GEOTECHNICAL DESIGN REPORT

HEALD BRIDGE NO. 0673
Redding Road over W. Branch of the Nezinscot River
Sumner, Maine
MaineDOT WIN 21704.00

FOR

Maine Department of Transportation
Augusta, ME

BY

NOBIS ENGINEERING, INC.

(800) 394-4182
www.nobiseng.com

Nobis Project No. 92270.03
September 21, 2018

Nobis
Engineering a Sustainable Future

Engineering a Sustainable Future

September 21, 2018
Project No. 92270.03

Ms. Laura Krusinski, P.E.
Senior Geotechnical Engineer
Maine Department of Transportation
State House Station 16
Augusta, Maine 04333-016
Laura.Krusinski@maine.gov

Re: Geotechnical Design Report
Heald Bridge No. 0673
Redding Road over W. Branch of the Nezinscot River
Sumner, Maine
WIN 21704.00

Dear Ms. Krusinski,

We are pleased to provide this Geotechnical Design Report to MaineDOT for the Heald Bridge No. 0673 which carries Redding Road over the West Branch of the Nezinscot River in Sumner, Maine. This report has been completed in accordance with the Project-Specific Task Order No, 20150610000000000814 dated March 7, 2017, and our proposal dated February 24, 2017.

It has been a pleasure serving the MaineDOT and Fuss & O'Neill on this project. Please let us know if you have any questions regarding this report.

Very truly yours,

Nobis Engineering, Inc.

Brien Waterman
Project Manager

STATE OF MAINE
KURT JELINEK
No. 11746
LICENSED
PROFESSIONAL ENGINEER

9/21/2018

Kurt Jelinek, P.E.
Director, Transportation Services

Table of Contents

1.0 INTRODUCTION **1**

2.0 PROJECT AND SITE DESCRIPTION **1**

3.0 SUBSURFACE EXPLORATIONS **1**

4.0 LABORATORY TESTING **2**

5.0 SUBSURFACE CONDITIONS **2**
- Pavement 2
- Fill……........ 2
- Stream Alluvium 3
- Outwash Deposits 3
- Bedrock 3
- Groundwater 3

6.0 GEOTECHNICAL DESIGN RECOMMENDATIONS **3**
- **6.1 Integral Abutment Design Recommendations** 4
- **6.2 Lateral Earth Pressures** 5
- **6.3 Approach Embankments** 5
- **6.4 Seismic Design Considerations** 5
- **6.5 Construction Considerations** 6

Figures

Figure 1	Site Locus Plan
Figure 2	Boring Location Plan
Figure 3	Surficial Geologic Map
Figure 4	Bedrock Geologic Map
Figure 5	Interpretive Subsurface Profile

Appendices

Appendix A	Limitations
Appendix B	Automatic Hammer Calibration Report
Appendix C	Boring Logs
Appendix D	Photo Logs of Rock Cores
Appendix E	Laboratory Test Results
Appendix F	Calculations
	F.1 – Lateral Pile Evaluation (Soil Properties and Output)
	F.2 – Global Slop Stability
	F.3 – Seismic Design Parameters
	F.4 – Preliminary Driveability Evaluation

1.0 INTRODUCTION

This geotechnical design report presents Nobis Engineering Inc.'s (Nobis) recommendations for the MaineDOT Heald Bridge No. 0673 located in Sumner, Maine. This report is subject to the limitations contained in **Appendix A**. Nobis performed geotechnical services in accordance with our original proposal dated February 24, 2017.

2.0 PROJECT AND SITE DESCRIPTION

Nobis understands that MaineDOT intends to replace the Heald Bridge which is located along Redding Road and crosses the West Branch of the Nezinscot River. A Site Locus Plan is included as **Figure 1**.

Heald Bridge – Sumner, Maine

The existing one-span bridge was constructed in 1938 and has a total length of 23 feet and a curb-to-curb roadway width of approximately 15 feet with no sidewalks. The existing superstructure consists of a concrete deck supported by steel girders and dry-laid stone abutments. Overhead power lines cross the bridge on the northern side.

The top of the roadway at the existing bridge approaches and bridge deck is relatively level, at approximate elevation (El.) 386, whereas the bed of the river is at approximate El. 376. Elevations referenced in this report are relative to the North American Vertical Datum of 1988 (NAVD 88). Refer to **Figure 2** for the approximate location of existing and proposed site features.

It is our understanding that MaineDOT intends to replace the existing structure on the same alignment on new abutments. The proposed bridge will have a span of 45 feet, will be supported by integral abutments, and the roadway width will be increased to 20 feet.

3.0 SUBSURFACE EXPLORATIONS

New England Boring Contractors (NEBC) of Hermon, Maine drilled two (2) test borings, designated BB-SWBNR-101 and BB-SWBNR-102 which were performed in June 2017. The borings were advanced using drive and wash methods with an automatic hammer, and were observed and logged by Nobis personnel. Refer to the attached **Figure 2** for the approximate locations of the test borings.

Borings BB-SWBNR-101 ad BB-SWBNR-102 were advanced to approximately 51.7 feet below ground surface (bgs) and 47 feet bgs, respectively. Approximately 9.2 and 9 feet of NX-size bedrock core sample was collected in BB-SWBNR-101 and BB-SWBNR-102, respectively. The pavement was restored with asphalt cold patch once the test borings had been completed and backfilled.

For the NEBC automatic hammer energy transfer ratio (ETR) calibration report, refer to **Appendix B**. Test boring logs are provided in **Appendix C**. Photo logs of the bedrock cores are provided in **Appendix D**.

4.0 LABORATORY TESTING

Soil and bedrock samples obtained from the subsurface exploration program were selected by Nobis and submitted to GeoTesting Express of Acton, Massachusetts, for laboratory analysis. Laboratory tests performed include the following:

- Two (2) particle size analyses – sieve only (in accordance with ASTM D422);
- One (1) Atterberg Limits analysis (ASTM D4318);
- Two (2) compressive strength and elastic moduli of rock tests (ASTM D7012); and
- One (1) each of: pH (ASTM D4972), laboratory soil resistivity (ASTM G57), chlorides (ASTM D512), sulfates (ASTM D516), oxidation-reduction potential (SM 2580B).

The laboratory test results are provided in **Appendix E**.

Streambed Scour Sample

Based on the particle size analysis performed on a soil sample obtained by Nobis, streambed soils consist of brown, fine to coarse sand with trace fine gravel and trace silt. Based on laboratory testing, the D_{50} of the streambed sample was 0.92 millimeters.

5.0 SUBSURFACE CONDITIONS

Existing Information

Based on a preliminary review of surficial geologic maps, the surficial geologic conditions at the site likely consist of stream alluvium overlying outwash deposits. A site-focused 2008 USGS surficial geologic map entitled “Surficial Geology of the Worthley Pond Quadrangle, Maine” (Thompson, Eusden Jr., Tolman, Tucker, Marvinney) along with the corresponding description of geologic units are provided on **Figure 3**.

Per a 1978 USGS bedrock geologic map entitled “Reconnaissance Bedrock Geology of the Buckfield Quadrangle, Maine” (Pankiwskyj), bedrock at the site is that of the Sangerville Formation (Anasagunticook Member), which consists of “…gray metasiltstone and dark gray metapelite, subordinate, light gray, calcareous graywacke metasandstone…” For a site-focused plan view of the bedrock geologic map, including a more detailed description of the bedrock at the site, refer to **Figure 4**.

Subsurface Conditions Encountered

The generalized stratigraphy encountered in the test borings generally consisted of asphalt overlying granular fill, stream alluvium, outwash deposits, and bedrock to the termination depth. Generalized descriptions of the subsurface conditions encountered in the test borings are discussed below, in order of increasing depth. An interpretive subsurface profile is included as **Figure 5**.

Pavement: Between approximately four (4) and six (6) inches of roadway Hot Mix Asphalt (HMA) pavement was encountered in BB-SWBMR-101 and BB-SWBMR-102, respectively.

Fill: The fill encountered in the test borings generally consisted of dry to wet, brown, very loose to medium dense, fine to coarse sand with varying amounts of silt and gravel, occasionally including asphalt particles and fragments. As an exception, BB-SWBNR-102 Sample 2D encountered cohesive fill soil consisting of light brown, moist, soft clayey silt with some fine sand. An inferred stratum change based on a change in drilling behavior and wash color in BB-SWBNR-101 indicated that there may be fill up to approximately 9.7 feet deep in the bridge approach embankments.

Stream Alluvium: The stream alluvium encountered in the borings generally consisted of tan or grey, wet, very loose to medium dense, fine to coarse sand with varying amounts of gravel and silt. As an exception, BB-SWBNR-101 Sample 5D encountered grey, wet, stiff, silty clay with some fine sand. Drilling behavior and casing blows indicate that a transition between stream alluvium and outwash deposits may occur between 15 and 22 feet bgs.

Outwash Deposits: Based on the samples obtained in the test borings, the outwash deposits generally consist of tan or grey, wet, very dense, fine to medium or fine to coarse sand with varying amounts of silt and gravel.

Bedrock: Bedrock was encountered at approximately 42 feet (corresponding to El. 444) and 37.7 feet (448.3) bgs in BB-SWBNR-101 and BB-SWBNR-102, respectively. Core samples generally consisted of grey, fresh, hard to very hard, fine- to medium-grained metasandstone and metasiltstone with quartzite intrusions, with very close to moderately close low-angle to moderately-dipping joints. Rock quality designations (RQDs) varied between 42% (poor) and 94% (excellent).

Groundwater: The elevation of the water in the West Branch Nezinscot River was measured at approximately 5.6 feet below the existing bridge deck, or El. 480.4, on April 5, 2017. Prior to drilling on June 26, 2017, the depth of the West Branch Nezinscot River was approximately 6 feet below the existing bridge deck, or El. 480.

Groundwater measurements were obtained under both cased and uncased borehole conditions after between 1 hour and 16 hours of stabilization. Measurements varied between approximately 4.25 and 5.85 feet bgs, or El. 481.8 and El. 480.2, in BB-SWBNR-101 and BB-SWBNR-102, respectively.

Note that water was introduced to boreholes during the test boring rotary wash process, and that fluctuations in the observed groundwater levels will occur due to variations in precipitation, river water level, temperature, and other factors different from those existing at the time the measurements were made.

6.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

The following sections present our geotechnical engineering evaluations of the subsurface conditions relative to replacement of the abutments.

6.1 Integral Abutment Design Recommendations

Loads

Factored loads were provided by Fuss & O'Neill via email on August 22, 2018. The factored axial demand is 164.5 kips per pile.

Axial Pile Resistance

Nobis anticipates the capacity of the piles will be achieved through end bearing resistance on or in bedrock. Calculations to determine the geotechnical axial pile resistance were not performed because we anticipate that the piles will be driven through the outwash deposits to competent bedrock. Based on the subsurface explorations, hard bedrock was encountered at the site, therefore, the structural resistance of the piles controls in accordance with AASHTO Article 10.7.3.2.3. By utilizing end bearing (primary) piles, total and differential settlements will be limited to elastic compression of the piles and are anticipated to be ≤ 0.5-inch.

Lateral Pile Evaluation

Nobis provided soil properties to Fuss & O'Neill for their lateral pile evaluation.

Based on the output files provided by Fuss & O'Neill on September 10, 2018, the depth of fixity (i.e. second point of zero deflection) below top of pile appears to be as follows:

- West Abutment - Abutment 1 (no scour): 15 feet
- West Abutment - Abutment 1 (with scour): 20 feet
- East Abutment - Abutment 2 (no scour): 14 feet
- East Abutment - Abutment 2 (with scour): 16 feet

The material properties (provided by Nobis) and output results (provided by Fuss & O'Neill) are included in **Appendix F**.

Nominal Geotechnical Driving Resistance

The piles will need to be driven to the required total nominal geotechnical driving resistance in order to support the factored loads. Based on the loads provided by Fuss & O'Neill, the maximum axial compression for the strength load case is 164.5 kips per pile. Therefore, the total nominal geotechnical driving resistance, using a resistance factor of 0.65 assuming dynamic testing is performed as described below, is 253 kips.

We recommend using a structural resistance factor (AASHTO Article 6.5.4.2) of 0.5 for H-piles subject to damage due to severe driving conditions. We recommend that the H-piles be protected with a driving shoe to protect the piles during driving.

Estimated Pile Tip Elevation

The proposed piles should be driven a minimum to five (5) feet past point of fixity (≥ 25 feet for west abutment and ≥ 21 feet for the east abutment). In locations where bedrock is less than five (5) feet below the elevation of the theoretical point of fixity, the piles should be driven to the top

of bedrock. Additionally, the piles need to be driven to the required total nominal geotechnical driving resistance, as discussed above.
Based on the borings, the top of bedrock varies at the proposed abutment locations. We recommend using an estimated pile tip elevation, for quantity estimating purposes, of El. 444 for the west abutment and El. 447 for the east abutment.

Corrosion Considerations

The proposed H-piles are anticipated to be driven through the alluvium and outwash deposits. Based on the results of the laboratory testing, a corrosive environment has not been identified for this project. Additionally, the proposed piles will be driven through natural materials below the water table. Therefore, sacrificial steel thickness is not needed for the piles.

Drainage and Frost Depth

The proposed integral abutments should be designed to drain in accordance with Section 5.4.1.9 of the MaineDOT Bridge Design Guide. We recommend 4 inch diameter drains (weep holes) at nominal 10 foot maximum spacing be installed 1-foot below the grade at the riverside face of the abutment (i.e. El. 481). The weep holes should be installed with a slope of 2 percent.

Using an assumed water content for granular soils of 15%, we recommend a frost depth of 6'-5" (6.4 feet). This is based on a design freezing index of 1,590 (Figure 5-1, MaineDOT Bridge Design Guide).

6.2 Lateral Earth Pressures

We recommend a passive earth pressure coefficient of 8.38, assuming the abutment moves laterally at least 2 percent of the wall height (0.020H for dense soils). For relative movement of less than 0.020H, Section 3.10.8 of the MassDOT LRFD Bridge Manual could be used.

6.3 Approach Embankments

Global Slope Stability

The 2D limit equilibrium software, Slide 6.0, by RocScience, Inc. was used to evaluate the global slope stability. The required resistance factor against global stability is 0.65 (AASHTO Section 11.6.2.3) for the abutments, which corresponds to a factor of safety of 1.5, and 0.75 for the embankments, which corresponds to a factor of safety of 1.3.

The results of our global stability evaluation indicate a safety factor above 1.5 is obtained at both the west and east abutments of the proposed bridge. Additionally, the results of our global stability evaluation indicate a safety factor above 1.3 is obtained at the approach embankments. Our global stability evaluations are included in **Appendix F**.

6.4 Seismic Design Considerations

Based on the SPT-N values, and using Method B (Table C3.10.3.1-1), the SPT blow count is approximately 29 to 38 in the area of the abutments, corresponding to a Site Class "D".

The seismic parameters developed for the proposed bridge are provided below per the AASHTO 7th Edition:

Mapped Ground and Spectral Response Coefficients (USGS Seismic Design Maps):

- Horizontal Peak Ground Acceleration (PGA): 0.089
- Horizontal Response Spectral Acceleration, 0.2 Sec (S_S): 0.181
- Horizontal Response Spectral Acceleration, 1.0 Sec (S_1): 0.049

Site Class: D (AASHTO Table 3.10.1-1):

- Site Factors for Site Class "D" (AASHTO Tables 3.10.3.2-1, -2, and -3):
  Zero-Period (F_{pga}) = 1.6, Short-Period, 0.2 Sec (F_a) = 1.6, and Long Period, 1.0 Sec (F_v) = 2.4.

- Design Spectral Response Parameters for Site Class "B":
  A_S = 0.143, S_{DS} = 0.289, S_{D1} = 0.117.

Per AASHTO Article 3.10.6 the site is assigned Seismic Zone 1 based on a calculated S_{D1} of 0.117. Seismic design parameters are included in **Appendix F**.

6.5 Construction Considerations

Dynamic Testing and Driveability

We recommend that piles be driven with an impact hammer utilizing fixed-lead pile installation equipment. Pile followers and pile jetting should not be allowed.

We performed a preliminary WEAP analysis to estimate pile driving feasibility. Based on our preliminary WEAP evaluation, HP 10x42 H-piles can be driven to the required total nominal driving resistance without overstressing the piles. However, a WEAP analysis shall be performed before construction by a Professional Engineer modeling the actual hammer and equipment to be used by the pile driving contractor. Our preliminary driveability calculation is included in **Appendix F**.

We recommend that dynamic pile testing using Pile Driving Analyzer (PDA) is used to confirm that piles are driven to the total nominal driving resistance which we anticipate to be on or within bedrock. We recommend piles be driven to a nominal resistance equal to the maximum factored axial compressive pile load divided by a resistance factor equal to 0.65 (AASHTO Table 10.5.5.2.3-1).

We recommend that 1 indicator pile at each abutment be tested during the end of initial driving with a PDA followed by a CAPWAP. This test is used to determine the pile driving acceptance criteria including blows per inch (or pile set in inches per blow), the hammer energy, and hammer stroke. Pile driving installation criteria, including refusal criteria, must be determined by the Contractor's geotechnical engineer and submitted to Nobis for review.

We also recommend that a re-strike test with a PDA and CAPWAP analysis be completed on previously tested piles a minimum of 24 hours after installation to verify that piles have been driven to the required nominal driving resistance. We recommend that the indicator piles are monitored to ensure that pile driving stresses in the piles are within allowable limits.

Subgrade Preparation Procedures

We recommend the following subgrade preparation procedures for the proposed integral abutments:

- Excavations should be completed in the dry, as discussed in the Construction Dewatering and Temporary Excavation Support section.

- Granular Borrow for Underwater Backfill should be used as backfill behind the proposed abutments, a minimum of 1.5 feet directly behind the heel of the proposed pile caps sloping up at a minimum 1.5 Horizontal to 1 Vertical (1.5H:1V).

- Granular Borrow for Underwater Backfill should be placed in maximum 12 inch thick loose lifts, and compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557, Method C (Modified Proctor).

Re-Use of On-site Soil

Based on soils encountered in test borings, the existing fill material generally consisted of sand with more than 20% silt and clay. Materials with fines up to 20% can be difficult to reuse if wet. We recommend those materials be reused in landscape areas or be disposed of offsite.

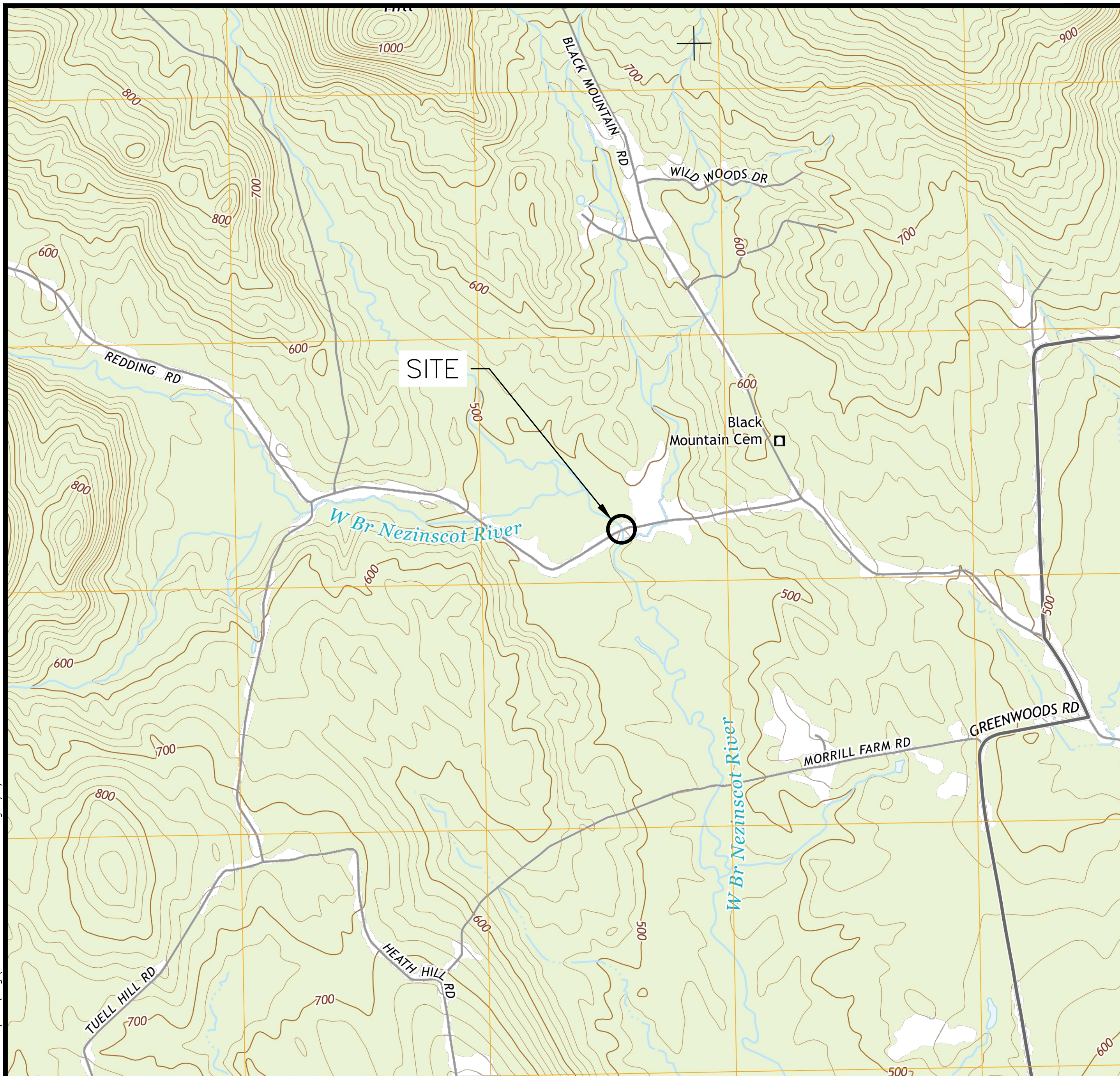
Construction Dewatering and Temporary Excavation Support

A temporary supported excavation will likely be required to install the piles and construct the pile cap. The Contractor will be required to manage and control the river water during excavation, as well as to control surface water from entering excavations, to provide a stable subgrade during pile installation and subsequent pile cap construction.

Based on the nature of the existing soils near the bottom of pile cap elevation, we anticipate that several wells/sumps could be required to manage large quantities of groundwater. The Contractor should be responsible for selecting the dewatering methods based on his proposed methods and equipment used for excavation and excavation support. The method of dewatering will depend on time of year that the work is performed, size of the open excavation, and the length of time the excavation is left open. Dewatering efforts must satisfy requirements of local, state, and federal environmental and conservation authorities.

Temporary earth support and dewatering systems should be selected by the Contractor and designed by a Professional Engineer registered in the State of Maine, and retained by the Contractor. The earth support and dewatering designs are integral with one another and should be submitted as a single submittal for review by MaineDOT. Where excavation sides are cut back and sloped, they should be in accordance with Occupational Safety and Health Administration (OSHA) Construction Industry Standards.

FIGURES



2014 USGS TOPOGRAPHIC MAP

NORTH

WORTHLEY POND QUADRANGLE
SUMNER, MAINE
CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

APPROXIMATE SCALE
1 INCH = 2,000 FEET

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
585 Middlesex Street
Lowell, MA 01851
T(978) 683-0891
www.nobiseng.com
Client - Focused, Employee - Owned

QUADRANGLE LOCATION

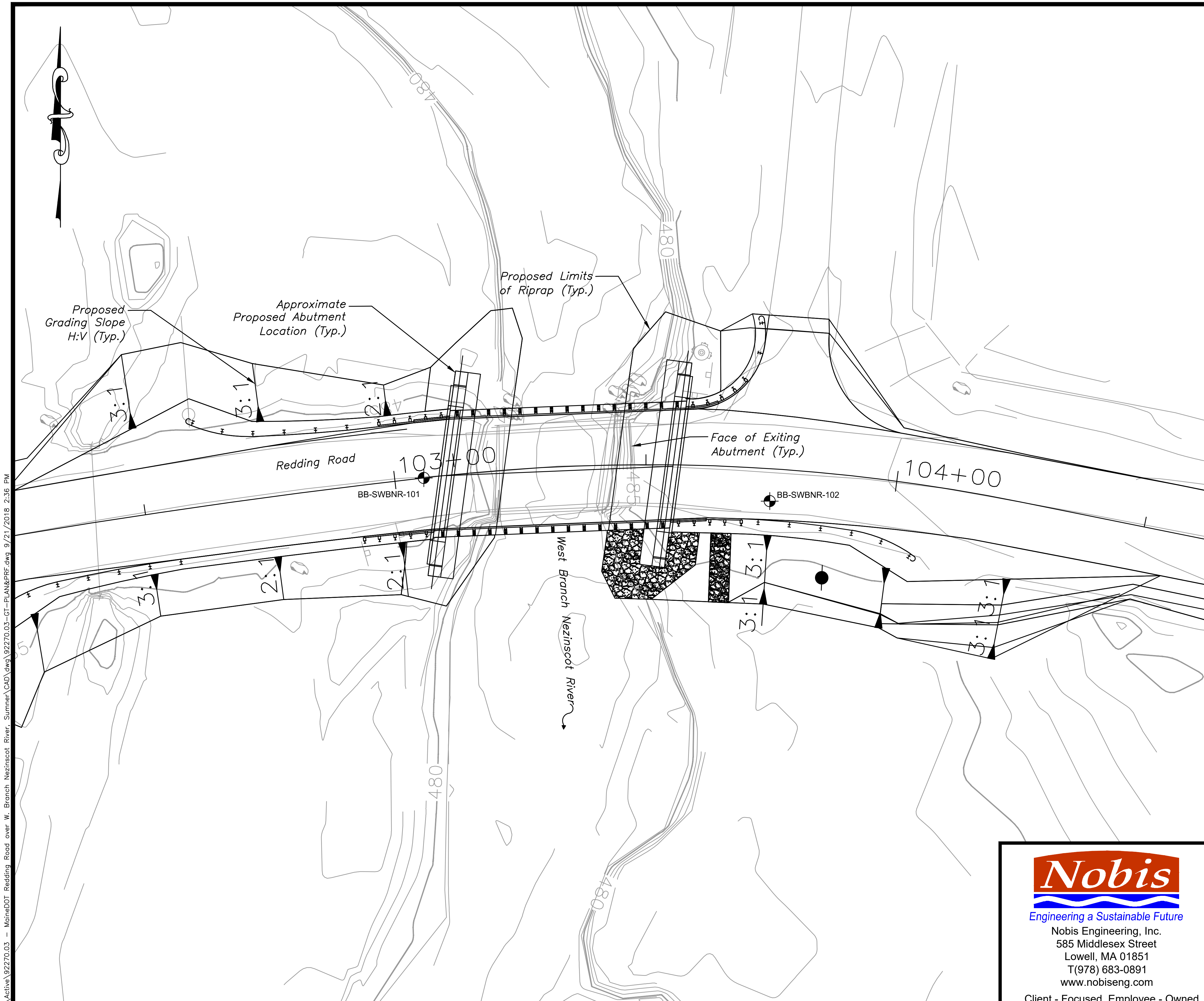
FIGURE 1

SITE LOCUS PLAN

HEALD BRIDGE (#0673)
REDDING ROAD OVER W. BRANCH
NEZINSCOT RIVER
SUMNER, MAINE

PROJECT NO.	92270.03	DATE:	JULY 2017

O:\Active\92270.03 – MaineDOT Redding Road over W. Branch Nezinscot River, Sumner\CAD\dwg\92270.03-GT-100-LOCUS.dwg 7/5/2017 10:51 AM



NOTES:

1. THE BASE PLAN WAS DEVELOPED FROM .DGN FILES PROVIDED BY FUSS & O'NEILL ON SEPTEMBER 10, 2018.
2. SOIL BORINGS WERE DRILLED BY NEW ENGLAND BORING CONTRACTORS OF HERMON, MAINE, AND OBSERVED BY NOBIS BETWEEN JUNE 26 AND JUNE 28, 2017.
3. LOCATIONS AND SITE FEATURES DEPICTED ARE APPROXIMATE AND GIVEN FOR ILLUSTRATIVE PURPOSES.
4. ELEVATIONS ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

LEGEND

BB-SWBNR-101 APPROXIMATE BORING LOCATION

0 10' 20'

GRAPHIC SCALE

Nobis

Engineering a Sustainable Future

Nobis Engineering, Inc.
585 Middlesex Street
Lowell, MA 01851
T(978) 683-0891
www.nobiseng.com

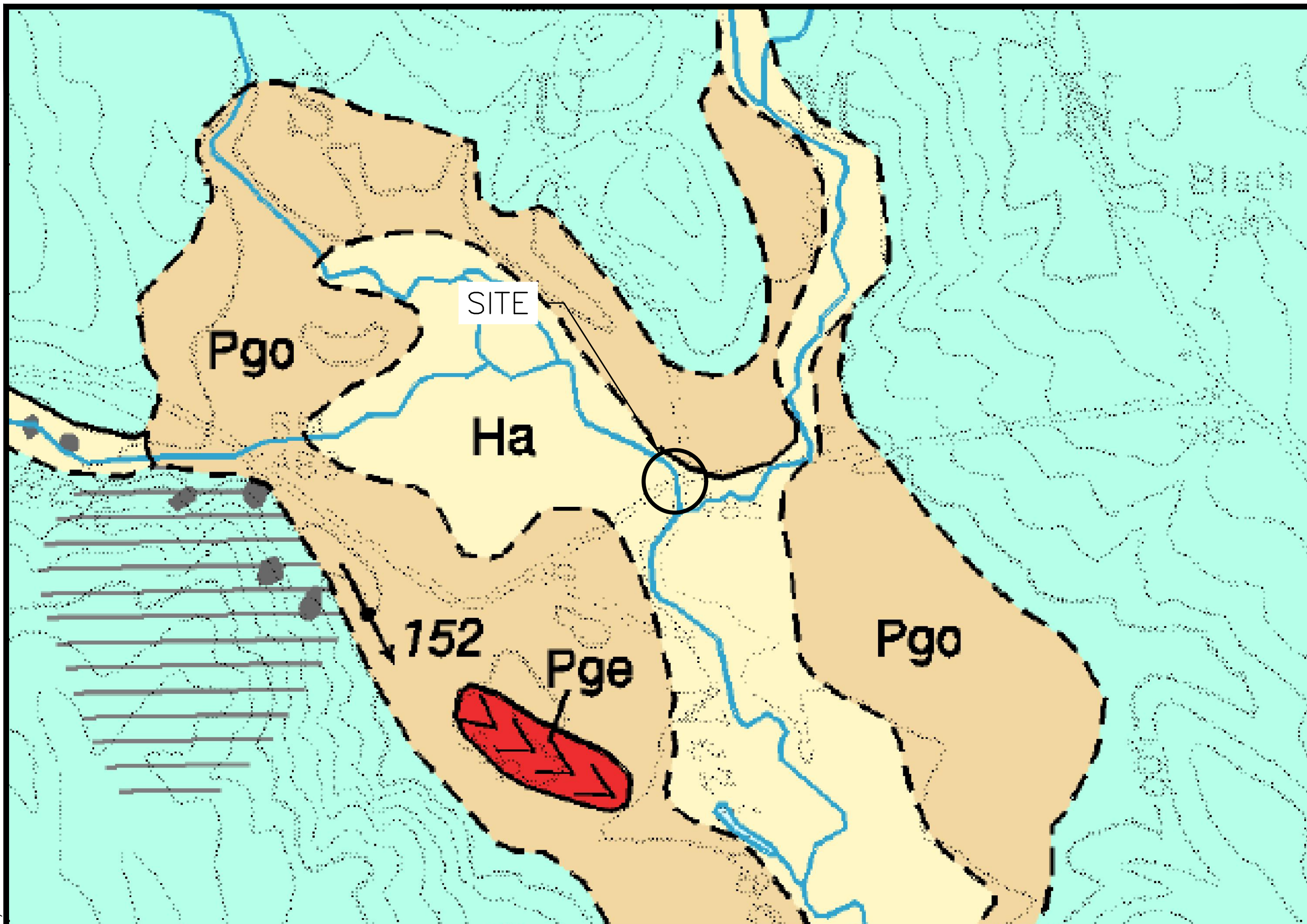
Client - Focused, Employee - Owned

FIGURE 2

BORING LOCATION PLAN
HEALD BRIDGE (#0673)
REDDING ROAD OVER W. BRANCH NEZINSCOT RIVER
SUMNER, MAINE

DRAWN BY:	PC	CHECKED BY:	BTW
PROJECT NO.	92270.03	DATE:	SEPTEMBER 20, 2018

O:\Active\92270.03 – MaineDOT Redding Road over W. Branch Nezinscot River, Sumner\CAD\dwg\92270.03-GT-PLAN&PRF.dwg 9/21/2018 2:36 PM



Ha	**Stream alluvium** - Sand, silt, gravel, and organic sediment. Deposited on the flood plain of the Androscoggin River and other modern streams. Unit includes some wetland areas.
Pgo	**Outwash deposits** - Sand and gravel deposited by glacial meltwater streams along the East Branch and West Branch of the Nezinscot River.
Pge	**Esker deposits** - Ridges of sand and gravel deposited by glacial meltwater streams in subglacial tunnels.
	Bedrock outcrops / thin-drift areas - Ruled pattern indicates areas where outcrops are common and/or surficial sediments are generally less than 10 ft thick (mapped partly from air photos). Dots show individual outcrops.

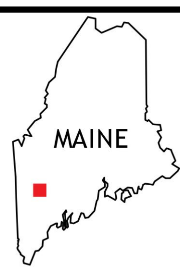
2008 USGS SURFICIAL GEOLOGIC MAP

"SURFICIAL GEOLOGY OF THE WORTHLEY POND QUADRANGLE, MAINE"
(THOMPSON, EUSDEN JR., TOLMAN, TUCKER, MARVINNEY)
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
CONTOUR INTERVAL 20 FEET
ORIGINAL SCALE 1:24,000

NORTH

NOT TO SCALE

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
585 Middlesex Street
Lowell, MA 01851
T(978) 683-0891
www.nobiseng.com
Client - Focused, Employee - Owned



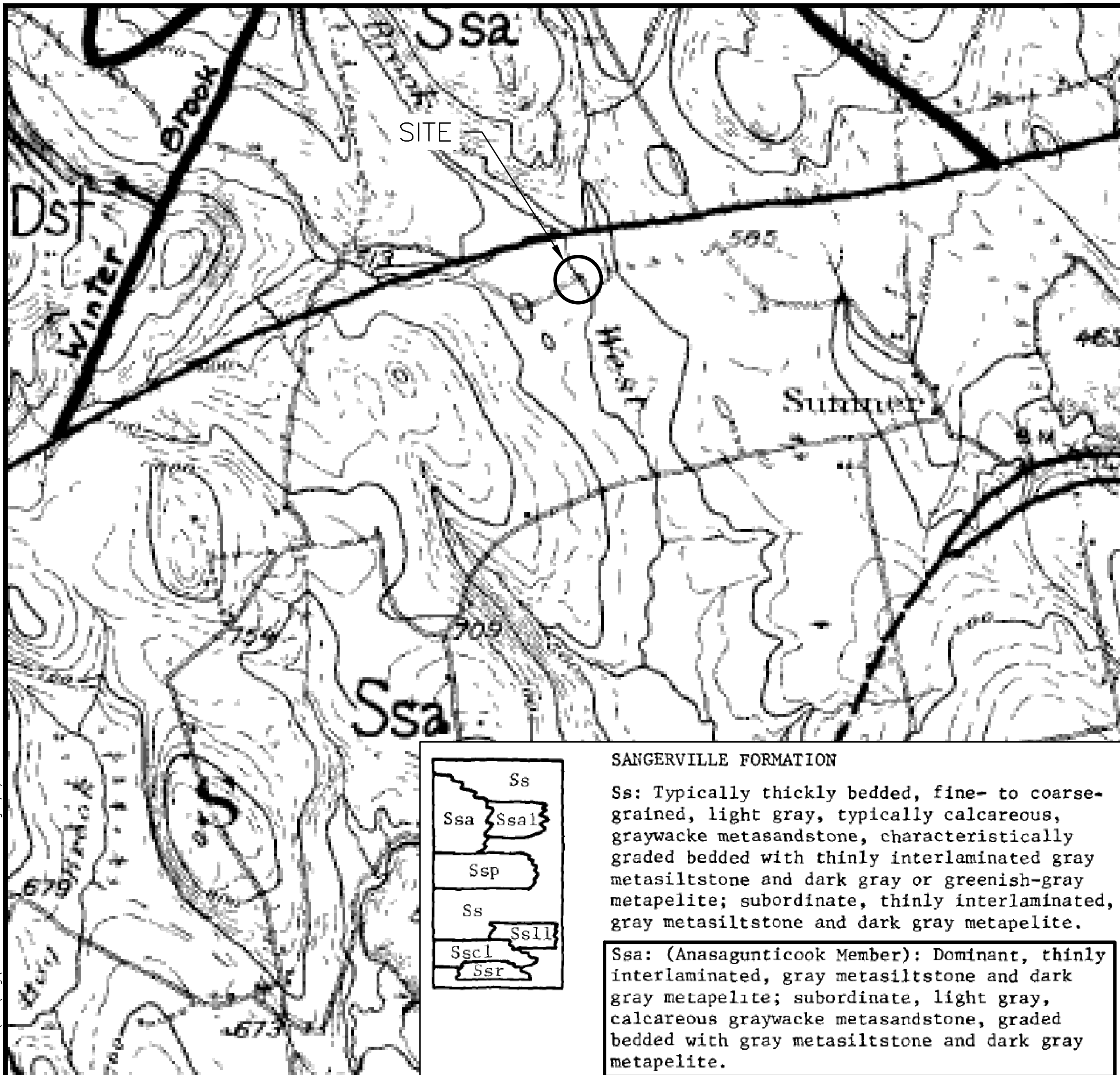
QUADRANGLE LOCATION

FIGURE 3

SURFICIAL GEOLOGIC MAP
HEALD BRIDGE (#0673)
REDDING ROAD OVER W. BRANCH
NEZINSCOT RIVER
SUMNER, MAINE

PROJECT NO. 92270.03 | DATE: JULY 2017

O:\Active\92270.03 - MaineDOT Redding Road over W. Branch Nezinscot River, Sumner\CAD\dwg\92270.03-GT-100-LOCUS.dwg 7/5/2017 10:52 AM



NORTH

1978 USGS BEDROCK GEOLOGIC MAP

"RECONNAISSANCE BEDROCK GEOLOGY OF
THE BUCKFIELD QUADRANGLE, MAINE"
(PANKIWSKYJ)
ORIGINAL SCALE 1:62,500

NOT TO SCALE

Engineering a Sustainable Future
Nobis Engineering, Inc.
585 Middlesex Street
Lowell, MA 01851
T(978) 683-0891
www.nobiseng.com
Client - Focused, Employee - Owned

