

14.528 Drilled Deep Foundations Spring 2014 Homework No. 2

Subsurface Exploration and Soil Parameters

Figure 1 presents a section of a plan for a multi-branch viaduct project. The related past borings, and borings carried out for the specific subsurface exploration program are also presented in Figure 1. Provided herein are the boring logs for NVB-A, B and C.

Using the available information, conduct the following:

1. Draw a subsurface section based on the available borings. The section is marked as A-A' on the plan. For doing so, use a horizontal and vertical scales of 1" = 25ft.
2. Identify and mark the predominant subsurface layers.
3. Establish typical soil parameters for each layer (whichever applicable), namely unit weight, γ , internal friction angle, ϕ , undrained shear strength, s_u , and modulus, E_u considering driven piles and drilled foundations.
4. Equip yourself with a tape measure and arrange a visit to the geotechnical lab at S-127. Use the box of a boring marked by NVB-3 and establish the rock recovery ratio and RQD for the Cambridge Argillite obtained in core C-6 between 145.5ft and 150.5ft, and that of core C-7 between 150.5ft and 155.5ft.

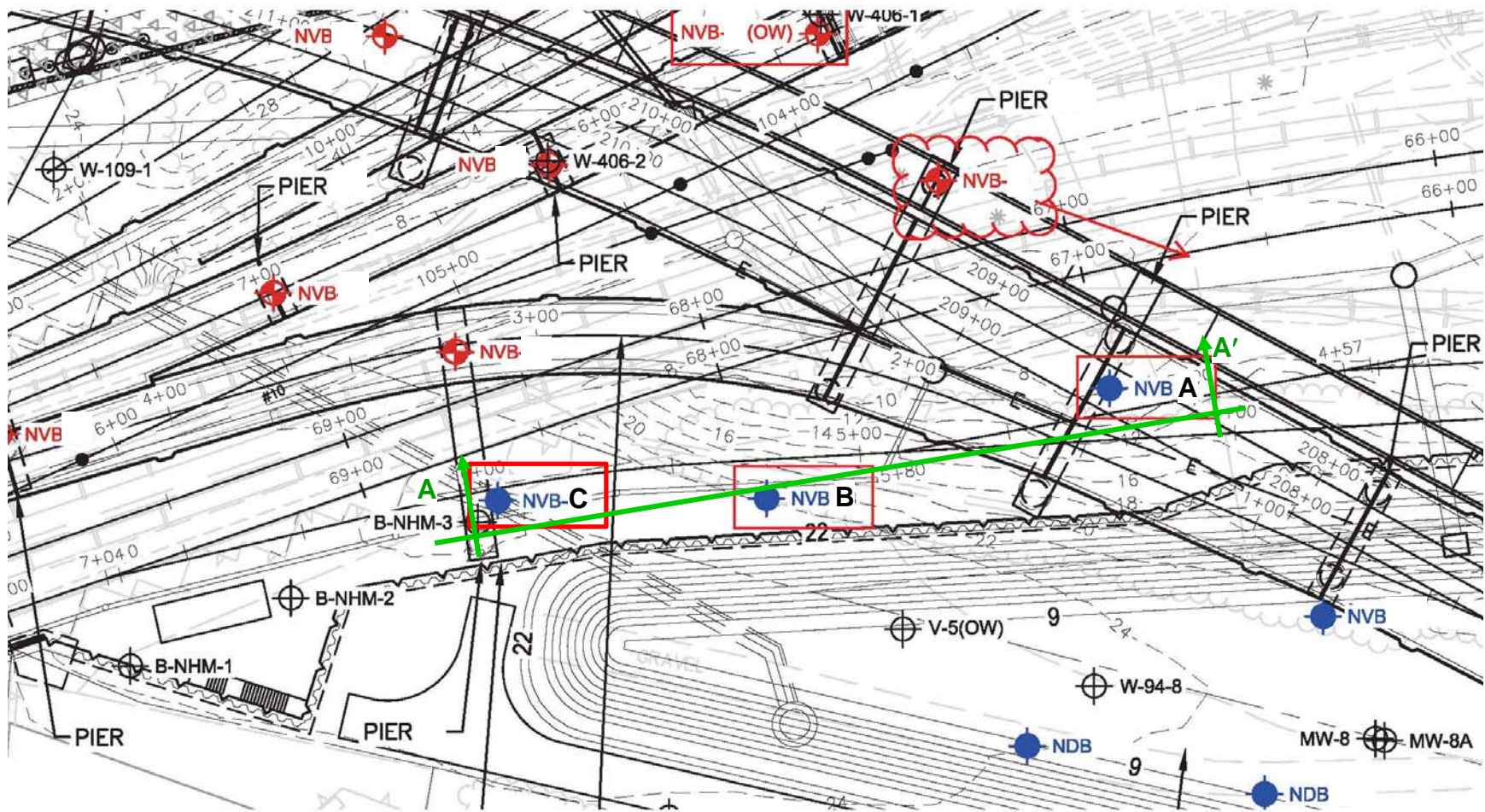


Figure 1. Boring Location Plan

1 in = 43.3 ft
 scale



BORING LOG

Project: Green Line Extension Project
 Location: Cambridge/ Somerville/ Medford, MA
 Nobis Project No.: _____

Boring No.: NVB-A
 Boring Location: _____
 Checked by: _____
 Date Start: September 12, 2013
 Date Finish: September 19, 2013

Contractor: New Hampshire Boring, Inc.
 Driller: R. Burne
 Nobis Rep.: R. Rizza

Rig Type / Model: ATV / Diedrich D-50
 Hammer Type: Safety Hammer
 Hammer Hoist: Wire Winch

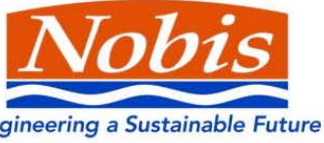
Ground Surface Elev.: (+/-) 9
 Datum: NAVD 88

Type	Drilling Method	Sampler	Groundwater Observations					
			Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time
	Casing	Split-Spoon	09/06/13	11:00	5.85	10	50	30 hours
