2 Depth (658.3 ft - 626.8 ft)	128	-	34	-	34	-	-
Soil Type 3 Depth (626.8 ft - 608.3 ft)	125	2600	0	250	26	-	-

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 8: Soil Profile and Estimated Engineering Properties - At Boring C-150-0-14

Wall AE: Profile for Analysis, C-150-0-14							
Soil Description	Moist Unit Weight[1] (pcf)	Total Cohesion[2] (psf)	Total Friction Angle[2] (degrees)	Effective Cohesion[3] (psf)	Effective Friction Angle[3] (degrees)	Presumptive Ultimate Unit Bond Stress (ksf)	
						Gravity Grouted (<50 psi)	Pressure Grouted (50 psi - 400 psi)
Soil Type 1 Depth (670.1 ft - 655.6 ft)	112	-	31	-	31	1.61	2.19
Soil Type 2 Depth (655.6 ft - 621.6 ft)	128	-	34	-	34	-	-
Soil Type 3 Depth (621.6 ft - 606.1 ft)	125	2600	0	250	26	-	-

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 9: Soil Profile and Estimated Engineering Properties - At Boring B-151-0-14

Wall AE: Profile for Analysis, B-151-0-14							
Soil Description	Moist Unit Weight[1] (pcf)	Total Cohesion[2] (psf)	Total Friction Angle[2] (degrees)	Effective Cohesion[3] (psf)	Effective Friction Angle[3] (degrees)	Presumptive Ultimate Unit Bond Stress (ksf)	
						Gravity Grouted (<50 psi)	Pressure Grouted (50 psi - 400 psi)
Soil Type 1 Depth (665.4 ft - 648.4 ft)	112	-	31	-	31	1.61	2.19
Soil Type 2 Depth (648.4 ft - 622.1 ft)	128	-	34	-	34	-	-
Soil Type 3 Depth (622.1 ft - 603.9 ft)	125	2600	0	250	26	-	-

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Retaining Wall AG

Table 10: Soil Profile and Estimated Engineering Properties - At Boring B-087-1-20

Wall AG: Profile for Analysis, B-087-1-20						
Soil Description	Moist Unit Weight[1] (pcf)	Total Cohesion[2] (psf)	Total Friction Angle (degrees)	Effective Cohesion[3] (psf)	Effective Friction Angle[3] (degrees)	Setup Factor (f_{su})
Fine Sand Depth (644.5 ft - 636.2 ft)	120	-	28	-	28	1.2
Coarse and Fine Sand Depth (636.2 ft - 623.7 ft)	128	-	33	-	33	1.0
Silt Depth (623.7 ft - 612.4 ft)	122	1950	0	200	25	1.5
Silt and Clay Depth (612.4 ft - 607.4 ft)	122	2250	0	200	25	1.5
Silt Depth (607.4 ft - 592.4 ft)	125	-	30	-	30	1.5
Silt and Clay Depth (592.4 ft - 587.4 ft)	125	3000	0	250	25	1.5
Silt Depth (587.4 ft - 562.4 ft)	128	3600	0	300	27	1.5
Silt and Clay Depth (562.4 ft - 553.7 ft)	122	2350	0	200	25	1.5
Silty Clay Elevation (553.7 ft - 534.2 ft)	125	2500	0	250	25	1.8

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 11: Soil Profile and Estimated Engineering Properties - At Boring B-087-3-20

Wall AG: Profile for Analysis, B-087-3-20						
Soil Description	**Moist Unit Weight[1] (pcf)**	**Total Cohesion[2] (psf)**	**Total Friction Angle (degrees)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**	**Setup Factor (f_{su})**
Coarse and Fine Sand Depth (670.1 ft - 650.6 ft)	125	-	33	-	33	1.0
Coarse and Fine Sand Depth (650.6 ft - 645.6 ft)	110	-	29	-	29	1.0
Coarse and Fine Sand Depth (645.6 ft - 619.1 ft)	125	-	33	-	33	1.0
Silt and Clay Depth (619.1 ft - 541.8 ft)	128	2200	0	200	24	1.5
Silty Clay Depth (541.8 ft - 528.6 ft)	122	1550	0	150	23	1.75

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 12: Soil Profile and Estimated Engineering Properties - At Boring B-169-1-20

Wall AG: Profile for Analysis, B-169-1-20						
Soil Description	**Moist Unit Weight[1] (pcf)**	**Total Cohesion[2] (psf)**	**Total Friction Angle (degrees)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**	**Setup Factor (f_{su})**
Coarse and Fine Sand Depth (645.2 ft - 623.2 ft)	125	-	33	-	33	1.0
Silt and Clay Depth (623.2 ft - 562.7 ft)	128	2200	0	200	24	1.5
Silty Clay Depth (562.7 ft - 560.2 ft)	122	1550	0	150	23	1.75

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 13: Soil Profile and Estimated Engineering Properties - At Boring B-002-D-06

Wall AG: Profile for Analysis, B-002-D-06						
Soil Description	**Moist Unit Weight[1] (pcf)**	**Total Cohesion[2] (psf)**	**Total Friction Angle (degrees)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**	**Setup Factor (f_{su})**
Coarse and Fine Sand Depth (668 ft - 660 ft)	125	-	33	-	33	1.0
Coarse and Fine Sand Depth (660 ft - 655 ft)	110	-	29	-	29	1.0
Coarse and Fine Sand Depth (655 ft - 618.5 ft)	125	-	33	-	33	1.0
Silt and Clay Depth (618.5 ft - 566.2 ft)	128	2200	0	200	24	1.5
Silty Clay Depth (566.2 ft - 538 ft)	122	1550	0	150	23	1.75

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

In addition to the Soil Type parameters presented above, a graphical depiction of the generalized subsurface profile for RW-AE is located within Appendix C. The generalized subsurface profile includes: a color coded general interpretation of the Soil Types between borings, a graphical interpretation of the soil strata identified by the project soil borings along the referenced wall profile, representative boring data (N_{60}-values, moisture contents, and groundwater levels) and current ground surface elevation along the proposed wall alignments.

5.1.3. Parameters for Lateral Load Analysis

Deep foundation elements subjected to horizontal loads and/or moments should be analyzed for maximum bending moments and lateral deflections. The required lateral load capacity can be obtained by increasing the diameter or the embedment depth of the foundation element. The generalized soil parameters, including recommended lateral soil modulus, and soil strain to be used to analyze the laterally loaded shaft by the p-y curve method are presented in Table 14 below. Furthermore, a resistance factor of 1.0 should be used when estimating the lateral geotechnical resistance of a single shaft/pile or shaft/pile group in accordance with LRFD BDS Tables 10.5.5.2.3-1 and 10.5.5.2.4-1.

Table 14: Soil Parameters for Lateral Load Analysis - CUY-90-1678 Forward Abutment & RW-AG

LPILE Parameters For Soil and Severely Weathered Bedrock							
Boring Number	p-y model	Elevation (ft)	Effective Unit Weight (pcf)	Friction Angle	Undrained Shear Strength (psf)	Lateral Soil Modulus Parameter, k (pci)	Soil Strain Parameter, E_{50} (%)
C-087-0-14	Sand (Reese)	671.4 - 655.4	122.0	32	-	80	-
	Sand (Reese)	655.4 - 624.4	87.6	33	-	70	-
	Stiff Clay with Water	624.4 - 566.4	59.6	25	1,900	640	0.006
	Stiff Clay with Water	566.4 - 554.4	59.6	24	2,050	680	0.006
B-167-0-14 & C-168-0-14	Sand (Reese)	671.9 - 654.8	122.0	32	-	80	-
	Sand (Reese)	654.8 - 621.3	68.0	33	-	70	-
	Stiff Clay with Water	621.3 - 604.5	59.6	25	1,900	640	0.006
B-168-1-20	Sand (Reese)	672.1 - 652.6	122.0	32	-	80	-
	Sand (Reese)	652.6 - 620.1	78.0	33	-	70	-
	Stiff Clay with Water	620.1 - 592.1	59.6	25	1,900	640	0.006
B-169-0-14	Sand (Reese)	671.9 - 649.9	122.0	32	-	80	-
	Sand (Reese)	649.9 - 622.4	85.3	33	-	70	-
	Stiff Clay with Water	622.4 - 610.9	59.6	25	1,900	640	0.006

5.1.4. Settlement

For pile supported walls, settlement is not anticipated as these wall and abutment types are generally in "cut" sections where additional fill is not added. With respect to settlement along RW-AG that is planned as a pile supported retaining wall, no fill to minimal amounts of fill (i.e., about 4 feet or less) is proposed. Furthermore, where fill is proposed the fill heights increase gradually and the soils underlying the proposed wall consist of loose to dense granular material extending to depths of about 30 to 35 ft below the proposed bottom of footing elevation. Therefore, it is our opinion that: 1) any settlement at this location will be predominantly elastic (immediate) and take place during construction; and, 2) the magnitude of total and differential consolidation (long-term) settlement will be minimal and is not anticipated to be a concern for the proposed wall.

5.1.5. External Stability – RW-AE

Based on our estimated engineering soil properties and the CIP retaining wall design assumptions provided in Sections 5.1.3. and 5.1.1. of this report, respectively, external stability analysis of the proposed CIP wall, RW-AE was performed. External stability was evaluated at one (1) cross-section along the RW-AE with the section evaluated consisting of the maximum total wall height section at approximate STA. 01+50. The referenced cross-section was evaluated for resistance to bearing pressure, sliding forces and overturning at the Strength Limit State in accordance with Section 11.5.3 of the AASHTO's LRFD BDS. The capacity to demand ratios (CDRs) calculated for the referenced cross-section with respect to bearing, sliding and overturning, as well as the calculated factored bearing resistance are presented in Table 15 below (External

Stability Results can be found in Appendix D). A CDR ratio greater than 1.0 indicates an acceptable design per AASHTO's LRFD.

Table 15: External Stability Analysis Summary

Dimensions	
Retaining Wall AE	
Design Wall Height (feet)	11.1
Exposed Wall Height (feet)	8.4
Footing Width, B (feet)	5.5
Approximate Station[(1)]	01+50
Slope in front of wall(°)	26.565
Capactiy Demand Ratio (CDR)	
Bearing Capacity	2.37
Overturning / Eccentricity	1.18
Sliding	1.05
Factored Bearing Resistance (ksf)[(2)]	7.6

Notes:
1. *Stationing in reference to respective retaining wall alignment.*
2. *Bearing Resistance calculated in accordance to Section 11.10.5.4 of 2014 LRFD BDS and factored using Resistance Factor provided in Table 11.5.7-1 of 2014 LRFD BDS.*

5.1.6. Global Stability

For purposes of evaluating the stability of RW-AE (i.e., CIP type wall segment), NEAS reviewed cross-sections along the length of the proposed retaining wall to determine the subsurface conditions that posed the greatest potential for slope instability. In general, cross-sections along the proposed wall alignment were reviewed to determine the section that would represent a combination of existing subsurface conditions and planned site grading that would be most critical to slope stability (i.e., maximum total wall height, maximum embankment height measured from toe of slope to top of wall, proposed/existing grades behind and in front of the wall, weak and/or thick soil layer, etc.). Based on our review of the available information at the referenced location and the associated soil properties, one (1) cross-sections were estimated to be most "critical" and was analyzed for global stability. The cross-sections analyzed for global stability consisted of the maximum wall height section of the proposed wall at approximate STA. 01+50.

For the indicated cross-section, NEAS developed a representative cross-sectional model to use as the basis for global stability analysis. The model was developed from NEAS's interpretation of the available information which included: 1) the RW-AE Stage 2 design information obtained via ProjectWise on January 15, 2024; 2) a live load surcharge of 250 pounds per square foot (psf) accounting for traffic induced loads; and, 3) test borings and laboratory data developed as part of this project. With respect to the soil's engineering properties, the provided generalized soil profile and estimated engineering properties presented in Section 5.1.3. of this report were used in our analysis as indicated.

The above referenced global stability models were analyzed for long-term (Effective Stress) and short-term (Total Stress) slope stability utilizing the software entitled *Slide 7.0* by Rocscience, Inc. Specifically, the Spencer analysis method was used to calculate a factor of safety (FOS) for both circular and block type slope failures. The FOS is the ratio of the resisting forces and the driving forces, with the desired safety factor being more than about 1.3 which equates to an AASHTO resistance factor less than 0.75 (per AASHTO's LRFD BDS, the specified resistance factors are essentially the inverse of the FOS that should be targeted in slope stability programs). For this analysis, a resistance factor of 0.75 or lower is targeted as the proposed wall does not contain or support a structural element. Based on our slope stability analyses for the referenced RW-AE sections, the minimum slope stability factor was estimated to be about 1.51

(0.66 resistance factor). Graphical outputs of the slope stability program (cross-sectional model, calculated safety factor, and critical failure plane) are presented within Appendix E.

With respect to global stability of the proposed pile supported walls (i.e., RW-AG), as the piles extend to significant depths to account for lateral loads associated with the exposed wall face, failure planes must travel beneath the piles for global failure. Therefore, AASHTO resistance factors less than 0.65 are anticipated at these locations.

5.1.7. Pile Foundation Analysis – RW-AG

Based on the determined soil profile and our estimated engineering soil properties, a pile analysis was performed using the computer program Driven to determine the estimated geotechnical pile length needed to achieve the UBV required to support the design load for a single pile at RW-AG (Driven results included within Appendix F). For the purposes of this report and our analysis, the term 'geotechnical pile length' has been assumed to represent the length of pile from bottom of pile cap (assumed pile cap bearing elevation) to the depth at which the required UBV is obtained. Based on the soil profile encountered at the site, it is our opinion that pile resistances obtained during dynamic testing (driving) may be reduced due to the potential for soil disturbance (development of high pore water pressure) near the pile perimeter. This disturbance could cause piles to potentially drive easily or "run" for extended depths and initial driving resistances may not reach the indicated target UBV utilizing the estimated pile lengths. This reduced resistance value obtained at the end of driving the estimated pile length is designated as the End of Initial Driving resistance or EOID. If the EOID is significantly different than the required UBV, it may be necessary let the piles "set up" (reduction of pore water pressure in the soils adjacent to the pile) for an established time period. To estimate the potential effects of this disturbance during driving, the setup factors presented in Tables 10 though 13 of Section 5.1.2. of this report are used to estimate driving strength losses as well as the side resistance expected to gain following the setup period.

The UBV and EOID values are determined in accordance with Sections 305.3.2.4 and 305.3.5.9 of the ODOT BDM. The UBV is determined by dividing the total factored load for the highest loaded pile at each substructure by the appropriate driven pile resistance factor, while the EOID is determined by subtracting the amount of side resistance expected to gain from soil setup from the UBV value. The amount of side resistance expected to gain from soil setup is taken as the difference between the side resistance obtained in ultimate (post setup) conditions and the side resistance obtained during driving (dynamic) conditions at the determined geotechnical pile length. It is recommended that the piles for the referenced project be installed according to ODOT's Construction and Material Specifications (CMS) 507 and CMS 523, and therefore, a driven pile resistance factor of 0.7 should be used. For deep foundation pile analysis purposes, the proposed bearing elevations along the wall were based on the elevations shown for the proposed wall within the available Stage 2 Plan developed by Baker dated December 15, 2023, while design pile loads are based on design information provided by the design team and obtained via email on November 17, 2023.

The results for our analysis including the estimated skin friction (Rs) and pile tip bearing (Rp) for ultimate and during driving conditions are summarized in Table 16 below (*Driven* results included within Appendix F). The referenced table also includes 1) the required geotechnical pile length in ultimate conditions for a 14-inch diameter CIP pile driven to the respective UBV per wall segment indicated; 2) the length of driven pile required in driving conditions for a 14-inch diameter CIP pile driven to the respective UBV per wall segment indicted; and, 3) the estimated difference in pile length between a pile in ultimate and driving conditions.

Table 16: RW-AG Deep Foundation Analysis Summary

Pile Type	Ultimate Conditions				Driving Conditions				Pile Length Difference Ultimate vs. Driving Conditions (ft)	End of Initial Driving Value[3] (kips)	Setup Factor (f_{su})
	Geotechnical Pile Length[1] (ft)	Ultimate Side Resistance[2] (kips)	Ultimate Point Resistance[2] (kips)	Ultimate Bearing Value[2] (kips)	Driven Pile Length[1] (ft)	Side Resistance During Driving[2] (kips)	Point Resistance During Driving[2] (kips)	Bearing Value During Driving[2] (kips)			
Wall AG STA. 500+39.4 to STA. 500+99.4, B-002-D-06											
14-inch CIP pile	21.8	48.1	53.5	102	21.8	48.1	53.5	102	0.0	102	1.0
Wall AG STA. 500+99.4 to STA. 501+59.4, B-002-D-06											
14-inch CIP pile	47.3	159.2	21.2	180	53.0	159.2	21.2	180	5.7	159	1.1
Wall AG STA. 501+59.4 to STA. 502+49.4, B-002-D-06											
14-inch CIP pile	51.3	178.9	21.2	200	60.7	178.9	21.2	200	9.4	154	1.3
Wall AG STA. 502+49.4 to STA. 506+50, B-087-1-20											
14-inch CIP pile	70.1	213.5	34.6	248	98.7	224.1	24.1	248	28.6	180	1.4

Notes:
1. *The length of pile from bottom of pile cap (pile cap bearing elevation) to the depth at which the required UBV is obtained.*
2. *Resistance factor for driven piles, dynamic analysis and static load test methods (BDM Table 305-1) for piles installed according to C&MS 507 using dynamic test methods according to C&MS 523 has not been applied to values calculated.*
3. *EOID is based on driving resistance obtained at the indicated geotechnical pile length.*
4. *Borings/Soundings B-087-3-20, B-169-1-20 and C-086-0-14 were considered in our analysis however the soil profile at these locations yielded shorter 'Estimated' and 'Order' pile lengths and therefore were not utilized for our pile length recommendations.*

5.1.7.1. Pile Drivability

NEAS's pile drivability evaluation estimated a Delmag D19-42 diesel hammer to determine if the pile type or size being considered would be overstressed (i.e., compressive stresses experienced by pile during driving are greater than 90% of the yield strength of the steel) at any time during pile installation. The results of the evaluation indicated that the referenced CIP pile size would not be overstressed during the pile installation process based on: 1) a minimum wall thickness calculated per Section 507.06 of ODOT's CMS; 2) the use of ASTM A 252 Grade 2 steel piles; 3) a pile hammer with a minimum rated energy of 42,000 ft-lbs; and, 4) our developed model used in the computer program *GRLWEAP* by GRL Engineers, Inc. Using the assumed UBVs shown in Table 16 of this report, the minimum wall thicknesses across the proposed Wall AG alignment were calculated to be 0.25 inches from STA.500+39.4 to STA. 502+49.4 and 0.275 inches from STA. 502+49.4 to 506+50. *GRLWEAP* results for each boring location are included within Appendix G.

It should be noted that the driving resistance of CIP piles through soils encountered at the RW-AG site is expected to be high. Drivability is difficult to assess quantitatively as the field test results (i.e., SPT N_{60} values, pocket penetrometer values, etc.) tend to be very high. Furthermore, pile drivability is highly reliant upon the specific equipment used in construction; therefore, it is recommended that the contractor provide an analysis to demonstrate that the equipment and pile combination planned for use is capable of obtaining the UBV without over-stressing the piles.

5.1.7.2. Pile Foundation Recommendations

Based on our evaluation of the subsurface conditions and our geotechnical engineering analysis for the proposed RW-AG, it is our opinion that the proposed foundations can be supported on driven friction CIP piles seated within the medium stiff to very stiff natural lacustrine/glacial till material encountered at the site.

We recommend that a driven pile foundation be used for support for the RW-AG. New 14-inch diameter CIP piles are recommended to be installed in accordance with Sections 507 and 523 of ODOT's CMS. Due to the during driving conditions along the segment of RW-AG from approximate STA. 502+49.4 to STA. 506+50, it is anticipated that the newly driven 14-inch diameter CIP piles would "run" for extended depths if driven to the required UBVs with piles potentially exceeding indicated geotechnical pile lengths by up to 28.6 ft. Therefore, it is recommended that the proposed piles for the indicated wall segment be driven to the full estimated length and pile/soil setup be utilized to achieve the required UBV. It is recommended that plan note 606.7 4 of ODOT's 2020 BDM "Piles Driven To Full Estimated Length With Pile/Soil Setup" be including on the plans. The first two piles for the referenced wall segment should be driven to the full

Estimated Length indicated below. After driving and testing the first two piles, drive the remaining piles to the same depth as the first two piles. After driving all piles to the estimated length, cease all driving operations for the referenced wall segment for a period of 14 days. After the specified waiting period, it is recommended that pile driving contractor perform a restrike on both of the first two piles. If the restrike test results indicate that both piles achieved the required UBV, all piles for the referenced wall segment 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. It should be noted that if preferred, methods B and C specified in Section 305.3.5.9 of ODOT's 2020 BDM can also be used to establish driving criteria accounting for the anticipated pile/soil setup for the segment of RW-AG from approximate STA. 502+49.4 to STA. 506+50.

When new piles are installed in accordance with referenced construction specifications utilizing the referenced method as specified in the ODOT BDM, 14-inch diameter CIP piles driven to the indicated UBVs may be used to support a total factored load (single pile) as indicated in Table 17 below. It should be noted that if preferred, methods B and C specified in Section 305.3.5.9 of ODOT's 2020 BDM can also be used to establish driving criteria accounting for the anticipated pile/soil setup.

Newly driven pile lengths and estimated geotechnical pile tip elevations based on: 1) our Deep Foundation Analysis (presented in Section 5.2.1); and, 2) the "Estimated Length" and "Order Length" definitions and formulas presented in Section 305.3.5.2 "Pile Foundations" of the ODOT BDM, are presented in Table 17 below.

Table 17: Estimated Pile Lengths

Pile Type	Bottom of Pile Cap Elevation (ft amsl)	Geotechnical Pile Length (ft)	Geotechnical Pile Tip Elevation (ft amsl)	Estimated Pile Length[(1)] (ft)	Order Length[(1)] (ft)	Total Factored Load (kips)	Ultimate Bearing Value (kips)
Wall AG STA. 500+39.4 to STA. 500+99.4, B-002-D-06							
14-inch CIP	659.0 - 662.5	21.8	637.2 - 640.7	25	30	71.1	102
Wall AG STA. 500+99.4 to STA. 501+59.4, B-002-D-06							
14-inch CIP	653.0 - 656.0	47.3	605.7 - 608.7	50	55	126.3	180
Wall AG STA. 501+59.4 to STA. 502+49.4, B-002-D-06							
14-inch CIP	644.5 - 650.0	51.3	593.2 - 598.7	55	60	140.1	200
Wall AG STA. 502+49.4 to STA. 506+50, B-087-1-20							
14-inch CIP	642.5 - 644.5	70.1	572.5 - 574.4	75	80	173.7	248

Notes:
1. *Based on definitions and formulas presented in Section 305.3.5.2 of the 2020 BDM.*

5.2. Bridge No. CUY-90-1678 Analysis and Recommendations

5.2.1. Soil Profile for Analysis

For analyses purposes, each boring drilled or CPT pushed for the proposed Bridge CUY-90-1678 foundations was reviewed, and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties for each soil stratum were estimated based on their field (i.e., SPT N_{60} Values, hand penetrometer values, etc.) and laboratory test (i.e., Atterberg Limits, grain size, etc.) results using correlations provided in published engineering manuals, research reports and guidance documents. Engineering soil properties were estimated for each individual classified layer per boring location. The developed soil profiles and estimated engineering soil properties for use in analysis of the Bridge CUY-90-1678 foundations (with cited correlation/reference material) are summarized within Tables 18 through 21 below.

Table 18: Soil Profile and Estimated Engineering Properties - At Boring C-086-0-14 & B-085-4-20

Bridge CUY-90-1678 Over IR-90: Rear Abutment, C-086-0-14 & B-085-4-20						
Soil Description[5]	**Moist Unit Weight[1] (pcf)**	**Total Cohesion[2] (psf)**	**Total Friction Angle (degrees)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**	**Setup Factor (f_{su})**
Coarse and Fine Sand Depth (670.8 ft - 662.8 ft)	115	-	36	-	36	1.0
Sandy silt to silty clay Depth (662.8 ft - 659.5 ft)	110	-	30	-	30	1.2
Coarse and Fine Sand Depth (659.5 ft - 655 ft)	110	-	31	-	31	1.0
Sandy silt to silty clay Depth (655 ft - 646 ft)	105	-	28	-	28	1.2
Coarse and Fine Sand Depth (646 ft - 623.5 ft)	125	-	33	-	33	1.0
Clay Elevation (623.5 ft - 573 ft)	120	1800	0	180	24	1.5
Clay Elevation (573 ft - 555.1 ft)	115	1550	0	155	23	1.75

Notes:
1. *Values estimated per Robertson (2014).*
2. *Remolded undrained shear strenght taken to be sleeve resistance per Robertson (2014).*
3. *Values calculated per ODOT OGE's guidance provided via email on April 19, 2021.*
4. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*
5. *Soil Description based on average Soil Behavior Type Index value of soil stratum per soil type correlations given by Robertson (2014) or AASHTO classification based on nearby boring B-085-4-20.*
6. *Setup factor per 2020 ODOT BDM Table 305-2 with classification estimated via nearby borings to Soil Behavior Type Index interpretation from Robertson (2014).*
7. *N60 values used in sited correlations calculated per Robertson (2012) with Soil Behavior Type Index calculated and interpreted from Robertson (2014).*

Table 19: Soil Profile and Estimated Engineering Properties - At Boring B-085-2-20

Bridge CUY-90-1678 Over IR-90: Pier 1A, B-085-2-20						
Soil Description	**Moist Unit Weight[1] (pcf)**	**Total Cohesion[2] (psf)**	**Total Friction Angle (degrees)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**	**Setup Factor (f_{su})**
Coarse and Fine Sand Depth (672 ft - 652.5 ft)	120	-	31	-	31	1.0
Gravel with Sand Depth (652.5 ft - 650 ft)	115	-	30	-	30	1.0
Gravel Depth (650 ft - 647.5 ft)	120	-	31	-	31	1.0
Coarse and Fine Sand Depth (647.5 ft - 645 ft)	118	-	30	-	30	1.0
Gravel with Sand Depth (645 ft - 637.5 ft)	125	-	34	-	34	1.0
Coarse and Fine Sand Depth (637.5 ft - 624.5 ft)	120	-	33	-	33	1.0
Silt Depth (624.5 ft - 618.7 ft)	128	3750	0	300	27	1.5
Silt and Clay Depth (618.7 ft - 603.7 ft)	125	2500	0	250	25	1.5
Silt Elevation (603.7 ft - 563.7 ft)	128	3900	0	300	27	1.5
Silt and Clay Elevation (563.7 ft - 540.5 ft)	125	3400	0	250	26	1.5

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 20: Soil Profile and Estimated Engineering Properties - At Boring B-086-1-20

Bridge CUY-90-1678 Over IR-90: Pier 1B, B-086-1-20						
Soil Description	**Moist Unit Weight[1] (pcf)**	**Total Cohesion[2] (psf)**	**Total Friction Angle (degrees)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**	**Setup Factor (f_{su})**
Coarse and Fine Sand Depth (670.4 ft - 655.9 ft)	115	-	30	-	30	1.0
Sandy Silt Depth (655.9 ft - 653.4 ft)	110	1100	0	100	23	1.5
Coarse and Fine Sand Depth (653.4 ft - 645.9 ft)	115	-	29	-	29	1.0
Coarse and Fine Sand Depth (645.9 ft - 620.9 ft)	120	-	33	-	33	1.0
Silt Depth (620.9 ft - 618.4 ft)	115	-	29	-	29	1.5
Silt and Clay Depth (618.4 ft - 607.1 ft)	122	1900	0	200	24	1.5
Silt Depth (607.1 ft - 592.1 ft)	120	1700	0	150	24	1.5
Silt and Clay Depth (592.1 ft - 567.1 ft)	125	3100	0	250	25	1.5
Clay Elevation (567.1 ft - 557.1 ft)	122	2250	0	200	24	2.0
Silt and Clay Elevation (557.1 ft - 528.9 ft)	122	2000	0	200	24	1.5

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 21: Soil Profile and Estimated Engineering Properties - At Boring C-087-0-14

Bridge CUY-90-1678 Over IR-90: Forward Abutment, C-087-0-14						
Soil Description[5]	**Moist Unit Weight[1] (pcf)**	**Total Cohesion[2] (psf)**	**Total Friction Angle (degrees)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**	**Setup Factor (f_{su})**
Sand to sandy silt Depth (671.4 ft - 662.9 ft)	120	-	36	-	36	1.0
Sand to sandy silt Depth (662.9 ft - 658.4 ft)	115	-	32	-	32	1.0
Sandy silt to silty clay Depth (658.4 ft - 655.4 ft)	118	-	32	-	32	1.2
Sand to sandy silt Depth (655.4 ft - 648.9 ft)	125	-	37	-	37	1.0
Sandy silt to silty clay Depth (648.9 ft - 645.4 ft)	125	3300	0	250	26	1.5
Sand to sandy silt Elevation (645.4 ft - 624.4 ft)	125	-	35	-	35	1.2
Silty clay to clay Elevation (624.4 ft - 608.4 ft)	122	3350	0	250	26	1.5
Clay Elevation (608.4 ft - 594.9 ft)	115	1350	0	135	23	1.5
Clay Elevation (594.9 ft - 566.4 ft)	120	2550	0	200	26	1.5
Clay Elevation (566.4 ft - 554.4 ft)	115	1050	0	105	23	1.75

Notes:
1. *Values estimated per Robertson (2014).*
2. *Remolded undrained shear strenght taken to be sleeve resistance per Robertson (2014).*
3. *Values calculated per ODOT OGE's guidance provided via email on April 19, 2021.*
4. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*
5. *Soil Description based on average Soil Behavior Type Index value of soil stratum per soil type correlations given by Robertson (2014) or AASHTO classification based on nearby boring B-085-4-20.*
6. *Setup factor per 2020 ODOT BDM Table 305-2 with classification estimated via nearby borings to Soil Behavior Type Index interpretation from Robertson (2014).*
7. *N60 values used in sited correlations calculated per Robertson (2012) with Soil Behavior Type Index calculated and interpreted from Robertson (2014).*

5.2.2. Parameters for Lateral Load Analysis

Deep foundation elements subjected to horizontal loads and/or moments should be analyzed for maximum bending moments and lateral deflections. The required lateral load capacity can be obtained by increasing the diameter or the embedment depth of the foundation element. The generalized soil parameters, including

recommended lateral soil modulus, and soil strain to be used to analyze the laterally loaded piles by the p-y curve method at the rear abutment location are presented in Table 22.

Table 22: Soil Parameters for Lateral Load Analysis - CUY-90-1678 Rear Abutment

LPILE Parameters For Soil and Severely Weathered Bedrock							
Boring Number	p-y model	Elevation (ft)	Effective Unit Weight (pcf)	Friction Angle	Undrained Shear Strength (psf)	Lateral Soil Modulus Parameter, k (pci)	Soil Strain Parameter, E_{50} (%)
C-086-0-14 & B-085-4-20	Sand (Reese)	670.8 - 662.8	115.0	36	-	220	-
	Sand (Reese)	662.8 - 659.5	110.0	30	-	45	-
	Sand (Reese)	659.5 - 655.0	110.0	31	-	60	-
	Sand (Reese)	655.0 - 646.0	96.7	28	-	20	-
	Sand (Reese)	646.0 - 623.5	62.6	33	-	70	-
	Stiff Clay with Water	623.5 - 573.0	57.6	24	1,800	600	0.007
	Stiff Clay with Water	573.0 - 555.1	52.6	23	1,550	530	0.007

5.2.3. Pile Foundation Analysis

Based on the determined soil profile and our estimated engineering soil properties, a pile analysis was performed using the computer program Driven to determine the estimated geotechnical pile length needed to achieve the UBV required to support the design load for a single pile at each substructure (Driven results included within Appendix F). For the purposes of this report and our analysis, the term 'geotechnical pile length' has been assumed to represent the length of pile from bottom of pile cap (assumed pile cap bearing elevation) to the depth at which the required UBV is obtained. Based on the soil profile encountered at the site, it is our opinion that pile resistances obtained during dynamic testing (driving) may be reduced due to the potential for soil disturbance (development of high pore water pressure) near the pile perimeter. This disturbance could cause piles to potentially drive easily or “run” for extended depths and initial driving resistances may not reach the indicated target UBV utilizing the estimated pile lengths. This reduced resistance value obtained at the end of driving the estimated pile length is designated as the End of Initial Driving resistance or EOID. If the EOID is significantly different than the required UBV, it may be necessary let the piles “set up” (reduction of pore water pressure in the soils adjacent to the pile) for an established time period. To estimate the potential effects of this disturbance during driving, the setup factors presented in Tables 18 and 19 of the Section 5.2.1. of this report are used to estimate driving strength losses as well as the side resistance expected to gain following the setup period.

The UBV and EOID values are determined in accordance with Sections 305.3.2.4 and 305.3.5.9 of the ODOT BDM. The UBV is determined by dividing the total factored load for the highest loaded pile at each substructure by the appropriate driven pile resistance factor, while the EOID is determined by subtracting the amount of side resistance expected to gain from soil setup from the UBV value. The amount of side resistance expected to gain from soil setup is taken as the difference between the side resistance obtained in ultimate (post setup) conditions and the side resistance obtained during driving (dynamic) conditions at the determined geotechnical pile length. It is recommended that the piles for the referenced project be installed according to ODOT's Construction and Material Specifications (CMS) 507 and CMS 523. It should also be noted that a resistance factor of 0.8 was utilized and a static pile load test is to be performed at the rear and forward abutment locations as more than 10,000 ft of pile was calculated when utilizing a resistance factor of 0.7. For deep foundation pile analysis purposes, the proposed bearing elevation for the pier was based on the elevations shown proposed structure basemaps developed by the design team and obtained via ProjectWise on June 14, 2022, while design pile loads are based on design information provided by the design team and obtained via ProjectWise on June 15, 2022.

The results for our analysis including the estimated skin friction (Rs) and pile tip bearing (Rp) for ultimate and during driving conditions are summarized in Table 23 below (*Driven* results included within Appendix F). The referenced table also includes 1) the required geotechnical pile length in ultimate conditions for a 14-inch diameter CIP pile driven to the respective UBV per substructure location; 2) the length of driven pile required in driving conditions for a 14-inch diameter CIP pile driven to the respective UBV per substructure location; and, 3) the estimated difference in pile length between a pile in ultimate and driving conditions.

Table 23: Deep Foundation Analysis Summary

Pile Type	Ultimate Conditions				Driving Conditions				Pile Length Difference Ultimate vs. Driving Conditions (ft)	End of Initial Driving Value[3] (kips)	Setup Factor (f_{su})
	Geotechnical Pile Length[1] (ft)	Ultimate Side Resistance[2] (kips)	Ultimate Point Resistance[2] (kips)	Ultimate Bearing Value[2] (kips)	Driven Pile Length[1] (ft)	Side Resistance During Driving[2] (kips)	Point Resistance During Driving[2] (kips)	Bearing Value During Driving[2][4] (kips)			
CUY-90-1678 Rear Abutment, C-086-0-14											
14-inch CIP pile	51.2	196.4	17.3	214	62.8	196.4	17.3	214	12	157	1.4
CUY-90-1678 Pier 1A, B-085-2-20											
16-inch CIP pile	78.6	313.0	42.7	356	98.5	270.1	42.7	313	> 19.9	257	1.4
CUY-90-1678 Pier 1B, B-086-1-20											
16-inch CIP pile	91.5	402.0	25.1	427	108.1	341.9	25.1	367	> 16.6	291	1.5
CUY-90-1678 Forward Abutment, C-087-0-14											
14-inch CIP pile	61.1	196.7	24.5	221	86.2	209.7	10.1	220	> 25.1	139	1.6

Notes:
1. *The length of pile from bottom of pile cap (pile cap bearing elevation) to the depth at which the required UBV is obtained.*
2. *Resistance factor for driven piles, dynamic analysis and static load test methods (BDM Table 305-1) for piles installed according to C&MS 507 using dynamic test methods according to C&MS 523 has not been applied to values calculated.*
3. *EOID is based on driving resistance obtained at the indicated geotechnical pile length.*
4. *At Pier 1A, Pier 1B, and Forward Abutment the required UBV could not be obtained during driving conditions within the length of the boring performed.*

5.2.4. Pile Drivability

NEAS's pile drivability evaluation estimated a Delmag D19-42 diesel hammer to determine if the pile type or size being considered would be overstressed (i.e., compressive stresses experienced by pile during driving are greater than 90% of the yield strength of the steel) at any time during pile installation. The results of the evaluation indicated that the referenced CIP pile size may become overstressed during the pile installation process based on: 1) a minimum wall thickness calculated to be 0.416 inches at Pier 1A and 0.432 inches at Pier 1B per Section 507.06 of ODOT's CMS; 2) the use of ASTM A 252 Grade 2 steel piles; 3) a pile hammer with a minimum rated energy of 42,000 ft-lbs; and, 4) our developed model used in the computer program *GRLWEAP* by GRL Engineers, Inc. Based on this analysis at the proposed bridge CUY-90-1678 pier location, it is recommended that considerations for an increased CIP wall thickness above the referenced minimum or higher grade steel be made if 14-inch diameter CIP pile size is utilized for support of the proposed bridge pier foundations. *GRLWEAP* results for each boring location are included within Appendix G.

It should be noted that the driving resistance of CIP piles through soils encountered at the bridge site is expected to be high. Drivability is difficult to assess quantitatively as the field test results (i.e., SPT N_{60} values, pocket penetrometer values, etc.) tend to be very high. Furthermore, pile drivability is highly reliant upon the specific equipment used in construction; therefore, it is recommended that the contractor provide an analysis to demonstrate that the equipment and pile combination planned for use is capable of obtaining the UBV without over-stressing the piles.

5.2.5. Pile Foundation Recommendations

Based on our evaluation of the subsurface conditions and our geotechnical engineering analysis for the proposed Bridge CUY-90-1678, it is our opinion that the bridge pier foundations can be supported on driven friction CIP piles seated within the medium stiff to hard natural lacustrine/glacial till material encountered at the site.

We recommend that a driven pile foundation be used for support for the proposed bridge pier. New 14 inch or 16 inch diameter CIP piles are recommended to be installed in accordance with Sections 507 and 523 of ODOT's CMS. During driving conditions and if driven to the UBVs indicated in Table 23 of this report, it is anticipated that the newly driven 14 inch/16 inch diameter CIP piles would "run" for extended depths at each substructure location extending the indicated geotechnical pile lengths by greater than 12 to 25 ft. Therefore, it is recommended that the proposed piles be driven to the full estimated length and pile/soil setup be utilized to achieve the required UBV. It is recommended that plan note 606.7-4 of ODOT's 2020 BDM "Piles Driven To Full Estimated Length With Pile/Soil Setup" be including on the plans. The first two piles at each pier should be driven to the full Estimated Length indicated in Table 24 below. 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 14 days. After the specified waiting period, it is recommended that pile driving contractor perform a restrike on both of the first two piles at each substructure. If the restrike test results indicate that both piles 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.

When new piles are installed in accordance with referenced construction specifications utilizing the referenced method as specified in the ODOT BDM 14-inch diameter CIP piles driven to the indicated UBVs may be used to support a total factored load (single pile) of 171 kips at the proposed Rear Abutment location and 177 kips at the proposed Forward Abutment location while 16-inch diameter CIP piles driven to the indicated UBVs may be used to support a total factored load (single pile) of 249 kips at the proposed Pier 1A location and 299 kips at the proposed Pier 1B location. It should be noted that if preferred, methods B and C specified in Section 305.3.5.9 of ODOT's 2020 BDM can also be used to establish driving criteria accounting for the anticipated pile/soil setup. It should also be noted that a resistance factor of 0.8 was utilized and a static pile load test is to be performed at the rear and forward abutment locations as more than 10,000 ft of pile was calculated when utilizing a resistance factor of 0.7.

Newly driven pile lengths and estimated geotechnical pile tip elevations based on: 1) our Deep Foundation Analysis (presented in Section 5.2.1); and, 2) the "Estimated Length" and "Order Length" definitions and formulas presented in Section 305.3.5.2 "Pile Foundations" of the ODOT BDM, are presented in Table 24 below.

Table 24: Estimated Pile Lengths

Pile Type	Bottom of Pile Cap Elevation (ft amsl)	Geotechnical Pile Length (ft)	Geotechnical Pile Tip Elevation (ft amsl)	Estimated Pile Length[(1)] (ft)	Order Length[(1)] (ft)
CUY-90-1678 Rear Abutment, C-086-0-14					
14-inch CIP	644.5	51.2	593.3	55	60
CUY-90-1678 Pier 1A, B-085-2-20					
16-inch CIP	639.0	78.6	560.4	85	90
CUY-90-1678 Pier 1B, B-086-1-20					
16-inch CIP	636.0	91.5	544.5	95	100
CUY-90-1678 Forward Abutment, C-087-0-14					
14-inch CIP	640.0	61.1	578.9	65	70

Notes:
1. *Based on definitions and formulas presented in Section 305.3.5.2 of the 2020 BDM.*

5.3. Settlement and Global Stability Analysis

For tangent drilled shaft walls, tangent drilled shaft abutments, and solider pile and lagging walls settlement and global stability are not anticipated to be a concern. With respect to settlement, as these wall and abutment types are generally in "cut" sections where additional fill is not added and settlement is not anticipated. For global stability, as the drilled shafts extend to significant depths to account for lateral loads associated with the exposed wall face, failure planes must travel beneath the drilled shafts for global failure. Therefore, AASHTO resistance factors less than 0.65 are anticipated.

5.4. Seismic Site Class

It is NEAS's opinion that the subsurface conditions encountered at the proposed Bridge CUY-90-1678 site are characterized as a Seismic Site Class of D in accordance with Section 3.10.3.1, Method B, of the LRFD BDS. For the overall bridge site, seismic site class parameters were determined at each substructure and subsequently averaged to obtain an overall global Site Class Definition. Seismic Site Classification Calculation results are included within Appendix H.

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface conditions at the site of the proposed Bridge CUY-90-1678 as well as Retaining Walls AE and AF. This report has been prepared for Michael Baker International, ODOT and their design consultants to be used solely in evaluating the soils underlying the referenced proposed structures and presenting geotechnical engineering recommendations specific to this project. The assessment of general site environmental conditions or the presence of pollutants in the soil, rock and groundwater of the site was beyond the scope of this geotechnical exploration. Our recommendations are based on the results of our field explorations, laboratory test results from representative soil samples, and geotechnical engineering analyses. The results of the field explorations and laboratory tests, which form the basis of our recommendations, are presented in the appendices as noted. This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes in the nature, design or location of the referenced proposed structures is made, the conclusions and recommendations contained in this report should not be considered valid until they are reviewed and have been modified or verified in writing by a geotechnical engineer.

It has been a pleasure to be of service to Michael Baker International in performing this geotechnical exploration for the CUY-90-16.28 (CCG3A) project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

Brendan P. Andrews, P.E.
Geotechnical Engineer

Kevin C. Arens, P.E.
Geotechnical Engineer

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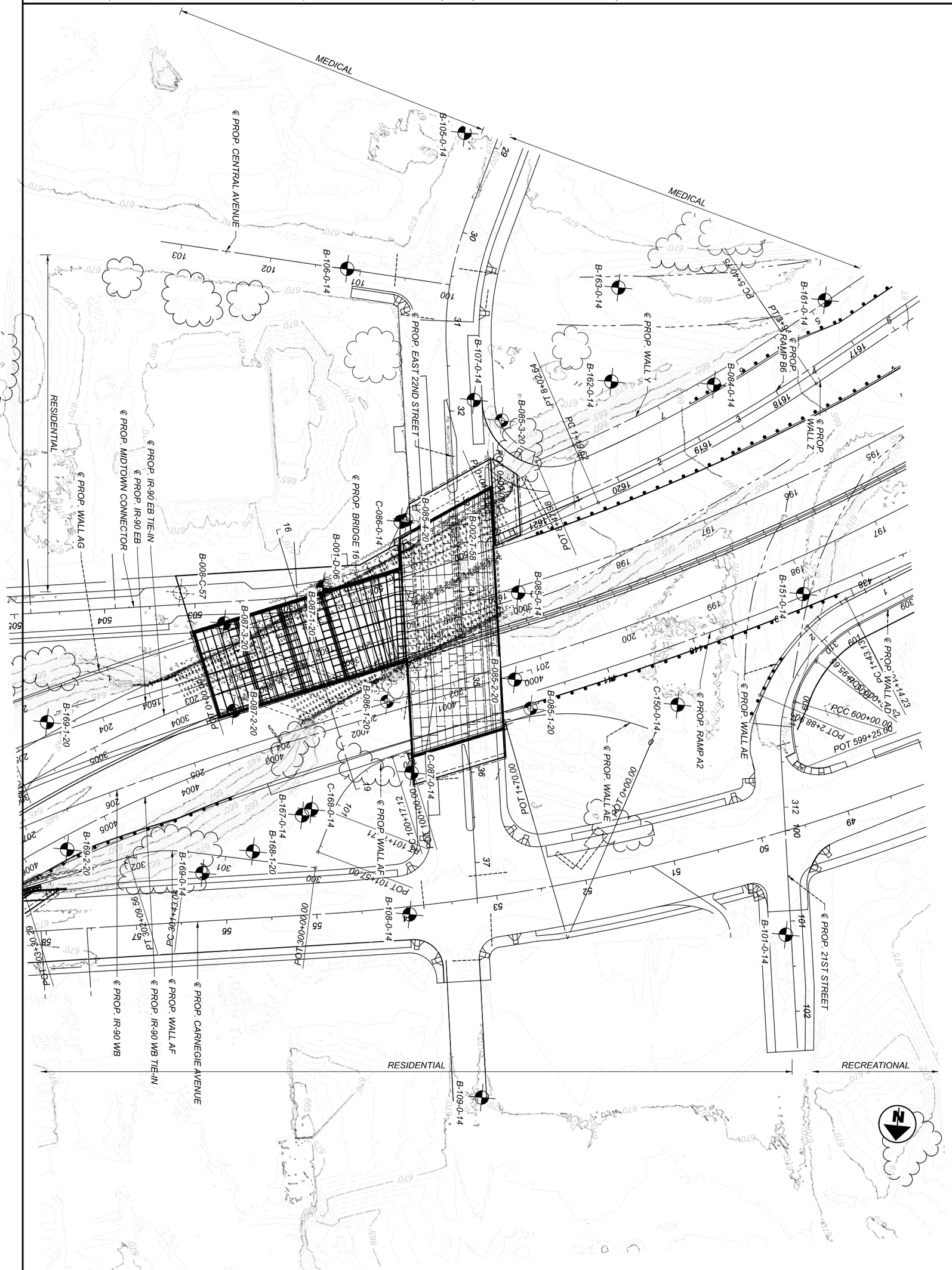
APPENDIX A

SOIL PROFILE SHEETS

CUY-90-16.28 (CCG3A)

MODEL: 82382_IP01503 PAPERSIZE: 17x11 (in.) DATE: 6/23/2022 TIME: 12:28:07 PM USER: mjasiewicz
pw:\\mb-us-pw.bentley.com:mb-us-pw-03\Documents\Cleveland_OH\01_Projects\ODOT\District2\82382\400-Engineering\Geotechnical\Sheets\82382_IP1503.dgn



DESIGN AGENCY	DESIGNER	REVIEWER	PROJECT ID	SUBSET	SHEET
REAS	MWJ	BPA 06/23/22	82382	69 TOTAL 302	P.0 TOTAL 0

2800 CORPORATE EXCHANGE DR. SUITE 240 COLUMBUS, OH. 43231 TEL:614.714.0299 WWW.REASINC.COM

SOIL PROFILE - ROADWAY
STA. 28+90 TO END EAST 22ND STREET

HORIZONTAL SCALE IN FEET
0 50
25 100

APPENDIX B

BORING/CPT LOGS AND LABORATORY TESTING RESULTS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 1/3/24 14:08 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2022 ARCHIVE\CUY-90-16.28 (CCG3A - MOD#:

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 35+35, 81' LT.	EXPLORATION ID B-085-1-20
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: E 22ND ST	
PID: 82382 SFN: 1807839	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 672.4 (MSL) EOB: 66.5 ft.	PAGE 1 OF 3
START: 3/16/21 END: 3/16/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.498493, -81.674299	

MATERIAL DESCRIPTION AND NOTES	ELEV. 672.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
5.0" TOPSOIL (DRILLERS DESCRIPTION)	672.0																	
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE GRAVEL, TRACE SILT, TRACE CLAY, DAMP		1																
		2																
		3	8 12 10	25	61	SS-1	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
		4																
		5	4 4 5	10	56	SS-2	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
	665.4	6																
MEDIUM DENSE, BROWN, **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, DAMP		7																
		8	4 3 9	14	67	SS-3	-	2	29	61	6	2	NP	NP	NP	7	A-3 (0)	
F.S.		9																
		10																
		11	4 5 5	11	67	SS-4	-	-	-	-	-	-	-	-	-	8	A-3 (V)	
	660.4	12																
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, SOME SILT, TRACE GRAVEL, TRACE CLAY, DAMP TO MOIST		13	4 4 4	9	67	SS-5	-	6	19	47	24	4	NP	NP	NP	13	A-3a (0)	
		14																
		15																
		16	4 5 8	15	89	SS-6	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
		17																
		18	5 5 8	15	78	SS-7	-	10	20	44	22	4	NP	NP	NP	12	A-3a (0)	
	652.9	19																
LOOSE, BROWN BECOMING BROWNISH GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, DAMP TO MOIST		20																
		21	4 3 3	7	78	SS-8	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
		22																
@22.5' TO 26.5'; SS-9 AND SS-10 BECOME MEDIUM DENSE TO DENSE		23	7 15 19	39	78	SS-9	-	35	36	17	10	2	NP	NP	NP	4	A-1-b (0)	
		24																
		25																
		26	9 12 12	27	83	SS-10	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
	645.4	27	▼ W 645.4															
LOOSE TO DENSE, GRAY, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE TO LITTLE GRAVEL, TRACE CLAY, MOIST TO WET @27.5' TO 29.0'; SS-11 CONTAINS A 2.0" A-4b SEAM		28	10 14 15	33	100	SS-11	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
		29																

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
LOOSE TO DENSE, GRAY, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE TO LITTLE GRAVEL, TRACE CLAY, MOIST TO WET *(continued)*	642.4	31	8 12 11	26	100	SS-12	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
		32																
		33	7 7 10	19	89	SS-13	-	-	-	-	-	-	-	-	-	25	A-3a (V)	
		34																
		35	6 10 16	30	100	SS-14	-	-	-	-	-	-	-	-	-	25	A-3a (V)	
		36																
		37	5 8 7	17	94	SS-15	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		38																
		39	3 4 3	8	89	SS-16	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		40																
		41	6 6 8	16	100	SS-17	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
		42																
		43	7 9 8	19	100	SS-18	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
		44																
		45	8 8 11	22	89	SS-19	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
		46																
		47	8 10 10	23	94	SS-20	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		48																
		49																
		50																
		51																
		52																
		53																
		54																
	616.9	55	3 2 3	6	78	SS-21A	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
STIFF TO HARD, GRAY, **SILT**, SOME CLAY, TRACE TO LITTLE SAND, TRACE GRAVEL, MOIST TO WET		56				SS-21B	4.25	0	0	6	61	33	29	19	10	23	A-4b (8)	
		57																
		58																
		59																
		60	3 4 5	10	89	SS-22	1.25	-	-	-	-	-	-	-	-	24	A-4b (V)	
		61																

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 35+35, 81' LT.	START: 3/16/21	END: 3/16/21	PG 3 OF 3	B-085-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
STIFF TO HARD, GRAY, **SILT**, SOME CLAY, TRACE TO LITTLE SAND, TRACE GRAVEL, MOIST TO WET *(continued)*	610.2	63 64 65																
	605.9	EOB 66	3 5 5	11	100	SS-23	1.50	0	1	13	60	26	25	18	7	23	A-4b (8)	

NOTES: GROUNDWATER ENCOUNTERED AT 27.0' DURING DRILLING, 26.4' AFTER PIEZOMETER INSTALLATION. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED 35 GAL. BENTONITE GROUT; POURED 2 BAGS CEMENT; POURED 7 BAGS SAND

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 1/3/24 14:08 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2022 ARCHIVE\CUY-90-16.28 (CCG3A - MOD#:

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 35+02, 65' LT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: E 22ND ST
PID: 82382 SFN: 1807839	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 672.0 (MSL) EOB: 131.5 ft.
START: 3/25/21 END: 3/25/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.498410, -81.674225

EXPLORATION ID B-085-2-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 672.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
6.0" TOPSOIL (DRILLERS DESCRIPTION)	671.5																	
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE CLAY, TRACE GRAVEL, DAMP		1																
		2																
		3	6 9 10	22	67	SS-1	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
		4																
		5	6 5 5	11	78	SS-2	-	7	40	41	10	2	NP	NP	NP	5	A-3a (0)	
		6																
		7																
		8	6 7 6	15	78	SS-3	-	-	-	-	-	-	-	-	-	10	A-3a (V)	
		9																
		10																
		11	4 4 5	10	83	SS-4	-	-	-	-	-	-	-	-	-	5	A-3a (V)	
		12																
@12.5' TO 19.0'; SS-5 THROUGH SS-7 CONTAIN INTERBEDDED SILT SEAMS, BECOMES WET TO MOIST		13	3 2 3	6	100	SS-5	-	-	-	-	-	-	-	-	-	26	A-3a (V)	
		14																
		15																
		16	3 4 3	8	89	SS-6	-	1	12	58	19	10	NP	NP	NP	15	A-3a (0)	
		17																
		18	4 4 4	9	94	SS-7	-	-	-	-	-	-	-	-	-	12	A-3a (V)	
	652.5	19																
LOOSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE SILT, TRACE CLAY, MOIST		20																
		21	3 3 3	7	89	SS-8	-	30	31	25	10	4	NP	NP	NP	12	A-1-b (0)	
	650.0	W 650.0 22																
LOOSE, BROWN, **GRAVEL**, LITTLE SAND, TRACE SILT, TRACE CLAY, WET		23	3 4 5	10	56	SS-9	-	-	-	-	-	-	-	-	-	16	A-1-a (V)	
	647.5	24																
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, LITTLE GRAVEL, TRACE CLAY, MOIST		25																
		26	4 5 5	11	50	SS-10	-	15	21	36	18	10	NP	NP	NP	13	A-3a (0)	
	645.0	27																
MEDIUM DENSE, GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET		28	4 6 8	16	67	SS-11	-	-	-	-	-	-	-	-	-	18	A-1-b (V)	
		29																

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE, GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET *(continued)*	642.0	31	8 11 14	29	83	SS-12	-	46	33	13	7	1	NP	NP	NP	13	A-1-b (0)	
		32																
		33	7 9 11	23	72	SS-13	-	-	-	-	-	-	-	-	-	16	A-1-b (V)	
	637.5	34																
MEDIUM DENSE TO DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET		35	7 10 10	23	83	SS-14	-	-	-	-	-	-	-	-	-	24	A-3a (V)	
		36																
		37																
		38	6 9 11	23	89	SS-15	-	1	22	66	9	2	NP	NP	NP	19	A-3a (0)	
		39																
		40																
		41	6 10 12	25	78	SS-16	-	-	-	-	-	-	-	-	-	23	A-3a (V)	
		42																
		43	7 12 13	29	89	SS-17	-	-	-	-	-	-	-	-	-	26	A-3a (V)	
		44																
		45																
		46	8 14 14	32	89	SS-18	-	-	-	-	-	-	-	-	-	23	A-3a (V)	
	624.5	47																
VERY STIFF TO HARD, GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST		48	8 12 14	30	78	SS-19	4.25	1	0	4	71	24	28	20	8	19	A-4b (8)	
		49																
		50																
		51	7 12 14	30	89	SS-20	2.50	-	-	-	-	-	-	-	-	21	A-4b (V)	
	618.7	52																
		53																
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		54																
		55																
		56	4 4 5	10	100	SS-21	0.75	0	0	5	63	32	30	19	11	23	A-6a (8)	
		57																
		58																
		59																
		60																
		61	8 11 12	26	100	SS-22	1.50	-	-	-	-	-	-	-	-	23	A-6a (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST *(continued)*	609.9	63																
		64																
		65	8 11 11	25	100	SS-23	1.75	-	-	-	-	-	-	-	-	24	A-6a (V)	
		66																
		67																
	603.7	68																
STIFF TO HARD, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO DAMP		69																
		70	8 9 11	23	100	SS-24	3.50	0	0	1	74	25	28	21	7	23	A-4b (8)	
		71																
		72																
		73																
		74																
		75	6 8 11	22	100	SS-25	1.75	0	0	1	57	42	32	22	10	25	A-4b (8)	
		76																
		77																
		78																
		79																
@80.0'; SS-26 CONTAINS NO RECOVERY		80	7 9 14	26	0	SS-26	-	-	-	-	-	-	-	-	-	-		
		81																
		82																
		83																
		84																
		85	10 11 16	31	100	SS-27	2.25	-	-	-	-	-	-	-	-	24	A-4b (V)	
		86																
		87																
		88																
		89																
		90	12 24 26	57	100	SS-28	4.25	0	0	1	67	32	26	19	7	20	A-4b (8)	
		91																
		92																
		93																
		94																

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
STIFF TO HARD, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO DAMP *(continued)*	577.7	95	12 18 20	43	89	SS-29	3.75	-	-	-	-	-	-	-	-	22	A-4b (V)	
		100	12 11 10	24	78	SS-30	4.25	-	-	-	-	-	-	-	-	19	A-4b (V)	
		105	10 11 10	24	100	SS-31	4.50	-	-	-	-	-	-	-	-	23	A-4b (V)	
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST TO WET	563.7	110	9 12 11	26	89	SS-32	1.25	1	2	5	49	43	29	18	11	23	A-6a (8)	
		115	10 12 11	26	100	SS-33	1.50	-	-	-	-	-	-	-	-	25	A-6a (V)	
		120	11 13 10	26	89	SS-34	1.50	-	-	-	-	-	-	-	-	23	A-6a (V)	
		125	10 11	29	100	SS-35	1.00	-	-	-	-	-	-	-	-	30	A-6a (V)	

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 35+02, 65' LT.	START: 3/25/21	END: 3/25/21	PG 5 OF 5	B-085-2-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST TO WET *(continued)*	545.6	127 128 129 130	14															
	540.5	131 EOB	11 11 15	30	100	SS-36	0.75	-	-	-	-	-	-	-	-	31	A-6a (V)	

NOTES: GROUNDWATER ENCOUNTERED AT 22.0' DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 250 GAL. BENTONITE GROUT; POURED 2 BAGS HOLE PLUG

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 33+19, 45' RT.	EXPLORATION ID B-085-4-20
TYPE: PIEZO	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: E 22ND ST	
PID: 82382 SFN: 1807839	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 670.8 (MSL) EOB: 51.5 ft.	PAGE 1 OF 2
START: 3/10/21 END: 3/10/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.497956, -81.673732	

MATERIAL DESCRIPTION AND NOTES	ELEV. 670.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
5.0" TOPSOIL (DRILLERS DESCRIPTION)	670.4																	
LOOSE TO MEDIUM DENSE, BROWN BECOMING GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE TO LITTLE GRAVEL, TRACE CLAY, SS-5 CONTAINS IRON STAINING, DAMP TO MOIST			4 10 12	25	89	SS-1	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
			4 8 10	21	100	SS-2	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
			4 6 6	14	89	SS-3	-	4	19	54	17	6	NP	NP	NP	6	A-3a (0)	
			4 4 5	10	89	SS-4	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
		647.2																
@25.0'; BECOMES WET			8 13 13	30	100	SS-5	-	-	-	-	-	-	-	-	-	21	A-3a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 1/3/24 14:08 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2022 ARCHIVE\CUY-90-16.28 (CCG3A - MOD#;

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 33+19, 45' RT.	START: 3/10/21	END: 3/10/21	PG 2 OF 2	B-085-4-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
LOOSE TO MEDIUM DENSE, BROWN BECOMING GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE TO LITTLE GRAVEL, TRACE CLAY, SS-5 CONTAINS IRON STAINING, DAMP TO MOIST *(continued)* @30.0'; 3.2' OF SAND HEAVE	640.8	31	7 10 14	27	100	SS-6	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
@35.0'; SAND HEAVE		35	4 4 6	11	78	SS-7	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
@40.0'; SAND HEAVE		40	5 7 10	19	89	SS-8	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
MEDIUM DENSE, GRAY, **SILT**, SOME SAND, LITTLE CLAY, TRACE GRAVEL, WET	627.5	45	6 7 8	17	100	SS-9	-	0	1	23	61	15	NP	NP	NP	24	A-4b (8)	
LOOSE, GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE GRAVEL, TRACE CLAY, WET	622.5	50	4 4 5	10	100	SS-10	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
	619.3	EOB																

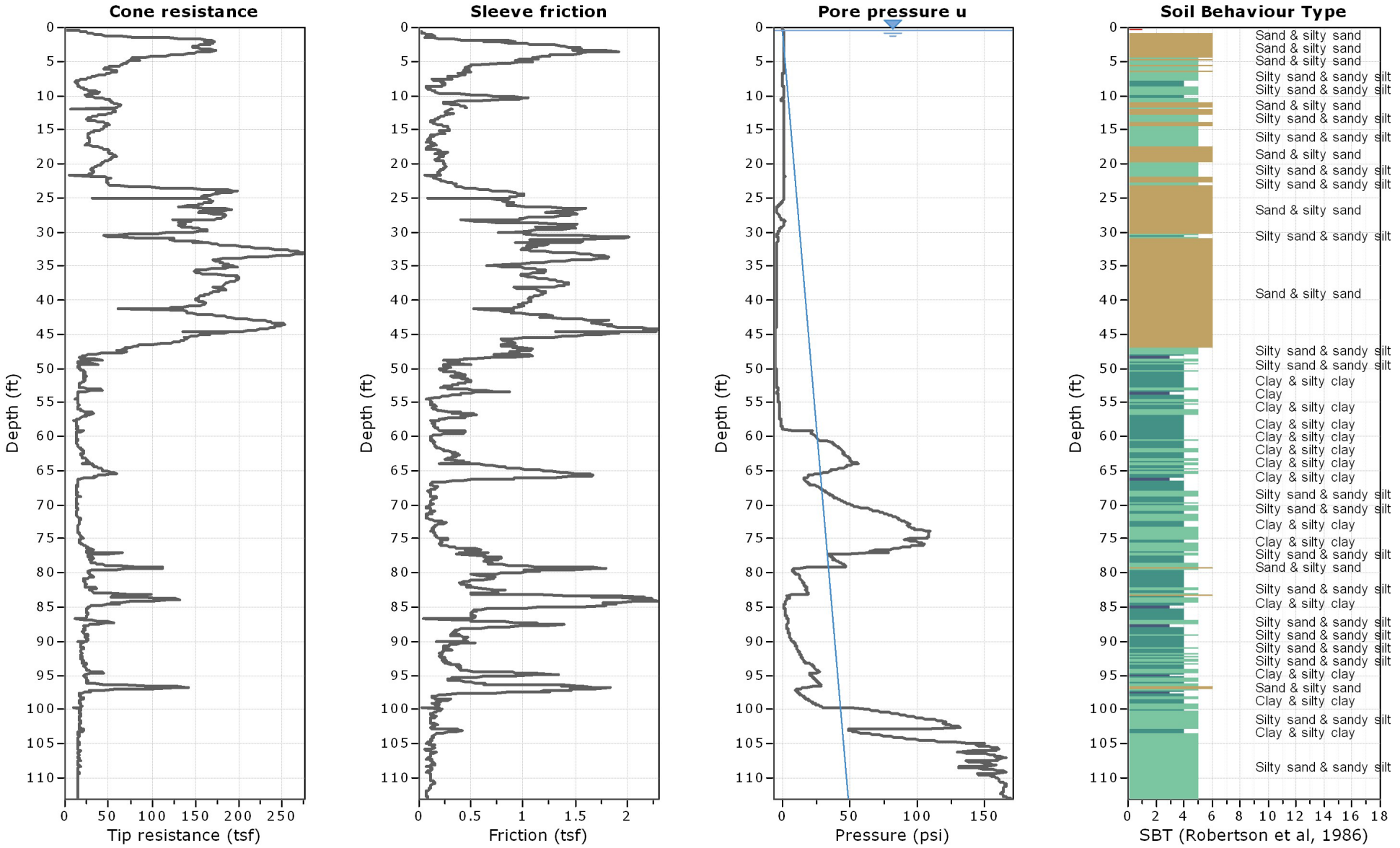
NOTES: GROUNDWATER ENCOUNTERED AT 23.6' DURING DRILLING. ENCOUNTERED SAND HEAVE IN SS-6 TO SS-8. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED 30 GAL. BENTONITE GROUT; POURED 2 BAGS CEMENT; POURED 7 BAGS SAND

Office of Geotechnical Engineering
Geology, Exploration and Laboratory Section
http://portal.dot.state.oh.us/Divisions/Engineering/Geotechnical

Project: **CUY-77-90-14.96-16.33 CCG3**
Location: **Cuyahoga County**

CPT: C-086-0-14
Total depth: 113.19 ft, Date: 5/21/2015



Dissipation Tests Results

Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for t_{50}, which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction c_h was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position
r: piezocone radius
I_r: stiffness index, equal to shear modulus G divided by the undrained strength of clay (S_u).
t_{50}: time corresponding to 50% consolidation

Permeability estimates based on dissipation test

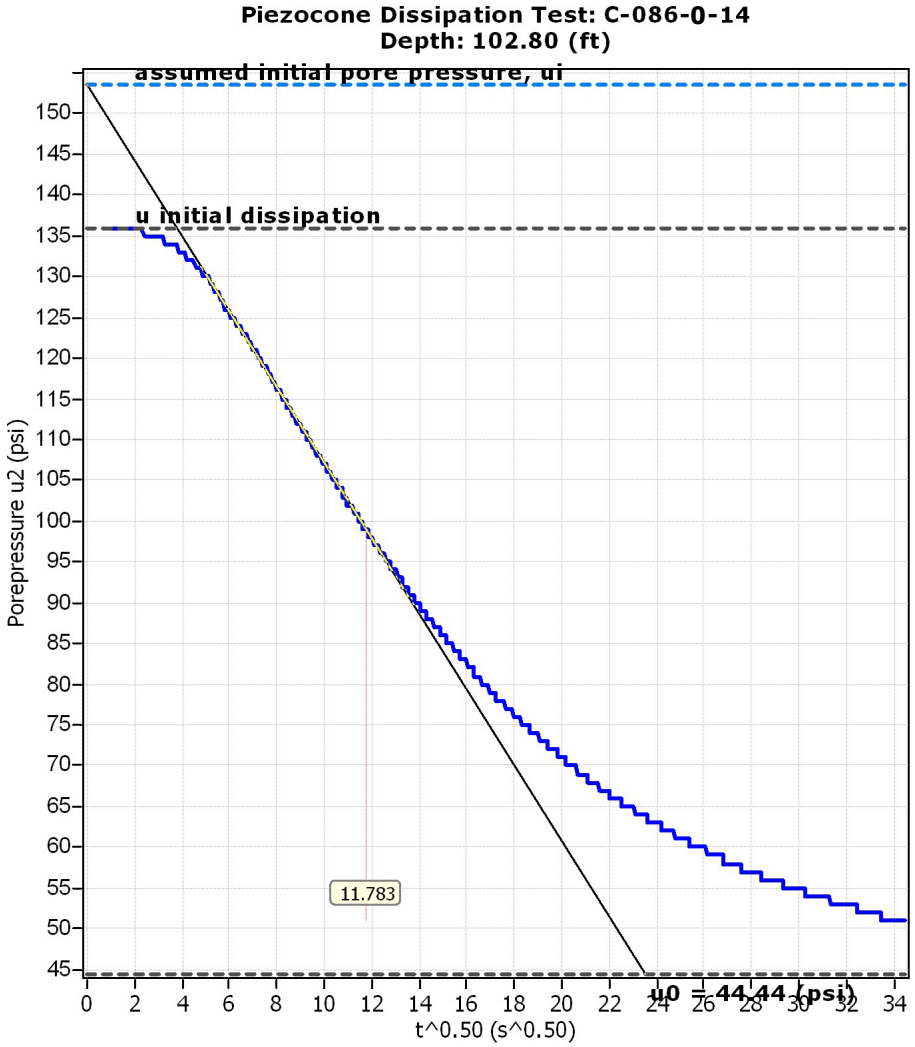
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

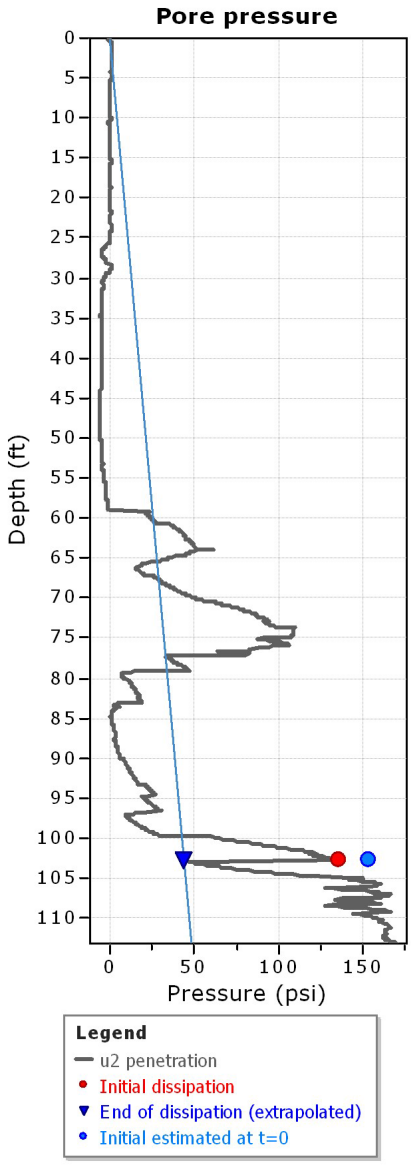
$$k_h = c_h \times \gamma_w / M$$

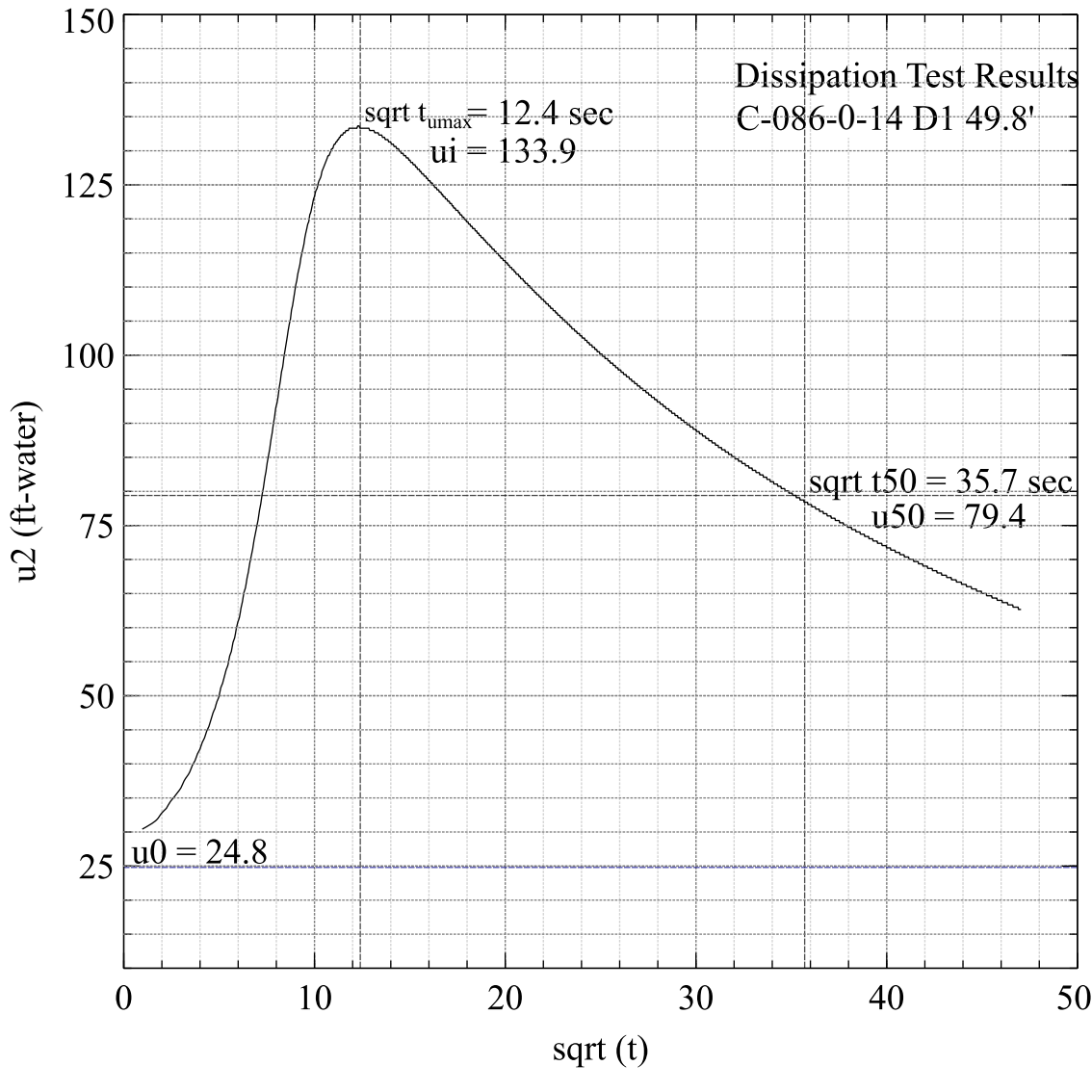
where: M is the 1-D constrained modulus and γ_w is the unit weight of water, in compatible units.

