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CONSTRUCTION  
MANAGEMENT

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## MEMORANDUM

TO: Mark D. Suennen, Vanasse Hangen Brustlin, Inc.

FROM: Nicholas Williams, EIT, Christopher Snow, PE, Andrew R. Blaisdell, PE

DATE: August 25, 2017

FILE NO.: 09.0025945.00

SUBJECT: Preliminary Geotechnical Design Basis  
Foundations for Overhead Sign Structures  
Maine Turnpike Authority Exit 44 Overhead Sign Structures  
South Portland, Maine



GZA GeoEnvironmental, Inc. (GZA) has prepared this preliminary geotechnical design basis memorandum for the proposed construction of three new overhead sign structures along the Maine Turnpike northbound in South Portland, Maine. Our services were provided in accordance with our executed contract dated June 9, 2017, which incorporates the scope of work in GZA's April 14, 2017 proposal No. 09.P00013.18. This memorandum is subject to the *Limitations* included in **Appendix A**.

### BACKGROUND

The project consists of three proposed Overhead Sign Structures (OHSS) along the Maine Turnpike northbound mainline at mile markers (MMs) 43.24, 44.04, and 44.14 in South Portland, Maine. Each sign will have an overhead bridge-type support, with one foundation in the median and one on the northbound shoulder. Foundations types for the new OHSS have not been determined. Spread footings, single or paired drilled shafts, and driven piles are considered technically feasible alternatives.

### SUBSURFACE EXPLORATIONS

GZA completed a subsurface investigation program consisting of seven test borings to develop subsurface conditions at the proposed sign structures: one at MM43.24, two at MM44.04, two at MM44.14 and two at MM43.6. The two borings at MM43.6 were drilled at a location where no sign is currently proposed. The test borings were drilled to depths from approximately 61 to 98 feet below ground surface, and were terminated upon rod probe refusal. The borings were drilled by New England Boring Contractors (NEBC) of Hermon, Maine between July 10, 2017 and July 13, 2017. Prior to the drilling, NEBC contacted Dig Safe® to locate public utilities at the Site. GZA personnel monitored the drilling work and prepared logs of each boring. Maine Turnpike Authority provided flagging services to create the lane closures needed for the drilling work.

The borings were drilled using 3-inch driven casing and drive-and-wash drilling techniques. The top 12 feet of each boring was drilled open-hole with solid stem augers. Standard



penetration testing (SPT) and split-spoon sampling were performed at 5-foot typical intervals to approximately 40 feet using a 24-inch-long, 1-3/8-inch inside-diameter sampler, driven with an automatic hammer with a rated hammer efficiency factor of 0.68.

Field vane shear tests were conducted to estimate the undrained shear strength of clay. The tests were conducted at 5- to 10-foot typical intervals. Pairs of shear vane tests were completed at each test interval. Sampling and vane shear testing were carried to a depth of approximately 40 feet, extending below what GZA judges to be the likely maximum depth of a drilled shaft foundation. Below that depth, rod probes were hydraulically advanced to refusal and the probes were subsequently driven using the SPT hammer until refusal. Test boring B-44.04-E was sampled through the clay soils and into the underlying marine sand, until split spoon refusal on possible bedrock.

The test borings were laid-out in the field by GZA personnel by taping and pacing from existing features shown on the site plan, and recorded using a hand-held global positioning unit reported to be accurate to plus or minus 10 feet. The approximate exploration locations are shown on **Figure 1**. Approximate ground surface elevations at the exploration locations were estimated to the nearest 1 foot by GZA by interpolating between Maine Office of GIS Data Catalog 2-foot contours, and should be considered accurate to the degree implied by the method used.

**LABORATORY TESTING**

GZA engaged Thielsch Engineering who completed a laboratory testing program to check the visual soil classifications and provide data for use in engineering evaluations. The program included four (4) gradation analysis/AASHTO Classification/Frost Classification assessments, four (4) Atterberg Limits evaluations, and nine (9) moisture content determinations on split spoon samples from the borings. Results of the testing are included in **Appendix C**.

**SUBSURFACE CONDITIONS**

Four principal subsurface units were encountered in the test borings: Fill, Sand, Silty Clay, and Marine Sand. Surficial materials included Asphalt and topsoil depending upon where the boring was located. The encountered thicknesses, generalized descriptions and engineering properties of the units encountered, in descending order from ground surface, are summarized in the following table. Detailed descriptions of the materials encountered at specific locations are provided on the boring logs in **Appendix B**.

GENERALIZED SUBSURFACE CONDITIONS		
Soil Unit	Approximate Encountered Thickness (ft)	Generalized Description
Topsoil	0.2 – 0.5	Brown, fine to coarse SAND, some Silt. <i>Encountered in borings B-43.24A-E, B-43.6-W, B-44.04-W, and B-44.14-W.</i>
Asphalt	0.5 – 0.8	Asphalt pavement. <i>Encountered in borings B-43.6-E, B-44.04-E, B-44.04-W,</i>
Fill	3.8 – 8.5	Medium dense, brown, fine to coarse SAND, little Gravel, trace Silt (USCS: SW-SM). <ul style="list-style-type: none"> <li>Maine Department of Transportation (MaineDOT) Frost Classification = 0</li> </ul> <i>Encountered in all borings.</i>



GENERALIZED SUBSURFACE CONDITIONS		
Soil Unit	Approximate Encountered Thickness (ft)	Generalized Description
Sand	7.5 – 14.5	Loose to medium dense, brown, wet, fine to medium SAND, little to some Silt, with occasional clay seams (USCS: SP-SM). <i>Encountered in all borings except B-43.6 E, and B- 43.6-W.</i>
Silty Clay	40 – 87	Medium stiff to stiff, gray, silty CLAY, with occasional sand seams in the shallower clay samples (USCS: CL) <i>Encountered in all borings</i>
Marine Sand	7	Loose to medium dense, gray, fine to coarse SAND, little Gravel, little Silt (USCS: SM) <i>Encountered in boring B-44.04-E only.</i>
Approximate Refusal Depth	61 – 98	50 blows / <1" penetration of split spoon or rod probe. <i>Encountered in all borings.</i>

GROUNDWATER

Groundwater was encountered in the test borings at depths of approximately 4 to 9 feet below ground surface. These observations were made during drilling and may have been affected by the drilling operations. Groundwater levels vary due to season, precipitation, construction activities and other factors. Consequently, water levels during and after construction are likely to vary from those encountered in the borings.

**ENGINEERING EVALUATIONS**

FEASIBLE FOUNDATION TYPES

The project includes the construction of three new full overhead sign structures. Each sign structure will have one foundation on the northbound shoulder and one in the median. Constructability will be more difficult in the median where the working width is limited to approximately 10 to 15 feet, and it is surrounded on both sides by active traffic lanes.

Since the sign boards are expected to be on the order of 12 feet by 48 feet and under-clearance will be on the order of 15 feet, large lateral loads and overturning moments are anticipated on the foundations. There are three technically feasible foundation types for the proposed foundations: driven piles, drilled shafts, and spread footings.

As a result of the limited working areas, we anticipate that there may not be sufficient width to construct spread footing sign foundations in the median. It is GZA’s opinion that similar foundation types should be provided at both locations of an individual sign. Therefore, spread footings are not a preferred foundation alternative for this site.

Both driven piles and drilled shafts could be constructed in the median. It is likely that a single element of either of these foundation types could be constructed within a temporary casing, and not require a braced excavation system. If the loads are large enough that paired foundation elements and a connecting beam are required to resist the loads, then a braced excavation system would be required for construction of the foundation.



Given the overall depths of overburden soil at the site, driven piles lengths may range from about 60 to 100 feet. Due to this significant depth to bearing materials, it is our opinion that drilled shafts are the preferred foundation type for this site. This judgement is made without specific loading information, and may be subject to revision based on the magnitude of the anticipated loads.

**DESIGN SOIL PROFILES**

GZA developed a series of design profiles for use by VHB in preliminary design of the sign support foundations. These are listed by foundation location and reference test borings in the tables that follow. The bottom of the deepest soil stratum corresponds to the deepest refusal depth at each OHSS.

<b>Mile Marker 43.24 (Boring ID: B-43.24A-E)</b> <b>Presumed Ground Surface Elevation 45.0 NAVD88</b> <b>Design Groundwater Depth 4.5 feet</b>							
Stratum	Depth (feet)	Soil Model	Unit Weight $\gamma_e$ (pcf) Above GW / below GW	$\phi'$ (deg)	k (pci) Above GW/below GW	$S_u$ (psf)	$E_{50}$
Fill	0-6	Reese Sand	125/62.6	35	190/110	--	--
Sand	6-11	Reese Sand	115/52.6	31	90/60	--	--
Silty Clay	11-98	Soft Clay	118/55.6	--	--	600	0.01

<b>Mile Marker 44.04 (Boring ID: B-44.04-E, B-44.04-W)</b> <b>Presumed Ground Surface Elevation 61.5 NAVD88</b> <b>Design Groundwater Depth 8 feet</b>							
Stratum	Depth (feet)	Soil Model	Unit Weight $\gamma_e$ (pcf) Above GW / below GW	$\phi'$ (deg)	k (pci) Above GW/below GW	$S_u$ (psf)	$E_{50}$
Fill	0-5	Reese Sand	125/62.6	35	190/110	--	--
Sand	5-18.5	Reese Sand	115/52.6	31	90/60	--	--
Silty Clay	18.5-45	Soft Clay	118/55.6	--	--	500	0.01
Silty Clay	45-69	Soft Clay	118/55.6	--	--	700	0.01



<b>Mile Marker 44.14 (Boring ID: B-44.14-E, B-44.14-W)</b> <b>Presumed Ground Surface Elevation 68.0 NAVD88</b> <b>Design Groundwater Depth 7 feet</b>							
Stratum	Depth (feet)	Soil Model	Unit Weight $\gamma_e$ (pcf) Above GW / below GW	$\phi'$ (deg)	k (pci) Above GW/below GW	$S_u$ (psf)	$E_{50}$
Fill	0-8.5	Reese Sand	125/62.6	35	190/110	--	--
Sand	8.5-18.5	Reese Sand	115/52.6	31	90/60	--	--
Silty Clay	18.5-40	Soft Clay	118/55.6	--	--	500	0.01
Silty Clay	40-68	Soft Clay	118/55.6	--	--	600	0.01

## FOUNDATION DESIGN METHODOLOGY

### LATERAL RESISTANCE

Preliminary lateral design of the drilled shafts may be based on the MaineDOT Section 626 design tables for lateral resistance. Where the loads exceed the limits of the Section 626 design tables, preliminary lateral load-deformation evaluation may be completed using other design approaches, such as L-Pile® for single shafts; or Group® or FBPIer® for paired shafts.

### AXIAL RESISTANCE

Using Allowable Stress Design (ASD) methodology, per AASHTO Standard Specifications for Structural Support for Highway Signs, Luminaires, and Traffic Signals 6<sup>th</sup> Edition 2013, the preliminary evaluation of axial resistance may be based on the following parameters. The undrained shear strength ( $S_u$ ) values for the clay stratum may be taken from the tables above.

Preliminary Axial Design Parameters for Drilled Shafts				
Soil Stratum	Nominal Unit Side Resistance (ksf)	Nominal Unit Tip Resistance (ksf)	Allowable Overstress AASHTO LTS T3.4-1	Safety Factor for Axial Compression
Fill	0.7	N/A	1.33	2.5
Sand	0.6	6	1.33	2.5
Clay	$\alpha S_u$	9 $S_u$	1.33	2.5

### USE OF PRELIMINARY DESIGN PARAMETERS

The generalized design profiles and geotechnical parameters provided herein are intended for preliminary foundation design. Initial design analyses by the structural engineer may reveal that the foundation type needs to be modified to accommodate the design loading.



