MAINE DEPARTMENT OF TRANSPORTATION
BRIDGE PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

# GEOTECHNICAL DESIGN REPORT

*For the Replacement of:*

**JOCK STREAM BRIDGE**
**OVER JOCK STREAM**
**MONMOUTH, MAINE**

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Soils Report No. 2009-32
Bridge No. 2412

Fed No. BR-1671(600)X
November 16, 2009

## Table of Contents



**Tables**



**Sheets**



**Appendices**

## GEOTECHNICAL DESIGN SUMMARY

The purpose of this design report is to make geotechnical recommendations for the replacement of Jock Stream Bridge over Jock Stream in Monmouth, Maine. The proposed replacement bridge will consist of a single span structure founded on H-pile supported integral abutments. The following design recommendations are discussed in detail in the attached report:

**Integral Abutment H-piles** - The use of stub abutments founded on a single row of driven integral H-piles is a viable foundation system for use at the site. The piles will be friction piles driven to an approved stopping criterion within the glacial till layer. Piles should be fitted with driving points to protect the tips and improve penetration. The H-piles shall be design for all relevant strength, service and extreme limit state load groups. The structural resistance check should include checking axial, lateral, and flexural resistance. An L-Pile® analysis is recommended to evaluate the combined axial compression and flexure with factored axial loads, moments and pile head displacements applied. As the proposed integral H-piles will be modeled as fully fixed at the pile head, the resistance of the piles should be evaluated for structural compliance with the interaction equation.

The Contractor is required to perform a wave equation analysis of the proposed pile-hammer system and a dynamic pile test with a 24-hour restrike test at each abutment. The first pile driven at each abutment should be dynamically tested to confirm capacity and verify the stopping criteria developed by the Contractor in the wave equation analysis. The ultimate pile resistance that must be achieved in the wave equation analysis and dynamic testing will be the factored axial pile load divided by a resistance factor, $\varphi_{dyn}$, of 0.52. The maximum factored axial pile load should be shown on the plans.

**Integral Stub Abutment Design -** Integral stub abutments shall be designed for all relevant strength, service and extreme limit states and load combinations. In designing integral abutments for passive earth pressure, the Rankine earth pressure coefficient ($K_p$) of 3.25 is allowed if the displacement of the abutment is less than 2 percent of the abutment height. All abutment designs shall include a drainage system to intercept any water. The approach slab should be positively connected to the integral abutment. Additional lateral earth pressure due to construction surcharge or live load surcharge is required if an approach slab is not specified. When a structural approach slab is specified, reduction, not elimination, of the surcharge load is permitted.

**Scour and Riprap**- The consequences of changes in foundation conditions resulting from the design flood for scour shall be considered at the strength and service limit states. For scour protection and protection of pile groups, the bridge approach slopes and slopes at abutments should be armored with 3 feet of riprap. The riprap shall be underlain by a Class 1 nonwoven erosion control geotextile and a 1 foot thick layer of bedding material.

**Settlement** - Evaluation of the potential settlement due to the placement of up to 6 inches of fill resulted in less than ½ inch of settlement. Provided the fills placed at the site are not in excess of 6 inches, no downdrag forces will need to be accounted for in the design of the pile foundations.

**Frost Protection** - Integral abutments shall be embedded a minimum of 4.0 feet for frost protection. Any foundation placed on granular subgrade soils should be founded a minimum of 6.0 feet below finished exterior grade for frost protection.

**Seismic Design Considerations** - Seismic analysis is not required for single span bridges regardless of seismic zone. However, superstructure connections and minimum support length requirements shall be satisfied.

**Construction Requirements** - Construction of the abutments will require soil excavation and partial or full removal of the existing abutments. Construction activities may require cofferdams and earth support systems. Using the excavated native soils as structural backfill should not be permitted. The existing subbase and subgrade fill soils in the bridge approaches should not be used to re-base the new bridge approaches.

## 1.0 INTRODUCTION

A subsurface investigation for the replacement of Jock Stream Bridge in Monmouth, Maine has been completed. The purpose of the investigation was to explore subsurface conditions at the site in order to develop geotechnical recommendations for the bridge replacement. This report presents the soils information obtained at the site, geotechnical design recommendations, and foundation recommendations.

The existing bridge was constructed in 1931 and consists of a 47 foot long, two span, non continuous and non composite, concrete superstructure with timber pile supported abutments and a mass concrete pier on timber piles. The bridge has a long history of scour problems and abutment movement. In 1997, the substructure was repaired and scour countermeasures were applied to channel bed by armoring with dry grout bags. The abutments and pier are cracked and spalled and are in poor overall condition with evident water damage and staining. Year 2007 MaineDOT Bridge Maintenance inspection reports indicate a Bridge Sufficiency Rating of 33.3. Year 2007 Bridge Inspection records assign the substructures a rating of 3, or “serious”. The bridge is located in an environmentally sensitive area with concerns due to endangered species and observed heavy turtle population.

The proposed bridge will consist of a single span structure founded on H-pile supported integral abutments. The proposed bridge will have a span of approximately 60 feet. The proposed bridge alignment will have a centerline approximately matching the existing bridge centerline. The roadway profile may be raised as much as 6 inches for construction of the proposed bridge. The road will be closed during construction of the proposed replacement bridge.

## 2.0 GEOLOGIC SETTING

Jock Stream Bridge in Monmouth crosses Jock Stream approximately 1.0 miles easterly of Sanborn Road as shown on Sheet 1 - Location Map found at the end of this report. Jock Stream flows in a northeasterly direction to Cobbosseecontee Lake.

According to the Surficial Geologic Map of Maine published by the Maine Geological Survey (1985) the surficial soils in the vicinity of the site consist primarily of till soils with glaciomarine deposits to the south. The till soils generally consist of a homogeneous mixture of sand, silt, clay and stones and may include boulders. The unit is generally deposited in a blanket deposit that conforms to the underlying bedrock surface. These soils were generally deposited by glacial ice. The glaciomarine deposits are generally comprised of silt, clay, sand and minor amounts of gravel. Sand is dominant in some areas, but may be underlain by finer-grained sediments. The unit may contain small areas of till not completely covered by marine sediments. The unit generally is deposited in areas where the topography is gently sloping except where dissected by modern streams and commonly has a branching network of steep-walled stream gullies. These soils were generally deposited as glacial sediments that accumulated on the ocean floor during the late-glacial marine submergence of lowland areas in southern Maine.

According to the Surficial Bedrock Map of Maine, published by the Maine Geological Survey (1985), the bedrock at the site is identified as interbedded pelite and sandstone of the Waterville formation bordered by interbedded pelite and limestone and/or dolostone of the Sangerville Formation.

## 3.0 SUBSURFACE INVESTIGATION

Subsurface conditions were explored by drilling two (2) test borings at the site. Test boring BB-MJS-101 was drilled behind the location of Abutment No. 1 (west). Test boring BB-MJS-102 behind the location of Abutment No. 2 (east). The exploration locations are shown on Sheet 2 - Boring Locations and Interpretive Subsurface Profile found at the end of this report.

The borings were drilled on between June 16 and July 14, 2009 using the Maine Department of Transportation (MaineDOT) drill rig. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented in the boring logs provided in Appendix A - Boring Logs and on Sheet 3 - Boring Logs found end of this report. The borings were drilled using driven cased wash boring and solid stem auger techniques. Soil samples were obtained where possible at 5-foot intervals using Standard Penetration Test (SPT) methods. During SPT sampling, the sampler is driven 24 inches and the hammer blows for each 6 inch interval of penetration are recorded. The standard penetration resistance, N-value, is the sum of the blows for the second and third intervals. The MaineDOT drill rig is equipped with a CME automatic hammer to drive the split spoon. The hammer was calibrated by MaineDOT in February of 2009 and was found to deliver approximately 40 percent more energy during driving than the standard rope and cathead system. All N-values discussed in this report are corrected values computed by applying an average energy transfer factor of 0.84 to the raw field N-values. This hammer efficiency factor (0.84) and both the raw field N-value and the corrected N-value are shown on the boring logs.

Undisturbed tube samples were obtained in the soft soil deposits where possible. In-situ vane shear tests were made where possible in soft soil deposits to measure the shear strength of the strata. The bedrock was cored in the borings using an NQ-2 core barrel and the Rock Quality Designation (RQD) of the core was calculated. The MaineDOT Geotechnical Team member selected the boring locations and drilling methods, designated type and depth of sampling techniques and identified field and laboratory testing requirements. A Northeast Transportation Technical Certification Program (NETTCP) certified subsurface inspector logged the subsurface conditions encountered. The borings were located in the field by use of a tape after completion of the drilling program.

Details and sampling methods used, field data obtained and soil and groundwater conditions encountered are presented in the boring logs in Appendix A and on Sheet 3 – Boring Logs found at the end of this report.

## 4.0 LABORATORY TESTING

Laboratory testing for samples obtained in the borings consisted of six (6) standard grain size analyses, twenty-eight (28) grain size analysis with hydrometer, twenty-two (22) Atterberg Limits test, five (5) consolidation tests and five (5) standard tube openings. Laboratory test results are provided in Appendix B - Laboratory Data at the end of this report. Moisture content information and other soil test results are included on the Boring Logs in Appendix A and on Sheet 3 - Boring Logs found at the end of this report.

## 5.0 SUBSURFACE CONDITIONS

The general soil stratigraphy encountered at the abutments consisted of fill sand, silt, clayey silt, and sand/glacial till. The full depth of the soil strata was not penetrated in the borings due to the great depth of the borings (>100 feet) and the difficult drilling conditions within the glacial till. An interpretive subsurface profile depicting the site stratigraphy is show on Sheet 2 – Boring Location Plan and Interpretive Subsurface Profile found at the end of this report. The following paragraphs discuss the subsurface conditions encountered in detail:

### 5.1 Sand Fill

Beneath the pavement, a layer of sand fill materials was encountered behind the abutments. This layer was found to be brown, moist to wet, fine to coarse sand, with some silt, trace gravel, trace gravel and trace organics. The thickness of the sand fill layer ranged from approximately 8.5 feet in boring BB-MJS-101 to approximately 8.0 feet in boring BB-MJS-102. Corrected SPT N-values in the fill layer ranged from 3 to 17 blows per foot (bpf) indicating that the soil is loose to medium dense in consistency. Water contents from three (3) samples obtained within this layer range from approximately 11% to 20%. Three (3) grain size analyses conducted on samples from this layer indicate that the soil is classified as an A-2-4 or A-4 by the AASHTO Classification System and a SM or SC-SM by the Unified Soil Classification System.

### 5.2 Silt

Beneath the sand fill layer a layer of silt was encountered. This layer was found to be grey, wet, silt, with some to little clay, and trace fine sand in layers. A thin layer (approximately 3.5 feet thick) of dark brown, wet, soft, silt with little fine sand, little clay and trace organics was encountered in the upper portion of boring BB-MJS-102. The thickness of the overall silt layer ranged from approximately 34.5 feet in boring BB-MJS-101 to approximately 42.0 feet in boring BB-MJS-102. Vane shear testing conducted within the silt showed measured undrained shear strengths ranging from approximately 247 to 879 psf while the remolded shear strength ranged from approximately 27 to 110 psf. These shear strength values indicate that the undisturbed silt is soft to medium stiff in consistency. Based on the ratio of peak to remolded shear strengths from the vane shear tests, the clayey silt was determined to have sensitivity ranging from approximately 3.5 to 16.0 and is classified as moderately sensitive to slightly quick. Water contents from twelve (12) samples obtained within this layer range from approximately 22% to 29%. Twelve (12) grain size analyses conducted on samples from this layer indicate that the soil is classified as an A-4 by the AASHTO Classification System and a CL-ML by the Unified Soil Classification System.

Table 5-1 below summarizes the results of the Atterberg Limits tests from samples of the silt:

| Sample No. | Water Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | Liquidity Index |
|---|---|---|---|---|---|
| BB-MJS-101 3D | 24.0 | Non Plastic | | | |
| BB-MJS-101 4D | 26.0 | Non Plastic | | | |
| BB-MJS-101 5D | 25.4 | Non Plastic | | | |
| BB-MJS-101 6D | 26.2 | 23 | 18 | 5 | 1.64 |
| BB-MJS-101 7D | 26.8 | Non Plastic | | | |
| BB-MJS-102 7D | 28.3 | Non Plastic | | | |
| BB-MJS-102 8D | 29.0 | 25 | 18 | 7 | 1.57 |
| BB-MJS-102 9D | 24.7 | 22 | 17 | 5 | 1.54 |
| BB-MJS-102 10D | 28.8 | 22 | 17 | 5 | 2.36 |

**Table 5-1 – Summary of Atterberg Limits Testing Results for Silt Samples**

Interpretation of these results indicates that the silt is on the verge of being a viscous liquid as the natural water content exceeds the liquid limit. This indicates that the soils have a high liquefaction potential. It can be inferred that overburden pressure and interparticle cementation are providing stability for these soils. Under these conditions the slightest disturbance causing remolding has the potential to convert this type of deposit into a viscous liquid. Liquidity index values greater than or equal to 1 are indicative of soils that are unconsolidated and have a high liquefaction potentially commonly referred to as "quick".

### 5.3 Sand

A thin layer (approximately 9.0 feet thick) of grey, wet, loose, fine to coarse sand with some silt, little clay and trace gravel was encountered at the bottom of the silt layer in boring BB-MJS-102. A water content from a sample obtained within this sand layer was approximately 17%. One (1) grain size analysis conducted on a sample from the sand layer indicated that the soil is classified as an A-2-4 by the AASHTO Classification System and a SC-SM by the Unified Soil Classification System. One (1) Atterberg Limits test conducted on a sample from the sand layer indicated that the soil is non-plastic. This layer was not encountered in boring BB-MJS-101.

### 5.4 Clayey Silt

Beneath the silt a layer of clayey silt was encountered. This layer was found to be grey, wet, clayey silt, with trace fine sand. The thickness of the clayey silt layer ranged from approximately 39.9 feet in boring BB-MJS-101 to approximately 34.5 feet in boring BB-MJS-102. Vane shear testing conducted within the clayey silt layer showed undrained shear strengths ranging from approximately 220 psf to 989 psf while the remolded shear strengths ranged from approximately 27 psf to 165 psf. These shear strength values indicate that the undisturbed clayey silt is very soft to medium stiff in consistency. Based on the ratio of peak to remolded shear strengths from the vane shear tests, the clayey silt was determined to have sensitivities ranging from approximately 4.0 to 29.5 and is classified as sensitive to slightly quick. Water contents from thirteen (13) samples obtained within the clayey layer range from approximately 26% to 36%. Thirteen (13) grain size analyses conducted on samples from this layer indicate that the soil is classified as an A-4 or A-6 by the AASHTO Classification System and a CL-ML or CL by the Unified Soil Classification System.

Table 5-2 below summarizes the results of the Atterberg Limits tests from samples of the clayey silt:

| Sample No. | Water Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | Liquidity Index |
|---|---|---|---|---|---|
| BB-MJS-101 10D | 27.8 | 23 | 17 | 6 | 1.80 |
| BB-MJS-101 1U | 33.4 | 25 | 18 | 7 | 2.20 |
| BB-MJS-101 2U | 30.7 | 26 | 18 | 8 | 1.59 |
| BB-MJS-101 12D | 26.3 | 24 | 16 | 8 | 1.29 |
| BB-MJS-101 3U | 35.6 | 35 | 21 | 14 | 1.04 |
| BB-MJS-101 13D | 28.9 | 31 | 19 | 12 | 0.83 |
| BB-MJS-102 12D | 27.6 | 26 | 18 | 8 | 1.20 |
| BB-MJS-102 2U | 28.7 | 23 | 18 | 5 | 2.14 |
| BB-MJS-102 3U | 31.6 | 29 | 19 | 10 | 1.26 |
| BB-MJS-102 13D | 28.7 | 30 | 20 | 10 | 0.87 |
| BB-MJS-102 14D | 26.6 | 36 | 21 | 15 | 0.37 |
| BB-MJS-102 15D | 26.1 | 30 | 19 | 11 | 0.65 |

**Table 5-2 – Summary of Atterberg Limits Testing Results for Clayey Silt Samples**

Interpretation of these results indicates that the clayey silt ranges from being on the verge of becoming a viscous liquid to slightly over-consolidated. For eight (8) samples the natural water content is equal to or exceeds the liquid limit and the liquidity index exceeds 1, indicating that the silty clay is on the verge of becoming a viscous liquid. These soils have a high liquefaction potential. It can be inferred that overburden pressure and interparticle cementation are providing stability for these soils. Under these conditions the slightest disturbance causing remolding has the potential to convert this type of deposit into a viscous liquid. Liquidity index values greater than or equal to 1 are indicative of soils that are unconsolidated and have a high liquefaction potentially commonly referred to as “quick”.

Five (5) one-dimensional consolidation tests were conducted on tube samples taken from various depths within the clayey silt layer. The results of these tests were used to calculate the anticipate settlements at the site and are included in Appendix B – Laboratory Data.

### 5.5 Sand/Glacial Till

Beneath the clayey silt layer a layer of sand/glacial till was encountered. This layer was found to be grey, wet, silty fine sand, fine to coarse sand, and sand/glacial till with cobbles and boulders. The thickness of the sand/glacial till layer was not fully penetrated in the borings. Corrected SPT N-values in the upper sand layer ranged from 3 to 27 bpf indicating that the upper sand is loose to medium dense in consistency. The layer increases in density with depth and becomes cemented. Attempts to sample the cemented glacial till were unsuccessful. Water contents from five (5) samples obtained within the upper sand range from approximately 17% to 24%. Five (5) grain size analyses conducted on samples from the upper sand indicate that the sand is classified as an A-4, A-2-4 or A-3 by the AASHTO Classification System and a SM, SP-SM, or SC-SM by the Unified Soil Classification System.

### 5.6 Groundwater

Groundwater was observed at a depths ranging from approximately 5.5 feet to 9.0 feet below the existing ground surface. The water levels measured upon completion of drilling are indicated on the boring logs found in Appendix A. Note that water was introduced into the boreholes during the drilling operations. It is likely that the water levels indicated on the boring logs do not represent stabilized groundwater conditions. Additionally, groundwater levels are expected to fluctuate seasonally depending upon the local precipitation magnitudes.

## 6.0 FOUNDATION ALTERNATIVES

The subsurface conditions encountered at the site indicate that the bridge location is underlain by a significant compressible silt and clayey silt layer. Due to the soft nature and depth of the soils, shallow foundations were not considered for use at the site. The following foundation alternatives are considered viable:

- Driven H-pile supported integral abutments
- Drilled shafts

It is anticipated that the proposed replacement structure will be supported on driven H-piles. Due to the great depth of the overburden at the site location it is also anticipated that the piles will be design as friction piles driven to an approved stopping criteria within the glacial till layer. The use of drilled shafts is likely more expensive than driven H-piles and has not been pursued as a part of this report.

## 7.0 FOUNDATION CONSIDERATIONS AND RECOMMENDATIONS

The following sections will discuss geotechnical design recommendations for stub abutments founded on a single row of integral friction H-piles which has been identified as the optimal substructure for the site.

## 7.1 Integral Abutment H-Piles

The use of stub abutments founded on a single row of driven integral H-piles is a viable foundation system for use at the site. The piles should be designed for end bearing and friction resistance and driven to an approved stopping criterion within the glacial till layer. Piles may be HP 12x53, HP 12x74, HP 14x73, HP 14x89, or HP 14x117 depending on the factored design axial loads. Piles should be 50 ksi, Grade A572 steel H-piles. The piles should be oriented for weak axis bending. Piles should be fitted with driving points to protect the tips and improve penetration.

Pile lengths at the proposed abutments will be on the order of 110 to 115 feet based on a required pile tip penetration of 10 feet into the basal till unit. The actual pile tip penetration may exceed 10 feet at some locations. Required and estimated pile tip elevations should be provided on the plans. The piles are anticipated to be friction piles driven to an approved stopping criterion within the glacial till layer. The full depth of the glacial till layer was not penetrated in the borings due to the great depth of the overburden soils.

The H-piles shall design for the strength limit state considering the structural resistance of the piles, the geotechnical resistance of the pile and loss of the lateral support due to scour at the design flood event. The structural resistance check should include checking axial, lateral, and flexural resistance. Resistance factors for use in the design of piles at the strength limit state are discussed in Section 7.1.1 below.

The design of the H-piles at the service limit state shall consider tolerable horizontal movement of the piles, overall stability of the pile group and displacements considering changes in foundation conditions due to scour at the design flood event. Extreme limit state design shall check that the nominal pile resistance remaining after scour due to the check flood can support the extreme limit state loads with a resistance factor of 1.0. The design and check floods for scour are defined in AASHTO LRFD Bridge Design Specifications 4th Edition (LRFD) Articles 2.6.4.4.2 and 3.7.5.

### 7.1.1 Strength Limit State Design

The nominal compressive resistance ($P_n$) in the strength limit state for piles loaded in compression shall be as specified in LRFD Article 6.9.4.1. For preliminary analyses the H-piles were assumed fully embedded and the column slenderness factor, $\lambda$, was taken as 0. The factored structural axial compressive resistances of the five (5) proposed H-pile sections were calculated using a resistance factor, $\phi_c$, of 0.50 and a $\lambda$ of 0. It is the responsibility of the structural designer to recalculate $\lambda$ for the upper and lower portions of the H-pile based on unbraced length and K-values from project specific L-Pile® analyses and recalculate structural resistances.

For the portion of the pile which is theoretically in pure compression, i.e. below the point of fixity, the factored structural axial resistances of five (5) H-pile sections were calculated using a resistance factor, $\phi_c$, of 0.50. The factored structural axial resistance may be controlled by the combined axial and flexural resistance of the pile. This is the responsibility of the structural designer.

The nominal and factored axial geotechnical resistance in the strength limit state was calculated using the FHWA software program DRIVEN which uses the α-method (Tomlinson) to calculate pile capacity versus depth for the soil profile in cohesive layers and Nordlund and Thurman methods to calculate shaft resistance and pile tip bearing resistance, respectively, in cohesion less layers. The factored geotechnical resistances of the five (5) proposed H-pile sections were calculated using a resistance factor, $\varphi_{stat}$, of 0.35 for side friction resistance in the silt clay unit and 0.45 for side friction and end bearing resistance in the cohesionless lower unit.

The drivability of the five (5) proposed H-pile sections was considered. The maximum driving stresses in the pile, assuming the use of 50 ksi steel, shall be less than 45 ksi. As the piles will be friction piles driven to an approved stopping criterion within the glacial till layer a drivability analysis to determine the resistance that must be achieved was conduced. The resistance factor for a single pile in axial compression when a dynamic test is done given in LRFD Table 10.5.5.2.3-1 is $\varphi_{dyn}$= 0.65. Table 10.5.5.2.3-3 requires that no less than three to four dynamic tests be conducted for sites with low to medium variability. Per LFRD Article 10.5.5.2.3 the resistance factor 0.65 is reduced by 20% since it is applied to a nonredundant pile group, i.e., there are less than 5 piles in a group. This results in a resistance factor, $\varphi_{dyn}$, of 0.52.

For the strength limit state, the calculated factored axial compressive structural, geotechnical and drivability resistances of the five (5) proposed H-pile sections for each abutment are summarized in Table 7-1 below. Supporting calculations are included in Appendix C-Calculations found at the end of this document.

| Pile Section | Strength Limit State Factored Axial Pile Resistance (kips) | | | | |
|---|---|---|---|---|---|
| | Structural Resistance* $\phi_c$=0.50 $\lambda$=0 | Geotechnical Resistance $\varphi_{stat}$=0.35 and $\varphi_{stat}$=0.45 (10 feet pile penetration into glacial till) | Geotechnical Resistance $\varphi_{stat}$=0.35 and $\varphi_{stat}$=0.45 (20 feet pile penetration into glacial till) | Drivability Resistance $\varphi_{dyn}$=0.52 | Governing Resistance Based on Static Analyses |
| HP 12 x 53 | 388 | 264 | 333 | 336 | 264 |
| HP 12 x 73 | 545 | 308 | 390 | 401 | 308 |
| HP 14 x 73 | 535 | 352 | 447 | 477 | 352 |
| HP 14 x 89 | 653 | 387 | 491 | 539 | 387 |
| HP 14 x 117 | 860 | 439 | 559 | 648 | 439 |

* based on preliminary assumption of $\lambda$=0 for the lower portion of the pile in only axial compression (no flexure)

**Table 7-1 - Factored Axial Resistances for Abutment Piles at the Strength Limit State**

The factored axial geotechnical resistance is less than the factored axial structural resistance and the factored axial drivability resistance. It is recommended that the maximum factored axial pile load used in design for the strength limit state not exceed the factored geotechnical resistance based on static analyses shown in Table 7-1, above.

Since the abutment piles will be modeled with a fixed pile head and subjected to lateral and axial loads, bending moments and displacements, the piles should be analyzed for combined axial compression and flexure resistance per LRFD Articles 6.9.2.2 and 6.15. An L-Pile® analysis by the project geotechnical engineer is recommended to evaluate the soil-pile interaction for combined axial and flexure, with factored axial loads, movements and pile head displacements applied. The resistance for the piles should be determined for compliance with the interaction equation. The upper portion of the pile is defined per LRFD Figure C6.15.2-1 as that portion of the pile above the point of second infection in the movement vs. pile depth curve, or at the lowest point of zero infection. Per LRFD Article 6.5.4.2, at the strength limit state, for H-piles in compression and bending, the axial resistance factor $\phi_c$=0.7 and the flexural resistance factor $\phi_f$ =1.0 shall be applied to the combined axial and flexural resistance of the pile in the interaction equation. The resistance of the pile in the lower zone need only be checked against axial load.

### 7.1.2 Service and Extreme Limit State Design

The design of the H-piles at the service limit state shall consider tolerable horizontal movement of the piles, overall stability of the pile group and displacements considering changes in foundation conditions due to scour at the design flood event. For the service limit state a resistance factor of 1.0 should be used for the calculation of structural, geotechnical and drivability axial pile resistances in accordance with LRFD Article 10.5.5.2. The overall global stability of the foundation should be investigated at the Service I Load Combination and a resistance factor of $\varphi$= 0.65.

The extreme limit state design shall include a determination that there is adequate nominal foundation resistance remaining after scour due to the check flood to resist the unfactored extreme limit state load combination with a resistance factor of 1.0.

The calculated factored axial structural, geotechnical and drivability resistances of the five (5) proposed H-pile sections were calculated for the service and extreme limit states and are summarized in Table 7-2 below. Supporting calculations are included in Appendix C-Calculations found at the end of this document.

| Pile Section | Service and Extreme Limit States Factored Axial Pile Resistance (kips) | | | | |
|---|---|---|---|---|---|
| | Structural Resistance* $\phi$=1.0 $\lambda$=0 | Geotechnical Resistance $\varphi$=1.0 (10 feet pile penetration into glacial till) | Geotechnical Resistance $\varphi$=1.0 (20 feet pile penetration into glacial till) | Drivability Resistance $\varphi$=1.0 | Governing Resistance |
| HP 12 x 53 | 775 | 619 | 772 | 647 | 619 |
| HP 12 x 73 | 1090 | 718 | 901 | 772 | 718 |
| HP 14 x 73 | 1070 | 822 | 1032 | 917 | 822 |
| HP 14 x 89 | 1305 | 898 | 1131 | 1037 | 898 |
| HP 14 x 117 | 1720 | 1015 | 1283 | 1247 | 1015 |

* based on preliminary assumption of $\lambda$=0 for the lower portion of the pile in only axial compression (no flexure)

**Table 7-2 - Factored Axial Resistances for Abutment Piles at the Service and Extreme Limit States**

The factored axial geotechnical resistance is less than the factored axial structural and drivability resistances. It is recommended that the maximum factored axial pile load used in design for the service and extreme limit states not exceed the factored geotechnical resistance shown in Table 7-2, above.

### 7.1.3 Driven Pile Resistance and Pile Quality Control

Based on the anticipated pile lengths at the site, pile splices will be required. The location and number of pile splices shall be in conformance with MaineDOT Standard Specification 501 and be subject to the approval of the Resident. The splices shall be the Champion HP-30000, or approved equivalent, mechanical splicer. Evaluation of equivalent products will be based on the submission of data demonstrating the capability of transferring the full pile strength in compression and tension and developing the bending moment capacity of the pile in both the x-x and y-y axes. The splicers shall be installed and welded as recommended by the manufacturer. Welding shall not be done when the temperature in the immediate vicinity of the weld is below 0°F; when the surfaces are damp or exposed to rain, snow, or high wind; or when the welders or welding operators are exposed to inclement conditions. The pile shall be preheated to and maintained at 150°F minimum within 6 inches from the weld during welding. Formal welding procedures are not required. Welders shall be prequalified in accordance with Section 504 - Structural Steel.

The Contract documents should require the Contractor to perform a wave equation analysis of the proposed pile-hammer system and a dynamic pile test with signal matching at each abutment. The first pile driven at each abutment should be dynamically tested to confirm capacity and verify the stopping criteria developed by the Contractor in the wave equation analysis. Restrikes will be required as part of the pile field quality control program. With this level of quality control, the ultimate pile resistance that must be achieved in the wave equation analysis and dynamic testing will be the factored axial pile load divided by a resistance factor, $\varphi_{dyn}$ of 0.52. The maximum factored pile load should be shown on the plans. If three to four piles are dynamically tested and if there are a minimum of five piles per group, the resistance factor may be increased by 20 percent to 0.65. Calculations for the pile resistance required by a drivability wave equation analysis are included the Appendix C- Calculations.

Piles should be driven to an acceptable penetration resistance as determined by the results of a wave equation analysis, the dynamic pile load test, the restrike pile test, the CAPWAP analysis and as approved by the Resident. Driving stresses in the pile determined in the drivability analysis shall be less than 45 ksi in accordance with LRFD Article 10.7.8. A hammer should be selected which provides the required resistance when the penetration resistance for the final 3 to 6 inches is 8 to 13 blows per inch. If an abrupt increase in driving resistance is encountered, the driving could be terminated when the penetration is less than 0.5-inch in 10 consecutive blows.

### 7.2 Integral Stub Abutment Design

Integral abutment sections shall be designed for all relevant strength, service and extreme limit states and load combinations specified in LRFD Articles 3.4.1 and 11.5.5. The design of pile supported abutments at the strength limit state shall consider pile group failure and structural reinforced concrete failure. Strength limit state design shall also consider change in foundation conditions and pile group resistance after scour due to the design flood.

A resistance factor of $\phi$= 1.0 shall be used to assess abutment design at the service limit state including: settlement, excessive horizontal movement and movement resulting from scour at the design flood. The strength limit state loads include any debris loads occurring during the design flood event. The overall global stability of the foundation should be investigated at the Service I Load Combination and a resistance factor, $\varphi$, of 0.65.

Extreme limit state design checks for abutments supported on piles shall include pile structural resistance, pile geotechnical resistance, pile resistance in combined axial and flexure, and overall stability. Resistance factors, $\phi$, for the extreme limit state shall be taken as 1.0. Extreme limit state design shall also check that the nominal resistance remaining after scour due to the check flood can support the extreme limit state loads with a resistance factor of 1.0.

The Designer may assume Soil Type 4 (MaineDOT BDG Section 3.6.1) for backfill material soil properties. The backfill properties are as follows: $\phi$ = 32 degrees, $\gamma$ = 125 pcf and a soil-concrete friction coefficient of 0.45. Cast-in-place integral abutments and wingwall sections that are integral with the abutments shall be designed to withstand a maximum applied lateral load equal to the passive earth pressure state. The Coulomb passive earth pressure coefficient, $K_p$, of 6.89 is recommended. Developing full passive requires displacements of the abutment on the order of 2 to 5 percent of the abutment height. If the calculated displacements are significantly less than that required to develop full passive pressure, the designer may consider using the Rankine passive earth pressure case, which assumes no wall friction, or designing using a reduced Coulomb passive earth pressure coefficient, but not less than the Rankine passive earth pressure case using a Rankine passive earth pressure coefficient, $K_p$, of 3.25. A load factor for passive earth pressure is not specified in LRFD. Use the maximum load factor for active earth pressure, $\gamma_{EH}$ = 1.50.

Additional lateral earth pressure due to construction surcharge or live load surcharge is required per Section 3.6.8 of the MaineDOT BDG for abutments and wingwalls if an approach slab is not specified. When a structural approach slab is specified, reduction, not elimination, of the surcharge load is permitted per LRFD Article 3.11.6.5. The live load surcharge on abutments may be estimated as a uniform horizontal earth pressure due to an equivalent height ($h_{eq}$) taken from Table 7-3 below:

| Abutment Height | $h_{eq}$ |
|---|---|
| 5 feet | 4.0 feet |
| 10 feet | 3.0 feet |
| ≥20 feet | 2.0 feet |

**Table 7-3 - Equivalent Height of Soil for Vehicular Loading on Abutments Perpendicular to Traffic**

All abutment and wingwall designs shall include a drainage system behind the abutments to intercept any groundwater. Drainage behind the structure shall be in accordance with Section 5.4.1.4 Drainage of the MaineDOT BDG. Geocomposite drainage board applied to the backsides of the abutments and wingwalls with weep holes will provide adequate drainage. The approach slab should be positively connected to the integral abutment.

Backfill within 10 feet of the abutments and wingwalls and side slope fill shall conform to Granular Borrow for Underwater Backfill - MaineDOT Specification 709.19. This gradation specifies 10 percent or less of the material passing the No. 200 sieve. This material is specified in order to reduce the amount of fines and to minimize frost action behind the structure.

Slopes in front of the pile supported integral abutments should be set back from the riverbank and should be constructed with riprap and erosion control geotextile. The slopes should not exceed 1.75H:1V.

### 7.3 Scour and Riprap

Grain size analyses were performed on soil samples taken at the approximate streambed elevation to generate grain size curves for determining parameters to be used in scour analysis. The samples were assumed to be similar in nature to the soils likely to be exposed to scour conditions. The following streambed grain size parameters can be used in scour analyses:

- Average diameter of particle at 50 percent passing, $D_{50}$ = 0.025 mm
- Average diameter of particle at 95 percent passing, $D_{95}$ = 0.182 mm
- Soil Classification AASHTO Soil Type A-4

The grain size curves are included in Appendix B- Laboratory Data found at the end of this report.

The consequences of changes in foundation conditions resulting from the design and check floods for scour shall be considered at the strength and extreme limit states, respectively. Design at the strength limit state should consider loss of lateral and vertical support due to scour. Design at the extreme limit state should check that the nominal foundation resistance due to scour at the check flood event is no less than the unfactored extreme limit state loads. At the service limit state, the design shall limit movements and overall stability considering scour at the design load.

For scour protection and protection of pile groups, the bridge approach slopes and slopes at abutments should be armored with 3 feet of riprap. Refer to MaineDOT BDG Section 2.3.11 for information regarding scour design.

Stone riprap shall conform to item number 703.26 of the MaineDOT Standard Specifications and shall be placed at a maximum slope of 1.75H:1V. The toe of the riprap section shall be constructed 1 foot below the streambed elevation. The riprap section shall be underlain by a Class 1 nonwoven erosion control geotextile and a 1 foot thick layer of bedding material conforming to item number 703.19 of the MaineDOT Standard Specifications.

### 7.4 Settlement

The vertical alignment of the proposed bridge may be raised as much as 6 inches for construction of the proposed replacement bridge. The soils at the site are compressible and are susceptible to consolidation if the in-situ stresses are increased above the current levels (i.e., consolidation will occur if fill is placed or if structures are supported on compressible soils). Evaluation of the potential settlement due to the placement of up to 6 inches of fill resulted in less than ½ inch of settlement. This settlement is anticipated to occur over a long period of time (years) and may require attention by a maintenance crew. Studies indicate that settlements in excess of 0.4 inches in soils where driven piles are present will result in downdrag forces on piles. Provided the fills placed at the site are not in excess of 6 inches, no downdrag forces will need to be accounted for in the design of the pile foundations. In the event that larger fills are found to be necessary during final design, the settlement induced by those fills and any downdrag considerations will need to the evaluated at that time.

### 7.5 Frost Protection

Integral abutments shall be embedded a minimum of 4.0 feet for frost protection per Figure 5-2 of the MaineDOT BDG.

Any foundation placed on granular subgrade soils should be designed with an appropriate embedment for frost protection. According to the MaineDOT frost depth maps for the State of Maine (MaineDOT BDG Figure 5-1) the site has a design-freezing index of approximately 1550 F-degree days. This correlates to a frost depth of 6.0 feet. Therefore, any foundations placed on granular soils should be founded a minimum of 6.0 feet below finished exterior grade for frost protection. See Appendix C- Calculations at the end of this report for supporting documentation.

### 7.6 Seismic Design Considerations

In conformance with LRFD Article 4.7.4.2 seismic analysis is not required for single-span bridges regardless of seismic zone. According to Figure 2-2 of the MaineDOT BDG, the Jock Stream Bridge is not on the National Highway System (NHS). The bridge is not classified as a major structure since the construction costs will not exceed $10 million. These criteria eliminate the MaineDOT BDG requirement to design the foundations for seismic earth loads. However, superstructure connections and minimum support length requirements shall be satisfied per LRFD Articles 3.10.9 and 4.7.4.4, respectively.

The following parameters were determined for the site from the USGS Seismic Parameters CD provided with the LRFD manual and LRFD Articles 3.10.3.1 and 3.10.6:

- Peak Ground Acceleration coefficient (PGA) = 0.084g
- Site Class E (site soils with an average N-value less than 15 bpf or any profile with more than 10 feet of soft clay and an undrained shear strength less than 500 psf)
- Acceleration coefficient ($A_s$) = 0.209
- Design spectral acceleration coefficient at 0.2-second period ($S_{DS}$) = 0.425g
- Design spectral acceleration coefficient at 1.0-second period ($S_{D1}$) = 0.162g
- Seismic Zone 2 (based on $S_{D1}$ greater than 0.15g and less than or equal to 0.30g)

See Appendix C- Calculations at the end of this report for supporting documentation.

### 7.7 Construction Considerations

Construction of the abutments will require soil excavation and partial or full removal of the existing abutments. Construction activities may require cofferdams and earth support systems. The removal of the existing abutments may require the replacement of excavated soils with compacted granular fill prior to pile driving.

In some locations the native soils may be saturated and significant water seepage may be encountered during construction. There may be localized sloughing and surface instability in some soil slopes. The Contractor should control groundwater, surface water infiltration and soil erosion during construction.

Using the excavated native soils as structural backfill should not be permitted. The native soils may only be used as common borrow in accordance with MaineDOT Standard Specifications 203 and 703.

The Contractor will have to excavate the existing subbase and subgrade fill soils in the bridge approaches. These materials should not be used to re-base the new bridge approaches. Excavated subbase sand and gravel may be used as fill below subgrade level in fill areas provided all other requirements of MaineDOT Standard Specifications 203 and 703 are met.

The Construction Documents shall include the following notes and information:

1. H-piles shall be driven to at least the minimum required tip penetration elevations shown in the table below and to the required penetration resistance as determined by wave equation analysis, dynamic load testing, restrikes, and signal matching analysis. For estimating purposes, it is anticipated that the piles will penetrate approximately 10 feet into the glacial till, however, the till material is variable and the actual penetration may exceed 10 feet at some locations. The estimated typical tip penetrations do not include the allowance for an additional 10 feet of pile required for those piles that undergo dynamic testing and restrike testing.

| Structure | Minimum Required Tip Penetration Elevation (NAVD 88) | Estimated Typical Tip Penetration Elevation (NAVD 88) |
|---|---|---|
| Abutment No. 1 | 53 feet | 33 feet |
| Abutment No. 2 | 48 feet | 28 feet |

**Table 7-4 – Estimated Pile Tip Elevations**

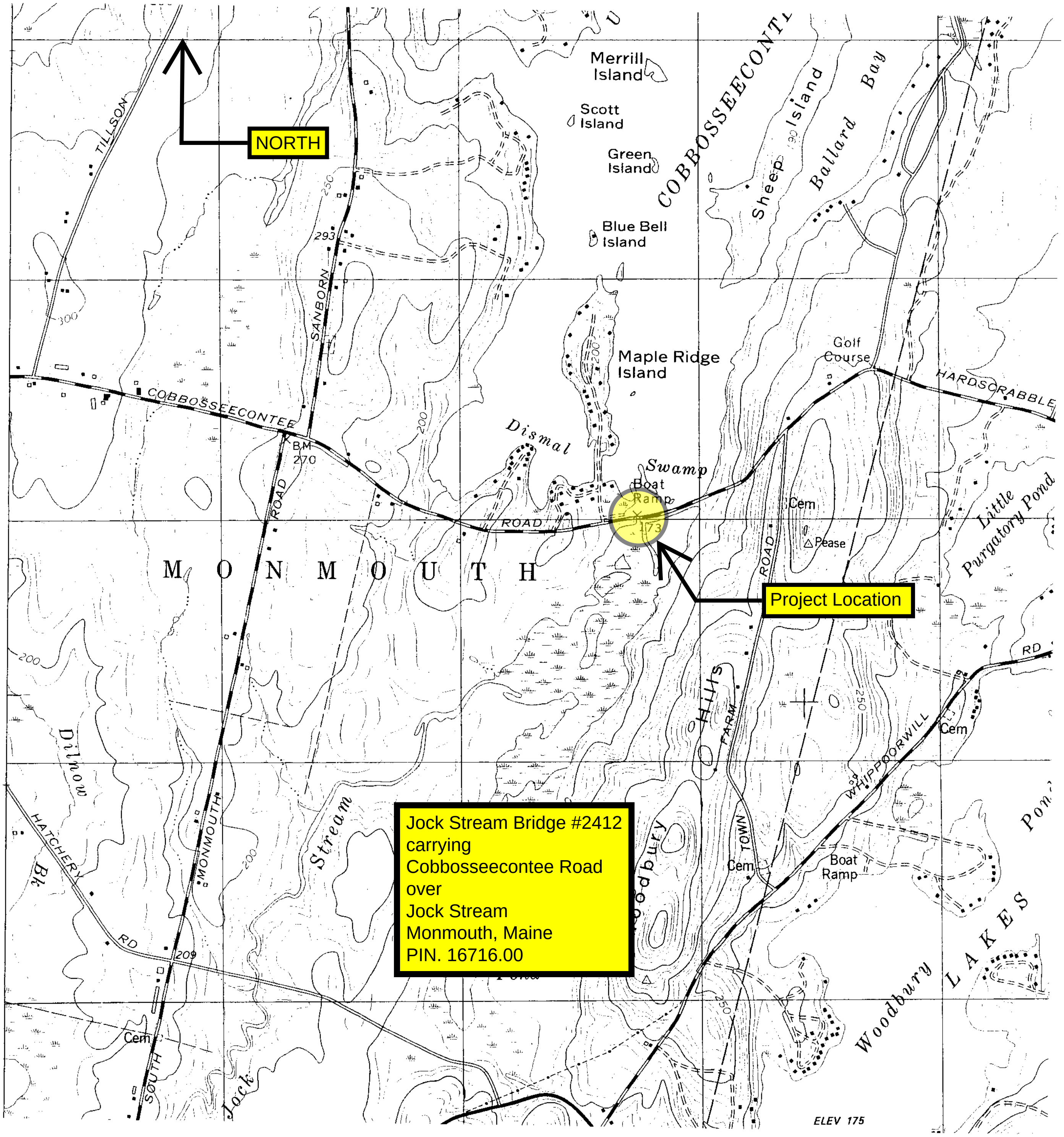
2. The Contractor shall perform one (1) dynamic load test and one (1) restrike load test after 24 hours at each abutment to confirm the normal resistance of the pile. The required nominal resistance of the pile is the maximum factored axial load divided by a resistance factor of 0.52 per LRFD Specifications. Each dynamic load test and restrike will be performed on the first production pile driven at each abutment in accordance with Standard Specification 501.

## 8.0 CLOSURE

This report has been prepared for the use of the MaineDOT Bridge Program for specific application to the proposed replacement of Jock Stream Bridge in Monmouth, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use is implied. In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes in design. Further, the analyses and recommendations are based in part upon limited soil explorations at discrete locations completed at the site. If variations from the conditions encountered during the investigation appear evident during construction, it may also become necessary to re-evaluate the recommendations made in this report.

We also recommend that we be provided the opportunity for a general review of the final design and specifications in order that the earthwork and foundation recommendations may be properly interpreted and implemented in the design.