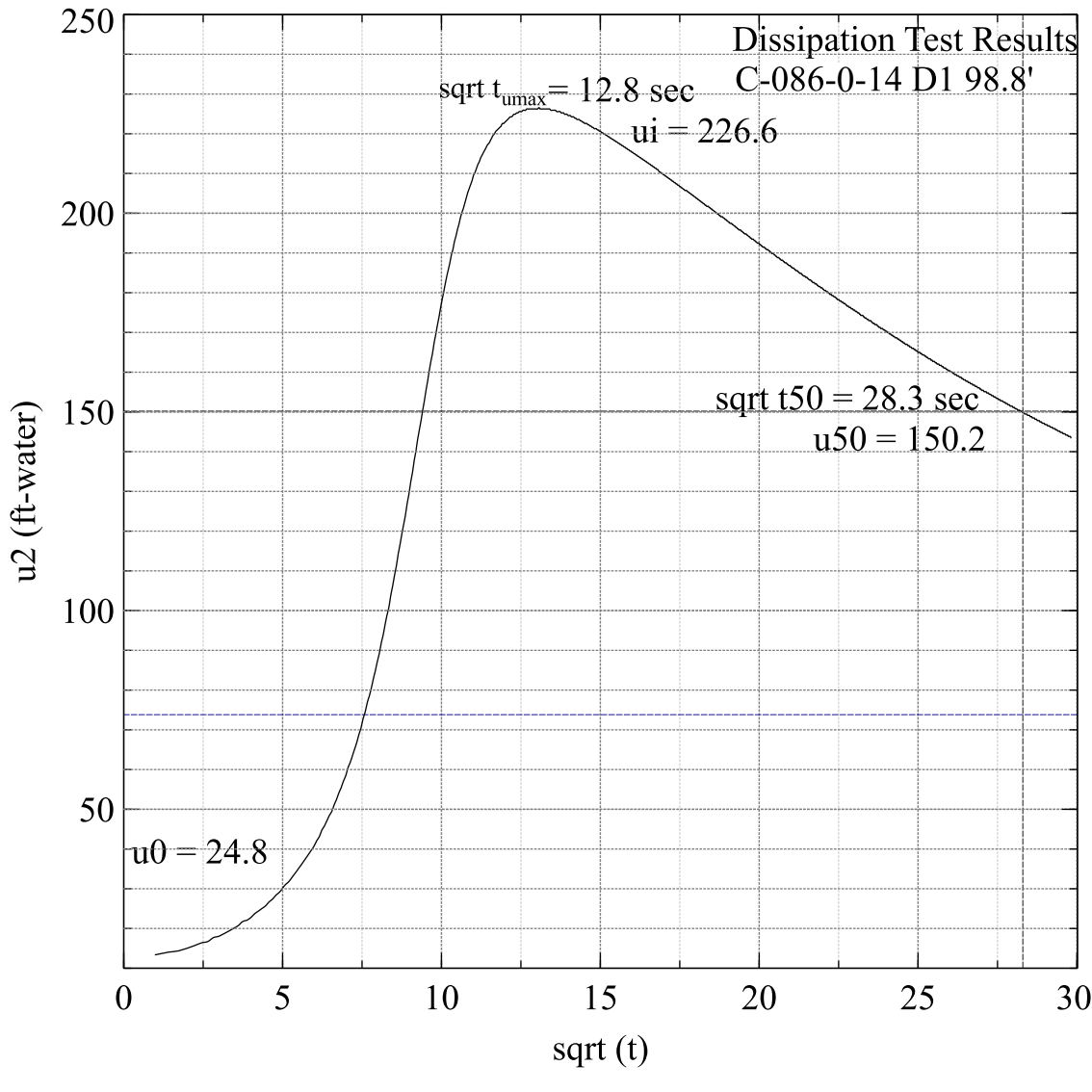
Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/S_u	c_h (ft^2/s)	c_h (ft^2/year)	M (tsf)	k_h (ft/s)
C-086-2-14	102.80	11.8	139	4.40E-006	610163.56	4.97E-003	156687	56.44	2.75E-006


Piezocone Dissipation Test: C-086-0-14
Depth: 102.80 (ft)
assumed initial pore pressure, ui
u initial dissipation
Porepressure u2 (psi)
t^0.50 (s^0.50)
11.783
u0 = 44.44 (psi)


Pore pressure
Depth (ft)
Pressure (psi)
Legend
u2 penetration
Initial dissipation
End of dissipation (extrapolated)
Initial estimated at t=0


Dissipation Test Results
C-086-0-14 D1 49.8'
sqrt t_{umax} = 12.4 sec
ui = 133.9
sqrt t50 = 35.7 sec
u50 = 79.4
u0 = 24.8
u2 (ft-water)
sqrt (t)
150
125
100
75
50
25
0
10
20
30
40
50


Dissipation Test Results
C-086-0-14 D1 98.8'
sqrt t_{umax} = 12.8 sec
ui = 226.6
sqrt t50 = 28.3 sec
u50 = 150.2
u0 = 24.8
u2 (ft-water)
sqrt (t)
250
200
150
100
50
0
5
10
15
20
25
30

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 1/3/24 14:08 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2022 ARCHIVE\CUY-90-16.28 (CCG3A - MOD#:

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 35+18, 77' RT.	EXPLORATION ID B-086-1-20
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: E 22ND ST	
PID: 82382 SFN: 1807841	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 670.4 (MSL) EOB: 141.5 ft.	PAGE 1 OF 5
START: 4/7/21 END: 4/7/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.498510, -81.673720	

MATERIAL DESCRIPTION AND NOTES	ELEV. 670.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
5.0" TOPSOIL (DRILLERS DESCRIPTION)	670.0																	
LOOSE, BROWN, **COARSE AND FINE SAND**, LITTLE TO SOME SILT, TRACE CLAY, TRACE GRAVEL, CONTAINS INTERBEDDED 0.25" TO 1.25" STIFF GRAY SILT AND CLAY (A-6A) SEAMS, CONTAINS TRACE COAL AND RED BRICK FRAGMENTS, DAMP **(FILL)**			2 3 3	7	89	SS-1	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
			2 3 4	8	78	SS-2	-	-	-	-	-	-	-	-	-	10	A-3a (V)	
			3 3 3	7	89	SS-3	-	3	17	46	24	10	NP	NP	NP	10	A-3a (0)	
			3 4 4	9	94	SS-4	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
			3 4 5	10	89	SS-5	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
	655.9																	
MEDIUM STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, CONTAINS NO INTACT SOIL FOR HP READINGS, DAMP **(FILL)**	653.4		3 4 4	9	89	SS-6	-	4	9	30	39	18	20	14	6	14	A-4a (4)	
LOOSE, BROWN, **COARSE AND FINE SAND**, LITTLE TO SOME SILT, TRACE CLAY, TRACE GRAVEL, CONTAINS RED BRICK FRAGMENTS, DAMP TO MOIST **(FILL)**			3 3 5	9	94	SS-7	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
			3 3 4	8	89	SS-8	-	-	-	-	-	-	-	-	-	10	A-3a (V)	
			3 4 5	10	78	SS-9	-	10	19	38	23	10	NP	NP	NP	12	A-3a (0)	
	645.9																	
LOOSE TO DENSE, BROWNISH GRAY BECOMING GRAY, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE CLAY, TRACE GRAVEL, DAMP		▼ 643.9	4 4 5	10	100	SS-10	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
@27.5' TO 49.0'; BECOMES WET			6 10 19	33	56	SS-11	-	-	-	-	-	-	-	-	-	24	A-3a (V)	

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 35+18, 77' RT.	START: 4/7/21	END: 4/7/21	PG 2 OF 5	B-086-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
LOOSE TO DENSE, BROWNISH GRAY BECOMING GRAY, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE CLAY, TRACE GRAVEL, DAMP *(continued)* @27.5' TO 49.0'; BECOMES WET	640.4	31	7 14 18	36	78	SS-12	-	-	-	-	-	-	-	-	-	29	A-3a (V)	
		32																
		33	6 10 10	23	56	SS-13	-	-	-	-	-	-	-	-	-	27	A-3a (V)	
		34																
		35	5 7 11	21	61	SS-14	-	-	-	-	-	-	-	-	-	23	A-3a (V)	
		36																
		37																
		38	5 7 13	23	89	SS-15	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
		39																
		40	4 8 14	25	100	SS-16	-	-	-	-	-	-	-	-	-	23	A-3a (V)	
		41																
		42																
		43	5 10 11	24	72	SS-17	-	-	-	-	-	-	-	-	-	30	A-3a (V)	
		44																
		45	7 11 11	25	94	SS-18	-	-	-	-	-	-	-	-	-	24	A-3a (V)	
		46																
		47																
		48	6 8 10	21	100	SS-19	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
	620.9	49																
MEDIUM DENSE, GRAY, **SILT**, SOME SAND, LITTLE CLAY, TRACE GRAVEL, WET		50	5 6 6	14	100	SS-20	-	1	0	24	57	18	NP	NP	NP	20	A-4b (8)	
	618.4	51																
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		52																
		53	4 5 6	13	100	SS-21	1.25	-	-	-	-	-	-	-	-	23	A-6a (V)	
		54																
		55	5 5 7	14	100	SS-22	2.50	0	0	3	60	37	32	19	13	24	A-6a (9)	
		56																
		57																
		58	6 6 8	16	100	SS-23	3.50	-	-	-	-	-	-	-	-	22	A-6a (V)	
		59																
		60	5 6 10	18	100	SS-24	1.50	-	-	-	-	-	-	-	-	24	A-6a (V)	
		61																

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
	608.3	63																
	607.1	64																
MEDIUM STIFF TO VERY STIFF, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST		65	5 5 7	14	100	SS-25	1.75	0	0	1	59	40	29	19	10	25	A-4b (8)	
		66																
		67																
		68																
		69																
		70	4 5 4	10	100	SS-26	2.25	-	-	-	-	-	-	-	-	25	A-4b (V)	
		71																
		72																
		73																
		74																
		75	5 5 10	17	100	SS-27	0.75	0	0	1	64	35	29	20	9	22	A-4b (8)	
		76																
		77																
	592.1	78																
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST		79																
		80	5 8 12	23	100	SS-28	4.25	-	-	-	-	-	-	-	-	20	A-6a (V)	
		81																
		82																
		83																
		84																
		85	7 10 15	29	100	SS-29	4.25	0	0	3	64	33	31	20	11	20	A-6a (8)	
		86																
		87																
		88																
		89																
		90	7 12 18	34	100	SS-30	4.50	-	-	-	-	-	-	-	-	20	A-6a (V)	
		91																
		92																
		93																
		94																

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 35+18, 77' RT.	START: 4/7/21	END: 4/7/21	PG 4 OF 5	B-086-1-20

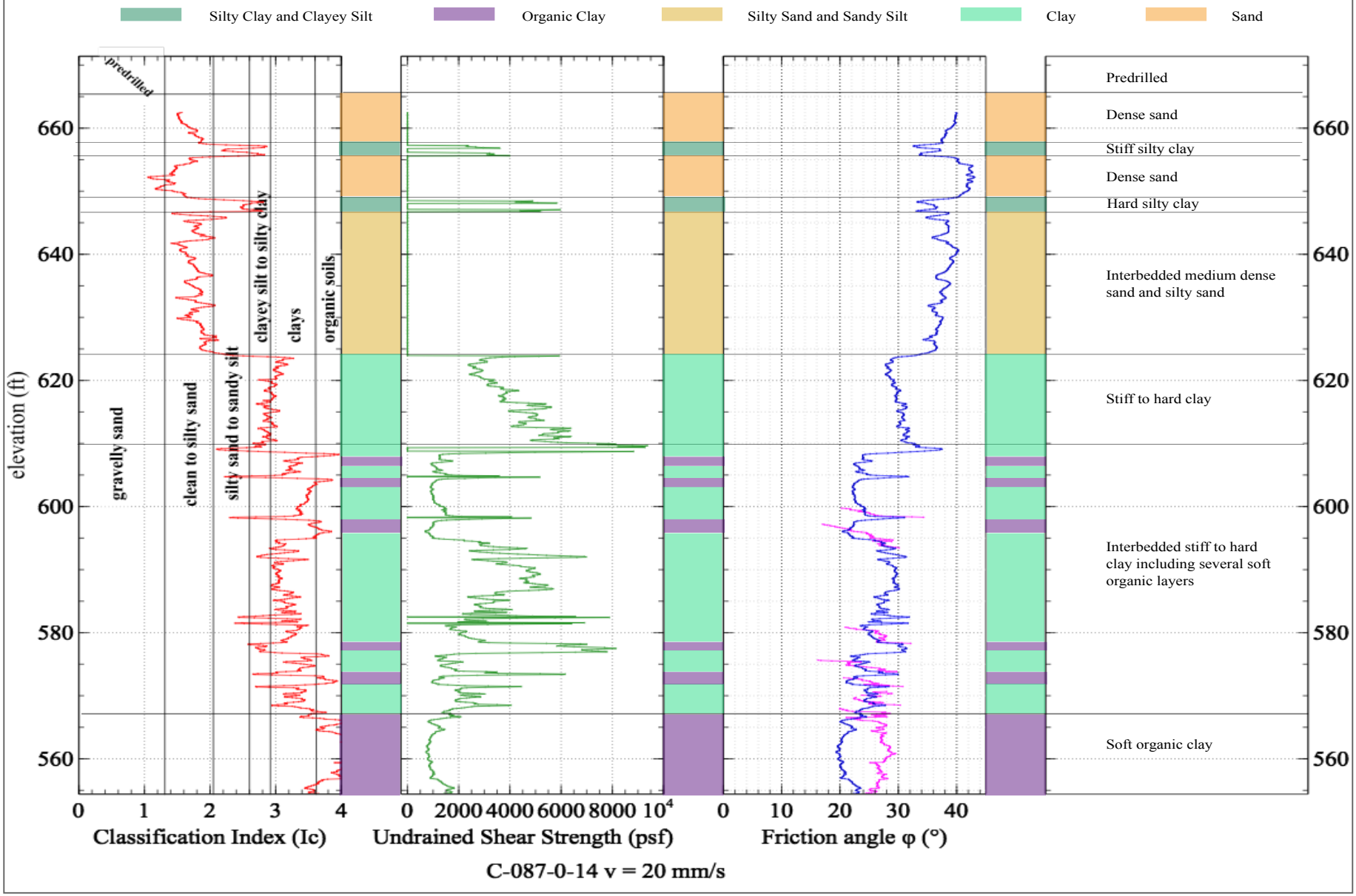
MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST *(continued)*	576.1	95																
		96	8 9 9	21	100	SS-31	2.25	-	-	-	-	-	-	-	-	23	A-6a (V)	
		97																
		98																
		99																
		100																
		101	10 8 7	17	100	SS-32	2.25	1	1	3	42	53	33	20	13	27	A-6a (9)	
		102																
	567.1	103																
SOFT TO MEDIUM STIFF, GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST		104																
		105																
		106	7 10 8	21	100	SS-33	0.75	-	-	-	-	-	-	-	-	29	A-7-6 (V)	
		107																
		108																
		109																
		110																
		111	5 7 6	15	100	SS-34	0.50	0	1	1	33	65	43	22	21	29	A-7-6 (13)	
		112																
	557.1	113																
SOFT TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		114																
		115																
		116	5 5 7	14	100	SS-35	0.50	-	-	-	-	-	-	-	-	22	A-6a (V)	
		117																
		118																
		119																
		120																
		121	5 6 8	16	100	SS-36	1.75	-	-	-	-	-	-	-	-	24	A-6a (V)	
		122																
		123																
		124																
		125																
		126	6 7	16	100	SS-37	3.00	0	0	1	50	49	32	19	13	22	A-6a (9)	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	PIEZ.
SOFT TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST *(continued)*	544.0	127	7															
		128																
		129																
		130	5															
		131	6 7	15	100	SS-38	2.75	-	-	-	-	-	-	-	-	22	A-6a (V)	
		132																
		133																
		134																
		135	7															
		136	8 7	17	100	SS-39	3.50	-	-	-	-	-	-	-	-	21	A-6a (V)	
		137																
		138																
		139																
		140	8															
	528.9	141 EOB	7 9	18	100	SS-40	3.00	0	0	1	50	49	33	18	15	22	A-6a (10)	

NOTES: GROUNDWATER ENCOUNTERED AT 26.5' DURING DRILLING, 26.9' AFTER PIEZOMETER INSTALLATION. HOLE DID NOT CAVE. BORING OFFSET 16.0' SOUTHWEST.

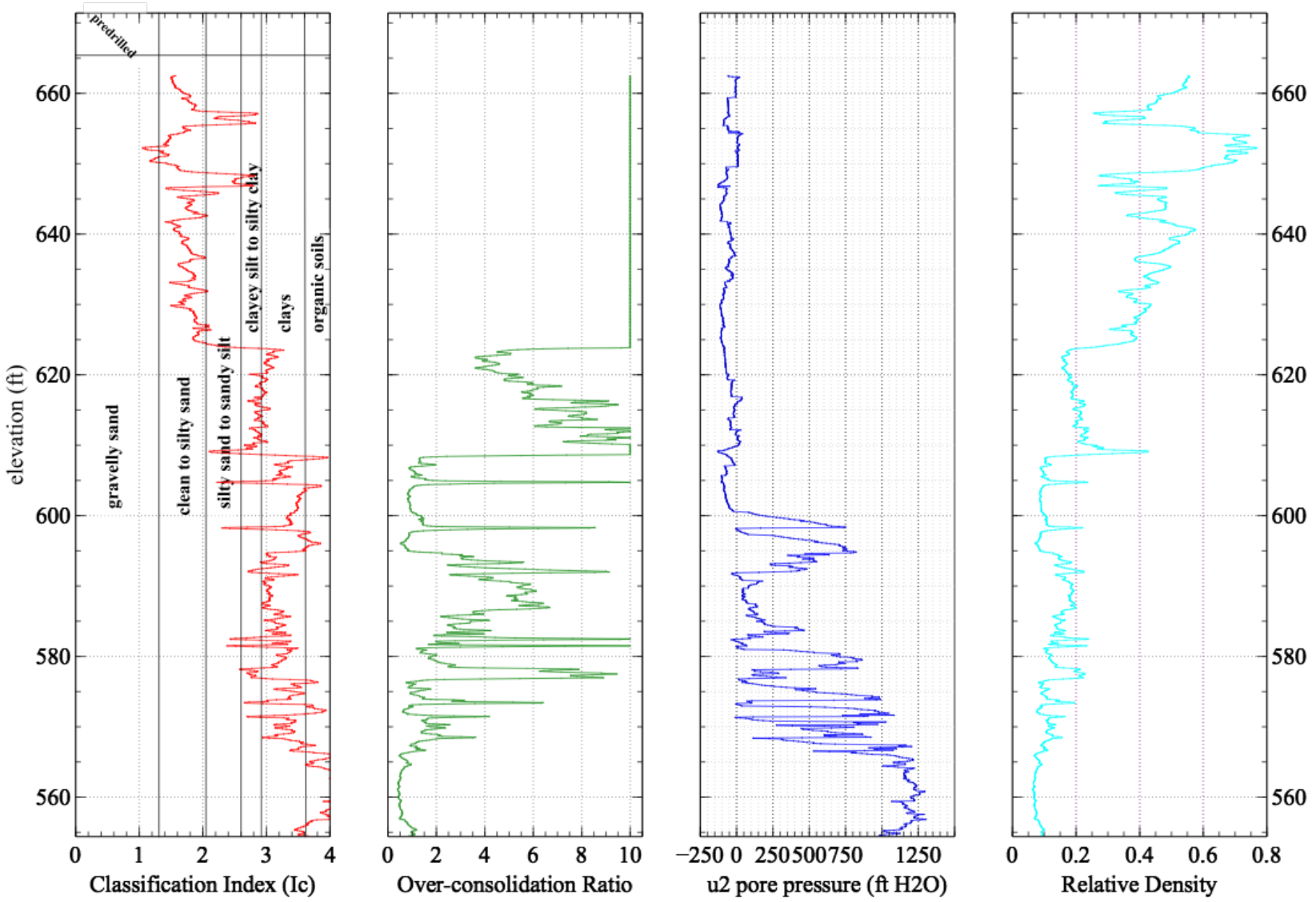
ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED 90 GAL. BENTONITE GROUT; POURED 2 BAGS CEMENT; POURED 10 BAGS SAND

PROJECT:	CUY-CCG3		CONE FIRM/OPERATOR:	ODOT/BINKLEY	RIG:	20-TON TRUCK RIG	STATION/OFFSET:	35+97, 65 RT	EXPLORATION ID C-087-0-14
TYPE:	BRIDGE/RETAINING WALL				VELOCITY:	V=20mm/s	ALIGNMENT:	E 22ND ST	
PID:	82380	BR ID: CUY-77-1676			CONE:	I-CFXYP20-15	ELEVATION:	671.4	PAGE 1 OF 2
START:	11/11/2014	END: 11/11/2014			SERIES:	091002	LAT/LONG:	41.498719, -81.673844	



PROJECT:	CUY-CCG3			CONE FIRM/OPERATOR:	ODOT/BINKLEY	RIG:	20-TON TRUCK RIG	STATION/OFFSET:	35+97, 65 RT
TYPE:	BRIDGE/RETAINING WALL					VELOCITY:	V=20mm/s	ALIGNMENT:	E 22ND ST
PID:	82380	BR ID:	CUY-77-1676			CONE:	I-CFXYP20-15	ELEVATION:	671.4
START:	11/11/2014	END:	11/11/2014			SERIES:	091002	LAT/LONG:	41.498719, -81.673844

EXPLORATION ID C-087-0-14



C-087-0-14 v = 20 mm/s

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 201+25, 63' RT.	EXPLORATION ID B-087-1-20
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: IR-90 EB	
PID: 82382 SFN: 1807841	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 670.7 (MSL) EOB: 136.5 ft.	PAGE 1 OF 5
START: 3/11/21 END: 3/11/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.498184, -81.673420	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
6.0" TOPSOIL (DRILLERS DESCRIPTION)	670.7																	
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE GRAVEL, DAMP TO MOIST	670.2		6 7 9	18	100	SS-1	-	-	-	-	-	-	-	-	-	10	A-3a (V)	
			5 5 7	14	89	SS-2	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
			7 10 12	25	100	SS-3	-	3	17	54	19	7	NP	NP	NP	9	A-3a (0)	
			7 11 12	26	100	SS-4	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
			7 10 13	26	89	SS-5	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
			6 12 14	30	89	SS-6	-	5	20	51	17	7	NP	NP	NP	9	A-3a (0)	
			6 8 8	18	89	SS-7	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
			6 6 5	13	94	SS-8	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
			4 7 5	14	78	SS-9	-	4	23	49	17	7	NP	NP	NP	11	A-3a (0)	
		W 646.3																
@25.0'; SS-10 BECOMES WET			2 3 3	7	89	SS-10	-	-	-	-	-	-	-	-	-	25	A-3a (V)	
			3 3 3	7	83	SS-11	-	-	-	-	-	-	-	-	-	12	A-3a (V)	
	641.2																	
F.S.																		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE, GRAY, **FINE SAND**, SOME COARSE SAND, LITTLE SILT, TRACE GRAVEL, TRACE CLAY, WET *(continued)* @30.0'; SS-12 CONTAINS NO RECOVERY	640.7	31	2 2 3	6	0	SS-12	-	-	-	-	-	-	-	-	-	-		
		32																
		33	2 2 3	6	100	SS-13	-	-	-	-	-	-	-	-	-	26	A-3 (V)	
	636.2	34																
LOOSE TO MEDIUM DENSE, BROWNISH GRAY AND GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE GRAVEL, WET		35	3 4 5	10	67	SS-14	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
		36																
		37																
		38	3 7 10	19	78	SS-15	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
		39																
		40																
		41	5 7 7	16	100	SS-16	-	-	-	-	-	-	-	-	-	26	A-3a (V)	
		42																
@42.5'; SS-17 AND SS-18 BECOME DENSE		43	9 13 18	35	100	SS-17	-	-	-	-	-	-	-	-	-	23	A-3a (V)	
		44																
		45																
		46	15 22 18	46	89	SS-18	-	-	-	-	-	-	-	-	-	24	A-3a (V)	
	623.7	47																
STIFF TO VERY STIFF, GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST		48	5 6 10	18	100	SS-19	2.50	-	-	-	-	-	-	-	-	23	A-4b (V)	
		49																
		50																
		51	5 6 7	15	78	SS-20	1.75	0	1	7	64	28	28	19	9	10	A-4b (8)	
		52																
		53	5 7 7	16	78	SS-21	3.50	-	-	-	-	-	-	-	-	20	A-4b (V)	
		54																
		55																
		56	6 5 7	14	83	SS-22	2.50	-	-	-	-	-	-	-	-	21	A-4b (V)	
	612.4	57																
		58																
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		59																
		60																
		61	6 8 8	18	78	SS-23	1.00	0	0	7	59	34	30	19	11	22	A-6a (8)	

MATERIAL DESCRIPTION AND NOTES	ELEV. 608.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	607.4	63																
MEDIUM DENSE, GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, WET		64																
		65	7 7 8	17	89	SS-24	-	0	0	2	73	25	NP	NP	NP	22	A-4b (8)	
		66																
		67																
		68																
		69																
		70																
@70.0'; SS-25 CONTAINS NO RECOVERY		71	6 8 8	18	0	SS-25	-	-	-	-	-	-	-	-	-	-		
		72																
		73																
		74																
		75																
		76	7 9 11	23	100	SS-26	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
		77																
	592.4	78																
STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		79																
		80																
		81	6 11 10	24	100	SS-27	1.25	0	0	1	57	42	30	19	11	26	A-6a (8)	
		82																
	587.4	83																
VERY STIFF TO HARD, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST		84																
		85																
		86	7 10 13	26	100	SS-28	4.25	-	-	-	-	-	-	-	-	20	A-4b (V)	
		87																
		88																
		89																
		90																
		91	8 12 14	30	100	SS-29	3.75	0	1	0	63	36	30	20	10	20	A-4b (8)	
		92																
		93																
		94																

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST *(continued)*	576.4	95																
		96	10 13 13	30	100	SS-30	4.00	-	-	-	-	-	-	-	-	20	A-4b (V)	
		97																
		98																
		99																
		100																
		101	11 11 14	29	83	SS-31	2.75	0	0	1	62	37	30	20	10	21	A-4b (8)	
		102																
		103																
		104																
		105																
		106	10 12 14	30	89	SS-32	4.50	-	-	-	-	-	-	-	-	21	A-4b (V)	
		107																
	562.4	108																
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		109																
		110																
		111	9 8 9	19	100	SS-33	2.00	0	1	1	51	47	32	20	12	25	A-6a (9)	
		112																
		113																
		114																
		115																
		116	7 8 9	19	100	SS-34	3.25	-	-	-	-	-	-	-	-	24	A-6a (V)	
	553.7	117																
MEDIUM STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		118																
		119																
		120																
		121	7 9 8	19	94	SS-35	2.00	-	-	-	-	-	-	-	-	26	A-6b (V)	
		122																
		123																
		124																
		125																
		126	7 7	18	100	SS-36	1.00	0	1	2	31	66	40	22	18	27	A-6b (11)	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST *(continued)*	544.3	127	9															
		128																
		129																
		130	8															
		131	10 9	22	100	SS-37	1.50	-	-	-	-	-	-	-	-	29	A-6b (V)	
		132																
		133																
		134																
		135	7															
	534.2	136 EOB	9 10	22	94	SS-38	1.50	-	-	-	-	-	-	-	-	27	A-6b (V)	

NOTES: GROUNDWATER ENCOUNTERED AT 24.4' DURING DRILLING. HOLE DID NOT CAVE. BORING OFFSET 22.0' WEST.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 300 GAL. BENTONITE GROUT

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 202+41, 58' RT.	EXPLORATION ID B-087-3-20
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: IR-90 EB	
PID: 82382 SFN: 1807841	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 670.1 (MSL) EOB: 141.5 ft.	PAGE 1 OF 5
START: 3/31/21 END: 3/31/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.498318, -81.673037	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
9.5" ASPHALT AND 6.0" CONCRETE (DRILLERS DESCRIPTION)	670.1																	
	668.8	1																
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE TO LITTLE GRAVEL AND STONE FRAGMENTS, TRACE CLAY, CONTAINS INTERBEDDED 0.25" TO 1.0" SOFT GRAY SILT AND CLAY (A-6A) LAYERS, CONTAINS RED BRICK FRAGMENTS AND CONCRETE FRAGMENTS, DAMP TO MOIST **(FILL)**		2	11 5 4	10	61	SS-1	-	18	18	42	16	6	NP	NP	NP	8	A-3a (0)	
		3																
		4	5 4 5	10	78	SS-2	-	6	20	54	15	5	NP	NP	NP	10	A-3a (0)	
		5	6 6 7	15	72	SS-3	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
		6	10 7 5	14	72	SS-4	-	-	-	-	-	-	-	-	-	12	A-3a (V)	
		7	5 6 6	14	78	SS-5	-	5	20	55	15	5	NP	NP	NP	11	A-3a (0)	
		8																
		9	5 7 5	14	78	SS-6	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
		10																
		11	6 5 7	14	83	SS-7	-	-	-	-	-	-	-	-	-	12	A-3a (V)	
		12																
		13	7 6 7	15	100	SS-8	-	4	18	52	17	9	NP	NP	NP	11	A-3a (0)	
		14																
	653.1	15																
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, SOME SILT, TRACE CLAY, TRACE GRAVEL, SS-9 CONTAINS A 3.0" GRAY SILT (A-4B) SEAM, MOIST TO DAMP		16	9 6 7	15	94	SS-9	-	-	-	-	-	-	-	-	-	15	A-3a (V)	
		17																
@20.0'; BECOMES TRACE TO LITTLE SILT		18	3 4 4	9	67	SS-10	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
		19																
		20	4 3 4	8	56	SS-11	-	1	7	64	20	8	NP	NP	NP	9	A-3a (0)	
		21																
		22	4 5 6	13	78	SS-12	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
	W 643.4	23																
@27.5'; BECOMES BROWNISH GRAY AND GRAY, WET		24	6 9 13	25	44	SS-13	-	-	-	-	-	-	-	-	-	23	A-3a (V)	
		25																
		26																
		27																
		28																
		29																

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, SOME SILT, TRACE CLAY, TRACE GRAVEL, SS-9 CONTAINS A 3.0" GRAY SILT (A-4B) SEAM, MOIST TO DAMP *(continued)*	640.1	31	7 10 15	29	72	SS-14	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
		33	6 12 13	29	89	SS-15	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
		35	7 14 12	30	83	SS-16	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		38	7 13 17	34	83	SS-17	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
		40	7 15 19	39	89	SS-18	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
		43	7 12 15	31	78	SS-19	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		45	5 8 12	23	78	SS-20	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		48	4 7 9	18	78	SS-21	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
	619.1	50	4 6 7	15	100	SS-22	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
STIFF TO VERY STIFF, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST		53	4 5 6	13	94	SS-23	1.75	0	1	8	61	30	28	18	10	22	A-4b (8)	
		55	3 5 5	11	100	SS-24	2.00	-	-	-	-	-	-	-	-	22	A-4b (V)	
		58	4 4 4	9	100	SS-25	1.50	-	-	-	-	-	-	-	-	24	A-4b (V)	
		60	3 3 5	9	100	SS-26	1.25	0	0	1	62	37	31	21	10	25	A-4b (8)	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
STIFF TO VERY STIFF, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST *(continued)*	607.9	63																
		64																
		65	5 6 8	16	100	SS-27	1.50	-	-	-	-	-	-	-	-	23	A-4b (V)	
		66																
		67																
	601.8	68																
STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST		69																
		70	7 7 11	21	100	SS-28	1.25	0	0	2	49	49	33	22	11	29	A-6a (8)	
		71																
		72																
		73																
		74																
		75	8 8 12	23	100	SS-29	1.50	-	-	-	-	-	-	-	-	26	A-6a (V)	
		76																
		77																
	591.8	78																
HARD, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO DAMP		79																
		80	10 12 16	32	100	SS-30	4.50	1	0	1	59	39	30	20	10	22	A-4b (8)	
		81																
		82																
		83																
		84																
		85	9 10 16	30	100	SS-31	4.50	-	-	-	-	-	-	-	-	18	A-4b (V)	
		86																
		87																
		88																
		89																
		90	8 10 17	31	100	SS-32	4.50	0	0	0	65	35	30	20	10	18	A-4b (8)	
		91																
		92																
		93																
		94																

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 202+41, 58' RT.	START: 3/31/21	END: 3/31/21	PG 4 OF 5	B-087-3-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
HARD, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO DAMP *(continued)*	575.8	95	9 11 12	26	100	SS-33	4.50	-	-	-	-	-	-	-	-	18	A-4b (V)	
		96																
		97																
		98																
		99																
		100	8 9 15	27	100	SS-34	4.50	0	0	0	66	34	28	20	8	20	A-4b (8)	
		101																
		102																
	566.8	103																
STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST		104																
		105	10 10 15	29	100	SS-35	2.00	-	-	-	-	-	-	-	-	25	A-6a (V)	
		106																
		107																
		108																
		109																
		110	11 12 14	30	100	SS-36	4.50	0	0	0	56	44	33	19	14	22	A-6a (10)	
		111																
		112																
		113																
		114																
		115	8 13 16	33	100	SS-37	4.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
		116																
		117																
		118																
		119																
		120	9 12 15	31	100	SS-38	3.75	-	-	-	-	-	-	-	-	24	A-6a (V)	
		121																
		122																
		123																
		124																
		125	10 10	26	100	SS-39	3.50	1	1	5	49	44	30	18	12	22	A-6a (9)	
		126																

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 202+41, 58' RT.	START: 3/31/21	END: 3/31/21	PG 5 OF 5	B-087-3-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP TO MOIST *(continued)*	543.7	127	13															
	541.8	128																
STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		129																
		130	12															
		131	11 13	27	100	SS-40	1.25	0	1	1	31	67	40	22	18	27	A-6b (11)	
		132																
		133																
		134																
		135	11															
		136	15 16	35	100	SS-41	1.25	-	-	-	-	-	-	-	-	30	A-6b (V)	
	531.8	137																
		138																
STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		139																
		140	8															
	528.6	141 EOB	18 20	43	100	SS-42	1.50	1	1	2	45	51	35	20	15	24	A-6a (10)	

NOTES: GROUNDWATER ENCOUNTERED AT 26.7' DURING DRILLING. HOLE DID NOT CAVE. BORING OFFSET 11.0' WEST AND 5.0' SOUTH.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 250 GAL. BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/22/22 14:18 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2017 ARCHIVE\CUY-CCG3 82380\GINT FILES

PROJECT: CUY-CCG3	DRILLING FIRM / OPERATOR: BARR / P.STROUD	DRILL RIG: MOBILE B-58	STATION / OFFSET: 306+08, 44' RT.	EXPLORATION ID B-148-0-14
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: BARR / D.KLIMKOWICZ	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: RAMP A1	
PID: 82380 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/26/14	ELEVATION: 667.3 (MSL) EOB: 61.5 ft.	PAGE 1 OF 2
START: 10/23/14 END: 10/24/14	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 41.497523, -81.676575	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
5.0", **ASPHALT**	667.3																	
9.0", **CONCRETE**	666.9																	
LOOSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE GRAVEL, TRACE CLAY, DAMP **(FILL)**	666.1		3 3 2	8	83	SS-1	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
STIFF, BROWN, ORANGISH BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, CONTAINS FEW ROOTS, DAMP TO MOIST **(FILL)**	664.8		3 3 3	9	89	SS-2	1.40	1	10	37	29	23	24	14	10	18	A-4a (3)	
			6 4 4	12	89	SS-3	1.50	-	-	-	-	-	-	-	-	14	A-4a (V)	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE GRAVEL, LITTLE SILT, TRACE CLAY, MOIST **(FILL)**	660.3		2 3 4	11	78	SS-4	-	-	-	-	-	-	-	-	-	12	A-3a (V)	
LOOSE, BROWN, **FINE SAND**, LITTLE SILT, TRACE COARSE SAND, TRACE GRAVEL, TRACE CLAY, DAMP	657.8		3 2 3	8	100	SS-5	-	-	-	-	-	-	-	-	-	9	A-3 (V)	
LOOSE, BROWN, **COARSE AND FINE SAND**, LITTLE GRAVEL, TRACE SILT, TRACE CLAY, WET	655.3		2 3 3	9	100	SS-6	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
			2 2 3	8	94	SS-7	-	20	27	40	9	4	NP	NP	NP	14	A-3a (0)	
@17.5'; SS-8 TO SS-13 BECOME MEDIUM DENSE TO DENSE, GRAYISH BROWN, TRACE GRAVEL			8 11 11	33	100	SS-8	-	-	-	-	-	-	-	-	-	23	A-3a (V)	
		W 646.3	6 10 11	32	100	SS-9	-	0	1	87	10	2	NP	NP	NP	24	A-3a (0)	
			5 7 10	26	100	SS-10	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
			7 10 11	32	100	SS-11	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
@27.5'; SS-12 AND SS-13 BECOME LITTLE TO SOME SILT			6 8 13	32	100	SS-12	-	-	-	-	-	-	-	-	-	21	A-3a (V)	

PID: 82380	SFN:	PROJECT: CUY-CCG3	STATION / OFFSET: 306+08, 44' RT.	START: 10/23/14	END: 10/24/14	PG 2 OF 2	B-148-0-14

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE, BROWN, **COARSE AND FINE SAND**, LITTLE GRAVEL, TRACE SILT, TRACE CLAY, WET *(continued)*	637.3	31	7 9 10	29	100	SS-13	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
	634.3	32																
MEDIUM DENSE, GRAY, **SILT**, SOME SAND, TRACE CLAY, TRACE GRAVEL, WET		33																
		34																
		35	5 8 10	27	100	SS-14	-	0	0	34	57	9	NP	NP	NP	28	A-4b (6)	
		36																
		37																
		38																
		39																
		40	7 8 8	24	100	SS-15	-	-	-	-	-	-	-	-	-	26	A-4b (V)	
		41																
	623.8	42																
MEDIUM STIFF TO HARD, GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, SS-18 CONTAINS NO INTACT SOIL FOR HP READINGS, MOIST TO WET		43																
		44																
		45	5 7 11	27	100	SS-16	4.50	0	0	2	75	23	27	17	10	20	A-4b (8)	
		46																
		47																
		48																
		49																
		50	3 5 5	15	100	SS-17	1.00	-	-	-	-	-	-	-	-	25	A-4b (V)	
		51																
		52																
		53																
		54																
		55	0 3 5	12	100	SS-18	-	0	0	1	73	26	26	17	9	30	A-4b (8)	
		56																
		57																
		58																
		59																
		60	5 6 9	23	100	SS-19	1.60	-	-	-	-	-	-	-	-	24	A-4b (V)	
	605.8	61																
		EOB																

NOTES: GROUNDWATER ENCOUNTERED AT 21.0' DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 1 BAG ASPHALT PATCH; SOIL MIXED WITH 3 BAGS CEMENT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/22/22 14:18 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2017 ARCHIVE\CUY-CCG3 82380\GINT FILES

PROJECT: CUY-CCG3	DRILLING FIRM / OPERATOR: BARR / P.STROUD	DRILL RIG: MOBILE B-58	STATION / OFFSET: 307+58, 34' RT.	EXPLORATION ID B-149-0-14
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: BARR / D.KLIMKOWICZ	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: RAMP A1	
PID: 82380 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/26/14	ELEVATION: 669.8 (MSL) EOB: 61.5 ft.	PAGE 1 OF 2
START: 10/22/14 END: 10/23/14	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 41.497763, -81.676127	

MATERIAL DESCRIPTION AND NOTES	ELEV. 669.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
4.0", **ASPHALT**	669.4																	
9.0", **GRANULAR BASE**	668.7																	
VERY LOOSE TO LOOSE, BROWN AND BLACK, **COARSE AND FINE SAND**, SOME SILT, TRACE CLAY, TRACE GRAVEL, MOIST TO WET **(FILL)**		1	3 2 1	5	78	SS-1	-	-	-	-	-	-	-	-	-	15	A-3a (V)	
		2	2 1 1	3	89	SS-2	-	8	23	40	21	8	NP	NP	NP	16	A-3a (0)	
		3																
		4																
		5	2 1 3	6	100	SS-3	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
		6																
@7.5'; SS-4 TO SS-5 BECOME LOOSE TO MEDIUM DENSE		7	3 4 3	11	100	SS-4	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
		8																
		9	3 2 4	9	100	SS-5	-	-	-	-	-	-	-	-	-	15	A-3a (V)	
	658.3	10																
MEDIUM DENSE, BROWN, **FINE SAND**, SOME COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, DAMP		11	6 5 8	20	100	SS-6	-	3	29	59	6	3	NP	NP	NP	6	A-3 (0)	
	655.3	12																
MEDIUM DENSE TO DENSE, BROWN, **COARSE AND FINE SAND**, TRACE GRAVEL, TRACE SILT, TRACE CLAY, DAMP TO WET		13	9 9 10	29	100	SS-7	-	-	-	-	-	-	-	-	-	5	A-3a (V)	
		14																
@17.5'; SS-8 BECOMES BROWN AND GRAY		15	9 13 14	41	100	SS-8	-	-	-	-	-	-	-	-	-	6	A-3a (V)	
		16																
@20.0'; SS-9 BECOMES GRAY		17	5 6 8	21	100	SS-9	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
W 648.3		18																
	647.3	19																
DENSE, GRAY, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, WET		20	8 11 11	33	100	SS-10	-	0	0	60	35	5	NP	NP	NP	22	A-4a (1)	
	645.3	21																
DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET		22	8 10 11	32	100	SS-11	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		23																
@27.5'; SS-12 AND SS-13 BECOME GRAYISH BROWN		24	8 10 11	32	100	SS-12	-	0	8	81	9	2	NP	NP	NP	22	A-3a (0)	
		25																
		26																
		27																
		28																
		29																

PID: 82380	SFN:	PROJECT: CUY-CCG3	STATION / OFFSET: 307+58, 34' RT.	START: 10/22/14	END: 10/23/14	PG 2 OF 2	B-149-0-14

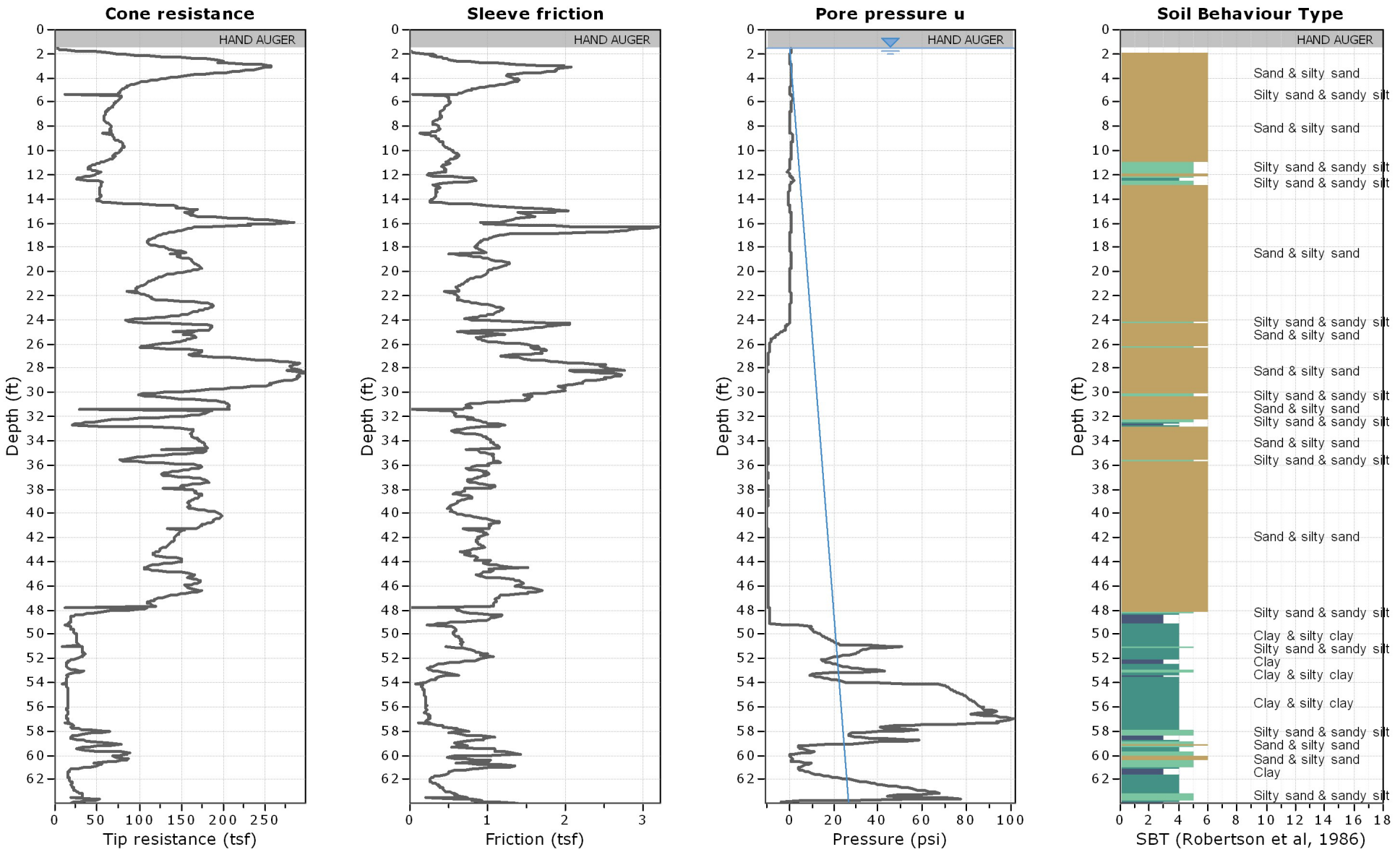
MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET *(continued)*	639.8	31	8 9 13	33	100	SS-13	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
	636.3	32																
MEDIUM DENSE TO DENSE, GRAYISH BROWN, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, WET		33																
		34																
		35	8 9 12	32	100	SS-14	-	-	-	-	-	-	-	-	-	25	A-4a (V)	
		36																
		37																
		38																
		39																
		40	4 7 9	24	100	SS-15	-	0	0	46	47	7	NP	NP	NP	26	A-4a (4)	
	626.8	41																
MEDIUM STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		42																
		43																
		44																
		45	2 3 5	12	100	SS-16	1.40	-	-	-	-	-	-	-	-	22	A-6a (V)	
		46																
		47																
		48																
		49																
		50	8 8 8	24	100	SS-17	0.80	1	0	3	61	35	29	18	11	24	A-6a (8)	
		51																
		52																
		53																
		54																
		55	8 9 10	29	100	SS-18	3.30	-	-	-	-	-	-	-	-	20	A-6a (V)	
		56																
		57																
		58																
		59																
		60	6 8 8	24	100	SS-19	1.00	-	-	-	-	-	-	-	-	21	A-6a (V)	
	608.3	61																
		EOB																

NOTES: GROUNDWATER ENCOUNTERED AT 21.5' DURING DRILLING. CAVE DEPTH 21.5'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED .5 BAG ASPHALT PATCH; POURED 3 BAGS CEMENT; SHOVELED SOIL CUTTINGS

Project: **CUY-77-90-14.96-16.33 CCG3**
Location: **Cuyahoga County**

CPT: C-150-2-14
Total depth: 63.98 ft, Date: 5/22/2015



Dissipation Tests Results

Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for t_{50}, which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction c_h was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position
r: piezocone radius
I_r: stiffness index, equal to shear modulus G divided by the undrained strength of clay (S_u).
t_{50}: time corresponding to 50% consolidation

Permeability estimates based on dissipation test

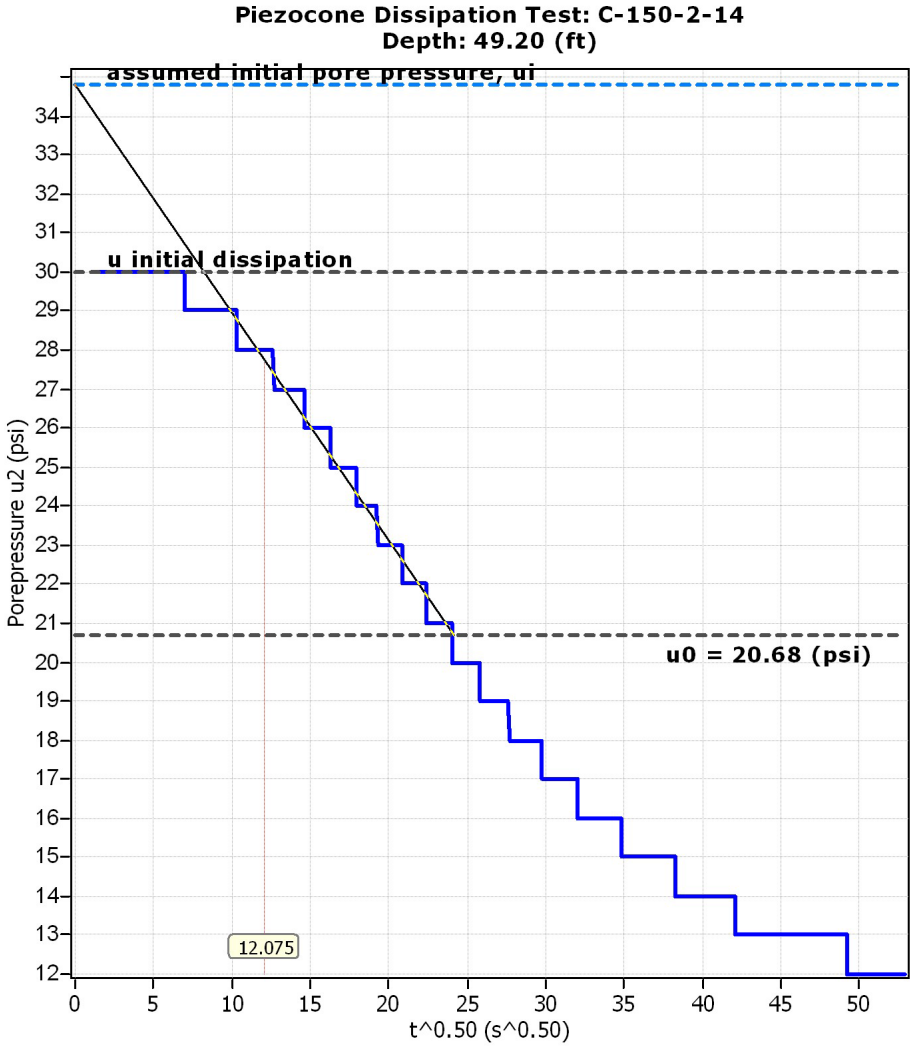
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

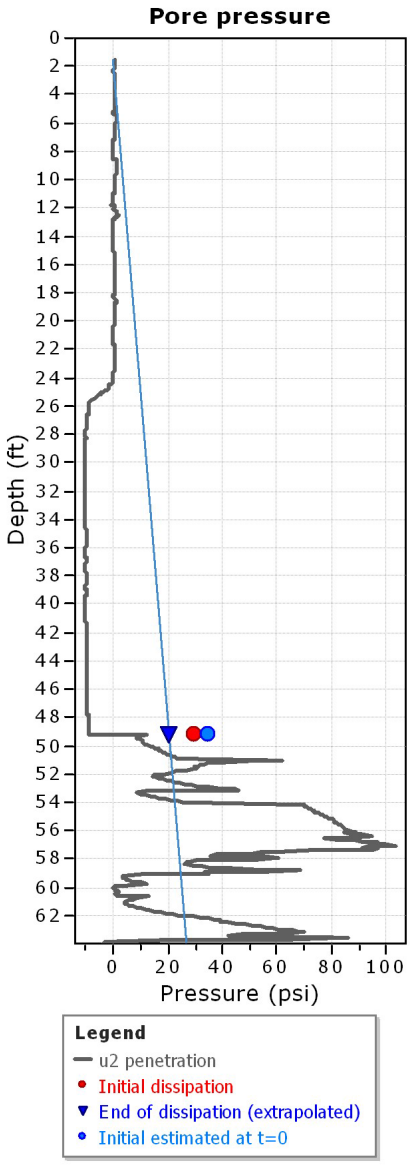
$$k_h = c_h \times \gamma_w / M$$

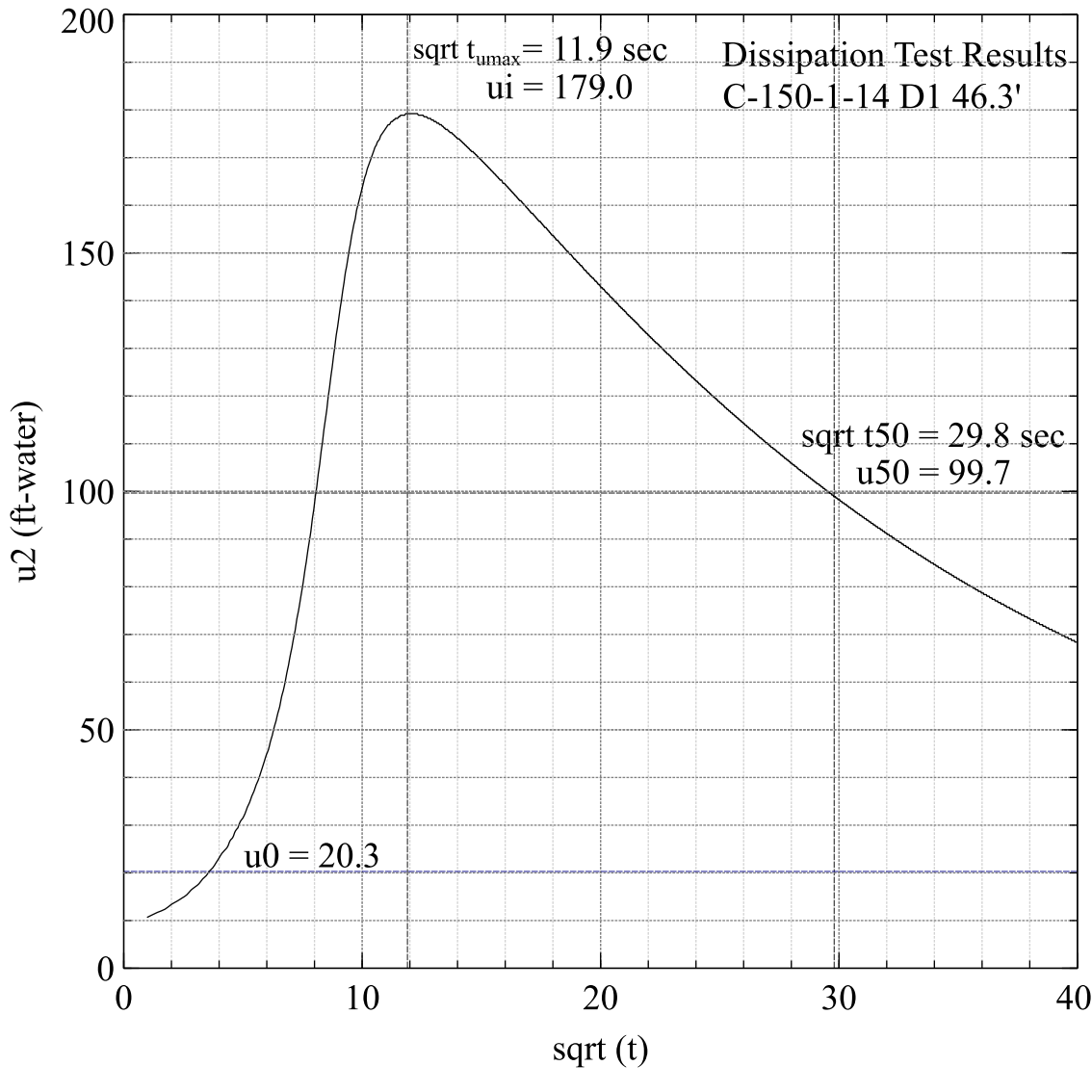
where: M is the 1-D constrained modulus and γ_w is the unit weight of water, in compatible units.

