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

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

ROUTE 119 STRUT
OVER TWITCHELL BROOK
PARIS, MAINE

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

Oxford County

Soils Report No. 2012-123

WIN 17536.00

May 15, 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 Twitchell Brook under Route 119 (Hebron Road), 0.63 miles south of East Oxford Road. Exeter Road is a Priority 4 Highway Corridor. The proposed replacement structure will be a 8-foot high by 12-foot wide prefabricated concrete box with two feet of soil placed in the bottom. The structure will be 95 feet wide at a skew to the highway, with 11-foot lanes and 5-feet from edge of travelled way to the face of guardrail. The following design and construction sections are discussed in this report:

Subsurface Conditions – The geotechnical investigation included one hollow stem auger borings, SB-PARI-101 at Station 14+14, 7.7 feet Right, and two probes to bedrock at Station 13+55, 7.0 feet Left and at Station 14+15, 7.5 feet Left. These borings locations are shown on Sheet 2, Boring Location Plan and Sheet 3, Interpretive Soil Cross Section. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented in the Boring Logs, Appendix A. No laboratory testing was done. Regional surficial geology maps indicate the site is surrounded by predominantly Till soils. NRCS mapping indicates that surficial soils at this site may be predominantly sand with approximately 20 to 28% silt.

Our borings encountered moist to wet, loose Sand with some gravel and some silt. Boulders and cobbles were common in the borings, and either bedrock or a layer of larger boulders was found at depths of 16 feet to 22 feet below existing ground surface. No rock cores were taken at this site. Groundwater was not observed in borings.

Table 1 below summarizes the top of bedrock elevations at the boring locations:

Boring Number	Station and offset	Approximate Depth to Bedrock	Approximate Bedrock Elevation
SB- PARI -101	14+14, 7.7 Rt	16.2 feet	406.3 feet
	13+54.8, 7.0 Lt	22.0 feet	400.7 feet
	14+14.6, 7.5 Lt	16.4 feet	406.3 feet

Table 1 - Summary of Bedrock Depths and Elevations

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.

The box culvert will be bedded on a one-foot thick layer of ¾ 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 – We recommend the use of integral concrete headwalls to prevent gravel and fill soils from sliding or eroding from slopes above the culvert into the stream. These headwalls need not be larger than a nominal 1-foot by 1-foot dimension.

Box Culvert Bearing Resistance – For this project, the strength limit state controls bearing resistance. A factored bearing resistance of 5.2 ksf shall be used for this project. In no case may the bearing stress exceed the nominal resistance of concrete, taken as 03.*f'c*.

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. 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 – Soils in the borings were loose, and excavation systems may be required to support these soils during construction.

Power Auger refusals encountered during the subsurface investigation may have been either large boulders or bedrock. No rock cores were taken. Mapped soils data by Maine Geologic Survey and by the National Resources Conservation Service do not indicate shallow bedrock at this site. If large boulders are encountered within the construction limits for this project, the boulders must be removed and the excavation backfilled with granular borrow or soils from the surrounding excavation, similar to soils at the same depth within the excavation. Bedrock excavation may be required at subgrade elevation for this construction.

