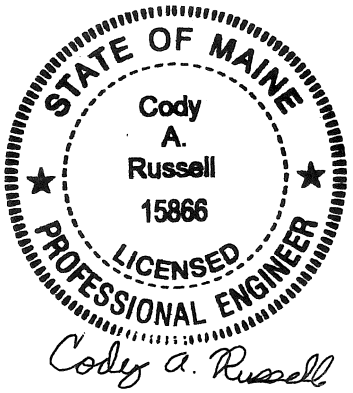
MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

GEOTECHNICAL DESIGN REPORT

For the Rehabilitation of

LARGE CULVERT #46526
ROUTE 5
DAYTON, MAINE

Prepared by:
Cody Russell, P.E.
Geotechnical Engineer



Reviewed by:
Kathleen Maguire, P.E.
Senior Geotechnical Engineer

York County
WIN 23551.00

Soils Report 2023-34
November 17, 2023

PROJECT DETAILS

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical design and construction recommendations for the rehabilitation of an existing large culvert (#46526) on Route 5 in Dayton. The existing structure consists of an approximately 60-inch span by 72-inch rise by 39-foot long granite box culvert, with a 60-inch span by 72-inch rise by 19-foot long concrete box culvert extension and a 60-inch diameter, 24-foot long corrugated metal pipe (CMP) culvert extension. The existing structure is in poor condition. The granite blocks have begun to shift, causing stability issues and creating voids throughout the structure. The pipe sections in the CMP extension have begun to deform and separate. The culvert is located at the intersection of Route 5, River Road, and Hollis Road as shown in the attached Location Map. Route 5 is a Highway Corridor Priority 3 road.

The proposed rehabilitation will consist of a slipline of the existing culvert with a 48-inch diameter, 90-foot long pipe. The invert of the proposed culvert slipline is approximately 13.5 feet below the existing road grade at the roadway centerline. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the slipline culvert and at the culvert outlet as shown on the Special Details sheets in the Plans. The roadway embankment slope at the proposed culvert slipline inlet shall be no steeper than 2H:1V to protect against erosion. The roadway embankment slope on the outlet end is supported by an existing stacked stone headwall and will not be impacted during construction.

SUBSURFACE INVESTIGATION

One (1) boring (HB-DAY-101) and one (1) probe (HB-DAY-102) were drilled for this project on December 5, 2019 by a S.W. Cole drill crew using a track-mounted drill rig. Exploration locations are shown on the attached Boring Location Plan. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are shown on the attached boring logs.

Boring HB-DAY-101 was drilled using hollow stem auger, cased wash boring, and open hole drilling techniques. Soil samples were obtained in boring HB-DAY-101 at 5-foot intervals using Standard Penetration Test (SPT) methods. The S.W. Cole drill rig is equipped with an automatic hammer to drive the split spoon. The S.W. Cole calibrated automatic hammer delivers approximately 69 percent more energy during driving than the standard rope and cathead system. All N-values discussed in this report are corrected values (N_{60}) computed by applying an average energy transfer factor of 1.011 to the raw field N-values. One (1) undisturbed thin-walled Shelby Tube sample was collected in boring HB-DAY-101. In-situ vane shear tests were conducted in boring HB-DAY-101 at 5-foot intervals in the soft soil deposits to determine the shear strength of the soft strata. Probe HB-DAY-102 was drilled using solid stem auger drilling techniques. No soil samples were obtained in the probe.

The MaineDOT Geotechnical Team member selected the boring and probe locations, drilling methods, designated type and depth of sampling, reviewed field logs for accuracy and identified field and laboratory testing requirements. A NorthEast Transportation Training and Certification (NETTCP) certified Subsurface Investigator logged the subsurface conditions encountered. The

boring and probe were located in the field by taping to surveyed site features after completion of the drilling program.

LABORATORY TESTING

A laboratory testing program was conducted to assist in soil classification, evaluation of engineering properties of the soils and geologic assessment of the project site. Laboratory testing consisted of two (2) standard grain size analysis with natural water content, eight (8) grain size analysis with hydrometer and natural water content, seven (7) Atterberg Limits tests, and one (1) Consolidation Test. The results of the laboratory testing program are discussed in the following section and are shown on the attached boring logs, Laboratory Testing Summary Sheet, Grain Size Distribution Curves, and Consolidation Curve.

SUBSURFACE CONDITIONS

Subsurface conditions encountered at the test boring generally consisted of fill underlain by Presumpscot Formation consisting of silty clay, clayey silt, and silt underlain by silty sand.

Boring HB-DAY-101 was drilled to a depth of approximately 47.0 feet below ground surface (bgs) and did not encounter a refusal surface. Probe HB-DAY-102 was drilled to a depth of approximately 25.0 feet bgs and did not encounter a refusal surface.

The table below summarizes the field and laboratory information obtained in boring HB-DAY-101:

Approx. Depth BGS[1] (feet)	Soil Description	AASHTO[2] Classification	USCS[3]	WC%[4]
0.0 – 0.6	HMA Pavement	--	--	--
0.6 – 9.0	Fill: Brown, damp, gravelly fine to coarse sand, trace silt. Olive, moist, fine to coarse sand, some gravel, some silt.	A-1-b A-2-4	SW-SM SM	2.3 25.9
9.0 – 45.5	Presumpscot Formation: Olive and grey, moist to wet, silty clay, trace fine sand. Grey, wet, silty clay, trace fine to medium sand. Grey, wet, silt, some clay, little fine to medium sand.	A-7-6, A-6, or A-4	CL	29.3 to 48.4
45.5 – 47.0	Grey, wet, silty fine to coarse sand, trace clay, trace gravel.	A-4	SC-SM	19.6

[1]BGS = below ground surface
[2]AASHTO = American Association of State Highway and Transportation Officials
[3]USCS = Unified Soil Classification System

[4]WC% = Water content in percent

Two (2) N_{60}-values obtained in the fill were 8 and 51 blows per foot (bpf) indicating that the fill is loose to very dense in consistency. Six (6) N_{60}-values obtained in the Presumpscot Formation ranged from weight of rod to 2 bpf, indicating that the Presumpscot Formation is very soft to soft in consistency.

Vane shear testing conducted within the clayey silt, silty clay, and silt layers showed measured undrained shear strengths ranging from approximately 402 to 729 pounds per square foot (psf) while the remolded shear strength ranged from approximately 22 to 89 psf. Based on the ratio of undrained to remolded shear strength from the vane shear tests, the clayey silt, silty clay, and silt were determined to have a sensitivity of approximately 5.9 to 26.4 and are classified as sensitive to slightly quick.