## Sheets




# PURGATORY QUADRANGLE

MAINE

7.5 MINUTE SERIES (TOPOGRAPHIC)

NW/4 GARDINER 15' QUADRANGLE

SCALE 1:24 000

1 ½ 0 1 MILE

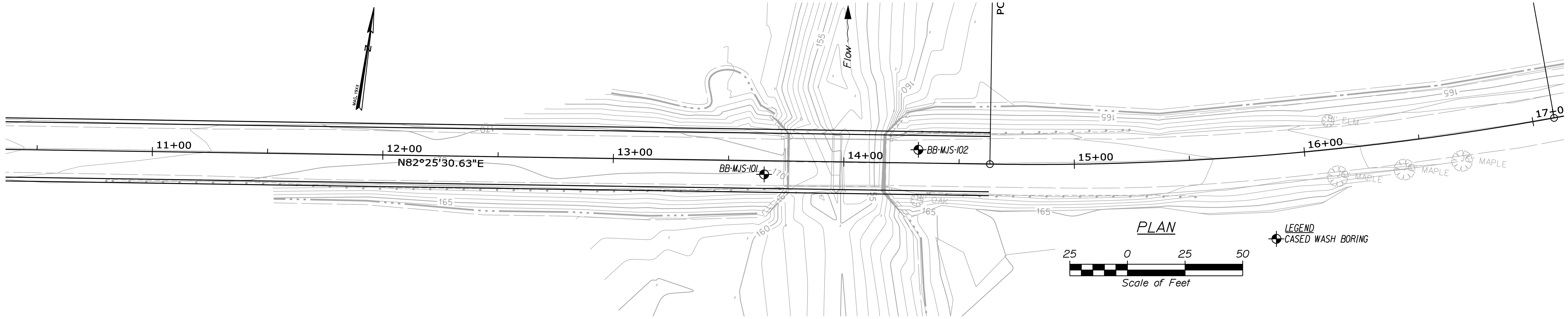
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

Filename: ...\GEOTECH\MSTA\006_BLP&ISP1.dgn Division: GEOTECH Username: terry.white Date:11/17/2009





Note: This generalized interpretive soil profile 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 may vary and are probably more erratic. For more specific information refer to the exploration logs.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BR-1671(600)X

PIN 16716.00

BRIDGE PLANS

BRIDGE NO. 2412

| | BY | DATE |
|---|---|---|
| PROJ. MANAGER | | |
| DESIGN-DETAILED | K. MAGUIRE | |
| CHECKED-REVIEWED | T. WHITE | OCT 2009 |
| DESIGN2-DETAILED2 | | |
| DESIGN3-DETAILED3 | | |
| REVISIONS 1 | | |
| REVISIONS 2 | | |
| REVISIONS 3 | | |
| REVISIONS 4 | | |
| FIELD CHANGES | | |

SIGNATURE

P.E. NUMBER

DATE

JOCK STREAM BRIDGE
JOCK STREAM
MONMOUTH KENNEBEC COUNTY

BORING LOCATION PLAN &
INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
2
OF 3

# Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock
Location: Monmouth, Maine

Boring No.: BB-MJS-101
PIN: 16716.00

| | | | | | |
|---|---|---|---|---|---|
| Driller: | MaineDOT | Elevation (ft.) | 169.8 | Auger ID/OD: | 5" Solid Stem |
| Operator: | E. Giguere, C. Giles | Datum: | NAVD 88 | Sampler: | Standard Split Spoon |
| Logged By: | B. Wilder | Rig Type: | CME 45C | Hammer Wt./Fall: | 140#/30" |
| Date Start/Finish: | 6/16,19,24/09 | Drilling Method: | Cased Wash Boring | Core Barrel: | NQ-2" |
| Boring Location: | 13+65.5, 5.9 Rt. | Casing ID/OD: | HW | Water Level*: | 9.0' bgs. |
| Hammer Efficiency Factor: 0.84 | | 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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | 169.45 | Pavement ——— 0.35 | |
| | 1D | 24/20 | 1.00 - 3.00 | 4/7/5/5 | 12 | 17 | | | Brown, moist, medium dense, fine to coarse SAND, some silt, trace gravel. | G#212264 A-2-4, SM WC=10.5% |
| 5 | 2D | 24/18 | 5.00 - 7.00 | 1/1/1/50 | 2 | 3 | | | Brown, wet, very loose, fine to coarse SAND, some silt, trace clay, trace gravel, trace organics. | G#212265 A-4, SC-SM WC=19.9% |
| | | | | | | | | 161.30 | ——— 8.50 | |
| 10 | MD | 24/0 | 10.00 - 12.00 | 2/2/2/3 | 4 | 6 | 22 | | Failed sample attempt, similar to 3D, medium stiff, off auger flight. | |
| | | | | | | | 29 | | | |
| | | | | | | | 25 | | | |
| | | | | | | | 26 | | | |
| | 3D | 24/21 | 14.00 - 16.00 | 3/4/4/4 | 8 | 11 | 38 | | Grey, wet, stiff, SILT, little clay, trace fine sand. | G#212266 A-4, CL-ML WC=24.0% Non-plastic |
| 15 | | | | | | | 38 | | | |
| | | | | | | | 36 | | | |
| | | | | | | | 31 | | | |
| | | | | | | | 31 | | | |
| | 4D | 24/17 | 19.00 - 21.00 | 1/1/WOH/WOH | 1 | 1 | 29 | | Grey, wet, very soft, SILT, little clay, trace fine sand. | G#212267 A-4, CL-ML WC=26.0% Non-plastic |
| 20 | | | | | | | 22 | | | |
| | | | | | | | 20 | | | |
| | | | | | | | 16 | | | |
| | | | | | | | 15 | | | |
| | 5D | 24/20 | 24.00 - 26.00 | WOH/WOH/WOH/WOH | --- | | 33 | | Grey, wet, soft, SILT, some clay, trace fine sand. | G#212268 A-4, CL-ML WC=25.4% Non-plastic |
| 25 | | | | | | | 26 | | Roller Coned ahead to 27.0' bgs. | |
| | V1 | | 26.00 - 26.37 | Su=312/89 psf | | | 25 | | 55x110 mm vane raw torque readings: V1: 7.0/2.0 ft-lbs | |
| | V2 | | 27.00 - 27.37 | Su=312/45 psf | | | 22 | | V2: 7.0/1.0 ft-lbs | |
| | | | | | | | 19 | | | |
| | 6D | 24/24 | 29.00 - 31.00 | WOR/WOR/WOR/WOR | --- | | 36 | | Grey, wet, soft, SILT, some clay, trace fine sand. | G#212269 A-4, CL-ML WC=26.2% LL=23 PL=18 PI=5 |
| 30 | | | | | | | 33 | | | |
| | V3 | | 31.00 - 31.43 | Su=247/55 psf | | | 28 | | 65x130 mm vane raw torque readings: V3: 9.0/2.0 ft-lbs | |
| | V4 | | 32.00 - 32.43 | Su=384/69 psf | | | 28 | | V4: 14.0/2.5 ft-lbs | |
| | | | | | | | 28 | | | |
| | MU/7D | 24/12 | 34.00 - 36.00 | WOR/WOR/WOR/WOR | --- | | 38 | | Failed Piston Sampler attempt. Grey, wet, soft, SILT, some clay, trace fine sand. | G#212270 A-4, CL-ML WC=26.8% Non-plastic |
| 35 | | | | | | | 32 | | | |
| | V5 | | 36.00 - 36.43 | Su=494/41 psf | | | 30 | | 65x130 mm vane raw torque readings: V5: 18.0/1.5 ft-lbs | |
| | V6 | | 37.00 - 37.43 | Su=384/27 psf | | | 36 | | V6: 14.0/1.0 ft-lbs | |
| | | | | | | | 33 | | | |
| | | | | | | | O&P | | O&P=Hydraulic Push | |
| 40 | MU/8D | 24/4 | 40.50 - 42.50 | WOR/WOR/WOR/WOR | --- | | 26 | | Failed Piston Sampler attempt. Grey, wet, soft, SILT, some clay, trace fine sand. | |
| | | | | | | | 50 | | | |
| | V7 | | 42.50 - 42.93 | Su=384/55 psf | | | 37 | 126.80 | ——— 43.00 65x130 mm vane raw torque readings: V7: 14.0/2.0 ft-lbs | |
| | V8 | | 43.50 - 43.93 | Su=494/41 psf | | | 33 | | V8: 18.0/1.5 ft-lbs | |
| | | | | | | | 38 | | | |
| 45 | MV 9D | 24/20 | 45.00 - 45.20 45.00 - 47.00 | Would Not Push WOR/WOR/WOR/WOR | --- | | 38 | | Failed 65x130 mm vane attempt. Grey, wet, soft, Clayey SILT with 1/2" fine sand layer. | G#212271 A-4, CL-ML WC=32.4% |
| | | | | | | | 31 | | | |
| | | | | | | | 28 | | | |
| | | | | | | | 30 | | | |
| | MU 10D | 24/0 24/24 | 49.00 - 51.00 49.00 - 51.00 | WOR/WOR/WOR/WOR | --- | | 30 | | Failed Piston Sampler attempt, let tube set 45 minutes. Grey, wet, soft to medium stiff, Clayey SILT, trace fine sand. | G#212272 A-4, CL-ML WC=27.8% LL=23 PL=17 PI=6 |
| 50 | | | | | | | 30 | | | |
| | V10 | | 51.00 - 51.43 | Su=220/55 psf | | | 27 | | 65x130 mm vane raw torque readings: V10: 8.0/1.5 ft-lbs | |
| | V11 | | 52.00 - 52.43 | Su=522/69 psf | | | 26 | | V11: 19.0/2.5 ft-lbs | |
| | | | | | | | 25 | | | |
| | 1U | 24/14 | 54.00 - 56.00 | Piston Sampler | | | 32 | | Grey, wet, soft, Clayey SILT, trace fine sand. Let tube set 60 minutes. | G,C#212273 A-4, CL WC=33.4% LL=25 PL=18 PI=7 |
| 55 | | | | | | | 29 | | | |
| | V12 | | 56.00 - 56.43 | Su=494/55 psf | | | 32 | | 65x130 mm vane raw torque readings: V12: 18.0/2.0 ft-lbs | |
| | V13 | | 57.00 - 57.43 | Su=467/41 psf | | | 24 | | V13: 17.0/1.5 ft-lbs | |
| | | | | | | | 24 | | | |
| | V14 11D | 24/24 | 59.00 - 59.43 59.00 - 61.00 | Su=494/82 psf WOR/WOR/WOR/WOR | --- | | 29 | | 65x130 mm vane raw torque readings: V14: 18.0/3.0 ft-lbs Similar to above, soft to medium stiff. | |
| 60 | V15 | | 60.00 - 60.43 | Su=604/55 psf | | | 23 | | V15: 22.0/2.0 ft-lbs | |
| | | | | | | | 21 | | | |
| | | | | | | | 21 | | | |
| | | | | | | | 30 | | | |
| | 2U | 24/24 | 64.00 - 66.00 | Piston Sampler | | | 30 | | Grey, wet, soft to medium stiff, Clayey SILT, trace fine sand. Let tube set 20 minutes. | G,C#212274 A-4, CL WC=30.7% LL=26 PL=18 PI=8 |
| 65 | | | | | | | 28 | | | |
| | V16 | | 66.00 - 66.43 | Su=343/27 psf | | | 27 | | 65x130 mm vane raw torque readings: V16: 12.5/1.0 ft-lbs | |
| | V17 | | 67.00 - 67.43 | Su=618/82 psf | | | 26 | | V17: 22.5/3.0 ft-lbs | |
| | | | | | | | 22 | | | |
| | V18 12D | 24/24 | 69.00 - 69.43 69.00 - 71.00 | Su=796/27 psf WOR/WOR/WOR/WOR | --- | | 31 | | 65x130 mm vane raw torque readings: V18: 29.0/1.0 ft-lbs Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G#212275 A-4, CL WC=26.3% LL=24 PL=16 PI=8 |
| 70 | V19 | | 70.00 - 70.43 | Su=687/96 psf | | | 28 | | V19: 25.0/3.5 ft-lbs | |
| | | | | | | | 26 | | | |
| | | | | | | | 21 | | | |
| | | | | | | | 23 | | | |
| | | | | | | | O&P | | | |
| 75 | | | | | | | | | | |

Remarks:

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: Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock
Location: Monmouth, Maine
Boring No.: BB-MJS-101
PIN: 16716.00
Driller: MaineDOT | Elevation (ft.) 169.8 | Auger ID/OD: 5" Solid Stem
Operator: E. Giguere, C. Giles | Datum: NAVD 88 | Sampler: Standard Split Spoon
Logged By: B. Wilder | Rig Type: CME 45C | Hammer Wt./Fall: 140#/30"
Date Start/Finish: 6/16,19,24/09 | Drilling Method: Cased Wash Boring | Core Barrel: NQ-2"
Boring Location: 13+65.5, 5.9 Rt. | Casing ID/OD: HW | Water Level*: 9.0' bgs.
Hammer Efficiency Factor: 0.84 | Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐

| 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.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 3U | 24/20 | 75.50 - 77.50 | Piston Sampler | | | 54 | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G,C#212301 A-6, CL WC=35.6% LL=35 PL=21 PI=14 |
| | | | | | | | 54 | | | |
| | V20 | | 77.50 - 77.93 | Su=536/41 psf | | | 50 | | 65x130 mm vane raw torque readings: V20: 19.5/1.5 ft-lbs | |
| | MV | | | Would Not Push | | | 43 | | Failed 65x130 mm vane attempt. | |
| | 13D | 24/24 | 79.00 - 81.00 | WOR/WOR/WOR/WOR | --- | | 54 | | Grey, wet, soft, Clayey SILT with 1/2" fine sand layers. | G#212302 A-6, CL WC=28.9% LL=31 PL=19 PI=12 |
| 80 | | | | | | | 46 | | | |
| | MV | | 81.00 - 81.30 | Would Not Push | | | 42 | | Failed 65x130 mm vane attempt. | |
| | | | | | | | 58 | | | |
| | | | | | | | 52 | 86.90 | ——— 82.90 | |
| | 14D | 24/17 | 84.00 - 86.00 | 8/8/11/16 | 19 | 27 | 40 | | Grey, wet, medium dense, Silty fine SAND. | G#212303 A-4, SM WC=23.0% |
| 85 | | | | | | | 41 | | | |
| | | | | | | | 47 | | | |
| | | | | | | | 64 | | | |
| | | | | | | | 73 | | | |
| | 15D | 24/15 | 89.00 - 91.00 | 2/4/4/5 | 8 | 11 | 27 | | Similar to above. | |
| 90 | | | | | | | 36 | | | |
| | | | | | | | 69 | | | |
| | | | | | | | 97 | | | |
| | | | | | | | 113 | | | |
| | 16D | 24/14 | 94.00 - 96.00 | 1/1/1/2 | 2 | 3 | 39 | | Grey, wet, very loose, fine SAND, little silt. | G#212304 A-2-4, SM WC=22.8% |
| 95 | | | | | | | 45 | | | |
| | | | | | | | 111 | | | |
| | | | | | | | 146 | | | |
| | | | | | | | 178 | | Grey, wet, loose, fine SAND, some silt. | G#212305 A-2-4, SM WC=23.5% |
| | 17D | 24/14 | 99.00 - 101.00 | 3/3/2/2 | 5 | 7 | 50 | | | |
| 100 | | | | | | | 37 | | | |
| | | | | | | | 38 | | | |
| | | | | | | | 69 | 66.80 | ——— 103.00 | |
| | | | | | | | 183 | | | |
| | 18D | 24/17 | 104.00 - 106.00 | 7/3/15/32 | 18 | 25 | 330 | | Grey, wet, medium dense, fine to coarse SAND, little gravel, trace silt, occasional cobbles. | G#212306 A-3, SP-SM WC=17.4% |
| 105 | | | | | | | 88 | | | |
| | R1 | 92.4/24 | 106.60 - 114.30 | | | | 155 NQ-2 | 63.20 | ——— 106.60 R1: COBBLES and GRAVEL. R1:Core Times (min:sec) 106.6-107.6' (2:45) 107.6-108.6' (1:10) 108.6-109.6' (1:53) 109.6-110.6' (2:40) 110.6-111.6' (3:20) 111.6-112.6' (2:49) 112.6-113.6' (1:20) 113.6-114.3' (2:00) | |
| | | | | | | | 215 | | | |
| | | | | | | | 190 | | | |
| | | | | | | | 166 | | | |
| 110 | | | | | | | 477 | | | |
| | | | | | | | 430 | | | |
| | | | | | | | 800 | | | |
| | | | | | | | OPEN HOLE | | | |
| | | | | | | | RC | | Roller Coned ahead to 129.0' bgs. | |
| 115 | | | | | | | | | | |
| 120 | | | | | | | | 49.80 | ——— 120.00 Cemented TILL at 120.0' bgs. | |
| 125 | | | | | | | | | | |
| | R2 | 48/6 | 129.00 - 133.00 | | | | NQ-2 | | R2: Grey, very dense, COBBLES and Cemented TILL. Put sample in jar. R2:Core Times (min:sec) 129.0-130.0' (1:42) 130.0-131.0' (1:10) 131.0-132.0' (0:30) 132.0-133.0' (0:30) | |
| 130 | | | | | | | | | | |
| | | | | | | | | 36.80 | ——— 133.00 Bottom of Exploration at 133.00 feet below ground surface. NO REFUSAL | |
| 135 | | | | | | | | | | |
| 140 | | | | | | | | | | |
| 145 | | | | | | | | | | |
| 150 | | | | | | | | | | |

Remarks:

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: Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock
Location: Monmouth, Maine

Boring No.: BB-MJS-102
PIN: 16716.00

| | | | | | |
|---|---|---|---|---|---|
| Driller: | MaineDOT | Elevation (ft.) | 169.4 | Auger ID/OD: | 5" Solid Stem |
| Operator: | E. Giguere, C. Giles | Datum: | NAVD 88 | Sampler: | Standard Split Spoon |
| Logged By: | B. Wilder | Rig Type: | CME 45C | Hammer Wt./Fall: | 140#/30" |
| Date Start/Finish: | 7/1,14/09 | Drilling Method: | Cased Wash Boring | Core Barrel: | NQ-2" |
| Boring Location: | 14+32.3, 5.8 Lt. | Casing ID/OD: | HW | Water Level*: | 5.5' bgs. |
| Hammer Efficiency Factor: 0.84 | | Hammer Type: | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

| 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.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | 168.95 | Pavement ——— 0.45 | |
| | 1D | 24/18 | 1.00 - 3.00 | 5/5/5/5 | 10 | 14 | | | Brown, moist, medium dense, fine to coarse SAND, some silt, trace gravel. | G#212307 A-2-4, SM WC=12.1% |
| 5 | 2D | 24/6 | 5.00 - 7.00 | 3/3/1/2 | 4 | 6 | | | Brown, wet, loose, fine to coarse SAND, some silt, trace gravel. | |
| | | | | | | | | 161.40 | ——— 8.00 | |
| 10 | 3D | 24/21 | 10.00 - 12.00 | 6/5/4/6 | 9 | 13 | 38 | | Grey, wet, stiff, SILT, some clay, trace fine sand. | G#212308 A-4, CL-ML WC=22.1% |
| | | | | | | | 39 | | | |
| | | | | | | | 36 | | | |
| | | | | | | | 35 | | | |
| | | | | | | | 28 | | | |
| 15 | 4D | 24/7 | 15.00 - 17.00 | WOH/WOH/2/5 | 2 | 3 | 39 | | Dark brown, wet, soft, SILT, little fine sand, little clay, trace organics, wood. | |
| | | | | | | | 34 | | | |
| | | | | | | | 31 | | | |
| | | | | | | | 40 | | | |
| | | | | | | | 36 | | | |
| 20 | 5D | 24/24 | 20.00 - 22.00 | 4/1/1/1 | 2 | 3 | 51 | | Grey, wet, soft, SILT, little fine sand, little clay. | G#212309 A-4, CL-ML WC=22.4% |
| | | | | | | | 47 | | | |
| | | | | | | | 44 | | | |
| | | | | | | | 38 | | | |
| | | | | | | | 40 | | | |
| 25 | 6D | 24/24 | 25.00 - 27.00 | WOR/WOR/WOR/WOR | --- | | 59 | | Grey, wet, soft, SILT, some fine sand, little clay. | G#212310 A-4, CL-ML WC=27.2% |
| | | | | | | | 37 | | | |
| | | | | | | | 43 | | | |
| | | | | | | | 35 | | | |
| | | | | | | | 37 | | | |
| 30 | 7D | 24/24 | 30.00 - 32.00 | WOR/WOR/WOR/WOR | --- | | 53 | | Grey, wet, soft, SILT, some clay, trace fine sand. | G#212311 A-4, CL-ML WC=28.3% Non-plastic |
| | | | | | | | 48 | | | |
| | V1 | | 32.00 - 32.43 | Su=384/41 psf | | | 43 | | 65x130 mm vane raw torque readings: V1: 14.0/1.5 ft-lbs | |
| | V2 | | 33.00 - 33.43 | Su=453/82 psf | | | 42 | | V2: 16.5/3.0 ft-lbs | |
| | | | | | | | 37 | | | |
| 35 | 8D MU | 24/24 24/0 | 35.00 - 37.00 35.00 - 37.00 | WOR/WOR/WOR/WOR Piston Sampler | --- | | 58 | | Grey, wet, medium stiff, SILT, some clay, with 1/4-1/2" sand layers. Failed tube attempt. | G#212312 A-4, CL-ML WC=29.0% LL=25 PL=18 PI=7 |
| | | | | | | | 47 | | | |
| | V3 | | 37.00 - 37.43 | Su=659/110 psf | | | 43 | | 65x130 mm vane raw torque readings: V3: 24.0/4.0 ft-lbs | |
| | MV | | | | | | 45 | | Failed 65x130 mm vane attempt. | |
| | | | | | | | 33 | | | |
| 40 | 9D V5 | 24/24 | 40.00 - 42.00 40.00 - 40.43 | WOR/WOR/WOR/WOR Su=467/110 psf | --- | | 57 | | Grey, wet, soft, SILT, some clay, trace fine sand. 65x130 mm vane raw torque readings: V5: 17.0/4.0 ft-lbs | G#212313 A-4, CL-ML WC=24.7% LL=22 PL=17 PI=5 |
| | V6 | | 41.00 - 41.43 | Su=467/55 psf | | | 48 | | V6: 17.0/2.0 ft-lbs | |
| | | | | | | | 42 | | | |
| | | | | | | | 40 | | | |
| | | | | | | | 31 | | | |
| 45 | MU 10D | 24/0 24/24 | 45.00 - 47.00 45.00 - 47.00 | Piston Sampler WOR/WOR/WOR/WOR | --- | | 41 | | Failed tube attempt. Grey, wet, medium stiff, SILT, some clay, trace fine sand. | G#212314 A-4, CL-ML WC=28.8% LL=22 PL=17 PI=5 |
| | | | | | | | 39 | | | |
| | V7 | | 47.00 - 47.43 | Su=604/82 psf | | | 37 | | 65x130 mm vane raw torque readings: V7: 22.0/3.0 ft-lbs | |
| | V8 | | 48.00 - 48.43 | Su=618/82 psf | | | 36 | | V8: 22.5/3.0 ft-lbs | |
| | | | | | | | 35 | | | |
| 50 | V9 11D | 24/24 | 50.00 - 50.43 50.00 - 52.00 | Su=879/55 psf WOR/WOR/WOR/WOR | --- | | 57 | | 65x130 mm vane raw torque readings: V9: 32.0/2.0 ft-lbs Grey, wet, loose, fine to coarse SAND, some silt, little clay, trace gravel. | G#212315 A-2-4, SC-SM WC=17.0% Non-plastic |
| | MV | | | | | | 60 | | Failed vane attempt. | |
| | | | | | | | 70 | | | |
| | | | | | | | 42 | | | |
| | | | | | | | 39 | | | |
| 55 | 1U | 24/24 | 55.00 - 57.00 | WOR/WOR | --- | | 40 | | Similar to above. Two dents in side of tube by unknown cause. (The shelby tube had two large dents preventing extraction of sample for testing) | #212316 Tube Damaged |
| | | | | | | | 52 | | | |
| | V11 | | 57.00 - 57.43 | Su=618/82 psf | | | 40 | | 65x130 mm vane raw torque readings: V11: 22.25/3.0 ft-lbs | |
| | V12 | | 58.00 - 58.43 | Su=618/55 psf | | | 43 | 110.40 | V12: 22.5/2.0 ft-lbs ——— 59.00 | |
| | | | | | | | 36 | | | |
| 60 | 12D V13 | 24/24 | 60.00 - 62.00 60.00 - 60.43 | WOR/WOR/WOR/WOR Su=604/82 psf | --- | | 55 | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. 65x130 mm vane raw torque readings: V13: 22.0/3.0 ft-lbs | G#212317 A-4, CL WC=27.6% LL=26 PL=18 PI=8 |
| | V14 | | 61.00 - 61.43 | Su=577/55 psf | | | 44 | | V14: 21.0/2.0 ft-lbs | |
| | | | | | | | 33 | | | |
| | | | | | | | 31 | | | |
| | | | | | | | 29 | | | |
| 65 | 2U | 24/24 | 65.00 - 67.00 | WOR/WOR | --- | | 42 | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G,C#212318 A-4, CL-ML WC=28.7% LL=23 PL=18 PI=5 |
| | | | | | | | 36 | | | |
| | V15 | | 67.00 - 67.43 | Su=687/82 psf | | | 30 | | 65x130 mm vane raw torque readings: V15: 25.0/3.0 ft-lbs | |
| | V16 | | 68.00 - 68.43 | Su=742/110 psf | | | 30 | | V16: 27.0/4.0 ft-lbs | |
| | | | | | | | 22 | | | |
| 70 | V17 MD | 24/0 | 70.00 - 70.43 70.00 - 72.00 | Su=659/82 psf WOR/WOR/WOR/WOR | --- | | 32 | | 65x130 mm vane raw torque readings: V17: 24.0/3.0 ft-lbs Failed sample attempt. | |
| | V18 | | 71.00 - 71.43 | Su=659/69 psf | | | 38 | | V18: 24.0/2.5 ft-lbs | |
| | | | | | | | 32 | | | |
| | | | | | | | 29 | | | |
| | | | | | | | 26 | | | |
| 75 | | | | | | | | | | |

Remarks:

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.



| 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.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 3U | 24/24 | 75.00 - 77.00 | WOR/WOR | --- | | 42 | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G,C#212319 A-6, CL WC=31.6% LL=29 PL=19 PI=10 |
| | | | | | | | 45 | | | |
| | V19 | | 77.00 - 77.43 | Su=796/82 psf | | | 42 | | 65x130 mm vane raw torque readings: V19: 29.0/3.0 ft-lbs | |
| | V20 | | 78.00 - 78.43 | Su=851/165 psf | | | 39 | | V20: 31.0/6.0 ft-lbs | |
| | | | | | | | 42 | | | |
| 80 | V21 13D | 24/24 | 80.00 - 80.43 80.00 - 82.00 | Su=824/82 psf WOR/WOR/WOR/WOR | --- | | 56 | | 65x130 mm vane raw torque readings: V21: 30.0/3.0 ft-lbs Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G#212320 A-6, CL WC=28.7% LL=30 PL=20 PI=10 |
| | V22 | | 81.00 - 81.43 | Su=824/110 psf | | | 53 | | V22: 30.0/4.0 ft-lbs | |
| | | | | | | | 47 | | | |
| | | | | | | | 46 | 85.90 | ——— 83.50 | |
| | | | | | | | 47 | | | |
| 85 | MU 14D | 24/0 24/24 | 85.00 - 87.00 85.00 - 87.00 | WOR/WOR WOR/WOR/WOR/WOR | --- | | OPEN HOLE | | Dark grey, wet, medium stiff, Silty CLAY, trace fine sand. Washed ahead to 87.0' bgs, then took vanes. | G#212321 A-6, CL WC=26.6% LL=36 PL=21 PI=15 |
| | V23 | | 87.00 - 87.43 | Su=989/110 psf | | | | | 65x130 mm vane raw torque readings: V23: 36.0/4.0 ft-lbs | |
| | V24 | | 88.00 - 88.43 | Su=961/110 psf | | | RC | | V24: 35.0/4.0 ft-lbs Roller Coned ahead to 90.0' bgs. | |
| 90 | MV 15D | 24/24 | 90.00 - 92.00 | WOR/WOR/WOR/WOR | --- | | | | Failed 65x130 mm vane attempt. Grey, wet, medium stiff, SILT, some clay, trace fine sand in 1/2- 2" layers. | G#212322 A-6, CL WC=26.1% LL=30 PL=19 PI=11 |
| | | | | | | | | 75.90 | ——— 93.50 | |
| 95 | 16D | 24/20 | 95.00 - 97.00 | WOR/WOR/3/8 | 3 | 4 | | | Grey, wet, loose, fine to medium SAND, some silt, trace clay. | G#212323 A-4, SC-SM WC=21.2% |
| | | | | | | | | 72.40 | ——— 97.00 Bottom of Exploration at 97.00 feet below ground surface. NO REFUSAL | |
| 100 | | | | | | | | | | |

Remarks:

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.



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
BR-1671(600)X
BRIDGE NO. 2412
PIN 16716.00
BRIDGE PLANS

| | BY | DATE |
|---|---|---|
| PROJ. MANAGER | | |
| DESIGN-DETAILED | K. MAGUIRE | T. WHITE | OCT 2009 |
| CHECKED-REVIEWED | | |
| DESIGN2-DETAILED2 | | |
| DESIGN3-DETAILED3 | | |
| REVISIONS 1 | | |
| REVISIONS 2 | | |
| REVISIONS 3 | | |
| REVISIONS 4 | | |
| FIELD CHANGES | | |

SIGNATURE
P.E. NUMBER
DATE

JOCK STREAM BRIDGE
JOCK STREAM
MONMOUTH KENNEBEC COUNTY

# BORING LOGS

SHEET NUMBER 3 OF 3

Filename: ...\msta\007_BORING LOGS1.dgn Division: GEOTECH Username: terry.white Date:11/17/2009

# Appendix A

Boring Logs

## UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES |
|---|---|---|---|---|
| COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size) | GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size) | CLEAN GRAVELS (little or no fines) | GW | Well-graded gravels, gravel-sand mixtures, little or no fines |
| | | | GP | Poorly-graded gravels, gravel sand mixtures, little or no fines |
| | | GRAVEL WITH FINES (Appreciable amount of fines) | GM | Silty gravels, gravel-sand-silt mixtures. |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures. |
| | SANDS (more than half of coarse fraction is smaller than No. 4 sieve size) | CLEAN SANDS (little or no fines) | SW | Well-graded sands, gravelly sands, little or no fines |
| | | | SP | Poorly-graded sands, gravelly sand, little or no fines. |
| | | SANDS WITH FINES (Appreciable amount of fines) | SM | Silty sands, sand-silt mixtures |
| | | | SC | Clayey sands, sand-clay mixtures. |
| FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size) | SILTS AND CLAYS (liquid limit less than 50) | | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity. |
| | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. |
| | | | OL | Organic silts and organic silty clays of low plasticity. |
| | SILTS AND CLAYS (liquid limit greater than 50) | | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. |
| | | | CH | Inorganic clays of high plasticity, fat clays. |
| | | | OH | Organic clays of medium to high plasticity, organic silts |
| | HIGHLY ORGANIC SOILS | | Pt | Peat and other highly organic soils. |

**Desired Soil Observations: (in this order)**

Color (Munsell color chart)
Moisture (dry, damp, moist, wet, saturated)
Density/Consistency (from above right hand side)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc., if applicable)
Cementation (weak, moderate, or strong, if applicable, ASTM D 2488)
Geologic Origin (till, marine clay, alluvium, etc.)
Unified Soil Classification Designation
Groundwater level

## TERMS DESCRIBING DENSITY/CONSISTENCY

**Coarse-grained soils** (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty clayey or gravelly sands. Consistency is rated according to standard penetration resistance.

Modified Burmister System

| Descriptive Term | Portion of Total |
|---|---|
| trace | 0% - 10% |
| little | 11% - 20% |
| some | 21% - 35% |
| adjective (e.g. sandy, clayey) | 36% - 50% |

| Density of Cohesionless Soils | Standard Penetration Resistance N-Value (blows per foot) |
|---|---|
| Very loose | 0 - 4 |
| Loose | 5 - 10 |
| Medium Dense | 11 - 30 |
| Dense | 31 - 50 |
| Very Dense | > 50 |

**Fine-grained soils** (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.

| Consistency of Cohesive soils | SPT N-Value blows per foot | Approximate Undrained Shear Strength (psf) | Field Guidelines |
|---|---|---|---|
| Very Soft | WOH, WOR, WOP, <2 | 0 - 250 | Fist easily Penetrates |
| Soft | 2 - 4 | 250 - 500 | Thumb easily penetrates |
| Medium Stiff | 5 - 8 | 500 - 1000 | Thumb penetrates with moderate effort |
| Stiff | 9 - 15 | 1000 - 2000 | Indented by thumb with great effort |
| Very Stiff | 16 - 30 | 2000 - 4000 | Indented by thumbnail |
| Hard | >30 | over 4000 | Indented by thumbnail with difficulty |

**Rock Quality Designation (RQD):**

$$RQD = \frac{\text{sum of the lengths of intact pieces of core* > 100 mm}}{\text{length of core advance}}$$

*Minimum NQ rock core (1.88 in. OD of core)

Correlation of RQD to Rock Mass Quality

| Rock Mass Quality | RQD |
|---|---|
| Very Poor | <25% |
| Poor | 26% - 50% |
| Fair | 51% - 75% |
| Good | 76% - 90% |
| Excellent | 91% - 100% |

**Desired Rock Observations: (in this order)**

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Lithology (igneous, sedimentary, metamorphic, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90)
- -spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m)
- -tightness (tight, open or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock mass quality (very poor, poor, etc.)
ref: AASHTO Standard Specification for Highway Bridges 17th Ed. Table 4.4.8.1.2A
Recovery

***Maine Department of Transportation***
***Geotechnical Section***
**Key to Soil and Rock Descriptions and Terms**
Field Identification Information

**Sample Container Labeling Requirements:**

| | |
|---|---|
| PIN | Blow Counts |
| Bridge Name / Town | Sample Recovery |
| Boring Number | Date |
| Sample Number | Personnel Initials |
| Sample Depth | |

# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

**Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream
**Location:** Monmouth, Maine

**Boring No.:** BB-MJS-101
**PIN:** 16716.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.8 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 6/16,19,24/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 13+65.5, 5.9 Rt. | **Casing ID/OD:** | HW | **Water Level*:** | 9.0' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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 | | | | | | | SSA | 169.45 | | Pavement —0.35 | |
| | 1D | 24/20 | 1.00 - 3.00 | 4/7/5/5 | 12 | 17 | | | | Brown, moist, medium dense, fine to coarse SAND, some silt, trace gravel. | G#212264 A-2-4, SM WC=10.5% |
| 5 | 2D | 24/18 | 5.00 - 7.00 | 1/1/1/50 | 2 | 3 | | | | Brown, wet, very loose, fine to coarse SAND, some silt, trace clay, trace gravel, trace organics. | G#212265 A-4, SC-SM WC=19.9% |
| | | | | | | | | 161.30 | | —8.50 | |
| 10 | MD | 24/0 | 10.00 - 12.00 | 2/2/2/3 | 4 | 6 | 22 | | | Failed sample attempt, similar to 3D, medium stiff, off auger flight. | |
| | | | | | | | 29 | | | | |
| | | | | | | | 25 | | | | |
| | | | | | | | 26 | | | | |
| | 3D | 24/21 | 14.00 - 16.00 | 3/4/4/4 | 8 | 11 | 38 | | | Grey, wet, stiff, SILT, little clay, trace fine sand. | G#212266 A-4, CL-ML WC=24.0% Non-plastic |
| 15 | | | | | | | 38 | | | | |
| | | | | | | | 36 | | | | |
| | | | | | | | 31 | | | | |
| | | | | | | | 31 | | | | |
| | 4D | 24/17 | 19.00 - 21.00 | 1/1/WOH/WOH | 1 | 1 | 29 | | | Grey, wet, very soft, SILT, little clay, trace fine sand. | G#212267 A-4, CL-ML WC=26.0% Non-plastic |
| 20 | | | | | | | 22 | | | | |
| | | | | | | | 20 | | | | |
| | | | | | | | 16 | | | | |
| | | | | | | | 15 | | | | |
| | 5D | 24/20 | 24.00 - 26.00 | WOH/WOH/WOH/ WOH | --- | | 33 | | | Grey, wet, soft, SILT, some clay, trace fine sand. | G#212268 A-4, CL-ML |
| 25 | | | | | | | | | | | |

**Remarks:**

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| **Maine Department of Transportation**<br>Soil/Rock Exploration Log<br>US CUSTOMARY UNITS | **Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream<br>**Location:** Monmouth, Maine | **Boring No.:** BB-MJS-101<br>**PIN:** 16716.00 |
|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.8 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 6/16,19,24/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 13+65.5, 5.9 Rt. | **Casing ID/OD:** | HW | **Water Level*:** | 9.0' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

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N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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 | | | | | | | 26 | | | Roller Coned ahead to 27.0' bgs. | WC=25.4% Non-plastic |
| | V1 | | 26.00 - 26.37 | Su=312/89 psf | | | 25 | | | 55x110 mm vane raw torque readings: V1: 7.0/2.0 ft-lbs | |
| | V2 | | 27.00 - 27.37 | Su=312/45 psf | | | 22 | | | V2: 7.0/1.0 ft-lbs | |
| | | | | | | | 19 | | | | |
| | 6D | 24/24 | 29.00 - 31.00 | WOR/WOR/WOR/ WOR | --- | | 36 | | | Grey, wet, soft, SILT, some clay, trace fine sand. | G#212269 A-4, CL-ML WC=26.2% LL=23 PL=18 PI=5 |
| 30 | | | | | | | 33 | | | | |
| | V3 | | 31.00 - 31.43 | Su=247/55 psf | | | 28 | | | 65x130 mm vane raw torque readings: V3: 9.0/2.0 ft-lbs | |
| | V4 | | 32.00 - 32.43 | Su=384/69 psf | | | 28 | | | V4: 14.0/2.5 ft-lbs | |
| | | | | | | | 28 | | | | |
| | MU/7D | 24/12 | 34.00 - 36.00 | WOR/WOR/WOR/ WOR | --- | | 38 | | | Failed Piston Sampler attempt. Grey, wet, soft, SILT, some clay, trace fine sand. | G#212270 A-4, CL-ML WC=26.8% Non-plastic |
| 35 | | | | | | | 32 | | | | |
| | V5 | | 36.00 - 36.43 | Su=494/41 psf | | | 35 | | | 65x130 mm vane raw torque readings: V5: 18.0/1.5 ft-lbs | |
| | V6 | | 37.00 - 37.43 | Su=384/27 psf | | | 36 | | | V6: 14.0/1.0 ft-lbs | |
| | | | | | | | 33 | | | | |
| | | | | | | | [a]HP | | | [a]HP=Hydraulic Push | |
| 40 | MU/8D | 24/4 | 40.50 - 42.50 | WOR/WOR/WOR/ WOR | --- | | 26 | | | Failed Piston Sampler attempt. Grey, wet, soft, SILT, some clay, trace fine sand. | |
| | | | | | | | 50 | | | | |
| | V7 | | 42.50 - 42.93 | Su=384/55 psf | | | 37 | | | 65x130 mm vane raw torque readings: V7: 14.0/2.0 ft-lbs | |
| | V8 | | 43.50 - 43.93 | Su=494/41 psf | | | 38 | 126.80 | | 43.00 V8: 18.0/1.5 ft-lbs | |
| | | | | | | | 38 | | | | |
| 45 | MV 9D | 24/20 | 45.00 - 45.20 45.00 - 47.00 | Would Not Push WOR/WOR/WOR/ WOR | --- | | 38 | | | Failed 65x130 mm vane attempt. Grey, wet, soft, Clayey SILT with 1/2" fine sand layer. | G#212271 A-4, CL-ML WC=32.4% |
| | | | | | | | 31 | | | | |
| | | | | | | | 28 | | | | |
| | | | | | | | 30 | | | | |
| 50 | MU | 24/0 | 49.00 - 51.00 | WOR/WOR/WOR/ WOR | --- | | 30 | | | Failed Piston Sampler attempt, let tube set 45 minutes. Grey, wet, soft to medium stiff, Clayey SILT, trace fine sand. | G#212272 A-4, CL-ML |

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# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

| | | | | | |
|---|---|---|---|---|---|
| **Project:** | Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream | | | **Boring No.:** | BB-MJS-101 |
| **Location:** | Monmouth, Maine | | | **PIN:** | 16716.00 |
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.8 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 6/16,19,24/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 13+65.5, 5.9 Rt. | **Casing ID/OD:** | HW | **Water Level*:** | 9.0' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
D = Split Spoon Sample
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N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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 | 10D | 24/24 | 49.00 - 51.00 | | | | 30 | | | | WC=27.8%<br>LL=23<br>PL=17<br>PI=6 |
| | V10 | | 51.00 - 51.43 | Su=220/55 psf | | | 27 | | | 65x130 mm vane raw torque readings:<br>V10: 8.0/2.0 ft-lbs<br>V11: 19.0/2.5 ft-lbs | |
| | V11 | | 52.00 - 52.43 | Su=522/69 psf | | | 26 | | | | |
| | | | | | | | 25 | | | | |
| | 1U | 24/14 | 54.00 - 56.00 | Piston Sampler | | | 32 | | | Grey, wet, soft, Clayey SILT, trace fine sand. Let tube set 60 minutes. | G,C#212273<br>A-4, CL<br>WC=33.4%<br>LL=25<br>PL=18<br>PI=7 |
| 55 | | | | | | | 29 | | | | |
| | V12 | | 56.00 - 56.43 | Su=494/55 psf | | | 32 | | | 65x130 mm vane raw torque readings:<br>V12: 18.0/2.0 ft-lbs<br>V13: 17.0/1.5 ft-lbs | |
| | V13 | | 57.00 - 57.43 | Su=467/41 psf | | | 24 | | | | |
| | | | | | | | 24 | | | | |
| | V14 | 24/24 | 59.00 - 59.43 | Su=494/82 psf | --- | | 29 | | | 65x130 mm vane raw torque readings:<br>V14: 18.0/3.0 ft-lbs | |
| 60 | 11D | | 59.00 - 61.00 | WOR/WOR/WOR/WOR | | | | | | Similar to above, soft to medium stiff. | |
| | V15 | | 60.00 - 60.43 | Su=604/55 psf | | | 29 | | | V15: 22.0/2.0 ft-lbs | |
| | | | | | | | 23 | | | | |
| | | | | | | | 21 | | | | |
| | | | | | | | 21 | | | | |
| | 2U | 24/24 | 64.00 - 66.00 | Piston Sampler | | | 30 | | | Grey, wet, soft to medium stiff, Clayey SILT, trace fine sand. Let tube set 20 minutes. | G,C#212274<br>A-4, CL<br>WC=30.7%<br>LL=26<br>PL=18<br>PI=8 |
| 65 | | | | | | | 28 | | | | |
| | V16 | | 66.00 - 66.43 | Su=343/27 psf | | | 28 | | | 65x130 mm vane raw torque readings:<br>V16: 12.5/1.0 ft-lbs<br>V17: 22.5/3.0 ft-lbs | |
| | V17 | | 67.00 - 67.43 | Su=618/82 psf | | | 20 | | | | |
| | | | | | | | 22 | | | | |
| | V18 | 24/24 | 69.00 - 69.43 | Su=796/27 psf | --- | | 31 | | | 65x130 mm vane raw torque readings:<br>V18: 29.0/1.0 ft-lbs | G#212275<br>A-4, CL<br>WC=26.3%<br>LL=24<br>PL=16<br>PI=8 |
| 70 | 12D | | 69.00 - 71.00 | WOR/WOR/WOR/WOR | | | | | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. | |
| | V19 | | 70.00 - 70.43 | Su=687/96 psf | | | 28 | | | V19: 25.0/3.5 ft-lbs | |
| | | | | | | | 26 | | | | |
| | | | | | | | 21 | | | | |
| | | | | | | | 23 | | | | |
| 75 | | | | | | | aHP | | | | |

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# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

**Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream
**Location:** Monmouth, Maine

**Boring No.:** BB-MJS-101
**PIN:** 16716.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.8 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 6/16,19,24/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 13+65.5, 5.9 Rt. | **Casing ID/OD:** | HW | **Water Level*:** | 9.0' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
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$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 3U | 24/20 | 75.50 - 77.50 | Piston Sampler | | | 54 | | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G,C#212301<br>A-6, CL<br>WC=35.6%<br>LL=35<br>PL=21<br>PI=14 |
| | | | | | | | 54 | | | | |
| | V20 | | 77.50 - 77.93 | Su=536/41 psf | | | 50 | | | 65x130 mm vane raw torque readings:<br>V20: 19.5/1.5 ft-lbs | |
| | MV | | | Would Not Push | | | 43 | | | Failed 65x130 mm vane attempt. | |
| | 13D | 24/24 | 79.00 - 81.00 | WOR/WOR/WOR/ WOR | --- | | 54 | | | Grey, wet, soft, Clayey SILT with 1/2" fine sand layers. | G#212302<br>A-6, CL<br>WC=28.9%<br>LL=31<br>PL=19<br>PI=12 |
| 80 | | | | | | | 46 | | | | |
| | MV | | 81.00 - 81.30 | Would Not Push | | | 42 | | | Failed 65x130 mm vane attempt. | |
| | | | | | | | 58 | 86.90 | | 82.90 | |
| | | | | | | | 66 | | | | |
| | 14D | 24/17 | 84.00 - 86.00 | 8/8/11/16 | 19 | 27 | 40 | | | Grey, wet, medium dense, Silty fine SAND. | G#212303<br>A-4, SM<br>WC=23.0% |
| 85 | | | | | | | 41 | | | | |
| | | | | | | | 47 | | | | |
| | | | | | | | 64 | | | | |
| | | | | | | | 73 | | | | |
| | 15D | 24/15 | 89.00 - 91.00 | 2/4/4/5 | 8 | 11 | 27 | | | Similar to above. | |
| 90 | | | | | | | 36 | | | | |
| | | | | | | | 69 | | | | |
| | | | | | | | 97 | | | | |
| | | | | | | | 113 | | | | |
| | 16D | 24/14 | 94.00 - 96.00 | 1/1/1/2 | 2 | 3 | 39 | | | Grey, wet, very loose, fine SAND, little silt. | G#212304<br>A-2-4, SM<br>WC=22.8% |
| 95 | | | | | | | 45 | | | | |
| | | | | | | | 111 | | | | |
| | | | | | | | 146 | | | | |
| | | | | | | | 178 | | | | |
| | 17D | 24/14 | 99.00 - 101.00 | 3/3/2/2 | 5 | 7 | 50 | | | Grey, wet, loose, fine SAND, some silt. | G#212305<br>A-2-4, SM |
| 100 | | | | | | | | | | | |

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# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

| | | | |
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| **Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream | | **Boring No.:** | BB-MJS-101 |
| **Location:** Monmouth, Maine | | **PIN:** | 16716.00 |
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.8 |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C |
| **Date Start/Finish:** | 6/16,19,24/09 | **Drilling Method:** | Cased Wash Boring |
| **Boring Location:** | 13+65.5, 5.9 Rt. | **Casing ID/OD:** | HW |
| **Auger ID/OD:** | 5" Solid Stem | **Sampler:** | Standard Split Spoon |
| **Hammer Wt./Fall:** | 140#/30" | **Core Barrel:** | NQ-2" |
| **Water Level*:** | 9.0' bgs. | **Hammer Efficiency Factor:** | 0.84 |
| **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

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|---|---|---|---|---|---|---|---|---|---|---|
| 100 | | | | | | | 37 | | | WC=23.5% |
| | | | | | | | 38 | | | |
| | | | | | | | 69 | | | |
| | | | | | | | 183 | 66.80 | 103.00 | |
| | 18D | 24/17 | 104.00 - 106.00 | 7/3/15/32 | 18 | 25 | 330 | | Grey, wet, medium dense, fine to coarse SAND, little gravel, trace silt, occasional cobbles. | G#212306 A-3, SP-SM WC=17.4% |
| 105 | | | | | | | 88 | | | |
| | R1 | 92.4/24 | 106.60 - 114.30 | | | | 155 NQ-2 | 63.20 | 106.60<br>R1: COBBLES and GRAVEL.<br>R1:Core Times (min:sec)<br>106.6-107.6' (2:45)<br>107.6-108.6' (1:10)<br>108.6-109.6' (1:53)<br>109.6-110.6' (2:40)<br>110.6-111.6' (3:20)<br>111.6-112.6' (2:49)<br>112.6-113.6' (1:20)<br>113.6-114.3' (2:00) | |
| | | | | | | | 215 | | | |
| | | | | | | | 190 | | | |
| | | | | | | | 166 | | | |
| 110 | | | | | | | 477 | | | |
| | | | | | | | 430 | | | |
| | | | | | | | 800 | | | |
| | | | | | | | OPEN HOLE | | | |
| | | | | | | | RC | | Roller Coned ahead to 129.0' bgs. | |
| 115 | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 120 | | | | | | | | 49.80 | 120.00<br>Cemented TILL at 120.0' bgs. | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 125 | | | | | | | | | | |

**Remarks:**

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# Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

**Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream
**Location:** Monmouth, Maine

**Boring No.:** BB-MJS-101

**PIN:** 16716.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.8 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 6/16,19,24/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 13+65.5, 5.9 Rt. | **Casing ID/OD:** | HW | **Water Level*:** | 9.0' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 | | | | | | | | | | | |
| | R2 | 48/6 | 129.00 - 133.00 | | | | NQ-2 | | | R2: Grey, very dense, COBBLES and Cemented TILL. Put sample in jar.<br>R2:Core Times (min:sec)<br>129.0-130.0' (1:42)<br>130.0-131.0' (1:10)<br>131.0-132.0' (0:30)<br>132.0-133.0' (0:30) | |
| 130 | | | | | | | | | | | |
| | | | | | | | | 36.80 | | 133.00 | |
| | | | | | | | | | | **Bottom of Exploration at 133.00 feet below ground surface.**<br>NO REFUSAL | |
| 135 | | | | | | | | | | | |
| 140 | | | | | | | | | | | |
| 145 | | | | | | | | | | | |
| 150 | | | | | | | | | | | |

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# Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

**Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream

**Location:** Monmouth, Maine

**Boring No.:** BB-MJS-102

**PIN:** 16716.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.4 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 7/1,14/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 14+32.3, 5.8 Lt. | **Casing ID/OD:** | HW | **Water Level*:** | 5.5' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | 168.95 | | Pavement — 0.45 | |
| | 1D | 24/18 | 1.00 - 3.00 | 5/5/5/5 | 10 | 14 | | | | Brown, moist, medium dense, fine to coarse SAND, some silt, trace gravel. | G#212307 A-2-4, SM WC=12.1% |
| 5 | 2D | 24/6 | 5.00 - 7.00 | 3/3/1/2 | 4 | 6 | | | | Brown, wet, loose, fine to coarse SAND, some silt, trace gravel. | |
| | | | | | | | | 161.40 | | 8.00 | |
| 10 | 3D | 24/21 | 10.00 - 12.00 | 6/5/4/6 | 9 | 13 | 38 | | | Grey, wet, stiff, SILT, some clay, trace fine sand. | G#212308 A-4, CL-ML WC=22.1% |
| | | | | | | | 39 | | | | |
| | | | | | | | 36 | | | | |
| | | | | | | | 35 | | | | |
| | | | | | | | 28 | | | | |
| 15 | 4D | 24/7 | 15.00 - 17.00 | WOH/WOH/2/5 | 2 | 3 | 39 | | | Dark brown, wet, soft, SILT, little fine sand, little clay, trace organics, wood. | |
| | | | | | | | 34 | | | | |
| | | | | | | | 31 | | | | |
| | | | | | | | 40 | | | | |
| | | | | | | | 36 | | | | |
| 20 | 5D | 24/24 | 20.00 - 22.00 | 4/1/1/1 | 2 | 3 | 51 | | | Grey, wet, soft, SILT, little fine sand, little clay. | G#212309 A-4, CL-ML WC=22.4% |
| | | | | | | | 47 | | | | |
| | | | | | | | 44 | | | | |
| | | | | | | | 38 | | | | |
| 25 | | | | | | | 40 | | | | |

**Remarks:**

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:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream
**Location:** Monmouth, Maine

