GEOTECHNICAL REPORT
ROUTE 1 SOUTHBOUND OFF RAMP
MAINE DOT PIN 11062.00
SOUTH PORTLAND, MAINE

PREPARED FOR:
Maine Department of Transportation
Augusta, Maine

PREPARED BY:
GZA GeoEnvironmental, Inc.
Portland, Maine

April 2011
File No. 09.0025658.00

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GZA
GeoEnvironmental, Inc.

Engineers and Scientists

April 4, 2011

File No. 09.0025658.00
Maine DOT PIN 11062.00

Ms. Laura Krusinski, P.E.
Maine Department of Transportation
State House Station 16
Augusta, Maine 04333-0016

Re: Geotechnical Report
Route 1 Southbound Off Ramp
Maine DOT PIN 11062.00
South Portland, Maine

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Dear Laura:

GZA GeoEnvironmental, Inc. (GZA) is pleased to provide you with this Geotechnical Report for the Route 1 Southbound Off Ramp in South Portland, Maine. Our work was completed in accordance with contract GCA No. U1210060627, GZA's Proposal Dated February 1, 2011 and the attached Limitations contained in **Appendix A** of the report.

It has been a pleasure serving you on this project. Michael J. Devoid, E.I.T. under the direction of the undersigned, prepared this report. If you have any questions regarding the report, or if we can provide further assistance, please do not hesitate to contact the undersigned.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

STATE OF MAINE
CHRISTOPHER L. SNOW
No. 7275
LICENSED
PROFESSIONAL ENGINEER

James V. Errico, P.E.
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1.0 INTRODUCTION

This report presents the results of GZA's subsurface exploration and geotechnical evaluation for replacement of the Route 1 Southbound Off Ramp in South Portland, Maine. Our services were provided in accordance with Maine Department of Transportation (MDOT) contract GCA No. U1210060627, GZA's proposal dated February 1, 2011 and the attached Limitations contained in **Appendix A** of this report.

1.1 OBJECTIVES AND SCOPE OF SERVICES

The objectives of our work were to evaluate subsurface conditions and to provide geotechnical engineering recommendations for the proposed Route 1 South Bound Off Ramp. To meet these objectives, GZA completed the following Scope of Services:

- Conducted a site visit to observe surficial conditions; and reviewed existing bridge plans, and mapped surficial and bedrock geology of the site;
- Coordinated and observed a subsurface exploration program consisting of three test borings;
- Conducted a laboratory testing program to evaluate engineering properties of the site soils;
- Developed geotechnical engineering recommendations including pavement design and drainage; and
- Prepared this report summarizing our findings, design recommendations, and supporting calculations.

1.2 BACKGROUND

The project involves removal of the Route 1 southbound off ramp, the overpass bridge and construction of a new at-grade off ramp at the intersection of Maine Street and Route 1 in South Portland, Maine. Part of the existing embankment east of the overpass bridge will be removed to accommodate the new at-grade ramp. The project is intended to be advertised for construction bidding in Summer 2011.

2.0 SUBSURFACE EXPLORATIONS

2.1 TEST BORINGS

Three test borings (HB-GZ-1, HB-GZ-2, and HB-GZ-3) were completed for this investigation. The test borings were completed using 2.25-inch solid stem and 3-inch hollow stem augers. The borings were drilled to depths of 12 to 50 feet below existing ground surface. Standard penetration testing (SPT) using a rope and cathead drive system and split-spoon sampling was performed continuously to a depth of 12 feet. Borings HB-GZ-2 and HB-GZ-3 were terminated at 12 feet in marine deposits. Boring HB-GZ-1was continuously sampled to 12 feet, then continued to a depth of 42 feet with SPT and split spoon sampling at 5-foot typical intervals. Between 42 and 50 feet depth, the boring was completed by driving an AW-Rod probe using a 300 lb hammer and a 24-inch drop. Penetration resistance was recorded in blows per foot and

reported in the casing blows column on the boring log. The boring was terminated in very dense glacial till. Maine Test Boring, Inc. of Brewer, Maine coordinated utility clearance and provided drilling services. Their work was completed on March 3, 2011. GZA personnel monitored the drilling work and prepared logs of each boring that are included in **Appendix B**.

The locations of the borings were determined approximately in the field by taping and pacing from features shown on existing condition plan. Approximate ground surface elevations at the borings were interpolated by GZA from contours on the existing conditions plan provided electronically on January 21, 2011 by TMSI Engineers, Inc[1]. Elevations referenced in this report are in feet and refer to North American Vertical Datum of 1988 (NAVD 1988). Boring locations and ground surface elevations at the borings are approximate and should be considered accurate only to the degree implied by the methods used to determine them. The approximate boring locations are shown on **Figure 2, Boring Location Plan.**

3.0 LABORATORY TESTING

GZA completed a laboratory soil testing program to support visual soil classifications, evaluate frost classifications, and estimate the engineering properties of the soils. The program included five gradations with hydrometer, one wash gradation, and six moisture content analysis/AASHTO Classification/Frost Classification assessments on soil samples. Results of the testing are included in **Appendix C,** and indicated on the boring logs.

4.0 SUBSURFACE CONDITIONS

4.1 SURFICIAL AND BEDROCK GEOLOGY

Surficial geologic units mapped in the project area include Marine Deposits, Glacial Till, and bedrock of the Cape Elizabeth Formation. The following are brief descriptions of the geologic units.

The marine deposits consist of layered sand, silt, and clay. The glacial till is a mixture of sand, gravel and silt with cobbles and boulders. Bedrock at the site is mapped as the Cape Elizabeth Formation; it typically consists of thin-bedded quartz-plagioclase-biotite-muscovite schist and granofels.

4.2 SUBSURFACE SOILS

The subgrade soils for this project consist of primarily fine to coarse SAND, trace Silt to CLAY & SILT. See table below for a summary of encountered subgrade soil conditions.

[1] PDF files received in the email correspondence include: Highway 11062 1-24-11.pdf, South Portland 11062 highway 1-21-11.pdf.

Generalized Subsurface Conditions		
Strata Designation	**Approximate Encountered Thickness (Ft)**	**Generalized Description**
Fill	4 to 6	Loose to dense, brown, fine to coarse SAND, little to trace Silt, little to trace Gravel
Reworked Marine Deposits (Fill)	3.5	Fill included medium dense, gray to olive, fine to coarse SAND, some Silt & Clay (reworked marine deposits) (encountered in HB-GZ-3 only)
Marine Deposits	1 to 24	Variable, ranging **from**: very stiff, brown/gray/olive mottled, CLAY & SILT, some to trace fine to coarse Sand, trace Gravel; **to**: medium dense to very dense, brown/gray, fine to coarse SAND, some to trace Gravel, little to trace Silt
Glacial Till	20+	Very dense, gray, fine to coarse SAND, little Gravel, trace Silt

Detailed descriptions of the materials encountered at specific locations are provided in the boring logs included in **Appendix B**.

4.3 GROUNDWATER

Groundwater was observed during drilling approximately 4 to 5 feet below the ground surface in borings HB-GZ-2 and HB-GZ-3, and approximately 11.2 feet below ground surface in boring HB-GZ-1. Groundwater levels in the 4- to 5-foot range may have been perched groundwater sitting on top of a less permeable layer of fine-grained soils. Groundwater levels were observed in the borings at the completion of drilling without sufficient time to reach stabilized levels. Groundwater levels fluctuate due to season, precipitation, infiltration, and construction activity in the area as well as river level. Therefore, groundwater levels during and after construction will vary from those encountered at the time of the test borings.

5.0 ENGINEERING EVALUATIONS

5.1 DRAINAGE, FROST AND SUBGRADE CONDITIONS

Drainage of the pavement section will be necessary to limit frost action on the new pavements. Drainage details are anticipated to include a free-draining subbase gravel material that feeds into ditches or falling embankment slopes at the roadway shoulders, or pavement underdrains in curbed sections or where ditches are not feasible. Drainage structures and culverts should be provided as deemed necessary by the highway designer to remove the water from the ditches.

Based on the Maine DOT Bridge Design Guide, Section 5.2.1 the Freezing Index for the site is 1250, and with moisture content ranging from 15 to 28 percent (15% worse case for frost susceptibility), the estimated depth of frost penetration is 5.7 feet.

Where roadways will be constructed in cut or at grade locations, the frost-susceptibility of the local subgrade material should be considered in design of the new pavement section. The Maine Frost Classification results from MDOT's soils laboratory indicate that, in general, the fill and marine deposits meet frost categories 2 to 4 (moderately frost-susceptible to highly frost-susceptible).