The following table summarizes the results of Atterberg Limits tests done on seven (7) samples of the native clayey silt, silty clay, and silt:

Boring No. and Sample No.	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
HB-DAY-101 3D	31.7	45	24	21	0.37
HB-DAY-101 4D	44.8	40	21	19	1.25
HB-DAY-101 1U	48.8	38	24	14	1.77
HB-DAY-101 5D	29.3	30	20	10	0.93
HB-DAY-101 6D	30.1	32	23	9	0.79
HB-DAY-101 7D	32.9	30	19	11	1.26
HB-DAY-101 8D	30.0	28	18	10	1.20

Interpretation of these results indicate that the clayey silt, silty clay, and silt range from having medium plasticity to high plasticity with plasticity generally decreasing with depth. The silty clay in sample 3D is overconsolidated, meaning it has experienced higher stresses in the past. The soils in samples 4D, 1U, 7D, and 8D are on the verge of being a viscous liquid if disturbed. Overburden pressure and interparticle cementation is providing stability to keep the soil in its current state, but the slightest disturbance causing remolding could convert the soil into a viscous fluid. The soils in samples 5D and 6D are normally consolidated, meaning they are currently experiencing their highest stress.

Groundwater was recorded at a depth of approximately 14.0 feet bgs in boring HB-DAY-101. Groundwater levels can be expected to fluctuate subject to seasonal variations, local soil conditions, topography, precipitation, and construction activity.

GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

Culvert Rehabilitation – The existing structure will be sliplined with a 48-inch diameter, 90-foot long pipe on a skew of approximately 22.8 degrees to the roadway centerline. The proposed culvert slipline shall be performed in accordance with Special Provision 603 – Culvert Sliplining.

The invert of the proposed culvert slipline pipe ranges from approximately 112.34 feet at the inlet end to approximately 111.64 feet at the outlet end with a 0.8% slope.

Settlement – The annular space around the proposed culvert slipline pipe will be filled with grout. Due to the presence of soft, compressible soils underlying the site, additional load from the grout will result in settlement along the alignment of the culvert. Evaluation of the potential settlement using Settle3D software from Rocscience resulted in approximately 0.5 inches to 0.75 inches of anticipated settlement along the culvert alignment. Due to the cohesive nature of the soils at the site, this settlement will occur over a long period of time (years) and may require maintenance from MaineDOT maintenance crews.

Scour and Riprap – The inlet of the culvert slipline pipe shall be protected against scour with riprap conforming to MaineDOT Standard Specification Section 703.26 Plain and Hand Laid Riprap. The roadway embankment slopes at the proposed culvert inlet and shall be no steeper than 2H:1V. No specific scour protection recommendations are needed other than armoring with riprap. The riprap on the slopes shall be underlain by a non-woven, Class 1 Erosion Control Geotextile meeting the requirements of MaineDOT Standard Specification 722.03 that is underlain by a 1-foot layer of protective aggregate cushion consisting of Granular Borrow Material for Underwater Backfill (703.19). The toe of the riprap sections shall be keyed into the existing soils 1 foot below the streambed elevation. The existing headwall on the outlet end of the structure will remain.

Construction Considerations – Construction activities will include construction of cofferdams and earth support systems to control stream flow during construction. Construction activities will also include common earth excavation.

The Contractor shall control groundwater and surface water infiltration using temporary ditches, sumps, granular drainage blankets, stone ditch protection or hand-laid riprap with geotextile underlayment to divert groundwater and surface water as needed to maintain a stable excavation and allow work in the dry.

CLOSURE

This report has been prepared for the use of the MaineDOT Highway Program and their project design consultant for specific application to the proposed rehabilitation of a large culvert (#46526) under Route 5 in Dayton, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or 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. These analyses and recommendations are based in part upon a limited subsurface investigation at discrete exploratory location 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.

It is recommended that a geotechnical engineer be provided the opportunity for a review of the design and specifications in order that the earthwork and foundation recommendations and

construction considerations presented in this report are properly interpreted and implemented in the design and specifications.

Attachments:

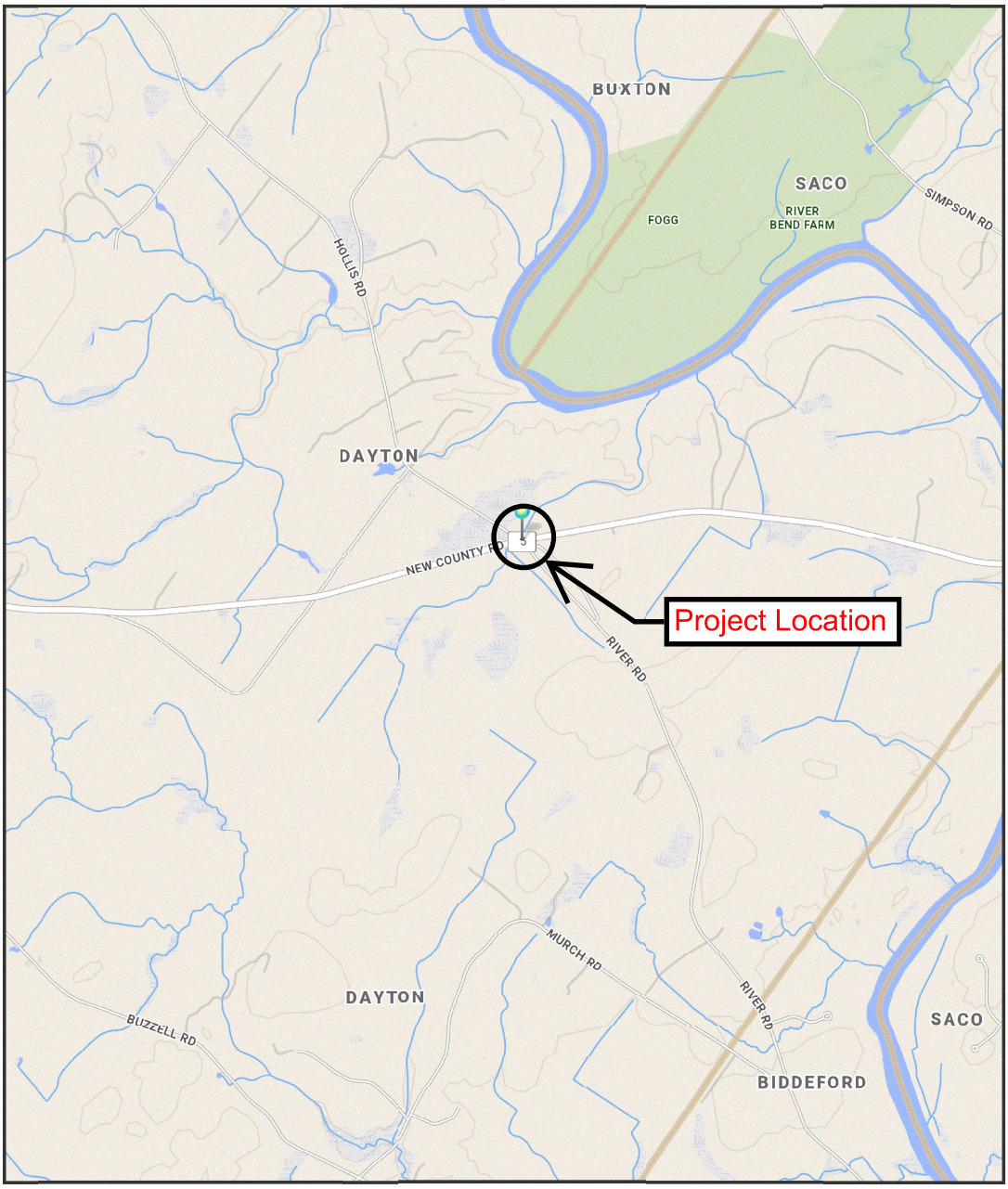
Location Map
Boring Location Plan
Key to Soil and Rock Descriptions and Terms
Boring Logs
Laboratory Testing Summary Sheet
Grain Size Distribution Curves
Consolidation Curve
Calculations

