

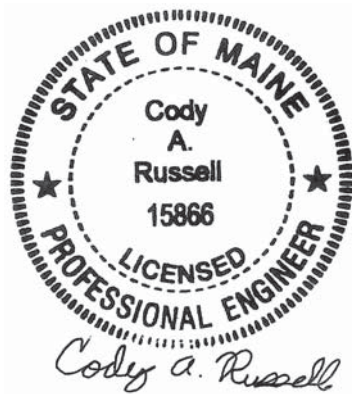
**MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE**

GEOTECHNICAL DESIGN REPORT

For the Reconstruction of:

**TRAFTON ROAD
WATERVILLE, MAINE**

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Kennebec County
WIN 23246.00

Soils Report 2020-05
February 13, 2020

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1.0 INTRODUCTION

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical design and construction recommendations for the reconstruction of an approximately 1.3-mile portion of Trafton Road in Waterville, as shown on Sheet 1 – Location Map. The project is needed to correct deficiencies vertical and horizontal alignment and increase safety. The scope includes reconstruction of the existing travel lanes and shoulders, relocation of two (2) light poles and three (3) large culvert replacements. Trafton Road is a Highway Corridor Priority 3 road.

2.0 GEOLOGIC SETTING

According to the Surficial Geology Map entitled Surficial Geology Waterville Quadrangle, Maine, Open File No. 16-8 (2016) published by the Maine Geological Survey (MGS), the surficial soils along the project length consist of Presumpscot Formation glaciomarine silt, clay, and sand.

According to the MGS map titled Bedrock Geologic Map of Maine (1985) the bedrock along the project consists of interbedded pelite and limestone and/or dolostone of the Sangerville Formation, unnamed sulfidic/carbonaceous pelite, and interbedded pelite and sandstone of the Waterville Formation.

3.0 SUBSURFACE INVESTIGATION

Subsurface conditions at the site were explored by drilling a total of eleven (11) test borings and four (4) probes.

Borings HB-WTVL-101 through HB-WTVL-105, HB-WTVL-107 through HB-WTVL-108, HB-WTVL-110 through HB-WTVL-111 and probes HB-WTVL-106, HB-WTVL-109, and HB-WTVL-112 were drilled between April 9, 2018 and April 11, 2018. Borings HB-WTVL-113 and HB-WTVL-114 were drilled on April 20, 2018. Probe HB-WTVL-201 was drilled on March 6, 2019. All explorations were drilled by the MaineDOT drill crew. The borings were drilled to depths ranging from approximately 12.0 to 19.5 feet below ground surface (bgs) using solid stem auger, cased wash boring, and rock core drilling techniques. The probes were drilled to depths ranging from approximately 10.8 to 14.5 feet bgs using solid stem auger drilling techniques. Boring and probe locations are shown on the Sheets 2 through 12 Boring Location Plans. Boring Logs are presented in Appendix A.

Soil samples were obtained in the borings at standard 5-foot intervals using Standard Penetration Testing (SPT). Bedrock was cored in six (6) of the borings using an NQ 2-inch core barrel and the Rock Quality Designation (RQD) of the rock core was calculated. No soil sampling was done in probes.

The MaineDOT drill rig is equipped with an automatic hammer to drive the split-spoon for soil sampling. The MaineDOT calibrated automatic hammer delivers approximately 42% more energy during driving than the standard rope and cathead system. All N-values discussed in this report are

corrected N-values (N_{60}) computed by applying a hammer efficiency factor of 0.854 to the raw field N-values. Both the raw field N-value and the corrected N_{60} -values are shown on the boring logs.

Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are shown in the Boring Logs in Appendix A. The MaineDOT Geotechnical Team member selected the boring locations, drilling methods, designated type and depth of sampling, reviewed field logs for accuracy and identified field and laboratory testing requirements. A North East Transportation Training and Certification Program (NETTCP) certified subsurface inspector logged the subsurface conditions encountered. The boring and probes were located in the field by taping to site features after completion of the drilling program.

4.0 LABORATORY TESTING

A laboratory testing program was conducted on select soil samples obtained in the test borings and test pits to assist in soil classification, evaluation of engineering properties of the soils and geologic assessment of the project site. Laboratory testing consisted of thirteen (13) standard grain size analyses and natural water content, eighteen (18) grain size analyses with hydrometer and natural water content, and three (3) Atterberg Limits tests. Two (2) samples had insufficient material for laboratory testing. The results of the laboratory tests are in Appendix B – Laboratory Test Results. Laboratory test results are also summarized on the boring logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions encountered at the test borings generally consisted of pavement and fill soils underlain by native sand, silt and glacial till. The boring locations are shown on Sheets 2 through 12 - Boring Location Plans. The boring logs are in Appendix A – Boring Logs.

5.1 Pavement and Fill Soils

The subsurface investigations found areas of pavement and roadway fill soils along the project. Where present, the pavement thickness ranged from approximately 3 to 4 inches. The fill soils consisted of:

- Brown, damp to moist, fine to coarse sand, trace to little silt, trace to some gravel.
- Dark brown, damp, gravelly fine to coarse sand, little silt.
- Brown, damp to moist, gravel, some fine to coarse sand, little to some silt.

The thickness of the fill ranged from approximately 2.5 to 9.7 feet. SPT N_{60} -values obtained in the fill sand ranged from 6 to 61 blows per foot (bpf) indicating that the fill is loose to very dense in consistency.

Water contents from twelve (12) samples obtained within the fill layer range from approximately 4% to 14%. Grain size analyses conducted on twelve (12) samples of the fill resulted in the soil being classified as an A-1-a, A-1-b, or A-2-4 under the AASHTO Soil Classification System and an SM or GM under the Unified Classification System.

5.2 Silt and Clayey Silt

In most areas the fill is underlain by layers of native silt, and clayey silt. The silt consisted of olive, olive brown, brown, light brown, and grey, moist to wet, silt, trace to little fine to coarse sand, trace to some clay, trace to little gravel. The thickness of the silt ranged from approximately 3.5 to 9.0 feet but the silt layers were not fully penetrated in all the explorations. SPT N_{60} -values obtained in the silt ranged from 9 to 26 bpf indicating that the silt is stiff to very stiff in consistency.

In one location (boring HB-WTVL-102) the fill and silt layers were separated by an approximately 2.2-foot thick layer of olive, moist soft, clayey silt, trace fine to coarse sand and trace gravel.

Water contents from thirteen (13) samples obtained within the silt and clayey silt layers range from approximately 17% to 29%. Grain size analyses with hydrometer conducted on thirteen (13) samples of the silt and clayey silt resulted in the soil being classified as an A-4 under the AASHTO Soil Classification System and a CL under the Unified Classification System.

The following table summarizes the results of Atterberg Limits tests done on three (3) samples of the silt:

Boring No. and Sample No.	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
HB-WTVL-101 2D	27.3	32	22	10	0.53
HB-WTVL-102 2D	24.0	29	21	8	0.38
HB-WTVL-110 2D	29.1	32	23	9	0.68

Interpretation of these results shows that the water content is between the liquid limit and the plastic limit indicating that the silt is overconsolidated and has experienced higher stresses in the past. The liquidity indices of the samples were calculated to be less than 1 indicating that the silt has low plasticity.

5.3 Glacial Till

In most areas the fill and silt are underlain by glacial till. The glacial till consisted of:

- Brown or grey, wet, fine to coarse sand, little to some silt, trace to some gravel, trace clay.
- Olive brown, wet, silty fine to coarse sand, trace clay, trace gravel.
- Light brown, wet, gravel, some fine to coarse sand, some silt.
- Grey, wet, fine to coarse sandy gravel, little silt.
- Grey, wet, silt, some gravel, little fine to coarse sand, little clay.

- Olive brown, wet, fine to coarse sandy silt, trace clay, trace gravel.

The thickness of the glacial till layer ranged from approximately 0.5 feet to 6.0 feet. The full depth of the glacial till was not penetrated in all the explorations. SPT N_{60} -values obtained in the glacial till layer ranged from 11 to >50 bpf indicating that the glacial till is medium dense to very dense in consistency.

Water contents from six (6) samples obtained within the glacial till layer range from approximately 9% to 25%. Grain size analyses and grain size analyses with hydrometer conducted on six (6) samples of glacial till resulted in the soil being classified as an A-1-b, A-2-4, or A-4 under the AASHTO Soil Classification System and a GM, SC-SM, or CL under the Unified Soil Classification System.

5.4 Bedrock

Bedrock was encountered at varying depths along the project. Refusal of the drilling tools varied from a depth of approximately 9.5 feet to 13.6 feet bgs in six (6) borings and four (4) probes. Bedrock was cored in each of the borings. The exact nature of the refusal surface was not determined in the probes. The table below summarizes the refusal surfaces encountered.

Approximate Station	Approximate Depth to Refusal (feet bgs)
327+82.5	9.5
329+43.1 to 330+00	10.8 - 13.6
346+20 to 346+96	10.5 - 11.3
357+87.9 to 358+08	11.0 – 14.5
360+06	11.5

The Rock Quality Designation (RQD) of the bedrock was determined to range between 0% and 83% correlating to Rock Quality ranging from very poor to good.

5.5 Groundwater

Groundwater levels were observed in four (4) borings. The measured groundwater levels in the borings where groundwater was observed ranged were approximately 5.8 and 8.7 feet bgs. The water levels observed are indicated on the boring logs in Appendix A. Note that in some cases water was introduced into the boreholes during the drilling operations. Groundwater levels can be expected to fluctuate subject to seasonal variations, local soil conditions, topography, precipitation, and construction activity.

6.0 GEOTECHNICAL RECOMMENDATIONS

The following sections discuss the geotechnical-related design features of this project. Areas of geotechnical concern are:

- Relocated light poles at approximate Stations 305+76 and 319+87
- Large Culvert at approximate Station 329+72
- Trafton Brook Bridge at approximate Station 346+88
- Farm Pond Bridge at approximate Station 357+72
- Bedrock Removal

6.1 Light Pole Foundations

Two (2) existing light poles will be relocated on new foundations at approximate Stations 305+76 and 319+87. The proposed foundations will consist of 30-inch diameter, 8.5-foot long cast-in-place concrete drilled shafts. The foundations design was completed in accordance with LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals and AASHTO LRFD Bridge Design Specifications 8th Edition 2017 based on the loading conditions of the existing light poles provided by the pole supplier (P&K Tubular, Inc. 4/21/2017). The foundation designs are shown on Sheets 13 and 14 – Light Pole Foundation and Boring Location Plan with Boring Logs.

6.2 Large Culvert and Bridge Structures

6.2.1 General Information

Large Culvert at 329+72 – The existing structure at approximate Station 329+72 is twin 48-inch and 24-inch corrugated metal pipe (CMP) culverts. The proposed replacement structure is a 9-foot span by 8-foot rise, 96-foot long precast concrete box culvert on an approximately 22-degree skew with an inlet elevation of approximately 149.9 feet and an outlet elevation of approximately 149.3 feet.

One (1) boring and (1) probe were drilled at opposite, diagonal corners of the proposed structure. The boring locations and the interpretive subsurface profile are shown on Sheet 15 – Boring Location Plan & Interpretive Subsurface Profile with Boring Logs. The boring logs are also provided in Appendix A – Boring Logs.

Boring HB-WTVL-105 was drilled to refusal at a depth of approximately 13.6 feet bgs. Bedrock was cored in the boring for a total depth of approximately 18.6 feet bgs. The subsurface conditions encountered in the boring consisted of sand fill underlain by native silt underlain by sandy gravel till underlain by bedrock. One (1) SPT N_{60} -value obtained in the fill was 24 bpf indicating that the fill is medium dense in consistency. One (1) SPT N_{60} -value obtained in the silt was 14 bpf indicating that the silt is stiff in consistency. One (1) SPT N_{60} -value obtained in the till was 36 bpf indicating that the till is dense in consistency. The RQD of the bedrock was determined to be 58 percent in boring HB-WTVL-105 which correlates to a Rock Quality of Fair. Probe HB-WTVL-

106 was drilled to a depth of approximately 10.8 feet bgs where it encountered a refusal surface. The exact nature of the refusal surface was not determined in the probe.

Trafton Brook Bridge at approximate Station 346+88 – The existing structure at approximate Station 346+88 is twin 48-inch and 24-inch CMP culverts. The proposed replacement structure is a 15-foot span by 6-foot rise, 88-foot long precast concrete box culvert on an approximately 8-degree skew with an inlet elevation of approximately 131.5 feet and an outlet elevation of approximately 130.2 feet.

One (1) boring and one (1) probe were drilled at opposite, diagonal corners of the proposed structure. The boring locations and the interpretive subsurface profile are shown on Sheet 16 – Boring Location Plan & Interpretive Subsurface Profile with Boring Logs. The boring logs are also provided in Appendix A – Boring Logs.

Boring HB-WTVL-108 to refusal at a depth of approximately 11.3 feet. Bedrock was cored in the boring for a total depth of approximately 15.6 feet bgs. The subsurface conditions encountered in the boring consisted of gravel fill underlain by sand till underlain by bedrock. SPT N_{60} -values in the fill ranged from 16 to 61 bpf indicating that the fill is medium dense to very dense in consistency. One (1) SPT N_{60} -value obtained in the till was >50 bpf indicating that the till is very dense in consistency. The RQD of the bedrock was determined to be 16 percent in boring HB-WTVL-108 which correlates to a Rock Quality of Very poor. Probe HB-WTVL-109 was drilled to a depth of approximately 11.0 feet bgs where it encountered a refusal surface. The exact nature of the refusal surface was not determined in the probe.

Farm Pond Bridge at approximate Station 357+72 – The existing structure at approximate Station 357+72 is twin 48-inch and 24-inch CMP culverts. The proposed replacement structure is a 15-foot span by 6-foot rise, 104-foot long precast concrete box culvert on an approximately 28-degree skew with an inlet elevation of approximately 116.1 feet and an outlet elevation of approximately 115.6 feet.

One (1) boring and one (1) probe were drilled near the proposed structure. The boring locations and the interpretive subsurface profile are shown on Sheet 17 – Boring Location Plan & Interpretive Subsurface Profile with Boring Logs. The boring logs are also provided in Appendix A – Boring Logs.

Boring HB-WTVL-111 to refusal at a depth of approximately 11.0 feet bgs. Bedrock was cored in the boring for a total depth of 19.5 feet bgs. The subsurface conditions encountered in the boring consisted of gravelly sand and gravel fill underlain by silt till underlain by bedrock. Two (2) SPT N_{60} -values obtained in the fill were both 26 bpf indicating that the fill is medium dense in consistency. No SPT N -values were obtained in the till. The RQD of the bedrock in boring HB-WTVL-111 was determined to be 0 percent in the first core run and 27 percent in the second which correlates to a Rock Quality of Very Poor to Poor, respectively. Probe HB-WTVL-201 was drilled to a depth of approximately 12.7 feet bgs where it encountered a refusal surface. The exact nature of the refusal surface was not determined in the probe.

6.2.2 Design and Construction – The proposed precast concrete box culverts shall be constructed in accordance with MaineDOT Standard Specification Section 534 and the Contract Plans. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the precast concrete box culverts as shown on the Streambed Details Sheets in the Plans.

The proposed precast concrete box culverts can be bedded on a 1-foot thick layer of Granular Borrow, Material for Underwater Backfill (MaineDOT Item 203.25, Granular Borrow). The bedding material should be placed in lifts of 6 to 8 inches loose measure and compacted to at least 95 percent of the AASHTO T-180 maximum dry density. The exposed subgrade shall be free of ponded water so that bedding material placement and compaction can be completed in the dry. The entire culvert bedding subgrade should be proof-rolled with multiple passes of a static roller to identify loose or weaving areas that require over-excavation and replacement and to achieve a firm and stable surface for construction. All subgrade surfaces shall be protected from any unnecessary construction traffic.

Due to the presence of shallow bedrock at the proposed culvert locations, bedrock removal will be necessary to construct the culvert at the planned elevations. Prior to placing the culvert bedding material, the bedrock surface shall be cleaned of all weathered bedrock, fractured material, loose soil, and/or ponded water. The full nature of the culvert bearing surface will not become evident until the culvert excavation is made. The need for and depth of bedrock removal will vary over the length of the precast concrete structures. The bottom elevation of the excavation shall take into account the wall thickness of the box culvert and the required 1-foot layer of bedding material. Any loose soils or soft or unsuitable materials encountered in the excavations shall be removed and replaced with Granular Borrow Material for Underwater Backfill (MaineDOT 703.19) or Crushed Stone ¾-Inch (MaineDOT 703.13). Any cobbles or boulders encountered in excess of 6 inches shall be removed and replaced with compacted Granular Borrow Material for Underwater Backfill or Crushed Stone ¾-Inch.

The soil envelope and backfill shall also consist of Granular Borrow (703.19) with a maximum particle size of 4 inches. The granular borrow backfill material shall be placed in lifts of 6 to 8 inches loose measure and compacted to the manufacturer’s specifications or, in the absence of manufacturer’s specifications, the bedding and backfill soil shall be compacted to at least 92 percent of the AASHTO T-180 maximum dry density.

Bearing Resistance - The factored bearing resistances for the proposed precast concrete box culverts bearing on compacted granular bedding placed on till at the service and strength limit states are presented in the table below. Supporting calculations in accordance with AASHTO LRFD Bridge Design Specifications 8th Edition 2017 (LRFD) are provided in Appendix C – Calculations.

Structure	Limit State	Resistance Factor ϕ_b	AASHTO LRFD Reference	Factored Bearing Resistance (ksf)
Large Culvert @ Sta. 329+72	Service	1.0	Article 10.5.5.1	10
	Strength	0.45	Table 10.5.5.2.2-1	5
Trafton Brook Bridge	Service	1.0	Article 10.5.5.1	8
	Strength	0.45	Table 10.5.5.2.2-1	8

Farm Pond Bridge	Service	1.0	Article 10.5.5.1	6
	Strength	0.45	Table 10.5.5.2.2-1	8

Modulus of Subgrade Reaction - The modulus of subgrade reaction for the proposed precast concrete box culverts bearing on compacted granular bedding placed on till at the service and strength limit states are presented in the table below. See Appendix C – Calculations for supporting documentation.

Structure	Modulus of Subgrade Reaction (pci)
Large Culvert @ Sta. 329+72	300
Trafton Brook Bridge	175
Farm Pond Bridge	150

6.3 Settlement

No settlement issues are anticipated for either the roadway or the proposed structures. The installation of the larger proposed culverts will result in a net unloading of the site soils at the structure locations. Placement of fill soils at the location of the existing structures and in areas where the proposed roadway grade is higher than existing is not anticipated to exceed the past loading condition of the site soils.

6.4 Scour and Riprap

Both the inlet and outlet of the proposed precast concrete box culverts shall be armored with riprap conforming to MaineDOT Supplemental Specification Section 703.26 Plain and Hand Laid Riprap. Riprap slopes shall not be steeper than 2H:1V. The riprap on the slopes shall be underlain by a non-woven Class 1 erosion control geotextile that meets the requirements for MaineDOT Standard Specification 722.03 that is underlain by a 1-foot layer of protective aggregate cushion conforming to MaineDOT Standard Specification 703.19 Granular Borrow Material for Underwater Backfill.

6.5 Seismic Design Considerations

In conformance with LRFD Article 3.10.1, seismic analysis is not required for buried structures, except where they cross active faults. There are no known active faults in Maine; therefore, seismic analysis is not required.

6.6 Additional Construction Considerations

Construction of the proposed precast concrete box culverts will require soil excavation. Earth support systems will be required if laying back slopes is not feasible. Regardless of the method of excavation, all excavations and earth support systems shall meet all applicable OSHA regulations.

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 to allow construction in the dry.

6.7 Bedrock Removal

Refusal of the drilling tools was encountered in several borings and probes along the project (see Sections 5.4 and 6.2.2). Bedrock removal is anticipated for drainage and subgrade installation near these locations. Additional shallow bedrock may be encountered during construction at other locations.