**Boring No.:** BB-MJS-102
**PIN:** 16716.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.4 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 7/1,14/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 14+32.3, 5.8 Lt. | **Casing ID/OD:** | HW | **Water Level*:** | 5.5' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu 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
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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 | 6D | 24/24 | 25.00 - 27.00 | WOR/WOR/WOR/ WOR | --- | | 59 | | | Grey, wet, soft, SILT, some fine sand, little clay. | G#212310 A-4, CL-ML WC=27.2% |
| | | | | | | | 37 | | | | |
| | | | | | | | 43 | | | | |
| | | | | | | | 35 | | | | |
| | | | | | | | 37 | | | | |
| 30 | 7D | 24/24 | 30.00 - 32.00 | WOR/WOR/WOR/ WOR | --- | | 53 | | | Grey, wet, soft, SILT, some clay, trace fine sand. | G#212311 A-4, CL-ML WC=28.3% Non-plastic |
| | | | | | | | 48 | | | | |
| | V1 | | 32.00 - 32.43 | Su=384/41 psf | | | 43 | | | 65x130 mm vane raw torque readings: V1: 14.0/1.5 ft-lbs | |
| | V2 | | 33.00 - 33.43 | Su=453/82 psf | | | 42 | | | V2: 16.5/3.0 ft-lbs | |
| | | | | | | | 37 | | | | |
| 35 | 8D MU | 24/24 24/0 | 35.00 - 37.00 35.00 - 37.00 | WOR/WOR/WOR/ WOR Piston Sampler | --- | | 58 | | | Grey, wet, medium stiff, SILT, some clay, with 1/4-1/2" sand layers. Failed tube attempt. | G#212312 A-4, CL-ML WC=29.0% LL=25 PL=18 PI=7 |
| | | | | | | | 47 | | | | |
| | V3 | | 37.00 - 37.43 | Su=659/110 psf | | | 43 | | | 65x130 mm vane raw torque readings: V3: 24.0/4.0 ft-lbs | |
| | MV | | | | | | 45 | | | Failed 65x130 mm vane attempt. | |
| | | | | | | | 33 | | | | |
| 40 | 9D V5 | 24/24 | 40.00 - 42.00 40.00 - 40.43 | WOR/WOR/WOR/ WOR Su=467/110 psf | --- | | 57 | | | Grey, wet, soft, SILT, some clay, trace fine sand. 65x130 mm vane raw torque readings: V5: 17.0/4.0 ft-lbs | G#212313 A-4, CL-ML WC=24.7% LL=22 PL=17 PI=5 |
| | V6 | | 41.00 - 41.43 | Su=467/55 psf | | | 48 | | | V6: 17.0/2.0 ft-lbs | |
| | | | | | | | 42 | | | | |
| | | | | | | | 40 | | | | |
| | | | | | | | 31 | | | | |
| 45 | MU 10D | 24/0 24/24 | 45.00 - 47.00 45.00 - 47.00 | Piston Sampler WOR/WOR/WOR/ WOR | --- | | 41 | | | Failed tube attempt. Grey, wet, medium stiff, SILT, some clay, trace fine sand. | G#212314 A-4, CL-ML WC=28.8% LL=22 PL=17 PI=5 |
| | | | | | | | 39 | | | | |
| | V7 | | 47.00 - 47.43 | Su=604/82 psf | | | 37 | | | 65x130 mm vane raw torque readings: V7: 22.0/3.0 ft-lbs | |
| | V8 | | 48.00 - 48.43 | Su=618/82 psf | | | 36 | | | V8: 22.5/3.0 ft-lbs | |
| 50 | | | | | | | 35 | | | | |

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# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

**Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream
**Location:** Monmouth, Maine

**Boring No.:** BB-MJS-102
**PIN:** 16716.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.4 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 7/1,14/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 14+32.3, 5.8 Lt. | **Casing ID/OD:** | HW | **Water Level*:** | 5.5' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **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 = Insitu Vane Shear Test, PP = Pocket Penetrometer
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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
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane 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 | V9 | 24/24 | 50.00 - 50.43 | Su=879/55 psf | --- | | 57 | | | 65x130 mm vane raw torque readings: V9: 32.0/2.0 ft-lbs | G#212315 A-2-4, SC-SM WC=17.0% Non-plastic |
| | ~~11D~~ | | ~~50.00 - 52.00~~ | ~~WOR/WOR/WOR/~~ WOR | | | | | | Grey, wet, loose, fine to coarse SAND, some silt, little clay, trace gravel. Failed vane attempt. | |
| | MV | | | | | | 60 | | | | |
| | | | | | | | 70 | | | | |
| | | | | | | | 42 | | | | |
| | | | | | | | 39 | | | | |
| 55 | 1U | 24/24 | 55.00 - 57.00 | WOR/WOR | --- | | 40 | | | Similar to above. Two dents in side of tube by unknown cause. (The shelby tube had two large dents preventing extraction of sample for testing) | #212316 Tube Damaged |
| | | | | | | | 52 | | | | |
| | V11 | | 57.00 - 57.43 | Su=618/82 psf | | | 40 | | | 65x130 mm vane raw torque readings: V11: 22.25/3.0 ft-lbs | |
| | V12 | | 58.00 - 58.43 | Su=618/55 psf | | | 43 | | | V12: 22.5/2.0 ft-lbs | |
| | | | | | | | 36 | 110.40 | | 59.00 | |
| 60 | 12D | 24/24 | 60.00 - 62.00 | WOR/WOR/WOR/ WOR | --- | | 55 | | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. 65x130 mm vane raw torque readings: | G#212317 A-4, CL WC=27.6% LL=26 PL=18 PI=8 |
| | ~~V13~~ | | ~~60.00 - 60.43~~ | Su=604/82 psf | | | | | | V13: 22.0/3.0 ft-lbs | |
| | V14 | | 61.00 - 61.43 | Su=577/55 psf | | | 44 | | | V14: 21.0/2.0 ft-lbs | |
| | | | | | | | 33 | | | | |
| | | | | | | | 31 | | | | |
| | | | | | | | 29 | | | | |
| 65 | 2U | 24/24 | 65.00 - 67.00 | WOR/WOR | --- | | 42 | | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G,C#212318 A-4, CL-ML WC=28.7% LL=23 PL=18 PI=5 |
| | | | | | | | 36 | | | | |
| | V15 | | 67.00 - 67.43 | Su=687/82 psf | | | 30 | | | 65x130 mm vane raw torque readings: V15: 25.0/3.0 ft-lbs | |
| | V16 | | 68.00 - 68.43 | Su=742/110 psf | | | 30 | | | V16: 27.0/4.0 ft-lbs | |
| | | | | | | | 22 | | | | |
| 70 | V17 | 24/0 | 70.00 - 70.43 | Su=659/82 psf | --- | | 32 | | | 65x130 mm vane raw torque readings: V17: 24.0/3.0 ft-lbs | |
| | ~~MD~~ | | ~~70.00 - 72.00~~ | ~~WOR/WOR/WOR/~~ WOR | | | | | | Failed sample attempt. | |
| | V18 | | 71.00 - 71.43 | Su=659/69 psf | | | 38 | | | V18: 24.0/2.5 ft-lbs | |
| | | | | | | | 32 | | | | |
| | | | | | | | 29 | | | | |
| 75 | | | | | | | 26 | | | | |

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# Maine Department of Transportation

Soil/Rock Exploration Log

US CUSTOMARY UNITS

**Project:** Jock Stream Bridge #2412 carrying Cobbosseecontee Road over Jock Stream
**Location:** Monmouth, Maine

**Boring No.:** BB-MJS-102
**PIN:** 16716.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 169.4 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | E. Giguere, C. Giles | **Datum:** | NAVD 88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 7/1,14/09 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 14+32.3, 5.8 Lt. | **Casing ID/OD:** | HW | **Water Level*:** | 5.5' bgs. |
| **Hammer Efficiency Factor:** | 0.84 | **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
D = Split Spoon Sample
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SSA = Solid Stem Auger
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N-uncorrected = Raw field SPT N-value
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$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
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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. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | 3U | 24/24 | 75.00 - 77.00 | WOR/WOR | --- | | 42 | | | Grey, wet, medium stiff, Clayey SILT, trace fine sand. | G,C#212319 A-6, CL WC=31.6% LL=29 PL=19 PI=10 |
| | | | | | | | 45 | | | | |
| | V19 | | 77.00 - 77.43 | Su=796/82 psf | | | 42 | | | 65x130 mm vane raw torque readings: V19: 29.0/3.0 ft-lbs | |
| | V20 | | 78.00 - 78.43 | Su=851/165 psf | | | 39 | | | V20: 31.0/6.0 ft-lbs | |
| | | | | | | | 42 | | | | |
| 80 | V21<br>13D | 24/24 | 80.00 - 80.43<br>80.00 - 82.00 | Su=824/82 psf<br>WOR/WOR/WOR/ WOR | --- | | 56 | | | 65x130 mm vane raw torque readings: V21: 30.0/3.0 ft-lbs Grey, wet, medium stiff, Clayey SILT, trace fine sand. V22: 30.0/4.0 ft-lbs | G#212320 A-6, CL WC=28.7% LL=30 PL=20 PI=10 |
| | V22 | | 81.00 - 81.43 | Su=824/110 psf | | | 53 | | | | |
| | | | | | | | 47 | | | | |
| | | | | | | | 46 | 85.90 | | 83.50 | |
| | | | | | | | 47 | | | | |
| 85 | MU<br>14D | 24/0<br>24/24 | 85.00 - 87.00<br>85.00 - 87.00 | WOR/WOR<br>WOR/WOR/WOR/ WOR | --- | | OPEN HOLE | | | Dark grey, wet, medium stiff, Silty CLAY, trace fine sand. Washed ahead to 87.0' bgs, then took vanes. | G#212321 A-6, CL WC=26.6% LL=36 PL=21 PI=15 |
| | | | | | | | | | | | |
| | V23 | | 87.00 - 87.43 | Su=989/110 psf | | | | | | 65x130 mm vane raw torque readings: V23: 36.0/4.0 ft-lbs | |
| | V24 | | 88.00 - 88.43 | Su=961/110 psf | | | RC | | | V24: 35.0/4.0 ft-lbs Roller Coned ahead to 90.0' bgs. | |
| | | | | | | | | | | | |
| 90 | MV<br>15D | 24/24 | 90.00 - 92.00 | WOR/WOR/WOR/ WOR | --- | | | | | Failed 65x130 mm vane attempt. Grey, wet, medium stiff, SILT, some clay, trace fine sand in 1/2- 2" layers. | G#212322 A-6, CL WC=26.1% LL=30 PL=19 PI=11 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | 75.90 | | 93.50 | |
| | | | | | | | | | | | |
| 95 | 16D | 24/20 | 95.00 - 97.00 | WOR/WOR/3/8 | 3 | 4 | | | | Grey, wet, loose, fine to medium SAND, some silt, trace clay. | G#212323 A-4, SC-SM WC=21.2% |
| | | | | | | | | | | | |
| | | | | | | | | 72.40 | | 97.00 **Bottom of Exploration at 97.00 feet below ground surface.** NO REFUSAL | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| 100 | | | | | | | | | | | |

**Remarks:**

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.

# **Appendix B**

Laboratory Data

State of Maine - Department of Transportation

## Laboratory Testing Summary Sheet

# Town(s): Monmouth Project Number: 16716.00

| Boring & Sample Identification Number | Station (Feet) | Offset (Feet) | Depth (Feet) | Reference Number | G.S.D.C. Sheet | W.C. % | L.L. | P.I. | Classification Unified | AASHTO | Frost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BB-MJS-101, 1D | 13+65.5 | 5.9 Rt. | 1.0-3.0 | 212264 | 1 | 10.5 | | | SM | A-2-4 | II |
| BB-MJS-101, 2D | 13+65.5 | 5.9 Rt. | 5.0-7.0 | 212265 | 1 | 19.9 | | | SC-SM | A-4 | III |
| BB-MJS-101, 3D | 13+65.5 | 5.9 Rt. | 14.0-16.0 | 212266 | 1 | 24.0 | -N | P- | CL-ML | A-4 | IV |
| BB-MJS-101, 4D | 13+65.5 | 5.9 Rt. | 19.0-21.0 | 212267 | 1 | 26.0 | -N | P- | CL-ML | A-4 | IV |
| BB-MJS-101, 5D | 13+65.5 | 5.9 Rt. | 24.0-26.0 | 212268 | 1 | 25.4 | -N | P- | CL-ML | A-4 | IV |
| BB-MJS-101, 6D | 13+65.5 | 5.9 Rt. | 29.0-31.0 | 212269 | 1 | 26.2 | 23 | 5 | CL-ML | A-4 | IV |
| BB-MJS-101, 7D | 13+65.5 | 5.9 Rt. | 34.0-36.0 | 212270 | 2 | 26.8 | -N | P- | CL-ML | A-4 | IV |
| BB-MJS-101, 9D | 13+65.5 | 5.9 Rt. | 45.0-47.0 | 212271 | 2 | 32.4 | | | CL-ML | A-4 | IV |
| BB-MJS-101, 10D | 13+65.5 | 5.9 Rt. | 49.0-51.0 | 212272 | 2 | 27.8 | 23 | 6 | CL-ML | A-4 | IV |
| BB-MJS-101, 1U | 13+65.5 | 5.9 Rt. | 54.0-56.0 | 212273 | 2 | 33.4 | 25 | 7 | CL | A-4 | IV |
| BB-MJS-101, 2U | 13+65.5 | 5.9 Rt. | 64.0-66.0 | 212274 | 2 | 30.7 | 26 | 8 | CL | A-4 | IV |
| BB-MJS-101, 12D | 13+65.5 | 5.9 Rt. | 69.0-71.0 | 212275 | 2 | 26.3 | 24 | 8 | CL | A-4 | IV |
| BB-MJS-101, 3U | 13+65.5 | 5.9 Rt. | 75.5-77.5 | 212301 | 3 | 35.6 | 35 | 14 | CL | A-6 | III |
| BB-MJS-101, 13D | 13+65.5 | 5.9 Rt. | 79.0-81.0 | 212302 | 3 | 28.9 | 31 | 12 | CL | A-6 | III |
| BB-MJS-101, 14D | 13+65.5 | 5.9 Rt. | 84.0-86.0 | 212303 | 3 | 23.0 | | | SM | A-4 | IV |
| BB-MJS-101, 16D | 13+65.5 | 5.9 Rt. | 94.0-96.0 | 212304 | 3 | 22.8 | | | SM | A-2-4 | II |
| BB-MJS-101, 17D | 13+65.5 | 5.9 Rt. | 99.0-101.0 | 212305 | 3 | 23.5 | | | SM | A-2-4 | II |
| BB-MJS-101, 18D | 13+65.5 | 5.9 Rt. | 104.0-106.0 | 212306 | 3 | 17.4 | | | SP-SM | A-3 | 0 |
| BB-MJS-102, 1D | 14+32.3 | 5.8 Lt. | 1.0-3.0 | 212307 | 4 | 12.1 | | | SM | A-2-4 | II |
| BB-MJS-102, 3D | 14+32.3 | 5.8 Lt. | 10.0-12.0 | 212308 | 4 | 22.1 | | | CL-ML | A-4 | IV |
| BB-MJS-102, 5D | 14+32.3 | 5.8 Lt. | 20.0-22.0 | 212309 | 4 | 22.4 | | | CL-ML | A-4 | IV |
| BB-MJS-102, 6D | 14+32.3 | 5.8 Lt. | 25.0-27.0 | 212310 | 4 | 27.2 | | | CL-ML | A-4 | IV |
| BB-MJS-102, 7D | 14+32.3 | 5.8 Lt. | 30.0-32.0 | 212311 | 4 | 28.3 | -N | P- | CL-ML | A-4 | IV |
| BB-MJS-102, 8D | 14+32.3 | 5.8 Lt. | 35.0-37.0 | 212312 | 4 | 29.0 | 25 | 7 | CL-ML | A-4 | IV |
| BB-MJS-102, 9D | 14+32.3 | 5.8 Lt. | 40.0-42.0 | 212313 | 5 | 24.7 | 22 | 5 | CL-ML | A-4 | IV |
| BB-MJS-102, 10D | 14+32.3 | 5.8 Lt. | 45.0-47.0 | 212314 | 5 | 28.8 | 22 | 5 | CL-ML | A-4 | IV |
| BB-MJS-102, 11D | 14+32.3 | 5.8 Lt. | 50.0-52.0 | 212315 | 5 | 17.0 | -N | P- | SC-SM | A-2-4 | III |
| BB-MJS-102, 1U | 14+32.3 | 5.8 Lt. | 55.0-57.0 | 212316 | --- | Tube Damaged | | | | | |
| BB-MJS-102, 12D | 14+32.3 | 5.8 Lt. | 60.0-62.0 | 212317 | 5 | 27.6 | 26 | 8 | CL | A-4 | IV |
| BB-MJS-102, 2U | 14+32.3 | 5.8 Lt. | 65.0-67.0 | 212318 | 5 | 28.7 | 23 | 5 | CL-ML | A-4 | IV |
| BB-MJS-102, 3U | 14+32.3 | 5.8 Lt. | 75.0-77.0 | 212319 | 6 | 31.6 | 29 | 10 | CL | A-6 | IV |
| BB-MJS-102, 13D | 14+32.3 | 5.8 Lt. | 80.0-82.0 | 212320 | 6 | 28.7 | 30 | 10 | CL | A-6 | IV |
| BB-MJS-102, 14D | 14+32.3 | 5.8 Lt. | 85.0-87.0 | 212321 | 6 | 26.6 | 36 | 15 | CL | A-6 | III |
| BB-MJS-102, 15D | 14+32.3 | 5.8 Lt. | 90.0-92.0 | 212322 | 6 | 26.1 | 30 | 11 | CL | A-6 | IV |
| BB-MJS-102, 16D | 14+32.3 | 5.8 Lt. | 95.0-97.0 | 212323 | 6 | 21.2 | | | SC-SM | A-4 | II |

**Classification of these soil samples is in accordance with AASHTO Classification System M-145-40. This classification is followed by the "Frost Susceptibility Rating" from zero (non-frost susceptible) to Class IV (highly frost susceptible). The "Frost Susceptibility Rating" is based upon the MaineDOT and Corps of Engineers Classification Systems.**

GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

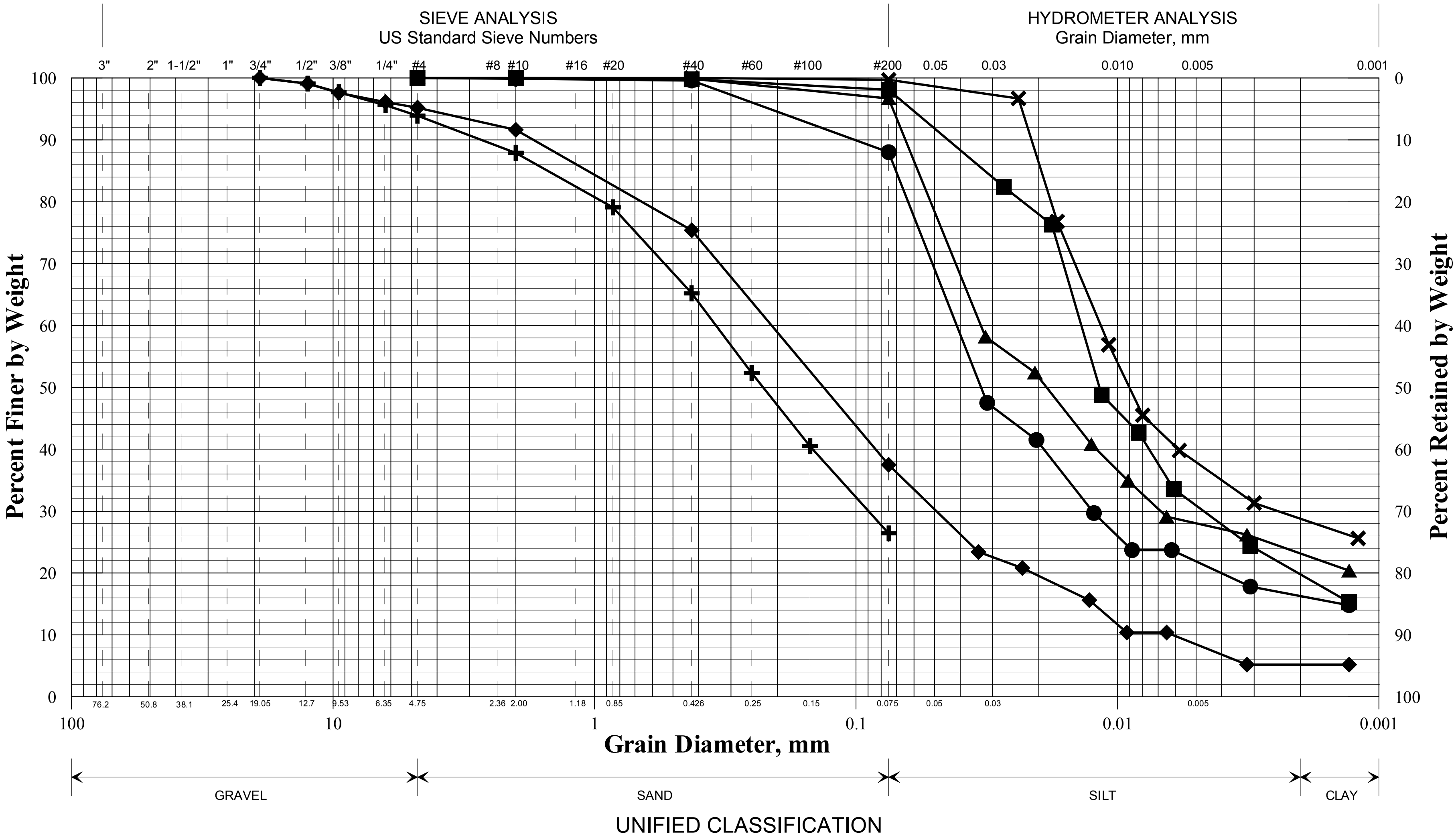
WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98

PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98

*State of Maine Department of Transportation*

**GRAIN SIZE DISTRIBUTION CURVE**

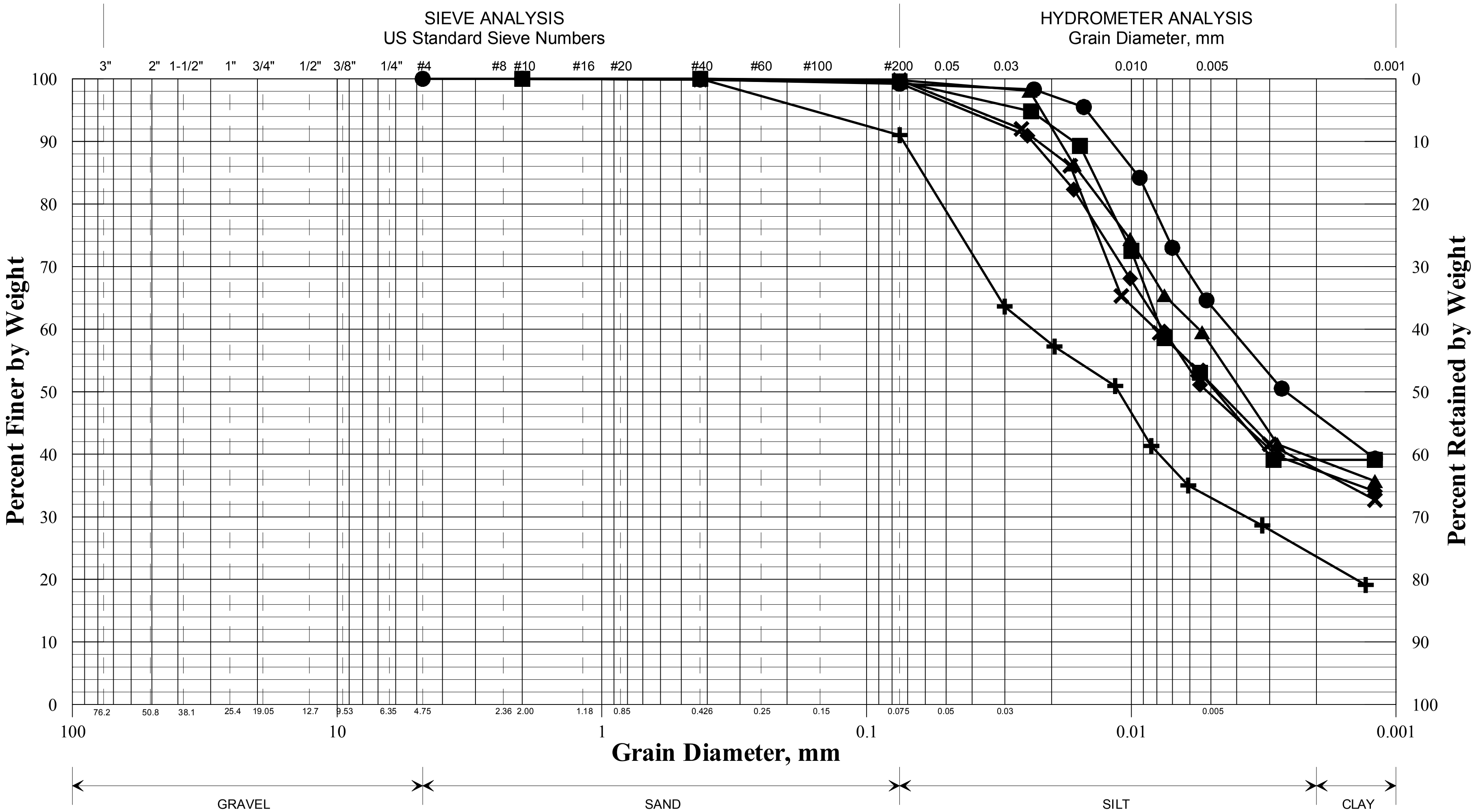



| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | BB-MJS-101/1D | 13+65.5 | 5.9 RT | 1.0-3.0 | SAND, some silt, trace gravel. | 10.5 | | | |
| ◆ | BB-MJS-101/2D | 13+65.5 | 5.9 RT | 5.0-7.0 | SAND, some silt, trace clay, trace gravel. | 19.9 | | | |
| ■ | BB-MJS-101/3D | 13+65.5 | 5.9 RT | 14.0-16.0 | SILT, little clay, trace sand. | 24.0 | | | NP |
| ● | BB-MJS-101/4D | 13+65.5 | 5.9 RT | 19.0-21.0 | SILT, little clay, little sand. | 26.0 | | | NP |
| ▲ | BB-MJS-101/5D | 13+65.5 | 5.9 RT | 24.0-26.0 | SILT, some clay, trace sand. | 25.4 | | | NP |
| ✖ | BB-MJS-101/6D | 13+65.5 | 5.9 RT | 29.0-31.0 | SILT, some clay, trace sand. | 26.2 | 23 | 18 | 5 |

| PIN |
|---|
| 016716.00 |
| Town |
| Monmouth |
| Reported by/Date |
| WHITE, TERRY A 8/27/2009 |

**SHEET 1**

# State of Maine Department of Transportation
## GRAIN SIZE DISTRIBUTION CURVE



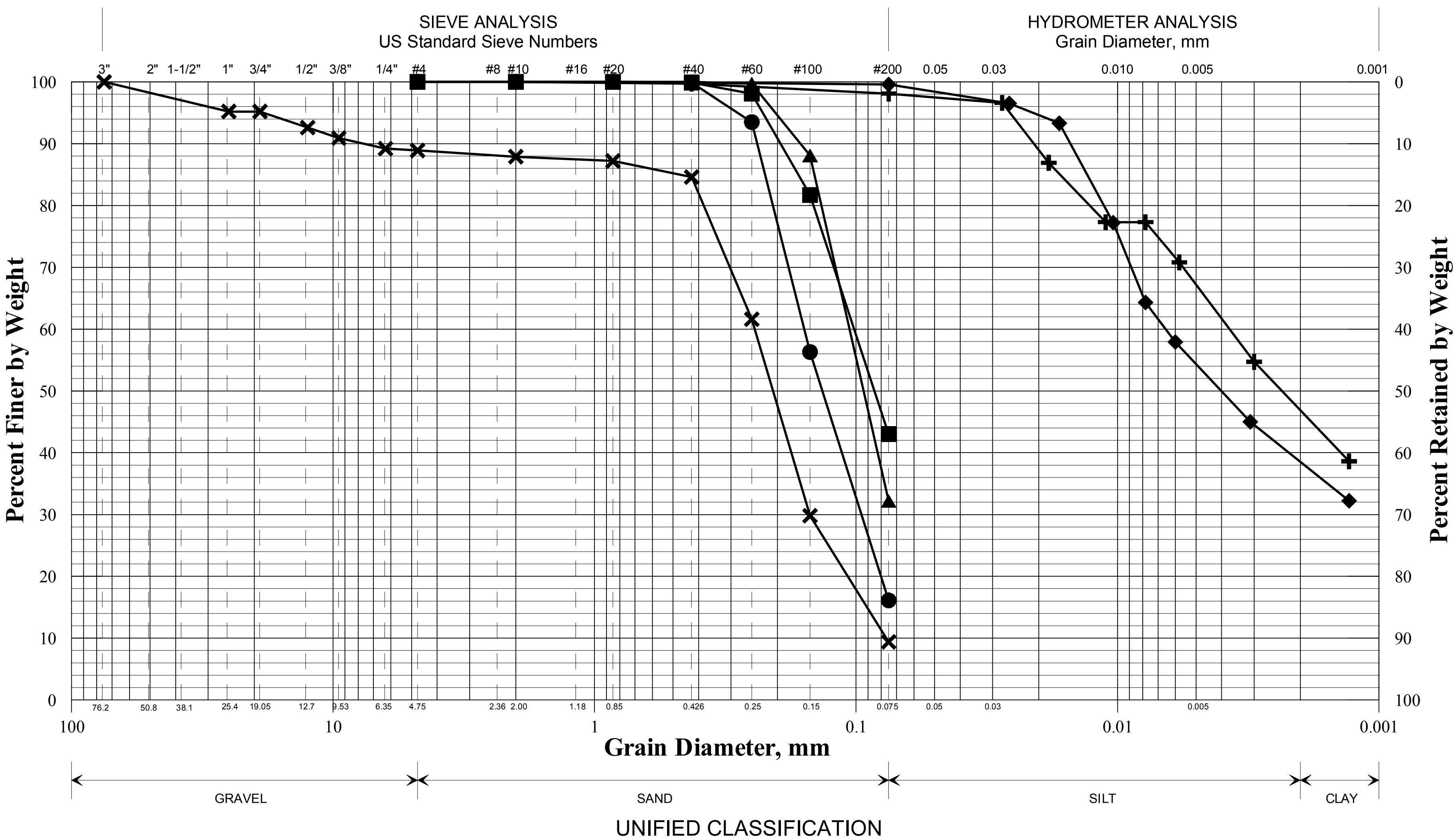

UNIFIED CLASSIFICATION

| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | BB-MJS-101/7D | 13+65.5 | 5.9 RT | 34.0-36.0 | SILT, some clay, trace sand. | 26.8 | | | NP |
| ◆ | BB-MJS-101/9D | 13+65.5 | 5.9 RT | 45.0-47.0 | Clayey SILT, trace sand. | 32.4 | | | |
| ■ | BB0MJS-101/10D | 13+65.5 | 5.9 RT | 49.0-51.0 | Clayey SILT, trace sand. | 27.8 | 23 | 17 | 6 |
| ● | BB-MJS-101/1U | 13+65.5 | 5.9 RT | 54.0-56.0 | Clayey SILT, trace sand. | 33.4 | 25 | 18 | 7 |
| ▲ | BB-MJS-101/2U | 13+65.5 | 5.9 RT | 64.0-66.0 | Clayey SILT, trace sand. | 30.7 | 26 | 18 | 8 |
| ✖ | BB-MJS-101/12D | 13+65.5 | 5.9 RT | 69.0-71.0 | Clayey SILT, trace sand. | 26.3 | 24 | 16 | 8 |

| PIN |
|---|
| 016716.00 |
| Town |
| Monmouth |
| Reported by/Date |
| WHITE, TERRY A 8/27/2009 |

SHEET 2

## *State of Maine Department of Transportation*
**GRAIN SIZE DISTRIBUTION CURVE**



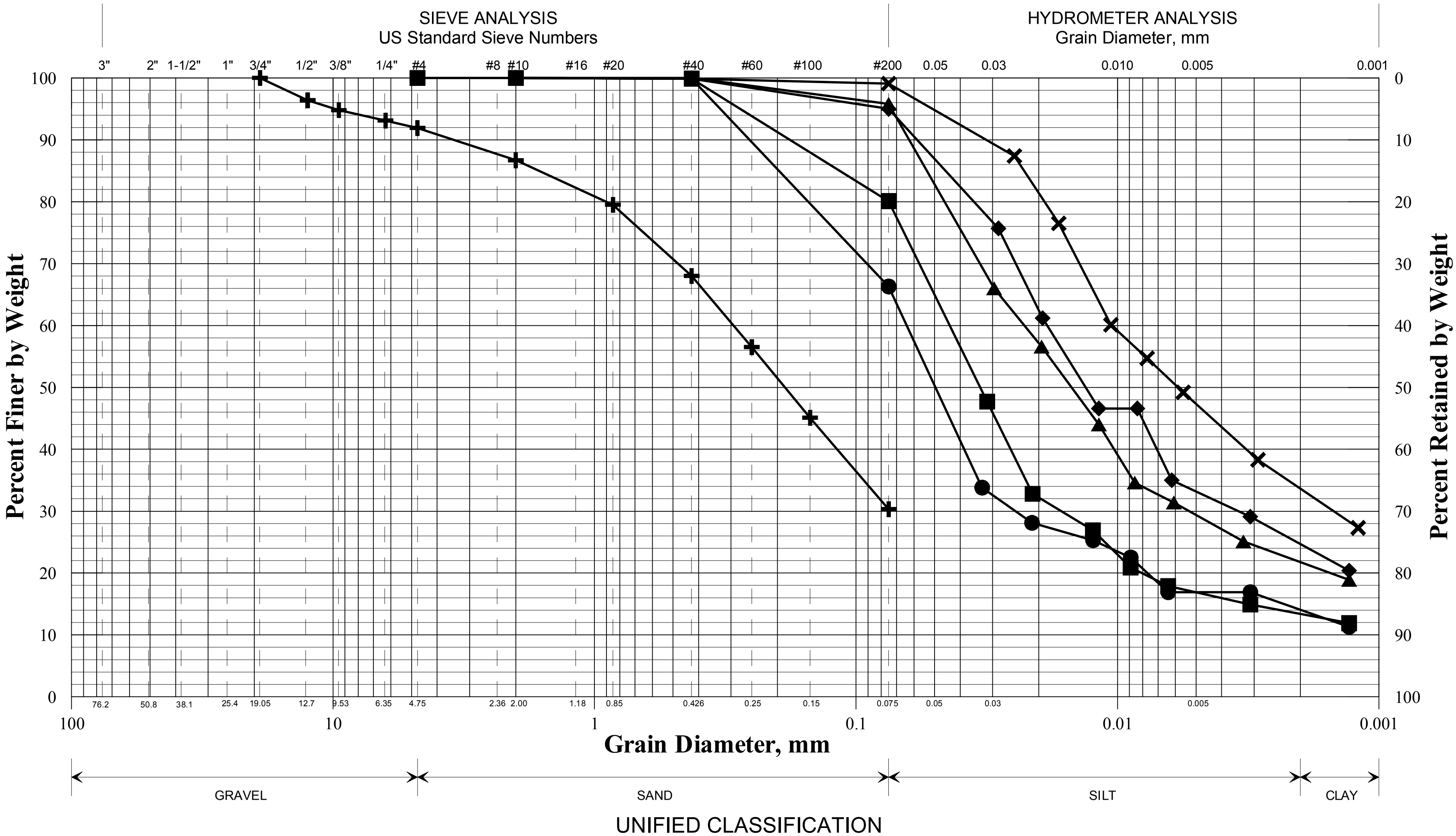

| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | BB-MJS-101/3U | 13+65.5 | 5.9 RT | 75.5-77.5 | Clayey SILT, trace sand. | 35.6 | 35 | 21 | 14 |
| ◆ | BB-MJS-101/13D | 13+65.5 | 5.9 RT | 79.0-81.0 | Clayey SILT, trace sand. | 28.9 | 31 | 19 | 12 |
| ■ | BB-MJS-101/14D | 13+65.5 | 5.9 RT | 84.0-86.0 | Silty SAND. | 23.0 | | | |
| ● | BB-MJS-101/16D | 13+65.5 | 5.9 RT | 94.0-96.0 | SAND, little silt. | 22.8 | | | |
| ▲ | BB-MJS-101/17D | 13+65.5 | 5.9 RT | 99.0-101.0 | SAND, some silt. | 23.5 | | | |
| ✖ | BB-MJS-101/18D | 13+65.5 | 5.9 RT | 104.0-106.0 | SAND, little gravel, trace silt. | 17.4 | | | |

| PIN | |
|---|---|
| 016716.00 | |
| Town | |
| Monmouth | |
| Reported by/Date | |
| WHITE, TERRY A | 8/27/2009 |

**SHEET 3**

*State of Maine Department of Transportation*

**GRAIN SIZE DISTRIBUTION CURVE**

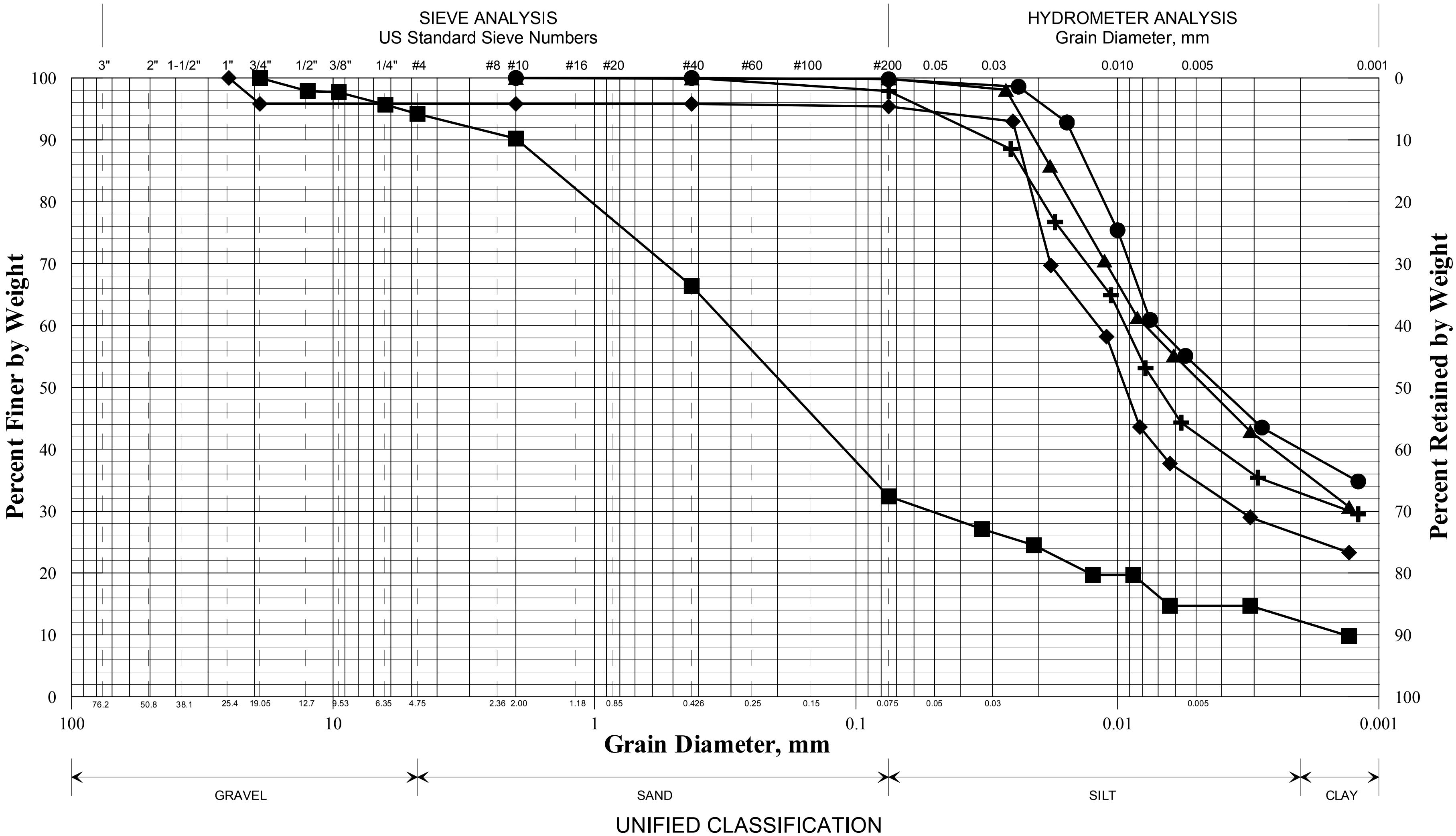



| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | BB-MJS-102/1D | 14+32.3 | 5.8 LT | 1.0-3.0 | SAND, some silt, trace gravel. | 12.1 | | | |
| ◆ | BB-MJS-102/3D | 14+32.3 | 5.8 LT | 10.0-12.0 | SILT, some clay, trace sand. | 22.1 | | | |
| ■ | BB-MJS-102/5D | 14+32.3 | 5.8 LT | 20.0-22.0 | SILT, little sand, little clay. | 22.4 | | | |
| ● | BB-MJS-102/6D | 14+32.3 | 5.8 LT | 25.0-27.0 | SILT, some sand, little clay. | 27.2 | | | |
| ▲ | BB-MJS-102/7D | 14+32.3 | 5.8 LT | 30.0-32.0 | SILT, some clay, trace sand. | 28.3 | | | NP |
| ✖ | BB-MJS-102/8D | 14+32.3 | 5.8 LT | 35.0-37.0 | SILT, some clay, trace sand. | 29.0 | 25 | 18 | 7 |

| PIN | |
|---|---|
| 016716.00 | |
| Town | |
| Monmouth | |
| Reported by/Date | |
| WHITE, TERRY A | 8/27/2009 |

**SHEET 4**

# State of Maine Department of Transportation
## GRAIN SIZE DISTRIBUTION CURVE

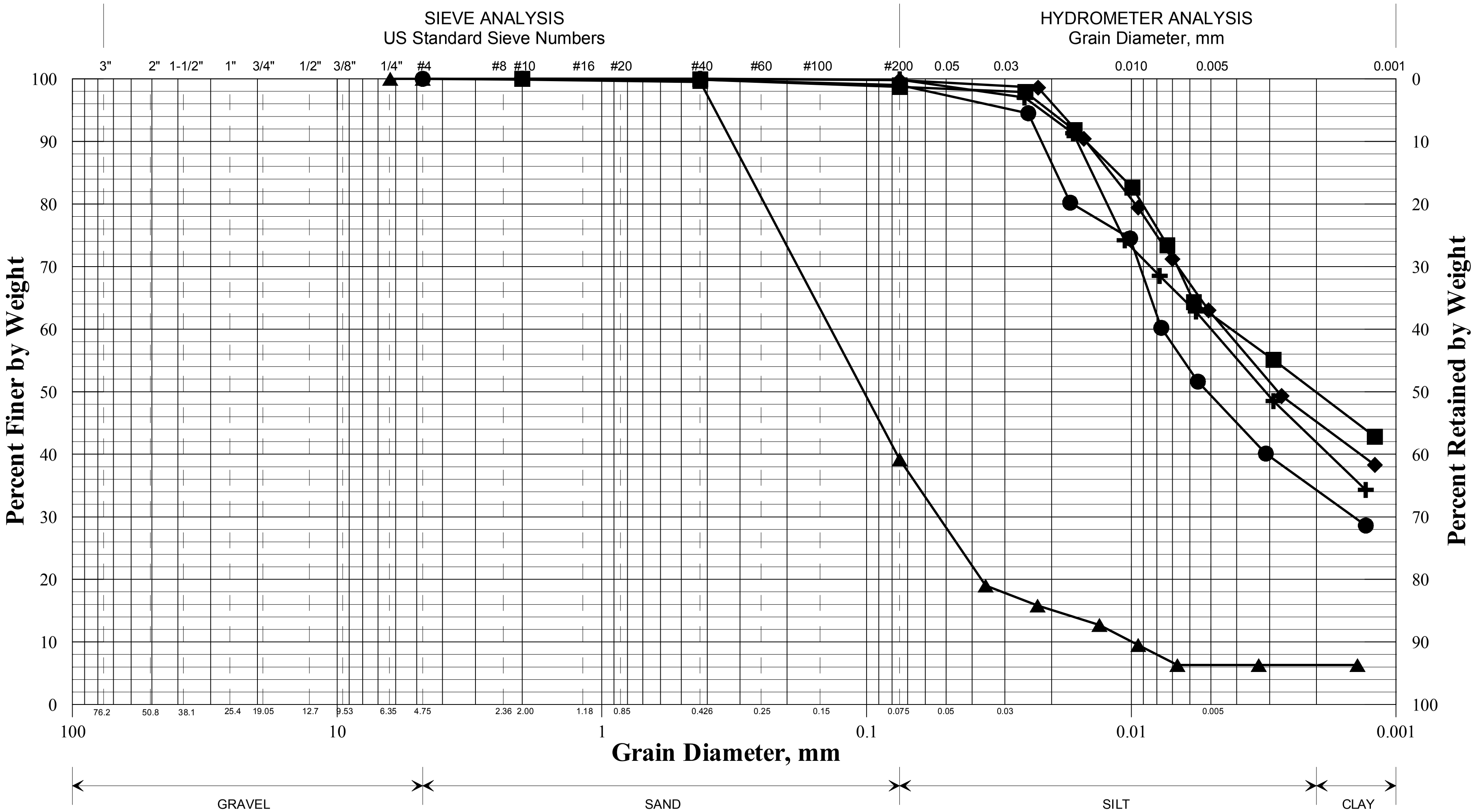



| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | BB-MJS-102/9D | 14+32.3 | 5.8 LT | 40.0-42.0 | SILT, some clay, trace sand. | 24.7 | 22 | 17 | 5 |
| ◆ | BB-MJS-102/10D | 14+32.3 | 5.8 LT | 45.0-47.0 | SILT, some clay, trace sand. | 28.8 | 22 | 17 | 5 |
| ■ | BB-MJS-102/11D | 14+32.3 | 5.8 LT | 50.0-52.0 | SAND, some silt, little clay, trace gravel. | 17.0 | | | NP |
| ● | BB-MJS-102/12D | 14+32.3 | 5.8 LT | 60.0-62.0 | Clayey SILT, trace sand. | 27.6 | 26 | 18 | 8 |
| ▲ | BB-MJS-102/2U | 14+32.3 | 5.8 LT | 65.0-67.0 | Clayey SILT, trace sand. | 28.7 | 23 | 18 | 5 |
| ✖ | | | | | | | | | |

| PIN |
|---|
| 016716.00 |
| Town |
| Monmouth |
| Reported by/Date |
| WHITE, TERRY A 8/27/2009 |