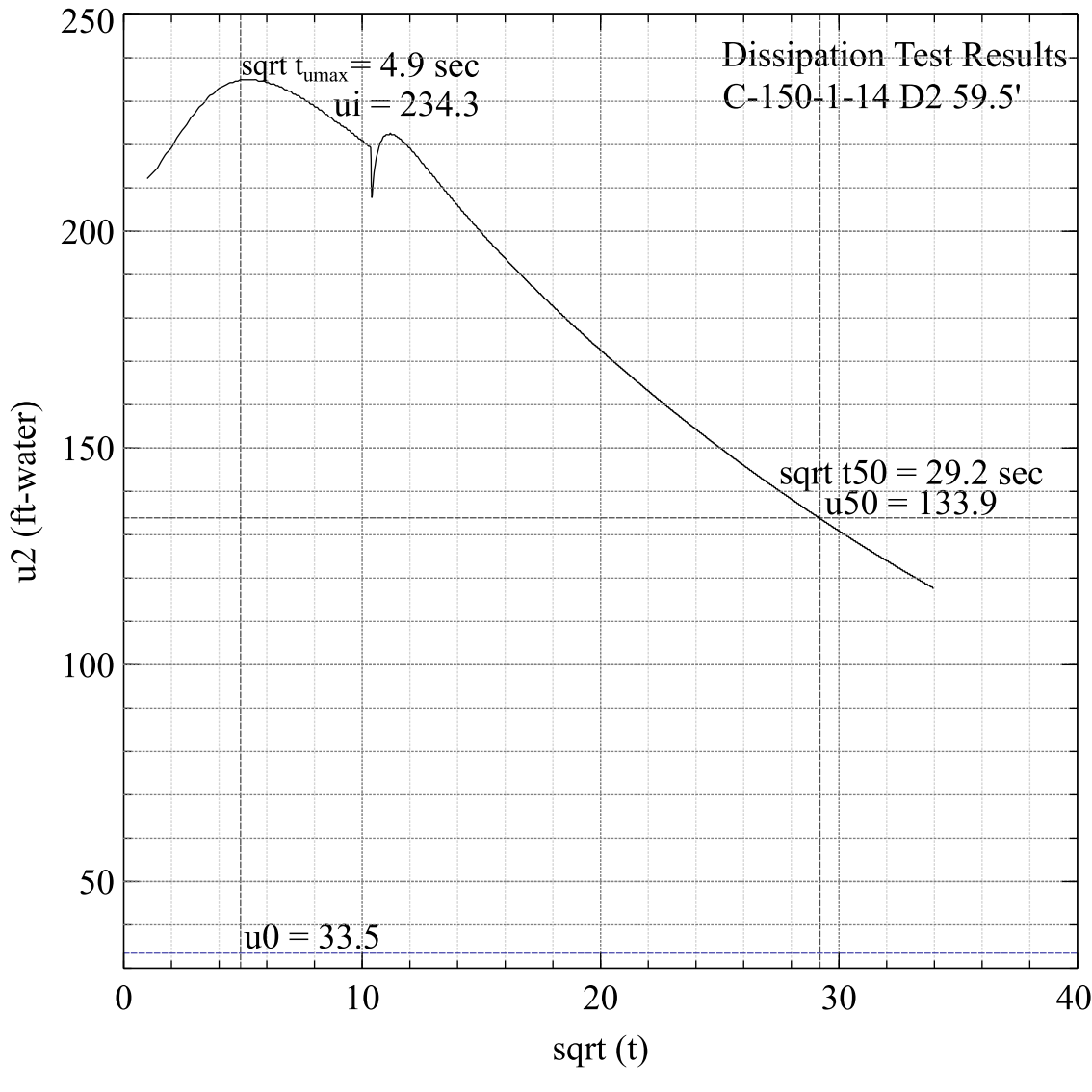
Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/S_u	c_h (ft^2/s)	c_h (ft^2/year)	M (tsf)	k_h (ft/s)
C-150-2-14	49.20	12.1	146	4.62E-006	598295.00	4.69E-003	147747	107.51	1.36E-006


Piezocone Dissipation Test: C-150-2-14
Depth: 49.20 (ft)
assumed initial pore pressure, ui
u initial dissipation
u0 = 20.68 (psi)
12.075
Porepressure u2 (psi)
t^0.50 (s^0.50)


Pore pressure
Depth (ft)
Pressure (psi)
Legend
u2 penetration
Initial dissipation
End of dissipation (extrapolated)
Initial estimated at t=0


Dissipation Test Results
C-150-1-14 D1 46.3'
sqrt t_{umax} = 11.9 sec
ui = 179.0
sqrt t50 = 29.8 sec
u50 = 99.7
u0 = 20.3
u2 (ft-water)
sqrt (t)
0
50
100
150
200
0
10
20
30
40


Dissipation Test Results
C-150-1-14 D2 59.5'
sqrt t_{umax} = 4.9 sec
ui = 234.3
sqrt t50 = 29.2 sec
u50 = 133.9
u0 = 33.5
u2 (ft-water)
sqrt (t)
250
200
150
100
50
0
10
20
30
40

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/22/22 14:18 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2017 ARCHIVE\CUY-CCG3 82380\GINT FILES

PROJECT: CUY-CCG3	DRILLING FIRM / OPERATOR: BARR / P.STROUD	DRILL RIG: MOBILE B-58	STATION / OFFSET: 198+05, 39' LT.	EXPLORATION ID B-151-0-14
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: BARR / C. PIERCE	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: IR-90 WB	
PID: 82380 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/26/14	ELEVATION: 665.4 (MSL) EOB: 61.5 ft.	PAGE 1 OF 2
START: 12/2/14 END: 12/3/14	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 41.498073, -81.675354	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE, BROWN AND DARK GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, CONTAINS FEW ROOTS, MOIST **(FILL)**	665.4	1	3 9 6	23	100	SS-1	-	38	22	29	8	3	NP	NP	NP	11	A-1-b (0)	
	663.4	2																
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, DAMP TO MOIST		3	3 4 4	12	100	SS-2	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
		4																
		5	4 4 4	12	100	SS-3	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
		6																
		7																
		8	2 3 3	9	100	SS-4	-	0	3	83	10	4	NP	NP	NP	11	A-3a (0)	
		9																
		10																
		11	3 3 3	9	100	SS-5	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
		12																
		13	3 3 3	9	100	SS-6	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
		14																
		15																
	W 649.4	16	3 3 4	11	100	SS-7	-	-	-	-	-	-	-	-	-	10	A-3a (V)	
	648.4	17																
MEDIUM DENSE TO DENSE, BROWN, **FINE SAND**, SOME COARSE SAND, TRACE GRAVEL, TRACE SILT, TRACE CLAY, WET		18	0 3 7	15	100	SS-8	-	6	30	59	3	2	NP	NP	NP	21	A-3 (0)	
		19																
		20																
		21	3 4 7	17	100	SS-9	-	-	-	-	-	-	-	-	-	20	A-3 (V)	
		22																
		23	5 7 8	23	100	SS-10	-	-	-	-	-	-	-	-	-	21	A-3 (V)	
		24																
		25																
		26	5 10 11	32	100	SS-11	-	-	-	-	-	-	-	-	-	18	A-3 (V)	
	638.4	27																
DENSE, GRAYISH BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET		28	6 12 14	39	100	SS-12	-	2	28	57	9	4	NP	NP	NP	17	A-3a (0)	
		29																

PID: 82380	SFN:	PROJECT: CUY-CCG3	STATION / OFFSET: 198+05, 39' LT.	START: 12/2/14	END: 12/3/14	PG 2 OF 2	B-151-0-14

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
DENSE, GRAYISH BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET *(continued)*	635.4	31	3 8 12	30	100	SS-13	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
		32																
		33																
		34																
		35	11 11 14	38	100	SS-14	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
		36																
		37																
	627.1	38																
DENSE, GRAYISH BROWN, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, WET		39																
		40	10 13 12	38	100	SS-15	-	0	1	51	42	6	NP	NP	NP	24	A-4a (3)	
	622.1	41																
MEDIUM STIFF TO VERY STIFF, GRAY, **SILT**, SOME TO "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO WET		42																
		43																
		44																
		45	7 10 14	36	100	SS-16	4.00	-	-	-	-	-	-	-	-	19	A-4b (V)	
		46																
		47																
		48																
		49																
		50	6 6 5	17	100	SS-17	0.60	0	1	2	61	36	29	19	10	25	A-4b (8)	
		51																
		52																
		53																
		54																
		55	4 3 5	12	100	SS-18	0.75	-	-	-	-	-	-	-	-	27	A-4b (V)	
		56																
		57																
		58																
		59																
		60	5 7 12	29	100	SS-19	1.00	0	1	1	69	29	26	18	8	22	A-4b (8)	
	603.9	61																
		EOB																

NOTES: GROUNDWATER ENCOUNTERED AT 16.0' DURING DRILLING. CAVE DEPTH 19.7'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/22/22 13:27 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CUY-90-16.28 (CCG3A - MOD#7)\GINT FILES\CUY-90-16.28 (CCG3

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 75T	STATION / OFFSET: 204+60, 15' RT.	EXPLORATION ID B-169-1-20
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: IR-90 EB	
PID: 82382 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/1/19	ELEVATION: 645.2 (MSL) EOB: 85.0 ft.	PAGE 1 OF 3
START: 3/8/21 END: 3/8/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 89	LAT / LONG: 41.498665, -81.672360	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE TO DENSE, BROWN AND BROWNISH GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE GRAVEL, CONTAINS TRACE IRON STAINING, MOIST TO WET	645.2																	
		3	6 7 7	21	83	SS-1	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
		6	5 7 8	22	100	SS-2	-	0	0	75	20	5	NP	NP	NP	25	A-3a (0)	
		9	5 6 10	24	100	SS-3	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		12	6 5 9	21	100	SS-4	-	-	-	-	-	-	-	-	-	25	A-3a (V)	
		15	4 10 12	33	100	SS-5	-	-	-	-	-	-	-	-	-	29	A-3a (V)	
W 630.2		16	6 10 13	34	100	SS-6	-	-	-	-	-	-	-	-	-	24	A-3a (V)	
	628.2																	
DENSE, BROWNISH GRAY, **COARSE AND FINE SAND**, LITTLE TO SOME SILT, TRACE CLAY, TRACE GRAVEL, WET		18	7 10 12	33	100	SS-7	-	-	-	-	-	-	-	-	-	27	A-3a (V)	
		21	6 10 13	34	100	SS-8	-	-	-	-	-	-	-	-	-	29	A-3a (V)	
	623.2																	
STIFF TO HARD, GRAY AND BROWNISH GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO WET		24	1 3 4	10	100	SS-9	1.75	-	-	-	-	-	-	-	-	29	A-4b (V)	
		27	2 2 4	9	100	SS-10	1.50	0	0	3	62	35	27	20	7	26	A-4b (8)	
		30	2 3 4	10	100	SS-11	1.50	-	-	-	-	-	-	-	-	24	A-4b (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
STIFF TO HARD, GRAY AND BROWNISH GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO WET *(continued)*	615.2	31	1 2 4	9	100	SS-12	4.25	-	-	-	-	-	-	-	-	23	A-4b (V)	
		32																
		33	1 1 3	6	100	SS-13	2.75	-	-	-	-	-	-	-	-	25	A-4b (V)	
	610.7	34																
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		35	1 2 3	7	100	SS-14	1.25	0	1	1	53	45	32	21	11	25	A-6a (8)	
		36																
		37																
		38	2 2 5	10	100	SS-15	1.75	-	-	-	-	-	-	-	-	24	A-6a (V)	
		39																
		40																
		41	3 4 5	13	100	SS-16	1.50	-	-	-	-	-	-	-	-	23	A-6a (V)	
		42																
		43	4 5 7	18	100	SS-17	2.00	0	0	2	49	49	30	19	11	26	A-6a (8)	
		44																
		45																
		46	3 5 8	19	100	SS-18	2.00	-	-	-	-	-	-	-	-	24	A-6a (V)	
		47																
		48																
		49																
		50																
		51	2 4 5	13	100	SS-19	2.75	-	-	-	-	-	-	-	-	25	A-6a (V)	
		52																
		53																
		54																
		55																
		56	3 4 6	15	100	SS-20	2.75	0	0	1	45	54	32	21	11	25	A-6a (8)	
		57																
	586.9	58																
VERY STIFF TO HARD, GRAY, **SILT**, "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO DAMP		59																
		60																
		61	4 6 8	21	100	SS-21	4.00	-	-	-	-	-	-	-	-	22	A-4b (V)	

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 204+60, 15' RT.	START: 3/8/21	END: 3/8/21	PG 3 OF 3	B-169-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, GRAY, **SILT**, "AND" CLAY, TRACE SAND, TRACE GRAVEL, MOIST TO DAMP *(continued)*	583.1	63																
		64																
		65	5 6 8	21	100	SS-22	2.75	0	0	1	55	44	30	20	10	21	A-4b (8)	
		66																
		67																
		68																
		69																
		70	6 8 14	33	100	SS-23	2.25	-	-	-	-	-	-	-	-	21	A-4b (V)	
		71																
		72																
		73																
		74																
		75	7 8 16	36	100	SS-24	3.25	-	-	-	-	-	-	-	-	19	A-4b (V)	
		76																
		77																
		78																
		79																
		80	6 9 13	33	100	SS-25	4.50	-	-	-	-	-	-	-	-	19	A-4b (V)	
		81																
	562.7	82																
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		83																
		84	7 10 14	36	100	SS-26	2.00	0	0	1	45	54	32	21	11	23	A-6a (8)	
	560.2	EOB 85																

NOTES: GROUNDWATER ENCOUNTERED AT 15.0' DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 180 GAL. BENTONITE GROUT

B-001-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

LOG OF: Boring W-DLZ-1 | *Location:* As per plan | *Date Drilled:* 9/26/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: 47.0' (with augers removed)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	671.0												
0.5	670.5						Topsoil - 6"						
		2 4 4	18	1			FILL: Loose to medium dense brown GRAVEL WITH SAND AND SILT (A-2-4); damp.						
		7 9 7	18	2									
5		4 4 9	16	3			S-3 contains 1" silty clay seam.						
		6 7 7	15	4									
10		9 11 13	18	5				6	17	--	53	24	
		6 11 12	18	6									
15		5 11 14	17	7									
		4 5 6	12	8			S-8 contains piece of wood.						
20		5 8 9	16	9									
		4 4 5	18	10			@ 23.5'; small brick fragments, piece of slag.						
25													
25.5	645.5						Very loose to loose gray GRAVEL WITH SAND AND SILT (A-2-4); wet.						
		4 2 3	18	11			S-12 contains wood fragments, 1" silty clay seam.						
		1 1 1	12	12									
30													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ *LL*
Blows per foot - ○
10 20 30 40

Non-Plastic

FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-001-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

LOG OF: Boring W-DLZ-1 | *Location:* As per plan | *Date Drilled:* 9/26/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: 47.0' (with augers removed)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N)
30	641.0						Very loose to loose gray GRAVEL WITH SAND AND SILT (A-2-4); wet.							Natural Moisture Content, % - ● PL ⊢——⊣ LL Blows per foot - ○ 10 20 30 40
35		WOH 2 4	18	13				0	0	--	88	9	3	Non-Plastic
40		2 5 11	16	14			S-14 contains wood fragment.							
41.8	629.3						Dense gray SILT (A-4b), little fine sand; wet.							
45		7 18 25	18	15										
46.8	624.3						Stiff to very stiff gray SILT AND CLAY (A-6a), trace fine to coarse sand; moist.							
50		7 8 8	18	16										
55		4 7 7	14	17		2.75								
60					P-1		@ 58.0'; 24" Press Tube - 0" Recovery.							

FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-001-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

LOG OF: Boring W-DLZ-1 | *Location:* As per plan | *Date Drilled:* 9/26/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: 47.0' (with augers removed)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
60	611.0						Stiff to very stiff gray SILT AND CLAY (A-6a), trace fine to coarse sand; moist.						
65		WOH 3 5	17	18		1.0							
70		WOH 1 2	18	19		0.5		0	0	--	1	51	48
75		2 5 8	16	20									
80		5 10 14	18	21		3.25							
85		4 5 10	18	22		2.75							
86.8	584.3						Stiff to very stiff gray SANDY SILT (A-4a); moist. @ 88.0'; 24" Press Tube - 24" recovery.						
90					P-2			0	0	--	2	62	36

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-001-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

LOG OF: Boring W-DLZ-1 | *Location:* As per plan | *Date Drilled:* 9/26/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: 47.0' (with augers removed)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
90	581.0						Stiff to very stiff gray SANDY SILT (A-4a); moist.						
		2 7 10	18	23		1.75							
95													
96.8	574.3						Stiff gray SILT AND CLAY (A-6a), trace fine sand; moist.						
		1 6 11	18	24		1.75							
100													
		WOH 4 4	18	25		0.25	@ 103.5'; very soft to soft, trace fine to coarse sand, trace gravel.						
105													
106.8	564.2						Very soft gray SILTY CLAY (A-6b), trace fine to coarse sand, trace gravel; moist.						
		WOH WOH 1	18	26		0.0							
110													
		WOH WOH WOH	18	27		0.0		1	1	--	2	32	65
115													
		WOH WOH WOH	18	28		0.0							
120													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-001-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

LOG OF: Boring W-DLZ-1 | *Location:* As per plan | *Date Drilled:* 9/26/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: 47.0' (with augers removed)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
120	551.0						Very soft gray SILTY CLAY (A-6b), trace fine to coarse sand, trace gravel; moist.						
125		WOH WOH WOH	18	29		0.0							
		WOH WOH 1	18	30		0.0							
130.0	541.0						Bottom of Boring - 130.0'						
135													
140													
145													
150													

GRADATION

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-002-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

LOG OF: Boring W-DLZ-2 | *Location:* As per plan | *Date Drilled:* 9/18/06 to 9/19/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: ?

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	668.0												
0.3	667.7						Asphalt Concrete - 4"						
		14 26 45	13	1			FILL: Very dense gray GRAVEL (A-1-a); contains brick; damp.						
3.0	665.0												
		7 17 10	8	2			FILL: Medium dense brown COARSE AND FINE SAND (A-3a), little gravel; contains brick, slag, roots; damp.						
5													
5.5	662.5						POSSIBLE FILL: Loose to medium dense light brown FINE SAND (A-3); damp.						
		4 6 6	15	3									
							@ 8.0'; brown.						
		4 4 5	18	4									
10													
10.5	657.5						Loose to medium dense brown GRAVEL WITH SAND AND SILT (A-2-4); damp.						
		4 4 5	18	5									
		1 3 10	18	6			@ 14.0'; 10" silty clay seam.						
15													
		3 8 10	16	7			@ 16.0'; peppered.						
		8 11 12	17	8			@ 18.5'; gray.						
20													
		8 11 11	17	9									
		8 12 14	14	10				0	1	--	94	5	
25													
		14 14 13	18	11			@ 26.0'; wet.						
		2 8 11	15	12									
30													

GRADATION

STANDARD PENETRATION (N)
Natural Moisture Content, % -
PL — *LL*
Blows per foot -
10 20 30 40

71

Non-Plastic

FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-002-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

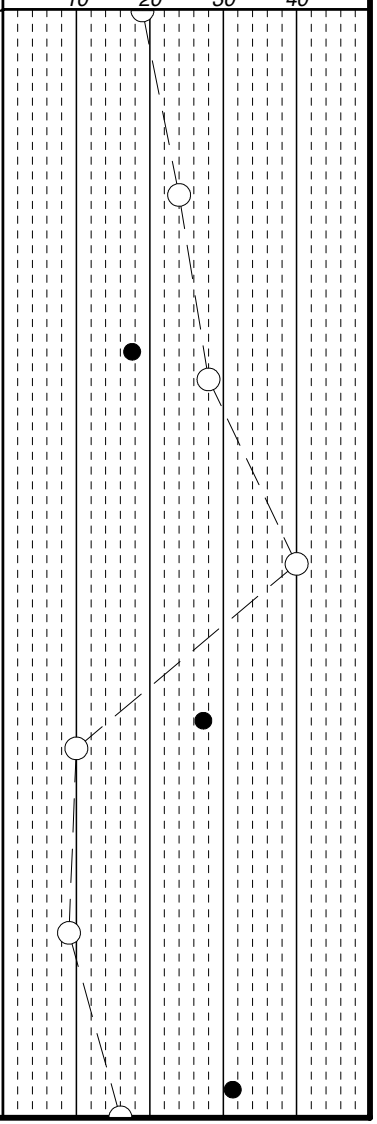
LOG OF: Boring W-DLZ-2 | *Location:* As per plan | *Date Drilled:* 9/18/06 to 9/19/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: ?

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION
30	638.0						Medium dense gray COARSE AND FINE SAND (A-3a); wet.
		3 9 15	18	13			
35							
		3 12 16	17	14			
40							
41.8	626.3						Dense gray SILT (A-4b), little fine sand, trace clay; wet.
		6 15 25		15			
45							
		4 5 5	18	16		0.75	
49.5	618.5						Medium stiff to stiff gray SANDY SILT (A-4a); moist.
50							
		2 3 6	14	17		1.0	
55							
		4 7 9	18	18		---	@ 58.5'; contains organic material.
60							

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40



FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-002-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

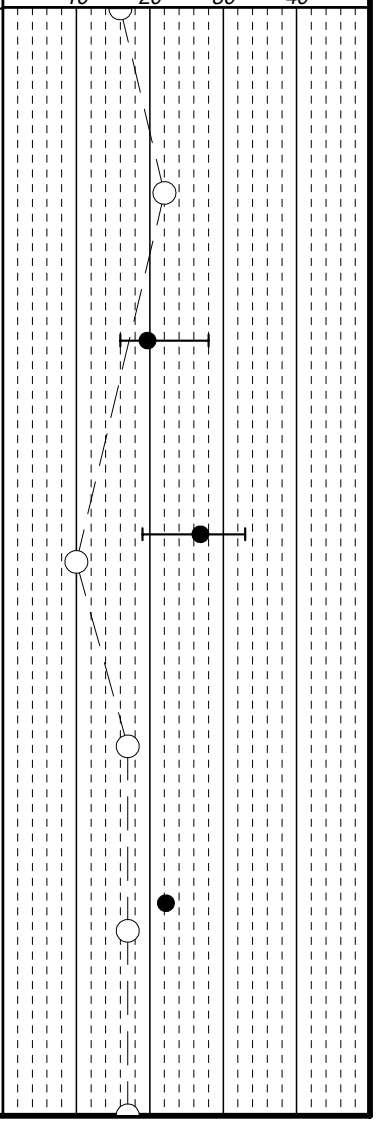
Client: Ohio Department of Transportation - District 12 | Project: ODOT Innerbelt - Retaining Walls | Job No. 0422-1007.00

LOG OF: Boring W-DLZ-2 | Location: As per plan | Date Drilled: 9/18/06 to 9/19/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: ?

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
60	608.0						Medium stiff to stiff gray SANDY SILT (A-4a); moist.						
61.8	606.3						Very stiff gray SILT AND CLAY (A-6a), trace fine sand; moist.						
65		7 9 13	18	19		2.25							
					P-1	2.5 TSF	@ 68.0'; 24" Press Tube - 24" Recovery.	0	0	--	1	62	37
70													
		2 4 6	18	20		2.25	@ 73.5'; trace fine and coarse sand, trace gravel.		0	--	1	45	54
75													
		4 7 10	14	21		1.75							
80													
		3 7 10	18	22		2.0							
85													
		5 7 10	18	23		1.25							
90													

STANDARD PENETRATION (N)
Natural Moisture Content, % -
PL — LL
Blows per foot - 10 20 30 40



FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-002-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

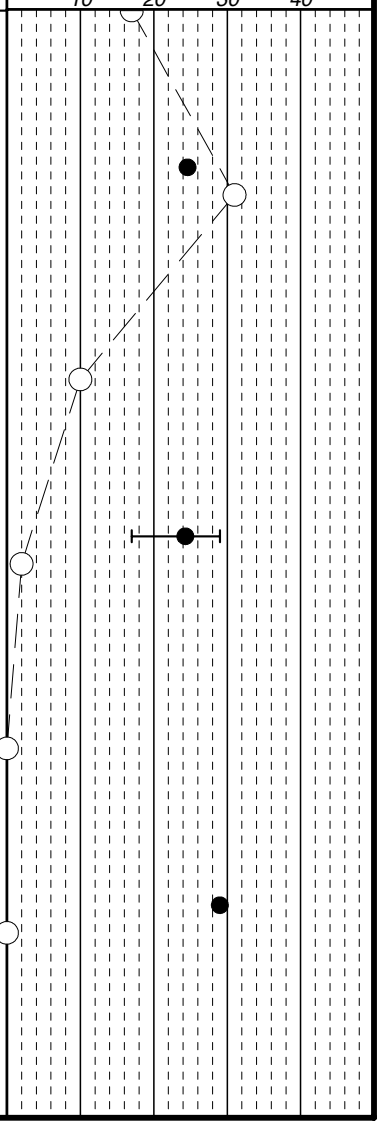
Client: Ohio Department of Transportation - District 12 | *Project:* ODOT Innerbelt - Retaining Walls | *Job No.* 0422-1007.00

LOG OF: Boring W-DLZ-2 | *Location:* As per plan | *Date Drilled:* 9/18/06 to 9/19/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: ?

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
578.0													
90.1	577.9						Very stiff gray SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; moist.						
		12 16 15	17	24		2.5							
95													
96.8	571.3						Soft to medium stiff gray SANDY SILT (A-4a), trace gravel; moist.						
		2 3 7	16	25		0.5							
100													
101.8	566.2						Very soft to soft SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; moist.						
		WOH WOH 2	18	26		0.0		1	3	--	8	48	40
105													
106.8	561.2						Very soft gray SILTY CLAY (A-6b), trace fine to coarse sand, trace gravel; moist.						
		WOH WOH WOH	18	27		0.0							
110													
		WOH WOH WOH	18	28		0.0							
115													
					29	0.0	@ 118.0'; 24" Press Tube - 0" recovery.						
120													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ *LL*
Blows per foot - ○
10 20 30 40



FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-002-D-06

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Ohio Department of Transportation - District 12 | Project: ODOT Innerbelt - Retaining Walls | Job No. 0422-1007.00

LOG OF: Boring W-DLZ-2 | Location: As per plan | Date Drilled: 9/18/06 to 9/19/06

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: ?

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION
120	548.0						Very soft gray SILTY CLAY (A-6b), trace fine to coarse sand, trace gravel; moist.
125		WOH WOH WOH	18	30		0.0	
		WOH WOH WOH	14	31		0.0	
130.0	538.0						Bottom of Boring - 130.0'
135							
140							
145							
150							

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

FILE: Innerbelt RW's Newest [11/25/2006 11:09 AM]

B-002-T-58

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

LOG OF BORING

CO., RT. NO., SEC. CUY-42-18.81 BRIDGE NO. CUY-42-1881
REAR ABUTMENT UNDER E. 22nd ST.

LOCATION: T.H. 2 STA. 2+73 OFFSET 18' LT. FED. NO.

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
669.8	0			
	2			
	4			
664.8	6	6	58585	BR. SILTY GRAVELLY SAND
	8			
659.8	10			
	12	12	58586	BR. SILTY GRAVELLY SAND
	14			
654.8	16	50	58587	BROWN SILTY SAND
	18			
649.8	20			
	22	32	58588	GRAY SILTY GRAVELLY SAND
	24			
644.8	26	57	58589	DK. GRAY SILTY SAND
	28			
639.8	30			
	32	63	58590	DK. GRAY SILTY SAND
	34			
634.8	36	63	58591	DK. GRAY SILTY SAND

RC
2-26-57

LOG OF BORING (CONTINUED) B-002-T-58

BRIDGE NO. CUY-42-1881 T.H. 2

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
	38			
629.8	40	32	58592	DK. GRAY SANDY SILT
	42			
	44			
624.8	46	14	58593	DK. GRAY SILT
	48			
619.8	50	12	58594	DK.GRAY SILT
	52			
	54			
614.8	56	17	58595	DK. GRAY SILT
	58			
609.8	60	14	58596	DK. GRAY SILT
	62			
	64			
604.8	66	14	58597	DK. GRAY SILT
	68			
599.8	70	15	58598	DK. GRAY SILTY CLAY
	72			
	74			
594.8	76	14	58599	DK. GRAY SILT
	78			
589.8	80	14	58600	DK. GRAY SILT
588.8	82			BOTTOM OF HOLE

RC
2-28-57

B-008-C-57

STATE OF OHIO
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

LOG OF BORING

CO., RT. NO. SEC. CUY-42-18.81 BRIDGE NO. CUY-42-1885
FORWARD ABUTMENT UNDER CEDAR AVE.

LOCATION: T.H. 8 STA. 2+82 OFFSET CL FED. NO.

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
671.0	0			
	2			
	4			
666.0	6	10	58601	BROWN GRAVELLY SAND
	8			
661.0	10	10	58602	BROWN GRAVELLY SAND
	12			
	14			
656.0	16	15	58603	BROWN SILTY SAND
	18			
651.0	20	22	58604	BROWN SANDY SILT
	22			
	24			
646.0	26	24	58605	BROWN SILTY SAND
	28			
641.0	30	26	58606	BROWN SILTY SAND
	32			
	34			
636.0	36	25	58607	BROWN SILTY SAND

RC
2.26.57

LOG OF BORING (CONTINUED)

BRIDGE NO. CUY-42-1885 T.H. 8

ELEV.	DEPTH	NO. BLOWS	SAMPLE NO.	DESCRIPTION
	38			
631.0	40	26	58608	BROWN SILTY SAND
	42			
	44			
626.0	46	15	58609	GRAY SILT
	48			
621.0	50	17	58610	GRAY SILT
	52			
	54			
616.0	56	16	58611	GRAY SILT
	58			
611.0	60	18	58612	GRAY SILT
	62			
	64			
606.0	66	18	58613	GRAY SILT & CLAY
	68			
601.0	70	21	58614	GRAY SILT
	72			
	74			
596.0	76	20	58615	GRAY SILT
	78			
591.0	80	22	58616	GRAY SILT & CLAY
	82			BOTTOM OF HOLE

RC
2-26-57

APPENDIX C

GENERALIZED SUBSURFACE PROFILE - RETAINING WALLS AE AND AF

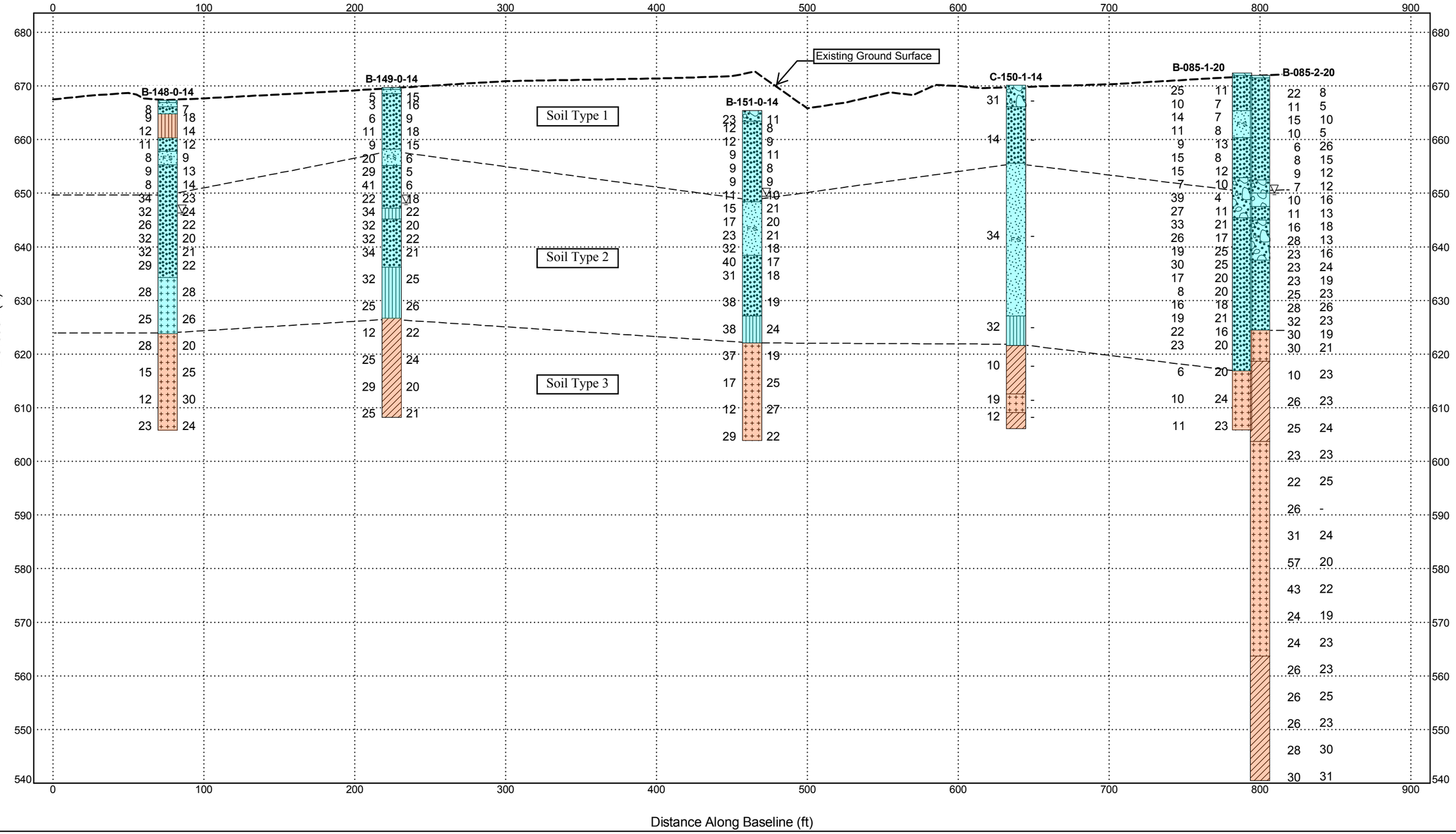
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

Non-cohesive
Cohesive

SUBSURFACE DIAGRAM
RETAINING WALL AE

Ohio DOT: Sod and Topsoil
Ohio DOT: A-1-a, gravel and/or stone fragments
Ohio DOT: Pavement or Aggregate base
Ohio DOT: A-3, fine sand
Ohio DOT: A-3a, coarse and fine sand
Ohio DOT: A-4b, silt
Concrete
Ohio DOT: A-1-b, gravel and/or stone fragments with sand
Ohio DOT: A-6a, silt and clay
Ohio DOT: A-4a, sandy silt

CLIENT Michael Baker International
PROJECT NUMBER 82382
PROJECT NAME CCG3A
PROJECT LOCATION Cuyahoga County, Ohio



STRATIGRAPHY & GW - B SIZE - OH DOT.GDT - 6/18/21 13:04 - C:\USERS\KAREN\DESKTOP\WALLAE_PROFILE061721.GPJ

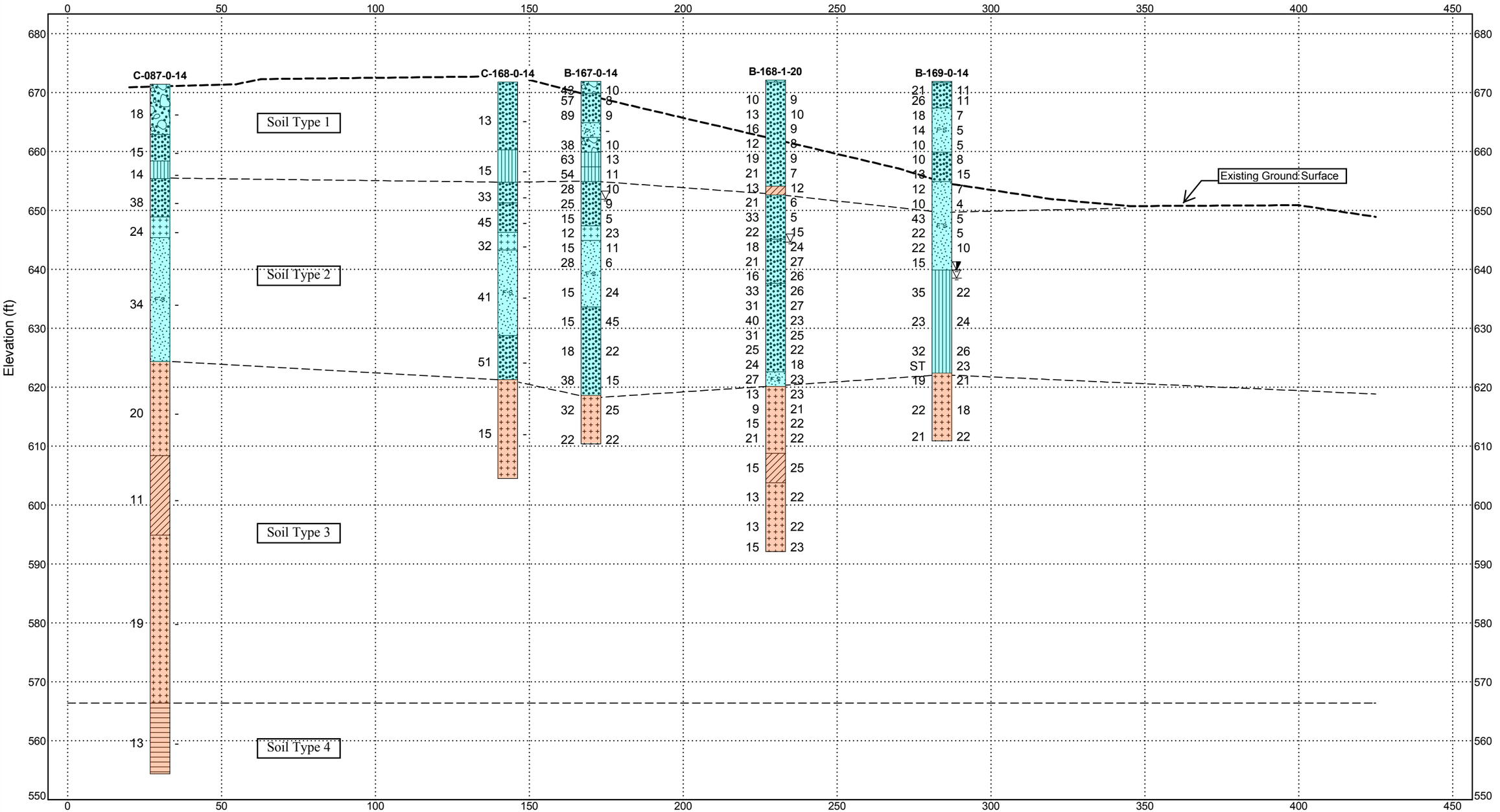
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

Non-cohesive
Cohesive

SUBSURFACE DIAGRAM
RETAINING WALL AF

Ohio DOT: A-1-b, gravel and/or stone fragments with sand
Ohio DOT: A-3a, coarse and fine sand
Concrete
Ohio DOT: A-4a, sandy silt
Ohio DOT: A-4b, silt
Ohio DOT: A-3, fine sand
Ohio DOT: Pavement or Aggregate base
Ohio DOT: A-6a, silt and clay
Ohio DOT: A-6b, silty clay

CLIENT Michael Baker International
PROJECT NUMBER 82382
PROJECT NAME CCG3A
PROJECT LOCATION Cuyahoga County, Ohio



STRATIGRAPHY & GW - B SIZE - OH DOT.GDT - 9/27/21 12:01 - C:\USERS\KARENS\DESKTOP\WALLAF_PROFILE061821.GPJ

APPENDIX D

EXTERNAL STABILITY ANALYSIS – RETAINING WALL AE (WEST)

RETAINING WALL AE – STA. 01+82

Objective: **To evaluate the external stability of CIP wall's with level backfill (no backslope).**
Method: **In accordance with ODOT Bridge Design Manual, 2019 [Sect. 204.6.2.2] LRFD Bridge Design Specifications, 8th Ed., Nov. 2017, [Sect. 11.6.1, Sect. 11.6.2, and Sect. 11.6.3].**

Givens:

Backfill Soil Design Parameters:

$\phi'_f := 30\ deg$ — Effective angle of internal friction

$\gamma_f := 120\ \frac{lbf}{ft^3}$ — Unit weight

$c'_f := 0\ \frac{lbf}{ft^2}$ — Effective Cohesion

$\delta := 0.67 \cdot \phi'_f$ $\quad \delta = 20.1\ deg$ — Friction angle between backfill and wall taken as specified in **LRFD BDS C3.11.5.3 (degrees)**

Foundation Soil Design Parameters:

Drained Conditions (Effective Stress):

$\phi'_{fd} := 31\ deg$ — Effective angle of internal friction

$\gamma_{fd} := 112\ \frac{lbf}{ft^3}$ — Unit weight

$c'_{fd} := 0\ \frac{lbf}{ft^2}$ — Effective Cohesion

$\delta_{fd} := 0.67 \cdot \phi'_{fd}$ $\quad \delta_{fd} = 20.8\ deg$ — Friction angle between foundation soils and footing taken as specified in **LRFD BDS C3.11.5.3 (degrees)**

Undrained Conditions (Total Stress):

$\phi_{fdu} := 31\ deg$ — Angle of internal friction (Same as Drained Conditions if granular soils)

$\gamma_{fd} = 112\ \frac{lbf}{ft^3}$ — Unit weight

$Su_{fdu} := 0\ \frac{lbf}{ft^2}$ — Undrained Shear Strength

$\delta_{fdu} := 0.67 \cdot \phi_{fdu}$ $\quad \delta_{fdu} = 20.8\ deg$ — Friction angle between foundation soils and footing taken as specified in **LRFD BDS C3.11.5.3 (degrees)**

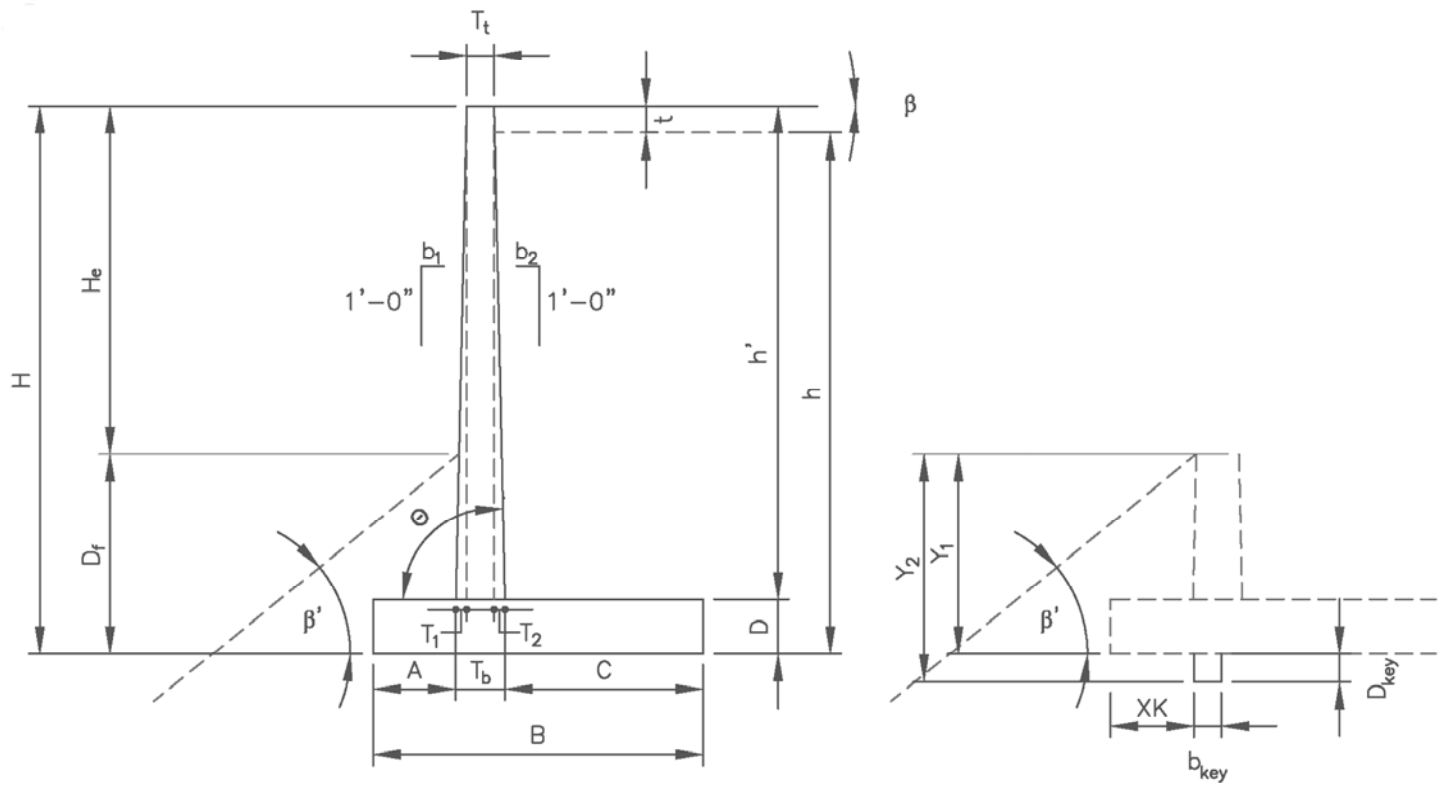
Foundation Surcharge Soil Parameters:

$\gamma_q := 120\ \frac{lbf}{ft^3}$ — Unit weight of Soil above bearing depth (Used in Bearing Resistance of Soil Calculation LRFD 10.6.3.1.2a-1)

Other Parameters:

$\gamma_c := 150\ \frac{lbf}{ft^3}$ — Concrete Unit weight

$\gamma_p := 150\ \frac{lbf}{ft^3}$ — Pavement Unit weight



Wall Geometry:

$H_e := 8.4\ ft$ — Exposed wall height

$D_f := 3\ ft$ — Footing cover at Toe
Note: Where the potential for scour, erosion of undermining exists, spread footings shall be located to bear below the maximum depth of scour or undermining. Spread footings shall be located below the depth of potential frost. **LRFD BDS 10.6.1.2.**

$H := H_e + D_f$ $\quad H = 11.4\ ft$ — Design Wall Height

$T_t := 1.5\ in$ — Stem thickness at top of wall

$b_1 := 0 \cdot \left(\frac{in}{ft}\right)$ — Frontwall batter, (b1H:12V)

$b_2 := 0 \cdot \left(\frac{in}{ft}\right)$ — Backwall batter, (b2H:12V)

$\beta := 0\ deg$ — Inclination of ground slope behind face of wall. Horizontal backfill behind CIP wall, β = 0 deg

Inclination of ground slope:

- Horizontal: **0**
- 3H:1V: **18.435**
- 2H:1V: **26.565**
- 1.5H:1V: **33.690**

$\beta' := 26.565\ deg$ — Inclination of ground slope in front of wall. If it is horizontal backfill in front of CIP wall, β' = 0 deg. A negative angle (-) indicates grades slope up from front of wall. Positive angle (+) indicates grade slope down from wall as shown in above figure.

$t := 25\ in$ — Pavement thickness

Preliminary Wall Dimensioning:

$B := 5.5\ ft$	$\frac{2}{5} \cdot H = 4.56\ ft$	to	$\frac{3}{5} \cdot H = 6.84\ ft$	Footing base width (2/5H to 3/5H)
$A := 1.16\ ft$	$\frac{H}{8} = 1.43\ ft$	to	$\frac{H}{5} = 2.28\ ft$	Toe projection (H/8 to H/5)
$D := 1.5\ ft$	$\frac{H}{8} = 1.43\ ft$	to	$\frac{H}{5} = 2.28\ ft$	Footing thickness (H/8 to H/5)

Shear Key Dimensioning:

$D_{key} := 0\ ft$		Depth of shear key from bottom of footing **Note:** Footings on rock typically require shear key
$b_{key} := 0\ ft$		Width of shear key
$XK := A$		Distance from toe to shear key

Other Wall Dimensions:

$h' := H - D$	$h' = 9.9\ ft$	Stem height
$T_1 := b_1 \cdot h'$	$T_1 = 0\ ft$	Stem front batter width
$T_2 := b_2 \cdot h'$	$T_2 = 0\ ft$	Stem back batter width
$T_b := T_1 + T_2 + T_t$	$T_b = 0.125\ ft$	Stem thickness at bottom of wall
$C := B - A - T_b$	$C = 4.215\ ft$	Heel projection
$\theta := 90\ deg$		Angle of back face of wall to horizontal = *atan(12/b2)*
$b := 12\ in$	$b = 1\ ft$	Concrete strip width (for design)
$y_1 := 3 \cdot ft$	$y_1 = 3\ ft$	Depth to where passive pressure may begin to be utilized in front of wall. (Typically Df)
$y_2 := D_f + D_{key}$	$y_2 = 3\ ft$	Bottom of shear key/footing depth i.e. depth to where passive pressure may no longer be utilized.
$h := H - t$	$h = 9.3\ ft$	Height of retained fill at back of heel

Live Load Surcharge Parameters:

$\lambda := 2\ ft$ — Horizontal distance from the back of the wall to point of traffic surcharge load

$SUR := \text{if}\left(\lambda < \frac{H}{2}, 250\ \frac{lbf}{ft^2}, 100\ \frac{lbf}{ft^2}\right) = 250\ \frac{lbf}{ft^2}$ — Live load surcharge (per LRFD BDS [3.11.6.4])
Note: If vehicular loading is within 1 ft of the backface of the wall and with a design height, H, less than 20 ft, see LRFD BDS Section 3.11.6.4 and Table 3.11.6.4-2 for adjusted surcharge load calculation.
Note: when λ < H/2, SUR equal 100 psf to account for construction loads

Calculations:

Earth Pressure Coefficients:

Backfill Active Earth:

$$\Gamma := \left(1 + \sqrt{\frac{\left(\sin\left(\phi'_f + \delta\right) \cdot \sin\left(\phi'_f - \beta\right)\right)}{\left(\sin\left(\theta - \delta\right) \cdot \sin\left(\theta + \beta\right)\right)}}\right)^2 \qquad \Gamma = 2.687$$

$$k_{af} := \left(\frac{\left(\sin\left(\theta + \phi'_f\right)\right)^2}{\left(\Gamma \cdot \left(\sin\left(\theta\right)\right)^2 \cdot \sin\left(\theta - \delta\right)\right)}\right) \qquad k_{af} = 0.297$$

Active Earth Pressure Coefficient (**per LRFD Sect. 3.11.5.3**)

Foundation Soil Passive Earth:

Drained Conditions assuming($\phi'_{fd} > 0$):

Input Parameters for **LRFD Figure 3.11.5.4-2**, assumes θ = 90 degrees

$$\frac{-\beta'}{\phi'_{fd}} = -0.857 \qquad \frac{-\delta_{fd}}{\phi'_{fd}} = -0.67$$

$k'_p := 1.66$

Passive Earth Pressure Coefficient from **LRFD Figure 3.11.5.4-2**

Determine Reduction Factor (R) by interpolation:

$R_d := 0.848$

Reduction Factor

$k_{pd} := R_d \cdot k'_p \qquad k_{pd} = 1.408$

Passive Earth Pressure Coefficient for Drained Conditions

Undrained Conditions ($\phi_{fdu} > 0$): **Note:** Expand window below to complete calculation

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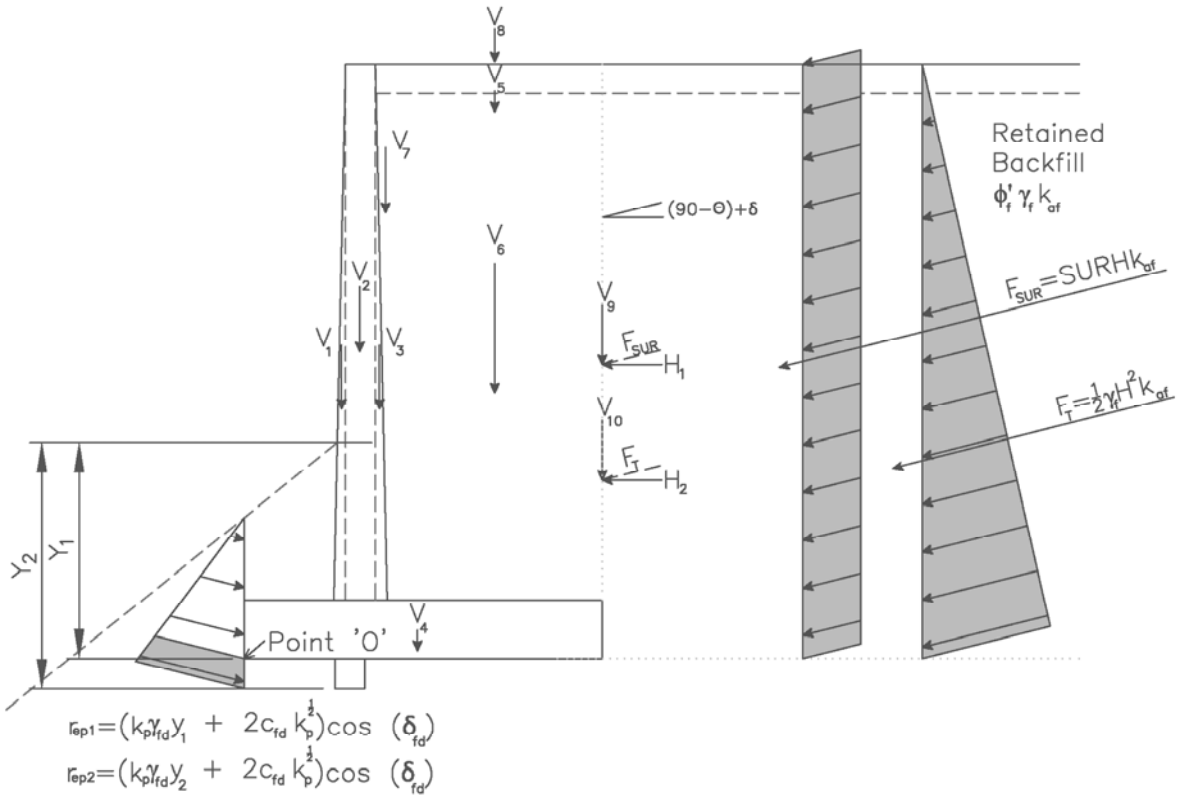
Undrained Conditions:

$k_{pu} := \text{if}\left(\phi_{fdu} > 0, k_{pu}, 1\right) \qquad k_{pu} = 1.408$

Passive Earth Pressure Coefficient for Resistance Undrained Conditions

Compute Unfactored Loads LRFD [Tables 3.4.1-1 and 3.4.1-2]:



$F_T := \frac{1}{2} \cdot \gamma_f \cdot H^2 \cdot k_{af}$ → $F_T = 2317.9 \ \frac{lbf}{ft}$ Active Earth Force Resultant (EH)

$F_{SUR} := SUR \cdot H \cdot k_{af}$ → $F_{SUR} = 847.2 \ \frac{lbf}{ft}$ Live Load Surcharge (LS)

Vertical Loads:

$V_1 := \frac{1}{2} \cdot T_1 \cdot h' \cdot \gamma_c$ → $V_1 = 0 \ \frac{lbf}{ft}$ Wall stem front batter (DC)

$V_2 := T_t \cdot h' \cdot \gamma_c$ → $V_2 = 185.6 \ \frac{lbf}{ft}$ Wall stem (DC)

$V_3 := \frac{1}{2} \cdot T_2 \cdot h' \cdot \gamma_c$ → $V_3 = 0 \ \frac{lbf}{ft}$ Wall stem back batter (DC)

$V_4 := D \cdot B \cdot \gamma_c$ → $V_4 = 1237.5 \ \frac{lbf}{ft}$ Wall Footing (DC)

$V_5 := t \cdot (T_2 + C) \cdot \gamma_p$ → $V_5 = 1317.2 \ \frac{lbf}{ft}$ Pavement (DC)

$V_6 := C \cdot (h' - t) \cdot \gamma_f$ → $V_6 = 3953.7 \ \frac{lbf}{ft}$ Soil Backfill - Heel (EV)

$V_7 := \frac{1}{2} \cdot b_2 \cdot (h' - t)^2 \cdot \gamma_f$ → $V_7 = 0 \ \frac{lbf}{ft}$ Soil Backfill - Batter (EV)

$V_8 := SUR \cdot (T_2 + C)$ → $V_8 = 1053.8 \ \frac{lbf}{ft}$ Live Load Surcharge above Heel- (LS) - Strength Ib

$V_9 := F_{SUR} \cdot \sin(90 \cdot deg - \theta + \delta)$ → $V_9 = 291.1 \ \frac{lbf}{ft}$ Live Load Surcharge Resultant (vertical comp. - LS) - Strength Ia

$V_{10} := F_T \cdot \sin(90 \cdot deg - \theta + \delta)$ → $V_{10} = 796.6 \ \frac{lbf}{ft}$ Active earth force resultant (vertical component - EH)

Moment Arm: | Moment:

Moments produced from vertical loads about Point 'O'

$d_{v1} := A + \frac{2}{3} \cdot T_1 = 1.2\ ft$ | $MV_1 := V_1 \cdot d_{v1} = 0\ lbf$

$d_{v2} := A + T_1 + \frac{T_t}{2} = 1.2\ ft$ | $MV_2 := V_2 \cdot d_{v2} = 226.9\ lbf$

$d_{v3} := A + T_1 + T_t + \frac{T_2}{3} = 1.3\ ft$ | $MV_3 := V_3 \cdot d_{v3} = 0\ lbf$

$d_{v4} := \frac{B}{2} = 2.8\ ft$ | $MV_4 := V_4 \cdot d_{v4} = 3403.1\ lbf$

$d_{v5} := B - \frac{T_2 + C}{2} = 3.4\ ft$ | $MV_5 := V_5 \cdot d_{v5} = 4468.6\ lbf$

$d_{v6} := B - \frac{C}{2} = 3.4\ ft$ | $MV_6 := V_6 \cdot d_{v6} = 13412.8\ lbf$

$d_{v7} := A + T_1 + T_t + \left(\frac{2}{3} \cdot b_2 \cdot (h' - t)\right) = 1.3\ ft$ | $MV_7 := V_7 \cdot d_{v7} = 0\ lbf$

$d_{v8} := B - \frac{T_2 + C}{2} = 3.4\ ft$ | $MV_8 := V_8 \cdot d_{v8} = 3574.8\ lbf$

$d_{v9} := B = 5.5\ ft$ | $MV_9 := V_9 \cdot d_{v9} = 1601.3\ lbf$

$d_{v10} := B = 5.5\ ft$ | $MV_{10} := V_{10} \cdot d_{v10} = 4381.2\ lbf$

Horizontal Loads:

$H_1 := F_{SUR} \cdot \cos(90 \cdot deg - \theta + \delta)$ $H_1 = 795.6\ \frac{lbf}{ft}$ Live Load Surcharge Resultant (horizontal comp. - LS)

$H_2 := F_T \cdot \cos(90 \cdot deg - \theta + \delta)$ $H_2 = 2176.7\ \frac{lbf}{ft}$ Active Earth Force Resultant (horizontal comp. - EH)

Moment Arm: | Moment:

$d_{h1} := \frac{H}{2}$ $d_{h1} = 5.7\ ft$ | $MH_1 := H_1 \cdot d_{h1}$ $MH_1 = 4534.9\ \frac{lbf \cdot ft}{ft}$

$d_{h2} := \frac{H}{3}$ $d_{h2} = 3.8\ ft$ | $MH_2 := H_2 \cdot d_{h2}$ $MH_2 = 8271.6\ \frac{lbf \cdot ft}{ft}$

Unfactored Loads by Load Type:

$V_{DC} := V_1 + V_2 + V_3 + V_4 + V_5$ $V_{DC} = 2740.3\ \frac{lbf}{ft}$

$V_{EV} := V_6 + V_7$ $V_{EV} = 3953.7\ \frac{lbf}{ft}$

$V_{LS\_Ia} := V_9$ $V_{LS\_Ia} = 291.1\ \frac{lbf}{ft}$

$V_{LS\_Ib} := V_8 + V_9$ $V_{LS\_Ib} = 1344.9\ \frac{lbf}{ft}$

$V_{EH} := V_{10}$ $V_{EH} = 796.6\ \frac{lbf}{ft}$

$H_{LS} := H_1$ $H_{LS} = 795.6\ \frac{lbf}{ft}$

$H_{EH} := H_2$ $H_{EH} = 2176.7\ \frac{lbf}{ft}$

Unfactored Moments by Load Type

$M_{DC} := MV_1 + MV_2 + MV_3 + MV_4 + MV_5$ $M_{DC} = 8098.6 \frac{lbf \cdot ft}{ft}$

$M_{EV} := MV_6 + MV_7$ $M_{EV} = 13412.8 \frac{lbf \cdot ft}{ft}$

$M_{LSV\_Ia} := MV_9$ $M_{LSV\_Ia} = 1601.3 \frac{lbf \cdot ft}{ft}$

$M_{LSV\_Ib} := MV_8 + MV_9$ $M_{LSV\_Ib} = 5176.1 \frac{lbf \cdot ft}{ft}$

$M_{EH1} := MV_{10}$ $M_{EH1} = 4381.2 \frac{lbf \cdot ft}{ft}$

$M_{LSH} := MH_1$ $M_{LSH} = 4534.9 \frac{lbf \cdot ft}{ft}$

$M_{EH2} := MH_2$ $M_{EH2} = 8271.6 \frac{lbf \cdot ft}{ft}$

Load Combination Limit States:

$\eta := 1$ LRFD Load Modifier

Strength Limit State I: EV(min) = 1.00 EV(max) = 1.35
EH(min) = 0.90 EH(max) = 1.50
LS = 1.75

Strength Limit State Ia: (Sliding and Eccentricity)	$Ia_{DC} := 0.9$	$Ia_{EV} := 1$	$Ia_{EH} := 1.5$	$Ia_{LS} := 1.75$
Strength Limit State Ib: (Bearing Capacity)	$Ib_{DC} := 1.25$	$Ib_{EV} := 1.35$	$Ib_{EH} := 1.5$	$Ib_{LS} := 1.75$

Factored Vertical Loads by Limit State:

$V_{Ia} := \eta \cdot \left(\left(Ia_{DC} \cdot V_{DC} \right) + \left(Ia_{EV} \cdot V_{EV} \right) + \left(Ia_{EH} \cdot V_{EH} \right) + \left(Ia_{LS} \cdot V_{LS\_Ia} \right) \right)$ $V_{Ia} = 8124.3 \frac{lbf}{ft}$

$V_{Ib} := \eta \cdot \left(\left(Ib_{DC} \cdot V_{DC} \right) + \left(Ib_{EV} \cdot V_{EV} \right) + \left(Ib_{EH} \cdot V_{EH} \right) + \left(Ib_{LS} \cdot V_{LS\_Ib} \right) \right)$ $V_{Ib} = 12311.3 \frac{lbf}{ft}$

Factored Horizontal Loads by Limit State:

$H_{Ia} := \eta \cdot \left(\left(Ia_{LS} \cdot H_{LS} \right) + \left(Ia_{EH} \cdot H_{EH} \right) \right)$ $H_{Ia} = 4657.4 \frac{lbf}{ft}$

$H_{Ib} := \eta \cdot \left(\left(Ib_{LS} \cdot H_{LS} \right) + \left(Ib_{EH} \cdot H_{EH} \right) \right)$ $H_{Ib} = 4657.4 \frac{lbf}{ft}$

Factored Moments Produced by Vertical Loads by Limit State:

$MV_{Ia} := \eta \cdot \left(\left(Ia_{DC} \cdot M_{DC} \right) + \left(Ia_{EV} \cdot M_{EV} \right) + \left(Ia_{EH} \cdot M_{EH1} \right) + \left(Ia_{LS} \cdot M_{LSV\_Ia} \right) \right)$ $MV_{Ia} = 30075.6 \frac{lbf \cdot ft}{ft}$

$MV_{Ib} := \eta \cdot \left(\left(Ib_{DC} \cdot M_{DC} \right) + \left(Ib_{EV} \cdot M_{EV} \right) + \left(Ib_{EH} \cdot M_{EH1} \right) + \left(Ib_{LS} \cdot M_{LSV\_Ib} \right) \right)$ $MV_{Ib} = 43860.6 \frac{lbf \cdot ft}{ft}$

Factored Moments Produced by Horizontal Loads by Limit State:

$MH_{Ia} := \eta \cdot \left(\left(Ia_{LS} \cdot M_{LSH} \right) + \left(Ia_{EH} \cdot M_{EH2} \right) \right)$ $MH_{Ia} = 20343.5 \frac{lbf \cdot ft}{ft}$

$MH_{Ib} := \eta \cdot \left(\left(Ib_{LS} \cdot M_{LSH} \right) + \left(Ib_{EH} \cdot M_{EH2} \right) \right)$ $MH_{Ib} = 20343.5 \frac{lbf \cdot ft}{ft}$

Compute Bearing Resistance:

Compute the resultant location about the toe of the base length (distance from "O") Strength Ib:

$\Sigma M_R := MV_{Ib}$ $\Sigma M_R = 43860.6 \frac{lbf \cdot ft}{ft}$ Sum of Resisting Moments (Strength Ib)

$\Sigma M_O := MH_{Ib}$ $\Sigma M_O = 20343.5 \frac{lbf \cdot ft}{ft}$ Sum of Overturning Moments (Strength Ib)

$\Sigma V := V_{Ib}$ $\Sigma V = 12311.3 \frac{lbf}{ft}$ Sum of Vertical Loads (Strength Ib)

$x := \frac{(\Sigma M_R - \Sigma M_O)}{\Sigma V}$ $x = 1.9\ ft$ Distance from Point "O" the resultant intersects the base

$e := \left| \frac{B}{2} - x \right|$ $e = 0.84\ ft$ Wall eccentricity, **Note:** The vertical stress is assumed to be uniformly distributed over the effective bearing width, B', since the wall is supported by a soil foundation **LRFD [11.6.3.2]**. The effective bearing width is equal to B-2e. When the foundation eccentricity is negative the absolute value is used.

