

**MAINE DEPARTMENT OF TRANSPORTATION  
HIGHWAY/BRIDGE PROGRAM  
GEOTECHNICAL SECTION  
AUGUSTA, MAINE**

**GEOTECHNICAL DESIGN REPORT**

*For the Replacement of:*

**LOGGIN ROAD STRUT  
OVER MEADOW BROOK  
FRANKFORT, MAINE**

*Prepared by:*  
Kalia Breskin, P.E.  
Senior Geotechnical Engineer



Waldo County

WIN 17532.00

Soils Report No. 2012-131

August 30, 2012

## GEOTECHNICAL DESIGN SUMMARY

The purpose of this report is to present subsurface information and make geotechnical recommendations for the replacement of a box culvert which carries Meadow Brook under Loggin Road, 1.95 miles west of the intersection of Route 1 in Frankfort. Loggin Road is a Priority 4 Highway Corridor. The proposed replacement structure will be an 8-foot high by 12-foot wide prefabricated concrete box with one foot of soil placed in the bottom. The structure will be 60 feet wide with 11-foot lanes and 5-feet from edge of travelled way to the face of guardrail.

**Native Soils** – The native soils surrounding this culvert are clay-silt and clay soils with low shear strength and high water contents. These soils have low bearing resistance and high sensitivity. Although the streambed is approximately ten-feet below the road surface, granular soils extend to a depth of only six-feet below the roadway at Station 15+15, 9-feet Left. A 4-inch thick layer of wood fibers was encountered at elevation 144 in this boring, and the wood may be the remains of an earlier structure at this location. Subsurface explorations in two borings were extended to depths of 22-feet and 25-feet and terminated in soft clay.

**Box Culvert Design and Construction** – The concrete box culvert will be supplier-designed as specified in Special Provision 534, Precast Structural Concrete Arches, Box Culverts, by either the LFD or LRFD method. The loading specified for the structure shall be MS-22.5 (HS-25) for LFD method or modified HL-93 Strength I for the LRFD method, in which the HS-20 design truck wheel loads are increased by a factor of 1.25.

The culvert will be constructed in general conformance with the MaineDOT Bridge Design Guide (BDG) Section 8, Buried Structures, and Special Provision 534. A copy of the Special Provision is attached to this report. The designer may assume Soil Type 4 (BDG Table 3-3) for backfill soil properties. Backfill properties are as follows:  $\phi = 32^\circ$ ,  $\gamma = 125$  pcf.

The box culvert will be bedded on a one-foot thick layer of  $\frac{3}{4}$  inch crushed stone wrapped in a geotextile fabric. The culvert soil envelope backfill shall consist of Standard Specification 703.19, Granular Borrow, Material for Underwater Backfill with a maximum particle size of 4 inches. Backfill shall be placed in lifts 6 to 8 inches thick and compacted to manufacturer's specifications. In no case shall the backfill soil be compacted less than 92% of AASHTO T-180 maximum dry density.

**Culvert Headwalls** – Soil slopes will be built above the box culvert. We recommend the use of integral concrete headwalls to prevent gravel and fill soils from sliding or eroding from these slopes into the stream. These headwalls need not be larger than a nominal 1-foot by 1-foot dimension. No wingwalls will be used, but 1.5H:1v riprap slopes will wrap around to match existing side slopes.

**Box Culvert Bearing Resistance** – For this project, the strength limit state controls bearing resistance. A factored bearing resistance of 2.9 ksf shall be used for this project.

**Settlement** – The new box culvert will replace two existing pipes with a single structure having a larger opening. As long as bearing resistance requirements are met, only minor settlements during construction are anticipated.

**Scour and Riprap** – Inlet and outlet seepage cutoff walls below the culvert inverts should be provided for scour protection. These cutoff walls should extend below the anticipated depth of scour, or to a depth of at least two foot below the structure inverts. Sideslopes should be armored with a 3-foot thick layer of plain riprap adjacent to the culvert openings. The toe of the riprap section shall be constructed 1 foot below the streambed elevation. The riprap section shall be underlain by a 1 foot thick layer of bedding material conforming to item number 703.19 of the Standard Specification and Class “1” Erosion Control Geotextile.

**Seismic Design Considerations** – Seismic analysis is not required for single span bridges regardless of seismic zone. However, superstructure connections and minimum support lengths should be designed in accordance with LRFD requirements.

**Construction Considerations** – The native soils are sensitive, with water contents higher than the liquid limit at a depth of 15-feet. These soils will be easily disturbed by construction traffic. Over-excavation into these lower soils should be minimized. Any soils that become disturbed by construction activities should be removed to the depth of disturbance and replaced with granular material. Soils should be protected from surface water and any groundwater infiltration should be controlled to permit construction in-the-dry.