QUADRANGLE LOCATION

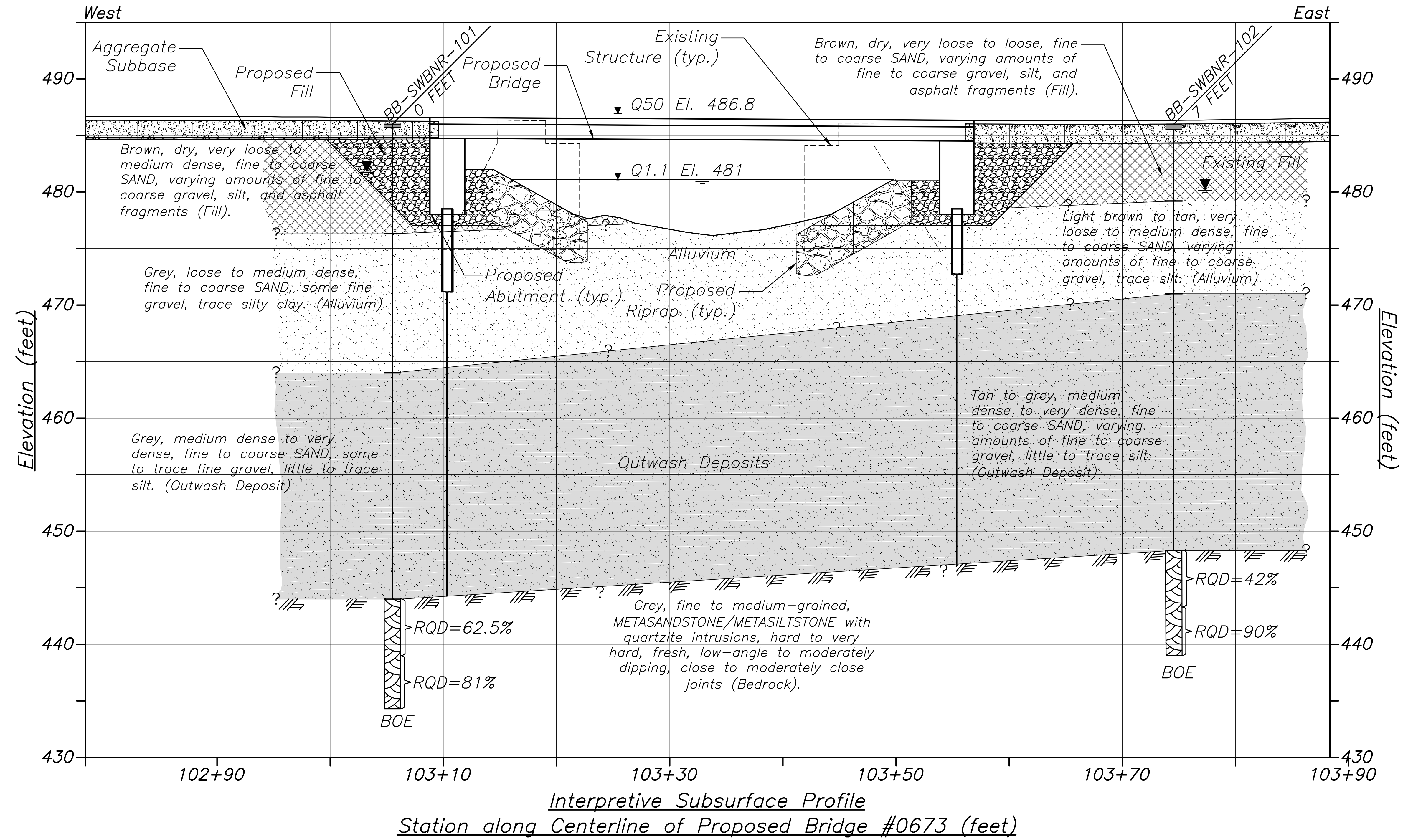
FIGURE 4

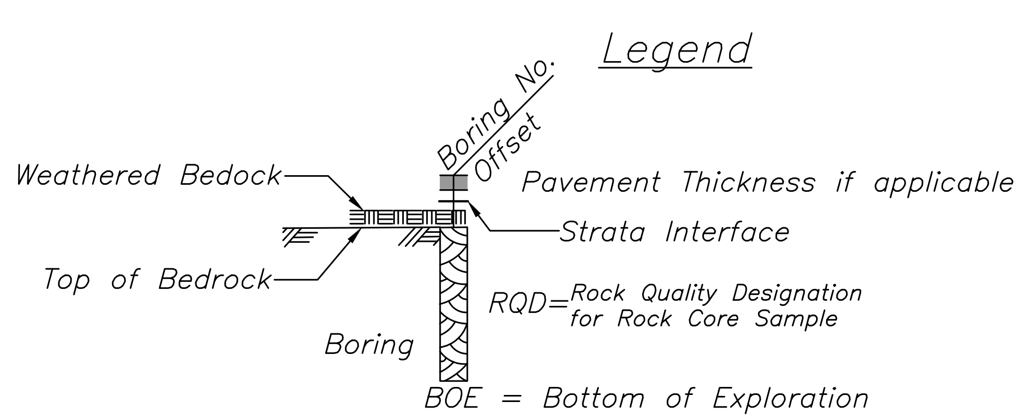
BEDROCK GEOLOGIC MAP

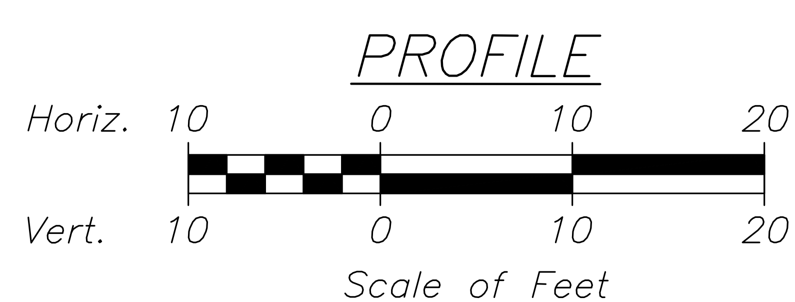
HEALD BRIDGE (#0673)
REDDING ROAD OVER W. BRANCH
NEZINSCOT RIVER
SUMNER, MAINE

PROJECT NO.	92270.03	DATE:	JULY 2017

O:\Active\92270.03 - MaineDOT Redding Road over W. Branch Nezinscot River, Sumner\CAD\dwg\92270.03-GT-100-LOCUS.dwg 7/5/2017 10:52 AM







NOTES:

1. THIS SUBSURFACE PROFILE WAS DEVELOPED FROM A DGN FILE PROVIDED BY FUSS & O'NEILL ON SEPTEMBER 10, 2018.
2. LINES REPRESENTING LIMITS OF STRATA ARE INTERPOLATED FROM SUBSURFACE EXPLORATION LOGS. ADDITIONALLY, THE SUBSURFACE EXPLORATIONS ARE WIDELY SPACED AND ARE BASED ON LIMITED SUBSURFACE INFORMATION COLLECTED DURING DRILLING. OTHER INTERPRETATIONS ARE POSSIBLE AND ACTUAL CONDITIONS MAY VARY FROM THOSE PRESENTED.
3. TOP OF BEDROCK SHOULD BE CONSIDERED APPROXIMATE AND CAN VARY SIGNIFICANTLY OVER SHORT DISTANCES.
4. WATER LEVELS PRESENTED WERE COLLECTED DURING DRILLING AND MAY NOT REPRESENT STABILIZED GROUNDWATER CONDITIONS. GROUNDWATER LEVELS WILL FLUCTUATE WITH SEASON, PRECIPITATION AND NEARBY ACTIVITIES.
5. EXISTING AND PROPOSED SITE FEATURES DEPICTED ARE APPROXIMATE AND GIVEN FOR ILLUSTRATIVE PURPOSES.
6. SOIL BORINGS WERE DRILLED BY NEW ENGLAND BORING CONTRACTORS, OF HERMON, MAINE AND OBSERVED BY NOBIS ON JUNE 26 THROUGH 28, 2017.
7. ELEVATIONS ARE BASE ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
585 Middlesex Street
Lowell, MA 01851
T(978) 683-0891
www.nobiseng.com
Client - Focused, Employee - Owned

FIGURE 5
INTERPRETIVE SUBSURFACE PROFILE
HEALD BRIDGE (#0673)
REDDING ROAD OVER WEST BRANCH OF NEZINSCOT RIVER
SUMNER, MAINE

DRAWN BY:	PC	CHECKED BY:	BTW
PROJECT NO.	92270.03	DATE:	SEPTEMBER 20, 2018

O:\Active\92270.03 - MaineDOT Redding Road over W. Branch Nezinscot River, Sumner\CAD\dwg\92270.03-GT-PLAN&PRF.dwg 9/21/2018 2:35 PM

APPENDIX A – Limitations

GEOTECHNICAL LIMITATIONS

Explorations and Subsurface Conditions

1. The analyses and design recommendations submitted in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

   In preparing this report, Nobis relied on certain information provided by the Client and other parties referenced therein which were made available to Nobis at the time of our evaluation. Nobis did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the exploration logs.

3. Water level readings have been made in the explorations at times and under conditions stated on the logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made. The water table encountered in the course of the work may differ from that indicated in the Report.

   Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

4. Nobis' geotechnical services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

Additional Services

5. Nobis recommends that we be retained to provide services during future site observations, design, implementation activities, construction and/or property development/ redevelopment. This will allow us the opportunity to: i) observe conditions and compliance with our recommendations, design concepts and/or opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design recommendations; and iv) assess the consequences of changes in technologies and/or regulations.

Use of Report

6. Nobis prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in our proposal and/or report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to Nobis.

   This report is for design purposes only and is not sufficient to prepare an accurate construction bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

7. Nobis' findings and conclusions are based on the work conducted as part of the scope of work set forth in our proposal and/or report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions considering the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the project design has been altered in any way, Nobis shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions.

8. Nobis' services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

Compliance with Codes and Regulations

9. Nobis used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

Opinion of Cost

10. This report may contain or be based on comparative cost opinions for the purpose of evaluating alternative foundation schemes. These opinions may also involve approximate quantity evaluations. It should be noted that quantity estimates may not be accurate enough for construction bids. In addition, since we are not professional estimators of labor and materials cost, the evaluation of construction costs should be considered as approximate guidelines and could vary significantly from actual costs. Nobis does not guarantee the accuracy of our cost opinions as compared to contractor's bids for construction costs.

END OF LIMITATIONS

APPENDIX B – Automatic Hammer Calibration Report

New England Boring Contractors (NEBC) – ETR for MaineDOT Projects
based on March 27 2017 Calibration

RIG B53 Track							
Hammer #NEBC 1							
	Average E over all blows	72.2	78.3	71.2	75.5		
	N (Ni)	19	40	26	37	∑Ni	122
	Average E over N (Ei)	71.8	78.5	71.2	75.5		
	NiEi	1364.9	3139.0	1851.4	2793.5	∑NiEi	9149
						∑NiEi/∑Ni	**75.0**

RIG B53 Rubber Track							
Hammer #NEBC 2							
	Average E over all blows	66.5	68.6	67.2	68.5		
	N (Ni)	30	26	16	23	∑Ni	95
	Average E over N (Ei)	66.9	68.8	66.9	68.8		
	NiEi	2008.2	1788.1	1070.8	1582.0	∑NiEi	6449
						∑NiEi/∑Ni	**67.7**

RIG CME Trailer							
Hammer #MTB AH3							
	Average E over all blows	68.0	70.0	70.5	66.5		
	N (Ni)	20	31	21	25	∑Ni	97
	Average E over N (Ei)	68.3	69.4	70.4	65.4		
	NiEi	1365.2	2152.4	1478.0	1636.2	∑NiEi	6632
						∑NiEi/∑Ni	**68.4**

APPENDIX C – Boring Logs

Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: Heald Bridge (#0673) Redding Road over West Branch Nezinscot River
Location: Sumner, Maine

Boring No.: BB-SWBNR-101

WIN: 21704.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	486	**Auger ID/OD:**	N/A
Operator:	M. Porter	**Datum:**	NAVD-88	**Sampler:**	1-3/8" Split-Spoon
Logged By:	P. Clarke (Nobis)	**Rig Type:**	B-53 Mobile ATV	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	June 26, 2017/June 27, 2017	**Drilling Method:**	Drive and Wash	**Core Barrel:**	NQ2
Boring Location:	STA 103+06, 0'	**Casing ID/OD:**	4"/4.5"	**Water Level*:**	4.25' bgs
Hammer Efficiency Factor:	.75	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/13	0.50 - 2.50	5/10/8/4	18	23	RC	485.67		Asphalt (4"). 0.33	
										1D-A (6"): Orange-brown, dry, medium dense, gravelly fine to coarse SAND, trace silt, very few asphalt fragments. (Fill). 1D-B (7"): Grey-brown, dry, medium dense, fine to coarse SAND, some fine gravel, trace silt, few asphalt particles and fragments. (Fill).	
	2D	24/16	2.50 - 4.50	4/3/3/5	6	8				2D-A (9"): Dark brown, moist, loose, fine to coarse SAND, some silt, little fine gravel, few asphalt particles. (Fill). 2D-B (7"): Brown, moist, loose, fine to coarse SAND, some fine to coarse gravel, little silt. (Fill).	
	3D	24/0	4.50 - 6.50	4/3/3/3	6	8				No recovery.	
5							17				
							16				
							23				
							20				
							32	476.30		9.70	
10	4D	24/6	10.00 - 12.00	8/7/6/6	13	16	24			Apparent strata change based on change in wash color at approximately 9.7' bgs. Grey-brown, wet, medium dense, fine to coarse SAND, some fine gravel, trace silt. (Stream Alluvium).	
							16				
							25				
							38				
							39				
15	5D	24/6	15.00 - 17.00	4/4/10/8	14	18	29			Grey, wet, stiff, Silty CLAY, some fine sand. (Stream Alluvium).	A-6, CL-ML WC=19% LL=24 PL=19 PI=5
							32				
							29				
							30				
							52				
20	6D	24/4	20.00 - 22.00	17/6/3/3	9	11	51			Grey, wet, loose, fine to coarse SAND, some fine gravel, trace silt. (Stream Alluvium).	
							45				
							75				
							139				
25							54				

Remarks:

-Borehole backfilled with native soils.
-Pavement restored with asphalt cold patch.
-bgs = below ground surface.
-Automatic Hammer ID# NEBC 1.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Boring No.: BB-SWBNR-101

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Heald Bridge (#0673) Redding Road over West Branch Nezinscot River
Location: Sumner, Maine

Driller:	New England Boring Contractors	**Elevation (ft.)**	486	**Auger ID/OD:**	N/A
Operator:	M. Porter	**Datum:**	NAVD-88	**Sampler:**	1-3/8" Split-Spoon
Logged By:	P. Clarke (Nobis)	**Rig Type:**	B-53 Mobile ATV	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	June 26, 2017/June 27, 2017	**Drilling Method:**	Drive and Wash	**Core Barrel:**	NQ2
Boring Location:	STA 103+06, 0'	**Casing ID/OD:**	4"/4.5"	**Water Level*:**	4.25' bgs
Hammer Efficiency Factor:	.75	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	7D	24/16	25.00 - 27.00	20/36/45/79	81	101	105			Grey, wet, very dense, fine to medium SAND, trace silt, trace fine gravel. (Outwash Deposit).	
							160				
							213				
							230				
30	8D	24/17	30.00 - 32.00	59/81/99/117	100	125				Grey, wet, very dense, fine to medium SAND, trace silt, trace fine gravel. (Outwash Deposit).	
35	9D	16/14	35.00 - 36.33	32/77/100/4"	100	125				Grey, wet, fine to medium SAND, little silt, trace fine gravel. (Outwash Deposit).	
40	10D	18/15	40.00 - 41.50	31/78/122	100	125				Grey to light brown, wet, very dense, fine to coarse SAND, some fine to coarse gravel, trace silt. (Outwash Deposit).	
	R1	60/48	42.50 - 47.50	RQD = 62.5%			NQ2	444.00 443.50		42.00 Probable transition into bedrock at approximately 42' bgs based on drilling action. Top of Bedrock Elevation at El. 444. 42.50 R1: Grey, fine to medium-grained METASANDSTONE/ METASILTSTONE with Quartzite intrusions, hard to very hard, fresh, low-angle to moderately-dipping, close to moderately close joints. Sangerville Formation (Anasagunticook Member). RQD = 62.5% (Fair). R1: Core Times (min:sec) 42.5'-43.5' (2:50) 43.5'-44.5' (2:20) 44.5'-45.5' (2:00) 45.5'-46.5' (1:50) 46.5'-47.5' (1:30)	UCT q_p= 9,744 psi
45											
	R2	50/62	47.50 - 51.67	RQD = 81%						R2: Grey, fine to medium-grained METASANDSTONE/ METASILTSTONE with Quartzite intrusions, hard to very hard, fresh, low-angle to moderately-dipping, close to moderately close	
50											

Remarks:

-Borehole backfilled with native soils.
-Pavement restored with asphalt cold patch.
-bgs = below ground surface.
-Automatic Hammer ID# NEBC 1.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Heald Bridge (#0673) Redding Road over West Branch Nezinscot River **Location:** Sumner, Maine	**Boring No.:** BB-SWBNR-101 **WIN:** 21704.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	486	**Auger ID/OD:**	N/A
Operator:	M. Porter	**Datum:**	NAVD-88	**Sampler:**	1-3/8" Split-Spoon
Logged By:	P. Clarke (Nobis)	**Rig Type:**	B-53 Mobile ATV	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	June 26, 2017/June 27, 2017	**Drilling Method:**	Drive and Wash	**Core Barrel:**	NQ2
Boring Location:	STA 103+06, 0'	**Casing ID/OD:**	4"/4.5"	**Water Level*:**	4.25' bgs
Hammer Efficiency Factor:	.75	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50										joints. Sangerville Formation (Anasagunticook Member). RQD = 94% (Excellent). R2: Core Times (min:sec) 47.5'-48.5' (1:50) 48.5'-49.5' (1:10) 49.5'-50.5' (1:30) 50.5'-51.5' (1:20) 51.5'-51.7' (0:15)	
								434.30		51.70	
										Bottom of Exploration at 51.70 feet below ground surface.	
55											
60											
65											
70											
75											

Remarks:

-Borehole backfilled with native soils.
-Pavement restored with asphalt cold patch.
-bgs = below ground surface.
-Automatic Hammer ID# NEBC 1.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

Project: Heald Bridge (#0673) Redding Road over West Branch Nezinscot River		**Location:** Sumner, Maine		**Boring No.:**	BB-SWBNR-102
				WIN:	21704.00
Driller:	New England Boring Contractors	**Elevation (ft.)**	486	**Auger ID/OD:**	N/A
Operator:	M. Porter	**Datum:**	NAVD-88	**Sampler:**	1-3/8" Split-Spoon
Logged By:	P. Clarke (Nobis)	**Rig Type:**	B-53 Mobile ATV	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	June 28, 2017/June 28, 2017	**Drilling Method:**	Drive and Wash	**Core Barrel:**	NQ2
Boring Location:	STA 103+75, 6' RT	**Casing ID/OD:**	4"/4.5"	**Water Level*:**	5.85' bgs
Hammer Efficiency Factor: .75		**Hammer Type:**	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/9	0.50 - 2.50	6/3/3/2	6	8	RC	485.50		Asphalt (6"). 0.50 1D-A (3"): Brown, dry, loose, sandy fine to coarse GRAVEL, trace silt. (Fill).	
										1D-B (6"): Dark brown, dry, loose, fine to coarse SAND, some fine to coarse gravel, little silt, few asphalt particles and fragments. (Fill).	
	2D	24/10	2.50 - 4.50	3/2/1/2	3	4				Light brown, moist, soft, Clayey SILT, some fine sand. (Fill).	
	3D	24/12	4.50 - 6.50	WOR/1/1/1	2	3				Light brown, wet, very loose, fine to medium SAND, some silt. (Fill).	
5							9				
	4D	24/6	6.50 - 8.50	1/1/1/1	2	3	9	479.20		4D-A (3"): Light brown, wet, very loose, fine to medium SAND, some silt. (Fill). 6.80	
							9			4D-B (3"): Light brown, wet, very loose, fine to coarse SAND, trace fine gravel, trace silt. (Stream Alluvium).	
							14				
							24				
10	5D	24/7	10.00 - 12.00	11/7/5/6	12	15	36			Tan, wet, medium dense, sandy fine to coarse GRAVEL, trace silt. (Stream Alluvium).	
							27				
							42				
							69				
							53				
15	6D	24/11	15.00 - 17.00	13/22/28/37	50	63	70			Tan, wet, very dense, fine to medium SAND, little silt, trace fine to coarse gravel. (Outwash Deposit).	A-2-4 (0), SM
							83				
							118				
							141				
							247			Begin washing ahead prior to advancing casing. Switch to 140# automatic hammer.	
20	7D	24/12	20.00 - 22.00	7/22/28/32	50	63	59			Tan with orange staining, wet, very dense, fine to coarse SAND, little silt. (Outwash Deposit).	
							41				
							74				
							124				
							169				
25											

Remarks:

-Borehole backfilled with native soils.
-Pavement restored with asphalt cold patch.
-bgs = below ground surface.
-Automatic Hammer ID# NEBC 1.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: Heald Bridge (#0673) Redding Road over West Branch Nezinscot River Location: Sumner, Maine	Boring No.: BB-SWBNR-102 WIN: 21704.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	486	**Auger ID/OD:**	N/A
Operator:	M. Porter	**Datum:**	NAVD-88	**Sampler:**	1-3/8" Split-Spoon
Logged By:	P. Clarke (Nobis)	**Rig Type:**	B-53 Mobile ATV	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	June 28, 2017/June 28, 2017	**Drilling Method:**	Drive and Wash	**Core Barrel:**	NQ2
Boring Location:	STA 103+75, 6' RT	**Casing ID/OD:**	4"/4.5"	**Water Level*:**	5.85' bgs
Hammer Efficiency Factor:	.75	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	8D	24/14	25.00 - 27.00	12/28/30/37	58	73	84			Tan with orange staining, wet, very dense, fine to coarse SAND, little silt, trace fine gravel. (Outwash Deposit).	
							52				
							94				
							246				
							736				
30	9D	5/5	30.00 - 30.42	100/5"	100	125	79			Grey, wet, fine to coarse SAND, some fine gravel, trace silt. (Outwash Deposit). Switch back to 300# hammer for casing advancement.	
							85				
							159				
							117				
							153				
35	10D	11/4	35.00 - 35.92	64/100/5"	100	125	74			Grey, wet, sandy fine to coarse GRAVEL, trace silt. (Outwash Deposit).	
							67				
								448.30		37.70	
	R1	48/45	38.00 - 42.00	RQD = 42%			NQ2	448.00		Probable transition into bedrock at approximately 37.7' bgs based on drilling action. Top of Bedrock Elevation at El. 448.3. 38.00 R1: Grey, fine to medium-grained METASANDSTONE/ METASILTSTONE with Quartzite intrusions, hard to very hard, fresh, low-angle to moderately-dipping, very close to moderately close joints. Sangerville Formation (Anasagunticook Member). RQD = 42% (Poor). R1: Core Times (min:sec) 38'-39' (10:20) 39'-40' (1:50) 40'-41' (1:30) 41'-42' (1:20)	UCT q_p= 13,113 psi
40											
	R2	60/62	42.00 - 47.00	RQD = 90%						R2: Grey, fine to medium-grained METASANDSTONE/ METASILTSTONE with Quartzite intrusions, hard to very hard, fresh, low-angle to moderately-dipping, very close to moderately close joints. Sangerville Formation (Anasagunticook Member). RQD = 90% (Good). R2: Core Times (min:sec) 42'-43' (1:40) 43'-44' (1:20) 44'-45' (1:30) 45'-46' (1:20) 46'-47' (1:30)	
45											
								439.00		47.00	
										Bottom of Exploration at 47.00 feet below ground surface.	
50											

Remarks:

-Borehole backfilled with native soils.
-Pavement restored with asphalt cold patch.
-bgs = below ground surface.
-Automatic Hammer ID# NEBC 1.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Boring No.: BB-SWBNR-102

APPENDIX D – Photo Logs of Rock Cores

92270.03 Heald Bridge (#0673) – Sumner, ME – Photo Log

Photo 1: Boring BB-SWBNR-101 Rock Core Samples R-1 (Row 1) and R-2 (Row 2); Boring BB-SWBNR-102; Rock Core Samples R-1 (Row 3)

Photo 2: Boring BB-SWBNR-102; Rock Core Samples R-2 (Row 4)

Note: Bedrock samples from Rows 1 and 3 were sent to geotechnical laboratory for testing.

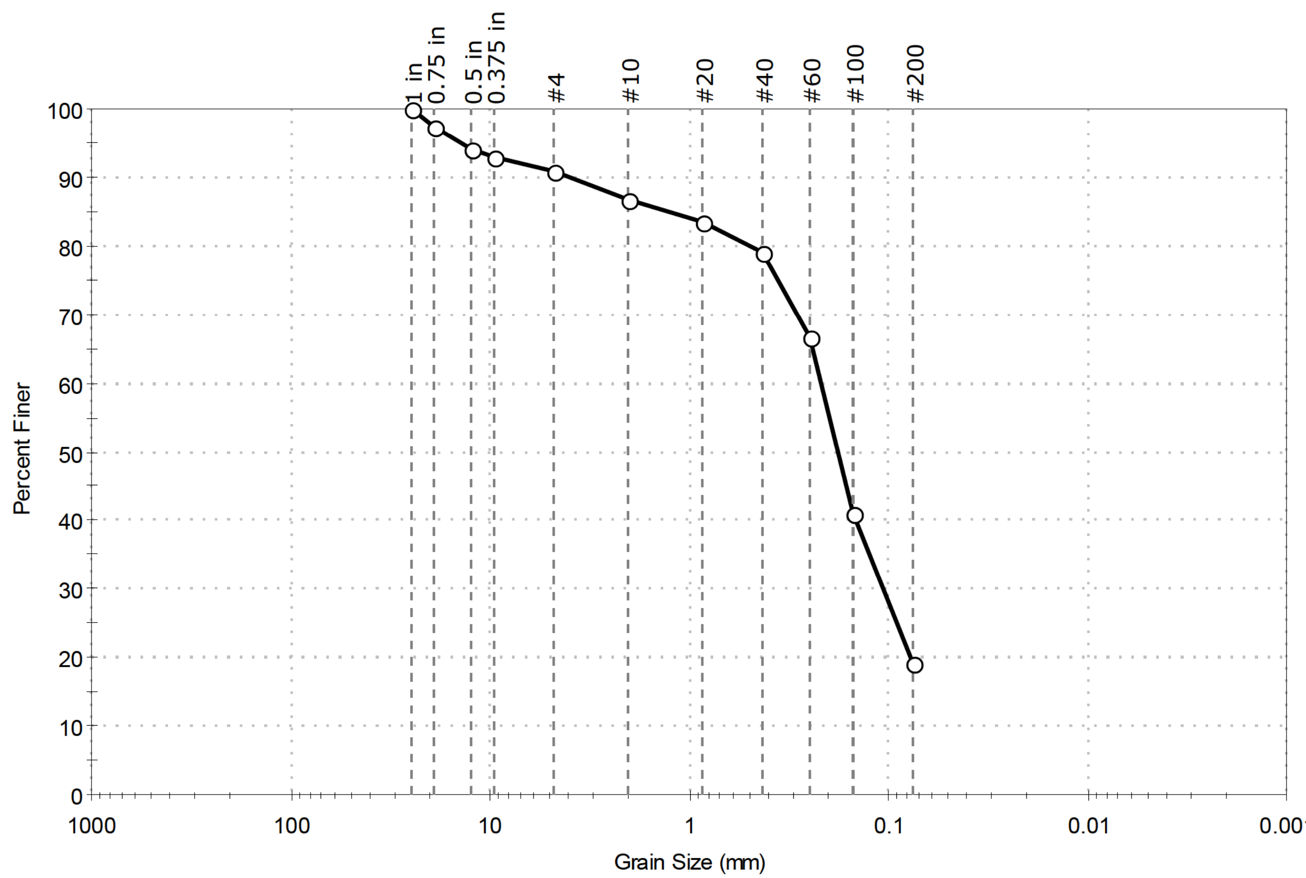
APPENDIX E – Laboratory Lab Results

Client:	Nobis Engineering, Inc.		
Project:	Heald Bridge #0673		
Location:	Sumner, ME	Project No:	GTX-306742

Boring ID:	BB-SWBNR-102	Sample Type:	bag	Tested By:	jbr
Sample ID:	S-6	Test Date:	07/31/17	Checked By:	jsc
Depth :	15-17 ft	Test Id:	417887		

Test Comment:	---
Visual Description:	Moist, light brown silty sand
Sample Comment:	---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	9.3	71.6	19.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	94		
0.375 in	9.50	93		
#4	4.75	91		
#10	2.00	87		
#20	0.85	83		
#40	0.42	79		
#60	0.25	67		
#100	0.15	41		
#200	0.075	19		

Coefficients

D_{85} = 1.2898 mm | D_{30} = 0.1058 mm
D_{60} = 0.2184 mm | D_{15} = N/A
D_{50} = 0.1790 mm | D_{10} = N/A
C_u = N/A | C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

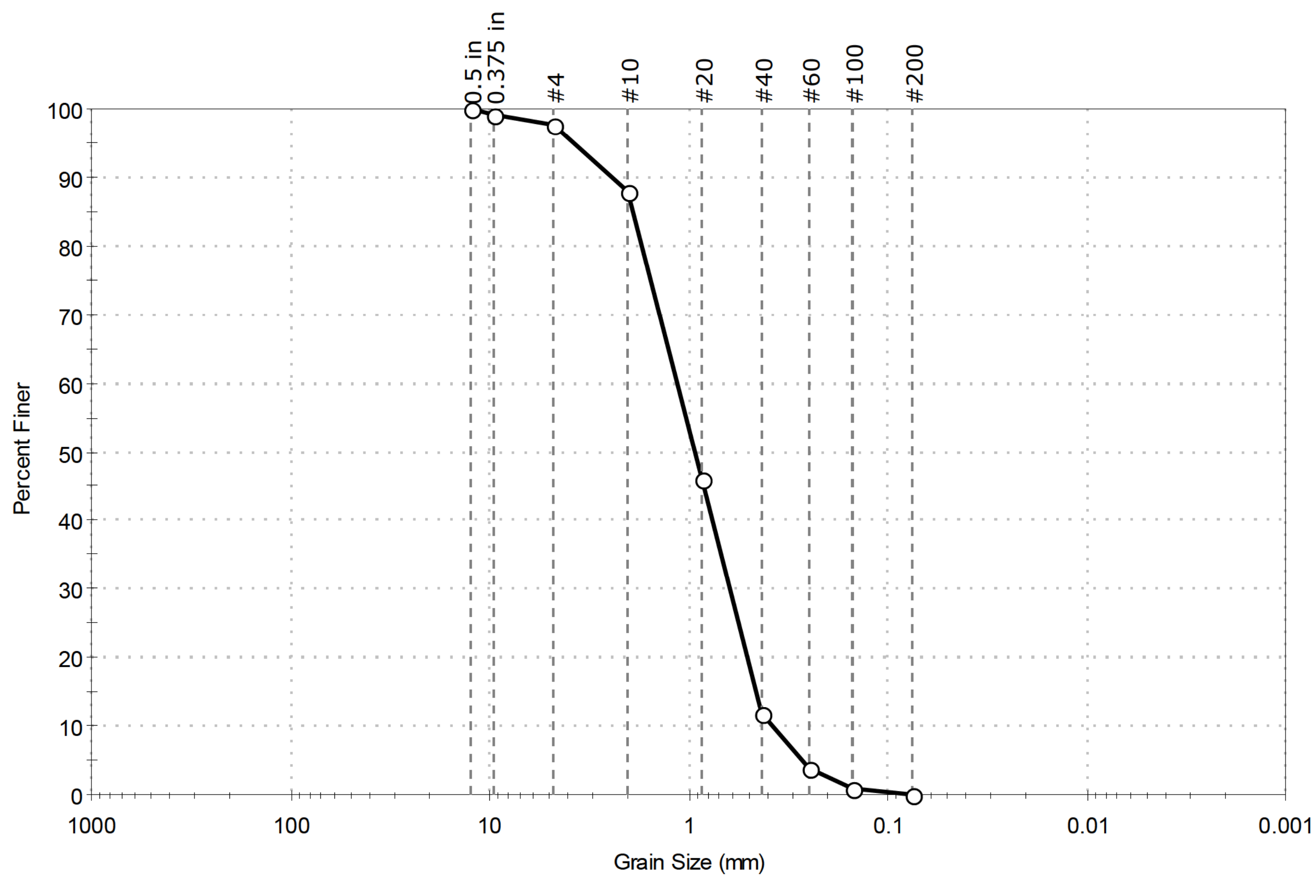
Sand/Gravel Hardness : HARD

printed 7/31/2017 12:53:56 PM

GeoTesting EXPRESS

Client:	Nobis Engineering, Inc.		
Project:	Heald Bridge #0673		
Location:	Sumner, ME	Project No:	GTX-306742
Boring ID: SWBNR-Grab	Sample Type: bag	Tested By:	jbr
Sample ID: G-1	Test Date: 07/31/17	Checked By:	jsc
Depth : 0-0.5 ft	Test Id: 417885		
Test Comment:	---		
Visual Description:	Moist, light yellowish brown sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	2.4	97.5	0.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	98		
#10	2.00	88		
#20	0.85	46		
#40	0.42	12		
#60	0.25	4		
#100	0.15	1		
#200	0.075	0.1		

Coefficients

D_{85} = 1.8795 mm | D_{30} = 0.6139 mm
D_{60} = 1.1281 mm | D_{15} = 0.4537 mm
D_{50} = 0.9197 mm | D_{10} = 0.3781 mm
C_u = 2.984 | C_c = 0.884

Classification

ASTM: Poorly graded sand (SP)

AASHTO: Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

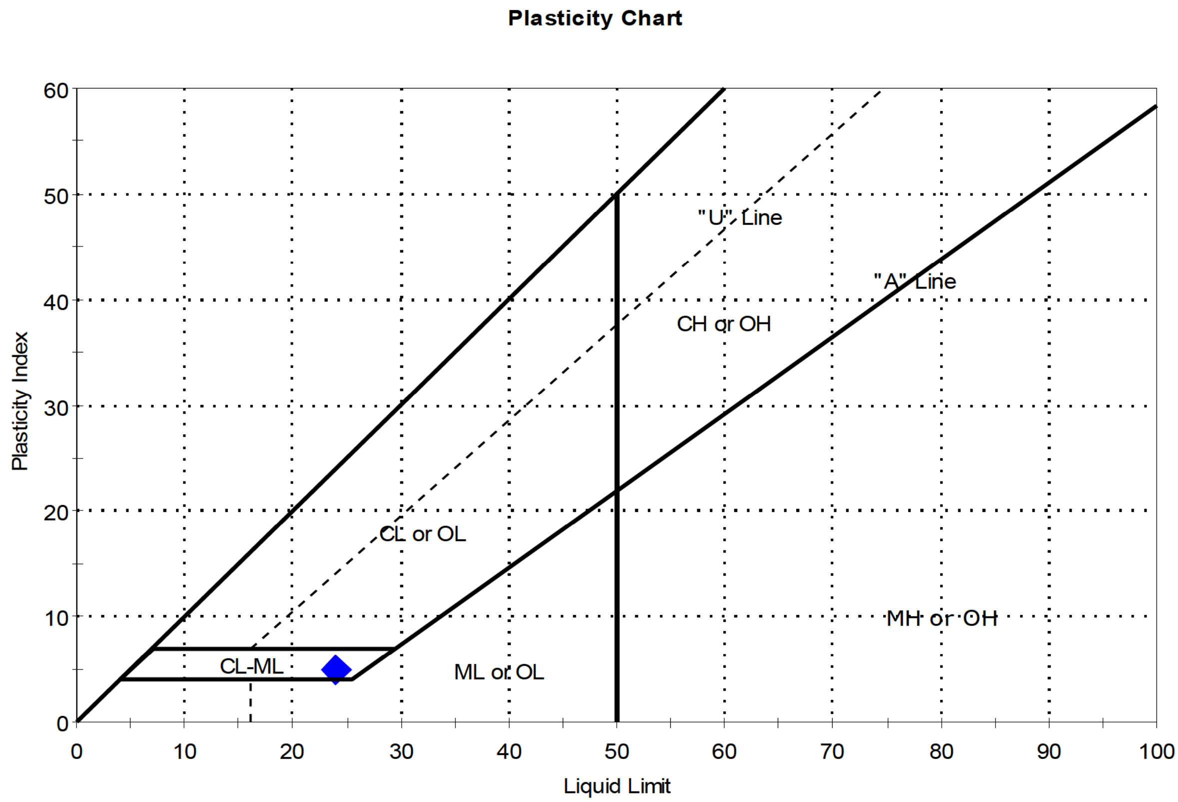
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

printed 7/31/2017 12:53:57 PM

Client:	Nobis Engineering, Inc.
Project:	Heald Bridge #0673
Location:	Sumner, ME
Project No:	GTX-306742
Boring ID:	BB-SWBNR-101
Sample Type:	bag
Tested By:	GA
Sample ID:	S-5
Test Date:	07/27/17
Checked By:	jsc
Depth :	15-17 ft
Test Id:	417884
Test Comment:	---
Visual Description:	Moist, gray silty clay
Sample Comment:	---

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-5	BB-SWBNR-1	15-17 ft	19	24	19	5	0.1	

Sample Prepared using the WET method

Dry Strength: LOW

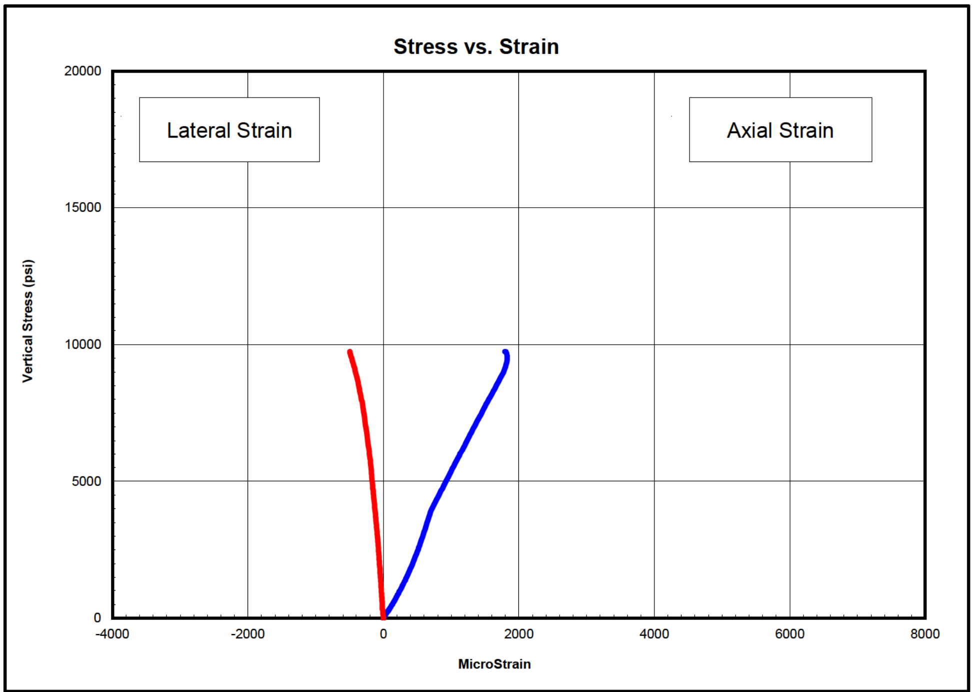
Dilatancy: RAPID

Toughness: MEDIUM

printed 7/31/2017 4:06:55 PM

Client:	Nobis Engineering, Inc.
Project Name:	Heald Bridge #0673
Project Location:	Sumner, ME
GTX #:	306742
Test Date:	7/27/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	BB-SWBNR-101
Sample ID:	C-1
Depth, ft:	43.43-43.84
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 9,744 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1000-3600	6,170,000	0.19
3600-6200	4,900,000	0.19
6200-8800	4,630,000	0.31