Foundation Layout:

$B' := B - 2 \cdot e$ $B' = 3.8\ ft$ Effective Footing Width

$L' := 30\ ft$ Effective Footing Length (Assumed)

$H' := H_{Ib}$ $H' = 4657.4 \frac{lbf}{ft}$ Summation of Horizontal Loads (Strength Ib)

$V' := V_{Ib}$ $V' = 12311.3 \frac{lbf}{ft}$ Summation of Vertical Loads (Strength Ib)

$D_f = 3\ ft$ Footing embedment

$d_w := 13.75\ ft$ Depth of Groundwater below ground surface at front of wall.

Drained Conditions (Effective Stress):

$N_q := \text{if}\left(\phi'_{fd} > 0, e^{\pi \cdot \tan(\phi'_{fd})} \cdot \tan\left(45\ deg + \frac{\phi'_{fd}}{2}\right)^2, 1.0\right)$ $N_q = 20.63$

$N_c := \text{if}\left(\phi'_{fd} > 0, \frac{N_q - 1}{\tan(\phi'_{fd})}, 5.14\right)$ $N_c = 32.67$

$N_\gamma := 2 \cdot (N_q + 1) \cdot \tan(\phi'_{fd})$ $N_\gamma = 26$

Compute shape correction factors per **LRFD [Table 10.6.3.1.2a-3]**:

$s_c := \text{if}\left(\phi'_{fd} > 0, 1 + \left(\frac{B'}{L'}\right) \cdot \left(\frac{N_q}{N_c}\right), 1 + \left(\frac{B'}{5 \cdot L'}\right)\right)$ $s_c = 1.08$

$s_q := \text{if}\left(\phi'_{fd} > 0, 1 + \left(\frac{B'}{L'} \cdot \tan(\phi'_{fd})\right), 1\right)$ $s_q = 1.077$

$s_\gamma := \text{if}\left(\phi'_{fd} > 0, 1 - 0.4 \cdot \left(\frac{B'}{L'}\right), 1\right)$ $s_\gamma = 0.949$

Load inclination factors:

$i_q := 1$

$i_\gamma := 1$

$i_c := 1$

Assumed to be 1.0, see **LRFD BDS C10.6.3.1.2a**. "Most geotechnical engineers do not used the load inclination factors". If desired, use LRFD Equations [10.6.3.1.2a-5] thru [10.6.3.1.2a-9].

Compute groundwater depth correction factors per **LRFD [Table 10.6.3.1.2a-2]**:

$C_{wq} := \text{if}\left(d_w \geq D_f, 1.0, 0.5\right)$ $C_{wq} = 1$

$C_{w\gamma} := \text{if}\left(d_w \geq (1.5 \cdot B) + D_f, 1.0, 0.5\right)$ $C_{w\gamma} = 1$

Depth Correction Factor per Hanson (1970):

$$d_q := \text{if}\left(\frac{D_f}{B} \leq 1, 1 + 2 \cdot \tan\left(\phi'_{fd}\right) \cdot \left(1 - \sin\left(\phi'_{fd}\right)\right)^2 \cdot \frac{D_f}{B}, 1 + 2 \cdot \tan\left(\phi'_{fd}\right) \cdot \left(1 - \sin\left(\phi'_{fd}\right)\right)^2 \cdot \text{atan}\left(\frac{D_f}{B}\right)\right)$$

$d_q = 1.15$

Compute modified bearing capacity factors **LRFD [Equation 10.6.3.1.2a-2 to 10.6.3.1.2a-4]:**

$N_{cm} := N_c \cdot s_c \cdot i_c$ $N_{cm} = 35.298$

$N_{qm} := N_q \cdot s_q \cdot i_q$ $N_{qm} = 22.209$

$N_{\gamma m} := N_\gamma \cdot s_\gamma \cdot i_\gamma$ $N_{\gamma m} = 24.67$

Compute nominal bearing resistance, **LRFD [Eq 10.6.3.1.2a-1]:**

$q_{nd} := c'_{fd} \cdot N_{cm} + \gamma_{fd} \cdot D_f \cdot N_{qm} \cdot d_q \cdot C_{wq} + 0.5 \cdot \gamma_{fd} \cdot B' \cdot N_{\gamma m} \cdot C_{w\gamma}$ $q_{nd} = 13890.8 \ \frac{lbf}{ft^2}$

Compute factored bearing resistance, **LRFD [Eq 10.6.3.1.1]:**

$\phi_b := .55$ Bearing resistance factor **LRFD Table 11.5.7-1.**

$q_{Rd} := \phi_b \cdot q_{nd}$ $q_{Rd} = 7.6 \ ksf$ Factored bearing resistance Drained Conditions

Undrained Conditions (Effective Stress):

$$N_q := \text{if}\left(\phi_{fdu} > 0, e^{\pi \cdot \tan\left(\phi_{fdu}\right)} \cdot \tan\left(45 \ deg + \frac{\phi_{fdu}}{2}\right)^2, 1.0\right)$$ $N_q = 20.63$

$$N_c := \text{if}\left(\phi_{fdu} > 0, \frac{N_q - 1}{\tan\left(\phi_{fdu}\right)}, 5.14\right)$$ $N_c = 32.67$

$N_\gamma := 2 \cdot \left(N_q + 1\right) \cdot \tan\left(\phi_{fdu}\right)$ $N_\gamma = 26$

Compute shape correction factors per **LRFD [Table 10.6.3.1.2a-3]**:

$s_c := \text{if}\left(\phi_{fdu} > 0\,,\, 1 + \left(\frac{B'}{L'}\right)\cdot\left(\frac{N_q}{N_c}\right),\, 1 + \left(\frac{B'}{5\cdot L'}\right)\right)$ $\quad s_c = 1.08$

$s_q := \text{if}\left(\phi_{fdu} > 0\,,\, 1 + \left(\frac{B'}{L'}\cdot\tan\left(\phi_{fdu}\right)\right),\, 1\right)$ $\quad s_q = 1.077$

$s_\gamma := \text{if}\left(\phi_{fdu} > 0\,,\, 1 - 0.4\cdot\left(\frac{B'}{L'}\right),\, 1\right)$ $\quad s_\gamma = 0.949$

Load inclination factors:

$i_q := 1$

$i_\gamma := 1$

$i_c := 1$

Assumed to be 1.0, see **LRFD BDS C10.6.3.1.2a**. "Most geotechnical engineers do not used the load inclination factors". If desired, use LRFD Equations [10.6.3.1.2a-5] thru [10.6.3.1.2a-9].

Compute modified bearing capacity factors **LRFD [Equation 10.6.3.1.2a-2 to 10.6.3.1.2a-4]:**

$N_{cm} := N_c\cdot s_c\cdot i_c$ $\quad N_{cm} = 35.298$

$N_{qm} := N_q\cdot s_q\cdot i_q$ $\quad N_{qm} = 22.209$

$N_{\gamma m} := N_\gamma\cdot s_\gamma\cdot i_\gamma$ $\quad N_{\gamma m} = 24.67$

Depth Correction Factor per Hanson (1970):

$d_q := \text{if}\left(\frac{D_f}{B} \le 1\,,\, 1 + 2\cdot\tan\left(\phi_{fdu}\right)\cdot\left(1-\sin\left(\phi_{fdu}\right)\right)^2\cdot\frac{D_f}{B},\, 1 + 2\cdot\tan\left(\phi_{fdu}\right)\cdot\left(1-\sin\left(\phi_{fdu}\right)\right)^2\cdot\text{atan}\left(\frac{D_f}{B}\right)\right)$

$d_q = 1.15$

Compute nominal bearing resistance, **LRFD [Eq 10.6.3.1.2a-1:**

$q_{nu} := Su_{fdu}\cdot N_{cm} + \gamma_{fd}\cdot D_f\cdot N_{qm}\cdot d_q\cdot C_{wq} + 0.5\cdot\gamma_{fd}\cdot B'\cdot N_{\gamma m}\cdot C_{w\gamma}$ $\quad q_{nu} = 13890.8\ \frac{lbf}{ft^2}$

Compute factored bearing resistance, **LRFD [Eq 10.6.3.1.1]:**

$\phi_b := 0.55$ Bearing resistance factor **LRFD Table 11.5.7-1.**

$q_{Ru} := \phi_b\cdot q_{nu}$ $\quad q_{Ru} = 7.6\ ksf$ Factored bearing resistance Undrained Conditions

Factored Bearing Resistance Drained vs. Undrained Conditions:

Drained Conditions: $q_{Rd} = 7.6\ ksf$

Undrained Conditions: $q_{Ru} = 7.6\ ksf$

Evaluate External Stability of Wall:

Compute the ultimate bearing stress :

$e = 0.84\ ft$

$\sigma_V := \frac{\Sigma V}{B - 2 \cdot e}$ $\sigma_V = 3.222\ ksf$

Bearing Capacity:Demand Ratio (CDR)

Drained Conditions:	$CDR_{Bearing\_D} := \frac{q_{Rd}}{\sigma_V}$	Is the CDR > or = to 1.0?	$CDR_{Bearing\_D} = 2.37$
Undrained Conditions:	$CDR_{Bearing\_U} := \frac{q_{Ru}}{\sigma_V}$	Is the CDR > or = to 1.0?	$CDR_{Bearing\_U} = 2.37$

Limiting Eccentricity at Base of Wall (Strength Ia):

Compute the resultant location about the toe "O" of the base length (distance from Pivot):

$e_{max} := \frac{B}{3}$	$e_{max} = 1.8\ ft$	Maximum Eccentricity **LRFD [11.6.3.3.] Equals B/3 for soil.**
$\Sigma M_R := MV_{Ia}$	$\Sigma M_R = 30075.6\ \frac{lbf \cdot ft}{ft}$	Sum of Resisting Moments (Strength Ia)
$\Sigma M_O := MH_{Ia}$	$\Sigma M_O = 20343.5\ \frac{lbf \cdot ft}{ft}$	Sum of Overturning Moments (Strength Ia)
$\Sigma V := V_{Ia}$	$\Sigma V = 8124.3\ \frac{lbf}{ft}$	Sum of Vertical Loads (Strength Ia)
$x := \frac{(\Sigma M_R - \Sigma M_O)}{\Sigma V}$	$x = 1.2\ ft$	Distance from Point "O" the resultant intersects the base
$e := \text{abs}\left(\frac{B}{2} - x\right)$	$e = 1.55\ ft$	Wall eccentricity, **Note:** The vertical stress is assumed to be uniformly distributed over the effective bearing width, B', since the wall is supported by a soil foundation **LRFD [11.6.3.2]**. The effective bearing width is equal to B-2e. .

Eccentricity Capacity:Demand Ratio (CDR)

$CDR_{Eccentricity} := \frac{e_{max}}{e}$	Is the CDR > or = to 1.0?	$CDR_{Eccentricity} = 1.18$

Sliding Resistance at Base of Wall LRFD [10.6.3.4]:

Factored Sliding Force (Strength Ia):

$R_u := H_{Ia}$ $\quad R_u = 4657.4 \ \frac{lbf}{ft}$

Drained Conditions (Effective Stress):

Compute passive resistance throughout the design life of the wall **LRFD [Eq 3.11.5.4-1]:**:

$r_{ep1} := \left(k_{pd} \cdot \gamma_{fd} \cdot y_1 + 2 \cdot c'_{fd} \cdot \sqrt{k_{pd}}\right) \cdot \cos\left(\delta_{fd}\right)$ Nominal passive pressure at y1

$r_{ep2} := \left(k_{pd} \cdot \gamma_{fd} \cdot y_2 + 2 \cdot c'_{fd} \cdot \sqrt{k_{pd}}\right) \cdot \cos\left(\delta_{fd}\right)$ Nominal passive pressure at y2

$R_{ep} := \frac{r_{ep1} + r_{ep2}}{2} \cdot \left(y_2 - y_1\right)$ $\quad R_{ep} = 0 \ \frac{lbf}{ft}$ Nominal passive resistance Drained Conditions

416 Note: Passive Resistance shall be neglected in stability computations, unless the base of the wall extends below the depth of maximum scour, freeze-thaw or other disturbances. In the latter case, only the embedment below the greater of these depths shall be considered effective **LRFD [11.6.3.5]**.

Compute sliding resistance between soil and foundation:

$c := 1.0$ c = 1.0 for Cast-in-Place
c = 0.8 for Precast

$\Sigma V := V_{Ia}$ $\quad \Sigma V = 8124.3 \ \frac{lbf}{ft}$ Sum of Vertical Loads (Strength Ia)

$R_\tau := c \cdot \Sigma V \cdot \tan\left(\phi'_{fd}\right)$ $\quad R_\tau = 4881.6 \ \frac{lbf}{ft}$ Nominal sliding resistance Cohesionless Soils

Compute factored resistance against failure by sliding **LRFD [10.6.3.4]**:

$\phi_{ep} := 0.5$ Resistance factor for passive resistance specified in **LRFD Table 10.5.5.2.2-1**

$\phi_\tau := 1.0$ Resistance factor for sliding resistance specified in **LRFD Table 11.5.7-1.**

$\phi R_n := \phi_\tau \cdot R_\tau + \phi_{ep} \cdot R_{ep}$ $\quad R_R := \phi R_n$

Factored Sliding Resistance to be used in CDR Calculations: $R_R = 4881.582 \ \frac{lbf}{ft}$

Sliding Capacity:Demand Ratio (CDR)

$CDR_{Sliding} := \frac{R_R}{R_u}$ Is the CDR > or = to 1.0? $CDR_{Sliding} = 1.05$

Undrained Conditions (Total Stress):

Compute passive resistance throughout the design life of the wall **LRFD [Eq 3.11.5.4-1]**::

$r_{ep1} := \left(k_{pu} \cdot \gamma_{fd} \cdot y_1 + 2 \cdot Su_{fdu} \cdot \sqrt{k_{pu}}\right) \cdot \cos\left(\delta_{fd}\right)$ Nominal passive pressure at y1

$r_{ep2} := \left(k_{pu} \cdot \gamma_{fd} \cdot y_2 + 2 \cdot Su_{fdu} \cdot \sqrt{k_{pu}}\right) \cdot \cos\left(\delta_{fd}\right)$ Nominal passive pressure at y2

$R_{ep} := \frac{r_{ep1} + r_{ep2}}{2} \cdot \left(y_2 - y_1\right)$ $R_{ep} = 0 \ \frac{lbf}{ft}$ Nominal passive resistance Drained Conditions

416 Note: Passive Resistance shall be neglected in stability computations, unless the base of the wall extends below the depth of maximum scour, freeze-thaw or other disturbances. In the latter case, only the embedment below the greater of these depths shall be considered effective **LRFD [11.6.3.5]**.

Compute sliding resistance between soil and foundation:

$c := 1.0$ c = 1.0 for Cast-in-Place
c = 0.8 for Precast

$\Sigma V := V_{Ia}$ $\Sigma V = 8124.3 \ \frac{lbf}{ft}$ Sum of Vertical Loads (Strength Ia)

$e = 1.55 \ ft$ Wall eccentricity, Calculated in above Limiting Eccentricity at Base of Wall (Strength Ia) Section.

$B = 5.5 \ ft$ Footing base width

$\frac{B}{6} = 0.9 \ ft$ If e < B/6 the resultant is in the middle one-third

$\sigma_{vmax} := \frac{\Sigma V}{B} \cdot \left(1 + 6 \cdot \frac{e}{B}\right)$ $\sigma_{vmax} = 3978.3 \ \frac{lbf}{ft^2}$ Max vertical stress (if resultant is in the middle one-third of base) **LRFD [11.6.3.2-2]**.

$\sigma_{vmin} := \frac{\Sigma V}{B} \cdot \left(1 - 6 \cdot \frac{e}{B}\right)$ $\sigma_{vmin} = -1024 \ \frac{lbf}{ft^2}$ Max verical stress (if resultant is in the middle one-third of base) **LRFD [11.6.3.2-2]**.

$q_{max} := \frac{1}{2} \cdot \sigma_{vmax}$ $q_{max} = 1989.1 \ \frac{lbf}{ft^2}$ Max unit shear resistance as 1/2 max vertical stress **LRFD [10.6.3.4]**.

$q_{min} := \frac{1}{2} \cdot \sigma_{vmin}$ $q_{min} = -512 \ \frac{lbf}{ft^2}$ Minimum unit shear resistance as 1/2 minimum vertical stress **LRFD [10.6.3.4]**.

Determine which Cohesive Soil Resistance Case is Present:

$Case_1 := \text{if}\left(q_{max} > Su_{fdu} > q_{min} \geq 0, 1, 0\right)$ $Case_1 = 0$

$Case_2 := \text{if}\left(Su_{fdu} > q_{max} > q_{min} \geq 0, 1, 0\right)$ $Case_2 = 0$

$Case_3 := \text{if}\left(q_{max} > q_{min} > Su_{fdu}, 1, 0\right)$ $Case_3 = 0$

$Case_4 := \text{if}\left(q_{min} < 0, \text{if}\left(Su_{fdu} < q_{max}, 1, 0\right), 0\right)$ $Case_4 = 1$

$Case_5 := \text{if}\left(q_{min} < 0, \text{if}\left(Su_{fdu} > q_{max}, 1, 0\right), 0\right)$ $Case_5 = 0$

Unit Shear Resistance for Case 1:

$S_1 := Su_{fdu} - q_{min} = 512 \ \frac{lbf}{ft^2}$

$S_2 := q_{min} = -512 \ \frac{lbf}{ft^2}$

$B_1 := \frac{B \cdot (Su_{fdu} - q_{min})}{q_{max} - q_{min}} = 1.1 \ ft$

$B_2 := \frac{B \cdot (q_{max} - Su_{fdu})}{q_{max} - q_{min}} = 4.4 \ ft$

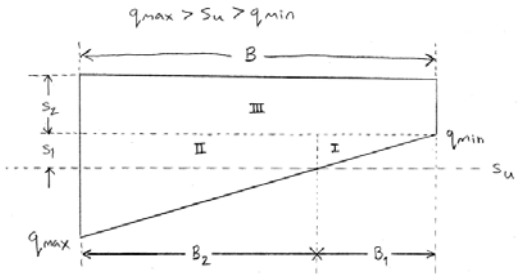
$B_3 := B = 5.5 \ ft$

$I := \frac{1}{2} \cdot S_1 \cdot B_1 = 288.2 \ \frac{lbf}{ft}$

$II := S_1 \cdot B_2 = 2239.5 \ \frac{lbf}{ft}$

$III := S_2 \cdot B_3 = -2815.9 \ \frac{lbf}{ft}$

$R_{\tau\_case1} := I + II + III = -288.2 \ \frac{lbf}{ft}$



Unit Shear Resistance for Case 2:

$S_1 := q_{max} - q_{min} = 2501.1 \ \frac{lbf}{ft^2}$

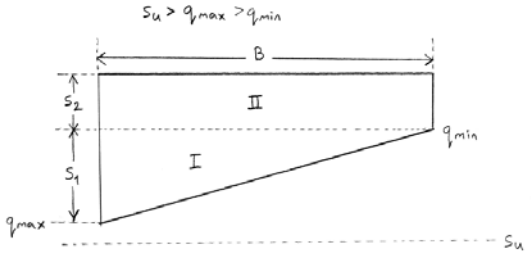
$S_2 := q_{min} = -512 \ \frac{lbf}{ft^2}$

$B = 5.5 \ ft$

$I := \frac{1}{2} \cdot S_1 \cdot B = 6878 \ \frac{lbf}{ft}$

$II := S_2 \cdot B = -2815.9 \ \frac{lbf}{ft}$

$R_{\tau\_case2} := I + II = 4062.2 \ \frac{lbf}{ft}$



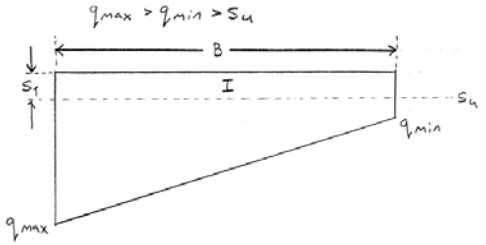
Unit Shear Resistance for Case 3:

$S_1 := Su_{fdu} = 0 \ \frac{lbf}{ft^2}$

$B = 5.5 \ ft$

$I := \frac{1}{2} \cdot S_1 \cdot B = 0 \ \frac{lbf}{ft}$

$R_{\tau\_case3} := I = 0 \ \frac{lbf}{ft}$



Unit Shear Resistance for Case 4:

$S_1 := Su_{fdu} = 0 \ \frac{lbf}{ft^2}$

$B_3 := \frac{B \cdot (-q_{min})}{q_{max} - q_{min}} = 1.1 \ ft$

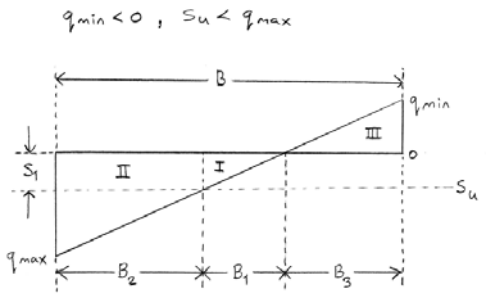
$B_1 := \left(\frac{Su_{fdu}}{q_{max}}\right) \cdot (B - B_3) = 0 \ ft$

$B_2 := B - (B_1 + B_3) = 4.4 \ ft$

$I := \frac{1}{2} \cdot S_1 \cdot B_1 = 0 \ \frac{lbf}{ft}$

$II := S_1 \cdot B_2 = 0 \ \frac{lbf}{ft}$

$R_{\tau\_case4} := I + II = 0 \ \frac{lbf}{ft}$



Unit Shear Resistance for Case 5:

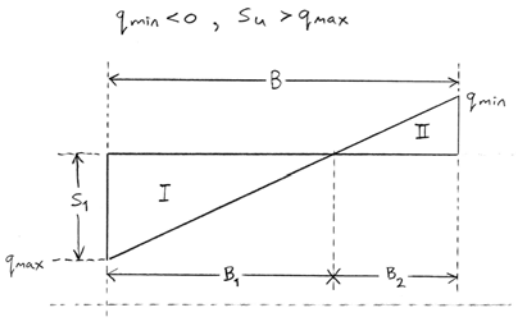
$S_1 := q_{max} = 1989.1 \ \frac{lbf}{ft^2}$

$B_1 := \frac{B \cdot q_{max}}{q_{max} - q_{min}} = 4.4 \ ft$

$B_2 := B - B_1 = 1.1 \ ft$

$I := \frac{1}{2} \cdot S_1 \cdot B_1 = 4350.4 \ \frac{lbf}{ft}$

$R_{\tau\_case5} := I = 4350.4 \ \frac{lbf}{ft}$



Define the Applicable Case:

$R_\tau := R_{\tau\_case5}$ $R_\tau = 4350.4 \ \frac{lbf}{ft}$ Nominal sliding resistance Cohesive Soils

Compute factored resistance against failure by sliding **LRFD [10.6.3.4]**:

$\phi_{ep} := 0.5$ Resistance factor for passive resistance specified in **LRFD Table 10.5.5.2.2-1**

$\phi_\tau := 1.0$ Resistance factor for sliding resistance specified in **LRFD Table 11.5.7-1.**

$\phi R_n := \phi_\tau \cdot R_\tau + \phi_{ep} \cdot R_{ep}$ $R_R := \phi R_n$

Factored Sliding Resistance to be used in CDR Calculations: $R_R = 4350.365 \ \frac{lbf}{ft}$

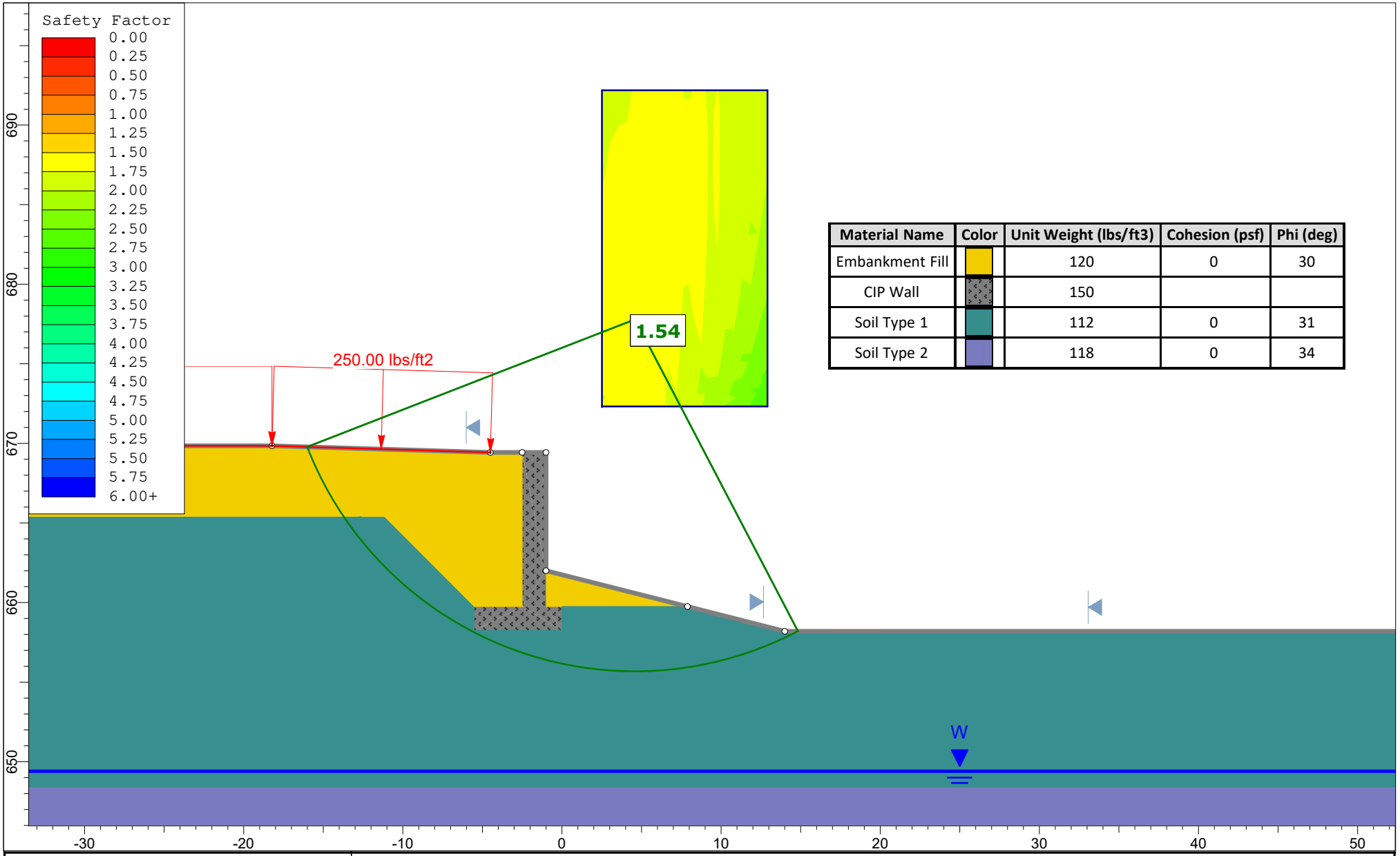
Sliding Capacity:Demand Ratio (CDR)

$CDR_{Sliding} := \frac{R_R}{R_u}$ Is the CDR > or = to 1.0? $CDR_{Sliding} = 0.93$

APPENDIX E

GLOBAL STABILITY ANALYSIS – RETAINING WALL AE (WEST)

RETAINING WALL AE – STA. 01+82

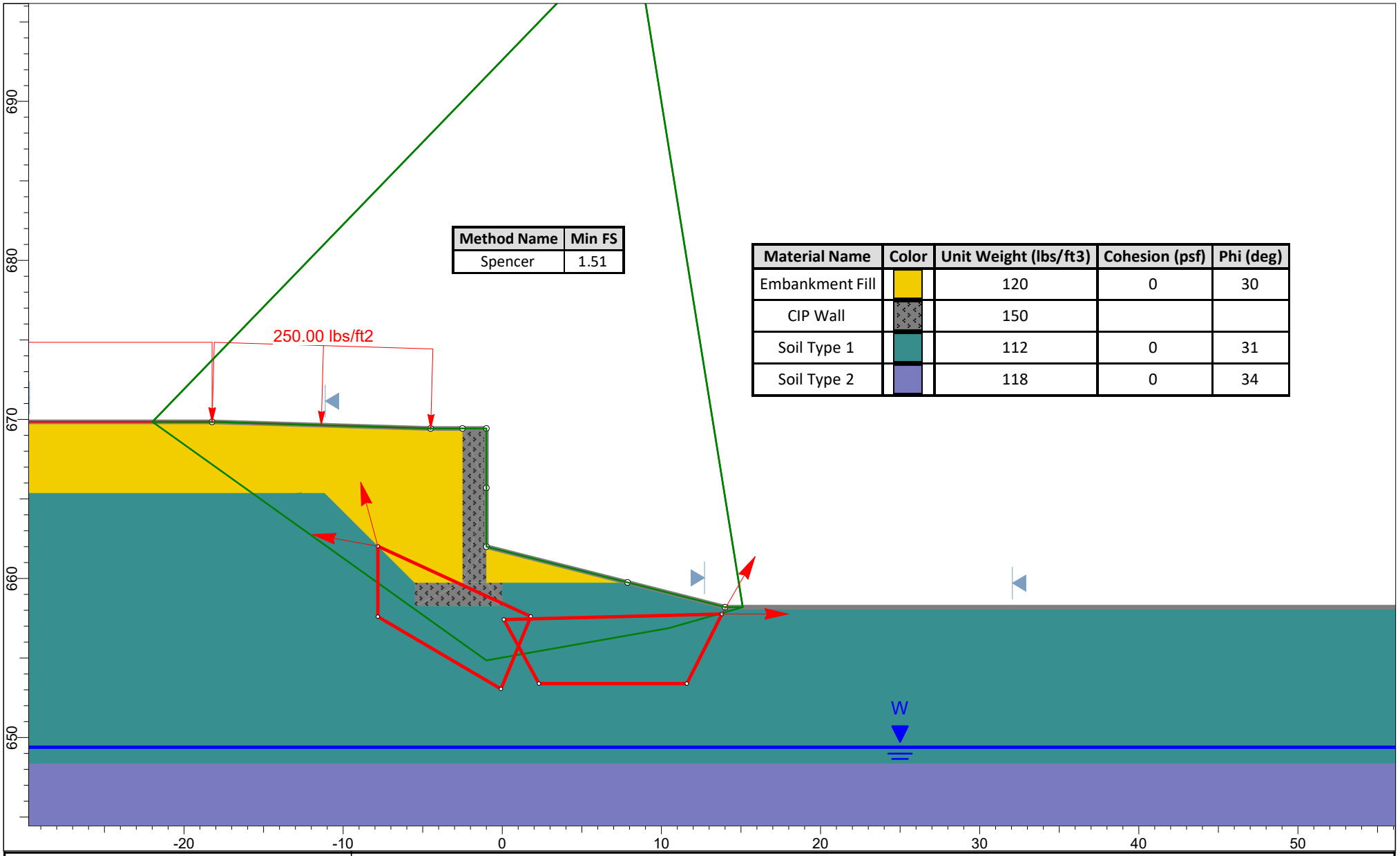


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment Fill		120	0	30
CIP Wall		150		
Soil Type 1		112	0	31
Soil Type 2		118	0	34

rocscience

SLIDEINTERPRET 9.025

Project	CUY-90-16.28 (CCG3A), PID 82380		
Analysis Description	Wall AE @ STA. 01+50, Global Stability - Effective Stress, Circular Failure		
Drawn By	KCA	*Company*	NEAS Inc.
Date	9/29/2021, 11:07:15 AM	*File Name*	WallAE_STA01+50_EffCircular011724.slim



Method Name	Min FS
Spencer	1.51

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment Fill		120	0	30
CIP Wall		150		
Soil Type 1		112	0	31
Soil Type 2		118	0	34

rocscience

SLIDEINTERPRET 9.025

Project	CUY-90-16.28 (CCG3A), PID 82380		
Analysis Description	Wall AE @ STA. 01+50, Global Stability - Effective Stress, Block Failure		
Drawn By	KCA	*Company*	NEAS Inc.
Date	9/29/2021, 11:07:15 AM	*File Name*	WallAE_STA01+50_EffBlock011724.slim

APPENDIX F

DRIVEN ANALYSIS

REAR ABUTMENT – C-086-0-14

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\BRIDGE13\RA_86-1.DVN
Project Name: CCG3A Project Date: 08/15/2023
Project Client: Michael Baker
Computed By: KCA
Project Manager: Brendan P. Andrews

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	-2.70 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	-2.70 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	21.00 ft	0.00%	125.00 pcf	33.0/33.0	Nordlund
2	Cohesive	50.50 ft	33.00%	120.00 pcf	1800.00 psf	T-80 Same
3	Cohesive	17.90 ft	50.00%	115.00 pcf	1550.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.31 psf	21.99	N/A	0.00 Kips
9.01 ft	Cohesionless	282.01 psf	21.99	N/A	4.41 Kips
18.01 ft	Cohesionless	563.71 psf	21.99	N/A	17.62 Kips
20.99 ft	Cohesionless	656.99 psf	21.99	N/A	23.94 Kips
21.01 ft	Cohesive	N/A	N/A	1357.70 psf	23.99 Kips
30.01 ft	Cohesive	N/A	N/A	1357.70 psf	53.99 Kips
39.01 ft	Cohesive	N/A	N/A	1424.16 psf	86.94 Kips
48.01 ft	Cohesive	N/A	N/A	1518.44 psf	124.67 Kips
57.01 ft	Cohesive	N/A	N/A	1612.72 psf	166.57 Kips
66.01 ft	Cohesive	N/A	N/A	1707.00 psf	212.63 Kips
71.49 ft	Cohesive	N/A	N/A	1724.35 psf	237.75 Kips
71.51 ft	Cohesive	N/A	N/A	1266.04 psf	237.81 Kips
80.51 ft	Cohesive	N/A	N/A	1266.04 psf	258.69 Kips
89.39 ft	Cohesive	N/A	N/A	1315.91 psf	280.93 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.63 psf	47.20	53.45 Kips	0.02 Kips
9.01 ft	Cohesionless	564.03 psf	47.20	53.45 Kips	18.37 Kips
18.01 ft	Cohesionless	1127.43 psf	47.20	53.45 Kips	36.73 Kips
20.99 ft	Cohesionless	1313.97 psf	47.20	53.45 Kips	42.80 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
30.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
39.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
48.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
66.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
71.49 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
71.51 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
80.51 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
89.39 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
9.01 ft	4.41 Kips	18.37 Kips	22.78 Kips
18.01 ft	17.62 Kips	36.73 Kips	54.35 Kips
20.99 ft	23.94 Kips	42.80 Kips	66.74 Kips
21.01 ft	23.99 Kips	17.32 Kips	41.31 Kips
30.01 ft	53.99 Kips	17.32 Kips	71.31 Kips
39.01 ft	86.94 Kips	17.32 Kips	104.26 Kips
48.01 ft	124.67 Kips	17.32 Kips	141.99 Kips
57.01 ft	166.57 Kips	17.32 Kips	183.88 Kips
66.01 ft	212.63 Kips	17.32 Kips	229.95 Kips
71.49 ft	237.75 Kips	17.32 Kips	255.07 Kips
71.51 ft	237.81 Kips	14.91 Kips	252.72 Kips
80.51 ft	258.69 Kips	14.91 Kips	273.60 Kips
89.39 ft	280.93 Kips	14.91 Kips	295.84 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.31 psf	21.99	N/A	0.00 Kips
9.01 ft	Cohesionless	282.01 psf	21.99	N/A	4.41 Kips
18.01 ft	Cohesionless	563.71 psf	21.99	N/A	17.62 Kips
20.99 ft	Cohesionless	656.99 psf	21.99	N/A	23.94 Kips
21.01 ft	Cohesive	N/A	N/A	1357.70 psf	24.01 Kips
30.01 ft	Cohesive	N/A	N/A	1357.70 psf	68.80 Kips
39.01 ft	Cohesive	N/A	N/A	1424.16 psf	117.97 Kips
48.01 ft	Cohesive	N/A	N/A	1518.44 psf	174.28 Kips
57.01 ft	Cohesive	N/A	N/A	1612.72 psf	236.81 Kips
66.01 ft	Cohesive	N/A	N/A	1707.00 psf	305.57 Kips
71.49 ft	Cohesive	N/A	N/A	1724.35 psf	343.06 Kips
71.51 ft	Cohesive	N/A	N/A	1266.04 psf	343.17 Kips
80.51 ft	Cohesive	N/A	N/A	1266.04 psf	384.93 Kips
89.39 ft	Cohesive	N/A	N/A	1315.91 psf	429.41 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.63 psf	47.20	53.45 Kips	0.02 Kips
9.01 ft	Cohesionless	564.03 psf	47.20	53.45 Kips	18.37 Kips
18.01 ft	Cohesionless	1127.43 psf	47.20	53.45 Kips	36.73 Kips
20.99 ft	Cohesionless	1313.97 psf	47.20	53.45 Kips	42.80 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
30.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
39.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
48.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
66.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
71.49 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
71.51 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
80.51 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
89.39 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
9.01 ft	4.41 Kips	18.37 Kips	22.78 Kips
18.01 ft	17.62 Kips	36.73 Kips	54.35 Kips
20.99 ft	23.94 Kips	42.80 Kips	66.74 Kips
21.01 ft	24.01 Kips	17.32 Kips	41.33 Kips
30.01 ft	68.80 Kips	17.32 Kips	86.12 Kips
39.01 ft	117.97 Kips	17.32 Kips	135.29 Kips
48.01 ft	174.28 Kips	17.32 Kips	191.60 Kips
57.01 ft	236.81 Kips	17.32 Kips	254.13 Kips
66.01 ft	305.57 Kips	17.32 Kips	322.88 Kips
71.49 ft	343.06 Kips	17.32 Kips	360.38 Kips
71.51 ft	343.17 Kips	14.91 Kips	358.09 Kips
80.51 ft	384.93 Kips	14.91 Kips	399.85 Kips
89.39 ft	429.41 Kips	14.91 Kips	444.32 Kips

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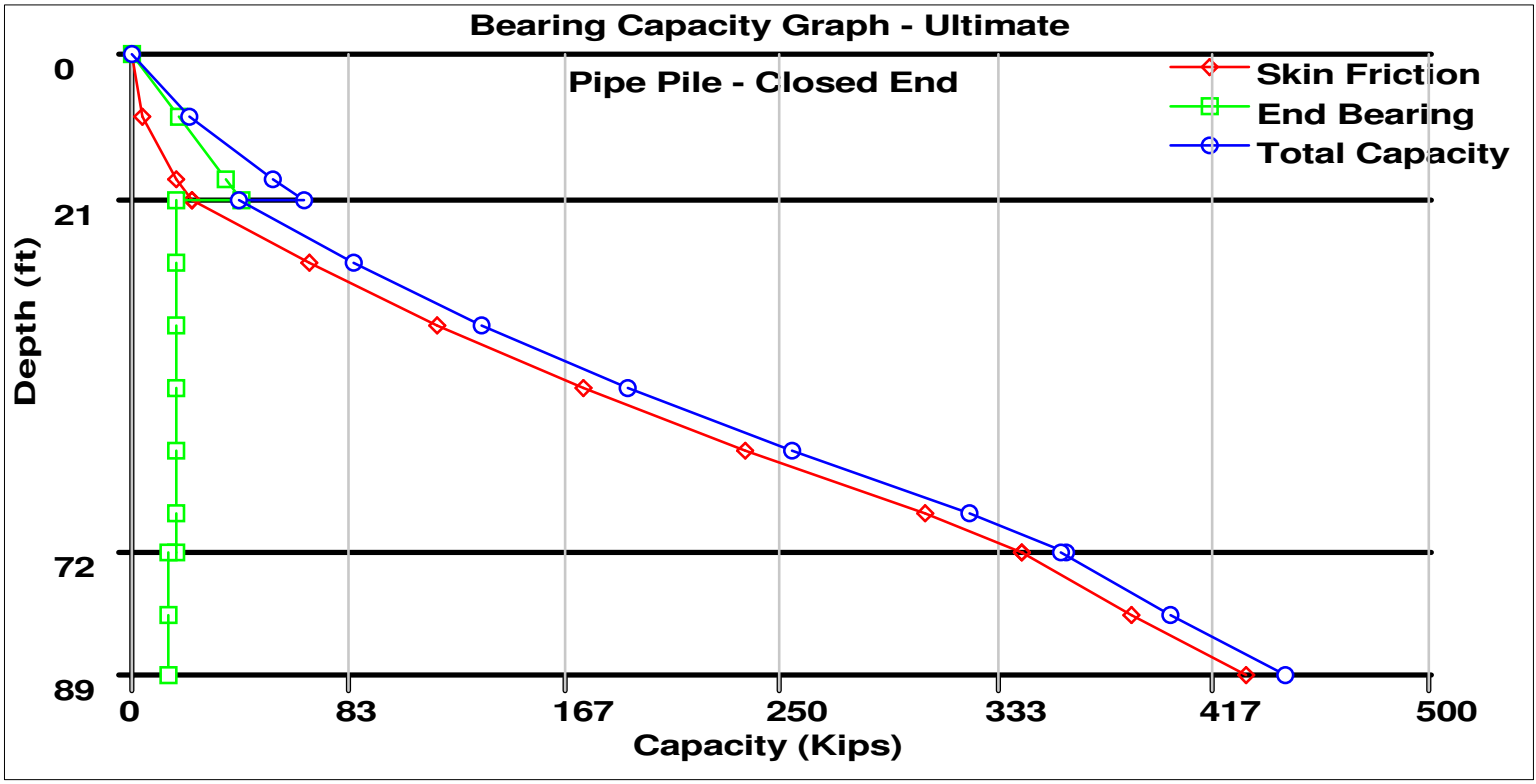

PIER 1A – B-085-2-20

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\BRIDGE13\P1A_85-2.DVN
Project Name: CCG3A Project Date: 09/27/2021
Project Client: Michael Baker
Computed By: ZM
Project Manager: Brendan P. Andrews

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

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

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	1.50 ft	0.00%	125.00 pcf	34.0/34.0	Nordlund
2	Cohesionless	13.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
3	Cohesive	5.80 ft	33.00%	128.00 pcf	3750.00 psf	T-80 Same
4	Cohesive	15.00 ft	33.00%	125.00 pcf	2500.00 psf	T-80 Same
5	Cohesive	40.00 ft	33.00%	128.00 pcf	3900.00 psf	T-80 Same
6	Cohesive	23.20 ft	33.00%	125.00 pcf	3400.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.31 psf	24.90	N/A	0.00 Kips
1.49 ft	Cohesionless	46.64 psf	24.90	N/A	0.18 Kips
1.51 ft	Cohesionless	94.19 psf	24.17	N/A	0.19 Kips
10.51 ft	Cohesionless	353.39 psf	24.17	N/A	7.75 Kips
14.49 ft	Cohesionless	468.01 psf	24.17	N/A	14.63 Kips
14.51 ft	Cohesive	N/A	N/A	892.50 psf	14.66 Kips
20.29 ft	Cohesive	N/A	N/A	892.50 psf	29.14 Kips
20.31 ft	Cohesive	N/A	N/A	1108.65 psf	29.20 Kips
29.31 ft	Cohesive	N/A	N/A	1108.65 psf	57.20 Kips
35.29 ft	Cohesive	N/A	N/A	1135.32 psf	76.93 Kips
35.31 ft	Cohesive	N/A	N/A	928.20 psf	76.99 Kips
44.31 ft	Cohesive	N/A	N/A	928.20 psf	100.44 Kips
53.31 ft	Cohesive	N/A	N/A	967.93 psf	125.89 Kips
62.31 ft	Cohesive	N/A	N/A	1044.39 psf	156.14 Kips
71.31 ft	Cohesive	N/A	N/A	1120.84 psf	190.24 Kips
75.29 ft	Cohesive	N/A	N/A	1154.65 psf	206.56 Kips
75.31 ft	Cohesive	N/A	N/A	844.97 psf	206.62 Kips
84.31 ft	Cohesive	N/A	N/A	844.97 psf	227.96 Kips
93.31 ft	Cohesive	N/A	N/A	907.05 psf	252.44 Kips
98.49 ft	Cohesive	N/A	N/A	975.81 psf	270.11 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.63 psf	55.60	102.65 Kips	0.03 Kips
1.49 ft	Cohesionless	93.27 psf	55.60	102.65 Kips	4.80 Kips
1.51 ft	Cohesionless	94.48 psf	47.20	69.81 Kips	4.02 Kips
10.51 ft	Cohesionless	612.88 psf	47.20	69.81 Kips	26.08 Kips
14.49 ft	Cohesionless	842.12 psf	47.20	69.81 Kips	35.83 Kips
14.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
20.29 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
20.31 ft	Cohesive	N/A	N/A	N/A	31.42 Kips
29.31 ft	Cohesive	N/A	N/A	N/A	31.42 Kips
35.29 ft	Cohesive	N/A	N/A	N/A	31.42 Kips
35.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
44.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
53.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
62.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
71.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
75.29 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
75.31 ft	Cohesive	N/A	N/A	N/A	42.73 Kips
84.31 ft	Cohesive	N/A	N/A	N/A	42.73 Kips
93.31 ft	Cohesive	N/A	N/A	N/A	42.73 Kips
98.49 ft	Cohesive	N/A	N/A	N/A	42.73 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.03 Kips	0.03 Kips
1.49 ft	0.18 Kips	4.80 Kips	4.98 Kips
1.51 ft	0.19 Kips	4.02 Kips	4.21 Kips
10.51 ft	7.75 Kips	26.08 Kips	33.82 Kips
14.49 ft	14.63 Kips	35.83 Kips	50.46 Kips
14.51 ft	14.66 Kips	47.12 Kips	61.79 Kips
20.29 ft	29.14 Kips	47.12 Kips	76.27 Kips
20.31 ft	29.20 Kips	31.42 Kips	60.61 Kips
29.31 ft	57.20 Kips	31.42 Kips	88.62 Kips
35.29 ft	76.93 Kips	31.42 Kips	108.34 Kips
35.31 ft	76.99 Kips	49.01 Kips	126.00 Kips
44.31 ft	100.44 Kips	49.01 Kips	149.45 Kips
53.31 ft	125.89 Kips	49.01 Kips	174.90 Kips
62.31 ft	156.14 Kips	49.01 Kips	205.14 Kips
71.31 ft	190.24 Kips	49.01 Kips	239.25 Kips
75.29 ft	206.56 Kips	49.01 Kips	255.56 Kips
75.31 ft	206.62 Kips	42.73 Kips	249.35 Kips
84.31 ft	227.96 Kips	42.73 Kips	270.69 Kips
93.31 ft	252.44 Kips	42.73 Kips	295.17 Kips
98.49 ft	270.11 Kips	42.73 Kips	312.83 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.31 psf	24.90	N/A	0.00 Kips
1.49 ft	Cohesionless	46.64 psf	24.90	N/A	0.18 Kips
1.51 ft	Cohesionless	94.19 psf	24.17	N/A	0.19 Kips
10.51 ft	Cohesionless	353.39 psf	24.17	N/A	7.75 Kips
14.49 ft	Cohesionless	468.01 psf	24.17	N/A	14.63 Kips
14.51 ft	Cohesive	N/A	N/A	892.50 psf	14.68 Kips
20.29 ft	Cohesive	N/A	N/A	892.50 psf	36.29 Kips
20.31 ft	Cohesive	N/A	N/A	1108.65 psf	36.38 Kips
29.31 ft	Cohesive	N/A	N/A	1108.65 psf	78.17 Kips
35.29 ft	Cohesive	N/A	N/A	1135.32 psf	107.62 Kips
35.31 ft	Cohesive	N/A	N/A	928.20 psf	107.71 Kips
44.31 ft	Cohesive	N/A	N/A	928.20 psf	142.70 Kips
53.31 ft	Cohesive	N/A	N/A	967.93 psf	180.69 Kips
62.31 ft	Cohesive	N/A	N/A	1044.39 psf	225.83 Kips
71.31 ft	Cohesive	N/A	N/A	1120.84 psf	276.74 Kips
75.29 ft	Cohesive	N/A	N/A	1154.65 psf	301.09 Kips
75.31 ft	Cohesive	N/A	N/A	844.97 psf	301.19 Kips
84.31 ft	Cohesive	N/A	N/A	844.97 psf	333.04 Kips
93.31 ft	Cohesive	N/A	N/A	907.05 psf	369.58 Kips
98.49 ft	Cohesive	N/A	N/A	975.81 psf	395.94 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.63 psf	55.60	102.65 Kips	0.03 Kips
1.49 ft	Cohesionless	93.27 psf	55.60	102.65 Kips	4.80 Kips
1.51 ft	Cohesionless	94.48 psf	47.20	69.81 Kips	4.02 Kips
10.51 ft	Cohesionless	612.88 psf	47.20	69.81 Kips	26.08 Kips
14.49 ft	Cohesionless	842.12 psf	47.20	69.81 Kips	35.83 Kips
14.51 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
20.29 ft	Cohesive	N/A	N/A	N/A	47.12 Kips
20.31 ft	Cohesive	N/A	N/A	N/A	31.42 Kips
29.31 ft	Cohesive	N/A	N/A	N/A	31.42 Kips
35.29 ft	Cohesive	N/A	N/A	N/A	31.42 Kips
35.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
44.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
53.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
62.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
71.31 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
75.29 ft	Cohesive	N/A	N/A	N/A	49.01 Kips
75.31 ft	Cohesive	N/A	N/A	N/A	42.73 Kips
84.31 ft	Cohesive	N/A	N/A	N/A	42.73 Kips
93.31 ft	Cohesive	N/A	N/A	N/A	42.73 Kips
98.49 ft	Cohesive	N/A	N/A	N/A	42.73 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.03 Kips	0.03 Kips
1.49 ft	0.18 Kips	4.80 Kips	4.98 Kips
1.51 ft	0.19 Kips	4.02 Kips	4.21 Kips
10.51 ft	7.75 Kips	26.08 Kips	33.82 Kips
14.49 ft	14.63 Kips	35.83 Kips	50.46 Kips
14.51 ft	14.68 Kips	47.12 Kips	61.81 Kips
20.29 ft	36.29 Kips	47.12 Kips	83.42 Kips
20.31 ft	36.38 Kips	31.42 Kips	67.79 Kips
29.31 ft	78.17 Kips	31.42 Kips	109.59 Kips
35.29 ft	107.62 Kips	31.42 Kips	139.03 Kips
35.31 ft	107.71 Kips	49.01 Kips	156.72 Kips
44.31 ft	142.70 Kips	49.01 Kips	191.71 Kips
53.31 ft	180.69 Kips	49.01 Kips	229.70 Kips
62.31 ft	225.83 Kips	49.01 Kips	274.84 Kips
71.31 ft	276.74 Kips	49.01 Kips	325.75 Kips
75.29 ft	301.09 Kips	49.01 Kips	350.10 Kips
75.31 ft	301.19 Kips	42.73 Kips	343.91 Kips
84.31 ft	333.04 Kips	42.73 Kips	375.77 Kips
93.31 ft	369.58 Kips	42.73 Kips	412.31 Kips
98.49 ft	395.94 Kips	42.73 Kips	438.67 Kips

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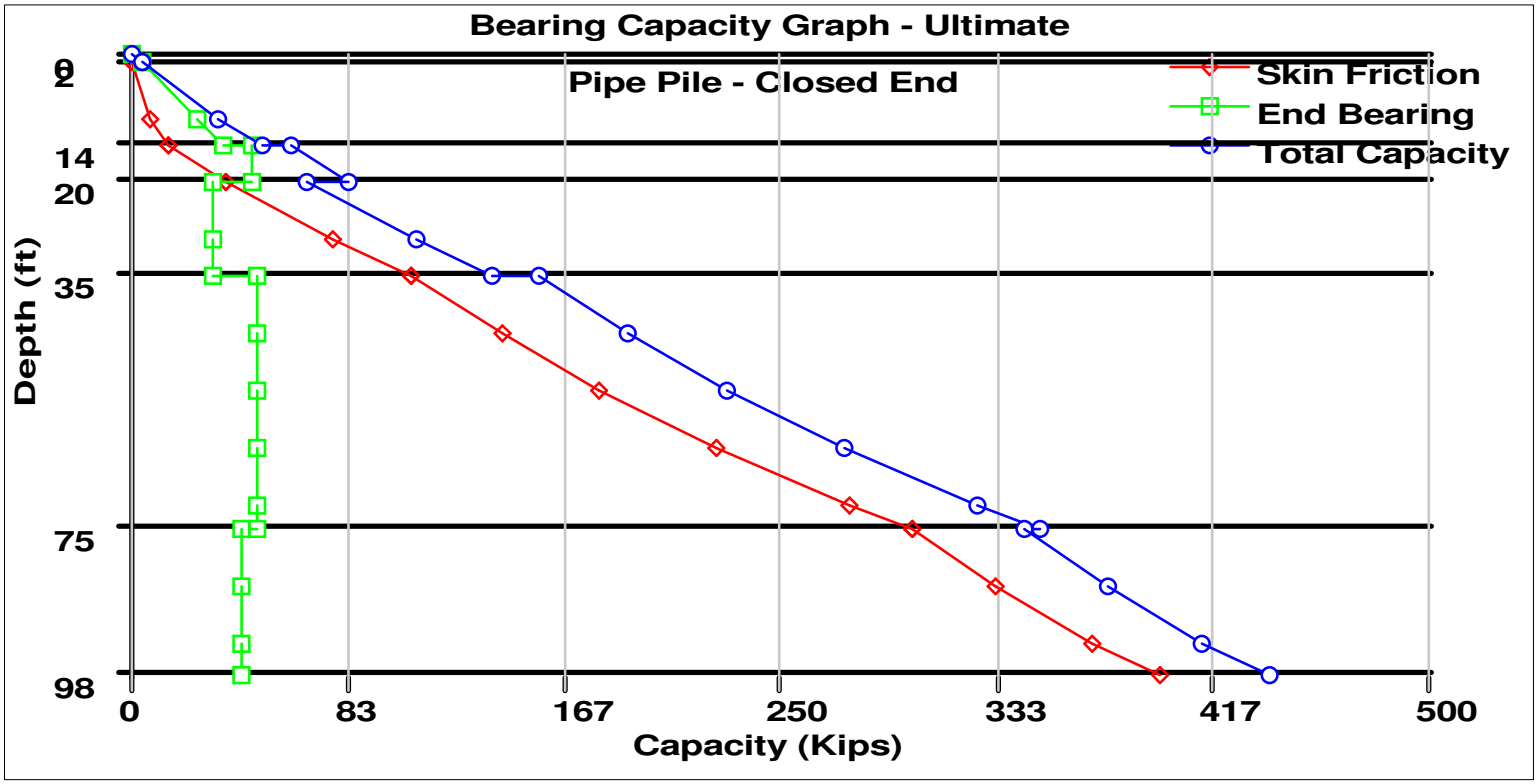

PIER 1B – B-086-1-20

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\BRIDGE13\P1B.DVN
Project Name: CCG3A Project Date: 06/21/2022
Project Client: Michael Baker International
Computed By: KCA
Project Manager: BPA

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	-6.90 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	-6.90 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	16.10 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
2	Cohesionless	2.50 ft	33.00%	115.00 pcf	29.0/29.0	Nordlund
3	Cohesive	11.30 ft	33.00%	122.00 pcf	1900.00 psf	T-80 Same
4	Cohesive	15.00 ft	33.00%	120.00 pcf	1700.00 psf	T-80 Same
5	Cohesive	25.00 ft	33.00%	125.00 pcf	3100.00 psf	T-80 Same
6	Cohesive	10.00 ft	50.00%	122.00 pcf	2250.00 psf	T-80 Same
7	Cohesive	28.20 ft	33.00%	122.00 pcf	2000.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.29 psf	24.17	N/A	0.00 Kips
9.01 ft	Cohesionless	259.49 psf	24.17	N/A	5.55 Kips
16.09 ft	Cohesionless	463.39 psf	24.17	N/A	17.71 Kips
16.11 ft	Cohesionless	927.62 psf	21.24	N/A	17.74 Kips
18.59 ft	Cohesionless	992.85 psf	21.24	N/A	20.29 Kips
18.61 ft	Cohesive	N/A	N/A	1375.66 psf	20.34 Kips
27.61 ft	Cohesive	N/A	N/A	1375.66 psf	55.09 Kips
29.89 ft	Cohesive	N/A	N/A	1375.66 psf	63.89 Kips
29.91 ft	Cohesive	N/A	N/A	1327.49 psf	63.97 Kips
38.91 ft	Cohesive	N/A	N/A	1327.49 psf	97.50 Kips
44.89 ft	Cohesive	N/A	N/A	1341.40 psf	120.36 Kips
44.91 ft	Cohesive	N/A	N/A	880.35 psf	120.43 Kips
53.91 ft	Cohesive	N/A	N/A	880.35 psf	142.66 Kips
62.91 ft	Cohesive	N/A	N/A	948.43 psf	168.34 Kips
69.89 ft	Cohesive	N/A	N/A	1050.03 psf	194.04 Kips
69.91 ft	Cohesive	N/A	N/A	1265.48 psf	194.10 Kips
78.91 ft	Cohesive	N/A	N/A	1265.48 psf	217.95 Kips
79.89 ft	Cohesive	N/A	N/A	1265.48 psf	220.55 Kips
79.91 ft	Cohesive	N/A	N/A	1375.16 psf	220.63 Kips
88.91 ft	Cohesive	N/A	N/A	1375.16 psf	255.36 Kips
97.91 ft	Cohesive	N/A	N/A	1424.89 psf	292.61 Kips
106.91 ft	Cohesive	N/A	N/A	1520.57 psf	335.85 Kips
108.09 ft	Cohesive	N/A	N/A	1533.12 psf	341.88 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.58 psf	47.20	69.81 Kips	0.02 Kips
9.01 ft	Cohesionless	518.98 psf	47.20	69.81 Kips	22.08 Kips
16.09 ft	Cohesionless	926.78 psf	47.20	69.81 Kips	39.43 Kips
16.11 ft	Cohesionless	927.89 psf	26.40	18.60 Kips	18.60 Kips
18.59 ft	Cohesionless	1058.33 psf	26.40	18.60 Kips	18.60 Kips
18.61 ft	Cohesive	N/A	N/A	N/A	23.88 Kips
27.61 ft	Cohesive	N/A	N/A	N/A	23.88 Kips
29.89 ft	Cohesive	N/A	N/A	N/A	23.88 Kips
29.91 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
38.91 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
44.89 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
44.91 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
53.91 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
62.91 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
69.89 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
69.91 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
78.91 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
79.89 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
79.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
88.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
97.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
106.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
108.09 ft	Cohesive	N/A	N/A	N/A	25.13 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
9.01 ft	5.55 Kips	22.08 Kips	27.63 Kips
16.09 ft	17.71 Kips	39.43 Kips	57.14 Kips
16.11 ft	17.74 Kips	18.60 Kips	36.33 Kips
18.59 ft	20.29 Kips	18.60 Kips	38.89 Kips
18.61 ft	20.34 Kips	23.88 Kips	44.22 Kips
27.61 ft	55.09 Kips	23.88 Kips	78.96 Kips
29.89 ft	63.89 Kips	23.88 Kips	87.77 Kips
29.91 ft	63.97 Kips	21.36 Kips	85.33 Kips
38.91 ft	97.50 Kips	21.36 Kips	118.86 Kips
44.89 ft	120.36 Kips	21.36 Kips	141.72 Kips
44.91 ft	120.43 Kips	38.96 Kips	159.38 Kips
53.91 ft	142.66 Kips	38.96 Kips	181.62 Kips
62.91 ft	168.34 Kips	38.96 Kips	207.29 Kips
69.89 ft	194.04 Kips	38.96 Kips	233.00 Kips
69.91 ft	194.10 Kips	28.27 Kips	222.37 Kips
78.91 ft	217.95 Kips	28.27 Kips	246.23 Kips
79.89 ft	220.55 Kips	28.27 Kips	248.83 Kips
79.91 ft	220.63 Kips	25.13 Kips	245.76 Kips
88.91 ft	255.36 Kips	25.13 Kips	280.49 Kips
97.91 ft	292.61 Kips	25.13 Kips	317.74 Kips
106.91 ft	335.85 Kips	25.13 Kips	360.98 Kips
108.09 ft	341.88 Kips	25.13 Kips	367.01 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.29 psf	24.17	N/A	0.00 Kips
9.01 ft	Cohesionless	259.49 psf	24.17	N/A	5.55 Kips
16.09 ft	Cohesionless	463.39 psf	24.17	N/A	17.71 Kips
16.11 ft	Cohesionless	927.62 psf	21.24	N/A	17.75 Kips
18.59 ft	Cohesionless	992.85 psf	21.24	N/A	21.56 Kips
18.61 ft	Cohesive	N/A	N/A	1375.66 psf	21.63 Kips
27.61 ft	Cohesive	N/A	N/A	1375.66 psf	73.50 Kips
29.89 ft	Cohesive	N/A	N/A	1375.66 psf	86.63 Kips
29.91 ft	Cohesive	N/A	N/A	1327.49 psf	86.75 Kips
38.91 ft	Cohesive	N/A	N/A	1327.49 psf	136.79 Kips
44.89 ft	Cohesive	N/A	N/A	1341.40 psf	170.92 Kips
44.91 ft	Cohesive	N/A	N/A	880.35 psf	171.02 Kips
53.91 ft	Cohesive	N/A	N/A	880.35 psf	204.20 Kips
62.91 ft	Cohesive	N/A	N/A	948.43 psf	242.53 Kips
69.89 ft	Cohesive	N/A	N/A	1050.03 psf	280.89 Kips
69.91 ft	Cohesive	N/A	N/A	1265.48 psf	281.01 Kips
78.91 ft	Cohesive	N/A	N/A	1265.48 psf	328.71 Kips
79.89 ft	Cohesive	N/A	N/A	1265.48 psf	333.91 Kips
79.91 ft	Cohesive	N/A	N/A	1375.16 psf	334.02 Kips
88.91 ft	Cohesive	N/A	N/A	1375.16 psf	385.86 Kips
97.91 ft	Cohesive	N/A	N/A	1424.89 psf	441.46 Kips
106.91 ft	Cohesive	N/A	N/A	1520.57 psf	506.00 Kips
108.09 ft	Cohesive	N/A	N/A	1533.12 psf	515.00 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.58 psf	47.20	69.81 Kips	0.02 Kips
9.01 ft	Cohesionless	518.98 psf	47.20	69.81 Kips	22.08 Kips
16.09 ft	Cohesionless	926.78 psf	47.20	69.81 Kips	39.43 Kips
16.11 ft	Cohesionless	927.89 psf	26.40	18.60 Kips	18.60 Kips
18.59 ft	Cohesionless	1058.33 psf	26.40	18.60 Kips	18.60 Kips
18.61 ft	Cohesive	N/A	N/A	N/A	23.88 Kips
27.61 ft	Cohesive	N/A	N/A	N/A	23.88 Kips
29.89 ft	Cohesive	N/A	N/A	N/A	23.88 Kips
29.91 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
38.91 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
44.89 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
44.91 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
53.91 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
62.91 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
69.89 ft	Cohesive	N/A	N/A	N/A	38.96 Kips
69.91 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
78.91 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
79.89 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
79.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
88.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
97.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
106.91 ft	Cohesive	N/A	N/A	N/A	25.13 Kips
108.09 ft	Cohesive	N/A	N/A	N/A	25.13 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
9.01 ft	5.55 Kips	22.08 Kips	27.63 Kips
16.09 ft	17.71 Kips	39.43 Kips	57.14 Kips
16.11 ft	17.75 Kips	18.60 Kips	36.35 Kips
18.59 ft	21.56 Kips	18.60 Kips	40.16 Kips
18.61 ft	21.63 Kips	23.88 Kips	45.51 Kips
27.61 ft	73.50 Kips	23.88 Kips	97.37 Kips
29.89 ft	86.63 Kips	23.88 Kips	110.51 Kips
29.91 ft	86.75 Kips	21.36 Kips	108.11 Kips
38.91 ft	136.79 Kips	21.36 Kips	158.16 Kips
44.89 ft	170.92 Kips	21.36 Kips	192.28 Kips
44.91 ft	171.02 Kips	38.96 Kips	209.97 Kips
53.91 ft	204.20 Kips	38.96 Kips	243.16 Kips
62.91 ft	242.53 Kips	38.96 Kips	281.48 Kips
69.89 ft	280.89 Kips	38.96 Kips	319.85 Kips
69.91 ft	281.01 Kips	28.27 Kips	309.28 Kips
78.91 ft	328.71 Kips	28.27 Kips	356.99 Kips
79.89 ft	333.91 Kips	28.27 Kips	362.18 Kips
79.91 ft	334.02 Kips	25.13 Kips	359.15 Kips
88.91 ft	385.86 Kips	25.13 Kips	410.99 Kips
97.91 ft	441.46 Kips	25.13 Kips	466.59 Kips
106.91 ft	506.00 Kips	25.13 Kips	531.13 Kips
108.09 ft	515.00 Kips	25.13 Kips	540.13 Kips