In any event, GZA anticipates that design refinement may be required as the designs develop. GZA can support that effort by providing refined design parameters, which may take into account other factors based on location-specific soils analyses or design methodology used by the structural designer.

GZA recommends that we review the preliminary design results and have an opportunity to refine the design basis as appropriate to advance the preliminary analyses to final design.

## **CLOSURE**

We trust that this information meets current project needs. Please feel free to call Chris Snow at (207) 358-5118 if you have any questions about this memorandum or if we can be of further assistance.

NVW/CLS:erc

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Attachments:   Figure 1 - Boring Location Plan  
                  Appendix A - Limitations  
                  Appendix B - Boring Logs  
                  Appendix C - Laboratory Test Results



## FIGURES



© 2017 - GZA GeoEnvironmental, Inc. C:\GIS\LocusPlans\Figure2-BoringLocationPlan25945.mxd, 8/17/2017, 12:59:53 PM, aimee.mountain



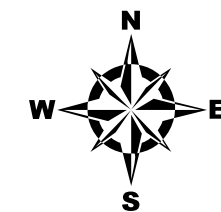
### LEGEND

B-44.14W

 BORING LOCATION AND DESIGNATION

### NOTES:


- 1) AS-DRILLED BORING LOCATIONS WERE ESTABLISHED USING HAND-HELD GPS EQUIPMENT AND ARE CONSIDERED APPROXIMATE.
- 2) GROUND SURFACE ELEVATIONS AT THE BORING LOCATIONS WERE ESTIMATED BY INTERPOLATING BETWEEN 2-FOOT CONTOURS FROM THE MAINE OFFICE OF GIS DATA CATALOG, AND ARE CONSIDERED APPROXIMATE.
- 3) BORINGS WERE DRILLED BY NEW ENGLAND BORING COMPANY OF HERMAN, MAINE BETWEEN JULY 10 AND 13, 2017; AND WERE OBSERVED AND LOGGED BY GZA.
- 4) AERIAL IMAGERY PROVIDED BY THE MAINE OFFICE OF GIS (MEGIS) AND THE MAINE LIBRARY OF GEOGRAPHIC INFORMATION (GEOLIBRARY).



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## MTA EXIT 44 FOUNDATION EVALUATION FOR OVERHEAD SIGN STRUCTURES SCARBOROUGH, MAINE

### BORING LOCATION PLAN

PREPARED BY:  <b>GZA GeoEnvironmental, Inc.</b> Engineers and Scientists www.gza.com		PREPARED FOR:  VHB	
PROJ MGR: NWV	REVIEWED BY: CLS	CHECKED BY: ARB	FIGURE <b>1</b>
DESIGNED BY: NWV	DRAWN BY: ADM	SCALE: 1" = 400 FEET	
DATE: 08/25/2017	PROJECT NO.: 09.0025945.00	REVISION NO.:	





## APPENDIX A – LIMITATIONS



## LIMITATIONS

### Use of Report

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

### Standard of Care

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, GZA shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions.
3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

### Subsurface Conditions

4. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs.
5. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein which were made available to GZA at the time of our evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.
6. Water level readings have been made in test holes (as described in the Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water table encountered in the course of the work may differ from that indicated in the Report.
7. GZA's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

### Compliance with Codes and Regulations

8. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.



## APPENDIX B – BORING LOGS



## LOG KEY



**GZA**  
**Geo Environmental, Inc.**  
*Engineers and Scientists*

### BURMISTER SOIL CLASSIFICATION (INORGANIC)

COMPONENT	NAME	PROPORTIONAL TERM	PERCENT BY WEIGHT	IDENTIFICATION OF FINES		
				Material	PI	Atterberg Thread Dia.
MAJOR	GRAVEL, SAND, FINES*		>50	SILT	0	Cannot Roll
Minor	Gravel, Sand, Fines*	and	35 - 50	Clayey SILT	1-5	1/4"
		some	20-35	SILT & CLAY	5-10	1/8"
		little	10-20	CLAY & SILT	10-20	1/16"
	*See identification of fines table.	trace	0-10	Silty CLAY	20-40	1/32"
				CLAY	>40	1/64"

GRADATION DESIGNATION	PROPORTION OF COMPONENT	PLASTIC SOILS		GRAVEL & SAND	
		Consistency	Blows/Ft. SPT N-Value	Density	Blows/Ft. SPT N-Value
Fine to coarse	All fractions > 10%	Very Soft	< 2	Very Loose	< 4
Medium to coarse	<10% fine	Soft	2 - 4	Loose	4 - 10
Fine to medium	<10% coarse	Medium Stiff	4 - 8	Medium Dense	10 - 30
Coarse	<10% fine and medium	Stiff	8 - 15	Dense	30 - 50
Medium	<10% coarse and fine	Very Stiff	15 - 30	Very Dense	> 50
Fine	<10% coarse and medium	Hard	>30		

### BURMISTER SOIL CLASSIFICATION (ORGANIC)

Fibrous PEAT (Pt) - Lightweight, spongy, mostly visible organic matter, water squeezes readily from sample. Typically near top of deposit.  
 Fine Grained PEAT (Pt) - Lightweight, spongy, little visible organic matter, water squeezes readily from sample. Typically below fibrous peat.  
 Organic Silt (OL) - Typically gray to dark gray, often has strong H<sub>2</sub>S odor. Typically contains shells or shell fragments. Lightweight. Usually found near coastal regions. May contain wide range of sand fractions.  
 Organic Clay (OH) - Typically gray to dark gray, high plasticity. Usually found near coastal regions. May contain wide range of sand fractions. Need organic content test for final identification.

### UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) (ASTM D 2487)

MAJOR DIVISIONS	Group Symbols
Coarse Grained Soils More than 50% of material larger than No. 200 sieve.	Gravel More than 50% larger than No. 4 sieve.  Sand More than 50% smaller than No. 4 sieve.
Fine Grained Soils More than 50% of material smaller than No. 200 sieve.	Clean Gravels (Little or no fines)  Gravels with Fines (Appreciable amount of fines)  Clean Sands (Little or no fines)  Sands with Fines (Appreciable amount of fines)  Silts and Clays Liquid Limit <50  Silts and Clays Liquid Limit >50  Highly Organic Soils
	GW GP  GM GC  SW SP  SM SC  ML CL  OL MH CH OH  Pt

### ABBREVIATIONS

MR = Mud Rotary HSA = Hollow Stem Auger SSA = Solid Stem Auger SS = Split Spoon Sampler U = Undisturbed Sample (Shelby Tube) MC = Modified California Sampler V = Vibracore M = Macrocore  USCS = Unified Soil Classification System (ASTM D2487) NYCBC = New York City Building Code WOR = Weight of Rods WOH = Weight of Hammer SPT = Standard Penetration Test (ASTM D1586) N-Value = Cumulative number of uncorrected blows for the middle two six-inch intervals (blows/foot).	Tv = Field Vane Shear Test (Torvane) PP = Pocket Penetrometer PI = Plasticity Index MC = Moisture Content CO = Consolidation UC = Unconfined Compression Test SI = Sieve Analysis DS = Direct Shear PID = Photoionization Detector ppm = Parts Per Million REC = Recovery RQD = Rock Quality Designation ▼ = Measured Water Level
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### TEST BORING LOG



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-43.24A-E  
SHEET: 1 of 4  
PROJECT NO: 09.0025945.00  
REVIEWED BY:

Logged By: N. Williams  
Drilling Co.: New England Boring Contractors  
Foreman: B. Enos

Type of Rig: ATV  
Rig Model: Mobile Drill B53  
Drilling Method:  
Drive & Wash

Boring Location (N,E): See Plan  
Ground Surface Elev. (ft.): 45  
Final Boring Depth (ft.): 98  
Date Start - Finish: 7/13/2017 - 7/13/2017

H. Datum:  
V. Datum: NAVD 88

Hammer Type: Automatic  
Hammer Weight (lb.): 140  
Hammer Fall (in.): 30  
Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
Sampler O.D. (in.): 2.0  
Sampler Length (in.): 24  
Rock Core Size:

#### Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
7/13/17	1415	4.4	

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0.0-2.0	24	8	2 7 13 24	20	S-1: Medium dense, brown, fine to coarse SAND, little Gravel, trace Silt. (SP)	1		0.4	TOPSOIL	44.6	
		S-2	5.0-7.0	24	6	4 5 2 2	7				S-2: Loose, brown, fine to medium SAND, little Silt, wet. (SP-SM) Clay seam at 6.8', piece of gravel in tip of spoon.	6	FILL	39.0
10		S-3	10.0-12.0	24	24	1 2 1 1	3	S-3: Top 12": Gray, fine to medium SAND, little Silt, wet. (SP-SM) Bottom 12": Gray, Silty CLAY, with fine Sand seams, wet. (CL)	2		11	SAND	34.0	
		S-4	15.0-17.0	24	0						S-4: No recovery.			
20		V-1	17.0					V-1: Field Vane, $T_{raw} = 24/2$ ft lbs ( $S_u = 745/60$ psf)						
		V-2	15.1-16.0					V-2: Field Vane, $T_{raw} = 18/3$ ft lbs ( $S_u = 560/90$ psf)						
		S-5	20.0-22.0	24	24			S-5: Medium stiff, gray, Silty CLAY, wet. (CL)						
		V-3	22.0					V-3: Field Vane, $T_{raw} = 18/5$ ft lbs ( $S_u = 560/155$ psf)						
25		V-4	20.1-21.0					V-4: Field Vane, $T_{raw} 21/4$ ft lbs ( $S_u = 650/120$ psf)						
			21.0-22.0											
30														

**REMARKS**  
1 - Advanced exploration using solid stem augers to 5.0' and drive & wash techniques, to 40.0'.  
2 - Tapered vane with 2.5" diameter, 4.5" height, and 45-degree taper was used for field vane tests.  $T_{raw}$  = measured torque;  $S_u$  = calculated undrained shear strength.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.24A-E**

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-43.24A-E  
SHEET: 2 of 4  
PROJECT NO: 09.0025945.00  
REVIEWED BY:

Logged By: N. Williams  
Drilling Co.: New England Boring Contractors  
Foreman: B. Enos

Type of Rig: ATV  
Rig Model: Mobile Drill B53  
Drilling Method:  
Drive & Wash

Boring Location (N,E): See Plan  
Ground Surface Elev. (ft.): 45  
Final Boring Depth (ft.): 98  
Date Start - Finish: 7/13/2017 - 7/13/2017

H. Datum:  
V. Datum: NAVD 88

Hammer Type: Automatic  
Hammer Weight (lb.): 140  
Hammer Fall (in.): 30  
Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
Sampler O.D. (in.): 2.0  
Sampler Length (in.): 24  
Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/13/17	1415	4.4	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
35		S-6	30.0-	24	24		0	S-6: Medium stiff, gray, Silty CLAY, wet. (CL)					
		V-5	32.0					V-5: Field Vane, $T_{raw} = 19/2$ ft lbs ( $S_u = 590/60$ psf)					
		V-6	30.1- 31.0 31.0- 32.0					V-6: Field Vane, $T_{raw} = 18/3$ ft lbs ( $S_u = 560/90$ psf)					
40		S-7	35.0- 37.0	24	24	WO1P WO1P WO1P WO1P	0	S-7: Medium stiff, gray, Silty CLAY, wet. (CL)					
		S-8	40.0-	24	24			S-8: Soft to medium stiff, gray, Silty CLAY, wet. (CL)					
45		V-7	42.0				3	V-7: Field Vane, $T_{raw} = 13/2$ ft lbs ( $S_u = 400/60$ psf)				SILTY CLAY	
		V-8	40.1- 41.0 41.0- 42.0					V-8: Field Vane, $T_{raw} = 19/1$ ft lbs ( $S_u = 590/30$ psf)					

**REMARKS**  
3 - Advanced rod probe hydraulically from 42.0'-98.0'. Drove rod probe to refusal at 98.0'. Blows per foot are recorded on log under casing blows.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.24A-E**