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Nobis Engineering, Inc.	Test Date:	7/24/2017
Project Name:	Heald Bridge #0673	Tested By:	rlc
Project Location:	Sumner, ME	Checked By:	jsc
GTX #:	306742		
Boring ID:	BB-SWBNR-101		
Sample ID:	C-1		
Depth:	43.43-43.84 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.27	4.27	4.27		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	592.22				
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**		YES	
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**		YES	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00020	-0.00010	0.00000	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010

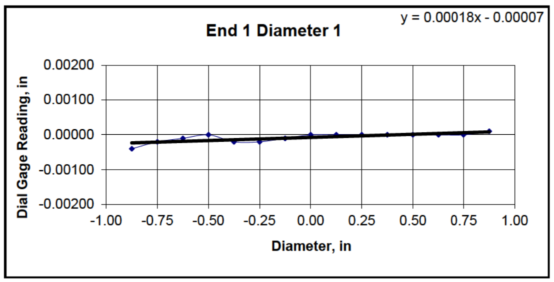
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00020

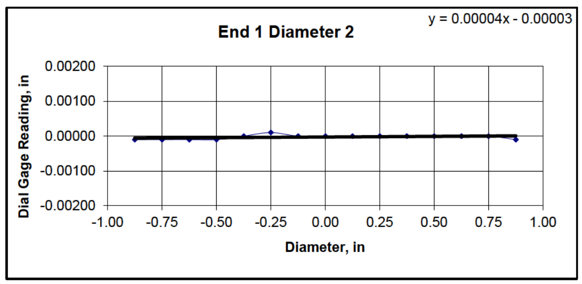
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00030	0.00000	0.00000	0.00000	-0.00020
Diameter 2, in (rotated 90°)	-0.00050	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040

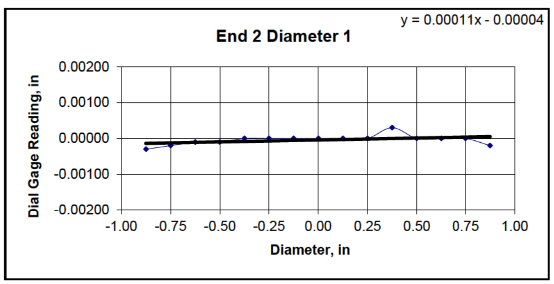
Difference between max and min readings, in:
0° = 0.0006 90° = 0.0005

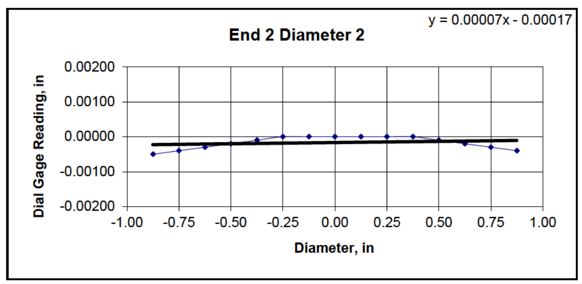
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00030

Flatness Tolerance Met? YES









DIAMETER 1

End 1:		
	Slope of Best Fit Line	0.00018
	Angle of Best Fit Line:	0.01031
End 2:		
	Slope of Best Fit Line	0.00011
	Angle of Best Fit Line:	0.00630
Maximum Angular Difference:		0.00401

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:		
	Slope of Best Fit Line	0.00004
	Angle of Best Fit Line:	0.00229
End 2:		
	Slope of Best Fit Line	0.00007
	Angle of Best Fit Line:	0.00401
Maximum Angular Difference:		0.00172

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	1.990	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00020	1.990	0.00010	0.006	YES
END 2					
Diameter 1, in	0.00060	1.990	0.00030	0.017	YES
Diameter 2, in (rotated 90°)	0.00050	1.990	0.00025	0.014	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Nobis Engineering, Inc.
Project Name:	Heald Bridge #0673
Project Location:	Sumner, ME
GTX #:	306742
Test Date:	7/27/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	BB-SWBNR-101
Sample ID:	C-1
Depth, ft:	43.43-43.84

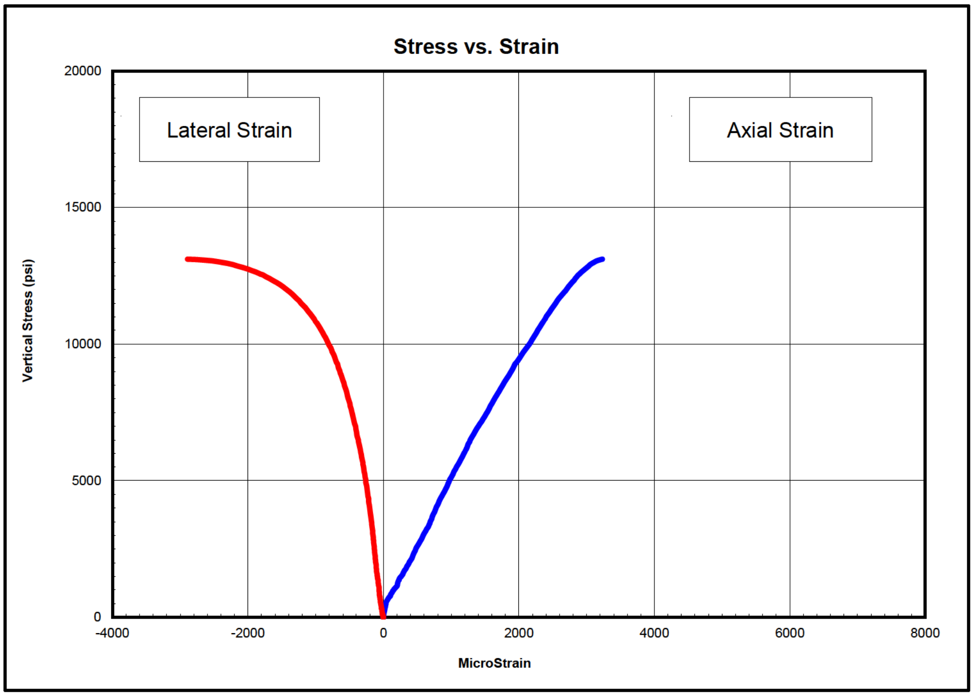
After cutting and grinding

After break

GeoTesting EXPRESS

Client:	Nobis Engineering, Inc.
Project Name:	Heald Bridge #0673
Project Location:	Sumner, ME
GTX #:	306742
Test Date:	7/27/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	BB-SWBNR-102
Sample ID:	C-1
Depth, ft:	38.23-38.62
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 13,113 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1300-4800	4,850,000	0.22
4800-8300	4,500,000	0.39
8300-11800	3,830,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

GeoTesting EXPRESS

Client:	Nobis Engineering, Inc.	Test Date:	7/24/2017
Project Name:	Heald Bridge #0673	Tested By:	rlc
Project Location:	Sumner, ME	Checked By:	jsc
GTX #:	306742		
Boring ID:	BB-SWBNR-102		
Sample ID:	C-1		
Depth:	38.23-38.62 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.10	4.10	4.10		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	582.91				
Bulk Density, lb/ft^3	174	**Minimum Diameter Tolerence Met?**			YES
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**			YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00050	0.00030	0.00010	-0.00010	-0.00010	0.00000	0.00010	0.00000	0.00000	0.00010	0.00010	0.00020	0.00040	0.00020	0.00010
Diameter 2, in (rotated 90^o)	0.00000	0.00000	0.00010	0.00010	0.00020	0.00030	0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00040	0.00040

Difference between max and min readings, in:

0° = 0.00060 90° = 0.00040

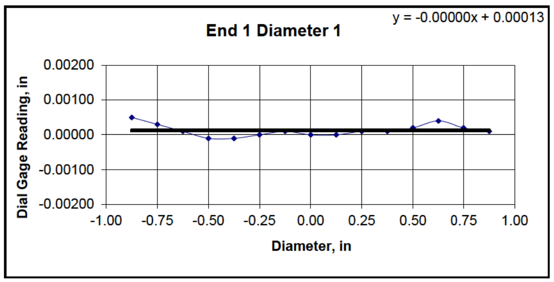
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00030	0.00010	0.00000	-0.00010	-0.00020	-0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	0.00000	0.00010	0.00030	0.00020
Diameter 2, in (rotated 90^o)	0.00020	0.00010	0.00020	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00040	0.00050

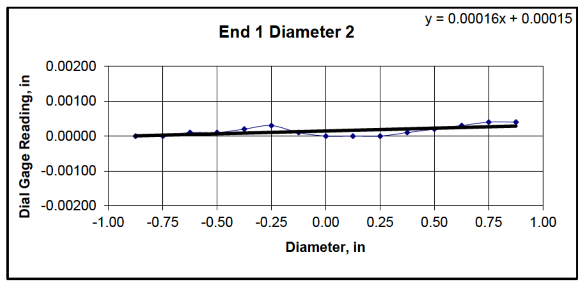
Difference between max and min readings, in:

0° = 0.0005 90° = 0.0005

Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00030

Flatness Tolerance Met? YES





DIAMETER 1

End 1:

Slope of Best Fit Line	0.00000
Angle of Best Fit Line:	0.00000

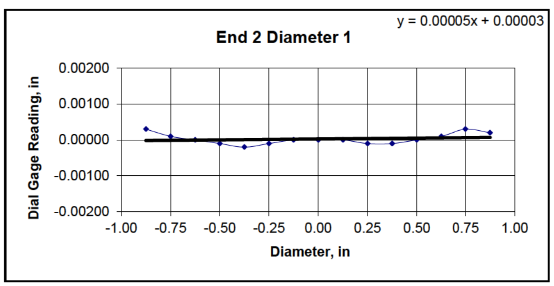
End 2:

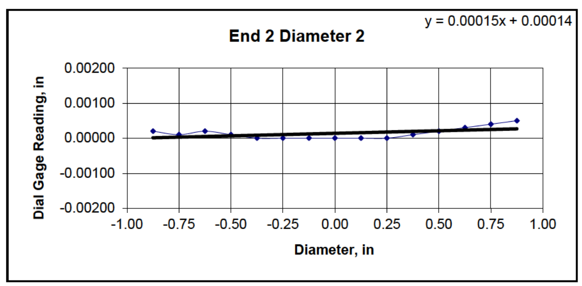
Slope of Best Fit Line	0.00005
Angle of Best Fit Line:	0.00286

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? YES

Spherically Seated





DIAMETER 2

End 1:

Slope of Best Fit Line	0.00016
Angle of Best Fit Line:	0.00917

End 2:

Slope of Best Fit Line	0.00015
Angle of Best Fit Line:	0.00859

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? YES

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00060	1.990	0.00030	0.017	YES
Diameter 2, in (rotated 90^o)	0.00040	1.990	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00050	1.990	0.00025	0.014	YES
Diameter 2, in (rotated 90^o)	0.00050	1.990	0.00025	0.014	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Nobis Engineering, Inc.
Project Name:	Heald Bridge #0673
Project Location:	Sumner, ME
GTX #:	306742
Test Date:	7/27/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	BB-SWBNR-102
Sample ID:	C-1
Depth, ft:	38.23-38.62

After cutting and grinding

After break

Client:	Nobis Engineering, Inc.				
Project:	Heald Bridge (#0673)				
Location:				Project No:	GTX-308728
Boring ID:	BB-SWBNR-102	Sample Type:	jar	Tested By:	jbr
Sample ID:	S-7/S-8	Test Date:	09/12/18	Checked By:	emm
Depth :	---	Test Id:	471021		

Test Comment: ---
Visual Description: Moist, light yellowish brown silty sand
Sample Comment: ---

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
3B-SWBNR-102	S-7/S-8	---	Moist, light yellowish brown silty sand	6.2	6.1

Notes: Sample Preparation: screened through #10 sieve
Method A, pH meter used

printed 9/13/2018 8:25:27 AM

Client:	Nobis Engineering, Inc.
Project:	Heald Bridge (#0673)
Location:	---
GTX#:	308728
Test Date:	09/12/18
Tested By:	njf
Checked By:	emm

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(\text{ohm-cm})^{-1}$
BB-SWBNR-102	S-7/S-8	---	Moist, light yellowish brown silty sand	35,123	2.85E-05

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F

testing services[sm]

PO Box 572455 / Salt Lake City UT 84157-2455 / USA
TEL +1 801 262 2448 · FAX +1 801 262 9870 · www.TEi-TS.com

GEOTESTING EXPRESS INCORPORATED
125 NAGOG PARK
ACTON MA 01720-3451
USA

Analysis No.	TS-A1807608
Report Date	10 September 2018
Date Sampled	29 August 2018
Date Received	30 August 2018
Where Sampled	Acton, MA USA
Sampled By	Client

This is to attest that we have examined: Soil for Project Name: Heald Bridge (#0673); Site Location: - ; Job Number: GTX-308728

When examined to the applicable requirements of:

ASTM D 512 - 12	“Standard Test Methods for Chloride Ion in Water” Method B
ASTM D 516 - 16	“Standard Test Method for Sulfate Ion in Water”
SM 2580 B	“Standard Methods for the Examination of Water and Wastewater 23nd Edition” Oxidation–Reduction Potential (ORP)

Results:

ASTM D 512 – Chloride Method B

Sample		Results		Detection Limit
		ppm (mg/kg)	%[1]	
BB-SWBNR-10		<10.	<0.0010	10.
S-7/S-8	-			

NOTE: [1]Percent by weight as received

ASTM D 516 - Sulfate (soluble)

Sample		Results		Detection Limit
		ppm (mg/kg)	%[1]	
BB-SWBNR-10		14.	0.0014	10.
S-7/S-8	-			

NOTE: [1]Percent by weight as received

3455 South 500 West
Salt Lake City, UT 84115-4234 USA
TEL: +1 801 262 2448
FAX: +1 801 262 9870

CERTIFICATE OF ANALYSIS

SM 2580 B – Oxidation–Reduction Potential (ORP)

Sample		Results	Detection Limit
BB-SWBNR-10		187.4 @ 23.9 ºC	0.1 mV
S-7/S-8	-		

USEPA Laboratory ID UT00930

END OF ANALYSIS

Merrill Gee P.E. – Engineer in Charge

APPENDIX F – Calculations

APPENDIX F.1 – Lateral Pile Evaluation (Soil Properties and Output)

Purpose: Provide Lpile parameters based on the subsurface conditions encountered in borings BB-SWBNR-101 and -102.

References:
1) Computer Program L-Pile User's Manual, Version 2016, by Ensoft, INC.
2) Computer Program Group User's Manual, Version 2016, by Ensoft, INC.
3) Design Basis Memorandum, Prepared by Nobis, dated August 31, 2017.

Solution:

Step 1: Soil Properties and Profile

Nobis used subsurface information from Reference No. 3 to develop soil parameters in the table below, see Reference No. 2 for details.

-Soil unit weight (γ_{moist}) and soil friction angle (ϕ) were estimated based on N-values.
-Soil modulus parameters (k) were determined using Table 3.7 from Reference No. 2.
-Uniaxial Compressive Strength (U.C.S.) of rock was based on Reference No 3.

Soil Layer	P-Y Curve Type	γ_{moist} [1] (pcf)	$\gamma_{effective}$ (pcf)	ϕ (°)	U.C.S. (psi)	k - Sand above WT (pci)	k - Submerged (pci)
Existing Fill	Sand (Reese)	120	57.6	32	-	25	20
Alluvium (Granular)	Sand (Reese)	125	62.6	33	-	-	40
Outwash (Granular)	Sand (Reese)	135	72.6	37	-	-	125
Bedrock	Strong Rock (Vuggy Limestone)	150	87.6	-	9,700	-	-

1. Use the moist unit weight for the existing fill for the material above the groundwater table.

```
================================================================================

                    LPile for Windows, Version 2018-10.006

                Analysis of Individual Piles and Drilled Shafts
               Subjected to Lateral Loading Using the p-y Method
                         © 1985-2018 by Ensoft, Inc.
                             All Rights Reserved

================================================================================

This copy of LPile is being used by:

Fuss & O'Neill
Manchester, NH

Serial Number of Security Device: 364301389

This copy of LPile is licensed for exclusive use by:

CLD Consulting Engineers, Manche

Use of this program by any entity other than CLD Consulting Engineers, Manche
is a violation of the software license agreement.

--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\Proj2016\160333 Heald Bridge Sumner\Struct\Calcs\03-Final\Substructure Design\Abutment 1\LPile\

Name of input data file:
HP10x42 Abut 1.lp10

Name of output report file:
HP10x42 Abut 1.lp10

Name of plot output file:
HP10x42 Abut 1.lp10

Name of runtime message file:
HP10x42 Abut 1.lp10


--------------------------------------------------------------------------------
                           Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  September 7, 2018          Time:  11:53:42


--------------------------------------------------------------------------------
                                 Problem Title
--------------------------------------------------------------------------------

Project Name:Heald Bridge
Job Number: 20160333
Client: Maine DOT
Engineer: Anna Giraldi
Description: Integral abutment with hinge


--------------------------------------------------------------------------------
                          Program Options and Settings
--------------------------------------------------------------------------------

Computational Options:
```

```
 - Use unfactored loads in computations (conventional analysis)
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed                  =         500
 - Deflection tolerance for convergence                  =   1.0000E-05 in
 - Maximum allowable deflection                          =     100.0000 in
 - Number of pile increments                             =         100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Use of p-y modification factors for p-y curves not selected
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats



--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                          =          1
Total length of pile                                     =       34.000 ft
Depth of ground surface below top of pile                =       0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

            Depth Below           Pile
Point        Pile Head          Diameter
 No.           feet              inches
-----      -------------     -------------
  1            0.000           10.1000
  2           34.000           10.1000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a H weak axis steel pile
   Length of section                                     =    34.000000 ft
   Pile width                                            =     9.700000 in
   Shear capacity of section                             =       0.0000 lbs



--------------------------------------------------------------------------------
                       Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------
```

```
Ground Slope Angle                                       =       0.000 degrees
                                                         =       0.000 radians

Pile Batter Angle                                        =       0.000 degrees
                                                         =       0.000 radians


--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer             =      0.0000 ft
   Distance from top of pile to bottom of layer          =    1.700000 ft
   Effective unit weight at top of layer                 =   57.600000 pcf
   Effective unit weight at bottom of layer              =   57.600000 pcf
   Friction angle at top of layer                        =   32.000000 deg.
   Friction angle at bottom of layer                     =   32.000000 deg.
   Subgrade k at top of layer                            =   20.000000 pci
   Subgrade k at bottom of layer                         =   20.000000 pci


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer             =    1.700000 ft
   Distance from top of pile to bottom of layer          =   14.330000 ft
   Effective unit weight at top of layer                 =   62.600000 pcf
   Effective unit weight at bottom of layer              =   62.600000 pcf
   Friction angle at top of layer                        =   33.000000 deg.
   Friction angle at bottom of layer                     =   33.000000 deg.
   Subgrade k at top of layer                            =   40.000000 pci
   Subgrade k at bottom of layer                         =   40.000000 pci


Layer 3 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer             =   14.330000 ft
   Distance from top of pile to bottom of layer          =   34.000000 ft
   Effective unit weight at top of layer                 =   72.600000 pcf
   Effective unit weight at bottom of layer              =   72.600000 pcf
   Friction angle at top of layer                        =   37.000000 deg.
   Friction angle at bottom of layer                     =   37.000000 deg.
   Subgrade k at top of layer                            =  125.000000 pci
   Subgrade k at bottom of layer                         =  125.000000 pci


Layer 4 is strong rock (vuggy limestone)

   Distance from top of pile to top of layer             =   34.000000 ft
   Distance from top of pile to bottom of layer          =   54.000000 ft
   Effective unit weight at top of layer                 =   87.600000 pcf
   Effective unit weight at bottom of layer              =   87.600000 pcf
   Uniaxial compressive strength at top of layer         =       9700. psi
   Uniaxial compressive strength at bottom of layer      =       9700. psi

 (Depth of the lowest soil layer extends 20.000 ft below the pile tip)



--------------------------------------------------------------------------------
                        Summary of Input Soil Properties
--------------------------------------------------------------------------------

Layer        Soil Type          Layer      Effective   Angle of    Uniaxial
Layer          Name             Depth       Unit Wt.   Friction       qu             kpy
 Num.     (p-y Curve Type)       ft           pcf        deg.         psi            pci
-----   -------------------   ----------  ----------  ----------  ----------  ----------
```

1	Sand	0.00	57.6000	32.0000	--	20.0000
	(Reese, et al.)	1.7000	57.6000	32.0000	--	20.0000
2	Sand	1.7000	62.6000	33.0000	--	40.0000
	(Reese, et al.)	14.3300	62.6000	33.0000	--	40.0000
3	Sand	14.3300	72.6000	37.0000	--	125.0000
	(Reese, et al.)	34.0000	72.6000	37.0000	--	125.0000
4	Strong Rock	34.0000	87.6000	--	9700.	--
	(Vuggy Limestone)	54.0000	87.6000	--	9700.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	4	y = 0.130000 in	M = 0.0000 in-lbs	164500.	N.A.
2	4	y = 0.130000 in	M = 0.0000 in-lbs	64475.	N.A.

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section	=	34.000000 ft
Flange Width	=	10.100000 in
Section Depth	=	9.700000 in
Flange Thickness	=	0.420000 in
Web Thickness	=	0.415000 in
Yield Stress of Pipe	=	50.000000 ksi
Elastic Modulus	=	29000. ksi
Cross-sectional Area	=	12.160900 sq. in.
Moment of Inertia	=	72.173841 in^4
Elastic Bending Stiffness	=	2093041. kip-in^2
Plastic Modulus, Z	=	21.803578in^3
Plastic Moment Capacity = Fy Z	=	1090.in-kip

Axial Structural Capacities:

```
Nom. Axial Structural Capacity = Fy As              =      608.045 kips
Nominal Axial Tensile Capacity                      =     -608.045 kips
```

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 2

Number	Axial Thrust Force kips
1	64.475
2	164.500

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 64.475 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000708	14.8233904	2092806.	30.8612477	6.3287637	
0.00001417	29.6467808	2092806.	17.9556239	7.3556992	
0.00002125	44.4701712	2092806.	13.6537492	8.3826349	
0.00002833	59.2935617	2092806.	11.5028119	9.4095704	
0.00003542	74.1169521	2092806.	10.2122495	10.4365060	
0.00004250	88.9403425	2092806.	9.3518746	11.4634417	
0.00004958	103.7637329	2092806.	8.7373211	12.4903773	
0.00005666	118.5871233	2092806.	8.2764060	13.5173129	
0.00006375	133.4105137	2092806.	7.9179164	14.5442485	
0.00007083	148.2339041	2092806.	7.6311248	15.5711841	
0.00007791	163.0572946	2092806.	7.3964771	16.5981198	
0.00008500	177.8806850	2092806.	7.2009373	17.6250554	
0.00009208	192.7040754	2092806.	7.0354806	18.6519910	
0.00009916	207.5274658	2092806.	6.8936606	19.6789266	
0.0001062	222.3508562	2092806.	6.7707498	20.7058622	
0.0001133	237.1742466	2092806.	6.6632030	21.7327978	
0.0001204	251.9976370	2092806.	6.5683087	22.7597335	
0.0001275	266.8210274	2092806.	6.4839582	23.7866691	
0.0001346	281.6444179	2092806.	6.4084867	24.8136047	
0.0001417	296.4678083	2092806.	6.3405624	25.8405403	
0.0001487	311.2911987	2092806.	6.2791070	26.8674759	
0.0001558	326.1145891	2092806.	6.2232385	27.8944115	
0.0001629	340.9379795	2092806.	6.1722282	28.9213472	
0.0001700	355.7613699	2092806.	6.1254687	29.9482828	
0.0001771	370.5847603	2092806.	6.0824499	30.9752184	
0.0001842	385.4081508	2092806.	6.0427403	32.0021540	
0.0001912	400.2315412	2092806.	6.0059721	33.0290896	
0.0001983	415.0549316	2092806.	5.9718303	34.0560252	
0.0002054	429.8783220	2092806.	5.9400430	35.0829608	
0.0002125	444.7017124	2092806.	5.9103749	36.1098965	
0.0002196	459.5251028	2092806.	5.8826209	37.1368321	
0.0002267	474.3484932	2092806.	5.8566015	38.1637677	
0.0002337	489.1718837	2092806.	5.8321590	39.1907033	
0.0002408	503.9952741	2092806.	5.8091543	40.2176389	
0.0002479	518.8186645	2092806.	5.7874642	41.2445745	
0.0002550	533.6420549	2092806.	5.7669791	42.2715102	
0.0002621	548.4654453	2092806.	5.7476013	43.2984458	
0.0002692	563.2888357	2092806.	5.7292434	44.3253814	
0.0002762	578.1122261	2092806.	5.7118269	45.3523170	
0.0002904	607.7590070	2092806.	5.6795426	47.4061882	
0.0003046	637.4057878	2092806.	5.6502616	49.4600595	
0.0003187	666.1567924	2089995.	5.6251863	50.0000000	Y
0.0003329	693.0946408	2081978.	5.6054353	50.0000000	Y
0.0003471	718.4253212	2069984.	5.5901302	50.0000000	Y
0.0003612	742.3455463	2055026.	5.5785173	50.0000000	Y
0.0003754	765.0424844	2037938.	5.5699436	50.0000000	Y

0.0003896	786.3309643	2018478.	5.5635599	50.0000000	Y
0.0004037	805.5391329	1995231.	5.5574883	50.0000000	Y
0.0004179	822.8048857	1968912.	5.5515231	50.0000000	Y
0.0004321	838.5016238	1940687.	5.5456970	50.0000000	Y
0.0004462	852.6530610	1910791.	5.5399360	50.0000000	Y
0.0004604	865.5495119	1880009.	5.5344115	50.0000000	Y
0.0004746	877.3467845	1848749.	5.5290154	50.0000000	Y
0.0004887	888.1534017	1817273.	5.5237261	50.0000000	Y
0.0005029	898.0721785	1785806.	5.5185238	50.0000000	Y
0.0005171	907.2002197	1754533.	5.5133901	50.0000000	Y
0.0005312	915.5899667	1723539.	5.5083980	50.0000000	Y
0.0005454	923.3193709	1692944.	5.5035569	50.0000000	Y
0.0005596	930.5003201	1662918.	5.4987838	50.0000000	Y
0.0005737	937.2093296	1633552.	5.4940635	50.0000000	Y
0.0005879	943.4433541	1604793.	5.4895678	50.0000000	Y
0.0006021	949.2010535	1576597.	5.4851182	50.0000000	Y
0.0006162	954.6126532	1549135.	5.4805740	50.0000000	Y
0.0006304	959.6452179	1522306.	5.4764065	50.0000000	Y
0.0006446	964.3889650	1496209.	5.4721635	50.0000000	Y
0.0006587	968.7844442	1470705.	5.4679937	50.0000000	Y
0.0006729	972.9982026	1446005.	5.4640435	50.0000000	Y
0.0006871	976.8536473	1421802.	5.4599687	50.0000000	Y
0.0007012	980.5761596	1398387.	5.4561036	50.0000000	Y
0.0007154	984.0022703	1375486.	5.4522660	50.0000000	Y
0.0007296	987.3375296	1353349.	5.4484561	50.0000000	Y
0.0007437	990.3683262	1331646.	5.4448287	50.0000000	Y
0.0007579	993.3515258	1310692.	5.4412211	50.0000000	Y
0.0007720	996.0783909	1290174.	5.4376062	50.0000000	Y
0.0007862	998.7464632	1270321.	5.4342894	50.0000000	Y
0.0008004	1001.	1250934.	5.4306238	50.0000000	Y
0.0008145	1004.	1232075.	5.4273928	50.0000000	Y
0.0008287	1006.	1213722.	5.4241073	50.0000000	Y
0.0008429	1008.	1195879.	5.4207080	50.0000000	Y
0.0008995	1016.	1129072.	5.4083826	50.0000000	Y
0.0009562	1022.	1068763.	5.3966522	50.0000000	Y
0.0010129	1027.	1014249.	5.3856785	50.0000000	Y
0.0010695	1032.	964745.	5.3755342	50.0000000	Y
0.0011262	1036.	919679.	5.3659749	50.0000000	Y
0.0011829	1039.	878542.	5.3568817	50.0000000	Y
0.0012395	1042.	840721.	5.3482894	50.0000000	Y
0.0012962	1045.	805971.	5.3400863	50.0000000	Y
0.0013529	1047.	773937.	5.3325725	50.0000000	Y
0.0014095	1049.	744266.	5.3250927	50.0000000	Y
0.0014662	1051.	716743.	5.3183342	50.0000000	Y
0.0015228	1053.	691163.	5.3116071	50.0000000	Y
0.0015795	1054.	667313.	5.3054516	50.0000000	Y
0.0016362	1055.	645001.	5.2994590	50.0000000	Y

Axial Thrust Force = 164.500 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000635	13.2935644	2092806.	78.4827263	14.4479116	
0.00001270	26.5871289	2092806.	41.7663631	15.3688638	
0.00001906	39.8806933	2092806.	29.5275754	16.2898162	
0.00002541	53.1742578	2092806.	23.4081816	17.2107683	
0.00003176	66.4678222	2092806.	19.7365453	18.1317206	
0.00003811	79.7613867	2092806.	17.2887877	19.0526728	
0.00004446	93.0549511	2092806.	15.5403895	19.9736251	
0.00005082	106.3485155	2092806.	14.2290908	20.8945774	
0.00005717	119.6420800	2092806.	13.2091918	21.8155296	
0.00006352	132.9356444	2092806.	12.3932726	22.7364818	
0.00006987	146.2292089	2092806.	11.7257024	23.6574341	
0.00007622	159.5227733	2092806.	11.1693939	24.5783864	
0.00008258	172.8163378	2092806.	10.6986713	25.4993386	
0.00008893	186.1099022	2092806.	10.2951947	26.4202909	
0.00009528	199.4034666	2092806.	9.9455151	27.3412431	
0.0001016	212.6970311	2092806.	9.6395454	28.2621954	

0.0001080	225.9905955	2092806.	9.3695721	29.1831476	
0.0001143	239.2841600	2092806.	9.1295959	30.1040999	
0.0001207	252.5777244	2092806.	8.9148803	31.0250521	
0.0001270	265.8712888	2092806.	8.7216363	31.9460044	
0.0001334	279.1648533	2092806.	8.5467965	32.8669566	
0.0001397	292.4584177	2092806.	8.3878512	33.7879089	
0.0001461	305.7519822	2092806.	8.2427272	34.7088612	
0.0001524	319.0455466	2092806.	8.1096969	35.6298134	
0.0001588	332.3391111	2092806.	7.9873091	36.5507657	
0.0001652	345.6326755	2092806.	7.8743356	37.4717179	
0.0001715	358.9262399	2092806.	7.7697306	38.3926702	
0.0001779	372.2198044	2092806.	7.6725974	39.3136224	
0.0001842	385.5133688	2092806.	7.5821630	40.2345747	
0.0001906	398.8069333	2092806.	7.4977575	41.1555269	
0.0001969	412.1004977	2092806.	7.4187976	42.0764792	
0.0002033	425.3940622	2092806.	7.3447727	42.9974314	
0.0002096	438.6876266	2092806.	7.2752341	43.9183837	
0.0002160	451.9811910	2092806.	7.2097861	44.8393359	
0.0002223	465.2747555	2092806.	7.1480779	45.7602882	
0.0002287	478.5683199	2092806.	7.0897980	46.6812404	
0.0002350	491.8618844	2092806.	7.0346683	47.6021927	
0.0002414	505.1554488	2092806.	6.9824402	48.5231449	
0.0002477	518.4490133	2092806.	6.9328904	49.4440972	
0.0002604	544.2624927	2089835.	6.8427369	50.0000000	Y
0.0002731	568.3261655	2080734.	6.7647248	50.0000000	Y
0.0002858	590.8014252	2066886.	6.6970634	50.0000000	Y
0.0002985	611.9404311	2049740.	6.6380420	50.0000000	Y
0.0003112	631.8747337	2030123.	6.5864418	50.0000000	Y
0.0003240	650.7537655	2008787.	6.5411761	50.0000000	Y
0.0003367	668.7475972	1986433.	6.5012462	50.0000000	Y
0.0003494	685.8833582	1963247.	6.4660820	50.0000000	Y
0.0003621	702.3289446	1939783.	6.4348856	50.0000000	Y
0.0003748	718.0549758	1915990.	6.4073704	50.0000000	Y
0.0003875	733.2215175	1892312.	6.3828807	50.0000000	Y
0.0004002	747.8682878	1868840.	6.3610789	50.0000000	Y
0.0004129	762.0338702	1845646.	6.3416678	50.0000000	Y
0.0004256	775.7532053	1822788.	6.3243894	50.0000000	Y
0.0004383	789.0636483	1800323.	6.3090068	50.0000000	Y
0.0004510	802.0118621	1778320.	6.2952841	50.0000000	Y
0.0004637	814.3822165	1756276.	6.2826595	50.0000000	Y
0.0004764	825.8474313	1733509.	6.2703129	50.0000000	Y
0.0004891	836.4986838	1710259.	6.2582022	50.0000000	Y
0.0005018	846.4219572	1686737.	6.2462881	50.0000000	Y
0.0005145	855.6980321	1663118.	6.2345339	50.0000000	Y
0.0005272	864.3060994	1639370.	6.2231524	50.0000000	Y
0.0005399	872.3852025	1615760.	6.2119540	50.0000000	Y
0.0005526	880.0210214	1592433.	6.2008612	50.0000000	Y
0.0005653	887.1307926	1569225.	6.1902446	50.0000000	Y
0.0005780	893.8038681	1546281.	6.1795090	50.0000000	Y
0.0005907	900.0696119	1523634.	6.1691032	50.0000000	Y
0.0006034	906.0431034	1501456.	6.1588881	50.0000000	Y
0.0006161	911.6695356	1479630.	6.1489378	50.0000000	Y
0.0006289	916.9554351	1458144.	6.1389455	50.0000000	Y
0.0006416	921.9810580	1437104.	6.1293744	50.0000000	Y
0.0006543	926.7926652	1416553.	6.1197442	50.0000000	Y
0.0006670	931.2513670	1396256.	6.1104806	50.0000000	Y
0.0006797	935.6173537	1376582.	6.1013746	50.0000000	Y
0.0006924	939.6535588	1357153.	6.0922151	50.0000000	Y
0.0007051	943.5771358	1338264.	6.0835149	50.0000000	Y
0.0007178	947.2596576	1319709.	6.0746167	50.0000000	Y
0.0007305	950.8399211	1301658.	6.0661630	50.0000000	Y
0.0007432	954.1555968	1283869.	6.0576823	50.0000000	Y
0.0007559	957.4604635	1266664.	6.0494631	50.0000000	Y
0.0008067	969.0256564	1201210.	6.0174739	50.0000000	Y
0.0008575	978.8343448	1141466.	5.9875899	50.0000000	Y
0.0009083	987.2303377	1086851.	5.9595585	50.0000000	Y
0.0009592	994.5417994	1036892.	5.9332353	50.0000000	Y
0.0010100	1001.	991010.	5.9081370	50.0000000	Y
0.0010608	1006.	948758.	5.8846159	50.0000000	Y
0.0011116	1011.	909835.	5.8622641	50.0000000	Y
0.0011624	1016.	873838.	5.8412042	50.0000000	Y

0.0012132	1020.	840456.	5.8208967	50.0000000	Y
0.0012641	1023.	809417.	5.8018748	50.0000000	Y
0.0013149	1026.	780578.	5.7836911	50.0000000	Y
0.0013657	1029.	753679.	5.7663911	50.0000000	Y
0.0014165	1032.	728451.	5.7498646	50.0000000	Y
0.0014673	1034.	704896.	5.7342159	50.0000000	Y

Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	64.4750000000	1055.
2	164.5000000000	1034.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	760.5018
2	1.7000	1.6435	Yes	No	760.5018	144576.
3	14.3300	12.6481	Yes	No	145336.	1594347.
4	34.0000	34.0000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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

Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head = 0.130000 inches
Moment at pile head = 0.0 in-lbs
Axial load at pile head = 164500.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch

0.00	0.1300	0.00	1743.	-0.00238	13527.	2.09E+09	0.00	0.00	0.00
0.3400	0.1203	8706.	1724.	-0.00237	14136.	2.09E+09	-9.1450	310.1374	0.00
0.6800	0.1107	17248.	1669.	-0.00234	14734.	2.09E+09	-18.0635	665.8560	0.00
1.0200	0.1012	25467.	1581.	-0.00230	15309.	2.09E+09	-24.7729	998.7840	0.00
1.3600	0.09191	33241.	1470.	-0.00224	15853.	2.09E+09	-30.0003	1332.	0.00
1.7000	0.08289	40471.	1320.	-0.00217	16359.	2.09E+09	-43.3429	2133.	0.00
2.0400	0.07420	46927.	1129.	-0.00209	16810.	2.09E+09	-50.5162	2778.	0.00
2.3800	0.06587	52481.	917.2086	-0.00199	17199.	2.09E+09	-53.1197	3290.	0.00
2.7200	0.05796	57082.	700.0903	-0.00188	17521.	2.09E+09	-53.3108	3752.	0.00
3.0600	0.05051	60720.	485.7114	-0.00177	17776.	2.09E+09	-51.7769	4182.	0.00
3.4000	0.04354	63418.	285.4068	-0.00165	17964.	2.09E+09	-46.4117	4349.	0.00
3.7400	0.03708	65259.	94.1989	-0.00152	18093.	2.09E+09	-47.3176	5207.	0.00
4.0800	0.03113	66228.	-99.0872	-0.00139	18161.	2.09E+09	-47.4304	6217.	0.00
4.4200	0.02571	66321.	-292.6121	-0.00126	18167.	2.09E+09	-47.4347	7528.	0.00
4.7600	0.02082	65537.	-486.4066	-0.00114	18113.	2.09E+09	-47.5626	9322.	0.00
5.1000	0.01645	63875.	-665.5646	-0.00101	17996.	2.09E+09	-40.2600	9988.	0.00
5.4400	0.01258	61460.	-814.7240	-8.87E-04	17827.	2.09E+09	-32.8574	10654.	0.00
5.7800	0.00921	58418.	-933.8756	-7.70E-04	17614.	2.09E+09	-25.5503	11320.	0.00
6.1200	0.00630	54873.	-1024.	-6.60E-04	17366.	2.09E+09	-18.5069	11985.	0.00
6.4600	0.00383	50949.	-1086.	-5.56E-04	17092.	2.09E+09	-11.8673	12651.	0.00
6.8000	0.00176	46761.	-1122.	-4.61E-04	16799.	2.09E+09	-5.7434	13317.	0.00
7.1400	6.40E-05	42416.	-1134.	-3.74E-04	16495.	2.09E+09	-0.2193	13983.	0.00
7.4800	-0.00129	38011.	-1125.	-2.96E-04	16187.	2.09E+09	4.6470	14649.	0.00
7.8200	-0.00235	33635.	-1097.	-2.26E-04	15880.	2.09E+09	8.8216	15315.	0.00
8.1600	-0.00314	29361.	-1054.	-1.65E-04	15581.	2.09E+09	12.2931	15981.	0.00
8.5000	-0.00369	25253.	-998.4040	-1.11E-04	15294.	2.09E+09	15.0690	16646.	0.00
8.8400	-0.00405	21363.	-932.6289	-6.59E-05	15022.	2.09E+09	17.1737	17312.	0.00
9.1800	-0.00423	17731.	-859.5583	-2.78E-05	14768.	2.09E+09	18.6452	17978.	0.00
9.5200	-0.00427	14387.	-781.6763	3.48E-06	14534.	2.09E+09	19.5323	18644.	0.00
9.8600	-0.00420	11348.	-701.2512	2.86E-05	14321.	2.09E+09	19.8918	19310.	0.00
10.2000	-0.00404	8626.	-620.3084	4.80E-05	14131.	2.09E+09	19.7861	19976.	0.00
10.5400	-0.00381	6222.	-540.6127	6.25E-05	13962.	2.09E+09	19.2804	20642.	0.00
10.8800	-0.00353	4131.	-463.6607	7.26E-05	13816.	2.09E+09	18.4412	21307.	0.00
11.2200	-0.00322	2341.	-390.6801	7.89E-05	13691.	2.09E+09	17.3336	21973.	0.00
11.5600	-0.00289	836.8890	-322.6373	8.20E-05	13586.	2.09E+09	16.0207	22639.	0.00
11.9000	-0.00255	-401.7174	-260.2493	8.24E-05	13555.	2.09E+09	14.5616	23305.	0.00
12.2400	-0.00221	-1397.	-204.0010	8.07E-05	13625.	2.09E+09	13.0110	23971.	0.00
12.5800	-0.00189	-2175.	-154.1652	7.72E-05	13679.	2.09E+09	11.4183	24637.	0.00
12.9200	-0.00158	-2759.	-110.8244	7.24E-05	13720.	2.09E+09	9.8272	25303.	0.00
13.2600	-0.00130	-3176.	-73.8942	6.66E-05	13749.	2.09E+09	8.2758	25968.	0.00
13.6000	-0.00104	-3451.	-43.1467	6.01E-05	13768.	2.09E+09	6.7965	26634.	0.00
13.9400	-8.09E-04	-3609.	-18.2326	5.33E-05	13779.	2.09E+09	5.4163	27300.	0.00
14.2800	-6.07E-04	-3672.	1.2976	4.62E-05	13784.	2.09E+09	4.1573	27966.	0.00
14.6200	-4.33E-04	-3660.	29.1390	3.90E-05	13783.	2.09E+09	9.4905	89474.	0.00
14.9600	-2.88E-04	-3486.	61.6892	3.21E-05	13771.	2.09E+09	6.4655	91555.	0.00
15.3000	-1.71E-04	-3200.	82.8950	2.55E-05	13751.	2.09E+09	3.9295	93636.	0.00
15.6400	-7.98E-05	-2844.	94.7286	1.96E-05	13726.	2.09E+09	1.8713	95717.	0.00
15.9800	-1.09E-05	-2453.	99.0808	1.45E-05	13699.	2.09E+09	0.2621	97798.	0.00
16.3200	3.84E-05	-2055.	97.6988	1.01E-05	13671.	2.09E+09	-0.9396	99878.	0.00
16.6600	7.14E-05	-1670.	92.1446	6.45E-06	13644.	2.09E+09	-1.7831	101959.	0.00
17.0000	9.10E-05	-1312.	83.7713	3.55E-06	13619.	2.09E+09	-2.3215	104040.	0.00
17.3400	1.00E-04	-990.8766	73.7137	1.30E-06	13596.	2.09E+09	-2.6087	106121.	0.00
17.6800	1.02E-04	-712.0632	62.8916	-3.57E-07	13577.	2.09E+09	-2.6962	108202.	0.00
18.0200	9.74E-05	-477.2010	52.0217	-1.52E-06	13560.	2.09E+09	-2.6321	110282.	0.00
18.3600	8.93E-05	-285.5298	41.6357	-2.26E-06	13547.	2.09E+09	-2.4591	112363.	0.00
18.7000	7.89E-05	-134.4201	32.1023	-2.67E-06	13536.	2.09E+09	-2.2141	114444.	0.00
19.0400	6.75E-05	-19.9914	23.6524	-2.82E-06	13528.	2.09E+09	-1.9280	116525.	0.00
19.3800	5.59E-05	62.3687	16.4029	-2.78E-06	13531.	2.09E+09	-1.6257	118606.	0.00
19.7200	4.48E-05	117.5859	10.3811	-2.60E-06	13535.	2.09E+09	-1.3262	120686.	0.00
20.0600	3.47E-05	150.5735	5.5471	-2.34E-06	13537.	2.09E+09	-1.0435	122767.	0.00
20.4000	2.57E-05	165.9938	1.8127	-2.03E-06	13539.	2.09E+09	-0.7871	124848.	0.00
20.7400	1.81E-05	168.0946	-0.9408	-1.71E-06	13539.	2.09E+09	-0.5627	126929.	0.00
21.0800	1.18E-05	160.6093	-2.8489	-1.39E-06	13538.	2.09E+09	-0.3727	129010.	0.00
21.4200	6.77E-06	146.7096	-4.0527	-1.09E-06	13537.	2.09E+09	-0.2174	131090.	0.00
21.7600	2.91E-06	128.9996	-4.6899	-8.19E-07	13536.	2.09E+09	-0.09500	133171.	0.00
22.1000	8.20E-08	109.5394	-4.8893	-5.87E-07	13535.	2.09E+09	-0.00272	135252.	0.00
22.4400	-1.88E-06	89.8905	-4.7660	-3.92E-07	13533.	2.09E+09	0.06312	137333.	0.00
22.7800	-3.12E-06	71.1748	-4.4200	-2.35E-07	13532.	2.09E+09	0.1065	139414.	0.00
23.1200	-3.79E-06	54.1393	-3.9342	-1.13E-07	13531.	2.09E+09	0.1316	141494.	0.00
23.4600	-4.04E-06	39.2230	-3.3759	-2.19E-08	13530.	2.09E+09	0.1421	143575.	0.00

23.8000	-3.97E-06	26.6216	-2.7966	4.22E-08	13529.	2.09E+09	0.1418	145656.	0.00
24.1400	-3.69E-06	16.3463	-2.2343	8.41E-08	13528.	2.09E+09	0.1338	147737.	0.00
24.4800	-3.29E-06	8.2766	-1.7152	1.08E-07	13528.	2.09E+09	0.1207	149818.	0.00
24.8200	-2.81E-06	2.2050	-1.2554	1.18E-07	13527.	2.09E+09	0.1047	151898.	0.00
25.1600	-2.32E-06	-2.1266	-0.8632	1.18E-07	13527.	2.09E+09	0.08759	153979.	0.00
25.5000	-1.85E-06	-4.9973	-0.5404	1.11E-07	13527.	2.09E+09	0.07062	156060.	0.00
25.8400	-1.41E-06	-6.6860	-0.2848	1.00E-07	13527.	2.09E+09	0.05470	158141.	0.00
26.1800	-1.03E-06	-7.4555	-0.09072	8.63E-08	13527.	2.09E+09	0.04043	160222.	0.00
26.5200	-7.07E-07	-7.5422	0.04913	7.17E-08	13527.	2.09E+09	0.02813	162302.	0.00
26.8600	-4.45E-07	-7.1508	0.1430	5.74E-08	13527.	2.09E+09	0.01791	164383.	0.00
27.2000	-2.39E-07	-6.4519	0.1995	4.41E-08	13527.	2.09E+09	0.00975	166464.	0.00
27.5400	-8.48E-08	-5.5822	0.2265	3.24E-08	13527.	2.09E+09	0.00350	168545.	0.00
27.8800	2.51E-08	-4.6469	0.2315	2.24E-08	13527.	2.09E+09	-0.00105	170626.	0.00
28.2200	9.79E-08	-3.7229	0.2209	1.42E-08	13527.	2.09E+09	-0.00415	172706.	0.00
28.5600	1.41E-07	-2.8631	0.2001	7.81E-09	13527.	2.09E+09	-0.00605	174787.	0.00
28.9000	1.62E-07	-2.1003	0.1735	2.98E-09	13527.	2.09E+09	-0.00701	176868.	0.00
29.2400	1.66E-07	-1.4514	0.1444	-4.85E-10	13527.	2.09E+09	-0.00726	178949.	0.00
29.5800	1.58E-07	-0.9214	0.1153	-2.80E-09	13527.	2.09E+09	-0.00700	181030.	0.00
29.9200	1.43E-07	-0.5068	0.08796	-4.19E-09	13527.	2.09E+09	-0.00640	183110.	0.00
30.2600	1.24E-07	-0.1980	0.06346	-4.88E-09	13527.	2.09E+09	-0.00561	185191.	0.00
30.6000	1.03E-07	0.01762	0.04239	-5.05E-09	13527.	2.09E+09	-0.00472	187272.	0.00
30.9400	8.23E-08	0.1546	0.02496	-4.89E-09	13527.	2.09E+09	-0.00382	189353.	0.00
31.2800	6.30E-08	0.2278	0.01113	-4.51E-09	13527.	2.09E+09	-0.00296	191434.	0.00
31.6200	4.55E-08	0.2515	7.01E-04	-4.05E-09	13527.	2.09E+09	-0.00216	193514.	0.00
31.9600	3.00E-08	0.2390	-0.00664	-3.57E-09	13527.	2.09E+09	-0.00144	195595.	0.00
32.3000	1.64E-08	0.2022	-0.01119	-3.14E-09	13527.	2.09E+09	-7.94E-04	197676.	0.00
32.6400	4.40E-09	0.1519	-0.01325	-2.79E-09	13527.	2.09E+09	-2.15E-04	199757.	0.00
32.9800	-6.39E-09	0.09782	-0.01304	-2.55E-09	13527.	2.09E+09	3.16E-04	201838.	0.00
33.3200	-1.64E-08	0.04888	-0.01073	-2.41E-09	13527.	2.09E+09	8.19E-04	203918.	0.00
33.6600	-2.60E-08	0.01352	-0.00638	-2.34E-09	13527.	2.09E+09	0.00131	205999.	0.00
34.0000	-3.55E-08	0.00	0.00	-2.33E-09	13527.	2.09E+09	0.00181	104040.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =     0.13000000 inches
Computed slope at pile head       =    -0.00237574 radians
Maximum bending moment            =         66321. inch-lbs
Maximum shear force               =          1743. lbs
Depth of maximum bending moment   =     4.42000000 feet below pile head
Depth of maximum shear force      =       0.000000 feet below pile head
Number of iterations              =              6
Number of zero deflection points  =              5
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head                          =     0.130000 inches
Moment at pile head                                =          0.0 in-lbs
Axial load at pile head                            =      64475.0 lbs
```

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1300	0.00	1915.	-0.00234	5302.	2.09E+09	0.00	0.00	0.00
0.3400	0.1204	8431.	1897.	-0.00234	5892.	2.09E+09	-9.1478	309.8939	0.00
0.6800	0.1109	16706.	1841.	-0.00231	6471.	2.09E+09	-18.1059	665.8560	0.00
1.0200	0.1016	24671.	1753.	-0.00227	7028.	2.09E+09	-24.8671	998.7840	0.00

Output Provided by Fuss & O'Neill on 9/10/2018

1.3600	0.09242	32209.	1641.	-0.00222	7555.	2.09E+09	-30.1644	1332.	0.00
1.7000	0.08351	39229.	1491.	-0.00215	8047.	2.09E+09	-43.4469	2123.	0.00
2.0400	0.07491	45505.	1299.	-0.00206	8486.	2.09E+09	-50.6801	2760.	0.00
2.3800	0.06667	50914.	1087.	-0.00197	8864.	2.09E+09	-53.3568	3265.	0.00
2.7200	0.05884	55409.	868.5099	-0.00187	9179.	2.09E+09	-53.6449	3720.	0.00
3.0600	0.05145	58982.	652.5176	-0.00175	9429.	2.09E+09	-52.2337	4142.	0.00
3.4000	0.04453	61656.	450.0970	-0.00164	9616.	2.09E+09	-46.9921	4305.	0.00
3.7400	0.03810	63516.	256.1747	-0.00151	9746.	2.09E+09	-48.0679	5147.	0.00
4.0800	0.03218	64543.	59.4293	-0.00139	9818.	2.09E+09	-48.3759	6134.	0.00
4.4200	0.02676	64732.	-138.4196	-0.00126	9831.	2.09E+09	-48.6089	7410.	0.00
4.7600	0.02187	64078.	-338.2812	-0.00114	9785.	2.09E+09	-49.3625	9210.	0.00
5.1000	0.01748	62570.	-526.2743	-0.00101	9680.	2.09E+09	-42.7910	9988.	0.00
5.4400	0.01359	60318.	-685.9623	-8.95E-04	9522.	2.09E+09	-35.4875	10654.	0.00
5.7800	0.01018	57443.	-815.9777	-7.80E-04	9321.	2.09E+09	-28.2455	11320.	0.00
6.1200	0.00723	54069.	-916.9136	-6.71E-04	9085.	2.09E+09	-21.2329	11985.	0.00
6.4600	0.00471	50314.	-989.9923	-5.69E-04	8822.	2.09E+09	-14.5900	12651.	0.00
6.8000	0.00258	46291.	-1037.	-4.75E-04	8541.	2.09E+09	-8.4300	13317.	0.00
7.1400	8.28E-04	42103.	-1060.	-3.89E-04	8248.	2.09E+09	-2.8390	13983.	0.00
7.4800	-5.91E-04	37846.	-1061.	-3.11E-04	7950.	2.09E+09	2.1221	14649.	0.00
7.8200	-0.00171	33605.	-1044.	-2.41E-04	7653.	2.09E+09	6.4166	15315.	0.00
8.1600	-0.00256	29454.	-1010.	-1.80E-04	7363.	2.09E+09	10.0292	15981.	0.00
8.5000	-0.00318	25455.	-963.5303	-1.26E-04	7083.	2.09E+09	12.9637	16646.	0.00
8.8400	-0.00359	21658.	-905.9937	-8.04E-05	6817.	2.09E+09	15.2405	17312.	0.00
9.1800	-0.00383	18104.	-840.4406	-4.17E-05	6569.	2.09E+09	16.8934	17978.	0.00
9.5200	-0.00393	14822.	-769.3250	-9.59E-06	6339.	2.09E+09	17.9672	18644.	0.00
9.8600	-0.00391	11832.	-694.9009	1.64E-05	6130.	2.09E+09	18.5151	19310.	0.00
10.2000	-0.00380	9143.	-619.1946	3.68E-05	5942.	2.09E+09	18.5958	19976.	0.00
10.5400	-0.00361	6760.	-543.9855	5.23E-05	5775.	2.09E+09	18.2714	20642.	0.00
10.8800	-0.00337	4677.	-470.7972	6.35E-05	5629.	2.09E+09	17.6052	21307.	0.00
11.2200	-0.00309	2884.	-400.8955	7.09E-05	5504.	2.09E+09	16.6603	21973.	0.00
11.5600	-0.00279	1368.	-335.2939	7.50E-05	5398.	2.09E+09	15.4974	22639.	0.00
11.9000	-0.00248	108.9532	-274.7636	7.64E-05	5309.	2.09E+09	14.1743	23305.	0.00
12.2400	-0.00217	-914.2430	-219.8495	7.57E-05	5366.	2.09E+09	12.7444	23971.	0.00
12.5800	-0.00186	-1725.	-170.8877	7.31E-05	5423.	2.09E+09	11.2565	24637.	0.00
12.9200	-0.00157	-2347.	-128.0261	6.91E-05	5466.	2.09E+09	9.7541	25303.	0.00
13.2600	-0.00130	-2806.	-91.2457	6.41E-05	5498.	2.09E+09	8.2755	25968.	0.00
13.6000	-0.00105	-3125.	-60.3825	5.83E-05	5521.	2.09E+09	6.8535	26634.	0.00
13.9400	-8.24E-04	-3329.	-35.1482	5.20E-05	5535.	2.09E+09	5.5162	27300.	0.00
14.2800	-6.25E-04	-3440.	-15.1499	4.54E-05	5542.	2.09E+09	4.2869	27966.	0.00
14.6200	-4.54E-04	-3477.	13.8966	3.87E-05	5545.	2.09E+09	9.9516	89474.	0.00
14.9600	-3.10E-04	-3347.	48.3807	3.20E-05	5536.	2.09E+09	6.9523	91555.	0.00
15.3000	-1.92E-04	-3099.	71.5744	2.57E-05	5519.	2.09E+09	4.4171	93636.	0.00
15.6400	-9.98E-05	-2776.	85.3598	2.00E-05	5496.	2.09E+09	2.3404	95717.	0.00
15.9800	-2.91E-05	-2413.	91.5593	1.50E-05	5471.	2.09E+09	0.6985	97798.	0.00
16.3200	2.23E-05	-2037.	91.8710	1.06E-05	5444.	2.09E+09	-0.5457	99878.	0.00
16.6600	5.75E-05	-1669.	87.8255	7.01E-06	5419.	2.09E+09	-1.4374	101959.	0.00
17.0000	7.95E-05	-1324.	80.7587	4.09E-06	5394.	2.09E+09	-2.0267	104040.	0.00
17.3400	9.09E-05	-1012.	71.8010	1.81E-06	5373.	2.09E+09	-2.3644	106121.	0.00
17.6800	9.43E-05	-738.8793	61.8769	1.08E-07	5354.	2.09E+09	-2.5003	108202.	0.00
18.0200	9.18E-05	-507.0712	51.7153	-1.11E-06	5337.	2.09E+09	-2.4809	110282.	0.00
18.3600	8.52E-05	-316.3002	41.8650	-1.91E-06	5324.	2.09E+09	-2.3477	112363.	0.00
18.7000	7.62E-05	-164.4485	32.7152	-2.38E-06	5313.	2.09E+09	-2.1374	114444.	0.00
19.0400	6.58E-05	-48.0926	24.5188	-2.59E-06	5305.	2.09E+09	-1.8805	116525.	0.00
19.3800	5.51E-05	36.9847	17.4148	-2.60E-06	5304.	2.09E+09	-1.6019	118606.	0.00
19.7200	4.47E-05	95.3778	11.4521	-2.47E-06	5309.	2.09E+09	-1.3210	120686.	0.00
20.0600	3.50E-05	131.7320	6.6106	-2.25E-06	5311.	2.09E+09	-1.0523	122767.	0.00
20.4000	2.63E-05	150.5015	2.8200	-1.97E-06	5312.	2.09E+09	-0.8058	124848.	0.00
20.7400	1.89E-05	155.7801	-0.02279	-1.67E-06	5313.	2.09E+09	-0.5877	126929.	0.00
21.0800	1.27E-05	151.1953	-2.0403	-1.37E-06	5312.	2.09E+09	-0.4012	129010.	0.00
21.4200	7.69E-06	139.8537	-3.3628	-1.09E-06	5312.	2.09E+09	-0.2471	131090.	0.00
21.7600	3.80E-06	124.3276	-4.1200	-8.32E-07	5311.	2.09E+09	-0.1241	133171.	0.00
22.1000	9.04E-07	106.6720	-4.4343	-6.06E-07	5309.	2.09E+09	-0.02995	135252.	0.00
22.4400	-1.15E-06	88.4630	-4.4167	-4.16E-07	5308.	2.09E+09	0.03859	137333.	0.00
22.7800	-2.49E-06	70.8511	-4.1642	-2.61E-07	5307.	2.09E+09	0.08518	139414.	0.00
23.1200	-3.28E-06	54.6208	-3.7586	-1.39E-07	5306.	2.09E+09	0.1136	141494.	0.00
23.4600	-3.62E-06	40.2535	-3.2667	-4.62E-08	5305.	2.09E+09	0.1275	143575.	0.00
23.8000	-3.65E-06	27.9886	-2.7406	2.04E-08	5304.	2.09E+09	0.1304	145656.	0.00
24.1400	-3.46E-06	17.8798	-2.2191	6.51E-08	5303.	2.09E+09	0.1252	147737.	0.00
24.4800	-3.12E-06	9.8461	-1.7299	9.21E-08	5303.	2.09E+09	0.1146	149818.	0.00
24.8200	-2.71E-06	3.7153	-1.2906	1.05E-07	5302.	2.09E+09	0.1008	151898.	0.00
25.1600	-2.26E-06	-0.7402	-0.9109	1.08E-07	5302.	2.09E+09	0.08536	153979.	0.00

25.5000	-1.82E-06	-3.7743	-0.5945	1.04E-07	5302.	2.09E+09	0.06974	156060.	0.00
25.8400	-1.41E-06	-5.6457	-0.3404	9.46E-08	5302.	2.09E+09	0.05483	158141.	0.00
26.1800	-1.05E-06	-6.6014	-0.1443	8.27E-08	5302.	2.09E+09	0.04127	160222.	0.00
26.5200	-7.40E-07	-6.8668	-9.29E-05	6.96E-08	5302.	2.09E+09	0.02943	162302.	0.00
26.8600	-4.83E-07	-6.6388	0.09965	5.64E-08	5302.	2.09E+09	0.01947	164383.	0.00
27.2000	-2.79E-07	-6.0833	0.1626	4.40E-08	5302.	2.09E+09	0.01140	166464.	0.00
27.5400	-1.24E-07	-5.3350	0.1963	3.29E-08	5302.	2.09E+09	0.00512	168545.	0.00
27.8800	-1.11E-08	-4.4986	0.2077	2.33E-08	5302.	2.09E+09	4.65E-04	170626.	0.00
28.2200	6.60E-08	-3.6521	0.2030	1.53E-08	5302.	2.09E+09	-0.00280	172706.	0.00
28.5600	1.14E-07	-2.8503	0.1873	9.01E-09	5302.	2.09E+09	-0.00489	174787.	0.00
28.9000	1.40E-07	-2.1285	0.1650	4.16E-09	5302.	2.09E+09	-0.00605	176868.	0.00
29.2400	1.48E-07	-1.5062	0.1394	6.15E-10	5302.	2.09E+09	-0.00649	178949.	0.00
29.5800	1.45E-07	-0.9913	0.1131	-1.82E-09	5302.	2.09E+09	-0.00641	181030.	0.00
29.9200	1.33E-07	-0.5827	0.08778	-3.35E-09	5302.	2.09E+09	-0.00598	183110.	0.00
30.2600	1.17E-07	-0.2733	0.06473	-4.19E-09	5302.	2.09E+09	-0.00532	185191.	0.00
30.6000	9.90E-08	-0.05225	0.04461	-4.51E-09	5302.	2.09E+09	-0.00455	187272.	0.00
30.9400	8.04E-08	0.09312	0.02772	-4.47E-09	5302.	2.09E+09	-0.00373	189353.	0.00
31.2800	6.26E-08	0.1763	0.01411	-4.20E-09	5302.	2.09E+09	-0.00294	191434.	0.00
31.6200	4.61E-08	0.2105	0.00366	-3.83E-09	5302.	2.09E+09	-0.00219	193514.	0.00
31.9600	3.14E-08	0.2081	-0.00387	-3.42E-09	5302.	2.09E+09	-0.00150	195595.	0.00
32.3000	1.82E-08	0.1807	-0.00875	-3.04E-09	5302.	2.09E+09	-8.84E-04	197676.	0.00
32.6400	6.57E-09	0.1384	-0.01120	-2.73E-09	5302.	2.09E+09	-3.21E-04	199757.	0.00
32.9800	-4.01E-09	0.09068	-0.01146	-2.50E-09	5302.	2.09E+09	1.99E-04	201838.	0.00
33.3200	-1.39E-08	0.04623	-0.00964	-2.37E-09	5302.	2.09E+09	6.93E-04	203918.	0.00
33.6600	-2.34E-08	0.01330	-0.00581	-2.31E-09	5302.	2.09E+09	0.00118	205999.	0.00
34.0000	-3.28E-08	0.00	0.00	-2.30E-09	5302.	2.09E+09	0.00167	104040.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =     0.13000000 inches
Computed slope at pile head       =    -0.00234362 radians
Maximum bending moment            =         64732. inch-lbs
Maximum shear force               =          1915. lbs
Depth of maximum bending moment   =     4.42000000 feet below pile head
Depth of maximum shear force      =       0.000000 feet below pile head
Number of iterations              =              6
Number of zero deflection points  =              5
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	0.1300	M, in-lb	0.00	164500.	0.1300	-0.00238	1743.	66321.
2	y, in	0.1300	M, in-lb	0.00	64475.	0.1300	-0.00234	1915.	64732.

Maximum pile-head deflection = 0.1300000000 inches
Maximum pile-head rotation   = -0.0023757429 radians = -0.136120 deg.

The analysis ended normally.

==

LPile for Windows, Version 2018-10.006

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

==

This copy of LPile is being used by:

Fuss & O'Neill
Manchester, NH

Serial Number of Security Device: 364301389

This copy of LPile is licensed for exclusive use by:

CLD Consulting Engineers, Manche

Files Used for Analysis

Path to file locations:
\Proj2016\160333 Heald Bridge Sumner\Struct\Calcs\03-Final\Substructure Design\Abutment 1\LPile Scour 4-HP10x42\

Name of input data file:
HP10x42 Abut 1scour.lp10

Name of output report file:
HP10x42 Abut 1scour.lp10

Name of plot output file:
HP10x42 Abut 1scour.lp10

Name of runtime message file:
HP10x42 Abut 1scour.lp10

Date and Time of Analysis

Date: September 7, 2018 Time: 11:27:06

Problem Title

Project Name:Heald Bridge
Job Number: 20160333
Client: Maine DOT
Engineer: Anna Giraldi
Description: Integral abutment with hinge and SCOUR

Program Options and Settings

```
Computational Options:
 - Use unfactored loads in computations (conventional analysis)
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed                =          500
 - Deflection tolerance for convergence                =   1.0000E-05 in
 - Maximum allowable deflection                        =     100.0000 in
 - Number of pile increments                           =          100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Use of p-y modification factors for p-y curves not selected
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats



--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                        =            1
Total length of pile                                   =       34.000 ft
Depth of ground surface below top of pile              =      14.6000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

            Depth Below          Pile
Point        Pile Head         Diameter
 No.           feet             inches
-----      -------------     -------------
  1            0.000           10.1000
  2           34.000           10.1000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a H weak axis steel pile
   Length of section                                   =    34.000000 ft
   Pile width                                          =     9.700000 in
   Shear capacity of section                           =       0.0000 lbs



--------------------------------------------------------------------------------
                       Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------
```

```
Ground Slope Angle                                    =        0.000 degrees
                                                      =        0.000 radians

Pile Batter Angle                                     =        0.000 degrees
                                                      =        0.000 radians
```

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer          =    14.600000 ft
   Distance from top of pile to bottom of layer       =    34.000000 ft
   Effective unit weight at top of layer              =    72.600000 pcf
   Effective unit weight at bottom of layer           =    72.600000 pcf
   Friction angle at top of layer                     =    37.000000 deg.
   Friction angle at bottom of layer                  =    37.000000 deg.
   Subgrade k at top of layer                         =   125.000000 pci
   Subgrade k at bottom of layer                      =   125.000000 pci
```

Layer 2 is strong rock (vuggy limestone)

```
   Distance from top of pile to top of layer          =    34.000000 ft
   Distance from top of pile to bottom of layer       =    54.000000 ft
   Effective unit weight at top of layer              =    87.600000 pcf
   Effective unit weight at bottom of layer           =    87.600000 pcf
   Uniaxial compressive strength at top of layer      =        9700. psi
   Uniaxial compressive strength at bottom of layer   =        9700. psi
```

(Depth of the lowest soil layer extends 20.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	Uniaxial qu psi	kpy pci
1	Sand	14.6000	72.6000	37.0000	--	125.0000
	(Reese, et al.)	34.0000	72.6000	37.0000	--	125.0000
2	Strong Rock	34.0000	87.6000	--	9700.	--
	(Vuggy Limestone)	54.0000	87.6000	--	9700.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length

```
   1     4     y =     0.130000 in    M =       0.0000 in-lbs          164500.          N.A.
   2     4     y =     0.130000 in    M =       0.0000 in-lbs           64475.          N.A.

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.



--------------------------------------------------------------------------------
     Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness
--------------------------------------------------------------------------------

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:
-------------------

Dimensions and Properties of Steel H Weak Axis:
---------------------------------------------

Length of Section                                     =    34.000000 ft
Flange Width                                          =    10.100000 in
Section Depth                                         =     9.700000 in
Flange Thickness                                      =     0.420000 in
Web Thickness                                         =     0.415000 in
Yield Stress of Pipe                                  =    50.000000 ksi
Elastic Modulus                                       =       29000. ksi
Cross-sectional Area                                  =    12.160900 sq. in.
Moment of Inertia                                     =    72.173841 in^4
Elastic Bending Stiffness                             =     2093041. kip-in^2
Plastic Modulus, Z                                    =    21.803578in^3
Plastic Moment Capacity = Fy Z                        =        1090.in-kip

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = Fy As                =      608.045 kips
Nominal Axial Tensile Capacity                        =     -608.045 kips



Number of Axial Thrust Force Values Determined from Pile-head Loadings = 2

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1             64.475
      2            164.500

Definition of Run Messages:

   Y = part of pipe section has yielded.


Axial Thrust Force =     64.475 kips

    Bending       Bending       Bending      Depth to      Max Total  Run
   Curvature      Moment       Stiffness      N Axis         Stress    Msg
    rad/in.       in-kip       kip-in2         in             ksi
------------- ------------- ------------- ------------- ------------- ---
   0.00000708    14.8233904      2092806.    30.8612477     6.3287637
   0.00001417    29.6467808      2092806.    17.9556239     7.3556992
```

0.00002125	44.4701712	2092806.	13.6537492	8.3826349	
0.00002833	59.2935617	2092806.	11.5028119	9.4095704	
0.00003542	74.1169521	2092806.	10.2122495	10.4365060	
0.00004250	88.9403425	2092806.	9.3518746	11.4634417	
0.00004958	103.7637329	2092806.	8.7373211	12.4903773	
0.00005666	118.5871233	2092806.	8.2764060	13.5173129	
0.00006375	133.4105137	2092806.	7.9179164	14.5442485	
0.00007083	148.2339041	2092806.	7.6311248	15.5711841	
0.00007791	163.0572946	2092806.	7.3964771	16.5981198	
0.00008500	177.8806850	2092806.	7.2009373	17.6250554	
0.00009208	192.7040754	2092806.	7.0354806	18.6519910	
0.00009916	207.5274658	2092806.	6.8936606	19.6789266	
0.0001062	222.3508562	2092806.	6.7707498	20.7058622	
0.0001133	237.1742466	2092806.	6.6632030	21.7327978	
0.0001204	251.9976370	2092806.	6.5683087	22.7597335	
0.0001275	266.8210274	2092806.	6.4839582	23.7866691	
0.0001346	281.6444179	2092806.	6.4084867	24.8136047	
0.0001417	296.4678083	2092806.	6.3405624	25.8405403	
0.0001487	311.2911987	2092806.	6.2791070	26.8674759	
0.0001558	326.1145891	2092806.	6.2232385	27.8944115	
0.0001629	340.9379795	2092806.	6.1722282	28.9213472	
0.0001700	355.7613699	2092806.	6.1254687	29.9482828	
0.0001771	370.5847603	2092806.	6.0824499	30.9752184	
0.0001842	385.4081508	2092806.	6.0427403	32.0021540	
0.0001912	400.2315412	2092806.	6.0059721	33.0290896	
0.0001983	415.0549316	2092806.	5.9718303	34.0560252	
0.0002054	429.8783220	2092806.	5.9400430	35.0829608	
0.0002125	444.7017124	2092806.	5.9103749	36.1098965	
0.0002196	459.5251028	2092806.	5.8826209	37.1368321	
0.0002267	474.3484932	2092806.	5.8566015	38.1637677	
0.0002337	489.1718837	2092806.	5.8321590	39.1907033	
0.0002408	503.9952741	2092806.	5.8091543	40.2176389	
0.0002479	518.8186645	2092806.	5.7874642	41.2445745	
0.0002550	533.6420549	2092806.	5.7669791	42.2715102	
0.0002621	548.4654453	2092806.	5.7476013	43.2984458	
0.0002692	563.2888357	2092806.	5.7292434	44.3253814	
0.0002762	578.1122261	2092806.	5.7118269	45.3523170	
0.0002904	607.7590070	2092806.	5.6795426	47.4061882	
0.0003046	637.4057878	2092806.	5.6502616	49.4600595	
0.0003187	666.1567924	2089995.	5.6251863	50.0000000	Y
0.0003329	693.0946408	2081978.	5.6054353	50.0000000	Y
0.0003471	718.4253212	2069984.	5.5901302	50.0000000	Y
0.0003612	742.3455463	2055026.	5.5785173	50.0000000	Y
0.0003754	765.0424844	2037938.	5.5699436	50.0000000	Y
0.0003896	786.3309643	2018478.	5.5635599	50.0000000	Y
0.0004037	805.5391329	1995231.	5.5574883	50.0000000	Y
0.0004179	822.8048857	1968912.	5.5515231	50.0000000	Y
0.0004321	838.5016238	1940687.	5.5456970	50.0000000	Y
0.0004462	852.6530610	1910791.	5.5399360	50.0000000	Y
0.0004604	865.5495119	1880009.	5.5344115	50.0000000	Y
0.0004746	877.3467845	1848749.	5.5290154	50.0000000	Y
0.0004887	888.1534017	1817273.	5.5237261	50.0000000	Y
0.0005029	898.0721785	1785806.	5.5185238	50.0000000	Y
0.0005171	907.2002197	1754533.	5.5133901	50.0000000	Y
0.0005312	915.5899667	1723539.	5.5083980	50.0000000	Y
0.0005454	923.3193709	1692944.	5.5035569	50.0000000	Y
0.0005596	930.5003201	1662918.	5.4987838	50.0000000	Y
0.0005737	937.2093296	1633552.	5.4940635	50.0000000	Y
0.0005879	943.4433541	1604793.	5.4895678	50.0000000	Y
0.0006021	949.2010535	1576597.	5.4851182	50.0000000	Y
0.0006162	954.6126532	1549135.	5.4805740	50.0000000	Y
0.0006304	959.6452179	1522306.	5.4764065	50.0000000	Y
0.0006446	964.3889650	1496209.	5.4721635	50.0000000	Y
0.0006587	968.7844442	1470705.	5.4679937	50.0000000	Y
0.0006729	972.9982026	1446005.	5.4640435	50.0000000	Y
0.0006871	976.8536473	1421802.	5.4599687	50.0000000	Y
0.0007012	980.5761596	1398387.	5.4561036	50.0000000	Y
0.0007154	984.0022703	1375486.	5.4522660	50.0000000	Y
0.0007296	987.3375296	1353349.	5.4484561	50.0000000	Y
0.0007437	990.3683262	1331646.	5.4448287	50.0000000	Y
0.0007579	993.3515258	1310692.	5.4412211	50.0000000	Y

0.0007720	996.0783909	1290174.	5.4376062	50.0000000	Y
0.0007862	998.7464632	1270321.	5.4342894	50.0000000	Y
0.0008004	1001.	1250934.	5.4306238	50.0000000	Y
0.0008145	1004.	1232075.	5.4273928	50.0000000	Y
0.0008287	1006.	1213722.	5.4241073	50.0000000	Y
0.0008429	1008.	1195879.	5.4207080	50.0000000	Y
0.0008995	1016.	1129072.	5.4083826	50.0000000	Y
0.0009562	1022.	1068763.	5.3966522	50.0000000	Y
0.0010129	1027.	1014249.	5.3856785	50.0000000	Y
0.0010695	1032.	964745.	5.3755342	50.0000000	Y
0.0011262	1036.	919679.	5.3659749	50.0000000	Y
0.0011829	1039.	878542.	5.3568817	50.0000000	Y
0.0012395	1042.	840721.	5.3482894	50.0000000	Y
0.0012962	1045.	805971.	5.3400863	50.0000000	Y
0.0013529	1047.	773937.	5.3325725	50.0000000	Y
0.0014095	1049.	744266.	5.3250927	50.0000000	Y
0.0014662	1051.	716743.	5.3183342	50.0000000	Y
0.0015228	1053.	691163.	5.3116071	50.0000000	Y
0.0015795	1054.	667313.	5.3054516	50.0000000	Y
0.0016362	1055.	645001.	5.2994590	50.0000000	Y

Axial Thrust Force = 164.500 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000635	13.2935644	2092806.	78.4827263	14.4479116	
0.00001270	26.5871289	2092806.	41.7663631	15.3688638	
0.00001906	39.8806933	2092806.	29.5275754	16.2898162	
0.00002541	53.1742578	2092806.	23.4081816	17.2107683	
0.00003176	66.4678222	2092806.	19.7365453	18.1317206	
0.00003811	79.7613867	2092806.	17.2887877	19.0526728	
0.00004446	93.0549511	2092806.	15.5403895	19.9736251	
0.00005082	106.3485155	2092806.	14.2290908	20.8945774	
0.00005717	119.6420800	2092806.	13.2091918	21.8155296	
0.00006352	132.9356444	2092806.	12.3932726	22.7364818	
0.00006987	146.2292089	2092806.	11.7257024	23.6574341	
0.00007622	159.5227733	2092806.	11.1693939	24.5783864	
0.00008258	172.8163378	2092806.	10.6986713	25.4993386	
0.00008893	186.1099022	2092806.	10.2951947	26.4202909	
0.00009528	199.4034666	2092806.	9.9455151	27.3412431	
0.0001016	212.6970311	2092806.	9.6395454	28.2621954	
0.0001080	225.9905955	2092806.	9.3695721	29.1831476	
0.0001143	239.2841600	2092806.	9.1295959	30.1040999	
0.0001207	252.5777244	2092806.	8.9148803	31.0250521	
0.0001270	265.8712888	2092806.	8.7216363	31.9460044	
0.0001334	279.1648533	2092806.	8.5467965	32.8669566	
0.0001397	292.4584177	2092806.	8.3878512	33.7879089	
0.0001461	305.7519822	2092806.	8.2427272	34.7088612	
0.0001524	319.0455466	2092806.	8.1096969	35.6298134	
0.0001588	332.3391111	2092806.	7.9873091	36.5507657	
0.0001652	345.6326755	2092806.	7.8743356	37.4717179	
0.0001715	358.9262399	2092806.	7.7697306	38.3926702	
0.0001779	372.2198044	2092806.	7.6725974	39.3136224	
0.0001842	385.5133688	2092806.	7.5821630	40.2345747	
0.0001906	398.8069333	2092806.	7.4977575	41.1555269	
0.0001969	412.1004977	2092806.	7.4187976	42.0764792	
0.0002033	425.3940622	2092806.	7.3447727	42.9974314	
0.0002096	438.6876266	2092806.	7.2752341	43.9183837	
0.0002160	451.9811910	2092806.	7.2097861	44.8393359	
0.0002223	465.2747555	2092806.	7.1480779	45.7602882	
0.0002287	478.5683199	2092806.	7.0897980	46.6812404	
0.0002350	491.8618844	2092806.	7.0346683	47.6021927	
0.0002414	505.1554488	2092806.	6.9824402	48.5231449	
0.0002477	518.4490133	2092806.	6.9328904	49.4440972	
0.0002604	544.2624927	2089835.	6.8427369	50.0000000	Y
0.0002731	568.3261655	2080734.	6.7647248	50.0000000	Y
0.0002858	590.8014252	2066886.	6.6970634	50.0000000	Y
0.0002985	611.9404311	2049740.	6.6380420	50.0000000	Y