5.2 EMBANKMENTS

The proposed off ramp alignment calls for cutting into the north side of the existing embankment overpass. The new configuration for an at-grade off ramp will be a left turn from Route 1 across traffic to the off ramp. The proposed off ramp will run alongside the current on ramp. Since no new fill or steep cut slopes are proposed, it is GZA's opinion that the existing stability conditions will remain unchanged or will be improved by the proposed grading changes.

5.3 PAVEMENT DESIGN

The pavement designs were developed using traffic criteria provided in by TMSI Engineers Inc, the 1993 AASHTO Guide for the Design of Pavement Structures, the Maine DOT Highway Design Guide for layer coefficients, and the Maine DOT Bridge Design Guide for servicibility, reliability, and standard deviation. The table below presents the design variables considered in our pavement design process.

GZA developed Roadbed Soil Resilient Modulus values for use in design based on an analysis of the test borings and laboratory test results for the soil conditions at the anticipated subgrade level. The soils at the anticipated subgrade level consist of variable fill ranging from: fine to coarse SAND, some to little Silt, trace Gravel; to: medium dense, gray to olive, fine to coarse SAND, some Silt & Clay (reworked marine deposits). The variable fill ranges from moderately frost-susceptible to highly frost-susceptible material with moisture contents ranging from 15 to 28 percent. If left in place the Silt & Clay subgrade materials are subject to weakening during seasonal freeze-thaw. In order to account for the weakening, we recommend using a roadbed resilient modulus of 3,000 psi for pavement design.

Location	**80-kip ESALs**	**Roadbed Soil Resilient Modulus**	**Initial Serviceability**	**Terminal Serviceability**	**Reliability Level %**	**Overall Standard Deviation**
Route 1 Southbound	7,745,300	3,000 psi	4.5	2.5	95	0.45
Ramp "L"	2,452,800	3,000 psi	4.5	2.5	95	0.45

6.0 GEOTECHNICAL RECOMMENDATIONS

6.1 GENERAL

GZA completed geotechnical engineering evaluations based on currently available subsurface exploration data, lab testing, existing and proposed plans, mapped surficial geology, and observation of visible conditions during a March 2011 site visit. Our recommendations are provided in the sections that follow.

6.2 SLOPE PROTECTION

Embankment slopes designed with MDOT typical slope angles should be provided with loam and seed for permanent erosion protection. If slopes steeper than 2H:1V are anticipated, bio-degradable, erosion control mat should be provided in addition to the loam and seed to protect the slopes from surface erosion until a root mass has developed.

6.3 DRAINAGE

We recommend that drainage of the pavement section be accomplished using the MDOT Standard details for 2-lane rural highways. These include a free-draining sub–base gravel material that feeds into ditches or falling embankment slopes at the roadway shoulders. Pavement underdrains may be considered at the south side of the ramp if the proposed grading does not allow the base of the ditch to extend to the bottom of the pavement subbase material. Drainage structures and culverts should be provided as deemed necessary by the highway designer to remove the water from the ditches.

6.4 FROST AND SUBGRADE CONDITIONS FOR USE IN PAVEMENT DESIGN

The anticipated depth of frost penetration in granular subgrade soils is approximately 5.7 feet for this project.

Since the roadways will be constructed in cut or at grade locations, the frost susceptibility of the subgrade material should be considered in design of the new pavement section. The Maine Frost Classification results indicate that, in general, the fill and marine deposits as subgrades fall into frost categories 2 to 4 (moderately frost-susceptible to highly frost-susceptible). In order to account for the potential of subgrade weakening, GZA recommends using a roadbed resilient modulus of 3,000 psi for pavement design.

6.5 PAVEMENT SECTION

Given the above input values for traffic, serviceability, and subgrade soil resilient modulus, GZA completed analyses in accordance with the AASHTO Guide for the Design of Pavement Structures to evaluate the required Structural Numbers for the two project segments. For Route 1 the required SN is 6.39 and for the ramp the required SN is 5.51. A variety of trial runs were made for each location to test different combinations and thicknesses of materials to arrive at what in GZA's opinion would be the optimum designs. The table below summarizes the results of the analyses.

Pavement Design Summary			
Material	**Structural Coefficients**	**Route 1 Thickness (inches)**	**Ramp Thickness (inches)**
Top 4" HMA	0.44	4	4
HMA Below 4"	0.34	4	4
Base Course Gravel Type B	0.12	14	12
Subbase Type D	0.09	18	12
Total thickness (in)		40	32
Design SN		6.42	5.64
Required SN		6.39	5.51

If the construction sequencing allows, reclaimed asphalt may be used as a direct substitute of the Base Course Gravel Type B.

6.6 REUSE OF EXISTING MATERIAL AND SOIL CUTS

The proposed alignment calls for cutting the existing grade. The cut material may be used for landscaping as it is unsuitable as granular borrow. Reclaimed asphalt may be used as a direct substitute of the Base Course Gravel Type B aggregate.

Soil types along the alignment within the depth of the proposed cuts are anticipated to be fill consisting of fine to coarse sand, some to trace silt, trace to little gravel. In the absence of ground water seepage conditions, these soils are considered stable for the MDOT standard 2H:1V earth cut slopes.

7.0 CONSTRUCTION CONSIDERATIONS

Unsuitable material including pavement, fill, forest mat, topsoil, peat and marsh deposits (if encountered) should be removed beneath proposed paved areas.

To identify areas of soft and or yielding material, exposed subgrades beneath proposed pavements should be proofrolled with two to four passes of a self-propelled static roller having a drum weight of at least 10 tons. In the event that weaving, rutting, or other indication of instability is observed during proofrolling, the suspect material should be excavated and replaced with compacted gravel. With the subgrade materials high in silts and clays the material will be moisture sensitive, especially in the winter and spring months when subjected to the freeze thaw cycles.

Roadway excavation should be maintained in such condition that the excavation surface will be well drained. Temporary drains, drainage ditches and culverts shall be constructed to intercept and divert water that may adversely affect the condition of the excavation and the prosecution of the work.

7.1 CONSTRUCTION SERVICES

We recommend that GZA be retained to provide geotechnical engineering observation and consultation services during construction to observe compliance with design and construction recommendations and specifications. Specifically, these services should include, On-Call Observation/Consultation for subgrade preparation and proofrolling.

FIGURES

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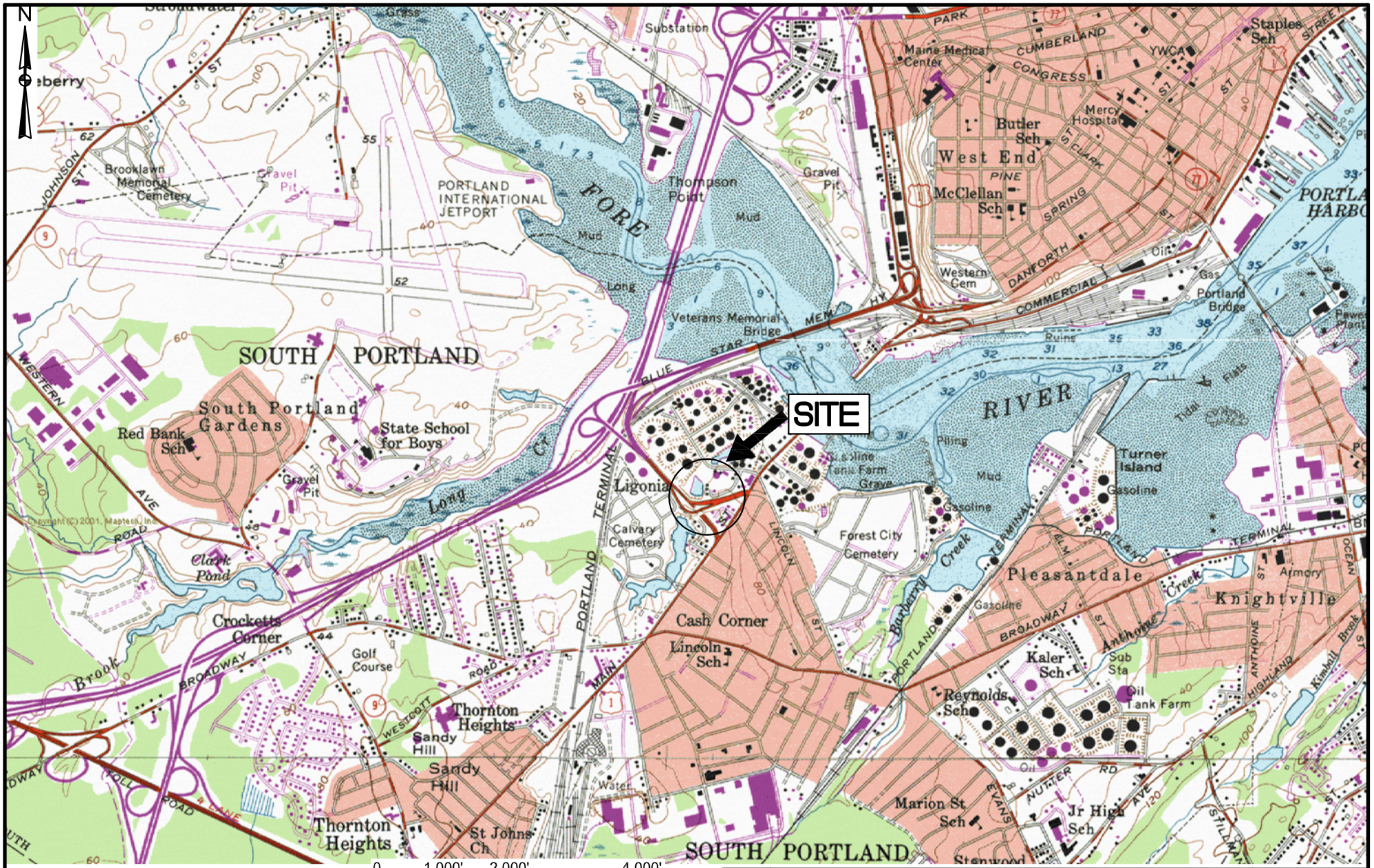