### TEST BORING LOG



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-43.24A-E  
 SHEET: 3 of 4  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
 Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 45  
**Final Boring Depth (ft.):** 98  
**Date Start - Finish:** 7/13/2017 - 7/13/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/13/17	1415	4.4	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
65													
70													
75											SILTY CLAY		
80													
85													
90													

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.24A-E**

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-43.24A-E  
 SHEET: 4 of 4  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

Logged By: N. Williams  
 Drilling Co.: New England Boring Contractors  
 Foreman: B. Enos

Type of Rig: ATV  
 Rig Model: Mobile Drill B53  
 Drilling Method:  
 Drive & Wash

Boring Location (N,E): See Plan  
 Ground Surface Elev. (ft.): 45  
 Final Boring Depth (ft.): 98  
 Date Start - Finish: 7/13/2017 - 7/13/2017

H. Datum:  
 V. Datum: NAVD 88

Hammer Type: Automatic  
 Hammer Weight (lb.): 140  
 Hammer Fall (in.): 30  
 Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
 Sampler O.D. (in.): 2.0  
 Sampler Length (in.): 24  
 Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/13/17	1415	4.4	

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample				SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
			Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
95												SILTY CLAY	
100	50/0"		98.0-98.0					Rod Probe Refusal End of exploration at 98 feet.			98		-53.0

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.24A-E**

**TEST BORING LOG**



**GZA**  
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*Engineers and Scientists*

**Vanasse Hangen Brustlin, Inc.**  
**MTA Exit 44 Foundation Evaluation for CHSS**

**EXPLORATION NO.: B-43.6-E**  
**SHEET: 1 of 3**  
**PROJECT NO: 09.0025945.00**  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 31  
**Final Boring Depth (ft.):** 61.3  
**Date Start - Finish:** 7/12/2017 - 7/12/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

Groundwater Depth (ft.)			
Date	Time	Water Depth	Stab. Time
7/12/17	1200	8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
		S-1	0.8-2.8	24	18	18 23 18 18	41	S-1: Dense, tan to dark brown, fine to coarse SAND, little Gravel, trace Silt, dry. (SP)			0.8	ASPHALT	30.2	
5		S-2	5.0-7.0	24	18	10 7 7 6	14	S-2: Medium dense, tan to dark brown, fine to coarse SAND, little Gravel, trace Silt, dry. (SP)				FILL		
10		S-3	10.0-12.0	24	12	5 3 5 7	8	S-3: Stiff, gray and dark brown, Silty CLAY, little fine Sand, wet, with few fine sand seams. (CL)	1		8.5		22.5	
15		S-4 V-1	15.0-17.0 15.1-16.0	24	20			S-4: Stiff, gray, Silty CLAY, wet, with sand seams. (CL) V-1: Field Vane, T <sub>raw</sub> = >50 ft lbs (S <sub>u</sub> = >1550 psf)	2 3				SILTY CLAY	
20		S-5 V-2 V-3	20.0-22.0 20.1-21.0 21.0-22.0	24	24			S-5: Medium stiff, gray, Silty CLAY, wet. (CL) V-2: Field Vane, T <sub>raw</sub> = 21/3 ft lbs (S <sub>u</sub> = 650/90 psf) V-3: Field Vane, T <sub>raw</sub> = 24/4 ft lbs (S <sub>u</sub> = 745/120 psf)						
25		S-6 V-4 V-5	25.0-27.0 25.1-26.0 26.0-27.0	24	24			S-6: Medium stiff, gray, Silty CLAY, wet. (CL) V-4: Field Vane, T <sub>raw</sub> = 20/3 ft lbs (S <sub>u</sub> = 620/90 psf) V-5: Field Vane, T <sub>raw</sub> 18/3 ft lbs (S <sub>u</sub> = 560/90 psf)						
30														

**REMARKS**  
1 - Advanced exploration using solid stem augers to 10.0' and drive & wash techniques, to 40.0'.  
2 - Tapered vane with 2.5" diameter, 4.5" height, and 45-degree taper was used for field vane tests. T<sub>raw</sub> = measured torque; S<sub>u</sub> = calculated undrained sheer strength.  
3 - Could not turn field vane V-1 at 17.0'. Switched to spoon to sample 15.0'-17.0'.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.6-E**



### TEST BORING LOG



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*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-43.6-E  
SHEET: 2 of 3  
PROJECT NO: 09.0025945.00  
REVIEWED BY:

Logged By: N. Williams  
Drilling Co.: New England Boring Contractors  
Foreman: B. Enos

Type of Rig: ATV  
Rig Model: Mobile Drill B53  
Drilling Method:  
Drive & Wash

Boring Location (N,E): See Plan  
Ground Surface Elev. (ft.): 31  
Final Boring Depth (ft.): 61.3  
Date Start - Finish: 7/12/2017 - 7/12/2017

H. Datum:  
V. Datum: NAVD 88

Hammer Type: Automatic  
Hammer Weight (lb.): 140  
Hammer Fall (in.): 30  
Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
Sampler O.D. (in.): 2.0  
Sampler Length (in.): 24  
Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/12/17	1200	8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
35		S-7	30.0-	24	24			S-7: Medium stiff, gray, Silty CLAY, wet. (CL) V-6: Field Vane, $T_{raw} = 22/3$ ft lbs ( $S_u = 680/90$ psf) V-7: Field Vane, $T_{raw} = 19/3$ ft lbs ( $S_u = 590/90$ psf)					
		V-6	32.0										
		V-7	30.1- 31.0 31.0- 32.0										
40		S-8	40.0-	24	24			S-8: Medium stiff, gray, Silty CLAY, wet. (CL) V-8: Field Vane, $T_{raw} = 24/2$ ft lbs ( $S_u = 745/60$ psf) V-9: Field Vane, $T_{raw} = 22/2$ ft lbs ( $S_u = 680/60$ psf)	4				
		V-8	42.0										
		V-9	40.1- 41.0 41.0- 42.0										
45													
50													
55													
60	2 13												

**REMARKS**  
4 - Advanced rod probe hydraulically from 42.0'-57.9'. Drove rod probe to refusal at 61.3'. Blows per foot are recorded on log under casing blows.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.6-E**

GZA TEMPLATE TEST BORING; 8/25/2017; 1:12:20 PM

**TEST BORING LOG**



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*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

**EXPLORATION NO.:** B-43.6-E  
**SHEET:** 3 of 3  
**PROJECT NO:** 09.0025945.00  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
 Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 31  
**Final Boring Depth (ft.):** 61.3  
**Date Start - Finish:** 7/12/2017 - 7/12/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/12/17	1200	8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
26													
83													
			61.3-61.3					Rod Probe Refusal End of exploration at 61.3 feet.			61.3	SILTY CLAY	-30.3
65													
70													
75													
80													
85													
90													

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.6-E**

**TEST BORING LOG**



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**MTA Exit 44 Foundation Evaluation for CHSS**

**EXPLORATION NO.: B-43.6-W**  
**SHEET: 1 of 3**  
**PROJECT NO: 09.0025945.00**  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 31  
**Final Boring Depth (ft.):** 68.2  
**Date Start - Finish:** 7/10/2017 - 7/10/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/10/17		8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample				SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
			Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
5		S-1	0.0-2.0	24	17	1 1 5 7	6	S-1: Loose, light brown, medium SAND, dry. (SP)			0.5	TOPSOIL	30.5
		S-2	5.0-7.0	24	20	10 15 18 21	33	S-2: Dense, light brown, fine to medium SAND, dry. (SP)			FILL		
10		S-3	10.0-12.0	24	20	4 3 5 8	8	S-3: Medium stiff, gray and brown, Silty CLAY, little fine Sand, wet, with seams of fine sand. (CL)	1		8.5		22.5
15		S-4	15.0-17.0	24	24	1 1 WOH WOH	1	S-4: Medium stiff, gray, Silty CLAY, trace fine Sand, wet, with seams of fine sand. (CL)					
20		S-5	20.0-	24	24			S-5: Medium stiff, gray, Silty CLAY, wet. (CL)	2				
		V-1	22.0				V-1: Field Vane, $T_{raw} = 22/4$ ft lbs ( $S_u = 680/125$ psf)						
		V-2	20.1-21.0-22.0				V-2: Field Vane, $T_{raw} = 21/5$ ft lbs ( $S_u = 650/155$ psf)						
		S-6	25.0-	24	24		S-6: Medium stiff, gray, Silty CLAY, wet. (CL)						
25		V-3	27.0				V-3: Field Vane, $T_{raw} = 16/1$ ft lbs ( $S_u = 495/30$ psf)						
		V-4	25.1-26.0-27.0				V-4: Field Vane, $T_{raw} = 18/2$ ft lbs ( $S_u = 555/62$ psf)						
30													

**REMARKS**  
1 - Advanced exploration using solid stem augers to 10.0' and Drive & Wash techniques, to 40.0'.  
2 - Tapered vane with 2.5" diameter, 4.5" height, and 45-degree taper was used for field vane tests.  $T_{raw}$  = measured torque;  $S_u$  = calculated undrained shear strength.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.6-W**

### TEST BORING LOG



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Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-43.6-W  
 SHEET: 2 of 3  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

Logged By: N. Williams  
 Drilling Co.: New England Boring Contractors  
 Foreman: B. Enos

Type of Rig: ATV  
 Rig Model: Mobile Drill B53  
 Drilling Method:  
 Drive & Wash

Boring Location (N,E): See Plan  
 Ground Surface Elev. (ft.): 31  
 Final Boring Depth (ft.): 68.2  
 Date Start - Finish: 7/10/2017 - 7/10/2017

H. Datum:  
 V. Datum: NAVD 88

Hammer Type: Automatic  
 Hammer Weight (lb.): 140  
 Hammer Fall (in.): 30  
 Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
 Sampler O.D. (in.): 2.0  
 Sampler Length (in.): 24  
 Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/10/17		8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
35		S-7	35.0-	24	24		S-7: Soft to medium stiff, gray, Silty CLAY, wet. (CL) V-5: Field Vane, $T_{raw} = 11/1$ ft lbs ( $S_u = 340/30$ psf) V-6: Field Vane, $T_{raw} = 19/4$ ft lbs ( $S_u = 590/125$ psf)				SILTY CLAY		
		V-5	37.0										
		V-6	35.1-										
			36.0										
			36.0-										
			37.0										
40		S-8	40.0-	24	24		S-8: Medium stiff, gray, Silty CLAY, wet. (CL) V-7: Field Vane, $T_{raw} = 16/6$ ft lbs ( $S_u = 495/185$ psf) V-8: Field Vane, $T_{raw} = 31/3$ ft lbs ( $S_u = 960/90$ psf)	3					
		V-7	42.0										
		V-8	40.1-										
			41.0										
			41.0-										
			42.0										
45													
50													
55													
60													

**REMARKS**  
 3 - Advanced rod probe hydraulically from 42.0'-65.8'. Drove rod probe to refusal at 68.2'. Blows per foot are recorded on log under casing blows.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.6-W**

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**TEST BORING LOG**



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**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

**EXPLORATION NO.:** B-43.6-W  
**SHEET:** 3 of 3  
**PROJECT NO:** 09.0025945.00  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
 Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 31  
**Final Boring Depth (ft.):** 68.2  
**Date Start - Finish:** 7/10/2017 - 7/10/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/10/17		8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
65	1												
103	80												
70	(50/<1")		68.2-68.2					Rod Probe Refusal Possible Bedrock End of exploration at 68.2 feet.			68.2		-37.2
75													
80													
85													
90													