0.0003112	631.8747337	2030123.	6.5864418	50.0000000	Y
0.0003240	650.7537655	2008787.	6.5411761	50.0000000	Y
0.0003367	668.7475972	1986433.	6.5012462	50.0000000	Y
0.0003494	685.8833582	1963247.	6.4660820	50.0000000	Y
0.0003621	702.3289446	1939783.	6.4348856	50.0000000	Y
0.0003748	718.0549758	1915990.	6.4073704	50.0000000	Y
0.0003875	733.2215175	1892312.	6.3828807	50.0000000	Y
0.0004002	747.8682878	1868840.	6.3610789	50.0000000	Y
0.0004129	762.0338702	1845646.	6.3416678	50.0000000	Y
0.0004256	775.7532053	1822788.	6.3243894	50.0000000	Y
0.0004383	789.0636483	1800323.	6.3090068	50.0000000	Y
0.0004510	802.0118621	1778320.	6.2952841	50.0000000	Y
0.0004637	814.3822165	1756276.	6.2826595	50.0000000	Y
0.0004764	825.8474313	1733509.	6.2703129	50.0000000	Y
0.0004891	836.4986838	1710259.	6.2582022	50.0000000	Y
0.0005018	846.4219572	1686737.	6.2462881	50.0000000	Y
0.0005145	855.6980321	1663118.	6.2345339	50.0000000	Y
0.0005272	864.3060994	1639370.	6.2231524	50.0000000	Y
0.0005399	872.3852025	1615760.	6.2119540	50.0000000	Y
0.0005526	880.0210214	1592433.	6.2008612	50.0000000	Y
0.0005653	887.1307926	1569225.	6.1902446	50.0000000	Y
0.0005780	893.8038681	1546281.	6.1795090	50.0000000	Y
0.0005907	900.0696119	1523634.	6.1691032	50.0000000	Y
0.0006034	906.0431034	1501456.	6.1588881	50.0000000	Y
0.0006161	911.6695356	1479630.	6.1489378	50.0000000	Y
0.0006289	916.9554351	1458144.	6.1389455	50.0000000	Y
0.0006416	921.9810580	1437104.	6.1293744	50.0000000	Y
0.0006543	926.7926652	1416553.	6.1197442	50.0000000	Y
0.0006670	931.2513670	1396256.	6.1104806	50.0000000	Y
0.0006797	935.6173537	1376582.	6.1013746	50.0000000	Y
0.0006924	939.6535588	1357153.	6.0922151	50.0000000	Y
0.0007051	943.5771358	1338264.	6.0835149	50.0000000	Y
0.0007178	947.2596576	1319709.	6.0746167	50.0000000	Y
0.0007305	950.8399211	1301658.	6.0661630	50.0000000	Y
0.0007432	954.1555968	1283869.	6.0576823	50.0000000	Y
0.0007559	957.4604635	1266664.	6.0494631	50.0000000	Y
0.0008067	969.0256564	1201210.	6.0174739	50.0000000	Y
0.0008575	978.8343448	1141466.	5.9875899	50.0000000	Y
0.0009083	987.2303377	1086851.	5.9595585	50.0000000	Y
0.0009592	994.5417994	1036892.	5.9332353	50.0000000	Y
0.0010100	1001.	991010.	5.9081370	50.0000000	Y
0.0010608	1006.	948758.	5.8846159	50.0000000	Y
0.0011116	1011.	909835.	5.8622641	50.0000000	Y
0.0011624	1016.	873838.	5.8412042	50.0000000	Y
0.0012132	1020.	840456.	5.8208967	50.0000000	Y
0.0012641	1023.	809417.	5.8018748	50.0000000	Y
0.0013149	1026.	780578.	5.7836911	50.0000000	Y
0.0013657	1029.	753679.	5.7663911	50.0000000	Y
0.0014165	1032.	728451.	5.7498646	50.0000000	Y
0.0014673	1034.	704896.	5.7342159	50.0000000	Y

Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	64.4750000000	1055.
2	164.5000000000	1034.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	14.6000	0.00	N.A.	No	0.00	561735.
2	34.0000	19.4000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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

Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head = 0.130000 inches
Moment at pile head = 0.0 in-lbs
Axial load at pile head = 164500.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1300	0.00	-44.4179	-9.41E-04	13527.	2.09E+09	0.00	0.00	0.00
0.3400	0.1262	450.4339	-44.4179	-9.41E-04	13558.	2.09E+09	0.00	0.00	0.00
0.6800	0.1223	900.2784	-44.4179	-9.39E-04	13590.	2.09E+09	0.00	0.00	0.00
1.0200	0.1185	1349.	-44.4179	-9.37E-04	13621.	2.09E+09	0.00	0.00	0.00
1.3600	0.1147	1796.	-44.4179	-9.34E-04	13653.	2.09E+09	0.00	0.00	0.00
1.7000	0.1109	2240.	-44.4179	-9.30E-04	13684.	2.09E+09	0.00	0.00	0.00
2.0400	0.1071	2682.	-44.4179	-9.25E-04	13715.	2.09E+09	0.00	0.00	0.00
2.3800	0.1033	3120.	-44.4179	-9.20E-04	13745.	2.09E+09	0.00	0.00	0.00
2.7200	0.09958	3554.	-44.4179	-9.13E-04	13776.	2.09E+09	0.00	0.00	0.00
3.0600	0.09587	3984.	-44.4179	-9.06E-04	13806.	2.09E+09	0.00	0.00	0.00
3.4000	0.09219	4408.	-44.4179	-8.98E-04	13835.	2.09E+09	0.00	0.00	0.00
3.7400	0.08854	4826.	-44.4179	-8.89E-04	13865.	2.09E+09	0.00	0.00	0.00
4.0800	0.08494	5238.	-44.4179	-8.79E-04	13893.	2.09E+09	0.00	0.00	0.00
4.4200	0.08137	5643.	-44.4179	-8.68E-04	13922.	2.09E+09	0.00	0.00	0.00
4.7600	0.07785	6041.	-44.4179	-8.57E-04	13950.	2.09E+09	0.00	0.00	0.00
5.1000	0.07438	6431.	-44.4179	-8.45E-04	13977.	2.09E+09	0.00	0.00	0.00
5.4400	0.07096	6813.	-44.4179	-8.32E-04	14004.	2.09E+09	0.00	0.00	0.00
5.7800	0.06759	7185.	-44.4179	-8.18E-04	14030.	2.09E+09	0.00	0.00	0.00
6.1200	0.06428	7549.	-44.4179	-8.04E-04	14055.	2.09E+09	0.00	0.00	0.00
6.4600	0.06103	7902.	-44.4179	-7.89E-04	14080.	2.09E+09	0.00	0.00	0.00
6.8000	0.05785	8245.	-44.4179	-7.73E-04	14104.	2.09E+09	0.00	0.00	0.00
7.1400	0.05472	8577.	-44.4179	-7.57E-04	14127.	2.09E+09	0.00	0.00	0.00
7.4800	0.05167	8898.	-44.4179	-7.40E-04	14150.	2.09E+09	0.00	0.00	0.00
7.8200	0.04869	9207.	-44.4179	-7.22E-04	14171.	2.09E+09	0.00	0.00	0.00
8.1600	0.04578	9505.	-44.4179	-7.04E-04	14192.	2.09E+09	0.00	0.00	0.00
8.5000	0.04295	9790.	-44.4179	-6.85E-04	14212.	2.09E+09	0.00	0.00	0.00
8.8400	0.04019	10062.	-44.4179	-6.66E-04	14231.	2.09E+09	0.00	0.00	0.00
9.1800	0.03752	10320.	-44.4179	-6.46E-04	14249.	2.09E+09	0.00	0.00	0.00

9.5200	0.03492	10566.	-44.4179	-6.25E-04	14266.	2.09E+09	0.00	0.00	0.00
9.8600	0.03241	10797.	-44.4179	-6.04E-04	14282.	2.09E+09	0.00	0.00	0.00
10.2000	0.02999	11015.	-44.4179	-5.83E-04	14298.	2.09E+09	0.00	0.00	0.00
10.5400	0.02765	11218.	-44.4179	-5.62E-04	14312.	2.09E+09	0.00	0.00	0.00
10.8800	0.02541	11406.	-44.4179	-5.40E-04	14325.	2.09E+09	0.00	0.00	0.00
11.2200	0.02325	11580.	-44.4179	-5.17E-04	14337.	2.09E+09	0.00	0.00	0.00
11.5600	0.02119	11738.	-44.4179	-4.94E-04	14348.	2.09E+09	0.00	0.00	0.00
11.9000	0.01922	11881.	-44.4179	-4.71E-04	14358.	2.09E+09	0.00	0.00	0.00
12.2400	0.01734	12008.	-44.4179	-4.48E-04	14367.	2.09E+09	0.00	0.00	0.00
12.5800	0.01556	12120.	-44.4179	-4.25E-04	14375.	2.09E+09	0.00	0.00	0.00
12.9200	0.01388	12216.	-44.4179	-4.01E-04	14382.	2.09E+09	0.00	0.00	0.00
13.2600	0.01229	12295.	-44.4179	-3.77E-04	14387.	2.09E+09	0.00	0.00	0.00
13.6000	0.01080	12359.	-44.4179	-3.53E-04	14392.	2.09E+09	0.00	0.00	0.00
13.9400	0.00941	12407.	-44.4179	-3.29E-04	14395.	2.09E+09	0.00	0.00	0.00
14.2800	0.00812	12438.	-44.4179	-3.05E-04	14397.	2.09E+09	0.00	0.00	0.00
14.6200	0.00693	12453.	-44.8418	-2.80E-04	14398.	2.09E+09	-0.2078	122.4000	0.00
14.9600	0.00583	12448.	-51.6904	-2.56E-04	14398.	2.09E+09	-3.1494	2203.	0.00
15.3000	0.00484	12375.	-68.4763	-2.32E-04	14393.	2.09E+09	-5.0790	4284.	0.00
15.6400	0.00394	12201.	-91.3780	-2.08E-04	14381.	2.09E+09	-6.1473	6365.	0.00
15.9800	0.00314	11908.	-117.1825	-1.84E-04	14360.	2.09E+09	-6.5020	8446.	0.00
16.3200	0.00244	11492.	-143.2690	-1.62E-04	14331.	2.09E+09	-6.2855	10526.	0.00
16.6600	0.00182	10956.	-167.5818	-1.40E-04	14294.	2.09E+09	-5.6326	12607.	0.00
17.0000	0.00130	10312.	-188.5943	-1.19E-04	14248.	2.09E+09	-4.6677	14688.	0.00
17.3400	8.52E-04	9577.	-205.2627	-9.95E-05	14197.	2.09E+09	-3.5031	16769.	0.00
17.6800	4.84E-04	8771.	-216.9732	-8.17E-05	14141.	2.09E+09	-2.2373	18850.	0.00
18.0200	1.86E-04	7916.	-223.4836	-6.54E-05	14081.	2.09E+09	-0.9540	20930.	0.00
18.3600	-4.94E-05	7035.	-224.8619	-5.08E-05	14019.	2.09E+09	0.2784	23011.	0.00
18.7000	-2.29E-04	6149.	-221.4240	-3.80E-05	13957.	2.09E+09	1.4068	25092.	0.00
19.0400	-3.59E-04	5279.	-213.6736	-2.68E-05	13896.	2.09E+09	2.3924	27173.	0.00
19.3800	-4.48E-04	4442.	-202.2445	-1.74E-05	13838.	2.09E+09	3.2101	29254.	0.00
19.7200	-5.01E-04	3652.	-187.8489	-9.47E-06	13782.	2.09E+09	3.8466	31334.	0.00
20.0600	-5.25E-04	2921.	-171.2309	-3.06E-06	13731.	2.09E+09	4.2995	33415.	0.00
20.4000	-5.26E-04	2259.	-153.1273	1.99E-06	13685.	2.09E+09	4.5748	35496.	0.00
20.7400	-5.09E-04	1669.	-134.2363	5.82E-06	13644.	2.09E+09	4.6855	37577.	0.00
21.0800	-4.78E-04	1156.	-115.1923	8.57E-06	13608.	2.09E+09	4.6497	39658.	0.00
21.4200	-4.39E-04	717.7747	-96.5493	1.04E-05	13577.	2.09E+09	4.4890	41738.	0.00
21.7600	-3.94E-04	353.7684	-78.7698	1.14E-05	13552.	2.09E+09	4.2265	43819.	0.00
22.1000	-3.45E-04	59.6553	-62.2198	1.18E-05	13531.	2.09E+09	3.8862	45900.	0.00
22.4400	-2.97E-04	-169.8442	-47.1697	1.17E-05	13539.	2.09E+09	3.4913	47981.	0.00
22.7800	-2.50E-04	-341.0041	-33.7981	1.12E-05	13551.	2.09E+09	3.0634	50062.	0.00
23.1200	-2.05E-04	-460.7230	-22.1997	1.05E-05	13559.	2.09E+09	2.6220	52142.	0.00
23.4600	-1.64E-04	-536.1914	-12.3954	9.49E-06	13564.	2.09E+09	2.1840	54223.	0.00
23.8000	-1.28E-04	-574.6028	-4.3433	8.40E-06	13567.	2.09E+09	1.7631	56304.	0.00
24.1400	-9.58E-05	-582.9126	2.0490	7.27E-06	13568.	2.09E+09	1.3704	58385.	0.00
24.4800	-6.84E-05	-567.6478	6.9126	6.15E-06	13567.	2.09E+09	1.0137	60466.	0.00
24.8200	-4.56E-05	-534.7657	10.4051	5.08E-06	13564.	2.09E+09	0.6983	62546.	0.00
25.1600	-2.70E-05	-489.5593	12.7008	4.08E-06	13561.	2.09E+09	0.4270	64627.	0.00
25.5000	-1.23E-05	-436.6037	13.9809	3.18E-06	13558.	2.09E+09	0.2004	66708.	0.00
25.8400	-1.03E-06	-379.7403	14.4253	2.38E-06	13554.	2.09E+09	0.01740	68789.	0.00
26.1800	7.18E-06	-322.0905	14.2065	1.70E-06	13549.	2.09E+09	-0.1246	70870.	0.00
26.5200	1.28E-05	-266.0939	13.4846	1.12E-06	13546.	2.09E+09	-0.2292	72950.	0.00
26.8600	1.63E-05	-213.5648	12.4037	6.57E-07	13542.	2.09E+09	-0.3006	75031.	0.00
27.2000	1.82E-05	-165.7609	11.0895	2.87E-07	13539.	2.09E+09	-0.3436	77112.	0.00
27.5400	1.87E-05	-123.4592	9.6487	4.93E-09	13536.	2.09E+09	-0.3628	79193.	0.00
27.8800	1.82E-05	-87.0344	8.1683	-2.00E-07	13533.	2.09E+09	-0.3629	81274.	0.00
28.2200	1.71E-05	-56.5368	6.7172	-3.40E-07	13531.	2.09E+09	-0.3484	83354.	0.00
28.5600	1.54E-05	-31.7654	5.3467	-4.26E-07	13529.	2.09E+09	-0.3234	85435.	0.00
28.9000	1.36E-05	-12.3352	4.0930	-4.69E-07	13528.	2.09E+09	-0.2912	87516.	0.00
29.2400	1.16E-05	2.2635	2.9787	-4.79E-07	13527.	2.09E+09	-0.2550	89597.	0.00
29.5800	9.67E-06	12.6141	2.0153	-4.65E-07	13528.	2.09E+09	-0.2172	91678.	0.00
29.9200	7.82E-06	19.3321	1.2055	-4.33E-07	13528.	2.09E+09	-0.1797	93758.	0.00
30.2600	6.13E-06	23.0328	0.5450	-3.92E-07	13529.	2.09E+09	-0.1440	95839.	0.00
30.6000	4.62E-06	24.3061	0.02498	-3.46E-07	13529.	2.09E+09	-0.1109	97920.	0.00
30.9400	3.31E-06	23.7011	-0.3667	-2.99E-07	13529.	2.09E+09	-0.08106	100001.	0.00
31.2800	2.18E-06	21.7157	-0.6433	-2.55E-07	13528.	2.09E+09	-0.05456	102082.	0.00
31.6200	1.23E-06	18.7937	-0.8185	-2.15E-07	13528.	2.09E+09	-0.03132	104162.	0.00
31.9600	4.23E-07	15.3258	-0.9049	-1.82E-07	13528.	2.09E+09	-0.01100	106243.	0.00
32.3000	-2.60E-07	11.6546	-0.9132	-1.56E-07	13528.	2.09E+09	0.00690	108324.	0.00
32.6400	-8.49E-07	8.0829	-0.8523	-1.37E-07	13528.	2.09E+09	0.02298	110405.	0.00
32.9800	-1.37E-06	4.8833	-0.7281	-1.24E-07	13527.	2.09E+09	0.03790	112486.	0.00
33.3200	-1.86E-06	2.3083	-0.5441	-1.17E-07	13527.	2.09E+09	0.05226	114566.	0.00

33.6600	-2.33E-06	0.6002	-0.3017	-1.14E-07	13527.	2.09E+09	0.06660	116647.	0.00
34.0000	-2.79E-06	0.00	0.00	-1.14E-07	13527.	2.09E+09	0.08127	59364.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

```
Pile-head deflection               =     0.13000000 inches
Computed slope at pile head        =    -0.00094115 radians
Maximum bending moment             =         12453. inch-lbs
Maximum shear force                =  -224.86187250 lbs
Depth of maximum bending moment    =    14.62000000 feet below pile head
Depth of maximum shear force       =    18.36000000 feet below pile head
Number of iterations               =              6
Number of zero deflection points   =              3
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Displacement and Moment (Loading Type 4)

```
Displacement of pile head                     =     0.130000 inches
Moment at pile head                           =          0.0 in-lbs
Axial load at pile head                       =      64475.0 lbs
```

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1300	0.00	27.1046	-8.90E-04	5302.	2.09E+09	0.00	0.00	0.00
0.3400	0.1264	344.7586	27.1046	-8.90E-04	5326.	2.09E+09	0.00	0.00	0.00
0.6800	0.1227	689.3405	27.1046	-8.89E-04	5350.	2.09E+09	0.00	0.00	0.00
1.0200	0.1191	1034.	27.1046	-8.87E-04	5374.	2.09E+09	0.00	0.00	0.00
1.3600	0.1155	1377.	27.1046	-8.85E-04	5398.	2.09E+09	0.00	0.00	0.00
1.7000	0.1119	1720.	27.1046	-8.82E-04	5422.	2.09E+09	0.00	0.00	0.00
2.0400	0.1083	2062.	27.1046	-8.78E-04	5446.	2.09E+09	0.00	0.00	0.00
2.3800	0.1047	2403.	27.1046	-8.74E-04	5470.	2.09E+09	0.00	0.00	0.00
2.7200	0.1012	2743.	27.1046	-8.69E-04	5494.	2.09E+09	0.00	0.00	0.00
3.0600	0.09764	3082.	27.1046	-8.63E-04	5517.	2.09E+09	0.00	0.00	0.00
3.4000	0.09413	3418.	27.1046	-8.57E-04	5541.	2.09E+09	0.00	0.00	0.00
3.7400	0.09065	3754.	27.1046	-8.50E-04	5564.	2.09E+09	0.00	0.00	0.00
4.0800	0.08720	4087.	27.1046	-8.42E-04	5588.	2.09E+09	0.00	0.00	0.00
4.4200	0.08378	4418.	27.1046	-8.34E-04	5611.	2.09E+09	0.00	0.00	0.00
4.7600	0.08039	4747.	27.1046	-8.25E-04	5634.	2.09E+09	0.00	0.00	0.00
5.1000	0.07705	5073.	27.1046	-8.15E-04	5657.	2.09E+09	0.00	0.00	0.00
5.4400	0.07374	5397.	27.1046	-8.05E-04	5679.	2.09E+09	0.00	0.00	0.00
5.7800	0.07048	5718.	27.1046	-7.94E-04	5702.	2.09E+09	0.00	0.00	0.00
6.1200	0.06726	6036.	27.1046	-7.83E-04	5724.	2.09E+09	0.00	0.00	0.00
6.4600	0.06409	6351.	27.1046	-7.71E-04	5746.	2.09E+09	0.00	0.00	0.00
6.8000	0.06097	6662.	27.1046	-7.58E-04	5768.	2.09E+09	0.00	0.00	0.00
7.1400	0.05790	6971.	27.1046	-7.45E-04	5790.	2.09E+09	0.00	0.00	0.00
7.4800	0.05489	7275.	27.1046	-7.31E-04	5811.	2.09E+09	0.00	0.00	0.00
7.8200	0.05194	7576.	27.1046	-7.16E-04	5832.	2.09E+09	0.00	0.00	0.00
8.1600	0.04905	7873.	27.1046	-7.01E-04	5853.	2.09E+09	0.00	0.00	0.00
8.5000	0.04622	8167.	27.1046	-6.86E-04	5873.	2.09E+09	0.00	0.00	0.00
8.8400	0.04345	8455.	27.1046	-6.69E-04	5893.	2.09E+09	0.00	0.00	0.00
9.1800	0.04075	8740.	27.1046	-6.53E-04	5913.	2.09E+09	0.00	0.00	0.00
9.5200	0.03813	9020.	27.1046	-6.35E-04	5933.	2.09E+09	0.00	0.00	0.00
9.8600	0.03557	9295.	27.1046	-6.18E-04	5952.	2.09E+09	0.00	0.00	0.00
10.2000	0.03309	9566.	27.1046	-5.99E-04	5971.	2.09E+09	0.00	0.00	0.00
10.5400	0.03068	9832.	27.1046	-5.80E-04	5990.	2.09E+09	0.00	0.00	0.00
10.8800	0.02835	10093.	27.1046	-5.61E-04	6008.	2.09E+09	0.00	0.00	0.00

11.2200	0.02610	10348.	27.1046	-5.41E-04	6026.	2.09E+09	0.00	0.00	0.00
11.5600	0.02394	10598.	27.1046	-5.21E-04	6043.	2.09E+09	0.00	0.00	0.00
11.9000	0.02186	10843.	27.1046	-5.00E-04	6061.	2.09E+09	0.00	0.00	0.00
12.2400	0.01986	11082.	27.1046	-4.78E-04	6077.	2.09E+09	0.00	0.00	0.00
12.5800	0.01795	11316.	27.1046	-4.56E-04	6094.	2.09E+09	0.00	0.00	0.00
12.9200	0.01614	11544.	27.1046	-4.34E-04	6110.	2.09E+09	0.00	0.00	0.00
13.2600	0.01441	11765.	27.1046	-4.11E-04	6125.	2.09E+09	0.00	0.00	0.00
13.6000	0.01278	11981.	27.1046	-3.88E-04	6140.	2.09E+09	0.00	0.00	0.00
13.9400	0.01124	12191.	27.1046	-3.65E-04	6155.	2.09E+09	0.00	0.00	0.00
14.2800	0.00980	12394.	27.1046	-3.41E-04	6169.	2.09E+09	0.00	0.00	0.00
14.6200	0.00846	12591.	26.5867	-3.16E-04	6183.	2.09E+09	-0.2539	122.4000	0.00
14.9600	0.00722	12778.	18.1125	-2.92E-04	6196.	2.09E+09	-3.9001	2203.	0.00
15.3000	0.00608	12893.	-2.8744	-2.67E-04	6204.	2.09E+09	-6.3875	4284.	0.00
15.6400	0.00505	12894.	-31.9661	-2.41E-04	6204.	2.09E+09	-7.8731	6365.	0.00
15.9800	0.00411	12759.	-65.3951	-2.16E-04	6195.	2.09E+09	-8.5137	8446.	0.00
16.3200	0.00328	12475.	-100.0285	-1.92E-04	6175.	2.09E+09	-8.4635	10526.	0.00
16.6600	0.00255	12043.	-133.3502	-1.68E-04	6145.	2.09E+09	-7.8707	12607.	0.00
17.0000	0.00191	11475.	-163.4314	-1.45E-04	6105.	2.09E+09	-6.8749	14688.	0.00
17.3400	0.00136	10786.	-188.8887	-1.23E-04	6057.	2.09E+09	-5.6041	16769.	0.00
17.6800	9.03E-04	9999.	-208.8329	-1.03E-04	6001.	2.09E+09	-4.1725	18850.	0.00
18.0200	5.22E-04	9136.	-222.8105	-8.44E-05	5941.	2.09E+09	-2.6793	20930.	0.00
18.3600	2.14E-04	8225.	-230.7395	-6.75E-05	5877.	2.09E+09	-1.2075	23011.	0.00
18.7000	-2.87E-05	7289.	-232.8430	-5.24E-05	5812.	2.09E+09	0.1763	25092.	0.00
19.0400	-2.13E-04	6352.	-229.5831	-3.91E-05	5746.	2.09E+09	1.4217	27173.	0.00
19.3800	-3.48E-04	5436.	-221.5969	-2.76E-05	5682.	2.09E+09	2.4932	29254.	0.00
19.7200	-4.39E-04	4559.	-209.6370	-1.79E-05	5621.	2.09E+09	3.3695	31334.	0.00
20.0600	-4.93E-04	3735.	-194.5180	-9.78E-06	5563.	2.09E+09	4.0418	33415.	0.00
20.4000	-5.19E-04	2977.	-177.0696	-3.24E-06	5510.	2.09E+09	4.5114	35496.	0.00
20.7400	-5.20E-04	2292.	-158.0978	1.90E-06	5462.	2.09E+09	4.7885	37577.	0.00
21.0800	-5.03E-04	1686.	-138.3540	5.77E-06	5420.	2.09E+09	4.8898	39658.	0.00
21.4200	-4.73E-04	1160.	-118.5117	8.55E-06	5383.	2.09E+09	4.8368	41738.	0.00
21.7600	-4.33E-04	713.9721	-99.1507	1.04E-05	5352.	2.09E+09	4.6539	43819.	0.00
22.1000	-3.88E-04	345.2603	-80.7487	1.14E-05	5326.	2.09E+09	4.3667	45900.	0.00
22.4400	-3.40E-04	49.0618	-63.6780	1.18E-05	5305.	2.09E+09	4.0012	47981.	0.00
22.7800	-2.92E-04	-180.5554	-48.2079	1.17E-05	5314.	2.09E+09	3.5821	50062.	0.00
23.1200	-2.45E-04	-350.4509	-34.5111	1.11E-05	5326.	2.09E+09	3.1320	52142.	0.00
23.4600	-2.01E-04	-468.0294	-22.6724	1.03E-05	5335.	2.09E+09	2.6712	54223.	0.00
23.8000	-1.61E-04	-540.9017	-12.7008	9.36E-06	5340.	2.09E+09	2.2168	56304.	0.00
24.1400	-1.25E-04	-576.5944	-4.5415	8.27E-06	5342.	2.09E+09	1.7828	58385.	0.00
24.4800	-9.31E-05	-582.3140	1.9106	7.14E-06	5343.	2.09E+09	1.3800	60466.	0.00
24.8200	-6.63E-05	-564.7627	6.7987	6.03E-06	5341.	2.09E+09	1.0161	62546.	0.00
25.1600	-4.39E-05	-530.0071	10.2915	4.96E-06	5339.	2.09E+09	0.6960	64627.	0.00
25.5000	-2.58E-05	-483.3937	12.5722	3.97E-06	5336.	2.09E+09	0.4220	66708.	0.00
25.8400	-1.15E-05	-429.5072	13.8297	3.08E-06	5332.	2.09E+09	0.1944	68789.	0.00
26.1800	-6.63E-07	-372.1645	14.2498	2.30E-06	5328.	2.09E+09	0.01152	70870.	0.00
26.5200	7.24E-06	-314.4392	14.0091	1.63E-06	5324.	2.09E+09	-0.1295	72950.	0.00
26.8600	1.26E-05	-258.7084	13.2704	1.07E-06	5320.	2.09E+09	-0.2326	75031.	0.00
27.2000	1.60E-05	-206.7167	12.1793	6.19E-07	5316.	2.09E+09	-0.3023	77112.	0.00
27.5400	1.77E-05	-159.6512	10.8618	2.62E-07	5313.	2.09E+09	-0.3435	79193.	0.00
27.8800	1.81E-05	-118.2221	9.4243	-9.12E-09	5310.	2.09E+09	-0.3612	81274.	0.00
28.2200	1.76E-05	-82.7443	7.9530	-2.05E-07	5308.	2.09E+09	-0.3600	83354.	0.00
28.5600	1.65E-05	-53.2176	6.5155	-3.38E-07	5306.	2.09E+09	-0.3446	85435.	0.00
28.9000	1.49E-05	-29.4003	5.1618	-4.18E-07	5304.	2.09E+09	-0.3189	87516.	0.00
29.2400	1.30E-05	-10.8771	3.9267	-4.57E-07	5303.	2.09E+09	-0.2865	89597.	0.00
29.5800	1.11E-05	2.8826	2.8318	-4.65E-07	5302.	2.09E+09	-0.2502	91678.	0.00
29.9200	9.25E-06	12.4750	1.8876	-4.50E-07	5303.	2.09E+09	-0.2126	93758.	0.00
30.2600	7.46E-06	18.5223	1.0963	-4.20E-07	5303.	2.09E+09	-0.1753	95839.	0.00
30.6000	5.82E-06	21.6417	0.4535	-3.81E-07	5303.	2.09E+09	-0.1398	97920.	0.00
30.9400	4.36E-06	22.4231	-0.04949	-3.38E-07	5303.	2.09E+09	-0.1068	100001.	0.00
31.2800	3.07E-06	21.4156	-0.4239	-2.95E-07	5303.	2.09E+09	-0.07674	102082.	0.00
31.6200	1.95E-06	19.1196	-0.6819	-2.56E-07	5303.	2.09E+09	-0.04974	104162.	0.00
31.9600	9.82E-07	15.9858	-0.8355	-2.21E-07	5303.	2.09E+09	-0.02556	106243.	0.00
32.3000	1.42E-07	12.4183	-0.8953	-1.94E-07	5303.	2.09E+09	-0.00377	108324.	0.00
32.6400	-5.99E-07	8.7817	-0.8700	-1.73E-07	5302.	2.09E+09	0.01621	110405.	0.00
32.9800	-1.27E-06	5.4104	-0.7655	-1.59E-07	5302.	2.09E+09	0.03501	112486.	0.00
33.3200	-1.90E-06	2.6191	-0.5853	-1.51E-07	5302.	2.09E+09	0.05329	114566.	0.00
33.6600	-2.51E-06	0.7136	-0.3305	-1.48E-07	5302.	2.09E+09	0.07162	116647.	0.00
34.0000	-3.11E-06	0.00	0.00	-1.47E-07	5302.	2.09E+09	0.09040	59364.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses

are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =     0.13000000 inches
Computed slope at pile head       =    -0.00089019 radians
Maximum bending moment            =         12894. inch-lbs
Maximum shear force               =  -232.84300292 lbs
Depth of maximum bending moment   =    15.64000000 feet below pile head
Depth of maximum shear force      =    18.70000000 feet below pile head
Number of iterations              =              6
Number of zero deflection points =              3
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	0.1300	M, in-lb	0.00	164500.	0.1300	-9.41E-04	-224.8619	12453.
2	y, in	0.1300	M, in-lb	0.00	64475.	0.1300	-8.90E-04	-232.8430	12894.

Maximum pile-head deflection = 0.1300000000 inches
Maximum pile-head rotation   = -0.0009411452 radians = -0.053924 deg.

The analysis ended normally.

```
================================================================================

                    LPile for Windows, Version 2018-10.006

                Analysis of Individual Piles and Drilled Shafts
               Subjected to Lateral Loading Using the p-y Method
                        © 1985-2018 by Ensoft, Inc.
                            All Rights Reserved

================================================================================

This copy of LPile is being used by:

Fuss & O'Neill
Manchester, NH

Serial Number of Security Device: 364301389

This copy of LPile is licensed for exclusive use by:

CLD Consulting Engineers, Manche

Use of this program by any entity other than CLD Consulting Engineers, Manche
is a violation of the software license agreement.

--------------------------------------------------------------------------------
                             Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\Proj2016\160333 Heald Bridge Sumner\Struct\Calcs\03-Final\Substructure Design\Abutment 2\LPile NO scour\

Name of input data file:
HP10x42 Abut 2.lp10

Name of output report file:
HP10x42 Abut 2.lp10

Name of plot output file:
HP10x42 Abut 2.lp10

Name of runtime message file:
HP10x42 Abut 2.lp10


--------------------------------------------------------------------------------
                            Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  September 7, 2018           Time:  12:43:44


--------------------------------------------------------------------------------
                                  Problem Title
--------------------------------------------------------------------------------

Project Name:Heald Bridge
Job Number: 20160333
Client: Maine DOT
Engineer: Anna Giraldi
Description: Integral abutment with hinge


--------------------------------------------------------------------------------
                           Program Options and Settings
--------------------------------------------------------------------------------

Computational Options:
```

- Use unfactored loads in computations (conventional analysis)

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 29.700 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	10.1000
2	29.700	10.1000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a H weak axis steel pile
Length of section = 29.700000 ft
Pile width = 9.700000 in
Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

```
Ground Slope Angle                                   =        0.000 degrees
                                                     =        0.000 radians

Pile Batter Angle                                    =        0.000 degrees
                                                     =        0.000 radians
```

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer         =       0.0000 ft
   Distance from top of pile to bottom of layer      =     7.500000 ft
   Effective unit weight at top of layer             =    62.600000 pcf
   Effective unit weight at bottom of layer          =    62.600000 pcf
   Friction angle at top of layer                    =    33.000000 deg.
   Friction angle at bottom of layer                 =    33.000000 deg.
   Subgrade k at top of layer                        =    40.000000 pci
   Subgrade k at bottom of layer                     =    40.000000 pci
```

Layer 2 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer         =     7.500000 ft
   Distance from top of pile to bottom of layer      =    29.700000 ft
   Effective unit weight at top of layer             =    72.600000 pcf
   Effective unit weight at bottom of layer          =    72.600000 pcf
   Friction angle at top of layer                    =    37.000000 deg.
   Friction angle at bottom of layer                 =    37.000000 deg.
   Subgrade k at top of layer                        =   125.000000 pci
   Subgrade k at bottom of layer                     =   125.000000 pci
```

Layer 3 is strong rock (vuggy limestone)