Date:10/26/2023

Division: GEOTECH

Username: terry.white

DAYTON, MAINE

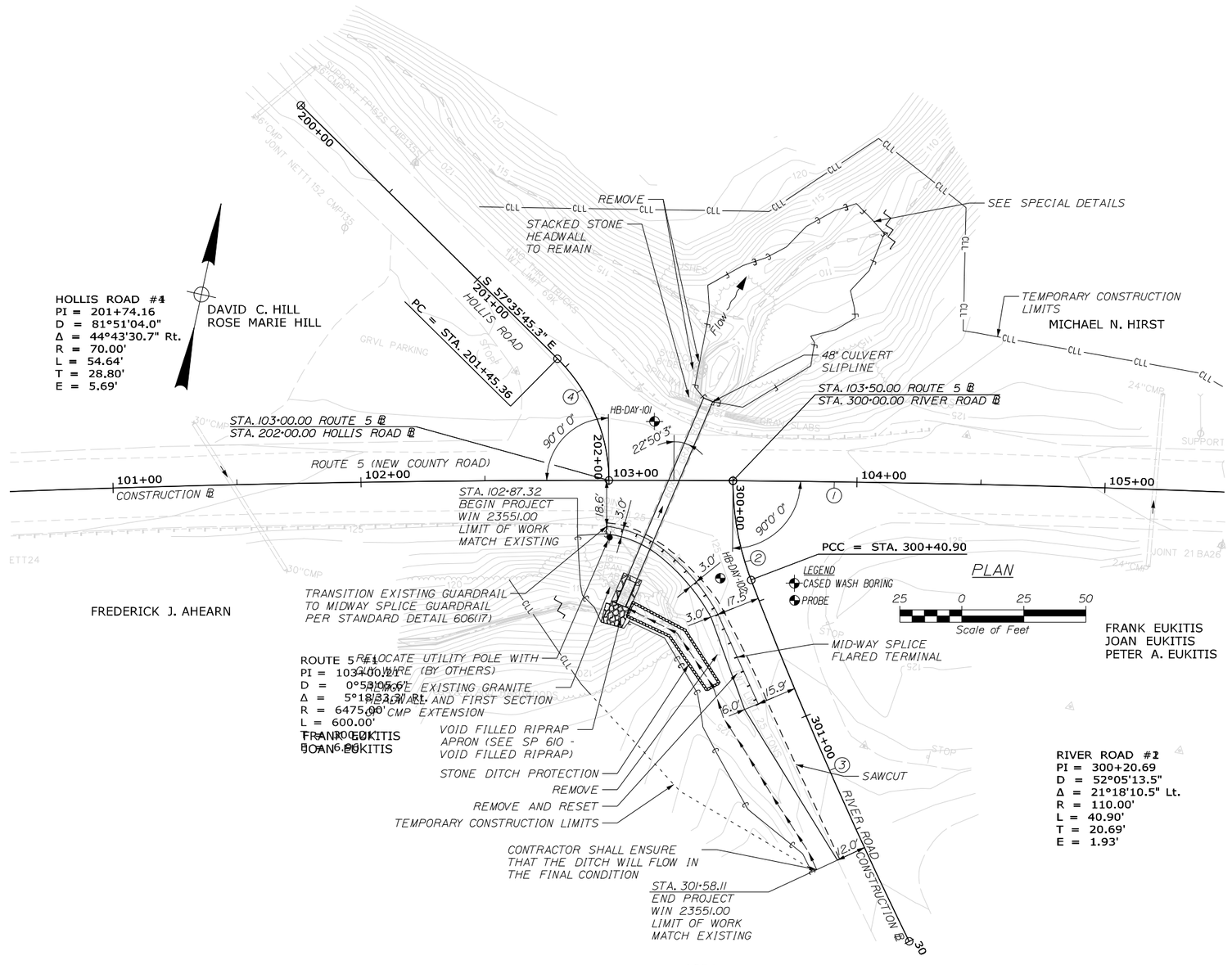


0.4 Miles

1 inch = 0.45 miles

Date: 10/26/2023
Time: 10:38:58 AM

SHEET NUMBER 1 OF 2	DAYTON ROUTE 5 LOCATION MAP	STATE OF MAINE DEPARTMENT OF TRANSPORTATION 23551.00 WIN 23551.00 HIGHWAY PLANS



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

23551.00

WIN 23551.00

HIGHWAY PLANS

	BY	DATE
PROJ. MANAGER	----------	----
DESIGN-DETAILED	----------	----
CHECKED-REVIEWED	----------	----
DESIGN2-DETAILED2	C.RUSSELL	OCT 2023
DESIGN3-DETAILED3	----------	----
REVISIONS 1	T.WHITE	----
REVISIONS 2	----------	----
REVISIONS 3	----------	----
REVISIONS 4	----------	----
FIELD CHANGES	----------	----

SIGNATURE

P.E. NUMBER

DATE

DAYTON
ROUTE 5

BORING LOCATION PLAN

SHEET NUMBER

2

OF 2

Filename: ...\GEOTECH\MSTA\002_BLP WBL1.dgn Division: GEOTECH Username: Cody.A.Russell Date:10/30/2023

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, if applicable):

Color (Munsell color chart)
Moisture (dry, damp, moist, wet)
Density/Consistency (from above right hand side)
Texture (fine, medium, coarse, etc.)
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.,)
Cementation (weak, moderate, or strong)
Geologic Origin (till, marine clay, alluvium, etc.)
Groundwater level

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

MODIFIED BURMISTER SYSTEM

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

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. Density is rated according to standard penetration resistance (N-value).

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 undrained 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 (%) = sum of the lengths of intact pieces of core* > 4 inches / length of core advance

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

Rock Quality Based on RQD

Rock Quality	RQD (%)
Very Poor	≤25
Poor	26 - 50
Fair	51 - 75
Good	76 - 90
Excellent	91 - 100

Desired Rock Observations (in this order, if applicable):

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Rock Type (granite, schist, sandstone, 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 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.)
- -spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet)
- -tightness (tight, open, or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock quality (very poor, poor, etc.)
ref: ASTM D6032 and FHWA NHI-16-072 GEC 5 - Geotechnical Site Characterization, Table 4-12
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

Sample Container Labeling Requirements:

WIN
Bridge Name / Town
Boring Number
Sample Number
Sample Depth
Blow Counts
Sample Recovery
Date
Personnel Initials

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 5 Large Culvert Rehabilitation
Location: Dayton, Maine