Size ID (in.)	5"	1-3/8						
Advancement	Drive and Wash	1404b Hammer						

Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	Graphic	LITHOLOGY	Stratum Elev. / Depth (ft.)	SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.								
1	S-1	12	0-2	12					FILL	7.0 / 2.0	S-1: Dense, brown, fine SAND, little Silt, trace medium to coarse Sand, trace fine to coarse Gravel. dry.	
2				18								
3	S-2	11	2-4	9					CLAYEY SILT	0.0 / 9.0	S-2: Very stiff, brown / olive, Clayey SILT, trace fine to medium Sand. moist.	
4				10								
5				15								
6				14								
7												
8												
9												
10	S-3	20	9-11	8					SILT & CLAY		S-3: Very stiff, brown / olive, SILT & CLAY. wet.	
11				9								
12				9								
13				11								
14												
15												
16	S-4	22	15-17	5							S-4: Stiff, olive, CLAY & SILT. wet.	
17				5								
18				6								
19				7								
20												
21	S-5	21	20-22	4					CLAY & SILT		S-5: Stiff, olive / gray, CLAY & SILT. wet.	
22				4								
23				5								
24				8								
25												

Soil	Percentage	Non-Soil
trace	5 - 10	very few
little	10 - 20	few
some	20 - 35	several
and	35 - 50	numerous

NOTES:
 Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.



BORING LOG

Project: Green Line Extension Project
 Location: Cambridge/ Somerville/ Medford, MA
 Nobis Project No.: _____

Boring No.: NVB-A
 Boring Location: _____
 Checked by: _____
 Date Start: September 12, 2013
 Date Finish: September 19, 2013

Contractor: New Hampshire Boring, Inc.
 Driller: R. Burne
 Nobis Rep.: R. Rizza

Rig Type / Model: ATV / Diedrich D-50
 Hammer Type: Safety Hammer
 Hammer Hoist: Wire Winch

Ground Surface Elev.: (+/-) 9
 Datum: NAVD 88

Type	Drilling Method	Sampler	Groundwater Observations					
			Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time
	Casing	Split-Spoon	09/06/13	11:00	5.85	10	50	30 hours
Size ID (in.)	5"	1-3/8						
Advancement	Drive and Wash	140lb Hammer						

Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY	SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.						
51	S-12	6	50-50.7	93			WEATHERED BEDROCK	S-12: Very dense, gray / tan, weathered ARGILLITE. wet.		
52				100/2"				S-13: Very dense, gray / tan, weathered ARGILLITE. wet.		
53										
54										
55										
56	S-13	2	55-55.2	100/2"				S-14: Very dense, gray / tan, weathered ARGILLITE. wet.		
57										
58										
59										
60										
61	S-14	2	60-60.2	100/2"				S-15: Very dense, gray / tan, weathered ARGILLITE. wet.		
62										
63										
64										
65										
66	S-15	3	65-65.3	100/3"				S-16: Very dense, gray / tan, weathered ARGILLITE. wet.		
67										
68										
69										
70										
71	S-16	3	70-70.3	100/3"						
72										
73										
74										
75										

Soil	Percentage	Non-Soil
trace	5 - 10	very few
little	10 - 20	few
some	20 - 35	several
and	35 - 50	numerous

NOTES:

Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.

BOREHOLE LOG - NOBIS GINT DATA TEMPLATE OCT 7 2011 LGDT - 1/2/14 - 10/01 - D:\ACTIVE\96320.00\META GREEN LINE EXTENSION TASK\1A\GEO\TECH\EXP\DRATIONS\BORING LOGS\NOBIS BORING LOGS.GPJ



BORING LOG

Project: Green Line Extension Project
 Location: Cambridge/ Somerville/ Medford, MA
 Nobis Project No.: _____

Boring No.: NVB-A
 Boring Location: _____
 Checked by: _____
 Date Start: September 12, 2013
 Date Finish: September 19, 2013

Contractor: New Hampshire Boring, Inc.
 Driller: R. Burne
 Nobis Rep.: R. Rizza

Rig Type / Model: ATV / Diedrich D-50
 Hammer Type: Safety Hammer
 Hammer Hoist: Wire Winch


Ground Surface Elev.: (+/-) 9
 Datum: NAVD 88

Type	Drilling Method	Sampler	Groundwater Observations					
			Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time
	Casing	Split-Spoon	09/06/13	11:00	5.85	10	50	30 hours
Size ID (in.)	5"	1-3/8						
Advancement	Drive and Wash	140-lb Hammer						

Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	Graphic	LITHOLOGY	SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/6 in.							
76	S-17	3	75-75.3	100/3"					S-17: Very dense, gray, weathered ARGILLITE, wet.		
77											
78											
79											
80											
81	S-18	1	80-80.1	100/1"					S-18: Very dense, gray, weathered ARGILLITE, wet.		
82											
83											
84											
85											
86	C-1	34.5	85-90		58/8	1.5			C-1: Medium Hard, slightly weathered, extremely to slightly fractured, gray, very fine grained, ARGILLITE, horizontal to high angle joints.		
87						1					
88						2					
89						3					
90						5.5					
91	C-2	32	90-95		53/7	2			C-2: Medium Hard, slightly weathered, extremely to moderately fractured, gray, very fine grained, ARGILLITE, horizontal to high angle joints.		
92						3					
93						2					
94						2					
95						4					
96	C-3	44.5	95-100		74/9	3			C-3: Medium Hard, slightly weathered, extremely to slightly fractured, gray, very fine grained, ARGILLITE, horizontal to high angle joints.		
97						3					
98						2					
99						3					
100						3.5					


Soil	Percentage	Non-Soil
trace	5 - 10	very few
little	10 - 20	few
some	20 - 35	several
and	35 - 50	numerous

NOTES:


		BORING LOG				Boring No.: <u>NVB-A</u>					
		Project: <u>Green Line Extension Project</u> Location: <u>Cambridge/ Somerville/ Medford, MA</u> Nobis Project No.: _____				Boring Location: _____ Checked by: _____ Date Start: <u>September 12, 2013</u> Date Finish: <u>September 19, 2013</u>					
Contractor: <u>New Hampshire Boring, Inc.</u>		Rig Type / Model: <u>ATV / Diedrich D-50</u>				Ground Surface Elev.: <u>(+/-) 9</u>					
Driller: <u>R. Burne</u>		Hammer Type: <u>Safety Hammer</u>				Datum: <u>NAVD 88</u>					
Nobis Rep.: <u>R. Rizza</u>		Hammer Hoist: <u>Wire Winch</u>									
		Drilling Method		Sampler		Groundwater Observations					
Type		Casing		Split-Spoon		Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time
Size ID (in.)		5"		1-3/8		▼ 09/06/13	11:00	5.85	10	50	30 hours
Advancement		Drive and Wash		140-lb Hammer							
Depth (ft.)	SAMPLE INFORMATION				REC % / RGD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY		SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.				Graphic	Stratum Elev. / Depth (ft.)		
126	C-11	56	125-130		93/77	3	BEDROCK		C-11: Medium Hard, fresh, extremely fractured to sound, gray, very fine grained, ARGILLITE, low to moderately dipping joints.		
127						6					
128						6					
129						4.5					
130						5.5					
131	C-12	58.5	130-135		98/89	3				C-12: Medium Hard, fresh, extremely fractured to sound, gray, very fine grained, ARGILLITE, low angle joints.	
132						3.5					
133						3					
134						4					
135						4.5					
136	C-13	37	135-138.3		95/28	3				C-13: Medium Hard, fresh to very slightly weathered, extremely fractured to sound, gray, very fine grained, ARGILLITE, horizontal to high angle joints.	
137						4.5					
138						5					
139	C-14	56.5	138.3-143.3		94/63	7				C-14: Medium Hard, fresh to very slightly weathered, moderately fractured to sound, gray, very fine grained, ARGILLITE, low to high angle joints.	
140						2.5					
141						5					
142						4					
143						3					
144						3.5		-134.3 / 143.3	Boring terminated at 143.3 feet.		
145											
146											
147											
148											
149											
150											
Soil	Percentage	Non-Soil	NOTES:								
trace	5 - 10	very few									
little	10 - 20	few									
some	20 - 35	several									
and	35 - 50	numerous									
Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.										Page No. <u>6</u> of <u>6</u>	

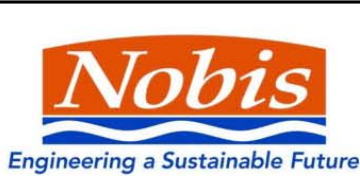
BOREHOLE LOG - NOBIS GINT DATA TEMPLATE OCT 7 2011 LGDT - 1/2/14 - 10:01 - O:\ACTIVE\065320.00\META GREEN LINE EXTENSION TASK\AGEOTECH\EXPLORATIONS\BORING LOGS\NOBIS BORING LOGS.GPJ

Nobis Engineering a Sustainable Future		BORING LOG				Boring No.: <u>NVB-B</u>				
Project: <u>Green Line Extension Project</u>		Location: <u>Cambridge/ Somerville/ Medford, MA</u>				Boring Location:				
Checked by: <u>J. Kalafatis</u>		Nobis Project No.: _____				Date Start: <u>September 10, 2013</u>				
Date Finish: <u>September 12, 2013</u>		Contractor: <u>Maine Test Borings</u>				Rig Type / Model: <u>Track / B-53 Mobile</u>				
Driller: <u>R. Leonard</u>		Hammer Type: <u>Safety Hammer</u>				Ground Surface Elev.: <u>(+/-) 19</u>				
Nobis Rep.: <u>E. Johnson</u>		Hammer Hoist: <u>Wire Winch</u>				Datum: <u>NAVD 88</u>				
Drilling Method		Sampler		Groundwater Observations						
Type	Casing	Split-Spoon		Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)			
Size ID (in.)	4"	1-3/8		09/11/13	07:35	13.7	45			
Advancement	Drive and Wash	140-lb Hammer					42			
							17 hours			
Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY	SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.						
1	S-1	14	0-2	2			TOPSOIL 18.5 / 0.5	S-1: Medium dense, black / brown, fine to coarse SAND, some Coal Ash, little Silt, trace fine Gravel, trace Organics (root fibers) in first 4" of sample. dry. (FILL).		
2				6						
3				6						
4				7						
5										
6	S-2	15	5-7	14				S-2: Dense, light brown, SILT and fine to coarse Sand, trace fine Gravel. dry. (FILL).		
7				26						
8				21						
9				26						
10										
11	S-3	12	10-12	15			FILL	S-3: Medium dense, brown, fine to coarse SAND & SILT, two seams of Coal Ash between 11' and 12'. moist. (FILL).		
12				15						
13				10						
14				9						
15				9						
16	S-4	0	15-17	5				S-4: No Recovery. Advance spoon 17' - 19'. Split spoon had remnants of medium to coarse Sand.		
17				8						
18				9						
19				8						
20	S-5	10	17-19					S-5A (5'): Brown / gray, fine to coarse SAND, trace Silt, trace fine Gravel. wet. S-5B (5'): Brown, fine to coarse SAND & SILT, trace fine Gravel. moist. (FILL).		
21										
22	S-6	8	20-22	34				S-6: Medium dense, gray, Weathered mica fragments, little fine to medium Sand, trace Silt. wet. (FILL).		
23				8						
24				5						
25				5						
								-3.0 / 22.0		
								ORGANIC DEPOSITS	Dark brown / gray peat, chunks of silt observed in wash cuttings. Organic odor noted.	
Soil	Percentage	Non-Soil	NOTES:							
trace	5 - 10	very few	1) Hole backfilled with drill cuttings.							
little	10 - 20	few	2) HQ coring tool used to advance into bedrock							
some	20 - 35	several	3) Safety hammer efficiency calibrated at 52%							
and	35 - 50	numerous								
Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.										
									Page No. 1 of 6	