```
   Distance from top of pile to top of layer         =    29.700000 ft
   Distance from top of pile to bottom of layer      =    47.000000 ft
   Effective unit weight at top of layer             =    87.600000 pcf
   Effective unit weight at bottom of layer          =    87.600000 pcf
   Uniaxial compressive strength at top of layer     =        9700. psi
   Uniaxial compressive strength at bottom of layer  =        9700. psi
```

(Depth of the lowest soil layer extends 17.300 ft below the pile tip)

Summary of Input Soil Properties

Layer Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	Uniaxial qu psi	kpy pci
1	Sand	0.00	62.6000	33.0000	--	40.0000
	(Reese, et al.)	7.5000	62.6000	33.0000	--	40.0000
2	Sand	7.5000	72.6000	37.0000	--	125.0000
	(Reese, et al.)	29.7000	72.6000	37.0000	--	125.0000
3	Strong Rock	29.7000	87.6000	--	9700.	--
	(Vuggy Limestone)	47.0000	87.6000	--	9700.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	4	y = 0.130000 in	M = 0.0000 in-lbs	163475.	N.A.
2	4	y = 0.130000 in	M = 0.0000 in-lbs	63725.	N.A.

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section	=	29.700000 ft
Flange Width	=	10.100000 in
Section Depth	=	9.700000 in
Flange Thickness	=	0.420000 in
Web Thickness	=	0.415000 in
Yield Stress of Pipe	=	50.000000 ksi
Elastic Modulus	=	29000. ksi
Cross-sectional Area	=	12.160900 sq. in.
Moment of Inertia	=	72.173841 in^4
Elastic Bending Stiffness	=	2093041. kip-in^2
Plastic Modulus, Z	=	21.803578in^3
Plastic Moment Capacity = Fy Z	=	1090.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As	=	608.045 kips
Nominal Axial Tensile Capacity	=	-608.045 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 2

Number	Axial Thrust Force kips
1	63.725
2	163.475

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 63.725 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000709	14.8348612	2092806.	30.5412746	6.2678852	
0.00001418	29.6697225	2092806.	17.7956373	7.2956155	
0.00002127	44.5045837	2092806.	13.5470915	8.3233458	
0.00002835	59.3394450	2092806.	11.4228186	9.3510761	
0.00003544	74.1743062	2092806.	10.1482549	10.3788064	
0.00004253	89.0091674	2092806.	9.2985458	11.4065367	
0.00004962	103.8440287	2092806.	8.6916107	12.4342670	
0.00005671	118.6788899	2092806.	8.2364093	13.4619973	
0.00006380	133.5137512	2092806.	7.8823638	14.4897276	
0.00007089	148.3486124	2092806.	7.5991275	15.5174578	
0.00007797	163.1834736	2092806.	7.3673886	16.5451881	
0.00008506	178.0183349	2092806.	7.1742729	17.5729184	
0.00009215	192.8531961	2092806.	7.0108673	18.6006487	
0.00009924	207.6880574	2092806.	6.8708053	19.6283790	
0.0001063	222.5229186	2092806.	6.7494183	20.6561093	
0.0001134	237.3577799	2092806.	6.6432047	21.6838396	
0.0001205	252.1926411	2092806.	6.5494867	22.7115699	
0.0001276	267.0275023	2092806.	6.4661819	23.7393002	
0.0001347	281.8623636	2092806.	6.3916460	24.7670305	
0.0001418	296.6972248	2092806.	6.3245637	25.7947608	
0.0001489	311.5320861	2092806.	6.2638702	26.8224911	
0.0001559	326.3669473	2092806.	6.2086943	27.8502214	
0.0001630	341.2018085	2092806.	6.1583163	28.8779516	
0.0001701	356.0366698	2092806.	6.1121364	29.9056819	
0.0001772	370.8715310	2092806.	6.0696510	30.9334122	
0.0001843	385.7063923	2092806.	6.0304336	31.9611425	
0.0001914	400.5412535	2092806.	5.9941213	32.9888728	
0.0001985	415.3761147	2092806.	5.9604027	34.0166031	
0.0002056	430.2109760	2092806.	5.9290095	35.0443334	
0.0002127	445.0458372	2092806.	5.8997092	36.0720637	
0.0002197	459.8806985	2092806.	5.8722992	37.0997940	
0.0002268	474.7155597	2092806.	5.8466023	38.1275243	
0.0002339	489.5504209	2092806.	5.8224629	39.1552546	
0.0002410	504.3852822	2092806.	5.7997434	40.1829849	
0.0002481	519.2201434	2092806.	5.7783221	41.2107152	
0.0002552	534.0550047	2092806.	5.7580910	42.2384454	
0.0002623	548.8898659	2092806.	5.7389534	43.2661757	
0.0002694	563.7247272	2092806.	5.7208230	44.2939060	
0.0002765	578.5595884	2092806.	5.7036224	45.3216363	
0.0002906	608.2293109	2092806.	5.6717384	47.3770969	
0.0003048	637.8990334	2092806.	5.6428203	49.4325575	
0.0003190	666.6953521	2090068.	5.6180344	50.0000000	Y
0.0003332	693.6768187	2082115.	5.5985469	50.0000000	Y
0.0003473	719.0495680	2070180.	5.5834826	50.0000000	Y
0.0003615	743.0104515	2055276.	5.5720906	50.0000000	Y
0.0003757	765.7467677	2038237.	5.5637199	50.0000000	Y
0.0003899	787.0202967	2018686.	5.5574712	50.0000000	Y
0.0004040	806.1822887	1995280.	5.5514287	50.0000000	Y
0.0004182	823.4317806	1968888.	5.5455755	50.0000000	Y
0.0004324	839.0717215	1940505.	5.5397781	50.0000000	Y
0.0004466	853.2177436	1910578.	5.5340860	50.0000000	Y
0.0004608	866.0969108	1879743.	5.5286448	50.0000000	Y
0.0004749	877.8766289	1848435.	5.5233238	50.0000000	Y
0.0004891	888.6655006	1816915.	5.5181020	50.0000000	Y
0.0005033	898.5664157	1785407.	5.5129600	50.0000000	Y
0.0005175	907.6765490	1754097.	5.5078798	50.0000000	Y
0.0005316	916.0365925	1723046.	5.5029619	50.0000000	Y
0.0005458	923.7481250	1692420.	5.4981624	50.0000000	Y
0.0005600	930.9113402	1662366.	5.4934251	50.0000000	Y
0.0005742	937.6028067	1632974.	5.4887350	50.0000000	Y

0.0005883	943.8075791	1604171.	5.4842940	50.0000000	Y
0.0006025	949.5816253	1576009.	5.4799393	50.0000000	Y
0.0006167	954.9757706	1548526.	5.4754112	50.0000000	Y
0.0006309	959.9793549	1521659.	5.4712861	50.0000000	Y
0.0006451	964.7385410	1495594.	5.4671251	50.0000000	Y
0.0006592	969.1051625	1470054.	5.4629907	50.0000000	Y
0.0006734	973.3022286	1445338.	5.4590409	50.0000000	Y
0.0006876	977.1606567	1421149.	5.4550692	50.0000000	Y
0.0007018	980.8666264	1397720.	5.4511980	50.0000000	Y
0.0007159	984.2953884	1374832.	5.4474576	50.0000000	Y
0.0007301	987.6143262	1352682.	5.4436355	50.0000000	Y
0.0007443	990.6474681	1330991.	5.4400999	50.0000000	Y
0.0007585	993.6031637	1310010.	5.4365083	50.0000000	Y
0.0007726	996.3435601	1289520.	5.4329466	50.0000000	Y
0.0007868	998.9926861	1269652.	5.4296614	50.0000000	Y
0.0008010	1001.	1250266.	5.4260578	50.0000000	Y
0.0008152	1004.	1231433.	5.4228729	50.0000000	Y
0.0008294	1006.	1213057.	5.4195929	50.0000000	Y
0.0008435	1008.	1195225.	5.4162694	50.0000000	Y
0.0009002	1016.	1128436.	5.4040484	50.0000000	Y
0.0009569	1022.	1068136.	5.3924400	50.0000000	Y
0.0010137	1027.	1013631.	5.3816336	50.0000000	Y
0.0010704	1032.	964147.	5.3716019	50.0000000	Y
0.0011271	1036.	919098.	5.3621386	50.0000000	Y
0.0011838	1039.	877978.	5.3531268	50.0000000	Y
0.0012405	1042.	840182.	5.3447061	50.0000000	Y
0.0012972	1045.	805446.	5.3365608	50.0000000	Y
0.0013539	1047.	773418.	5.3291308	50.0000000	Y
0.0014106	1049.	743775.	5.3217544	50.0000000	Y
0.0014673	1051.	716257.	5.3150628	50.0000000	Y
0.0015240	1053.	690694.	5.3084574	50.0000000	Y
0.0015807	1054.	666854.	5.3023205	50.0000000	Y
0.0016374	1055.	644558.	5.2964364	50.0000000	Y

Axial Thrust Force = 163.475 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000636	13.3092412	2092806.	77.9392101	14.3647112	
0.00001272	26.6184825	2092806.	41.4946051	15.2867495	
0.00001908	39.9277237	2092806.	29.3464034	16.2087878	
0.00002544	53.2369650	2092806.	23.2723025	17.1308259	
0.00003180	66.5462062	2092806.	19.6278420	18.0528644	
0.00003816	79.8554474	2092806.	17.1982017	18.9749026	
0.00004452	93.1646887	2092806.	15.4627443	19.8969411	
0.00005088	106.4739299	2092806.	14.1611513	20.8189793	
0.00005724	119.7831712	2092806.	13.1488011	21.7410176	
0.00006360	133.0924124	2092806.	12.3389210	22.6630559	
0.00006995	146.4016536	2092806.	11.6762918	23.5850942	
0.00007631	159.7108949	2092806.	11.1241008	24.5071325	
0.00008267	173.0201361	2092806.	10.6568623	25.4291709	
0.00008903	186.3293774	2092806.	10.2563722	26.3512091	
0.00009539	199.6386186	2092806.	9.9092807	27.2732475	
0.0001018	212.9478598	2092806.	9.6055756	28.1952858	
0.0001081	226.2571011	2092806.	9.3376006	29.1173241	
0.0001145	239.5663423	2092806.	9.0994006	30.0393624	
0.0001208	252.8755836	2092806.	8.8862742	30.9614007	
0.0001272	266.1848248	2092806.	8.6944605	31.8834390	
0.0001335	279.4940660	2092806.	8.5209148	32.8054773	
0.0001399	292.8033073	2092806.	8.3631459	33.7275157	
0.0001463	306.1125485	2092806.	8.2190961	34.6495540	
0.0001526	319.4217897	2092806.	8.0870504	35.5715923	
0.0001590	332.7310310	2092806.	7.9655684	36.4936306	
0.0001653	346.0402722	2092806.	7.8534312	37.4156689	
0.0001717	359.3495135	2092806.	7.7496004	38.3377072	
0.0001781	372.6587547	2092806.	7.6531861	39.2597455	
0.0001844	385.9679959	2092806.	7.5634210	40.1817838	
0.0001908	399.2772372	2092806.	7.4796403	41.1038221	

0.0001971	412.5864784	2092806.	7.4012648	42.0258604	
0.0002035	425.8957197	2092806.	7.3277878	42.9478988	
0.0002099	439.2049609	2092806.	7.2587639	43.8699371	
0.0002162	452.5142021	2092806.	7.1938003	44.7919754	
0.0002226	465.8234434	2092806.	7.1325489	45.7140137	
0.0002289	479.1326846	2092806.	7.0747003	46.6360520	
0.0002353	492.4419259	2092806.	7.0199787	47.5580903	
0.0002417	505.7511671	2092806.	6.9681371	48.4801286	
0.0002480	519.0604083	2092806.	6.9189541	49.4021669	
0.0002607	544.9394798	2089970.	6.8294032	50.0000000	Y
0.0002735	569.0662348	2080990.	6.7519354	50.0000000	Y
0.0002862	591.6191761	2067309.	6.6847299	50.0000000	Y
0.0002989	612.8144223	2050250.	6.6261637	50.0000000	Y
0.0003116	632.7909795	2030672.	6.5750071	50.0000000	Y
0.0003243	651.7249875	2009416.	6.5301180	50.0000000	Y
0.0003371	669.7721954	1987133.	6.4905341	50.0000000	Y
0.0003498	686.9440257	1963967.	6.4557243	50.0000000	Y
0.0003625	703.4402785	1940564.	6.4248219	50.0000000	Y
0.0003752	719.2002589	1916785.	6.3976136	50.0000000	Y
0.0003879	734.3999300	1893121.	6.3734099	50.0000000	Y
0.0004006	749.0790530	1869660.	6.3518756	50.0000000	Y
0.0004134	763.2762527	1846477.	6.3327150	50.0000000	Y
0.0004261	777.0289970	1823635.	6.3156660	50.0000000	Y
0.0004388	790.3735756	1801188.	6.3004955	50.0000000	Y
0.0004515	803.3450769	1779178.	6.2869950	50.0000000	Y
0.0004642	815.6838811	1757012.	6.2744601	50.0000000	Y
0.0004770	827.1172029	1734129.	6.2621938	50.0000000	Y
0.0004897	837.7363119	1710772.	6.2501544	50.0000000	Y
0.0005024	847.6272766	1687149.	6.2383032	50.0000000	Y
0.0005151	856.8709554	1663436.	6.2266037	50.0000000	Y
0.0005278	865.4320076	1639572.	6.2153063	50.0000000	Y
0.0005406	873.4786550	1615880.	6.2041483	50.0000000	Y
0.0005533	881.0691625	1592452.	6.1931233	50.0000000	Y
0.0005660	888.1450285	1569168.	6.1825386	50.0000000	Y
0.0005787	894.8405132	1546251.	6.1719331	50.0000000	Y
0.0005914	901.0590990	1523512.	6.1615831	50.0000000	Y
0.0006042	907.0002276	1501272.	6.1513781	50.0000000	Y
0.0006169	912.6235150	1479434.	6.1415627	50.0000000	Y
0.0006296	917.8865952	1457906.	6.1315908	50.0000000	Y
0.0006423	922.8656139	1436788.	6.1220577	50.0000000	Y
0.0006550	927.6828874	1416244.	6.1125696	50.0000000	Y
0.0006677	932.1093156	1395896.	6.1032934	50.0000000	Y
0.0006805	936.4425920	1376173.	6.0942422	50.0000000	Y
0.0006932	940.4843988	1356753.	6.0851417	50.0000000	Y
0.0007059	944.3621943	1337800.	6.0764614	50.0000000	Y
0.0007186	948.0490589	1319253.	6.0676881	50.0000000	Y
0.0007313	951.5977932	1301161.	6.0592024	50.0000000	Y
0.0007441	954.9173790	1283381.	6.0508407	50.0000000	Y
0.0007568	958.1771770	1266119.	6.0426299	50.0000000	Y
0.0008077	969.7215217	1200657.	6.0109229	50.0000000	Y
0.0008585	979.4611052	1140851.	5.9811768	50.0000000	Y
0.0009094	987.8341726	1086235.	5.9533553	50.0000000	Y
0.0009603	995.1009316	1036253.	5.9271635	50.0000000	Y
0.0010112	1001.	990350.	5.9021663	50.0000000	Y
0.0010620	1007.	948089.	5.8788304	50.0000000	Y
0.0011129	1012.	909170.	5.8565925	50.0000000	Y
0.0011638	1016.	873176.	5.8357081	50.0000000	Y
0.0012147	1020.	839821.	5.8155545	50.0000000	Y
0.0012655	1024.	808777.	5.7966516	50.0000000	Y
0.0013164	1027.	779933.	5.7785751	50.0000000	Y
0.0013673	1030.	753066.	5.7614152	50.0000000	Y
0.0014182	1032.	727833.	5.7449746	50.0000000	Y
0.0014690	1035.	704274.	5.7294032	50.0000000	Y

Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1

		Nominal
Load	Axial	Moment

No.	Thrust kips	Capacity in-kips
1	63.7250000000	1055.
2	163.4750000000	1035.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	24199.
2	7.5000	6.6604	Yes	No	24199.	1355029.
3	29.7000	29.7000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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

Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head = 0.130000 inches
Moment at pile head = 0.0 in-lbs
Axial load at pile head = 163475.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1300	0.00	1915.	-0.00240	13443.	2.09E+09	0.00	0.00	0.00
0.2970	0.1214	8224.	1899.	-0.00239	14018.	2.09E+09	-9.1051	267.2131	0.00
0.5940	0.1129	16325.	1848.	-0.00237	14585.	2.09E+09	-19.3062	609.2851	0.00
0.8910	0.1045	24164.	1761.	-0.00234	15133.	2.09E+09	-29.3685	1001.	0.00
1.1880	0.09626	31606.	1641.	-0.00229	15654.	2.09E+09	-38.3139	1419.	0.00
1.4850	0.08819	38531.	1491.	-0.00223	16139.	2.09E+09	-45.8957	1855.	0.00
1.7820	0.08035	44834.	1317.	-0.00216	16580.	2.09E+09	-51.5629	2287.	0.00
2.0790	0.07278	50437.	1127.	-0.00208	16972.	2.09E+09	-55.1929	2703.	0.00
2.3760	0.06552	55289.	927.5663	-0.00199	17311.	2.09E+09	-56.6486	3081.	0.00
2.6730	0.05860	59367.	726.0202	-0.00189	17597.	2.09E+09	-56.4525	3433.	0.00
2.9700	0.05203	62669.	527.5036	-0.00179	17828.	2.09E+09	-54.9485	3764.	0.00
3.2670	0.04585	65211.	339.6789	-0.00168	18006.	2.09E+09	-50.4526	3922.	0.00
3.5640	0.04006	67048.	161.9126	-0.00157	18134.	2.09E+09	-49.3040	4386.	0.00
3.8610	0.03468	68191.	-14.9195	-0.00145	18214.	2.09E+09	-49.9283	5131.	0.00

4.1580	0.02972	68633.	-191.9841	-0.00134	18245.	2.09E+09	-49.4345	5929.	0.00
4.4550	0.02517	68378.	-369.4498	-0.00122	18227.	2.09E+09	-50.1534	7103.	0.00
4.7520	0.02103	67419.	-544.3074	-0.00110	18160.	2.09E+09	-47.9709	8129.	0.00
5.0490	0.01731	65784.	-704.5268	-9.89E-04	18046.	2.09E+09	-41.9390	8637.	0.00
5.3460	0.01398	63550.	-843.1813	-8.79E-04	17889.	2.09E+09	-35.8694	9146.	0.00
5.6430	0.01104	60798.	-960.3751	-7.73E-04	17697.	2.09E+09	-29.8960	9654.	0.00
5.9400	0.00847	57606.	-1057.	-6.73E-04	17473.	2.09E+09	-24.1361	10162.	0.00
6.2370	0.00624	54050.	-1133.	-5.78E-04	17225.	2.09E+09	-18.6897	10670.	0.00
6.5340	0.00435	50203.	-1191.	-4.89E-04	16955.	2.09E+09	-13.6385	11178.	0.00
6.8310	0.00276	46133.	-1231.	-4.07E-04	16671.	2.09E+09	-9.0462	11686.	0.00
7.1280	0.00145	41902.	-1256.	-3.32E-04	16375.	2.09E+09	-4.9588	12194.	0.00
7.4250	3.94E-04	37567.	-1267.	-2.64E-04	16071.	2.09E+09	-1.4043	12702.	0.00
7.7220	-4.33E-04	33177.	-1261.	-2.04E-04	15764.	2.09E+09	5.0184	41282.	0.00
8.0190	-0.00106	28817.	-1229.	-1.51E-04	15459.	2.09E+09	12.7403	42870.	0.00
8.3160	-0.00151	24591.	-1173.	-1.06E-04	15163.	2.09E+09	18.8381	44457.	0.00
8.6130	-0.00181	20580.	-1098.	-6.71E-05	14883.	2.09E+09	23.4095	46045.	0.00
8.9100	-0.00199	16845.	-1009.	-3.53E-05	14621.	2.09E+09	26.5805	47633.	0.00
9.2070	-0.00206	13432.	-910.4305	-9.50E-06	14382.	2.09E+09	28.4970	49221.	0.00
9.5040	-0.00206	10367.	-807.4046	1.08E-05	14168.	2.09E+09	29.3178	50808.	0.00
9.8010	-0.00199	7664.	-703.1125	2.61E-05	13979.	2.09E+09	29.2075	52396.	0.00
10.0980	-0.00187	5324.	-600.5800	3.72E-05	13815.	2.09E+09	28.3304	53984.	0.00
10.3950	-0.00172	3340.	-502.2561	4.46E-05	13676.	2.09E+09	26.8458	55572.	0.00
10.6920	-0.00155	1692.	-410.0387	4.88E-05	13561.	2.09E+09	24.9036	57159.	0.00
10.9890	-0.00137	359.8984	-325.3132	5.06E-05	13468.	2.09E+09	22.6416	58747.	0.00
11.2860	-0.00119	-685.3711	-248.9999	5.03E-05	13491.	2.09E+09	20.1830	60335.	0.00
11.5830	-0.00101	-1474.	-181.6083	4.85E-05	13546.	2.09E+09	17.6350	61923.	0.00
11.8800	-8.47E-04	-2036.	-123.2951	4.55E-05	13585.	2.09E+09	15.0885	63510.	0.00
12.1770	-6.91E-04	-2405.	-73.9224	4.17E-05	13611.	2.09E+09	12.6178	65098.	0.00
12.4740	-5.49E-04	-2612.	-33.1161	3.74E-05	13625.	2.09E+09	10.2814	66686.	0.00
12.7710	-4.24E-04	-2685.	-0.3199	3.29E-05	13631.	2.09E+09	8.1227	68274.	0.00
13.0680	-3.15E-04	-2653.	25.1528	2.84E-05	13628.	2.09E+09	6.1717	69862.	0.00
13.3650	-2.22E-04	-2539.	44.0740	2.40E-05	13620.	2.09E+09	4.4462	71449.	0.00
13.6620	-1.44E-04	-2366.	57.2604	1.98E-05	13608.	2.09E+09	2.9536	73037.	0.00
13.9590	-8.08E-05	-2154.	65.5395	1.59E-05	13593.	2.09E+09	1.6924	74625.	0.00
14.2560	-3.06E-05	-1918.	69.7216	1.25E-05	13577.	2.09E+09	0.6544	76213.	0.00
14.5530	7.98E-06	-1671.	70.5773	9.40E-06	13560.	2.09E+09	-0.1742	77800.	0.00
14.8500	3.64E-05	-1426.	68.8210	6.77E-06	13542.	2.09E+09	-0.8113	79388.	0.00
15.1470	5.62E-05	-1189.	65.0992	4.54E-06	13526.	2.09E+09	-1.2772	80976.	0.00
15.4440	6.88E-05	-966.7897	59.9834	2.71E-06	13510.	2.09E+09	-1.5936	82564.	0.00
15.7410	7.55E-05	-764.2261	53.9671	1.23E-06	13496.	2.09E+09	-1.7826	84151.	0.00
16.0380	7.76E-05	-583.5471	47.4652	8.37E-08	13484.	2.09E+09	-1.8660	85739.	0.00
16.3350	7.61E-05	-425.9916	40.8174	-7.76E-07	13472.	2.09E+09	-1.8645	87327.	0.00
16.6320	7.20E-05	-291.6963	34.2924	-1.39E-06	13463.	2.09E+09	-1.7972	88915.	0.00
16.9290	6.62E-05	-179.9394	28.0938	-1.79E-06	13455.	2.09E+09	-1.6812	90502.	0.00
17.2260	5.93E-05	-89.3593	22.3680	-2.02E-06	13449.	2.09E+09	-1.5319	92090.	0.00
17.5230	5.18E-05	-18.1492	17.2107	-2.11E-06	13444.	2.09E+09	-1.3622	93678.	0.00
17.8200	4.43E-05	35.7763	12.6754	-2.09E-06	13445.	2.09E+09	-1.1828	95266.	0.00
18.1170	3.69E-05	74.6418	8.7809	-2.00E-06	13448.	2.09E+09	-1.0027	96853.	0.00
18.4140	3.00E-05	100.6975	5.5179	-1.85E-06	13450.	2.09E+09	-0.8284	98441.	0.00
18.7110	2.37E-05	116.1305	2.8563	-1.67E-06	13451.	2.09E+09	-0.6652	100029.	0.00
19.0080	1.81E-05	122.9987	0.7505	-1.46E-06	13451.	2.09E+09	-0.5165	101617.	0.00
19.3050	1.33E-05	123.1847	-0.8548	-1.25E-06	13451.	2.09E+09	-0.3844	103205.	0.00
19.6020	9.18E-06	118.3661	-2.0208	-1.05E-06	13451.	2.09E+09	-0.2700	104792.	0.00
19.8990	5.81E-06	110.0011	-2.8107	-8.53E-07	13450.	2.09E+09	-0.1733	106380.	0.00
20.1960	3.10E-06	99.3252	-3.2870	-6.75E-07	13450.	2.09E+09	-0.09392	107968.	0.00
20.4930	9.97E-07	87.3579	-3.5089	-5.16E-07	13449.	2.09E+09	-0.03063	109556.	0.00
20.7900	-5.77E-07	74.9148	-3.5315	-3.78E-07	13448.	2.09E+09	0.01799	111143.	0.00
21.0870	-1.70E-06	62.6258	-3.4038	-2.61E-07	13447.	2.09E+09	0.05364	112731.	0.00
21.3840	-2.43E-06	50.9561	-3.1691	-1.64E-07	13446.	2.09E+09	0.07809	114319.	0.00
21.6810	-2.86E-06	40.2278	-2.8639	-8.63E-08	13445.	2.09E+09	0.09314	115907.	0.00
21.9780	-3.05E-06	30.6427	-2.5188	-2.59E-08	13445.	2.09E+09	0.1005	117494.	0.00
22.2750	-3.05E-06	22.3041	-2.1581	1.92E-08	13444.	2.09E+09	0.1019	119082.	0.00
22.5720	-2.91E-06	15.2373	-1.8009	5.11E-08	13444.	2.09E+09	0.09862	120670.	0.00
22.8690	-2.68E-06	9.4080	-1.4610	7.21E-08	13443.	2.09E+09	0.09208	122258.	0.00
23.1660	-2.40E-06	4.7390	-1.1484	8.42E-08	13443.	2.09E+09	0.08335	123845.	0.00
23.4630	-2.08E-06	1.1240	-0.8692	8.92E-08	13443.	2.09E+09	0.07335	125433.	0.00
23.7600	-1.76E-06	-1.5604	-0.6265	8.88E-08	13443.	2.09E+09	0.06283	127021.	0.00
24.0570	-1.45E-06	-3.4452	-0.4212	8.45E-08	13443.	2.09E+09	0.05237	128609.	0.00
24.3540	-1.16E-06	-4.6613	-0.2523	7.76E-08	13443.	2.09E+09	0.04239	130196.	0.00
24.6510	-8.98E-07	-5.3344	-0.1176	6.91E-08	13443.	2.09E+09	0.03320	131784.	0.00
24.9480	-6.68E-07	-5.5804	-0.01394	5.98E-08	13443.	2.09E+09	0.02499	133372.	0.00

25.2450	-4.71E-07	-5.5035	0.06240	5.04E-08	13443.	2.09E+09	0.01785	134960.	0.00
25.5420	-3.09E-07	-5.1943	0.1153	4.13E-08	13443.	2.09E+09	0.01182	136548.	0.00
25.8390	-1.77E-07	-4.7298	0.1486	3.28E-08	13443.	2.09E+09	0.00687	138135.	0.00
26.1360	-7.46E-08	-4.1734	0.1661	2.52E-08	13443.	2.09E+09	0.00292	139723.	0.00
26.4330	2.72E-09	-3.5756	0.1711	1.86E-08	13443.	2.09E+09	-1.08E-04	141311.	0.00
26.7300	5.83E-08	-2.9757	0.1667	1.31E-08	13443.	2.09E+09	-0.00234	142899.	0.00
27.0270	9.59E-08	-2.4026	0.1556	8.49E-09	13443.	2.09E+09	-0.00389	144486.	0.00
27.3240	1.19E-07	-1.8764	0.1400	4.85E-09	13443.	2.09E+09	-0.00487	146074.	0.00
27.6210	1.30E-07	-1.4102	0.1217	2.05E-09	13443.	2.09E+09	-0.00540	147662.	0.00
27.9180	1.33E-07	-1.0113	0.1021	-1.29E-11	13443.	2.09E+09	-0.00559	149250.	0.00
28.2150	1.30E-07	-0.6824	0.08231	-1.46E-09	13443.	2.09E+09	-0.00552	150837.	0.00
28.5120	1.23E-07	-0.4229	0.06310	-2.40E-09	13443.	2.09E+09	-0.00526	152425.	0.00
28.8090	1.13E-07	-0.2298	0.04500	-2.95E-09	13443.	2.09E+09	-0.00489	154013.	0.00
29.1060	1.02E-07	-0.09873	0.02834	-3.23E-09	13443.	2.09E+09	-0.00446	155601.	0.00
29.4030	9.02E-08	-0.02410	0.01331	-3.34E-09	13443.	2.09E+09	-0.00398	157188.	0.00
29.7000	7.83E-08	0.00	0.00	-3.36E-09	13443.	2.09E+09	-0.00349	79388.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     0.13000000 inches
Computed slope at pile head      =    -0.00240158 radians
Maximum bending moment           =         68633. inch-lbs
Maximum shear force              =          1915. lbs
Depth of maximum bending moment  =     4.15800000 feet below pile head
Depth of maximum shear force     =       0.000000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              4
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head                    =     0.130000 inches
Moment at pile head                          =          0.0 in-lbs
Axial load at pile head                      =      63725.0 lbs
```

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1300	0.00	2086.	-0.00237	5240.	2.09E+09	0.00	0.00	0.00
0.2970	0.1215	7972.	2069.	-0.00236	5798.	2.09E+09	-9.1073	267.0414	0.00
0.5940	0.1131	15825.	2019.	-0.00234	6347.	2.09E+09	-19.3168	608.4648	0.00
0.8910	0.1048	23426.	1932.	-0.00231	6879.	2.09E+09	-29.3950	999.2860	0.00
1.1880	0.09667	30646.	1811.	-0.00226	7384.	2.09E+09	-38.3645	1414.	0.00
1.4850	0.08869	37366.	1661.	-0.00221	7855.	2.09E+09	-45.9797	1848.	0.00
1.7820	0.08094	43487.	1487.	-0.00214	8283.	2.09E+09	-51.6889	2276.	0.00
2.0790	0.07345	48935.	1296.	-0.00206	8664.	2.09E+09	-55.3673	2686.	0.00
2.3760	0.06626	53661.	1096.	-0.00197	8995.	2.09E+09	-56.8876	3060.	0.00
2.6730	0.05940	57644.	893.5140	-0.00188	9273.	2.09E+09	-56.7724	3406.	0.00
2.9700	0.05288	60883.	693.6820	-0.00178	9500.	2.09E+09	-55.3667	3731.	0.00
3.2670	0.04674	63395.	504.1900	-0.00167	9676.	2.09E+09	-50.9699	3887.	0.00
3.5640	0.04098	65235.	324.3687	-0.00156	9805.	2.09E+09	-49.9399	4344.	0.00
3.8610	0.03561	66416.	145.0157	-0.00145	9887.	2.09E+09	-50.7072	5075.	0.00
4.1580	0.03065	66927.	-35.0968	-0.00134	9923.	2.09E+09	-50.3661	5857.	0.00
4.4550	0.02609	66772.	-216.2072	-0.00122	9912.	2.09E+09	-51.2671	7003.	0.00
4.7520	0.02194	65941.	-396.7487	-0.00111	9854.	2.09E+09	-50.0469	8129.	0.00
5.0490	0.01819	64448.	-564.4924	-9.97E-04	9750.	2.09E+09	-44.0854	8637.	0.00
5.3460	0.01483	62370.	-710.8725	-8.89E-04	9604.	2.09E+09	-38.0583	9146.	0.00

5.6430	0.01185	59785.	-835.8925	-7.85E-04	9423.	2.09E+09	-32.0988	9654.	0.00
5.9400	0.00923	56769.	-940.0018	-6.86E-04	9212.	2.09E+09	-26.3239	10162.	0.00
6.2370	0.00696	53396.	-1024.	-5.92E-04	8976.	2.09E+09	-20.8342	10670.	0.00
6.5340	0.00501	49738.	-1089.	-5.05E-04	8720.	2.09E+09	-15.7127	11178.	0.00
6.8310	0.00336	45862.	-1137.	-4.23E-04	8449.	2.09E+09	-11.0252	11686.	0.00
7.1280	0.00199	41828.	-1169.	-3.49E-04	8167.	2.09E+09	-6.8204	12194.	0.00
7.4250	8.78E-04	37690.	-1186.	-2.81E-04	7877.	2.09E+09	-3.1301	12702.	0.00
7.7220	-8.18E-06	33499.	-1192.	-2.20E-04	7584.	2.09E+09	0.09475	41282.	0.00
8.0190	-6.91E-04	29296.	-1177.	-1.67E-04	7290.	2.09E+09	8.3152	42870.	0.00
8.3160	-0.00120	25187.	-1135.	-1.20E-04	7002.	2.09E+09	14.9264	44457.	0.00
8.6130	-0.00155	21257.	-1073.	-8.08E-05	6728.	2.09E+09	20.0128	46045.	0.00
8.9100	-0.00177	17574.	-995.2119	-4.77E-05	6470.	2.09E+09	23.6888	47633.	0.00
9.2070	-0.00189	14185.	-906.5044	-2.07E-05	6233.	2.09E+09	26.0909	49221.	0.00
9.5040	-0.00192	11122.	-811.2379	8.69E-07	6018.	2.09E+09	27.3696	50808.	0.00
9.8010	-0.00188	8402.	-713.1340	1.75E-05	5828.	2.09E+09	27.6831	52396.	0.00
10.0980	-0.00180	6031.	-615.3475	2.98E-05	5662.	2.09E+09	27.1914	53984.	0.00
10.3950	-0.00167	4003.	-520.4700	3.83E-05	5520.	2.09E+09	26.0507	55572.	0.00
10.6920	-0.00152	2304.	-430.5501	4.37E-05	5401.	2.09E+09	24.4094	57159.	0.00
10.9890	-0.00136	913.8110	-347.1264	4.64E-05	5304.	2.09E+09	22.4052	58747.	0.00
11.2860	-0.00119	-191.7740	-271.2715	4.71E-05	5254.	2.09E+09	20.1621	60335.	0.00
11.5830	-0.00102	-1041.	-203.6422	4.60E-05	5313.	2.09E+09	17.7893	61923.	0.00
11.8800	-8.63E-04	-1664.	-144.5343	4.37E-05	5357.	2.09E+09	15.3801	63510.	0.00
12.1770	-7.12E-04	-2091.	-93.9390	4.05E-05	5386.	2.09E+09	13.0123	65098.	0.00
12.4740	-5.74E-04	-2352.	-51.5989	3.67E-05	5405.	2.09E+09	10.7476	66686.	0.00
12.7710	-4.51E-04	-2476.	-17.0617	3.26E-05	5413.	2.09E+09	8.6335	68274.	0.00
13.0680	-3.42E-04	-2489.	10.2693	2.84E-05	5414.	2.09E+09	6.7037	69862.	0.00
13.3650	-2.48E-04	-2415.	31.0895	2.42E-05	5409.	2.09E+09	4.9799	71449.	0.00
13.6620	-1.69E-04	-2278.	46.1528	2.02E-05	5400.	2.09E+09	3.4731	73037.	0.00
13.9590	-1.04E-04	-2096.	56.2366	1.65E-05	5387.	2.09E+09	2.1855	74625.	0.00
14.2560	-5.20E-05	-1885.	62.1126	1.31E-05	5372.	2.09E+09	1.1119	76213.	0.00
14.5530	-1.11E-05	-1659.	64.5241	1.01E-05	5356.	2.09E+09	0.2413	77800.	0.00
14.8500	1.98E-05	-1429.	64.1675	7.45E-06	5340.	2.09E+09	-0.4415	79388.	0.00
15.1470	4.20E-05	-1205.	61.6796	5.20E-06	5324.	2.09E+09	-0.9547	80976.	0.00
15.4440	5.69E-05	-992.0290	57.6294	3.33E-06	5310.	2.09E+09	-1.3182	82564.	0.00
15.7410	6.58E-05	-795.5748	52.5131	1.81E-06	5296.	2.09E+09	-1.5529	84151.	0.00
16.0380	6.98E-05	-618.5379	46.7533	6.06E-07	5283.	2.09E+09	-1.6793	85739.	0.00
16.3350	7.01E-05	-462.5923	40.7006	-3.15E-07	5273.	2.09E+09	-1.7173	87327.	0.00
16.6320	6.76E-05	-328.2811	34.6368	-9.88E-07	5263.	2.09E+09	-1.6855	88915.	0.00
16.9290	6.30E-05	-215.2526	28.7804	-1.45E-06	5255.	2.09E+09	-1.6009	90502.	0.00
17.2260	5.72E-05	-122.4755	23.2929	-1.74E-06	5249.	2.09E+09	-1.4785	92090.	0.00
17.5230	5.07E-05	-48.4310	18.2858	-1.88E-06	5244.	2.09E+09	-1.3313	93678.	0.00
17.8200	4.38E-05	8.7214	13.8275	-1.92E-06	5241.	2.09E+09	-1.1705	95266.	0.00
18.1170	3.70E-05	51.0026	9.9508	-1.87E-06	5244.	2.09E+09	-1.0050	96853.	0.00
18.4140	3.05E-05	80.4987	6.6596	-1.76E-06	5246.	2.09E+09	-0.8419	98441.	0.00
18.7110	2.45E-05	99.2693	3.9353	-1.60E-06	5247.	2.09E+09	-0.6868	100029.	0.00
19.0080	1.91E-05	109.2775	1.7429	-1.42E-06	5248.	2.09E+09	-0.5435	101617.	0.00
19.3050	1.43E-05	112.3395	0.03545	-1.24E-06	5248.	2.09E+09	-0.4146	103205.	0.00
19.6020	1.03E-05	110.0915	-1.2407	-1.05E-06	5248.	2.09E+09	-0.3015	104792.	0.00
19.8990	6.86E-06	103.9708	-2.1430	-8.64E-07	5247.	2.09E+09	-0.2048	106380.	0.00
20.1960	4.10E-06	95.2088	-2.7290	-6.94E-07	5247.	2.09E+09	-0.1241	107968.	0.00
20.4930	1.91E-06	84.8337	-3.0548	-5.41E-07	5246.	2.09E+09	-0.05873	109556.	0.00
20.7900	2.40E-07	73.6796	-3.1728	-4.06E-07	5245.	2.09E+09	-0.00747	111143.	0.00
21.0870	-9.84E-07	62.4022	-3.1307	-2.90E-07	5245.	2.09E+09	0.03113	112731.	0.00
21.3840	-1.83E-06	51.4961	-2.9706	-1.93E-07	5244.	2.09E+09	0.05868	114319.	0.00
21.6810	-2.36E-06	41.3153	-2.7292	-1.14E-07	5243.	2.09E+09	0.07681	115907.	0.00
21.9780	-2.64E-06	32.0942	-2.4370	-5.17E-08	5242.	2.09E+09	0.08715	117494.	0.00
22.2750	-2.73E-06	23.9677	-2.1191	-4.00E-09	5242.	2.09E+09	0.09124	119082.	0.00
22.5720	-2.67E-06	16.9909	-1.7953	3.09E-08	5241.	2.09E+09	0.09047	120670.	0.00
22.8690	-2.51E-06	11.1566	-1.4806	5.48E-08	5241.	2.09E+09	0.08612	122258.	0.00
23.1660	-2.28E-06	6.4120	-1.1859	6.98E-08	5241.	2.09E+09	0.07927	123845.	0.00
23.4630	-2.01E-06	2.6717	-0.9184	7.75E-08	5240.	2.09E+09	0.07085	125433.	0.00
23.7600	-1.73E-06	-0.1696	-0.6824	7.97E-08	5240.	2.09E+09	0.06161	127021.	0.00
24.0570	-1.45E-06	-2.2284	-0.4797	7.76E-08	5240.	2.09E+09	0.05215	128609.	0.00
24.3540	-1.18E-06	-3.6239	-0.3102	7.26E-08	5240.	2.09E+09	0.04293	130196.	0.00
24.6510	-9.27E-07	-4.4727	-0.1726	6.57E-08	5240.	2.09E+09	0.03429	131784.	0.00
24.9480	-7.07E-07	-4.8843	-0.06440	5.78E-08	5240.	2.09E+09	0.02644	133372.	0.00
25.2450	-5.15E-07	-4.9580	0.01750	4.94E-08	5241.	2.09E+09	0.01952	134960.	0.00
25.5420	-3.54E-07	-4.7819	0.07649	4.11E-08	5240.	2.09E+09	0.01358	136548.	0.00
25.8390	-2.22E-07	-4.4315	0.1161	3.33E-08	5240.	2.09E+09	0.00862	138135.	0.00
26.1360	-1.17E-07	-3.9698	0.1396	2.61E-08	5240.	2.09E+09	0.00460	139723.	0.00
26.4330	-3.64E-08	-3.4481	0.1504	1.98E-08	5240.	2.09E+09	0.00144	141311.	0.00

26.7300	2.37E-08	-2.9068	0.1513	1.44E-08	5240.	2.09E+09	-9.50E-04	142899.	0.00
27.0270	6.61E-08	-2.3764	0.1448	9.88E-09	5240.	2.09E+09	-0.00268	144486.	0.00
27.3240	9.41E-08	-1.8792	0.1331	6.26E-09	5240.	2.09E+09	-0.00386	146074.	0.00
27.6210	1.11E-07	-1.4302	0.1181	3.44E-09	5240.	2.09E+09	-0.00459	147662.	0.00
27.9180	1.19E-07	-1.0389	0.1011	1.34E-09	5240.	2.09E+09	-0.00497	149250.	0.00
28.2150	1.20E-07	-0.7103	0.08315	-1.52E-10	5240.	2.09E+09	-0.00509	150837.	0.00
28.5120	1.18E-07	-0.4462	0.06512	-1.14E-09	5240.	2.09E+09	-0.00503	152425.	0.00
28.8090	1.12E-07	-0.2457	0.04752	-1.73E-09	5240.	2.09E+09	-0.00485	154013.	0.00
29.1060	1.05E-07	-0.1067	0.03070	-2.03E-09	5240.	2.09E+09	-0.00460	155601.	0.00
29.4030	9.77E-08	-0.02596	0.01483	-2.14E-09	5240.	2.09E+09	-0.00431	157188.	0.00
29.7000	9.00E-08	0.00	0.00	-2.16E-09	5240.	2.09E+09	-0.00401	79388.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 2:

```
Pile-head deflection            =     0.13000000 inches
Computed slope at pile head     =    -0.00237134 radians
Maximum bending moment          =         66927. inch-lbs
Maximum shear force             =          2086. lbs
Depth of maximum bending moment =     4.15800000 feet below pile head
Depth of maximum shear force    =       0.000000 feet below pile head
Number of iterations            =              6
Number of zero deflection points =             4
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	0.1300	M, in-lb	0.00	163475.	0.1300	-0.00240	1915.	68633.
2	y, in	0.1300	M, in-lb	0.00	63725.	0.1300	-0.00237	2086.	66927.

Maximum pile-head deflection = 0.1300000000 inches
Maximum pile-head rotation   = -0.0024015813 radians = -0.137600 deg.

The analysis ended normally.

==

LPile for Windows, Version 2018-10.006

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

==

This copy of LPile is being used by:

Fuss & O'Neill
Manchester, NH

Serial Number of Security Device: 364301389

This copy of LPile is licensed for exclusive use by:

CLD Consulting Engineers, Manche

Files Used for Analysis

Path to file locations:
\Proj2016\160333 Heald Bridge Sumner\Struct\Calcs\03-Final\Substructure Design\Abutment 2\LPile scour\

Name of input data file:
HP10x42Abut 2scour.lp10

Name of output report file:
HP10x42Abut 2scour.lp10

Name of plot output file:
HP10x42Abut 2scour.lp10

Name of runtime message file:
HP10x42Abut 2scour.lp10

Date and Time of Analysis

Date: September 7, 2018 Time: 12:16:40

Problem Title

Project Name:Heald Bridge
Job Number: 20160333
Client: Maine DOT
Engineer: Anna Giraldi
Description: Integral abutment with hinge and SCOUR

Program Options and Settings

Computational Options:

```
 - Use unfactored loads in computations (conventional analysis)
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed                  =         500
 - Deflection tolerance for convergence                  =   1.0000E-05 in
 - Maximum allowable deflection                          =     100.0000 in
 - Number of pile increments                             =         100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Use of p-y modification factors for p-y curves not selected
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats



--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                          =           1
Total length of pile                                     =      29.700 ft
Depth of ground surface below top of pile                =     11.5000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

            Depth Below           Pile
Point        Pile Head          Diameter
 No.           feet              inches
-----      -------------     -------------
  1            0.000            10.1000
  2           29.700            10.1000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is a H weak axis steel pile
   Length of section                                     =    29.700000 ft
   Pile width                                            =     9.700000 in
   Shear capacity of section                             =       0.0000 lbs



--------------------------------------------------------------------------------
                       Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------
```

```
Ground Slope Angle                                    =       0.000 degrees
                                                      =       0.000 radians

Pile Batter Angle                                     =       0.000 degrees
                                                      =       0.000 radians
```

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer          =    11.500000 ft
   Distance from top of pile to bottom of layer       =    29.700000 ft
   Effective unit weight at top of layer              =    72.600000 pcf
   Effective unit weight at bottom of layer           =    72.600000 pcf
   Friction angle at top of layer                     =    37.000000 deg.
   Friction angle at bottom of layer                  =    37.000000 deg.
   Subgrade k at top of layer                         =   125.000000 pci
   Subgrade k at bottom of layer                      =   125.000000 pci
```

Layer 2 is strong rock (vuggy limestone)

```
   Distance from top of pile to top of layer          =    29.700000 ft
   Distance from top of pile to bottom of layer       =    40.000000 ft
   Effective unit weight at top of layer              =    87.600000 pcf
   Effective unit weight at bottom of layer           =    87.600000 pcf
   Uniaxial compressive strength at top of layer      =        9700. psi
   Uniaxial compressive strength at bottom of layer   =        9700. psi
```

(Depth of the lowest soil layer extends 10.300 ft below the pile tip)

Summary of Input Soil Properties

Layer Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	Uniaxial qu psi	kpy pci
1	Sand	11.5000	72.6000	37.0000	--	125.0000
	(Reese, et al.)	29.7000	72.6000	37.0000	--	125.0000
2	Strong Rock	29.7000	87.6000	--	9700.	--
	(Vuggy Limestone)	40.0000	87.6000	--	9700.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	4	y = 0.130000 in	M = 0.0000 in-lbs	163475.	N.A.

```
   2     4     y =     0.130000 in    M =       0.0000 in-lbs           63725.          N.A.

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.



--------------------------------------------------------------------------------
     Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness
--------------------------------------------------------------------------------

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:
-------------------

Dimensions and Properties of Steel H Weak Axis:
---------------------------------------------

Length of Section                                      =    29.700000 ft
Flange Width                                           =    10.100000 in
Section Depth                                          =     9.700000 in
Flange Thickness                                       =     0.420000 in
Web Thickness                                          =     0.415000 in
Yield Stress of Pipe                                   =    50.000000 ksi
Elastic Modulus                                        =       29000. ksi
Cross-sectional Area                                   =    12.160900 sq. in.
Moment of Inertia                                      =    72.173841 in^4
Elastic Bending Stiffness                              =     2093041. kip-in^2
Plastic Modulus, Z                                     =    21.803578in^3
Plastic Moment Capacity = Fy Z                         =        1090.in-kip

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = Fy As                 =      608.045 kips
Nominal Axial Tensile Capacity                         =     -608.045 kips



Number of Axial Thrust Force Values Determined from Pile-head Loadings = 2

   Number     Axial Thrust Force
                   kips
   ------     ------------------
      1              63.725
      2             163.475

Definition of Run Messages:

   Y = part of pipe section has yielded.


Axial Thrust Force =     63.725 kips

    Bending       Bending       Bending       Depth to      Max Total  Run
   Curvature      Moment       Stiffness       N Axis        Stress    Msg
    rad/in.       in-kip        kip-in2          in            ksi
------------- ------------- ------------- ------------- ------------- ---
   0.00000709    14.8348612      2092806.    30.5412746     6.2678852
   0.00001418    29.6697225      2092806.    17.7956373     7.2956155
   0.00002127    44.5045837      2092806.    13.5470915     8.3233458
```

0.00002835	59.3394450	2092806.	11.4228186	9.3510761	
0.00003544	74.1743062	2092806.	10.1482549	10.3788064	
0.00004253	89.0091674	2092806.	9.2985458	11.4065367	
0.00004962	103.8440287	2092806.	8.6916107	12.4342670	
0.00005671	118.6788899	2092806.	8.2364093	13.4619973	
0.00006380	133.5137512	2092806.	7.8823638	14.4897276	
0.00007089	148.3486124	2092806.	7.5991275	15.5174578	
0.00007797	163.1834736	2092806.	7.3673886	16.5451881	
0.00008506	178.0183349	2092806.	7.1742729	17.5729184	
0.00009215	192.8531961	2092806.	7.0108673	18.6006487	
0.00009924	207.6880574	2092806.	6.8708053	19.6283790	
0.0001063	222.5229186	2092806.	6.7494183	20.6561093	
0.0001134	237.3577799	2092806.	6.6432047	21.6838396	
0.0001205	252.1926411	2092806.	6.5494867	22.7115699	
0.0001276	267.0275023	2092806.	6.4661819	23.7393002	
0.0001347	281.8623636	2092806.	6.3916460	24.7670305	
0.0001418	296.6972248	2092806.	6.3245637	25.7947608	
0.0001489	311.5320861	2092806.	6.2638702	26.8224911	
0.0001559	326.3669473	2092806.	6.2086943	27.8502214	
0.0001630	341.2018085	2092806.	6.1583163	28.8779516	
0.0001701	356.0366698	2092806.	6.1121364	29.9056819	
0.0001772	370.8715310	2092806.	6.0696510	30.9334122	
0.0001843	385.7063923	2092806.	6.0304336	31.9611425	
0.0001914	400.5412535	2092806.	5.9941213	32.9888728	
0.0001985	415.3761147	2092806.	5.9604027	34.0166031	
0.0002056	430.2109760	2092806.	5.9290095	35.0443334	
0.0002127	445.0458372	2092806.	5.8997092	36.0720637	
0.0002197	459.8806985	2092806.	5.8722992	37.0997940	
0.0002268	474.7155597	2092806.	5.8466023	38.1275243	
0.0002339	489.5504209	2092806.	5.8224629	39.1552546	
0.0002410	504.3852822	2092806.	5.7997434	40.1829849	
0.0002481	519.2201434	2092806.	5.7783221	41.2107152	
0.0002552	534.0550047	2092806.	5.7580910	42.2384454	
0.0002623	548.8898659	2092806.	5.7389534	43.2661757	
0.0002694	563.7247272	2092806.	5.7208230	44.2939060	
0.0002765	578.5595884	2092806.	5.7036224	45.3216363	
0.0002906	608.2293109	2092806.	5.6717384	47.3770969	
0.0003048	637.8990334	2092806.	5.6428203	49.4325575	
0.0003190	666.6953521	2090068.	5.6180344	50.0000000	Y
0.0003332	693.6768187	2082115.	5.5985469	50.0000000	Y
0.0003473	719.0495680	2070180.	5.5834826	50.0000000	Y
0.0003615	743.0104515	2055276.	5.5720906	50.0000000	Y
0.0003757	765.7467677	2038237.	5.5637199	50.0000000	Y
0.0003899	787.0202967	2018686.	5.5574712	50.0000000	Y
0.0004040	806.1822887	1995280.	5.5514287	50.0000000	Y
0.0004182	823.4317806	1968888.	5.5455755	50.0000000	Y
0.0004324	839.0717215	1940505.	5.5397781	50.0000000	Y
0.0004466	853.2177436	1910578.	5.5340860	50.0000000	Y
0.0004608	866.0969108	1879743.	5.5286448	50.0000000	Y
0.0004749	877.8766289	1848435.	5.5233238	50.0000000	Y
0.0004891	888.6655006	1816915.	5.5181020	50.0000000	Y
0.0005033	898.5664157	1785407.	5.5129600	50.0000000	Y
0.0005175	907.6765490	1754097.	5.5078798	50.0000000	Y
0.0005316	916.0365925	1723046.	5.5029619	50.0000000	Y
0.0005458	923.7481250	1692420.	5.4981624	50.0000000	Y
0.0005600	930.9113402	1662366.	5.4934251	50.0000000	Y
0.0005742	937.6028067	1632974.	5.4887350	50.0000000	Y
0.0005883	943.8075791	1604171.	5.4842940	50.0000000	Y
0.0006025	949.5816253	1576009.	5.4799393	50.0000000	Y
0.0006167	954.9757706	1548526.	5.4754112	50.0000000	Y
0.0006309	959.9793549	1521659.	5.4712861	50.0000000	Y
0.0006451	964.7385410	1495594.	5.4671251	50.0000000	Y
0.0006592	969.1051625	1470054.	5.4629907	50.0000000	Y
0.0006734	973.3022286	1445338.	5.4590409	50.0000000	Y
0.0006876	977.1606567	1421149.	5.4550692	50.0000000	Y
0.0007018	980.8666264	1397720.	5.4511980	50.0000000	Y
0.0007159	984.2953884	1374832.	5.4474576	50.0000000	Y
0.0007301	987.6143262	1352682.	5.4436355	50.0000000	Y
0.0007443	990.6474681	1330991.	5.4400999	50.0000000	Y
0.0007585	993.6031637	1310010.	5.4365083	50.0000000	Y
0.0007726	996.3435601	1289520.	5.4329466	50.0000000	Y

0.0007868	998.9926861	1269652.	5.4296614	50.0000000	Y
0.0008010	1001.	1250266.	5.4260578	50.0000000	Y
0.0008152	1004.	1231433.	5.4228729	50.0000000	Y
0.0008294	1006.	1213057.	5.4195929	50.0000000	Y
0.0008435	1008.	1195225.	5.4162694	50.0000000	Y
0.0009002	1016.	1128436.	5.4040484	50.0000000	Y
0.0009569	1022.	1068136.	5.3924400	50.0000000	Y
0.0010137	1027.	1013631.	5.3816336	50.0000000	Y
0.0010704	1032.	964147.	5.3716019	50.0000000	Y
0.0011271	1036.	919098.	5.3621386	50.0000000	Y
0.0011838	1039.	877978.	5.3531268	50.0000000	Y
0.0012405	1042.	840182.	5.3447061	50.0000000	Y
0.0012972	1045.	805446.	5.3365608	50.0000000	Y
0.0013539	1047.	773418.	5.3291308	50.0000000	Y
0.0014106	1049.	743775.	5.3217544	50.0000000	Y
0.0014673	1051.	716257.	5.3150628	50.0000000	Y
0.0015240	1053.	690694.	5.3084574	50.0000000	Y
0.0015807	1054.	666854.	5.3023205	50.0000000	Y
0.0016374	1055.	644558.	5.2964364	50.0000000	Y

Axial Thrust Force = 163.475 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000636	13.3092412	2092806.	77.9392101	14.3647112	
0.00001272	26.6184825	2092806.	41.4946051	15.2867495	
0.00001908	39.9277237	2092806.	29.3464034	16.2087878	
0.00002544	53.2369650	2092806.	23.2723025	17.1308259	
0.00003180	66.5462062	2092806.	19.6278420	18.0528644	
0.00003816	79.8554474	2092806.	17.1982017	18.9749026	
0.00004452	93.1646887	2092806.	15.4627443	19.8969411	
0.00005088	106.4739299	2092806.	14.1611513	20.8189793	
0.00005724	119.7831712	2092806.	13.1488011	21.7410176	
0.00006360	133.0924124	2092806.	12.3389210	22.6630559	
0.00006995	146.4016536	2092806.	11.6762918	23.5850942	
0.00007631	159.7108949	2092806.	11.1241008	24.5071325	
0.00008267	173.0201361	2092806.	10.6568623	25.4291709	
0.00008903	186.3293774	2092806.	10.2563722	26.3512091	
0.00009539	199.6386186	2092806.	9.9092807	27.2732475	
0.0001018	212.9478598	2092806.	9.6055756	28.1952858	
0.0001081	226.2571011	2092806.	9.3376006	29.1173241	
0.0001145	239.5663423	2092806.	9.0994006	30.0393624	
0.0001208	252.8755836	2092806.	8.8862742	30.9614007	
0.0001272	266.1848248	2092806.	8.6944605	31.8834390	
0.0001335	279.4940660	2092806.	8.5209148	32.8054773	
0.0001399	292.8033073	2092806.	8.3631459	33.7275157	
0.0001463	306.1125485	2092806.	8.2190961	34.6495540	
0.0001526	319.4217897	2092806.	8.0870504	35.5715923	
0.0001590	332.7310310	2092806.	7.9655684	36.4936306	
0.0001653	346.0402722	2092806.	7.8534312	37.4156689	
0.0001717	359.3495135	2092806.	7.7496004	38.3377072	
0.0001781	372.6587547	2092806.	7.6531861	39.2597455	
0.0001844	385.9679959	2092806.	7.5634210	40.1817838	
0.0001908	399.2772372	2092806.	7.4796403	41.1038221	
0.0001971	412.5864784	2092806.	7.4012648	42.0258604	
0.0002035	425.8957197	2092806.	7.3277878	42.9478988	
0.0002099	439.2049609	2092806.	7.2587639	43.8699371	
0.0002162	452.5142021	2092806.	7.1938003	44.7919754	
0.0002226	465.8234434	2092806.	7.1325489	45.7140137	
0.0002289	479.1326846	2092806.	7.0747003	46.6360520	
0.0002353	492.4419259	2092806.	7.0199787	47.5580903	
0.0002417	505.7511671	2092806.	6.9681371	48.4801286	
0.0002480	519.0604083	2092806.	6.9189541	49.4021669	
0.0002607	544.9394798	2089970.	6.8294032	50.0000000	Y
0.0002735	569.0662348	2080990.	6.7519354	50.0000000	Y
0.0002862	591.6191761	2067309.	6.6847299	50.0000000	Y
0.0002989	612.8144223	2050250.	6.6261637	50.0000000	Y
0.0003116	632.7909795	2030672.	6.5750071	50.0000000	Y

0.0003243	651.7249875	2009416.	6.5301180	50.0000000	Y
0.0003371	669.7721954	1987133.	6.4905341	50.0000000	Y
0.0003498	686.9440257	1963967.	6.4557243	50.0000000	Y
0.0003625	703.4402785	1940564.	6.4248219	50.0000000	Y
0.0003752	719.2002589	1916785.	6.3976136	50.0000000	Y
0.0003879	734.3999300	1893121.	6.3734099	50.0000000	Y
0.0004006	749.0790530	1869660.	6.3518756	50.0000000	Y
0.0004134	763.2762527	1846477.	6.3327150	50.0000000	Y
0.0004261	777.0289970	1823635.	6.3156660	50.0000000	Y
0.0004388	790.3735756	1801188.	6.3004955	50.0000000	Y
0.0004515	803.3450769	1779178.	6.2869950	50.0000000	Y
0.0004642	815.6838811	1757012.	6.2744601	50.0000000	Y
0.0004770	827.1172029	1734129.	6.2621938	50.0000000	Y
0.0004897	837.7363119	1710772.	6.2501544	50.0000000	Y
0.0005024	847.6272766	1687149.	6.2383032	50.0000000	Y
0.0005151	856.8709554	1663436.	6.2266037	50.0000000	Y
0.0005278	865.4320076	1639572.	6.2153063	50.0000000	Y
0.0005406	873.4786550	1615880.	6.2041483	50.0000000	Y
0.0005533	881.0691625	1592452.	6.1931233	50.0000000	Y
0.0005660	888.1450285	1569168.	6.1825386	50.0000000	Y
0.0005787	894.8405132	1546251.	6.1719331	50.0000000	Y
0.0005914	901.0590990	1523512.	6.1615831	50.0000000	Y
0.0006042	907.0002276	1501272.	6.1513781	50.0000000	Y
0.0006169	912.6235150	1479434.	6.1415627	50.0000000	Y
0.0006296	917.8865952	1457906.	6.1315908	50.0000000	Y
0.0006423	922.8656139	1436788.	6.1220577	50.0000000	Y
0.0006550	927.6828874	1416244.	6.1125696	50.0000000	Y
0.0006677	932.1093156	1395896.	6.1032934	50.0000000	Y
0.0006805	936.4425920	1376173.	6.0942422	50.0000000	Y
0.0006932	940.4843988	1356753.	6.0851417	50.0000000	Y
0.0007059	944.3621943	1337800.	6.0764614	50.0000000	Y
0.0007186	948.0490589	1319253.	6.0676881	50.0000000	Y
0.0007313	951.5977932	1301161.	6.0592024	50.0000000	Y
0.0007441	954.9173790	1283381.	6.0508407	50.0000000	Y
0.0007568	958.1771770	1266119.	6.0426299	50.0000000	Y
0.0008077	969.7215217	1200657.	6.0109229	50.0000000	Y
0.0008585	979.4611052	1140851.	5.9811768	50.0000000	Y
0.0009094	987.8341726	1086235.	5.9533553	50.0000000	Y
0.0009603	995.1009316	1036253.	5.9271635	50.0000000	Y
0.0010112	1001.	990350.	5.9021663	50.0000000	Y
0.0010620	1007.	948089.	5.8788304	50.0000000	Y
0.0011129	1012.	909170.	5.8565925	50.0000000	Y
0.0011638	1016.	873176.	5.8357081	50.0000000	Y
0.0012147	1020.	839821.	5.8155545	50.0000000	Y
0.0012655	1024.	808777.	5.7966516	50.0000000	Y
0.0013164	1027.	779933.	5.7785751	50.0000000	Y
0.0013673	1030.	753066.	5.7614152	50.0000000	Y
0.0014182	1032.	727833.	5.7449746	50.0000000	Y
0.0014690	1035.	704274.	5.7294032	50.0000000	Y

Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	63.7250000000	1055.
2	163.4750000000	1035.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	11.5000	0.00	N.A.	No	0.00	477137.
2	29.7000	18.2000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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

Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head = 0.130000 inches
Moment at pile head = 0.0 in-lbs
Axial load at pile head = 163475.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1300	0.00	-13.2398	-0.00109	13443.	2.09E+09	0.00	0.00	0.00
0.2970	0.1261	590.2297	-13.2398	-0.00109	13484.	2.09E+09	0.00	0.00	0.00
0.5940	0.1222	1180.	-13.2398	-0.00109	13525.	2.09E+09	0.00	0.00	0.00
0.8910	0.1183	1768.	-13.2398	-0.00109	13566.	2.09E+09	0.00	0.00	0.00
1.1880	0.1144	2355.	-13.2398	-0.00109	13607.	2.09E+09	0.00	0.00	0.00
1.4850	0.1106	2939.	-13.2398	-0.00108	13648.	2.09E+09	0.00	0.00	0.00
1.7820	0.1067	3521.	-13.2398	-0.00108	13689.	2.09E+09	0.00	0.00	0.00
2.0790	0.1029	4099.	-13.2398	-0.00107	13729.	2.09E+09	0.00	0.00	0.00
2.3760	0.09911	4673.	-13.2398	-0.00106	13770.	2.09E+09	0.00	0.00	0.00
2.6730	0.09534	5242.	-13.2398	-0.00105	13809.	2.09E+09	0.00	0.00	0.00
2.9700	0.09160	5806.	-13.2398	-0.00104	13849.	2.09E+09	0.00	0.00	0.00
3.2670	0.08789	6364.	-13.2398	-0.00103	13888.	2.09E+09	0.00	0.00	0.00
3.5640	0.08423	6916.	-13.2398	-0.00102	13927.	2.09E+09	0.00	0.00	0.00
3.8610	0.08060	7462.	-13.2398	-0.00101	13965.	2.09E+09	0.00	0.00	0.00
4.1580	0.07703	7999.	-13.2398	-9.97E-04	14002.	2.09E+09	0.00	0.00	0.00
4.4550	0.07350	8529.	-13.2398	-9.83E-04	14039.	2.09E+09	0.00	0.00	0.00
4.7520	0.07002	9050.	-13.2398	-9.68E-04	14076.	2.09E+09	0.00	0.00	0.00
5.0490	0.06660	9563.	-13.2398	-9.52E-04	14112.	2.09E+09	0.00	0.00	0.00
5.3460	0.06323	10066.	-13.2398	-9.36E-04	14147.	2.09E+09	0.00	0.00	0.00
5.6430	0.05993	10558.	-13.2398	-9.18E-04	14181.	2.09E+09	0.00	0.00	0.00
5.9400	0.05669	11041.	-13.2398	-9.00E-04	14215.	2.09E+09	0.00	0.00	0.00
6.2370	0.05352	11512.	-13.2398	-8.80E-04	14248.	2.09E+09	0.00	0.00	0.00
6.5340	0.05041	11972.	-13.2398	-8.60E-04	14280.	2.09E+09	0.00	0.00	0.00
6.8310	0.04738	12420.	-13.2398	-8.40E-04	14312.	2.09E+09	0.00	0.00	0.00
7.1280	0.04443	12856.	-13.2398	-8.18E-04	14342.	2.09E+09	0.00	0.00	0.00
7.4250	0.04155	13279.	-13.2398	-7.96E-04	14372.	2.09E+09	0.00	0.00	0.00
7.7220	0.03876	13689.	-13.2398	-7.73E-04	14401.	2.09E+09	0.00	0.00	0.00
8.0190	0.03604	14086.	-13.2398	-7.49E-04	14428.	2.09E+09	0.00	0.00	0.00
8.3160	0.03342	14468.	-13.2398	-7.25E-04	14455.	2.09E+09	0.00	0.00	0.00

Output Provided by Fuss & O'Neill on 9/10/2018

8.6130	0.03088	14836.	-13.2398	-7.00E-04	14481.	2.09E+09	0.00	0.00	0.00
8.9100	0.02843	15189.	-13.2398	-6.74E-04	14505.	2.09E+09	0.00	0.00	0.00
9.2070	0.02607	15527.	-13.2398	-6.48E-04	14529.	2.09E+09	0.00	0.00	0.00
9.5040	0.02381	15850.	-13.2398	-6.21E-04	14552.	2.09E+09	0.00	0.00	0.00
9.8010	0.02164	16157.	-13.2398	-5.94E-04	14573.	2.09E+09	0.00	0.00	0.00
10.0980	0.01957	16448.	-13.2398	-5.66E-04	14594.	2.09E+09	0.00	0.00	0.00
10.3950	0.01760	16723.	-13.2398	-5.38E-04	14613.	2.09E+09	0.00	0.00	0.00
10.6920	0.01573	16981.	-13.2398	-5.10E-04	14631.	2.09E+09	0.00	0.00	0.00
10.9890	0.01397	17222.	-13.2398	-4.80E-04	14648.	2.09E+09	0.00	0.00	0.00
11.2860	0.01231	17446.	-13.2398	-4.51E-04	14663.	2.09E+09	0.00	0.00	0.00
11.5830	0.01076	17653.	-15.6260	-4.21E-04	14678.	2.09E+09	-1.3391	443.7180	0.00
11.8800	0.00931	17826.	-27.4675	-3.91E-04	14690.	2.09E+09	-5.3060	2031.	0.00
12.1770	0.00797	17913.	-51.3455	-3.60E-04	14696.	2.09E+09	-8.0936	3619.	0.00
12.4740	0.00674	17879.	-83.3159	-3.30E-04	14694.	2.09E+09	-9.8472	5207.	0.00
12.7710	0.00562	17703.	-119.9522	-3.00E-04	14681.	2.09E+09	-10.7118	6795.	0.00
13.0680	0.00460	17374.	-158.3397	-2.70E-04	14658.	2.09E+09	-10.8300	8383.	0.00
13.3650	0.00370	16889.	-196.0639	-2.41E-04	14624.	2.09E+09	-10.3396	9970.	0.00
13.6620	0.00289	16256.	-231.1902	-2.12E-04	14580.	2.09E+09	-9.3721	11558.	0.00
13.9590	0.00218	15488.	-262.2371	-1.85E-04	14526.	2.09E+09	-8.0504	13146.	0.00
14.2560	0.00157	14603.	-288.1427	-1.60E-04	14464.	2.09E+09	-6.4870	14734.	0.00
14.5530	0.00104	13621.	-308.2256	-1.36E-04	14396.	2.09E+09	-4.7829	16321.	0.00
14.8500	6.02E-04	12564.	-322.1424	-1.13E-04	14322.	2.09E+09	-3.0267	17909.	0.00
15.1470	2.37E-04	11456.	-329.8416	-9.29E-05	14244.	2.09E+09	-1.2938	19497.	0.00
15.4440	-5.98E-05	10321.	-331.5168	-7.43E-05	14165.	2.09E+09	0.3537	21085.	0.00
15.7410	-2.93E-04	9180.	-327.5599	-5.77E-05	14085.	2.09E+09	1.8668	22672.	0.00
16.0380	-4.71E-04	8054.	-318.5154	-4.31E-05	14006.	2.09E+09	3.2087	24260.	0.00
16.3350	-6.00E-04	6960.	-305.0375	-3.03E-05	13930.	2.09E+09	4.3547	25848.	0.00
16.6320	-6.87E-04	5915.	-287.8499	-1.93E-05	13857.	2.09E+09	5.2904	27436.	0.00
16.9290	-7.38E-04	4931.	-267.7103	-1.01E-05	13788.	2.09E+09	6.0112	29023.	0.00
17.2260	-7.59E-04	4018.	-245.3789	-2.47E-06	13724.	2.09E+09	6.5204	30611.	0.00
17.5230	-7.56E-04	3184.	-221.5923	3.66E-06	13665.	2.09E+09	6.8279	32199.	0.00
17.8200	-7.33E-04	2434.	-197.0417	8.45E-06	13613.	2.09E+09	6.9491	33787.	0.00
18.1170	-6.96E-04	1770.	-172.3562	1.20E-05	13567.	2.09E+09	6.9035	35374.	0.00
18.4140	-6.47E-04	1192.	-148.0916	1.46E-05	13526.	2.09E+09	6.7130	36962.	0.00
18.7110	-5.92E-04	697.4804	-124.7217	1.62E-05	13491.	2.09E+09	6.4014	38550.	0.00
19.0080	-5.32E-04	283.8666	-102.6358	1.70E-05	13463.	2.09E+09	5.9926	40138.	0.00
19.3050	-4.71E-04	-53.9109	-82.1375	1.72E-05	13446.	2.09E+09	5.5104	41726.	0.00
19.6020	-4.10E-04	-321.6412	-63.4481	1.69E-05	13465.	2.09E+09	4.9775	43313.	0.00
19.8990	-3.50E-04	-525.8280	-46.7112	1.61E-05	13479.	2.09E+09	4.4147	44901.	0.00
20.1960	-2.94E-04	-673.4172	-31.9998	1.51E-05	13490.	2.09E+09	3.8409	46489.	0.00
20.4930	-2.43E-04	-771.5512	-19.3242	1.39E-05	13497.	2.09E+09	3.2723	48077.	0.00
20.7900	-1.95E-04	-827.3548	-8.6411	1.25E-05	13501.	2.09E+09	2.7227	49664.	0.00
21.0870	-1.53E-04	-847.7530	0.1373	1.11E-05	13502.	2.09E+09	2.2034	51252.	0.00
21.3840	-1.16E-04	-839.3225	7.1335	9.67E-06	13501.	2.09E+09	1.7227	52840.	0.00
21.6810	-8.43E-05	-808.1773	12.4966	8.27E-06	13499.	2.09E+09	1.2869	54428.	0.00
21.9780	-5.72E-05	-759.8844	16.3930	6.94E-06	13496.	2.09E+09	0.8997	56015.	0.00
22.2750	-3.48E-05	-699.4100	18.9992	5.69E-06	13492.	2.09E+09	0.5629	57603.	0.00
22.5720	-1.67E-05	-631.0917	20.4954	4.56E-06	13487.	2.09E+09	0.2767	59191.	0.00
22.8690	-2.32E-06	-558.6326	21.0591	3.55E-06	13482.	2.09E+09	0.03961	60779.	0.00
23.1660	8.62E-06	-485.1161	20.8607	2.66E-06	13477.	2.09E+09	-0.1509	62366.	0.00
23.4630	1.66E-05	-413.0351	20.0601	1.89E-06	13472.	2.09E+09	-0.2984	63954.	0.00
23.7600	2.21E-05	-344.3341	18.8035	1.25E-06	13467.	2.09E+09	-0.4068	65542.	0.00
24.0570	2.55E-05	-280.4589	17.2217	7.17E-07	13462.	2.09E+09	-0.4808	67130.	0.00
24.3540	2.72E-05	-222.4129	15.4293	2.89E-07	13458.	2.09E+09	-0.5250	68717.	0.00
24.6510	2.76E-05	-170.8154	13.5240	-4.63E-08	13455.	2.09E+09	-0.5441	70305.	0.00
24.9480	2.69E-05	-125.9602	11.5873	-2.99E-07	13451.	2.09E+09	-0.5427	71893.	0.00
25.2450	2.55E-05	-87.8729	9.6851	-4.81E-07	13449.	2.09E+09	-0.5248	73481.	0.00
25.5420	2.35E-05	-56.3644	7.8689	-6.04E-07	13447.	2.09E+09	-0.4944	75069.	0.00
25.8390	2.11E-05	-31.0798	6.1773	-6.78E-07	13445.	2.09E+09	-0.4549	76656.	0.00
26.1360	1.86E-05	-11.5425	4.6375	-7.15E-07	13443.	2.09E+09	-0.4092	78244.	0.00
26.4330	1.61E-05	2.8090	3.2675	-7.22E-07	13443.	2.09E+09	-0.3596	79832.	0.00
26.7300	1.35E-05	12.5896	2.0774	-7.09E-07	13444.	2.09E+09	-0.3082	81420.	0.00
27.0270	1.10E-05	18.4429	1.0716	-6.83E-07	13444.	2.09E+09	-0.2563	83007.	0.00
27.3240	8.63E-06	21.0229	0.2501	-6.49E-07	13444.	2.09E+09	-0.2047	84595.	0.00
27.6210	6.38E-06	20.9814	-0.3896	-6.13E-07	13444.	2.09E+09	-0.1542	86183.	0.00
27.9180	4.26E-06	18.9603	-0.8512	-5.79E-07	13444.	2.09E+09	-0.1048	87771.	0.00
28.2150	2.25E-06	15.5892	-1.1384	-5.50E-07	13444.	2.09E+09	-0.05639	89358.	0.00
28.5120	3.37E-07	11.4863	-1.2542	-5.27E-07	13443.	2.09E+09	-0.00861	90946.	0.00
28.8090	-1.50E-06	7.2628	-1.1999	-5.11E-07	13443.	2.09E+09	0.03907	92534.	0.00
29.1060	-3.30E-06	3.5283	-0.9749	-5.01E-07	13443.	2.09E+09	0.08723	94122.	0.00
29.4030	-5.08E-06	0.8983	-0.5764	-4.98E-07	13443.	2.09E+09	0.1364	95709.	0.00

29.7000	-6.85E-06	0.00	0.00	-4.97E-07	13443.	2.09E+09	0.1870	48649.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =     0.13000000 inches
Computed slope at pile head       =    -0.00109404 radians
Maximum bending moment            =         17913. inch-lbs
Maximum shear force               =  -331.51678949 lbs
Depth of maximum bending moment   =    12.17700000 feet below pile head
Depth of maximum shear force      =    15.44400000 feet below pile head
Number of iterations              =              6
Number of zero deflection points  =              3
```

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head                     =     0.130000 inches
Moment at pile head                           =          0.0 in-lbs
Axial load at pile head                       =      63725.0 lbs
```

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1300	0.00	70.8990	-0.00105	5240.	2.09E+09	0.00	0.00	0.00
0.2970	0.1262	492.1711	70.8990	-0.00105	5275.	2.09E+09	0.00	0.00	0.00
0.5940	0.1225	984.1518	70.8990	-0.00105	5309.	2.09E+09	0.00	0.00	0.00
0.8910	0.1187	1476.	70.8990	-0.00105	5343.	2.09E+09	0.00	0.00	0.00
1.1880	0.1150	1967.	70.8990	-0.00105	5378.	2.09E+09	0.00	0.00	0.00
1.4850	0.1113	2457.	70.8990	-0.00104	5412.	2.09E+09	0.00	0.00	0.00
1.7820	0.1076	2946.	70.8990	-0.00104	5446.	2.09E+09	0.00	0.00	0.00
2.0790	0.1039	3435.	70.8990	-0.00103	5480.	2.09E+09	0.00	0.00	0.00
2.3760	0.1002	3921.	70.8990	-0.00103	5515.	2.09E+09	0.00	0.00	0.00
2.6730	0.09653	4407.	70.8990	-0.00102	5548.	2.09E+09	0.00	0.00	0.00
2.9700	0.09291	4890.	70.8990	-0.00101	5582.	2.09E+09	0.00	0.00	0.00
3.2670	0.08932	5372.	70.8990	-0.00100	5616.	2.09E+09	0.00	0.00	0.00
3.5640	0.08575	5852.	70.8990	-9.94E-04	5650.	2.09E+09	0.00	0.00	0.00
3.8610	0.08223	6329.	70.8990	-9.84E-04	5683.	2.09E+09	0.00	0.00	0.00
4.1580	0.07874	6804.	70.8990	-9.73E-04	5716.	2.09E+09	0.00	0.00	0.00
4.4550	0.07529	7276.	70.8990	-9.61E-04	5749.	2.09E+09	0.00	0.00	0.00
4.7520	0.07189	7746.	70.8990	-9.48E-04	5782.	2.09E+09	0.00	0.00	0.00
5.0490	0.06854	8212.	70.8990	-9.34E-04	5815.	2.09E+09	0.00	0.00	0.00
5.3460	0.06523	8676.	70.8990	-9.20E-04	5847.	2.09E+09	0.00	0.00	0.00
5.6430	0.06198	9136.	70.8990	-9.05E-04	5879.	2.09E+09	0.00	0.00	0.00
5.9400	0.05878	9592.	70.8990	-8.89E-04	5911.	2.09E+09	0.00	0.00	0.00
6.2370	0.05564	10045.	70.8990	-8.72E-04	5943.	2.09E+09	0.00	0.00	0.00
6.5340	0.05256	10494.	70.8990	-8.55E-04	5974.	2.09E+09	0.00	0.00	0.00
6.8310	0.04955	10939.	70.8990	-8.37E-04	6006.	2.09E+09	0.00	0.00	0.00
7.1280	0.04660	11379.	70.8990	-8.18E-04	6036.	2.09E+09	0.00	0.00	0.00
7.4250	0.04372	11815.	70.8990	-7.98E-04	6067.	2.09E+09	0.00	0.00	0.00
7.7220	0.04091	12247.	70.8990	-7.77E-04	6097.	2.09E+09	0.00	0.00	0.00
8.0190	0.03818	12674.	70.8990	-7.56E-04	6127.	2.09E+09	0.00	0.00	0.00
8.3160	0.03552	13096.	70.8990	-7.34E-04	6156.	2.09E+09	0.00	0.00	0.00
8.6130	0.03295	13513.	70.8990	-7.11E-04	6186.	2.09E+09	0.00	0.00	0.00
8.9100	0.03045	13924.	70.8990	-6.88E-04	6214.	2.09E+09	0.00	0.00	0.00
9.2070	0.02804	14330.	70.8990	-6.64E-04	6243.	2.09E+09	0.00	0.00	0.00
9.5040	0.02572	14731.	70.8990	-6.39E-04	6271.	2.09E+09	0.00	0.00	0.00
9.8010	0.02349	15126.	70.8990	-6.14E-04	6299.	2.09E+09	0.00	0.00	0.00