## **Attachments**

### **Sheets**

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Sheet 1 - Location Map

Sheet 2 - Boring Location Plan and Interpretive Subsurface Profile

Sheet 3 – Boring Logs

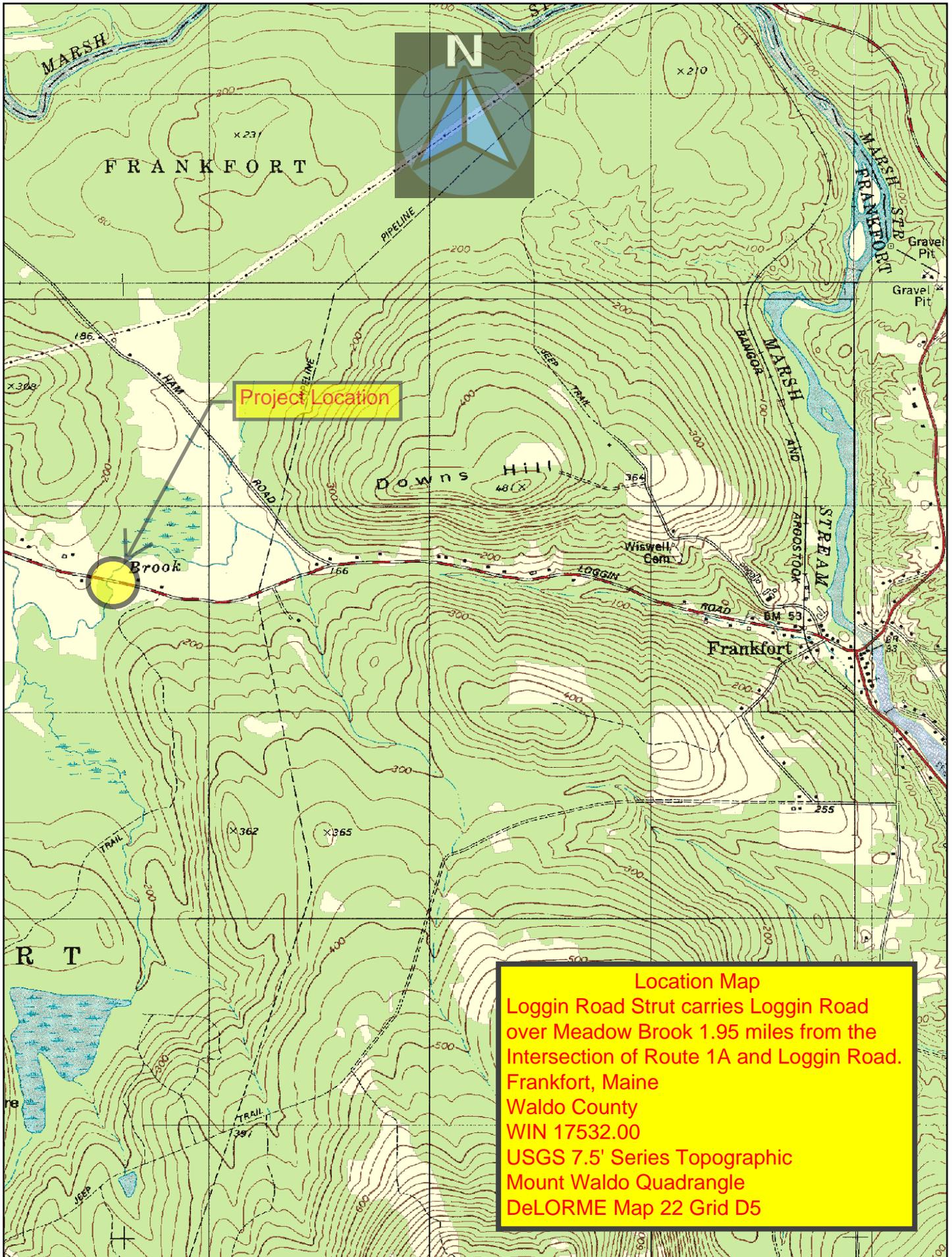
### **Appendices**

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Appendix A - Boring Logs

Appendix B - Laboratory Data

Appendix C - Calculations

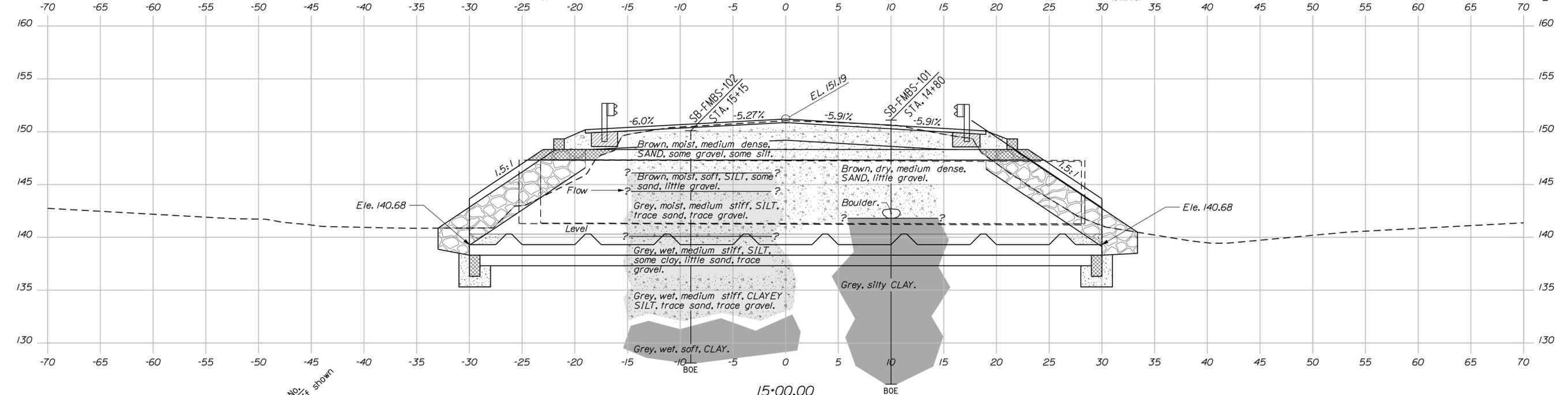
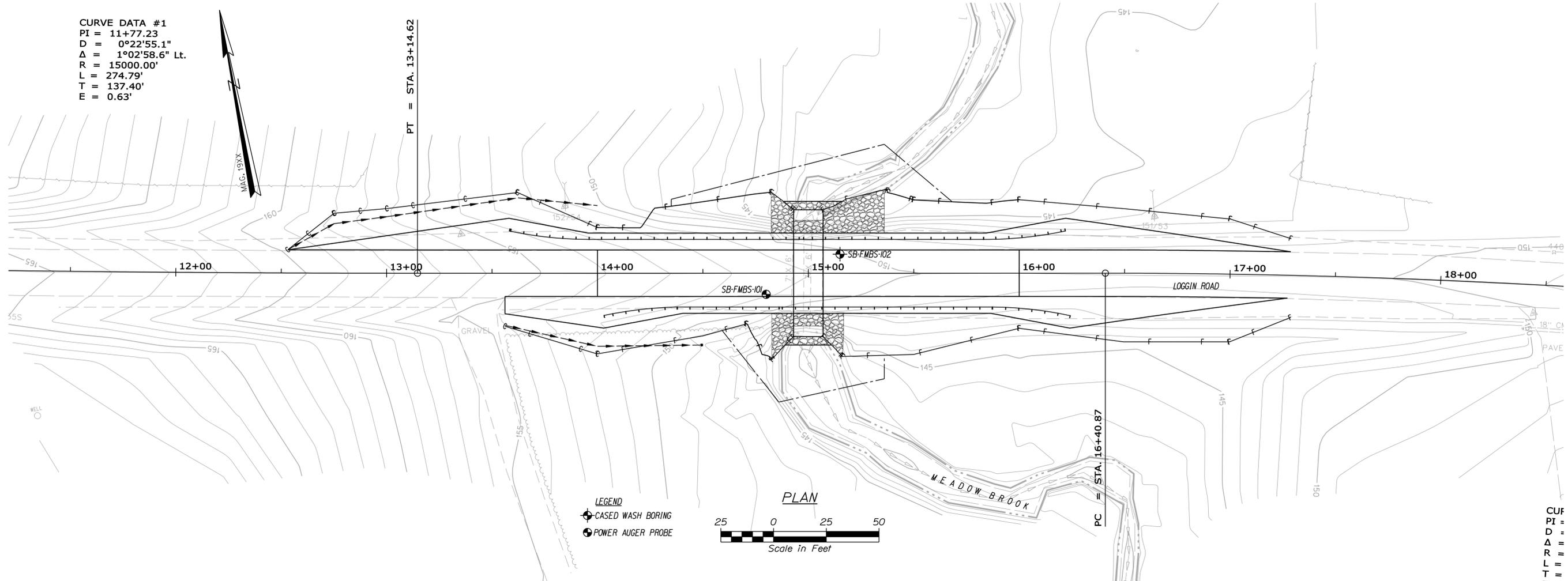


Map Scale 1:24000

The Maine Department of Transportation provides this publication for information only. Reliance upon this information is at user risk. It is subject to revision and may be incomplete depending upon changing conditions. The Department assumes no liability if injuries or damages result from this information. This map is not intended to support emergency dispatch. Road names used on this map may not match official road names.