Blasting, if required, shall be conducted in accordance with MaineDOT Standard Specifications Sections 105.2.7 and 203. The Contractor is required to conduct pre- and post-blast surveys, as well as blast vibrations monitoring at nearby structures in accordance with industry standards at the time of the blast.

7.0 CLOSURE

This report has been prepared for the use of the MaineDOT Highway Program for specific application to the proposed reconstruction of Trafton Road in Waterville, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

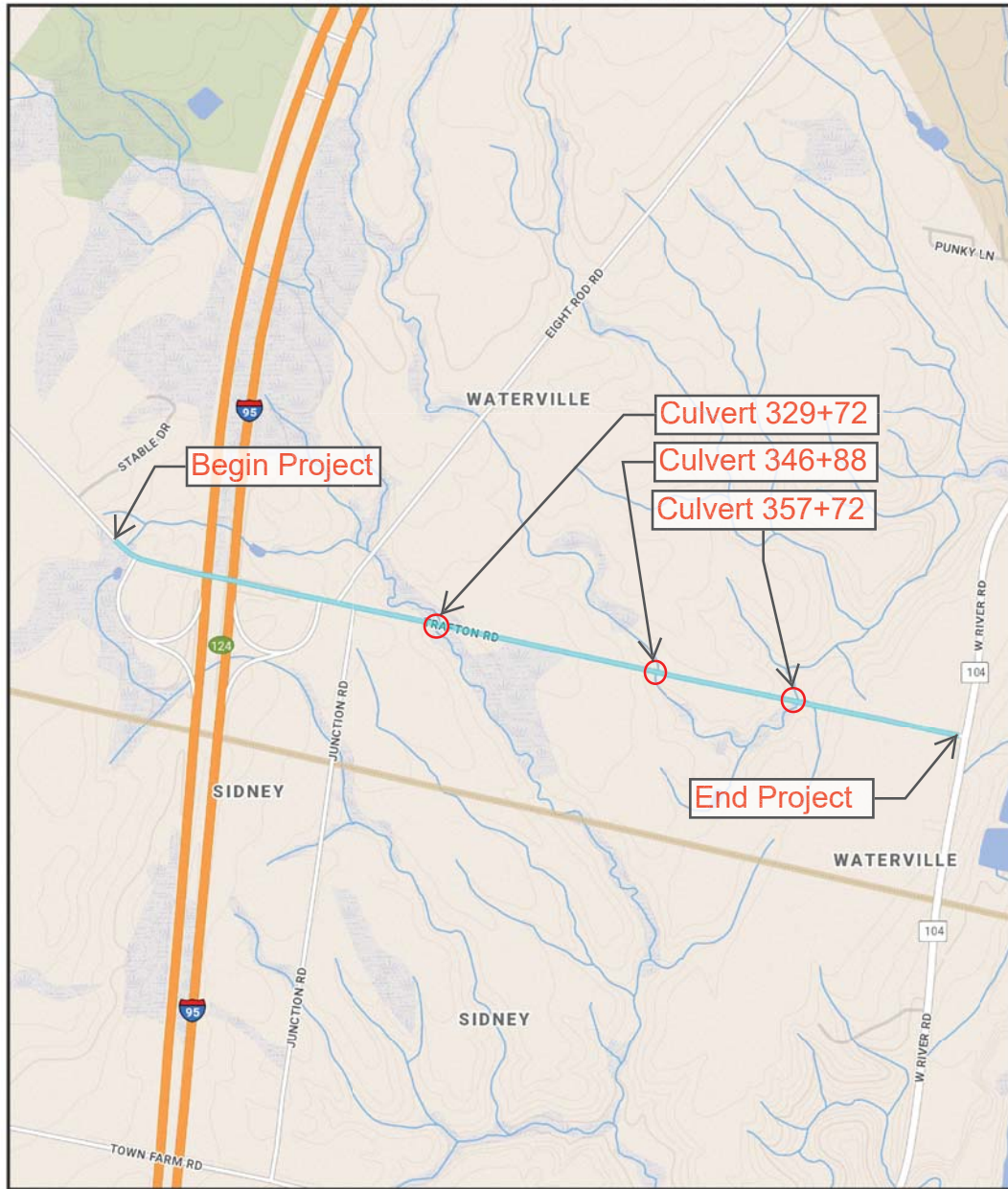
In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes in design. These analyses and recommendations are based in part upon a limited subsurface investigation at discrete exploratory 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.

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.

Sheets



WATERVILLE, MAINE

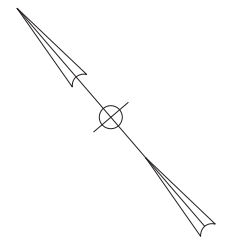
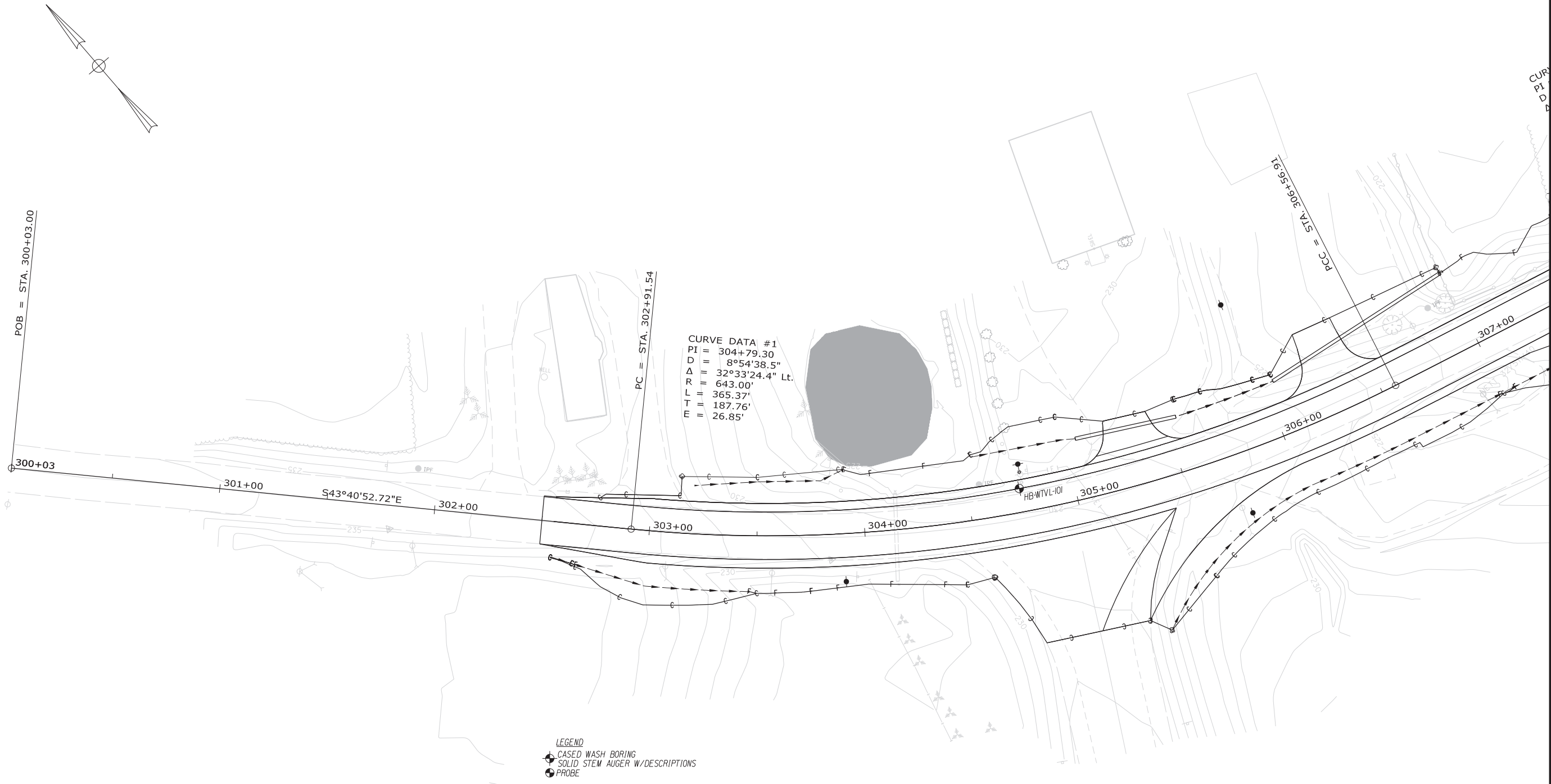


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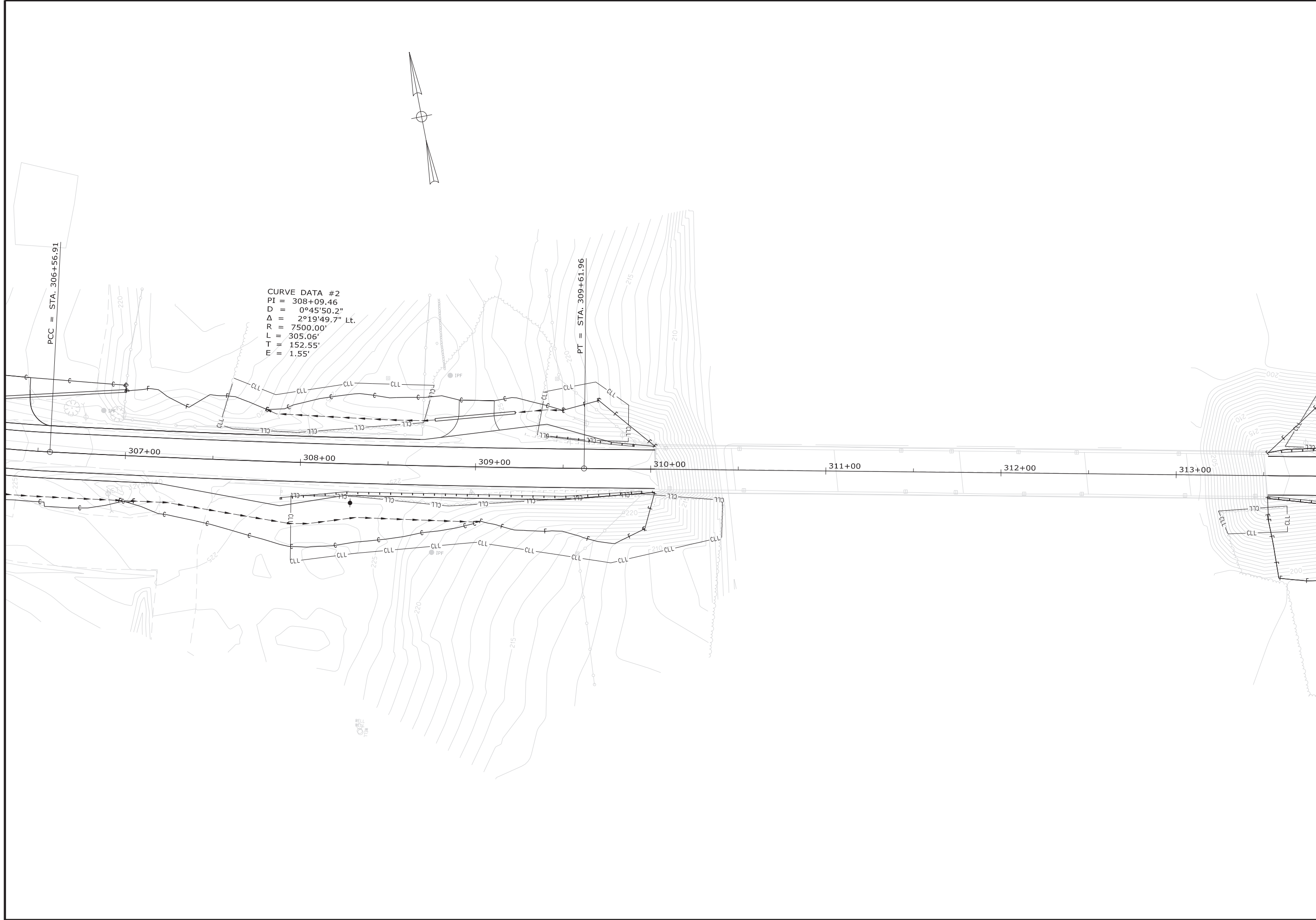
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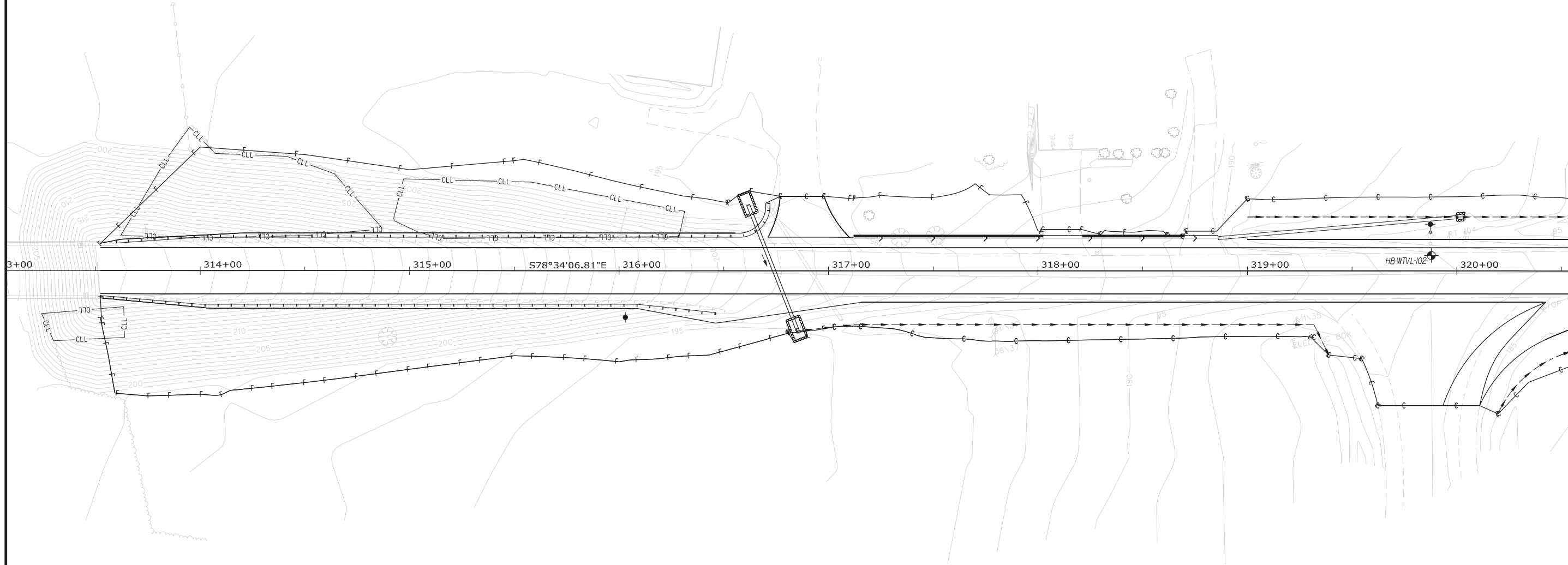
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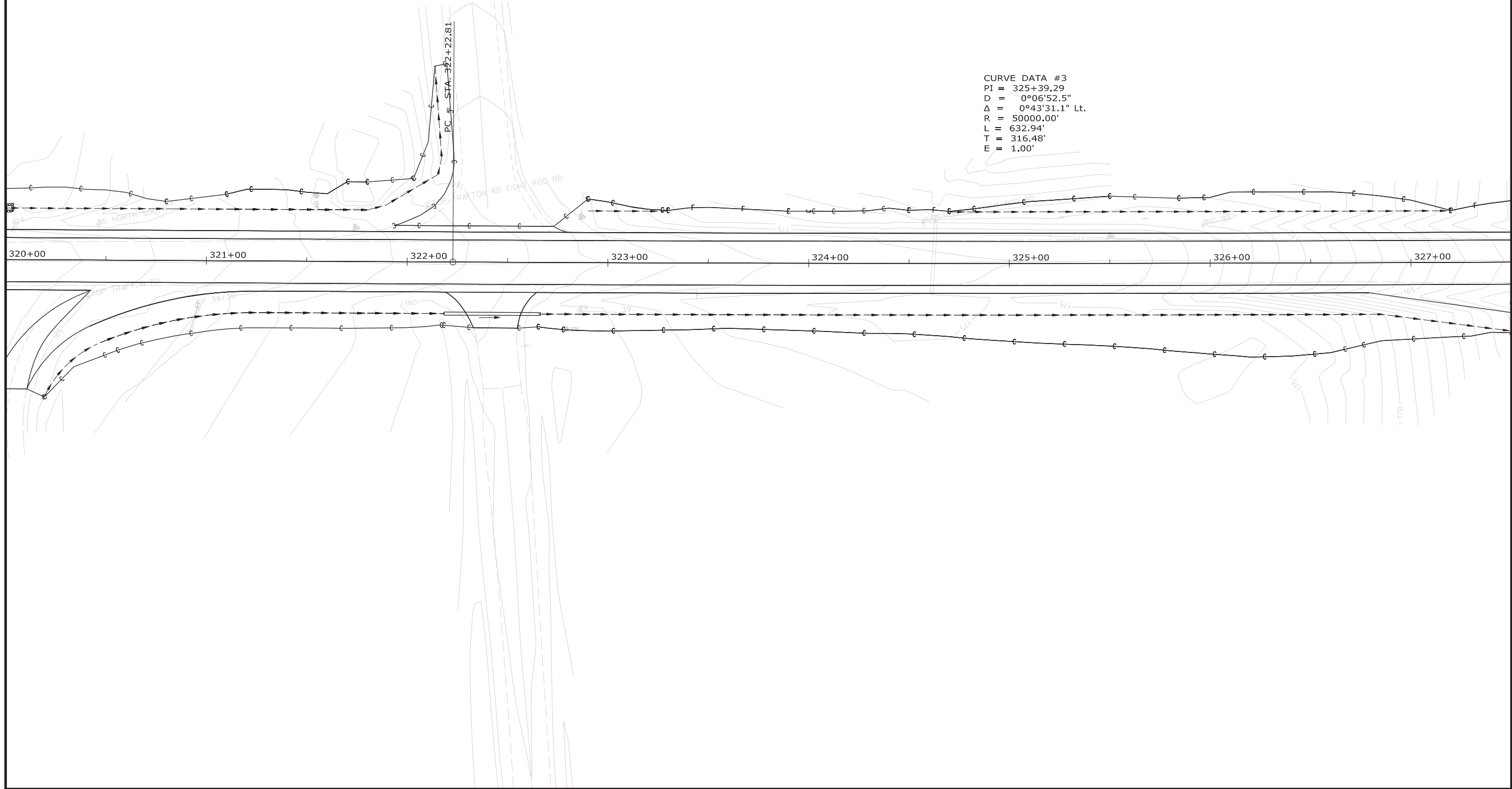