NO.	ISSUE/DESCRIPTION	BY	DATE

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PORTLAND, MAINE 04101
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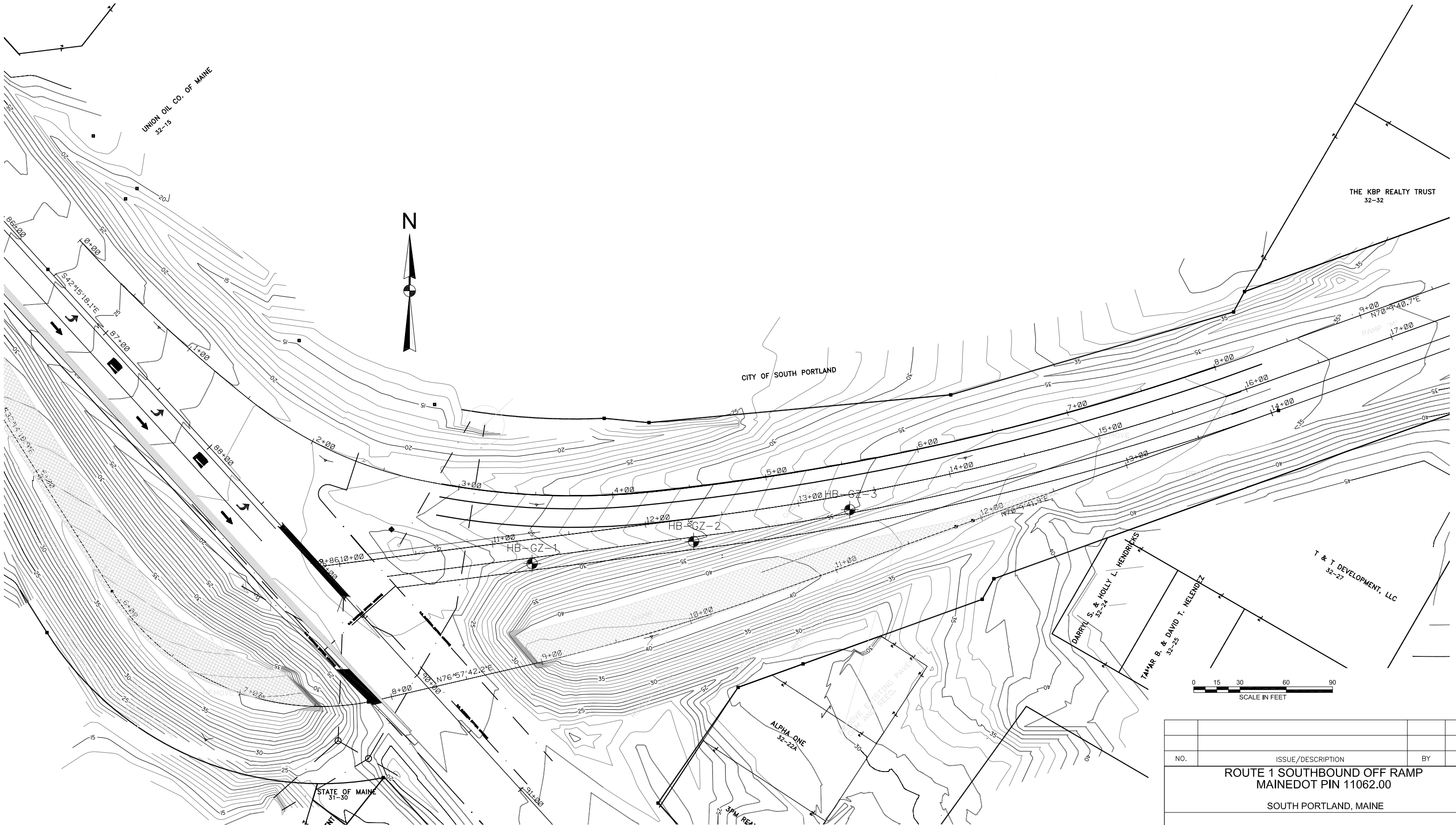
PREPARED FOR:
MAINE DEPARTMENT OF TRANSPORTATION

ROUTE 1 SOUTHBOUND OFF RAMP
MAINEDOT PIN 11062.00

SOUTH PORTLAND, MAINE

LOCUS PLAN

PROJ MGR: CLS	DATE APRIL 2011	FIGURE 1
DESIGNED BY: MJD	PROJECT NO. 09.0025658.00	
REVIEWED BY: CLS		
DRAWN BY: MJD		
CHECKED BY: ARB	REVISION NO.	SHEET NO.
SCALE: AS NOTED		



LEGEND

HB-GZ-3 — DESIGNATION AND APPROXIMATE LOCATION OF TEST BORING DRILLED BY MAINE TEST BORINGS, OBSERVED BY GZA ON MARCH 3, 2011.

NOTES:

1. BASE MAP DEVELOPED FROM THE FOLLOWING ELECTRONIC DRAWING FILES PROVIDED BY TMSI:
   - ALIGNMENTS.DGN, DATED MARCH 9, 2011.
   - CONTOURS.DGN, DATED MARCH 9, 2011.
   - HIGHWAY.DGN DATED MARCH 9, 2011.
   - RWPLAN.DGN DATED MARCH 9, 2011
2. THE EXPLORATIONS WERE LOCATED USING TAPING AND PACED MEASUREMENTS FROM EXISTING FEATURES SHOWN ON THE SITE PLAN PROVIDED BY TMSI DATED JANUARY 24, 2011. THE BORING LOCATIONS ARE ACCURATE TO THE DEGREE IMPLIED BY THE METHOD USED TO LOCATE THEM.
3. HB-GZ-SERIES TEST BORINGS WERE PERFORMED BY MAINE TEST BORING OF BREWER, MAINE ON MARCH 3, 2011 AND OBSERVED BY GZA PERSONNEL.

UNLESS SPECIFICALLY STATED BY WRITTEN AGREEMENT, THIS DRAWING IS THE SOLE PROPERTY OF GZA GEOENVIRONMENTAL, INC. (GZA). THE INFORMATION SHOWN ON THE DRAWING IS SOLELY FOR USE BY GZA'S CLIENT OR THE CLIENT'S DESIGNATED REPRESENTATIVE FOR THE SPECIFIC PROJECT AND LOCATION IDENTIFIED ON THE DRAWING. THE DRAWING SHALL NOT BE TRANSFERRED, REUSED, COPIED, OR ALTERED IN ANY MANNER FOR USE AT ANY OTHER LOCATION OR FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF GZA. ANY TRANSFER, REUSE, OR MODIFICATION TO THE DRAWING BY THE CLIENT OR OTHERS, WITHOUT THE PRIOR WRITTEN EXPRESS CONSENT OF GZA, WILL BE AT THE USER'S SOLE RISK AND WITHOUT ANY RISK OR LIABILITY TO GZA.