Filename: ... \GEOTECH\MSTA\001\_BLP&ISCS1.dgn Division: GEOTECH Username: kity.breskin Date: 8/16/2012

**CURVE DATA #1**  
 PI = 11+77.23  
 D = 0°22'55.1"  
 Δ = 1°02'58.6" Lt.  
 R = 15000.00'  
 L = 274.79'  
 T = 137.40'  
 E = 0.63'



**LEGEND**

Boring No.  
 Offset, if shown  
 Pavement Thickness if applicable  
 Strata Interface  
 RQD= Rock Quality Designation for Rock Core Sample  
 BOE= Bottom Of Exploration  
 No Refusal

Note: This generalized interpretive soil cross section 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	
017532.00		WIN	
017532.00		HIGHWAY PLANS	
PROJ. MANAGER	BY	DATE	SIGNATURE
DESIGN-DETAILED	R. BARROWS	AUG. 2012	T. WHITE
CHECKED-REVIEWED	K. BRESKIN		
DESIGN DETAILED	K. BRESKIN		
DESIGN DETAILED			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			
FRANKFORT		LOGGIN ROAD STRUT	
BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE CROSS SECTION			
SHEET NUMBER		DATE	
2			
OF 3			

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Loggin Rd. Strut carries Loggin Rd. over Meadow Brook Location: Frankfort, Maine				Boring No.: SB-FMBS-102 WIN: 17532.00																	
Driller: MainDOT		Elevation (ft.): 150.1		Auger ID/OD: 4.25-6.25 HSA		Sampler: Standard Split Spoon		Operator: Giguere/Giles		Datum: NAVD88		Logged By: K. Breskin		Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"		Date Start/Finish: 6/6/12: 08:00-		Drilling Method: Cased Wash Boring		Core Barrel: N/A		Water Level#: None Observed	
Boring Location: 15+15, 9.0 ft Lt.				Casing ID/OD: HW				Definitions: D = Split Spoon Sample M = Unsuccessful Split Spoon Sample attempt B = Thin Wall Tube Sample H = Rock Core Sample V = In Situ Vane Shear Test SSA = Solid Stem Auger				Definitions: S <sub>v</sub> = In Situ Field Vane Shear Strength (psf) T <sub>v</sub> = Pocket Torque Shear Strength (psf) q <sub>c</sub> = Uncorrected Compressive Strength (psf) S <sub>u</sub> (lab) = Lab Vane Shear Strength (psf) W <sub>h</sub> = weight of 140lb. hammer W <sub>h</sub> = weight of rods, W <sub>h</sub> = weight of casing				Definitions: WC = water content, percent LL = Liquid Limit PL = Plasticity Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test									
Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows 1/6 in. Strength per 100 (13)	N-value	Casing Blows	Elevation (ft.)	Stratigraphic Log	Visual Description and Remarks	Laboratory Testing Results/ASHTO and Unified Class															
0							150.00	6" PAVEMENT.	Brown, moist medium dense SAND, some gravel, some silt.																
10	24/12	1.00 - 3.00	9/11/10/9	21			49.10																		
5	20/AC	5.00 - 7.00	1/12/10/6	22			44.35	20/A (5.0-5.5 ft bgs) Brown, moist, soft, SILT, some sand, little gravel. 20/B (5.5-9.75 ft bgs) 4 inches of wood fiber. 20/C (5.75-7.0 ft bgs) Grey, moist, medium stiff, SILT, trace sand, trace gravel.		GW15845 A=4, M <sub>h</sub> WC=16.35 GW15846 A=4, M <sub>h</sub> WC=25.8%															
10	30/AB M1	10.00 - 12.00 10.00	3/3/2/2 Could not turn	5			40.10	30/A (10.0-11.25 ft bgs) Grey, wet, medium stiff, SILT, some clay, little sand, trace gravel. Failed 55x110 mm vane attempt 30/B (11.25-12.0 ft bgs) 3" organic layer at 11.25 ft bgs.		GW15847 A=4, CL-M <sub>h</sub> WC=21.1 LL=23 PI=19 FI=4															
15	40 V1 V2	15.00 - 17.00 15.63 16.63	WDR/WDR/WDR Su=280/134 psf					Grey, wet, medium stiff, CLAY, trace sand, trace gravel. 55x110 mm vane raw torque readings: V1: 13.0/3.0 ft-lbs V2: 10.0/3.0 ft-lbs		GW15848 A=6, CL WC=33.7% LL=31 PL=20 PI=11															
20	50 V3 V4	20.00 - 22.00 20.00 21.00	WDR/WDR/WDR Su=302/82 psf					Grey, wet, soft, Clayey SILT, trace sand, trace gravel. 55x110 mm vane raw torque readings: V3: 11.0/3.0 ft-lbs V4: 10.0/3.0 ft-lbs																	
22.00							28.10	Bottom of Exploration at 22.00 feet below ground surface.																	

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.