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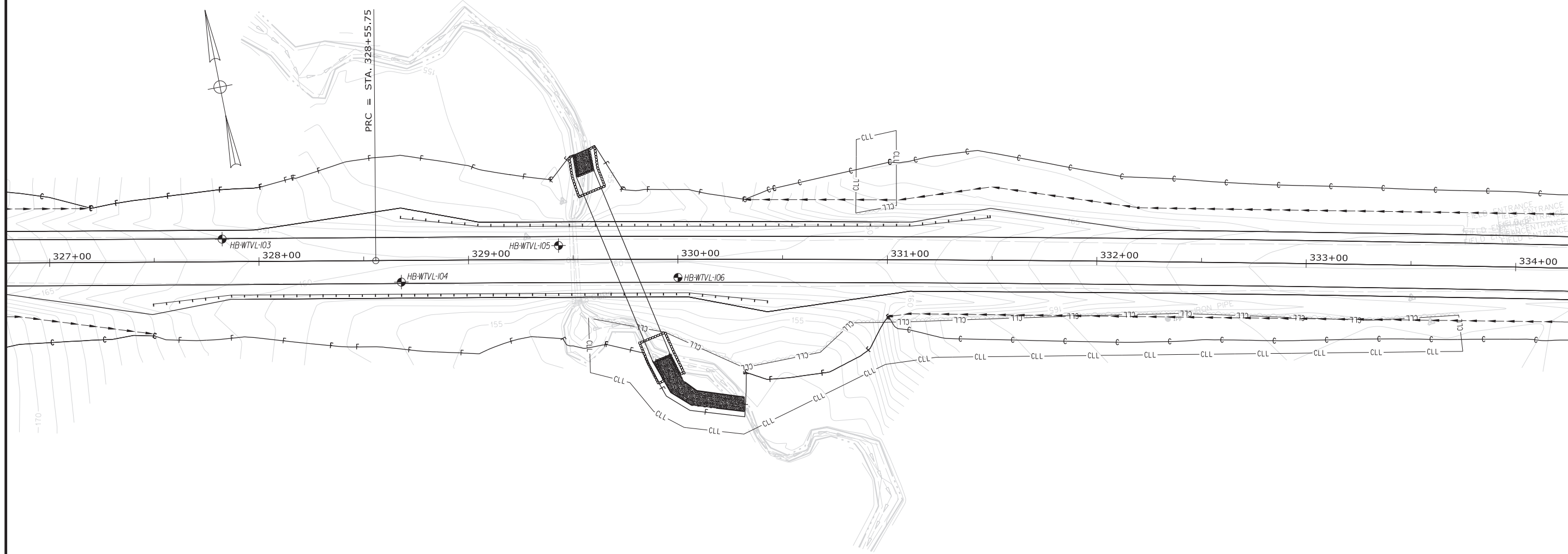


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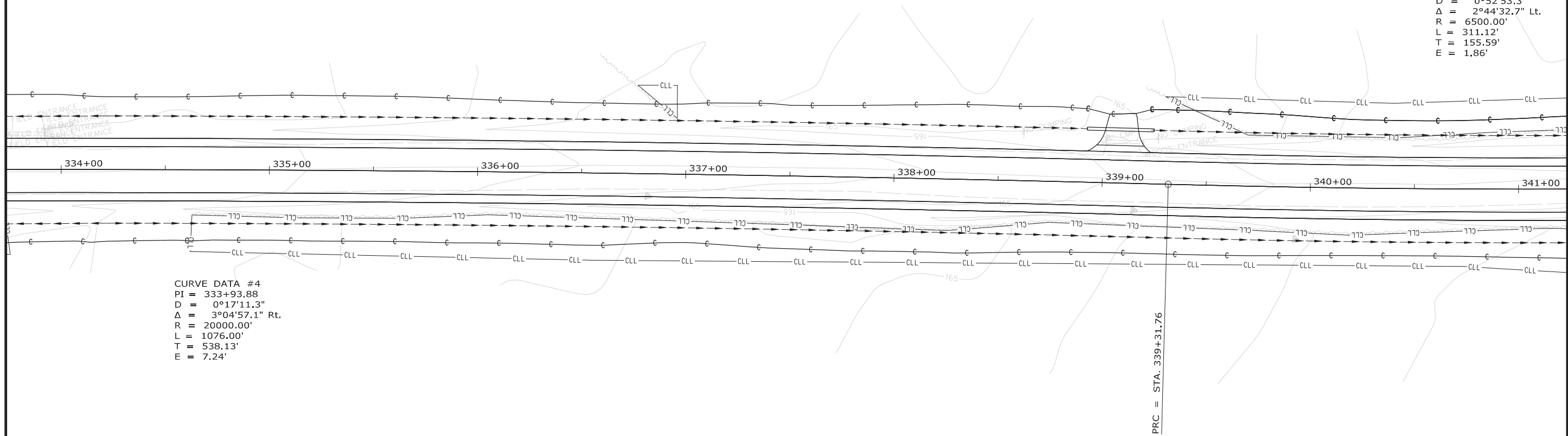
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REVISIONS 3		DATE	
REVISIONS 4			
FIELD CHANGES			



CURVE DATA #4
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 D = 0°17'11.3"
 Δ = 3°04'57.1" Rt.
 R = 20000.00'
 L = 1076.00'
 T = 538.13'
 E = 7.24'

CURVE DATA #5
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 D = 0°52'53.3"
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 R = 6500.00'
 L = 311.12'
 T = 155.59'
 E = 1.86'

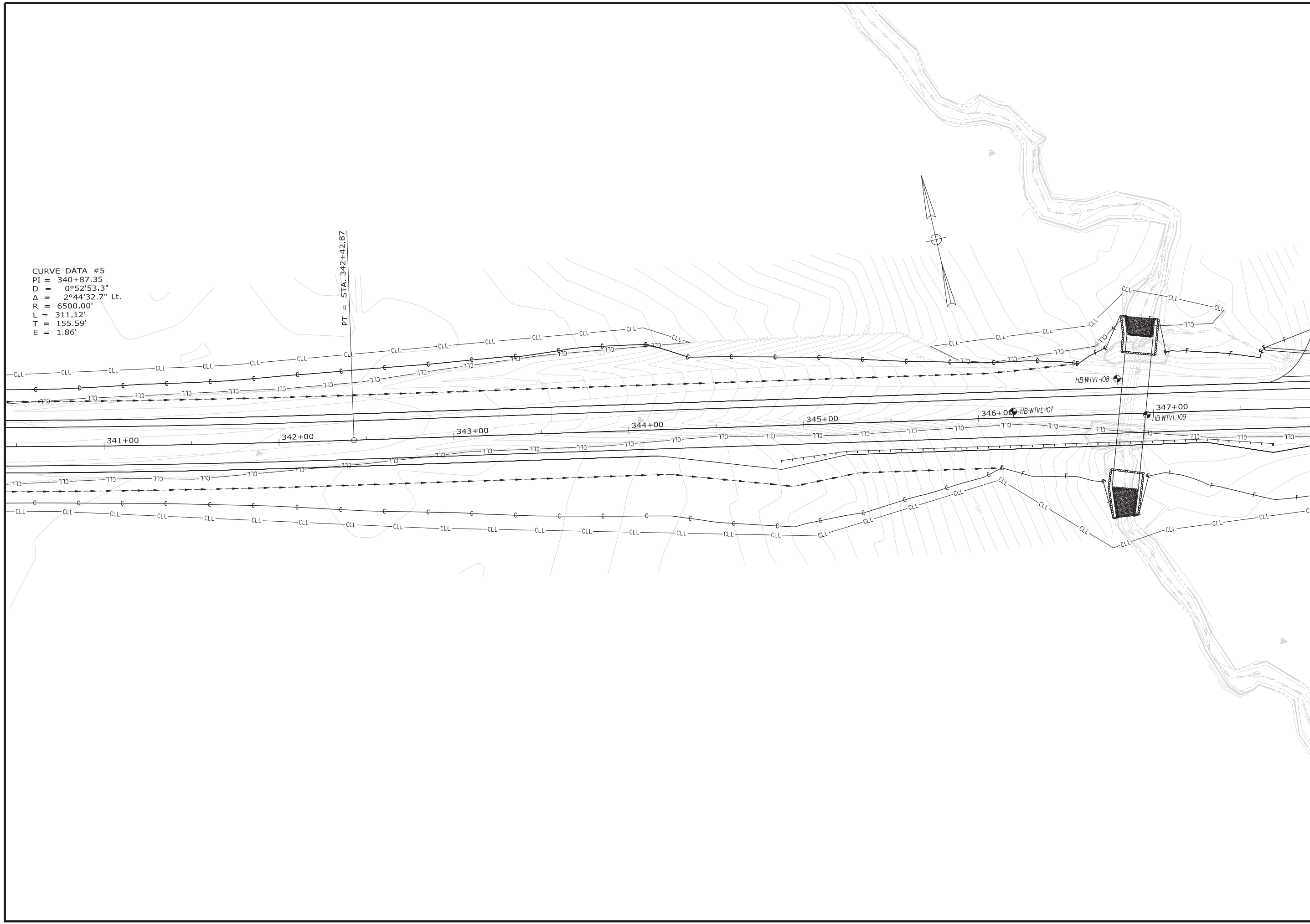
STATE OF MAINE
 DEPARTMENT OF TRANSPORTATION
 023246.00
 WIN
 023246.00
 HIGHWAY PLANS

DATE	SIGNATURE	P.E. NUMBER
JAN 2020	T. WHITE	

PROJ. MANAGER	BY	DATE
E. MARTIN	M. YOUNG-SEAGGS	
CHECKED-REVIEWED		
DESIGNS-DETAILED	C. RUSSELL	
DESIGNS-DETAILED		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

WATERVILLE
 TRAFTON ROAD
 BORING LOCATION PLAN

SHEET NUMBER
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 OF 17



CURVE DATA #5
 PI = 340+87.35
 D = 0°52'53.3"
 Δ = 2°44'32.7" Lt.
 R = 6500.00'
 L = 311.12'
 T = 155.59'
 E = 1.86'

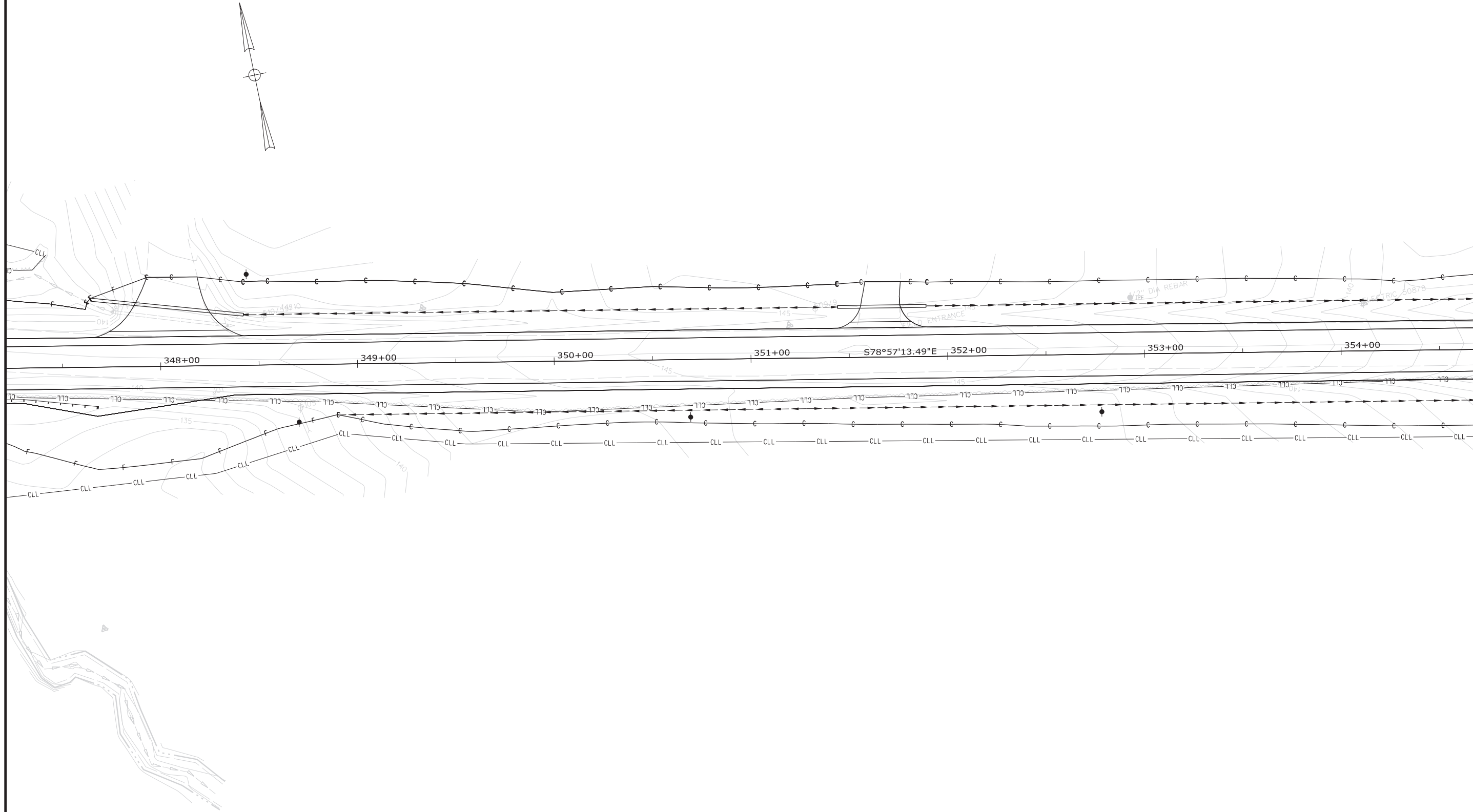
PT = STA. 342+42.87

STATE OF MAINE
 DEPARTMENT OF TRANSPORTATION
 023246.00
 WIN
 023246.00
 HIGHWAY PLANS

PROJ. MANAGER	E. MARTIN	BY	DATE
DESIGN-DETAILED	M. YOUNG-SAGGS		
CHECKED-REVIEWED			
DESIGN-DETAILED	C. RUSSELL	T. WHITE	JAN 2020
DESIGN-DETAILED			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

WATERVILLE
 TRAFTON ROAD
 BORING LOCATION PLAN

SHEET NUMBER
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 OF 17



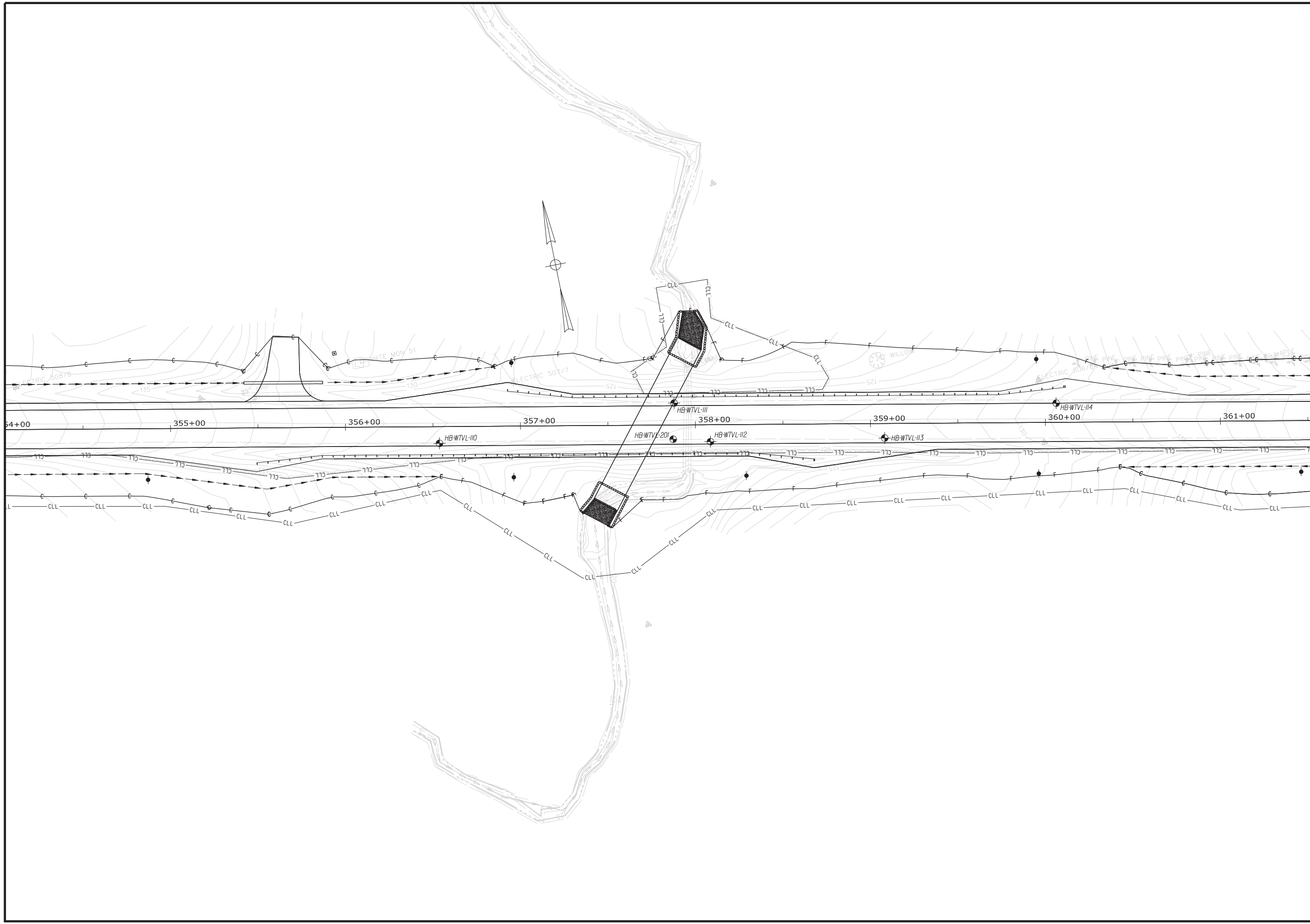
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
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WIN
023246.00
HIGHWAY PLANS

PROJ. MANAGER
E. MARTIN
BY
M. YOUNG-SEAGGS
CHECKED-REVIEWED
DESIGN-DETAILED
DESIGNS-DETAILED
REVISIONS 1
REVISIONS 2
REVISIONS 3
REVISIONS 4
FIELD CHANGES

DATE
JAN 2020
SIGNATURE
T. WHITE
P.E. NUMBER
DATE

WATERVILLE
TRAFTON ROAD
BORING LOCATION PLAN

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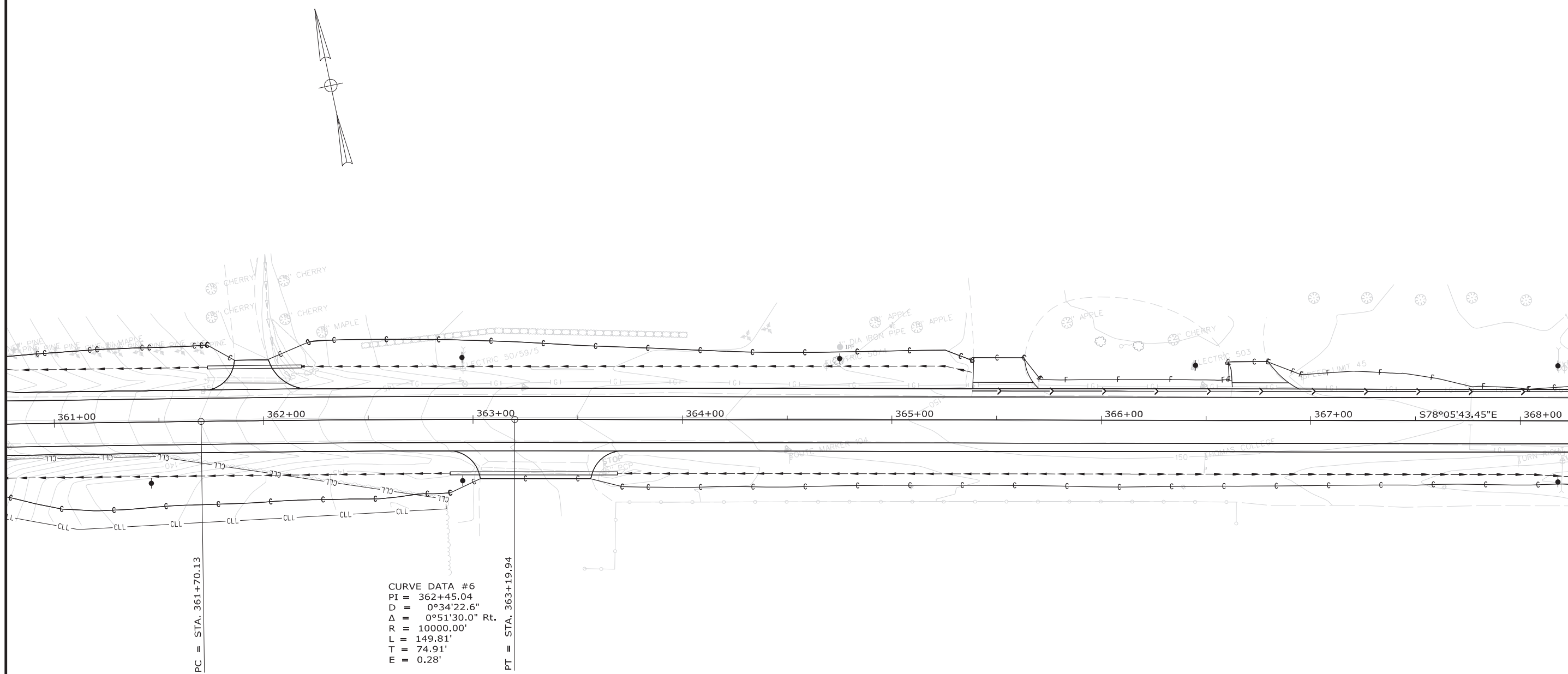
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
023246.00
WIN
023246.00
HIGHWAY PLANS