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-43.6-W**



**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

**Vanasse Hangen Brustlin, Inc.**  
**MTA Exit 44 Foundation Evaluation for CHSS**

**EXPLORATION NO.: B-44.04-E**  
**SHEET: 1 of 3**  
**PROJECT NO: 09.0025945.00**  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 61  
**Final Boring Depth (ft.):** 65.8  
**Date Start - Finish:** 7/12/2017 - 7/12/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/12/17		8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
		S-1	0.5-2.5	24	14	7 9 11 9	20	S-1: Medium dense, light brown, fine to medium SAND, little Gravel, trace Silt. (SP)	1		0.5	ASPHALT	60.5	
5		S-2	5.0-7.0	24	16	5 7 7 9	14	S-2: Medium dense, light brown, fine to medium SAND, trace Silt, moist. (SP-SM)				FILL		
10		S-3	10.0-12.0	24	12	3 1 3 2	4	S-3: Loose, brown, fine to medium SAND, some Silt, wet. (SM)						
15		S-4	15.0-17.0	24	8	6 7 5 1	12	S-4: Medium dense, brown, fine to medium SAND, little Silt, wet. (SM)						
20		S-5	20.0-22.0	24	24	WOH WOH WOH WOH	0	S-5: Soft, gray, CLAY & SILT, trace fine Sand, wet. (CL)						
25		S-6	25.0-27.0	24	24			S-6: Medium stiff, gray, CLAY & SILT, wet. (CL)						
		V-1	27.0					V-1: Field Vane, $T_{raw} = 16/3$ ft lbs ( $S_u = 495/90$ psf)	2					
		V-2	25.1-26.0-26.0-27.0					V-2: Field Vane, $T_{raw} = 17/2$ ft lbs ( $S_u = 525/60$ psf)						
30											18.5		42.5	
													SILTY CLAY	

**REMARKS**  
1 - Advanced exploration using solid stem augers to 10.0' and drive & wash techniques, to 65.0'.  
2 - Tapered vane with 2.5" diameter, 4.5" height, and 45-degree taper was used for field vane tests.  $T_{raw}$  = measured torque;  $S_u$  = calculated undrained shear strength.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.04-E**

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

**Vanasse Hangen Brustlin, Inc.**  
**MTA Exit 44 Foundation Evaluation for CHSS**

**EXPLORATION NO.: B-44.04-E**  
**SHEET: 2 of 3**  
**PROJECT NO: 09.0025945.00**  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 61  
**Final Boring Depth (ft.):** 65.8  
**Date Start - Finish:** 7/12/2017 - 7/12/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/12/17		8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample				Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)						
		No.	Depth (ft.)	Pen. (in)	Rec. (in)														
35		S-7	30.0-	24	24		S-7: Soft, gray, Silty CLAY, wet. (CL) V-3: Field Vane, T <sub>raw</sub> = 13/3 ft lbs (S <sub>u</sub> = 400/90 psf) V-4: Field Vane, T <sub>raw</sub> = 16/2 ft lbs (S <sub>u</sub> = 495/60 psf)												
		V-3	32.0																
		V-4	30.1-																
			31.0																
40		S-8	40.0-	24	24		S-8: Soft to medium stiff, gray, Silty CLAY, wet. (CL) V-5: Field Vane, T <sub>raw</sub> = 15/0 ft lbs (S <sub>u</sub> = 465/0 psf) V-6: Field Vane, T <sub>raw</sub> = 17/1 ft lbs (S <sub>u</sub> = 525/30 psf)	3											
		V-5	42.0																
		V-6	40.1-																
			41.0																
45			41.0-																
			42.0																
	50		S-9	50.0-	24	20								S-9: Medium stiff, gray, Silty CLAY, wet. (CL) V-7: Field Vane, T <sub>raw</sub> = 25/5 ft lbs (S <sub>u</sub> = 775/155 psf) V-8: Field Vane, T <sub>raw</sub> = 29/3 ft lbs (S <sub>u</sub> = 900/90 psf)					
			V-7	52.0															
		V-8	50.1-																
			51.0																
55			51.0-																
			52.0																
	60		S-10	55.0-	24	24								S-10: Medium stiff, gray, Silty CLAY, wet. (CL) V-9: Field Vane, T <sub>raw</sub> = 22/5 ft lbs (S <sub>u</sub> = 680/155 psf) V-10: Field Vane, T <sub>raw</sub> = 26/1 ft lbs (S <sub>u</sub> = 805/30 psf)					
			V-9	57.0															
		V-10	55.1-																
			56.0																
			56.0-				S-11: No recovery.												
			57.0	24	0	6 8													
		S-11	57.0	24	0	6 8	S-11: No recovery.			59		2.0							

**REMARKS**  
3 - Hydraulically pushed 3" casing to 59.0' prior to sampling S-11.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.04-E**

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.04-E  
 SHEET: 3 of 3  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

Logged By: N. Williams  
 Drilling Co.: New England Boring Contractors  
 Foreman: B. Enos

Type of Rig: ATV  
 Rig Model: Mobile Drill B53  
 Drilling Method:  
 Drive & Wash

Boring Location (N,E): See Plan  
 Ground Surface Elev. (ft.): 61  
 Final Boring Depth (ft.): 65.8  
 Date Start - Finish: 7/12/2017 - 7/12/2017

H. Datum:  
 V. Datum: NAVD 88

Hammer Type: Automatic  
 Hammer Weight (lb.): 140  
 Hammer Fall (in.): 30  
 Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
 Sampler O.D. (in.): 2.0  
 Sampler Length (in.): 24  
 Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/12/17		8.7	

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample				SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
			Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
65	20 20	S-12	59.0-61.0 61.0-63.0	24	6	7 9 2 2 4 4	15  6	S-12: Loose, gray, fine to coarse SAND, little Gravel, little Silt, wet. (SM)			MARINE SAND		
		S-13	65.0-65.8			9 4	50 150/3"						R
70			65.8-65.8					Split Spoon Refusal Possible bedrock End of exploration at 65.8 feet.					
90													

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.04-E**

### TEST BORING LOG



**GZA**  
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*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.04-W  
 SHEET: 1 of 3  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

Logged By: N. Williams  
 Drilling Co.: New England Boring Contractors  
 Foreman: B. Enos

Type of Rig: ATV  
 Rig Model: Mobile Drill B53  
 Drilling Method:  
 Drive & Wash

Boring Location (N,E): See Plan  
 Ground Surface Elev. (ft.): 62  
 Final Boring Depth (ft.): 69.3  
 Date Start - Finish: 7/11/2017 - 7/11/2017

H. Datum:  
 V. Datum: NAVD 88

Hammer Type: Automatic  
 Hammer Weight (lb.): 140  
 Hammer Fall (in.): 30  
 Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
 Sampler O.D. (in.): 2.0  
 Sampler Length (in.): 24  
 Rock Core Size:

#### Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
7/11/17		7.5	

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0.5-2.5	24	12	5 5 5 5	10	S-1: Loose, light brown, fine to coarse SAND, trace Silt, dry. (SP)	1		0.5	TOPSOIL	61.5	
10		S-2	5.0-7.0	24	15	2 1 2 3	3	S-2: Very loose, tan, fine to medium SAND, trace Silt, wet. (SP-SM)			3.75	FILL	58.3	
15		S-3	10.0-12.0	24	17	WOH 1 1 1	2	S-3: Very loose, tan to brown, fine to medium SAND, little Silt, wet. Clay seam at top of sample. (SP-SM)	2			SAND		
20		S-4	15.0-17.0	24	13	3 4 6 4	10	S-4: Loose, brown, fine to medium SAND, trace Silt, wet. (SP-SM)			18.5		43.5	
25		S-5	20.0-22.0	24	24			S-5: Stiff, gray to tan, CLAY & SILT, trace fine Sand. (CL)	3			SILTY CLAY		
		V-1	20.1-21.0					V-1: Field Vane, T <sub>raw</sub> = 45/7 ft lbs (S <sub>u</sub> = 1395/215 psf)						
30		V-2	21.0-22.0					V-2: Field Vane, T <sub>raw</sub> = >50 ft lbs (S <sub>u</sub> = >1550 psf)						
		S-6	25.0-27.0	24	24			S-6: Stiff, gray, CLAY & SILT, trace fine Sand, wet. (CL)						
		V-3	26.0-27.0					V-3: Field Vane, T <sub>raw</sub> = 41/4 ft lbs (S <sub>u</sub> = 1270/120 psf)						
		V-4	25.1-26.0					V-4: Field Vane, T <sub>raw</sub> = 49/15 ft lbs (S <sub>u</sub> = 1520/465 psf)						

**REMARKS**

1 - Advanced exploration using solid stem augers to 10.0' and drive & wash techniques to 40.0'.  
 2 - Driller noted possible gravel layer during roller cone advancement at approximately 13.0'-13.5'.  
 3 - Tapered vane with 2.5" diameter, 4.5" height, and 45-degree taper was used for field vane tests. T<sub>raw</sub> = measured torque; S<sub>u</sub> = calculated undrained shear strength.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.04-W**

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.04-W  
 SHEET: 2 of 3  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

Logged By: N. Williams  
 Drilling Co.: New England Boring Contractors  
 Foreman: B. Enos

Type of Rig: ATV  
 Rig Model: Mobile Drill B53  
 Drilling Method:  
 Drive & Wash

Boring Location (N,E): See Plan  
 Ground Surface Elev. (ft.): 62  
 Final Boring Depth (ft.): 69.3  
 Date Start - Finish: 7/11/2017 - 7/11/2017

H. Datum:  
 V. Datum: NAVD 88

Hammer Type: Automatic  
 Hammer Weight (lb.): 140  
 Hammer Fall (in.): 30  
 Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
 Sampler O.D. (in.): 2.0  
 Sampler Length (in.): 24  
 Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/11/17		7.5	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
35		S-7	30.0-	24	24		S-7: Medium stiff, gray, Silty CLAY, wet. (CL) V-5: Field Vane, $T_{raw} = 18/3$ ft lbs ( $S_u = 560/90$ psf) V-6: Field Vane, $T_{raw} = 21/5$ ft lbs ( $S_u = 650/155$ psf)						
		V-5	32.0										
		V-6	30.1-31.0-31.0-32.0										
40		S-8	40.0-	24	24		S-8: Medium stiff, gray, Silty CLAY, wet. (CL) V-7: Field Vane, $T_{raw} = 15/3$ ft lbs ( $S_u = 465/90$ psf) V-8: Field Vane, $T_{raw} = 18/4$ ft lbs ( $S_u = 560/120$ psf)	4					
		V-7	42.0										
		V-8	40.1-41.0-41.0-42.0										
45											SILTY CLAY		
50													
55													
60													

**REMARKS**  
 4 - Advanced rod probe hydraulically from 42.0'-67.1'. Drove rod probe to refusal (50 blows/1") at 69.3'. Blows per foot are recorded on log under casing blows.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.04-W**



### TEST BORING LOG



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.04-W  
 SHEET: 3 of 3  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
 Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 62  
**Final Boring Depth (ft.):** 69.3  
**Date Start - Finish:** 7/11/2017 - 7/11/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/11/17		7.5	

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample				SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
			Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
65	3 6 70/2"										69.3	SILTY CLAY	-7.3
70							End of exploration at 69.3 feet.						
75													
80													
85													
90													

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.04-W**

### TEST BORING LOG



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.14-E  
 SHEET: 1 of 3  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

Logged By: N. Williams  
 Drilling Co.: New England Boring Contractors  
 Foreman: B. Enos

Type of Rig: ATV  
 Rig Model: Mobile Drill B53  
 Drilling Method:  
 Drive & Wash

Boring Location (N,E): See Plan  
 Ground Surface Elev. (ft.): 68  
 Final Boring Depth (ft.): 61.6  
 Date Start - Finish: 7/13/2017 - 7/13/2017

H. Datum:  
 V. Datum: NAVD 88

Hammer Type: Automatic  
 Hammer Weight (lb.): 140  
 Hammer Fall (in.): 30  
 Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
 Sampler O.D. (in.): 2.0  
 Sampler Length (in.): 24  
 Rock Core Size:

#### Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
7/13/17		7.5	

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0.0-2.0	24	18	16 13 15 15	28	S-1: Medium dense, tan, fine to coarse SAND, little Gravel, trace Silt, dry. (SP)	1				FILL	
		S-2	5.0-7.0	24	12	12 12 10 14	22	S-2: Medium dense, tan, fine to coarse SAND, trace Silt, moist. Wet in tip of spoon. (SP)						
10	13	S-3	10.0-12.0	24	12	1 2 4 4	6	S-3: Loose, brown, fine to medium SAND, trace Silt, wet. (SP-SM)					SAND	
15	16	S-4	15.0-17.0	24	12	7 9 9 6	18	S-4: Medium dense, tan, fine to medium SAND, trace Silt, wet. (SP-SM)						
20	14	S-5	20.0-22.0	24	24	2 WOH WOH 1	0	S-5: Soft to medium stiff, gray, Silty CLAY, wet. (CL)	2				SILTY CLAY	
25		S-6	25.0-27.0	24	14			S-6: Soft to medium stiff, gray, Silty CLAY, wet. (CL)						
30		V-1	27.0					V-1: Field Vane, $T_{raw} = 13/4$ ft lbs ( $S_u = 400/120$ psf)						
		V-2	25.1-26.0-27.0					V-2: Field Vane, $T_{raw} = 18/2$ ft lbs ( $S_u = 560/60$ psf)						

**REMARKS**  
 1 - Advanced exploration using solid stem augers to 10.0' and drive & wash techniques to 40.0'.  
 2 - Tapered vane with 2.5" diameter, 4.5" height, and 45-degree taper was used for field vane tests.  $T_{raw}$  = measured torque;  $S_u$  = calculated undrained shear strength.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.14-E**

### TEST BORING LOG



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.14-E  
SHEET: 2 of 3  
PROJECT NO: 09.0025945.00  
REVIEWED BY:

Logged By: N. Williams  
Drilling Co.: New England Boring Contractors  
Foreman: B. Enos

Type of Rig: ATV  
Rig Model: Mobile Drill B53  
Drilling Method:  
Drive & Wash

Boring Location (N,E): See Plan  
Ground Surface Elev. (ft.): 68  
Final Boring Depth (ft.): 61.6  
Date Start - Finish: 7/13/2017 - 7/13/2017

H. Datum:  
V. Datum: NAVD 88

Hammer Type: Automatic  
Hammer Weight (lb.): 140  
Hammer Fall (in.): 30  
Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
Sampler O.D. (in.): 2.0  
Sampler Length (in.): 24  
Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/13/17		7.5	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
35		S-7	30.0-	24	24		S-7: Medium stiff, gray, Silty CLAY, wet. (CL) V-3: Field Vane, $T_{raw} = 15/2$ ft lbs ( $S_u = 465/60$ psf) V-4: Field Vane, $T_{raw} = 20/4$ ft lbs ( $S_u = 620/120$ psf)						
		V-3	32.0										
		V-4	30.1-										
			31.0										
40		S-8	40.0-	24	24		S-8: Medium stiff, gray, Silty CLAY, wet. (CL) V-5: Field vane, $T_{raw} = 17/1$ ft lbs ( $S_u = 525/30$ psf) V-6: Field Vane, $T_{raw} = 25/3$ ft lbs ( $S_u = 775/90$ psf)	3					
		V-5	42.0										
		V-6	40.1-										
			41.0										
45			41.0-										
			42.0										
	55		32								55		13.0
			33										
60			26										
			18										
			33										
			4										

**REMARKS**  
3 - Advanced rod probe hydraulically from 42.0'-53.1'. Drove rod probe to refusal at 61.6'. Blows per foot are recorded on log under casing blows.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.14-E**

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

**EXPLORATION NO.:** B-44.14-E  
**SHEET:** 3 of 3  
**PROJECT NO:** 09.0025945.00  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
 Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 68  
**Final Boring Depth (ft.):** 61.6  
**Date Start - Finish:** 7/13/2017 - 7/13/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/13/17		7.5	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum	
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)					Depth (ft.)	Description
40												
84												
65			61.6-61.6					Rod Probe Refusal Possible Bedrock End of exploration at 61.6 feet.			POSSIBLE MARINE SAND 61.6 6.4	
70												
75												
80												
85												
90												

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.14-E**

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

**Vanasse Hangen Brustlin, Inc.**  
**MTA Exit 44 Foundation Evaluation for CHSS**

**EXPLORATION NO.: B-44.14-W**  
**SHEET: 1 of 3**  
**PROJECT NO: 09.0025945.00**  
**REVIEWED BY:**

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 68  
**Final Boring Depth (ft.):** 68.4  
**Date Start - Finish:** 7/11/2017 - 7/11/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/11/17		7.0	

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0.0-2.0	24	16	2 2 4 8	6	S-1: Loose, black to brown, fine to coarse SAND, little Gravel, little Silt, dry. (SP)	1		0.2	TOPSOIL	67.8	
		S-2	5.0-7.0	24	21	7 8 8 10	16	S-2: Medium dense, light brown, fine to medium SAND, trace Silt, wet. Clay seams. (SP-SM)			8.5		59.5	
10		S-3	10.0-12.0	24	19	WOR WOR 1 2	1	S-3: Very loose, tan, fine to medium SAND, trace Silt, wet. (SM)				SAND		
15		S-4	15.0-17.0	24	11	5 6 3 3	9	S-4: Loose, brown, fine to medium SAND, little Silt, wet. One seam of clay. (SM)						
20		S-5	20.0-22.0	24	24	1 WOH WOH WOH	0	S-5: Medium stiff, gray, Silty CLAY, wet. (CL)			18.5		49.5	
25		S-6	25.0-27.0	24	24			S-6: Medium stiff, gray, Silty CLAY, wet. Fine sand seam at bottom of sample. (CL)	2					
		V-1	27.0					V-1: Field Vane, T <sub>raw</sub> = 15/1 ft lbs (S <sub>u</sub> = 465/30 psf)						
		V-2	25.1-26.0-27.0					V-2: Field Vane, T <sub>raw</sub> = 44/10 ft lbs (S <sub>u</sub> = 1365/300 psf)						
30														

**REMARKS**  
1 - Advanced exploration using solid stem augers to 10.0' and drive & wash techniques to 40.0'.  
2 - Tapered vane with 2.5" diameter, 4.5" height, and 45-degree taper was used for field vane tests. T<sub>raw</sub> = measured torque; S<sub>u</sub> = calculated undrained shear strength.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.14-W**



### TEST BORING LOG



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.14-W  
SHEET: 2 of 3  
PROJECT NO: 09.0025945.00  
REVIEWED BY:

Logged By: N. Williams  
Drilling Co.: New England Boring Contractors  
Foreman: B. Enos

Type of Rig: ATV  
Rig Model: Mobile Drill B53  
Drilling Method:  
Drive & Wash

Boring Location (N,E): See Plan  
Ground Surface Elev. (ft.): 68  
Final Boring Depth (ft.): 68.4  
Date Start - Finish: 7/11/2017 - 7/11/2017

H. Datum:  
V. Datum: NAVD 88

Hammer Type: Automatic  
Hammer Weight (lb.): 140  
Hammer Fall (in.): 30  
Auger or Casing O.D./I.D Dia (in.): 3

Sampler Type: SS  
Sampler O.D. (in.): 2.0  
Sampler Length (in.): 24  
Rock Core Size:

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/11/17		7.0	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
35		S-7	30.0-	24	24		S-7: Medium stiff, gray, Silty CLAY, wet. (CL) V-3: Field Vane, $T_{raw} = 16/2$ ft lbs ( $S_u = 495/60$ psf) V-4: Field Vane, $T_{raw} = 17/3$ ft lbs ( $S_u = 525/90$ psf)						
		V-3	32.0										
		V-4	30.1-										
			31.0-										
40		S-8	40.0-	24	24		S-8: Medium stiff, gray, Silty CLAY, wet. (CL) V-5: Field Vane, $T_{raw} = 19/3$ ft lbs ( $S_u = 590/90$ psf) V-6: Field Vane, $T_{raw} = 21/4$ ft lbs ( $S_u = 650/120$ psf)	3					
		V-5	42.0										
		V-6	40.1-										
			41.0-										
45			41.0-										
			42.0										
50													
55													
60													

**REMARKS**  
3 - Advanced rod probe hydraulically from 42.0'-64.7'. Drove rod probe to refusal at 68.4. Blows per foot are recorded on log under casing blows.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.14-W**

GZA TEMPLATE TEST BORING; 8/25/2017; 1:12:26 PM

**TEST BORING LOG**



**GZA**  
**GeoEnvironmental, Inc.**  
*Engineers and Scientists*

Vanasse Hangen Brustlin, Inc.  
 MTA Exit 44 Foundation Evaluation for CHSS

EXPLORATION NO.: B-44.14-W  
 SHEET: 3 of 3  
 PROJECT NO: 09.0025945.00  
 REVIEWED BY:

**Logged By:** N. Williams  
**Drilling Co.:** New England Boring Contractors  
**Foreman:** B. Enos

**Type of Rig:** ATV  
**Rig Model:** Mobile Drill B53  
**Drilling Method:**  
 Drive & Wash

**Boring Location (N,E):** See Plan  
**Ground Surface Elev. (ft.):** 68  
**Final Boring Depth (ft.):** 68.4  
**Date Start - Finish:** 7/11/2017 - 7/11/2017

**H. Datum:**  
**V. Datum:** NAVD 88

**Hammer Type:** Automatic  
**Hammer Weight (lb.):** 140  
**Hammer Fall (in.):** 30  
**Auger or Casing O.D./I.D Dia (in.):** 3

**Sampler Type:** SS  
**Sampler O.D. (in.):** 2.0  
**Sampler Length (in.):** 24  
**Rock Core Size:**

**Groundwater Depth (ft.)**

Date	Time	Water Depth	Stab. Time
7/11/17		7.0	

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
65	38 21 16 83											SILTY CLAY	
70			68.4- 68.4					Rod Probe Refusal Possible Bedrock End of exploration at 68.4 feet.			68.4		-0.4
75													
80													
85													
90													

**REMARKS**

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

**Exploration No.:**  
**B-44.14-W**



APPENDIX C – LABORATORY TEST REPORTS

## LABORATORY TESTING DATA SHEET



Project Name MTA Exit 44 OHSS  
 Project No. 09.0025945.00  
 Project Manager N. Williams

Location South Portland, ME  
 Assigned By NVW  
 Report Date 08.18.17

Reviewed By \_\_\_\_\_  
 Date Reviewed 08.18.17

Boring/ Test Pit No.	Sample No.	Depth ft.	Lab No.	Identification Tests						Corrosivity					Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Gravel %	Sand %	Fines (<#200) %	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Resistivity (Mohms-cm)	GTL Resist	
B-44.04-E	S-1	0.5-2.5	1				27.6	67.0	5.4						Brown f-m SAND, some f-c Gravel, trace Silt
B-44.04-E	S-2	5-7	2				0.0	94.0	6.0						Brown f-m SAND, trace Silt
B-44.04-E	S-3	10-12	3				0.0	50.4	49.6						Brown fine SAND and SILT
B-44.04-E	S-4	15-17	4				0.0	81.5	18.5						Brown fine SAND, little Silt
B-44.04-E	S-6	25-27	5	38.6	36	19									Grey CLAY & SILT
B-44.04-E	S-7	30-32	6	37.9											Water Content Only
B-44.04-E	S-8	40-42	7	28.7	49	22									Grey Silty CLAY
B-44.04-E	S-9	50-52	8	38.5	40	20									Grey Silty CLAY
B-44.04-E	S-10	55-57	9	31.8											Water Content Only
B-44.04-W	S-5	20-22	10	36.6											Water Content Only
B-44.04-W	S-6	25-27	11	35.6	32	18									Grey CLAY & SILT
B-44.04-W	S-7	30-32	12	34.2											Water Content Only
B-44.04-W	S-8	40-42	13	47.6											Water Content Only