**SHEET 5**

## *State of Maine Department of Transportation*
**GRAIN SIZE DISTRIBUTION CURVE**



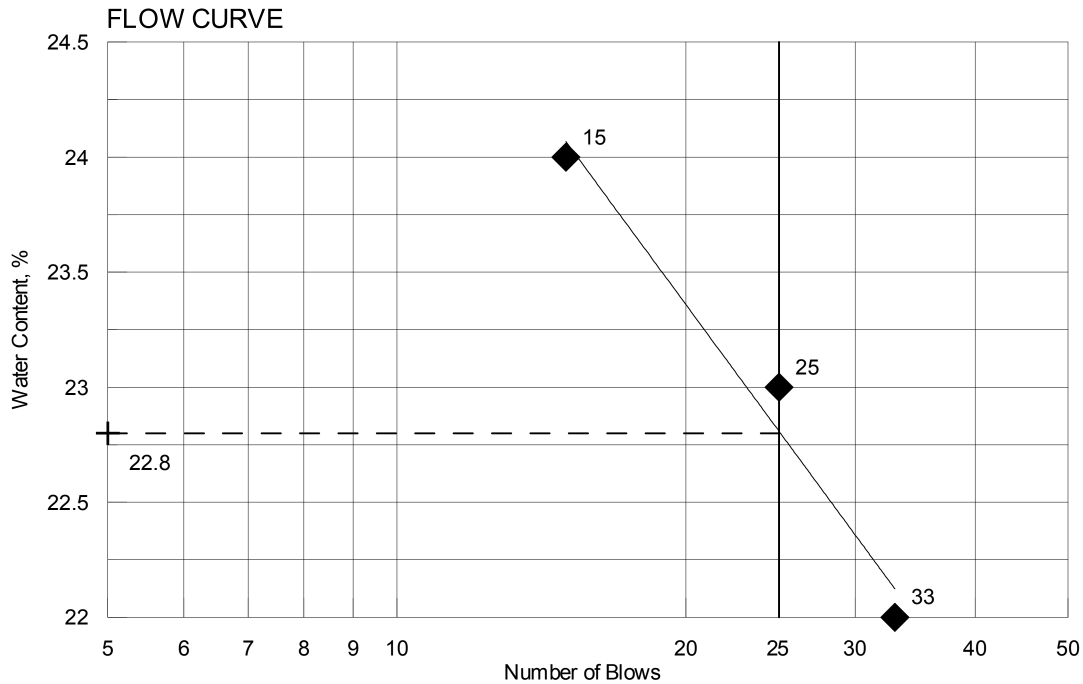

UNIFIED CLASSIFICATION

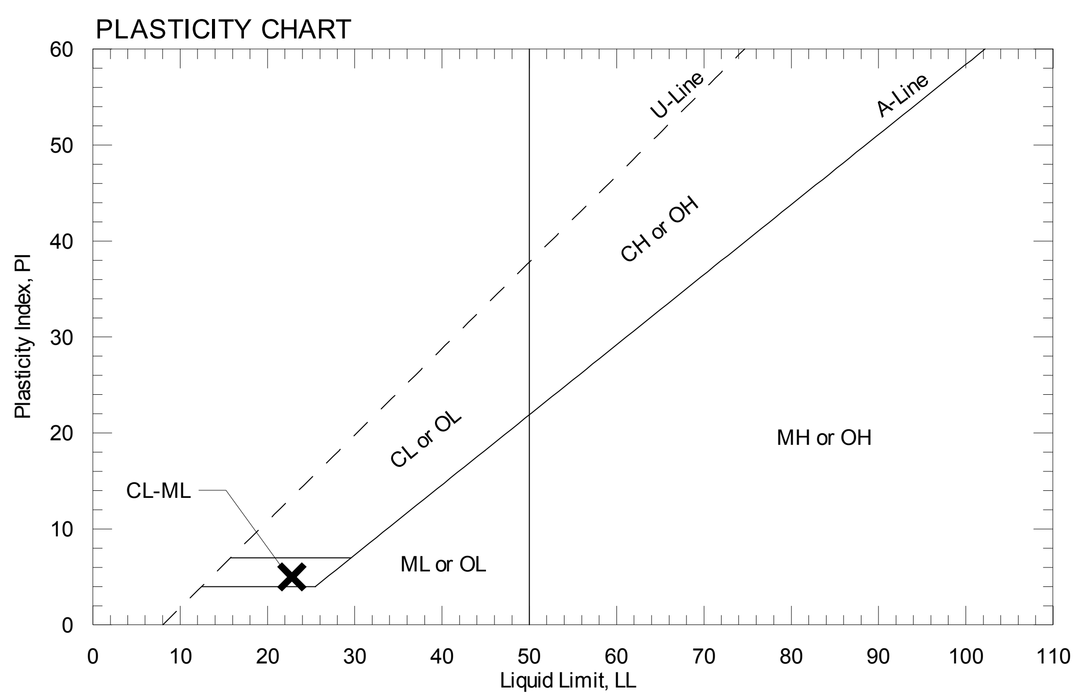
| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | BB-MJS-102/3U | 14+32.3 | 5.8 LT | 75.0-77.0 | Clayey SILT, trace sand. | 31.6 | 29 | 19 | 10 |
| ◆ | BB-MJS-102/13D | 14+32.3 | 5.8 LT | 80.0-82.0 | Clayey SILT, trace sand. | 28.7 | 30 | 20 | 10 |
| ■ | BB-MJS-102/14D | 14+32.3 | 5.8 LT | 85.0-87.0 | Silty CLAY, trace sand. | 26.6 | 36 | 21 | 15 |
| ● | BB-MJS-102/15D | 14+32.3 | 5.8 LT | 90.0-92.0 | SILT, some clay, trace sand. | 26.1 | 30 | 19 | 11 |
| ▲ | BB-MJS-102/16D | 14+32.3 | 5.8 LT | 95.0-97.0 | SAND, some silt, trace clay. | 21.2 | | | |
| ✖ | | | | | | | | | |

| PIN | |
|---|---|
| 016716.00 | |
| Town | |
| Monmouth | |
| Reported by/Date | |
| WHITE, TERRY A | 8/27/2009 |

**SHEET 6**

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212269 |
| PIN | 016716.00 | Water Content, % | 26.2 |
| Sampled | 6/19/2009 | Plastic Limit | 18 |
| Boring No./Sample No. | BB-MJS-101/6D | Liquid Limit | 23 |
| Station | 13+65.5 | Plasticity Index | 5 |
| Depth | 29.0-31.0 | Tested By | BBURR |



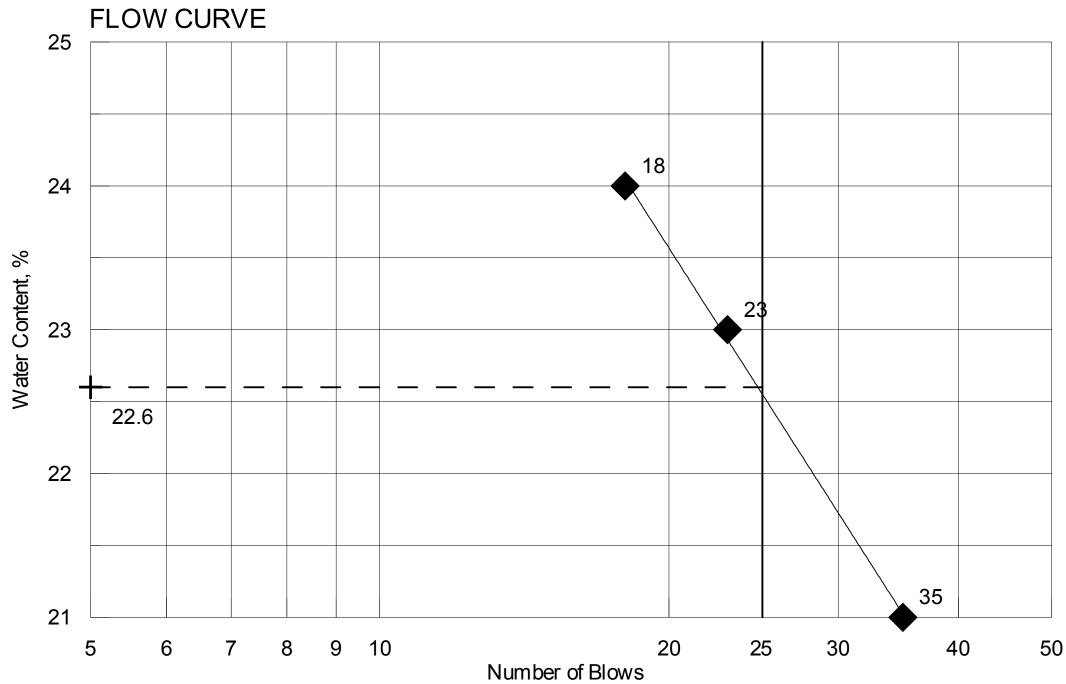


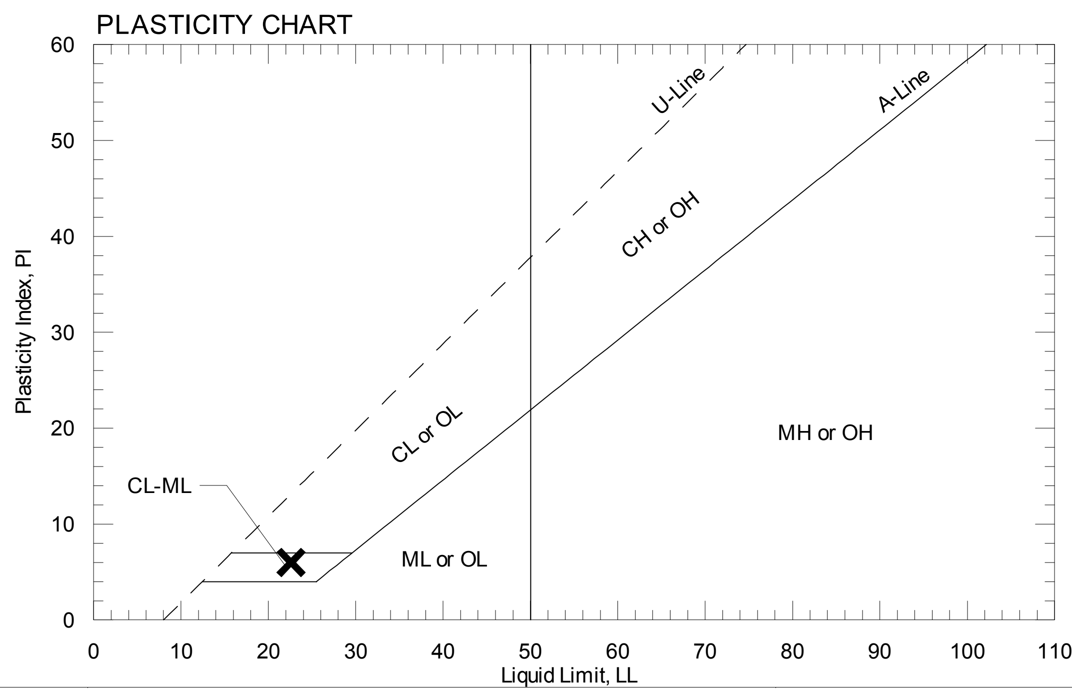

**A U T H O R I Z A T I O N   A N D   D I S T R I B U T I O N**

Reported by: **FOGG, BRIAN** Date Reported: **8/17/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212272 |
| PIN | 016716.00 | Water Content, % | 27.8 |
| Sampled | 6/17/2009 | Plastic Limit | 17 |
| Boring No./Sample No. | BB0MJS-101/10D | Liquid Limit | 23 |
| Station | 13+65.5 | Plasticity Index | 6 |
| Depth | 49.0-51.0 | Tested By | BBURR |



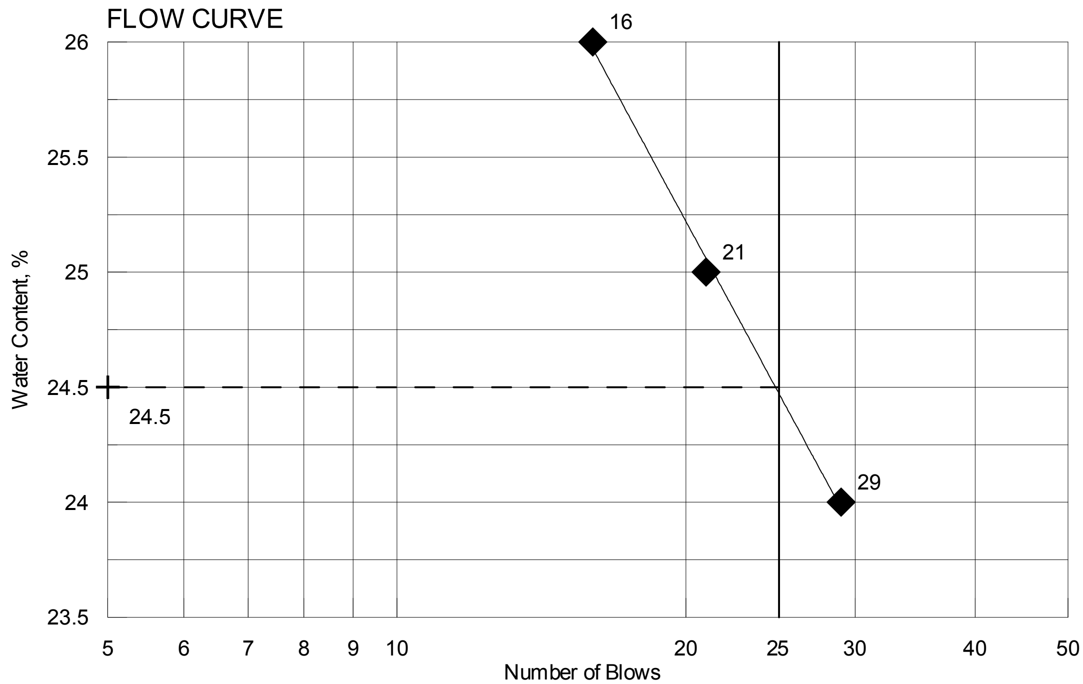


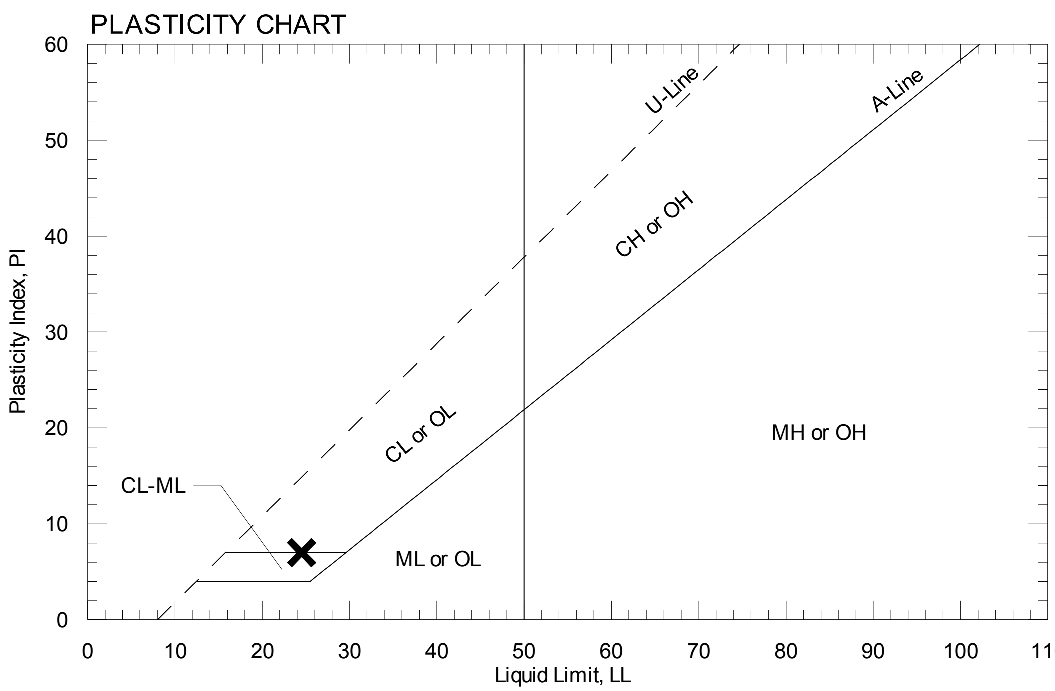

**AUTHORIZATION AND DISTRIBUTION**

Reported by: **FOGG, BRIAN** Date Reported: **8/17/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212273 |
| PIN | 016716.00 | Water Content, % | 33.4 |
| Sampled | 7/14/2009 | Plastic Limit | 18 |
| Boring No./Sample No. | BB-MJS-101/1U | Liquid Limit | 25 |
| Station | 13+65.5 | Plasticity Index | 7 |
| Depth | 54.0-56.0 | Tested By | BBURR |



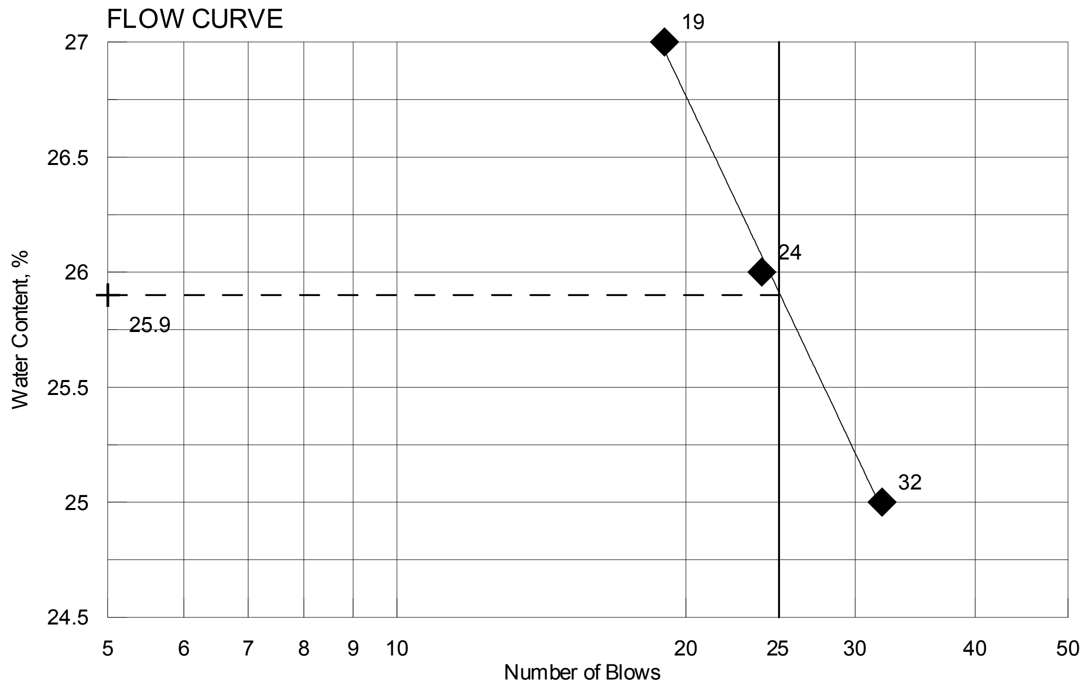


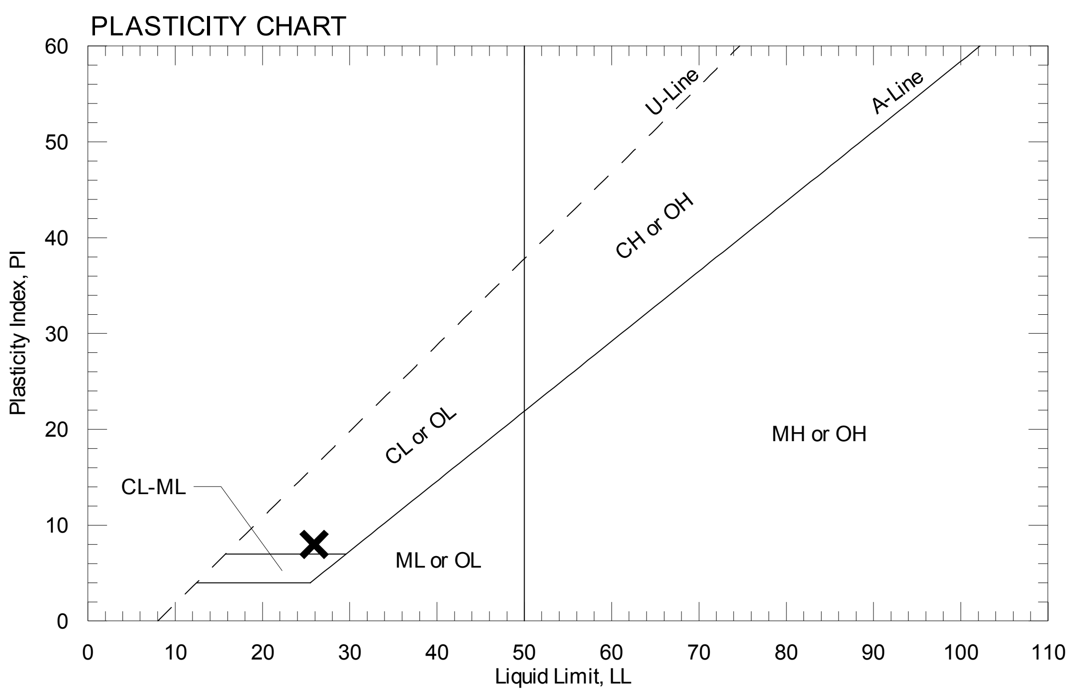

**AUTHORIZATION AND DISTRIBUTION**

Reported by: **FOGG, BRIAN** Date Reported: **8/24/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212274 |
| PIN | 016716.00 | Water Content, % | 30.7 |
| Sampled | 7/14/2009 | Plastic Limit | 18 |
| Boring No./Sample No. | BB-MJS-101/2U | Liquid Limit | 26 |
| Station | 13+65.5 | Plasticity Index | 8 |
| Depth | 64.0-66.0 | Tested By | BBURR |



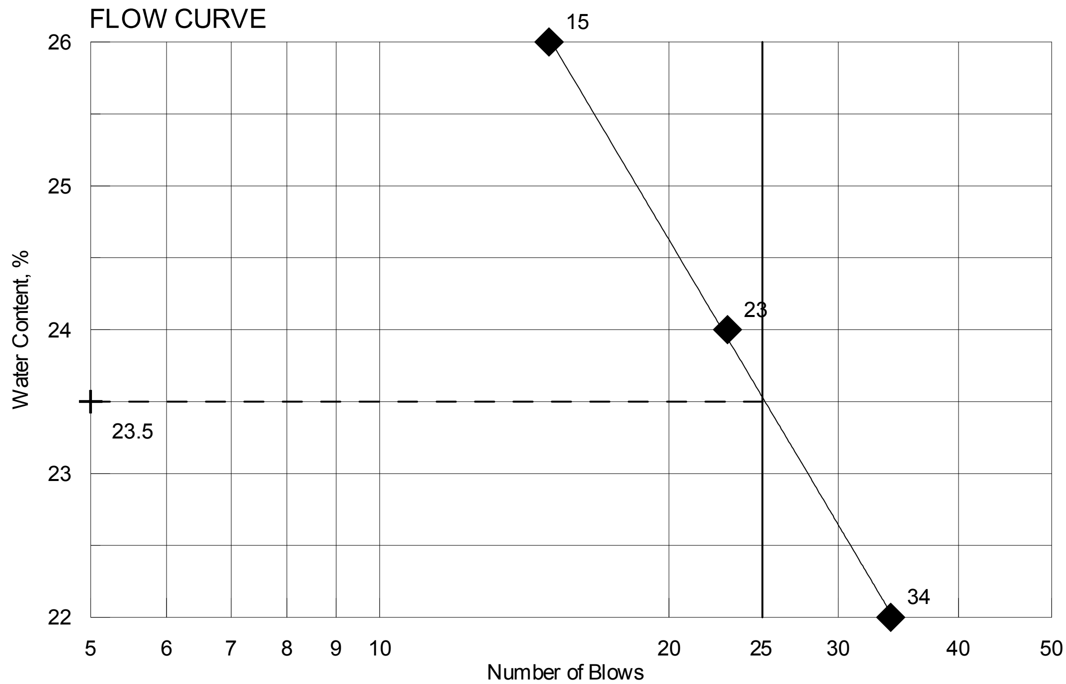


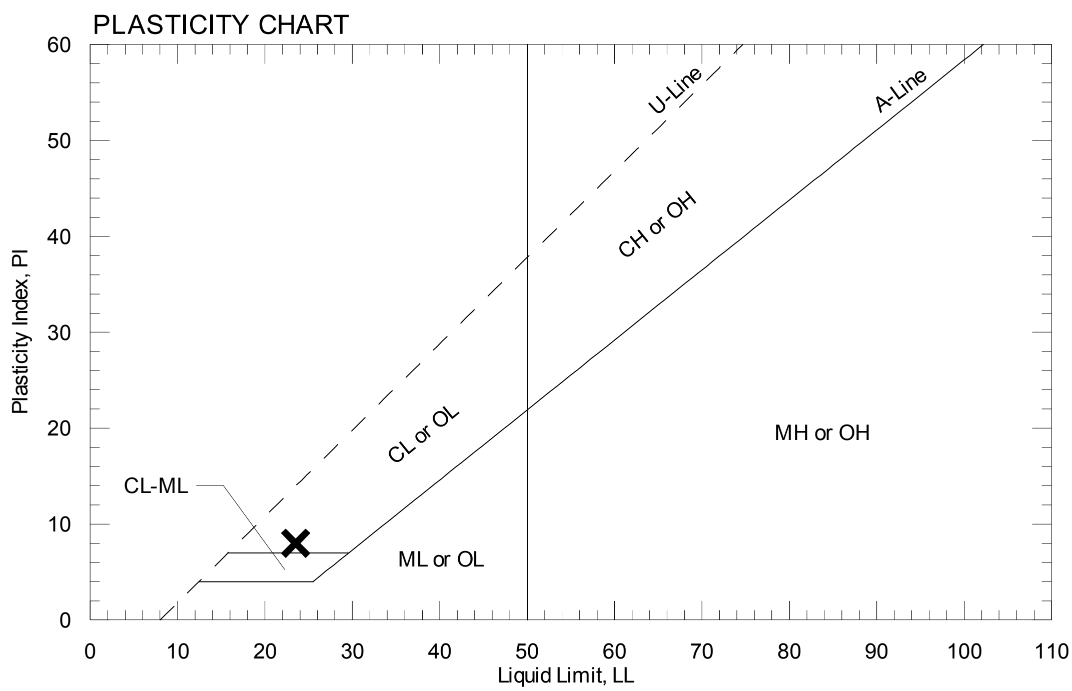

**A U T H O R I Z A T I O N   A N D   D I S T R I B U T I O N**

Reported by: **FOGG, BRIAN** Date Reported: **8/19/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212275 |
| PIN | 016716.00 | Water Content, % | 26.3 |
| Sampled | 6/17/2009 | Plastic Limit | 16 |
| Boring No./Sample No. | BB-MJS-101/12D | Liquid Limit | 24 |
| Station | 13+65.5 | Plasticity Index | 8 |
| Depth | 69.0-71.0 | Tested By | BBURR |



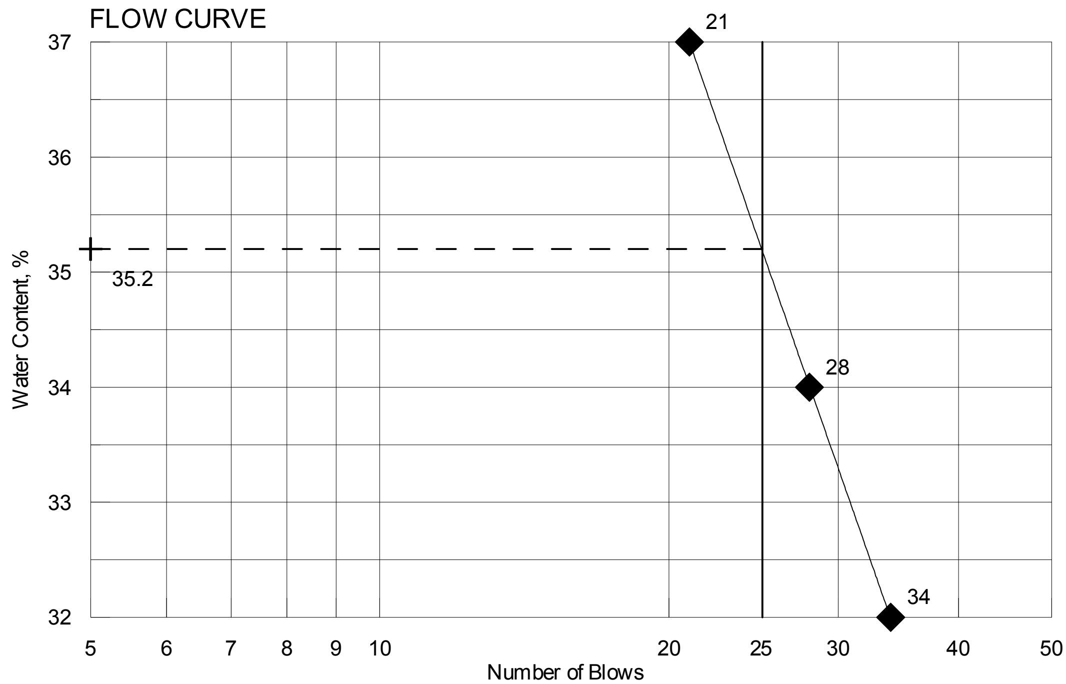


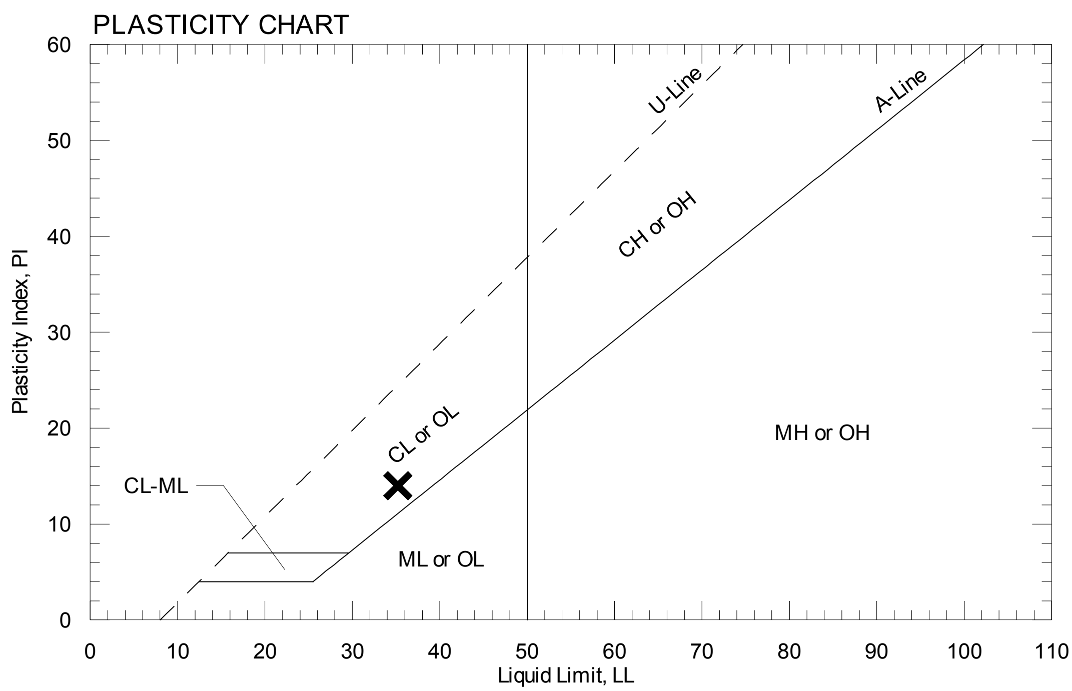

**AUTHORIZATION AND DISTRIBUTION**

Reported by: **FOGG, BRIAN** Date Reported: **8/17/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212301 |
| PIN | 016716.00 | Water Content, % | 35.6 |
| Sampled | 7/14/2009 | Plastic Limit | 21 |
| Boring No./Sample No. | BB-MJS-101/3U | Liquid Limit | 35 |
| Station | 13+65.5 | Plasticity Index | 14 |
| Depth | 75.5-77.5 | Tested By | BBURR |



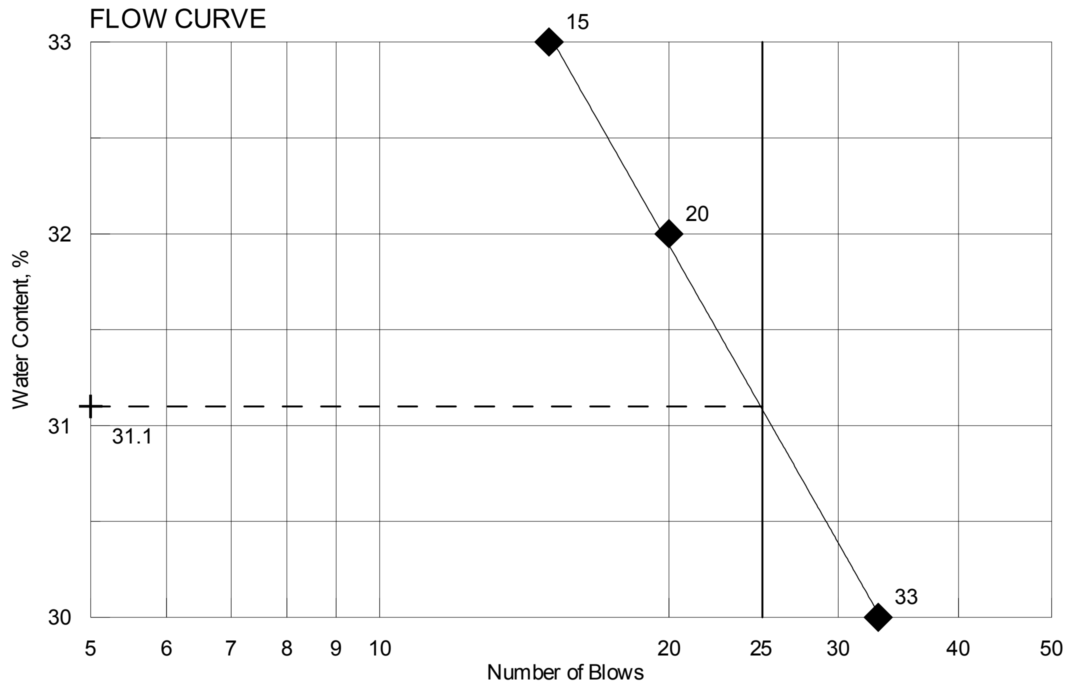


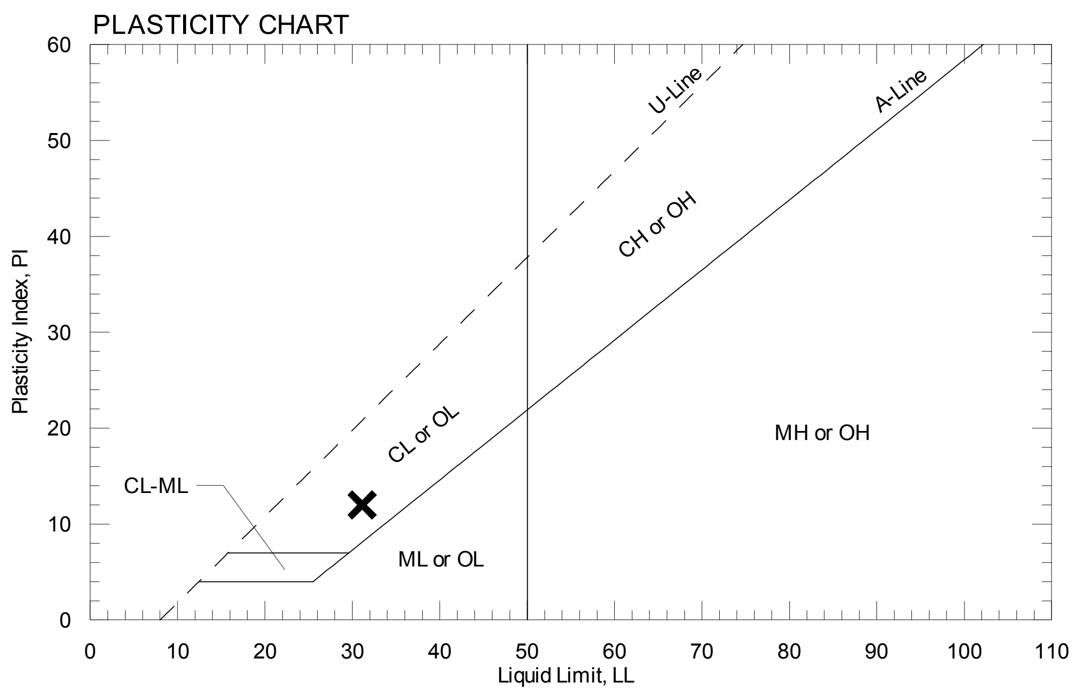

**AUTHORIZATION AND DISTRIBUTION**

Reported by: **FOGG, BRIAN** Date Reported: **8/24/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212302 |
| PIN | 016716.00 | Water Content, % | 28.9 |
| Sampled | 6/23/2009 | Plastic Limit | 19 |
| Boring No./Sample No. | BB-MJS-101/13D | Liquid Limit | 31 |
| Station | 13+65.5 | Plasticity Index | 12 |
| Depth | 79.0-81.0 | Tested By | BBURR |



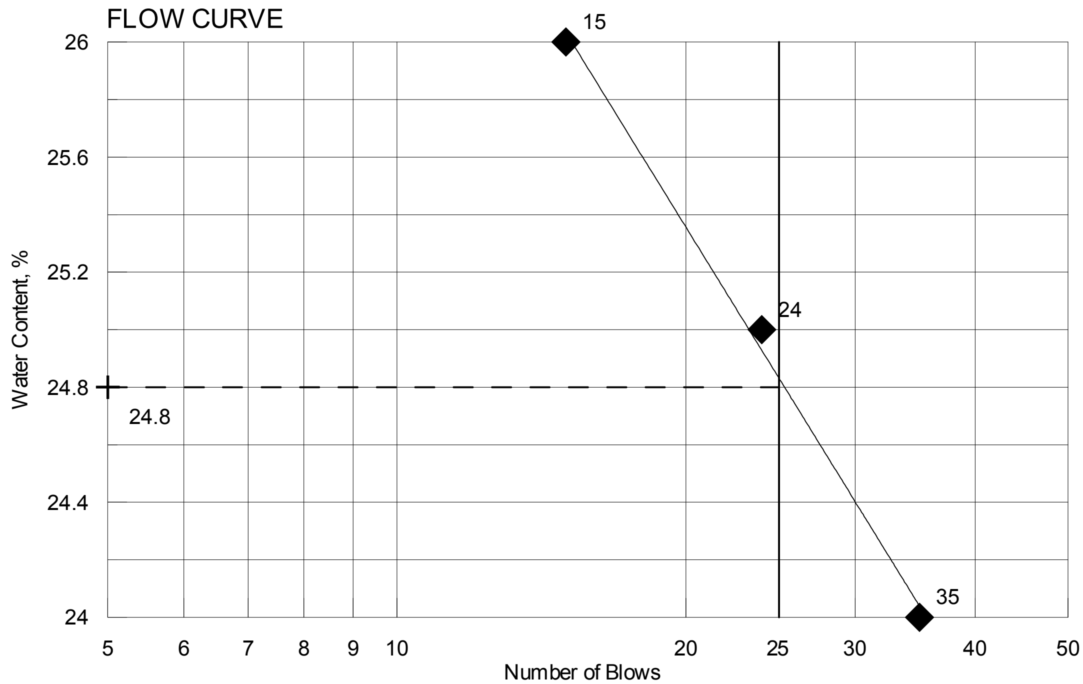


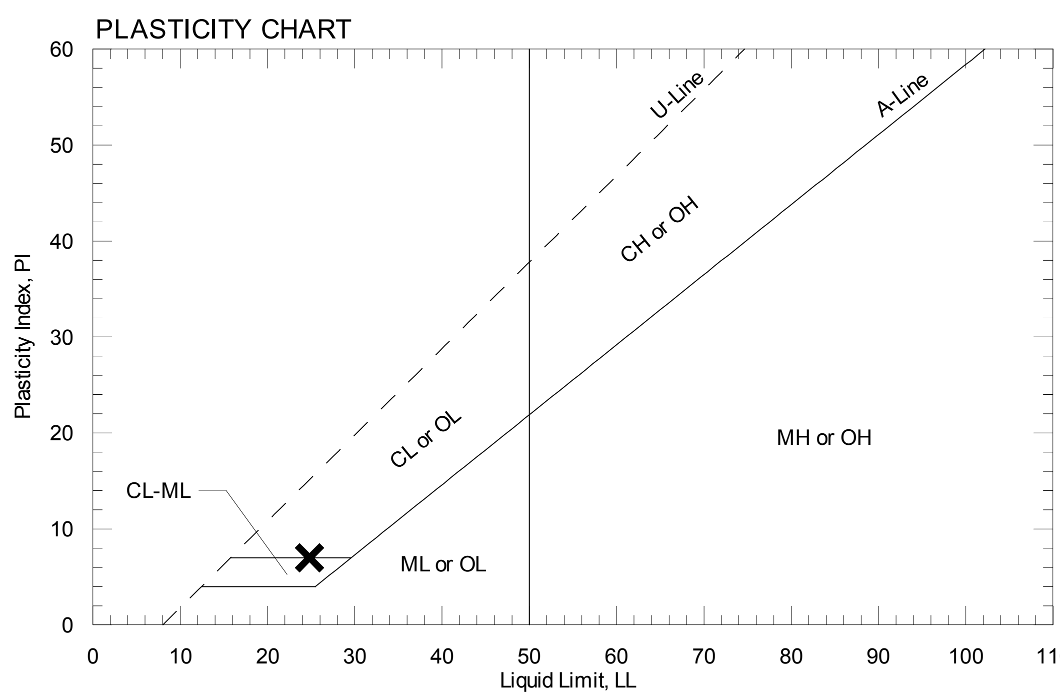

**AUTHORIZATION AND DISTRIBUTION**

Reported by: **FOGG, BRIAN** Date Reported: **8/19/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| TOWN | Monmouth | Reference No. | 212312 |
|---|---|---|---|
| PIN | 016716.00 | Water Content, % | 29 |
| Sampled | 7/1/2009 | Plastic Limit | 18 |
| Boring No./Sample No. | BB-MJS-102/8D | Liquid Limit | 25 |
| Station | 14+32.3 | Plasticity Index | 7 |
| Depth | 35.0-37.0 | Tested By | BBURR |






**AUTHORIZATION AND DISTRIBUTION**

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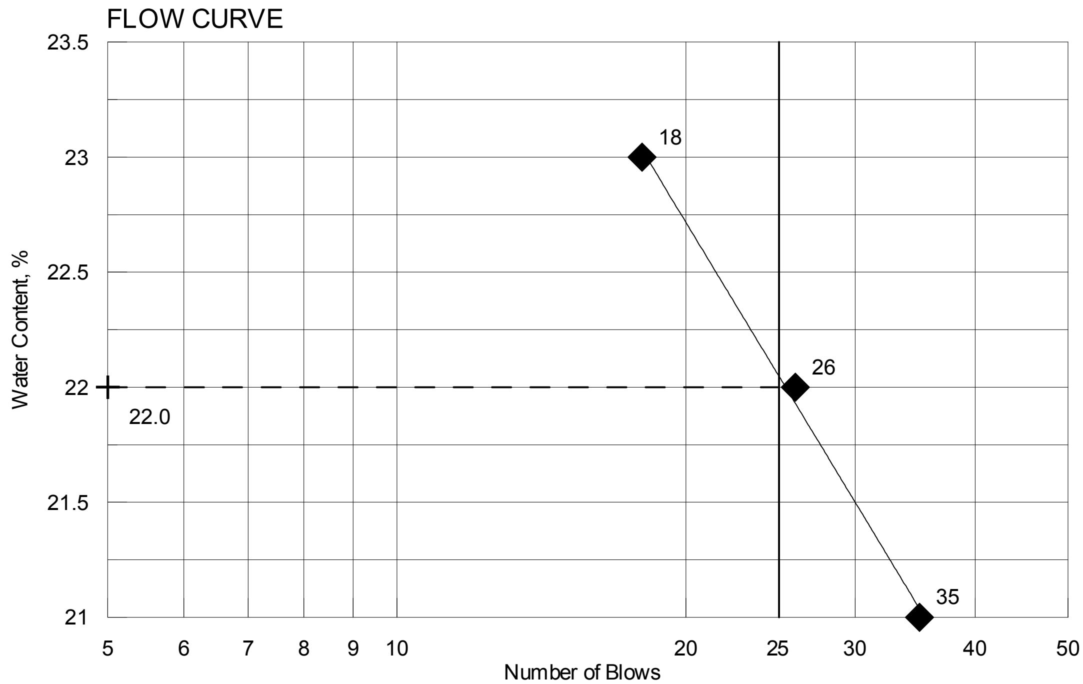
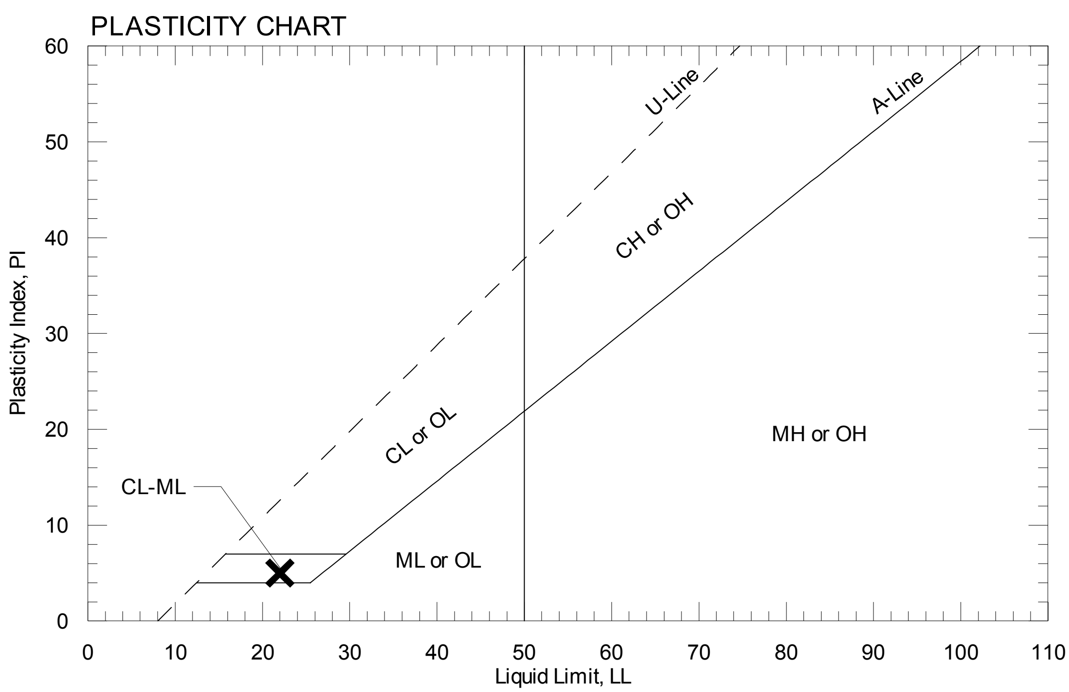
| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212313 |
| PIN | 016716.00 | Water Content, % | 24.7 |
| Sampled | 7/1/2009 | Plastic Limit | 17 |
| Boring No./Sample No. | BB-MJS-102/9D | Liquid Limit | 22 |
| Station | 14+32.3 | Plasticity Index | 5 |
| Depth | 40.0-42.0 | Tested By | BBURR |