		BORING LOG				Boring No.: <u>NVB-B1</u>						
		Project: <u>Green Line Extension Project</u>				Boring Location: _____						
Location: <u>Cambridge/ Somerville/ Medford, MA</u>				Checked by: <u>J. Kalafatis</u>		Date Start: <u>September 10, 2013</u>						
Nobis Project No.: _____				Date Finish: <u>September 12, 2013</u>								
Contractor: <u>Maine Test Borings</u>			Rig Type / Model: <u>Track / B-53 Mobile</u>			Ground Surface Elev.: <u>(+/-) 19</u>						
Driller: <u>R. Leonard</u>			Hammer Type: <u>Safety Hammer</u>									
Nobis Rep.: <u>E. Johnson</u>			Hammer Hoist: <u>Wire Winch</u>			Datum: <u>NAVD 88</u>						
		Drilling Method		Sampler		Groundwater Observations						
Type		Casing		Split-Spoon		Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time	
Size ID (in.)		4"		1-3/8		09/11/13	07:35	13.7	45	42	17 hours	
Advancement		Drive and Wash		140-lb Hammer								
Depth (ft.)		SAMPLE INFORMATION				LITHOLOGY		SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)				NOTES
		Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.	REC % / RQD %	Drilling Rate (min/ft)	Ground Water	Graphic		Stratum Elev. / Depth (ft.)	
26									ORGANIC DEPOSITS -8.0 / 27.0			
27									Cuttings change at 27'. Olive / gray chunks of Silt & Clay.			
28												
29												
30												
31		S-7	24	30-32	6				S-7: Very stiff, olive, CLAY & SILT, trace fine Gravel. moist to wet. (Boston Blue Clay).			
32					7							
33					10							
34					11							
35									SILTY CLAY			
36												
37												
38												
39												
40												
41		S-8	20	40-42	3				S-8: Stiff, olive / gray, Silty CLAY. moist to wet. (Boston Blue Clay).			
42					4							
43					5							
44					6				-24.5 / 43.5			
45									Increased drilling resistance noted at approximately 43.5'. Potential glacial till.			
46												
47									GLACIAL TILL			
48												
49												
50												
Soil		Percentage		Non-Soil		NOTES:						
trace		5 - 10		very few		1) Hole backfilled with drill cuttings.						
little		10 - 20		few		2) HQ coring tool used to advance into bedrock						
some		20 - 35		several		3) Safety hammer efficiency calibrated at 52%						
and		35 - 50		numerous								
Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.											Page No. <u>2</u> of <u>6</u>	