NO.	ISSUE/DESCRIPTION	BY	DATE

ROUTE 1 SOUTHBOUND OFF RAMP
MAINEDOT PIN 11062.00

SOUTH PORTLAND, MAINE

BORING LOCATION PLAN

PREPARED BY:
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PORTLAND, MAINE 04101
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PREPARED FOR:
MAINE DEPARTMENT OF TRANSPORTATION

PROJ MGR: CLS	REVIEWED BY: CLS	CHECKED BY: ARB	FIGURE 2
DESIGNED BY: MJD	DRAWN BY: MJD	SCALE: AS NOTED	
DATE APRIL 2011	PROJECT NO. 09.0025658.00	REVISION NO.	SHEET NO.

©2011 - GZA GeoEnvironmental, Inc. GZA-P:\09 Jobs\00256500s\09.0025658.00\Figures-CAD\BORING LOCATION PLAN.dwg [22x34] April 04, 2011 - 4:12pm Michael.Devold

APPENDIX A

LIMITATIONS

LIMITATIONS

Explorations

1. The analyses and recommendations in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

3. Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by GZA GeoEnvironmental, Inc. It is recommended that this firm be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Construction

5. It is recommended that this firm be retained to provide soil engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Use of Report

6. This soil and foundation engineering report has been prepared for this project by GZA GeoEnvironmental, Inc. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

7. This report has been prepared for this project by GZA GeoEnvironmental, Inc. for the exclusive use of the Maine Department of Transportation and their project team for specific application to the RT1 Southbound Off Ramp in South Portland, Maine in accordance with generally accepted soil and foundation engineering practices. No Warranty, express or implied, is made.

APPENDIX B

BORING LOGS

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 1
Location: South Portland, Maine

Boring No.: HB-GZ-1
PIN: 11062.00

Driller:	Maine Test Boring	**Elevation (ft.)**	25±	**Auger ID/OD:**	3" ID
Operator:	Mike Porter	**Datum:**	NAVD 88	**Sampler:**	D-53
Logged By:	Mike Devoid	**Rig Type:**	Track	**Hammer Wt./Fall:**	140#/30
Date Start/Finish:	03/03/11-03/03/11	**Drilling Method:**	HSA	**Core Barrel:**	
Boring Location:	See Plan	**Casing ID/OD:**		**Water Level*:**	11.2
Hammer Efficiency Factor:	.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR = weight of rods
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/14	0.0 - 2.0	5-4-5-5	9	9			Loose, brown, fine to coarse SAND, little Silt, dry. -FILL-	
	2D	24/15	2.0 - 4.0	4-1-2-2	3	3			Very loose, brown, fine to medium SAND, and SILT & CLAY, trace black ash, damp.	SC/A-6/III WC=20.8%
	3D	24/14	4.0 - 6.0	2-2-3-1	5	5			Loose, brown, fine to coarse SAND, some Silt & Clay, trace black ash, wet.	
5								19.0	6.0	
	4D	24/14	6.0 - 8.0	1-2-1-2	3	3			Soft, olive/brown mottled, Silty CLAY, some fine Sand, wet.	CL/A-7/IV WC=23.9%
	5D	24/24	8.0 - 10.0	5-5-11-13	16	16			Very stiff, gray/brown mottled, CLAY & SILT, some fine Sand, wet. -MARINE DEPOSIT-	
10	6D	24/24	10.0 - 12.0	5-9-10-11	19	19			Very stiff, gray/brown mottled, CLAY & SILT, trace fine to medium Sand, wet.	
								12.0	13.0	
15	7D	24/17	15.0 - 17.0	5-8-11-18	19	19			Medium dense, brown to 15.4' then gray, fine to medium SAND, trace Gravel, wet. -MARINE DEPOSIT-	
20	8D	24/12	20.0 - 22.0	22-25-28-32	53	53			Very dense, gray, fine to coarse SAND, some Gravel, trace Silt, wet.	
								2.0	23.0	
25	9D	24/24	25.5 - 27.5	7-9-7-7	16	16			Top 12": Gray/brown mottled, SILT & CLAY, little fine	

Remarks:

1. Increased drilling resistance between 10-13' and at 23.0'.
2. Sand heaved into augers 2'; pulled augers back 1' and drove spoon 20'-22'.
3. Drove AW rod probe from 42' to 50' using 300 lb hammer and 24" drop. Recorded blows/foot penetration in the casing blows column.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 1
Location: South Portland, Maine

Boring No.: HB-GZ-1
PIN: 11062.00

Driller:	Maine Test Boring	**Elevation (ft.)**	25±	**Auger ID/OD:**	3" ID
Operator:	Mike Porter	**Datum:**	NAVD 88	**Sampler:**	D-53
Logged By:	Mike Devoid	**Rig Type:**	Track	**Hammer Wt./Fall:**	140#/30
Date Start/Finish:	03/03/11-03/03/11	**Drilling Method:**	HSA	**Core Barrel:**	
Boring Location:	See Plan	**Casing ID/OD:**		**Water Level*:**	11.2
Hammer Efficiency Factor:	.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR = weight of rods
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
								-1.5		Sand . Bottom 12": Brown, fine to medium SAND, wet. 26.5 -MARINE DEPOSIT-	
30	10D	24/18	30.0 - 32.0	7-9-25-11	34	34		-5.3		Dense, top 3" brown, bottom 15" gray, fine to coarse SAND and SILT, some Gravel, wet. 30.3	
35	11D	24/22	35.0 - 37.0	40-51-52-63	103	103				Very dense, gray, fine to coarse SAND, little Gravel, trace Silt, wet. -GLACIAL TILL-	
40	12D	24/17	40.0 - 42.0	18-43-24-23	67	67				Very dense, gray, fine to coarse SAND, little Gravel, trace Silt, wet. -GLACIAL TILL-	
							22				
							30				
							30				
45							32				
							65				
							110				
							93				
							102				
50								-25.0		50.0 **Bottom of Exploration at 50.00 feet below ground surface.** No Refusal.	

Remarks:

1. Increased drilling resistance between 10-13' and at 23.0'.
2. Sand heaved into augers 2'; pulled augers back 1' and drove spoon 20'-22'.
3. Drove AW rod probe from 42' to 50' using 300 lb hammer and 24" drop. Recorded blows/foot penetration in the casing blows column.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 1
Location: South Portland, Maine

Boring No.: HB-GZ-2
PIN: 11062.00

Driller:	Maine Test Boring	**Elevation (ft.)**	30±	**Auger ID/OD:**	2.25" ID
Operator:	Mike Porter	**Datum:**	NAVD 88	**Sampler:**	D-53
Logged By:	Mike Devoid	**Rig Type:**	Track	**Hammer Wt./Fall:**	140#/30
Date Start/Finish:	03/03/11-03/03/11	**Drilling Method:**	SSA	**Core Barrel:**	
Boring Location:	See Plan	**Casing ID/OD:**		**Water Level*:**	4.3
Hammer Efficiency Factor:	.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR = weight of rods
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/14	0.0 - 2.0	1-3-4-5	7	7			Loose, brown, fine to coarse SAND, little Silt, dry. -FILL-	
	2D	24/17	2.0 - 4.0	5-6-5-7	11	11			Medium dense, light brown, fine to medium SAND, some SILT, damp.	SM/A-2-4/II WC=22.4%
	3D	24/19	4.0 - 6.0	5-3-3-2	6	6		26.1	3.9	SM/A-2-4/II WC=28.3%
5								25.1	Loose, brown, fine to medium SAND, little Silt, trace root fibers in top 12", wet. (Possible topsoil layer.) 4.9	
	4D	24/19	6.0 - 8.0	4-7-7-14	14	14			Top 5": similar to 3D. Middle 7": Medium dense, brown, fine to coarse SAND, trace Silt. Wet.	
	5D	24/17	8.0 - 10.0	7-8-11-13	19	19		22.8	-MARINE DEPOSIT- Bottom 7": Brown/gray mottled, Clayey SILT, wet. 7.2	
10	6D	24/16	10.0 - 12.0	9-8-12-11	20	20			Very stiff, gray/brown mottled, SILT & CLAY, trace fine Sand, damp. -MARINE DEPOSIT- Very stiff, SILT & CLAY, trace fine Sand, 1/8" sand seams approximately 6" apart.	
								18.0	12.0	
15									**Bottom of Exploration at 12.00 feet below ground surface.** No Refusal.	
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Route 1
Location: South Portland, Maine