SIGNATURE
P.E. NUMBER
DATE

PROJ. MANAGER	BY	DATE
E. MARTIN		
CHECKED-REVIEWED	M. YOUNG-SRAGGS	
DESIGNS-DETAILED	C. RUSSELL	JAN 2020
DESIGNS-DETAILED	T. WHITE	
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

WATERVILLE
TRAFTON ROAD
BORING LOCATION PLAN

SHEET NUMBER
10
OF 17

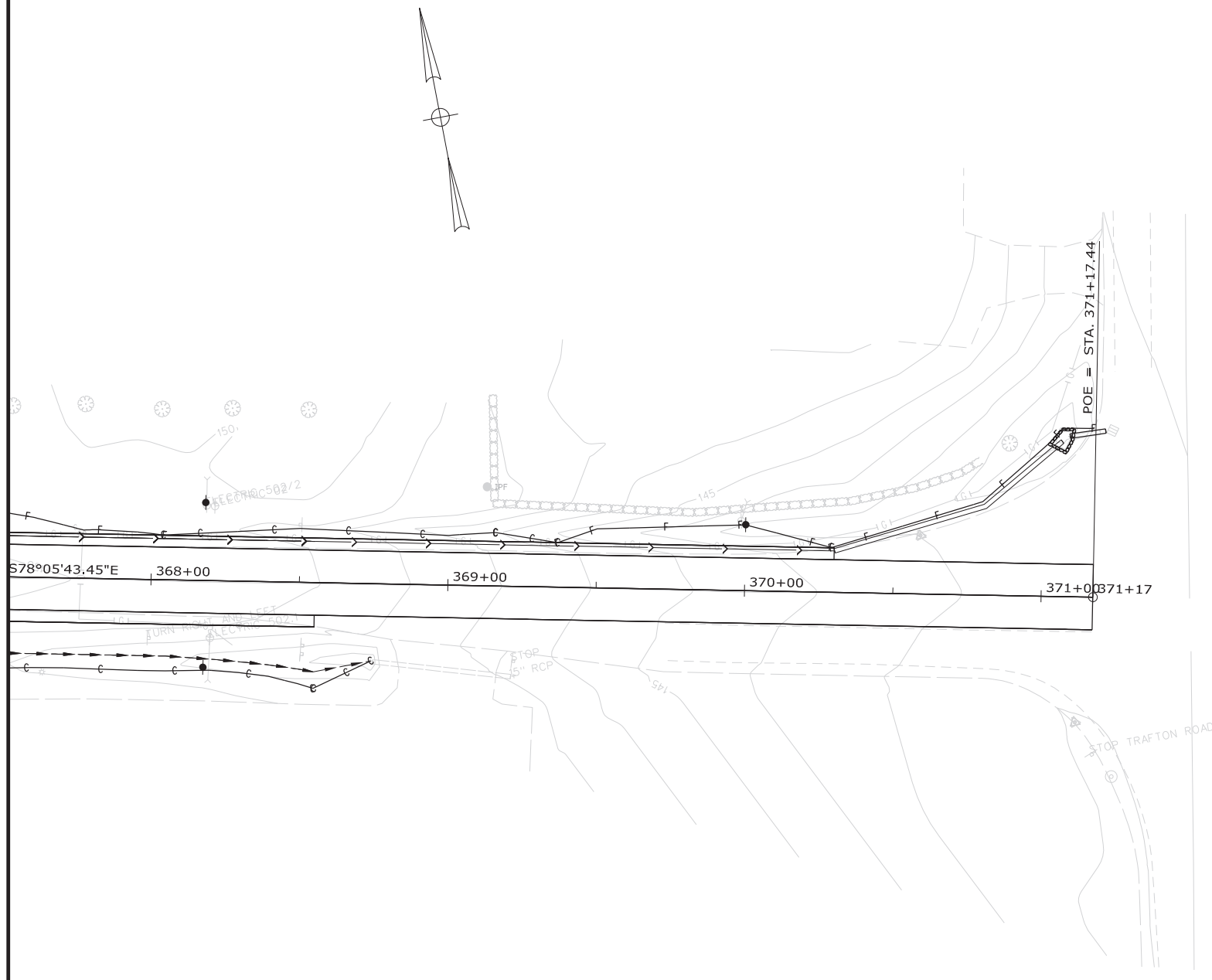


STATE OF MAINE
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 WIN 023246.00
 HIGHWAY PLANS

PROJ. MANAGER	E. MARTIN	BY	DATE
DESIGN-DETAILED	M. YOUNG-SEAGGS		
CHECKED-REVIEWED			
DESIGN-DETAILED	C. RUSSELL	T. WHITE	JAN 2020
DESIGN-DETAILED			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

WATERVILLE
 TRAFTON ROAD
 BORING LOCATION PLAN

SHEET NUMBER
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 OF 17

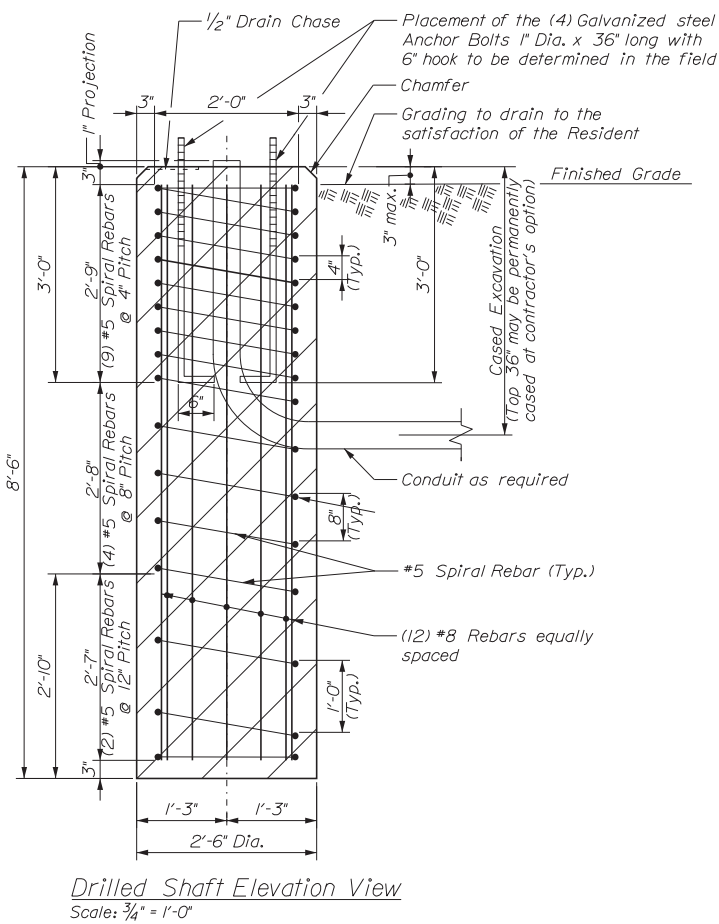
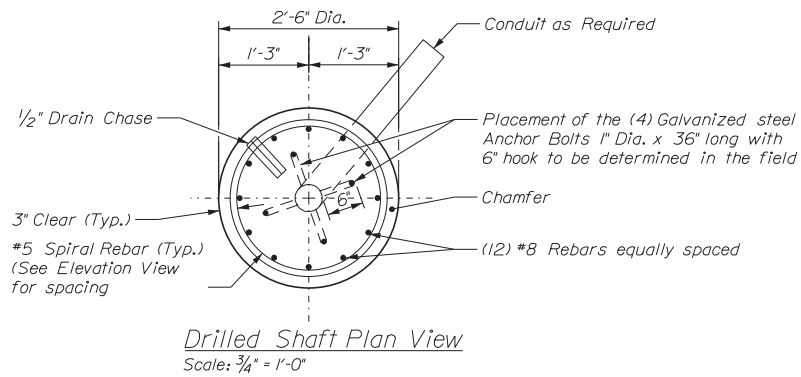


SHEET NUMBER
12
OF 17

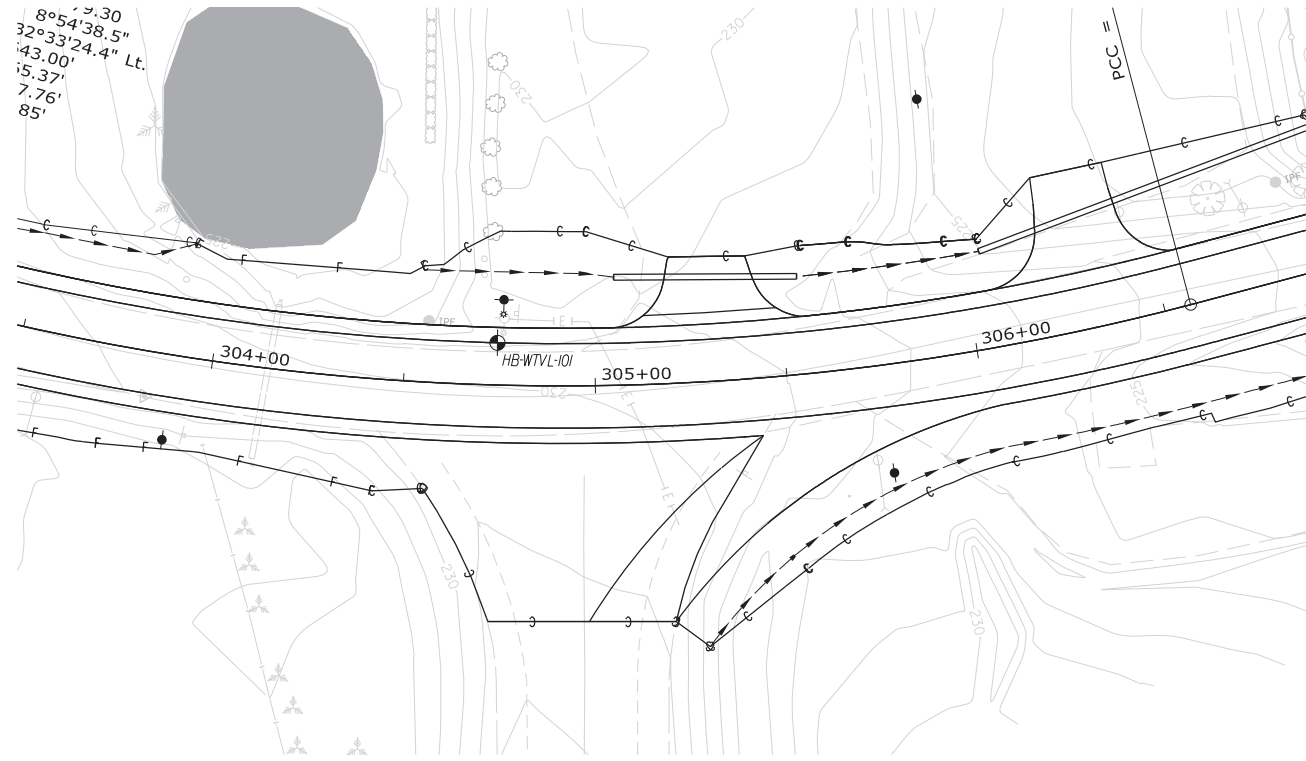
WATERVILLE
TRAFTON ROAD
BORING LOCATION PLAN

PROJ. MANAGER	E. MARTIN	BY	DATE
DESIGN-DETAILED	M. YOUNG-SR	AGGS	
CHECKED-REVIEWED	C. RUSSELL	T. WHITE	JAN 2020
DESIGN-DETAILED			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
023246.00
WIN
023246.00 HIGHWAY PLANS



LIGHT POLE FOUNDATION



- NOTES:
1. All reinforcing steel is to be grade 60 and conform to MaineDOT Standard Specification requirements along with any project specific Supplementals or Special Provisions.
 2. All rebar shall have 3" cover unless otherwise noted.
 3. Should there be a discrepancy between these Details and actual observed field conditions report it to the Resident immediately.
 4. Do not proceed with dependent work until any such discrepancy is resolved to the satisfaction of the Resident.
 5. Concrete to be Class LP with $f'c = 5,000$ PSI.

Maine Department of Transportation Soil/Borehole Exploration Log US CUSTOMER UNITS		Project: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine		Boring No.: HB-WTVL-101 WIN: 23246.00				
Driller: Molinebdt	Elevation (ft.): 228.7	Auger ID/DB: 5" Bit						
Operator: Troy L Johnson	Date: N/A	Supplier: Standard Spill Spoon						
Logged By: B. White	Rtg Type: ENE 45C	Hammer Wt./Fall: N/A						
Date Started/Finished: 4/9/2018-4/9/2018	Drilling Method: Solid Stem Auger	Cone Barrels: N/A						
Boring Location: 304+4.3, 11.1 Ft Lt.	Casing ID/DB: N/A	Water Level: None Observed						
Hammer Efficiency Factor: 0.854	Hammer Type: Automatic 80	Log Scale: 1/4" = 1'-0"						
R = Rock Core Sample S = Soil Sample W = Unconsolidated Soil Sample U = Unconsolidated Soil Sample C = Consolidated Soil Sample G = Gravel Sample M = Muck Sample O = Organic Material Sample P = Peat Sample F = Fines Sample L = Lignite Sample C = Coal Sample S = Sand Sample G = Gravel Sample M = Muck Sample O = Organic Material Sample P = Peat Sample F = Fines Sample L = Lignite Sample C = Coal Sample	S _u = Undrained Shear Strength (psi) S _v = Vertical Consolidation Pressure (psi) S _h = Horizontal Consolidation Pressure (psi) S _u = Undrained Shear Strength (psi) S _v = Vertical Consolidation Pressure (psi) S _h = Horizontal Consolidation Pressure (psi)	S _u = Undrained Shear Strength (psi) S _v = Vertical Consolidation Pressure (psi) S _h = Horizontal Consolidation Pressure (psi)	Laboratory Testing Results: ASD/ST and 1/4" Foot Class					
Depth (ft.)	Soil No.	Pen. (lb./ft.)	Soil Depth (ft.)	Blow Count (1/4" in. / 100 ft.)	Penetration (ft./min)	Soil Description and Remarks	Laboratory Results ASD/ST and 1/4" Foot Class	
0	10	24/6	0.00 - 2.00	3/4/3/3	7	10	SSA	Brown, comp. loose, fine to coarse SAND, little silt, trace gravel (1111). G4300883 A=4, CL W=8.6%
5	20	24/24	5.00 - 7.00	6/6/6/6	12	17		Olive, moist, very stiff, SILT, some clay, trace fine sand. G4300884 A=4, CL W=27.3% LL=62 PL=42 PI=10
10	30	24/24	10.00 - 12.00	3/3/3/3	8	11		Olive-brown, wet, stiff, SILT, little clay, little fine to coarse sand, trace gravel. G4300885 A=4, CL W=25.9%
15								
20								
25								

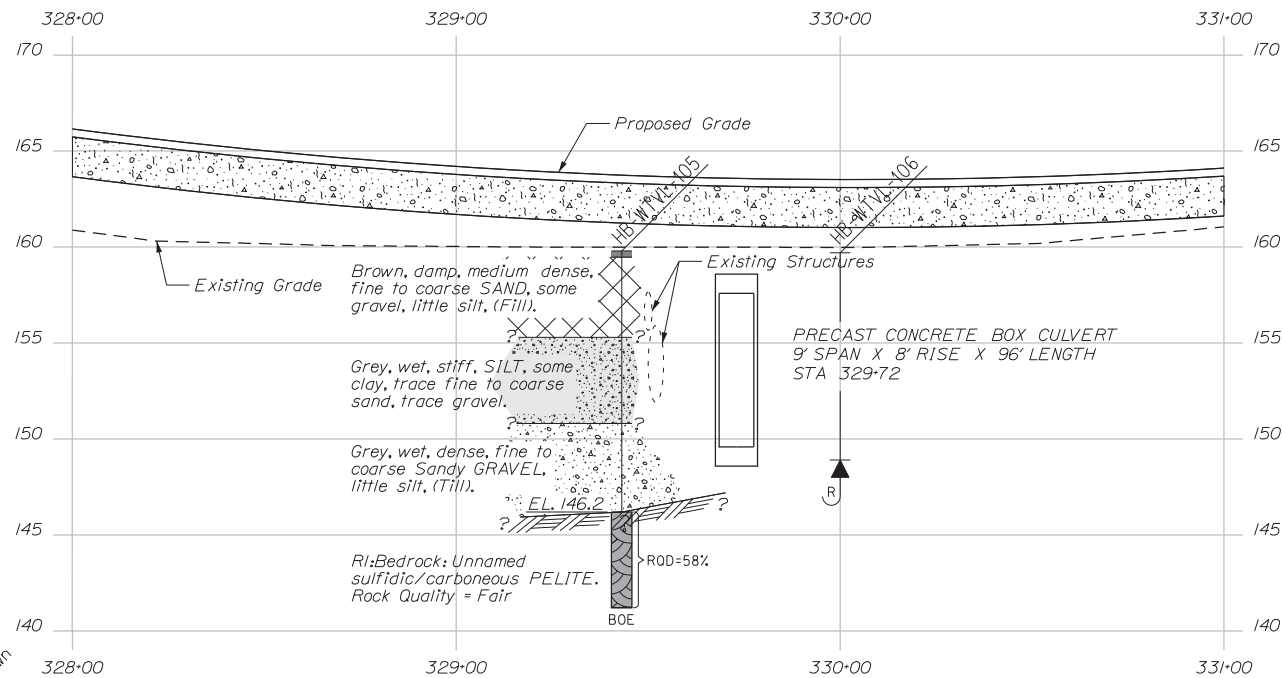
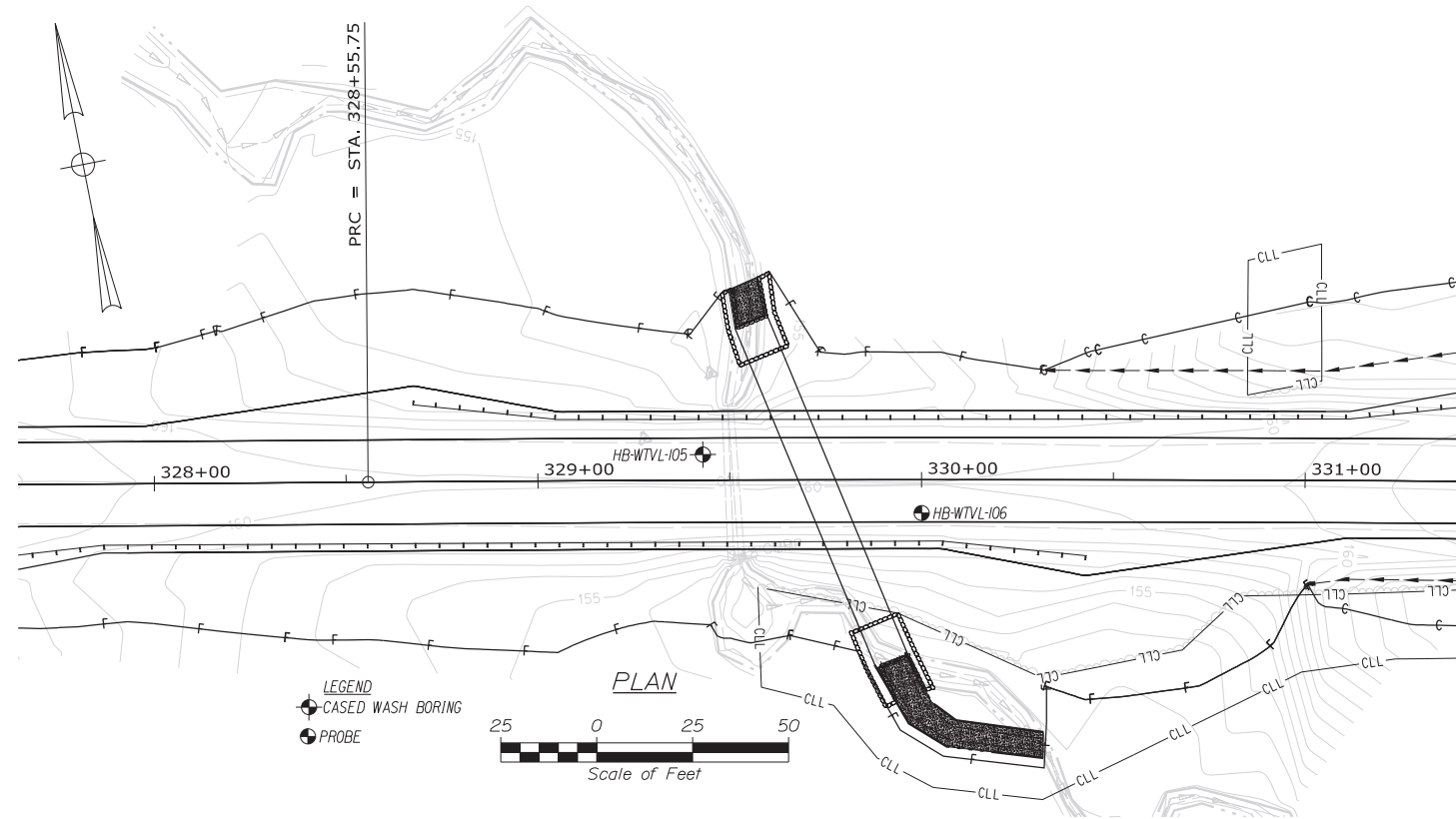
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
023246.00
WIN 023246.00
HIGHWAY PLANS