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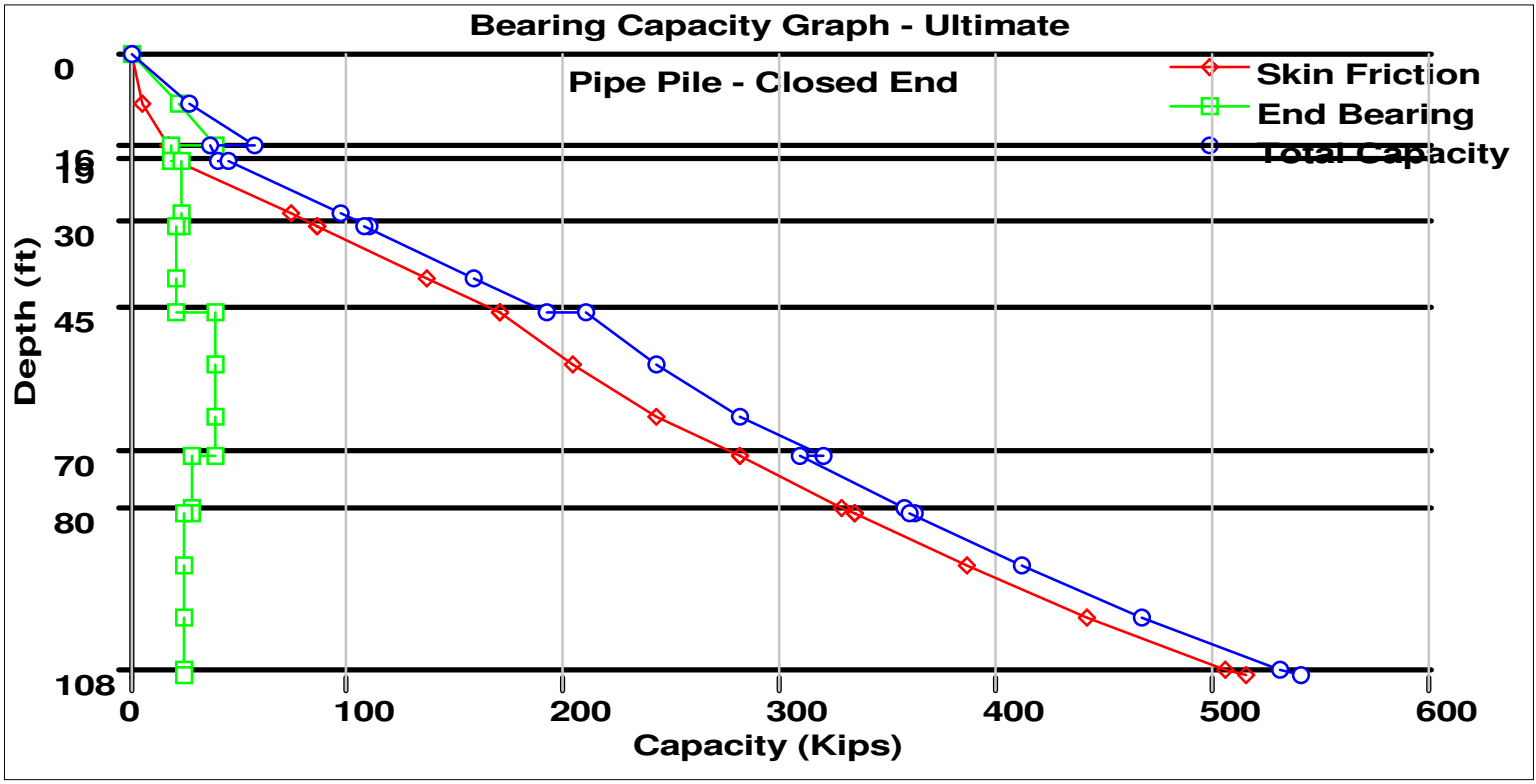

FORWARD ABUTMENT AND WING WALLS – C-087-0-14

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\BRIDGE13\FA_087.DVN
Project Name: CCG3A Project Date: 11/16/2023
Project Client: Michael Baker International
Computed By: KCA
Project Manager: BPA

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	-5.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	-5.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	15.60 ft	17.00%	125.00 pcf	35.0/35.0	Nordlund
2	Cohesive	16.00 ft	33.00%	122.00 pcf	3350.00 psf	T-80 Same
3	Cohesive	13.50 ft	33.00%	115.00 pcf	1350.00 psf	T-80 Same
4	Cohesive	28.50 ft	33.00%	120.00 pcf	2550.00 psf	T-80 Same
5	Cohesive	12.00 ft	43.00%	115.00 pcf	1050.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.31 psf	23.33	N/A	0.00 Kips
9.01 ft	Cohesionless	282.01 psf	23.33	N/A	4.38 Kips
15.59 ft	Cohesionless	487.97 psf	23.33	N/A	13.12 Kips
15.61 ft	Cohesive	N/A	N/A	842.47 psf	13.15 Kips
24.61 ft	Cohesive	N/A	N/A	842.47 psf	31.77 Kips
31.59 ft	Cohesive	N/A	N/A	909.58 psf	48.85 Kips
31.61 ft	Cohesive	N/A	N/A	1166.25 psf	48.90 Kips
40.61 ft	Cohesive	N/A	N/A	1166.25 psf	74.68 Kips
45.09 ft	Cohesive	N/A	N/A	1175.83 psf	87.83 Kips
45.11 ft	Cohesive	N/A	N/A	1080.61 psf	87.88 Kips
54.11 ft	Cohesive	N/A	N/A	1080.61 psf	111.77 Kips
63.11 ft	Cohesive	N/A	N/A	1199.71 psf	140.92 Kips
72.11 ft	Cohesive	N/A	N/A	1368.70 psf	178.64 Kips
73.59 ft	Cohesive	N/A	N/A	1396.49 psf	185.56 Kips
73.61 ft	Cohesive	N/A	N/A	960.60 psf	185.62 Kips
82.61 ft	Cohesive	N/A	N/A	960.60 psf	203.68 Kips
85.59 ft	Cohesive	N/A	N/A	961.42 psf	209.68 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.63 psf	64.00	115.03 Kips	0.03 Kips
9.01 ft	Cohesionless	564.03 psf	64.00	115.03 Kips	26.24 Kips
15.59 ft	Cohesionless	975.93 psf	64.00	115.03 Kips	45.40 Kips
15.61 ft	Cohesive	N/A	N/A	N/A	32.23 Kips
24.61 ft	Cohesive	N/A	N/A	N/A	32.23 Kips
31.59 ft	Cohesive	N/A	N/A	N/A	32.23 Kips
31.61 ft	Cohesive	N/A	N/A	N/A	12.99 Kips
40.61 ft	Cohesive	N/A	N/A	N/A	12.99 Kips
45.09 ft	Cohesive	N/A	N/A	N/A	12.99 Kips
45.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
54.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
63.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
72.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
73.59 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
73.61 ft	Cohesive	N/A	N/A	N/A	10.10 Kips
82.61 ft	Cohesive	N/A	N/A	N/A	10.10 Kips
85.59 ft	Cohesive	N/A	N/A	N/A	10.10 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.03 Kips	0.03 Kips
9.01 ft	4.38 Kips	26.24 Kips	30.62 Kips
15.59 ft	13.12 Kips	45.40 Kips	58.52 Kips
15.61 ft	13.15 Kips	32.23 Kips	45.38 Kips
24.61 ft	31.77 Kips	32.23 Kips	64.00 Kips
31.59 ft	48.85 Kips	32.23 Kips	81.08 Kips
31.61 ft	48.90 Kips	12.99 Kips	61.89 Kips
40.61 ft	74.68 Kips	12.99 Kips	87.67 Kips
45.09 ft	87.83 Kips	12.99 Kips	100.81 Kips
45.11 ft	87.88 Kips	24.53 Kips	112.42 Kips
54.11 ft	111.77 Kips	24.53 Kips	136.30 Kips
63.11 ft	140.92 Kips	24.53 Kips	165.45 Kips
72.11 ft	178.64 Kips	24.53 Kips	203.17 Kips
73.59 ft	185.56 Kips	24.53 Kips	210.09 Kips
73.61 ft	185.62 Kips	10.10 Kips	195.72 Kips
82.61 ft	203.68 Kips	10.10 Kips	213.78 Kips
85.59 ft	209.68 Kips	10.10 Kips	219.78 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.31 psf	23.33	N/A	0.00 Kips
9.01 ft	Cohesionless	282.01 psf	23.33	N/A	5.28 Kips
15.59 ft	Cohesionless	487.97 psf	23.33	N/A	15.80 Kips
15.61 ft	Cohesive	N/A	N/A	842.47 psf	15.85 Kips
24.61 ft	Cohesive	N/A	N/A	842.47 psf	43.64 Kips
31.59 ft	Cohesive	N/A	N/A	909.58 psf	69.13 Kips
31.61 ft	Cohesive	N/A	N/A	1166.25 psf	69.22 Kips
40.61 ft	Cohesive	N/A	N/A	1166.25 psf	107.69 Kips
45.09 ft	Cohesive	N/A	N/A	1175.83 psf	127.31 Kips
45.11 ft	Cohesive	N/A	N/A	1080.61 psf	127.40 Kips
54.11 ft	Cohesive	N/A	N/A	1080.61 psf	163.04 Kips
63.11 ft	Cohesive	N/A	N/A	1199.71 psf	206.55 Kips
72.11 ft	Cohesive	N/A	N/A	1368.70 psf	262.85 Kips
73.59 ft	Cohesive	N/A	N/A	1396.49 psf	273.18 Kips
73.61 ft	Cohesive	N/A	N/A	960.60 psf	273.28 Kips
82.61 ft	Cohesive	N/A	N/A	960.60 psf	304.97 Kips
85.59 ft	Cohesive	N/A	N/A	961.42 psf	315.50 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.63 psf	64.00	115.03 Kips	0.03 Kips
9.01 ft	Cohesionless	564.03 psf	64.00	115.03 Kips	26.24 Kips
15.59 ft	Cohesionless	975.93 psf	64.00	115.03 Kips	45.40 Kips
15.61 ft	Cohesive	N/A	N/A	N/A	32.23 Kips
24.61 ft	Cohesive	N/A	N/A	N/A	32.23 Kips
31.59 ft	Cohesive	N/A	N/A	N/A	32.23 Kips
31.61 ft	Cohesive	N/A	N/A	N/A	12.99 Kips
40.61 ft	Cohesive	N/A	N/A	N/A	12.99 Kips
45.09 ft	Cohesive	N/A	N/A	N/A	12.99 Kips
45.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
54.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
63.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
72.11 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
73.59 ft	Cohesive	N/A	N/A	N/A	24.53 Kips
73.61 ft	Cohesive	N/A	N/A	N/A	10.10 Kips
82.61 ft	Cohesive	N/A	N/A	N/A	10.10 Kips
85.59 ft	Cohesive	N/A	N/A	N/A	10.10 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.03 Kips	0.03 Kips
9.01 ft	5.28 Kips	26.24 Kips	31.52 Kips
15.59 ft	15.80 Kips	45.40 Kips	61.21 Kips
15.61 ft	15.85 Kips	32.23 Kips	48.09 Kips
24.61 ft	43.64 Kips	32.23 Kips	75.88 Kips
31.59 ft	69.13 Kips	32.23 Kips	101.36 Kips
31.61 ft	69.22 Kips	12.99 Kips	82.20 Kips
40.61 ft	107.69 Kips	12.99 Kips	120.68 Kips
45.09 ft	127.31 Kips	12.99 Kips	140.30 Kips
45.11 ft	127.40 Kips	24.53 Kips	151.93 Kips
54.11 ft	163.04 Kips	24.53 Kips	187.57 Kips
63.11 ft	206.55 Kips	24.53 Kips	231.08 Kips
72.11 ft	262.85 Kips	24.53 Kips	287.39 Kips
73.59 ft	273.18 Kips	24.53 Kips	297.71 Kips
73.61 ft	273.28 Kips	10.10 Kips	283.39 Kips
82.61 ft	304.97 Kips	10.10 Kips	315.07 Kips
85.59 ft	315.50 Kips	10.10 Kips	325.60 Kips

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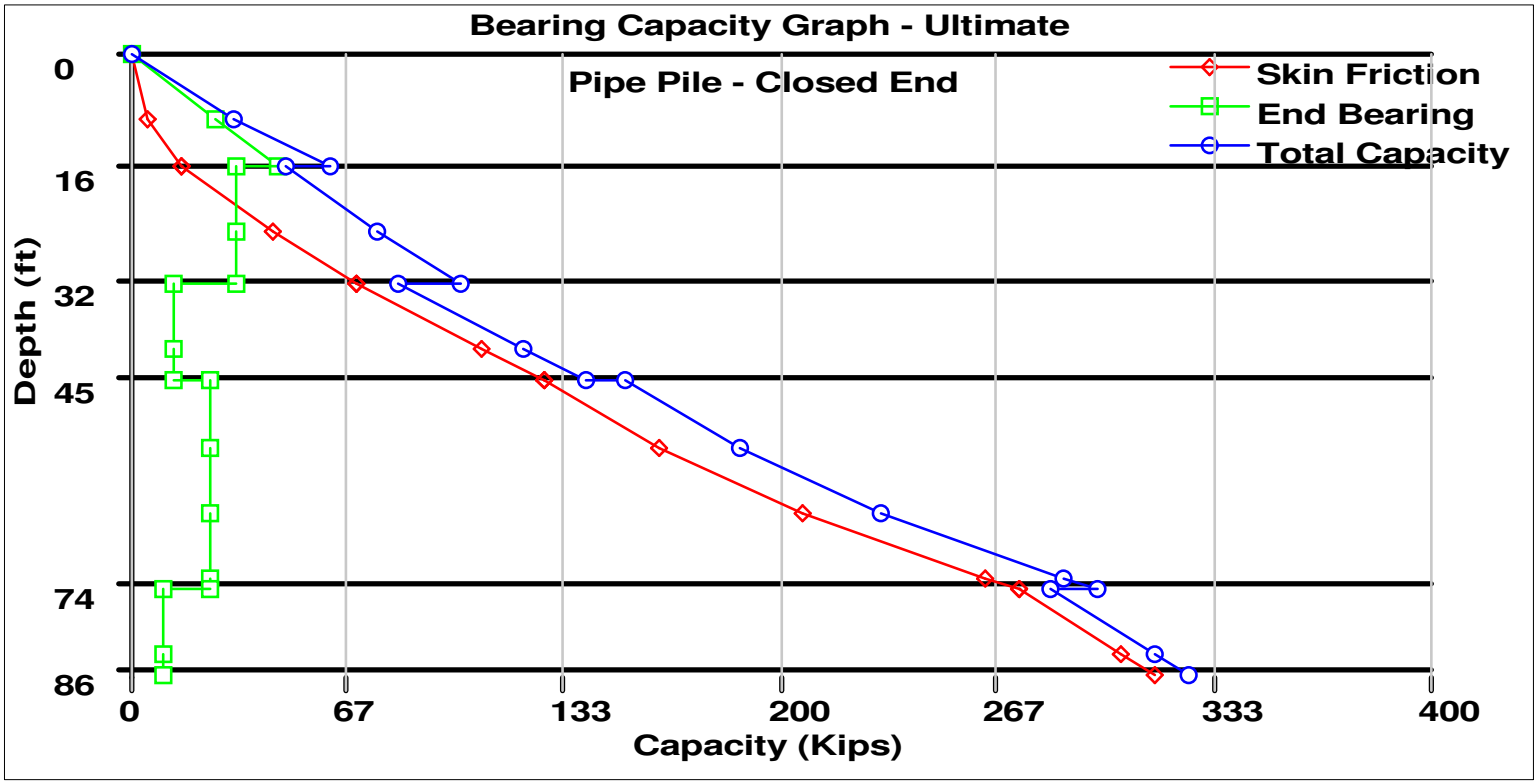

WALL AG - STA. 500+39.4 TO STA. 500+99.4 – B-002-D-06

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\WALLAG\AG1_2-~1.DVN
Project Name: CCG3A Project Date: 00/00/ 0
Project Client: Michael Baker
Computed By: KCA
Project Manager: Brendan P. Andrews

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	19.10 ft
	- Driving/Restrike	19.10 ft
	- Ultimate:	19.10 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	2.50 ft	0.00%	125.00 pcf	33.0/33.0	Nordlund
2	Cohesionless	5.00 ft	0.00%	110.00 pcf	29.0/29.0	Nordlund
3	Cohesionless	36.50 ft	0.00%	125.00 pcf	33.0/33.0	Nordlund
4	Cohesive	52.30 ft	33.00%	128.00 pcf	2200.00 psf	T-80 Same
5	Cohesive	28.20 ft	50.00%	122.00 pcf	1550.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.62 psf	21.99	N/A	0.00 Kips
2.49 ft	Cohesionless	155.62 psf	21.99	N/A	0.67 Kips
2.51 ft	Cohesionless	313.05 psf	19.33	N/A	0.68 Kips
7.49 ft	Cohesionless	586.95 psf	19.33	N/A	4.05 Kips
7.51 ft	Cohesionless	863.12 psf	21.99	N/A	4.08 Kips
16.51 ft	Cohesionless	1425.62 psf	21.99	N/A	26.36 Kips
19.09 ft	Cohesionless	1586.88 psf	21.99	N/A	35.99 Kips
19.11 ft	Cohesionless	2312.81 psf	21.99	N/A	36.07 Kips
28.11 ft	Cohesionless	2594.51 psf	21.99	N/A	76.61 Kips
37.11 ft	Cohesionless	2876.21 psf	21.99	N/A	125.96 Kips
43.99 ft	Cohesionless	3091.56 psf	21.99	N/A	169.61 Kips
44.01 ft	Cohesive	N/A	N/A	1299.08 psf	169.69 Kips
53.01 ft	Cohesive	N/A	N/A	1299.08 psf	198.40 Kips
62.01 ft	Cohesive	N/A	N/A	1390.17 psf	231.14 Kips
71.01 ft	Cohesive	N/A	N/A	1519.41 psf	270.44 Kips
80.01 ft	Cohesive	N/A	N/A	1648.65 psf	315.45 Kips
89.01 ft	Cohesive	N/A	N/A	1777.89 psf	366.17 Kips
96.29 ft	Cohesive	N/A	N/A	1801.68 psf	401.01 Kips
96.31 ft	Cohesive	N/A	N/A	1266.04 psf	401.06 Kips
105.31 ft	Cohesive	N/A	N/A	1266.04 psf	421.94 Kips
114.31 ft	Cohesive	N/A	N/A	1316.87 psf	444.50 Kips
123.31 ft	Cohesive	N/A	N/A	1388.98 psf	469.79 Kips
124.49 ft	Cohesive	N/A	N/A	1398.44 psf	473.28 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.25 psf	47.20	53.45 Kips	0.04 Kips
2.49 ft	Cohesionless	311.25 psf	47.20	53.45 Kips	10.14 Kips
2.51 ft	Cohesionless	313.60 psf	26.40	14.24 Kips	4.94 Kips
7.49 ft	Cohesionless	861.40 psf	26.40	14.24 Kips	13.57 Kips
7.51 ft	Cohesionless	863.75 psf	47.20	53.45 Kips	28.14 Kips
16.51 ft	Cohesionless	1988.75 psf	47.20	53.45 Kips	53.45 Kips
19.09 ft	Cohesionless	2311.25 psf	47.20	53.45 Kips	53.45 Kips
19.11 ft	Cohesionless	2313.13 psf	47.20	53.45 Kips	53.45 Kips
28.11 ft	Cohesionless	2876.53 psf	47.20	53.45 Kips	53.45 Kips
37.11 ft	Cohesionless	3439.93 psf	47.20	53.45 Kips	53.45 Kips
43.99 ft	Cohesionless	3870.61 psf	47.20	53.45 Kips	53.45 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
62.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
71.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
80.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
89.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
96.29 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
96.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
105.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
114.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
123.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
124.49 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
2.49 ft	0.67 Kips	10.14 Kips	10.81 Kips
2.51 ft	0.68 Kips	4.94 Kips	5.62 Kips
7.49 ft	4.05 Kips	13.57 Kips	17.62 Kips
7.51 ft	4.08 Kips	28.14 Kips	32.22 Kips
16.51 ft	26.36 Kips	53.45 Kips	79.81 Kips
19.09 ft	35.99 Kips	53.45 Kips	89.44 Kips
19.11 ft	36.07 Kips	53.45 Kips	89.52 Kips
28.11 ft	76.61 Kips	53.45 Kips	130.06 Kips
37.11 ft	125.96 Kips	53.45 Kips	179.41 Kips
43.99 ft	169.61 Kips	53.45 Kips	223.06 Kips
44.01 ft	169.69 Kips	21.17 Kips	190.86 Kips
53.01 ft	198.40 Kips	21.17 Kips	219.57 Kips
62.01 ft	231.14 Kips	21.17 Kips	252.31 Kips
71.01 ft	270.44 Kips	21.17 Kips	291.60 Kips
80.01 ft	315.45 Kips	21.17 Kips	336.61 Kips
89.01 ft	366.17 Kips	21.17 Kips	387.33 Kips
96.29 ft	401.01 Kips	21.17 Kips	422.17 Kips
96.31 ft	401.06 Kips	14.91 Kips	415.97 Kips
105.31 ft	421.94 Kips	14.91 Kips	436.86 Kips
114.31 ft	444.50 Kips	14.91 Kips	459.41 Kips
123.31 ft	469.79 Kips	14.91 Kips	484.70 Kips
124.49 ft	473.28 Kips	14.91 Kips	488.20 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.62 psf	21.99	N/A	0.00 Kips
2.49 ft	Cohesionless	155.62 psf	21.99	N/A	0.67 Kips
2.51 ft	Cohesionless	313.05 psf	19.33	N/A	0.68 Kips
7.49 ft	Cohesionless	586.95 psf	19.33	N/A	4.05 Kips
7.51 ft	Cohesionless	863.12 psf	21.99	N/A	4.08 Kips
16.51 ft	Cohesionless	1425.62 psf	21.99	N/A	26.36 Kips
19.09 ft	Cohesionless	1586.88 psf	21.99	N/A	35.99 Kips
19.11 ft	Cohesionless	2312.81 psf	21.99	N/A	36.07 Kips
28.11 ft	Cohesionless	2594.51 psf	21.99	N/A	76.61 Kips
37.11 ft	Cohesionless	2876.21 psf	21.99	N/A	125.96 Kips
43.99 ft	Cohesionless	3091.56 psf	21.99	N/A	169.61 Kips
44.01 ft	Cohesive	N/A	N/A	1299.08 psf	169.73 Kips
53.01 ft	Cohesive	N/A	N/A	1299.08 psf	212.58 Kips
62.01 ft	Cohesive	N/A	N/A	1390.17 psf	261.44 Kips
71.01 ft	Cohesive	N/A	N/A	1519.41 psf	320.10 Kips
80.01 ft	Cohesive	N/A	N/A	1648.65 psf	387.27 Kips
89.01 ft	Cohesive	N/A	N/A	1777.89 psf	462.98 Kips
96.29 ft	Cohesive	N/A	N/A	1801.68 psf	514.98 Kips
96.31 ft	Cohesive	N/A	N/A	1266.04 psf	515.09 Kips
105.31 ft	Cohesive	N/A	N/A	1266.04 psf	556.85 Kips
114.31 ft	Cohesive	N/A	N/A	1316.87 psf	601.97 Kips
123.31 ft	Cohesive	N/A	N/A	1388.98 psf	652.55 Kips
124.49 ft	Cohesive	N/A	N/A	1398.44 psf	659.53 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.25 psf	47.20	53.45 Kips	0.04 Kips
2.49 ft	Cohesionless	311.25 psf	47.20	53.45 Kips	10.14 Kips
2.51 ft	Cohesionless	313.60 psf	26.40	14.24 Kips	4.94 Kips
7.49 ft	Cohesionless	861.40 psf	26.40	14.24 Kips	13.57 Kips
7.51 ft	Cohesionless	863.75 psf	47.20	53.45 Kips	28.14 Kips
16.51 ft	Cohesionless	1988.75 psf	47.20	53.45 Kips	53.45 Kips
19.09 ft	Cohesionless	2311.25 psf	47.20	53.45 Kips	53.45 Kips
19.11 ft	Cohesionless	2313.13 psf	47.20	53.45 Kips	53.45 Kips
28.11 ft	Cohesionless	2876.53 psf	47.20	53.45 Kips	53.45 Kips
37.11 ft	Cohesionless	3439.93 psf	47.20	53.45 Kips	53.45 Kips
43.99 ft	Cohesionless	3870.61 psf	47.20	53.45 Kips	53.45 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
62.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
71.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
80.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
89.01 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
96.29 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
96.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
105.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
114.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
123.31 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
124.49 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
2.49 ft	0.67 Kips	10.14 Kips	10.81 Kips
2.51 ft	0.68 Kips	4.94 Kips	5.62 Kips
7.49 ft	4.05 Kips	13.57 Kips	17.62 Kips
7.51 ft	4.08 Kips	28.14 Kips	32.22 Kips
16.51 ft	26.36 Kips	53.45 Kips	79.81 Kips
19.09 ft	35.99 Kips	53.45 Kips	89.44 Kips
19.11 ft	36.07 Kips	53.45 Kips	89.52 Kips
28.11 ft	76.61 Kips	53.45 Kips	130.06 Kips
37.11 ft	125.96 Kips	53.45 Kips	179.41 Kips
43.99 ft	169.61 Kips	53.45 Kips	223.06 Kips
44.01 ft	169.73 Kips	21.17 Kips	190.89 Kips
53.01 ft	212.58 Kips	21.17 Kips	233.75 Kips
62.01 ft	261.44 Kips	21.17 Kips	282.61 Kips
71.01 ft	320.10 Kips	21.17 Kips	341.26 Kips
80.01 ft	387.27 Kips	21.17 Kips	408.44 Kips
89.01 ft	462.98 Kips	21.17 Kips	484.14 Kips
96.29 ft	514.98 Kips	21.17 Kips	536.14 Kips
96.31 ft	515.09 Kips	14.91 Kips	530.00 Kips
105.31 ft	556.85 Kips	14.91 Kips	571.76 Kips
114.31 ft	601.97 Kips	14.91 Kips	616.88 Kips
123.31 ft	652.55 Kips	14.91 Kips	667.46 Kips
124.49 ft	659.53 Kips	14.91 Kips	674.44 Kips

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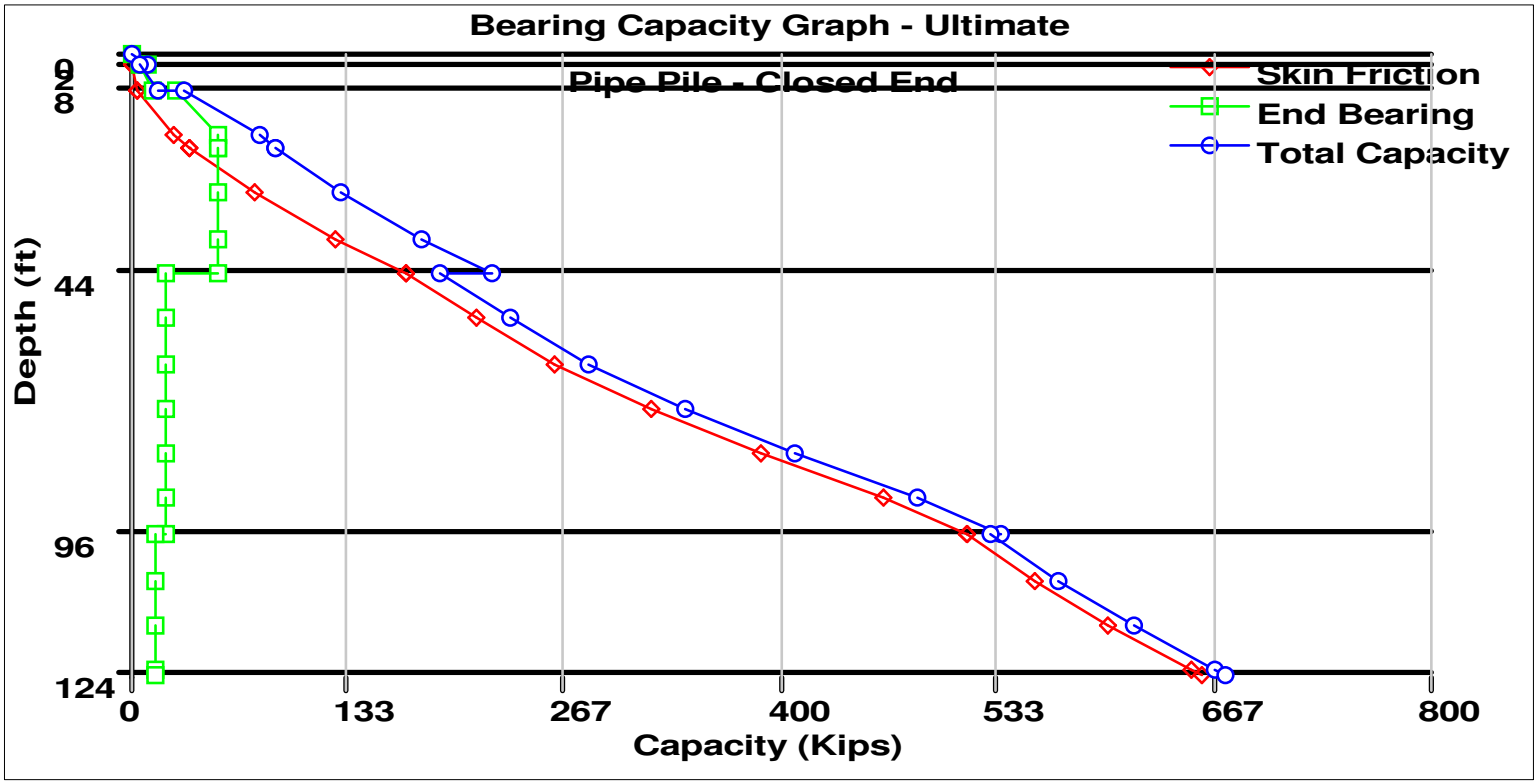

WALL AG - STA. 500+99.4 TO STA. 501+59.4 – B-002-D-06

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\WALLAG\AG1_2-~1.DVN
Project Name: CCG3A Project Date: 12/07/2023
Project Client: Michael Baker
Computed By: KCA
Project Manager: Brendan P. Andrews

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	15.60 ft
	- Driving/Restrike	15.60 ft
	- Ultimate:	15.60 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.00 ft	0.00%	110.00 pcf	29.0/29.0	Nordlund
2	Cohesionless	36.50 ft	0.00%	125.00 pcf	33.0/33.0	Nordlund
3	Cohesive	52.30 ft	33.00%	128.00 pcf	2200.00 psf	T-80 Same
4	Cohesive	28.20 ft	50.00%	122.00 pcf	1550.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.55 psf	19.33	N/A	0.00 Kips
3.99 ft	Cohesionless	219.45 psf	19.33	N/A	1.01 Kips
4.01 ft	Cohesionless	440.62 psf	21.99	N/A	1.02 Kips
13.01 ft	Cohesionless	1003.12 psf	21.99	N/A	16.70 Kips
15.59 ft	Cohesionless	1164.38 psf	21.99	N/A	24.44 Kips
15.61 ft	Cohesionless	1890.31 psf	21.99	N/A	24.51 Kips
24.61 ft	Cohesionless	2172.01 psf	21.99	N/A	58.45 Kips
33.61 ft	Cohesionless	2453.71 psf	21.99	N/A	101.19 Kips
40.49 ft	Cohesionless	2669.06 psf	21.99	N/A	139.80 Kips
40.51 ft	Cohesive	N/A	N/A	1299.08 psf	139.87 Kips
49.51 ft	Cohesive	N/A	N/A	1299.08 psf	168.58 Kips
58.51 ft	Cohesive	N/A	N/A	1390.17 psf	201.32 Kips
67.51 ft	Cohesive	N/A	N/A	1519.41 psf	240.62 Kips
76.51 ft	Cohesive	N/A	N/A	1648.65 psf	285.63 Kips
85.51 ft	Cohesive	N/A	N/A	1777.89 psf	336.35 Kips
92.79 ft	Cohesive	N/A	N/A	1801.68 psf	371.19 Kips
92.81 ft	Cohesive	N/A	N/A	1266.04 psf	371.24 Kips
101.81 ft	Cohesive	N/A	N/A	1266.04 psf	392.12 Kips
110.81 ft	Cohesive	N/A	N/A	1316.87 psf	414.68 Kips
119.81 ft	Cohesive	N/A	N/A	1388.98 psf	439.97 Kips
120.99 ft	Cohesive	N/A	N/A	1398.44 psf	443.46 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.10 psf	26.40	14.24 Kips	0.02 Kips
3.99 ft	Cohesionless	438.90 psf	26.40	14.24 Kips	6.91 Kips
4.01 ft	Cohesionless	441.25 psf	47.20	53.45 Kips	14.37 Kips
13.01 ft	Cohesionless	1566.25 psf	47.20	53.45 Kips	51.02 Kips
15.59 ft	Cohesionless	1888.75 psf	47.20	53.45 Kips	53.45 Kips
15.61 ft	Cohesionless	1890.63 psf	47.20	53.45 Kips	53.45 Kips
24.61 ft	Cohesionless	2454.03 psf	47.20	53.45 Kips	53.45 Kips
33.61 ft	Cohesionless	3017.43 psf	47.20	53.45 Kips	53.45 Kips
40.49 ft	Cohesionless	3448.11 psf	47.20	53.45 Kips	53.45 Kips
40.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
49.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
58.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
67.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
92.79 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
92.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
101.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
110.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
119.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
120.99 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
3.99 ft	1.01 Kips	6.91 Kips	7.92 Kips
4.01 ft	1.02 Kips	14.37 Kips	15.40 Kips
13.01 ft	16.70 Kips	51.02 Kips	67.73 Kips
15.59 ft	24.44 Kips	53.45 Kips	77.89 Kips
15.61 ft	24.51 Kips	53.45 Kips	77.96 Kips
24.61 ft	58.45 Kips	53.45 Kips	111.90 Kips
33.61 ft	101.19 Kips	53.45 Kips	154.64 Kips
40.49 ft	139.80 Kips	53.45 Kips	193.25 Kips
40.51 ft	139.87 Kips	21.17 Kips	161.04 Kips
49.51 ft	168.58 Kips	21.17 Kips	189.75 Kips
58.51 ft	201.32 Kips	21.17 Kips	222.49 Kips
67.51 ft	240.62 Kips	21.17 Kips	261.78 Kips
76.51 ft	285.63 Kips	21.17 Kips	306.79 Kips
85.51 ft	336.35 Kips	21.17 Kips	357.51 Kips
92.79 ft	371.19 Kips	21.17 Kips	392.35 Kips
92.81 ft	371.24 Kips	14.91 Kips	386.16 Kips
101.81 ft	392.12 Kips	14.91 Kips	407.04 Kips
110.81 ft	414.68 Kips	14.91 Kips	429.60 Kips
119.81 ft	439.97 Kips	14.91 Kips	454.89 Kips
120.99 ft	443.46 Kips	14.91 Kips	458.38 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.55 psf	19.33	N/A	0.00 Kips
3.99 ft	Cohesionless	219.45 psf	19.33	N/A	1.01 Kips
4.01 ft	Cohesionless	440.62 psf	21.99	N/A	1.02 Kips
13.01 ft	Cohesionless	1003.12 psf	21.99	N/A	16.70 Kips
15.59 ft	Cohesionless	1164.38 psf	21.99	N/A	24.44 Kips
15.61 ft	Cohesionless	1890.31 psf	21.99	N/A	24.51 Kips
24.61 ft	Cohesionless	2172.01 psf	21.99	N/A	58.45 Kips
33.61 ft	Cohesionless	2453.71 psf	21.99	N/A	101.19 Kips
40.49 ft	Cohesionless	2669.06 psf	21.99	N/A	139.80 Kips
40.51 ft	Cohesive	N/A	N/A	1299.08 psf	139.91 Kips
49.51 ft	Cohesive	N/A	N/A	1299.08 psf	182.76 Kips
58.51 ft	Cohesive	N/A	N/A	1390.17 psf	231.62 Kips
67.51 ft	Cohesive	N/A	N/A	1519.41 psf	290.27 Kips
76.51 ft	Cohesive	N/A	N/A	1648.65 psf	357.45 Kips
85.51 ft	Cohesive	N/A	N/A	1777.89 psf	433.16 Kips
92.79 ft	Cohesive	N/A	N/A	1801.68 psf	485.15 Kips
92.81 ft	Cohesive	N/A	N/A	1266.04 psf	485.27 Kips
101.81 ft	Cohesive	N/A	N/A	1266.04 psf	527.03 Kips
110.81 ft	Cohesive	N/A	N/A	1316.87 psf	572.15 Kips
119.81 ft	Cohesive	N/A	N/A	1388.98 psf	622.73 Kips
120.99 ft	Cohesive	N/A	N/A	1398.44 psf	629.71 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.10 psf	26.40	14.24 Kips	0.02 Kips
3.99 ft	Cohesionless	438.90 psf	26.40	14.24 Kips	6.91 Kips
4.01 ft	Cohesionless	441.25 psf	47.20	53.45 Kips	14.37 Kips
13.01 ft	Cohesionless	1566.25 psf	47.20	53.45 Kips	51.02 Kips
15.59 ft	Cohesionless	1888.75 psf	47.20	53.45 Kips	53.45 Kips
15.61 ft	Cohesionless	1890.63 psf	47.20	53.45 Kips	53.45 Kips
24.61 ft	Cohesionless	2454.03 psf	47.20	53.45 Kips	53.45 Kips
33.61 ft	Cohesionless	3017.43 psf	47.20	53.45 Kips	53.45 Kips
40.49 ft	Cohesionless	3448.11 psf	47.20	53.45 Kips	53.45 Kips
40.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
49.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
58.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
67.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
92.79 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
92.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
101.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
110.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
119.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
120.99 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
3.99 ft	1.01 Kips	6.91 Kips	7.92 Kips
4.01 ft	1.02 Kips	14.37 Kips	15.40 Kips
13.01 ft	16.70 Kips	51.02 Kips	67.73 Kips
15.59 ft	24.44 Kips	53.45 Kips	77.89 Kips
15.61 ft	24.51 Kips	53.45 Kips	77.96 Kips
24.61 ft	58.45 Kips	53.45 Kips	111.90 Kips
33.61 ft	101.19 Kips	53.45 Kips	154.64 Kips
40.49 ft	139.80 Kips	53.45 Kips	193.25 Kips
40.51 ft	139.91 Kips	21.17 Kips	161.07 Kips
49.51 ft	182.76 Kips	21.17 Kips	203.92 Kips
58.51 ft	231.62 Kips	21.17 Kips	252.79 Kips
67.51 ft	290.27 Kips	21.17 Kips	311.44 Kips
76.51 ft	357.45 Kips	21.17 Kips	378.62 Kips
85.51 ft	433.16 Kips	21.17 Kips	454.32 Kips
92.79 ft	485.15 Kips	21.17 Kips	506.32 Kips
92.81 ft	485.27 Kips	14.91 Kips	500.18 Kips
101.81 ft	527.03 Kips	14.91 Kips	541.94 Kips
110.81 ft	572.15 Kips	14.91 Kips	587.06 Kips
119.81 ft	622.73 Kips	14.91 Kips	637.64 Kips
120.99 ft	629.71 Kips	14.91 Kips	644.62 Kips

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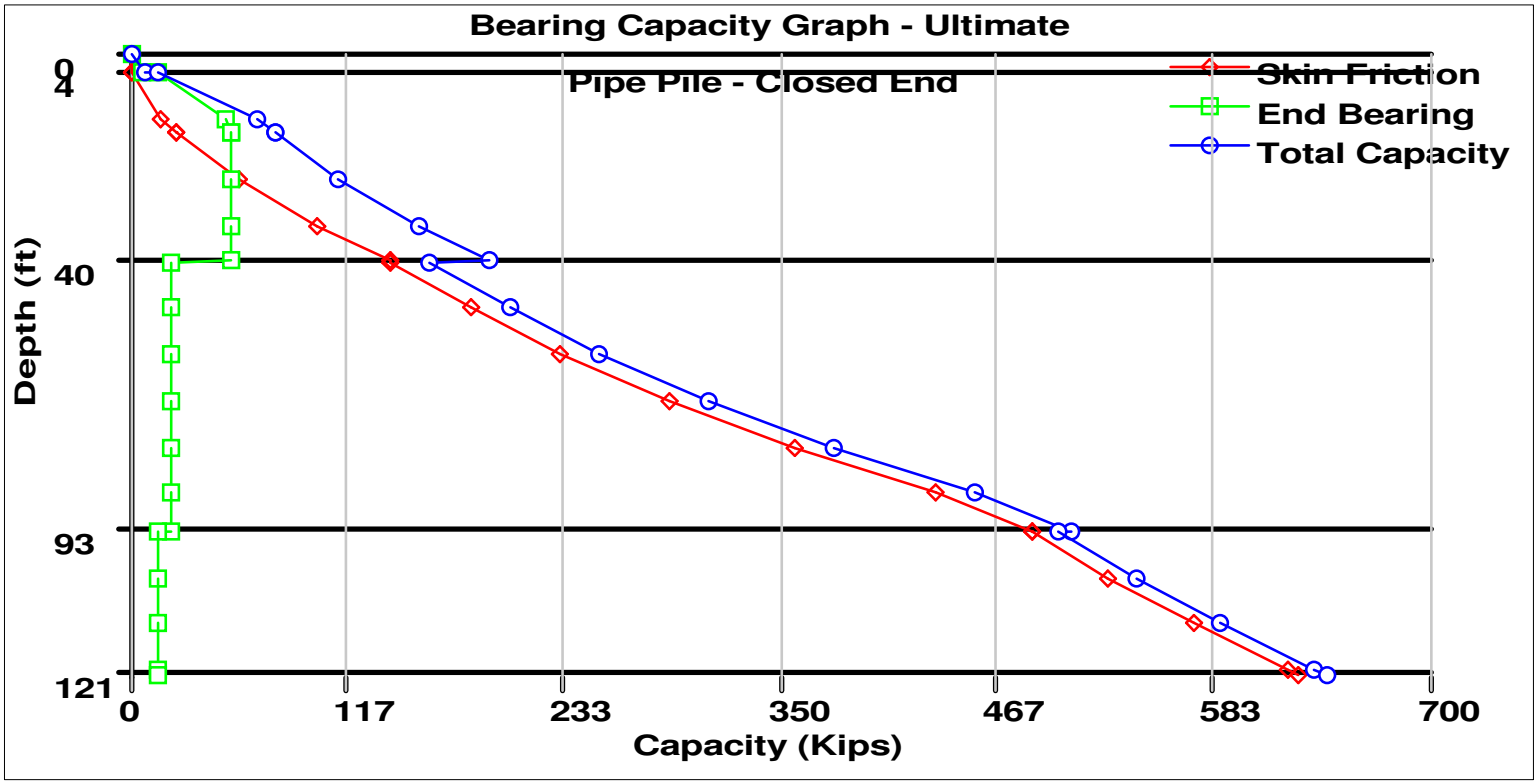

WALL AG - STA. 501+59.4 TO STA. 502+49.4 – B-002-D-06

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\WALLAG\AG1_2-~1.DVN
Project Name: CCG3A Project Date: 12/07/2023
Project Client: Michael Baker
Computed By: KCA
Project Manager: Brendan P. Andrews

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	12.60 ft
	- Driving/Restrike	12.60 ft
	- Ultimate:	12.60 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	37.50 ft	0.00%	125.00 pcf	33.0/33.0	Nordlund
2	Cohesive	52.30 ft	33.00%	128.00 pcf	2200.00 psf	T-80 Same
3	Cohesive	28.20 ft	50.00%	122.00 pcf	1550.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.62 psf	21.99	N/A	0.00 Kips
9.01 ft	Cohesionless	563.12 psf	21.99	N/A	8.81 Kips
12.59 ft	Cohesionless	786.88 psf	21.99	N/A	17.20 Kips
12.61 ft	Cohesionless	1575.31 psf	21.99	N/A	17.25 Kips
21.61 ft	Cohesionless	1857.01 psf	21.99	N/A	46.27 Kips
30.61 ft	Cohesionless	2138.71 psf	21.99	N/A	84.09 Kips
37.49 ft	Cohesionless	2354.06 psf	21.99	N/A	118.94 Kips
37.51 ft	Cohesive	N/A	N/A	1299.08 psf	119.01 Kips
46.51 ft	Cohesive	N/A	N/A	1299.08 psf	147.72 Kips
55.51 ft	Cohesive	N/A	N/A	1390.17 psf	180.46 Kips
64.51 ft	Cohesive	N/A	N/A	1519.41 psf	219.75 Kips
73.51 ft	Cohesive	N/A	N/A	1648.65 psf	264.76 Kips
82.51 ft	Cohesive	N/A	N/A	1777.89 psf	315.48 Kips
89.79 ft	Cohesive	N/A	N/A	1801.68 psf	350.32 Kips
89.81 ft	Cohesive	N/A	N/A	1266.04 psf	350.38 Kips
98.81 ft	Cohesive	N/A	N/A	1266.04 psf	371.26 Kips
107.81 ft	Cohesive	N/A	N/A	1316.87 psf	393.82 Kips
116.81 ft	Cohesive	N/A	N/A	1388.98 psf	419.11 Kips
117.99 ft	Cohesive	N/A	N/A	1398.44 psf	422.60 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.25 psf	47.20	53.45 Kips	0.04 Kips
9.01 ft	Cohesionless	1126.25 psf	47.20	53.45 Kips	36.69 Kips
12.59 ft	Cohesionless	1573.75 psf	47.20	53.45 Kips	51.27 Kips
12.61 ft	Cohesionless	1575.63 psf	47.20	53.45 Kips	51.33 Kips
21.61 ft	Cohesionless	2139.03 psf	47.20	53.45 Kips	53.45 Kips
30.61 ft	Cohesionless	2702.43 psf	47.20	53.45 Kips	53.45 Kips
37.49 ft	Cohesionless	3133.11 psf	47.20	53.45 Kips	53.45 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
82.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
89.79 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
89.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
98.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
107.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
116.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
117.99 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
9.01 ft	8.81 Kips	36.69 Kips	45.50 Kips
12.59 ft	17.20 Kips	51.27 Kips	68.46 Kips
12.61 ft	17.25 Kips	51.33 Kips	68.58 Kips
21.61 ft	46.27 Kips	53.45 Kips	99.72 Kips
30.61 ft	84.09 Kips	53.45 Kips	137.54 Kips
37.49 ft	118.94 Kips	53.45 Kips	172.39 Kips
37.51 ft	119.01 Kips	21.17 Kips	140.17 Kips
46.51 ft	147.72 Kips	21.17 Kips	168.88 Kips
55.51 ft	180.46 Kips	21.17 Kips	201.62 Kips
64.51 ft	219.75 Kips	21.17 Kips	240.92 Kips
73.51 ft	264.76 Kips	21.17 Kips	285.93 Kips
82.51 ft	315.48 Kips	21.17 Kips	336.65 Kips
89.79 ft	350.32 Kips	21.17 Kips	371.49 Kips
89.81 ft	350.38 Kips	14.91 Kips	365.29 Kips
98.81 ft	371.26 Kips	14.91 Kips	386.17 Kips
107.81 ft	393.82 Kips	14.91 Kips	408.73 Kips
116.81 ft	419.11 Kips	14.91 Kips	434.02 Kips
117.99 ft	422.60 Kips	14.91 Kips	437.51 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.62 psf	21.99	N/A	0.00 Kips
9.01 ft	Cohesionless	563.12 psf	21.99	N/A	8.81 Kips
12.59 ft	Cohesionless	786.88 psf	21.99	N/A	17.20 Kips
12.61 ft	Cohesionless	1575.31 psf	21.99	N/A	17.25 Kips
21.61 ft	Cohesionless	1857.01 psf	21.99	N/A	46.27 Kips
30.61 ft	Cohesionless	2138.71 psf	21.99	N/A	84.09 Kips
37.49 ft	Cohesionless	2354.06 psf	21.99	N/A	118.94 Kips
37.51 ft	Cohesive	N/A	N/A	1299.08 psf	119.04 Kips
46.51 ft	Cohesive	N/A	N/A	1299.08 psf	161.89 Kips
55.51 ft	Cohesive	N/A	N/A	1390.17 psf	210.76 Kips
64.51 ft	Cohesive	N/A	N/A	1519.41 psf	269.41 Kips
73.51 ft	Cohesive	N/A	N/A	1648.65 psf	336.59 Kips
82.51 ft	Cohesive	N/A	N/A	1777.89 psf	412.29 Kips
89.79 ft	Cohesive	N/A	N/A	1801.68 psf	464.29 Kips
89.81 ft	Cohesive	N/A	N/A	1266.04 psf	464.40 Kips
98.81 ft	Cohesive	N/A	N/A	1266.04 psf	506.16 Kips
107.81 ft	Cohesive	N/A	N/A	1316.87 psf	551.28 Kips
116.81 ft	Cohesive	N/A	N/A	1388.98 psf	601.86 Kips
117.99 ft	Cohesive	N/A	N/A	1398.44 psf	608.84 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.25 psf	47.20	53.45 Kips	0.04 Kips
9.01 ft	Cohesionless	1126.25 psf	47.20	53.45 Kips	36.69 Kips
12.59 ft	Cohesionless	1573.75 psf	47.20	53.45 Kips	51.27 Kips
12.61 ft	Cohesionless	1575.63 psf	47.20	53.45 Kips	51.33 Kips
21.61 ft	Cohesionless	2139.03 psf	47.20	53.45 Kips	53.45 Kips
30.61 ft	Cohesionless	2702.43 psf	47.20	53.45 Kips	53.45 Kips
37.49 ft	Cohesionless	3133.11 psf	47.20	53.45 Kips	53.45 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
82.51 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
89.79 ft	Cohesive	N/A	N/A	N/A	21.17 Kips
89.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
98.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
107.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
116.81 ft	Cohesive	N/A	N/A	N/A	14.91 Kips
117.99 ft	Cohesive	N/A	N/A	N/A	14.91 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
9.01 ft	8.81 Kips	36.69 Kips	45.50 Kips
12.59 ft	17.20 Kips	51.27 Kips	68.46 Kips
12.61 ft	17.25 Kips	51.33 Kips	68.58 Kips
21.61 ft	46.27 Kips	53.45 Kips	99.72 Kips
30.61 ft	84.09 Kips	53.45 Kips	137.54 Kips
37.49 ft	118.94 Kips	53.45 Kips	172.39 Kips
37.51 ft	119.04 Kips	21.17 Kips	140.21 Kips
46.51 ft	161.89 Kips	21.17 Kips	183.06 Kips
55.51 ft	210.76 Kips	21.17 Kips	231.92 Kips
64.51 ft	269.41 Kips	21.17 Kips	290.58 Kips
73.51 ft	336.59 Kips	21.17 Kips	357.75 Kips
82.51 ft	412.29 Kips	21.17 Kips	433.46 Kips
89.79 ft	464.29 Kips	21.17 Kips	485.46 Kips
89.81 ft	464.40 Kips	14.91 Kips	479.31 Kips
98.81 ft	506.16 Kips	14.91 Kips	521.08 Kips
107.81 ft	551.28 Kips	14.91 Kips	566.19 Kips
116.81 ft	601.86 Kips	14.91 Kips	616.77 Kips
117.99 ft	608.84 Kips	14.91 Kips	623.76 Kips

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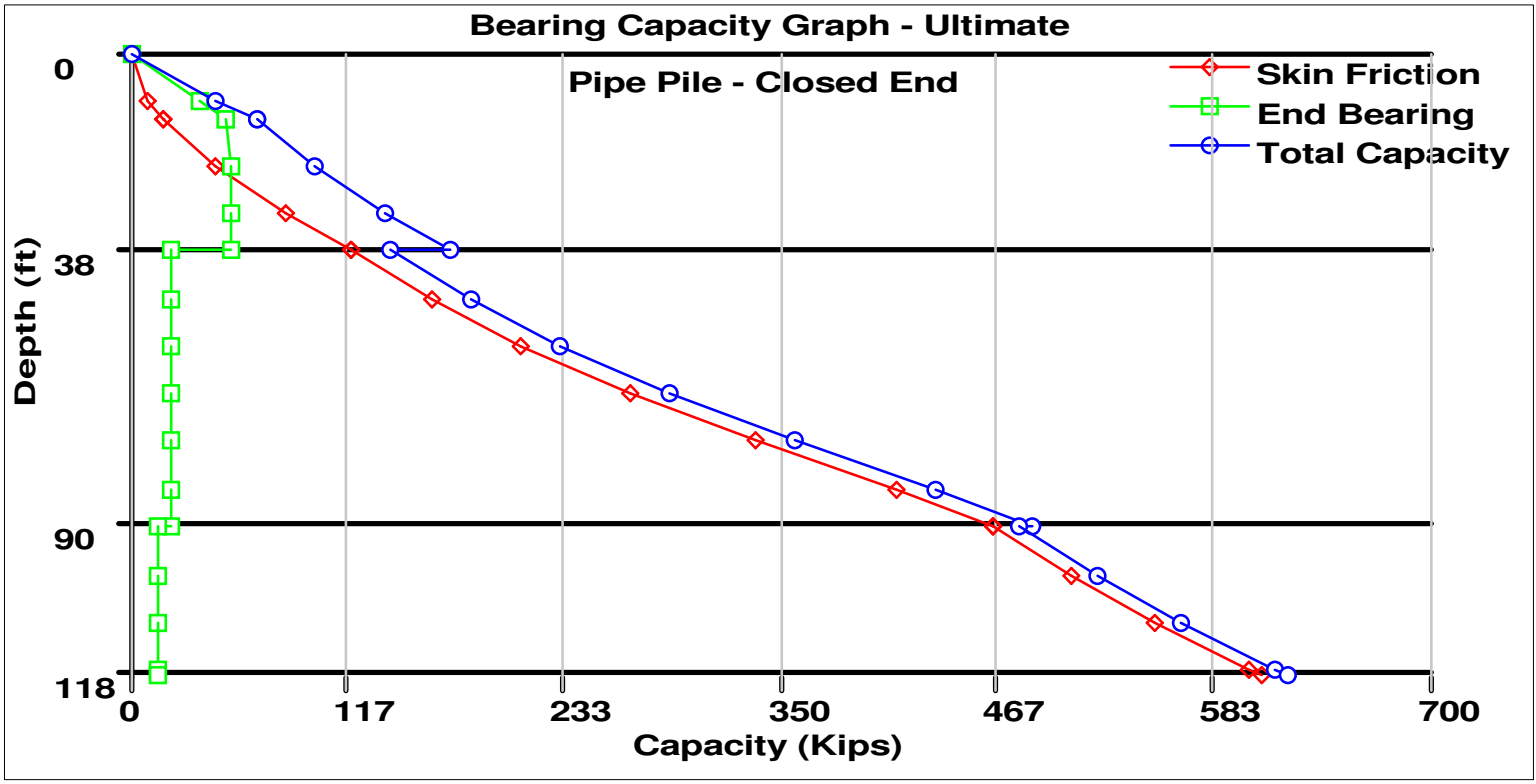

WALL AG - STA. 502+49.4 TO STA. 506+50 – B-087-1-20

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\CCG3\WALLAG\AG4_08~1.DVN
Project Name: CCG3A Project Date: 12/07/2023
Project Client: Michael Baker
Computed By: KCA
Project Manager: Brendan P. Andrews

PILE INFORMATION

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

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	-1.80 ft
	- Driving/Restrike	-1.80 ft
	- Ultimate:	-1.80 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.30 ft	17.00%	120.00 pcf	28.0/28.0	Nordlund
2	Cohesionless	12.50 ft	0.00%	128.00 pcf	33.0/33.0	Nordlund
3	Cohesive	11.30 ft	33.00%	122.00 pcf	1950.00 psf	T-80 Same
4	Cohesive	5.00 ft	33.00%	122.00 pcf	2250.00 psf	T-80 Same
5	Cohesionless	15.00 ft	33.00%	125.00 pcf	30.0/30.0	Nordlund
6	Cohesive	5.00 ft	33.00%	125.00 pcf	3000.00 psf	T-80 Same
7	Cohesive	25.00 ft	33.00%	128.00 pcf	3600.00 psf	T-80 Same
8	Cohesive	8.70 ft	33.00%	122.00 pcf	2350.00 psf	T-80 Same
9	Cohesive	19.50 ft	43.00%	125.00 pcf	2500.00 psf	T-80 Same

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	-112.03 psf	18.66	N/A	0.00 Kips
8.29 ft	Cohesionless	126.43 psf	18.66	N/A	0.92 Kips
8.31 ft	Cohesionless	366.09 psf	21.99	N/A	0.93 Kips
17.31 ft	Cohesionless	661.29 psf	21.99	N/A	11.27 Kips
20.79 ft	Cohesionless	775.43 psf	21.99	N/A	17.74 Kips
20.81 ft	Cohesive	N/A	N/A	1382.37 psf	17.79 Kips
29.81 ft	Cohesive	N/A	N/A	1382.37 psf	48.34 Kips
32.09 ft	Cohesive	N/A	N/A	1382.37 psf	56.08 Kips
32.11 ft	Cohesive	N/A	N/A	1265.48 psf	56.14 Kips
37.09 ft	Cohesive	N/A	N/A	1265.48 psf	71.62 Kips
37.11 ft	Cohesionless	2157.55 psf	19.99	N/A	71.67 Kips
46.11 ft	Cohesionless	2439.25 psf	19.99	N/A	90.04 Kips
52.09 ft	Cohesionless	2626.43 psf	19.99	N/A	104.59 Kips
52.11 ft	Cohesive	N/A	N/A	907.69 psf	104.64 Kips
57.09 ft	Cohesive	N/A	N/A	907.69 psf	115.74 Kips
57.11 ft	Cohesive	N/A	N/A	867.09 psf	115.78 Kips
66.11 ft	Cohesive	N/A	N/A	867.09 psf	134.94 Kips
75.11 ft	Cohesive	N/A	N/A	952.62 psf	157.89 Kips
82.09 ft	Cohesive	N/A	N/A	1046.74 psf	179.99 Kips
82.11 ft	Cohesive	N/A	N/A	1202.12 psf	180.06 Kips
90.79 ft	Cohesive	N/A	N/A	1202.12 psf	205.68 Kips
90.81 ft	Cohesive	N/A	N/A	1108.65 psf	205.73 Kips
99.81 ft	Cohesive	N/A	N/A	1108.65 psf	226.58 Kips
108.81 ft	Cohesive	N/A	N/A	1225.39 psf	251.81 Kips
110.29 ft	Cohesive	N/A	N/A	1252.63 psf	256.71 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	-111.74 psf	22.80	14.24 Kips	-1.46 Kips
8.29 ft	Cohesionless	365.18 psf	22.80	14.24 Kips	4.77 Kips
8.31 ft	Cohesionless	366.42 psf	47.20	53.45 Kips	11.94 Kips
17.31 ft	Cohesionless	956.82 psf	47.20	53.45 Kips	31.17 Kips
20.79 ft	Cohesionless	1185.10 psf	47.20	53.45 Kips	38.61 Kips
20.81 ft	Cohesive	N/A	N/A	N/A	18.76 Kips
29.81 ft	Cohesive	N/A	N/A	N/A	18.76 Kips
32.09 ft	Cohesive	N/A	N/A	N/A	18.76 Kips
32.11 ft	Cohesive	N/A	N/A	N/A	21.65 Kips
37.09 ft	Cohesive	N/A	N/A	N/A	21.65 Kips
37.11 ft	Cohesionless	2157.87 psf	30.00	14.24 Kips	14.24 Kips
46.11 ft	Cohesionless	2721.27 psf	30.00	14.24 Kips	14.24 Kips
52.09 ft	Cohesionless	3095.61 psf	30.00	14.24 Kips	14.24 Kips
52.11 ft	Cohesive	N/A	N/A	N/A	28.86 Kips
57.09 ft	Cohesive	N/A	N/A	N/A	28.86 Kips
57.11 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
66.11 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
75.11 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
82.09 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
82.11 ft	Cohesive	N/A	N/A	N/A	22.61 Kips
90.79 ft	Cohesive	N/A	N/A	N/A	22.61 Kips
90.81 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
99.81 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
108.81 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
110.29 ft	Cohesive	N/A	N/A	N/A	24.05 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	-1.46 Kips	-1.46 Kips
8.29 ft	0.92 Kips	4.77 Kips	5.69 Kips
8.31 ft	0.93 Kips	11.94 Kips	12.87 Kips
17.31 ft	11.27 Kips	31.17 Kips	42.44 Kips
20.79 ft	17.74 Kips	38.61 Kips	56.34 Kips
20.81 ft	17.79 Kips	18.76 Kips	36.55 Kips
29.81 ft	48.34 Kips	18.76 Kips	67.10 Kips
32.09 ft	56.08 Kips	18.76 Kips	74.84 Kips
32.11 ft	56.14 Kips	21.65 Kips	77.79 Kips
37.09 ft	71.62 Kips	21.65 Kips	93.27 Kips
37.11 ft	71.67 Kips	14.24 Kips	85.91 Kips
46.11 ft	90.04 Kips	14.24 Kips	104.28 Kips
52.09 ft	104.59 Kips	14.24 Kips	118.83 Kips
52.11 ft	104.64 Kips	28.86 Kips	133.50 Kips
57.09 ft	115.74 Kips	28.86 Kips	144.60 Kips
57.11 ft	115.78 Kips	34.64 Kips	150.42 Kips
66.11 ft	134.94 Kips	34.64 Kips	169.58 Kips
75.11 ft	157.89 Kips	34.64 Kips	192.53 Kips
82.09 ft	179.99 Kips	34.64 Kips	214.63 Kips
82.11 ft	180.06 Kips	22.61 Kips	202.67 Kips
90.79 ft	205.68 Kips	22.61 Kips	228.29 Kips
90.81 ft	205.73 Kips	24.05 Kips	229.78 Kips
99.81 ft	226.58 Kips	24.05 Kips	250.63 Kips
108.81 ft	251.81 Kips	24.05 Kips	275.87 Kips
110.29 ft	256.71 Kips	24.05 Kips	280.76 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.29 psf	18.66	N/A	0.00 Kips
8.29 ft	Cohesionless	238.75 psf	18.66	N/A	2.10 Kips
8.31 ft	Cohesionless	478.41 psf	21.99	N/A	2.11 Kips
17.31 ft	Cohesionless	773.61 psf	21.99	N/A	14.20 Kips
20.79 ft	Cohesionless	887.75 psf	21.99	N/A	21.35 Kips
20.81 ft	Cohesive	N/A	N/A	1382.37 psf	21.42 Kips
29.81 ft	Cohesive	N/A	N/A	1382.37 psf	67.02 Kips
32.09 ft	Cohesive	N/A	N/A	1382.37 psf	78.58 Kips
32.11 ft	Cohesive	N/A	N/A	1265.48 psf	78.67 Kips
37.09 ft	Cohesive	N/A	N/A	1265.48 psf	101.77 Kips
37.11 ft	Cohesionless	2269.87 psf	19.99	N/A	101.85 Kips
46.11 ft	Cohesionless	2551.57 psf	19.99	N/A	130.52 Kips
52.09 ft	Cohesionless	2738.75 psf	19.99	N/A	153.08 Kips
52.11 ft	Cohesive	N/A	N/A	907.69 psf	153.15 Kips
57.09 ft	Cohesive	N/A	N/A	907.69 psf	169.72 Kips
57.11 ft	Cohesive	N/A	N/A	867.09 psf	169.79 Kips
66.11 ft	Cohesive	N/A	N/A	867.09 psf	198.39 Kips
75.11 ft	Cohesive	N/A	N/A	952.62 psf	232.64 Kips
82.09 ft	Cohesive	N/A	N/A	1046.74 psf	265.63 Kips
82.11 ft	Cohesive	N/A	N/A	1202.12 psf	265.73 Kips
90.79 ft	Cohesive	N/A	N/A	1202.12 psf	303.97 Kips
90.81 ft	Cohesive	N/A	N/A	1108.65 psf	304.05 Kips
99.81 ft	Cohesive	N/A	N/A	1108.65 psf	340.62 Kips
108.81 ft	Cohesive	N/A	N/A	1225.39 psf	384.90 Kips
110.29 ft	Cohesive	N/A	N/A	1252.63 psf	393.49 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.58 psf	22.80	14.24 Kips	0.01 Kips
8.29 ft	Cohesionless	477.50 psf	22.80	14.24 Kips	6.24 Kips
8.31 ft	Cohesionless	478.74 psf	47.20	53.45 Kips	15.59 Kips
17.31 ft	Cohesionless	1069.14 psf	47.20	53.45 Kips	34.83 Kips
20.79 ft	Cohesionless	1297.42 psf	47.20	53.45 Kips	42.26 Kips
20.81 ft	Cohesive	N/A	N/A	N/A	18.76 Kips
29.81 ft	Cohesive	N/A	N/A	N/A	18.76 Kips
32.09 ft	Cohesive	N/A	N/A	N/A	18.76 Kips
32.11 ft	Cohesive	N/A	N/A	N/A	21.65 Kips
37.09 ft	Cohesive	N/A	N/A	N/A	21.65 Kips
37.11 ft	Cohesionless	2270.19 psf	30.00	14.24 Kips	14.24 Kips
46.11 ft	Cohesionless	2833.59 psf	30.00	14.24 Kips	14.24 Kips
52.09 ft	Cohesionless	3207.93 psf	30.00	14.24 Kips	14.24 Kips
52.11 ft	Cohesive	N/A	N/A	N/A	28.86 Kips
57.09 ft	Cohesive	N/A	N/A	N/A	28.86 Kips
57.11 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
66.11 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
75.11 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
82.09 ft	Cohesive	N/A	N/A	N/A	34.64 Kips
82.11 ft	Cohesive	N/A	N/A	N/A	22.61 Kips
90.79 ft	Cohesive	N/A	N/A	N/A	22.61 Kips
90.81 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
99.81 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
108.81 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
110.29 ft	Cohesive	N/A	N/A	N/A	24.05 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.01 Kips	0.01 Kips
8.29 ft	2.10 Kips	6.24 Kips	8.34 Kips
8.31 ft	2.11 Kips	15.59 Kips	17.71 Kips
17.31 ft	14.20 Kips	34.83 Kips	49.03 Kips
20.79 ft	21.35 Kips	42.26 Kips	63.62 Kips
20.81 ft	21.42 Kips	18.76 Kips	40.19 Kips
29.81 ft	67.02 Kips	18.76 Kips	85.79 Kips
32.09 ft	78.58 Kips	18.76 Kips	97.34 Kips
32.11 ft	78.67 Kips	21.65 Kips	100.32 Kips
37.09 ft	101.77 Kips	21.65 Kips	123.42 Kips
37.11 ft	101.85 Kips	14.24 Kips	116.09 Kips
46.11 ft	130.52 Kips	14.24 Kips	144.76 Kips
52.09 ft	153.08 Kips	14.24 Kips	167.32 Kips
52.11 ft	153.15 Kips	28.86 Kips	182.02 Kips
57.09 ft	169.72 Kips	28.86 Kips	198.59 Kips
57.11 ft	169.79 Kips	34.64 Kips	204.42 Kips
66.11 ft	198.39 Kips	34.64 Kips	233.03 Kips
75.11 ft	232.64 Kips	34.64 Kips	267.27 Kips
82.09 ft	265.63 Kips	34.64 Kips	300.27 Kips
82.11 ft	265.73 Kips	22.61 Kips	288.33 Kips
90.79 ft	303.97 Kips	22.61 Kips	326.58 Kips
90.81 ft	304.05 Kips	24.05 Kips	328.11 Kips
99.81 ft	340.62 Kips	24.05 Kips	364.68 Kips
108.81 ft	384.90 Kips	24.05 Kips	408.95 Kips
110.29 ft	393.49 Kips	24.05 Kips	417.55 Kips