Boring No.: HB-GZ-3
PIN: 11062.00

Driller:	Maine Test Boring	**Elevation (ft.)**	35±	**Auger ID/OD:**	2.25" ID
Operator:	Mike Porter	**Datum:**	NAVD 88	**Sampler:**	D-53
Logged By:	Mike Devoid	**Rig Type:**	Track	**Hammer Wt./Fall:**	140#/30
Date Start/Finish:	03/03/11-03/03/11	**Drilling Method:**	SSA	**Core Barrel:**	
Boring Location:	See Plan	**Casing ID/OD:**		**Water Level*:**	5
Hammer Efficiency Factor:	.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR = weight of rods
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/8	0.0 - 2.0	5-7-8-10	15	15			Medium dense, brown, fine to coarse SAND, trace Gravel, trace Silt, dry.	
	2D	24/7	2.0 - 4.0	4-19-13-14	32	32			Dense, brown, fine SAND, little Silt.	SM/A-2-4/II WC= 15.0%
	3D	24/8	4.0 - 6.0	2-6-5-25	11	11			Medium dense, brown, fine to coarse SAND, some Silt, little Gravel, wet. -FILL-	
5	4D	24/18	6.0 - 8.0	14-12-6-6	18	18			Medium dense, gray/olive, fine to coarse SAND, some Silt & Clay, wet. -FILL-	
	5D	24/18	8.0 - 10.0	1-10-11-8	21	21			Medium dense, gray, fine to medium SAND and SILT, trace Gravel. Bottom 6": fine to medium SAND, little Silt, trace organics/ roots, wet.	SM/A-4/IV WC=17.3%
10	6D	24/19	10.0 - 12.0	6-11-13-15	24	24		25.0	10.0	
								24.5	Top 6": Gray/brown, fine to medium SAND, little Silt, trace organics/roots. (Possible topsoil layer.) 10.5	
								23.0	Bottom 12": Very stiff, gray/olive, Clayey SILT, trace fine Sand, wet. -MARINE DEPOSIT- 12.0	
15									**Bottom of Exploration at 12.00 feet below ground surface.** No refusal.	
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 C

LABORATORY TESTING RESULTS

GZA GeoEnvironmental, Inc.

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Route 1 Southbound Off Ramp

MDOT Project Number:

Town(s): South Portland

GZA Project Number: 09.0025658.00

Boring & Sample Identification Number	Station (Feet)	Sample No.	Depth (Feet)	Reference Number	G.S.D.C. Sheet	W.C.	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
HB-GZ-1		2D	2-4			20.8			SC	A-6	III
HB-GZ-1		4D	6-8			23.9			CL	A-7	IV
HB-GZ-2		2D	2-4			22.4			SM	A-2-4	II
HB-GZ-2		3D	4-6			28.3			SM	A-2-4	II
HB-GZ-3		2D	2-4			15			SM	A-2-4	II
HB-GZ-3		5D	8-10			17.3			SM	A-4	IV

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

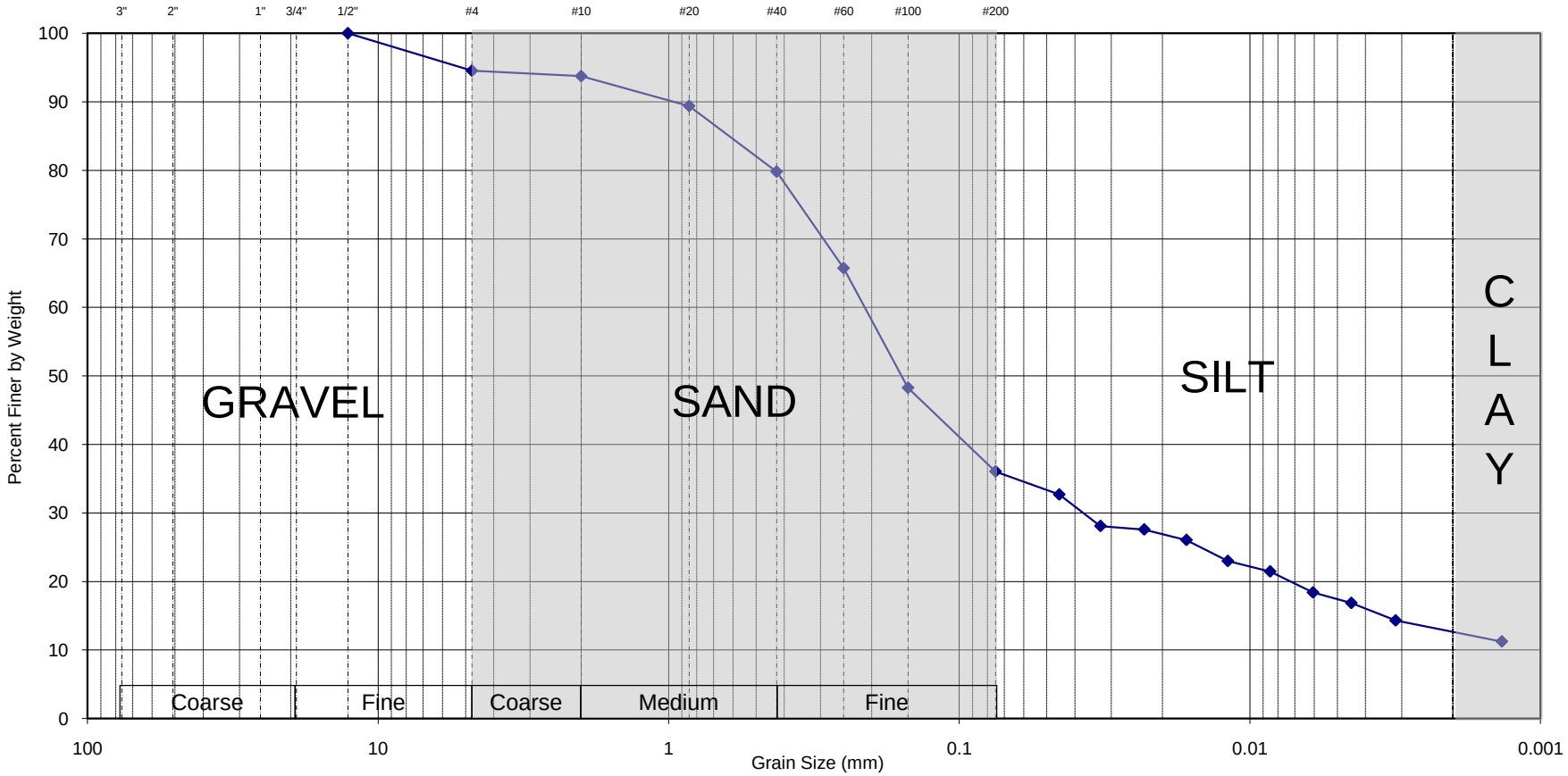
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