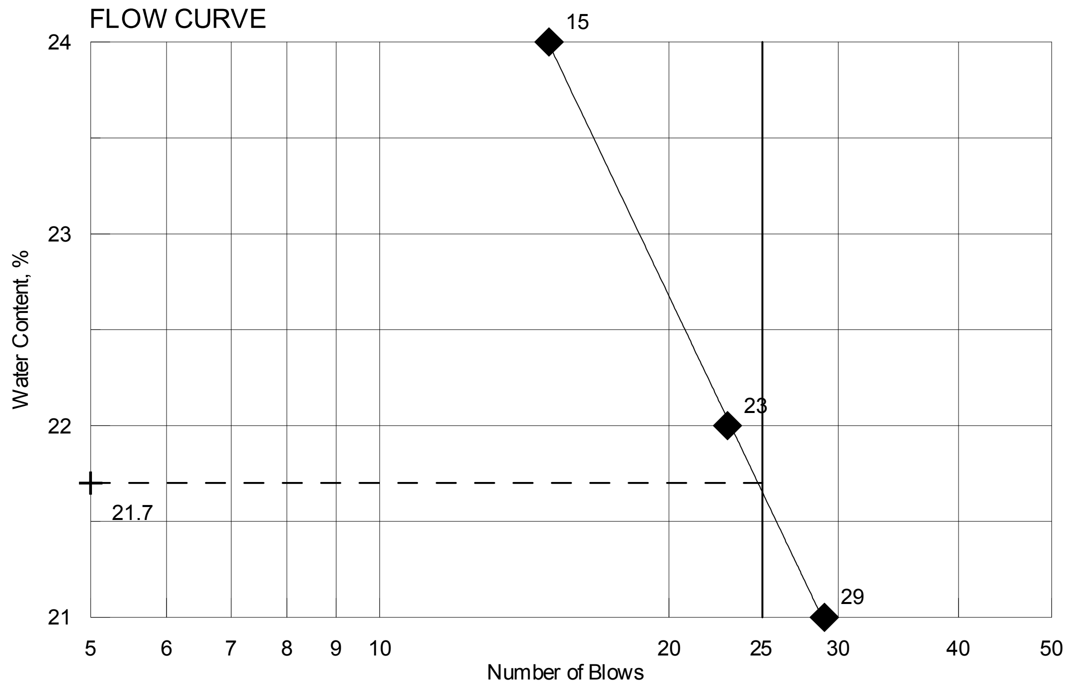


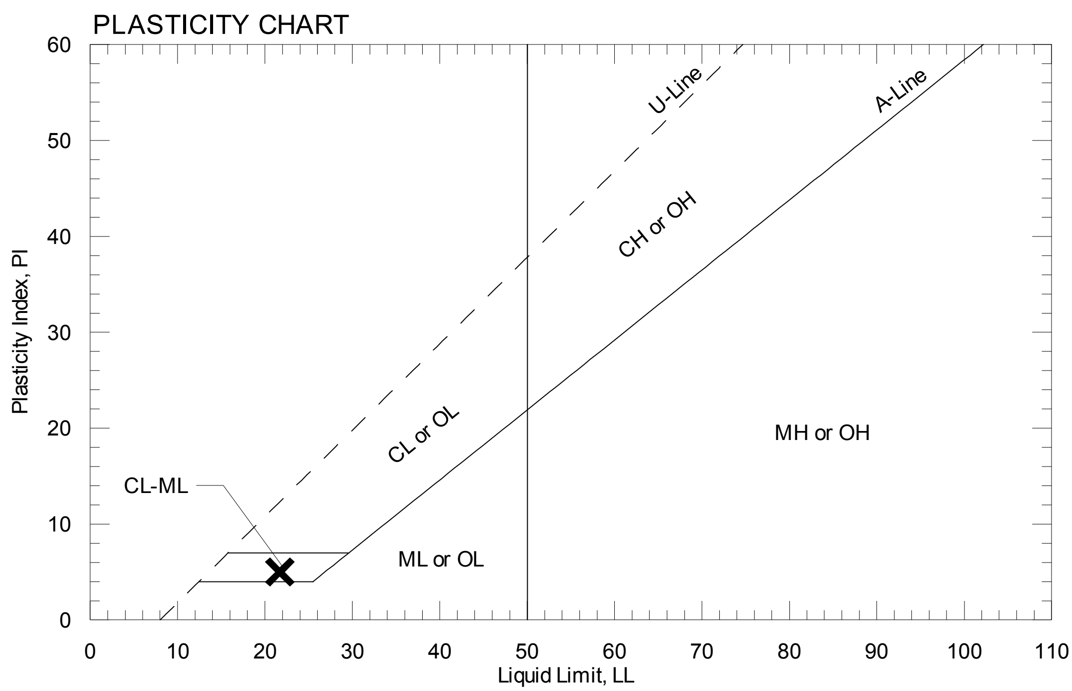

**AUTHORIZATION AND DISTRIBUTION**

Reported by: **FOGG, BRIAN** Date Reported: **8/4/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212314 |
| PIN | 016716.00 | Water Content, % | 28.8 |
| Sampled | 7/1/2009 | Plastic Limit | 17 |
| Boring No./Sample No. | BB-MJS-102/10D | Liquid Limit | 22 |
| Station | 14+32.3 | Plasticity Index | 5 |
| Depth | 45.0-47.0 | Tested By | BBURR |



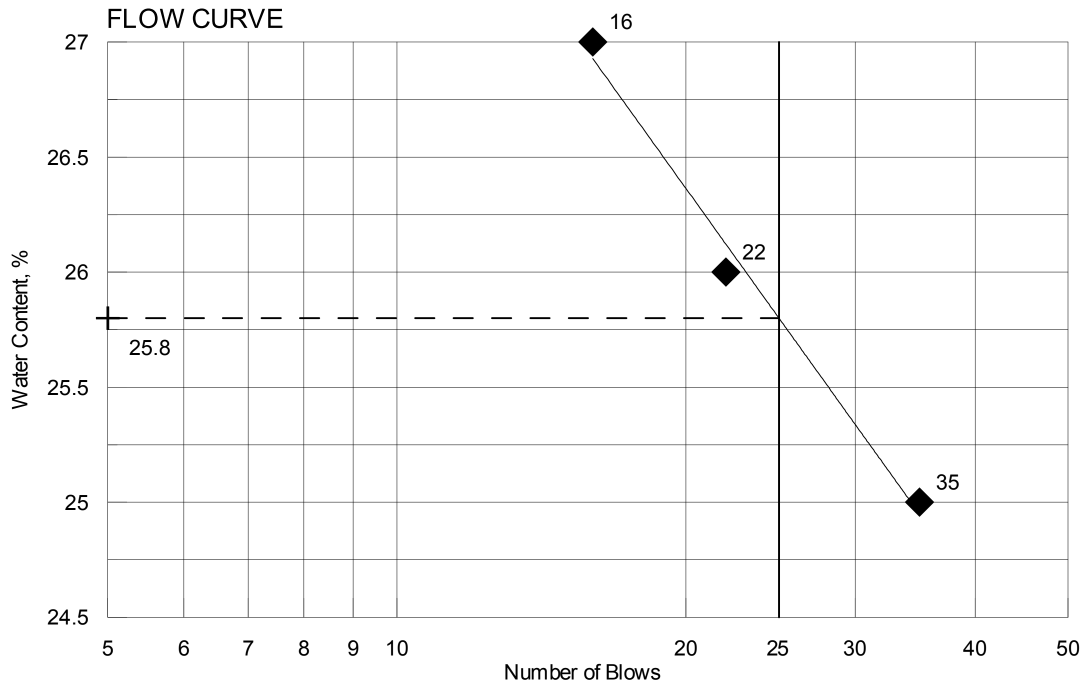


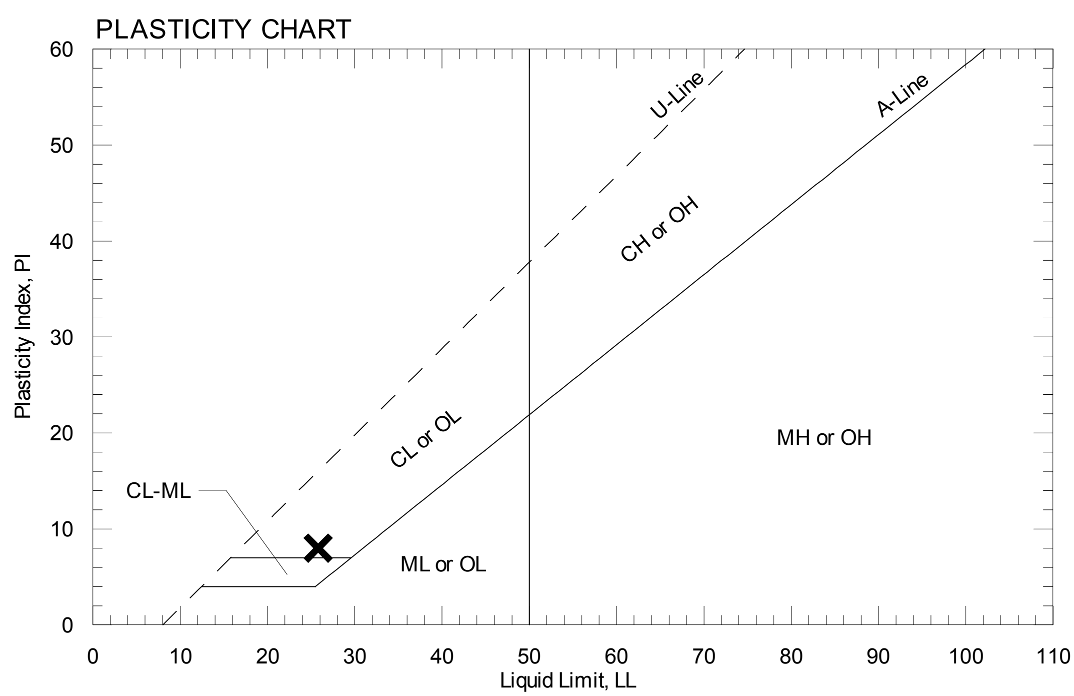

**AUTHORIZATION AND DISTRIBUTION**

Reported by: **FOGG, BRIAN** Date Reported: **8/19/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212317 |
| PIN | 016716.00 | Water Content, % | 27.6 |
| Sampled | 7/14/2009 | Plastic Limit | 18 |
| Boring No./Sample No. | BB-MJS-102/12D | Liquid Limit | 26 |
| Station | 14+32.3 | Plasticity Index | 8 |
| Depth | 60.0-62.0 | Tested By | BBURR |



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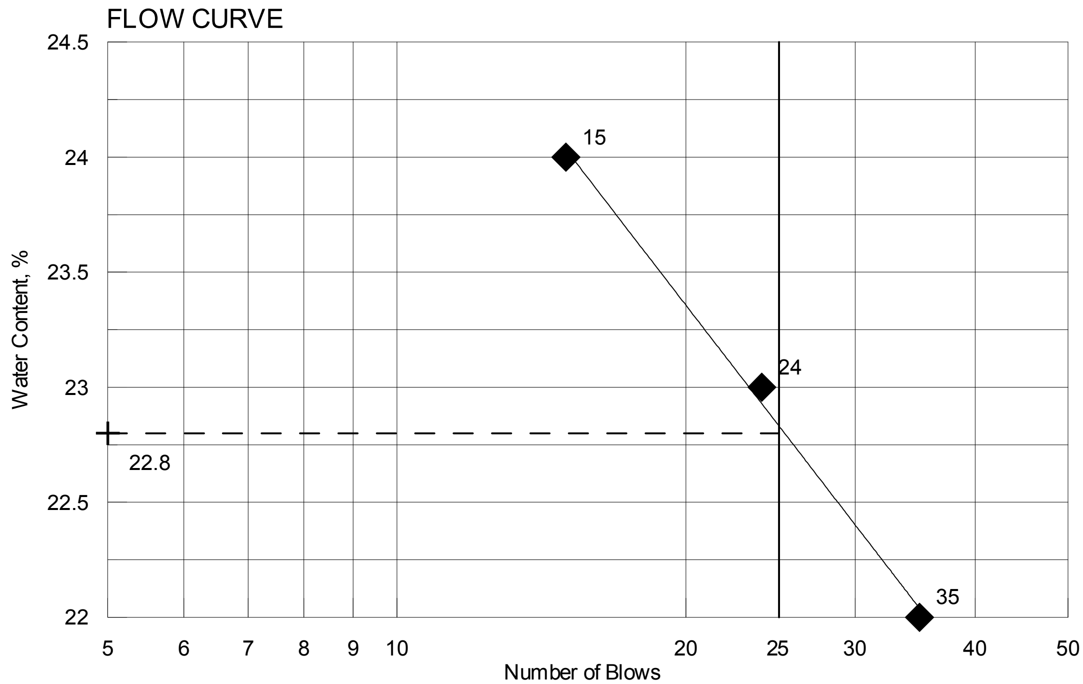
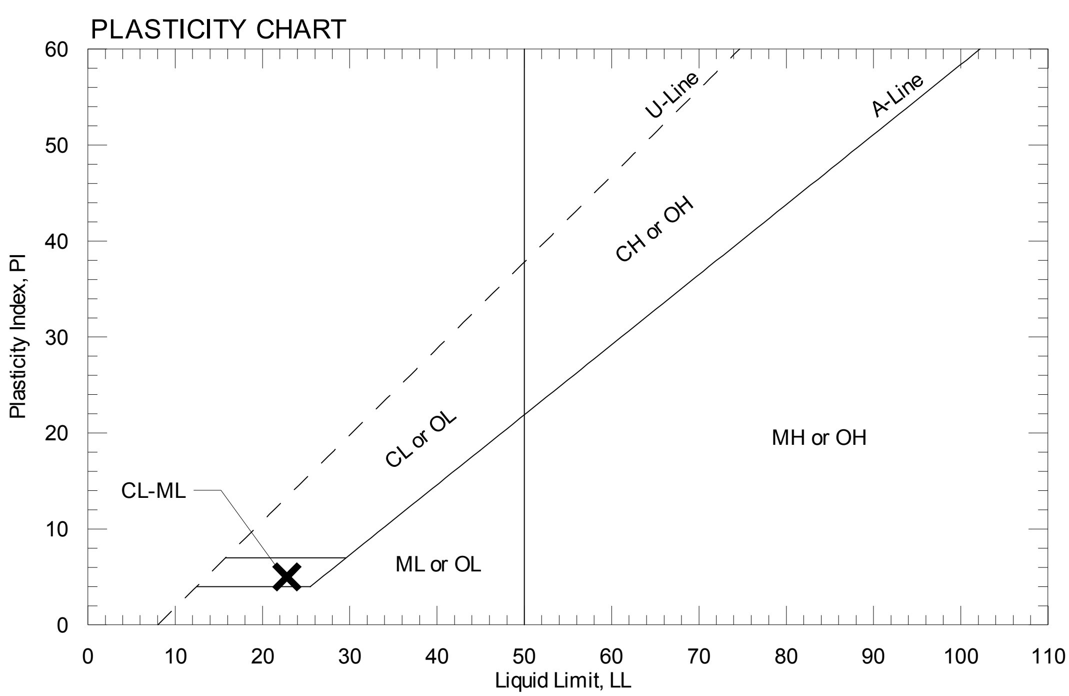
*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212318 |
| PIN | 016716.00 | Water Content, % | 28.7 |
| Sampled | 7/14/2009 | Plastic Limit | 18 |
| Boring No./Sample No. | BB-MJS-102/2U | Liquid Limit | 23 |
| Station | 14+32.3 | Plasticity Index | 5 |
| Depth | 65.0-67.0 | Tested By | BBURR |



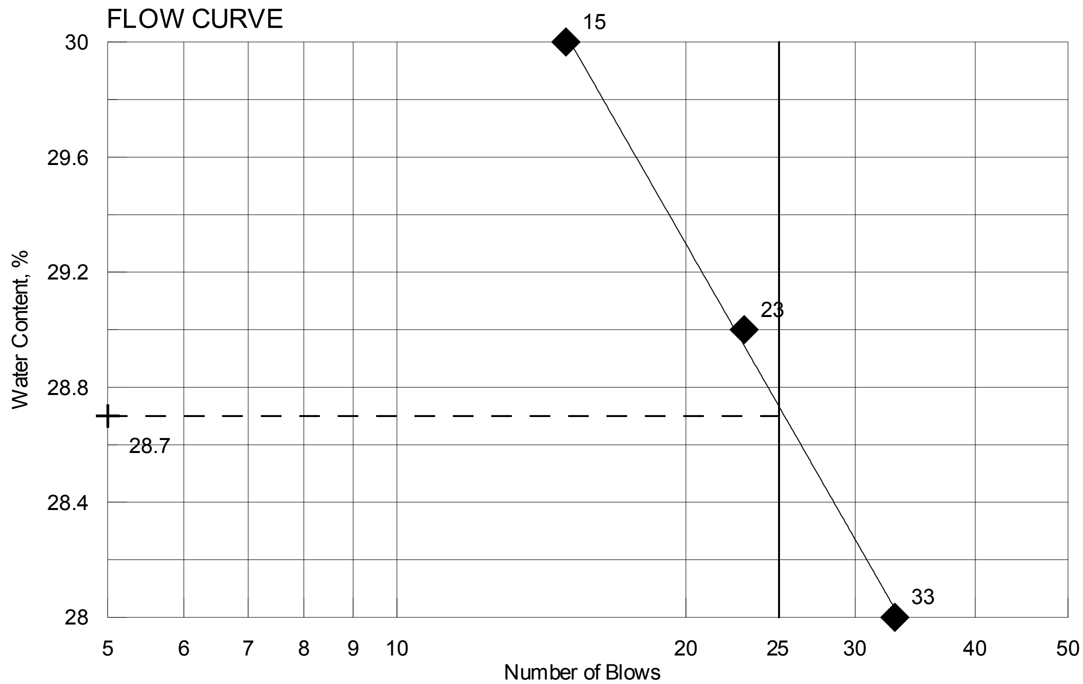


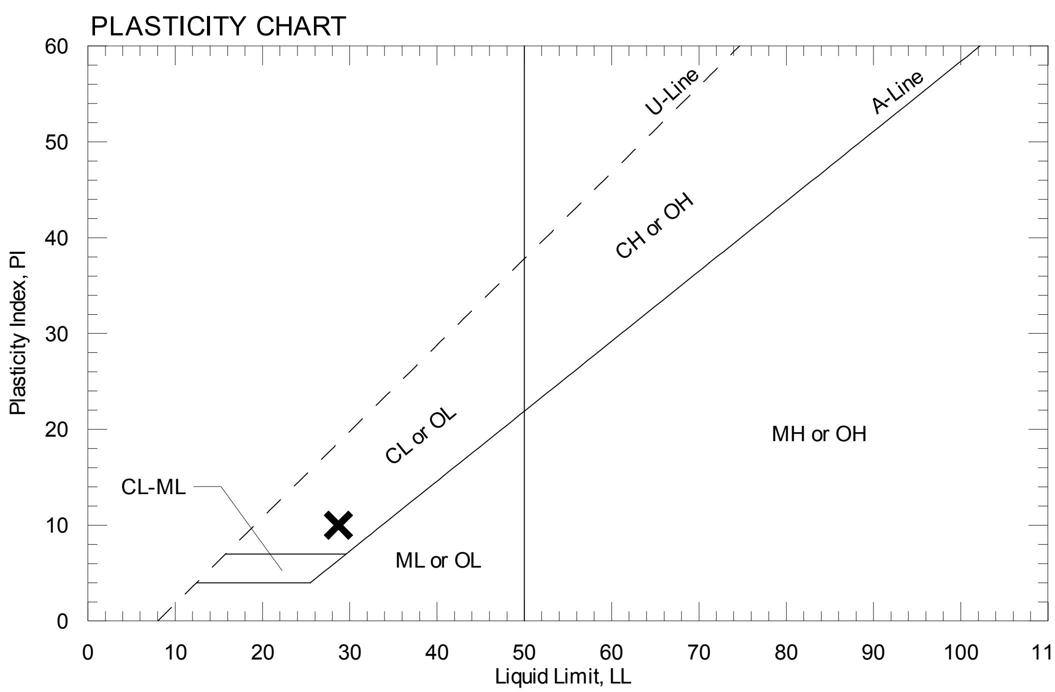

**A U T H O R I Z A T I O N   A N D   D I S T R I B U T I O N**

Reported by: **FOGG, BRIAN** Date Reported: **8/24/2009**

*Paper Copy: Lab File; Project File; Geotech File*

| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212319 |
| PIN | 016716.00 | Water Content, % | 31.6 |
| Sampled | 7/14/2009 | Plastic Limit | 19 |
| Boring No./Sample No. | BB-MJS-102/3U | Liquid Limit | 29 |
| Station | 14+32.3 | Plasticity Index | 10 |
| Depth | 75.0-77.0 | Tested By | BBURR |



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Reported by: **FOGG, BRIAN** Date Reported: **8/24/2009**

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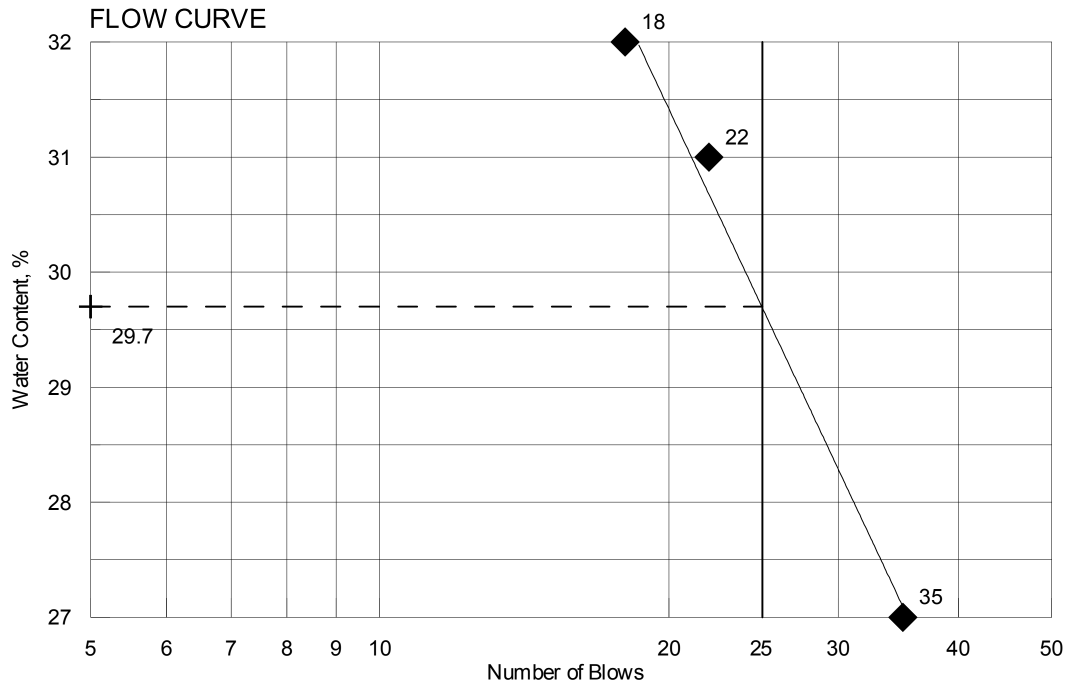
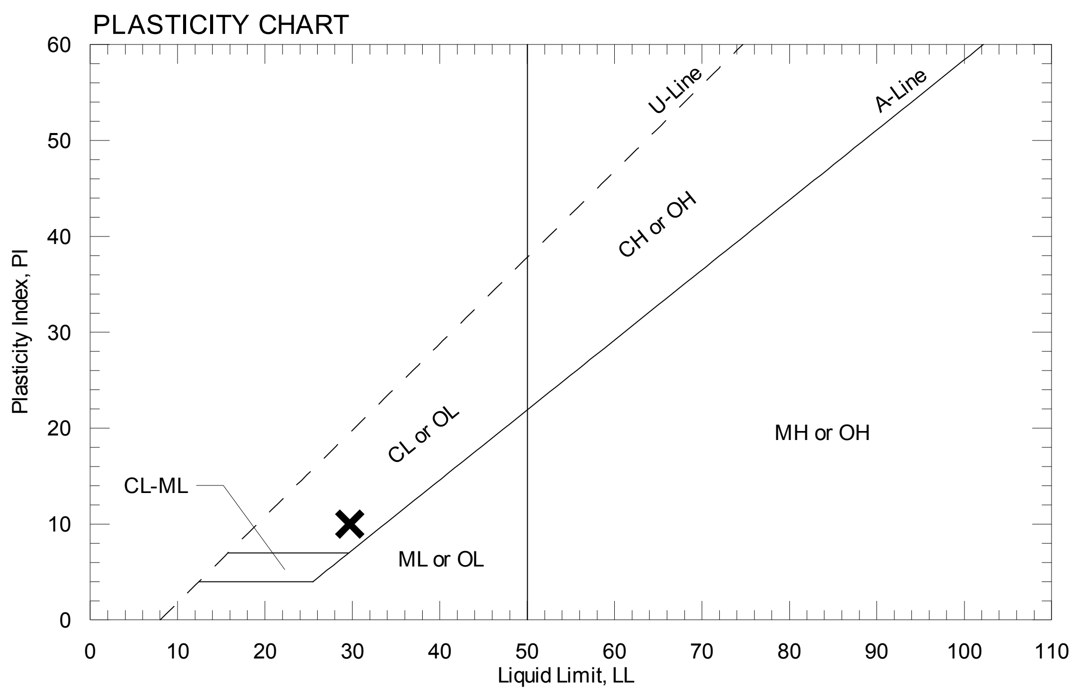
| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212320 |
| PIN | 016716.00 | Water Content, % | 28.7 |
| Sampled | 7/14/2009 | Plastic Limit | 20 |
| Boring No./Sample No. | BB-MJS-102/13D | Liquid Limit | 30 |
| Station | 14+32.3 | Plasticity Index | 10 |
| Depth | 80.0-82.0 | Tested By | BBURR |



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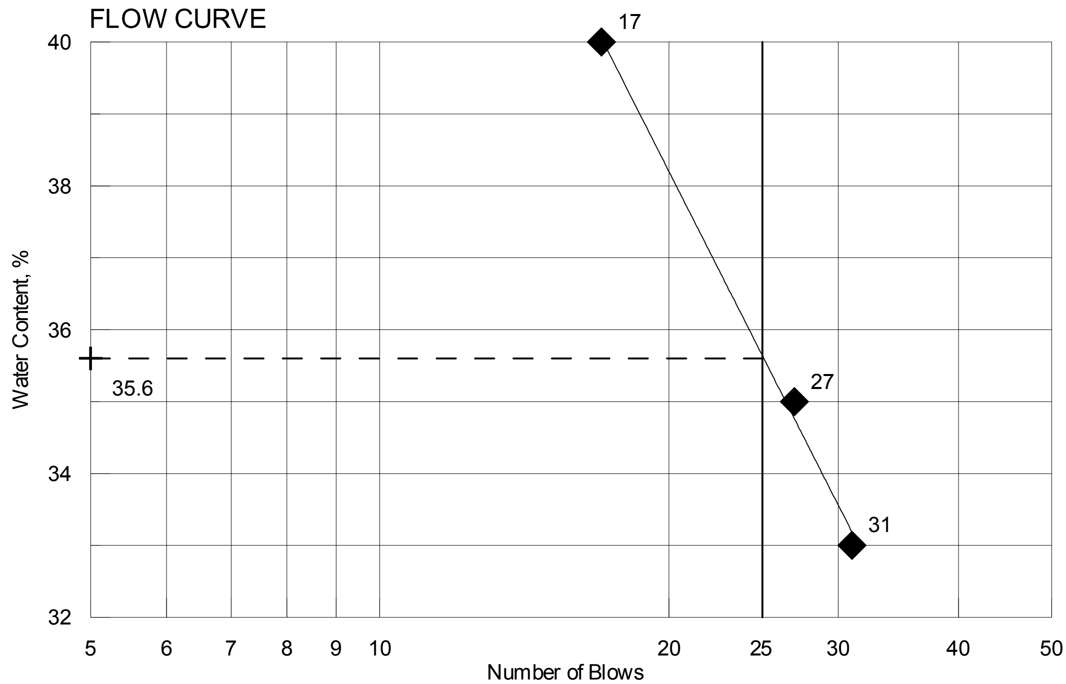
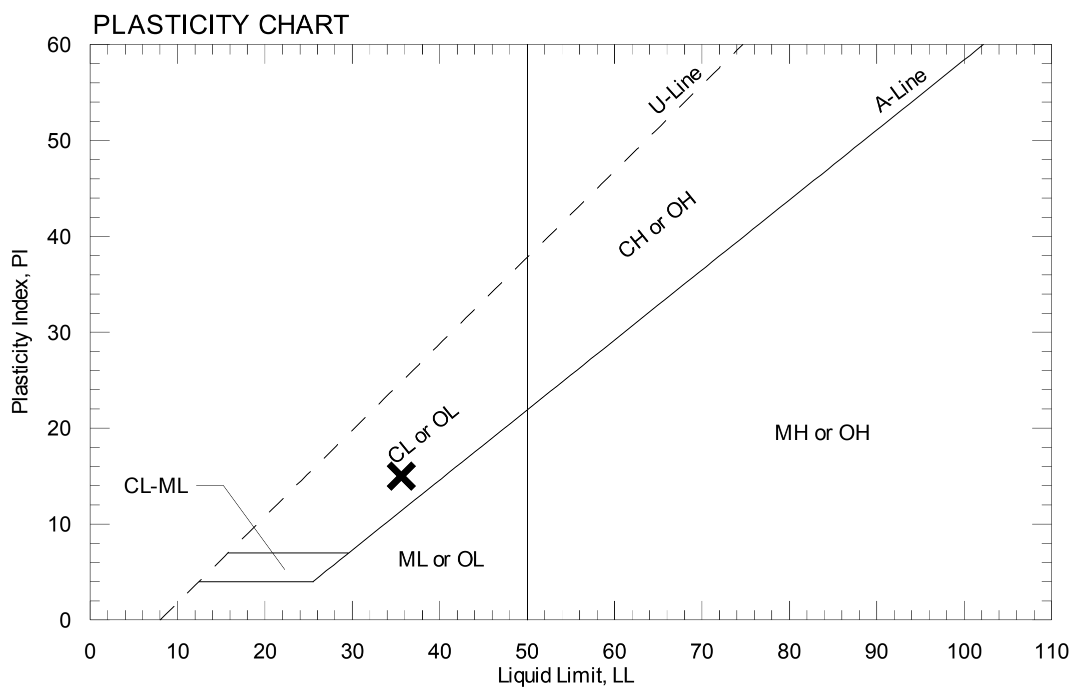
| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212321 |
| PIN | 016716.00 | Water Content, % | 26.6 |
| Sampled | 7/14/2009 | Plastic Limit | 21 |
| Boring No./Sample No. | BB-MJS-102/14D | Liquid Limit | 36 |
| Station | 14+32.3 | Plasticity Index | 15 |
| Depth | 85.0-87.0 | Tested By | BBURR |



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Reported by: **FOGG, BRIAN** Date Reported: **8/17/2009**

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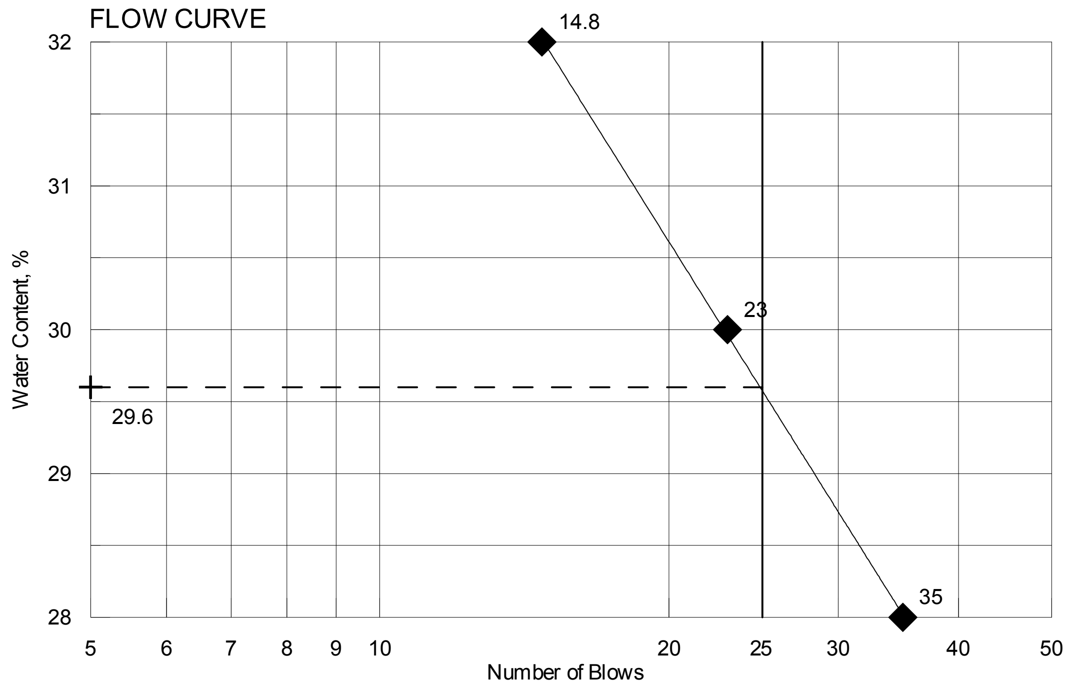
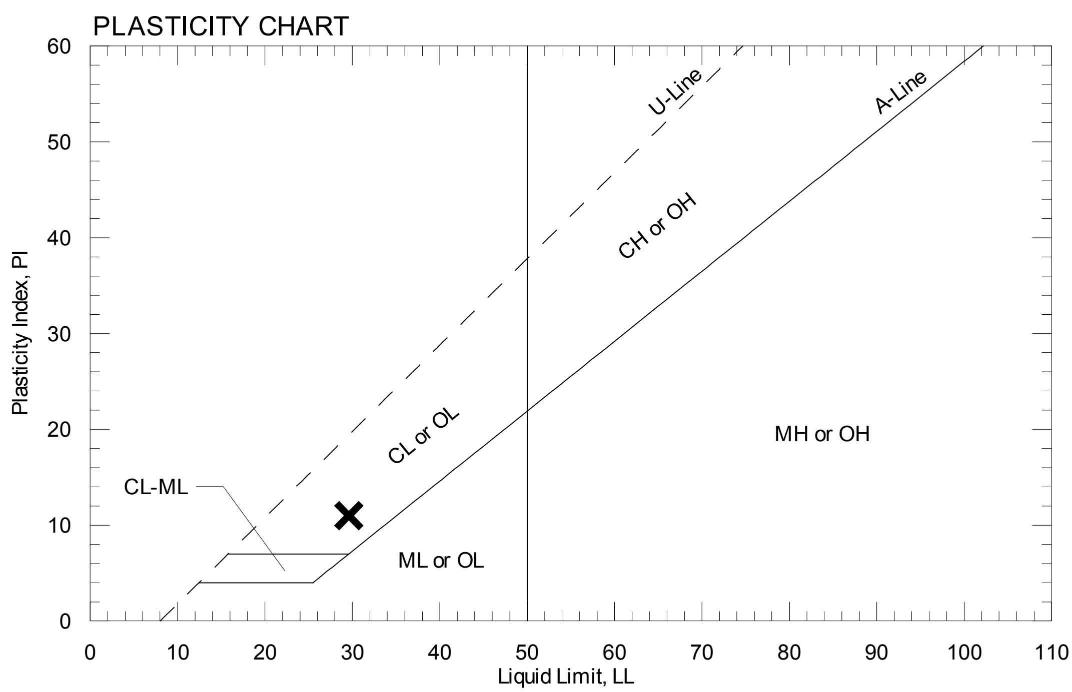
| | | | |
|---|---|---|---|
| TOWN | Monmouth | Reference No. | 212322 |
| PIN | 016716.00 | Water Content, % | 26.1 |
| Sampled | 7/14/2009 | Plastic Limit | 19 |
| Boring No./Sample No. | BB-MJS-102/15D | Liquid Limit | 30 |
| Station | 14+32.3 | Plasticity Index | 11 |
| Depth | 90.0-92.0 | Tested By | BBURR |





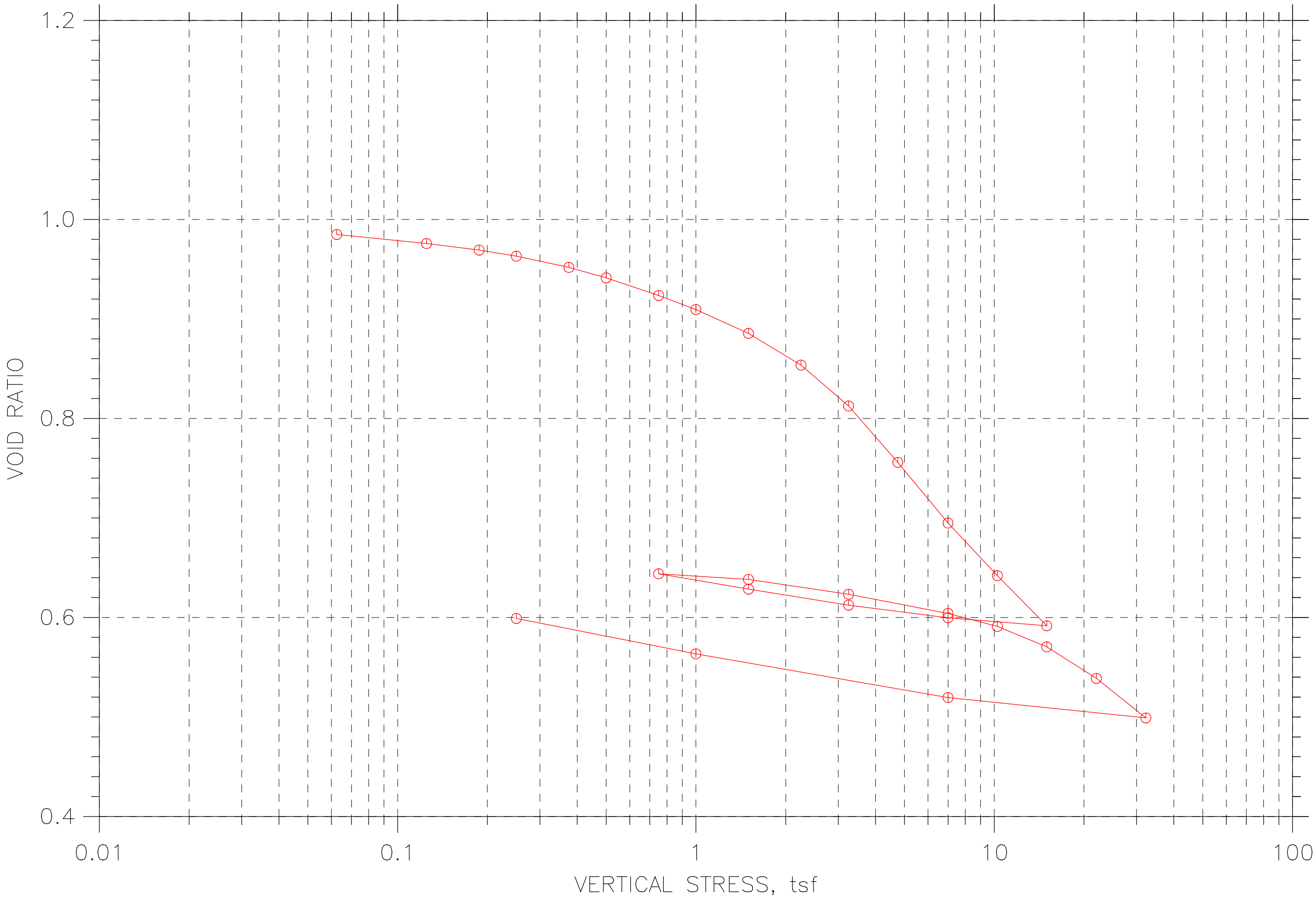

**AUTHORIZATION AND DISTRIBUTION**

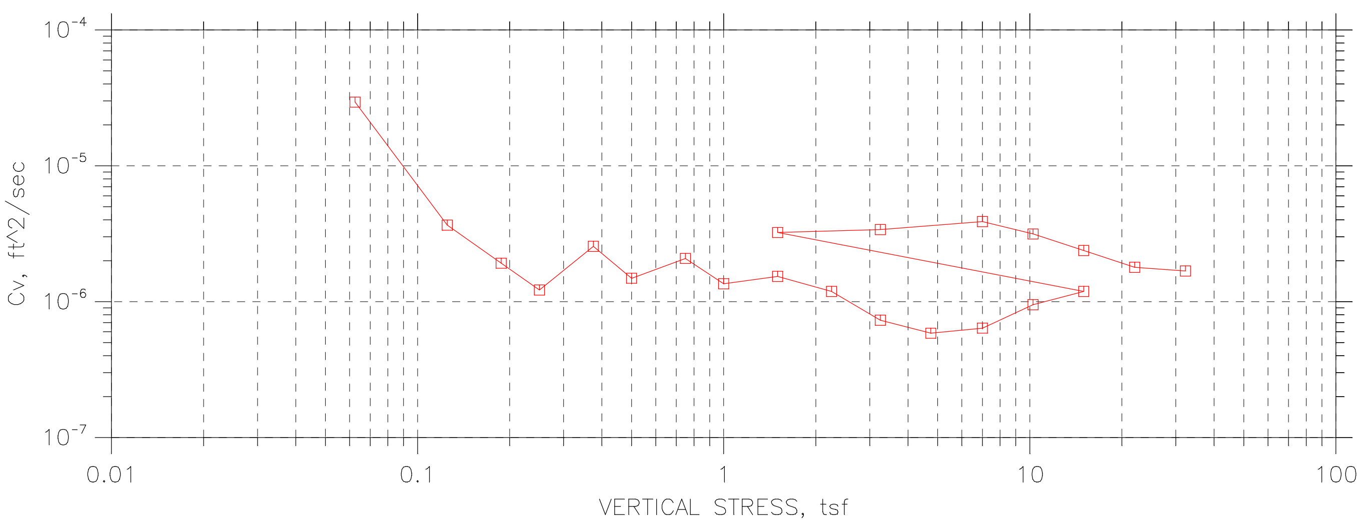
Reported by: **FOGG, BRIAN** Date Reported: **8/19/2009**

*Paper Copy: Lab File; Project File; Geotech File*

# CONSOLIDATION TEST DATA

SUMMARY REPORT




| | | | |
|---|---|---|---|
| | Project: Jock Stream Bridge | Location: Monmouth | Project No.: 16716.00 |
| | Boring No.: BB-MJS-101 | Tested By: Brian Fogg | Checked By: km |
| | Sample No.: 1U | Test Date: 7/27/09 | Depth: 54-56 ft |
| | Test No.: 212273 | Sample Type: Shelby Tube | Elevation: 114.8 ft |
| | Description: Clayey Silt | | |
| | Remarks: OCR = 1.5; Cc = 0.3541; C'c = 0.1771; Cr = 0.04 | | |
| | | | |

Wed, 04-NOV-2009 12:50:21

# CONSOLIDATION TEST DATA

Project: Jock Stream Bridge
Location: Monmouth
Project No.: 16716.00
Boring No.: BB-MJS-101
Tested By: Brian Fogg
Checked By: km
Sample No.: 1U
Test Date: 7/27/09
Depth: 54-56 ft
Test No.: 212273
Sample Type: Shelby Tube
Elevation: 114.8 ft

Soil Description: Clayey Silt
Remarks: OCR = 1.5; Cc = 0.3541; C'c = 0.1771; Cr = 0.04

Measured Specific Gravity: 2.75
Initial Void Ratio: 1.00
Final Void Ratio: 0.60
Liquid Limit: 25
Plastic Limit: 18
Plasticity Index: 7
Initial Height: 1.04 in
Specimen Diameter: 2.48 in

| | Before Consolidation | | After Consolidation | |
|---|---|---|---|---|
| | Trimmings | Specimen+Ring | Specimen+Ring | Trimmings |
| Container ID | 162 | RING | RING | 89 |
| Wt. Container + Wet Soil, gm | 212.12 | 414.22 | 400.29 | 191.43 |
| Wt. Container + Dry Soil, gm | 177.6 | 375.54 | 375.54 | 166.72 |
| Wt. Container, gm | 66.87 | 262.23 | 262.23 | 53.57 |
| Wt. Dry Soil, gm | 110.73 | 113.31 | 113.31 | 113.15 |
| Water Content, % | 31.17 | 34.13 | 21.84 | 21.84 |
| Void Ratio | --- | 1.00 | 0.60 | --- |
| Degree of Saturation, % | --- | 94.13 | 100.26 | --- |
| Dry Unit Weight, pcf | --- | 85.963 | 107.37 | --- |

# CONSOLIDATION TEST DATA

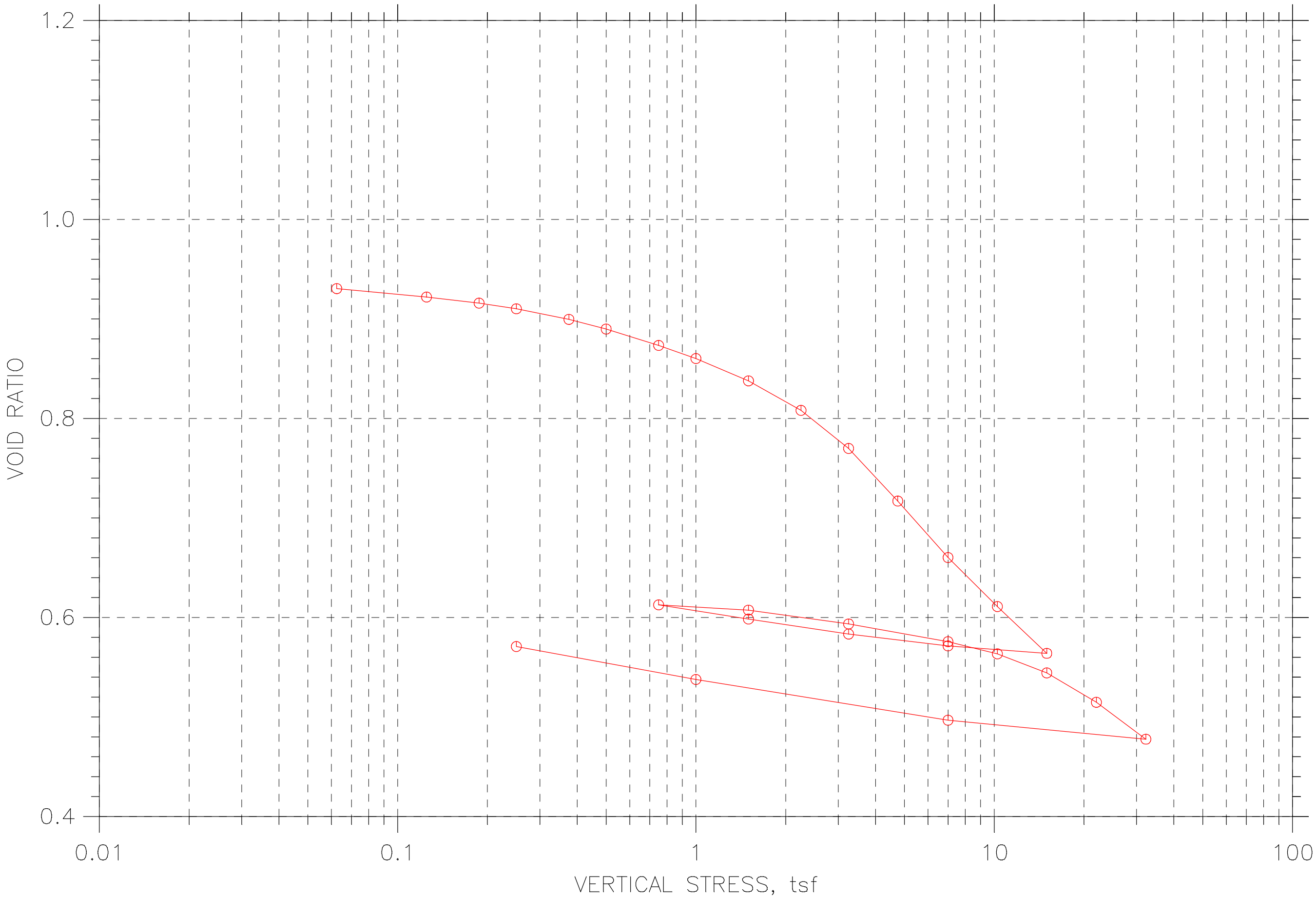
Project: Jock Stream Bridge
Location: Monmouth
Project No.: 16716.00
Boring No.: BB-MJS-101
Tested By: Brian Fogg
Checked By: km
Sample No.: 1U
Test Date: 7/27/09
Depth: 54-56 ft
Test No.: 212273
Sample Type: Shelby Tube
Elevation: 114.8 ft