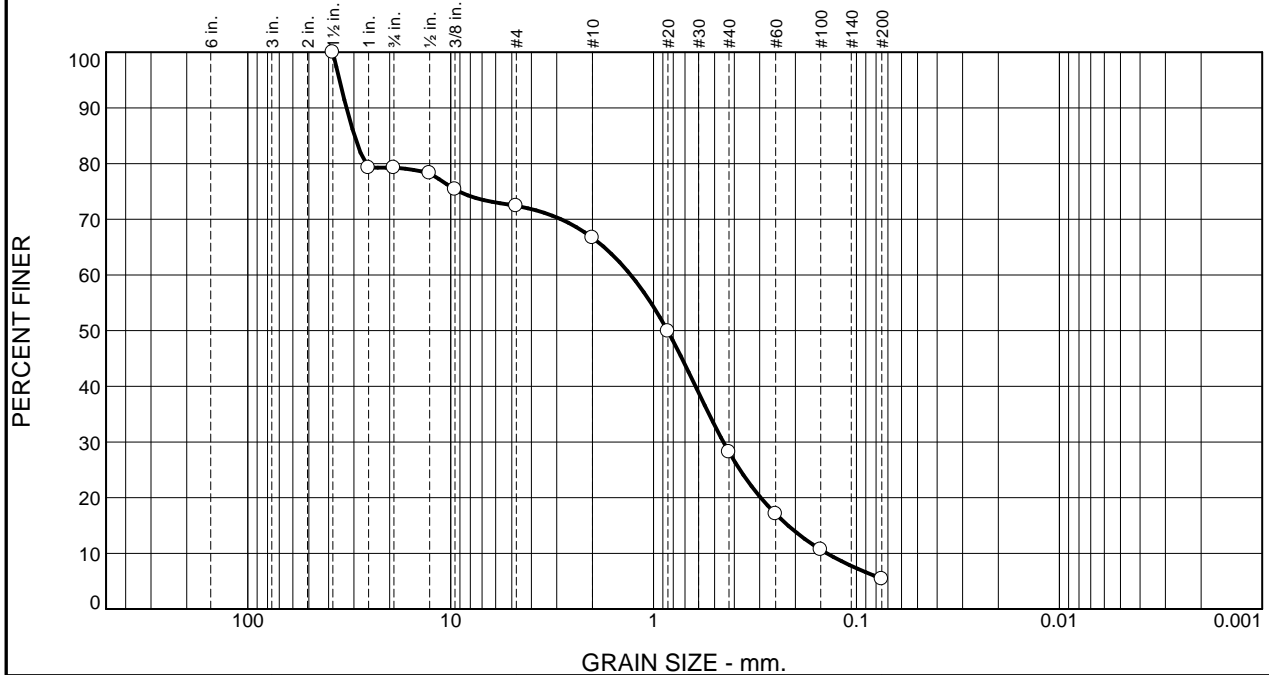
195 Frances Avenue  
 Cranston, RI 02910

401-467-6454





# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	20.7	6.9	5.7	38.5	22.8	5.4	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	79.3		
.75	79.3		
0.5	78.3		
.375	75.4		
#4	72.4		
#10	66.7		
#20	49.9		
#40	28.2		
#60	17.1		
#100	10.7		
#200	5.4		

\* (no specification provided)

**Material Description**

Brown f-m SAND, some f-c Gravel, trace Silt

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SW-SM    AASHTO (M 145)= A-1-b

**Coefficients**

D<sub>90</sub>= 32.6308              D<sub>85</sub>= 29.8023              D<sub>60</sub>= 1.2960  
D<sub>50</sub>= 0.8532              D<sub>30</sub>= 0.4528              D<sub>15</sub>= 0.2174  
D<sub>10</sub>= 0.1399              C<sub>u</sub>= 9.26                      C<sub>c</sub>= 1.13

Remarks


---

Date Received: 08.15.17              Date Tested: 08.17.17

Tested By: SA

Checked By: Matthew Colman, P.E.

Title: Laboratory Manager

Source of Sample: Borings              Depth: 0.5-2.5'  
Sample Number: B-44.04-E

Date Sampled:

**Thielsch Engineering Inc.**

**Cranston, RI**

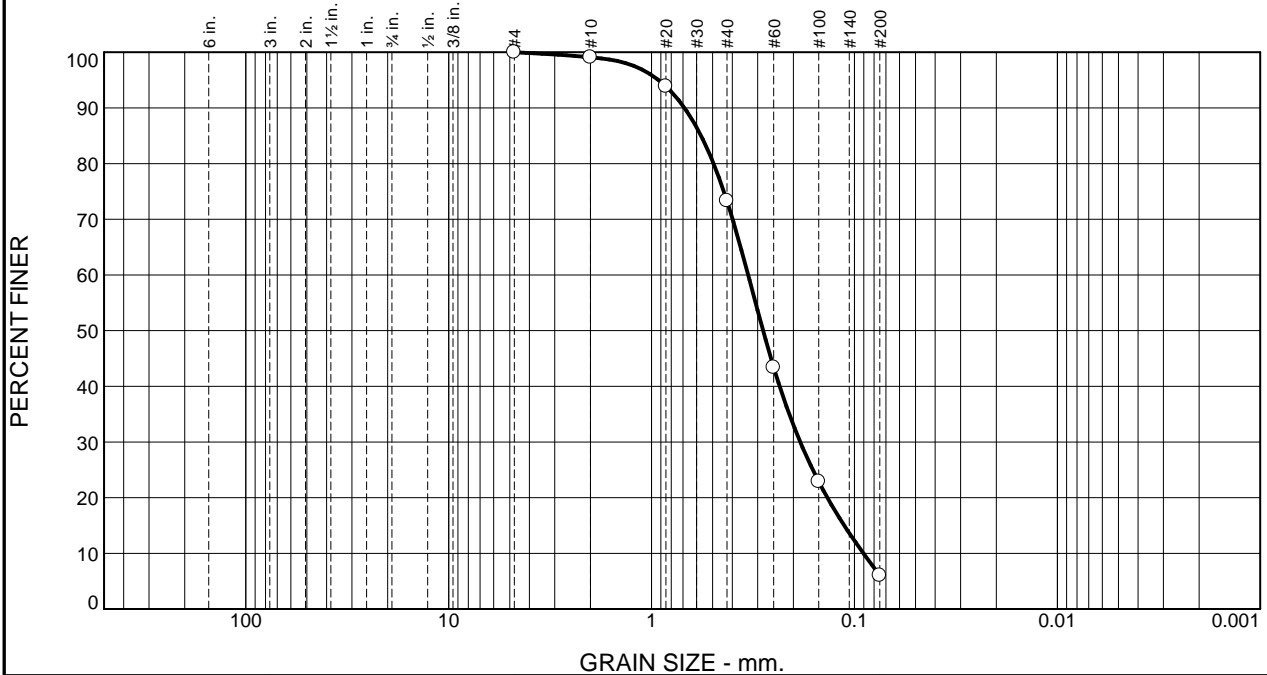
Client: GZA GeoEnvironmental / Maine DOT

Project: MTA Exit 44 OHSS  
South Portland, ME

Project No: 09.0025945.00

Figure S1

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.9	25.8	67.3	6.0	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.1		
#20	93.9		
#40	73.3		
#60	43.4		
#100	22.9		
#200	6.0		

\* (no specification provided)

**Material Description**

Brown f-m SAND, trace Silt

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI=

**Classification**

USCS (D 2487)= SP-SM      AASHTO (M 145)= A-3

**Coefficients**

D <sub>90</sub> = 0.6882	D <sub>85</sub> = 0.5702	D <sub>60</sub> = 0.3341
D <sub>50</sub> = 0.2819	D <sub>30</sub> = 0.1851	D <sub>15</sub> = 0.1123
D <sub>10</sub> = 0.0903	C <sub>u</sub> = 3.70	C <sub>c</sub> = 1.14

Remarks

Date Received: 08.15.17      Date Tested: 08.17.17

Tested By: SA

Checked By: Matthew Colman, P.E.

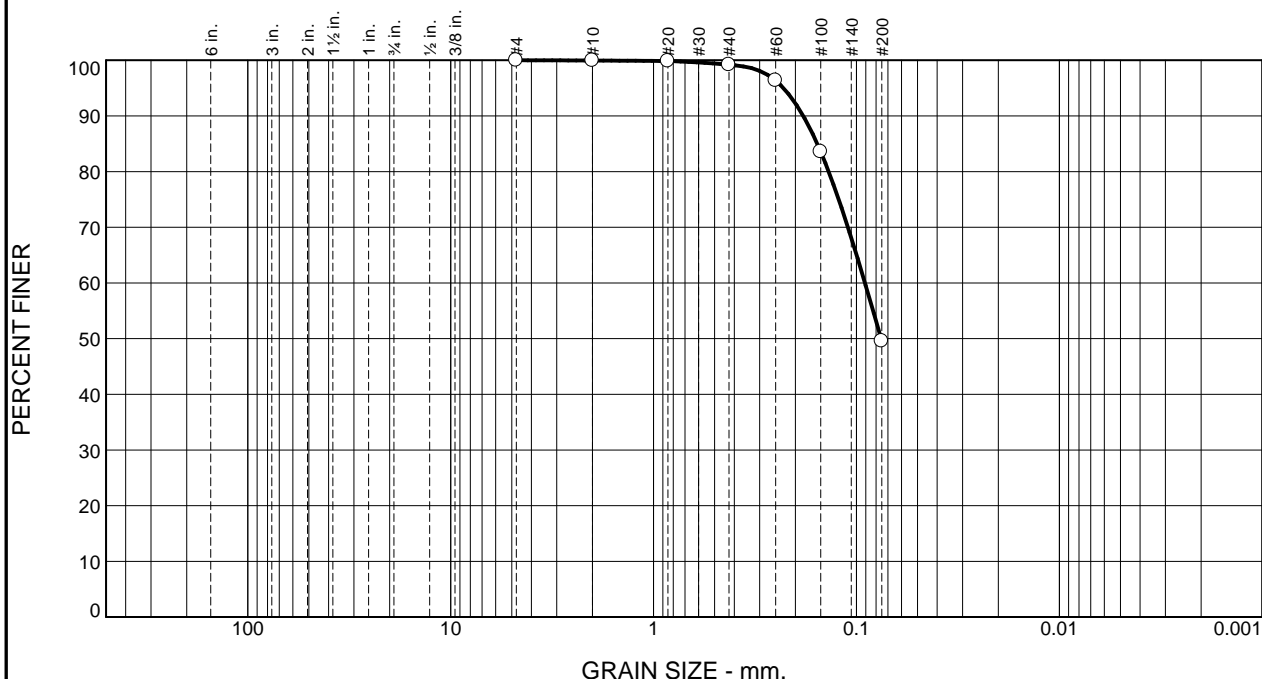
Title: Laboratory Manager

Source of Sample: Borings      Depth: 5-7'  
 Sample Number: B-44.04-E

Date Sampled:

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	Client: GZA GeoEnvironmental / Maine DOT Project: MTA Exit 44 OHSS South Portland, ME Project No: 09.0025945.00
	Figure S2

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.7	49.6	49.6	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	99.9		
#40	99.2		
#60	96.3		
#100	83.6		
#200	49.6		

\* (no specification provided)

**Material Description**

Brown fine SAND and SILT

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SM                      AASHTO (M 145)= A-4(0)

**Coefficients**

D<sub>90</sub>= 0.1830                      D<sub>85</sub>= 0.1561                      D<sub>60</sub>= 0.0908  
D<sub>50</sub>= 0.0756                      D<sub>30</sub>=                                      D<sub>15</sub>=  
D<sub>10</sub>=                                      C<sub>u</sub>=                                      C<sub>c</sub>=

**Remarks**

Sample contained standing water.  
Material plasticity is visual estimate only.