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

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

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

U.S. STANDARD SIEVE AND HYDROMETER



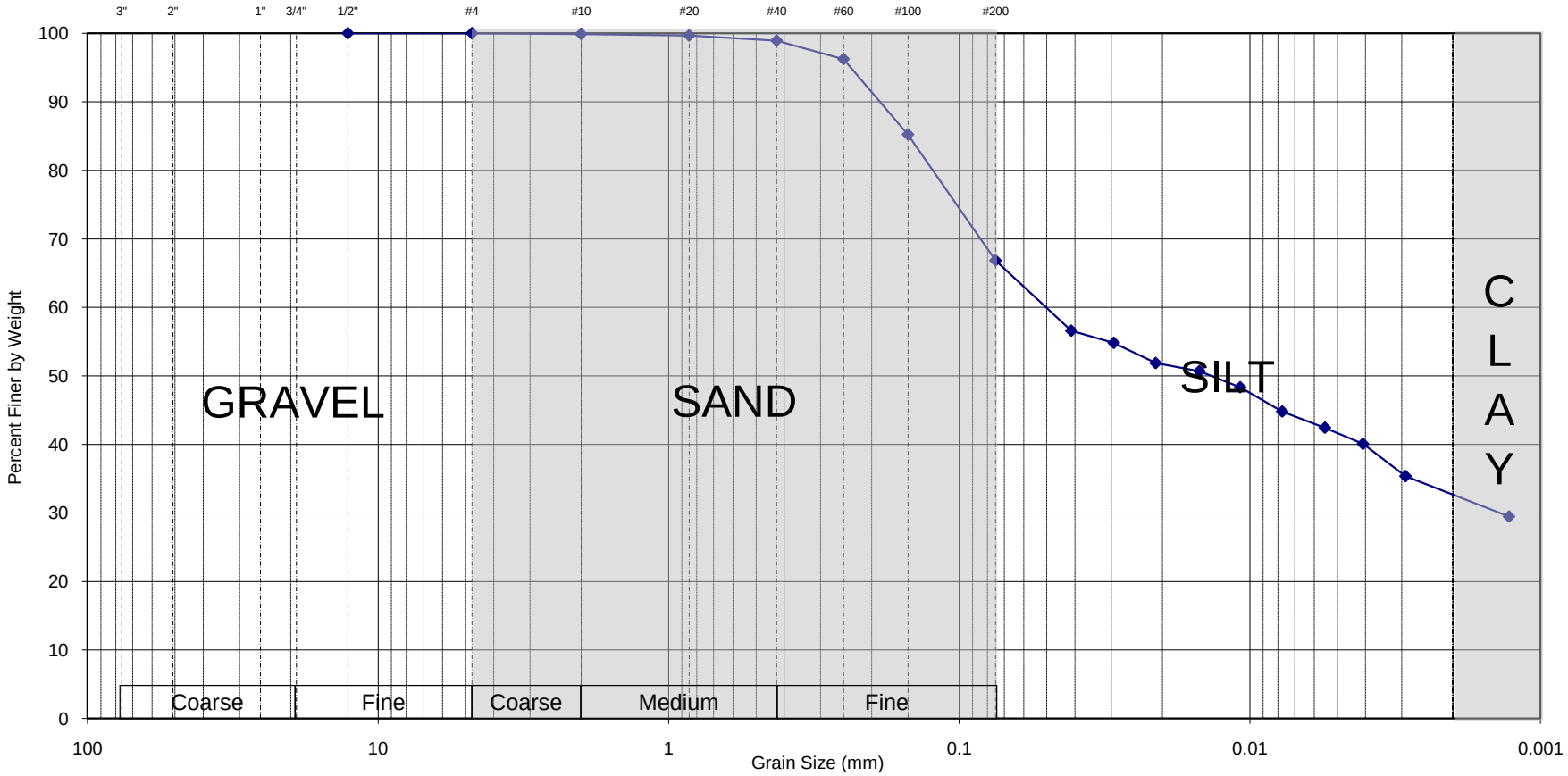
Gravel	Sand	Fines
5.5%	58.5%	36.1%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
1	HB-GZ-1	2D	2-4'	Brown f-m SAND and SILT & CLAY, trace Gravel (SC)	20.8			

Route 1 Southbound Off Ramp
South Portland, ME
GZA File # 09.0025658.00

Tested by: MST/TAJ Date: 3/17/11
Reviewed by: MBP Date: 3/18/11

U.S. STANDARD SIEVE AND HYDROMETER



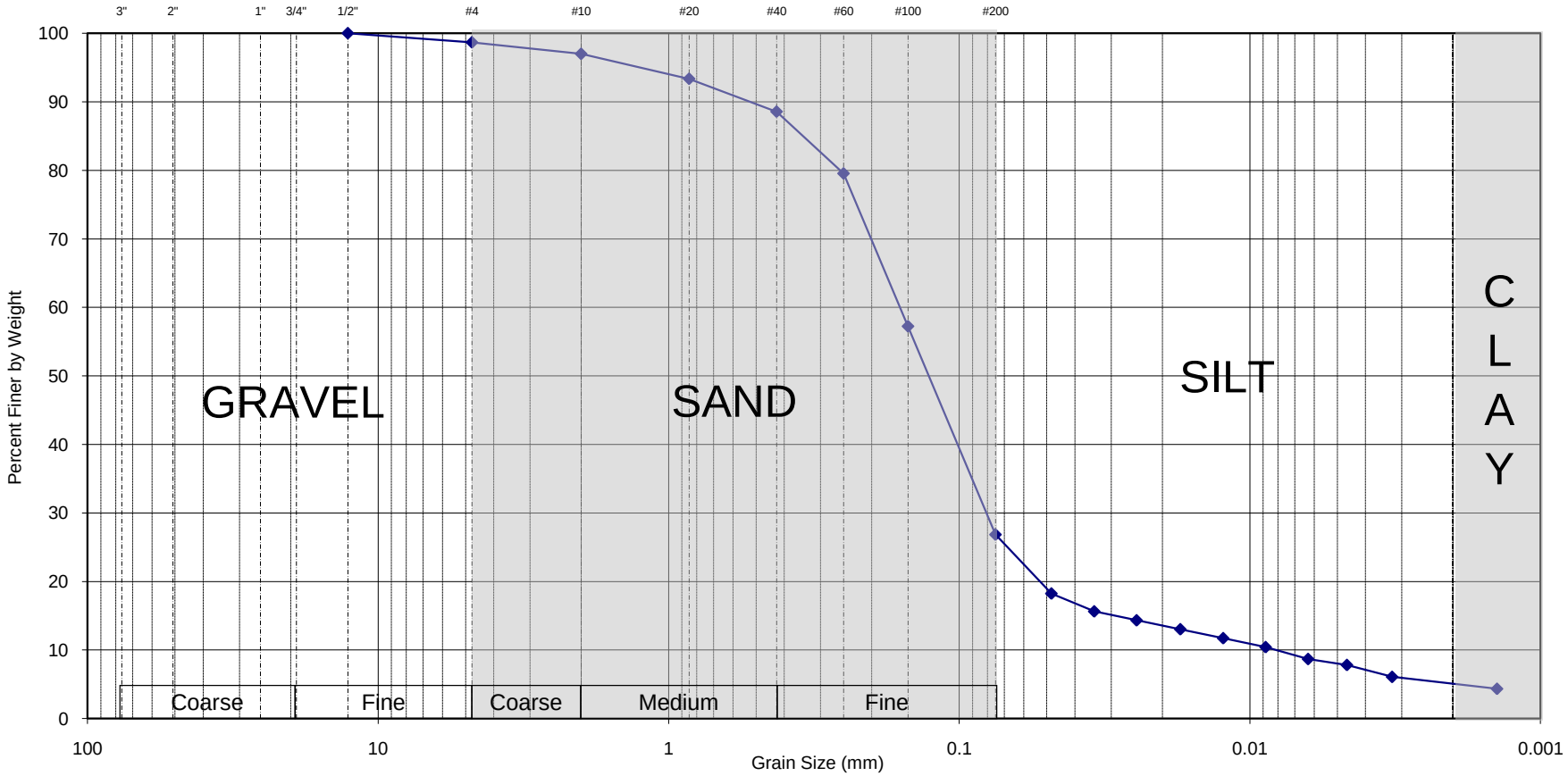
Gravel	Sand	Fines
0.0%	33.2%	66.8%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
2	HB-GZ-1	4D	6-8'	Brown Silty CLAY, some fine Sand (CL)	23.9			