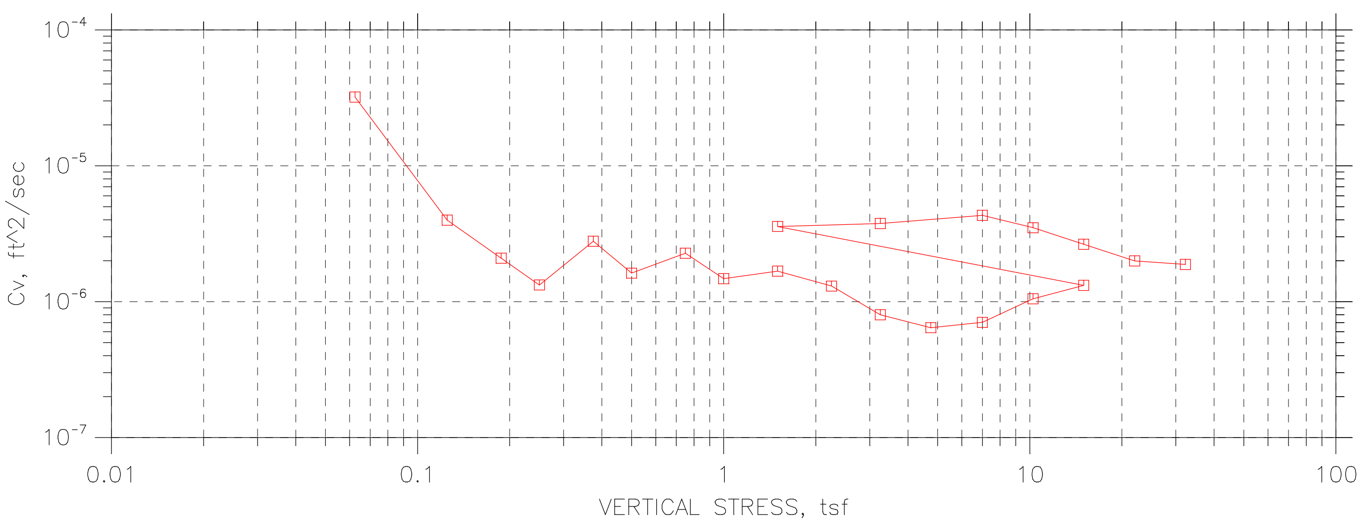
Soil Description: Clayey Silt
Remarks: OCR = 1.5; Cc = 0.3541; C'c = 0.1771; Cr = 0.04

| | Applied Stress | Final Displacement | Void Ratio | Strain at End | T50 Fitting | | Coefficient of Consolidation | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sq.Rt. | Log | Sq.Rt. | Log | Ave. |
| | tsf | in | | % | min | min | ft^2/sec | ft^2/sec | ft^2/sec |
| 1 | 0.0625 | 0.00634 | 0.985 | 0.61 | 0.2 | 0.2 | 2.45e-005 | 3.69e-005 | 2.94e-005 |
| 2 | 0.125 | 0.01108 | 0.976 | 1.07 | 1.6 | 0.0 | 3.65e-006 | 0.00e+000 | 3.65e-006 |
| 3 | 0.188 | 0.01445 | 0.969 | 1.40 | 3.4 | 2.9 | 1.78e-006 | 2.08e-006 | 1.92e-006 |
| 4 | 0.25 | 0.01764 | 0.963 | 1.70 | 4.9 | 0.0 | 1.22e-006 | 0.00e+000 | 1.22e-006 |
| 5 | 0.375 | 0.02351 | 0.952 | 2.27 | 2.3 | 2.3 | 2.58e-006 | 2.52e-006 | 2.55e-006 |
| 6 | 0.5 | 0.02894 | 0.941 | 2.80 | 4.5 | 3.3 | 1.28e-006 | 1.77e-006 | 1.49e-006 |
| 7 | 0.75 | 0.0381 | 0.924 | 3.68 | 3.6 | 1.9 | 1.60e-006 | 2.97e-006 | 2.08e-006 |
| 8 | 1 | 0.04543 | 0.909 | 4.39 | 4.6 | 3.7 | 1.22e-006 | 1.52e-006 | 1.35e-006 |
| 9 | 1.5 | 0.0579 | 0.885 | 5.59 | 3.6 | 3.6 | 1.55e-006 | 1.52e-006 | 1.53e-006 |
| 10 | 2.25 | 0.07442 | 0.854 | 7.19 | 5.0 | 4.1 | 1.08e-006 | 1.32e-006 | 1.19e-006 |
| 11 | 3.25 | 0.09569 | 0.813 | 9.24 | 7.1 | 7.0 | 7.23e-007 | 7.36e-007 | 7.29e-007 |
| 12 | 4.75 | 0.1251 | 0.756 | 12.08 | 9.2 | 7.5 | 5.33e-007 | 6.49e-007 | 5.85e-007 |
| 13 | 7 | 0.1567 | 0.695 | 15.13 | 7.0 | 7.3 | 6.48e-007 | 6.29e-007 | 6.38e-007 |
| 14 | 10.3 | 0.1841 | 0.642 | 17.78 | 4.8 | 4.3 | 8.99e-007 | 1.00e-006 | 9.48e-007 |
| 15 | 15 | 0.2102 | 0.592 | 20.30 | 3.4 | 3.4 | 1.19e-006 | 1.19e-006 | 1.19e-006 |
| 16 | 7 | 0.2061 | 0.600 | 19.90 | 0.2 | 0.0 | 2.54e-005 | 0.00e+000 | 2.54e-005 |
| 17 | 3.25 | 0.1994 | 0.612 | 19.26 | 0.7 | 0.0 | 5.58e-006 | 0.00e+000 | 5.58e-006 |
| 18 | 1.5 | 0.1911 | 0.629 | 18.45 | 1.8 | 2.4 | 2.30e-006 | 1.71e-006 | 1.97e-006 |
| 19 | 0.75 | 0.1831 | 0.644 | 17.69 | 4.8 | 4.3 | 8.50e-007 | 9.63e-007 | 9.03e-007 |
| 20 | 1.5 | 0.1861 | 0.638 | 17.97 | 1.3 | 0.0 | 3.23e-006 | 0.00e+000 | 3.23e-006 |
| 21 | 3.25 | 0.1938 | 0.623 | 18.72 | 1.2 | 0.0 | 3.39e-006 | 0.00e+000 | 3.39e-006 |
| 22 | 7 | 0.2038 | 0.604 | 19.68 | 1.0 | 0.0 | 3.88e-006 | 0.00e+000 | 3.88e-006 |
| 23 | 10.3 | 0.2106 | 0.591 | 20.34 | 1.2 | 1.3 | 3.33e-006 | 2.99e-006 | 3.15e-006 |
| 24 | 15 | 0.2212 | 0.570 | 21.36 | 1.6 | 1.6 | 2.38e-006 | 2.37e-006 | 2.38e-006 |
| 25 | 22 | 0.2376 | 0.539 | 22.95 | 2.1 | 2.1 | 1.80e-006 | 1.78e-006 | 1.79e-006 |
| 26 | 32.3 | 0.2582 | 0.499 | 24.94 | 1.7 | 2.5 | 2.12e-006 | 1.39e-006 | 1.68e-006 |
| 27 | 7 | 0.2476 | 0.520 | 23.91 | 0.1 | 0.0 | 2.81e-005 | 0.00e+000 | 2.81e-005 |
| 28 | 1 | 0.2248 | 0.563 | 21.71 | 2.4 | 2.8 | 1.52e-006 | 1.30e-006 | 1.40e-006 |
| 29 | 0.25 | 0.2064 | 0.599 | 19.93 | 18.9 | 0.0 | 2.03e-007 | 0.00e+000 | 2.03e-007 |

# CONSOLIDATION TEST DATA

SUMMARY REPORT




| | | | |
|---|---|---|---|
| | Project: Jock Stream Bridge | Location: Monmouth | Project No.: 16716.00 |
| | Boring No.: BB-MJS-101 | Tested By: Brian Fogg | Checked By: km |
| | Sample No.: 2U | Test Date: 7/27/09 | Depth: 64-66 ft |
| | Test No.: 212274 | Sample Type: Shelby Tube | Elevation: 104.8 ft |
| | Description: Clayey Silt | | |
| | Remarks: OCR = 1.35; Cc = 0.3174; C'c = 0.1636; Cr = 0.0463 | | |
| | | | |

Wed, 04-NOV-2009 12:55:08

# CONSOLIDATION TEST DATA

Project: Jock Stream Bridge
Location: Monmouth
Project No.: 16716.00
Boring No.: BB-MJS-101
Tested By: Brian Fogg
Checked By: km
Sample No.: 2U
Test Date: 7/27/09
Depth: 64-66 ft
Test No.: 212274
Sample Type: Shelby Tube
Elevation: 104.8 ft

Soil Description: Clayey Silt
Remarks: OCR = 1.35; Cc = 0.3174; C'c = 0.1636; Cr = 0.0463

Measured Specific Gravity: 2.73
Initial Void Ratio: 0.94
Final Void Ratio: 0.57
Liquid Limit: 26
Plastic Limit: 18
Plasticity Index: 8
Initial Height: 1.08 in
Specimen Diameter: 2.48 in

| | Before Consolidation | | After Consolidation | |
|---|---|---|---|---|
| | Trimmings | Specimen+Ring | Specimen+Ring | Trimmings |
| Container ID | 35 | RING | RING | 89 |
| Wt. Container + Wet Soil, gm | 189.74 | 418 | 408.21 | 197.28 |
| Wt. Container + Dry Soil, gm | 159.84 | 382.98 | 382.98 | 172.44 |
| Wt. Container, gm | 64.69 | 262.29 | 262.29 | 53.59 |
| Wt. Dry Soil, gm | 95.15 | 120.69 | 120.69 | 118.85 |
| Water Content, % | 31.42 | 29.01 | 20.90 | 20.90 |
| Void Ratio | --- | 0.94 | 0.57 | --- |
| Degree of Saturation, % | --- | 84.09 | 99.96 | --- |
| Dry Unit Weight, pcf | --- | 87.764 | 108.5 | --- |

# CONSOLIDATION TEST DATA

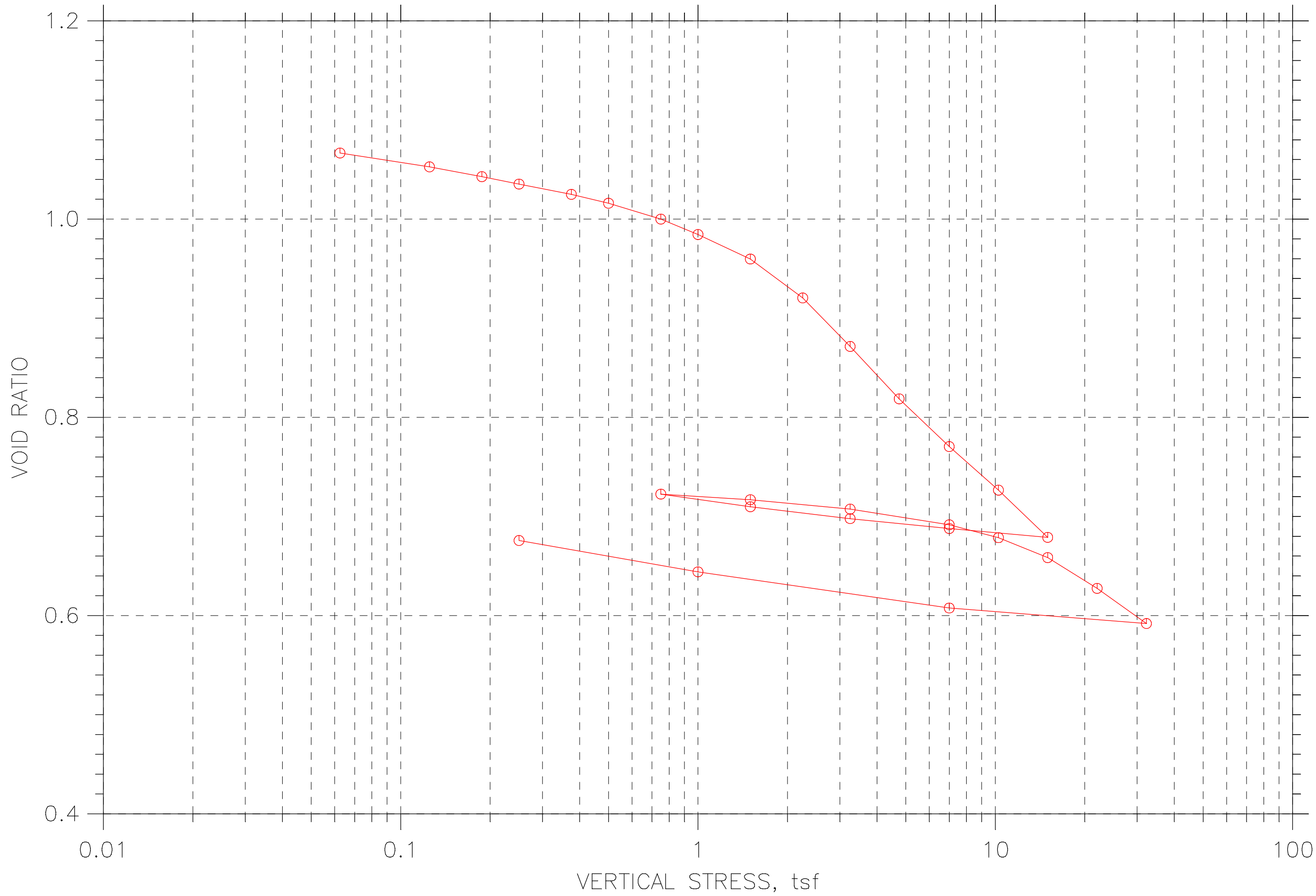
Project: Jock Stream Bridge
Location: Monmouth
Project No.: 16716.00
Boring No.: BB-MJS-101
Tested By: Brian Fogg
Checked By: km
Sample No.: 2U
Test Date: 7/27/09
Depth: 64-66 ft
Test No.: 212274
Sample Type: Shelby Tube
Elevation: 104.8 ft

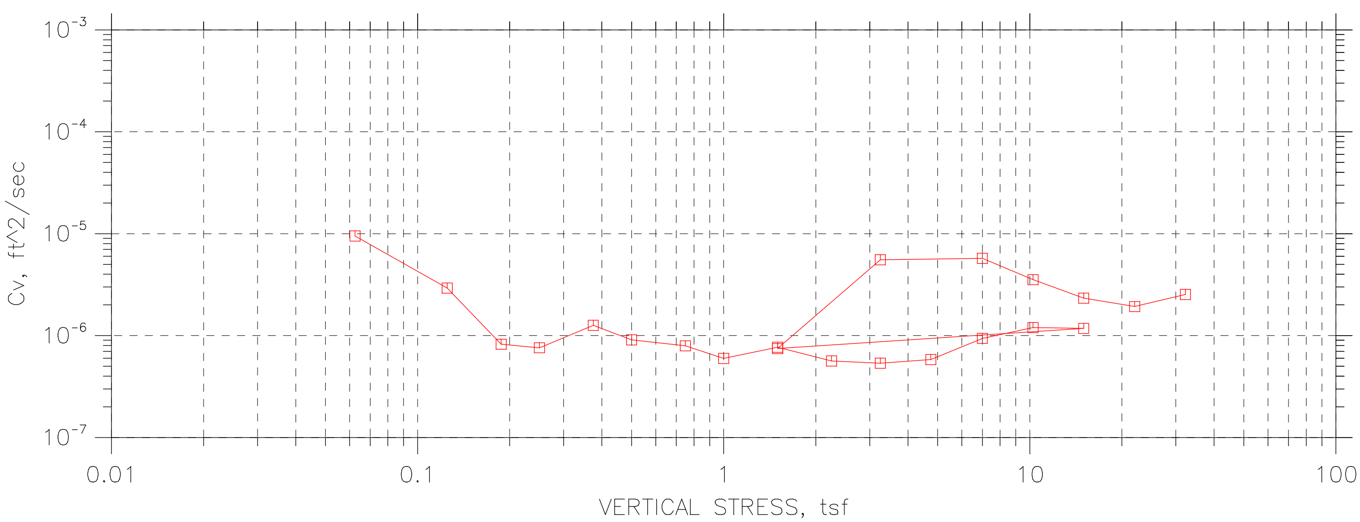
Soil Description: Clayey Silt
Remarks: OCR = 1.35; Cc = 0.3174; C'c = 0.1636; Cr = 0.0463

| | Applied Stress tsf | Final Displacement in | Void Ratio | Strain at End % | T50 Fitting Sq.Rt. min | T50 Fitting Log min | Coefficient of Consolidation Sq.Rt. ft^2/sec | Coefficient of Consolidation Log ft^2/sec | Coefficient of Consolidation Ave. ft^2/sec |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0625 | 0.00634 | 0.930 | 0.59 | 0.2 | 0.2 | 2.66e-005 | 4.02e-005 | 3.20e-005 |
| 2 | 0.125 | 0.01108 | 0.922 | 1.03 | 1.6 | 0.0 | 3.98e-006 | 0.00e+000 | 3.98e-006 |
| 3 | 0.188 | 0.01445 | 0.916 | 1.34 | 3.4 | 2.9 | 1.94e-006 | 2.26e-006 | 2.09e-006 |
| 4 | 0.25 | 0.01764 | 0.910 | 1.63 | 4.9 | 0.0 | 1.33e-006 | 0.00e+000 | 1.33e-006 |
| 5 | 0.375 | 0.02351 | 0.900 | 2.18 | 2.3 | 2.3 | 2.81e-006 | 2.75e-006 | 2.78e-006 |
| 6 | 0.5 | 0.02894 | 0.890 | 2.68 | 4.5 | 3.3 | 1.40e-006 | 1.93e-006 | 1.62e-006 |
| 7 | 0.75 | 0.0381 | 0.873 | 3.53 | 3.6 | 1.9 | 1.75e-006 | 3.24e-006 | 2.27e-006 |
| 8 | 1 | 0.04543 | 0.860 | 4.21 | 4.6 | 3.7 | 1.33e-006 | 1.66e-006 | 1.48e-006 |
| 9 | 1.5 | 0.0579 | 0.838 | 5.36 | 3.6 | 3.6 | 1.70e-006 | 1.66e-006 | 1.68e-006 |
| 10 | 2.25 | 0.07442 | 0.808 | 6.89 | 5.0 | 4.1 | 1.18e-006 | 1.45e-006 | 1.30e-006 |
| 11 | 3.25 | 0.09569 | 0.770 | 8.86 | 7.1 | 7.0 | 7.92e-007 | 8.07e-007 | 8.00e-007 |
| 12 | 4.75 | 0.1251 | 0.717 | 11.58 | 9.2 | 7.5 | 5.86e-007 | 7.13e-007 | 6.43e-007 |
| 13 | 7 | 0.1567 | 0.660 | 14.50 | 7.0 | 7.3 | 7.15e-007 | 6.93e-007 | 7.04e-007 |
| 14 | 10.3 | 0.1841 | 0.611 | 17.04 | 4.8 | 4.3 | 9.95e-007 | 1.11e-006 | 1.05e-006 |
| 15 | 15 | 0.2102 | 0.564 | 19.46 | 3.4 | 3.4 | 1.32e-006 | 1.32e-006 | 1.32e-006 |
| 16 | 7 | 0.2061 | 0.571 | 19.08 | 0.2 | 0.0 | 2.82e-005 | 0.00e+000 | 2.82e-005 |
| 17 | 3.25 | 0.1994 | 0.583 | 18.46 | 0.7 | 0.0 | 6.20e-006 | 0.00e+000 | 6.20e-006 |
| 18 | 1.5 | 0.1911 | 0.598 | 17.69 | 1.8 | 2.4 | 2.55e-006 | 1.90e-006 | 2.18e-006 |
| 19 | 0.75 | 0.1831 | 0.613 | 16.95 | 4.8 | 4.3 | 9.42e-007 | 1.07e-006 | 1.00e-006 |
| 20 | 1.5 | 0.1861 | 0.607 | 17.22 | 1.3 | 0.0 | 3.57e-006 | 0.00e+000 | 3.57e-006 |
| 21 | 3.25 | 0.1938 | 0.593 | 17.94 | 1.2 | 0.0 | 3.76e-006 | 0.00e+000 | 3.76e-006 |
| 22 | 7 | 0.2038 | 0.576 | 18.86 | 1.0 | 0.0 | 4.31e-006 | 0.00e+000 | 4.31e-006 |
| 23 | 10.3 | 0.2106 | 0.563 | 19.49 | 1.2 | 1.3 | 3.70e-006 | 3.32e-006 | 3.50e-006 |
| 24 | 15 | 0.2212 | 0.544 | 20.48 | 1.6 | 1.6 | 2.65e-006 | 2.64e-006 | 2.64e-006 |
| 25 | 22 | 0.2376 | 0.515 | 22.00 | 2.1 | 2.1 | 2.01e-006 | 1.98e-006 | 1.99e-006 |
| 26 | 32.3 | 0.2582 | 0.478 | 23.91 | 1.7 | 2.5 | 2.36e-006 | 1.56e-006 | 1.88e-006 |
| 27 | 7 | 0.2476 | 0.497 | 22.92 | 0.1 | 0.0 | 3.14e-005 | 0.00e+000 | 3.14e-005 |
| 28 | 1 | 0.2248 | 0.538 | 20.81 | 2.4 | 2.8 | 1.70e-006 | 1.45e-006 | 1.57e-006 |
| 29 | 0.25 | 0.2064 | 0.571 | 19.11 | 18.9 | 0.0 | 2.25e-007 | 0.00e+000 | 2.25e-007 |

# CONSOLIDATION TEST DATA

SUMMARY REPORT




| | | |
|---|---|---|
| Project: Jock Stream Bridge | Location: Monmouth | Project No.: 16716.00 |
| Boring No.: BB-MJS-101 | Tested By: Brian Fogg | Checked By: km |
| Sample No.: 3U | Test Date: 8/3/09 | Depth: 75.5-77.5FT |
| Test No.: 212301 | Sample Type: Shelby Tube | Elevation: 93.3 ft |
| Description: Clayey Silt | | |
| Remarks: OCR = 1.22; Cc = 0.3043; C'c = 0.1429; Cr = 0.0374 | | |

Wed, 04-NOV-2009 12:57:36

# CONSOLIDATION TEST DATA

Project: Jock Stream Bridge
Boring No.: BB-MJS-101
Sample No.: 3U
Test No.: 212301

Location: Monmouth
Tested By: Brian Fogg
Test Date: 8/3/09
Sample Type: Shelby Tube

Project No.: 16716.00
Checked By: km
Depth: 75.5-77.5FT
Elevation: 93.3 ft

Soil Description: Clayey Silt
Remarks: OCR = 1.22; Cc = 0.3043; C'c = 0.1429; Cr = 0.0374

Measured Specific Gravity: 2.76
Initial Void Ratio: 1.13
Final Void Ratio: 0.68

Liquid Limit: 35
Plastic Limit: 21
Plasticity Index: 14

Initial Height: 1.05 in
Specimen Diameter: 2.48 in

| | Before Consolidation | | After Consolidation | |
|---|---|---|---|---|
| | Trimmings | Specimen+Ring | Specimen+Ring | Trimmings |
| Container ID | 203 | RING | RING | 203 |
| Wt. Container + Wet Soil, gm | 181.57 | 410.92 | 396.16 | 197.96 |
| Wt. Container + Dry Soil, gm | 149.87 | 369.76 | 369.76 | 171.59 |
| Wt. Container, gm | 64.17 | 262.23 | 262.23 | 64.17 |
| Wt. Dry Soil, gm | 85.7 | 107.53 | 107.53 | 107.42 |
| Water Content, % | 36.99 | 38.27 | 24.55 | 24.55 |
| Void Ratio | --- | 1.13 | 0.68 | --- |
| Degree of Saturation, % | --- | 93.31 | 100.27 | --- |
| Dry Unit Weight, pcf | --- | 80.812 | 102.82 | --- |

# CONSOLIDATION TEST DATA

Project: Jock Stream Bridge
Boring No.: BB-MJS-101
Sample No.: 3U
Test No.: 212301

Location: Monmouth
Tested By: Brian Fogg
Test Date: 8/3/09
Sample Type: Shelby Tube

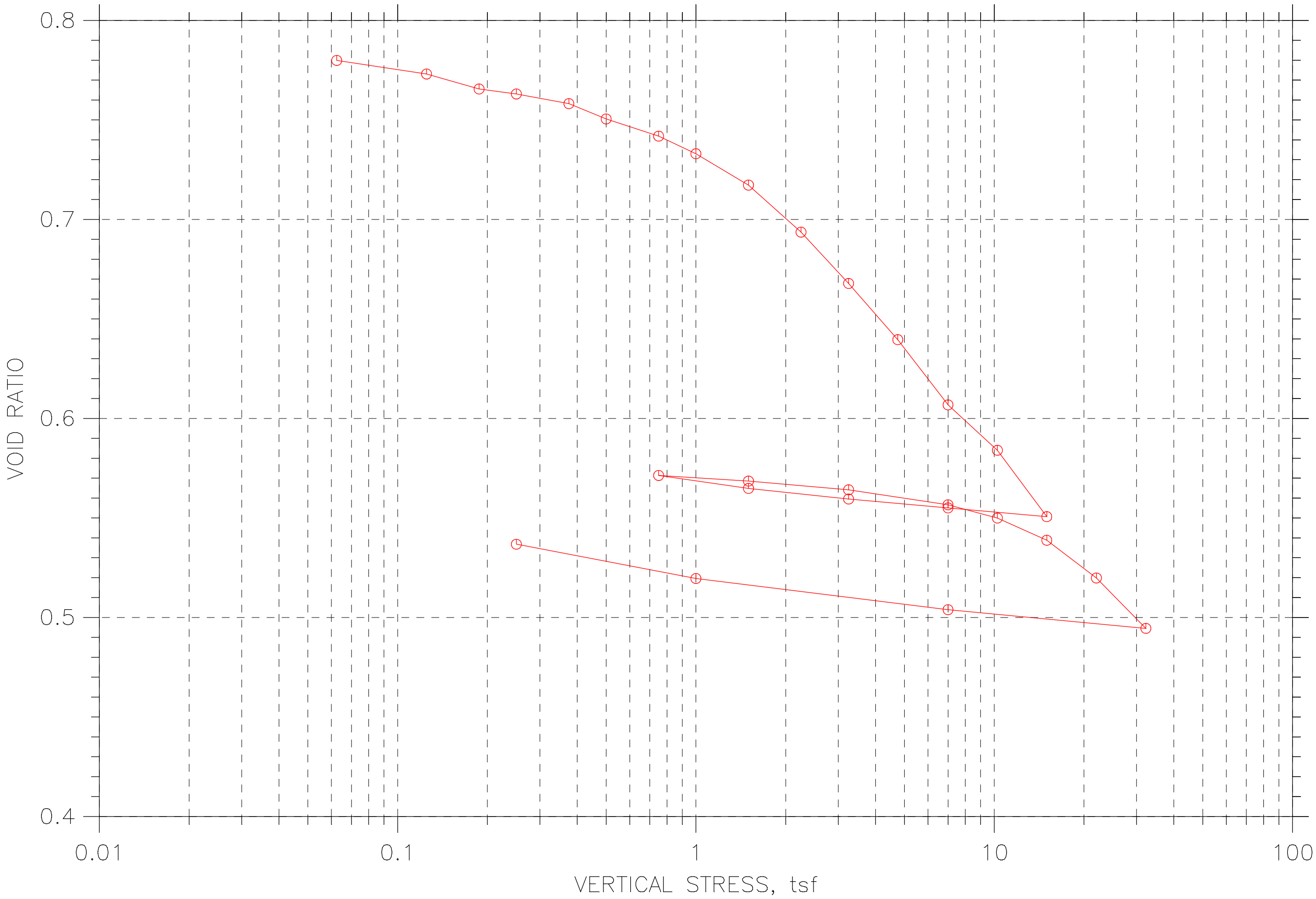
Project No.: 16716.00
Checked By: km
Depth: 75.5-77.5FT
Elevation: 93.3 ft

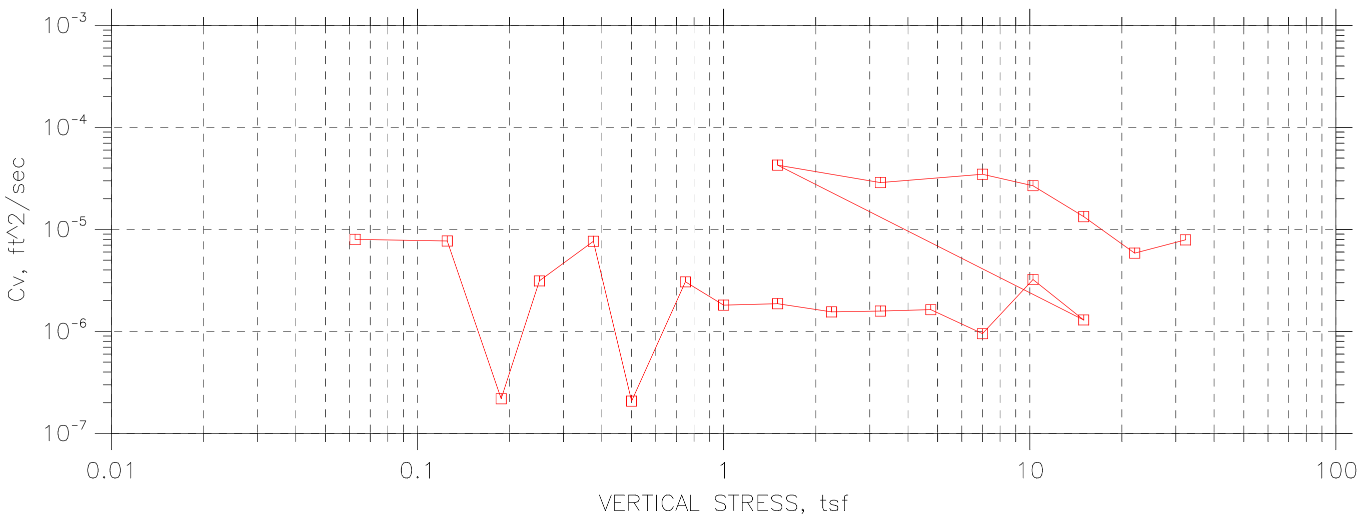
Soil Description: Clayey Silt
Remarks: OCR = 1.22; Cc = 0.3043; C'c = 0.1429; Cr = 0.0374

| | Applied Stress | Final Displacement | Void Ratio | Strain at End | T50 Fitting | | Coefficient of Consolidation | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sq.Rt. | Log | Sq.Rt. | Log | Ave. |
| | tsf | in | | % | min | min | ft^2/sec | ft^2/sec | ft^2/sec |
| 1 | 0.0625 | 0.0321 | 1.067 | 3.07 | 0.7 | 0.5 | 8.37e-006 | 1.10e-005 | 9.51e-006 |
| 2 | 0.125 | 0.03896 | 1.053 | 3.73 | 2.0 | 0.0 | 2.93e-006 | 0.00e+000 | 2.93e-006 |
| 3 | 0.188 | 0.04381 | 1.043 | 4.19 | 6.7 | 7.3 | 8.56e-007 | 7.91e-007 | 8.22e-007 |
| 4 | 0.25 | 0.04745 | 1.035 | 4.54 | 7.5 | 7.6 | 7.63e-007 | 7.55e-007 | 7.59e-007 |
| 5 | 0.375 | 0.05256 | 1.025 | 5.03 | 4.8 | 4.2 | 1.18e-006 | 1.35e-006 | 1.26e-006 |
| 6 | 0.5 | 0.05693 | 1.016 | 5.45 | 6.6 | 5.7 | 8.47e-007 | 9.76e-007 | 9.07e-007 |
| 7 | 0.75 | 0.06477 | 1.000 | 6.20 | 5.2 | 8.8 | 1.07e-006 | 6.30e-007 | 7.93e-007 |
| 8 | 1 | 0.0724 | 0.984 | 6.93 | 9.1 | 0.0 | 5.97e-007 | 0.00e+000 | 5.97e-007 |
| 9 | 1.5 | 0.08452 | 0.960 | 8.09 | 6.9 | 0.0 | 7.68e-007 | 0.00e+000 | 7.68e-007 |
| 10 | 2.25 | 0.1038 | 0.920 | 9.93 | 9.2 | 0.0 | 5.63e-007 | 0.00e+000 | 5.63e-007 |
| 11 | 3.25 | 0.1278 | 0.871 | 12.23 | 9.2 | 0.0 | 5.36e-007 | 0.00e+000 | 5.36e-007 |
| 12 | 4.75 | 0.1537 | 0.819 | 14.70 | 7.0 | 9.0 | 6.66e-007 | 5.18e-007 | 5.82e-007 |
| 13 | 7 | 0.1773 | 0.770 | 16.96 | 4.7 | 4.7 | 9.46e-007 | 9.32e-007 | 9.39e-007 |
| 14 | 10.3 | 0.1988 | 0.727 | 19.02 | 3.5 | 3.5 | 1.21e-006 | 1.19e-006 | 1.20e-006 |
| 15 | 15 | 0.2222 | 0.679 | 21.26 | 3.4 | 3.3 | 1.16e-006 | 1.19e-006 | 1.18e-006 |
| 16 | 7 | 0.2178 | 0.688 | 20.84 | 0.1 | 0.0 | 2.64e-005 | 0.00e+000 | 2.64e-005 |
| 17 | 3.25 | 0.2129 | 0.698 | 20.37 | 0.5 | 0.2 | 8.36e-006 | 2.09e-005 | 1.19e-005 |
| 18 | 1.5 | 0.2071 | 0.710 | 19.81 | 1.5 | 2.1 | 2.64e-006 | 1.86e-006 | 2.18e-006 |
| 19 | 0.75 | 0.2008 | 0.723 | 19.21 | 4.7 | 4.0 | 8.66e-007 | 1.02e-006 | 9.35e-007 |
| 20 | 1.5 | 0.2036 | 0.717 | 19.48 | 5.4 | 0.0 | 7.46e-007 | 0.00e+000 | 7.46e-007 |
| 21 | 3.25 | 0.2082 | 0.707 | 19.92 | 0.7 | 0.0 | 5.54e-006 | 0.00e+000 | 5.54e-006 |
| 22 | 7 | 0.216 | 0.692 | 20.66 | 0.7 | 0.6 | 5.31e-006 | 6.21e-006 | 5.73e-006 |
| 23 | 10.3 | 0.2223 | 0.679 | 21.27 | 1.2 | 1.0 | 3.38e-006 | 3.72e-006 | 3.54e-006 |
| 24 | 15 | 0.2322 | 0.658 | 22.21 | 1.7 | 1.6 | 2.22e-006 | 2.45e-006 | 2.33e-006 |
| 25 | 22 | 0.2474 | 0.627 | 23.67 | 2.0 | 1.9 | 1.88e-006 | 1.98e-006 | 1.93e-006 |
| 26 | 32.3 | 0.2648 | 0.592 | 25.34 | 1.2 | 1.6 | 2.99e-006 | 2.20e-006 | 2.53e-006 |
| 27 | 7 | 0.2571 | 0.608 | 24.60 | 0.0 | 0.0 | 1.70e-004 | 0.00e+000 | 1.70e-004 |
| 28 | 1 | 0.2392 | 0.644 | 22.89 | 2.3 | 2.3 | 1.56e-006 | 1.59e-006 | 1.58e-006 |
| 29 | 0.25 | 0.2237 | 0.676 | 21.41 | 14.0 | 0.0 | 2.70e-007 | 0.00e+000 | 2.70e-007 |

# CONSOLIDATION TEST DATA

SUMMARY REPORT




| | | | |
|---|---|---|---|
| | Project: Jock Stream Bridge | Location: Monmouth | Project No.: 16716.00 |
| | Boring No.: BB-MJS-102 | Tested By: Brian Fogg | Checked By: km |
| | Sample No.: 2U | Test Date: 8/5/09 | Depth: 65-67 ft |
| | Test No.: 212318 | Sample Type: Shelby Tube | Elevation: 103.4 ft |
| | Description: Clayey Silt | | |
| | Remarks: OCR =1.51; Cc = 0.1831; C'c = 0.0974; Cr = 0.179 | | |
| | | | |

# CONSOLIDATION TEST DATA

Project: Jock Stream Bridge
Boring No.: BB-MJS-102
Sample No.: 2U
Test No.: 212318

Location: Monmouth
Tested By: Brian Fogg
Test Date: 8/5/09
Sample Type: Shelby Tube

Project No.: 16716.00
Checked By: km
Depth: 65-67 ft
Elevation: 103.4 ft

Soil Description: Clayey Silt
Remarks: OCR =1.51; Cc = 0.1831; C'c = 0.0974; Cr = 0.179

Measured Specific Gravity: 2.87
Initial Void Ratio: 0.88
Final Void Ratio: 0.54

Liquid Limit: 23
Plastic Limit: 18
Plasticity Index: 5

Initial Height: 1.03 in
Specimen Diameter: 2.48 in

| | Before Consolidation | | After Consolidation | |
|---|---|---|---|---|
| | Trimmings | Specimen+Ring | Specimen+Ring | Trimmings |
| Container ID | 231 | RING | RING | 89 |
| Wt. Container + Wet Soil, gm | 221.17 | 421.24 | 410.52 | 201.78 |
| Wt. Container + Dry Soil, gm | 190.91 | 387.13 | 387.13 | 178.41 |
| Wt. Container, gm | 66.66 | 262.3 | 262.3 | 53.66 |
| Wt. Dry Soil, gm | 124.25 | 124.83 | 124.83 | 124.75 |
| Water Content, % | 24.35 | 27.32 | 18.73 | 18.73 |
| Void Ratio | --- | 0.88 | 0.54 | --- |
| Degree of Saturation, % | --- | 88.78 | 100.00 | --- |
| Dry Unit Weight, pcf | --- | 95.06 | 116.4 | --- |

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

# CONSOLIDATION TEST DATA

Project: Jock Stream Bridge
Boring No.: BB-MJS-102
Sample No.: 2U
Test No.: 212318

Location: Monmouth
Tested By: Brian Fogg
Test Date: 8/5/09
Sample Type: Shelby Tube

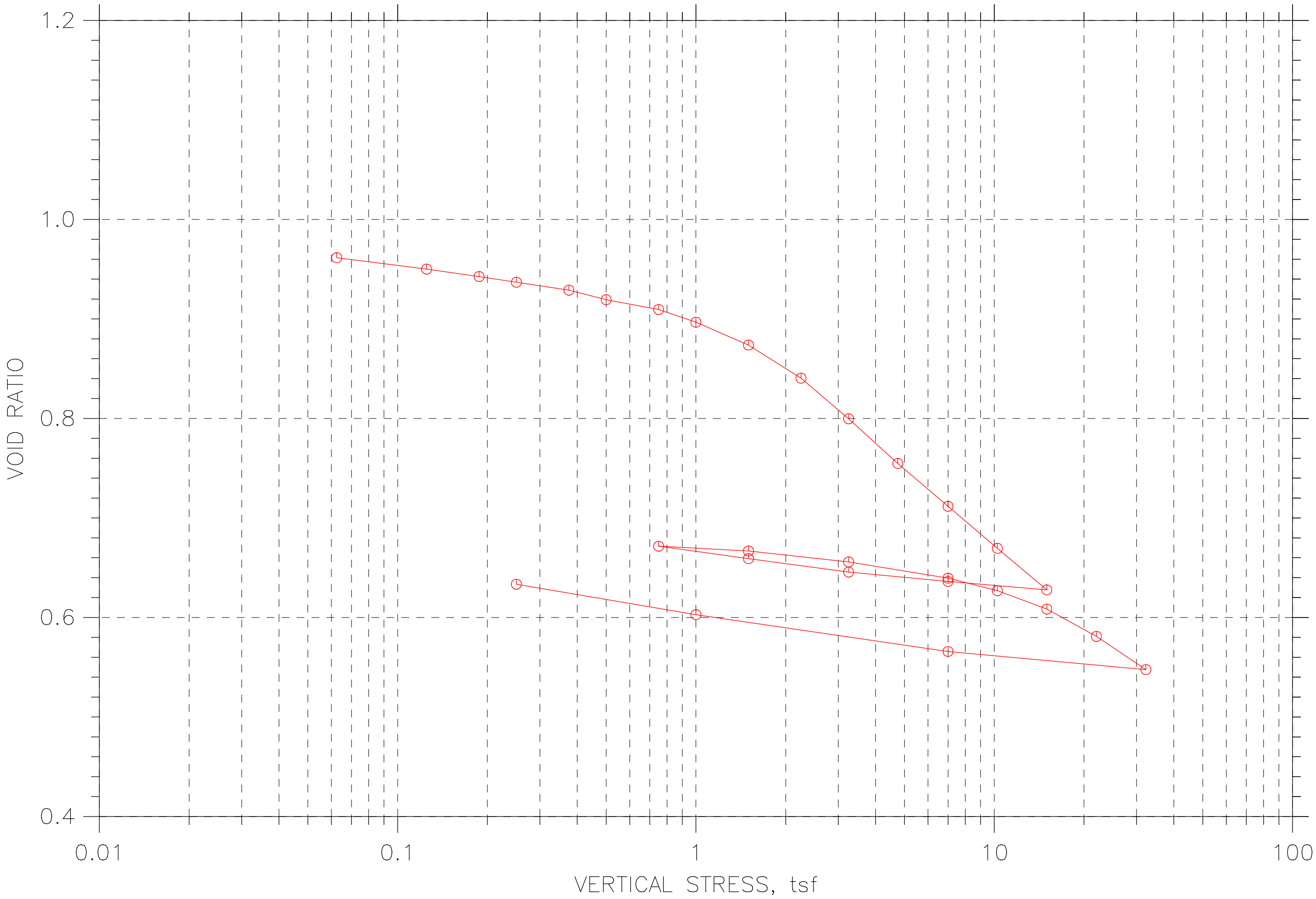
Project No.: 16716.00
Checked By: km
Depth: 65-67 ft
Elevation: 103.4 ft

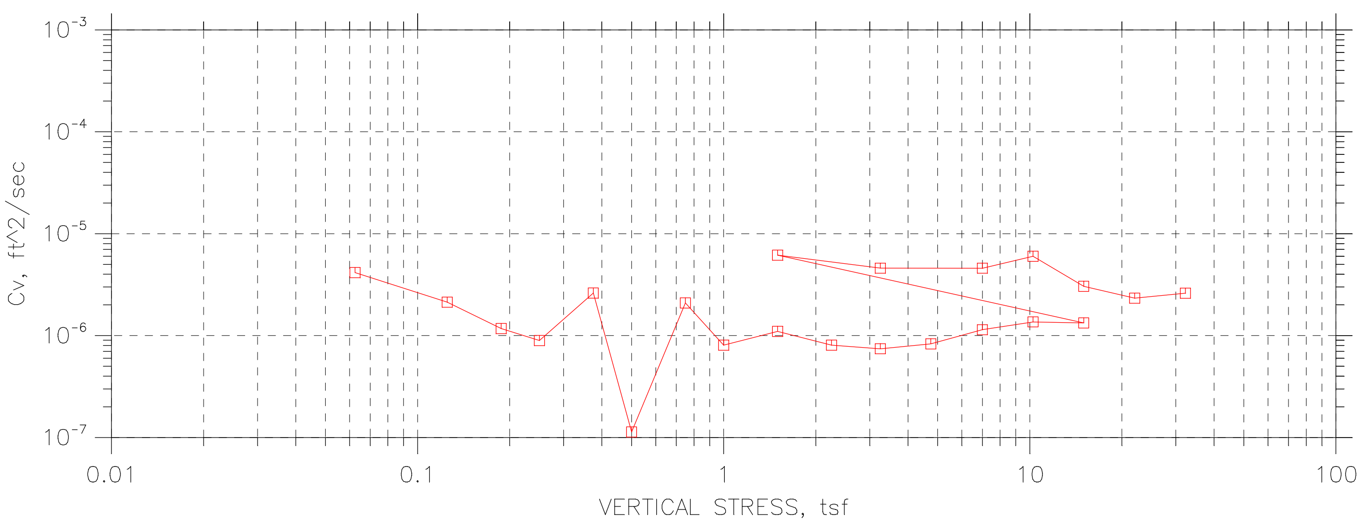
Soil Description: Clayey Silt
Remarks: OCR =1.51; Cc = 0.1831; C'c = 0.0974; Cr = 0.179

| | Applied Stress tsf | Final Displacement in | Void Ratio | Strain at End % | T50 Fitting Sq.Rt. min | T50 Fitting Log min | Coefficient of Consolidation Sq.Rt. ft^2/sec | Coefficient of Consolidation Log ft^2/sec | Coefficient of Consolidation Ave. ft^2/sec |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0625 | 0.05587 | 0.780 | 5.42 | 0.8 | 0.7 | 7.65e-006 | 8.34e-006 | 7.98e-006 |
| 2 | 0.125 | 0.0596 | 0.773 | 5.78 | 0.7 | 0.0 | 7.71e-006 | 0.00e+000 | 7.71e-006 |
| 3 | 0.188 | 0.06374 | 0.766 | 6.18 | 24.5 | 0.0 | 2.19e-007 | 0.00e+000 | 2.19e-007 |
| 4 | 0.25 | 0.0651 | 0.763 | 6.31 | 1.4 | 2.0 | 3.79e-006 | 2.66e-006 | 3.13e-006 |
| 5 | 0.375 | 0.06777 | 0.758 | 6.57 | 0.7 | 0.0 | 7.66e-006 | 0.00e+000 | 7.66e-006 |
| 6 | 0.5 | 0.07199 | 0.750 | 6.98 | 25.5 | 0.0 | 2.07e-007 | 0.00e+000 | 2.07e-007 |
| 7 | 0.75 | 0.07673 | 0.742 | 7.44 | 1.6 | 1.8 | 3.27e-006 | 2.88e-006 | 3.06e-006 |
| 8 | 1 | 0.08157 | 0.733 | 7.91 | 3.2 | 2.5 | 1.59e-006 | 2.09e-006 | 1.81e-006 |
| 9 | 1.5 | 0.0902 | 0.717 | 8.74 | 3.0 | 2.5 | 1.71e-006 | 2.07e-006 | 1.87e-006 |
| 10 | 2.25 | 0.1032 | 0.694 | 10.00 | 4.5 | 1.9 | 1.11e-006 | 2.60e-006 | 1.55e-006 |
| 11 | 3.25 | 0.1173 | 0.668 | 11.37 | 3.4 | 2.7 | 1.41e-006 | 1.80e-006 | 1.58e-006 |
| 12 | 4.75 | 0.1328 | 0.640 | 12.87 | 3.4 | 2.3 | 1.38e-006 | 2.01e-006 | 1.63e-006 |
| 13 | 7 | 0.1507 | 0.607 | 14.61 | 4.8 | 0.0 | 9.50e-007 | 0.00e+000 | 9.50e-007 |
| 14 | 10.3 | 0.1632 | 0.584 | 15.83 | 1.1 | 1.6 | 3.89e-006 | 2.75e-006 | 3.23e-006 |
| 15 | 15 | 0.1815 | 0.551 | 17.60 | 3.3 | 0.0 | 1.30e-006 | 0.00e+000 | 1.30e-006 |
| 16 | 7 | 0.1791 | 0.555 | 17.36 | 0.0 | 0.0 | 4.71e-004 | 0.00e+000 | 4.71e-004 |
| 17 | 3.25 | 0.1767 | 0.559 | 17.13 | 0.0 | 0.0 | 1.12e-004 | 0.00e+000 | 1.12e-004 |
| 18 | 1.5 | 0.1737 | 0.565 | 16.84 | 0.5 | 0.0 | 9.28e-006 | 0.00e+000 | 9.28e-006 |
| 19 | 0.75 | 0.1702 | 0.571 | 16.50 | 1.0 | 0.8 | 4.07e-006 | 4.99e-006 | 4.48e-006 |
| 20 | 1.5 | 0.1717 | 0.569 | 16.65 | 0.1 | 0.1 | 3.08e-005 | 6.92e-005 | 4.26e-005 |
| 21 | 3.25 | 0.1741 | 0.564 | 16.88 | 0.2 | 0.1 | 2.74e-005 | 3.03e-005 | 2.88e-005 |
| 22 | 7 | 0.1783 | 0.557 | 17.28 | 0.2 | 0.1 | 2.62e-005 | 5.14e-005 | 3.47e-005 |
| 23 | 10.3 | 0.1819 | 0.550 | 17.64 | 0.2 | 0.1 | 1.90e-005 | 4.59e-005 | 2.68e-005 |
| 24 | 15 | 0.188 | 0.539 | 18.23 | 0.5 | 0.2 | 8.86e-006 | 2.69e-005 | 1.33e-005 |
| 25 | 22 | 0.1984 | 0.520 | 19.24 | 1.1 | 0.3 | 3.69e-006 | 1.42e-005 | 5.86e-006 |
| 26 | 32.3 | 0.2123 | 0.495 | 20.58 | 0.7 | 0.3 | 5.52e-006 | 1.39e-005 | 7.91e-006 |
| 27 | 7 | 0.2071 | 0.504 | 20.08 | 0.0 | 0.0 | 2.25e-004 | 0.00e+000 | 2.25e-004 |
| 28 | 1 | 0.1986 | 0.520 | 19.25 | 0.5 | 0.0 | 8.34e-006 | 0.00e+000 | 8.34e-006 |
| 29 | 0.25 | 0.1891 | 0.537 | 18.33 | 3.5 | 3.5 | 1.16e-006 | 1.14e-006 | 1.15e-006 |