Boring No.: HB-DAY-101
WIN: 23551.00

Driller:	S.W. Cole	**Elevation (ft.)**	124.8	**Auger ID/OD:**	HSA 2.5/6.25"
Operator:	Brent/Cory	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50 Track	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	12/5/2019; 08:00-13:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	103+18.3, 23.8 ft Lt.	**Casing ID/OD:**	HW-4"/NW-3"	**Water Level*:**	14.0 ft bgs.
Hammer Efficiency Factor:	1.011	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							HSA	124.2		7" HMA. 0.6	
	1D	24/8	1.00 - 3.00	24/17/13/8	30	51				Brown, damp, very dense, Gravelly fine to coarse SAND, trace silt, (Fill).	G#340667 A-1-b, SW-SM WC=2.3%
								120.8		4.0	
	2D	24/8	4.50 - 6.50	1/1/4/3	5	8				Olive, moist, loose, fine to coarse SAND, some gravel, some silt.	G#340668 A-2-4, SM WC=25.9%
5											
								115.8		9.0	
	3D	24/24	9.50 - 11.50	WOH/WOH/1/2	1	2				Olive, moist, soft, Silty CLAY, trace fine sand.	G#340669 A-7-6, CL WC=31.7% LL=45 PL=24 PI=21
10											
	V1	24/24	14.50 - 14.87	Su=580/45 psf	---		HYD-			55x110 mm raw torque readings: V1: 13.0/1.0 ft-lbs	G#340670 A-7-6, CL WC=44.8% LL=40 PL=21 PI=19
15	4D		14.50 - 16.50	WOR/WOR/WOR/							
	V2		15.50 - 15.87	WOR Su=513/89 psf			PUSH			Grey, wet, very soft, Silty CLAY, trace fine sand. Changed to NW Casing. V2: 11.5/2.0 ft-lbs	
20	1U	24/24	20.00 - 22.00	Hydraulic Push			OPEN HOLE			Grey, wet, very soft, Silty CLAY, trace fine sand.	G,C#340676 A-6, CL WC=48.4% LL=38 PL=24 PI=14
	V3		22.63 - 23.00	Su=580/22 psf						Grey, wet, very soft, Silty CLAY, trace fine sand, with sand layers. 55x110 mm raw torque readings: V3: 13.0/0.5 ft-lbs	
	V4		23.63 - 24.00	Su=402/22 psf						V4: 9.0/0.5 ft-lbs	
25								100.3		24.5	

Remarks:

Hammer #306

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

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

Boring No.: HB-DAY-101

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 5 Large Culvert Rehabilitation
Location: Dayton, Maine

Boring No.: HB-DAY-101
WIN: 23551.00

Driller:	S.W. Cole	**Elevation (ft.)**	124.8	**Auger ID/OD:**	HSA 2.5/6.25"
Operator:	Brent/Cory	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50 Track	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	12/5/2019; 08:00-13:00	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	N/A
Boring Location:	103+18.3, 23.8 ft Lt.	**Casing ID/OD:**	HW-4"/NW-3"	**Water Level*:**	14.0 ft bgs.
Hammer Efficiency Factor: 1.011		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
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N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
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T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: 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	5D	24/24	25.00 - 27.00	WOR/WOR/WOR/ WOR	---					Grey, wet, very soft, Clayey SILT, trace fine to medium sand.	G#340671 A-6, CL WC=29.3% LL=30 PL=20 PI=10
	V5		25.63 - 26.00	Su=446/22 psf						55x110 mm raw torque readings:	
	V6		26.63 - 27.00	Su=491/22 psf						V5: 10.0/0.5 ft-lbs	
										V6: 11.0-0.5 ft-lbs	
30	6D	24/24	30.00 - 32.00	WOR/WOR/WOR/ WOR	---					Grey, wet, very soft, Clayey SILT, trace fine to medium sand.	G#340672 A-4, CL WC=30.1% LL=32 PL=23 PI=9
	V7		30.63 - 31.00	Su=446/45 psf						55x110 mm raw torque readings:	
	V8		31.63 - 32.00	Su=536/45 psf						V7: 10.0/1.0 ft-lbs	
										V8: 12.0/1.0 ft-lbs	
35	7D	24/24	35.00 - 37.00	WOR/WOR/WOR/ WOR	---					Grey, wet, very soft, Clayey SILT, trace fine to medium sand.	G#340673 A-4, CL WC=32.9% LL=30 PL=19 PI=11
	V9		35.63 - 36.00	Su=625/45 psf						55x110 mm raw torque readings:	
	V10		36.63 - 37.00	Su=670/67 psf						V9: 14.0/1.0 ft-lbs	
										V10: 15.0-1.5 ft-lbs	
								85.3		39.5	
40	8D	24/24	40.00 - 42.00	WOR/WOR/WOR/ WOR	---					Grey, wet, very soft, SILT, some clay, little fine to medium sand.	G#340674 A-4, CL WC=30.0% LL=28 PL=18 PI=10
	V11		40.63 - 41.00	Su=670/45 psf						55x110 mm raw torque readings:	
	V12		41.63 - 42.00	Su=759/45 psf						V11: 15.0/1.0 ft-lbs	
										V12: 17.0/1.0 ft-lbs	
45	9D	24/18	45.00 - 47.00	1/5/6/11	11	19		79.3		45.5	
	MV			Would Not Push						Grey, wet, medium dense, Silty fine to coarse SAND, trace clay, trace gravel.	G#340675 A-4, SC-SM WC=19.6%
								77.8		Failed 55x110 mm vane attempt.	
										47.0	
50										**Bottom of Exploration at 47.0 feet below ground surface.** NO REFUSAL	

Remarks:

Hammer #306

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

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

Boring No.: HB-DAY-101

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 5 Large Culvert Rehabilitation
Location: Dayton, Maine

Boring No.: HB-DAY-102
WIN: 23551.00

Drilling Contractor:	S.W. Cole	**Elevation (ft.)**	124.9	**Auger ID/OD:**	5" Dia.
Operator:	Brent/Cory	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50 Track	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	08:00-13:00	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	103+45.2, 39.3 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Spilt Spoon Sample
S = Sample off Auger Flights
B = Bucket Sample off Auger Flights
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MV = Unsuccessful Field Vane Shear Test Attempt
V = Field Vane Shear Test, PP= Pocket Penetrometer
MU = Unsuccessful Thin Wall Tube Sample 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 1 Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-value = Raw Field SPT N-value
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent ≅ = Similar or Equal too
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA			Probe, no material samples taken.	
5										
10										
15										
20										
25										

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: Route 5 Large Culvert Rehabilitation
Location: Dayton, Maine

Boring No.: HB-DAY-102
WIN: 23551.00

Drilling Contractor:	S.W. Cole	**Elevation (ft.)**	124.9	**Auger ID/OD:**	5" Dia.
Operator:	Brent/Cory	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50 Track	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	08:00-13:00	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	103+45.2, 39.3 ft Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions: D = Spilt Spoon Sample; S = Sample off Auger Flights; B = Bucket Sample off Auger Flights; MD = Unsuccessful Split Spoon Sample Attempt; U = Thin Wall Tube Sample; MV = Unsuccessful Field Vane Shear Test Attempt; V = Field Vane Shear Test, PP= Pocket Penetrometer; MU = Unsuccessful Thin Wall Tube Sample 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 1 Person; S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf); $S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-value = Raw Field SPT N-value; T_v = Pocket Torvane Shear Strength (psf); WC = Water Content, percent ≅ = Similar or Equal too; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							99.9		25.0	
									Bottom of Exploration at 25.0 feet below ground surface. NO REFUSAL	
30										
35										
40										
45										
50										