Route 1 Southbound Off Ramp
South Portland, ME
GZA File # 09.0025658.00

Tested by: MST/TAJ Date: 3/17/11
Reviewed by: MBP Date: 3/18/11

U.S. STANDARD SIEVE AND HYDROMETER



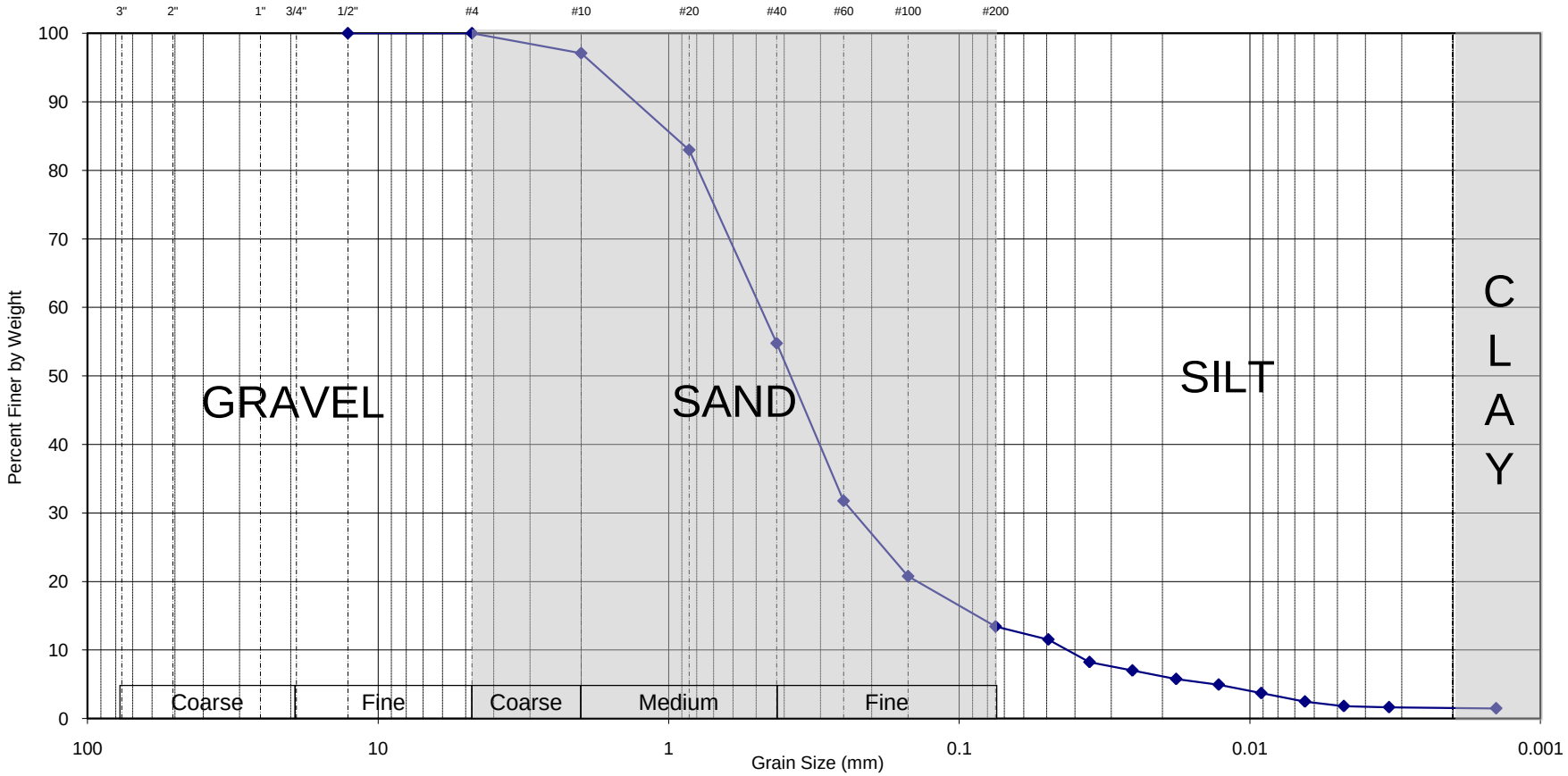
Gravel	Sand	Fines
1.3%	71.8%	26.8%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
3	HB-GZ-2	2D	2-4'	Brown f-m SAND, some Silt, trace Gravel (SM)	22.4			

Route 1 Southbound Off Ramp
South Portland, ME
GZA File # 09.0025658.00

Tested by: MST/TAJ Date: 3/17/11
Reviewed by: MBP Date: 3/18/11

U.S. STANDARD SIEVE AND HYDROMETER



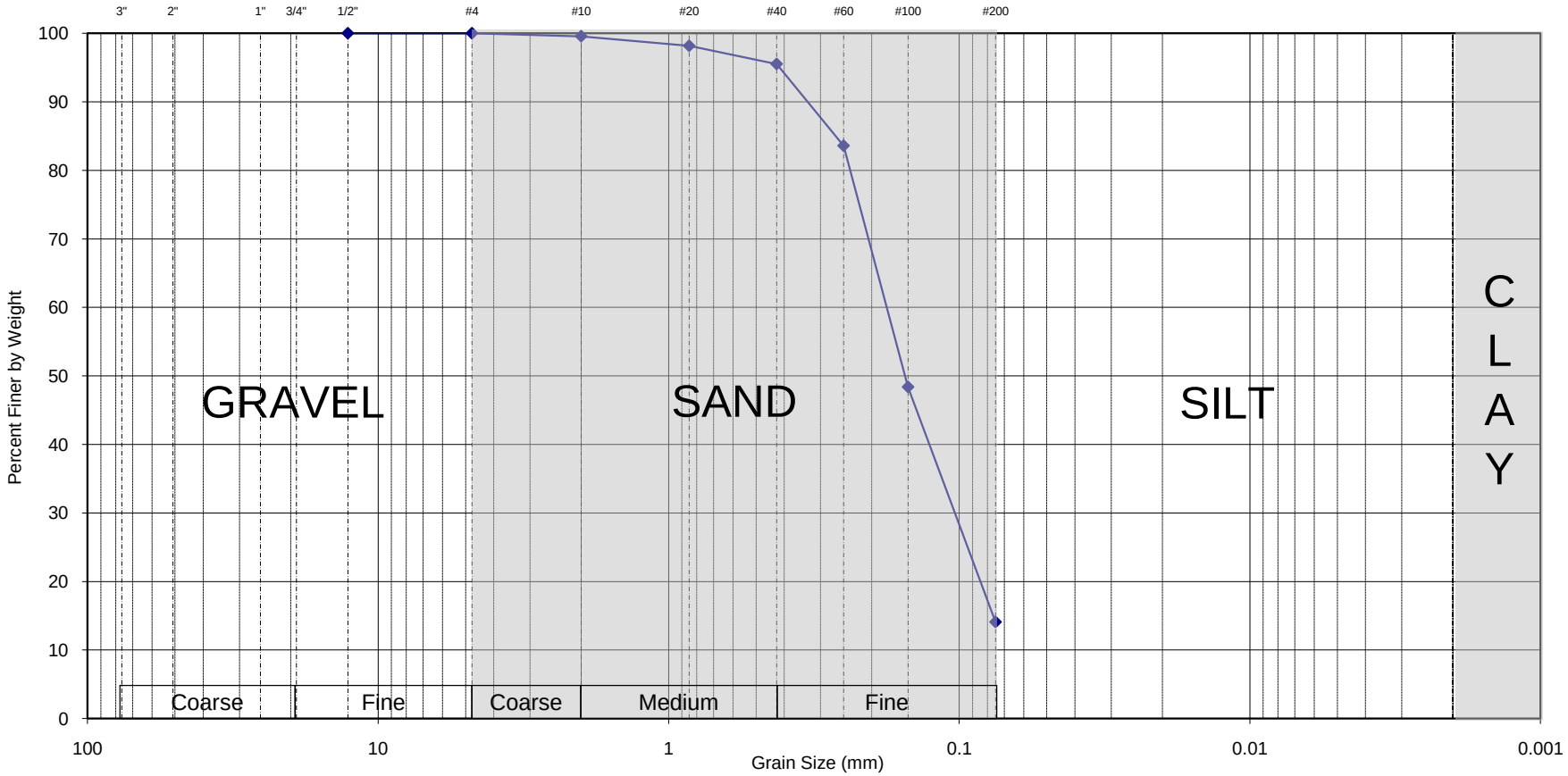
Gravel	Sand	Fines
0.0%	86.6%	13.4%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
4	HB-GZ-2	3D	4-6'	Brown f-m SAND, little Silt (SM)	28.3			