Nobis Engineering a Sustainable Future		BORING LOG				Boring No.: <u>NVB-B</u>				
Project: <u>Green Line Extension Project</u>		Location: <u>Cambridge/ Somerville/ Medford, MA</u>				Boring Location: _____				
Nobis Project No.: _____		Checked by: <u>J. Kalafatis</u>				Date Start: <u>September 10, 2013</u>				
Date Finish: <u>September 12, 2013</u>		Rig Type / Model: <u>Track / B-53 Mobile</u>				Ground Surface Elev.: <u>(+/-) 19</u>				
Contractor: <u>Maine Test Borings</u>		Driller: <u>R. Leonard</u>				Datum: <u>NAVD 88</u>				
Nobis Rep.: <u>E. Johnson</u>		Hammer Type: <u>Safety Hammer</u>				Hammer Rep.: _____				
Hammer Hoist: <u>Wire Winch</u>		Groundwater Observations								
Type	Casing	Sampler	Split-Spoon	Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time	
				09/11/13	07:35	13.7	45	42	17 hours	
Size ID (in.)	4"		1-3/8							
Advancement	Drive and Wash		140-lb Hammer							
Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY	SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.						
51	S-9	17	50-52	50			GLACIAL TILL -34.5 / 53.5	S-9: Very dense, dark olive / gray, fine to medium SAND, some Silt, trace fine Gravel, trace Clay. wet. (GLACIAL TILL).		
				62						
52				64						
				72						
53							WEATHERED BEDROCK	Drilling resistance changes at 53.5', somewhat smoother but firm. Probable weathered bedrock interface.		
54										
55	S-10	11	55-57	19						S-10: Very dense, gray, weathered ARGILLITE fragments and Silty Clay. moist to wet.
56				22						
57				29						
				45						
58										
59										
60	S-11	10	60-62	38						S-11: Very dense, gray / light gray, weathered ARGILLITE fragments and Clay & Silt. moist.
61				56						
62				60						
				66						
63										
64										
65	S-12	12	65-66.4	28				S-12: Very dense, gray, weathered ARGILLITE fragments, some Clay & Silt. moist.		
66				85						
				100/5"						
67										
68										
69										
70	S-13	2	70-70.3					S-13: Very dense, gray, weathered ARGILLITE fragments, some Clay & Silt. wet.		
71				100/3"						
72										
73										
74										
75							-56.0 / 75.0			
Soil	Percentage	Non-Soil	NOTES:							
trace	5 - 10	very few	1) Hole backfilled with drill cuttings.							
little	10 - 20	few	2) HQ coring tool used to advance into bedrock							
some	20 - 35	several	3) Safety hammer efficiency calibrated at 52%							
and	35 - 50	numerous								
Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.									Page No. 3 of 6	

		BORING LOG				Boring No.: <u>NVB-B</u>				
		Project: <u>Green Line Extension Project</u>				Boring Location: _____				
Location: <u>Cambridge/ Somerville/ Medford, MA</u>				Checked by: <u>J. Kalafatis</u>		Date Start: <u>September 10, 2013</u>				
Nobis Project No.: _____				Date Finish: <u>September 12, 2013</u>						
Contractor: <u>Maine Test Borings</u>		Rig Type / Model: <u>Track / B-53 Mobile</u>		Ground Surface Elev.: <u>(+/-) 19</u>						
Driller: <u>R. Leonard</u>		Hammer Type: <u>Safety Hammer</u>								
Nobis Rep.: <u>E. Johnson</u>		Hammer Hoist: <u>Wire Winch</u>		Datum: <u>NAVD 88</u>						
				Groundwater Observations						
Type	Casing	Split-Spoon	Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time		
Size ID (in.)	4"	1-3/8	09/11/13	07:35	13.7	45	42	17 hours		
Advancement	Drive and Wash	140-lb Hammer								
Depth (ft.)	SAMPLE INFORMATION				Drilling Rate (min/ft)	Ground Water	LITHOLOGY		SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.			REC % / RQD %	Graphic		
76	C-1	9	75-76.2		64/29	4.5		C-1: Medium Hard to Soft, fresh to very severely weathered, moderately fractured, gray, very fine grained, ARGILLITE, close, moderately dipping closed joints.		
77	C-2	36	76.2-79.7		86/0	3.5		C-2: Medium to Moderately Hard, fresh to very slightly weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, moderately dipping closed joints.		
78						3				
79						4				
80	C-3	35	79.7-83		88/0	5		C-3: Medium Hard to Soft, fresh to very severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, very close, moderately to steeply dipping closed and open joints.		
81						3.75				
82						3.75				
83						3				
84	C-4	52	83-87.8		90/29	3.4		C-4: Moderately Hard to Soft, fresh to moderately weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, moderately to very close, shallow to moderately dipping closed joints.		
85						3				
86						2.75				
87						4				
88	C-5	40	87.8-92.8		67/20	3.5		C-5: Moderately Hard to Very Soft, fresh to very severely weathered, sound to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to steeply dipping closed joints.		
89						2.6				
90						2.5				
91						3				
92						4				
93	C-6	60	92.8-97.8		100/32	3		C-6: Moderately Hard, fresh to slightly weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to moderately dipping closed and open joints.		
94						2.75				
95						2.25				
96						2.5				
97						3.5				
98	C-7	60	97.8-102.8		100/63	2.5		C-7: Moderately to Medium Hard, fresh to very slightly weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close, shallow to moderately dipping closed to open joints.		
99						2.5				
100						2.5				
Soil	Percentage	Non-Soil	NOTES:							
trace	5 - 10	very few	1) Hole backfilled with drill cuttings.							
little	10 - 20	few	2) HQ coring tool used to advance into bedrock							
some	20 - 35	several	3) Safety hammer efficiency calibrated at 52%							
and	35 - 50	numerous								
Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.									Page No. <u>4</u> of <u>6</u>	