PROJECT: WATERVILLE TRAFTON ROAD
LIGHT POLE FOUNDATION & BORING LOCATION PLAN WITH BORING LOGS

SHEET NUMBER
13
OF 17

PROJ. MANAGER	DATE	BY	DATE
E. MARTIN			
CHECKED-REVIEWED	M. YOUNG-SEAGGS		
DESIGNED-DETAILED	K. MAGUIRE	T. WHITE	JAN 2020
DESIGNED-DETAILED			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE
P.E. NUMBER
DATE



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 and bedrock transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS		Project: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine		Boring No.: HB-WTVL-105 WIN: 23246.00					
Driller: Malm001	Elevation (ft.): 159.8	Auger ID/OD: 5" Solid Stem							
Operator: Travis/Jann	Date: NAD98	Sampler: Standard Split Spoon							
Logged By: B. Wilder	Rig Type: CME 45C	Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/9/2018-4/9/2018	Drilling Method: Cased Wash Boring	Core Barrel: ND-2"							
Boring Location: 329+43.1, 6.6 ft Lt.	Casing ID/OD: 1.5"	Water Level: 7.0 ft bgs.							
Hammer Efficiency Factor: 0.854	Hammer Type: Automatic B	Hydraulic C	Rope & Cable: C						
DEFINITIONS: B = Split Spoon Sample SA = Solid Stem Auger WSP = Washed Split Spoon Sample MS = Unconsolidated Split Spoon Sample SSSA = Solid Stem Auger WSSA = Washed Split Spoon Sample U = Thin Wall Tube Sample MC = Rotary Core WMC = Washed Rotary Core M = Unconsolidated Thin Wall Tube Sample MW = Weight of Hole, Hammer WMC = Washed Rotary Core V = Field Vane Shear Test PP = Pocket Penetrometer MW = Weight of Hole or Casing WMC = Washed Rotary Core W = Unconsolidated Thin Wall Tube Sample WMC = Weight of Hole or Casing WMC = Washed Rotary Core									
Depth (ft.)	Sample No.	Pen./Roc. (ft.)	Sample Depth (ft.)	Blows / 6 in. (N)	Penetrometer (ft.)	Log	Visual Description and Remarks	Laboratory Testing Results/ASHTO and Unified Class	
0						SSA	2" SSB.		
10	24/17	1.00 - 3.00	10/9/8/10	17	24	SSA	Brown, damp, medium dense, fine to coarse SAND, some gravel, little silt, (F111).	CA300895 A-1, G-1 UC-6, 7L	
5	20	24/18	5.00 - 7.00	2/4/6/5	10	14		Grey, wet, stiff, SILT, some clay, trace fine to coarse sand, trace gravel.	G3300896 A-1, G-1 UC-24, 6L
10	30	24/16	10.00 - 12.00	12/14/11/9	25	36	17	Grey, wet, dense, fine to coarse SANDY GRAVEL, little silt, (F111).	CA300897 A-1, G-1 UC-24, 6L
15	RI	60/95	13.40 - 18.60	ROD = 58%	985	ND-2	146.2	985 blows for 0.6 ft. Top of Bedrock at Elev. 146.2 ft. RI: Bedrock: Unnamed sulfidic/carbonaceous PELITE. Rock Quality = Fair RI: Core: (Minimum) 13.0-14.6 ft (1228) 14.6-16.6 ft (1308) 16.6-17.6 ft (1315) 17.6-18.6 ft (1322) 92% Recovery	
20							141.2	Bottom of Exploration at 18.6 feet below ground surface.	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS		Project: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine		Boring No.: HB-WTVL-106 WIN: 23246.00				
Drilling Contractor: Malm001	Elevation (ft.): 159.7	Auger ID/OD: 5" Dia.						
Operator: Travis/Jann	Date: NAD98	Sampler: N/A						
Logged By: C. Russell	Rig Type: CME 45C	Hammer Wt./Fall: N/A						
Date Start/Finish: 4/10/2018-08:20-08:45	Drilling Method: Solid Stem Auger	Core Barrel: N/A						
Boring Location: 330+00, 8.7 ft Rt.	Casing ID/OD: N/A	Water Level: None Observed						
DEFINITIONS: B = Split Spoon Sample SA = Solid Stem Auger WSP = Washed Split Spoon Sample MS = Unconsolidated Split Spoon Sample SSSA = Solid Stem Auger WSSA = Washed Split Spoon Sample U = Thin Wall Tube Sample MC = Rotary Core WMC = Washed Rotary Core M = Unconsolidated Thin Wall Tube Sample MW = Weight of Hole, Hammer WMC = Washed Rotary Core V = Field Vane Shear Test PP = Pocket Penetrometer MW = Weight of Hole or Casing WMC = Washed Rotary Core								
Depth (ft.)	Sample No.	Pen./Roc. (ft.)	Sample Depth (ft.)	Blows / 6 in. (N)	Penetrometer (ft.)	Log	Visual Description and Remarks	Laboratory Testing Results/ASHTO and Unified Class
0						SSA	Probe, no material description given.	
5								
10								
15								
20								
25								

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HIGHWAY PLANS

WATERVILLE
TRAFTON ROAD
BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE PROFILE WITH BORING LOGS

SHEET NUMBER
15
OF 17

PROJ. MANAGER	DATE	BY	DATE
E. MARTIN		M. YOUNG-SEAGGS	
CHECKED/REVIEWED		DESIGNED/DETAILED	
C. RUSSELL	JAN 2020	C. RUSSELL	T. WHITE
DESIGNED/DETAILED		REVISIONS 1	
		REVISIONS 2	
		REVISIONS 3	
		REVISIONS 4	
		FIELD CHANGES	

LABORATORY TESTING RESULTS/ASHTO and Unified Class

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P.E. NUMBER
DATE

Appendix A

Boring Logs

UNIFIED SOIL CLASSIFICATION SYSTEM				MODIFIED BURMISTER 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	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	<u>Descriptive Term</u> trace little some adjective (e.g. Sandy, Clayey)	<u>Portion of Total (%)</u> 0 - 10 11 - 20 21 - 35 36 - 50	
		(little or no fines)	GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.			
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	GM	Silty gravels, gravel-sand-silt mixtures.	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).		
			GC	Clayey gravels, gravel-sand-clay mixtures.			
		SANDS WITH FINES (Appreciable amount of fines)	SW	Well-graded sands, Gravelly sands, little or no fines	<u>Density of Cohesionless Soils</u> Very loose Loose Medium Dense Dense Very Dense		<u>Standard Penetration Resistance N-Value (blows per foot)</u> 0 - 4 5 - 10 11 - 30 31 - 50 > 50
			SP	Poorly-graded sands, Gravelly sand, little or no fines.			
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)	SM	Silty sands, sand-silt mixtures	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.			
		SC	Clayey sands, sand-clay mixtures.				
		ML	Inorganic silts and very fine sands, rock flour, Silty or Clayey fine sands, or Clayey silts with slight plasticity.				
	SILTS AND CLAYS (liquid limit greater than 50)	CL	Inorganic clays of low to medium plasticity, Gravelly clays, Sandy clays, Silty clays, lean clays.	<u>Consistency of Cohesive soils</u> Very Soft Soft Medium Stiff Stiff Very Stiff Hard		<u>Approximate Undrained Shear Strength (psf)</u> WOH, WOR, WOP, <2 2 - 4 5 - 8 9 - 15 16 - 30 >30	
		OL	Organic silts and organic Silty clays of low plasticity.				
		MH	Inorganic silts, micaceous or diatomaceous fine Sandy or Silty soils, elastic silts.				
SILTS AND CLAYS (liquid limit greater than 50)	CH	Inorganic clays of high plasticity, fat clays.	<u>Field Guidelines</u> Fist easily penetrates Thumb easily penetrates Thumb penetrates with moderate effort Indented by thumb with great effort Indented by thumbnail Indented by thumbnail with difficulty				
	OH	Organic clays of medium to high plasticity, organic silts.					
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	Rock Quality Designation (RQD): RQD (%) = $\frac{\text{sum of the lengths of intact pieces of core}^* > 4 \text{ inches}}{\text{length of core advance}}$ *Minimum NQ rock core (1.88 in. OD of core)				
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				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))			
Maine Department of Transportation Geotechnical Section Key to Soil and Rock Descriptions and Terms Field Identification Information				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: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-101							
Driller: MaineDOT				Elevation (ft.): 228.7				Auger ID/OD: 5" Dia.							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: N/A							
Date Start/Finish: 4/9/2018-4/9/2018				Drilling Method: Solid Stem Auger				Core Barrel: N/A							
Boring Location: 304+74.3, 11.1 ft Lt.				Casing ID/OD: N/A				Water Level*: None Observed							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information								Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0	1D	24/6	0.00 - 2.00	3/4/3/3	7	10	SSA			Brown, damp, loose, fine to coarse SAND, little silt, trace gravel, (Fill).	G#300883 A-1-b, SM WC=8.8%				
5	2D	24/24	5.00 - 7.00	6/6/6/8	12	17			225.2	Olive, moist, very stiff, SILT, some clay, trace fine sand.	G#300884 A-4, CL WC=27.3% LL=32 PL=22 PI=10				
10	3D	24/24	10.00 - 12.00	3/3/5/37	8	11			217.2	Olive-brown, wet, stiff, SILT, little clay, little fine to coarse sand, trace gravel.	G#300885 A-4, CL WC=22.9%				
									216.7	Brown, wet, dense, fine to coarse SAND, little silt, (Till).					
										Bottom of Exploration at 12.0 feet below ground surface. NO REFUSAL					

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: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-102							
Driller: MaineDOT				Elevation (ft.): 187.1				Auger ID/OD: 5" Dia.							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: N/A							
Date Start/Finish: 4/9/2018-4/9/2018				Drilling Method: Solid Stem Auger				Core Barrel: N/A							
Boring Location: 319+87.9, 7.3 ft Lt.				Casing ID/OD: N/A				Water Level*: None Observed							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information								Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0									186.8	4" HMA.					
	1D/A	24/13	1.00 - 3.00	5/3/3/3	6	9			184.3	1D (1.0-2.8 ft bgs) Brown, moist, loose, fine to coarse SAND, some gravel, trace silt, (Fill).	G#300886 A-1-b, SM WC=7.8%				
									182.1	1D/A (2.8-3.0 ft bgs) Olive, moist, soft, Clayey SILT, trace fine to coarse sand, trace gravel.	G#300887 A-4, CL WC=22.9%				
5	2D	24/22	5.00 - 7.00	7/8/10/9	18	26			182.1	Olive, moist, very stiff, SILT, some clay, trace fine to medium sand.	G#300888 A-4, CL WC=24.0% LL=29 PL=21 PI=8				
									178.6						
10	3D	24/24	10.00 - 12.00	3/4/4/6	8	11			175.1	Olive-brown, wet, medium dense, Silty, fine to coarse SAND, trace clay, trace gravel, (Till).	G#300889 A-4, SC-SM WC=24.8%				
									175.1	Bottom of Exploration at 12.0 feet below ground surface. NO REFUSAL					

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: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-103 WIN: 23246.00							
Driller: MaineDOT				Elevation (ft.): 161.0				Auger ID/OD: 5" Solid Stem							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/9/2018-4/9/2018				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"							
Boring Location: 327+82.5, 10.8 ft Lt.				Casing ID/OD: NW-3"				Water Level*: None Observed							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information							Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0							SSA	160.7		4" HMA.					
	1D	24/8	1.00 - 3.00	4/2/2/4	4	6				Brown, moist, loose, fine to coarse SAND, some gravel, little silt, (Fill).	G#300890 A-1-b, SM WC=6.8%				
								157.5							
5	2D	24/20	5.00 - 7.00	5/5/6/7	11	16				Brown, wet, medium dense, fine to coarse SAND, some silt, little gravel, trace clay, (Till).	G#300891 A-2-4, SC-SM WC=14.1%				
10	R1	60/60	9.70 - 14.70	RQD = 40%			a50 NQ-2	151.5 151.3		a50 blows for 0.5 ft. Top of Bedrock at Elev. 151.5 ft. Roller Coned ahead to 9.7 ft bgs.					
										R1: Bedrock: Unnamed sulfidic/carbonaceous PELITE. Rock Quality = Poor R1: Core Times (min:sec) 9.7-10.7 ft (2:10) 10.7-11.7 ft (2:16) 11.7-12.7 ft (2:38) 12.7-13.7 ft (2:29) 13.7-14.7 ft (2:40) 100% Recovery					
15								146.3		Bottom of Exploration at 14.7 feet below ground surface.					
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.

Driller: MaineDOT	Elevation (ft.): 159.8	Auger ID/OD: 5" Solid Stem
Operator: Travis/John	Datum: NAVD88	Sampler: Standard Split Spoon
Logged By: C. Russell	Rig Type: CME 45C	Hammer Wt./Fall: 140#/30"
Date Start/Finish: 4/10/2018; 09:25-10:20	Drilling Method: Cased Wash Boring	Core Barrel: N/A
Boring Location: 328+67.9, 10.3 ft Rt.	Casing ID/OD: NW-3"	Water Level*: None Observed

Hammer Efficiency Factor: 0.854 **Hammer Type:** Automatic Hydraulic Rope & Cathead

Definitions: R = Rock Core Sample S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) T_v = Pocket Torvane Shear Strength (psf)
 D = Split Spoon Sample SSA = Solid Stem Auger S_{u(lab)} = Lab Vane Undrained Shear Strength (psf) WC = Water Content, percent
 MD = Unsuccessful Split Spoon Sample Attempt HSA = Hollow Stem Auger q_p = Unconfined Compressive Strength (ksf) LL = Liquid Limit
 U = Thin Wall Tube Sample RC = Roller Cone N-uncorrected = Raw Field SPT N-value PL = Plastic Limit
 MU = Unsuccessful Thin Wall Tube Sample Attempt WOH = Weight of 140lb. Hammer Hammer Efficiency Factor = Rig Specific Annual Calibration Value PI = Plasticity Index
 V = Field Vane Shear Test, PP = Pocket Penetrometer WOR/C = Weight of Rods or Casing N₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency G = Grain Size Analysis
 MV = Unsuccessful Field Vane Shear Test Attempt WO1P = Weight of One Person N₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected C = Consolidation Test

Depth (ft.)	Sample Information							Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows				
0							SSA	159.5	4" HMA.		
	1D	24/8	1.00 - 3.00	6/8/6/7	14	20			0.3	Dark brown, damp, medium dense, Gravelly, fine to coarse SAND, little silt, (Fill).	G#300892 A-1-a, SM WC=5.6%
5									5.5		
	2D	24/14	5.00 - 7.00	5/4/12/10	16	23	15	154.3	67	Brown, moist, stiff, SILT, some clay, little gravel, little fine to coarse sand.	G#300893 A-4, CL WC=21.4%
									99		
									124		
10									191		
	3D	24/8	10.00 - 12.00	13/8/7/13	15	21		149.8	10.0	Light brown, wet, GRAVEL, some fine to coarse sand, some silt, (Till).	G#300894 insufficient material
									12.0		
								147.8	Bottom of Exploration at 12.0 feet below ground surface. NO REFUSAL		

Remarks:

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-107							
Driller: MaineDOT				Elevation (ft.): 143.2				Auger ID/OD: 5" Solid Stem							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: C. Russell				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/10/2010; 11:20-14:00				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"							
Boring Location: 346+20, 3.5 ft Lt.				Casing ID/OD: NW-3"				Water Level*: None Observed							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information								Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0	1D	24/5	0.00 - 2.00	3/3/3	6	9	SSA			Brown, moist, loose, fine to coarse SAND, some gravel, little silt, (Fill).	G#300898 A-1-b, SM WC=13.8%				
5	2D	24/24	5.00 - 7.00	1/3/9/11	12	17		137.7		Grey, moist, stiff, SILT, some clay, trace fine to coarse sand, trace gravel.	G#300899 A-4, CL WC=19.5%				
10	R1	60/60	10.70 - 15.70	RQD = 83%				133.5 132.7		Top of Weathered Rock at Elev. 133.5 ft. Top of Bedrock at Elev. 132.7 ft. Auger Refusal at 10.5 ft bgs. Roller Coned ahead to 10.7 ft bgs. R1: Bedrock: Interbedded PELITE and SANDSTONE, [Waterville Formation]. Rock Quality = Good R1: Core Times (min:sec) 10.7-11.7 ft (1:54) 11.7-12.7 ft (3:25) 12.7-13.7 ft (3:35) 13.7-14.7 ft (2:35) 14.7-15.7 ft (2:56) 100% Recovery					
15								127.5		Bottom of Exploration at 15.7 feet below ground surface.					
20															
25															

Remarks:

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 * 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: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-110							
Driller: MaineDOT				Elevation (ft.): 128.8				Auger ID/OD: 5" Solid Stem							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/11/2018-4/11/2018				Drilling Method: Cased Wash Boring				Core Barrel: N/A							
Boring Location: 356+53.6, 9.7 ft Rt.				Casing ID/OD: NW-3"				Water Level*: None Observed							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information								Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0	1D	24/13	0.00 - 2.00	2/2/4/8	6	9	SSA			Brown, moist, loose, fine to coarse SAND, some gravel, little silt, (Fill).	G#296328 A-1-b, SM WC=9.9%				
5	2D	24/24	5.00 - 7.00	3/4/4/4	8	11				Brown, wet, stiff, SILT, some clay, trace fine sand.	G#296329 A-4, CL WC=29.1% LL=32 PL=23 PI=9				
10	3D	24/18	10.00 - 12.00	2/3/3/4	6	9				Light brown, wet, stiff, SILT, some clay, trace fine sand, trace gravel.	G#296330 A-4, CL WC=27.8%				
								116.8		Bottom of Exploration at 12.0 feet below ground surface. NO REFUSAL					

Remarks:

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* 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: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-111 WIN: 23246.00							
Driller: MaineDOT				Elevation (ft.): 126.9				Auger ID/OD: 5" Solid Stem							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/11/2018-4/11/2018				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"							
Boring Location: 357+87.9, 12.5 ft Lt.				Casing ID/OD: NW-3"				Water Level*: 7.6 ft bgs.							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information								Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0								SSA	126.6	4" HMA.					
	1D	24/10	1.00 - 3.00	6/9/9/8	18	26				Brown, damp, medium dense, Gravelly, fine to coarse SAND, little silt, (Fill).	G#296331 A-1-a, SM WC=5.0%				
5															
	2D	24/11	5.00 - 7.00	8/9/9/8	18	26	28			Brown, moist, medium dense, GRAVEL, some fine to coarse sand, some silt.	G#296332 A-2-4, GM WC=8.5%				
							37								
							15			Wood layer from 8.5-8.9 ft bgs.					
							39								
10							29		116.9						
	3D	12/6	10.00 - 11.00	16/40	---		72		115.9	Grey, wet, hard, SILT, some gravel, little fine to coarse sand, little clay, (Till).	G#296333 A-4, CL WC=11.9%				
	R1	50.4/47	11.00 - 15.20	RQD = 0%						Top of Bedrock at Elev. 115.9 ft. R1: Bedrock: Interbedded PELITE and SANDSTONE, [Waterville Formation]. Rock Quality = Very Poor R1: Core Times (min:sec) 11.0-12.0 ft (2:20) 12.0-13.0 ft (3:16) 13.0-14.0 ft (3:33) 14.0-15.0 ft (3:45) 15.0-15.2 ft (2:00) Core Blocked 94% Recovery					
15															
	R2	51.6/51.6	15.20 - 19.50	RQD = 27%						R2: Bedrock: Interbedded PELITE and SANDSTONE, [Waterville Formation]. Rock Quality = Poor R2: Core Times (min:sec) 15.2-16.2 ft (2:48) 16.2-17.2 ft (3:00) 17.2-18.2 ft (3:43) 18.2-19.2 ft (3:36) 19.2-19.5 ft (3:00) Core Blocked 100% Recovery					
									107.4						
20															
										Bottom of Exploration at 19.5 feet below ground surface.					
25															

Remarks:

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 * 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: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-113							
Driller: MaineDOT				Elevation (ft.): 127.0				Auger ID/OD: 5" Dia.							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/20/2018:08:00-09:00				Drilling Method: Soild Stem Auger				Core Barrel: N/A							
Boring Location: 359+08.1, 8.3 ft Rt.				Casing ID/OD: NW-3"				Water Level*: 5.8 ft bgs.							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information								Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0									126.8	3" HMA.					
	1D	24/13	1.00 - 3.00	4/5/7/8	12	17			123.7	Brown, damp, medium dense, Gravelly, fine to coarse SAND, little silt, (Fill).	G#336637 A-1-b, SM WC=6.6%				
5	2D	24/19	5.00 - 7.00	2/3/3/5	6	9				Light brown, wet, stiff, SILT, little clay, trace fine sand, trace gravel.	G#336638 A-4, CL WC=25.4%				
10	3D	24/18	10.00 - 12.00	3/5/11/17	16	23			115.0	Light brown, wet, very stiff, SILT, some clay, trace fine to coarse sand, trace gravel.	G#336639 A-4, CL WC=17.4%				
										Bottom of Exploration at 12.0 feet below ground surface. NO REFUSAL					

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: Reconstruction of a 1.3 mile portion of Trafton Road Location: Waterville, Maine				Boring No.: HB-WTVL-114							
Driller: MaineDOT				Elevation (ft.): 131.0				Auger ID/OD: 5" Solid Stem							
Operator: Travis/John				Datum: NAVD88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/20/2018; 09:00-11:00				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"							
Boring Location: 360+06.2, 11.0 ft Lt.				Casing ID/OD: NW-3"				Water Level*: None Observed							
Hammer Efficiency Factor: 0.854				Hammer Type: Automatic <input checked="" type="checkbox"/> Hydraulic <input type="checkbox"/> Rope & Cathead <input type="checkbox"/>											
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 Information								Elevation (ft.)	Graphic Log	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-uncorrected	N ₆₀	Casing Blows								
0								130.7		3 1/2" HMA.					
	1D/A	24/17	1.00 - 3.00	4/5/5/2	10	14		129.0		1D (1.0-2.0 ft bgs.) Brown, damp, loose, Gravelly, fine to coarse SAND, little silt, (Fill).	G#336640 A-1-b, SM WC=4.2%				
										1D/A (2.0-3.0 ft bgs.) Olive, moist, stiff, SILT, little fine to coarse sand, little clay, trace gravel.	G#336641 A-4, CL WC=19.8%				
5	2D	24/18	5.00 - 7.00	3/6/9/14	15	21				Olive, wet, very stiff, SILT, some clay, trace fine to medium sand.	G#336642 A-4, CL WC=19.9%				
								122.5							
10	3D	18/12	10.00 - 11.50	5/10/50	---					Olive-brown, wet, very stiff, fine to coarse Sandy SILT, little gravel, trace clay, (Till).	G#336643 A-4, SC-SM WC=12.0%				
	R1	60/60	11.50 - 16.50	RQD = 33%				119.5		Top of Bedrock at Elev. 119.5 ft. R1: Bedrock: Interbedded PELITE and SANDSTONE [Waterville Formation]. Rock Quality = Poor R1: Core Times (min:sec) 11.5-12.5 ft (2:00) 12.5-13.5 ft (3:15) 13.5-14.5 ft (3:56) 14.5-15.5 ft (4:02) 15.5-16.5 ft (3:00) 100% Recovery					
15								114.5							
										Bottom of Exploration at 16.5 feet below ground surface.					
20															
25															

Remarks:

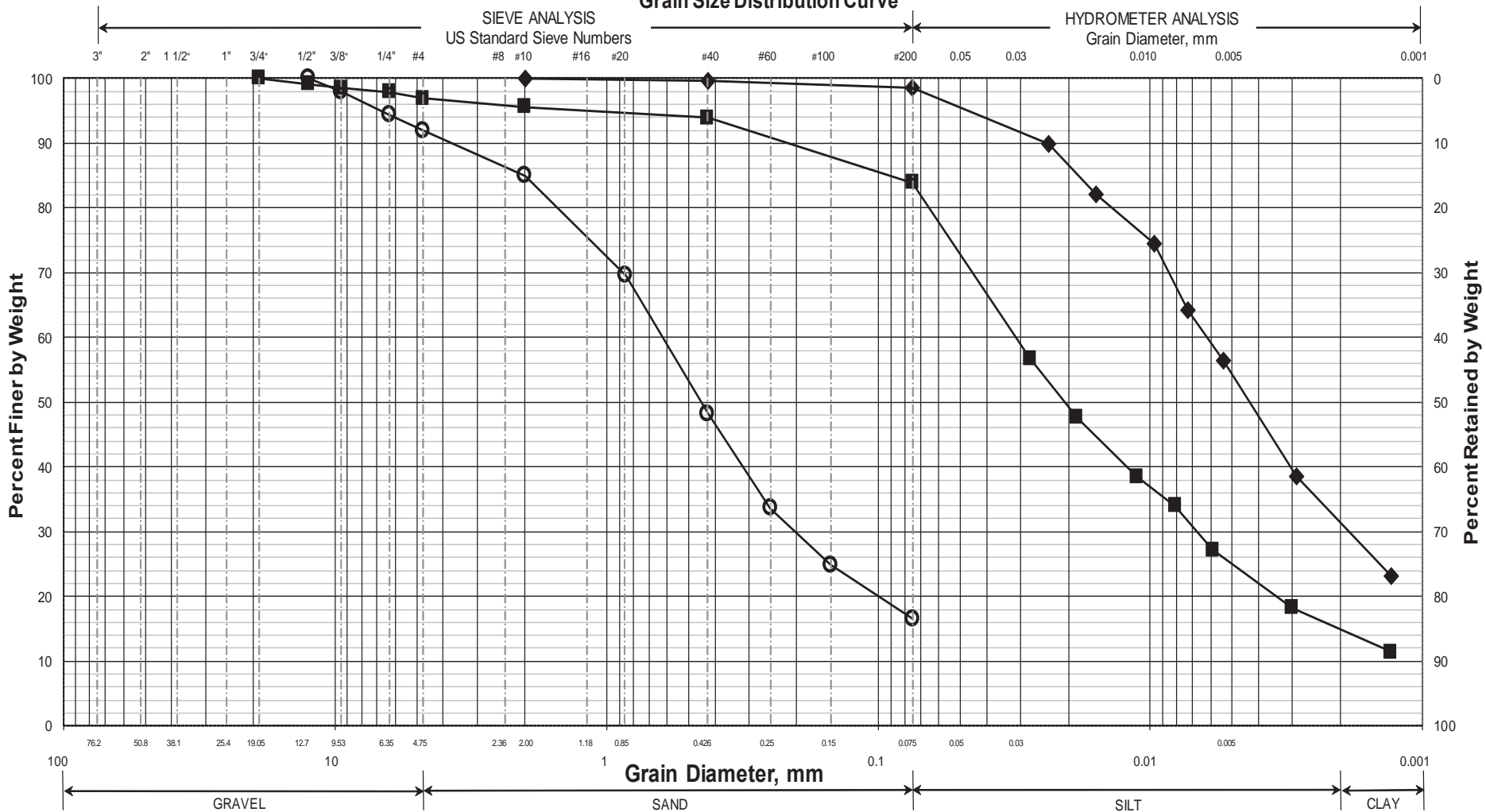
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* 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.

Appendix B

Laboratory Test Results

Maine Department of Transportation Grain Size Distribution Curve

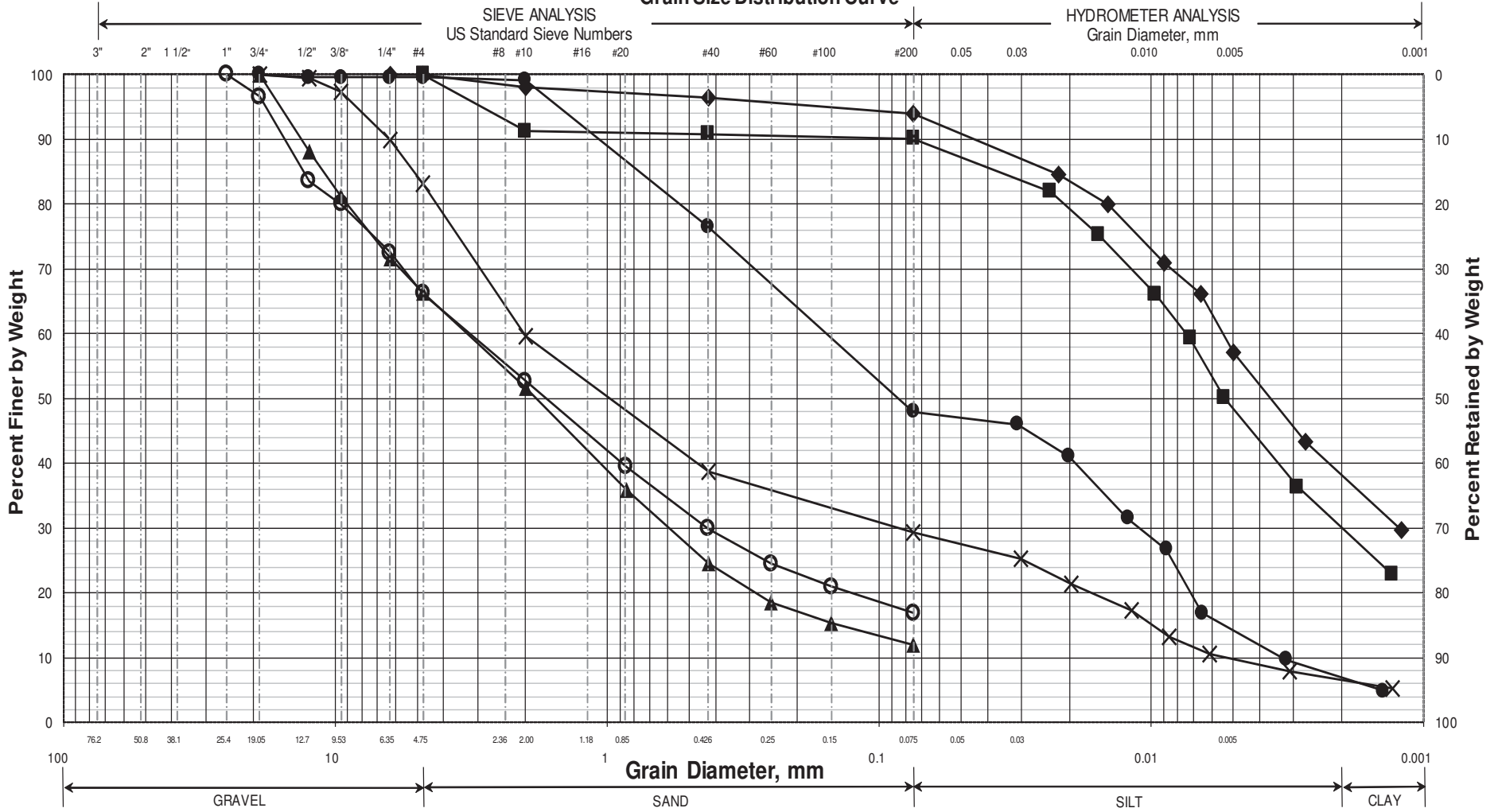


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WTVL-101/1D	304+74.3	11.1 LT	0.0-2.0	SAND, little silt, trace gravel.	8.8			
◆	HB-WTVL-101/2D	304+74.3	11.1 LT	5.0-7.0	SILT, some clay, trace sand.	27.3	32	22	10
■	HB-WTVL-101/3D	304+74.3	11.1 LT	10.0-12.0	SILT, little clay, little sand, trace gravel.	22.9			
●									
▲									
X									

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Maine Department of Transportation Grain Size Distribution Curve

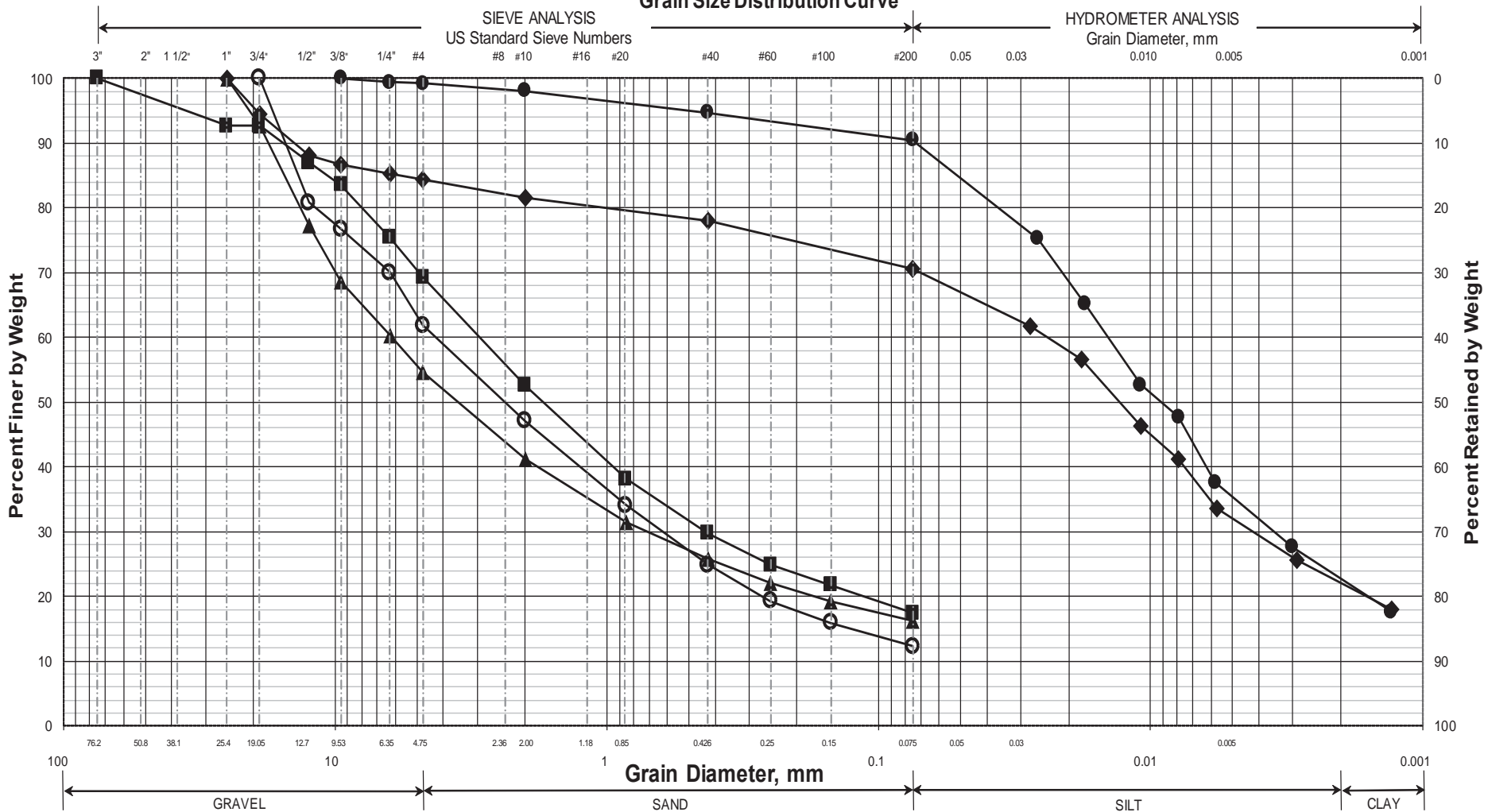


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WTVL-102/1D	319+87.9	7.3 LT	1.0-3.0	SAND, some gravel, little silt.	7.8			
◆	HB-WTVL-102/1DA	319+87.9	7.3 LT	1.0-3.0	Clayey SILT, trace sand, trace gravel.	22.9			
■	HB-WTVL-102/2D	319+87.9	7.3 LT	5.0-7.0	SILT, some clay, trace sand.	24.0	29	21	8
●	HB-WTVL-102/3D	319+87.9	7.3 LT	10.0-12.0	Silty SAND, trace clay, trace gravel.	24.8			
▲	HB-WTVL-103/1D	327+82.5	10.8 LT	1.0-3.0	SAND, some gravel, little silt.	6.8			
×	HB-WTVL-103/2D	327+82.5	10.8 LT	5.0-7.0	SAND, some silt, little gravel, trace clay.	14.1			