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

Laboratory Testing Summary Sheet

Town(s): Dayton Work Number: 23551.00

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
HB-DAY-101, 1D	103+18.3	23.8 Lt.	1.0-3.0	340667	1	2.3			SW-SM	A-1-b	0
HB-DAY-101, 2D	103+18.3	23.8 Lt.	4.5-6.5	340668	1	25.9			SM	A-2-4	III
HB-DAY-101, 3D	103+18.3	23.8 Lt.	9.5-11.5	340669	1	31.7	45	21	CL	A-7-6	III
HB-DAY-101, 4D	103+18.3	23.8 Lt.	14.5-16.5	340670	1	44.8	40	19	CL	A-7-6	III
HB-DAY-101, 1U	103+18.3	23.8 Lt.	20.0-22.0	340676	3	48.4	38	14	CL	A-6	III
HB-DAY-101, 5D	103+18.3	23.8 Lt.	25.0-27.0	340671	2	29.3	30	10	CL	A-6	IV
HB-DAY-101, 6D	103+18.3	23.8 Lt.	30.0-32.0	340672	2	30.1	32	9	CL	A-4	IV
HB-DAY-101, 7D	103+18.3	23.8 Lt.	35.0-37.0	340673	2	32.9	30	11	CL	A-4	IV
HB-DAY-101, 8D	103+18.3	23.8 Lt.	40.0-42.0	340674	2	30.0	28	10	CL	A-4	IV
HB-DAY-101, 9D	103+18.3	23.8 Lt.	45.5-47.0	340675	2	19.6			SC-SM	A-4	III

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.

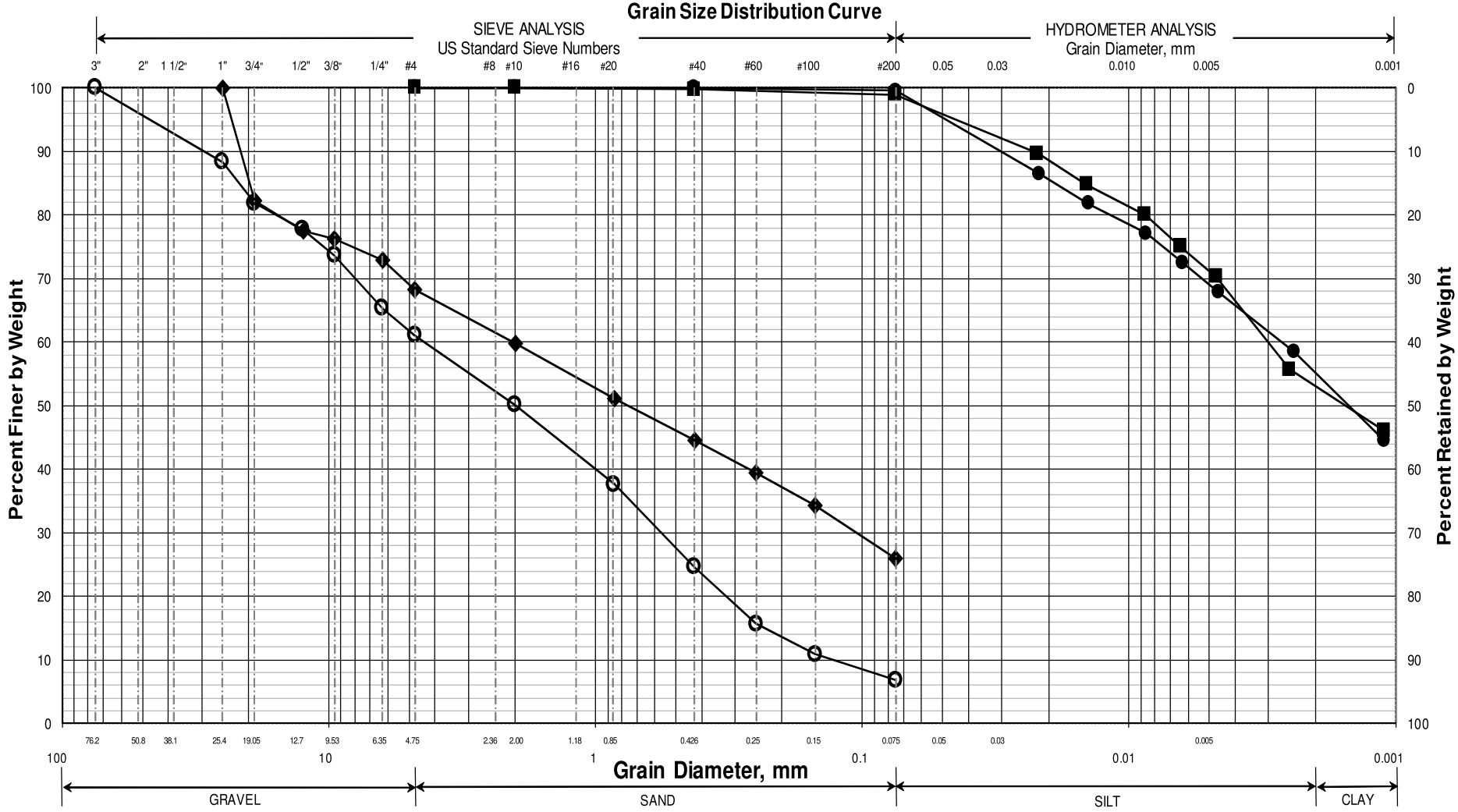
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