Date Received: 08.15.17                      Date Tested: 08.17.17  
Tested By: SA  
Checked By: Matthew Colman, P.E.  
Title: Laboratory Manager

Source of Sample: Borings  
Sample Number: B-44.04-E

Depth: 10-12'

Date Sampled:

**Thielsch Engineering Inc.**

**Cranston, RI**

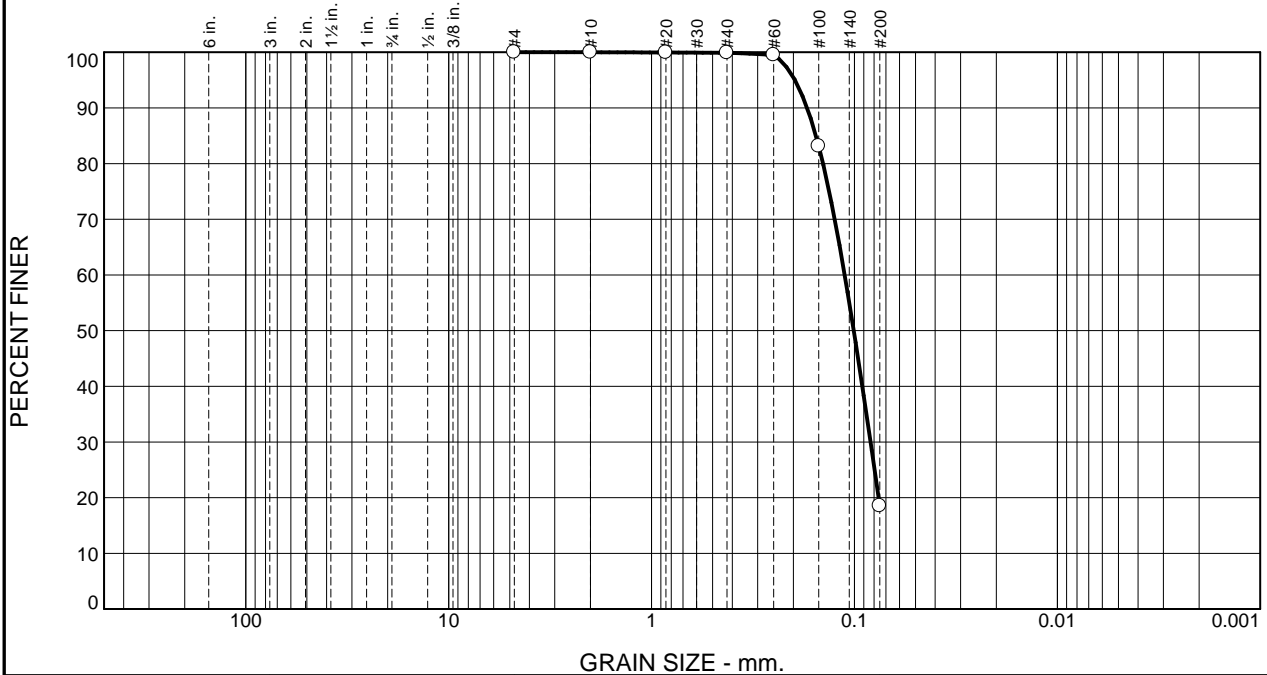
Client: GZA GeoEnvironmental / Maine DOT

Project: MTA Exit 44 OHSS  
South Portland, ME

Project No: 09.0025945.00

Figure S3

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	81.4	18.5	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	100.0		
#40	99.9		
#60	99.5		
#100	83.1		
#200	18.5		

\* (no specification provided)

**Material Description**

Brown fine SAND, little Silt

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SM                      AASHTO (M 145)= A-2-4(0)

**Coefficients**

D<sub>90</sub>= 0.1711                      D<sub>85</sub>= 0.1549                      D<sub>60</sub>= 0.1118  
D<sub>50</sub>= 0.1008                      D<sub>30</sub>= 0.0833                      D<sub>15</sub>=  
D<sub>10</sub>=                                      C<sub>u</sub>=                                      C<sub>c</sub>=

**Remarks**

Sample contained standing water.

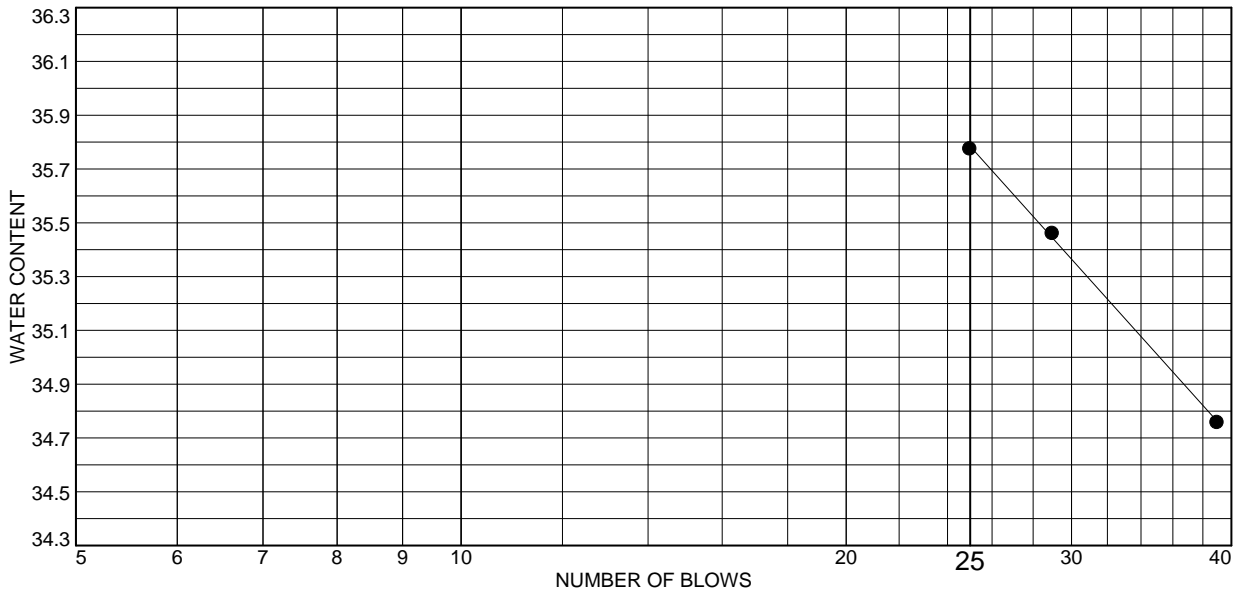
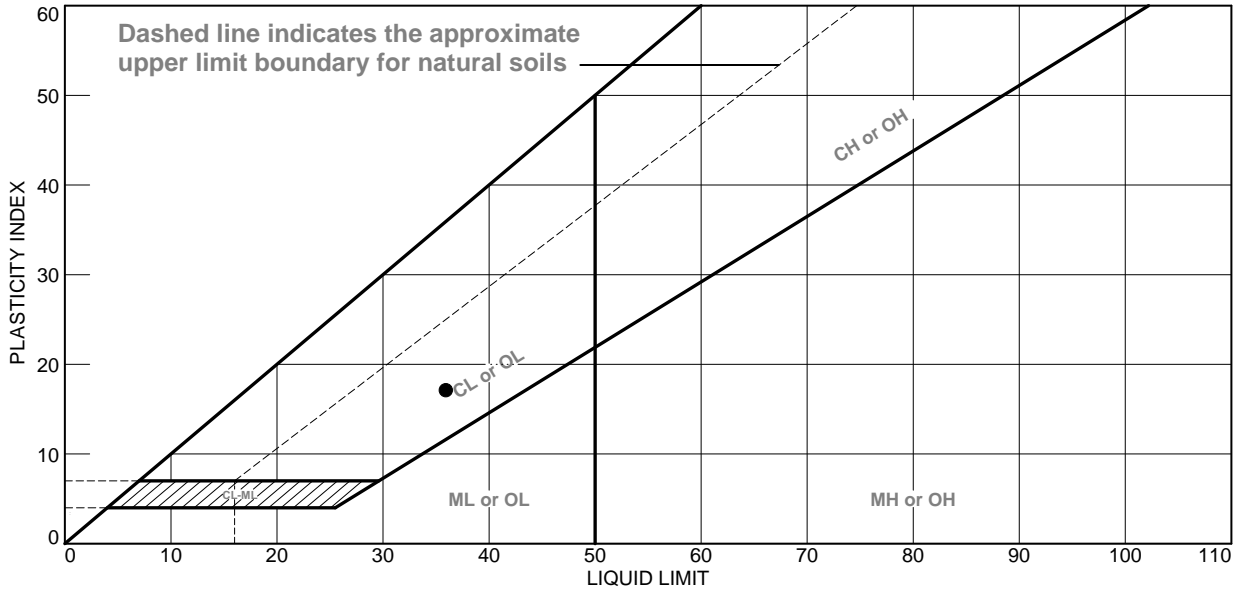
Date Received: 08.15.17                      Date Tested: 08.16.17  
Tested By: SA  
Checked By: Matthew Colman, P.E.  
Title: Laboratory Manager

Source of Sample: Borings                      Depth: 15-17'                      Date Sampled:

Sample Number: B-44.04-E

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> GZA GeoEnvironmental / Maine DOT <b>Project:</b> MTA Exit 44 OHSS South Portland, ME <b>Project No:</b> 09.0025945.00 <b>Figure</b> S4
---	--

# LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Grey CLAY & SILT	36	19	17			CL

**Project No.** 09.0025945.00 **Client:** GZA GeoEnvironmental / Maine DOT  
**Project:** MTA Exit 44 OHSS  
 South Portland, ME  
**Source of Sample:** Borings **Depth:** 25-27'  
**Sample Number:** B-44.04-E