Route 1 Southbound Off Ramp
South Portland, ME
GZA File # 09.0025658.00

Tested by: MST/TAJ Date: 3/17/11
Reviewed by: MBP Date: 3/18/11

U.S. STANDARD SIEVE AND HYDROMETER



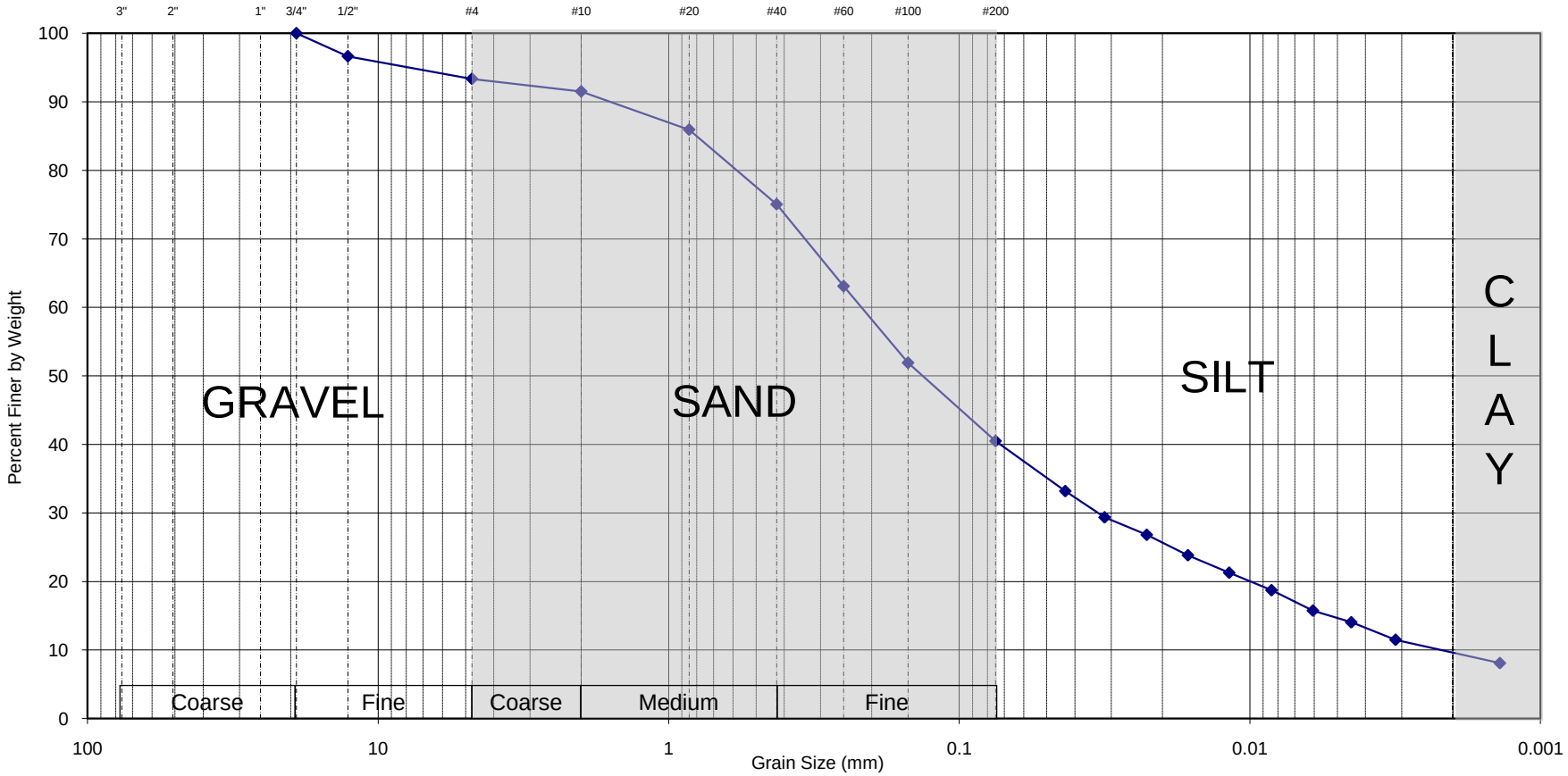
Gravel	Sand	Fines
0.0%	85.9%	14.1%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
5	HB-GZ-3	2D	2-4'	Brown fine SAND, little Silt (SM)	15.0			

Route 1 Southbound Off Ramp
South Portland, ME
GZA File # 09.0025658.00

Tested by: MST/TAJ Date: 3/17/11
Reviewed by: MBP Date: 3/18/11

U.S. STANDARD SIEVE AND HYDROMETER



Gravel	Sand	Fines
6.7%	52.8%	40.5%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
6	HB-GZ-3	5D	8-10'	Brown f-m SAND and SILT, trace Gravel (SM)	17.3			

Route 1 Southbound Off Ramp
South Portland, ME
GZA File # 09.0025658.00

Tested by: MST/TAJ Date: 3/17/11
Reviewed by: MBP Date: 3/18/11

APPENDIX D

CALCULATIONS

GZA
GeoEnvironmental, Inc
4 Free Street
Portland, Maine 04101
207-879-9190
Fax 207-879-0099
http://www.gza.com

Engineers and Scientists

JOB: 09.0025658.00
SUBJECT: Pavement Calcs
SHEET: 1 OF 3
CALCULATED BY MJD 3/29/11
CHECKED BY CLS 4/4/11
REMARK:

Objective

Determine required roadway structural numbers and pavement design.

Methodology

Maine Department of Transportation Highway Design Guide, Chapter 13.

References (i.e. AASHTO)

1. American Association of State Highway and Transportation Officials, Guide for the Design of Pavement Structures, 1993.
2. Maine Department of Transportation (MDOT), Highway Design Guide, Flexible Pavement Design, Chapter 13, December 2007.
3. Maine Department of Transportation (MDOT), Bridge Design Guide (BDG), August 2003 with 2009 revisions.
4. Van Til, C.J., et al., "Evaluation of AASHTO Interim Guides for Design of Pavement Structures," NCHRP Report 128, National Research Board, Washington, DC, 1972.

Reliability

Roadway location and Type: Urban (in the City of South Portland Maine US Route 1)
Reliability: 95% (per MDOT BDG for National Highway System)
Number of Stages: 1(new lanes completed before old access removed per TMSI)
Standard Deviation: 0.45 (per MDOT BDG)

Traffic

SOUTH PORTLAND PIN 11062.00
March 9, 2011

TRAFFIC DATA FOR PAVEMENT DESIGN:
(Adjusted for future conversion of Exit 4 to full service interchange)

	Rte. 1 SB	
	nw/o Ramp L	Ramp L
2010 AADT	6985	3470
2030 AADT	9525	4645
DHV	1143	511
%T_AADT	10%	7%
%T_DHV	8%	6%
DD_DHV	100%	100%
18k P 2.0	1114	352
18k P 2.5	1061	336

Please provide pavement design for both the full reconstruction of Ramp L and for the widening of Rte. 1 Southbound.

provided by TMSI

ESAL CALCULATIONS (20 years)
Route 1 ESAL=1061*365*20=7,745,300
Ramp "L" ESAL= 336*365*20=2,452,800

Serviceability

Initial Serviceability: 4.5 (per MDOT BDG Table 2-8)
Terminal Serviceability: 2.5 (per MDOT BDG for arterials and collectors Table 2-8)

Subgrade Resilient Modulus

Based on local project and MDOT experience, a soil support "S" value of 3 was assumed. This includes the effects of frost and seasonal thaw weakening on the Clay and Silt subgrade soils. Based on Van Til, C.J., et al., "Evaluation of AASHTO Interim Guides for Design of Pavement Structures," NCHRP Report 128, National Research Board, Washington, DC, 1972 and a soil support "S" value the subgrade resilient modulus is estimated to be 3000psi during seasonal thaw weakening.

The design resilient modulus of 3000psi for a Silt and Clay subgrade was used for calculating the required SN.

Required Structural Number (SN)

Computation: AASHTO without environmental effects 20 year performance period

Route 1	Ramp L
SN: 6.39	SN: 5.51

Layer Coefficients

Per MDOT BDG Table 2-8 and MDOT Highway Design Guide, Chapter 13, Flexible Pavement Design 13-6.4.1 the layer coefficients are as follows:

Top 4" HMA	0.44
HMA>4"	0.34
Reclaimed	0.14
Base Course Gravel Type B	0.12
Subbase Type D	0.09

GZA
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Engineers and Scientists

JOB: 09.0025658.00
SUBJECT: Pavement Calcs
SHEET: 3 OF 3
CALCULATED BY MJD 3/29/11
CHECKED BY CLS 4/4/11
REMARK:

Results

The following Pavement sections are recommended for the project.

Route 1 Southbound Off Ramp South Portland, Maine				
Rt.1 Southbound Off Ramp				
EASL = 336x365x20 = 2,452,800				
	w/o env			
Design Structural Number	**5.51**			
Total Thickness	32			
Layer	Struct. Coeff	Drain Coeff	Thickness	SN
Top 4" HMA	0.44	1	4	1.76
HMA > 4"	0.34	1	4	1.36
Reclaimed	0.14	1	0	0
Base Course Gravel Type B	0.12	1	12	1.44
Subbase Type D	0.09	1	12	1.08
			Sum	**5.64**
Rt. 1 Southbound				
EASL = 1061x365x20 = 7,745,300				
	w/o env			
Design Structural Number	**6.39**			
Total Thickness	40			
Layer	Struct. Coeff	Drain Coeff	Thickness	SN
Top 4" HMA	0.44	1	4	1.76
HMA > 4"	0.34	1	4	1.36
Reclaimed	0.14	1	0	0
Base Course Gravel Type B	0.12	1	14	1.68
Subbase Type D	0.09	1	18	1.62
			Sum	**6.42**