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 NP = Non Plastic

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

Maine Department of Transportation
Grain Size Distribution Curve

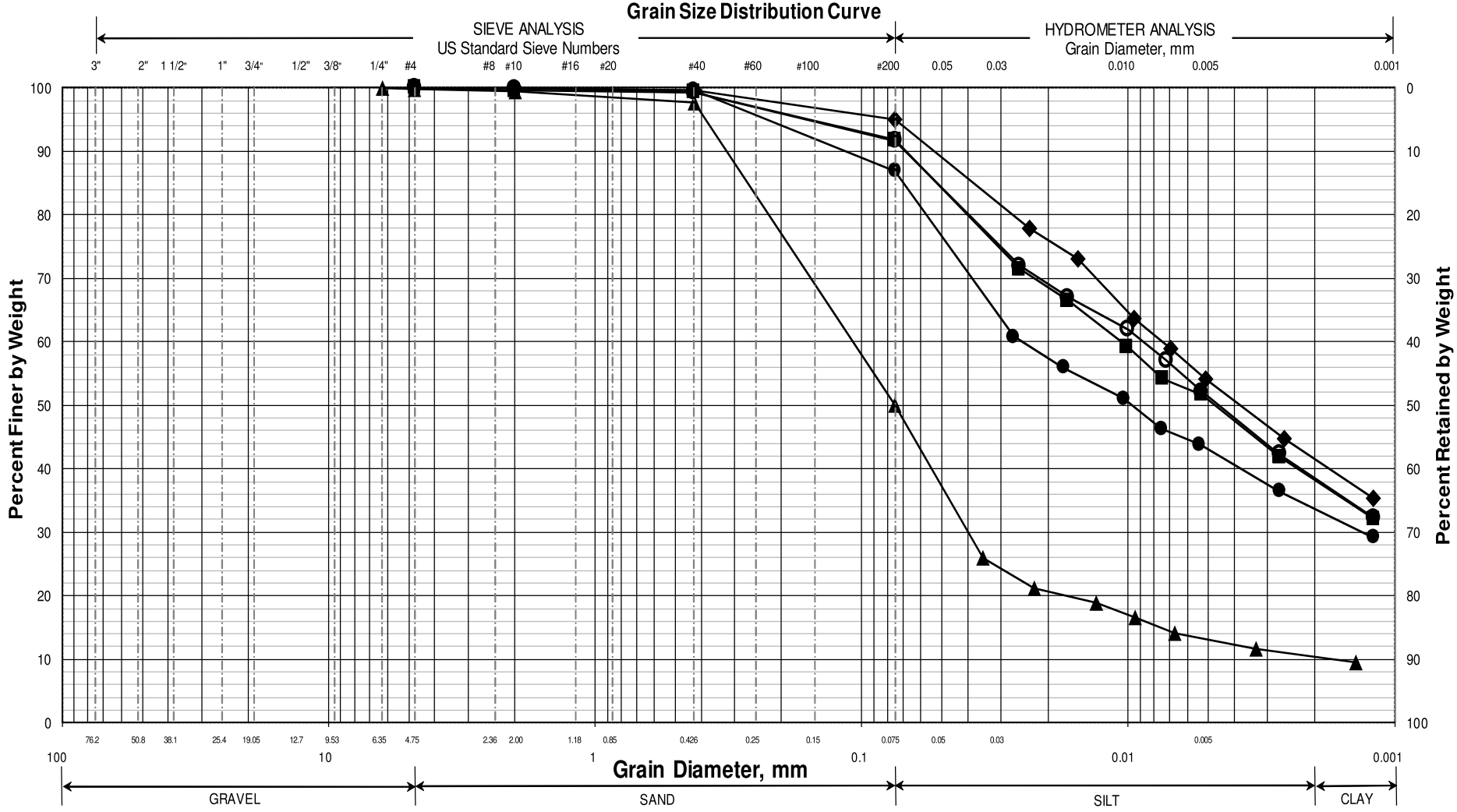


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-DAY-101/1D	103+18.3	23.8 LT	1.0-3.0	Gravelly SAND, trace silt.	2.3			
◆	HB-DAY-101/2D	103+18.3	23.8 LT	4.5-6.5	SAND, some gravel, some silt.	25.9			
■	HB-DAY-101/3D	103+18.3	23.8 LT	9.5-11.5	Silty CLAY, trace sand.	31.7	45	24	21
●	HB-DAY-101/4D	103+18.3	23.8 LT	14.5-16.5	Silty CLAY, trace sand.	44.8	40	21	19
▲									
×									

WIN
023551.00
Town
Dayton
Reported by/Date
WHITE, TERRY A 1/16/2020

Maine Department of Transportation
Grain Size Distribution Curve

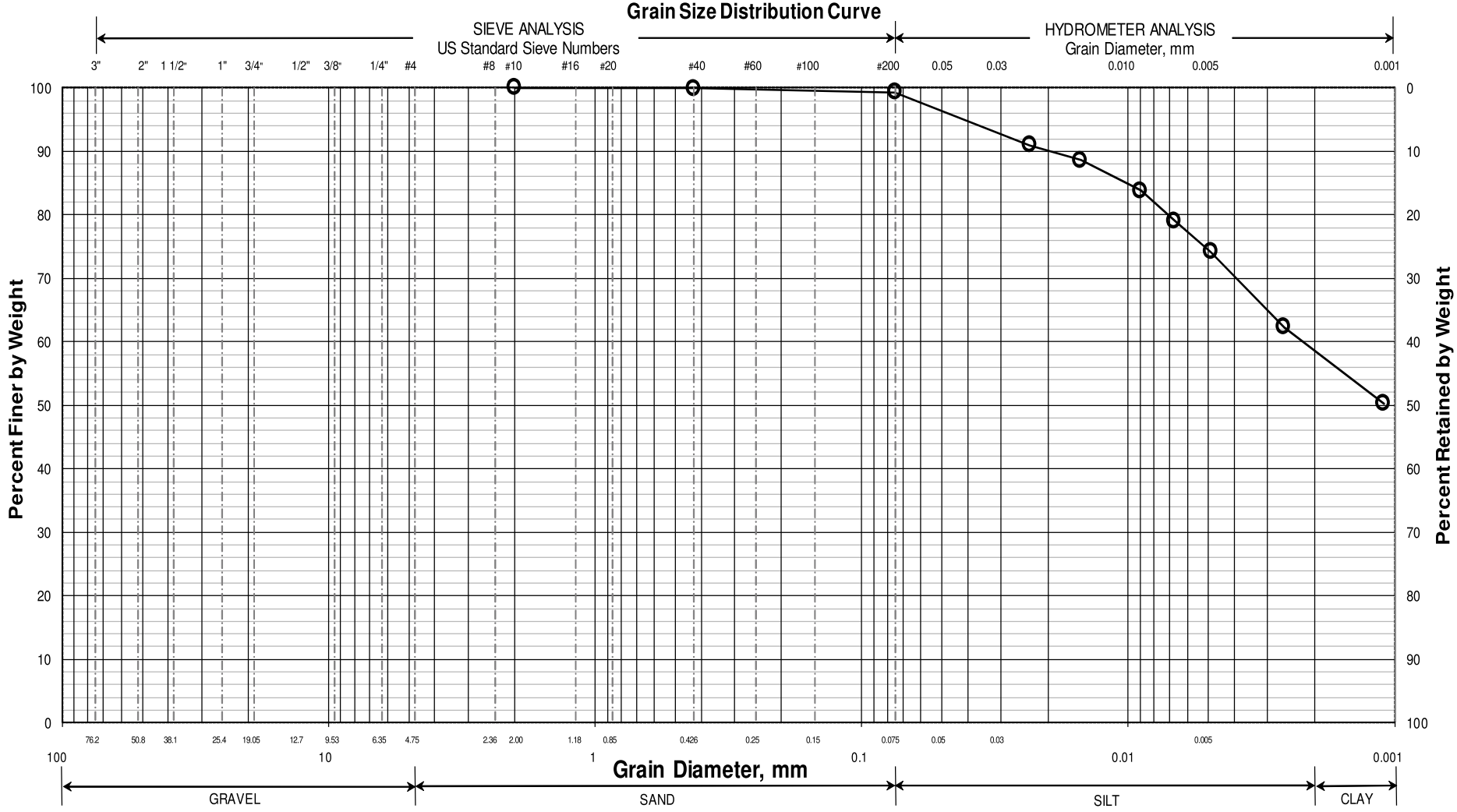


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-DAY-101/5D	103+18.3	23.8 LT	25.0-27.0	Clayey SILT, trace sand.	29.3	30	20	10
◆	HB-DAY-101/6D	103+18.3	23.8 LT	30.0-32.0	Clayey SILT, trace sand.	30.1	32	23	9
■	HB-DAY-101/7D	103+18.3	23.8 LT	35.0-37.0	Clayey SILT, trace sand.	32.9	30	19	11
●	HB-DAY-101/8D	103+18.3	23.8 LT	40.0-42.0	SILT, some clay, little sand.	30.0	28	18	10
▲	HB-DAY-101/9D	103+18.3	23.8 LT	45.5-47.0	Silty SAND, trace clay, trace gravel.	19.6			
×									