Page 1 of 1  
Boring No.: SB-FMBS-102

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Loggin Rd. Strut carries Loggin Rd. over Meadow Brook Location: Frankfort, Maine				Boring No.: SB-FMBS-101 WIN: 17532.00																	
Driller: MainDOT		Elevation (ft.): 151.1		Auger ID/OD: 5" Dia.		Sampler: Visual		Operator: Giguere/Giles		Datum: NAVD88		Logged By: E. Giguere		Rig Type: CME 45C		Hammer Wt./Fall: N/A		Date Start/Finish: 6/6/12: 07:00-08:00		Drilling Method: Solid Stem Auger		Core Barrel: N/A		Water Level#: None Observed	
Boring Location: 14+80, 10.0 ft Rt.				Casing ID/OD: N/A				Definitions: D = Split Spoon Sample M = Unsuccessful Split Spoon Sample attempt B = Thin Wall Tube Sample H = Rock Core Sample V = In Situ Vane Shear Test SSA = Solid Stem Auger				Definitions: S <sub>v</sub> = In Situ Field Vane Shear Strength (psf) T <sub>v</sub> = Pocket Torque Shear Strength (psf) q <sub>c</sub> = Uncorrected Compressive Strength (psf) S <sub>u</sub> (lab) = Lab Vane Shear Strength (psf) W <sub>h</sub> = weight of 140lb. hammer W <sub>h</sub> = weight of rods, W <sub>h</sub> = weight of casing				Definitions: WC = water content, percent LL = Liquid Limit PL = Plasticity Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test									
Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows 1/6 in. Strength per 100 (13)	N-value	Casing Blows	Elevation (ft.)	Stratigraphic Log	Visual Description and Remarks	Laboratory Testing Results/ASHTO and Unified Class															
0							150.60	6" PAVEMENT.	Brown, dry, medium to coarse SAND, little gravel.																
5																									
10							41.80	Boulder from 8.4-9.3 ft bgs. Grey, silty CLAY.																	
15																									
20																									
25							26.10	Bottom of Exploration at 25.00 feet below ground surface. NO REFUSAL																	

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.

Page 1 of 1  
Boring No.: SB-FMBS-101

STATE OF MAINE DEPARTMENT OF TRANSPORTATION		017532.00	
SIGNATURE		P.E. NUMBER	
DATE		DATE	
PROJ. MANAGER	BY	DATE	DATE
DESIGN-DETAILED	R. BARTOWS		
CHECKED-REVIEWED	T. WHITE	AUG. 2012	
DESIGN-DETAILED	K. BRESKIN		
DESIGN-DETAILED			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			
FRANKFORT LOGGIN ROAD STRUT		BORING LOGS	
SHEET NUMBER		HIGHWAY PLANS	
3		017532.00	
OF 3			

Loggin Road Strut  
Meadow Brook  
Frankfort, Maine  
WIN 17532.00

## **Appendix A Boring Logs**

<b>Driller:</b> MaineDOT	<b>Elevation (ft.):</b> 151.1	<b>Auger ID/OD:</b> 5" Dia.
<b>Operator:</b> Giguere/Giles	<b>Datum:</b> NAVD88	<b>Sampler:</b> Visual
<b>Logged By:</b> E. Giguere	<b>Rig Type:</b> CME 45C	<b>Hammer Wt./Fall:</b> N/A
<b>Date Start/Finish:</b> 6/6/12; 07:00-08:00	<b>Drilling Method:</b> Solid Stem Auger	<b>Core Barrel:</b> N/A
<b>Boring Location:</b> 14+80, 10.0 ft Rt.	<b>Casing ID/OD:</b> N/A	<b>Water Level*:</b> None Observed

Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample attempt U = Thin Wall Tube Sample R = Rock Core Sample V = Insitu Vane Shear Test SSA = Solid Stem Auger	Definitions: S <sub>U</sub> = Insitu Field Vane Shear Strength (psf) T <sub>V</sub> = Pocket Torvane Shear Strength (psf) q <sub>p</sub> = Unconfined Compressive Strength (ksf) S <sub>U</sub> (lab) = Lab Vane Shear Strength (psf) WOH = weight of 140lb. hammer WOR = weight of rods	Definitions: WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test
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Sample Information										Visual Description and Remarks	Laboratory Testing Results/AASHTO and Unified Class.
Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows ((6 in.) Shear Strength (psf) or RQD (%))	N-value	Casing Blows	Elevation (ft.)	Graphic Log			
0						SSA	150.60		6" PAVEMENT.	-0.5	
5									Brown, dry, medium to coarse SAND, little gravel.		
10							141.80		Boulder from 8.4-9.3 ft bgs.		
15									Grey, silty CLAY.	-9.3	
20											
25											

**Remarks:**

<b>Driller:</b> MaineDOT	<b>Elevation (ft.):</b> 151.1	<b>Auger ID/OD:</b> 5" Dia.
<b>Operator:</b> Giguere/Giles	<b>Datum:</b> NAVD88	<b>Sampler:</b> Visual
<b>Logged By:</b> E. Giguere	<b>Rig Type:</b> CME 45C	<b>Hammer Wt./Fall:</b> N/A
<b>Date Start/Finish:</b> 6/6/12; 07:00-08:00	<b>Drilling Method:</b> Solid Stem Auger	<b>Core Barrel:</b> N/A
<b>Boring Location:</b> 14+80, 10.0 ft Rt.	<b>Casing ID/OD:</b> N/A	<b>Water Level*:</b> None Observed

Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample attempt U = Thin Wall Tube Sample R = Rock Core Sample V = Insitu Vane Shear Test SSA = Solid Stem Auger	Definitions: S <sub>u</sub> = Insitu Field Vane Shear Strength (psf) T <sub>v</sub> = Pocket Torvane Shear Strength (psf) q <sub>p</sub> = Unconfined Compressive Strength (ksf) S <sub>u</sub> (lab) = Lab Vane Shear Strength (psf) WOH = weight of 140lb. hammer WOR = weight of rods	Definitions: WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test
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Depth (ft.)	Sample Information									Visual Description and Remarks	Laboratory Testing Results/AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows ((6 in.) Shear Strength (psf) or RQD (%))	N-value	Casing Blows	Elevation (ft.)	Graphic Log			
25							126.10			Bottom of Exploration at 25.00 feet below ground surface. Bottom of Exploration at 25.00 feet below ground surface. NO REFUSAL	
30											
35											
40											
45											
50											

**Remarks:**

<b>Driller:</b> MaineDOT	<b>Elevation (ft.):</b> 150.1	<b>Auger ID/OD:</b> 4.25-/6.25 HSA
<b>Operator:</b> Giguere/Giles	<b>Datum:</b> NAVD88	<b>Sampler:</b> Standard Split Spoon
<b>Logged By:</b> K. Breskin	<b>Rig Type:</b> CME 45C	<b>Hammer Wt./Fall:</b> 140#/30"
<b>Date Start/Finish:</b> 6/6/12; 08:00-	<b>Drilling Method:</b> Cased Wash Boring	<b>Core Barrel:</b> N/A
<b>Boring Location:</b> 15+15, 9.0 ft Lt.	<b>Casing ID/OD:</b> HW	<b>Water Level*:</b> None Observed

Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample attempt U = Thin Wall Tube Sample R = Rock Core Sample V = Insitu Vane Shear Test SSA = Solid Stem Auger	Definitions: $S_u$ = Insitu Field Vane Shear Strength (psf) $T_v$ = Pocket Torvane Shear Strength (psf) $q_p$ = Unconfined Compressive Strength (ksf) $S_u(\text{lab})$ = Lab Vane Shear Strength (psf) WOH = weight of 140lb. hammer WOR = weight of rods	Definitions: WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test
---	--	--

Sample Information										Visual Description and Remarks	Laboratory Testing Results/AASHTO and Unified Class.
Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log			
0						HSA	149.10		Brown, moist medium dense SAND, some gravel, some silt.	G#175845 A-4, ML WC=16.3% G#175846 A-4, ML WC=25.8%	
	1D	24/12	1.0 - 3.0	9/11/10/9	21		146.10		2D/A (5.0-5.5 ft bgs) Brown, moist, soft, SILT, some sand, little gravel. 2D/B (5.5-5.75 ft bgs) 4 inches of wood fiber.		
5							144.35		2D/C (5.75-7.0 ft bgs) Grey, moist, medium stiff, SILT, trace sand, trace gravel.	G#175847 A-4, CL-ML WC=21.1 LL=23 PL=19 PI=4	
	2D/AC	24/18	5.0 - 7.0	1/12/10/6	22		140.10		3D/A (10.0-11.25 ft bgs) Grey, wet, medium stiff, SILT, some clay, little sand, trace gravel. Failed 55x110 mm vane attempt 3D/B (11.25-12.0 ft bgs) 3" Organic layer at 11.25 ft bgs.		
10									Grey, wet, medium stiff, CLAY, trace sand, trace gravel. 55x110 mm vane raw torque readings: V1: 13.0/3.0 ft-lbs V2: 10.0/3.0 ft-lbs	G#175848 A-6, CL WC=33.7% LL=31 PL=20 PI=11	
	3D/AB MV	24/24	10.0 - 12.0 10.0 - 10.0	3/3/2/2 Could not turn	5				Grey, wet, soft, Clayey SILT, trace sand, trace gravel. 65x130 mm vane raw torque readings: V3: 11.0/3.0 ft-lbs V4: 10.0/3.0 ft-lbs		
15											
	4D V1 V2	24/24	15.0 - 17.0 15.6 - 16.0 16.6 - 17.0	WOH/WOH/WOH/ WOH Su=580/134 psf Su=446/134 psf	---						
20											
	5D V3 V4	24/24	20.0 - 22.0 20.6 - 21.0 21.6 - 22.0	WOR/WOR/WOR/ WOR Su=302/82 psf Su=275/82 psf	---						
25							128.10		Bottom of Exploration at 22.00 feet below ground surface.		

**Remarks:**

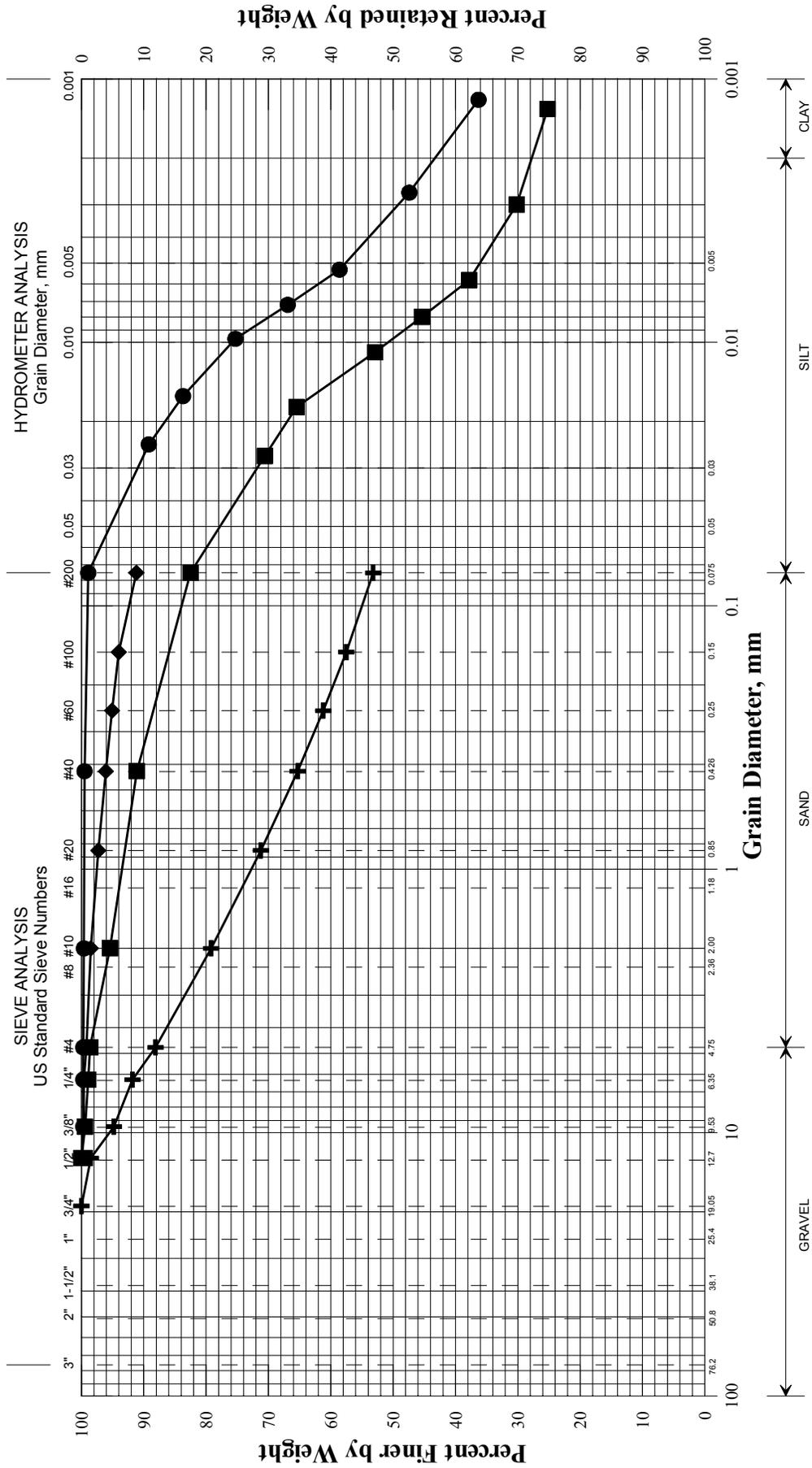
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