BORING LOG

Project: Green Line Extension Project
 Location: Cambridge/ Somerville/ Medford, MA
 Nobis Project No.: _____

Boring No.: NVB-B
 Boring Location: _____
 Checked by: J. Kalafatis
 Date Start: September 10, 2013
 Date Finish: September 12, 2013

Contractor: Maine Test Borings
 Driller: R. Leonard
 Nobis Rep.: E. Johnson

Rig Type / Model: Track / B-53 Mobile
 Hammer Type: Safety Hammer
 Hammer Holst: Wire Winch

Ground Surface Elev.: (+/-) 19
 Datum: NAVD 88

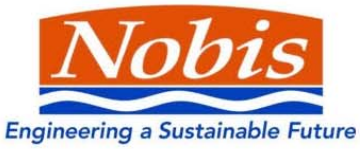
Type	Drilling Method	Sampler	Groundwater Observations					
			Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time
	Casing	Split-Spoon	09/11/13	07:35	13.7	45	42	17 hours
Size ID (in.)	4"	1-3/8						
Advancement	Drive and Wash	140-lb Hammer						

Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY	SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.						
101										
102										
103	C-8	60	102.8-107.8		100/49				C-8: Moderately Hard to Very Soft, fresh to very severely weathered, sound to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to steeply dipping closed joints.	
104										
105										
106										
107										
108	C-9	29	107.8-110.8		81/26				C-9: Soft to Medium Hard, fresh to slightly weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to steeply dipping closed joints.	
109										
110										
111	C-10	38	110.8-113.8		106/17				C-10: Medium Hard, fresh to slightly weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, horizontal to vertically dipping closed joints.	
112										
113								BEDROCK		
114	C-11	62	113.8-119		100/81				C-11: Hard to Moderately Hard, fresh to very slightly weathered, sound to moderately fractured, gray, very fine grained, ARGILLITE, moderately to very close, shallow to moderately dipping closed joints.	
115										
116										
117										
118										
119										
120	C-12	62	119-124.5		94/76				C-12: Moderately to Medium Hard, fresh to slightly weathered, sound to slightly fractured, gray, very fine grained, ARGILLITE, close to moderately close, shallow to steeply dipping open and closed joints.	
121										
122										
123										
124										
125	C-13	35	124.5-127		117/93				C-13: Moderately Hard, fresh to very slightly weathered, sound to slightly fractured,	

Soil	Percentage	Non-Soil
trace	5 - 10	very few
little	10 - 20	few
some	20 - 35	several
and	35 - 50	numerous

NOTES:
 1) Hole backfilled with drill cuttings.
 2) HQ coring tool used to advance into bedrock
 3) Safety hammer efficiency calibrated at 52%