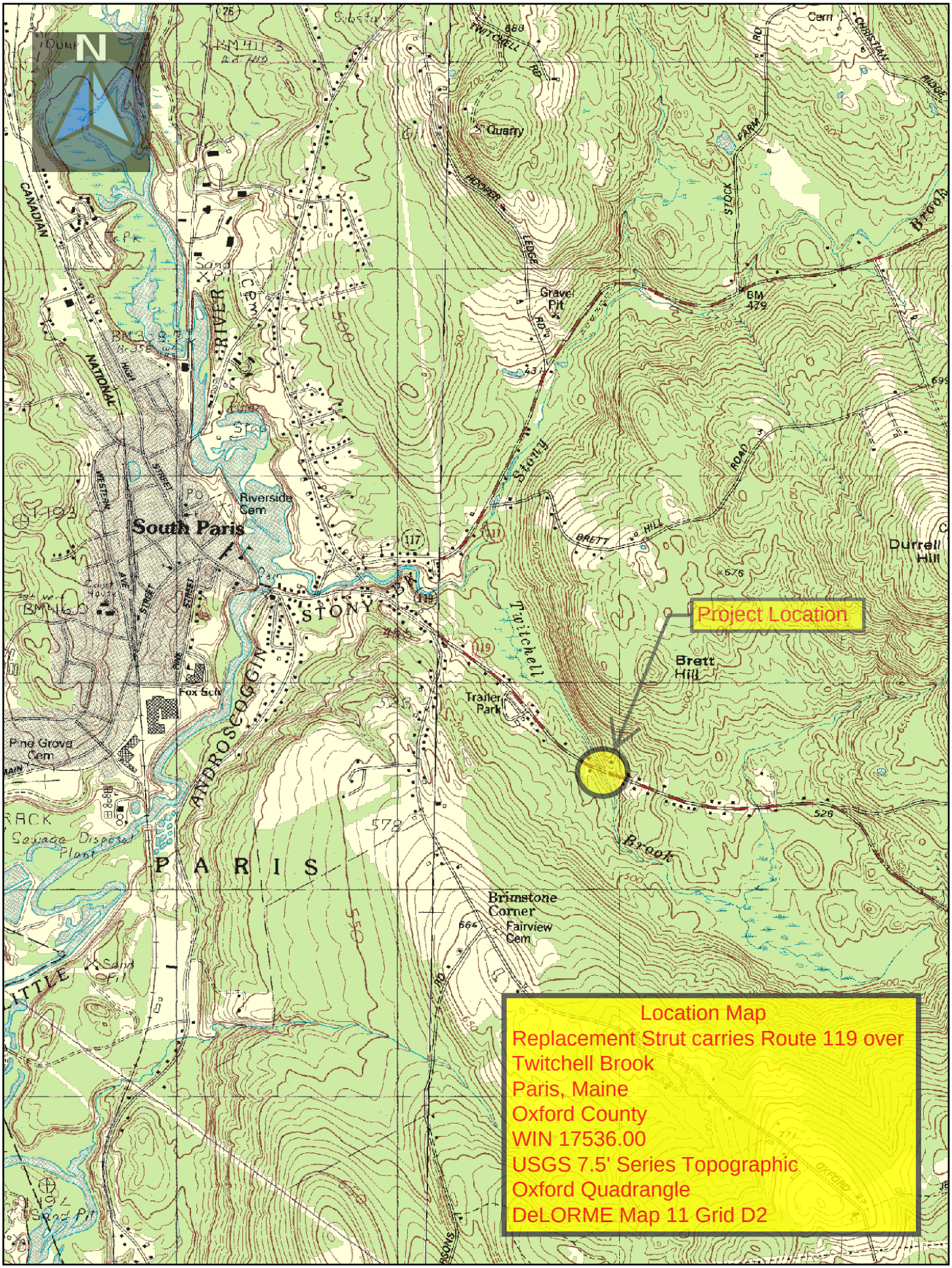
Attachments

Sheets

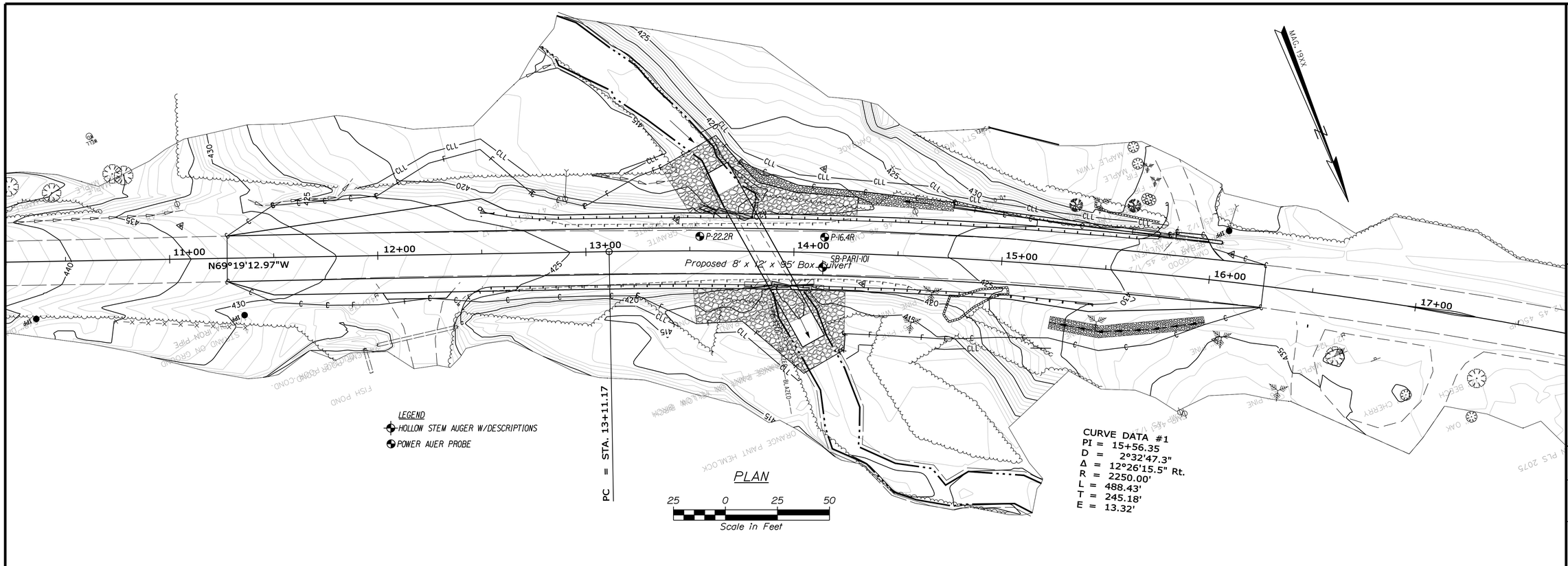
Sheet 1 - Location Map
Sheet 2 - Boring Location Plan and Interpretive Subsurface Profile
Sheet 3 – Boring Logs