# CONSOLIDATION TEST DATA

SUMMARY REPORT




| | | | |
|---|---|---|---|
| | Project: Jock Stream Bridge | Location: Monmouth | Project No.: 16716.00 |
| | Boring No.: BB-MJS-102 | Tested By: Brian Fogg | Checked By: km |
| | Sample No.: 3U | Test Date: 8/5/09 | Depth: 75-77 ft |
| | Test No.: 212319 | Sample Type: Shelby Tube | Elevation: 93.4 ft |
| | Description: Clayey Silt | | |
| | Remarks: OCR = 1.28; Cc = 0.2588; C'c = 0.1307; Cr = 0.0419 | | |
| | | | |

Wed, 04-NOV-2009 13:02:13

CONSOLIDATION TEST DATA

Project: Jock Stream Bridge
Boring No.: BB-MJS-102
Sample No.: 3U
Test No.: 212319

Location: Monmouth
Tested By: Brian Fogg
Test Date: 8/5/09
Sample Type: Shelby Tube

Project No.: 16716.00
Checked By: km
Depth: 75-77 ft
Elevation: 93.4 ft

Soil Description: Clayey Silt
Remarks: OCR = 1.28; Cc = 0.2588; C'c = 0.1307; Cr = 0.0419

Measured Specific Gravity: 2.67
Initial Void Ratio: 0.98
Final Void Ratio: 0.63

Liquid Limit: 29
Plastic Limit: 19
Plasticity Index: 10

Initial Height: 1.03 in
Specimen Diameter: 2.48 in

| | Before Consolidation | | After Consolidation | |
|---|---|---|---|---|
| | Trimmings | Specimen+Ring | Specimen+Ring | Trimmings |
| Container ID | 40 | RING | RING | 47 |
| Wt. Container + Wet Soil, gm | 274.57 | 412.36 | 399.39 | 188.11 |
| Wt. Container + Dry Soil, gm | 225.67 | 373.11 | 373.11 | 161.9 |
| Wt. Container, gm | 61.62 | 262.23 | 262.23 | 51.29 |
| Wt. Dry Soil, gm | 164.05 | 110.88 | 110.88 | 110.61 |
| Water Content, % | 29.81 | 35.39 | 23.70 | 23.70 |
| Void Ratio | --- | 0.98 | 0.63 | --- |
| Degree of Saturation, % | --- | 96.90 | 100.00 | --- |
| Dry Unit Weight, pcf | --- | 84.438 | 102.16 | --- |

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

# CONSOLIDATION TEST DATA

Project: Jock Stream Bridge | Location: Monmouth | Project No.: 16716.00
Boring No.: BB-MJS-102 | Tested By: Brian Fogg | Checked By: km
Sample No.: 3U | Test Date: 8/5/09 | Depth: 75-77 ft
Test No.: 212319 | Sample Type: Shelby Tube | Elevation: 93.4 ft

Soil Description: Clayey Silt
Remarks: OCR = 1.28; Cc = 0.2588; C'c = 0.1307; Cr = 0.0419

| | Applied Stress tsf | Final Displacement in | Void Ratio | Strain at End % | T50 Fitting Sq.Rt. min | T50 Fitting Log min | Coefficient of Consolidation Sq.Rt. ft^2/sec | Coefficient of Consolidation Log ft^2/sec | Coefficient of Consolidation Ave. ft^2/sec |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0625 | 0.007709 | 0.962 | 0.75 | 1.5 | 0.0 | 4.15e-006 | 0.00e+000 | 4.15e-006 |
| 2 | 0.125 | 0.01371 | 0.950 | 1.33 | 3.4 | 2.2 | 1.76e-006 | 2.71e-006 | 2.13e-006 |
| 3 | 0.188 | 0.0176 | 0.943 | 1.71 | 6.9 | 3.1 | 8.52e-007 | 1.88e-006 | 1.17e-006 |
| 4 | 0.25 | 0.02058 | 0.937 | 2.00 | 6.8 | 6.3 | 8.67e-007 | 9.23e-007 | 8.94e-007 |
| 5 | 0.375 | 0.02478 | 0.929 | 2.40 | 2.2 | 0.0 | 2.62e-006 | 0.00e+000 | 2.62e-006 |
| 6 | 0.5 | 0.02975 | 0.919 | 2.88 | 50.7 | 0.0 | 1.14e-007 | 0.00e+000 | 1.14e-007 |
| 7 | 0.75 | 0.03491 | 0.909 | 3.38 | 2.3 | 3.1 | 2.48e-006 | 1.81e-006 | 2.09e-006 |
| 8 | 1 | 0.04157 | 0.897 | 4.03 | 7.0 | 0.0 | 8.06e-007 | 0.00e+000 | 8.06e-007 |
| 9 | 1.5 | 0.05354 | 0.874 | 5.19 | 4.6 | 5.5 | 1.21e-006 | 1.00e-006 | 1.10e-006 |
| 10 | 2.25 | 0.07092 | 0.840 | 6.88 | 6.9 | 6.4 | 7.76e-007 | 8.40e-007 | 8.07e-007 |
| 11 | 3.25 | 0.09224 | 0.800 | 8.94 | 6.9 | 6.9 | 7.44e-007 | 7.41e-007 | 7.43e-007 |
| 12 | 4.75 | 0.1157 | 0.755 | 11.21 | 6.9 | 4.9 | 7.12e-007 | 9.96e-007 | 8.30e-007 |
| 13 | 7 | 0.1381 | 0.712 | 13.39 | 4.6 | 3.6 | 1.03e-006 | 1.29e-006 | 1.14e-006 |
| 14 | 10.3 | 0.1602 | 0.669 | 15.53 | 3.4 | 3.1 | 1.31e-006 | 1.42e-006 | 1.36e-006 |
| 15 | 15 | 0.1819 | 0.628 | 17.64 | 3.5 | 2.8 | 1.20e-006 | 1.49e-006 | 1.33e-006 |
| 16 | 7 | 0.1775 | 0.636 | 17.21 | 0.1 | 0.0 | 4.22e-005 | 0.00e+000 | 4.22e-005 |
| 17 | 3.25 | 0.1726 | 0.646 | 16.74 | 0.5 | 0.2 | 8.94e-006 | 2.16e-005 | 1.26e-005 |
| 18 | 1.5 | 0.1656 | 0.659 | 16.05 | 1.7 | 2.2 | 2.43e-006 | 1.89e-006 | 2.13e-006 |
| 19 | 0.75 | 0.1591 | 0.672 | 15.42 | 3.6 | 3.3 | 1.21e-006 | 1.32e-006 | 1.26e-006 |
| 20 | 1.5 | 0.1615 | 0.667 | 15.66 | 0.7 | 0.0 | 6.15e-006 | 0.00e+000 | 6.15e-006 |
| 21 | 3.25 | 0.1673 | 0.656 | 16.22 | 0.9 | 0.0 | 4.59e-006 | 0.00e+000 | 4.59e-006 |
| 22 | 7 | 0.1758 | 0.639 | 17.04 | 0.9 | 0.0 | 4.59e-006 | 0.00e+000 | 4.59e-006 |
| 23 | 10.3 | 0.1824 | 0.627 | 17.68 | 0.7 | 0.7 | 5.78e-006 | 6.24e-006 | 6.00e-006 |
| 24 | 15 | 0.192 | 0.608 | 18.62 | 1.3 | 1.4 | 3.13e-006 | 2.96e-006 | 3.04e-006 |
| 25 | 22 | 0.2063 | 0.581 | 20.00 | 1.6 | 1.8 | 2.48e-006 | 2.20e-006 | 2.33e-006 |
| 26 | 32.3 | 0.2237 | 0.548 | 21.69 | 1.4 | 1.5 | 2.75e-006 | 2.48e-006 | 2.61e-006 |
| 27 | 7 | 0.2142 | 0.566 | 20.77 | 0.0 | 0.0 | 1.86e-004 | 0.00e+000 | 1.86e-004 |
| 28 | 1 | 0.195 | 0.603 | 18.90 | 2.0 | 2.3 | 1.92e-006 | 1.67e-006 | 1.79e-006 |
| 29 | 0.25 | 0.179 | 0.633 | 17.35 | 16.9 | 0.0 | 2.40e-007 | 0.00e+000 | 2.40e-007 |

# Appendix C

Calculations

## LIQUIDITY INDEX (LI):

$$\text{Liquidity Index} = \frac{\text{natural water content - Plastic Limit}}{\text{Liquid Limit -Plastic Limit}}$$

| | |
|---|---|
| wc is close to LL | Soil is normally consolidated |
| wc is close to PL | Soil is some-to-heavily over consolidated |
| wc is intermediate | Soil is over consolidated |
| wc is greater than LL | Soil is on the verge of being a viscous liquid when remolded |

| Sample | WC | LL | PL | PI | LI | |
|---|---|---|---|---|---|---|
| BB-MJS-101/6D | 26.2 | 23 | 18 | 5 | 1.64 | Viscous liquid when remolded |
| BB-MJS-101/10D | 27.8 | 23 | 17 | 6 | 1.80 | Viscous liquid when remolded |
| BB-MJS-101/1U | 33.4 | 25 | 18 | 7 | 2.20 | Viscous liquid when remolded |
| BB-MJS-101/2U | 30.7 | 26 | 18 | 8 | 1.59 | Viscous liquid when remolded |
| BB-MJS-101/12D | 26.3 | 24 | 16 | 8 | 1.29 | Viscous liquid when remolded |
| BB-MJS-101/3U | 35.6 | 35 | 21 | 14 | 1.04 | Normally consolidated |
| BB-MJS-101/13D | 28.9 | 31 | 19 | 12 | 0.83 | Over consolidated |
| BB-MJS-102/8D | 29.0 | 25 | 18 | 7 | 1.57 | Viscous liquid when remolded |
| BB-MJS-102/9D | 24.7 | 22 | 17 | 5 | 1.54 | Viscous liquid when remolded |
| BB-MJS-102/10D | 28.8 | 22 | 17 | 5 | 2.36 | Viscous liquid when remolded |
| BB-MJS-102/12D | 27.6 | 26 | 18 | 8 | 1.20 | Viscous liquid when remolded |
| BB-MJS-102/2U | 28.7 | 23 | 18 | 5 | 2.14 | Viscous liquid when remolded |
| BB-MJS-102/3U | 31.6 | 29 | 19 | 10 | 1.26 | Viscous liquid when remolded |
| BB-MJS-102/13D | 28.7 | 30 | 20 | 10 | 0.87 | Over consolidated |
| BB-MJS-102/14D | 26.6 | 36 | 21 | 15 | 0.37 | Over consolidated |
| BB-MJS-102/15D | 26.1 | 30 | 19 | 11 | 0.65 | Over consolidated |

# CONSOLIDATION TEST RESULTS

$$\text{tsf} := g \cdot \left(\frac{\text{ton}}{\text{ft}^2}\right)$$

BB-MJS-101 Sample 1U

Determine in-situ over burden stress:

Sample depth = 54.0 ft below ground surface

Groundwater table at 9.0 ft below ground surface

Unit weight of water = 62.4pcf

Initial void ratio $e_0 := 1.0$

Clay is overlain by:
8.5 ft of sand at 125 pcf
34.5 ft of silt at 115 pcf
11.0 ft of clay at 115 pcf

$$\sigma'_{vo} := 8.5 \cdot \text{ft} \cdot 125 \cdot \text{pcf} + 0.5 \cdot \text{ft} \cdot (125 - 62.4) \cdot \text{pcf} + 34 \cdot \text{ft} \cdot (115 - 62.4) \cdot \text{pcf} + 11 \cdot \text{ft} \cdot (115 - 62.4) \cdot \text{pcf}$$

$\sigma'_{vo} = 3461 \cdot \text{psf}$ or $\sigma'_{vo} = 1.73 \cdot \text{tsf}$

Maximum past pressure from consolidation curve Casagrande construction: $\sigma'_p := 2.6 \cdot \text{tsf}$

Determine OCR: $\text{OCR} := \frac{\sigma'_p}{\sigma'_{vo}}$ $\text{OCR} = 1.5025$ *over consolidated*

Determine Cc:

from consolidation curve and lab results:

$p_1 := 3.25 \cdot \text{tsf}$ $e_1 := 0.813$ $p_2 := 7 \cdot \text{tsf}$ $e_2 := 0.695$

$$C_c := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_c = 0.3541$$

Determine C'c:

from consolidation curve and lab results:

$\varepsilon_1 := \frac{9.24}{100}$ $\varepsilon_2 := \frac{15.13}{100}$ strain is given in percent

$$C'_c := \frac{\varepsilon_2 - \varepsilon_1}{\log\left(\frac{p_2}{p_1}\right)} \qquad C'_c = 0.1768$$

or: $C'c := \frac{C_c}{1 + e_0}$ $C'c = 0.1771$

Determine Cr:

from consolidation curve and lab results:

$p_1 := 15 \cdot \text{tsf}$ $e_1 := 0.592$ $p_2 := 0.75 \cdot \text{tsf}$ $e_2 := 0.644$

$$C_r := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_r = 0.04$$

BB-MJS-101 Sample 2U

Determine in-situ over burden stress:

Sample depth = 64.0 ft below ground surface

Groundwater table at 9.0 ft below ground surface

Unit weight of water = 62.4pcf

Initial void ratio $e_0 := 0.94$

Clay is overlain by:
8.5 ft of sand at 125 pcf
34.5 ft of silt at 115 pcf
21.0 ft of clay at 115 pcf

$$\sigma'_{vo} := 8.5 \cdot ft \cdot 125 \cdot pcf + 0.5 \cdot ft \cdot (125 - 62.4) \cdot pcf + 34 \cdot ft \cdot (115 - 62.4) \cdot pcf + 21 \cdot ft \cdot (115 - 62.4) \cdot pcf$$

$\sigma'_{vo} = 3987 \cdot psf$ or $\sigma'_{vo} = 1.993 \cdot tsf$

Maximum past pressure from consolidation curve Casagrande construction: $\sigma'_p := 2.7 \cdot tsf$

Determine OCR: $OCR := \dfrac{\sigma'_p}{\sigma'_{vo}}$ $OCR = 1.3545$ *over consolidated*

Determine Cc:

from consolidation curve and lab results:

$p_1 := 3.25 \cdot tsf$ $e_1 := 0.770$ $p_2 := 10.3 \cdot tsf$ $e_2 := 0.611$

$$C_c := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_c = 0.3174$$

Determine C'c:

from consolidation curve and lab results:

$\varepsilon_1 := \dfrac{8.86}{100}$ $\varepsilon_2 := \dfrac{17.04}{100}$ strain is given in percent

$$C'_c := \frac{\varepsilon_2 - \varepsilon_1}{\log\left(\frac{p_2}{p_1}\right)} \qquad C'_c = 0.1633$$ or: $$C'c := \frac{C_c}{1 + e_0} \qquad C'c = 0.1636$$

Determine Cr:

from consolidation curve and lab results:

$p_1 := 1.5 \cdot tsf$ $e_1 := 0.607$ $p_2 := 7 \cdot tsf$ $e_2 := 0.576$

$$C_r := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_r = 0.0463$$

BB-MJS-101 Sample 3U

Determine in-situ over burden stress:

Sample depth = 75.5 ft below ground surface

Groundwater table at 9.0 ft below ground surface

Unit weight of water = 62.4pcf

Initial void ratio $e_0 := 1.13$

Clay is overlain by:
8.5 ft of sand at 125 pcf
34.5 ft of silt at 115 pcf
32.5 ft of clay at 115 pcf

$$\sigma'_{vo} := 8.5 \cdot ft \cdot 125 \cdot pcf + 0.5 \cdot ft \cdot (125 - 62.4) \cdot pcf + 34 \cdot ft \cdot (115 - 62.4) \cdot pcf + 32.5 \cdot ft \cdot (115 - 62.4) \cdot pcf$$

$\sigma'_{vo} = 4592 \cdot psf$ or $\sigma'_{vo} = 2.296 \cdot tsf$

Maximum past pressure from consolidation curve Casagrande construction: $\sigma'_p := 2.8 \cdot tsf$

Determine OCR: $OCR := \dfrac{\sigma'_p}{\sigma'_{vo}}$ $OCR = 1.2196$ *over consolidated*

Determine Cc:

from consolidation curve and lab results:

$p_1 := 2.25 \cdot tsf$ $e_1 := 0.92$ $p_2 := 7 \cdot tsf$ $e_2 := 0.77$

$$C_c := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_c = 0.3043$$

Determine C'c:

from consolidation curve and lab results:

$\varepsilon_1 := \dfrac{9.93}{100}$ $\varepsilon_2 := \dfrac{16.96}{100}$ strain is given in percent

$$C'_c := \frac{\varepsilon_2 - \varepsilon_1}{\log\left(\frac{p_2}{p_1}\right)} \qquad C'_c = 0.1426$$ or: $$C'c := \frac{C_c}{1 + e_0} \qquad C'c = 0.1429$$

Determine Cr:

from consolidation curve and lab results:

$p_1 := 1.5 \cdot tsf$ $e_1 := 0.717$ $p_2 := 7 \cdot tsf$ $e_2 := 0.692$

$$C_r := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_r = 0.0374$$

BB-MJS-102 Sample 2U

Determine in-situ over burden stress:

Sample depth = 65 ft below ground surface

Groundwater table at 5.5 ft below ground surface

Unit weight of water = 62.4pcf

Initial void ratio $e_0 := 0.88$

Clay is overlain by:
8 ft of sand at 125 pcf
51 ft of silt at 115 pcf
6 ft of clay at 115 pcf

$$\sigma'_{vo} := 5.5 \cdot ft \cdot 125 \cdot pcf + 2.5 \cdot ft \cdot (125 - 62.4) \cdot pcf + 51 \cdot ft \cdot (115 - 62.4) \cdot pcf + 6 \cdot ft \cdot (115 - 62.4) \cdot pcf$$

$\sigma'_{vo} = 3842 \cdot psf$ or $\sigma'_{vo} = 1.921 \cdot tsf$

Maximum past pressure from consolidation curve Casagrande construction: $\sigma'_p := 2.9 \cdot tsf$

Determine OCR: $OCR := \frac{\sigma'_p}{\sigma'_{vo}}$ $OCR = 1.5096$ *over consolidated*

Determine Cc:

from consolidation curve and lab results:

$p_1 := 3.25 \cdot tsf$ $e_1 := 0.668$ $p_2 := 7 \cdot tsf$ $e_2 := 0.607$

$$C_c := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_c = 0.1831$$

Determine C'c:

from consolidation curve and lab results:

$\varepsilon_1 := \frac{11.37}{100}$ $\varepsilon_2 := \frac{14.61}{100}$ strain is given in percent

$$C'_c := \frac{\varepsilon_2 - \varepsilon_1}{\log\left(\frac{p_2}{p_1}\right)} \qquad C'_c = 0.0972$$ or: $$C'c := \frac{C_c}{1 + e_0} \qquad C'c = 0.0974$$

Determine Cr:

from consolidation curve and lab results:

$p_1 := 1.5 \cdot tsf$ $e_1 := 0.569$ $p_2 := 7 \cdot tsf$ $e_2 := 0.557$

$$C_r := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_r = 0.0179$$

BB-MJS-102 Sample 3U

Determine in-situ over burden stress:

Sample depth = 75 ft below ground surface

Groundwater table at 5.5 ft below ground surface

Unit weight of water = 62.4pcf

Initial void ratio $e_0 := 0.98$

Clay is overlain by:
8 ft of sand at 125 pcf
51 ft of silt at 115 pcf
16 ft of clay at 115 pcf

$$\sigma'_{vo} := 5.5 \cdot ft \cdot 125 \cdot pcf + 2.5 \cdot ft \cdot (125 - 62.4) \cdot pcf + 51 \cdot ft \cdot (115 - 62.4) \cdot pcf + 16 \cdot ft \cdot (115 - 62.4) \cdot pcf$$

$\sigma'_{vo} = 4368 \cdot psf$ or $\sigma'_{vo} = 2.184 \cdot tsf$

Maximum past pressure from consolidation curve Casagrande construction: $\sigma'_p := 2.8 \cdot tsf$

Determine OCR: $OCR := \frac{\sigma'_p}{\sigma'_{vo}}$ $OCR = 1.282$ *over consolidated*

Determine Cc:

from consolidation curve and lab results:

$p_1 := 2.25 \cdot tsf$ $e_1 := 0.84$ $p_2 := 10.3 \cdot tsf$ $e_2 := 0.669$

$$C_c := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_c = 0.2588$$

Determine C'c:

from consolidation curve and lab results:

$\varepsilon_1 := \frac{6.88}{100}$ $\varepsilon_2 := \frac{15.53}{100}$ strain is given in percent

$$C'_c := \frac{\varepsilon_2 - \varepsilon_1}{\log\left(\frac{p_2}{p_1}\right)} \qquad C'_c = 0.1309$$ or: $$C'c := \frac{C_c}{1 + e_0} \qquad C'c = 0.1307$$

Determine Cr:

from consolidation curve and lab results:

$p_1 := 1.5 \cdot tsf$ $e_1 := 0.667$ $p_2 := 7 \cdot tsf$ $e_2 := 0.639$

$$C_r := \frac{e_1 - e_2}{\log\left(\frac{p_2}{p_1}\right)} \qquad C_r = 0.0419$$

# Abutment Foundations: Integral driven H-piles

## Axial Structural Resistance of H-piles

Ref: AASHTO LRFD Bridge Design Specifications 4th Edition 2007

Look at the following piles:

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

Note: All matrices set up in this order

H-pile Steel area: $A_s := \begin{pmatrix} 15.5 \\ 21.8 \\ 21.4 \\ 26.1 \\ 34.4 \end{pmatrix} \cdot in^2$

yield strength: $F_y := 50 \cdot ksi$

**Nominal** Compressive Resistance $P_n = 0.66^{\lambda} * F_y * A_s$: eq. 6.9.4.1-1

Where $\lambda$=normalized column slenderness factor

$\lambda = (Kl/r_s\pi)2 * F_y/E$ eq. 6.9.4.1-3

$\lambda := 0$ as l unbraced length is 0

$P_n := 0.66^{\lambda} \cdot F_y \cdot A_s$

$P_n = \begin{pmatrix} 775 \\ 1090 \\ 1070 \\ 1305 \\ 1720 \end{pmatrix} \cdot kip$

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

# STRENGTH LIMIT STATE:

Factored Resistance:

**Strength Limit State** Axial Resistance factor for piles in compression under severe driving conditions:

From Article 6.5.4.2 $\phi_c := 0.5$

**Factored** Compressive Resistance:

eq. 6.9.2.1-1 $P_f := \phi_c \cdot P_n$

$P_f = \begin{pmatrix} 388 \\ 545 \\ 535 \\ 653 \\ 860 \end{pmatrix} \cdot kip$

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

Strength Limit State

# SERVICE/EXTREME LIMIT STATES:

**Service and Extreme Limit States** Axial Resistance

**Nominal** Compressive Resistance $P_n = 0.66^{\lambda} * F_y * A_s$: eq. 6.9.4.1-1

Where $\lambda$=normalized column slenderness factor

$\lambda = (Kl/r_s\pi)2 * F_y/E$ eq. 6.9.4.1-3

$\lambda := 0$ as l unbraced length is 0

$$P_n := 0.66^{\lambda} \cdot F_y \cdot A_s \qquad P_n = \begin{pmatrix} 775 \\ 1090 \\ 1070 \\ 1305 \\ 1720 \end{pmatrix} \cdot kip$$

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

Resistance Factors for Service and Extreme Limit States $\phi = 1.0$ LRFD 10.5.5.1 and 10.5.8.3

$\phi := 1.0$

**Factored** Compressive Resistance for Service and Extreme Limit States:

eq. 6.9.2.1-1

$$P_f := \phi \cdot P_n \qquad P_f = \begin{pmatrix} 775 \\ 1090 \\ 1070 \\ 1305 \\ 1720 \end{pmatrix} \cdot kip$$

**HP 12 x 53**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

Service/Extreme Limit States

## Geotechnical Resistance

Assume piles will be friction piles driven through overlying silt and clayey silt to required resistance in the glacial till.

For Side Friction in clay - for the α method LRFD code specifies:
Tomlinson 1987; Skempton 1951 (LRFD Table 10.5.5.2.3-1) $\phi_{sideinclay} := 0.35$
For Side Friction in cohesionless soils LRFD code specifies:
Nordlund (Hannigan et al., 2005) (LRFD Table 10.5.5.2.3-1) $\phi_{sideinsand} := 0.45$
For End Bearing in cohesionless soils LRFD code specifies:
Thurman (Hannigan et al., 2005) (LRFD Table 10.5.5.2.3-1 $\phi_{endbearinginsand} := 0.45$

References:
1. AASHTO LRFD Bridge Design Specifications 4th Edition 2007
2. Design and Construction of Driven Pile Foundations Reference Manual - Volume 1

### Axial Geotechnical Resistance of H-piles

Look at these piles:

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73** Note: All matrices set up in this order
**HP 14 x 89**
**HP 14 x 117**

Use FHWA Driven software to determine capacity.
Driven uses the α-method to calculate the pile capacity versus depth for the silt-clay soil profile (Tomlinson).
Driven uses Nordlund method to calculate the side resistance in the sand and basal till deposit.
Driven uses Thurman method to calculate the point resistance in the basal till.

Determine the % Driving strength loss for each layer:

% Driving strength loss = 1 - [1/setup factor}

Setup Factor found in Section 9.10.1.1 Table 9-19 of Reference 2

Layer 1 = silt

Setup factor = 1.0 Therefore, % driving loss = 0%

Layer 2 = clayey silt

Setup factor = 1.0 Therefore, % driving loss = 0%

Layer 3 = glacial till (sand)

Setup factor = 1.0 Therefore, % driving loss = 0%

Determine undrained shear strength for Layers 1 & 2 from field testing:

Layer 1 - Average undrained shear strength = 450 psf
Layer 2 - Average undrained shear strength = 650 psf

Choose graph for cohesive soil layer properties:

Use "Piles driven through soft clay" (Tomlinson 1980)
This correlates to Figure 9.19 graph c of Reference 2.

## PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

## ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

## ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 37.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

## DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.44 Kips | 0.45 Kips |
| 9.01 ft | 8.57 Kips | 0.44 Kips | 9.00 Kips |
| 18.01 ft | 24.94 Kips | 0.44 Kips | 25.38 Kips |
| 27.01 ft | 40.44 Kips | 0.44 Kips | 40.88 Kips |
| 36.01 ft | 53.92 Kips | 0.44 Kips | 54.36 Kips |
| 42.99 ft | 64.37 Kips | 0.44 Kips | 64.81 Kips |
| 43.01 ft | 64.40 Kips | 0.63 Kips | 65.03 Kips |
| 52.01 ft | 75.57 Kips | 0.63 Kips | 76.20 Kips |
| 61.01 ft | 98.71 Kips | 0.63 Kips | 99.34 Kips |
| 70.01 ft | 120.51 Kips | 0.63 Kips | 121.14 Kips |
| 79.01 ft | 139.21 Kips | 0.63 Kips | 139.84 Kips |
| 82.99 ft | 147.48 Kips | 0.63 Kips | 148.11 Kips |
| 83.01 ft | 147.60 Kips | 16.32 Kips | 163.91 Kips |
| 92.01 ft | 242.50 Kips | 16.32 Kips | 258.82 Kips |
| 101.01 ft | 347.66 Kips | 16.32 Kips | 363.98 Kips |
| 110.01 ft | 463.09 Kips | 16.32 Kips | 479.41 Kips |
| 119.01 ft | 588.78 Kips | 16.32 Kips | 605.10 Kips |
| 119.99 ft | 603.09 Kips | 16.32 Kips | 619.40 Kips |

Cohesionless

**10 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay12x53} := 147.6 \cdot kip \cdot \phi_{sideinclay}$ $R_{sideinclay12x53} = 52 \cdot kip$

Side Friction in sand: $R_{sideinsand12x53} := (603.09 \cdot kip - 147.6 \cdot kip) \cdot \phi_{sideinsand}$ $R_{sideinsand12x53} = 205 \cdot kip$

End Bearing: $R_{endbearing12x53} := 16.32 \cdot kip \cdot \phi_{endbearinginsand}$ $R_{endbearing12x53} = 7 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech12x53} := R_{sideinclay12x53} + R_{sideinsand12x53} + R_{endbearing12x53}$

$R_{str\_geotech12x53} = 264 \cdot kip$

Service Limit State: $R_{ser\_geotech12x53} := 619 \cdot kip$

## DRIVEN 1.2

### GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON1274.DVN
Project Name: Monmouth
Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

### PILE INFORMATION

Pile Type: H Pile - HP12X74
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

### ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

### ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 37.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

### DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.61 Kips | 0.62 Kips |
| 9.01 ft | 8.75 Kips | 0.61 Kips | 9.37 Kips |
| 18.01 ft | 25.24 Kips | 0.61 Kips | 25.85 Kips |
| 27.01 ft | 41.33 Kips | 0.61 Kips | 41.94 Kips |
| 36.01 ft | 55.10 Kips | 0.61 Kips | 55.71 Kips |
| 42.99 ft | 65.78 Kips | 0.61 Kips | 66.39 Kips |
| 43.01 ft | 65.81 Kips | 0.89 Kips | 66.69 Kips |
| 52.01 ft | 77.22 Kips | 0.89 Kips | 78.11 Kips |
| 61.01 ft | 100.48 Kips | 0.89 Kips | 101.36 Kips |
| 70.01 ft | 123.14 Kips | 0.89 Kips | 124.02 Kips |
| 79.01 ft | 142.24 Kips | 0.89 Kips | 143.13 Kips |
| 82.99 ft | 150.69 Kips | 0.89 Kips | 151.58 Kips |
| 83.01 ft | 150.83 Kips | 22.95 Kips | 173.79 Kips |
| 92.01 ft | 264.22 Kips | 22.95 Kips | 287.17 Kips |
| 101.01 ft | 389.87 Kips | 22.95 Kips | 412.82 Kips |
| 110.01 ft | 527.78 Kips | 22.95 Kips | 550.73 Kips |
| 119.01 ft | 677.95 Kips | 22.95 Kips | 700.90 Kips |
| 119.99 ft | 695.04 Kips | 22.95 Kips | 717.99 Kips |

Cohesionless

**10 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay12x74} := 150.83 \cdot kip \cdot \phi_{sideinclay}$ $\qquad R_{sideinclay12x74} = 53 \cdot kip$

Side Friction in sand: $R_{sideinsand12x74} := (695.04 \cdot kip - 150.83 \cdot kip) \cdot \phi_{sideinsand}$ $\qquad R_{sideinsand12x74} = 245 \cdot kip$

End Bearing: $R_{endbearing12x74} := 22.95 \cdot kip \cdot \phi_{endbearinginsand}$ $\qquad R_{endbearing12x74} = 10 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech12x74} := R_{sideinclay12x74} + R_{sideinsand12x74} + R_{endbearing12x74}$

$R_{str\_geotech12x74} = 308 \cdot kip$

Service Limit State: $R_{ser\_geotech12x74} := 718 \cdot kip$

## DRIVEN 1.2

### GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON1473.DVN
Project Name: Monmouth
Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

### PILE INFORMATION

Pile Type: H Pile - HP14X73
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

### ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

### ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 37.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

### DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.60 Kips | 0.61 Kips |
| 9.01 ft | 10.14 Kips | 0.60 Kips | 10.74 Kips |
| 18.01 ft | 25.88 Kips | 0.60 Kips | 26.48 Kips |
| 27.01 ft | 47.86 Kips | 0.60 Kips | 48.47 Kips |
| 36.01 ft | 63.81 Kips | 0.60 Kips | 64.41 Kips |
| 42.99 ft | 76.18 Kips | 0.60 Kips | 76.78 Kips |
| 43.01 ft | 76.21 Kips | 0.87 Kips | 77.08 Kips |
| 52.01 ft | 89.43 Kips | 0.87 Kips | 90.30 Kips |
| 61.01 ft | 111.24 Kips | 0.87 Kips | 112.11 Kips |
| 70.01 ft | 142.61 Kips | 0.87 Kips | 143.48 Kips |
| 79.01 ft | 164.74 Kips | 0.87 Kips | 165.61 Kips |
| 82.99 ft | 174.53 Kips | 0.87 Kips | 175.40 Kips |
| 83.01 ft | 174.69 Kips | 22.53 Kips | 197.22 Kips |
| 92.01 ft | 304.84 Kips | 22.53 Kips | 327.37 Kips |
| 101.01 ft | 449.07 Kips | 22.53 Kips | 471.60 Kips |
| 110.01 ft | 607.37 Kips | 22.53 Kips | 629.90 Kips |
| 119.01 ft | 779.74 Kips | 22.53 Kips | 802.27 Kips |
| 119.99 ft | 799.36 Kips | 22.53 Kips | 821.89 Kips |

Cohesionless

**10 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay14x73} := 174.69 \cdot kip \cdot \phi_{sideinclay}$ $R_{sideinclay14x73} = 61 \cdot kip$

Side Friction in sand: $R_{sideinsand14x73} := (799.36 \cdot kip - 174.69 \cdot kip) \cdot \phi_{sideinsand}$ $R_{sideinsand14x73} = 281 \cdot kip$

End Bearing: $R_{endbearing14x73} := 22.53 \cdot kip \cdot \phi_{endbearinginsand}$ $R_{endbearing14x73} = 10 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech14x73} := R_{sideinclay14x73} + R_{sideinsand14x73} + R_{endbearing14x73}$

$R_{str\_geotech14x73} = 352 \cdot kip$

Service Limit State: $R_{ser\_geotech14x73} := 822 \cdot kip$

## DRIVEN 1.2

### GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON1489.DVN
Project Name: Monmouth
Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

### PILE INFORMATION

Pile Type: H Pile - HP14X89
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

### ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

### ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 37.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

### DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.73 Kips | 0.75 Kips |
| 9.01 ft | 10.25 Kips | 0.73 Kips | 10.99 Kips |
| 18.01 ft | 26.05 Kips | 0.73 Kips | 26.78 Kips |
| 27.01 ft | 48.42 Kips | 0.73 Kips | 49.16 Kips |
| 36.01 ft | 64.56 Kips | 0.73 Kips | 65.29 Kips |
| 42.99 ft | 77.07 Kips | 0.73 Kips | 77.81 Kips |
| 43.01 ft | 77.11 Kips | 1.06 Kips | 78.17 Kips |
| 52.01 ft | 90.48 Kips | 1.06 Kips | 91.54 Kips |
| 61.01 ft | 112.34 Kips | 1.06 Kips | 113.40 Kips |
| 70.01 ft | 144.28 Kips | 1.06 Kips | 145.34 Kips |
| 79.01 ft | 166.67 Kips | 1.06 Kips | 167.73 Kips |
| 82.99 ft | 176.57 Kips | 1.06 Kips | 177.63 Kips |
| 83.01 ft | 176.75 Kips | 27.48 Kips | 204.22 Kips |
| 92.01 ft | 321.35 Kips | 27.48 Kips | 348.83 Kips |
| 101.01 ft | 481.59 Kips | 27.48 Kips | 509.07 Kips |
| 110.01 ft | 657.47 Kips | 27.48 Kips | 684.94 Kips |
| 119.01 ft | 848.98 Kips | 27.48 Kips | 876.46 Kips |
| 119.99 ft | 870.78 Kips | 27.48 Kips | 898.26 Kips |

Cohesionless

**10 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay14x89} := 176.75 \cdot kip \cdot \phi_{sideinclay}$ $\quad R_{sideinclay14x89} = 62 \cdot kip$

Side Friction in sand: $R_{sideinsand14x89} := (870.78 \cdot kip - 176.75 \cdot kip) \cdot \phi_{sideinsand}$ $\quad R_{sideinsand14x89} = 312 \cdot kip$

End Bearing: $R_{endbearing14x89} := 27.48 \cdot kip \cdot \phi_{endbearinginsand}$ $\quad R_{endbearing14x89} = 12 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech14x89} := R_{sideinclay14x89} + R_{sideinsand14x89} + R_{endbearing14x89}$

$R_{str\_geotech14x89} = 387 \cdot kip$

Service Limit State: $R_{ser\_geotech14x89} := 898 \cdot kip$

# DRIVEN 1.2

## GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON14117.DVN
Project Name: Monmouth
Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

## PILE INFORMATION

Pile Type: H Pile - HP14X117
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

## ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

## ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 37.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

## DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.97 Kips | 0.98 Kips |
| 9.01 ft | 10.46 Kips | 0.97 Kips | 11.43 Kips |
| 18.01 ft | 26.34 Kips | 0.97 Kips | 27.31 Kips |
| 27.01 ft | 49.39 Kips | 0.97 Kips | 50.36 Kips |
| 36.01 ft | 65.85 Kips | 0.97 Kips | 66.82 Kips |
| 42.99 ft | 78.61 Kips | 0.97 Kips | 79.58 Kips |
| 43.01 ft | 78.65 Kips | 1.40 Kips | 80.04 Kips |
| 52.01 ft | 92.29 Kips | 1.40 Kips | 93.68 Kips |
| 61.01 ft | 114.24 Kips | 1.40 Kips | 115.64 Kips |
| 70.01 ft | 147.16 Kips | 1.40 Kips | 148.56 Kips |
| 79.01 ft | 170.00 Kips | 1.40 Kips | 171.40 Kips |
| 82.99 ft | 180.10 Kips | 1.40 Kips | 181.49 Kips |
| 83.01 ft | 180.30 Kips | 36.22 Kips | 216.51 Kips |
| 92.01 ft | 346.62 Kips | 36.22 Kips | 382.84 Kips |
| 101.01 ft | 530.94 Kips | 36.22 Kips | 567.15 Kips |
| 110.01 ft | 733.24 Kips | 36.22 Kips | 769.46 Kips |
| 119.01 ft | 953.53 Kips | 36.22 Kips | 989.74 Kips |
| 119.99 ft | 978.60 Kips | 36.22 Kips | 1014.82 Kips |

Cohesionless

**10 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay14x117} := 180.3 \cdot kip \cdot \phi_{sideinclay}$ $\quad R_{sideinclay14x117} = 63 \cdot kip$

Side Friction in sand: $R_{sideinsand14x117} := (978.6 \cdot kip - 180.3 \cdot kip) \cdot \phi_{sideinsand}$ $\quad R_{sideinsand14x117} = 359 \cdot kip$

End Bearing: $R_{endbearing14x117} := 36.22 \cdot kip \cdot \phi_{endbearinginsand}$ $\quad R_{endbearing14x117} = 16 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech14x117} := R_{sideinclay14x117} + R_{sideinsand14x117} + R_{endbearing14x117}$

$$R_{str\_geotech14x117} = 439 \cdot kip$$

Service Limit State: $R_{ser\_geotech14x117} := 1015 \cdot kip$

# DRIVEN 1.2

## GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON1253.DVN
Project Name: Monmouth — Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

## PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

## ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

## ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 47.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

## DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.44 Kips | 0.45 Kips |
| 9.01 ft | 8.57 Kips | 0.44 Kips | 9.00 Kips |
| 18.01 ft | 24.94 Kips | 0.44 Kips | 25.38 Kips |
| 27.01 ft | 40.44 Kips | 0.44 Kips | 40.88 Kips |
| 36.01 ft | 53.92 Kips | 0.44 Kips | 54.36 Kips |
| 42.99 ft | 64.37 Kips | 0.44 Kips | 64.81 Kips |
| 43.01 ft | 64.40 Kips | 0.63 Kips | 65.03 Kips |
| 52.01 ft | 75.57 Kips | 0.63 Kips | 76.20 Kips |
| 61.01 ft | 98.71 Kips | 0.63 Kips | 99.34 Kips |
| 70.01 ft | 120.51 Kips | 0.63 Kips | 121.14 Kips |
| 79.01 ft | 139.21 Kips | 0.63 Kips | 139.84 Kips |
| 82.99 ft | 147.48 Kips | 0.63 Kips | 148.11 Kips |
| 83.01 ft | 147.60 Kips | 16.32 Kips | 163.91 Kips |
| 92.01 ft | 242.50 Kips | 16.32 Kips | 258.82 Kips |
| 101.01 ft | 347.66 Kips | 16.32 Kips | 363.98 Kips |
| 110.01 ft | 463.09 Kips | 16.32 Kips | 479.41 Kips |
| 119.01 ft | 588.78 Kips | 16.32 Kips | 605.10 Kips |
| 128.01 ft | 724.73 Kips | 16.32 Kips | 741.05 Kips |
| 129.99 ft | 756.02 Kips | 16.32 Kips | 772.34 Kips |

Cohesionless

**20 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay12x53a} := 147.6 \cdot kip \cdot \phi_{sideinclay}$ $R_{sideinclay12x53a} = 52 \cdot kip$

Side Friction in sand: $R_{sideinsand12x53a} := (756.02 \cdot kip - 147.6 \cdot kip) \cdot \phi_{sideinsand}$ $R_{sideinsand12x53a} = 274 \cdot kip$

End Bearing: $R_{endbearing12x53a} := 16.32 \cdot kip \cdot \phi_{endbearinginsand}$ $R_{endbearing12x53a} = 7 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech12x53a} := R_{sideinclay12x53a} + R_{sideinsand12x53a} + R_{endbearing12x53a}$

$R_{str\_geotech12x53a} = 333 \cdot kip$

Service Limit State: $R_{ser\_geotech12x53a} := 772 \cdot kip$

## DRIVEN 1.2

### GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON1274.DVN
Project Name: Monmouth
Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

### PILE INFORMATION

Pile Type: H Pile - HP12X74
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

### ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

### ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 47.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

### DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.61 Kips | 0.62 Kips |
| 9.01 ft | 8.75 Kips | 0.61 Kips | 9.37 Kips |
| 18.01 ft | 25.24 Kips | 0.61 Kips | 25.85 Kips |
| 27.01 ft | 41.33 Kips | 0.61 Kips | 41.94 Kips |
| 36.01 ft | 55.10 Kips | 0.61 Kips | 55.71 Kips |
| 42.99 ft | 65.78 Kips | 0.61 Kips | 66.39 Kips |
| 43.01 ft | 65.81 Kips | 0.89 Kips | 66.69 Kips |
| 52.01 ft | 77.22 Kips | 0.89 Kips | 78.11 Kips |
| 61.01 ft | 100.48 Kips | 0.89 Kips | 101.36 Kips |
| 70.01 ft | 123.14 Kips | 0.89 Kips | 124.02 Kips |
| 79.01 ft | 142.24 Kips | 0.89 Kips | 143.13 Kips |
| 82.99 ft | 150.69 Kips | 0.89 Kips | 151.58 Kips |
| 83.01 ft | 150.83 Kips | 22.95 Kips | 173.79 Kips |
| 92.01 ft | 264.22 Kips | 22.95 Kips | 287.17 Kips |
| 101.01 ft | 389.87 Kips | 22.95 Kips | 412.82 Kips |
| 110.01 ft | 527.78 Kips | 22.95 Kips | 550.73 Kips |
| 119.01 ft | 677.95 Kips | 22.95 Kips | 700.90 Kips |
| 128.01 ft | 840.38 Kips | 22.95 Kips | 863.33 Kips |
| 129.99 ft | 877.76 Kips | 22.95 Kips | 900.71 Kips |

Cohesionless

**20 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay12x74a} := 150.83 \cdot kip \cdot \phi_{sideinclay}$ $\quad R_{sideinclay12x74a} = 53 \cdot kip$

Side Friction in sand: $R_{sideinsand12x74a} := (877.76 \cdot kip - 150.83 \cdot kip) \cdot \phi_{sideinsand}$ $\quad R_{sideinsand12x74a} = 327 \cdot kip$

End Bearing: $R_{endbearing12x74a} := 22.95 \cdot kip \cdot \phi_{endbearinginsand}$ $\quad R_{endbearing12x74a} = 10 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech12x74a} := R_{sideinclay12x74a} + R_{sideinsand12x74a} + R_{endbearing12x74a}$

$R_{str\_geotech12x74a} = 390 \cdot kip$

Service Limit State: $R_{ser\_geotech12x74a} := 901 \cdot kip$

## DRIVEN 1.2

### GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON1473.DVN
Project Name: Monmouth
Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

### PILE INFORMATION

Pile Type: H Pile - HP14X73
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

### ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

### ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 47.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

### DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.60 Kips | 0.61 Kips |
| 9.01 ft | 10.14 Kips | 0.60 Kips | 10.74 Kips |
| 18.01 ft | 25.88 Kips | 0.60 Kips | 26.48 Kips |
| 27.01 ft | 47.86 Kips | 0.60 Kips | 48.47 Kips |
| 36.01 ft | 63.81 Kips | 0.60 Kips | 64.41 Kips |
| 42.99 ft | 76.18 Kips | 0.60 Kips | 76.78 Kips |
| 43.01 ft | 76.21 Kips | 0.87 Kips | 77.08 Kips |
| 52.01 ft | 89.43 Kips | 0.87 Kips | 90.30 Kips |
| 61.01 ft | 111.24 Kips | 0.87 Kips | 112.11 Kips |
| 70.01 ft | 142.61 Kips | 0.87 Kips | 143.48 Kips |
| 79.01 ft | 164.74 Kips | 0.87 Kips | 165.61 Kips |
| 82.99 ft | 174.53 Kips | 0.87 Kips | 175.40 Kips |
| 83.01 ft | 174.69 Kips | 22.53 Kips | 197.22 Kips |
| 92.01 ft | 304.84 Kips | 22.53 Kips | 327.37 Kips |
| 101.01 ft | 449.07 Kips | 22.53 Kips | 471.60 Kips |
| 110.01 ft | 607.37 Kips | 22.53 Kips | 629.90 Kips |
| 119.01 ft | 779.74 Kips | 22.53 Kips | 802.27 Kips |
| 128.01 ft | 966.20 Kips | 22.53 Kips | 988.73 Kips |
| 129.99 ft | 1009.11 Kips | 22.53 Kips | 1031.64 Kips |

Cohesionless

**20 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay14x73a} := 174.69 \cdot kip \cdot \phi_{sideinclay}$ $R_{sideinclay14x73a} = 61 \cdot kip$

Side Friction in sand: $R_{sideinsand14x73a} := (1009.11 \cdot kip - 174.69 \cdot kip) \cdot \phi_{sideinsand}$ $R_{sideinsand14x73a} = 375 \cdot kip$

End Bearing: $R_{endbearing14x73a} := 22.53 \cdot kip \cdot \phi_{endbearinginsand}$ $R_{endbearing14x73a} = 10 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech14x73a} := R_{sideinclay14x73a} + R_{sideinsand14x73a} + R_{endbearing14x73a}$

$R_{str\_geotech14x73a} = 447 \cdot kip$

Service Limit State: $R_{ser\_geotech14x73a} := 1032 \cdot kip$

## DRIVEN 1.2

### GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON1489.DVN
Project Name: Monmouth  Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

### PILE INFORMATION

Pile Type: H Pile - HP14X89
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

### ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

### ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 47.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

### DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.73 Kips | 0.75 Kips |
| 9.01 ft | 10.25 Kips | 0.73 Kips | 10.99 Kips |
| 18.01 ft | 26.05 Kips | 0.73 Kips | 26.78 Kips |
| 27.01 ft | 48.42 Kips | 0.73 Kips | 49.16 Kips |
| 36.01 ft | 64.56 Kips | 0.73 Kips | 65.29 Kips |
| 42.99 ft | 77.07 Kips | 0.73 Kips | 77.81 Kips |
| 43.01 ft | 77.11 Kips | 1.06 Kips | 78.17 Kips |
| 52.01 ft | 90.48 Kips | 1.06 Kips | 91.54 Kips |
| 61.01 ft | 112.34 Kips | 1.06 Kips | 113.40 Kips |
| 70.01 ft | 144.28 Kips | 1.06 Kips | 145.34 Kips |
| 79.01 ft | 166.67 Kips | 1.06 Kips | 167.73 Kips |
| 82.99 ft | 176.57 Kips | 1.06 Kips | 177.63 Kips |
| 83.01 ft | 176.75 Kips | 27.48 Kips | 204.22 Kips |
| 92.01 ft | 321.35 Kips | 27.48 Kips | 348.83 Kips |
| 101.01 ft | 481.59 Kips | 27.48 Kips | 509.07 Kips |
| 110.01 ft | 657.47 Kips | 27.48 Kips | 684.94 Kips |
| 119.01 ft | 848.98 Kips | 27.48 Kips | 876.46 Kips |
| 128.01 ft | 1056.14 Kips | 27.48 Kips | 1083.61 Kips |
| 129.99 ft | 1103.81 Kips | 27.48 Kips | 1131.29 Kips |

Cohesionless

**20 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay14x89a} := 176.75 \cdot kip \cdot \phi_{sideinclay}$  $R_{sideinclay14x89a} = 62 \cdot kip$

Side Friction in sand: $R_{sideinsand14x89a} := (1103.81 \cdot kip - 176.75 \cdot kip) \cdot \phi_{sideinsand}$  $R_{sideinsand14x89a} = 417 \cdot kip$

End Bearing: $R_{endbearing14x89a} := 27.48 \cdot kip \cdot \phi_{endbearinginsand}$  $R_{endbearing14x89a} = 12 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech14x89a} := R_{sideinclay14x89a} + R_{sideinsand14x89a} + R_{endbearing14x89a}$

Service Limit State: $R_{ser\_geotech14x89a} := 1131 \cdot kip$  $R_{str\_geotech14x89a} = 491 \cdot kip$

## DRIVEN 1.2

### GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\MON14117.DVN
Project Name: Monmouth — Project Date: 11/02/2009
Project Client: Jock Stream Bridge
Computed By: km
Project Manager: JWentworth

### PILE INFORMATION

Pile Type: H Pile - HP14X117
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

### ULTIMATE CONSIDERATIONS

| | | |
|---|---|---|
| Water Table Depth At Time Of: | - Drilling: | 9.00 ft |
| | - Driving/Restrike | 9.00 ft |
| | - Ultimate: | 9.00 ft |
| Ultimate Considerations: | - Local Scour: | 0.00 ft |
| | - Long Term Scour: | 0.00 ft |
| | - Soft Soil: | 106.00 ft |

### ULTIMATE PROFILE

| Layer | Type | Thickness | Driving Loss | Unit Weight | Strength | Ultimate Curve |
|---|---|---|---|---|---|---|
| 1 | Cohesive | 43.00 ft | 0.00% | 115.00 pcf | 450.00 psf | T-80 Clay |
| 2 | Cohesive | 40.00 ft | 0.00% | 115.00 pcf | 650.00 psf | T-80 Clay |
| 3 | Cohesionless | 47.00 ft | 0.00% | 125.00 pcf | 36.0/36.0 | Nordlund |

### DRIVING - SUMMARY OF CAPACITIES

| Depth | Skin Friction | End Bearing | Total Capacity |
|---|---|---|---|
| 0.01 ft | 0.01 Kips | 0.97 Kips | 0.98 Kips |
| 9.01 ft | 10.46 Kips | 0.97 Kips | 11.43 Kips |
| 18.01 ft | 26.34 Kips | 0.97 Kips | 27.31 Kips |
| 27.01 ft | 49.39 Kips | 0.97 Kips | 50.36 Kips |
| 36.01 ft | 65.85 Kips | 0.97 Kips | 66.82 Kips |
| 42.99 ft | 78.61 Kips | 0.97 Kips | 79.58 Kips |
| 43.01 ft | 78.65 Kips | 1.40 Kips | 80.04 Kips |
| 52.01 ft | 92.29 Kips | 1.40 Kips | 93.68 Kips |
| 61.01 ft | 114.24 Kips | 1.40 Kips | 115.64 Kips |
| 70.01 ft | 147.16 Kips | 1.40 Kips | 148.56 Kips |
| 79.01 ft | 170.00 Kips | 1.40 Kips | 171.40 Kips |
| 82.99 ft | 180.10 Kips | 1.40 Kips | 181.49 Kips |
| 83.01 ft | 180.30 Kips | 36.22 Kips | 216.51 Kips |
| 92.01 ft | 346.62 Kips | 36.22 Kips | 382.84 Kips |
| 101.01 ft | 530.94 Kips | 36.22 Kips | 567.15 Kips |
| 110.01 ft | 733.24 Kips | 36.22 Kips | 769.46 Kips |
| 119.01 ft | 953.53 Kips | 36.22 Kips | 989.74 Kips |
| 128.01 ft | ~~1191.80 Kips~~ | 36.22 Kips | 1228.02 Kips |
| 129.99 ft | 1246.64 Kips | 36.22 Kips | 1282.85 Kips |

Cohesionless

**20 foot penetration into glacial till**

Strength Limit State:

Side Friction in silt and clay: $R_{sideinclay14x117a} := 180.3 \cdot kip \cdot \phi_{sideinclay}$ $\quad R_{sideinclay14x117a} = 63 \cdot kip$

Side Friction in sand: $R_{sideinsand14x117a} := (1246.64 \cdot kip - 180.3 \cdot kip) \cdot \phi_{sideinsand}$ $\quad R_{sideinsand14x117a} = 480 \cdot kip$

End Bearing: $R_{endbearing14x117a} := 36.22 \cdot kip \cdot \phi_{endbearinginsand}$ $\quad R_{endbearing14x117a} = 16 \cdot kip$

Total Geotechnical Capacity: $R_{str\_geotech14x117a} := R_{sideinclay14x117a} + R_{sideinsand14x117a} + R_{endbearing14x117a}$

$$R_{str\_geotech14x117a} = 559 \cdot kip$$

Service Limit State: $R_{ser\_geotech14x117a} := 1283 \cdot kip$

# STRENGTH LIMIT STATE:

**Factored** Geotechnical Resistance at Strength Limit State:

Nominal Geotechnical Resistance, Rstr_geotech:

**10 foot penetration into glacial till**

$$R_{str\_geotech\_10} := \begin{pmatrix} 264 \\ 308 \\ 352 \\ 387 \\ 439 \end{pmatrix} \cdot kip$$

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

**20 foot penetration into glacial till**

$$R_{str\_geotech\_20} := \begin{pmatrix} 333 \\ 390 \\ 447 \\ 491 \\ 559 \end{pmatrix} \cdot kip$$

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

# SERVICE/EXTREME LIMIT STATES:

**Factored** Geotechnical Resistance at the Service/Extreme Limit States:

Resistance Factors for Service and Extreme Limit States $\phi = 1.0$ LRFD 10.5.5.1 and 10.5.8.3

$$\phi := 1.0$$

**10 foot penetration into glacial till**

$$R_{servext\_geotech\_10} := \begin{pmatrix} 619 \\ 717 \\ 822 \\ 898 \\ 1015 \end{pmatrix} \cdot kip$$

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

**20 foot penetration into glacial till**

$$R_{servext\_geotech\_20} := \begin{pmatrix} 772 \\ 901 \\ 1032 \\ 1131 \\ 1283 \end{pmatrix} \cdot kip$$

**HP 12 x 53**
**HP 12 x 74**
**HP 14 x 73**
**HP 14 x 89**
**HP 14 x 117**

## DRIVABILITY ANALYSIS

Ref: LRFD Article 10.7.8

For steel piles in compression or tension
$\sigma_{dr} = 0.9 \times \phi_{da} \times f_y$ (eq. 10.7.8-1)

$f_y := 50 \cdot ksi$ yield strength of steel

$\phi_{da} := 1.0$ resistance factor from LRFD Table 10.5.5.2.3-1
Pile Drivability Analysis, Steel piles

$\sigma_{dr} := 0.9 \cdot \phi_{da} \cdot f_y$ $\sigma_{dr} = 45 \cdot ksi$ driving stresses in pile cannot exceed 45 ksi

**Compute Resistance that can be achieved in a drivability analysis:**

The resistance that must be achieved in a drivability analysis will be the maximum applied pile axial load (must be less than the the factored geotechnical resistance from above as this governs) divided by the appropriate resistance factor for wave equation analysis and dynamic test which will be required for construction.