10.0980	0.02134	15515.	70.8990	-5.88E-04	6326.	2.09E+09	0.00	0.00	0.00
10.3950	0.01930	15899.	70.8990	-5.61E-04	6353.	2.09E+09	0.00	0.00	0.00
10.6920	0.01734	16276.	70.8990	-5.34E-04	6379.	2.09E+09	0.00	0.00	0.00
10.9890	0.01549	16646.	70.8990	-5.06E-04	6405.	2.09E+09	0.00	0.00	0.00
11.2860	0.01374	17011.	70.8990	-4.77E-04	6430.	2.09E+09	0.00	0.00	0.00
11.5830	0.01209	17368.	68.2162	-4.48E-04	6455.	2.09E+09	-1.5055	443.7180	0.00
11.8800	0.01055	17700.	54.8178	-4.18E-04	6479.	2.09E+09	-6.0133	2031.	0.00
12.1770	0.00911	17949.	27.6089	-3.87E-04	6496.	2.09E+09	-9.2555	3619.	0.00
12.4740	0.00779	18073.	-9.1597	-3.57E-04	6505.	2.09E+09	-11.3779	5207.	0.00
12.7710	0.00657	18046.	-51.7594	-3.26E-04	6503.	2.09E+09	-12.5276	6795.	0.00
13.0680	0.00546	17852.	-96.9837	-2.95E-04	6489.	2.09E+09	-12.8508	8383.	0.00
13.3650	0.00446	17489.	-142.1421	-2.65E-04	6464.	2.09E+09	-12.4906	9970.	0.00
13.6620	0.00357	16960.	-185.0441	-2.36E-04	6427.	2.09E+09	-11.5846	11558.	0.00
13.9590	0.00278	16277.	-223.9762	-2.08E-04	6379.	2.09E+09	-10.2629	13146.	0.00
14.2560	0.00209	15457.	-257.6715	-1.81E-04	6322.	2.09E+09	-8.6458	14734.	0.00
14.5530	0.00149	14522.	-285.2721	-1.55E-04	6256.	2.09E+09	-6.8427	16321.	0.00
14.8500	9.85E-04	13494.	-306.2876	-1.31E-04	6184.	2.09E+09	-4.9505	17909.	0.00
15.1470	5.58E-04	12399.	-320.5492	-1.09E-04	6108.	2.09E+09	-3.0527	19497.	0.00
15.4440	2.06E-04	11259.	-328.1623	-8.91E-05	6028.	2.09E+09	-1.2195	21085.	0.00
15.7410	-7.74E-05	10100.	-329.4580	-7.10E-05	5947.	2.09E+09	0.4924	22672.	0.00
16.0380	-3.00E-04	8943.	-324.9457	-5.47E-05	5866.	2.09E+09	2.0398	24260.	0.00
16.3350	-4.68E-04	7809.	-315.2673	-4.05E-05	5787.	2.09E+09	3.3915	25848.	0.00
16.6320	-5.88E-04	6714.	-301.1548	-2.81E-05	5710.	2.09E+09	4.5280	27436.	0.00
16.9290	-6.68E-04	5675.	-283.3918	-1.76E-05	5637.	2.09E+09	5.4401	29023.	0.00
17.2260	-7.13E-04	4702.	-262.7785	-8.73E-06	5569.	2.09E+09	6.1275	30611.	0.00
17.5230	-7.30E-04	3806.	-240.1028	-1.49E-06	5506.	2.09E+09	6.5974	32199.	0.00
17.8200	-7.24E-04	2991.	-216.1155	4.30E-06	5449.	2.09E+09	6.8635	33787.	0.00
18.1170	-7.00E-04	2263.	-191.5111	8.78E-06	5399.	2.09E+09	6.9437	35374.	0.00
18.4140	-6.61E-04	1622.	-166.9135	1.21E-05	5354.	2.09E+09	6.8597	36962.	0.00
18.7110	-6.13E-04	1068.	-142.8655	1.44E-05	5315.	2.09E+09	6.6352	38550.	0.00
19.0080	-5.59E-04	597.4728	-119.8238	1.58E-05	5282.	2.09E+09	6.2950	40138.	0.00
19.3050	-5.01E-04	206.6981	-98.1568	1.65E-05	5255.	2.09E+09	5.8638	41726.	0.00
19.6020	-4.41E-04	-109.6744	-78.1462	1.66E-05	5248.	2.09E+09	5.3655	43313.	0.00
19.8990	-3.83E-04	-357.8511	-59.9907	1.62E-05	5265.	2.09E+09	4.8228	44901.	0.00
20.1960	-3.26E-04	-544.6300	-43.8122	1.54E-05	5278.	2.09E+09	4.2561	46489.	0.00
20.4930	-2.73E-04	-677.1374	-29.6638	1.44E-05	5288.	2.09E+09	3.6836	48077.	0.00
20.7900	-2.24E-04	-762.5938	-17.5381	1.31E-05	5294.	2.09E+09	3.1209	49664.	0.00
21.0870	-1.79E-04	-808.1126	-7.3770	1.18E-05	5297.	2.09E+09	2.5811	51252.	0.00
21.3840	-1.40E-04	-820.5332	0.9191	1.04E-05	5298.	2.09E+09	2.0744	52840.	0.00
21.6810	-1.05E-04	-806.2872	7.4820	9.02E-06	5297.	2.09E+09	1.6085	54428.	0.00
21.9780	-7.56E-05	-771.2984	12.4664	7.68E-06	5294.	2.09E+09	1.1886	56015.	0.00
22.2750	-5.06E-05	-720.9134	16.0422	6.41E-06	5291.	2.09E+09	0.8180	57603.	0.00
22.5720	-3.00E-05	-659.8594	18.3867	5.23E-06	5286.	2.09E+09	0.4977	59191.	0.00
22.8690	-1.33E-05	-592.2282	19.6788	4.16E-06	5282.	2.09E+09	0.2274	60779.	0.00
23.1660	-2.91E-07	-521.4799	20.0931	3.22E-06	5277.	2.09E+09	0.00509	62366.	0.00
23.4630	9.59E-06	-450.4653	19.7956	2.39E-06	5272.	2.09E+09	-0.1720	63954.	0.00
23.7600	1.67E-05	-381.4614	18.9409	1.68E-06	5267.	2.09E+09	-0.3076	65542.	0.00
24.0570	2.16E-05	-316.2176	17.6691	1.09E-06	5262.	2.09E+09	-0.4060	67130.	0.00
24.3540	2.45E-05	-256.0088	16.1050	5.98E-07	5258.	2.09E+09	-0.4717	68717.	0.00
24.6510	2.58E-05	-201.6925	14.3569	2.08E-07	5254.	2.09E+09	-0.5093	70305.	0.00
24.9480	2.59E-05	-153.7674	12.5166	-9.44E-08	5251.	2.09E+09	-0.5234	71893.	0.00
25.2450	2.51E-05	-112.4315	10.6600	-3.21E-07	5248.	2.09E+09	-0.5184	73481.	0.00
25.5420	2.37E-05	-77.6373	8.8481	-4.83E-07	5246.	2.09E+09	-0.4983	75069.	0.00
25.8390	2.17E-05	-49.1431	7.1282	-5.91E-07	5244.	2.09E+09	-0.4668	76656.	0.00
26.1360	1.94E-05	-26.5593	5.5355	-6.55E-07	5242.	2.09E+09	-0.4270	78244.	0.00
26.4330	1.70E-05	-9.3885	4.0948	-6.86E-07	5241.	2.09E+09	-0.3815	79832.	0.00
26.7300	1.46E-05	2.9400	2.8223	-6.91E-07	5240.	2.09E+09	-0.3326	81420.	0.00
27.0270	1.21E-05	11.0428	1.7273	-6.80E-07	5241.	2.09E+09	-0.2819	83007.	0.00
27.3240	9.71E-06	15.5607	0.8140	-6.57E-07	5241.	2.09E+09	-0.2306	84595.	0.00
27.6210	7.42E-06	17.1436	0.08333	-6.29E-07	5241.	2.09E+09	-0.1795	86183.	0.00
27.9180	5.23E-06	16.4404	-0.4660	-6.00E-07	5241.	2.09E+09	-0.1288	87771.	0.00
28.2150	3.14E-06	14.0945	-0.8359	-5.74E-07	5241.	2.09E+09	-0.07876	89358.	0.00
28.5120	1.14E-06	10.7428	-1.0280	-5.53E-07	5241.	2.09E+09	-0.02900	90946.	0.00
28.8090	-8.03E-07	7.0185	-1.0425	-5.38E-07	5241.	2.09E+09	0.02084	92534.	0.00
29.1060	-2.70E-06	3.5562	-0.8783	-5.29E-07	5240.	2.09E+09	0.07129	94122.	0.00
29.4030	-4.57E-06	0.9981	-0.5324	-5.25E-07	5240.	2.09E+09	0.1228	95709.	0.00
29.7000	-6.44E-06	0.00	0.00	-5.24E-07	5240.	2.09E+09	0.1759	48649.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual

stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =     0.13000000 inches
Computed slope at pile head       =    -0.00105447 radians
Maximum bending moment            =         18073. inch-lbs
Maximum shear force               =  -329.45802301 lbs
Depth of maximum bending moment   =    12.47400000 feet below pile head
Depth of maximum shear force      =    15.74100000 feet below pile head
Number of iterations              =              6
Number of zero deflection points =              3
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

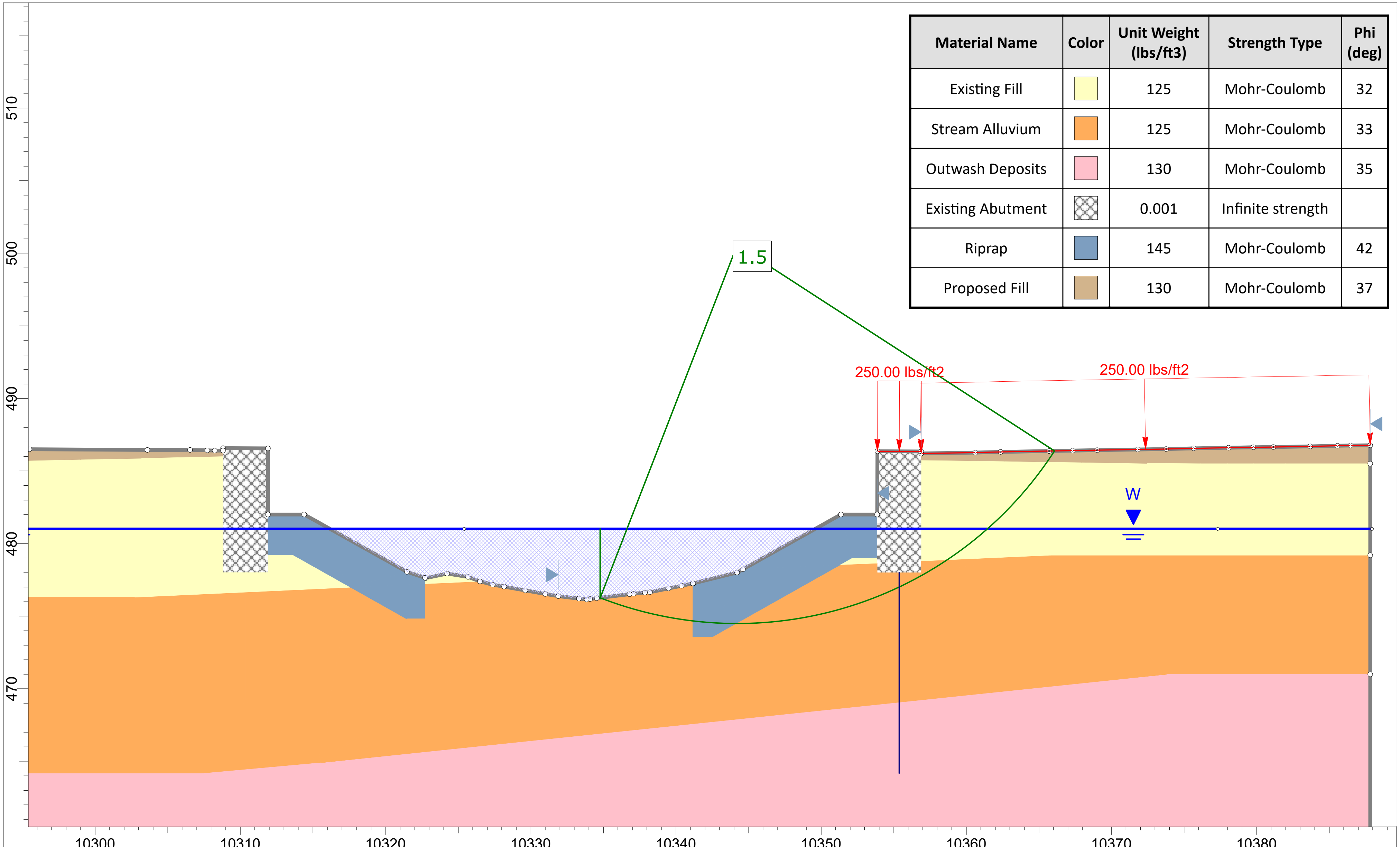
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	0.1300	M, in-lb	0.00	163475.	0.1300	-0.00109	-331.5168	17913.
2	y, in	0.1300	M, in-lb	0.00	63725.	0.1300	-0.00105	-329.4580	18073.

Maximum pile-head deflection = 0.1300000000 inches
Maximum pile-head rotation = -0.0010940423 radians = -0.062684 deg.

The analysis ended normally.

APPENDIX F.2 – Global Slope Stability

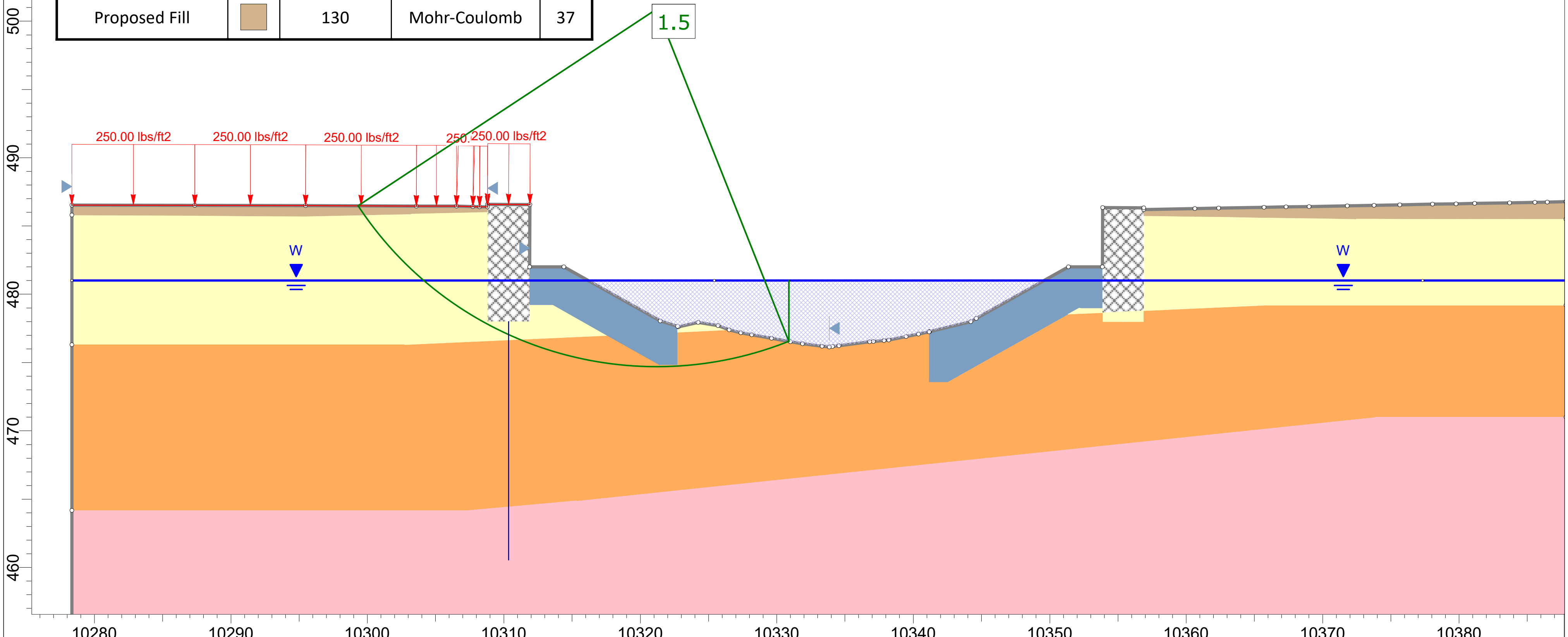


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Phi (deg)
Existing Fill		125	Mohr-Coulomb	32
Stream Alluvium		125	Mohr-Coulomb	33
Outwash Deposits		130	Mohr-Coulomb	35
Existing Abutment		0.001	Infinite strength	
Riprap		145	Mohr-Coulomb	42
Proposed Fill		130	Mohr-Coulomb	37

SLIDEINTERPRET 8.016

Project	Heald Bridge (#0673) Redding Road over West Branch Nezinscot River
Analysis Description	Proposed East Abutment - Global Slope Stability - View to North
Drawn By	Patrick Clarke Checked by: BTW
Scale	1:110
Company	Nobis Group
Date	8/28/18
File Name	East Abutment - Global Slope Stability.slim

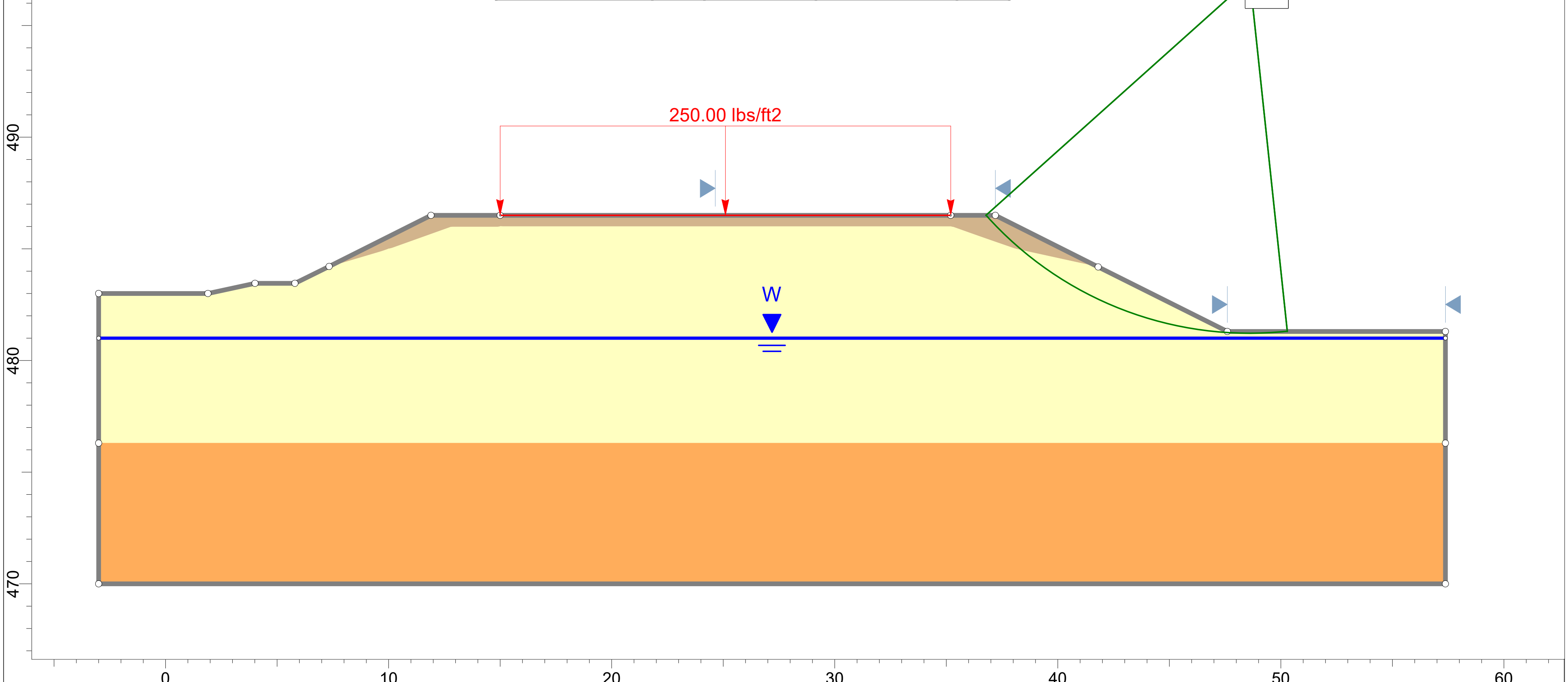
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Phi (deg)
Existing Fill		125	Mohr-Coulomb	32
Stream Alluvium		125	Mohr-Coulomb	33
Outwash Deposits		130	Mohr-Coulomb	35
Existing Abutment		0.001	Infinite strength	
Riprap		145	Mohr-Coulomb	42
Proposed Fill		130	Mohr-Coulomb	37



SLIDEINTERPRET 8.016

Project	Heald Bridge (#0673) Redding Road over West Branch Nezinscot River
Analysis Description	Proposed West Abutment - Global Slope Stability - View to North
Drawn By	Patrick Clarke Checked by: BTW
Scale	1:131
Company	Nobis Group
Date	8/28/18
File Name	West Abutment - Global Slope Stability.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Phi (deg)
Existing Fill		125	Mohr-Coulomb	32
Stream Alluvium		125	Mohr-Coulomb	33
Proposed Fill		130	Mohr-Coulomb	37



SLIDEINTERPRET 8.016

Project	Heald Bridge (#0673) Redding Road over West Branch Nezinscot River
Analysis Description	Proposed West Approach - Global Slope Stability - View to East
Drawn By	Patrick Clarke Checked by: BTW
Scale	1:80
Company	Nobis Group
Date	8/28/18
File Name	West Approach - Global Slope Stability.slim

APPENDIX F.3 – Seismic Design Parameters

Seismic site classification for the Heald Bridge - Redding Road over West Branch Nezinscot River

Objective: Evaluate seismic site classification for the above-referenced project site in Sumner, Maine.

References:

1) AASHTO LRFD Bridge Design Specifications, 8th Edition.
2) Borings observed by Nobis Group in June, 2017.
3) MaineDOT Bridge Design Manual, 2003, with revisions through March, 2017.

Solution:

AASHTO Section 3.10 was used to determine the seismic site classification for the Heald Bridge project site, as follows:

Step 1: Check for the three categories of Site Class F as described in Table 3.10.3.1-1 - Site Classification Definitions, as follows:

1. Peats or highly organic clays (H>10 ft of peat or highly organic clay where H = thickness of soil).
2. Very high plasticity clays (H>25 ft with PI >75).
3. Very thick soft/medium stiff clays (H > 120 ft).

Soil conditions for Site Class F were not shown on the Nobis Boring Logs.

Step 2: Check for existence of a soft layer with total thickness >10 ft, where soft layer is defined by su<0.5 ksf, w>40%, and PI>20. If these criteria are met, classify site as Site Class E.

Soil conditions for Site Class E were not shown on the Nobis Boring Logs.

Step 3: Categorize the site using one of three methods (i.e. A, B, or C).

Method B (N-bar Method) was used to determine the average Standard Penetration Test (SPT) blow count (blows/ft) for the upper 100 ft of the soil profile using the 2017 borings. See attached Table 3.10.3.1-1. The borings were performed in general accordance with ASTM D1586. The samples were obtained using a 1-3/8" diameter sampler driven with a 140-lb safety hammer dropping a distance of 30 inches.

Conclusion:

Based on the Nobis boring logs, the average Standard Penetration Resistance, N-bar, for the site is approximately 27. Per Reference 1, the seismic site classification for the site is **Site Class D - Stiff Soil Profile**. The calculated values for the borings are summarized in the following table. See attached tables presenting the value of SPT-N vs. depth for the respective borings.

Sample Calculation: Consider Boring BB-SWBNR-101

Determine N-bar: Use the average N value of each layer, N_i, for each layer provided in the table toward the end of this report.

$$\overline{N} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{N_i}}$$

$$\overline{N} = \frac{2.5' + 2' + 5.2' + 3.8' + 5' + 3.5' + 6.5' + 13.5' + 58'}{\frac{2.5'}{18} + \frac{2'}{6} + \frac{5.2'}{6} + \frac{3.8'}{13} + \frac{5'}{14} + \frac{3.5'}{9} + \frac{6.5'}{81} + \frac{13.5'}{100} + \frac{58'}{100}} = 32\ bpf$$

Determine the site class for this boring using the Site Class Definitions, attached (Table 3.10.3.1-1, Reference 1)

Below, summary tables provide general information for all of the borings considered in this analysis.

Table: Summary of Seismic Site Classification from Borings Performed by Nobis Group

Boring No.	N-bar (bpf)	Site Class	Comments
BB-SWBNR-101	**32**	D	Bedrock encountered about 42 feet bgs
BB-SWBNR-102	**22**	D	Bedrock encountered about 37.7 feet bgs

Data from Boring BB-SWBNR-101 (performed June, 2017)

Layer	Depth Range		Thickness (d_i)	N_i	d_i/N_i	Comments
	Start [ft]	End [ft]	[ft]	blows/ft		
1	0	2.5	2.5	18	0.139	Fill
2	2.5	4.5	2	6	0.333	
3	4.5	9.7	5.2	6	0.867	
4	9.7	13.5	3.8	13	0.292	Stream Alluvium
5	13.5	18.5	5	14	0.357	
6	18.5	22	3.5	9	0.389	
7	22	28.5	6.5	81	0.080	Outwash Deposit
8	28.5	42	13.5	100	0.135	
9	42	100	58	100	0.580	Bedrock
SUM			**100**		**3.172**	

N-bar	**32**

Site Class D - Stiff Soil

Data from Boring BB-SWBNR-102 (performed June, 2017)

Layer	Depth Range		Thickness (d_i)	N_i	d_i/N_i	Comments
	Start [ft]	End [ft]	[ft]	blows/ft		
1	0	2.5	2.5	6	0.417	Fill
2	2.5	4.5	2	3	0.667	
3	4.5	6.8	2.3	2	1.150	
4	6.8	8.4	1.6	2	0.800	Stream Alluvium
5	8.4	15	6.6	12	0.550	
6	15	23.5	8.5	50	0.170	Outwash Deposit
7	23.5	28.5	5	58	0.086	
8	28.5	37.7	9.2	100	0.092	
9	37.7	100	62.3	100	0.623	Bedrock
SUM			**100**		**4.555**	

N-bar	**22**

Site Class D - Stiff Soil

USGS Design Maps Summary Report

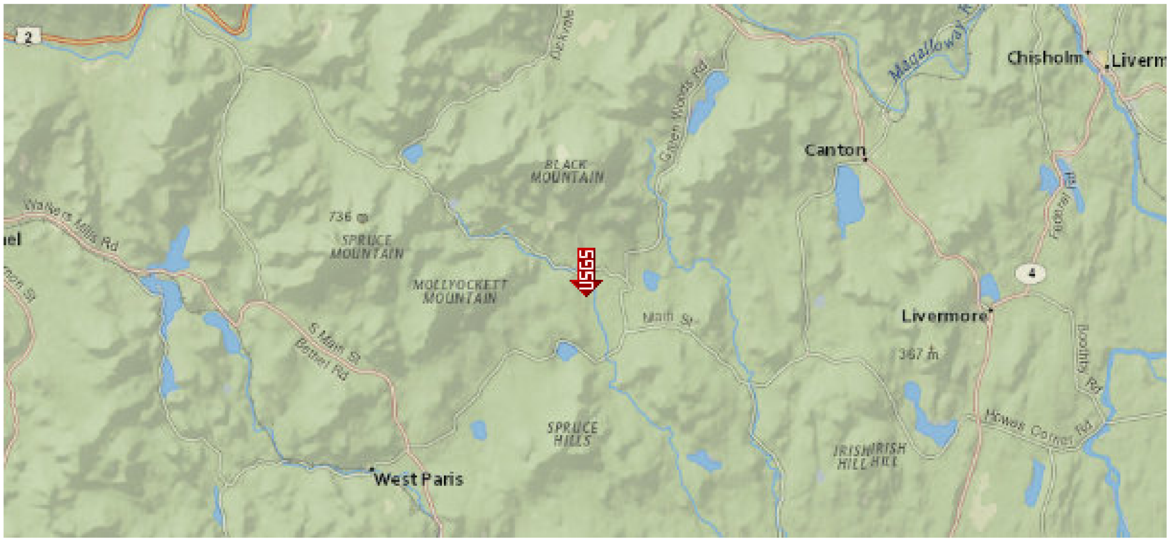
User–Specified Input

Report Title Heald Bridge (#0673)
Tue August 21, 2018 20:30:07 UTC

Building Code Reference Document 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design
(which utilizes USGS hazard data available in 2002)

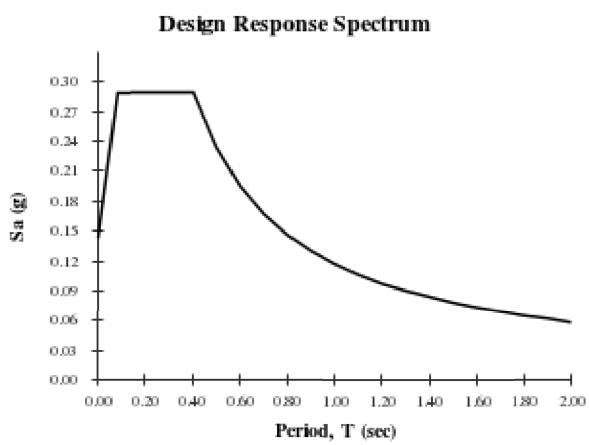
Site Coordinates 44.3987°N, 70.46221°W

Site Soil Classification Site Class D – "Stiff Soil"



USGS–Provided Output

PGA =	0.089 g	**A_s =**	0.143 g
S_S =	0.181 g	**S_{DS} =**	0.289 g
S_1 =	0.049 g	**S_{D1} =**	0.117 g



USGS Design Maps Detailed Report

2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (44.3987°N, 70.46221°W)

Site Class D – "Stiff Soil"

Article 3.4.1 — Design Spectra Based on General Procedure

Note: Maps in the 2009 AASHTO Specifications are provided by AASHTO for Site Class B.
Adjustments for other Site Classes are made, as needed, in Article 3.4.2.3.

From Figure 3.4.1-2 [1]	PGA = 0.089 g
From Figure 3.4.1-3 [2]	S_S = 0.181 g
From Figure 3.4.1-4 [3]	S_1 = 0.049 g

Article 3.4.2.1 — Site Class Definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Article 3.4.2.

Table 3.4.2.1–1 Site Class Definitions

SITE CLASS	SOIL PROFILE NAME	Soil shear wave velocity, $\bar{v}_S$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_S > 5{,}000$	N/A	N/A
B	Rock	$2{,}500 < \bar{v}_S \le 5{,}000$	N/A	N/A
C	Very dense soil and soft rock	$1{,}200 < \bar{v}_S \le 2{,}500$	$\bar{N} > 50$	>2,000 psf
D	Stiff soil profile	$600 \le \bar{v}_S < 1{,}200$	$15 \le \bar{N} \le 50$	1,000 to 2,000 psf
E	Stiff soil profile	$\bar{v}_S < 600$	$\bar{N} < 15$	<1,000 psf
E	—	Any profile with more than 10 ft of soil having the characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \ge 40\%$, and 3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H > 10$ feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H > 25$ feet with plasticity index $PI > 75$) 4. Very thick soft/medium stiff clays ($H > 120$ feet)		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Article 3.4.2.3 — Site Coefficients

Table 3.4.2.3-1 (for F_{pga})—Values of F_{pga} as a Function of Site Class and Mapped Peak Ground Acceleration Coefficient

Site Class	Mapped Peak Ground Acceleration				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	$\boxed{1.6}$	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.089 g, F_{PGA} = 1.600

Table 3.4.2.3-1 (for F_a)—Values of F_a as a Function of Site Class and Mapped Short-Period Spectral Acceleration Coefficient

Site Class	Spectral Response Acceleration Parameter at Short Periods				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	$\boxed{1.6}$	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.181 g, F_a = 1.600

Table 3.4.2.3-2—Values of F_v as a Function of Site Class and Mapped 1-sec Period Spectral Acceleration Coefficient

Site Class	Mapped Spectral Response Acceleration Coefficient at 1-sec Periods				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	$\boxed{2.4}$	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_1

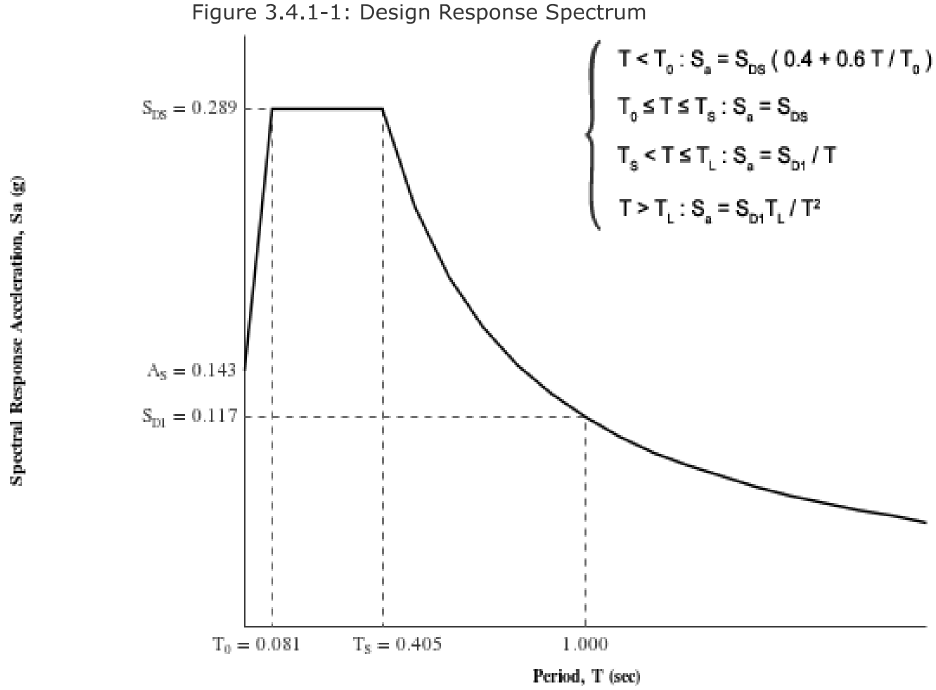
For Site Class = D and S_1 = 0.049 g, F_v = 2.400

Equation (3.4.1-1): $A_S = F_{PGA}$ PGA = 1.600 x 0.089 = 0.143 g

Equation (3.4.1-2): $S_{DS} = F_a S_S$ = 1.600 x 0.181 = 0.289 g

Equation (3.4.1-3): $S_{D1} = F_v S_1$ = 2.400 x 0.049 = 0.117 g

Figure 3.4.1-1: Design Response Spectrum



Article 3.5 - Selection of Seismic Design Category (SDC)

Table 3.5-1—Partitions for Seismic Design Categories A, B, C, and D

VALUE OF S_{D1}	SDC
$S_{D1} < 0.15g$	A
$0.15g \le S_{D1} < 0.30g$	B
$0.30g \le S_{D1} < 0.50g$	C
$0.50g \le S_{D1}$	D

For S_{D1} = 0.117 g, Seismic Design Category = A

Seismic Design Category ≡ “the design category in accordance with Table 3.5-1” = A

References

1. *Figure 3.4.1-2*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-2.pdf
2. *Figure 3.4.1-3*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-3.pdf
3. *Figure 3.4.1-4*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-4.pdf

APPENDIX F.4 - Preliminary Driveability Calculation

Project No.:	92270.03		
Project Title:	Heald Bridge - Sumner, Maine		
Calculated by:	RAC	**Date:**	6/19/2018
Checked by:	BTW	**Date:**	8/24/2018

Preliminary Driveability Evaluation - Revision 1

Objective: Evaluate preliminary driveability of proposed HP10x42 piles for integral abutments.

Approach: 1. Use GRLWEAP to evaluate preliminary driveability.

References: 1. Borings BB-SWBNR-101 and BB-SWBNR-102.
2.Various email communications with Fuss & O'Neill.

Assumptions: 1. Piles terminate on or within bedrock corresponding to approximate 34-foot pile lengths.

Solution:

For piles in compression or tension

$\sigma_{dr} = 0.9 \times \phi_{da} \times f_y$ where; $f_y =$ 50 ksi

$\phi_{da} =$ 1

$\sigma_{dr} =$ 45 ksi

Required nominal geotechnical driving resistance

R_{dr} = Pile Factored Axial Demand / fdyn

Pile Factored Axial Demand = 164.5 kips

$\phi_{dyn} =$ 0.65

$R_{dr} =$ 253 kips

General Soil Profile (N.T.S)

Based on Reference 1

Layer	El.
Top of Pile	478
Alluvium	
	470
Outwash	
	444
Bedrock	

Nobis
Engineering a Sustainable Future

Project No.: 92270.03
Project Title: Heald Bridge - Sumner, Maine
Calculated by: RAC **Date:** 6/19/2018
Checked by: BTW **Date:** 8/24/2018

Heald Bridge PRELIM - Sumner ME

Hammer Information
Select from following list [10/17/2016-2003]: ID: 37

ID	Name	Type	Ram Wt/Ecc. M.	Energy/Power
36	DELMAG D 6-32	OED	1.322	13.524
37	DELMAG D 12-32	OED	2.820	31.330
38	DELMAG D 12-42	OED	2.820	33.304

Hammer parameters
Efficiency 0.8
Pressure 1550 psi Fixed 95 %
Stroke 11.11 ft Variable

Pile material
Concrete ◉ Steel Timber

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	34.	ft	Auto	Segments
Penetration	34.	ft	Auto.	S-Length
Section Area	12.4	in^2	Auto.	S-St. Wt
Elast Modulus	29000.	ksi	0	Splices
Spec Weight	493.356	lb/ft^3		
Toe Area	100.	in^2	Pile Type:	
Perimeter	3.333	ft	H Pile	
Pile Size	10.	in		

Ultimate Capacities (up to 10)
kips

1	190.0	6	240.0
2	200.0	7	253.0
3	210.0	8	260.0
4	220.0	9	270.0
5	230.0	10	280.0

Incr. 0 Action >>

Soil Parameters
2nd Toe - No

Quake
Shaft 0.1 in Const
Toe 0.04 in

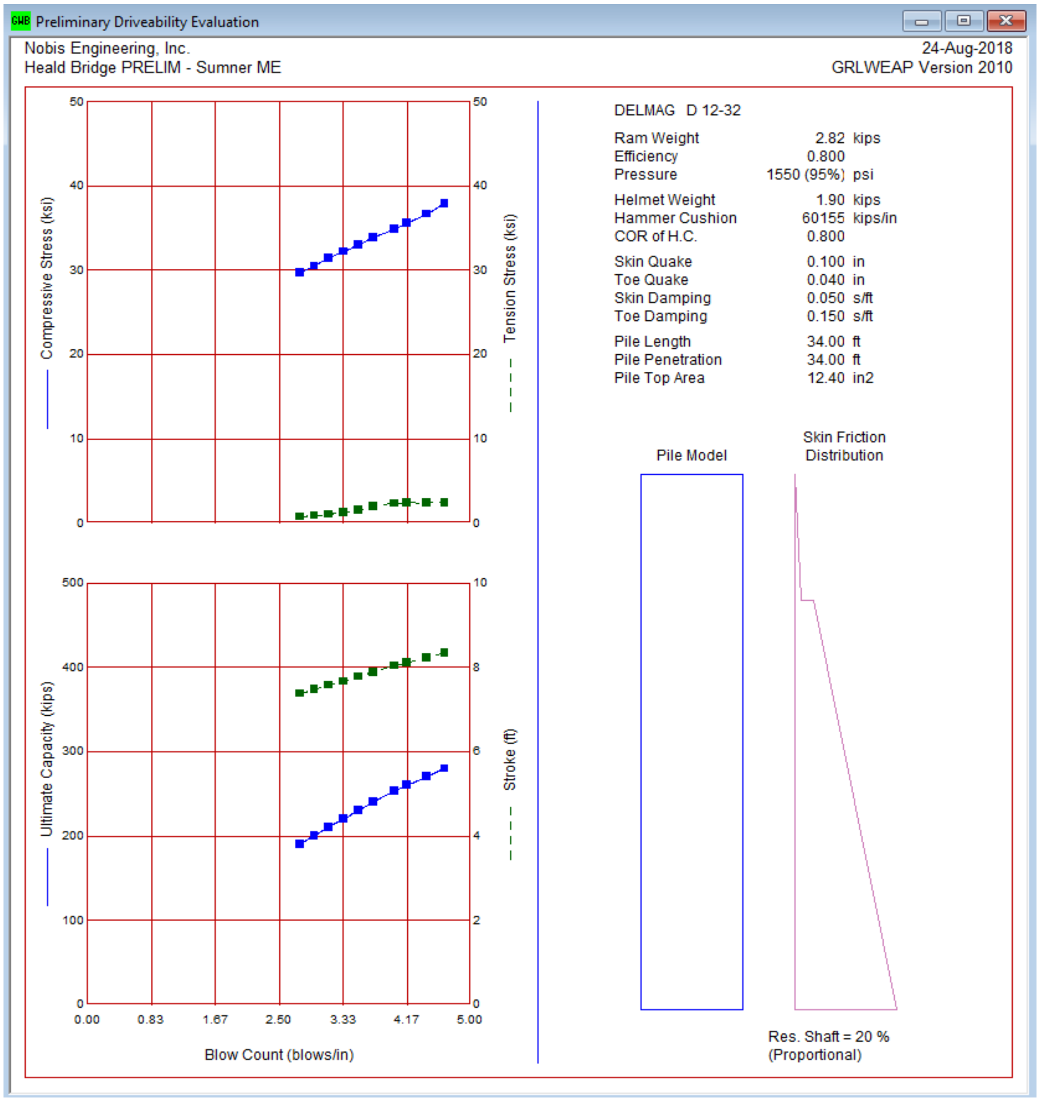
Damping
Shaft 0.05 s/ft Const
Toe 0.15 s/ft Smith

Shaft Resistance
Percentage 20 %
100%
Dist. Shape Num 0.0

Residual Stress Analysis: No

Engineering a Sustainable Future

Project No.: 92270.03
Project Title: Heald Bridge - Sumner, Maine
Calculated by: RAC **Date:** 6/19/2018
Checked by: BTW **Date:** 8/24/2018



Nobis Engineering, Inc. — 24-Aug-2018
Heald Bridge PRELIM - Sumner ME — GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft
190.0	29.67	0.75	2.8	7.38	11.88
200.0	30.49	0.87	3.0	7.47	11.91
210.0	31.39	1.02	3.1	7.58	11.99
220.0	32.20	1.26	3.3	7.66	12.03
230.0	32.97	1.52	3.5	7.78	12.15
240.0	33.85	1.94	3.7	7.89	12.31
253.0	34.84	2.33	4.0	8.04	12.51
260.0	35.57	2.40	4.2	8.11	12.57
270.0	36.67	2.39	4.4	8.23	12.65
280.0	37.84	2.43	4.7	8.34	12.84