Loggin Road Strut  
Meadow Brook  
Frankfort, Maine  
WIN 17532.00

## **Appendix B Laboratory Data**



*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
+	15+15	9.0 LT	5.0-5.5	SILT, some sand, little gravel.	16.3			
◆	15+15	9.0 LT	5.75-7.0	SILT, trace sand, trace gravel.	25.8			
■	15+15	9.0 LT	10.0-11.25	SILT, some clay, little sand, trace gravel.	21.1	23	19	4
●	15+15	9.0 LT	15.0-17.0	Clayey SILT, trace sand, trace gravel.	33.7	31	20	11
▲								
×								

WIN	017532.00
Town	Frankfort
Reported by/Date	WHITE, TERRY A 6/26/2012



# GEOTECHNICAL TEST REPORT

## Central Laboratory

### SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
<b>175845</b>	<b>HB-FRAN-102/2DA</b>	<b><u>GEOTECHNICAL (DISTURBED)</u></b>	6/6/2012	6/6/2012
Sample Type: <b>GEOTECHNICAL</b>		Location: <b>ROADWAY</b>	Station: <b>15+15</b>	Offset, ft: <b>9.0</b>
WIN/Town <b>017532.00 - FRANKFORT</b>		LT Dbfg, ft: <b>5.0-5.5</b>		
				Sampler: <b>WILDER, BRUCE H</b>

### TEST RESULTS

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2" style="text-align: center;">Sieve Analysis (T 27, T 11)</th> </tr> <tr> <td colspan="2" style="text-align: center;">Wash Method</td> </tr> <tr> <td colspan="2" style="text-align: center; color: red;">Procedure A</td> </tr> <tr> <th style="text-align: center;">SIEVE SIZE U.S. [SI]</th> <th style="text-align: center;">% Passing</th> </tr> <tr> <td>3 in. [75.0 mm]</td> <td></td> </tr> <tr> <td>1 in. [25.0 mm]</td> <td></td> </tr> <tr> <td>¾ in. [19.0 mm]</td> <td style="text-align: center;"><b>100.0</b></td> </tr> <tr> <td>½ in. [12.5 mm]</td> <td style="text-align: center;"><b>98.5</b></td> </tr> <tr> <td>⅜ in. [9.5 mm]</td> <td style="text-align: center;"><b>94.8</b></td> </tr> <tr> <td>¼ in. 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Comments:

### AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN**      Date Reported: **6/12/2012**



# GEOTECHNICAL TEST REPORT

## Central Laboratory

### SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
<b>175846</b>	<b>HB-FRAN-102/2DC</b>	<b><u>GEOTECHNICAL (DISTURBED)</u></b>	6/6/2012	6/6/2012
Sample Type: <b>GEOTECHNICAL</b>		Location: <b>ROADWAY</b>	Station: <b>15+15</b>	Offset, ft: <b>9.0</b>
WIN/Town <b>017532.00 - FRANKFORT</b>		LT Dbfg, ft: <b>5.75-7.0</b>		
Sampler: <b>WILDER, BRUCE H</b>				

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### AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN** Date Reported: **6/12/2012**



# GEOTECHNICAL TEST REPORT

## Central Laboratory

### SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
<b>175847</b>	<b>HB-FRAN-102/3DA</b>	<b><u>GEOTECHNICAL (DISTURBED)</u></b>	6/6/2012	6/6/2012
Sample Type: <b>GEOTECHNICAL</b>		Location: <b>ROADWAY</b>	Station: <b>15+15</b>	Offset, ft: <b>9.0</b>
WIN/Town <b>017532.00 - FRANKFORT</b>		LT Dbfg, ft: <b>10.0-11.25</b>		
Sampler: <b>WILDER, BRUCE H</b>				