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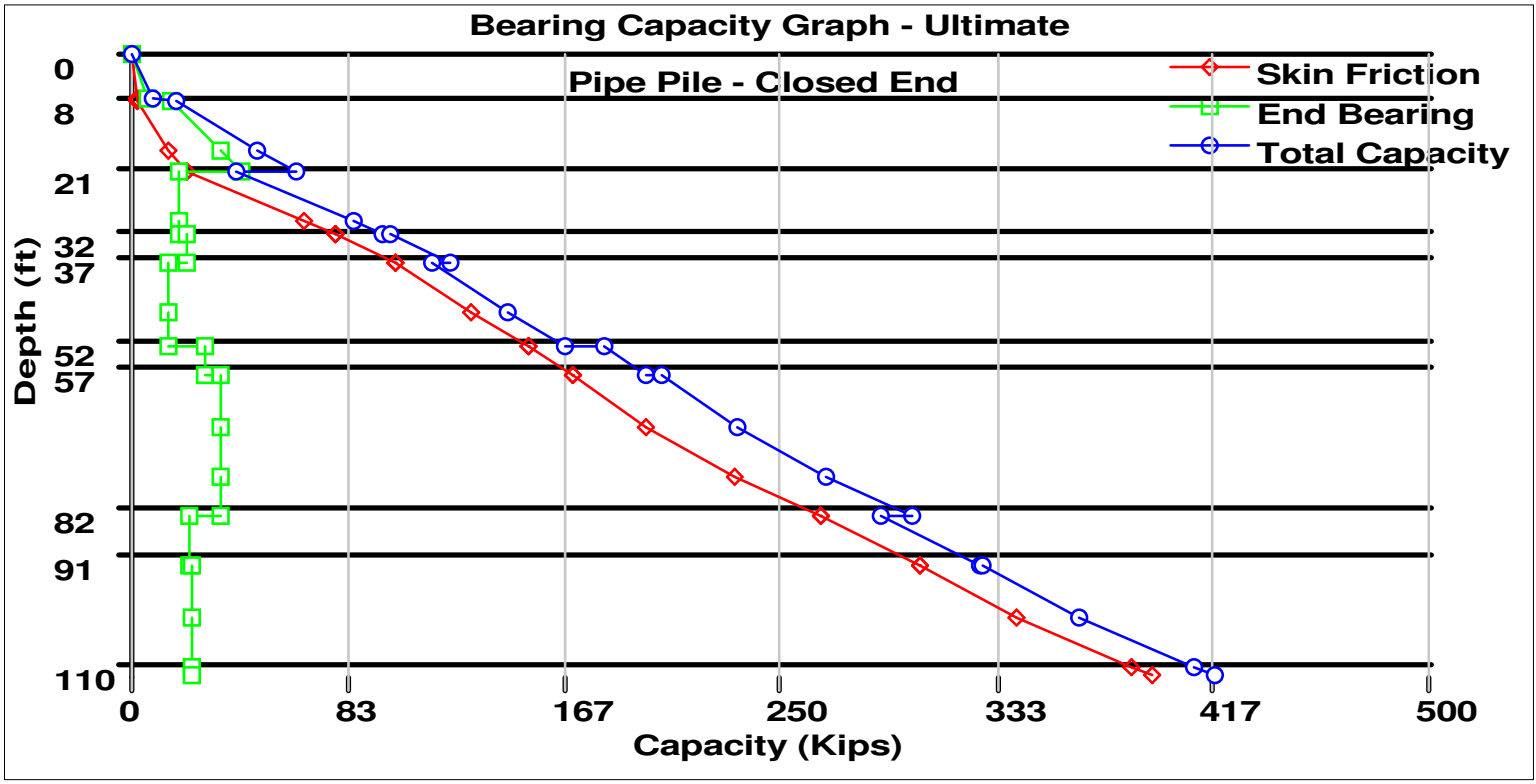


APPENDIX G

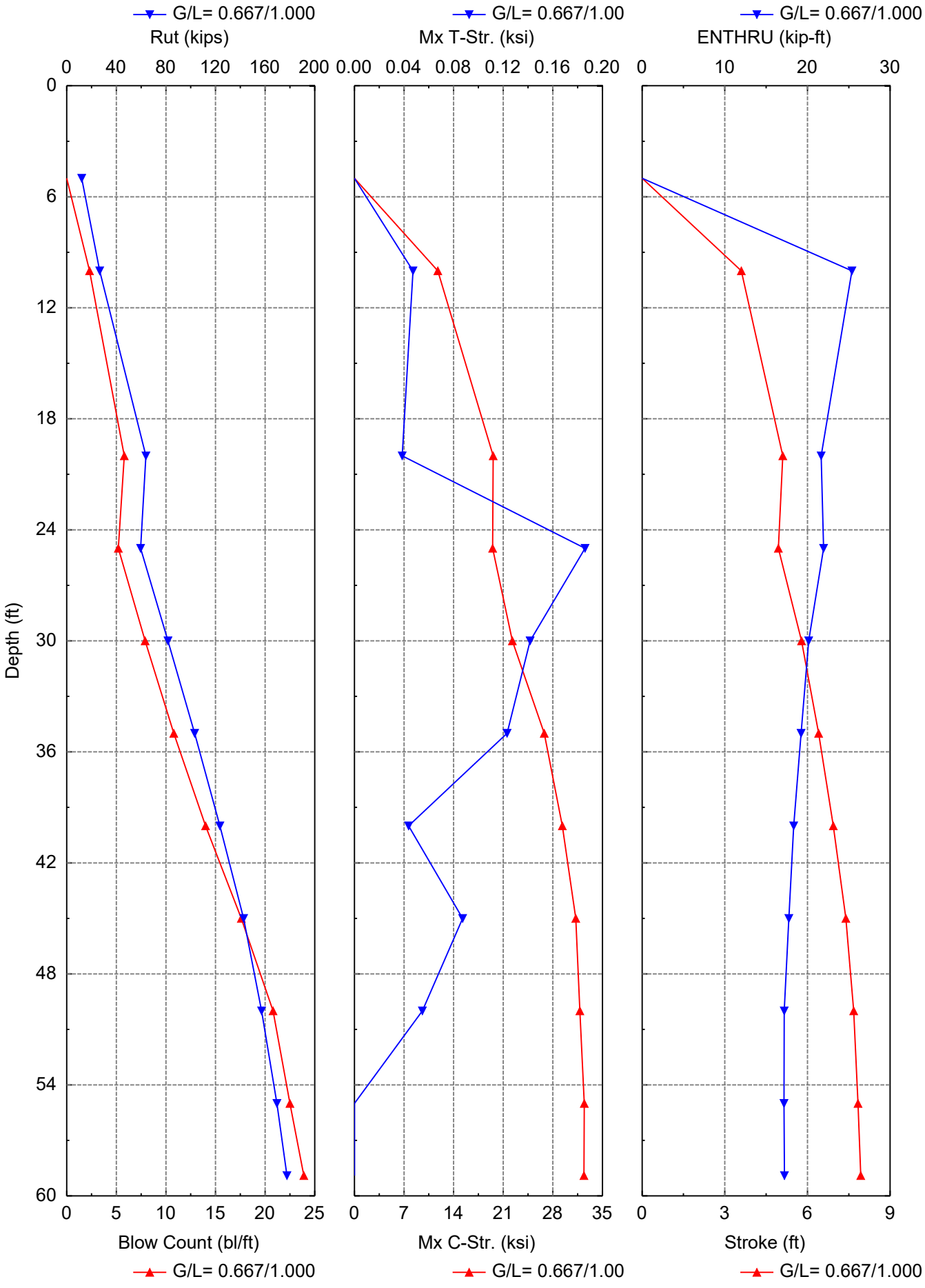
DRIVABILITY ANALYSIS

REAR ABUTMENT – C-086-0-14

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

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
5.0	12.1	1.5	10.6	0.0	0.000	0.000	0.00	0.0	D 19-42
10.0	26.6	5.7	20.9	2.3	11.762	0.047	3.60	25.4	D 19-42
20.0	63.8	22.4	41.4	5.8	19.589	0.038	5.10	21.6	D 19-42
25.0	59.6	42.3	17.3	5.2	19.500	0.186	4.95	21.9	D 19-42
30.0	81.6	64.3	17.3	7.9	22.291	0.142	5.78	20.1	D 19-42
35.0	103.1	85.8	17.3	10.8	26.791	0.123	6.41	19.2	D 19-42
40.0	123.5	106.2	17.3	14.0	29.344	0.044	6.94	18.3	D 19-42
45.0	142.6	125.3	17.3	17.6	31.237	0.087	7.39	17.8	D 19-42
50.0	157.2	139.9	17.3	20.8	31.812	0.055	7.68	17.2	D 19-42
55.0	169.5	152.2	17.3	22.5	32.444	0.000	7.84	17.2	D 19-42
58.9	177.6	160.3	17.3	23.9	32.384	0.000	7.93	17.2	D 19-42

Total driving time: 13 minutes; Total Number of Blows: 589 (starting at penetration 5.0 ft)


G/L= 0.667/1.000
Rut (kips)
0 40 80 120 160 200
Mx T-Str. (ksi)
0.00 0.04 0.08 0.12 0.16 0.20
ENTHRU (kip-ft)
0 10 20 30
Depth (ft)
0 6 12 18 24 30 36 42 48 54 60
Blow Count (bl/ft)
0 5 10 15 20 25
Mx C-Str. (ksi)
0 7 14 21 28 35
Stroke (ft)
0 3 6 9
G/L= 0.667/1.00
G/L= 0.667/1.000

Bridge CUY-90-1678 (Over IR-90) Replacement + Rear Abutment 8/15/2023
NATIONAL ENGINEERING AND ARCHITECTURAL 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.

HAMMER DATA

Hammer Model:	D 19-42	Made By:	DELMAG
Hammer ID:	41	Hammer Type:	OED
Hammer Database Type:	PDI		
Hammer Database Name:			PDIHammer.gwh

Hammer and Drive System Segment Data

Segment -	Weight kips	Stiffness kips/in	COR -	C-Slack in	Damping kips/ft/s
1	0.800	140,084.4	1.000	0.000	
2	0.800	140,084.4	1.000	0.000	
3	0.800	140,084.4	1.000	0.000	
4	0.800	140,084.4	1.000	0.000	
5	0.800	70,754.7	0.900	0.120	
Imp Block	0.753	2,861.8	0.800	0.120	
Helmet	1.200				1.1

Ram Weight: (kips)	4.00	Ram Length: (ft)	10.76
Ram Area: (in²)	124.69		
Maximum (Eq) Stroke: (ft)	10.81	Actual (Eq) Stroke: (ft)	10.81
Efficiency:	0.800	Rated Energy: (kip-ft)	43.24
Maximum Pressure: (psi)	1,600.00	Actual Pressure: (psi)	1,600.00
Combustion Delay: (ms)	2.00	Ignition Duration: (ms)	2.00
Expansion Exponent:	1.25		

Hammer Cushion		Pile Cushion	
Cross Sect. Area: (in²)	10.80	Cross Sect. Area: (in²)	0.00
Elastic Modulus: (ksi)	530.0	Elastic Modulus: (ksi)	0.0
Thickness: (in)	2.00	Thickness: (in)	0.00
Coeff. of Restitution:	0.800	Coeff. of Restitution:	0.500
RoundOut: (in)	0.120	RoundOut: (in)	0.120
Stiffness: (kips/in)	2,861.8	Stiffness: (kips/in)	0.0
Helmet Weight: (kips)	1.200		

PILE INPUT

Uniform Pile		Pile Type:	Closed-End Pipe
Pile Length: (ft)	70.000	Pile Penetration: (ft)	58.900
Pile Size: (ft)	1.17	Toe Area: (in²)	153.94

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp Length ft	Wait Time Hr	Hammer -
5.00	5.0	0.0	DELMAG D 19-42
10.00	10.0	0.0	DELMAG D 19-42
15.00	15.0	0.0	DELMAG D 19-42
20.00	20.0	0.0	DELMAG D 19-42
25.00	25.0	0.0	DELMAG D 19-42
30.00	30.0	0.0	DELMAG D 19-42
35.00	35.0	0.0	DELMAG D 19-42
40.00	40.0	0.0	DELMAG D 19-42
45.00	45.0	0.0	DELMAG D 19-42
50.00	50.0	0.0	DELMAG D 19-42
55.00	55.0	0.0	DELMAG D 19-42
58.90	58.9	0.0	DELMAG D 19-42

Other Information for DELMAG D 19-42

Depth ft	Stroke ft	Diesel Pressure %	Efficiency -	P.C. Stiff. Fact. -	P.C. COR -
5.00	10.8	100.0	0.80	1.0	0.50
10.00	10.8	100.0	0.80	1.0	0.50
15.00	10.8	100.0	0.80	1.0	0.50
20.00	10.8	100.0	0.80	1.0	0.50
25.00	10.8	100.0	0.80	1.0	0.50
30.00	10.8	100.0	0.80	1.0	0.50
35.00	10.8	100.0	0.80	1.0	0.50
40.00	10.8	100.0	0.80	1.0	0.50
45.00	10.8	100.0	0.80	1.0	0.50
50.00	10.8	100.0	0.80	1.0	0.50
55.00	10.8	100.0	0.80	1.0	0.50
58.90	10.8	100.0	0.80	1.0	0.50

PILE, SOIL, ANALYSIS OPTIONS

Analysis type:	Driveability Analysis	Soil Damping Option:	Smith
Max No Analysis Iterations:	0	Time Increment/Critical:	160
Residual Stress Analysis:	0	Analysis Time-Input(ms):	0
Output Level:	Normal	Gravitational Acceleration (ft/s²):	32.169
Hammer Gravity (ft/s²):	32.169	Pile Gravity (ft/s²):	32.169

DRIVEABILITY ANALYSIS

Analysis Depth (ft)	58.90	Standard Soil Setup	
Hammer Name	DELMAG D 19-42	Hammer ID	41
Diesel Pressure: (psi)	230.40	Stroke (ft)	10.81
Efficiency	0.80		
Shaft Gain/Loss Factor	0.667	Toe Gain/Loss Factor	1.000

SOIL RESISTANCE PARAMETERS

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Setup F.	Limit D.	Setup T	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.00	0.0	0.4	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
1.75	0.1	3.7	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
3.50	0.1	7.1	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
5.25	0.2	10.4	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
7.00	0.2	13.8	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
8.75	0.3	17.2	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
10.50	0.3	20.5	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
12.25	0.4	23.9	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
14.00	0.4	27.2	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
15.75	0.5	30.6	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
17.50	0.5	33.9	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
19.25	0.6	37.3	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
21.00	0.6	40.7	0.10	0.160	0.050	0.1	1.0	6.00	1.0	153.94
21.00	1.5	16.2	0.10	0.144	0.150	0.1	1.5	6.00	168.0	153.94
58.90	1.5	16.2	0.10	0.144	0.150	0.1	1.5	6.00	168.0	153.94

PILE PROFILE

Lb Top	X-Area	E-Mod	Spec. Wt	Perim.	C-Index	Wave Sp	Impedance
ft	in²	ksi	lb/ft³	ft	-	ft/s	kips/ft/s
0.00	10.8	30,000	492.00	3.665	0	16,806.4	19.3
58.90	10.8	30,000	492.00	3.665	0	16,806.4	19.3

PILE AND SOIL MODEL Total Capacity Rut (kips): 177.608

Seg.	Weight	Stiffn.	C-Slk	T-Slk	COR	Ru	Js/Jt	Qs/Qt	LbTop	Perim.	X-Area
-	kips	kips/in	in	in	-	kips	s/ft	in	ft	ft	in²
1	0.12	8,251	0.12	0.00	0.85	0.7	0.050	0.10	3.27	3.67	10.8
2	0.12	8,251	0.00	0.00	1.00	1.8	0.050	0.10	6.54	3.67	10.8
3	0.12	8,251	0.00	0.00	1.00	3.0	0.050	0.10	9.82	3.67	10.8
4	0.12	8,251	0.00	0.00	1.00	4.2	0.050	0.10	13.09	3.67	10.8
5	0.12	8,251	0.00	0.00	1.00	5.4	0.050	0.10	16.36	3.67	10.8
6	0.12	8,251	0.00	0.00	1.00	6.5	0.050	0.10	19.63	3.67	10.8
7	0.12	8,251	0.00	0.00	1.00	9.9	0.127	0.10	22.91	3.67	10.8

8	0.12	8,251	0.00	0.00	1.00	11.7	0.150	0.10	26.18	3.67	10.8
18	0.12	8,251	0.00	0.00	1.00	11.7	0.150	0.10	58.90	3.67	10.8
Toe						17.3	0.149	0.14	58.90		

2.173 kips total unreduced pile weight (g = 32.169 ft/s²)
2.173 kips total reduced pile weight (g = 32.169 ft/s²)

OTHER OPTIONS

Pile Damping (%):	1	Pile Damping Fact. (kips/ft/s):	0.386

EXTREMA TABLE at 58.9 FT; HAMMER: D 19-42

Shaft/Toe Gain/Loss Factor = 0.667/1.000

Rut = 177.6 kips Rtoe = 17.3 kips Time Inc. = 0.076 ms

Hammer DELMAG D 19-42 Efficiency 0.800

Lb Top ft	Mx.T-For. kips	Mx.C-For kips	Mx.T-Str. ksi	Mx.C-Str. ksi	Mx Vel. ft/s	Mx Dis. in	ENTHRU kip-ft
3.3	0.0	325.2	0.00	30.12	12.73	0.803	17.21
6.5	0.0	335.2	0.00	31.04	12.57	0.781	16.94
9.8	0.0	342.2	0.00	31.69	12.41	0.760	16.62
13.1	0.0	346.8	0.00	32.11	12.16	0.742	16.23
16.4	0.0	349.2	0.00	32.34	11.85	0.725	15.77
19.6	0.0	349.7	0.00	32.38	11.37	0.708	15.24
22.9	0.0	348.2	0.00	32.25	10.79	0.692	14.43
26.2	0.0	334.6	0.00	30.99	10.20	0.677	13.26
29.5	0.0	312.6	0.00	28.94	9.62	0.664	12.02
32.7	0.0	286.7	0.00	26.55	9.04	0.653	10.82
36.0	0.0	256.4	0.00	23.74	8.63	0.644	9.67
39.3	0.0	223.7	0.00	20.72	8.71	0.636	8.54
42.5	0.0	203.1	0.00	18.81	8.52	0.630	7.43
45.8	0.0	184.5	0.00	17.09	8.18	0.624	6.34
49.1	0.0	158.9	0.00	14.71	8.03	0.619	5.26
52.4	0.0	128.3	0.00	11.88	8.40	0.614	4.18
55.6	0.0	97.6	0.00	9.04	8.51	0.610	3.11
58.9	0.0	68.2	0.00	6.31	8.49	0.607	2.57

Converged Stroke (ft) 7.93 Fixed Combustion Pressure (psi) 1,600.0

(Eq) Strokes Analyzed and Last Return (ft)

10.81 7.99 7.93

SUMMARY TABLE at 58.9 FT; HAMMER: D 19-42

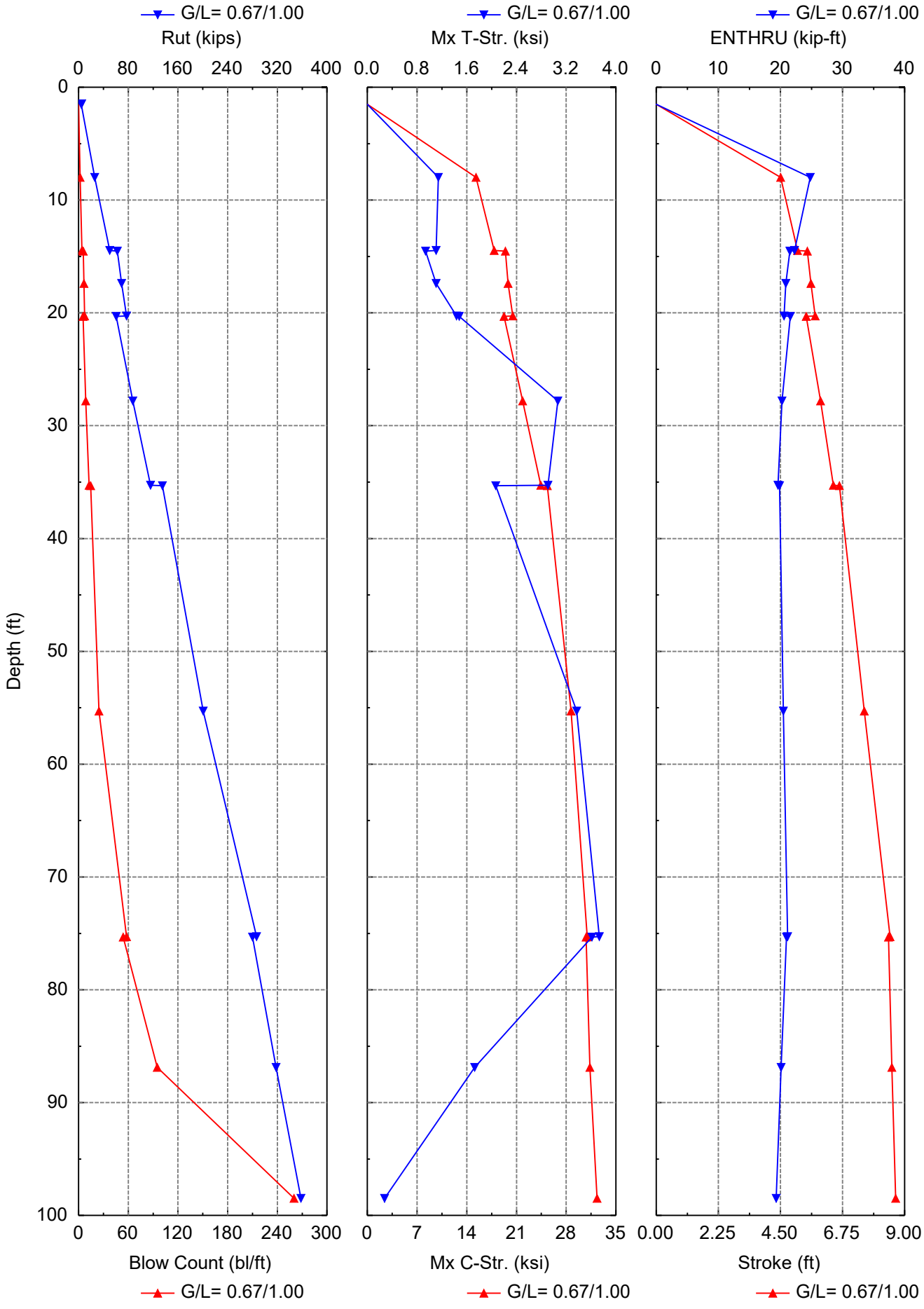
Rut kips	Bl Ct b/ft	Stk Dn ft	Stk Up ft	Mx T-Str ksi	LTop ft	Mx C-Str ksi	LTop ft	ENTHRU kip-ft	Bl Rt b/min	ActRes kips
177.6	23.9	7.93	0.00	0.00	3.3	32.38	19.6	17.2	41.7	177.6

PIER 1A – B-085-2-20

Gain/Loss Factor at Shaft/Toe = 0.670/1.000

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
1.5	5.2	0.1	5.1	0.3	0.000	0.000	10.81	0.0	D 19-42
1.5	4.4	0.1	4.3	0.3	0.000	0.000	10.81	0.0	D 19-42
8.0	26.1	4.8	21.3	2.0	15.314	1.142	4.50	24.8	D 19-42
14.5	50.1	11.9	38.3	4.2	17.871	1.105	5.12	22.3	D 19-42
14.5	62.3	12.0	50.4	5.7	19.429	0.936	5.48	21.5	D 19-42
17.4	69.3	18.9	50.4	6.5	19.808	1.107	5.61	20.9	D 19-42
20.3	77.2	26.8	50.4	7.4	20.482	1.435	5.75	20.6	D 19-42
20.3	60.5	27.0	33.6	5.5	19.239	1.477	5.43	21.6	D 19-42
27.8	87.4	53.8	33.6	8.7	21.880	3.064	5.95	20.3	D 19-42
35.3	115.9	82.4	33.6	12.6	24.427	2.908	6.42	19.6	D 19-42
35.3	134.9	82.5	52.4	14.6	25.351	2.068	6.63	19.8	D 19-42
55.3	200.7	148.4	52.4	24.6	28.684	3.370	7.54	20.5	D 19-42
75.3	286.4	234.0	52.4	58.0	30.975	3.732	8.47	21.2	D 19-42
75.3	279.9	234.2	45.7	53.8	30.813	3.615	8.41	21.0	D 19-42
86.9	317.8	272.1	45.7	95.1	31.343	1.728	8.53	20.1	D 19-42
98.5	357.9	312.3	45.7	260.1	32.336	0.278	8.67	19.3	D 19-42

Total driving time: 105 minutes; Total Number of Blows: 4338 (starting at penetration 1.5 ft)


G/L= 0.67/1.00
Rut (kips)
0 80 160 240 320 400
Blow Count (bl/ft)
0 60 120 180 240 300
G/L= 0.67/1.00
Mx T-Str. (ksi)
0.0 0.8 1.6 2.4 3.2 4.0
Mx C-Str. (ksi)
0 7 14 21 28 35
G/L= 0.67/1.00
ENTHRU (kip-ft)
0 10 20 30 40
Stroke (ft)
0.00 2.25 4.50 6.75 9.00
G/L= 0.67/1.00
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100
G/L= 0.67/1.00
G/L= 0.67/1.00

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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

HAMMER DATA

Hammer Model:	D 19-42	Made By:	DELMAG
Hammer ID:	41	Hammer Type:	OED
Hammer Database Type:	PDI		
Hammer Database Name:			PDIHammer.gwh

Hammer and Drive System Segment Data

Segment	Weight	Stiffness	COR	C-Slack	Damping
-	kips	kips/in	-	in	kips/ft/s
1	0.800	140,084.4	1.000	0.000	
2	0.800	140,084.4	1.000	0.000	
3	0.800	140,084.4	1.000	0.000	
4	0.800	140,084.4	1.000	0.000	
5	0.800	70,754.7	0.900	0.120	
Imp Block	0.753	4,703.8	0.800	0.120	
Helmet	1.900				1.4

Ram Weight: (kips)	4.00	Ram Length: (ft)	10.76
Ram Area: (in²)	124.69		
Maximum (Eq) Stroke: (ft)	10.81	Actual (Eq) Stroke: (ft)	10.81
Efficiency:	0.800	Rated Energy: (kip-ft)	43.24
Maximum Pressure: (psi)	1,600.00	Actual Pressure: (psi)	1,600.00
Combustion Delay: (ms)	2.00	Ignition Duration: (ms)	2.00
Expansion Exponent:	1.25		

Hammer Cushion		Pile Cushion	
Cross Sect. Area: (in²)	17.75	Cross Sect. Area: (in²)	0.00
Elastic Modulus: (ksi)	530.0	Elastic Modulus: (ksi)	0.0
Thickness: (in)	2.00	Thickness: (in)	0.00
Coeff. of Restitution:	0.800	Coeff. of Restitution:	0.500
RoundOut: (in)	0.120	RoundOut: (in)	0.120
Stiffness: (kips/in)	4,703.8	Stiffness: (kips/in)	0.0
Helmet Weight: (kips)	1.900		

PILE INPUT

Uniform Pile		Pile Type:	Closed-End Pipe
Pile Length: (ft)	98.480	Pile Penetration: (ft)	98.480
Pile Size: (ft)	1.33	Toe Area: (in²)	201.06

Table of Depths Analyzed with Driving System Modifiers

Depth	Temp Length	Wait Time	Hammer
ft	ft	Hr	-
1.48	98.5	0.0	DELMAG D 19-42
1.52	98.5	0.0	DELMAG D 19-42
8.00	98.5	0.0	DELMAG D 19-42
14.48	98.5	0.0	DELMAG D 19-42
14.52	98.5	0.0	DELMAG D 19-42
17.40	98.5	0.0	DELMAG D 19-42
20.28	98.5	0.0	DELMAG D 19-42
20.32	98.5	0.0	DELMAG D 19-42
27.80	98.5	0.0	DELMAG D 19-42
35.28	98.5	0.0	DELMAG D 19-42
35.32	98.5	0.0	DELMAG D 19-42
55.30	98.5	0.0	DELMAG D 19-42
75.28	98.5	0.0	DELMAG D 19-42
75.32	98.5	0.0	DELMAG D 19-42
86.88	98.5	0.0	DELMAG D 19-42
98.48	98.5	0.0	DELMAG D 19-42

Other Information for DELMAG D 19-42

Depth	Stroke	Diesel Pressure	Efficiency	P.C. Stiff. Fact.	P.C. COR
ft	ft	%	-	-	-
1.48	10.8	100.0	0.80	1.0	0.50
1.52	10.8	100.0	0.80	1.0	0.50
8.00	10.8	100.0	0.80	1.0	0.50
14.48	10.8	100.0	0.80	1.0	0.50
14.52	10.8	100.0	0.80	1.0	0.50
17.40	10.8	100.0	0.80	1.0	0.50
20.28	10.8	100.0	0.80	1.0	0.50
20.32	10.8	100.0	0.80	1.0	0.50
27.80	10.8	100.0	0.80	1.0	0.50
35.28	10.8	100.0	0.80	1.0	0.50
35.32	10.8	100.0	0.80	1.0	0.50
55.30	10.8	100.0	0.80	1.0	0.50
75.28	10.8	100.0	0.80	1.0	0.50
75.32	10.8	100.0	0.80	1.0	0.50
86.88	10.8	100.0	0.80	1.0	0.50
98.48	10.8	100.0	0.80	1.0	0.50

PILE, SOIL, ANALYSIS OPTIONS

Analysis type:	Driveability Analysis	Soil Damping Option:	Smith
Max No Analysis Iterations:	0	Time Increment/Critical:	160
Residual Stress Analysis:	0	Analysis Time-Input(ms):	0
Output Level:	Normal	Gravitational Acceleration (ft/s²):	32.169
Hammer Gravity (ft/s²):	32.170	Pile Gravity (ft/s²):	32.170

DRIVEABILITY ANALYSIS

Analysis Depth (ft)	98.48	Standard Soil Setup	
Hammer Name	DELMAG D 19-42	Hammer ID	41
Diesel Pressure: (psi)	230.40	Stroke (ft)	10.81
Efficiency	0.80		
Shaft Gain/Loss Factor	0.670	Toe Gain/Loss Factor	1.000

SOIL RESISTANCE PARAMETERS

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Setup F.	Limit D.	Setup T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.01	0.0	0.0	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
1.49	0.0	3.7	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
1.51	0.2	3.1	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
10.51	0.2	20.0	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
14.49	0.4	27.4	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
14.51	0.8	36.1	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
20.29	1.0	36.1	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
20.31	1.3	24.0	0.10	0.130	0.150	0.2	1.5	6.00	168.0	201.06
29.31	1.3	24.0	0.10	0.130	0.150	0.2	1.5	6.00	168.0	201.06
35.29	1.5	24.0	0.10	0.130	0.150	0.2	1.5	6.00	168.0	201.06
35.31	1.3	37.5	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
44.31	1.1	37.5	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
53.31	1.2	37.5	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
62.31	1.5	37.5	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
71.31	1.7	37.5	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
75.29	1.8	37.5	0.10	0.120	0.150	0.2	1.5	6.00	24.0	201.06
75.31	1.4	32.7	0.10	0.120	0.150	0.2	1.5	6.00	168.0	201.06
84.31	1.0	32.7	0.10	0.120	0.150	0.2	1.5	6.00	168.0	201.06
93.31	1.2	32.7	0.10	0.120	0.150	0.2	1.5	6.00	168.0	201.06
98.48	1.5	32.7	0.10	0.120	0.150	0.2	1.5	6.00	168.0	201.06

PILE PROFILE

Lb Top	X-Area	E-Mod	Spec. Wt	Perim.	C-Index	Wave Sp	Impedance
ft	in²	ksi	lb/ft³	ft	-	ft/s	kips/ft/s
0.00	12.4	30,000	492.00	4.189	0	16,806.4	22.1
98.48	12.4	30,000	492.00	4.189	0	16,806.4	22.1

PILE AND SOIL MODEL

Total Capacity Rut (kips): 357.933

Seg.	Weight	Stiffn.	C-Slk	T-Slk	COR	Ru	Js/Jt	Qs/Qt	LbTop	Perim.	X-Area
-	kips	kips/in	in	in	-	kips	s/ft	in	ft	ft	in²
1	0.14	9,421	0.12	0.00	0.85	1.3	0.050	0.10	3.28	4.19	12.4

2	0.14	9,421	0.00	0.00	1.00	2.4	0.050	0.10	6.57	4.19	12.4
3	0.14	9,421	0.00	0.00	1.00	2.6	0.050	0.10	9.85	4.19	12.4
4	0.14	9,421	0.00	0.00	1.00	3.5	0.050	0.10	13.13	4.19	12.4
5	0.14	9,421	0.00	0.00	1.00	6.6	0.126	0.10	16.41	4.19	12.4
6	0.14	9,421	0.00	0.00	1.00	8.7	0.150	0.10	19.70	4.19	12.4
7	0.14	9,421	0.00	0.00	1.00	11.3	0.150	0.10	22.98	4.19	12.4
8	0.14	9,421	0.00	0.00	1.00	11.8	0.150	0.10	26.26	4.19	12.4
9	0.14	9,421	0.00	0.00	1.00	11.9	0.150	0.10	29.54	4.19	12.4
10	0.14	9,421	0.00	0.00	1.00	12.4	0.150	0.10	32.83	4.19	12.4
11	0.14	9,421	0.00	0.00	1.00	12.8	0.150	0.10	36.11	4.19	12.4
12	0.14	9,421	0.00	0.00	1.00	11.2	0.150	0.10	39.39	4.19	12.4
13	0.14	9,421	0.00	0.00	1.00	10.6	0.150	0.10	42.67	4.19	12.4
14	0.14	9,421	0.00	0.00	1.00	10.1	0.150	0.10	45.96	4.19	12.4
15	0.14	9,421	0.00	0.00	1.00	10.5	0.150	0.10	49.24	4.19	12.4
16	0.14	9,421	0.00	0.00	1.00	11.0	0.150	0.10	52.52	4.19	12.4
17	0.14	9,421	0.00	0.00	1.00	11.5	0.150	0.10	55.81	4.19	12.4
18	0.14	9,421	0.00	0.00	1.00	12.3	0.150	0.10	59.09	4.19	12.4
19	0.14	9,421	0.00	0.00	1.00	13.1	0.150	0.10	62.37	4.19	12.4
20	0.14	9,421	0.00	0.00	1.00	13.8	0.150	0.10	65.65	4.19	12.4
21	0.14	9,421	0.00	0.00	1.00	14.5	0.150	0.10	68.94	4.19	12.4
22	0.14	9,421	0.00	0.00	1.00	15.2	0.150	0.10	72.22	4.19	12.4
23	0.14	9,421	0.00	0.00	1.00	16.0	0.150	0.10	75.50	4.19	12.4
24	0.14	9,421	0.00	0.00	1.00	12.3	0.150	0.10	78.78	4.19	12.4
25	0.14	9,421	0.00	0.00	1.00	10.9	0.150	0.10	82.07	4.19	12.4
26	0.14	9,421	0.00	0.00	1.00	9.5	0.150	0.10	85.35	4.19	12.4
27	0.14	9,421	0.00	0.00	1.00	9.7	0.150	0.10	88.63	4.19	12.4
28	0.14	9,421	0.00	0.00	1.00	10.5	0.150	0.10	91.91	4.19	12.4
29	0.14	9,421	0.00	0.00	1.00	11.4	0.150	0.10	95.20	4.19	12.4
30	0.14	9,421	0.00	0.00	1.00	13.0	0.150	0.10	98.48	4.19	12.4
Toe						45.7	0.150	0.12	98.48		

4.162 kips total unreduced pile weight (g = 32.169 ft/s²)
4.163 kips total reduced pile weight (g = 32.169 ft/s²)

OTHER OPTIONS

Pile Damping (%):	1	Pile Damping Fact. (kips/ft/s):	0.442

EXTREMA TABLE at 98.5 FT; HAMMER: D 19-42

Shaft/Toe Gain/Loss Factor = 0.670/1.000

Rut = 357.9 kips Rtoe = 45.7 kips Time Inc. = 0.076 ms

Hammer DELMAG D 19-42 Efficiency 0.800

Lb Top ft	Mx.T-For. kips	Mx.C-For kips	Mx.T-Str. ksi	Mx.C-Str. ksi	Mx Vel. ft/s	Mx Dis. in	ENTHRU kip-ft
3.3	0.0	368.6	0.00	29.80	12.85	0.767	19.31
6.6	2.2	377.8	0.18	30.54	12.39	0.735	18.78
9.8	2.9	386.0	0.24	31.20	12.04	0.703	18.19
13.1	3.4	393.6	0.28	31.82	11.72	0.671	17.56
16.4	3.1	400.0	0.25	32.34	11.28	0.638	16.70
19.7	0.0	396.0	0.00	32.02	10.77	0.605	15.54
23.0	0.0	385.1	0.00	31.13	10.24	0.573	14.20
26.3	0.0	367.5	0.00	29.71	9.69	0.542	12.81
29.5	0.0	349.1	0.00	28.22	9.13	0.512	11.51
32.8	0.0	331.1	0.00	26.77	8.59	0.482	10.30
36.1	0.0	312.7	0.00	25.28	8.09	0.455	9.17
39.4	0.0	295.6	0.00	23.89	7.62	0.430	8.19
42.7	0.0	283.5	0.00	22.92	7.18	0.408	7.39
46.0	0.0	271.0	0.00	21.91	6.77	0.386	6.67
49.2	0.0	258.5	0.00	20.90	6.44	0.363	6.00
52.5	0.0	248.4	0.00	20.08	6.12	0.340	5.36
55.8	0.0	237.9	0.00	19.23	5.82	0.318	4.73
59.1	0.0	226.6	0.00	18.32	5.52	0.296	4.15
62.4	0.0	214.0	0.00	17.30	5.25	0.276	3.61
65.7	0.0	202.4	0.00	16.36	4.98	0.258	3.12
68.9	0.0	186.8	0.00	15.10	4.72	0.241	2.66
72.2	0.0	169.5	0.00	13.70	4.48	0.225	2.24
75.5	0.0	152.3	0.00	12.31	4.27	0.210	1.85
78.8	0.0	137.3	0.00	11.10	4.10	0.197	1.52
82.1	0.0	125.4	0.00	10.14	4.02	0.186	1.28
85.3	0.0	115.2	0.00	9.31	3.87	0.175	1.09
88.6	0.0	105.8	0.00	8.56	3.92	0.167	0.93
91.9	0.0	95.3	0.00	7.70	4.33	0.159	0.78
95.2	0.0	82.8	0.00	6.69	4.90	0.153	0.64
98.5	0.0	68.5	0.00	5.54	5.08	0.147	0.56

Converged Stroke (ft) 8.67 Fixed Combustion Pressure (psi) 1,600.0

(Eq) Strokes Analyzed and Last Return (ft)

10.81 8.77 8.68 8.67

SUMMARY TABLE at 98.5 FT; HAMMER: D 19-42

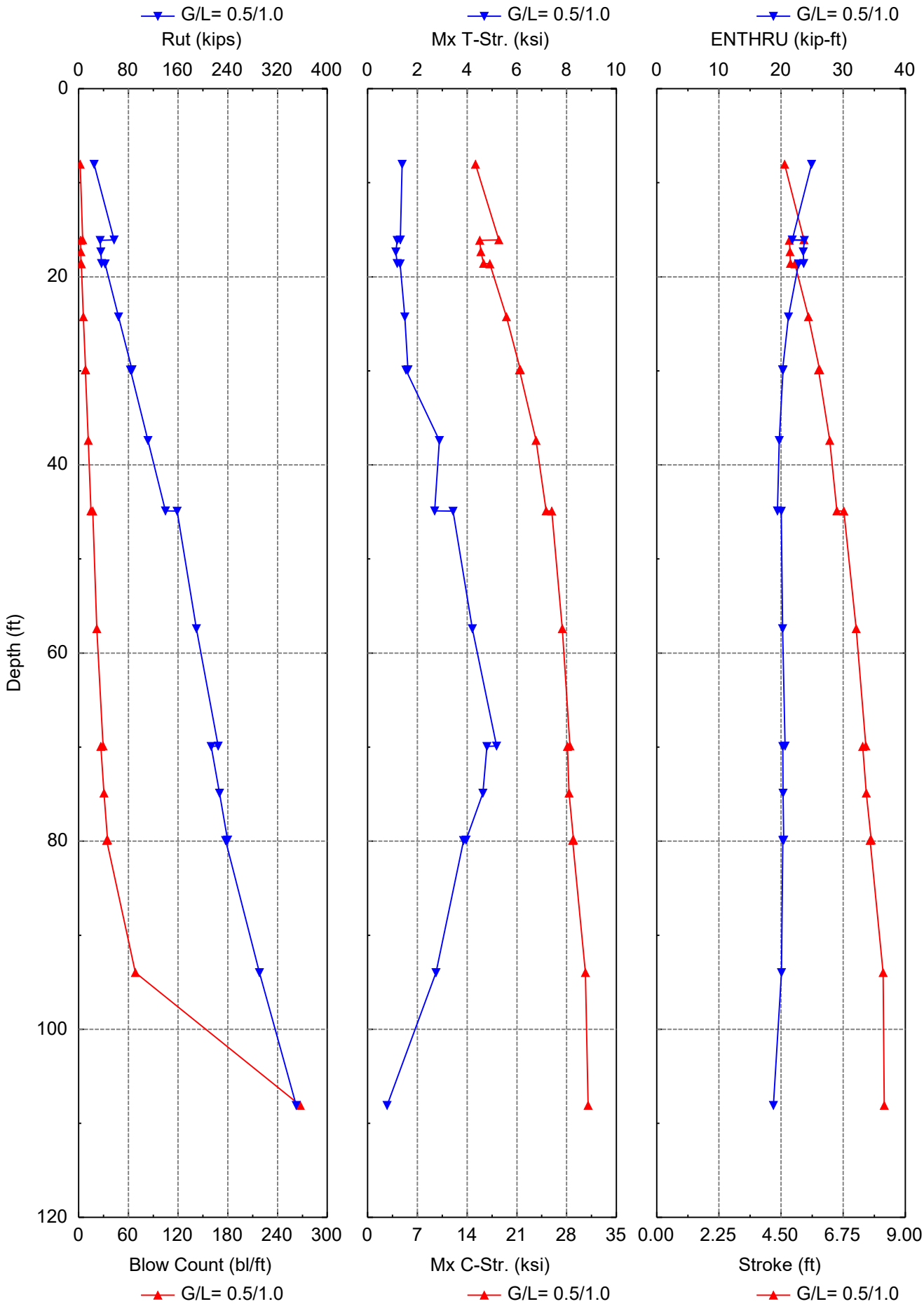
Rut	Bl Ct	Stk Dn	Stk Up	Mx T-Str	LTop	Mx C-Str	LTop	ENTHRU	Bl Rt	ActRes
kips	b/ft	ft	ft	ksi	ft	ksi	ft	kip-ft	b/min	kips
357.9	260.1	8.67	0.00	0.28	13.1	32.34	16.4	19.3	40.1	357.9

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.670/1.000

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Bl Ct b/ft	Mx C-Str ksi	Mx T-Str ksi	Stroke ft	ENTHRU kip-ft	Hammer -
1.5	5.2	0.1	5.1	0.0	0.00	0.00	10.81	0.0	D 19-42
1.5	4.4	0.1	4.3	0.0	0.00	0.00	10.81	0.0	D 19-42
8.0	26.1	4.8	21.3	2.0	15.31	1.14	4.50	24.8	D 19-42
14.5	50.1	11.9	38.3	4.2	17.87	1.10	5.12	22.3	D 19-42
14.5	62.3	12.0	50.4	5.7	19.43	0.94	5.48	21.5	D 19-42
17.4	69.3	18.9	50.4	6.5	19.81	1.11	5.61	20.9	D 19-42
20.3	77.2	26.8	50.4	7.4	20.48	1.44	5.75	20.6	D 19-42
20.3	60.5	27.0	33.6	5.5	19.24	1.48	5.43	21.6	D 19-42
27.8	87.4	53.8	33.6	8.7	21.88	3.06	5.95	20.3	D 19-42
35.3	115.9	82.4	33.6	12.6	24.43	2.91	6.42	19.6	D 19-42
35.3	134.9	82.5	52.4	14.6	25.35	2.07	6.63	19.8	D 19-42
55.3	200.7	148.4	52.4	24.6	28.68	3.37	7.54	20.5	D 19-42
75.3	286.4	234.0	52.4	58.0	30.98	3.73	8.47	21.2	D 19-42
75.3	279.9	234.2	45.7	53.8	30.81	3.61	8.41	21.0	D 19-42
86.9	317.8	272.1	45.7	95.1	31.34	1.73	8.53	20.1	D 19-42
98.5	357.9	312.3	45.7	260.1	32.34	0.28	8.67	19.3	D 19-42

PIER 1B – B-086-1-20


G/L= 0.5/1.0
Rut (kips)
0 80 160 240 320 400
G/L= 0.5/1.0
Mx T-Str. (ksi)
0 2 4 6 8 10
G/L= 0.5/1.0
ENTHRU (kip-ft)
0 10 20 30 40
Depth (ft)
0 20 40 60 80 100 120
0 60 120 180 240 300
Blow Count (bl/ft)
G/L= 0.5/1.0
0 7 14 21 28 35
Mx C-Str. (ksi)
G/L= 0.5/1.0
0.00 2.25 4.50 6.75 9.00
Stroke (ft)
G/L= 0.5/1.0

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

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
8.1	24.8	3.7	21.1	1.8	15.163	1.381	4.63	24.9	D 19-42
16.1	56.9	14.8	42.1	4.9	18.464	1.313	5.33	21.8	D 19-42
16.1	34.7	14.8	19.9	2.5	15.785	1.190	4.80	23.7	D 19-42
17.4	35.8	15.9	19.9	2.6	15.935	1.135	4.82	23.6	D 19-42
18.6	36.9	17.0	19.9	2.6	16.295	1.190	4.84	23.6	D 19-42
18.6	42.6	17.1	25.5	3.3	17.196	1.299	5.00	22.8	D 19-42
24.3	64.3	38.8	25.5	5.7	19.535	1.496	5.49	21.2	D 19-42
29.9	86.1	60.6	25.5	8.3	21.489	1.623	5.90	20.2	D 19-42
29.9	83.5	60.7	22.8	8.0	21.363	1.536	5.85	20.3	D 19-42
37.4	111.4	88.6	22.8	11.7	23.707	2.880	6.26	19.7	D 19-42
44.9	139.5	116.7	22.8	14.8	25.106	2.695	6.52	19.4	D 19-42
44.9	158.4	116.8	41.7	17.0	25.901	3.430	6.77	20.0	D 19-42
57.4	189.5	147.8	41.7	21.9	27.400	4.207	7.22	20.2	D 19-42
69.9	224.6	183.0	41.7	29.5	28.455	5.187	7.57	20.6	D 19-42
69.9	213.3	183.1	30.2	26.7	28.132	4.794	7.45	20.3	D 19-42
74.9	226.5	196.3	30.2	30.5	28.350	4.634	7.58	20.3	D 19-42
79.9	239.7	209.5	30.2	34.9	28.972	3.959	7.77	20.4	D 19-42
79.9	236.5	209.6	26.9	33.9	28.858	3.859	7.72	20.3	D 19-42
94.0	291.0	264.1	26.9	68.5	30.649	2.750	8.20	20.1	D 19-42
108.1	350.0	323.2	26.9	267.5	31.010	0.778	8.23	18.8	D 19-42

Total driving time: 101 minutes; Total Number of Blows: 4230 (starting at penetration 8.1 ft)

CCG3A : 06/21/2022 : KCA 5/21/2024
NATIONAL ENGINEERING AND ARCHITECTURAL 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

HAMMER DATA

Hammer Model:	D 19-42	Made By:	DELMAG
Hammer ID:	41	Hammer Type:	OED
Hammer Database Type:	PDI		
Hammer Database Name:			PDIHammer.gwh

Hammer and Drive System Segment Data

Segment	Weight	Stiffness	COR	C-Slack	Damping
-	kips	kips/in	-	in	kips/ft/s
1	0.800	140,084.4	1.000	0.000	
2	0.800	140,084.4	1.000	0.000	
3	0.800	140,084.4	1.000	0.000	
4	0.800	140,084.4	1.000	0.000	
5	0.800	70,754.7	0.900	0.120	
Imp Block	0.753	4,878.7	0.800	0.120	
Helmet	2.500				1.5

Ram Weight: (kips)	4.00	Ram Length: (ft)	10.76
Ram Area: (in²)	124.69		
Maximum (Eq) Stroke: (ft)	10.81	Actual (Eq) Stroke: (ft)	10.81
Efficiency:	0.800	Rated Energy: (kip-ft)	43.24
Maximum Pressure: (psi)	1,600.00	Actual Pressure: (psi)	1,600.00
Combustion Delay: (ms)	2.00	Ignition Duration: (ms)	2.00
Expansion Exponent:	1.25		

Hammer Cushion		Pile Cushion	
Cross Sect. Area: (in²)	18.41	Cross Sect. Area: (in²)	0.00
Elastic Modulus: (ksi)	530.0	Elastic Modulus: (ksi)	0.0
Thickness: (in)	2.00	Thickness: (in)	0.00
Coeff. of Restitution:	0.800	Coeff. of Restitution:	0.500
RoundOut: (in)	0.120	RoundOut: (in)	0.120
Stiffness: (kips/in)	4,878.7	Stiffness: (kips/in)	0.0
Helmet Weight: (kips)	2.500		

PILE INPUT

Uniform Pile		Pile Type:	Closed-End Pipe
Pile Length: (ft)	108.080	Pile Penetration: (ft)	108.080
Pile Size: (ft)	1.33	Toe Area: (in²)	201.06

Table of Depths Analyzed with Driving System Modifiers

Depth	Temp Length	Wait Time	Hammer
ft	ft	Hr	-
8.05	108.1	0.0	DELMAG D 19-42
16.08	108.1	0.0	DELMAG D 19-42
16.12	108.1	0.0	DELMAG D 19-42
17.35	108.1	0.0	DELMAG D 19-42
18.58	108.1	0.0	DELMAG D 19-42
18.62	108.1	0.0	DELMAG D 19-42
24.25	108.1	0.0	DELMAG D 19-42
29.88	108.1	0.0	DELMAG D 19-42
29.92	108.1	0.0	DELMAG D 19-42
37.40	108.1	0.0	DELMAG D 19-42
44.88	108.1	0.0	DELMAG D 19-42
44.92	108.1	0.0	DELMAG D 19-42
57.40	108.1	0.0	DELMAG D 19-42
69.88	108.1	0.0	DELMAG D 19-42
69.92	108.1	0.0	DELMAG D 19-42
74.90	108.1	0.0	DELMAG D 19-42
79.88	108.1	0.0	DELMAG D 19-42
79.92	108.1	0.0	DELMAG D 19-42
93.98	108.1	0.0	DELMAG D 19-42
108.08	108.1	0.0	DELMAG D 19-42

Other Information for DELMAG D 19-42

Depth	Stroke	Diesel Pressure	Efficiency	P.C. Stiff. Fact.	P.C. COR
ft	ft	%	-	-	-
8.05	10.8	100.0	0.80	1.0	0.50
16.08	10.8	100.0	0.80	1.0	0.50
16.12	10.8	100.0	0.80	1.0	0.50
17.35	10.8	100.0	0.80	1.0	0.50
18.58	10.8	100.0	0.80	1.0	0.50
18.62	10.8	100.0	0.80	1.0	0.50
24.25	10.8	100.0	0.80	1.0	0.50
29.88	10.8	100.0	0.80	1.0	0.50
29.92	10.8	100.0	0.80	1.0	0.50
37.40	10.8	100.0	0.80	1.0	0.50
44.88	10.8	100.0	0.80	1.0	0.50
44.92	10.8	100.0	0.80	1.0	0.50
57.40	10.8	100.0	0.80	1.0	0.50
69.88	10.8	100.0	0.80	1.0	0.50

69.92	10.8	100.0	0.80	1.0	0.50
74.90	10.8	100.0	0.80	1.0	0.50
79.88	10.8	100.0	0.80	1.0	0.50
79.92	10.8	100.0	0.80	1.0	0.50
93.98	10.8	100.0	0.80	1.0	0.50
108.08	10.8	100.0	0.80	1.0	0.50

PILE, SOIL, ANALYSIS OPTIONS

Analysis type:	Driveability Analysis	Soil Damping Option:	Smith
Max No Analysis Iterations:	0	Time Increment/Critical:	160
Residual Stress Analysis:	0	Analysis Time-Input(ms):	0
Output Level:	Normal	Gravitational Acceleration (ft/s²):	32.169
Hammer Gravity (ft/s²):	32.170	Pile Gravity (ft/s²):	32.170

DRIVEABILITY ANALYSIS

Analysis Depth (ft)	108.08	Standard Soil Setup	
Hammer Name	DELMAG D 19-42	Hammer ID	41
Diesel Pressure: (psi)	230.40	Stroke (ft)	10.81
Efficiency	0.80		
Shaft Gain/Loss Factor	0.500	Toe Gain/Loss Factor	1.000

SOIL RESISTANCE PARAMETERS

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Setup F.	Limit D.	Setup T.	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.01	0.0	0.0	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
9.01	0.2	16.9	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
16.09	0.4	30.2	0.10	0.160	0.050	0.2	1.0	6.00	1.0	201.06
16.11	0.3	14.2	0.10	0.200	0.100	0.2	1.5	6.00	24.0	201.06
18.59	0.3	14.2	0.10	0.200	0.100	0.2	1.5	6.00	24.0	201.06
18.61	1.4	18.3	0.10	0.140	0.150	0.2	1.5	6.00	168.0	201.06
29.89	1.4	18.3	0.10	0.140	0.150	0.2	1.5	6.00	168.0	201.06
29.91	1.3	16.4	0.10	0.150	0.150	0.2	1.5	6.00	24.0	201.06
38.91	1.3	16.4	0.10	0.150	0.150	0.2	1.5	6.00	24.0	201.06
44.89	1.4	16.4	0.10	0.150	0.150	0.2	1.5	6.00	24.0	201.06
44.91	0.9	29.8	0.10	0.130	0.150	0.2	1.5	6.00	168.0	201.06
53.91	0.9	29.8	0.10	0.130	0.150	0.2	1.5	6.00	168.0	201.06
62.91	1.0	29.8	0.10	0.130	0.150	0.2	1.5	6.00	168.0	201.06
69.89	1.1	29.8	0.10	0.130	0.150	0.2	1.5	6.00	168.0	201.06
69.91	1.3	21.6	0.10	0.140	0.198	0.2	2.0	6.00	168.0	201.06
79.89	1.3	21.6	0.10	0.140	0.198	0.2	2.0	6.00	168.0	201.06
79.91	1.4	19.2	0.10	0.140	0.150	0.2	1.5	6.00	168.0	201.06
88.91	1.4	19.2	0.10	0.140	0.150	0.2	1.5	6.00	168.0	201.06
97.91	1.5	19.2	0.10	0.140	0.150	0.2	1.5	6.00	168.0	201.06
106.91	1.6	19.2	0.10	0.140	0.150	0.2	1.5	6.00	168.0	201.06
108.08	1.6	19.2	0.10	0.140	0.150	0.2	1.5	6.00	168.0	201.06

PILE PROFILE

Lb Top	X-Area	E-Mod	Spec. Wt	Perim.	C-Index	Wave Sp	Impedance
ft	in²	ksi	lb/ft³	ft	-	ft/s	kips/ft/s
0.00	12.4	30,000	492.00	4.189	0	16,806.4	22.1
108.08	12.4	30,000	492.00	4.189	0	16,806.4	22.1

PILE AND SOIL MODEL

Total Capacity Rut (kips): 350.034

Seg.	Weight	Stiffn.	C-Slk	T-Slk	COR	Ru	Js/Jt	Qs/Qt	LbTop	Perim.	X-Area
-	kips	kips/in	in	in	-	kips	s/ft	in	ft	ft	in²

1	0.14	9,442	0.12	0.00	0.85	0.6	0.050	0.10	3.28	4.19	12.4
2	0.14	9,442	0.00	0.00	1.00	1.8	0.050	0.10	6.55	4.19	12.4
3	0.14	9,442	0.00	0.00	1.00	3.1	0.050	0.10	9.83	4.19	12.4
4	0.14	9,442	0.00	0.00	1.00	4.3	0.050	0.10	13.10	4.19	12.4
5	0.14	9,442	0.00	0.00	1.00	5.2	0.053	0.10	16.38	4.19	12.4
6	0.14	9,442	0.00	0.00	1.00	6.0	0.134	0.10	19.65	4.19	12.4
7	0.14	9,442	0.00	0.00	1.00	12.6	0.150	0.10	22.93	4.19	12.4
9	0.14	9,442	0.00	0.00	1.00	12.6	0.150	0.10	29.48	4.19	12.4
10	0.14	9,442	0.00	0.00	1.00	12.3	0.150	0.10	32.75	4.19	12.4
11	0.14	9,442	0.00	0.00	1.00	12.2	0.150	0.10	36.03	4.19	12.4
12	0.14	9,442	0.00	0.00	1.00	12.2	0.150	0.10	39.30	4.19	12.4
13	0.14	9,442	0.00	0.00	1.00	12.3	0.150	0.10	42.58	4.19	12.4
14	0.14	9,442	0.00	0.00	1.00	11.2	0.150	0.10	45.85	4.19	12.4
15	0.14	9,442	0.00	0.00	1.00	8.1	0.150	0.10	49.13	4.19	12.4
17	0.14	9,442	0.00	0.00	1.00	8.1	0.150	0.10	55.68	4.19	12.4
18	0.14	9,442	0.00	0.00	1.00	8.5	0.150	0.10	58.95	4.19	12.4
19	0.14	9,442	0.00	0.00	1.00	8.8	0.150	0.10	62.23	4.19	12.4
20	0.14	9,442	0.00	0.00	1.00	9.2	0.150	0.10	65.50	4.19	12.4
21	0.14	9,442	0.00	0.00	1.00	9.7	0.150	0.10	68.78	4.19	12.4
22	0.14	9,442	0.00	0.00	1.00	9.1	0.183	0.10	72.05	4.19	12.4
23	0.14	9,442	0.00	0.00	1.00	8.7	0.200	0.10	75.33	4.19	12.4
24	0.14	9,442	0.00	0.00	1.00	8.7	0.200	0.10	78.60	4.19	12.4
25	0.14	9,442	0.00	0.00	1.00	11.1	0.168	0.10	81.88	4.19	12.4
26	0.14	9,442	0.00	0.00	1.00	12.6	0.150	0.10	85.15	4.19	12.4
27	0.14	9,442	0.00	0.00	1.00	12.6	0.150	0.10	88.43	4.19	12.4
28	0.14	9,442	0.00	0.00	1.00	12.7	0.150	0.10	91.70	4.19	12.4
29	0.14	9,442	0.00	0.00	1.00	13.0	0.150	0.10	94.98	4.19	12.4
30	0.14	9,442	0.00	0.00	1.00	13.2	0.150	0.10	98.25	4.19	12.4
31	0.14	9,442	0.00	0.00	1.00	13.6	0.150	0.10	101.53	4.19	12.4
32	0.14	9,442	0.00	0.00	1.00	13.9	0.150	0.10	104.80	4.19	12.4
33	0.14	9,442	0.00	0.00	1.00	14.3	0.150	0.10	108.08	4.19	12.4
Toe						26.9	0.150	0.14	108.08		

4.568 kips total unreduced pile weight (g = 32.169 ft/s²)
4.568 kips total reduced pile weight (g = 32.169 ft/s²)

OTHER OPTIONS

Pile Damping (%):	1	Pile Damping Fact. (kips/ft/s):	0.442

EXTREMA TABLE at 108.1 FT; HAMMER: D 19-42

Shaft/Toe Gain/Loss Factor = 0.500/1.000

Rut = 350.0 kips Rtoe = 26.9 kips Time Inc. = 0.076 ms

Hammer DELMAG D 19-42 Efficiency 0.800

Lb Top ft	Mx.T-For. kips	Mx.C-For kips	Mx.T-Str. ksi	Mx.C-Str. ksi	Mx Vel. ft/s	Mx Dis. in	ENTHRU kip-ft
3.3	0.0	378.5	0.00	30.60	12.57	0.775	18.75
6.6	5.0	382.4	0.41	30.92	12.24	0.745	18.30
9.8	8.3	383.6	0.67	31.01	11.78	0.714	17.75
13.1	9.6	382.9	0.78	30.96	11.23	0.683	17.11
16.4	9.0	380.9	0.73	30.79	10.69	0.652	16.41
19.7	6.7	378.0	0.55	30.56	10.16	0.621	15.58
22.9	2.9	374.6	0.24	30.28	9.64	0.591	14.38
26.2	0.0	354.9	0.00	28.69	9.13	0.561	12.95
29.5	0.0	337.8	0.00	27.30	8.65	0.533	11.63
32.8	0.0	321.5	0.00	25.99	8.21	0.506	10.43
36.0	0.0	306.6	0.00	24.79	7.82	0.480	9.33
39.3	0.0	292.4	0.00	23.63	7.48	0.455	8.33
42.6	0.0	278.5	0.00	22.52	7.16	0.432	7.41
45.9	0.0	264.9	0.00	21.41	6.84	0.412	6.62
49.1	0.0	253.1	0.00	20.46	6.52	0.393	5.99
52.4	0.0	245.2	0.00	19.82	6.18	0.373	5.48
55.7	0.0	235.6	0.00	19.05	5.85	0.354	4.99
59.0	0.0	223.4	0.00	18.06	5.51	0.334	4.51
62.2	0.0	208.2	0.00	16.83	5.17	0.314	4.05
65.5	0.0	200.1	0.00	16.18	4.84	0.295	3.62
68.8	0.0	199.8	0.00	16.15	4.53	0.277	3.21
72.1	0.0	195.0	0.00	15.76	4.31	0.260	2.84
75.3	0.0	186.1	0.00	15.04	4.15	0.244	2.51
78.6	0.0	175.3	0.00	14.17	3.99	0.228	2.20
81.9	0.0	165.3	0.00	13.37	3.82	0.213	1.91
85.2	0.0	153.1	0.00	12.38	3.67	0.199	1.63
88.4	0.0	141.2	0.00	11.42	3.51	0.186	1.36
91.7	0.0	128.8	0.00	10.41	3.50	0.176	1.13
95.0	0.0	115.8	0.00	9.36	3.45	0.167	0.94
98.3	0.0	101.6	0.00	8.21	3.33	0.160	0.76
101.5	0.0	85.7	0.00	6.93	3.75	0.155	0.59
104.8	0.0	68.0	0.00	5.50	4.29	0.150	0.44
108.1	0.0	49.0	0.00	3.96	4.56	0.146	0.36

Converged Stroke (ft) 8.23 Fixed Combustion Pressure (psi) 1,600.0

(Eq) Strokes Analyzed and Last Return (ft)

10.81 8.25 8.23

SUMMARY TABLE at 108.1 FT; HAMMER: D 19-42

Rut	Bl Ct	Stk Dn	Stk Up	Mx T-Str	LTop	Mx C-Str	LTop	ENTHRU	Bl Rt	ActRes
kips	b/ft	ft	ft	ksi	ft	ksi	ft	kip-ft	b/min	kips
350.0	267.5	8.23	0.00	0.78	13.1	31.01	9.8	18.8	41.1	350.0

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.500/1.000

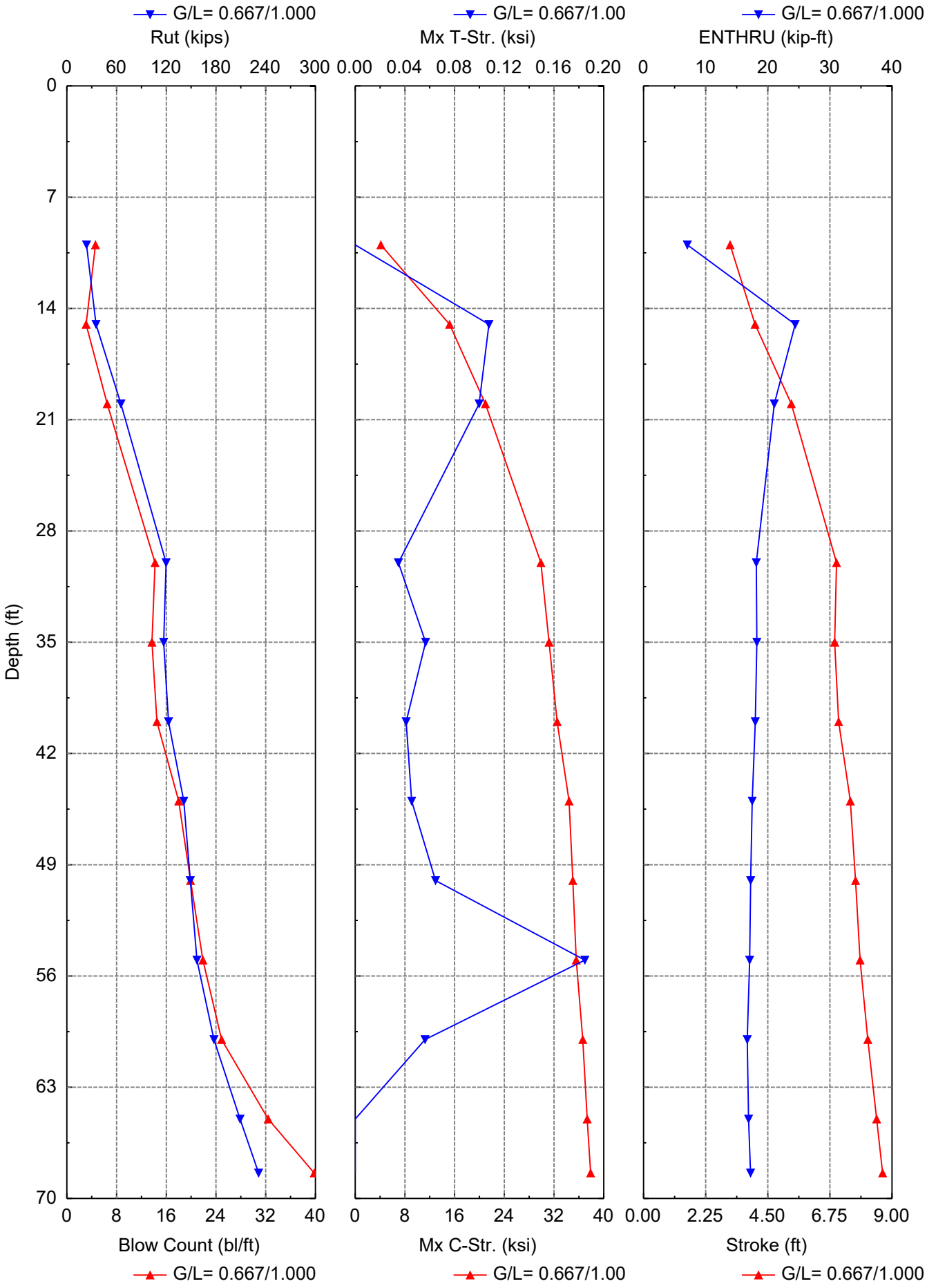
Depth	Rut	Rshaft	Rtoe	Bl Ct	Mx C-Str	Mx T-Str	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	b/ft	ksi	ksi	ft	kip-ft	-
8.1	24.8	3.7	21.1	1.8	15.16	1.38	4.63	24.9	D 19-42
16.1	56.9	14.8	42.1	4.9	18.46	1.31	5.33	21.8	D 19-42
16.1	34.7	14.8	19.9	2.5	15.79	1.19	4.80	23.7	D 19-42
17.4	35.8	15.9	19.9	2.6	15.93	1.14	4.82	23.6	D 19-42
18.6	36.9	17.0	19.9	2.6	16.29	1.19	4.84	23.6	D 19-42
18.6	42.6	17.1	25.5	3.3	17.20	1.30	5.00	22.8	D 19-42
24.3	64.3	38.8	25.5	5.7	19.53	1.50	5.49	21.2	D 19-42
29.9	86.1	60.6	25.5	8.3	21.49	1.62	5.90	20.2	D 19-42
29.9	83.5	60.7	22.8	8.0	21.36	1.54	5.85	20.3	D 19-42
37.4	111.4	88.6	22.8	11.7	23.71	2.88	6.26	19.7	D 19-42
44.9	139.5	116.7	22.8	14.8	25.11	2.70	6.52	19.4	D 19-42
44.9	158.4	116.8	41.7	17.0	25.90	3.43	6.77	20.0	D 19-42
57.4	189.5	147.8	41.7	21.9	27.40	4.21	7.22	20.2	D 19-42
69.9	224.6	183.0	41.7	29.5	28.46	5.19	7.57	20.6	D 19-42
69.9	213.3	183.1	30.2	26.7	28.13	4.79	7.45	20.3	D 19-42
74.9	226.5	196.3	30.2	30.5	28.35	4.63	7.58	20.3	D 19-42
79.9	239.7	209.5	30.2	34.9	28.97	3.96	7.77	20.4	D 19-42
79.9	236.5	209.6	26.9	33.9	28.86	3.86	7.72	20.3	D 19-42
94.0	291.0	264.1	26.9	68.5	30.65	2.75	8.20	20.1	D 19-42
108.1	350.0	323.2	26.9	267.5	31.01	0.78	8.23	18.8	D 19-42

FORWARD ABUTMENT AND WING WALLS – C-087-0-14

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

Depth	Rut	Rshaft	Rtoe	Blow Ct	Mx C-Str	Mx T-Str.	Stroke	ENTHRU	Hammer
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft	-
10.0	23.7	4.4	19.3	4.6	4.127	0.000	3.14	7.0	D 19-42
15.0	35.3	11.7	23.6	3.1	15.193	0.108	4.04	24.4	D 19-42
20.0	65.2	41.6	23.6	6.5	20.959	0.100	5.35	21.1	D 19-42
30.0	119.8	96.2	23.6	14.2	29.891	0.035	6.99	18.1	D 19-42
35.0	116.9	103.9	13.0	13.7	31.204	0.057	6.92	18.2	D 19-42
40.0	122.7	109.7	13.0	14.5	32.505	0.041	7.07	18.0	D 19-42
45.0	141.1	118.5	22.6	18.0	34.423	0.045	7.49	17.5	D 19-42
50.0	149.0	126.4	22.6	19.9	35.029	0.065	7.68	17.2	D 19-42
55.0	157.0	134.3	22.6	21.9	35.576	0.185	7.84	17.1	D 19-42
60.0	177.5	154.9	22.6	24.9	36.625	0.056	8.12	16.7	D 19-42
65.0	209.0	186.4	22.6	32.4	37.347	0.000	8.44	16.9	D 19-42
68.4	231.4	208.8	22.6	39.8	37.882	0.000	8.66	17.2	D 19-42

Total driving time: 22 minutes; Total Number of Blows: 950 (starting at penetration 10.0 ft)


G/L= 0.667/1.000
Rut (kips)
0 60 120 180 240 300
G/L= 0.667/1.00
Mx T-Str. (ksi)
0.00 0.04 0.08 0.12 0.16 0.20
G/L= 0.667/1.000
ENTHRU (kip-ft)
0 10 20 30 40
Depth (ft)
0 7 14 21 28 35 42 49 56 63 70
0 8 16 24 32 40
Blow Count (bl/ft)
0 8 16 24 32 40
Mx C-Str. (ksi)
0.00 2.25 4.50 6.75 9.00
Stroke (ft)
G/L= 0.667/1.000
G/L= 0.667/1.00
G/L= 0.667/1.000

Bridge CUY-90-1678 (Over IR-90) Replacement + Forward Abutment 8/15/2023
NATIONAL ENGINEERING AND ARCHITECTURAL 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.