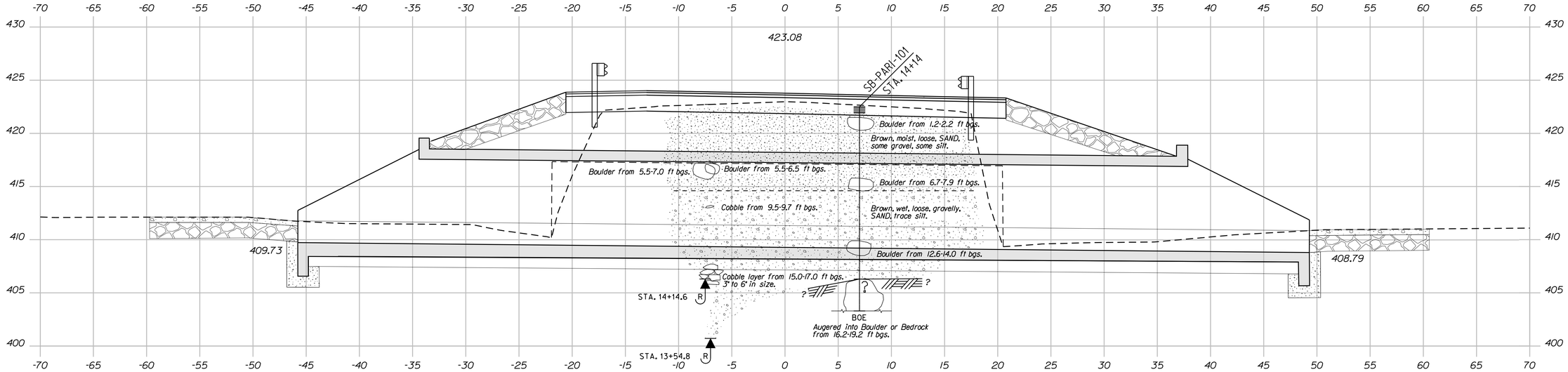
Appendices

Appendix A - Boring Logs
Appendix B - Calculations



Map Scale 1:24000





LEGEND

Boring No. / Station — Pavement Thickness if applicable

Strata Interface

Boring — RQD= Rock Quality Designation for Rock Core Sample

BOE= Bottom Of Exploration

R — Refusal

BOE — No Refusal

13+84
(Skewed Section)

CROSS SECTION

HORIZ 5 0 5 10

VERT 5 0 5 10

SCALE

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

17536.00

WIN 17536.00

HIGHWAY PLANS

		BY	DATE
PROJ. MANAGER	SHAWN SMITH		
DESIGN-DETAILED	T. ADAMS		
CHECKED-REVIEWED			
DESIGN2-DETAILED2	K.BRESKIN	T.WHITE	MAY 2012
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

PARIS
ROUTE 119 STRUT

GEOPLAN & INTERPRETIVE SUBSURFACE CROSS SECTION

SHEET NUMBER

2

OF 3

Filename: ...\msta\002_BORING LOGS1.dgn Division: GEOTECH Username: kitty.breskin Date:5/15/2012

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 119 Strut over Twitchell Brook
Location: Paris, Maine

Boring No.: SB-PARI-101
WIN: 17536.00

Driller:	MaineDOT	Elevation (ft.)	422.5	Auger ID/OD:	2.25/6.25 in.
Operator:	Giguere/Giles/Daggett	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	4/30/12-4/30/12	Drilling Method:	Hollow Stem Auger	Core Barrel:	N/A
Boring Location:	14+14. 7.0 ft Rt.	Casing ID/OD:	N/A	Water Level*:	None Observed
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
WU = 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
WOIP = 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							HSA	421.92		7" PAVEMENT. 0.58	
										Boulder from 1.0-2.2 ft bgs.	
	1D	24/16	2.20 - 4.20	4/4/6/6	10	14				Brown, moist, loose, fine to coarse SAND, some gravel, some silt.	
5	2D	20.4/14	5.00 - 6.70	2/4/5/30(2.4")	9	13				Similar to above.	
								414.50		Boulder from 6.7-7.9 ft bgs. 8.00	
10	3D	24/5	10.00 - 12.00	2/2/2/3	4	6				Brown, wet, loose, gravelly, fine to coarse SAND, trace silt.	
										Boulder from 12.6-14.0 ft bgs.	
15	4D	14.4/12	15.00 - 16.20	4/7/35(2.4")	---					Similar to above.	
								406.30		Solid drilling, augered into Boulder or Bedrock from 16.2 to 19.2 ft bgs. 16.20	
								403.30		Bottom of Exploration at 19.20 feet below ground surface. 19.20	
20											
25											