Table 10.5.5.2.3-1 pg 10-38 gives resistance factor for dynamic test, $\phi_{dyn}$:

$\phi_{dyn} := 0.65$

Table 10.5.5.2.3-3 requires no less than 3 to 4 piles dynamically tested for a site with low to medium site variability. There will probably only be 4 to 5 piles total at each abutment. Only 1 or 2 piles will be tested - one per abutment will be requested. Therefore, reduce the $\phi$ by 20%

$\phi_{dyn.reduced} := 0.65 \cdot 0.8$ $\phi_{dyn.reduced} = 0.52$

# Pile Size = 12 x 53

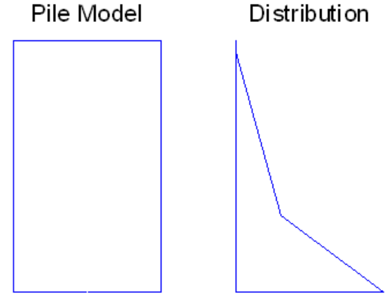
**Assume Contractor will use a Delmag D 36-32 hammer to install 12 x 53 piles**

State of Maine Dept. Of Transportation — 02-Nov-2009
Monmouth Jock Stream Drivability 12x53 — GRLWEAP (TM) Version 2003

| Ultimate Capacity kips | Maximum Compression Stress ksi | Maximum Tension Stress ksi | Blow Count blows/in | Stroke feet | Energy kips-ft |
|---|---|---|---|---|---|
| 645.0 | 37.02 | 3.86 | 14.0 | 7.82 | 50.65 |
| 646.0 | 37.03 | 3.87 | 14.6 | 7.83 | 50.56 |
| 647.0 | 37.07 | 3.88 | 14.8 | 7.82 | 50.63 |
| 648.0 | 37.08 | 3.88 | 15.4 | 7.83 | 50.54 |
| 649.0 | 37.13 | 3.89 | 15.2 | 7.84 | 50.74 |
| 650.0 | 37.13 | 3.89 | 16.3 | 7.83 | 50.52 |
| 651.0 | 37.18 | 3.90 | 16.1 | 7.84 | 50.70 |
| 652.0 | 37.20 | 3.91 | 16.8 | 7.85 | 50.64 |
| 653.0 | 37.23 | 3.92 | 17.1 | 7.84 | 50.69 |
| 654.0 | 37.25 | 3.92 | 17.8 | 7.85 | 50.63 |

DELMAG D 36-32

| | | |
|---|---|---|
| Efficiency | 0.800 | |
| Helmet | 3.20 | kips |
| Hammer Cushion | 109975 | kips/in |
| Skin Quake | 0.100 | in |
| Toe Quake | 0.100 | in |
| Skin Damping | 0.050 | sec/ft |
| Toe Damping | 0.150 | sec/ft |
| Pile Length | 115.00 | ft |
| Pile Penetration | 110.00 | ft |
| Pile Top Area | 15.50 | in2 |




Res. Shaft = 90 %
(Proportional)

Limit blow count to 15 blows per inch

Strength Limit State:

$R_{dr\_12x53\_factored} := 647 \cdot kip \cdot \phi_{dyn.reduced}$

$R_{dr\_12x53\_factored} = 336 \cdot kip$

Service and Extreme Limit States: $\phi := 1.0$

$R_{dr\_12x53\_servext} := 647 \cdot kip$

# Pile Size = 12 x 74

**Assume Contractor will use a Delmag D 36-32 hammer to install 12 x 74 piles**

State of Maine Dept. Of Transportation — 02-Nov-2009
Monmouth Jock Sttream Drivability 12x74 — GRLWEAP (TM) Version 2003

| Ultimate Capacity kips | Maximum Compression Stress ksi | Maximum Tension Stress ksi | Blow Count blows/in | Stroke feet | Energy kips-ft |
|---|---|---|---|---|---|
| 770.0 | 33.48 | 2.94 | 14.4 | 7.84 | 45.70 |
| 771.0 | 33.46 | 2.94 | 14.7 | 7.84 | 45.67 |
| 772.0 | 33.50 | 2.94 | 15.0 | 7.84 | 45.65 |
| 773.0 | 33.56 | 2.94 | 14.7 | 7.85 | 45.84 |
| 774.0 | 33.56 | 2.94 | 15.1 | 7.85 | 45.80 |
| 775.0 | 33.53 | 2.94 | 15.4 | 7.86 | 45.76 |
| 776.0 | 33.55 | 2.94 | 15.7 | 7.86 | 45.74 |
| 777.0 | 33.60 | 2.94 | 15.4 | 7.86 | 45.94 |
| 778.0 | 33.58 | 2.94 | 16.0 | 7.88 | 45.83 |
| 779.0 | 33.66 | 2.94 | 15.7 | 7.88 | 46.03 |

Limit blow count to 15 blows per inch

Strength Limit State:

$R_{dr\_12x74\_factored} := 772 \cdot kip \cdot \phi_{dyn.reduced}$

$R_{dr\_12x74\_factored} = 401 \cdot kip$

Service and Extreme Limit States: $\phi := 1.0$

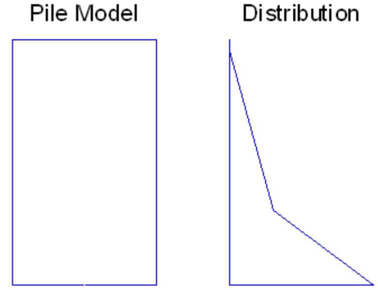
$R_{dr\_12x74\_servext} := 772 \cdot kip$

DELMAG D 36-32

| | | |
|---|---|---|
| Efficiency | 0.800 | |
| Helmet | 3.20 | kips |
| Hammer Cushion | 109975 | kips/in |
| Skin Quake | 0.100 | in |
| Toe Quake | 0.100 | in |
| Skin Damping | 0.050 | sec/ft |
| Toe Damping | 0.150 | sec/ft |
| Pile Length | 115.00 | ft |
| Pile Penetration | 110.00 | ft |
| Pile Top Area | 21.80 | in2 |

Pile Model

Skin Friction Distribution



Res. Shaft = 90 %
(Proportional)

# Pile Size = 14 x 73

**Assume Contractor will use a Delmag D 46-32 hammer to install 14 x 73 piles**

State of Maine Dept. Of Transportation — 02-Nov-2009
Monmouth Jock Stream Drivability 14x73 — GRLWEAP (TM) Version 2003

| Ultimate Capacity kips | Maximum Compression Stress ksi | Maximum Tension Stress ksi | Blow Count blows/in | Stroke feet | Energy kips-ft |
|---|---|---|---|---|---|
| 915.0 | 38.79 | 2.07 | 14.2 | 8.91 | 66.73 |
| 916.0 | 38.75 | 2.05 | 14.6 | 8.91 | 66.62 |
| 917.0 | 38.79 | 2.04 | 14.9 | 8.92 | 66.53 |
| 918.0 | 38.84 | 2.07 | 14.6 | 8.92 | 66.84 |
| 919.0 | 38.78 | 2.06 | 15.1 | 8.91 | 66.66 |
| 920.0 | 38.76 | 2.05 | 15.4 | 8.91 | 66.60 |
| 921.0 | 38.79 | 2.04 | 15.8 | 8.92 | 66.52 |
| 922.0 | 38.83 | 2.06 | 15.5 | 8.93 | 66.75 |
| 923.0 | 38.82 | 2.05 | 16.0 | 8.93 | 66.66 |
| 924.0 | 38.88 | 2.08 | 15.6 | 8.94 | 66.93 |

Limit blow count to 15 blows per inch

Strength Limit State:

$R_{dr\_14x73\_factored} := 917 \cdot kip \cdot \phi_{dyn.reduced}$

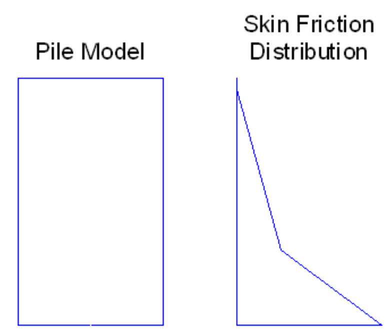
$R_{dr\_14x73\_factored} = 477 \cdot kip$

Service and Extreme Limit States: $\phi := 1.0$

$R_{dr\_14x73\_servext} := 917 \cdot kip$

DELMAG D 46-32

| | | |
|---|---|---|
| Efficiency | 0.800 | |
| Helmet | 3.20 | kips |
| Hammer Cushion | 109975 | kips/in |
| Skin Quake | 0.100 | in |
| Toe Quake | 0.100 | in |
| Skin Damping | 0.050 | sec/ft |
| Toe Damping | 0.150 | sec/ft |
| Pile Length | 115.00 | ft |
| Pile Penetration | 110.00 | ft |
| Pile Top Area | 21.40 | in2 |




Res. Shaft = 90 %
(Proportional)

# Pile Size = 14 x 89

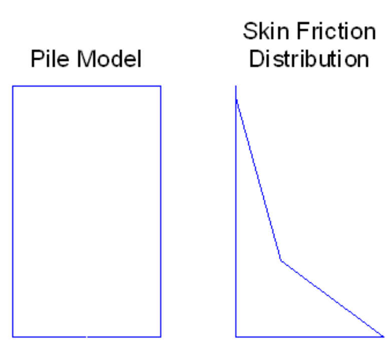
**Assume Contractor will use a Delmag D 46-32 hammer to install 14 x 89 piles**

State of Maine Dept. Of Transportation — 02-Nov-2009
Monmouth Jock Stream Drivability 14x89 — GRLWEAP (TM) Version 2003

| Ultimate Capacity kips | Maximum Compression Stress ksi | Maximum Tension Stress ksi | Blow Count blows/in | Stroke feet | Energy kips-ft |
|---|---|---|---|---|---|
| 1030.0 | 37.69 | 2.25 | 14.1 | 9.02 | 63.60 |
| 1031.0 | 37.70 | 2.26 | 14.3 | 9.03 | 63.56 |
| 1032.0 | 37.72 | 2.26 | 14.1 | 9.04 | 63.80 |
| 1033.0 | 37.72 | 2.27 | 14.2 | 9.04 | 63.79 |
| 1034.0 | 37.74 | 2.27 | 14.4 | 9.04 | 63.73 |
| 1035.0 | 37.75 | 2.28 | 14.6 | 9.04 | 63.69 |
| 1036.0 | 37.75 | 2.28 | 14.8 | 9.05 | 63.66 |
| 1037.0 | 37.70 | 2.29 | 15.0 | 9.03 | 63.51 |
| 1038.0 | 37.74 | 2.28 | 14.8 | 9.04 | 63.80 |
| 1039.0 | 37.74 | 2.29 | 15.1 | 9.04 | 63.71 |

DELMAG D 46-32

| | | |
|---|---|---|
| Efficiency | 0.800 | |
| Helmet | 3.20 | kips |
| Hammer Cushion | 109975 | kips/in |
| Skin Quake | 0.100 | in |
| Toe Quake | 0.100 | in |
| Skin Damping | 0.050 | sec/ft |
| Toe Damping | 0.150 | sec/ft |
| Pile Length | 115.00 | ft |
| Pile Penetration | 110.00 | ft |
| Pile Top Area | 26.10 | in2 |




Res. Shaft = 90 %
(Proportional)

Limit blow count to 15 blows per inch

Strength Limit State:

$R_{dr\_14x89\_factored} := 1037 \cdot kip \cdot \phi_{dyn.reduced}$

$R_{dr\_14x89\_factored} = 539 \cdot kip$

Service and Extreme Limit States: $\phi := 1.0$

$R_{dr\_14x89\_servext} := 1037 \cdot kip$

# Pile Size = 14 x 117

**Assume Contractor will use a Delmag D 46-32 hammer to install 14 x 117 piles**

State of Maine Dept. Of Transportation — 02-Nov-2009
Monmouth Jock Stream Drivability 14x117 — GRLWEAP (TM) Version 2003

| Ultimate Capacity kips | Maximum Compression Stress ksi | Maximum Tension Stress ksi | Blow Count blows/in | Stroke feet | Energy kips-ft |
|---|---|---|---|---|---|
| 1240.0 | 36.28 | 2.71 | 14.5 | 9.24 | 60.03 |
| 1241.0 | 36.30 | 2.70 | 14.6 | 9.24 | 59.99 |
| 1242.0 | 36.30 | 2.69 | 14.8 | 9.24 | 59.93 |
| 1243.0 | 36.31 | 2.68 | 14.9 | 9.25 | 59.88 |
| 1244.0 | 36.32 | 2.67 | 15.0 | 9.25 | 59.86 |
| 1245.0 | 36.36 | 2.70 | 14.7 | 9.25 | 60.16 |
| 1246.0 | 36.36 | 2.70 | 14.8 | 9.25 | 60.16 |
| 1247.0 | 36.36 | 2.68 | 15.0 | 9.26 | 60.10 |
| 1248.0 | 36.36 | 2.68 | 15.1 | 9.26 | 60.08 |
| 1249.0 | 36.36 | 2.67 | 15.2 | 9.26 | 60.04 |

Limit driving stress to 45 ksi

Strength Limit State:

$R_{dr\_14x117\_factored} := 1247 \cdot kip \cdot \phi_{dyn.reduced}$

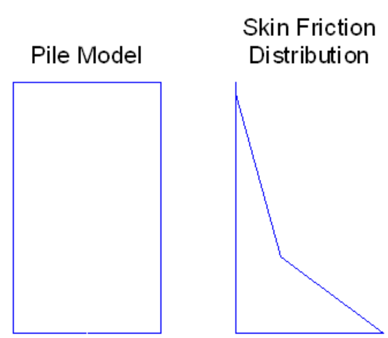
$R_{dr\_14x117\_factored} = 648 \cdot kip$

Service and Extreme Limit States: $\phi := 1.0$

$R_{dr\_14x117\_servext} := 1247 \cdot kip$

DELMAG D 46-32

| | | |
|---|---|---|
| Efficiency | 0.800 | |
| Helmet | 3.20 | kips |
| Hammer Cushion | 109975 | kips/in |
| Skin Quake | 0.100 | in |
| Toe Quake | 0.100 | in |
| Skin Damping | 0.050 | sec/ft |
| Toe Damping | 0.150 | sec/ft |
| Pile Length | 115.00 | ft |
| Pile Penetration | 110.00 | ft |
| Pile Top Area | 34.40 | in2 |




Res. Shaft = 90 %
(Proportional)

## Abutment and Wingwall Passive and Active Earth Pressure:

For cases where interface friction is considered (for gravity structures) use Coulomb Theory

Coulomb Theory - Passive Earth Pressure from Maine DOT Bridge Design Guide
Section 3.6.6 pg 3-8

Angle of back face of wall to the horizontal: $\alpha := 90 \cdot deg$

Angle of internal soil friction: $\phi := 32 \cdot deg$

Friction angle between fill and wall:
From LRFD Table 3.11.5.3-1 range from 17 to 22 $\delta := 20 \cdot deg$

Angle of backfill to the horizontal $\beta := 0 \cdot deg$

$$K_p := \frac{\sin(\alpha - \phi)^2}{\sin(\alpha)^2 \cdot \sin(\alpha + \delta) \cdot \left(1 - \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi + \beta)}{\sin(\alpha + \delta) \cdot \sin(\alpha + \beta)}}\right)^2}$$

$K_p = 6.89$

Rankine Theory - Passive Earth Pressure from Bowles 5th Edition Section 11-5 pg 602

Angle of backfill to the horizontal $\beta := 0 \cdot deg$

Angle of internal soil friction: $\phi := 32 \cdot deg$

$$K_{p\_rank} := \frac{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}$$

$K_{p\_rank} = 3.25$

Bowles does not recommend the use of the Rankine Method for $K_p$ when $\beta>0$.

Rankine Theory - Active Earth Pressure from Maine DOT Bridge Design Guide Section 3.6.5.2 pg 3-7

For a horizontal backfill surface:

$\phi := 32 \cdot deg$

$$K_a := \tan\left(45 \cdot deg - \frac{\phi}{2}\right)^2$$

$K_a = 0.307$

## Settlement Analyses:

Reference: FHWA Soils and Foundations Reference Manual - Volume 1 (FHWA NHI-06-088) Hough pg 7-16

The roadway grade at centerline may be raised by as much as 0.5 feet .
Look at a simplified soil profile based on BB-MJS-101:

Finished Grade

Proposed Fill - Look at 0.5 feet of fill
N = 25 bpf (medium dense)
$\gamma$ = 125 pcf

Existing Grade

Existing Fill/Native sand - fine to coarse sand

$H_1 := 9.0 \cdot ft$ $\gamma_{sand} := 125 \cdot pcf$ $N_{sand1} := 10$

Groundwater at top of silt

$\gamma_w := 62.4pcf$

Silt - Su=450 psf (soft)
Total Layer height: H = 43.0 ft - divide into 5 layers

$H_2 := 43.0 \cdot ft$

$H_{2silt1} := 7.0 \cdot ft$ $\gamma_{silt} := 115 \cdot pcf$ $N_{silt1} := 9$

$H_{2silt2} := 9.0 \cdot ft$ $N_{silt2} := 1$

$H_{2silt3} := 9.0 \cdot ft$ $N_{silt3} := 1$

$H_{2silt4} := 9.0 \cdot ft$ $N_{silt4} := 1$

$H_{2silt5} := 9.0 \cdot ft$ $N_{silt5} := 1$

Clayey Silt - Su=650 psf (medium stiff)
Total Layer height: H = 40.0 ft - divide into 4 layers

$H_3 := 40.0 \cdot ft$

$H_{3claysilt1} := 10.0 \cdot ft$ $\gamma_{claysilt} := 115 \cdot pcf$ $C_{c\_claysilt1} := 0.3514$ $C_{r\_claysilt1} := 0.04$ $e_{oclaysilt1} := 1.0$

$H_{3claysilt2} := 10.0 \cdot ft$ $C_{c\_claysilt2} := 0.3514$ $C_{r\_claysilt2} := 0.04$ $e_{oclaysilt2} := 1.0$

$H_{3claysilt3} := 10.0 \cdot ft$ $C_{c\_claysilt3} := 0.3174$ $C_{r\_claysilt3} := 0.0463$ $e_{oclaysilt3} := 0.94$

$H_{3claysilt4} := 10.0 \cdot ft$ $C_{c\_claysilt4} := 0.3043$ $C_{r\_claysilt4} := 0.0374$ $e_{oclaysilt4} := 1.13$

Glacial Till - Sand - fine sand, medium dense

$H_4 := 40.0 \cdot ft$ $\gamma_{sand} := 125 \cdot pcf$ $N_{sand2} := 15$

LOADING ON AN INFINITE STRIP - VERTICAL EMBANKMENT LOADING

Project Name: Jock Stream Bridge    Client: Monmouth
Project Number: 16716.00    Project Manager: Wentworth
Date: 10/22/09    Computed by: km

Embank. slope a = 10.00(ft)
Embank. width b = 27.00(ft)
p load/unit area = 62.50(psf)

INCREMENT OF STRESSES FOR Z-DIRECTION

X = 20.00(ft)

| Z (ft) | Vert. Δz (psf) |
|---|---|
| 0.50 | 62.49 |
| 4.50 | 59.79 |
| 8.50 | 52.74 |
| 12.50 | 45.49 |
| 16.50 | 39.35 |
| 20.50 | 34.36 |
| 24.50 | 30.32 |
| 28.50 | 27.03 |
| 32.50 | 24.33 |
| 36.50 | 22.07 |
| 40.50 | 20.18 |
| 44.50 | 18.57 |
| 48.50 | 17.18 |
| 52.50 | 15.98 |
| 56.50 | 14.93 |
| 60.50 | 14.01 |
| 64.50 | 13.19 |
| 68.50 | 12.46 |
| 72.50 | 11.80 |
| 76.50 | 11.21 |
| 80.50 | 10.67 |
| 84.50 | 10.18 |
| 88.50 | 9.74 |
| 92.50 | 9.33 |
| 96.50 | 8.95 |
| 100.50 | 8.61 |
| 104.50 | 8.28 |
| 108.50 | 7.98 |
| 112.50 | 7.71 |

at 4.5 ft

$\Delta\sigma_{zsand1} := 59.79 \cdot psf$

at 12.5 ft

$\Delta\sigma_{zsilt1} := 45.49 \cdot psf$

at 20.5 ft

$\Delta\sigma_{zsilt2} := 34.36 \cdot psf$

at 29.5 ft

$\Delta\sigma_{zsilt3} := 26.31 \cdot psf$

at 38.5 ft

$\Delta\sigma_{zsilt4} := 21.09 \cdot psf$

at 47.5 ft

$\Delta\sigma_{zsilt5} := 17.51 \cdot psf$

at 57.0 ft

$\Delta\sigma_{zclaysilt1} := 14.81 \cdot psf$

at 67.0 ft

$\Delta\sigma_{zclaysilt2} := 12.72 \cdot psf$

at 77.0 ft

$\Delta\sigma_{zclaysilt3} := 11.14 \cdot psf$

at 87.0 ft

$\Delta\sigma_{zclaysilt4} := 9.90 \cdot psf$

at 112.0 ft

$\Delta\sigma_{zsand2} := 7.74 \cdot psf$

**Existing Fill/Sand**

$tsf := psf \cdot 1000$

Determine corrected N-value normalized for overburden $N1_{60}$:

Calculate vertical stress: $\sigma_{sand1o} := \frac{H_1}{2} \cdot (\gamma_{sand})$ $\sigma_{sand1o} = 0.563 \cdot tsf$ at mid-point

Corrected SPT $N_{60}$-value (bpf) $N_{sand1} = 10$

At $P_o$ = 0.563 tsf $C_{Nsand1} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{sand1o}}\right)$ Eq. 10.4.6.2.4 LRFD

$C_{Nsand1} = 1.426$

Corrected N-value normalized for overburden $N1_{60}$: $N1_{60} := C_{Nsand1} \cdot N_{sand1}$ $N1_{60} = 14$
From Eq 3-3 pg 3-36

From Figure 7-7 pg 7-17 using the "clean well graded fine to coarse sand" curve

Bearing Capacity Index: $C1 := 57$

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$\Delta\sigma_{zsand1} = 59.79 \cdot psf$

**Silt - 5 layers**

Silt Layer 1:

Determine corrected N-value normalized for overburden $N1_{60}$:

Calculate vertical stress: $\sigma_{silt1o} := \left[\frac{H_{2silt1}}{2} \cdot (\gamma_{silt} - \gamma_w)\right] + H_1 \cdot (\gamma_{sand})$ $\sigma_{silt1o} = 1.3091 \cdot tsf$ at mid-point

Corrected SPT $N_{60}$-value (bpf) $N_{silt1} = 9$

At $P_o$ = 1.3 tsf $C_{Nsilt1} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{silt1o}}\right)$ Eq. 10.4.6.2.4 LRFD

$C_{Nsilt1} = 1.1435$

Corrected N-value normalized for overburden $N1_{60}$: $N1_{60} := C_{Nsilt1} \cdot N_{silt1}$ $N1_{60} = 10$
From Eq 3-3 pg 3-36

From Figure 7-7 pg 7-17 using the "Inorganic silt" curve

Bearing Capacity Index: $C2_{silt1} := 29$

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$\Delta\sigma_{zsilt1} = 45.49 \cdot psf$

Silt Layer 2:

Determine corrected N-value normalized for overburden $N1_{60}$:

Calculate vertical stress:

$$\sigma_{silt2o} := \left[\frac{H_{2silt2}}{2}\cdot\left(\gamma_{silt}-\gamma_{w}\right)\right] + H_{2silt1}\cdot\left(\gamma_{silt}-\gamma_{w}\right) + H_{1}\cdot\left(\gamma_{sand}\right) \qquad \sigma_{silt2o} = 1.7299\cdot\text{tsf}$$

at mid-point

Corrected SPT $N_{60}$-value (bpf) $\quad N_{silt2} = 1$

At $P_o$ = 1.7 tsf

$$C_{Nsilt2} := 0.77\cdot\log\left(\frac{40\cdot\text{ksf}}{\sigma_{silt2o}}\right)$$

Eq. 10.4.6.2.4 LRFD

$C_{Nsilt2} = 1.0503$

Corrected N-value normalized for overburden $N1_{60}$: $\quad N1_{60} := C_{Nsilt2}\cdot N_{silt2} \qquad N1_{60} = 1$
From Eq 3-3 pg 3-36

From Figure 7-7 pg 7-17 using the "Inorganic silt" curve

Bearing Capacity Index: $\quad C2_{silt2} := 17$

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zsilt2} = 34.36\cdot\text{psf}$$

Silt Layer 3:

Determine corrected N-value normalized for overburden $N1_{60}$:

Calculate vertical stress:

$$\sigma_{silt3o} := \left[\frac{H_{2silt3}}{2}\cdot\left(\gamma_{silt}-\gamma_{w}\right)\right] + \left(H_{2silt2}+H_{2silt1}\right)\cdot\left(\gamma_{silt}-\gamma_{w}\right) + H_{1}\cdot\left(\gamma_{sand}\right) \qquad \sigma_{silt3o} = 2.2033\cdot\text{tsf}$$

at mid-point

Corrected SPT $N_{60}$-value (bpf) $\quad N_{silt3} = 1$

At $P_o$ = 2.2 tsf

$$C_{Nsilt3} := 0.77\cdot\log\left(\frac{40\cdot\text{ksf}}{\sigma_{silt3o}}\right)$$

Eq. 10.4.6.2.4 LRFD

$C_{Nsilt3} = 0.9694$

Corrected N-value normalized for overburden $N1_{60}$: $\quad N1_{60} := C_{Nsilt3}\cdot N_{silt3} \qquad N1_{60} = 1$
From Eq 3-3 pg 3-36

From Figure 7-7 pg 7-17 using the "Inorganic silt" curve

Bearing Capacity Index: $\quad C2_{silt3} := 15$

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zsilt3} = 26.31\cdot\text{psf}$$

Silt Layer 4:

Determine corrected N-value normalized for overburden $N1_{60}$:

Calculate vertical stress:

$$\sigma_{silt4o} := \left[\frac{H_{2silt4}}{2}\cdot(\gamma_{silt}-\gamma_w)\right]+(H_{2silt3}+H_{2silt2}+H_{2silt1})\cdot(\gamma_{silt}-\gamma_w)+H_1\cdot(\gamma_{sand}) \qquad \sigma_{silt4o} = 2.6767\cdot tsf$$

at mid-point

Corrected SPT $N_{60}$-value (bpf) $\quad N_{silt4} = 1$

At $P_o$ = 2.7 tsf

$$C_{Nsilt4} := 0.77\cdot\log\left(\frac{40\cdot ksf}{\sigma_{silt4o}}\right)$$

Eq. 10.4.6.2.4 LRFD

$$C_{Nsilt4} = 0.9043$$

Corrected N-value normalized for overburden $N1_{60}$: $\quad N1_{60} := C_{Nsilt4}\cdot N_{silt4} \qquad N1_{60} = 1$
From Eq 3-3 pg 3-36

From Figure 7-7 pg 7-17 using the "Inorganic silt" curve

Bearing Capacity Index: $\quad C2_{silt4} := 15$

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zsilt4} = 21.09\cdot psf$$

Silt Layer 5:

Determine corrected N-value normalized for overburden $N1_{60}$:

Calculate vertical stress:

$$\sigma_{silt5o} := \left[\frac{H_{2silt5}}{2}\cdot(\gamma_{silt}-\gamma_w)\right]+(H_{2silt4}+H_{2silt3}+H_{2silt2}+H_{2silt1})\cdot(\gamma_{silt}-\gamma_w)+H_1\cdot(\gamma_{sand}) \qquad \sigma_{silt5o} = 3.1501\cdot tsf$$

at mid-point

Corrected SPT $N_{60}$-value (bpf) $\quad N_{silt5} = 1$

At $P_o$ = 3.2 tsf

$$C_{Nsilt5} := 0.77\cdot\log\left(\frac{40\cdot ksf}{\sigma_{silt5o}}\right)$$

Eq. 10.4.6.2.4 LRFD

$$C_{Nsilt5} = 0.8499$$

Corrected N-value normalized for overburden $N1_{60}$: $\quad N1_{60} := C_{Nsilt5}\cdot N_{silt5} \qquad N1_{60} = 1$
From Eq 3-3 pg 3-36

From Figure 7-7 pg 7-17 using the "Inorganic silt" curve

Bearing Capacity Index: $\quad C2_{silt5} := 15$

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zsilt5} = 17.51\cdot psf$$

**Clayey Silt - 4 layers**

Clayey Silt Layer 1:

Average values from lab data: $e_{oclaysilt1} = 1$ $C_{r\_claysilt1} = 0.04$

$$\sigma_{claysilt1o} := \frac{H_{3claysilt1}}{2} \cdot \left(\gamma_{claysilt} - \gamma_w\right) + H_2 \cdot \left(\gamma_{silt} - \gamma_w\right) + H_1 \cdot \left(\gamma_{sand}\right) \qquad \sigma_{claysilt1o} = 3.65 \cdot tsf$$ at mid-point

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zclaysilt1} = 14.81 \cdot psf$$

Clayey Silt Layer 2:

Average values from lab data: $e_{oclaysilt2} = 1$ $C_{r\_claysilt2} = 0.04$

$$\sigma_{claysilt2o} := \frac{H_{3claysilt2}}{2} \cdot \left(\gamma_{claysilt} - \gamma_w\right) + H_{3claysilt1} \cdot \left(\gamma_{claysilt} - \gamma_w\right) + H_2 \cdot \left(\gamma_{silt} - \gamma_w\right) + H_1 \cdot \left(\gamma_{sand}\right)$$

$\sigma_{claysilt2o} = 4.18 \cdot tsf$ at mid-point

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zclaysilt2} = 12.72 \cdot psf$$

Clayey Silt Layer 3:

Average values from lab data: $e_{oclaysilt3} = 0.94$ $C_{r\_claysilt3} = 0.0463$

$$\sigma_{claysilt3o} := \frac{H_{3claysilt3}}{2} \cdot \left(\gamma_{claysilt} - \gamma_w\right) + \left(H_{3claysilt2} + H_{3claysilt1}\right) \cdot \left(\gamma_{claysilt} - \gamma_w\right) + H_2 \cdot \left(\gamma_{silt} - \gamma_w\right) + H_1 \cdot \left(\gamma_{sand}\right)$$

$\sigma_{claysilt3o} = 4.7 \cdot tsf$ at mid-point

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zclaysilt3} = 11.14 \cdot psf$$

Clayey Silt Layer 4:

Average values from lab data: $e_{oclaysilt4} = 1.13$ $C_{r\_claysilt4} = 0.0374$

$$\sigma_{claysilt4o} := \frac{H_{3claysilt4}}{2} \cdot \left(\gamma_{claysilt} - \gamma_w\right) + \left(H_{3claysilt3} + H_{3claysilt2} + H_{3claysilt1}\right) \cdot \left(\gamma_{claysilt} - \gamma_w\right) + H_2 \cdot \left(\gamma_{silt} - \gamma_w\right) + H_1 \cdot \left(\gamma_{sand}\right)$$

$\sigma_{claysilt4o} = 5.23 \cdot tsf$ at mid-point

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zclaysilt4} = 9.9 \cdot psf$$

**Glacial Till - Sand**

Determine corrected N-value normalized for overburden $N1_{60}$:

Calculate vertical stress:

$$\sigma_{sand2o} := \frac{H_4}{2}\left(\gamma_{sand} - \gamma_w\right) + H_3 \cdot \left(\gamma_{claysilt} - \gamma_w\right) + H_2 \cdot \left(\gamma_{silt} - \gamma_w\right) + H_1 \cdot \left(\gamma_{sand}\right) \qquad \sigma_{sand2o} = 6.7428 \cdot tsf$$

at mid-point

Corrected SPT $N_{60}$-value (bpf) $N_{sand2} = 15$

AT $P_o$ = 6.7 tsf $C_{Nsand2} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{sand2o}}\right)$ Eq. 10.4.6.2.4 LRFD

$C_{Nsand2} = 0.5954$

Corrected N-value normalized for overburden $N1_{60}$:

From Eq 3-3 pg 3-36 $N1_{60} := C_{Nsand2} \cdot N_{sand2}$ $N1_{60} = 9$

From Figure 7-7 pg 7-17 using the "clean well graded fine to coarse sand" curve

Bearing Capacity Index: $C4_{sand2} := 47$

Use STRESS to determine the change in stress at the mid point of the layer under consideration (above)

$$\Delta\sigma_{zsand2} = 7.74 \cdot psf$$

**Calculate Settlement:**

Fill/Sand: $\Delta H_1 := H_1 \cdot \frac{1}{C1} \cdot \log\left(\frac{\sigma_{sand1o} + \Delta\sigma_{zsand1}}{\sigma_{sand1o}}\right)$ $\Delta H_1 = 0.0831 \cdot in$

Silt Layer 1: $\Delta H_{2silt1} := H_{2silt1} \cdot \frac{1}{C2_{silt1}} \cdot \log\left(\frac{\sigma_{silt1o} + \Delta\sigma_{zsilt1}}{\sigma_{silt1o}}\right)$ $\Delta H_{2silt1} = 0.043 \cdot in$

Silt Layer 2: $\Delta H_{2silt2} := H_{2silt2} \cdot \frac{1}{C2_{silt2}} \cdot \log\left(\frac{\sigma_{silt2o} + \Delta\sigma_{zsilt2}}{\sigma_{silt2o}}\right)$ $\Delta H_{2silt2} = 0.0543 \cdot in$

Silt Layer 3: $\Delta H_{2silt3} := H_{2silt3} \cdot \frac{1}{C2_{silt3}} \cdot \log\left(\frac{\sigma_{silt3o} + \Delta\sigma_{zsilt3}}{\sigma_{silt3o}}\right)$ $\Delta H_{2silt3} = 0.0371 \cdot in$

Silt Layer 4: $\Delta H_{2silt4} := H_{2silt4} \cdot \frac{1}{C2_{silt4}} \cdot \log\left(\frac{\sigma_{silt4o} + \Delta\sigma_{zsilt4}}{\sigma_{silt4o}}\right)$ $\Delta H_{2silt4} = 0.0245 \cdot in$

Silt Layer 5: $\Delta H_{2silt5} := H_{2silt5} \cdot \frac{1}{C2_{silt5}} \cdot \log\left(\frac{\sigma_{silt5o} + \Delta\sigma_{zsilt5}}{\sigma_{silt5o}}\right)$ $\Delta H_{2silt5} = 0.0173 \cdot in$

Clayey Silt Layer 1: $\Delta H_{3cs1} := H_{3claysilt1} \cdot \left(\frac{C_{r\_claysilt1}}{1 + e_{oclaysilt1}}\right) \cdot \log\left(\frac{\sigma_{claysilt1o} + \Delta\sigma_{zclaysilt1}}{\sigma_{claysilt1o}}\right)$ $\Delta H_{3cs1} = 0.0042 \cdot in$

Clayey Silt Layer 2: $\Delta H_{3cs2} := H_{3claysilt2} \cdot \left(\frac{C_{r\_claysilt2}}{1 + e_{oclaysilt2}}\right) \cdot \log\left(\frac{\sigma_{claysilt2o} + \Delta\sigma_{zclaysilt2}}{\sigma_{claysilt2o}}\right)$ $\Delta H_{3cs2} = 0.0032 \cdot in$

Clayey Silt Layer 3: $\Delta H_{3cs3} := H_{3claysilt3} \cdot \left(\frac{C_{r\_claysilt3}}{1 + e_{oclaysilt3}}\right) \cdot \log\left(\frac{\sigma_{claysilt3o} + \Delta\sigma_{zclaysilt3}}{\sigma_{claysilt3o}}\right)$ $\Delta H_{3cs3} = 0.0029 \cdot in$

Clayey Silt Layer 4: $\Delta H_{3cs4} := H_{3claysilt4} \cdot \left(\frac{C_{r\_claysilt4}}{1 + e_{oclaysilt4}}\right) \cdot \log\left(\frac{\sigma_{claysilt4o} + \Delta\sigma_{zclaysilt4}}{\sigma_{claysilt4o}}\right)$ $\Delta H_{3cs4} = 0.0017 \cdot in$

Glacial Till - Sand: $\Delta H_4 := H_4 \cdot \frac{1}{C4_{sand2}} \cdot \log\left(\frac{\sigma_{sand2o} + \Delta\sigma_{zsand2}}{\sigma_{sand2o}}\right)$ $\Delta H_4 = 0.0051 \cdot in$

Total Settlement =

$$\Delta H_T := \Delta H_1 + \Delta H_{2silt1} + \Delta H_{2silt2} + \Delta H_{2silt3} + \Delta H_{2silt4} + \Delta H_{2silt5} + \Delta H_{3cs1} + \Delta H_{3cs2} + \Delta H_{3cs3} + \Delta H_{3cs4} + \Delta H_4$$

$\Delta H_T = 0.2765 \cdot in$

6 inches of fill results in settlements of less than 0.4 inches
Therefore, downdrag will not be an issue.

# Frost Protection:

***Method 1 - MaineDOT Design Freezing Index (DFI) Map and Depth of Frost Penetration Table are in BDG Section 5.2.1.***

From the Design Freezing Index Map:
Monmouth, Maine
DFI = 1550 degree-days

From the lab testing: the upper fill soils are coarse grained have a water content = ~14%

From Table 5-1 MaineDOT BDG for Design Freezing Index of 1550 at wc = 14% frost penetration = 77.7 inches

$$\text{Frost\_depth} := 77.7\text{in} \qquad \text{Frost\_depth} = 6.475 \cdot \text{ft}$$

**Method 2 - Check Frost Depth using Modberg Software**

Closest Station is Gardiner

--- ModBerg Results ---

Project Location: Gardiner, Maine

| | |
|---|---|
| Air Design Freezing Index | = 1489 F-days |
| N-Factor | = 0.80 |
| Surface Design Freezing Index | = 1191 F-days |
| Mean Annual Temperature | = 44.1 deg F |
| Design Length of Freezing Season | = 128 days |

| Layer #:Type | t | w% | d | Cf | Cu | Kf | Ku | L |
|---|---|---|---|---|---|---|---|---|
| 1-Coarse | 75.9 | 14.0 | 125.0 | 30 | 39 | 2.8 | 1.8 | 2,520 |

t = Layer thickness, in inches.
w% = Moisture content, in percentage of dry density.
d = Dry density, in lbs/cubic ft.
Cf = Heat Capacity of frozen phase, in BTU/(cubic ft degree F).
Cu = Heat Capacity of thawed phase, in BTU/(cubic ft degree F).
Kf = Thermal conductivity in frozen phase, in BTU/(ft hr degree).
Ku = Thermal conductivity in thawed phase, in BTU/(ft hr degree).
L = Latent heat of fusion, in BTU / cubic ft.

Total Depth of Frost Penetration = 6.33 ft = 75.9 in.

Use Modberg Frost Depth = 6.0 feet for design

**Seismic:**

Monmouth Jock Stream Bridge PIN 16716.00
Date and Time: 10/20/2009 11:03:08 AM

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
AASHTO Spectrum for 7% PE in 75 years
State - Maine
Zip Code - 04259
Zip Code Latitude = 44.221800
Zip Code Longitude = -070.016600
Site Class B
Data are based on a 0.05 deg grid spacing.

| Period (sec) | Sa (g) | |
|---|---|---|
| 0.0 | 0.084 | PGA - Site Class B |
| 0.2 | 0.170 | Ss - Site Class B |
| 1.0 | 0.046 | S1 - Site Class B |

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
Spectral Response Accelerations SDs and SD1
State - Maine
Zip Code - 04259
Zip Code Latitude = 44.221800
Zip Code Longitude = -070.016600
As = FpgaPGA, SDs = FaSs, and SD1 = FvS1
Site Class E - Fpga = 2.50, Fa = 2.50, Fv = 3.50
Data are based on a 0.05 deg grid spacing.

| Period (sec) | Sa (g) | |
|---|---|---|
| 0.0 | 0.209 | As - Site Class E |
| 0.2 | 0.425 | SDs - Site Class E |
| 1.0 | 0.162 | SD1 - Site Class E |

**Seismic Design Parameters for**
**2007 AASHTO Seismic Design Guidelines**

**Purpose** - The ground motion parameters obtained in this analysis are for use with the design procedures described in AASHTO Guidelines for the Seismic Design of Highway Bridges (2007) The user may calculate seismic design parameters and response spectra (both for period and displacement), for Site Class A through E.

**Description** - This program allows the user to obtain seismic design parameters for sites in the 50 states of the United States, Puerto Rico and the U.S. Virgin Islands. In most cases the user may perform an analysis for a site by specifying location by either latitude-longitude (recommended) or zip code. However, locations in Puerto and the Virgin Islands may only be specified by latitude-longitude.

Ground motion maps are included in PDF format. These maps may be opened using a map viewer that is part of the software package.

**Data** - The 2007 AASHTO maps are based on 5% in 50 year probabilistic data from the U.S. Geological Survey data sets for the following regions: 48 conterminous states (2002), Alaska (2006), Hawaii (1998), Puerto Rico and the Virgin Islands (2003). These were the most recent data available at the time of preparation of the AASHTO maps. The AASHTO maps are labelled with a probability of exceedance of 7% in 75 years which is approximately equal to the 5% in 50 year data.

**Disclaimer** - Correct application of the data obtained from the use of this program and/or maps is the responsibility of the user. This software is not a substitute for technical knowledge of seismic design and/or analysis.