### TEST RESULTS

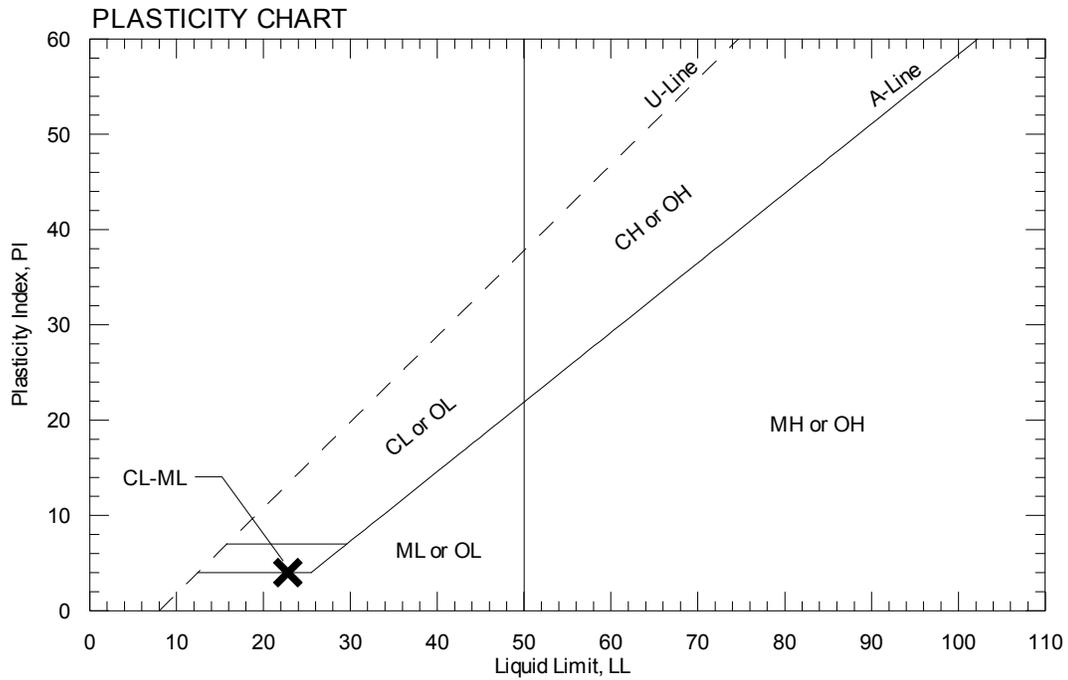
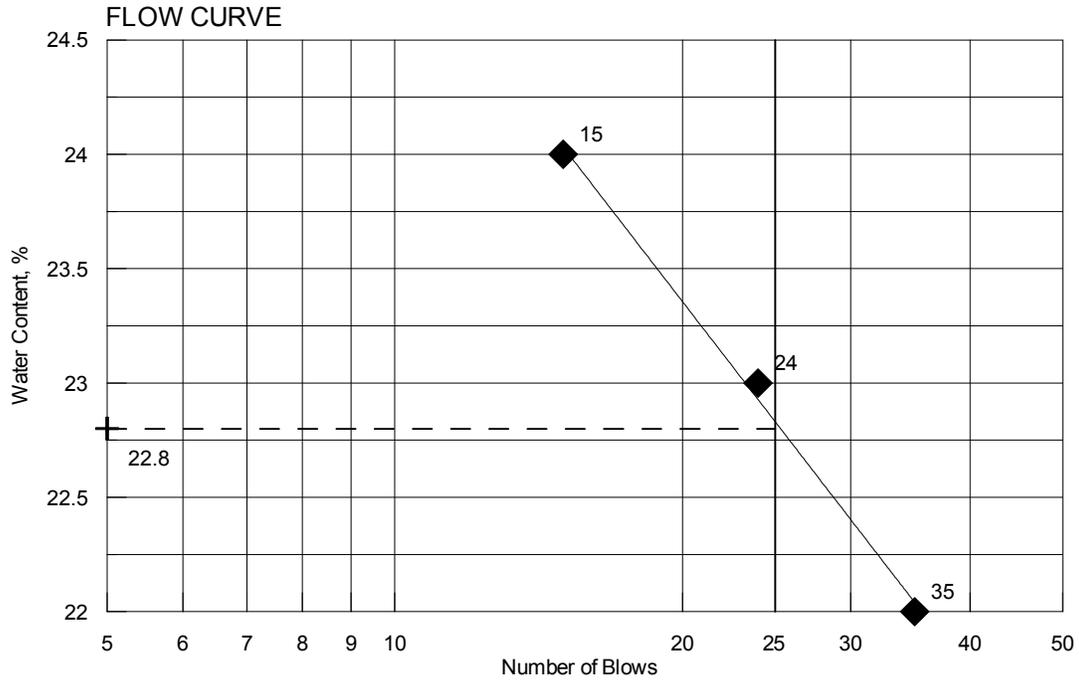
Sieve Analysis (T 88)	Direct Shear (T 236)	Miscellaneous Tests
Wash Method	Shear Angle, °	Liquid Limit @ 25 blows (T 89), %
	Initial Water Content, %	<b>23</b>
SIEVE SIZE U.S. [SI]	Normal Stress, psi	Plastic Limit (T 90), %
% Passing	Wet Density, lbs/ft <sup>3</sup>	<b>19</b>
3 in. [75.0 mm]	Dry Density, lbs/ft <sup>3</sup>	Plasticity Index (T 90), %
1 in. [25.0 mm]	Specimen Thickness, in	<b>4</b>
¾ in. [19.0 mm]		Specific Gravity, Corrected to 20°C (T 100)
½ in. [12.5 mm]		<b>2.67</b>
¼ in. [9.5 mm]		Loss on Ignition (T 267)
⅜ in. [6.3 mm]		Loss, %      H <sub>2</sub> O, %
No. 4 [4.75 mm]		
No. 10 [2.00 mm]		Water Content (T 265), %
No. 20 [0.850 mm]		<b>21.1</b>
No. 40 [0.425 mm]		
No. 60 [0.250 mm]		
No. 100 [0.150 mm]		
No. 200 [0.075 mm]		
[0.0270 mm]		
[0.0176 mm]		
[0.0109 mm]		
[0.0080 mm]		
[0.0058 mm]		
[0.0030 mm]		
[0.0013 mm]		
[ mm]		

Comments:

### AUTHORIZATION AND DISTRIBUTION

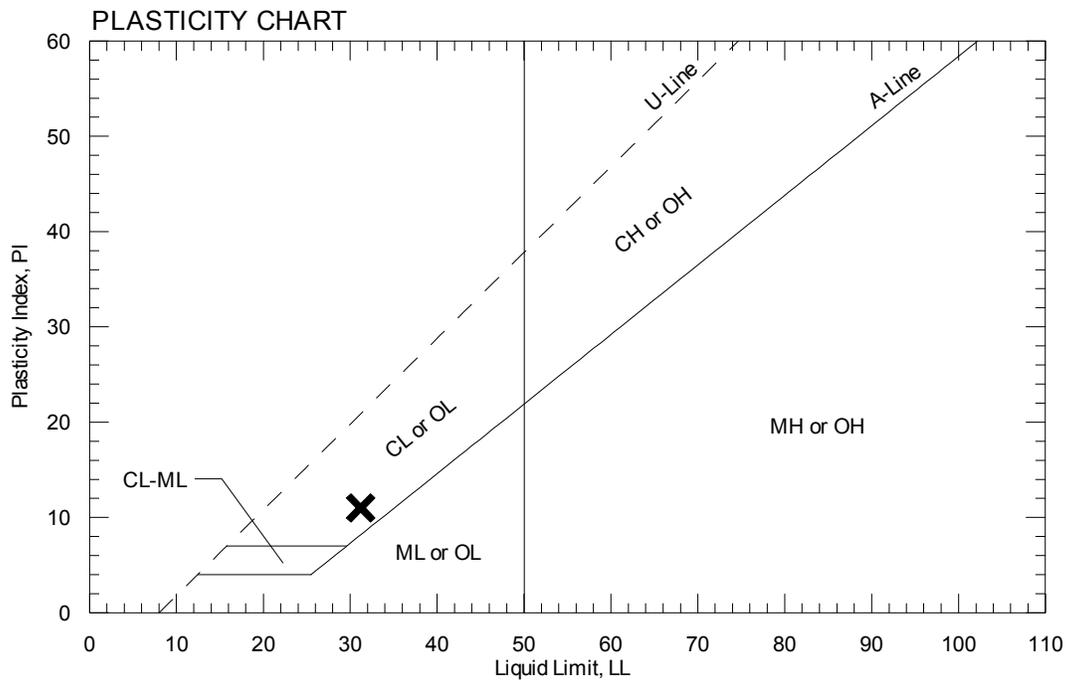
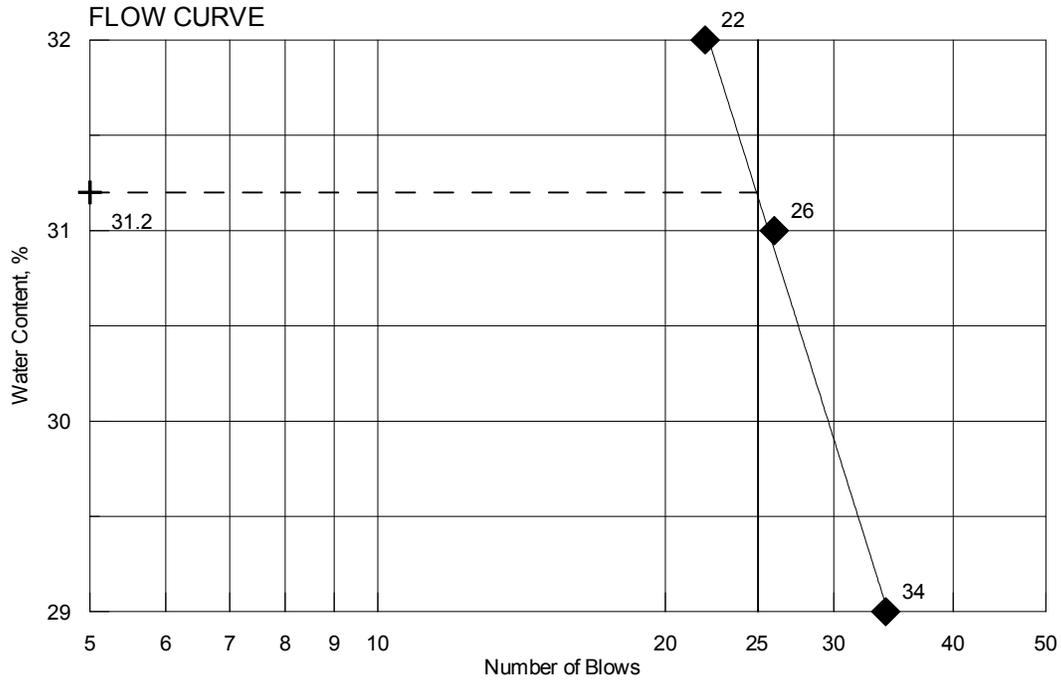
Reported by: **FOGG, BRIAN**      Date Reported: **6/25/2012**