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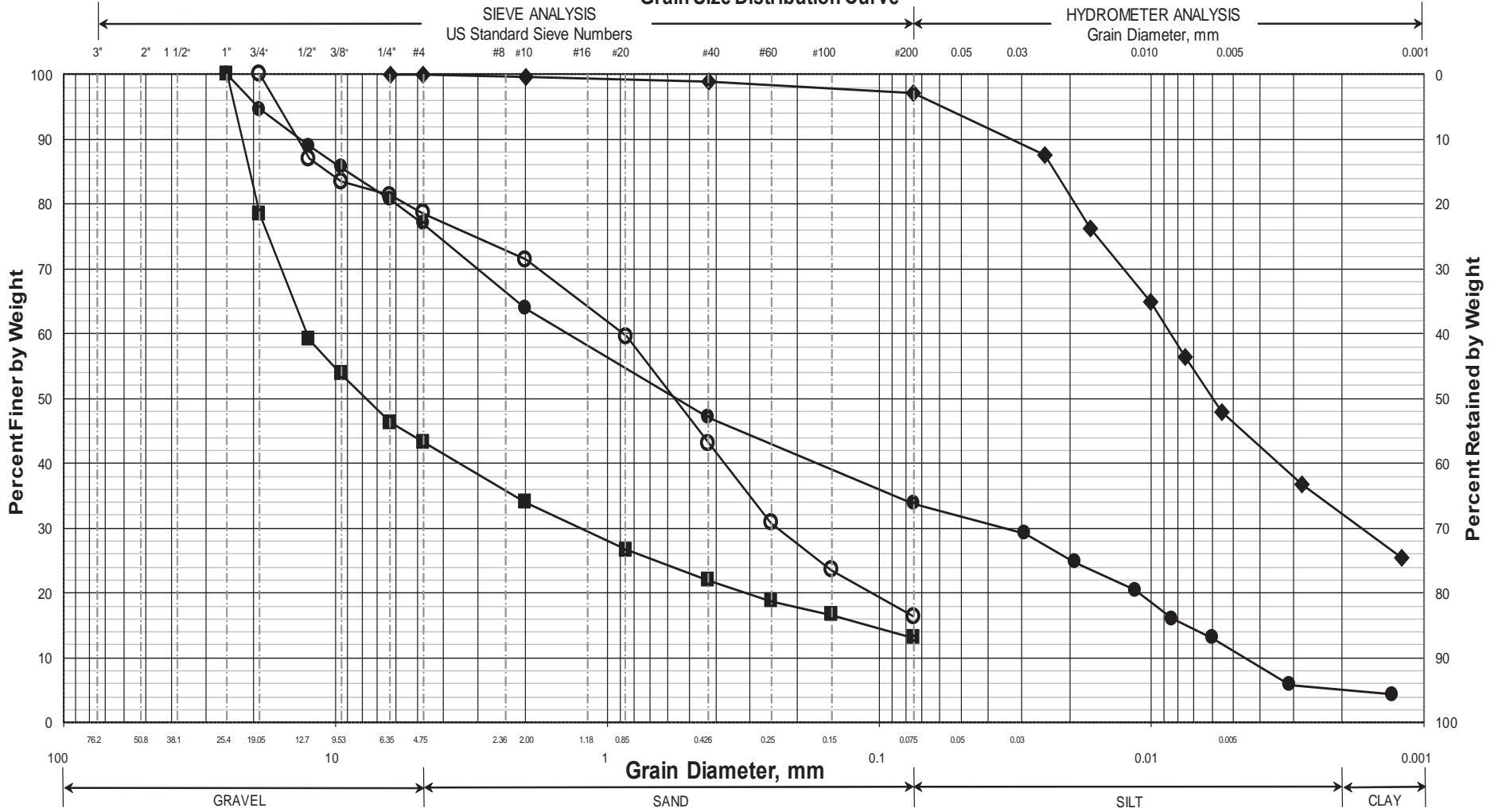


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WTVL-104/1D	328+67.9	10.3 RT	1.0-3.0	Gravelly SAND, little silt.	5.6			
◆	HB-WTVL-104/2D	328+67.9	10.3 RT	5.5-7.0	SILT, some clay, little gravel, little sand.	21.4			
■	HB-WTVL-105/1D	329+43.1	6.6 LT	1.0-3.0	SAND, some gravel, little silt.	5.7			
●	HB-WTVL-105/2D	329+43.1	6.6 LT	5.0-7.0	SILT, some clay, trace sand, trace gravel.	24.6			
▲	HB-WTVL-105/3D	329+43.1	6.6 LT	10.0-12.0	Sandy GRAVEL, little silt.	9.4			
X									

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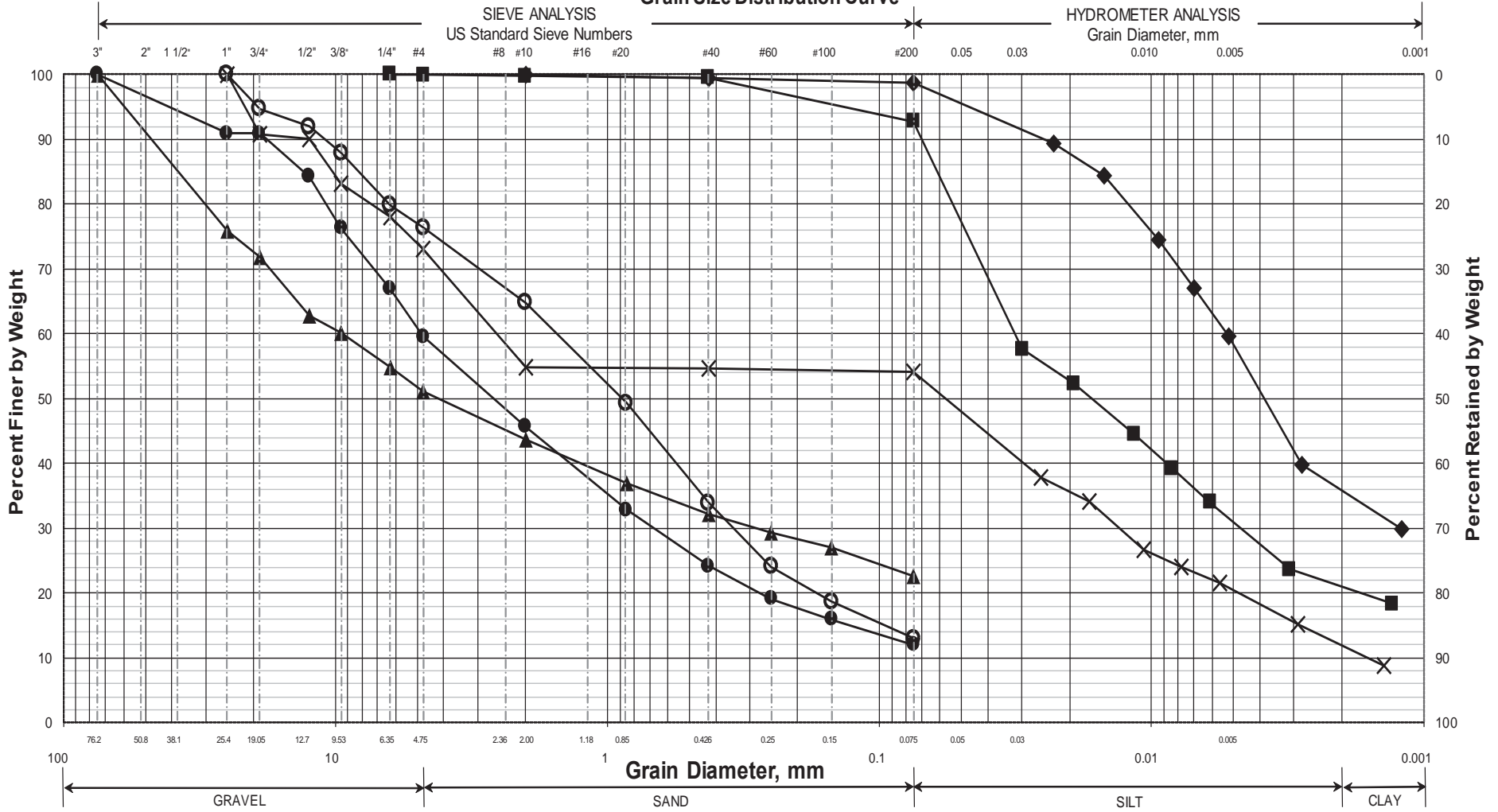


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WTVL-107/1D	346+20	3.5 LT	0.0-2.0	SAND, some gravel, little silt.	13.8			
◆	HB-WTVL-107/2D	346+20	3.5 LT	5.0-7.0	SILT, some clay, trace sand, trace gravel.	19.5			
■	HB-WTVL-108/2D	346+79.9	20.2 LT	5.0-7.0	GRAVEL, some sand, little silt.	4.4			
●	HB-WTVL-108/3D	346+79.9	20.2 LT	10.0-11.3	SAND, some silt, some gravel, trace clay.	14.8			
▲									
X									

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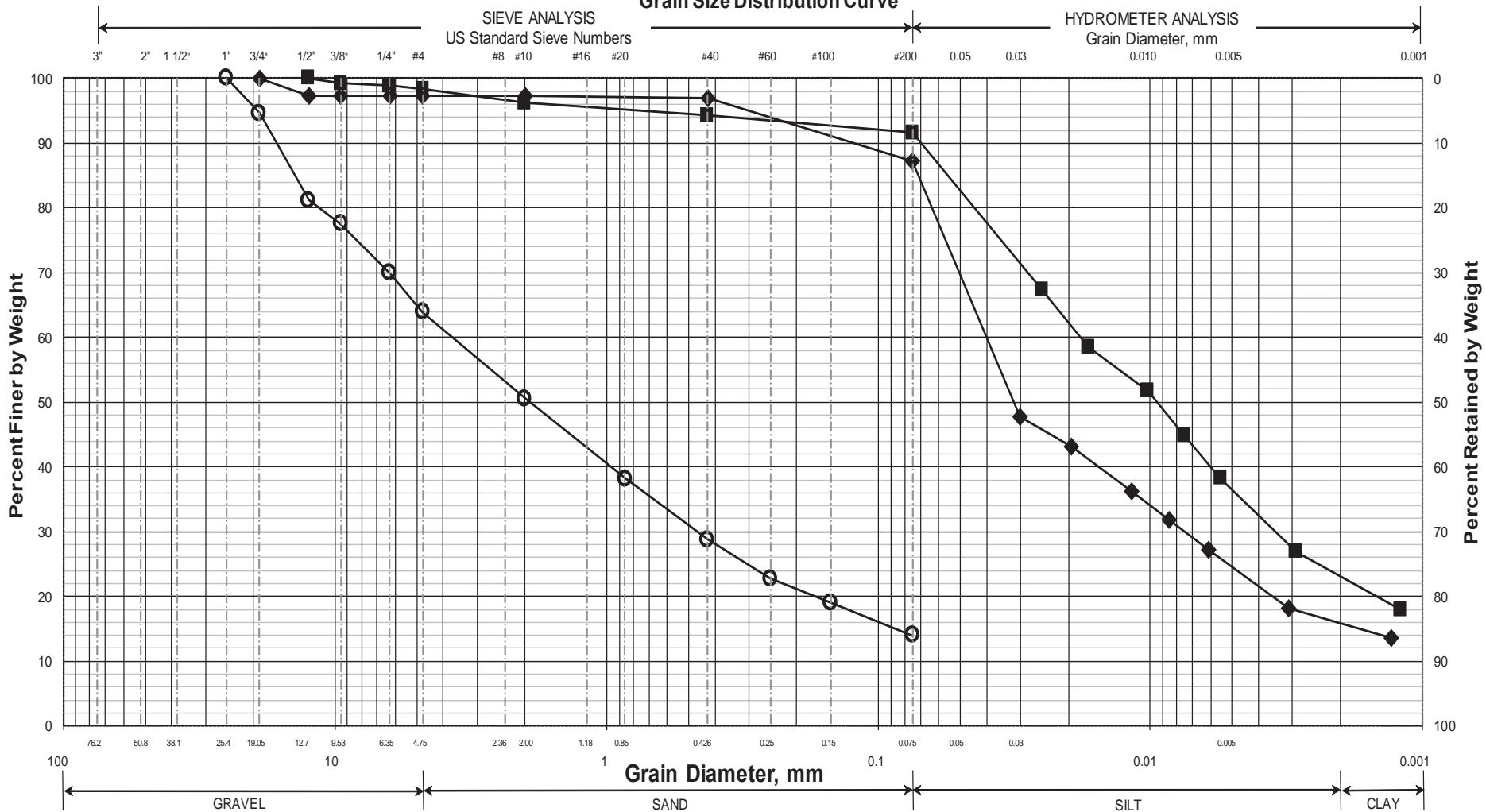


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WTVL-110/1D	356+53.6	9.7 RT	0.0-2.0	SAND, some gravel, little silt.	9.9			
◆	HB-WTVL-110/2D	356+53.6	9.7 RT	5.0-7.0	SILT, some clay, trace sand.	29.1	32	23	9
■	HB-WTVL-110/3D	356+53.6	9.7 RT	10.0-12.0	SILT, some clay, trace sand, trace gravel.	27.8			
●	HB-WTVL-111/1D	357+87.9	12.5 LT	1.0-3.0	Gravelly SAND, little silt.	5.0			
▲	HB-WTVL-111/2D	357+87.9	12.5 LT	5.0-7.0	GRAVEL, some sand, some silt.	8.5			
X	HB-WTVL-111/3D	357+87.9	12.5 LT	10.0-11.0	SILT, some gravel, little sand, little clay.	11.9			

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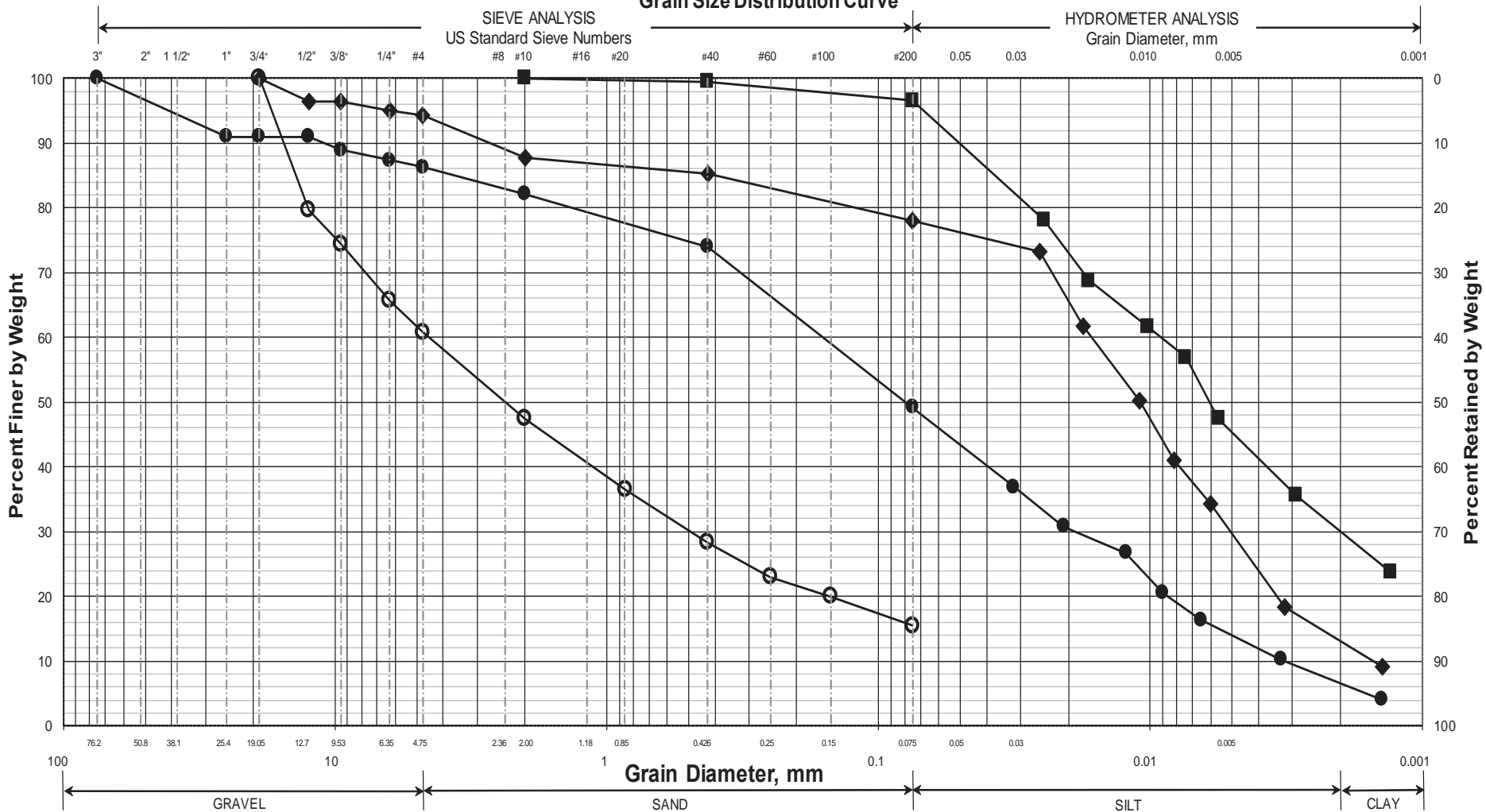


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WTVL-113/1D	359+08.1	8.3 RT	1.0-3.0	Gravelly SAND, little silt.	6.6			
◆	HB-WTVL-113/2D	359+08.1	8.3 RT	5.0-7.0	SILT, little clay, trace sand, trace gravel.	25.4			
■	HB-WTVL-113/3D	359+08.1	8.3 RT	10.0-12.0	SILT, some clay, trace sand, trace gravel.	17.4			
●									
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X									

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Maine Department of Transportation Grain Size Distribution Curve



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WTVL-114/1D	360+06.2	11.0 LT	1.0-2.0	Gravelly SAND, little silt.	4.2			
◆	HB-WTVL-114/1DA	360+06.2	11.0 LT	2.0-3.0	SILT, little sand, little clay, trace gravel.	19.8			
■	HB-WTVL-114/2D	360+06.2	11.0 LT	5.0-7.0	SILT, some clay, trace sand.	19.9			
●	HB-WTVL-114/3D	360+06.2	11.0 LT	10.0-11.5	Sandy SILT, little gravel, trace clay.	12.0			
▲									
X									

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Appendix C

Calculations

Bearing Resistance - Existing Soils:

Part 1 - Service Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till - Large Culvert at Station 329+72

Presumptive Bearing Resistance for Service Limit State ONLY

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017
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: fine to coarse sandy gravel (GM) (till)

Based on N-values, soils are medium dense at the bearing elevation

Density In Place: dense

Bearing Resistance: Ordinary Range (ksf) 8 to 14

Recommended Value of Use:

$$q_{nom} := 10 \cdot \text{ksf}$$

Resistance factor at the **service limit state** = 1.0 (LRFD Article 10.5.5.1)

$$\phi_{service_bc} := 1.0$$

$$q_{factored_service_bc} := q_{nom} \cdot \phi_{service_bc}$$

$$q_{factored_service_bc} = 10 \cdot \text{ksf}$$

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

Part 2 - Strength Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017 - Article 10.6.3.1

Assumptions:

1. The box will be founded at ~ Elev 149.9 feet to 149.3 feet

Bottom of Construction will be 2 feet below box invert

$$D_{footing} := 2.0 \cdot \text{ft}$$

2. Assumed parameters for fill soils:

Saturated unit weight: $\gamma_s := 125 \cdot \text{pcf}$

Internal friction angle: $\phi_{ns} := 32 \cdot \text{deg}$

Undrained shear strength: $c_{ns} := 0 \cdot \text{psf}$

3. Box Culvert parameters

Width of box culvert, B $B_{box} := 9 \cdot \text{ft}$

Length of box culvert, L $L_{box} := 96 \cdot \text{ft}$

Nominal Bearing Resistance per LRFD Equation 10.6.3.1.2a-1

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

Bearing Capacity Factors - LRFD Table 10.6.3.1.2a-1

For $\phi=32$ deg $N_c := 35.5$ $N_q := 23.2$ $N_\gamma := 30.2$

Shape Correction Factors LRFD Table 10.6.3.1.2a-3

for $\phi=32$

$$s_c := 1 + \left(\frac{B_{\text{box}}}{L_{\text{box}}} \right) \left(\frac{N_q}{N_c} \right) \quad s_c = 1.06$$

$$s_\gamma := 1 - 0.4 \left(\frac{B_{\text{box}}}{L_{\text{box}}} \right) \quad s_\gamma = 0.9625$$

$$s_q := 1 + \left(\frac{B_{\text{box}}}{L_{\text{box}}} \cdot \tan(\phi_{ns}) \right) \quad s_q = 1.06$$

Load Inclination Factors:

Assume all are 1.0 (LRFD Article C10.6.3.1.2a)

$i_c := 1.0$ $i_q := 1.0$ $i_\gamma := 1.0$

Depth Correction Factor LRFD Table 10.6.3.1.2a-4

$$\frac{D_{\text{footing}}}{B_{\text{box}}} = 0.2222 \quad \text{for } \phi=32 \text{ degrees} \quad d_q := 1.2$$

$$N_{cm} := N_c \cdot s_c \cdot i_c \quad N_{cm} = 37.675 \quad \text{LRFD Eq. 10.6.3.1.2a-2}$$

$$N_{qm} := N_q \cdot s_q \cdot d_q \cdot i_q \quad N_{qm} = 29.47 \quad \text{LRFD Eq. 10.6.3.1.2a-3}$$

$$N_{\gamma m} := N_\gamma \cdot s_\gamma \cdot i_\gamma \quad N_{\gamma m} = 29.07 \quad \text{LRFD Eq. 10.6.3.1.2a-4}$$

Coefficients for Groundwater Depths LRFD Table 10.6.3.1.2a-2

Depth the water table: $D_w := 0 \cdot \text{ft}$ $C_{wq} := 0.5$ $C_{w\gamma} := 0.5$

$$q_{\text{nominal}} := c_{ns} \cdot N_{cm} + \gamma_s \cdot D_{\text{footing}} \cdot N_{qm} \cdot C_{wq} + 0.5(\gamma_s) B_{\text{box}} \cdot N_{\gamma m} \cdot C_{w\gamma}$$

$$q_{\text{nominal}} = 11.9 \cdot \text{ksf}$$

Factored Bearing Resistance for Strength Limit State

Resistance Factor: $\phi_b := 0.45$ LRFD Table 10.5.5.2.2-1

$$q_{\text{factored}} := q_{\text{nominal}} \cdot \phi_b$$

$$q_{\text{factored}} = 5.3 \cdot \text{ksf}$$

Recommend a limiting factored bearing resistance of 5.0 ksf for the Strength Limit State.