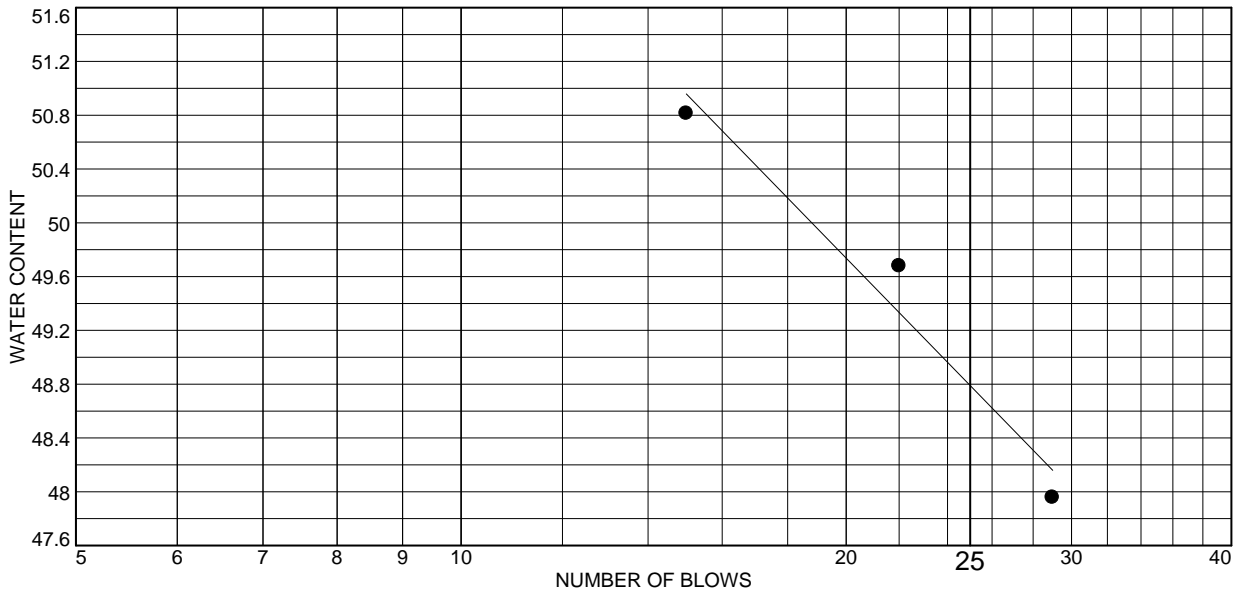
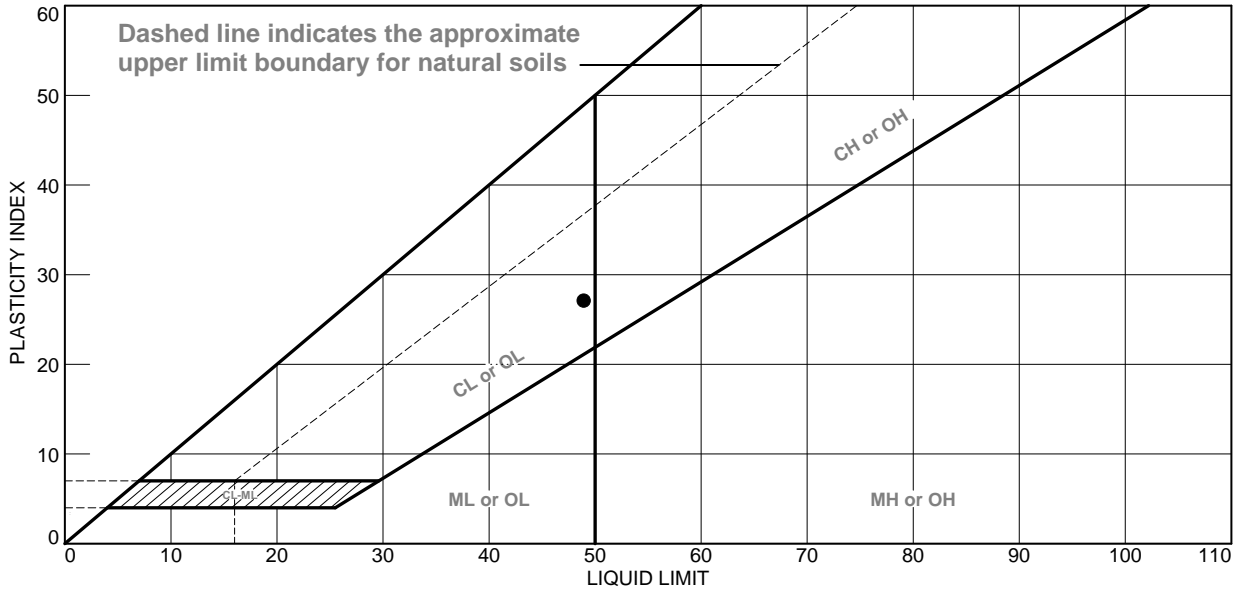
**Thielsch Engineering Inc.**  
**Cranston, RI**

**Remarks:**

**Figure** L5

**Tested By:** SA \_\_\_\_\_ **Checked By:** Matthew Colman, P.E. \_\_\_\_\_

# LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Grey Silty CLAY	49	22	27			CL

**Project No.** 09.0025945.00 **Client:** GZA GeoEnvironmental / Maine DOT  
**Project:** MTA Exit 44 OHSS  
 South Portland, ME  
**Source of Sample:** Borings **Depth:** 40-42'  
**Sample Number:** B-44.04-E

**Thielsch Engineering Inc.**  
**Cranston, RI**

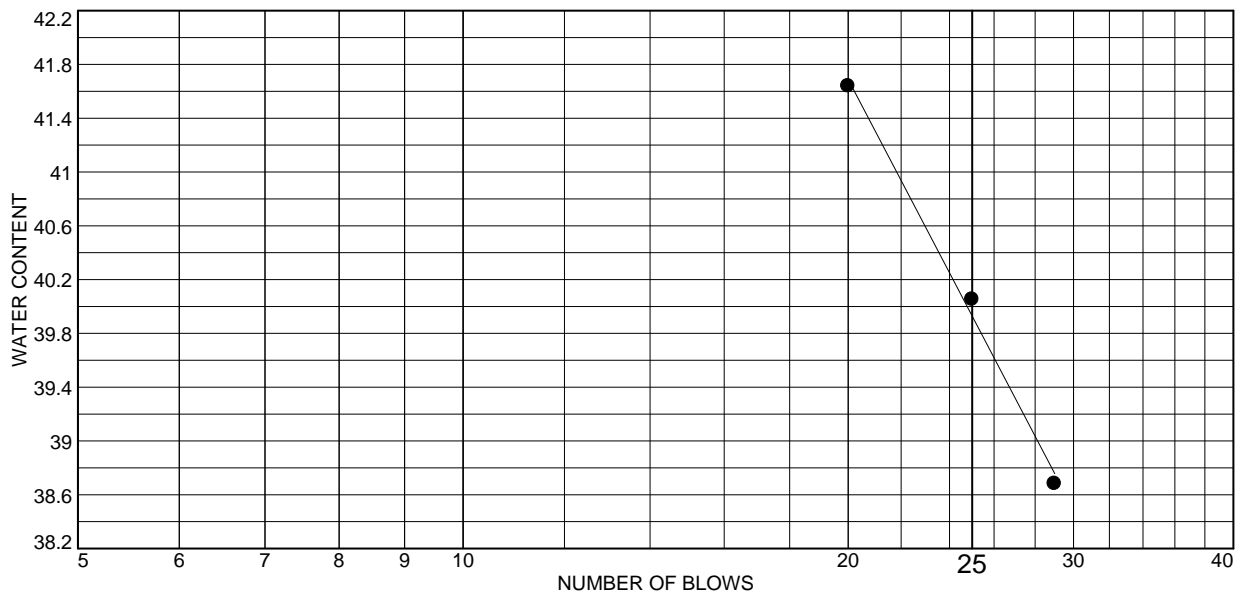
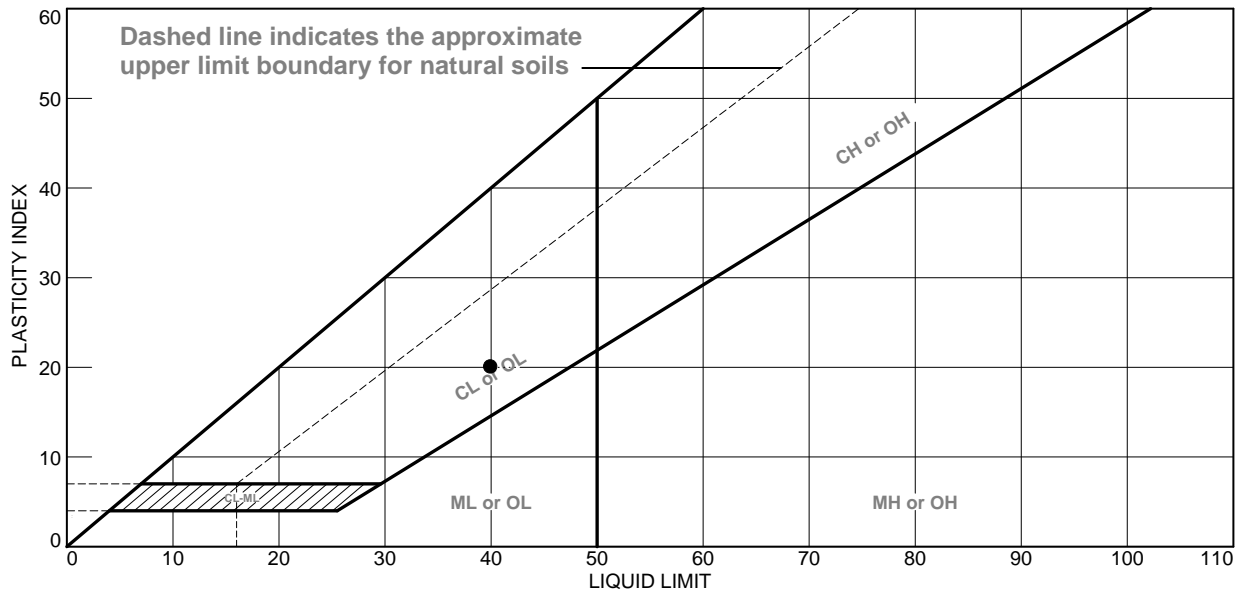
**Remarks:**

**Figure** L7

**Tested By:** SA \_\_\_\_\_ **Checked By:** Matthew Colman, P.E. \_\_\_\_\_



# LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Grey Silty CLAY	40	20	20			CL

**Project No.** 09.0025945.00 **Client:** GZA GeoEnvironmental / Maine DOT  
**Project:** MTA Exit 44 OHSS  
 South Portland, ME  
**Source of Sample:** Borings **Depth:** 50-52'  
**Sample Number:** B-44.04-E

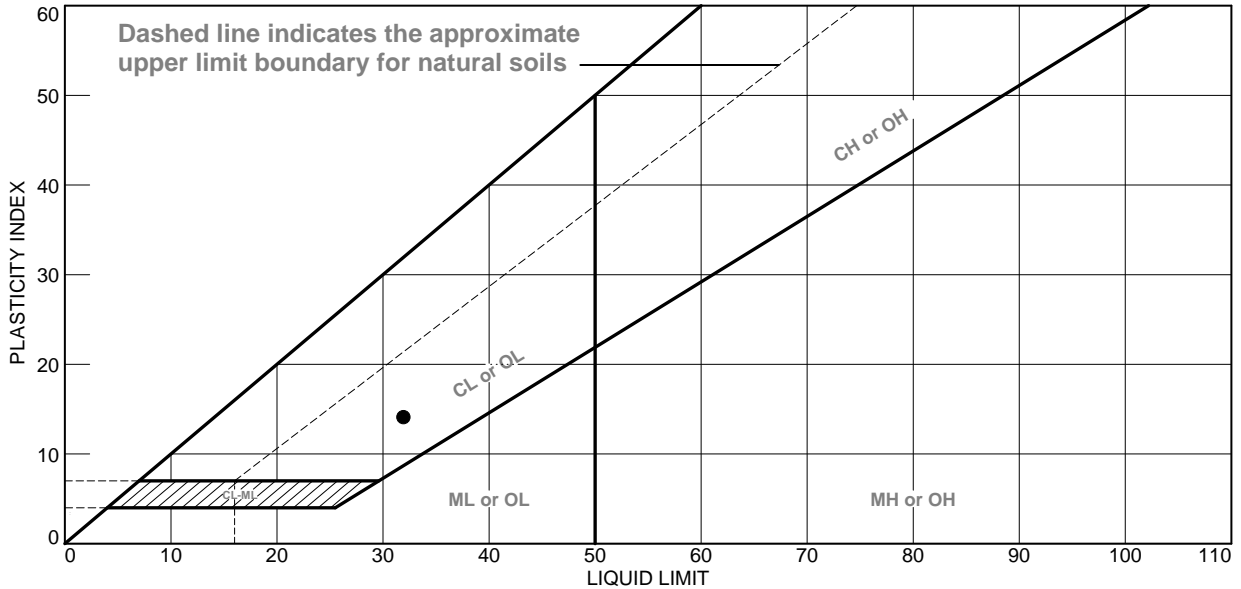
**Thielsch Engineering Inc.**  
**Cranston, RI**

**Remarks:**

**Figure** L8

**Tested By:** SA \_\_\_\_\_ **Checked By:** Matthew Colman, P.E. \_\_\_\_\_

# LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Grey CLAY & SILT	32	18	14			CL

**Project No.** 09.0025945.00 **Client:** GZA GeoEnvironmental / Maine DOT  
**Project:** MTA Exit 44 OHSS  
 South Portland, ME  
**Source of Sample:** Borings **Depth:** 25-27'  
**Sample Number:** B-44.04-W

**Thielsch Engineering Inc.**  
 Cranston, RI

**Remarks:**

**Figure** L11

**Tested By:** SA \_\_\_\_\_ **Checked By:** Matthew Colman, P.E. \_\_\_\_\_