TOWN	Frankfort	Reference No.	175847
WIN	017532.00	Water Content, %	21.1
Sampled	6/6/2012	Liquid Limit @ 25 blows (T 89), %	23
Boring No./Sample No.	HB-FRAN-102/3DA	Plastic Limit (T 90), %	19
Station	15+15	Plasticity Index (T 90), %	4
Depth	10.0-11.25	Tested By	BBURR





TOWN	Frankfort	Reference No.	175848
WIN	017532.00	Water Content, %	33.7
Sampled	6/6/2012	Liquid Limit @ 25 blows (T 89), %	31
Boring No./Sample No.	HB-FRAN-102/4D	Plastic Limit (T 90), %	20
Station	15+15	Plasticity Index (T 90), %	11
Depth	15.0-17.0	Tested By	BBURR



Loggin Road Strut  
Meadow Brook  
Frankfort, Maine  
WIN 17532.00

## **Appendix C Calculations**

## **Headwall Active Earth Pressures:**

Effective active earth pressure coefficient:

Rankine Theory - Active Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.5.2, pg 3-7

$\beta := 0 \cdot \text{deg}$  slope angle of backfill soils from horizontal

$\phi_a := 34 \cdot \text{deg}$  assumed effective friction angle for dense gravelly sand

$$K_a := \tan\left(45 \cdot \text{deg} - \frac{\phi_a}{2}\right)^2 \quad K_a = 0.28$$

## **Service Limit State Bearing Resistance - Native Clay-Silt Soils:**

### **Nominal and factored Bearing Resistance**

### **Presumptive Bearing Resistance for Service Limit State ONLY**

Reference: AASHTO LRFD Bridge Design Specifications 5th Edition  
Table C10.6.2.6.1-1 Presumptive Bearing Resistances for Spread Footings at the Service Limit State Modified after US Department of Navy (1982)

Type of Bearing Material: Clay-Silt (Presumpscot Formation)

Consistency In Place: medium stiff

Bearing Resistance: Ordinary Range (ksf)  
8 - 14 medium dense to dense

Recommended Value of Use: 2 to 6 ksf

**Recommended Value:**

$$4 \cdot \text{ksf} = 2 \cdot \text{tsf}$$

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

*Note: This bearing resistance is settlement limited (1 inch) and applies only a the service limit state.*

## Characteristics of Native Soils at foundation level

Gray-brown, wet, dense gravelly fine SAND (fill)

wc := 0.211      estimated water content

e := 0.8          estimated void ratio

$\gamma_w$  := 62.4pcf      unit weight of water

sp := 2.67        estimated specific gravity

saturation       $sat := \frac{(wc \cdot sp)}{e}$       sat = 0.7042

total unit weight

$$\gamma_t := \frac{(sp + sat \cdot e) \cdot \gamma_w}{(1 + e)} \quad \gamma_t = 112.1 \cdot \text{pcf}$$

saturated unit weight

$$\gamma_{sat} := \frac{(sp + e) \cdot \gamma_w}{(1 + e)} \quad \gamma_{sat} = 120 \cdot \text{pcf}$$

## Strength Limit State Bearing Resistance - Native Granular Soils:

### Nominal and factored Bearing Resistance for box culvert and wingwall base slab

Assumptions

1. Box culvert will be embedded 2.0 feet below streambed

$$D_f := 2.0\text{ft}$$

2. Assumed parameters based on granular fill

Moist unit weight       $\gamma_m := 112\text{pcf}$

Saturated unit weight       $\gamma_s := 120\text{pcf}$

Angle of internal friction       $\phi_b := 15\text{deg}$

Undrained shear strength  $c := 510.\text{psf}$

Depth to groundwater       $D_w := 0\text{ft}$

3.  $L > B$ , so use Terzaghi strip foundation equations

Terzaghi shape factors       $B := 12\text{ft}$

$$s_c := 1.0$$

Meyerhof bearing capacity factors       $s_\gamma := 1.0$

$$N_c := 10.97$$

$$N_q := 3.9$$

$$N_{\gamma} := 1.2$$

Effective stress at footing level

$$q_{\text{eff}} := D_w \cdot \gamma_m + (D_f - D_w) \cdot (\gamma_s - \gamma_w)$$

$$q_{\text{eff}} = 115 \cdot \text{psf}$$

Nominal Bearing Resistance

$$q_{\text{nom}} := c \cdot N_c \cdot s_c + q_{\text{eff}} \cdot N_q + 0.5 \cdot (\gamma_s - \gamma_w) \cdot B \cdot N_{\gamma} \cdot s_{\gamma}$$

$$q_{\text{nom}} = 6.459 \cdot \text{ksf}$$

Resistance Factor from LRFD Table 10.5.5.2.2-1, pg 10-32

$$\Phi_b := 0.45$$

$$q_{\text{factored}} := q_{\text{nom}} \cdot \Phi_b$$

$$q_{\text{factored}} = 2.906 \cdot \text{ksf}$$

**For this project, the Strength limit state controls.  
Factored Bearing Resistance of 2.9 ksf should be used.**