WIN
023551.00
Town
Dayton
Reported by/Date
WHITE, TERRY A 1/16/2020

Maine Department of Transportation
Grain Size Distribution Curve



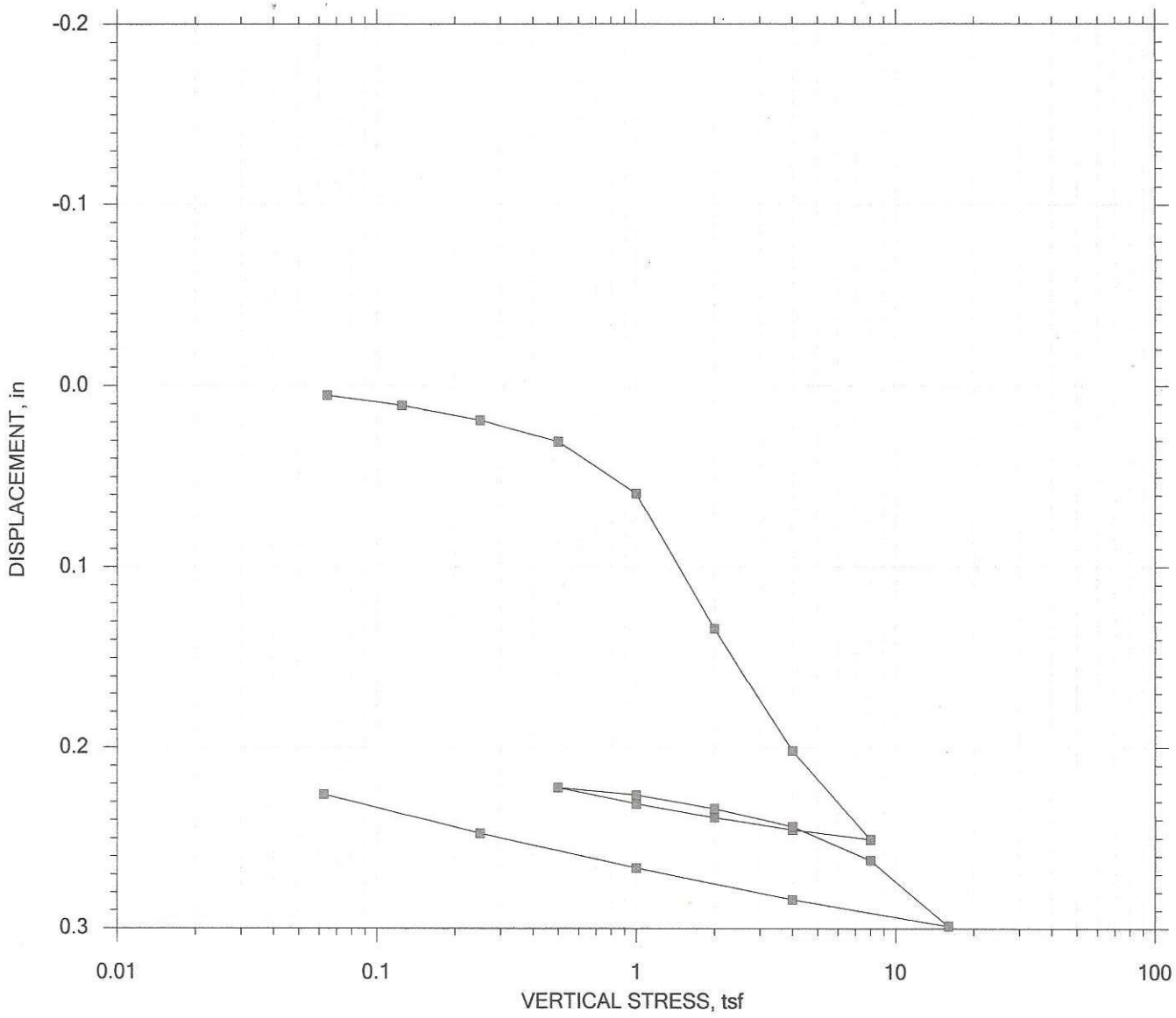
UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-DAY-101/1U	103+18.3	23.8 LT	20.0-22.0	Silty CLAY, trace sand.	48.4	38	24	14
◆									
■									
●									
▲									
×									

WIN
023551.00
Town
Dayton
Reported by/Date
WHITE, TERRY A 3/4/2020

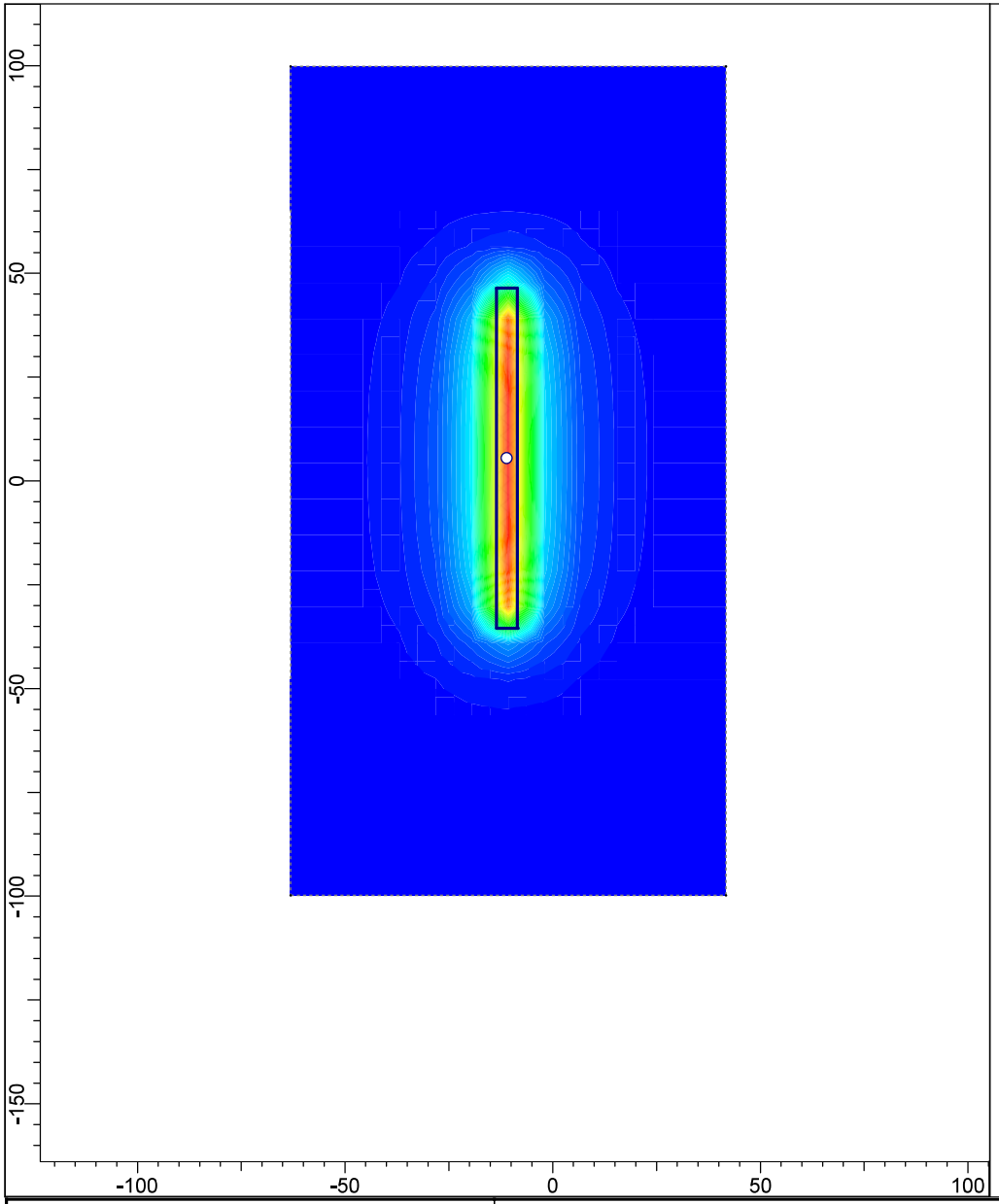
One-Dimensional Consolidation by ASTM D2435 - Method B