HAMMER DATA

Hammer Model:	D 19-42	Made By:	DELMAG
Hammer ID:	41	Hammer Type:	OED
Hammer Database Type:	PDI		
Hammer Database Name:			PDIHammer.gwh

Hammer and Drive System Segment Data

Segment -	Weight kips	Stiffness kips/in	COR -	C-Slack in	Damping kips/ft/s
1	0.800	140,084.4	1.000	0.000	
2	0.800	140,084.4	1.000	0.000	
3	0.800	140,084.4	1.000	0.000	
4	0.800	140,084.4	1.000	0.000	
5	0.800	70,754.7	0.900	0.120	
Imp Block	0.753	2,861.8	0.800	0.120	
Helmet	1.200				1.1

Ram Weight: (kips)	4.00	Ram Length: (ft)	10.76
Ram Area: (in²)	124.69		
Maximum (Eq) Stroke: (ft)	10.81	Actual (Eq) Stroke: (ft)	10.81
Efficiency:	0.800	Rated Energy: (kip-ft)	43.24
Maximum Pressure: (psi)	1,600.00	Actual Pressure: (psi)	1,600.00
Combustion Delay: (ms)	2.00	Ignition Duration: (ms)	2.00
Expansion Exponent:	1.25		

Hammer Cushion		Pile Cushion	
Cross Sect. Area: (in²)	10.80	Cross Sect. Area: (in²)	0.00
Elastic Modulus: (ksi)	530.0	Elastic Modulus: (ksi)	0.0
Thickness: (in)	2.00	Thickness: (in)	0.00
Coeff. of Restitution:	0.800	Coeff. of Restitution:	0.500
RoundOut: (in)	0.120	RoundOut: (in)	0.120
Stiffness: (kips/in)	2,861.8	Stiffness: (kips/in)	0.0
Helmet Weight: (kips)	1.200		

PILE INPUT

Uniform Pile		Pile Type:	Closed-End Pipe
Pile Length: (ft)	80.000	Pile Penetration: (ft)	68.400
Pile Size: (ft)	1.17	Toe Area: (in²)	153.94

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp Length ft	Wait Time Hr	Hammer -
5.00	5.0	0.0	DELMAG D 19-42
10.00	10.0	0.0	DELMAG D 19-42
15.00	15.0	0.0	DELMAG D 19-42
20.00	20.0	0.0	DELMAG D 19-42
25.00	25.0	0.0	DELMAG D 19-42
30.00	30.0	0.0	DELMAG D 19-42
35.00	35.0	0.0	DELMAG D 19-42
40.00	40.0	0.0	DELMAG D 19-42
45.00	45.0	0.0	DELMAG D 19-42
50.00	50.0	0.0	DELMAG D 19-42
55.00	55.0	0.0	DELMAG D 19-42
60.00	60.0	0.0	DELMAG D 19-42
65.00	65.0	0.0	DELMAG D 19-42
68.40	68.4	0.0	DELMAG D 19-42

Other Information for DELMAG D 19-42

Depth ft	Stroke ft	Diesel Pressure %	Efficiency -	P.C. Stiff. Fact. -	P.C. COR -
5.00	10.8	100.0	0.80	1.0	0.50
10.00	10.8	100.0	0.80	1.0	0.50
15.00	10.8	100.0	0.80	1.0	0.50
20.00	10.8	100.0	0.80	1.0	0.50
25.00	10.8	100.0	0.80	1.0	0.50
30.00	10.8	100.0	0.80	1.0	0.50
35.00	10.8	100.0	0.80	1.0	0.50
40.00	10.8	100.0	0.80	1.0	0.50
45.00	10.8	100.0	0.80	1.0	0.50
50.00	10.8	100.0	0.80	1.0	0.50
55.00	10.8	100.0	0.80	1.0	0.50
60.00	10.8	100.0	0.80	1.0	0.50
65.00	10.8	100.0	0.80	1.0	0.50
68.40	10.8	100.0	0.80	1.0	0.50

PILE, SOIL, ANALYSIS OPTIONS

Analysis type:	Driveability Analysis	Soil Damping Option:	Smith
Max No Analysis Iterations:	0	Time Increment/Critical:	160
Residual Stress Analysis:	0	Analysis Time-Input(ms):	0
Output Level:	Normal	Gravitational Acceleration (ft/s²):	32.169
Hammer Gravity (ft/s²):	32.169	Pile Gravity (ft/s²):	32.169

DRIVEABILITY ANALYSIS

Analysis Depth (ft)	68.40	Standard Soil Setup	
Hammer Name	DELMAG D 19-42	Hammer ID	41
Diesel Pressure: (psi)	230.40	Stroke (ft)	10.81
Efficiency	0.80		
Shaft Gain/Loss Factor	0.667	Toe Gain/Loss Factor	1.000

SOIL RESISTANCE PARAMETERS

Depth	Unit Rs	Unit Rt	Qs	Qt	Js	Jt	Setup F.Limit D.		Setup T	EB Area
ft	ksf	ksf	in	in	s/ft	s/ft	-	ft	Hours	in²
0.00	0.0	0.4	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
1.83	0.1	3.7	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
3.65	0.1	6.9	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
5.48	0.2	10.1	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
7.30	0.2	13.3	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
9.13	0.3	16.5	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
10.95	0.3	19.8	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
12.78	0.4	23.0	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
14.60	0.4	26.2	0.10	0.145	0.050	0.1	1.2	6.00	24.0	153.94
14.60	2.3	22.0	0.10	0.134	0.150	0.1	1.5	6.00	24.0	153.94
30.60	2.3	22.0	0.10	0.134	0.150	0.1	1.5	6.00	24.0	153.94
30.60	0.6	12.1	0.10	0.154	0.150	0.1	1.5	6.00	168.0	153.94
44.10	0.6	12.1	0.10	0.154	0.150	0.1	1.5	6.00	168.0	153.94
44.10	1.5	21.1	0.10	0.135	0.150	0.1	1.5	6.00	24.0	153.94
68.40	1.5	21.1	0.10	0.135	0.150	0.1	1.5	6.00	24.0	153.94

PILE PROFILE

Lb Top	X-Area	E-Mod	Spec. Wt	Perim.	C-Index	Wave Sp	Impedance
ft	in²	ksi	lb/ft³	ft	-	ft/s	kips/ft/s
0.00	10.8	30,000	492.00	3.665	0	16,806.4	19.3
68.40	10.8	30,000	492.00	3.665	0	16,806.4	19.3

PILE AND SOIL MODEL Total Capacity Rut (kips): 231.406

Seg.	Weight	Stiffn.	C-Slk	T-Slk	COR	Ru	Js/Jt	Qs/Qt	LbTop	Perim.	X-Area
-	kips	kips/in	in	in	-	kips	s/ft	in	ft	ft	in²
1	0.12	8,289	0.12	0.00	0.85	0.5	0.050	0.10	3.26	3.67	10.8
2	0.12	8,289	0.00	0.00	1.00	1.4	0.050	0.10	6.51	3.67	10.8
3	0.12	8,289	0.00	0.00	1.00	2.3	0.050	0.10	9.77	3.67	10.8
4	0.12	8,289	0.00	0.00	1.00	3.2	0.050	0.10	13.03	3.67	10.8
5	0.12	8,289	0.00	0.00	1.00	11.3	0.136	0.10	16.29	3.67	10.8
6	0.12	8,289	0.00	0.00	1.00	18.2	0.150	0.10	19.54	3.67	10.8
9	0.12	8,289	0.00	0.00	1.00	18.2	0.150	0.10	29.31	3.67	10.8

10	0.12	8,289	0.00	0.00	1.00	9.9	0.150	0.10	32.57	3.67	10.8
11	0.12	8,289	0.00	0.00	1.00	4.4	0.150	0.10	35.83	3.67	10.8
13	0.12	8,289	0.00	0.00	1.00	4.4	0.150	0.10	42.34	3.67	10.8
14	0.12	8,289	0.00	0.00	1.00	8.1	0.150	0.10	45.60	3.67	10.8
15	0.12	8,289	0.00	0.00	1.00	12.3	0.150	0.10	48.86	3.67	10.8
21	0.12	8,289	0.00	0.00	1.00	12.3	0.150	0.10	68.40	3.67	10.8
Toe						22.6	0.149	0.14	68.40		

2.524 kips total unreduced pile weight (g = 32.169 ft/s²)
2.524 kips total reduced pile weight (g = 32.169 ft/s²)

OTHER OPTIONS

Pile Damping (%):	1	Pile Damping Fact. (kips/ft/s):	0.386

EXTREMA TABLE at 68.4 FT; HAMMER: D 19-42

Shaft/Toe Gain/Loss Factor = 0.667/1.000

Rut = 231.4 kips Rtoe = 22.6 kips Time Inc. = 0.076 ms

Hammer DELMAG D 19-42 Efficiency 0.800

Lb Top ft	Mx.T-For. kips	Mx.C-For kips	Mx.T-Str. ksi	Mx.C-Str. ksi	Mx Vel. ft/s	Mx Dis. in	ENTHRU kip-ft
3.3	0.0	386.3	0.00	35.77	13.39	0.721	17.23
6.5	0.0	397.7	0.00	36.83	13.21	0.690	16.83
9.8	0.0	405.0	0.00	37.51	12.86	0.661	16.42
13.0	0.0	408.6	0.00	37.84	12.20	0.632	15.96
16.3	0.0	409.1	0.00	37.88	11.33	0.603	15.04
19.5	0.0	388.9	0.00	36.01	10.44	0.574	13.44
22.8	0.0	352.8	0.00	32.67	9.57	0.549	11.66
26.1	0.0	319.3	0.00	29.56	8.79	0.528	10.06
29.3	0.0	288.0	0.00	26.67	8.27	0.512	8.61
32.6	0.0	257.8	0.00	23.87	7.95	0.499	7.55
35.8	0.0	244.3	0.00	22.62	7.66	0.487	7.02
39.1	0.0	239.0	0.00	22.13	7.34	0.476	6.68
42.3	0.0	229.1	0.00	21.22	7.05	0.464	6.36
45.6	0.0	215.2	0.00	19.92	7.27	0.452	5.95
48.9	0.0	199.1	0.00	18.43	7.19	0.441	5.32
52.1	0.0	187.1	0.00	17.33	6.79	0.431	4.61
55.4	0.0	170.2	0.00	15.76	6.30	0.423	3.93
58.6	0.0	148.8	0.00	13.77	6.08	0.417	3.28
61.9	0.0	126.0	0.00	11.67	6.26	0.412	2.64
65.1	0.0	100.0	0.00	9.26	6.81	0.408	2.01
68.4	0.0	71.1	0.00	6.58	7.05	0.405	1.69

Converged Stroke (ft) 8.66 Fixed Combustion Pressure (psi) 1,600.0

(Eq) Strokes Analyzed and Last Return (ft)

10.81 8.78 8.66 8.66

SUMMARY TABLE at 68.4 FT; HAMMER: D 19-42

Rut kips	Bl Ct b/ft	Stk Dn ft	Stk Up ft	Mx T-Str ksi	LTop ft	Mx C-Str ksi	LTop ft	ENTHRU kip-ft	Bl Rt b/min	ActRes kips
231.4	39.8	8.66	0.00	0.00	3.3	37.88	16.3	17.2	40.1	231.4

WALL AG - STA. 500+39.4 TO STA. 502+49.4 – B-002-D-06

Gain/Loss 3 at Shaft and Toe 0.500 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.5	7.9	0.6	7.3	1.2	10.702	-1.564	3.75	19.9
2.5	4.1	0.6	3.6	0.0	0.000	0.000	10.81	0.0
5.0	6.8	1.4	5.4	0.0	0.000	0.000	10.81	0.0
7.5	9.8	2.6	7.3	1.3	12.243	-3.035	3.92	20.0
7.5	17.7	2.6	15.1	1.6	14.164	-1.902	4.38	24.7
25.8	86.8	35.4	51.5	7.7	20.015	0.000	5.69	20.6
44.0	157.8	104.3	53.5	13.9	23.402	-3.723	6.47	20.3
44.0	125.6	104.5	21.2	10.1	22.307	-3.537	6.03	20.0
70.2	213.1	191.9	21.2	23.5	27.145	-5.605	7.40	21.0
96.3	321.2	300.0	21.2	126.6	30.462	-5.141	8.56	21.8
96.3	315.1	300.2	14.9	106.6	30.395	-5.112	8.51	21.7
110.4	347.9	333.0	14.9	336.4	31.246	-3.199	8.57	20.5
124.5	382.6	367.7	14.9	9999.0	31.805	-1.006	8.65	19.2

Refusal occurred; no driving time output possible

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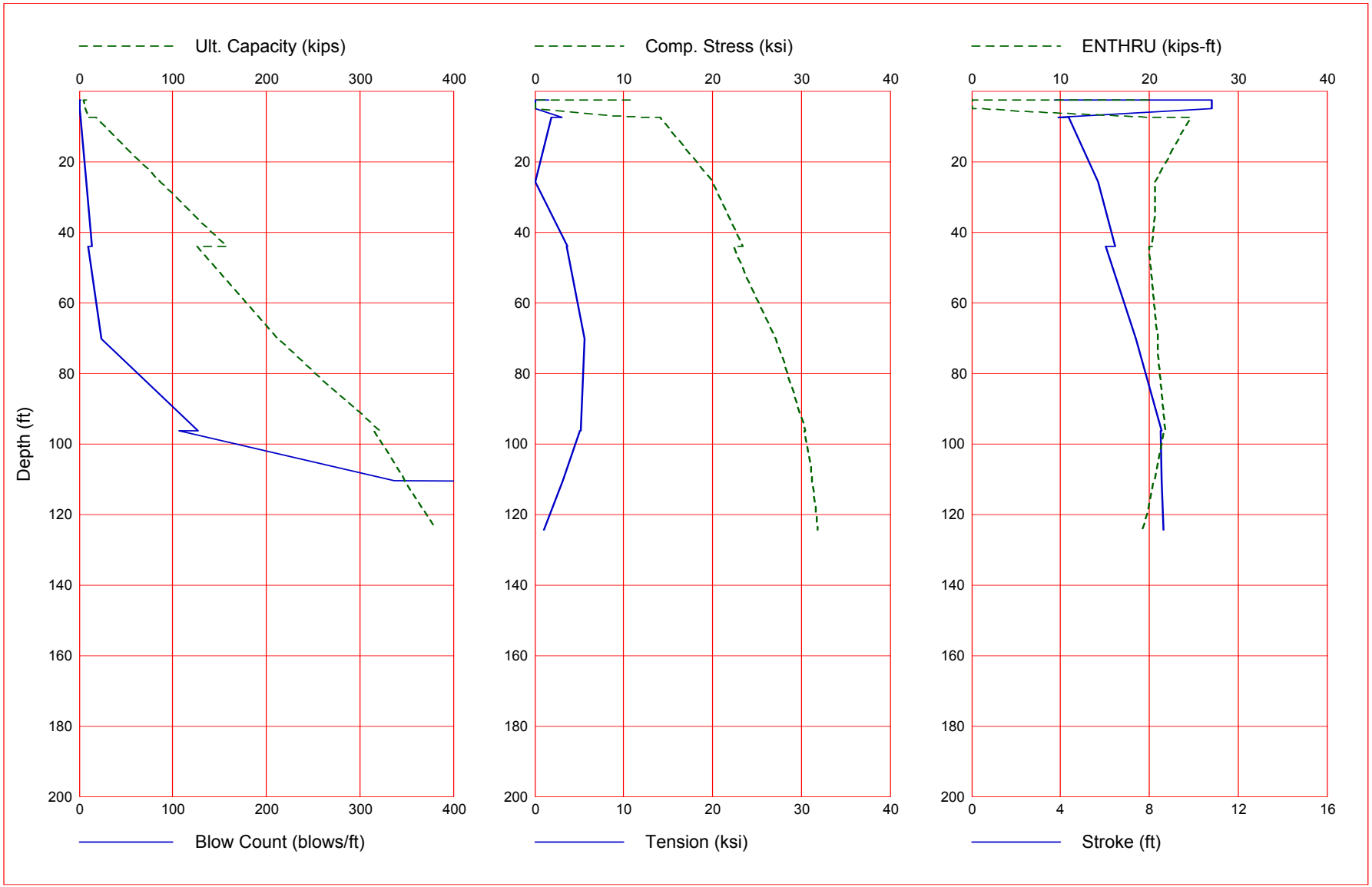
Jan 17 2024
GRLWEAP Version 2010

Gain/Loss 3 at Shaft and Toe 0.500 / 1.000



GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

♀
Input File: C:\USERS\KARENS\DESKTOP\GRL\AG1_14IN.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
Hammer File Version: 2003 (10/17/2016)

Input File Contents

CCG3A : 12/07/2023 : KCA

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
-100	0	41	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size	Pile Type
32.170	32.170	144.000	14.000	Unknown

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
2.500	10.790	530.0	2.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	CI	CoR	ROut
124.480	10.80	30000.0	492.000	3.670	0	0.850	0.010

FFatigue	F0	0-Bottom
0	0.000	0.000

Manufac	Hmr Name	HmrType No	Seg-s
DELMAG	D 19-42	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
4.00	129.10	12.60	11.86	10.81	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
0.75	25.30	12.60	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
16.65	124.70	157.70	0.0020	0.0020	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1600.00	1440.00	1295.00	1165.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.8100	0.8000	1600.0000	0.0000	0.0000	0.0000	0.0100	0.0000

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

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

0.000	0.000	0.000	0.000

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

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Rtoe	Qs	Qt	Js	Jt	SU F	LimL	TSf0
0.01	0.00	0.04	0.10	0.15	0.05	0.15	1.00	7.00	1.000
1.09	0.06	4.44	0.10	0.15	0.05	0.15	1.00	7.00	1.000
1.11	0.06	4.50	0.10	0.15	0.05	0.15	1.00	7.00	1.000
2.49	0.11	7.31	0.10	0.15	0.05	0.15	1.00	7.00	1.000
2.51	0.07	3.55	0.10	0.20	0.05	0.15	1.00	7.00	1.000
7.49	0.15	7.29	0.10	0.20	0.05	0.15	1.00	7.00	1.000
7.51	0.22	15.11	0.10	0.20	0.05	0.15	1.00	7.00	1.000
16.51	0.49	33.46	0.10	0.16	0.05	0.15	1.00	7.00	1.000
25.51	0.75	51.40	0.10	0.16	0.05	0.15	1.00	7.00	1.000
34.51	1.02	53.45	0.10	0.16	0.05	0.15	1.00	7.00	1.000
43.51	1.29	53.45	0.10	0.16	0.05	0.15	1.00	7.00	1.000
43.99	1.30	53.45	0.10	0.16	0.05	0.15	1.00	7.00	1.000
44.01	1.30	21.17	0.10	0.14	0.15	0.15	1.49	7.00	168.000
53.01	1.30	21.17	0.10	0.14	0.15	0.15	1.49	7.00	168.000
62.01	1.39	21.17	0.10	0.14	0.15	0.15	1.49	7.00	168.000
71.01	1.52	21.17	0.10	0.14	0.15	0.15	1.49	7.00	168.000
80.01	1.65	21.17	0.10	0.14	0.15	0.15	1.49	7.00	168.000
89.01	1.78	21.17	0.10	0.14	0.15	0.15	1.49	7.00	168.000
96.29	1.80	21.17	0.10	0.14	0.15	0.15	1.49	7.00	168.000
96.31	1.27	14.91	0.10	0.15	0.20	0.15	2.00	7.00	168.000
105.31	1.27	14.91	0.10	0.15	0.20	0.15	2.00	7.00	168.000
114.31	1.32	14.91	0.10	0.15	0.20	0.15	2.00	7.00	168.000
123.31	1.39	14.91	0.10	0.15	0.20	0.15	2.00	7.00	168.000
124.48	1.40	14.91	0.10	0.15	0.20	0.15	2.00	7.00	168.000

Gain/Loss factors: shaft and toe

0.40000	0.45000	0.50000	0.55000	0.60000
1.00000	1.00000	1.00000	1.00000	1.00000

Dpth	L	Wait	Strk	Pmx%	Eff.	Stff	CoR
2.48	0.00	0.00	0.000	0.0	0.000	0.000	0.000
2.52	0.00	0.00	0.000	0.0	0.000	0.000	0.000
5.00	0.00	0.00	0.000	0.0	0.000	0.000	0.000
7.48	0.00	0.00	0.000	0.0	0.000	0.000	0.000
7.52	0.00	0.00	0.000	0.0	0.000	0.000	0.000
25.75	0.00	0.00	0.000	0.0	0.000	0.000	0.000
43.98	0.00	0.00	0.000	0.0	0.000	0.000	0.000
44.02	0.00	0.00	0.000	0.0	0.000	0.000	0.000
70.15	0.00	0.00	0.000	0.0	0.000	0.000	0.000
96.28	0.00	0.00	0.000	0.0	0.000	0.000	0.000
96.32	0.00	0.00	0.000	0.0	0.000	0.000	0.000
110.38	0.00	0.00	0.000	0.0	0.000	0.000	0.000
124.48	0.00	0.00	0.000	0.0	0.000	0.000	0.000

0.00 0.00 0.00 0.000 0.0 0.000 0.000 0.000

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

CCG3A : 12/07/2023 : KCA

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.6	1.000	0.0000	
3	0.800	140046.6	1.000	0.0000	
4	0.800	140046.6	1.000	0.0000	
5	0.800	140046.6	1.000	0.0000	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	2.500	2859.4	0.800	0.0100	5.8
Combined Pile Top		8025.4			

HAMMER OPTIONS:

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

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1600.00	Actual Pressure	(psi)	1600.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	10.79	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	2859.4	Stiffness	(kips/in)	0.0

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Depth	(ft)	2.5	Standard Soil Setup		
Shaft Gain/Loss Factor		0.400	Toe Gain/Loss Factor		1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type		Unknown
Pile Size	(inch)	14.000			

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3

```
    124.5    10.80   30000.    492.0      3.7        0    16807.     19.3

 Wave Travel Time 2L/c (ms)    14.813

        Pile and Soil Model            Total Capacity Rut  (kips)       7.9
No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch     ft    ft     in2
  1  0.124     8025 0.010 0.000 0.85     0.0   0.000 0.100   3.36   3.7    10.8
  2  0.124     8025 0.000 0.000 1.00     0.0   0.000 0.100   6.73   3.7    10.8
 37  0.124     8025 0.000 0.000 1.00     0.6   0.050 0.100 124.48   3.7    10.8
Toe                                      7.3   0.150 0.150

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

 PILE, SOIL, ANALYSIS OPTIONS:
 Uniform pile                          Pile Segments: Automatic
 No. of Slacks/Splices             0  Pile Damping           (%)         1
                                      Pile Damping Fact.(k/ft/s)     0.386
 Driveability Analysis
 Soil Damping Option           Smith
 Max No Analysis Iterations        0  Time Increment/Critical          160
 Output Time Interval              1  Analysis Time-Input   (ms)         0
 Output Level: Normal
 Gravity Mass, Pile, Hammer:   32.170    32.170    32.170
 Output Segment Generation: Automatic

    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
     2.48     10.81      1.00     0.800
♀
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    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi              ksi          kip-ft   b/min
    7.9     1.2   3.75   3.77   -1.56   6  21    10.70   1   7   19.9    60.8
    7.9     1.2   3.75   3.77   -1.56   6  21    10.70   1   7   19.9    60.8
    7.9     1.2   3.75   3.77   -1.56   6  21    10.70   1   7   19.9    60.8
    7.9     1.2   3.75   3.77   -1.56   6  21    10.70   1   7   19.9    60.8
    7.9     1.2   3.75   3.77   -1.56   6  21    10.70   1   7   19.9    60.8
♀
CCG3A : 12/07/2023 : KCA                                        01/17/2024
National Engineering & Architectural Ser                 GRLWEAP Version 2010

 Depth                 (ft)       2.5  Standard Soil Setup
 Shaft Gain/Loss Factor         0.400  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area             (in2)   144.000  Pile Type                     Unknown
 Pile Size           (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s    k/ft/s
      0.0    10.80   30000.    492.0      3.7        0    16807.     19.3
    124.5    10.80   30000.    492.0      3.7        0    16807.     19.3

 Wave Travel Time 2L/c (ms)    14.813

        Pile and Soil Model            Total Capacity Rut  (kips)       4.1
No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch     ft    ft     in2
  1  0.124     8025 0.010 0.000 0.85     0.0   0.000 0.100   3.36   3.7    10.8
```

```
  2  0.124     8025 0.000 0.000 1.00     0.0   0.000 0.100   6.73   3.7    10.8
 37  0.124     8025 0.000 0.000 1.00     0.6   0.050 0.100 124.48   3.7    10.8
Toe                                      3.6   0.150 0.200

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


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
     2.52     10.81      1.00     0.800


INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     7.8     4.1
 Hammer+Pile Weight > Rult: Pile Runs


INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     7.8     4.1
 Hammer+Pile Weight > Rult: Pile Runs


INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     7.8     4.1
 Hammer+Pile Weight > Rult: Pile Runs


INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     7.8     4.1
 Hammer+Pile Weight > Rult: Pile Runs


INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     7.8     4.1
 Hammer+Pile Weight > Rult: Pile Runs
♀
CCG3A : 12/07/2023 : KCA                                         01/17/2024
National Engineering & Architectural Ser                GRLWEAP Version 2010

    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi              ksi         kip-ft   b/min
    4.1     0.0  10.81   0.00    0.00   1   0     0.00   1   7    0.0    78.4
    4.1     0.0  10.81   0.00    0.00   1   0     0.00   1   7    0.0    78.4
    4.1     0.0  10.81   0.00    0.00   1   0     0.00   1   7    0.0    78.4
    4.1     0.0  10.81   0.00    0.00   1   0     0.00   1   7    0.0    78.4
    4.1     0.0  10.81   0.00    0.00   1   0     0.00   1   7    0.0    78.4
♀
CCG3A : 12/07/2023 : KCA                                         01/17/2024
National Engineering & Architectural Ser                GRLWEAP Version 2010

 Depth                 (ft)       5.0  Standard Soil Setup
 Shaft Gain/Loss Factor         0.400  Toe Gain/Loss Factor           1.000

 PILE PROFILE:
 Toe Area             (in2)   144.000  Pile Type                    Unknown
 Pile Size           (inch)    14.000

  L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp      EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s    k/ft/s
      0.0    10.80   30000.    492.0      3.7        0    16807.     19.3
    124.5    10.80   30000.    492.0      3.7        0    16807.     19.3

 Wave Travel Time 2L/c (ms)    14.813

       Pile and Soil Model           Total Capacity Rut  (kips)       6.8
No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake  LbTop Perim    Area
      kips     k/in    ft    ft        kips    s/ft  inch     ft    ft     in2
```

1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	0.3	0.050	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	1.1	0.050	0.100	124.48	3.7	10.8
Toe						5.4	0.150	0.200			

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

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
5.00	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.8 6.8
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.8 6.8
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.8 6.8
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.8 6.8
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.8 6.8
Hammer+Pile Weight > Rult: Pile Runs
♀
CCG3A : 12/07/2023 : KCA 01/17/2024
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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
6.8	0.0	10.81	0.00	0.00	1	0	0.00	1	7	0.0	78.4
6.8	0.0	10.81	0.00	0.00	1	0	0.00	1	7	0.0	78.4
6.8	0.0	10.81	0.00	0.00	1	0	0.00	1	7	0.0	78.4
6.8	0.0	10.81	0.00	0.00	1	0	0.00	1	7	0.0	78.4
6.8	0.0	10.81	0.00	0.00	1	0	0.00	1	7	0.0	78.4

♀
CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 7.5 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model Total Capacity Rut (kips) 9.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	0.1	0.050	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	1.0	0.050	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	1.5	0.050	0.100	124.48	3.7	10.8
Toe						7.3	0.150	0.200			

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

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
7.48	10.81	1.00	0.800

♀
CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
9.8	1.3	3.92	3.94	-3.03	9	21	12.24	1	7	20.0	59.5
9.8	1.3	3.92	3.94	-3.03	9	21	12.24	1	7	20.0	59.5
9.8	1.3	3.92	3.94	-3.03	9	21	12.24	1	7	20.0	59.5
9.8	1.3	3.92	3.94	-3.03	9	21	12.24	1	7	20.0	59.5
9.8	1.3	3.92	3.94	-3.03	9	21	12.24	1	7	20.0	59.5

♀
CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 7.5 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model Total Capacity Rut (kips) 17.7

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	0.1	0.050	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	1.0	0.050	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	1.5	0.050	0.100	124.48	3.7	10.8
Toe						15.1	0.150	0.200			

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

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
7.52	10.81	1.00	0.800

♀

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
17.7	1.6	4.38	4.40	-1.90	10	20	14.16	1	7	24.7	56.6
17.7	1.6	4.38	4.40	-1.90	10	20	14.16	1	7	24.7	56.6
17.7	1.6	4.38	4.40	-1.90	10	20	14.16	1	7	24.7	56.6
17.7	1.6	4.38	4.40	-1.90	10	20	14.16	1	7	24.7	56.6
17.7	1.6	4.38	4.40	-1.90	10	20	14.16	1	7	24.7	56.6

♀

Depth (ft) 25.8 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model — Total Capacity Rut (kips) 86.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	0.5	0.050	0.100	100.93	3.7	10.8
31	0.124	8025	0.000	0.000	1.00	1.2	0.050	0.100	104.29	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	2.2	0.050	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	3.8	0.050	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	5.1	0.050	0.100	114.39	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	6.3	0.050	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	7.5	0.050	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	8.8	0.050	0.100	124.48	3.7	10.8
Toe						51.5	0.150	0.160			

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

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
25.75	10.81	1.00	0.800

♀

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
86.8	7.7	5.69	5.74	0.00	1	0	20.01	28	10	20.6	49.2
86.8	7.7	5.69	5.74	0.00	1	0	20.01	28	10	20.6	49.2
86.8	7.7	5.69	5.74	0.00	1	0	20.01	28	10	20.6	49.2
86.8	7.7	5.69	5.74	0.00	1	0	20.01	28	10	20.6	49.2
86.8	7.7	5.69	5.74	0.00	1	0	20.01	28	10	20.6	49.2

♀

Depth (ft) 44.0 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model — Total Capacity Rut (kips) 157.8

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
24	0.124	8025	0.000	0.000	1.00	0.0	0.050	0.100	80.74	3.7	10.8
25	0.124	8025	0.000	0.000	1.00	0.9	0.050	0.100	84.11	3.7	10.8
26	0.124	8025	0.000	0.000	1.00	1.4	0.050	0.100	87.47	3.7	10.8
27	0.124	8025	0.000	0.000	1.00	3.0	0.050	0.100	90.84	3.7	10.8
28	0.124	8025	0.000	0.000	1.00	4.4	0.050	0.100	94.20	3.7	10.8
29	0.124	8025	0.000	0.000	1.00	5.6	0.050	0.100	97.57	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	6.8	0.050	0.100	100.93	3.7	10.8
31	0.124	8025	0.000	0.000	1.00	8.1	0.050	0.100	104.29	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	9.3	0.050	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	10.5	0.050	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	11.7	0.050	0.100	114.39	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	13.0	0.050	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	14.2	0.050	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	15.4	0.050	0.100	124.48	3.7	10.8
Toe						53.5	0.150	0.160			

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

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
43.98	10.81	1.00	0.800

♀
CCG3A : 12/07/2023 : KCA 01/17/2024
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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
157.8	13.9	6.47	6.49	-3.72	27	44	23.40	27	10	20.3	46.1
157.8	13.9	6.47	6.49	-3.72	27	44	23.40	27	10	20.3	46.1
157.8	13.9	6.47	6.49	-3.72	27	44	23.40	27	10	20.3	46.1
157.8	13.9	6.47	6.49	-3.72	27	44	23.40	27	10	20.3	46.1
157.8	13.9	6.47	6.49	-3.72	27	44	23.40	27	10	20.3	46.1

♀
CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 44.0 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type		Unknown
Pile Size	(inch)	14.000			

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model — Total Capacity Rut (kips) 125.6

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
24	0.124	8025	0.000	0.000	1.00	0.0	0.050	0.100	80.74	3.7	10.8
25	0.124	8025	0.000	0.000	1.00	0.9	0.050	0.100	84.11	3.7	10.8
26	0.124	8025	0.000	0.000	1.00	1.4	0.050	0.100	87.47	3.7	10.8
27	0.124	8025	0.000	0.000	1.00	3.0	0.050	0.100	90.84	3.7	10.8
28	0.124	8025	0.000	0.000	1.00	4.4	0.050	0.100	94.20	3.7	10.8
29	0.124	8025	0.000	0.000	1.00	5.6	0.050	0.100	97.57	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	6.8	0.050	0.100	100.93	3.7	10.8
31	0.124	8025	0.000	0.000	1.00	8.1	0.050	0.100	104.29	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	9.3	0.050	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	10.5	0.050	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	11.8	0.050	0.100	114.39	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	13.0	0.050	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	14.2	0.050	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	15.4	0.051	0.100	124.48	3.7	10.8
Toe						21.2	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
44.02	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	Stroke (ft) up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
125.6	10.1	6.03	6.07	-3.54	24	50	22.31	27	10	20.0	47.8
125.6	10.1	6.03	6.07	-3.54	24	50	22.31	27	10	20.0	47.8
125.6	10.1	6.03	6.07	-3.54	24	50	22.31	27	10	20.0	47.8
125.6	10.1	6.03	6.07	-3.53	24	50	22.33	27	10	20.0	47.8
125.6	10.1	6.03	6.07	-3.54	24	50	22.31	27	10	20.0	47.8

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Depth	(ft)	70.2	Standard Soil Setup		
Shaft Gain/Loss Factor		0.400	Toe Gain/Loss Factor		1.000

PILE PROFILE:

Toe Area	(in2)	144.000	Pile Type		Unknown
Pile Size	(inch)	14.000			

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3

124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model — Total Capacity Rut (kips) 204.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
17	0.124	8025	0.000	0.000	1.00	0.7	0.050	0.100	57.19	3.7	10.8
18	0.124	8025	0.000	0.000	1.00	1.3	0.050	0.100	60.56	3.7	10.8
19	0.124	8025	0.000	0.000	1.00	2.6	0.050	0.100	63.92	3.7	10.8
20	0.124	8025	0.000	0.000	1.00	4.1	0.050	0.100	67.29	3.7	10.8
21	0.124	8025	0.000	0.000	1.00	5.3	0.050	0.100	70.65	3.7	10.8
22	0.124	8025	0.000	0.000	1.00	6.5	0.050	0.100	74.02	3.7	10.8
23	0.124	8025	0.000	0.000	1.00	7.8	0.050	0.100	77.38	3.7	10.8
24	0.124	8025	0.000	0.000	1.00	9.0	0.050	0.100	80.74	3.7	10.8
25	0.124	8025	0.000	0.000	1.00	10.2	0.050	0.100	84.11	3.7	10.8
26	0.124	8025	0.000	0.000	1.00	11.5	0.050	0.100	87.47	3.7	10.8
27	0.124	8025	0.000	0.000	1.00	12.7	0.050	0.100	90.84	3.7	10.8
28	0.124	8025	0.000	0.000	1.00	13.9	0.050	0.100	94.20	3.7	10.8
29	0.124	8025	0.000	0.000	1.00	15.2	0.050	0.100	97.57	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	11.1	0.127	0.100	100.93	3.7	10.8
31	0.124	8025	0.000	0.000	1.00	9.7	0.150	0.100	104.29	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	9.7	0.150	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	9.8	0.150	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	10.1	0.150	0.100	114.39	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	10.4	0.150	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	10.7	0.150	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	11.1	0.150	0.100	124.48	3.7	10.8
Toe						21.2	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
70.15	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	Stroke (ft) up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
204.4	21.6	7.27	7.23	-5.11	19	35	26.70	19	12	20.7	43.6
208.8	22.6	7.33	7.30	-5.38	19	35	26.91	19	12	20.8	43.4
213.1	23.5	7.40	7.37	-5.61	19	35	27.15	19	12	21.0	43.2
217.4	24.5	7.47	7.43	-5.84	19	35	27.36	19	12	21.1	43.0
221.7	25.7	7.54	7.52	-6.06	19	35	27.57	19	12	21.2	42.8

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Depth (ft) 96.3 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s

0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model — Total Capacity Rut (kips) 301.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
9	0.124	8025	0.000	0.000	1.00	0.4	0.050	0.100	30.28	3.7	10.8
10	0.124	8025	0.000	0.000	1.00	1.2	0.050	0.100	33.64	3.7	10.8
11	0.124	8025	0.000	0.000	1.00	2.1	0.050	0.100	37.01	3.7	10.8
12	0.124	8025	0.000	0.000	1.00	3.8	0.050	0.100	40.37	3.7	10.8
13	0.124	8025	0.000	0.000	1.00	5.0	0.050	0.100	43.74	3.7	10.8
14	0.124	8025	0.000	0.000	1.00	6.3	0.050	0.100	47.10	3.7	10.8
15	0.124	8025	0.000	0.000	1.00	7.5	0.050	0.100	50.46	3.7	10.8
16	0.124	8025	0.000	0.000	1.00	8.7	0.050	0.100	53.83	3.7	10.8
17	0.124	8025	0.000	0.000	1.00	10.0	0.050	0.100	57.19	3.7	10.8
18	0.124	8025	0.000	0.000	1.00	11.2	0.050	0.100	60.56	3.7	10.8
19	0.124	8025	0.000	0.000	1.00	12.4	0.050	0.100	63.92	3.7	10.8
20	0.124	8025	0.000	0.000	1.00	13.7	0.050	0.100	67.29	3.7	10.8
21	0.124	8025	0.000	0.000	1.00	14.9	0.050	0.100	70.65	3.7	10.8
22	0.124	8025	0.000	0.000	1.00	12.5	0.104	0.100	74.02	3.7	10.8
23	0.124	8025	0.000	0.000	1.00	9.7	0.150	0.100	77.38	3.7	10.8
25	0.124	8025	0.000	0.000	1.00	9.8	0.150	0.100	84.11	3.7	10.8
26	0.124	8025	0.000	0.000	1.00	10.0	0.150	0.100	87.47	3.7	10.8
27	0.124	8025	0.000	0.000	1.00	10.3	0.150	0.100	90.84	3.7	10.8
28	0.124	8025	0.000	0.000	1.00	10.6	0.150	0.100	94.20	3.7	10.8
29	0.124	8025	0.000	0.000	1.00	11.0	0.150	0.100	97.57	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	11.3	0.150	0.100	100.93	3.7	10.8
31	0.124	8025	0.000	0.000	1.00	11.7	0.150	0.100	104.29	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	12.1	0.150	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	12.4	0.150	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	12.8	0.150	0.100	114.39	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	13.1	0.150	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	13.3	0.150	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	13.4	0.150	0.100	124.48	3.7	10.8
Toe						21.2	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
96.28	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
301.9	82.8	8.33	8.30	-4.88	13	29	29.78	13	11	21.4	40.8
311.6	101.3	8.44	8.40	-5.02	13	29	30.11	13	11	21.6	40.6
321.2	126.6	8.56	8.49	-5.14	13	29	30.46	13	11	21.8	40.3
330.8	173.2	8.58	8.58	-5.24	13	28	30.68	13	11	21.8	40.2
340.5	240.6	8.66	8.65	-5.32	13	28	30.97	13	11	22.0	40.0

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Depth (ft) 96.3 Standard Soil Setup

Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model Total Capacity Rut (kips) 295.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
9	0.124	8025	0.000	0.000	1.00	0.4	0.050	0.100	30.28	3.7	10.8
10	0.124	8025	0.000	0.000	1.00	1.2	0.050	0.100	33.64	3.7	10.8
11	0.124	8025	0.000	0.000	1.00	2.2	0.050	0.100	37.01	3.7	10.8
12	0.124	8025	0.000	0.000	1.00	3.8	0.050	0.100	40.37	3.7	10.8
13	0.124	8025	0.000	0.000	1.00	5.0	0.050	0.100	43.74	3.7	10.8
14	0.124	8025	0.000	0.000	1.00	6.3	0.050	0.100	47.10	3.7	10.8
15	0.124	8025	0.000	0.000	1.00	7.5	0.050	0.100	50.46	3.7	10.8
16	0.124	8025	0.000	0.000	1.00	8.7	0.050	0.100	53.83	3.7	10.8
17	0.124	8025	0.000	0.000	1.00	10.0	0.050	0.100	57.19	3.7	10.8
18	0.124	8025	0.000	0.000	1.00	11.2	0.050	0.100	60.56	3.7	10.8
19	0.124	8025	0.000	0.000	1.00	12.4	0.050	0.100	63.92	3.7	10.8
20	0.124	8025	0.000	0.000	1.00	13.7	0.050	0.100	67.29	3.7	10.8
21	0.124	8025	0.000	0.000	1.00	14.9	0.050	0.100	70.65	3.7	10.8
22	0.124	8025	0.000	0.000	1.00	12.4	0.106	0.100	74.02	3.7	10.8
23	0.124	8025	0.000	0.000	1.00	9.7	0.150	0.100	77.38	3.7	10.8
25	0.124	8025	0.000	0.000	1.00	9.8	0.150	0.100	84.11	3.7	10.8
26	0.124	8025	0.000	0.000	1.00	10.0	0.150	0.100	87.47	3.7	10.8
27	0.124	8025	0.000	0.000	1.00	10.3	0.150	0.100	90.84	3.7	10.8
28	0.124	8025	0.000	0.000	1.00	10.6	0.150	0.100	94.20	3.7	10.8
29	0.124	8025	0.000	0.000	1.00	11.0	0.150	0.100	97.57	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	11.3	0.150	0.100	100.93	3.7	10.8
31	0.124	8025	0.000	0.000	1.00	11.7	0.150	0.100	104.29	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	12.1	0.150	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	12.4	0.150	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	12.8	0.150	0.100	114.39	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	13.1	0.150	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	13.3	0.150	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	13.3	0.150	0.100	124.48	3.7	10.8
Toe						14.9	0.150	0.150			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
96.32	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
295.8	73.0	8.27	8.26	-4.81	12	29	29.70	13	11	21.2	40.9
305.4	87.2	8.39	8.35	-4.96	13	29	30.05	13	11	21.4	40.7

315.1	106.6	8.51	8.45	-5.11	13	29	30.40	13	11	21.7	40.4
324.7	135.5	8.61	8.54	-5.23	13	28	30.72	13	11	21.9	40.2
334.4	185.2	8.64	8.62	-5.34	13	28	30.95	13	11	22.0	40.1

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Depth (ft) 110.4 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model Total Capacity Rut (kips) 322.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.124	8025	0.010	0.000	0.85	0.0	0.000	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	0.0	0.000	0.100	6.73	3.7	10.8
5	0.124	8025	0.000	0.000	1.00	0.6	0.050	0.100	16.82	3.7	10.8
6	0.124	8025	0.000	0.000	1.00	1.2	0.050	0.100	20.19	3.7	10.8
7	0.124	8025	0.000	0.000	1.00	2.5	0.050	0.100	23.55	3.7	10.8
8	0.124	8025	0.000	0.000	1.00	4.0	0.050	0.100	26.91	3.7	10.8
9	0.124	8025	0.000	0.000	1.00	5.3	0.050	0.100	30.28	3.7	10.8
10	0.124	8025	0.000	0.000	1.00	6.5	0.050	0.100	33.64	3.7	10.8
11	0.124	8025	0.000	0.000	1.00	7.7	0.050	0.100	37.01	3.7	10.8
12	0.124	8025	0.000	0.000	1.00	9.0	0.050	0.100	40.37	3.7	10.8
13	0.124	8025	0.000	0.000	1.00	10.2	0.050	0.100	43.74	3.7	10.8
14	0.124	8025	0.000	0.000	1.00	11.4	0.050	0.100	47.10	3.7	10.8
15	0.124	8025	0.000	0.000	1.00	12.7	0.050	0.100	50.46	3.7	10.8
16	0.124	8025	0.000	0.000	1.00	13.9	0.050	0.100	53.83	3.7	10.8
17	0.124	8025	0.000	0.000	1.00	15.1	0.050	0.100	57.19	3.7	10.8
18	0.124	8025	0.000	0.000	1.00	11.4	0.123	0.100	60.56	3.7	10.8
19	0.124	8025	0.000	0.000	1.00	9.7	0.150	0.100	63.92	3.7	10.8
21	0.124	8025	0.000	0.000	1.00	9.8	0.150	0.100	70.65	3.7	10.8
22	0.124	8025	0.000	0.000	1.00	10.1	0.150	0.100	74.02	3.7	10.8
23	0.124	8025	0.000	0.000	1.00	10.3	0.150	0.100	77.38	3.7	10.8
24	0.124	8025	0.000	0.000	1.00	10.7	0.150	0.100	80.74	3.7	10.8
25	0.124	8025	0.000	0.000	1.00	11.0	0.150	0.100	84.11	3.7	10.8
26	0.124	8025	0.000	0.000	1.00	11.4	0.150	0.100	87.47	3.7	10.8
27	0.124	8025	0.000	0.000	1.00	11.8	0.150	0.100	90.84	3.7	10.8
28	0.124	8025	0.000	0.000	1.00	12.1	0.150	0.100	94.20	3.7	10.8
29	0.124	8025	0.000	0.000	1.00	12.5	0.150	0.100	97.57	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	12.8	0.150	0.100	100.93	3.7	10.8
31	0.124	8025	0.000	0.000	1.00	13.2	0.150	0.100	104.29	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	13.3	0.150	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	12.1	0.157	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	6.3	0.200	0.100	114.39	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	6.3	0.200	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	6.3	0.200	0.100	124.48	3.7	10.8
Toe						14.9	0.150	0.150			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
110.38	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	Stroke (ft) up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
322.0	137.6	8.38	8.33	-2.96	8	26	30.57	9	10	20.1	40.8
334.9	199.6	8.48	8.42	-3.08	9	26	30.93	9	10	20.4	40.5
347.9	336.4	8.57	8.52	-3.20	9	26	31.25	9	10	20.5	40.3
360.8	857.2	8.67	8.59	-3.28	9	25	31.56	9	10	20.7	40.1
373.7	9999.0	8.67	8.66	-3.42	9	25	31.75	9	10	20.7	40.0

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Depth (ft) 124.5 Standard Soil Setup
Shaft Gain/Loss Factor 0.400 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0	16807.	19.3
124.5	10.80	30000.	492.0	3.7	0	16807.	19.3

Wave Travel Time 2L/c (ms) 14.813

Pile and Soil Model — Total Capacity Rut (kips) 349.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.124	8025	0.010	0.000	0.85	0.8	0.050	0.100	3.36	3.7	10.8
2	0.124	8025	0.000	0.000	1.00	1.3	0.050	0.100	6.73	3.7	10.8
3	0.124	8025	0.000	0.000	1.00	2.9	0.050	0.100	10.09	3.7	10.8
4	0.124	8025	0.000	0.000	1.00	4.3	0.050	0.100	13.46	3.7	10.8
5	0.124	8025	0.000	0.000	1.00	5.5	0.050	0.100	16.82	3.7	10.8
6	0.124	8025	0.000	0.000	1.00	6.7	0.050	0.100	20.19	3.7	10.8
7	0.124	8025	0.000	0.000	1.00	8.0	0.050	0.100	23.55	3.7	10.8
8	0.124	8025	0.000	0.000	1.00	9.2	0.050	0.100	26.91	3.7	10.8
9	0.124	8025	0.000	0.000	1.00	10.4	0.050	0.100	30.28	3.7	10.8
10	0.124	8025	0.000	0.000	1.00	11.7	0.050	0.100	33.64	3.7	10.8
11	0.124	8025	0.000	0.000	1.00	12.9	0.050	0.100	37.01	3.7	10.8
12	0.124	8025	0.000	0.000	1.00	14.1	0.050	0.100	40.37	3.7	10.8
13	0.124	8025	0.000	0.000	1.00	15.4	0.050	0.100	43.74	3.7	10.8
14	0.124	8025	0.000	0.000	1.00	10.2	0.142	0.100	47.10	3.7	10.8
15	0.124	8025	0.000	0.000	1.00	9.7	0.150	0.100	50.46	3.7	10.8
16	0.124	8025	0.000	0.000	1.00	9.7	0.150	0.100	53.83	3.7	10.8
17	0.124	8025	0.000	0.000	1.00	9.9	0.150	0.100	57.19	3.7	10.8
18	0.124	8025	0.000	0.000	1.00	10.1	0.150	0.100	60.56	3.7	10.8
19	0.124	8025	0.000	0.000	1.00	10.4	0.150	0.100	63.92	3.7	10.8
20	0.124	8025	0.000	0.000	1.00	10.7	0.150	0.100	67.29	3.7	10.8
21	0.124	8025	0.000	0.000	1.00	11.1	0.150	0.100	70.65	3.7	10.8
22	0.124	8025	0.000	0.000	1.00	11.5	0.150	0.100	74.02	3.7	10.8
23	0.124	8025	0.000	0.000	1.00	11.8	0.150	0.100	77.38	3.7	10.8
24	0.124	8025	0.000	0.000	1.00	12.2	0.150	0.100	80.74	3.7	10.8
25	0.124	8025	0.000	0.000	1.00	12.6	0.150	0.100	84.11	3.7	10.8
26	0.124	8025	0.000	0.000	1.00	12.9	0.150	0.100	87.47	3.7	10.8
27	0.124	8025	0.000	0.000	1.00	13.2	0.150	0.100	90.84	3.7	10.8
28	0.124	8025	0.000	0.000	1.00	13.3	0.150	0.100	94.20	3.7	10.8

29	0.124	8025	0.000	0.000	1.00	10.7	0.165	0.100	97.57	3.7	10.8
30	0.124	8025	0.000	0.000	1.00	6.3	0.200	0.100	100.93	3.7	10.8
32	0.124	8025	0.000	0.000	1.00	6.3	0.200	0.100	107.66	3.7	10.8
33	0.124	8025	0.000	0.000	1.00	6.4	0.200	0.100	111.02	3.7	10.8
34	0.124	8025	0.000	0.000	1.00	6.5	0.200	0.100	114.39	3.7	10.8
35	0.124	8025	0.000	0.000	1.00	6.6	0.200	0.100	117.75	3.7	10.8
36	0.124	8025	0.000	0.000	1.00	6.7	0.200	0.100	121.12	3.7	10.8
37	0.124	8025	0.000	0.000	1.00	6.8	0.200	0.100	124.48	3.7	10.8
Toe						14.9	0.150	0.150			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
124.48	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
349.8	418.1	8.50	8.46	-0.94	4	23	31.10	5	9	18.9	40.5
366.2	6577.3	8.58	8.54	-0.97	4	23	31.44	5	9	19.0	40.3
382.6	9999.0	8.65	8.59	-1.01	4	23	31.81	5	9	19.2	40.2
399.0	9999.0	8.74	8.66	-1.04	4	22	32.17	5	9	19.3	40.0
415.4	9999.0	8.72	8.71	-1.06	4	22	32.37	5	9	19.2	40.0

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.400 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
2.5	7.9	0.6	7.3	1.2	10.702	-1.564	3.75	19.9
2.5	4.1	0.6	3.6	0.0	0.000	0.000	10.81	0.0
5.0	6.8	1.4	5.4	0.0	0.000	0.000	10.81	0.0
7.5	9.8	2.6	7.3	1.3	12.243	-3.035	3.92	20.0
7.5	17.7	2.6	15.1	1.6	14.164	-1.902	4.38	24.7
25.8	86.8	35.4	51.5	7.7	20.015	0.000	5.69	20.6
44.0	157.8	104.3	53.5	13.9	23.402	-3.723	6.47	20.3
44.0	125.6	104.5	21.2	10.1	22.310	-3.538	6.03	20.0
70.2	204.4	183.3	21.2	21.6	26.700	-5.113	7.27	20.7
96.3	301.9	280.7	21.2	82.8	29.780	-4.881	8.33	21.4
96.3	295.8	280.9	14.9	73.0	29.698	-4.809	8.27	21.2
110.4	322.0	307.1	14.9	137.6	30.571	-2.956	8.38	20.1
124.5	349.8	334.9	14.9	418.1	31.103	-0.937	8.50	18.9

Total Driving Time 181 minutes; Total No. of Blows 7463
Starting at penetration 2.5 ft

G/L at Shaft and Toe: 0.450 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
2.5	7.9	0.6	7.3	1.2	10.702	-1.564	3.75	19.9
2.5	4.1	0.6	3.6	0.0	0.000	0.000	10.81	0.0
5.0	6.8	1.4	5.4	0.0	0.000	0.000	10.81	0.0
7.5	9.8	2.6	7.3	1.3	12.243	-3.035	3.92	20.0
7.5	17.7	2.6	15.1	1.6	14.164	-1.902	4.38	24.7
25.8	86.8	35.4	51.5	7.7	20.015	0.000	5.69	20.6

44.0	157.8	104.3	53.5	13.9	23.402	-3.723	6.47	20.3
44.0	125.6	104.5	21.2	10.1	22.311	-3.538	6.03	20.0
70.2	208.8	187.6	21.2	22.6	26.908	-5.376	7.33	20.8
96.3	311.6	290.4	21.2	101.3	30.115	-5.016	8.44	21.6
96.3	305.4	290.5	14.9	87.2	30.047	-4.964	8.39	21.4
110.4	334.9	320.0	14.9	199.6	30.930	-3.085	8.48	20.4
124.5	366.2	351.3	14.9	6577.3	31.443	-0.968	8.58	19.0

Total Driving Time 1290 minutes; Total No. of Blows 52126
Starting at penetration 2.5 ft

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.500 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
2.5	7.9	0.6	7.3	1.2	10.702	-1.564	3.75	19.9
2.5	4.1	0.6	3.6	0.0	0.000	0.000	10.81	0.0
5.0	6.8	1.4	5.4	0.0	0.000	0.000	10.81	0.0
7.5	9.8	2.6	7.3	1.3	12.243	-3.035	3.92	20.0
7.5	17.7	2.6	15.1	1.6	14.164	-1.902	4.38	24.7
25.8	86.8	35.4	51.5	7.7	20.015	0.000	5.69	20.6
44.0	157.8	104.3	53.5	13.9	23.402	-3.723	6.47	20.3
44.0	125.6	104.5	21.2	10.1	22.307	-3.537	6.03	20.0
70.2	213.1	191.9	21.2	23.5	27.145	-5.605	7.40	21.0
96.3	321.2	300.0	21.2	126.6	30.462	-5.141	8.56	21.8
96.3	315.1	300.2	14.9	106.6	30.395	-5.112	8.51	21.7
110.4	347.9	333.0	14.9	336.4	31.246	-3.199	8.57	20.5
124.5	382.6	367.7	14.9	9999.0	31.805	-1.006	8.65	19.2

Refusal occurred; no driving time output possible

G/L at Shaft and Toe: 0.550 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
2.5	7.9	0.6	7.3	1.2	10.702	-1.564	3.75	19.9
2.5	4.1	0.6	3.6	0.0	0.000	0.000	10.81	0.0
5.0	6.8	1.4	5.4	0.0	0.000	0.000	10.81	0.0
7.5	9.8	2.6	7.3	1.3	12.243	-3.035	3.92	20.0
7.5	17.7	2.6	15.1	1.6	14.164	-1.902	4.38	24.7
25.8	86.8	35.4	51.5	7.7	20.015	0.000	5.69	20.6
44.0	157.8	104.3	53.5	13.9	23.402	-3.723	6.47	20.3
44.0	125.6	104.5	21.2	10.1	22.327	-3.534	6.03	20.0
70.2	217.4	196.2	21.2	24.5	27.363	-5.837	7.47	21.1
96.3	330.8	309.7	21.2	173.2	30.676	-5.242	8.58	21.8
96.3	324.7	309.8	14.9	135.5	30.720	-5.234	8.61	21.9
110.4	360.8	345.9	14.9	857.2	31.562	-3.285	8.67	20.7
124.5	399.0	384.1	14.9	9999.0	32.171	-1.039	8.74	19.3

Refusal occurred; no driving time output possible

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.600 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
2.5	7.9	0.6	7.3	1.2	10.702	-1.564	3.75	19.9