Modulus of Subgrade Reaction:

Reference: Foundation Analysis and Design 5th Edition JE Bowles Section 9-6

Width of box culvert, B $B_{\text{box}} = 9 \text{ ft}$
 Length of box culvert, L $L_{\text{box}} = 96 \text{ ft}$
 Thickness of box culvert, t $t_{\text{box}} := 12 \cdot \text{in}$ assumed
 Depth of box, D $D_{\text{box}} := 14 \cdot \text{ft}$
 Bearing Resistance: $q_{\text{factored_service_bc}} = 10 \cdot \text{ksf}$ Calculated above

Modulus of
 Elasticity: Site soils are Gravel (dense)
 From Bowles Table 2-8 Modulus E_s for sand and gravel, dense ranges from 2,000 - 4,100 ksf
 Use: Modulus of Elasticity, E_s $E_s := 2000 \cdot \text{ksf}$

Poisson's
 Ratio: Site soils are Gravel (dense)
 From Bowles Table 2-7 Poisson's Ration μ for Sand/Till ranges from 0.3 - 0.4
 Use Possion's Ratio, μ $\mu := 0.35$

$$E_{\text{prime_s}} := \frac{1 - \mu^2}{E_s} \quad E_{\text{prime_s}} = 0.000439 \cdot \frac{\text{ft}^2}{\text{kip}}$$

Analyze corner:

Take H as 5*B as recommended in Bowles Chapter 5

$$H_{\text{inf}} := \frac{5 \cdot B_{\text{box}}}{B_{\text{box}}} \quad H_{\text{inf}} = 5 \quad \text{N in Table 5-2} \quad \text{From Table 5-2 for N=5 and M=10.7}$$

$$\frac{L_{\text{box}}}{B_{\text{box}}} = 10.6667 \quad \text{M in Table 5-2} \quad I_1 := 0.533$$

$$I_2 := 0.141 \quad \text{by interpolation}$$

Determine Steinbrenner influence factor - Bowles Section 5-6:

$$I_s := I_1 + \left[\frac{1 - (2 \cdot \mu)}{1 - \mu} \right] \cdot I_2 \quad I_s = 0.5981$$

Determine Influence factor for footing depth - Bowles Figure

5-7
 Depth ratio: $\frac{D_{\text{box}}}{B_{\text{box}}} = 1.5556$ $\frac{L_{\text{box}}}{B_{\text{box}}} = 10.6667$ $\mu = 0.35$ $I_F := 0.8$

Calculate modulus of subgrade reaction - Bowles Eq. 9-7

$$k_s := \frac{1}{B_{\text{box}} \cdot E_{\text{prime_s}} \cdot I_s \cdot I_F} \quad \text{Bowles Eq. 9-7}$$

$$k_s = 306 \cdot \text{pci}$$

Recommend Modulus of Subgrade Reaction of 300 pci

Bearing Resistance - Existing Soils:

Part 1 - Service Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till - Trafton Brook Bridge

Presumptive Bearing Resistance for Service Limit State ONLY

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017
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: fine to coarse sand (SC-SM) (till)

Based on N-values, soils are very dense at the bearing elevation

Density In Place: very dense

Bearing Resistance: Ordinary Range (ksf) 8 to 12

Recommended Value of Use:

$$q_{nom} := 8 \cdot ksf$$

Resistance factor at the **service limit state** = 1.0 (LRFD Article 10.5.5.1)

$$\phi_{service_bc} := 1.0$$

$$q_{factored_service_bc} := q_{nom} \cdot \phi_{service_bc}$$

$$q_{factored_service_bc} = 8 \cdot ksf$$

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

Part 2 - Strength Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017 - Article 10.6.3.1

Assumptions:

1. The box will be founded at ~ Elev 131.5 feet to 130.2 feet

Bottom of Construction will be 2 feet below box invert

$$D_{footing} := 2.0 \cdot ft$$

2. Assumed parameters for fill soils:

Saturated unit weight: $\gamma_s := 125 \cdot pcf$

Internal friction angle: $\phi_{ns} := 32 \cdot deg$

Undrained shear strength: $c_{ns} := 0 \cdot psf$

3. Box Culvert parameters

Width of box culvert, B $B_{box} := 15 \cdot ft$

Length of box culvert, L $L_{box} := 88 \cdot ft$

Nominal Bearing Resistance per LRFD Equation 10.6.3.1.2a-1

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

Bearing Capacity Factors - LRFD Table 10.6.3.1.2a-1

For $\phi=32$ deg $N_c := 35.5$ $N_q := 23.2$ $N_\gamma := 30.2$

Shape Correction Factors LRFD Table 10.6.3.1.2a-3

for $\phi=32$

$$s_c := 1 + \left(\frac{B_{\text{box}}}{L_{\text{box}}} \right) \left(\frac{N_q}{N_c} \right) \quad s_c = 1.11$$

$$s_\gamma := 1 - 0.4 \left(\frac{B_{\text{box}}}{L_{\text{box}}} \right) \quad s_\gamma = 0.9318$$

$$s_q := 1 + \left(\frac{B_{\text{box}}}{L_{\text{box}}} \cdot \tan(\phi_{ns}) \right) \quad s_q = 1.11$$

Load Inclination Factors:

Assume all are 1.0 (LRFD Article C10.6.3.1.2a)

$i_c := 1.0$ $i_q := 1.0$ $i_\gamma := 1.0$

Depth Correction Factor LRFD Table 10.6.3.1.2a-4

$$\frac{D_{\text{footing}}}{B_{\text{box}}} = 0.1333 \quad \text{for } \phi=32 \text{ degrees} \quad d_q := 1.2$$

$$N_{cm} := N_c \cdot s_c \cdot i_c \quad N_{cm} = 39.4545 \quad \text{LRFD Eq. 10.6.3.1.2a-2}$$

$$N_{qm} := N_q \cdot s_q \cdot d_q \cdot i_q \quad N_{qm} = 30.81 \quad \text{LRFD Eq. 10.6.3.1.2a-3}$$

$$N_{\gamma m} := N_\gamma \cdot s_\gamma \cdot i_\gamma \quad N_{\gamma m} = 28.14 \quad \text{LRFD Eq. 10.6.3.1.2a-4}$$

Coefficients for Groundwater Depths LRFD Table 10.6.3.1.2a-2

Depth the water table: $D_w := 0 \cdot \text{ft}$ $C_{wq} := 0.5$ $C_{w\gamma} := 0.5$

$$q_{\text{nominal}} := c_{ns} \cdot N_{cm} + \gamma_s \cdot D_{\text{footing}} \cdot N_{qm} \cdot C_{wq} + 0.5(\gamma_s) B_{\text{box}} \cdot N_{\gamma m} \cdot C_{w\gamma}$$

$$q_{\text{nominal}} = 17 \cdot \text{ksf}$$

Factored Bearing Resistance for Strength Limit State

Resistance Factor: $\phi_b := 0.45$ LRFD Table 10.5.5.2.2-1

$$q_{\text{factored}} := q_{\text{nominal}} \cdot \phi_b$$

$$q_{\text{factored}} = 7.7 \cdot \text{ksf}$$

Recommend a limiting factored bearing resistance of 8.0 ksf for the Strength Limit State.

Modulus of Subgrade Reaction:

Reference: Foundation Analysis and Design 5th Edition JE Bowles Section 9-6

Width of box culvert, B $B_{\text{box}} = 15 \text{ ft}$
 Length of box culvert, L $L_{\text{box}} = 88 \text{ ft}$
 Thickness of box culvert, t $t_{\text{box}} := 12 \cdot \text{in}$ assumed
 Depth of box, D $D_{\text{box}} := 14 \cdot \text{ft}$
 Bearing Resistance: $q_{\text{factored_service_bc}} = 8 \cdot \text{ksf}$ Calculated above

Modulus of Elasticity: Site soils are Sand (very dense)
 From Bowles Table 2-8 Modulus E_s for sand and gravel, dense ranges from 2,000 - 4,100 ksf
 Use: Modulus of Elasticity, $E_s := 2000 \cdot \text{ksf}$

Poisson's Ratio: Site soils are Sand (dense)
 From Bowles Table 2-7 Poisson's Ratio μ for Sand/Till ranges from 0.3 - 0.4
 Use Poisson's Ratio, $\mu := 0.35$

$$E_{\text{prime_s}} := \frac{1 - \mu^2}{E_s} \quad E_{\text{prime_s}} = 0.000439 \cdot \frac{\text{ft}^2}{\text{kip}}$$

Analyze corner:

Take H as $5 \cdot B$ as recommended in Bowles Chapter 5

$$H_{\text{inf}} := \frac{5 \cdot B_{\text{box}}}{B_{\text{box}}} \quad H_{\text{inf}} = 5 \quad \text{N in Table 5-2} \quad \text{From Table 5-2 for N=5 and M=5.9}$$

$$\frac{L_{\text{box}}}{B_{\text{box}}} = 5.8667 \quad \text{M in Table 5-2} \quad I_1 := 0.549$$

$$I_2 := 0.119 \quad \text{by interpolation}$$

Determine Steinbrenner influence factor - Bowles Section 5-6:

$$I_s := I_1 + \left[\frac{1 - (2 \cdot \mu)}{1 - \mu} \right] \cdot I_2 \quad I_s = 0.6039$$

Determine Influence factor for footing depth - Bowles Figure

5-7
 Depth ratio: $\frac{D_{\text{box}}}{B_{\text{box}}} = 0.9333$ $\frac{L_{\text{box}}}{B_{\text{box}}} = 5.8667$ $\mu = 0.35$ $I_F := 0.83$

Calculate modulus of subgrade reaction - Bowles Eq. 9-7

$$k_s := \frac{1}{B_{\text{box}} \cdot E_{\text{prime_s}} \cdot I_s \cdot I_F} \quad \text{Bowles Eq. 9-7}$$

$$k_s = 175 \cdot \text{pci}$$

Recommend Modulus of Subgrade Reaction of 175 pci

Bearing Resistance - Existing Soils:

Part 1 - Service Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till - Farm Pond Bridge

Presumptive Bearing Resistance for Service Limit State ONLY

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017
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: silt (CL) (till)

Based on blow counts, soils are hard at the bearing elevation

Density In Place: hard

Bearing Resistance: Ordinary Range (ksf) 4 to 8

Recommended Value of Use:

$$q_{nom} := 6 \cdot ksf$$

Resistance factor at the **service limit state** = 1.0 (LRFD Article 10.5.5.1)

$$\phi_{service_bc} := 1.0$$

$$q_{factored_service_bc} := q_{nom} \cdot \phi_{service_bc}$$

$$q_{factored_service_bc} = 6 \cdot ksf$$

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

Part 2 - Strength Limit State

Nominal and factored Bearing Resistance - Box Culvert on Till

Reference: AASHTO LRFD Bridge Design Specifications 8th Edition 2017 - Article 10.6.3.1

Assumptions:

1. The box will be founded at ~ Elev 116.1 feet to 115.6 feet

Bottom of Construction will be 2 feet below box invert

$$D_{footing} := 2.0 \cdot ft$$

2. Assumed parameters for fill soils:

Saturated unit weight: $\gamma_s := 125 \cdot pcf$

Internal friction angle: $\phi_{ns} := 32 \cdot deg$

Undrained shear strength: $c_{ns} := 0 \cdot psf$

3. Box Culvert parameters

Width of box culvert, B $B_{box} := 15 \cdot ft$

Length of box culvert, L $L_{box} := 104 \cdot ft$

Nominal Bearing Resistance per LRFD Equation 10.6.3.1.2a-1

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

Bearing Capacity Factors - LRFD Table 10.6.3.1.2a-1

For $\phi=32$ deg $N_c := 35.5$ $N_q := 23.2$ $N_\gamma := 30.2$

Shape Correction Factors LRFD Table 10.6.3.1.2a-3

for $\phi=32$

$$s_c := 1 + \left(\frac{B_{\text{box}}}{L_{\text{box}}} \right) \left(\frac{N_q}{N_c} \right) \quad s_c = 1.09$$

$$s_\gamma := 1 - 0.4 \left(\frac{B_{\text{box}}}{L_{\text{box}}} \right) \quad s_\gamma = 0.9423$$

$$s_q := 1 + \left(\frac{B_{\text{box}}}{L_{\text{box}}} \cdot \tan(\phi_{ns}) \right) \quad s_q = 1.09$$

Load Inclination Factors:

Assume all are 1.0 (LRFD Article C10.6.3.1.2a)

$i_c := 1.0$ $i_q := 1.0$ $i_\gamma := 1.0$

Depth Correction Factor LRFD Table 10.6.3.1.2a-4

$$\frac{D_{\text{footing}}}{B_{\text{box}}} = 0.1333 \quad \text{for } \phi=32 \text{ degrees} \quad d_q := 1.2$$

$$N_{cm} := N_c \cdot s_c \cdot i_c \quad N_{cm} = 38.8462 \quad \text{LRFD Eq. 10.6.3.1.2a-2}$$

$$N_{qm} := N_q \cdot s_q \cdot d_q \cdot i_q \quad N_{qm} = 30.35 \quad \text{LRFD Eq. 10.6.3.1.2a-3}$$

$$N_{\gamma m} := N_\gamma \cdot s_\gamma \cdot i_\gamma \quad N_{\gamma m} = 28.46 \quad \text{LRFD Eq. 10.6.3.1.2a-4}$$

Coefficients for Groundwater Depths LRFD Table 10.6.3.1.2a-2

Depth the water table: $D_w := 0 \cdot \text{ft}$ $C_{wq} := 0.5$ $C_{w\gamma} := 0.5$

$$q_{\text{nominal}} := c_{ns} \cdot N_{cm} + \gamma_s \cdot D_{\text{footing}} \cdot N_{qm} \cdot C_{wq} + 0.5(\gamma_s) B_{\text{box}} \cdot N_{\gamma m} \cdot C_{w\gamma}$$

$$q_{\text{nominal}} = 17.1 \cdot \text{ksf}$$

Factored Bearing Resistance for Strength Limit State

Resistance Factor: $\phi_b := 0.45$ LRFD Table 10.5.5.2.2-1

$$q_{\text{factored}} := q_{\text{nominal}} \cdot \phi_b$$

$$q_{\text{factored}} = 7.7 \cdot \text{ksf}$$

Recommend a limiting factored bearing resistance of 8.0 ksf for the Strength Limit State.

Modulus of Subgrade Reaction:

Reference: Foundation Analysis and Design 5th Edition JE Bowles Section 9-6

Width of box culvert, B $B_{\text{box}} = 15 \text{ ft}$
 Length of box culvert, L $L_{\text{box}} = 104 \text{ ft}$
 Thickness of box culvert, t $t_{\text{box}} := 12 \cdot \text{in}$ assumed
 Depth of box, D $D_{\text{box}} := 15 \cdot \text{ft}$
 Bearing Resistance: $q_{\text{factored_service_bc}} = 6 \cdot \text{ksf}$ Calculated above

Modulus of Elasticity: Site soils are Silt (hard)
 Es values for silt unrealistically low do to density and gravel content of soil. Use values for silty sand.
 From Bowles Table 2-8 Modulus Es for silty sand, dense ranges from 1,050 - 1,700 ksf
 Use: Modulus of Elasticity, Es $E_s := 1700 \cdot \text{ksf}$

Poisson's Ratio: Site soils are Silt (hard)
 From Bowles Table 2-7 Poisson's Ration μ for Silt ranges from 0.3 - 0.35
 Use Poisson's Ratio, μ $\mu := 0.35$

$$E_{\text{prime_s}} := \frac{1 - \mu^2}{E_s} \quad E_{\text{prime_s}} = 0.000516 \cdot \frac{\text{ft}^2}{\text{kip}}$$

Analyze corner:

Take H as 5*B as recommended in Bowles Chapter 5

$$H_{\text{inf}} := \frac{5 \cdot B_{\text{box}}}{B_{\text{box}}} \quad H_{\text{inf}} = 5 \quad \text{N in Table 5-2} \quad \text{From Table 5-2 for N=5 and M=6.9}$$

$$\frac{L_{\text{box}}}{B_{\text{box}}} = 6.9333 \quad \text{M in Table 5-2} \quad I_1 := 0.543$$

$$I_2 := 0.127 \quad \text{by interpolation}$$

Determine Steinbrenner influence factor - Bowles Section 5-6:

$$I_s := I_1 + \left[\frac{1 - (2 \cdot \mu)}{1 - \mu} \right] \cdot I_2 \quad I_s = 0.6016$$

Determine Influence factor for footing depth - Bowles Figure

5-7
 Depth ratio: $\frac{D_{\text{box}}}{B_{\text{box}}} = 1$ $\frac{L_{\text{box}}}{B_{\text{box}}} = 6.9333$ $\mu = 0.35$ $I_F := 0.82$

Calculate modulus of subgrade reaction - Bowles Eq. 9-7

$$k_s := \frac{1}{B_{\text{box}} \cdot E_{\text{prime_s}} \cdot I_s \cdot I_F} \quad \text{Bowles Eq. 9-7}$$

$$k_s = 152 \cdot \text{pci}$$

Recommend Modulus of Subgrade Reaction of 150 pci