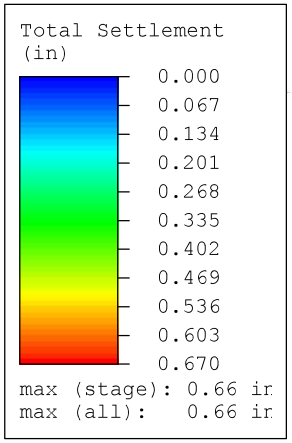
SUMMARY REPORT

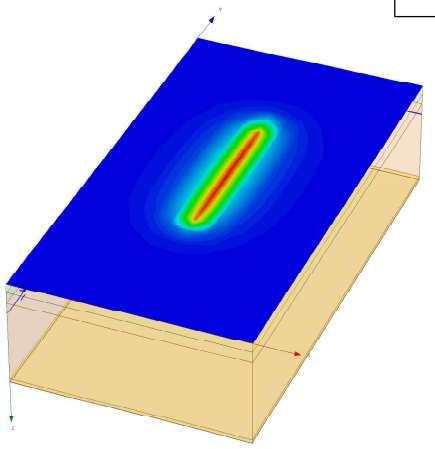


				Before Test	After Test
Current Vertical Effective Stress: ---			Water Content, %	49.31	31.05
Preconsolidation Stress: ---			Dry Unit Weight, pcf	72.432	91.498
Compression Ratio: ---			Saturation, %	100.60	100.00
Diameter: 2.495 in		Height: 1.003 in	Void Ratio	1.32	0.84
LL: 38	PL: 24	PI: 14	GS: 2.69		

	Project: Dayton	Location: --	Project No.: 23551.00
	Boring No.: HB-DAY-101	Tested By: JGG	Checked By: GSL
	Sample No.: 1U	Test Date: 1/8/2020	Test No.: 340676
	Depth: 20.0-22.0 FT	Sample Type: UNDISTURBED	Elevation: --
	Description: Soft Grey Clay		
	Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test		
	Displacement at End of Increment		







rocscience	*Project*	23551, Dayton	
	Analysis Description	Culvert Slipline Settlement	
	Drawn By	Cody Russell	*Company* MaineDOT
	Date	4/22/2021, 2:20:52 PM	*File Name* 23551, Dayton Settlement Analysis.s3z

SETTLE3D 3.006

Settle3D Analysis Information
23551, Dayton

Project Settings

Document Name	23551, Dayton Settlement Analysis.s3z
Project Title	23551, Dayton
Analysis	Culvert Slipline Settlement
Author	Cody Russell
Company	MaineDOT
Date Created	4/22/2021, 2:20:52 PM
Stress Computation Method	Boussinesq
Use average properties to calculate layered stresses	

Stage Settings

Stage #	Name
1	Stage 1

Results

Time taken to compute: 0.120579 seconds

Stage: Stage 1

Data Type	Minimum	Maximum
Total Settlement [in]	0	0.663622
Consolidation Settlement [in]	0	0.65895
Immediate Settlement [in]	0	0.00467179
Loading Stress [ksf]	0	0.84
Effective Stress [ksf]	0	3.55466
Total Stress [ksf]	0	5.61386
Total Strain	0	0.00662403
Pore Water Pressure [ksf]	0	2.0592
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	0.023	3.55016
Over-consolidation Ratio	1	1
Void Ratio	0	1.32
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0.69909

Loads

1. Rectangular Load

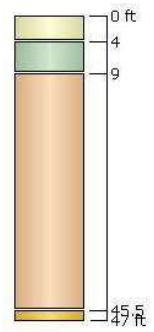
Length	82 ft
Width	5 ft
Rotation angle	90 degrees
Load Type	Flexible
Area of Load	410 ft^2
Load	0.84 ksf
Depth	13.5 ft
Installation Stage	Stage 1

Coordinates

X [ft]	Y [ft]
-8.567	-35.538
-8.567	46.462
-13.567	46.462
-13.567	-35.538

Soil Layers

Layer #	Type	Thickness [ft]	Depth [ft]
1	Gravelly Sand	4	0
2	Sand	5	4
3	Soft to Very Soft Clay and Silt	36.5	9
4	Silty Sand	1.5	45.5



Soil Properties

Property	Gravelly Sand	Sand	Soft to Very Soft Clay and Silt	Silty Sand
Color				
Unit Weight [kips/ft^3]	0.115	0.091	0.1	0.103
Saturated Unit Weight [kips/ft^3]	0.131	0.115	0.125	0.125
Immediate Settlement	Enabled	Enabled	Disabled	Enabled
Es [ksf]	2819.53	355.052		292.396
Esur [ksf]	2819.53	355.052		292.396
Primary Consolidation	Disabled	Disabled	Enabled	Disabled
Material Type			Non-Linear	
Cc			0.074	
Cr			0.00657	
e0			1.32	
OCR	1	1	1	1
Undrained Su A [kips/ft2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Groundwater

Groundwater method Piezometric Lines
Water Unit Weight 0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	14 ft

Field Point Grid

Number of points 312
Expansion Factor 2

Grid Coordinates

X [ft]	Y [ft]
41.6725	99.8265
41.6725	-99.8675
-63.1745	-99.8675
-63.1745	99.8265