2.5	4.1	0.6	3.6	0.0	0.000	0.000	10.81	0.0
5.0	6.8	1.4	5.4	0.0	0.000	0.000	10.81	0.0
7.5	9.8	2.6	7.3	1.3	12.243	-3.035	3.92	20.0
7.5	17.7	2.6	15.1	1.6	14.164	-1.902	4.38	24.7
25.8	86.8	35.4	51.5	7.7	20.015	0.000	5.69	20.6
44.0	157.8	104.3	53.5	13.9	23.402	-3.723	6.47	20.3
44.0	125.6	104.5	21.2	10.1	22.312	-3.538	6.03	20.0
70.2	221.7	200.5	21.2	25.7	27.568	-6.063	7.54	21.2
96.3	340.5	319.3	21.2	240.6	30.974	-5.322	8.66	22.0
96.3	334.4	319.5	14.9	185.2	30.950	-5.338	8.64	22.0
110.4	373.7	358.8	14.9	9999.0	31.755	-3.422	8.67	20.7
124.5	415.4	400.5	14.9	9999.0	32.366	-1.059	8.72	19.2

Refusal occurred; no driving time output possible

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Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
2.48	124.48	0.00	10.81	1.00	0.80	1.00	1.00
2.52	124.48	0.00	10.81	1.00	0.80	1.00	1.00
5.00	124.48	0.00	10.81	1.00	0.80	1.00	1.00
7.48	124.48	0.00	10.81	1.00	0.80	1.00	1.00
7.52	124.48	0.00	10.81	1.00	0.80	1.00	1.00
25.75	124.48	0.00	10.81	1.00	0.80	1.00	1.00
43.98	124.48	0.00	10.81	1.00	0.80	1.00	1.00
44.02	124.48	0.00	10.81	1.00	0.80	1.00	1.00
70.15	124.48	0.00	10.81	1.00	0.80	1.00	1.00
96.28	124.48	0.00	10.81	1.00	0.80	1.00	1.00
96.32	124.48	0.00	10.81	1.00	0.80	1.00	1.00
110.38	124.48	0.00	10.81	1.00	0.80	1.00	1.00
124.48	124.48	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.04	0.100	0.150	0.050	0.150	0.000	7.000	1.000
1.09	0.06	4.44	0.100	0.150	0.050	0.150	0.000	7.000	1.000
1.11	0.06	4.50	0.100	0.150	0.050	0.150	0.000	7.000	1.000
2.49	0.11	7.31	0.100	0.150	0.050	0.150	0.000	7.000	1.000
2.51	0.07	3.55	0.100	0.200	0.050	0.150	0.000	7.000	1.000
7.49	0.15	7.29	0.100	0.200	0.050	0.150	0.000	7.000	1.000
7.51	0.22	15.11	0.100	0.200	0.050	0.150	0.000	7.000	1.000
16.51	0.49	33.46	0.100	0.160	0.050	0.150	0.000	7.000	1.000
25.51	0.75	51.40	0.100	0.160	0.050	0.150	0.000	7.000	1.000
34.51	1.02	53.45	0.100	0.160	0.050	0.150	0.000	7.000	1.000
43.51	1.29	53.45	0.100	0.160	0.050	0.150	0.000	7.000	1.000
43.99	1.30	53.45	0.100	0.160	0.050	0.150	0.000	7.000	1.000
44.01	1.30	21.17	0.100	0.140	0.150	0.150	0.660	7.000	168.000
53.01	1.30	21.17	0.100	0.140	0.150	0.150	0.660	7.000	168.000
62.01	1.39	21.17	0.100	0.140	0.150	0.150	0.660	7.000	168.000
71.01	1.52	21.17	0.100	0.140	0.150	0.150	0.660	7.000	168.000
80.01	1.65	21.17	0.100	0.140	0.150	0.150	0.660	7.000	168.000
89.01	1.78	21.17	0.100	0.140	0.150	0.150	0.660	7.000	168.000
96.29	1.80	21.17	0.100	0.140	0.150	0.150	0.660	7.000	168.000
96.31	1.27	14.91	0.100	0.150	0.200	0.150	1.000	7.000	168.000

105.31	1.27	14.91	0.100	0.150	0.200	0.150	1.000	7.000	168.000
114.31	1.32	14.91	0.100	0.150	0.200	0.150	1.000	7.000	168.000
123.31	1.39	14.91	0.100	0.150	0.200	0.150	1.000	7.000	168.000
124.48	1.40	14.91	0.100	0.150	0.200	0.150	1.000	7.000	168.000

WALL AG - STA. 502+49.4 TO STA. 506+50 – B-087-1-20

Gain/Loss 3 at Shaft and Toe 0.570 / 1.000

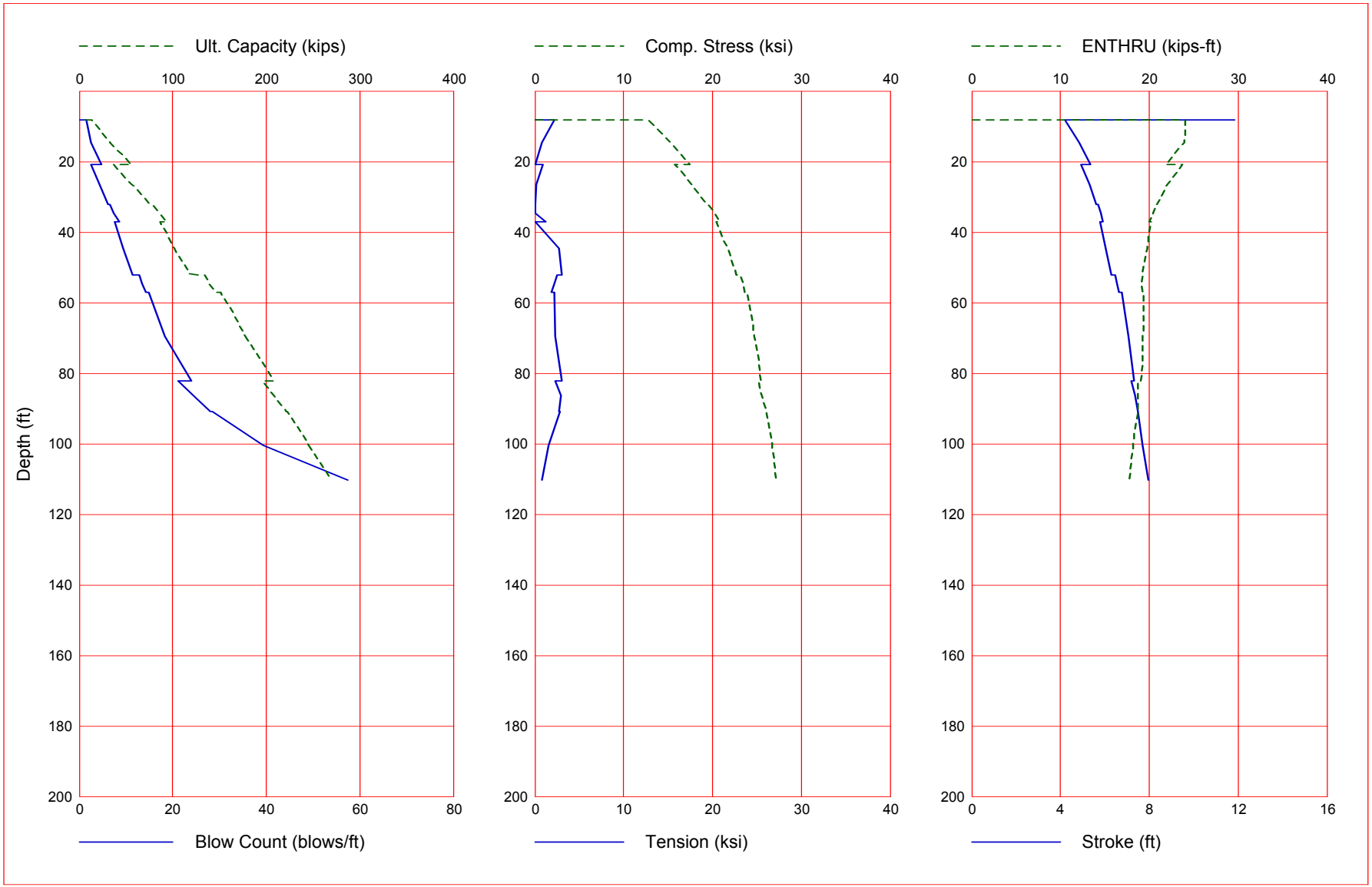
Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
8.3	6.1	1.3	4.8	0.0	0.000	0.000	11.86	0.0
8.3	13.3	1.4	12.0	1.5	12.707	-2.166	4.22	24.0
14.6	32.8	7.5	25.3	2.5	15.295	-0.782	4.86	23.9
20.8	56.7	18.2	38.6	4.7	17.412	0.000	5.36	21.8
20.8	37.0	18.3	18.8	2.6	15.701	-0.959	4.92	23.7
26.5	56.2	37.4	18.8	4.3	17.621	-0.194	5.32	22.0
32.1	75.3	56.5	18.8	6.1	19.403	0.000	5.63	20.9
32.1	78.3	56.6	21.6	6.5	19.563	0.000	5.68	20.7
34.6	86.0	64.4	21.6	7.4	20.251	0.000	5.82	20.4
37.1	93.7	72.1	21.6	8.6	20.867	-1.180	5.91	20.0
37.1	86.4	72.2	14.2	7.6	20.406	0.000	5.77	20.2
44.6	101.4	87.1	14.2	9.5	21.724	-2.708	6.04	19.8
52.1	119.3	105.1	14.2	11.4	22.658	-3.008	6.30	19.3
52.1	134.0	105.2	28.9	12.9	23.196	-2.458	6.47	19.2
54.6	139.6	110.7	28.9	13.5	23.419	-2.165	6.55	19.1
57.1	145.1	116.2	28.9	14.2	23.651	-1.824	6.62	19.2
57.1	151.0	116.3	34.6	14.9	23.928	-2.206	6.75	19.4
69.6	177.7	143.1	34.6	18.4	24.730	-2.327	7.05	19.3
82.1	207.4	172.7	34.6	24.0	25.399	-3.085	7.33	19.0
82.1	195.5	172.8	22.6	21.2	25.141	-2.288	7.21	18.7
86.4	208.2	185.6	22.6	24.4	25.551	-2.883	7.35	18.7
90.8	221.0	198.4	22.6	28.0	26.054	-2.741	7.47	18.7
90.8	222.6	198.5	24.0	28.5	26.080	-2.811	7.49	18.7
100.5	245.1	221.1	24.0	39.4	26.749	-1.549	7.68	18.2
110.3	269.2	245.2	24.0	57.4	27.187	-0.836	7.94	17.8

Total Continuous Driving Time 41.00 minutes; Total Number of Blows 1817 (starting at penetration 8.3 ft)

National Engineering & Architectural Ser
CCG3A : 12/07/2023 : KCA

Jan 17 2024
GRLWEAP Version 2010

Gain/Loss 3 at Shaft and Toe 0.570 / 1.000



GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

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

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

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

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

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

♀

Input File: C:\USERS\KARENS\DESKTOP\GRL\AG4_14IN.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
Hammer File Version: 2003 (10/17/2016)

Input File Contents

CCG3A : 12/07/2023 : KCA

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
-100	0	41	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size	Pile Type
32.170	32.170	144.000	14.000	Unknown

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
2.500	11.850	530.0	2.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	CI	CoR	ROut
110.280	11.86	29000.0	492.000	3.670	0	0.850	0.010

FFatigue	F0	0-Bottom
0	0.000	0.000

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 19-42	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
4.00	129.10	12.60	11.86	10.81	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
0.75	25.30	12.60	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
16.65	124.70	157.70	0.0020	0.0020	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1600.00	1440.00	1295.00	1165.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.8100	0.8000	1600.0000	0.0000	0.0000	0.0000	0.0100	0.0000

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

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

0.000	0.000	0.000	0.000

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

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Rtoe	Qs	Qt	Js	Jt	SU F	LimL	TSf0
0.01	0.00	-1.46	0.10	0.23	0.05	0.15	1.21	7.00	24.000
8.29	0.11	4.77	0.10	0.23	0.05	0.15	1.21	7.00	24.000
8.31	0.17	11.94	0.10	0.16	0.05	0.15	1.00	7.00	1.000
17.31	0.45	31.17	0.10	0.16	0.05	0.15	1.00	7.00	1.000
20.79	0.56	38.61	0.10	0.16	0.05	0.15	1.00	7.00	1.000
20.81	1.38	18.76	0.10	0.14	0.10	0.15	1.49	7.00	24.000
29.81	1.38	18.76	0.10	0.14	0.10	0.15	1.49	7.00	24.000
32.09	1.38	18.76	0.10	0.14	0.10	0.15	1.49	7.00	24.000
32.11	1.26	21.65	0.10	0.14	0.15	0.15	1.49	7.00	168.000
37.09	1.26	21.65	0.10	0.14	0.15	0.15	1.49	7.00	168.000
37.11	0.74	14.24	0.10	0.18	0.10	0.15	1.49	7.00	24.000
46.11	0.93	14.24	0.10	0.18	0.10	0.15	1.49	7.00	24.000
52.09	1.05	14.24	0.10	0.18	0.10	0.15	1.49	7.00	24.000
52.11	0.91	28.86	0.10	0.13	0.15	0.15	1.49	7.00	168.000
57.09	0.91	28.86	0.10	0.13	0.15	0.15	1.49	7.00	168.000
57.11	0.87	34.64	0.10	0.12	0.10	0.15	1.49	7.00	24.000
66.11	0.87	34.64	0.10	0.12	0.10	0.15	1.49	7.00	24.000
75.11	0.95	34.64	0.10	0.12	0.10	0.15	1.49	7.00	24.000
82.09	1.05	34.64	0.10	0.12	0.10	0.15	1.49	7.00	24.000
82.11	1.20	22.61	0.10	0.14	0.15	0.15	1.49	7.00	168.000
90.79	1.20	22.61	0.10	0.14	0.15	0.15	1.49	7.00	168.000
90.81	1.11	24.05	0.10	0.13	0.20	0.15	1.75	7.00	168.000
99.81	1.11	24.05	0.10	0.13	0.20	0.15	1.75	7.00	168.000
108.81	1.23	24.05	0.10	0.13	0.20	0.15	1.75	7.00	168.000
110.28	1.25	24.05	0.10	0.13	0.20	0.15	1.75	7.00	168.000

Gain/Loss factors: shaft and toe

0.48400	0.52700	0.57000	0.61300	0.65600
1.00000	1.00000	1.00000	1.00000	1.00000

Dpth	L	Wait	Strk	Pmx%	Eff.	Stff	CoR
8.28	0.00	0.00	0.000	0.0	0.000	0.000	0.000
8.32	0.00	0.00	0.000	0.0	0.000	0.000	0.000
14.55	0.00	0.00	0.000	0.0	0.000	0.000	0.000
20.78	0.00	0.00	0.000	0.0	0.000	0.000	0.000
20.82	0.00	0.00	0.000	0.0	0.000	0.000	0.000
26.45	0.00	0.00	0.000	0.0	0.000	0.000	0.000
32.08	0.00	0.00	0.000	0.0	0.000	0.000	0.000
32.12	0.00	0.00	0.000	0.0	0.000	0.000	0.000
34.60	0.00	0.00	0.000	0.0	0.000	0.000	0.000
37.08	0.00	0.00	0.000	0.0	0.000	0.000	0.000
37.12	0.00	0.00	0.000	0.0	0.000	0.000	0.000
44.60	0.00	0.00	0.000	0.0	0.000	0.000	0.000

52.08	0.00	0.00	0.000	0.0	0.000	0.000	0.000
52.12	0.00	0.00	0.000	0.0	0.000	0.000	0.000
54.60	0.00	0.00	0.000	0.0	0.000	0.000	0.000
57.08	0.00	0.00	0.000	0.0	0.000	0.000	0.000
57.12	0.00	0.00	0.000	0.0	0.000	0.000	0.000
69.60	0.00	0.00	0.000	0.0	0.000	0.000	0.000
82.08	0.00	0.00	0.000	0.0	0.000	0.000	0.000
82.12	0.00	0.00	0.000	0.0	0.000	0.000	0.000
86.45	0.00	0.00	0.000	0.0	0.000	0.000	0.000
90.78	0.00	0.00	0.000	0.0	0.000	0.000	0.000
90.82	0.00	0.00	0.000	0.0	0.000	0.000	0.000
100.53	0.00	0.00	0.000	0.0	0.000	0.000	0.000
110.28	0.00	0.00	0.000	0.0	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.0	0.000	0.000	0.000

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

CCG3A : 12/07/2023 : KCA

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.6	1.000	0.0000	
3	0.800	140046.6	1.000	0.0000	
4	0.800	140046.6	1.000	0.0000	
5	0.800	140046.6	1.000	0.0000	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	2.500	3140.2	0.800	0.0100	5.8
Combined Pile Top		8576.7			

HAMMER OPTIONS:

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

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1600.00	Actual Pressure	(psi)	1600.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	11.85	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	3140.2	Stiffness	(kips/in)	0.0

♀

Depth (ft) 8.3 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 6.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	0.4	0.050	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	0.8	0.050	0.100	110.28	3.7	11.9
Toe						4.8	0.150	0.230			

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

PILE, SOIL, ANALYSIS OPTIONS:
Uniform pile Pile Segments: Automatic
No. of Slacks/Splices 0 Pile Damping (%) 1
Pile Damping Fact.(k/ft/s) 0.416
Driveability Analysis
Soil Damping Option Smith
Max No Analysis Iterations 0 Time Increment/Critical 160
Output Time Interval 1 Analysis Time-Input (ms) 0
Output Level: Normal
Gravity Mass, Pile, Hammer: 32.170 32.170 32.170
Output Segment Generation: Automatic

Depth ft	Stroke ft	Pressure Ratio	Efficy
8.28	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.7 6.0
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.7 6.1
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.7 6.1
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.7 6.1
Hammer+Pile Weight > Rult: Pile Runs

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 7.7 6.2
Hammer+Pile Weight > Rult: Pile Runs

♀

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
6.0	0.0	10.81	0.00	0.00	1	0	0.00	1	0	0.0	78.4
6.1	0.0	11.86	0.00	0.00	1	0	0.00	1	0	0.0	74.4
6.1	0.0	11.86	0.00	0.00	1	0	0.00	1	0	0.0	74.4
6.1	0.0	11.86	0.00	0.00	1	0	0.00	1	0	0.0	74.4
6.2	0.0	11.86	0.00	0.00	1	0	0.00	1	0	0.0	74.4

♀

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National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 8.3 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 13.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	0.4	0.050	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	0.8	0.050	0.100	110.28	3.7	11.9
Toe						12.0	0.150	0.160			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
8.32	10.81	1.00	0.800

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
13.3	1.5	4.22	4.21	-2.17	9	19	12.68	1	7	24.0	57.8
13.3	1.5	4.22	4.21	-2.17	9	19	12.68	1	7	24.0	57.8
13.3	1.5	4.22	4.21	-2.17	9	19	12.71	1	7	24.0	57.8
13.3	1.5	4.22	4.21	-2.17	9	19	12.72	1	7	24.0	57.8
13.4	1.5	4.22	4.21	-2.16	9	19	12.73	1	7	24.0	57.8

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 14.6 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L	b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
	0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
	110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 32.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	0.4	0.050	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	0.8	0.050	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	2.5	0.050	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	3.9	0.050	0.100	110.28	3.7	11.9
Toe						25.3	0.150	0.160			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
14.55	10.81	1.00	0.800

♀
CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
32.8	2.5	4.86	4.85	-0.80	5	17	15.31	13	7	23.9	53.8
32.8	2.5	4.86	4.85	-0.78	5	17	15.29	14	7	23.9	53.8
32.8	2.5	4.86	4.85	-0.78	5	17	15.30	14	7	23.9	53.8
32.8	2.5	4.86	4.85	-0.78	5	17	15.30	14	7	23.9	53.8
32.9	2.5	4.86	4.85	-0.76	5	17	15.27	14	7	23.9	53.8

♀
CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 20.8 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L	b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
	0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
	110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 56.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	0.3	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	2.2	0.050	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	3.7	0.050	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	5.0	0.050	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	6.2	0.050	0.100	110.28	3.7	11.9
Toe						38.6	0.150	0.160			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
20.78	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
56.7	4.7	5.36	5.33	0.00	1	0	17.40	23	9	21.8	51.1
56.7	4.7	5.36	5.33	0.00	1	0	17.39	23	9	21.8	51.1
56.7	4.7	5.36	5.33	0.00	1	0	17.41	23	9	21.8	51.1
56.8	4.7	5.36	5.33	0.00	1	0	17.40	23	9	21.8	51.1
56.8	4.7	5.36	5.34	0.00	1	0	17.41	23	9	21.8	51.1

♀

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Depth (ft) 20.8 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 37.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	0.3	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	2.2	0.050	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	3.7	0.050	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	5.0	0.050	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	6.3	0.051	0.100	110.28	3.7	11.9
Toe						18.8	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
20.82	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
37.0	2.6	4.92	4.89	-0.98	5	17	15.72	8	6	23.7	53.5
37.0	2.6	4.92	4.89	-1.00	5	17	15.76	8	6	23.8	53.5
37.0	2.6	4.92	4.89	-0.96	5	17	15.70	8	6	23.7	53.5
37.1	2.6	4.92	4.89	-0.97	5	17	15.72	8	6	23.7	53.5
37.1	2.6	4.92	4.89	-0.99	5	17	15.76	8	6	23.7	53.5

♀

Depth (ft) 26.5 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 54.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	0.2	0.050	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	0.6	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	1.6	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	3.3	0.050	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	4.6	0.050	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	5.9	0.050	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	9.1	0.092	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	110.28	3.7	11.9
Toe						18.8	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
26.45	10.81	1.00	0.800

♀

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

kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
54.2	4.1	5.29	5.25	-0.34	3	17	17.48	20	8	22.1	51.5
55.2	4.2	5.30	5.27	-0.26	3	17	17.54	21	9	22.1	51.4
56.2	4.3	5.32	5.29	-0.19	3	17	17.62	21	9	22.0	51.3
57.1	4.4	5.34	5.31	-0.15	3	17	17.75	22	9	21.9	51.2
58.1	4.5	5.35	5.33	-0.06	3	17	17.81	22	9	21.9	51.2

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Depth (ft) 32.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L	b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
	ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
	0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
	110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 71.4

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	0.1	0.050	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	0.5	0.050	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	1.0	0.050	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	2.9	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	4.2	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	5.5	0.050	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	7.9	0.080	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	103.60	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	110.28	3.7	11.9
Toe						18.8	0.150	0.140			

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

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
32.08	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
71.4	5.8	5.56	5.54	0.00	1	0	19.08	25	9	21.0	50.0
73.4	5.9	5.60	5.58	0.00	1	0	19.24	25	9	20.9	49.9
75.3	6.1	5.63	5.61	0.00	1	0	19.40	25	9	20.9	49.7
77.2	6.3	5.66	5.64	0.00	1	0	19.51	25	9	20.8	49.6
79.1	6.5	5.69	5.67	0.00	1	0	19.67	25	9	20.7	49.5

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Depth (ft) 32.1 Standard Soil Setup

Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 74.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	0.1	0.050	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	0.5	0.050	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	1.0	0.050	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	2.9	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	4.2	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	5.5	0.050	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	7.9	0.081	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	103.60	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	110.28	3.7	11.9
Toe						21.6	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
32.12	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
74.4	6.1	5.62	5.60	0.00	1	0	19.28	25	9	20.8	49.8
76.4	6.3	5.65	5.63	0.00	1	0	19.46	25	9	20.8	49.6
78.3	6.5	5.68	5.66	0.00	1	0	19.56	25	9	20.7	49.5
80.2	6.7	5.71	5.69	0.00	1	0	19.69	25	9	20.6	49.3
82.1	6.9	5.74	5.72	0.00	1	0	19.84	25	9	20.6	49.2

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Depth (ft) 34.6 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model					Total Capacity Rut (kips)					81.4
No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	0.4	0.050	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	0.8	0.050	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	2.5	0.050	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	3.9	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	5.1	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.8	0.064	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	100.25	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	9.6	0.137	0.100	110.28	3.7	11.9
Toe						21.6	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
34.60	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
81.4	6.9	5.75	5.74	0.00	1	0	19.94	25	9	20.5	49.1
83.7	7.2	5.78	5.77	0.00	1	0	20.09	25	9	20.4	49.0
86.0	7.4	5.82	5.81	0.00	1	0	20.25	25	9	20.4	48.8
88.3	7.8	5.80	5.85	-0.14	25	50	20.35	25	9	20.2	48.7
90.6	8.1	5.84	5.89	-0.50	24	50	20.44	25	9	20.1	48.6

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 37.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model					Total Capacity Rut (kips)					88.3
No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	0.2	0.050	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	1.9	0.050	0.100	83.55	3.7	11.9

26	0.135	8577	0.000	0.000	1.00	3.5	0.050	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	4.8	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	6.1	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	9.8	0.097	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	100.25	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	9.8	0.123	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	110.28	3.7	11.9
Toe						21.6	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
37.08	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
88.3	7.9	5.82	5.88	-0.32	24	50	20.47	25	9	20.1	48.6
91.0	8.2	5.87	5.91	-0.74	24	50	20.71	25	9	20.1	48.5
93.7	8.6	5.91	5.95	-1.18	23	50	20.87	25	9	20.0	48.3
96.4	8.9	5.95	5.99	-1.65	23	50	21.02	25	9	19.9	48.1
99.1	9.3	5.99	6.03	-2.06	23	50	21.23	25	9	19.9	48.0

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Depth (ft) 37.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L ft	b Top in2	Area ksi	E-Mod lb/ft3	Spec Wt ft	Perim	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7		0	16524.	20.8
110.3	11.86	29000.	492.0	3.7		0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 81.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	0.3	0.050	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	1.9	0.050	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	3.6	0.050	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	4.8	0.050	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	6.1	0.050	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	9.8	0.097	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	100.25	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	9.8	0.124	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	9.3	0.150	0.100	110.28	3.7	11.9
Toe						14.2	0.150	0.180			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
37.12	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
81.0	6.9	5.75	5.73	0.00	1	0	20.08	25	9	20.5	49.1
83.7	7.2	5.73	5.79	0.00	1	0	20.20	25	9	20.3	49.1
86.4	7.6	5.77	5.83	0.00	1	0	20.41	25	9	20.2	48.9
89.1	7.9	5.82	5.87	-0.40	24	50	20.60	25	9	20.1	48.7
91.8	8.2	5.87	5.91	-0.83	24	50	20.78	25	9	20.1	48.5

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National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 44.6 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 94.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	0.4	0.050	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	0.8	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	2.4	0.050	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	3.9	0.050	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	5.1	0.050	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	6.8	0.063	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	90.23	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	9.6	0.136	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	8.4	0.142	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	5.8	0.100	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	110.28	3.7	11.9
Toe						14.2	0.150	0.180			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
44.60	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
94.5	8.6	5.93	5.97	-1.69	21	50	21.18	24	9	19.9	48.2
98.0	9.1	5.98	6.02	-2.24	21	50	21.45	24	9	19.8	48.0
101.4	9.5	6.04	6.07	-2.71	21	50	21.72	24	9	19.8	47.8
104.8	9.9	6.09	6.12	-3.04	21	50	21.99	24	9	19.7	47.6
108.2	10.3	6.14	6.17	-3.27	22	50	22.22	24	9	19.7	47.4

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Depth (ft) 52.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L	b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
	0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
	110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 110.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	0.1	0.050	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	0.5	0.050	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	1.0	0.050	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	2.9	0.050	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	4.2	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	5.4	0.050	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	7.8	0.080	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	83.55	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	9.4	0.149	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	7.5	0.132	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.0	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	6.5	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.0	0.100	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	7.5	0.100	0.100	110.28	3.7	11.9
Toe						14.2	0.150	0.180			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
52.08	10.81	1.00	0.800

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
110.7	10.7	6.20	6.22	-3.50	20	50	22.24	22	9	19.6	47.2

115.0	11.0	6.25	6.27	-3.32	20	49	22.47	22	9	19.5	47.0
119.3	11.4	6.30	6.32	-3.01	20	49	22.66	22	9	19.3	46.8
123.6	11.8	6.35	6.37	-2.69	19	49	22.89	22	9	19.2	46.6
127.9	12.1	6.39	6.41	-2.44	20	46	23.15	23	9	19.2	46.5

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 52.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 125.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	0.1	0.050	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	0.5	0.050	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	1.0	0.050	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	2.9	0.050	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	4.2	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	5.4	0.050	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	7.9	0.080	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	83.55	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	7.5	0.132	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.0	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	6.5	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.0	0.100	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	7.5	0.100	0.100	110.28	3.7	11.9
Toe						28.9	0.150	0.130			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
52.12	10.81	1.00	0.800

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
125.4	12.1	6.38	6.39	-2.43	20	47	22.72	22	9	19.2	46.5
129.7	12.5	6.43	6.44	-2.42	21	46	22.99	22	9	19.2	46.4
134.0	12.9	6.47	6.48	-2.46	21	45	23.20	23	9	19.2	46.2
138.3	13.3	6.51	6.53	-2.44	21	45	23.44	23	9	19.2	46.1
142.7	13.8	6.56	6.57	-2.26	21	44	23.66	23	9	19.2	45.9

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CCG3A : 12/07/2023 : KCA 01/17/2024

Depth (ft) 54.6 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 130.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	0.3	0.050	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	0.8	0.050	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	2.4	0.050	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	3.9	0.050	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	5.1	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	6.8	0.063	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	80.20	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	9.6	0.136	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	8.5	0.142	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	5.8	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	6.9	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.4	0.100	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	7.0	0.136	0.100	110.28	3.7	11.9
Toe						28.9	0.150	0.130			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
54.60	10.81	1.00	0.800

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
130.4	12.7	6.45	6.46	-2.29	20	46	22.93	22	9	19.2	46.3
135.0	13.1	6.50	6.51	-2.27	20	45	23.20	22	9	19.2	46.1
139.6	13.5	6.55	6.56	-2.17	20	44	23.42	22	9	19.1	45.9
144.1	13.9	6.66	6.60	-1.95	20	44	23.77	22	9	19.3	45.7
148.7	14.4	6.71	6.65	-2.12	19	39	24.01	22	9	19.4	45.5

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CCG3A : 12/07/2023 : KCA 01/17/2024
National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 57.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 135.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	53.47	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	0.2	0.050	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	1.9	0.050	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	3.5	0.050	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	4.8	0.050	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	6.1	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	9.7	0.097	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	80.20	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	9.8	0.123	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	5.8	0.102	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.2	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.7	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	7.3	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.2	0.123	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	6.7	0.150	0.100	110.28	3.7	11.9
Toe						28.9	0.150	0.130			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
57.08	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	Stroke (ft) up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
135.4	13.2	6.52	6.53	-2.04	19	45	23.11	21	8	19.1	46.1
140.2	13.7	6.57	6.58	-1.89	20	44	23.38	21	8	19.1	45.9
145.1	14.2	6.62	6.63	-1.82	18	40	23.65	21	8	19.2	45.7
150.0	14.6	6.74	6.67	-2.11	19	39	23.98	22	9	19.3	45.4
154.8	15.2	6.79	6.72	-2.40	19	39	24.31	22	9	19.4	45.2

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Depth (ft) 57.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 141.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	53.47	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	0.2	0.050	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	1.9	0.050	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	3.5	0.050	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	4.8	0.050	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	6.1	0.050	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	9.8	0.097	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	80.20	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	9.8	0.123	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	5.7	0.101	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.2	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.8	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	7.3	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.2	0.123	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	6.7	0.150	0.100	110.28	3.7	11.9
Toe						34.6	0.150	0.120			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
57.12	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	Stroke (ft) up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
141.2	13.8	6.65	6.59	-1.80	20	44	23.42	21	8	19.3	45.7
146.1	14.4	6.64	6.64	-1.92	18	40	23.55	21	8	19.2	45.6
151.0	14.9	6.75	6.69	-2.21	19	39	23.93	21	8	19.4	45.4
155.8	15.4	6.80	6.74	-2.47	19	39	24.22	22	9	19.5	45.2
160.7	16.0	6.85	6.80	-2.65	19	38	24.44	22	9	19.5	45.0

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Depth (ft) 69.6 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s

0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 165.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	0.1	0.050	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	0.6	0.050	0.100	46.79	3.7	11.9
15	0.135	8577	0.000	0.000	1.00	1.4	0.050	0.100	50.13	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	3.2	0.050	0.100	53.47	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	4.5	0.050	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	5.7	0.050	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	8.8	0.090	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	66.84	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	10.0	0.110	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	6.7	0.119	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	6.1	0.100	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	6.6	0.100	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	7.1	0.100	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	7.4	0.111	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.7	0.150	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.5	0.113	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	103.60	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	6.5	0.100	0.100	110.28	3.7	11.9
Toe						34.6	0.150	0.120			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
69.60	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
165.3	16.7	6.92	6.87	-1.37	13	35	24.12	17	7	19.0	44.8
171.5	17.6	6.99	6.94	-1.81	14	34	24.40	18	8	19.1	44.6
177.7	18.4	7.05	7.00	-2.33	14	34	24.73	18	8	19.3	44.4
183.9	19.3	7.11	7.07	-2.78	15	34	25.01	18	8	19.3	44.2
190.1	20.2	7.18	7.14	-3.15	15	34	25.27	18	8	19.4	44.0

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Depth (ft) 82.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8

110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 192.1

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
9	0.135	8577	0.000	0.000	1.00	0.1	0.050	0.100	30.08	3.7	11.9
10	0.135	8577	0.000	0.000	1.00	0.4	0.050	0.100	33.42	3.7	11.9
11	0.135	8577	0.000	0.000	1.00	0.9	0.050	0.100	36.76	3.7	11.9
12	0.135	8577	0.000	0.000	1.00	2.9	0.050	0.100	40.10	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	4.1	0.050	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	5.4	0.050	0.100	46.79	3.7	11.9
15	0.135	8577	0.000	0.000	1.00	7.7	0.079	0.100	50.13	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	53.47	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	9.4	0.148	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	7.6	0.133	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	5.9	0.100	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	6.5	0.100	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	7.0	0.100	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	7.5	0.100	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	6.8	0.148	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	6.6	0.127	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	90.23	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.5	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.7	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	7.0	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.3	0.100	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	7.6	0.100	0.100	110.28	3.7	11.9
Toe						34.6	0.150	0.120			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
82.08	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
192.1	21.1	7.19	7.15	-2.09	11	32	24.83	14	7	18.8	44.0
199.7	22.5	7.26	7.22	-2.61	12	31	25.14	14	7	18.9	43.8
207.4	24.0	7.33	7.31	-3.09	12	31	25.40	14	7	19.0	43.5
215.0	25.6	7.41	7.38	-3.53	12	31	25.73	14	7	19.1	43.3
222.7	27.4	7.49	7.47	-3.85	12	30	25.98	15	7	19.2	43.1

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Depth (ft) 82.1 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L	b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c

ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 180.1

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
9	0.135	8577	0.000	0.000	1.00	0.1	0.050	0.100	30.08	3.7	11.9
10	0.135	8577	0.000	0.000	1.00	0.4	0.050	0.100	33.42	3.7	11.9
11	0.135	8577	0.000	0.000	1.00	1.0	0.050	0.100	36.76	3.7	11.9
12	0.135	8577	0.000	0.000	1.00	2.9	0.050	0.100	40.10	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	4.2	0.050	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	5.4	0.050	0.100	46.79	3.7	11.9
15	0.135	8577	0.000	0.000	1.00	7.8	0.079	0.100	50.13	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	53.47	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	9.4	0.148	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	7.6	0.133	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	6.0	0.100	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	6.5	0.100	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	7.0	0.100	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	7.5	0.100	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	6.7	0.149	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	6.6	0.126	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	90.23	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.5	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	6.7	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	7.0	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.3	0.100	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	7.6	0.100	0.100	110.28	3.7	11.9
Toe						22.6	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
82.12	10.81	1.00	0.800

♀

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
180.1	18.8	7.06	7.02	-1.47	7	32	24.53	14	7	18.5	44.4
187.8	20.0	7.13	7.10	-1.79	8	32	24.85	14	7	18.6	44.2
195.5	21.2	7.21	7.18	-2.29	11	31	25.14	14	7	18.7	43.9
203.1	22.6	7.29	7.26	-2.85	12	31	25.46	14	7	18.8	43.7
210.8	24.1	7.36	7.34	-3.33	12	31	25.72	14	7	18.9	43.5

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Depth (ft) 86.4 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 191.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
8	0.135	8577	0.000	0.000	1.00	0.2	0.050	0.100	26.73	3.7	11.9
9	0.135	8577	0.000	0.000	1.00	0.6	0.050	0.100	30.08	3.7	11.9
10	0.135	8577	0.000	0.000	1.00	1.5	0.050	0.100	33.42	3.7	11.9
11	0.135	8577	0.000	0.000	1.00	3.3	0.050	0.100	36.76	3.7	11.9
12	0.135	8577	0.000	0.000	1.00	4.5	0.050	0.100	40.10	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	5.8	0.050	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	9.0	0.091	0.100	46.79	3.7	11.9
15	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	50.13	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	10.0	0.112	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	6.5	0.117	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	6.1	0.100	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	6.6	0.100	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	7.2	0.100	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	7.4	0.113	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	6.7	0.150	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	6.5	0.111	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	86.89	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	6.6	0.100	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.8	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	7.0	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	7.4	0.100	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	8.0	0.117	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	8.9	0.150	0.100	110.28	3.7	11.9
Toe						22.6	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
86.45	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
191.7	21.2	7.19	7.16	-1.90	10	31	24.83	13	7	18.5	44.0
200.0	22.7	7.26	7.24	-2.43	10	31	25.15	11	10	18.6	43.8
208.2	24.4	7.35	7.32	-2.88	11	31	25.55	11	10	18.7	43.5
216.5	26.2	7.42	7.41	-3.23	11	30	25.94	11	10	18.8	43.3
224.8	28.2	7.51	7.49	-3.43	11	30	26.33	11	10	18.9	43.0

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Depth (ft) 90.8 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 203.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
6	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	20.05	3.7	11.9
7	0.135	8577	0.000	0.000	1.00	0.3	0.050	0.100	23.39	3.7	11.9
8	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	26.73	3.7	11.9
9	0.135	8577	0.000	0.000	1.00	2.1	0.050	0.100	30.08	3.7	11.9
10	0.135	8577	0.000	0.000	1.00	3.6	0.050	0.100	33.42	3.7	11.9
11	0.135	8577	0.000	0.000	1.00	4.9	0.050	0.100	36.76	3.7	11.9
12	0.135	8577	0.000	0.000	1.00	6.2	0.050	0.100	40.10	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	10.0	0.099	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	46.79	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	9.7	0.127	0.100	53.47	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	9.1	0.148	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	5.7	0.100	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	6.3	0.100	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	6.8	0.100	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	7.3	0.100	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	7.1	0.127	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	6.7	0.146	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	80.20	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	6.6	0.100	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	6.9	0.100	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	7.1	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	7.5	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	8.4	0.132	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	8.9	0.150	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	8.9	0.150	0.100	110.28	3.7	11.9
Toe						22.6	0.150	0.140			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
90.78	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
203.2	23.9	7.30	7.28	-2.28	10	31	25.18	10	10	18.4	43.6
212.1	25.9	7.39	7.37	-2.57	10	30	25.62	10	10	18.5	43.4
221.0	28.0	7.47	7.45	-2.74	9	29	26.05	10	10	18.7	43.1
230.0	30.5	7.56	7.54	-3.07	9	29	26.47	10	10	18.8	42.9
238.9	33.3	7.64	7.63	-3.34	10	28	26.87	10	10	18.8	42.7

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Depth (ft) 90.8 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 204.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
6	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	20.05	3.7	11.9
7	0.135	8577	0.000	0.000	1.00	0.3	0.050	0.100	23.39	3.7	11.9
8	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	26.73	3.7	11.9
9	0.135	8577	0.000	0.000	1.00	2.1	0.050	0.100	30.08	3.7	11.9
10	0.135	8577	0.000	0.000	1.00	3.6	0.050	0.100	33.42	3.7	11.9
11	0.135	8577	0.000	0.000	1.00	4.9	0.050	0.100	36.76	3.7	11.9
12	0.135	8577	0.000	0.000	1.00	6.2	0.050	0.100	40.10	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	10.1	0.099	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	46.79	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	9.7	0.127	0.100	53.47	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	9.1	0.148	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	5.7	0.100	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	6.3	0.100	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	6.8	0.100	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	7.3	0.100	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	7.1	0.128	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	6.7	0.146	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	80.20	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	6.6	0.100	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	6.9	0.100	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	7.1	0.100	0.100	96.91	3.7	11.9
30	0.135	8577	0.000	0.000	1.00	7.5	0.100	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	8.4	0.132	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	8.9	0.150	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	8.9	0.150	0.100	110.28	3.7	11.9
Toe						24.0	0.150	0.130			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
90.82	10.81	1.00	0.800

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

kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
204.7	24.3	7.32	7.29	-2.37	10	31	25.23	10	10	18.5	43.6
213.7	26.3	7.40	7.38	-2.62	10	30	25.66	10	10	18.6	43.4
222.6	28.5	7.49	7.47	-2.81	9	29	26.08	10	10	18.7	43.1
231.5	31.0	7.57	7.56	-3.12	10	29	26.50	10	10	18.8	42.9
240.4	33.8	7.66	7.64	-3.39	10	28	26.91	10	10	18.9	42.6

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National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 100.5 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L	b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
	ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
	0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
	110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model Total Capacity Rut (kips) 223.9

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.135	8577	0.010	0.000	0.85	0.0	0.000	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.0	0.000	0.100	6.68	3.7	11.9
3	0.135	8577	0.000	0.000	1.00	0.0	0.050	0.100	10.03	3.7	11.9
4	0.135	8577	0.000	0.000	1.00	0.2	0.050	0.100	13.37	3.7	11.9
5	0.135	8577	0.000	0.000	1.00	0.7	0.050	0.100	16.71	3.7	11.9
6	0.135	8577	0.000	0.000	1.00	1.9	0.050	0.100	20.05	3.7	11.9
7	0.135	8577	0.000	0.000	1.00	3.5	0.050	0.100	23.39	3.7	11.9
8	0.135	8577	0.000	0.000	1.00	4.8	0.050	0.100	26.73	3.7	11.9
9	0.135	8577	0.000	0.000	1.00	6.1	0.050	0.100	30.08	3.7	11.9
10	0.135	8577	0.000	0.000	1.00	9.8	0.097	0.100	33.42	3.7	11.9
11	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	36.76	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	9.8	0.123	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	46.79	3.7	11.9
15	0.135	8577	0.000	0.000	1.00	5.8	0.102	0.100	50.13	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	6.2	0.100	0.100	53.47	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	6.7	0.100	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	7.3	0.100	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	7.2	0.123	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	6.7	0.150	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	6.6	0.100	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	6.8	0.100	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	7.1	0.100	0.100	86.89	3.7	11.9
27	0.135	8577	0.000	0.000	1.00	7.4	0.100	0.100	90.23	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	8.3	0.128	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	8.9	0.150	0.100	96.91	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	6.8	0.195	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	6.6	0.200	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	6.6	0.200	0.100	110.28	3.7	11.9
Toe						24.0	0.150	0.130			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
100.53	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
223.9	31.1	7.56	7.55	-1.69	7	29	25.91	7	9	18.2	42.9
234.5	34.7	7.65	7.65	-1.63	7	29	26.37	7	9	18.3	42.6
245.1	39.4	7.68	7.74	-1.55	8	28	26.75	7	9	18.2	42.4
255.7	44.2	7.79	7.83	-1.74	7	26	27.24	7	9	18.4	42.1
266.4	49.9	7.89	7.91	-1.95	7	26	27.70	7	9	18.5	41.9

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National Engineering & Architectural Ser GRLWEAP Version 2010

Depth (ft) 110.3 Standard Soil Setup
Shaft Gain/Loss Factor 0.484 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 144.000 Pile Type Unknown
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	11.86	29000.	492.0	3.7	0	16524.	20.8
110.3	11.86	29000.	492.0	3.7	0	16524.	20.8

Wave Travel Time 2L/c (ms) 13.348

Pile and Soil Model — Total Capacity Rut (kips) 244.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.135	8577	0.010	0.000	0.85	0.2	0.050	0.100	3.34	3.7	11.9
2	0.135	8577	0.000	0.000	1.00	0.6	0.050	0.100	6.68	3.7	11.9
3	0.135	8577	0.000	0.000	1.00	1.7	0.050	0.100	10.03	3.7	11.9
4	0.135	8577	0.000	0.000	1.00	3.4	0.050	0.100	13.37	3.7	11.9
5	0.135	8577	0.000	0.000	1.00	4.7	0.050	0.100	16.71	3.7	11.9
6	0.135	8577	0.000	0.000	1.00	6.0	0.050	0.100	20.05	3.7	11.9
7	0.135	8577	0.000	0.000	1.00	9.5	0.095	0.100	23.39	3.7	11.9
8	0.135	8577	0.000	0.000	1.00	10.2	0.100	0.100	26.73	3.7	11.9
10	0.135	8577	0.000	0.000	1.00	9.9	0.119	0.100	33.42	3.7	11.9
11	0.135	8577	0.000	0.000	1.00	9.4	0.150	0.100	36.76	3.7	11.9
12	0.135	8577	0.000	0.000	1.00	6.1	0.108	0.100	40.10	3.7	11.9
13	0.135	8577	0.000	0.000	1.00	6.2	0.100	0.100	43.44	3.7	11.9
14	0.135	8577	0.000	0.000	1.00	6.7	0.100	0.100	46.79	3.7	11.9
15	0.135	8577	0.000	0.000	1.00	7.2	0.100	0.100	50.13	3.7	11.9
16	0.135	8577	0.000	0.000	1.00	7.3	0.119	0.100	53.47	3.7	11.9
17	0.135	8577	0.000	0.000	1.00	6.7	0.150	0.100	56.81	3.7	11.9
18	0.135	8577	0.000	0.000	1.00	6.4	0.105	0.100	60.15	3.7	11.9
19	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	63.49	3.7	11.9
20	0.135	8577	0.000	0.000	1.00	6.4	0.100	0.100	66.84	3.7	11.9
21	0.135	8577	0.000	0.000	1.00	6.6	0.100	0.100	70.18	3.7	11.9
22	0.135	8577	0.000	0.000	1.00	6.8	0.100	0.100	73.52	3.7	11.9
23	0.135	8577	0.000	0.000	1.00	7.1	0.100	0.100	76.86	3.7	11.9
24	0.135	8577	0.000	0.000	1.00	7.4	0.100	0.100	80.20	3.7	11.9
25	0.135	8577	0.000	0.000	1.00	8.2	0.123	0.100	83.55	3.7	11.9
26	0.135	8577	0.000	0.000	1.00	8.9	0.150	0.100	86.89	3.7	11.9
28	0.135	8577	0.000	0.000	1.00	7.0	0.191	0.100	93.57	3.7	11.9
29	0.135	8577	0.000	0.000	1.00	6.6	0.200	0.100	96.91	3.7	11.9

30	0.135	8577	0.000	0.000	1.00	6.6	0.200	0.100	100.25	3.7	11.9
31	0.135	8577	0.000	0.000	1.00	6.7	0.200	0.100	103.60	3.7	11.9
32	0.135	8577	0.000	0.000	1.00	7.0	0.200	0.100	106.94	3.7	11.9
33	0.135	8577	0.000	0.000	1.00	7.3	0.200	0.100	110.28	3.7	11.9
Toe						24.0	0.150	0.130			

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

Depth ft	Stroke ft	Pressure Ratio	Efficy
110.28	10.81	1.00	0.800

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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
244.3	42.3	7.72	7.78	-0.48	4	26	26.45	6	5	17.6	42.3
256.8	49.2	7.83	7.87	-0.68	4	25	26.80	6	5	17.7	42.1
269.2	57.4	7.94	7.95	-0.84	4	25	27.19	6	5	17.8	41.8
281.7	67.3	8.04	8.02	-0.94	5	24	27.60	6	5	18.0	41.6
294.1	81.3	8.13	8.10	-0.98	5	24	27.90	6	5	18.0	41.4

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.484 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
8.3	6.0	1.3	4.8	0.0	0.000	0.000	10.81	0.0
8.3	13.3	1.3	12.0	1.5	12.678	-2.165	4.22	24.0
14.6	32.8	7.5	25.3	2.5	15.312	-0.796	4.86	23.9
20.8	56.7	18.1	38.6	4.7	17.402	0.000	5.36	21.8
20.8	37.0	18.2	18.8	2.6	15.716	-0.976	4.92	23.7
26.5	54.2	35.4	18.8	4.1	17.485	-0.335	5.29	22.1
32.1	71.4	52.7	18.8	5.8	19.082	0.000	5.56	21.0
32.1	74.4	52.8	21.6	6.1	19.284	0.000	5.62	20.8
34.6	81.4	59.7	21.6	6.9	19.938	0.000	5.75	20.5
37.1	88.3	66.7	21.6	7.9	20.467	-0.317	5.82	20.1
37.1	81.0	66.8	14.2	6.9	20.083	0.000	5.75	20.5
44.6	94.5	80.3	14.2	8.6	21.184	-1.695	5.93	19.9
52.1	110.7	96.4	14.2	10.7	22.237	-3.500	6.20	19.6
52.1	125.4	96.5	28.9	12.1	22.721	-2.428	6.38	19.2
54.6	130.4	101.5	28.9	12.7	22.934	-2.285	6.45	19.2
57.1	135.4	106.5	28.9	13.2	23.108	-2.037	6.52	19.1
57.1	141.2	106.6	34.6	13.8	23.424	-1.796	6.65	19.3
69.6	165.3	130.7	34.6	16.7	24.122	-1.366	6.92	19.0
82.1	192.1	157.4	34.6	21.1	24.832	-2.088	7.19	18.8
82.1	180.1	157.5	22.6	18.8	24.527	-1.471	7.06	18.5
86.4	191.7	169.1	22.6	21.2	24.829	-1.904	7.19	18.5
90.8	203.2	180.6	22.6	23.9	25.183	-2.282	7.30	18.4
90.8	204.7	180.7	24.0	24.3	25.230	-2.369	7.32	18.5
100.5	223.9	199.8	24.0	31.1	25.907	-1.692	7.56	18.2
110.3	244.3	220.3	24.0	42.3	26.454	-0.481	7.72	17.6

Total Driving Time 35 minutes; Total No. of Blows 1550
Starting at penetration 8.3 ft

G/L at Shaft and Toe: 0.527 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
8.3	6.1	1.3	4.8	0.0	0.000	0.000	11.86	0.0
8.3	13.3	1.3	12.0	1.5	12.684	-2.166	4.22	24.0
14.6	32.8	7.5	25.3	2.5	15.290	-0.782	4.86	23.9
20.8	56.7	18.1	38.6	4.7	17.388	0.000	5.36	21.8
20.8	37.0	18.2	18.8	2.6	15.764	-0.998	4.92	23.8
26.5	55.2	36.4	18.8	4.2	17.545	-0.261	5.30	22.1
32.1	73.4	54.6	18.8	5.9	19.241	0.000	5.60	20.9
32.1	76.4	54.7	21.6	6.3	19.456	0.000	5.65	20.8
34.6	83.7	62.1	21.6	7.2	20.093	0.000	5.78	20.4
37.1	91.0	69.4	21.6	8.2	20.713	-0.741	5.87	20.1
37.1	83.7	69.5	14.2	7.2	20.201	0.000	5.73	20.3
44.6	98.0	83.7	14.2	9.1	21.447	-2.237	5.98	19.8
52.1	115.0	100.8	14.2	11.0	22.471	-3.320	6.25	19.5
52.1	129.7	100.8	28.9	12.5	22.986	-2.421	6.43	19.2
54.6	135.0	106.1	28.9	13.1	23.203	-2.265	6.50	19.2
57.1	140.2	111.4	28.9	13.7	23.379	-1.892	6.57	19.1
57.1	146.1	111.5	34.6	14.4	23.553	-1.919	6.64	19.2
69.6	171.5	136.9	34.6	17.6	24.397	-1.807	6.99	19.1
82.1	199.7	165.1	34.6	22.5	25.141	-2.615	7.26	18.9
82.1	187.8	165.2	22.6	20.0	24.850	-1.792	7.13	18.6
86.4	200.0	177.4	22.6	22.7	25.151	-2.431	7.26	18.6
90.8	212.1	189.5	22.6	25.9	25.618	-2.570	7.39	18.5
90.8	213.7	189.6	24.0	26.3	25.658	-2.616	7.40	18.6
100.5	234.5	210.4	24.0	34.7	26.368	-1.627	7.65	18.3
110.3	256.8	232.7	24.0	49.2	26.804	-0.679	7.83	17.7

Total Driving Time 38 minutes; Total No. of Blows 1674
Starting at penetration 8.3 ft

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.570 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
8.3	6.1	1.3	4.8	0.0	0.000	0.000	11.86	0.0
8.3	13.3	1.4	12.0	1.5	12.707	-2.166	4.22	24.0
14.6	32.8	7.5	25.3	2.5	15.295	-0.782	4.86	23.9
20.8	56.7	18.2	38.6	4.7	17.412	0.000	5.36	21.8
20.8	37.0	18.3	18.8	2.6	15.701	-0.959	4.92	23.7
26.5	56.2	37.4	18.8	4.3	17.621	-0.194	5.32	22.0
32.1	75.3	56.5	18.8	6.1	19.403	0.000	5.63	20.9
32.1	78.3	56.6	21.6	6.5	19.563	0.000	5.68	20.7
34.6	86.0	64.4	21.6	7.4	20.251	0.000	5.82	20.4
37.1	93.7	72.1	21.6	8.6	20.867	-1.180	5.91	20.0
37.1	86.4	72.2	14.2	7.6	20.406	0.000	5.77	20.2
44.6	101.4	87.1	14.2	9.5	21.724	-2.708	6.04	19.8
52.1	119.3	105.1	14.2	11.4	22.658	-3.008	6.30	19.3
52.1	134.0	105.2	28.9	12.9	23.196	-2.458	6.47	19.2
54.6	139.6	110.7	28.9	13.5	23.419	-2.165	6.55	19.1
57.1	145.1	116.2	28.9	14.2	23.651	-1.824	6.62	19.2
57.1	151.0	116.3	34.6	14.9	23.928	-2.206	6.75	19.4
69.6	177.7	143.1	34.6	18.4	24.730	-2.327	7.05	19.3
82.1	207.4	172.7	34.6	24.0	25.399	-3.085	7.33	19.0
82.1	195.5	172.8	22.6	21.2	25.141	-2.288	7.21	18.7
86.4	208.2	185.6	22.6	24.4	25.551	-2.883	7.35	18.7
90.8	221.0	198.4	22.6	28.0	26.054	-2.741	7.47	18.7
90.8	222.6	198.5	24.0	28.5	26.080	-2.811	7.49	18.7
100.5	245.1	221.1	24.0	39.4	26.749	-1.549	7.68	18.2

110.3	269.2	245.2	24.0	57.4	27.187	-0.836	7.94	17.8

Total Driving Time 41 minutes; Total No. of Blows 1817
Starting at penetration 8.3 ft

G/L at Shaft and Toe: 0.613 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
8.3	6.1	1.4	4.8	0.0	0.000	0.000	11.86	0.0
8.3	13.3	1.4	12.0	1.5	12.719	-2.165	4.22	24.0
14.6	32.8	7.6	25.3	2.5	15.298	-0.780	4.86	23.9
20.8	56.8	18.2	38.6	4.7	17.398	0.000	5.36	21.8
20.8	37.1	18.3	18.8	2.6	15.719	-0.968	4.92	23.7
26.5	57.1	38.4	18.8	4.4	17.754	-0.149	5.34	21.9
32.1	77.2	58.4	18.8	6.3	19.510	0.000	5.66	20.8
32.1	80.2	58.6	21.6	6.7	19.686	0.000	5.71	20.6
34.6	88.3	66.7	21.6	7.8	20.346	-0.140	5.80	20.2
37.1	96.4	74.8	21.6	8.9	21.020	-1.646	5.95	19.9
37.1	89.1	74.9	14.2	7.9	20.598	-0.400	5.82	20.1
44.6	104.8	90.6	14.2	9.9	21.986	-3.038	6.09	19.7
52.1	123.6	109.4	14.2	11.8	22.892	-2.687	6.35	19.2
52.1	138.3	109.5	28.9	13.3	23.442	-2.436	6.51	19.2
54.6	144.1	115.3	28.9	13.9	23.773	-1.949	6.66	19.3
57.1	150.0	121.1	28.9	14.6	23.983	-2.111	6.74	19.3
57.1	155.8	121.2	34.6	15.4	24.218	-2.471	6.80	19.5
69.6	183.9	149.2	34.6	19.3	25.011	-2.779	7.11	19.3
82.1	215.0	180.4	34.6	25.6	25.731	-3.531	7.41	19.1
82.1	203.1	180.5	22.6	22.6	25.459	-2.846	7.29	18.8
86.4	216.5	193.9	22.6	26.2	25.942	-3.226	7.42	18.8
90.8	230.0	207.3	22.6	30.5	26.473	-3.072	7.56	18.8
90.8	231.5	207.5	24.0	31.0	26.500	-3.119	7.57	18.8
100.5	255.7	231.7	24.0	44.2	27.235	-1.738	7.79	18.4
110.3	281.7	257.6	24.0	67.3	27.598	-0.941	8.04	18.0

Total Driving Time 45 minutes; Total No. of Blows 1976
Starting at penetration 8.3 ft

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.656 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
8.3	6.2	1.4	4.8	0.0	0.000	0.000	11.86	0.0
8.3	13.4	1.4	12.0	1.5	12.726	-2.160	4.22	24.0
14.6	32.9	7.6	25.3	2.5	15.270	-0.764	4.86	23.9
20.8	56.8	18.2	38.6	4.7	17.405	0.000	5.36	21.8
20.8	37.1	18.3	18.8	2.6	15.765	-0.994	4.92	23.7
26.5	58.1	39.3	18.8	4.5	17.813	-0.057	5.35	21.9
32.1	79.1	60.3	18.8	6.5	19.670	0.000	5.69	20.7
32.1	82.1	60.5	21.6	6.9	19.842	0.000	5.74	20.6
34.6	90.6	69.0	21.6	8.1	20.440	-0.504	5.84	20.1
37.1	99.1	77.4	21.6	9.3	21.226	-2.064	5.99	19.9
37.1	91.8	77.5	14.2	8.2	20.783	-0.826	5.87	20.1
44.6	108.2	94.0	14.2	10.3	22.225	-3.271	6.14	19.7
52.1	127.9	113.7	14.2	12.1	23.149	-2.440	6.39	19.2
52.1	142.7	113.8	28.9	13.8	23.659	-2.261	6.56	19.2
54.6	148.7	119.9	28.9	14.4	24.014	-2.116	6.71	19.4
57.1	154.8	126.0	28.9	15.2	24.305	-2.402	6.79	19.4
57.1	160.7	126.1	34.6	16.0	24.437	-2.649	6.85	19.5
69.6	190.1	155.4	34.6	20.2	25.273	-3.145	7.18	19.4

82.1	222.7	188.0	34.6	27.4	25.982	-3.847	7.49	19.2
82.1	210.8	188.2	22.6	24.1	25.717	-3.326	7.36	18.9
86.4	224.8	202.2	22.6	28.2	26.331	-3.434	7.51	18.9
90.8	238.9	216.3	22.6	33.3	26.870	-3.340	7.64	18.8
90.8	240.4	216.4	24.0	33.8	26.912	-3.390	7.66	18.9
100.5	266.4	242.3	24.0	49.9	27.705	-1.948	7.89	18.5
110.3	294.1	270.1	24.0	81.3	27.904	-0.976	8.13	18.0

Total Driving Time 50 minutes; Total No. of Blows 2170
Starting at penetration 8.3 ft
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Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
8.28	110.28	0.00	10.81	1.00	0.80	1.00	1.00
8.32	110.28	0.00	10.81	1.00	0.80	1.00	1.00
14.55	110.28	0.00	10.81	1.00	0.80	1.00	1.00
20.78	110.28	0.00	10.81	1.00	0.80	1.00	1.00
20.82	110.28	0.00	10.81	1.00	0.80	1.00	1.00
26.45	110.28	0.00	10.81	1.00	0.80	1.00	1.00
32.08	110.28	0.00	10.81	1.00	0.80	1.00	1.00
32.12	110.28	0.00	10.81	1.00	0.80	1.00	1.00
34.60	110.28	0.00	10.81	1.00	0.80	1.00	1.00
37.08	110.28	0.00	10.81	1.00	0.80	1.00	1.00
37.12	110.28	0.00	10.81	1.00	0.80	1.00	1.00
44.60	110.28	0.00	10.81	1.00	0.80	1.00	1.00
52.08	110.28	0.00	10.81	1.00	0.80	1.00	1.00
52.12	110.28	0.00	10.81	1.00	0.80	1.00	1.00
54.60	110.28	0.00	10.81	1.00	0.80	1.00	1.00
57.08	110.28	0.00	10.81	1.00	0.80	1.00	1.00
57.12	110.28	0.00	10.81	1.00	0.80	1.00	1.00
69.60	110.28	0.00	10.81	1.00	0.80	1.00	1.00
82.08	110.28	0.00	10.81	1.00	0.80	1.00	1.00
82.12	110.28	0.00	10.81	1.00	0.80	1.00	1.00
86.45	110.28	0.00	10.81	1.00	0.80	1.00	1.00
90.78	110.28	0.00	10.81	1.00	0.80	1.00	1.00
90.82	110.28	0.00	10.81	1.00	0.80	1.00	1.00
100.53	110.28	0.00	10.81	1.00	0.80	1.00	1.00
110.28	110.28	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	-1.46	0.100	0.230	0.050	0.150	0.396	7.000	24.000
8.29	0.11	4.77	0.100	0.230	0.050	0.150	0.396	7.000	24.000
8.31	0.17	11.94	0.100	0.160	0.050	0.150	0.000	7.000	1.000
17.31	0.45	31.17	0.100	0.160	0.050	0.150	0.000	7.000	1.000
20.79	0.56	38.61	0.100	0.160	0.050	0.150	0.000	7.000	1.000
20.81	1.38	18.76	0.100	0.140	0.100	0.150	0.768	7.000	24.000
29.81	1.38	18.76	0.100	0.140	0.100	0.150	0.768	7.000	24.000
32.09	1.38	18.76	0.100	0.140	0.100	0.150	0.768	7.000	24.000
32.11	1.26	21.65	0.100	0.140	0.150	0.150	0.768	7.000	168.000
37.09	1.26	21.65	0.100	0.140	0.150	0.150	0.768	7.000	168.000
37.11	0.74	14.24	0.100	0.180	0.100	0.150	0.768	7.000	24.000
46.11	0.93	14.24	0.100	0.180	0.100	0.150	0.768	7.000	24.000

52.09	1.05	14.24	0.100	0.180	0.100	0.150	0.768	7.000	24.000
52.11	0.91	28.86	0.100	0.130	0.150	0.150	0.768	7.000	168.000
57.09	0.91	28.86	0.100	0.130	0.150	0.150	0.768	7.000	168.000
57.11	0.87	34.64	0.100	0.120	0.100	0.150	0.768	7.000	24.000
66.11	0.87	34.64	0.100	0.120	0.100	0.150	0.768	7.000	24.000
75.11	0.95	34.64	0.100	0.120	0.100	0.150	0.768	7.000	24.000
82.09	1.05	34.64	0.100	0.120	0.100	0.150	0.768	7.000	24.000
82.11	1.20	22.61	0.100	0.140	0.150	0.150	0.768	7.000	168.000
90.79	1.20	22.61	0.100	0.140	0.150	0.150	0.768	7.000	168.000
90.81	1.11	24.05	0.100	0.130	0.200	0.150	1.000	7.000	168.000
99.81	1.11	24.05	0.100	0.130	0.200	0.150	1.000	7.000	168.000
108.81	1.23	24.05	0.100	0.130	0.200	0.150	1.000	7.000	168.000
110.28	1.25	24.05	0.100	0.130	0.200	0.150	1.000	7.000	168.000

APPENDIX H

SEISMIC SITE CLASSIFICATION CALCULATION

Seismic Site Classification - Bridge CUY-90-1678

B-085-2-20			
Depth (ft)	Layer Thickness, d (ft)	Avg. SPT Value, N (bpf)	d/N
20.8	20.8	26.9	0.77
25.8	5.0	10.0	0.50
55.8	30.0	25.5	1.18
65.8	10.0	50.0	0.20
100.0	34.2	26.4	1.29
Sum	100		3.94
N-avg	25.4		

C-086-0-14 & B-085-4-20			
Depth (ft)	Layer Thickness, d (ft)	Avg. SPT Value, N (bpf)	d/N
8.0	8.0	20.1	0.40
11.3	3.3	8.4	0.39
15.8	4.5	11.7	0.39
24.8	9.0	5.0	1.80
47.3	22.5	24.0	0.94
97.8	50.5	14.5	3.48
100.0	2.2	12.7	0.17
Sum	100		7.57
N-avg	13.2		

B-086-1-20			
Depth (ft)	Layer Thickness, d (ft)	Avg. SPT Value, N (bpf)	d/N
16.0	16.0	23.1	0.69
44.8	28.8	14.5	1.99
64.8	20.0	26.8	0.75
100.0	35.2	16.3	2.16
Sum	100		5.59
N-avg	17.9		

Site Average	**18.8**