Remarks:

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

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

Boring No.: SB-PARI-101

State of Maine - Department of Transportation

Power Auger Probe Summary Sheet

Town(s): Paris **Work Number: 17536.00**

Station (Feet)	Offset (Feet)	Weathered Rock (Feet)	Refusal (Feet)	No Refusal (Feet)	Water Depth (Ft.)	Comments / Date 4/30/2012
13+54.8	7.0 Lt.		22.0			Similar soils and depth
						to SB-PARI-101.
						5.5-6.5 ft, boulder.
						9.5-9.7 ft, cobble.
						15.0-17.0 ft, 3"-6" Dia.
						cobble layer.
14+14.6	7.5 Lt.		16.4			Similar soils and depth
						to SB-PARI-101.
						5.5-7.0 ft, boulder

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

17536.00

WIN 17536.00

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REVISIONS 4	-----	-----	-----
FIELD CHANGES	-----	-----	-----

SIGNATURE

P.E. NUMBER

DATE

PARIS
ROUTE 119 STRUT

BORING LOGS

SHEET NUMBER

3

OF 3

Appendix A
Boring Logs

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 119 Strut over Twitchell Brook
Location: Paris, Maine

Boring No.: SB-PARI-101
PIN: 17536.00

Driller:	MaineDOT	**Elevation (ft.)**	422.5	**Auger ID/OD:**	2.25/6.25 in.
Operator:	Giguere/Giles/Daggett	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	4/30/12-4/30/12	**Drilling Method:**	Hollow Stem Auger	**Core Barrel:**	N/A
Boring Location:	14+14, 7.0 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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State of Maine - Department of Transportation

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						cobble layer.
14+14.6	7.5 Lt.		16.4			Similar soils and depth
						to SB-PARI-101.
						5.5-7.0 ft, boulder

MaineDOT Drill Crew
Logged By: B. Wilder
Drill Rig: CME 45C

5" Solid Stem Auger

Appendix B
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

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

$\phi_a := 36 \cdot deg$ assumed effective friction angle for dense gravelly sand

$$K_a := \tan\left(45 \cdot deg - \frac{\phi_a}{2}\right)^2 \qquad K_a = 0.26$$

Service Limit State Bearing Resistance - Native Granular 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: gravelly SAND (Fill)

Consistency In Place: loose

Bearing Resistance: Ordinary Range (ksf)
4 - 12 loose

Recommended Value of Use: 6 ksf

Recommended Value: $6 \cdot ksf = 3 \cdot tsf$ $tsf := g \cdot \left(\frac{ton}{ft^2}\right)$

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, loose gravelly fine SAND (fill)

$wc := 0.2$ estimated water content

$e := 0.6$ estimated void ratio

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

$sp := 2.65$ estimated specific gravity

saturation $sat := \frac{(wc \cdot sp)}{e}$ $sat = 0.8833$

total unit weight $\gamma_t := \frac{(sp + sat \cdot e) \cdot \gamma_w}{(1 + e)}$ $\gamma_t = 124 \cdot pcf$

saturated unit weight $\gamma_{sat} := \frac{(sp + e) \cdot \gamma_w}{(1 + e)}$ $\gamma_{sat} = 127 \cdot pcf$

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 1.0 feet below streambed

$D_f := 2.0ft$

2. Assumed parameters based on granular fill

Moist unit weight	$\gamma_m := 124pcf$
Saturated unit weight	$\gamma_s := 127pcf$
Angle of internal friction	$\phi_b := 32deg$
Undrained shear strength	$c := 0$
Depth to groundwater	$D_w := 0ft$

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

Terzaghi shape factors	$B := 12ft$
	$s_c := 1.0$
	$s_\gamma := 1.0$
Meyerhof bearing capacity factors	$N_c := 35.47$
	$N_q := 23.2$

$$N_\gamma := 22.0$$

Effective stress at footing level

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

$$q_{eff} = 129 \cdot psf$$

Nominal Bearing Resistance

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

$$q_{nom} = 11.525 \cdot ksf$$

Resistance Factor from LRFD Table 10.5.5.2.2-1, pg 10-32 $\Phi_b := 0.45$

$$q_{factored} := q_{nom} \cdot \Phi_b \qquad q_{factored} = 5.186 \cdot ksf$$

For this project, the Strength limit state controls.
Factored Bearing Resistance of 5.2 ksf should be used.