Drilling Method		Sampler		Groundwater Observations				
Type	Casing	Split-Spoon	Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time
			09/11/13	07:35	13.7	45	42	17 hours
Size ID (in.)	4"	1-3/8						
Advancement	Drive and Wash	140-lb Hammer						


		BORING LOG			Boring No.: <u>NVB-B</u>	
Project: <u>Green Line Extension Project</u>		Location: <u>Cambridge/ Somerville/ Medford, MA</u>			Boring Location: _____	
Nobis Project No.: _____		Checked by: <u>J. Kalafatis</u>			Date Start: <u>September 10, 2013</u>	
Date Finish: <u>September 12, 2013</u>		Contractor: <u>Maine Test Borings</u>			Rig Type / Model: <u>Track / B-53 Mobile</u>	
Driller: <u>R. Leonard</u>		Hammer Type: <u>Safety Hammer</u>			Ground Surface Elev.: <u>(+/-) 19</u>	
Nobis Rep.: <u>E. Johnson</u>		Hammer Hoist: <u>Wire Winch</u>			Datum: <u>NAVD 88</u>	

Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY		SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.				Graphic	Stratum Elev. / Depth (ft.)		
126						2				gray, very fine grained, ARGILLITE, close, moderately to steeply dipping open and closed joints.	
127						2					
128	C-14	60	127-132		100/72	2				C-14: Moderately Hard, fresh to very slightly weathered, sound to slightly fractured, gray, very fine grained, ARGILLITE, close to moderately close, shallow to moderately dipping closed joints.	
129						2					
130						2					
131						2.5					
132						3					
133	C-15	60	132-137		100/63	2.25				C-15: Hard to Moderately Hard, fresh to very slightly weathered, sound to moderately fractured, gray, very fine grained, ARGILLITE, very close to moderately close, moderately to steeply dipping open and closed joints.	
134						1.75		BEDROCK			
135						2.25					
136						2.5					
137						2.5					
138	C-16	58	137-142		97/76	2.25				C-16: Hard to Moderately Hard, fresh, sound to moderately fractured, gray, very fine grained, ARGILLITE, moderately to steeply dipping open and closed joints.	
139						2					
140						2.5					
141						3.25					
142						3					
143											Boring terminated at 142 feet.
144											
145											
146											
147											
148											
149											
150											


Soil	Percentage	Non-Soil	NOTES:
trace	5 - 10	very few	1) Hole backfilled with drill cuttings.
little	10 - 20	few	2) HQ coring tool used to advance into bedrock
some	20 - 35	several	3) Safety hammer efficiency calibrated at 52%
and	35 - 50	numerous	

Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.


BOREHOLE LOG - NOBIS GINT DATA TEMPLATE OCT 7 2011 GDT - 12/12/13 09:37 - \\MA-NETAPP\MA_FILE_STORAGE\ACTIVE\196320_00\MBTA GREEN LINE EXTENSION TASK TAGGED\TECH\EXPLORATIONS\BORING_LOGS\NOBIS BORING LOGS.GPJ

		BORING LOG				Boring No.: <u>NVB-C</u>					
		Project: <u>Green Line Extension Project</u>				Boring Location: _____					
Location: <u>Cambridge/ Somerville/ Medford, MA</u>				Checked by: _____		Date Start: <u>July 17, 2013</u>					
Nobis Project No.: _____				Date Finish: <u>July 23, 2013</u>							
Contractor: <u>New Hampshire Boring, Inc.</u>		Rig Type / Model: <u>Falling Strata Star 15</u>		Ground Surface Elev.: <u>(+/-) 25</u>							
Driller: <u>G. Leavitt</u>		Hammer Type: <u>Safety Hammer</u>									
Nobis Rep.: <u>E. Johnson</u>		Hammer Hoist: <u>Wire Winch</u>		Datum: <u>NAVD 88</u>							
Type	Drilling Method		Sampler		Groundwater Observations						
	Casing	Split-Spoon	Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time			
Size ID (in.)	5"	1-3/8	07/19/13	07:05	17.5	45	59	17 hours			
Advancement	Drive and Wash	140lb Hammer	07/22/13	07:05	17.4	45	89	2.5 days			
Depth (ft.)	SAMPLE INFORMATION				REC % / ROD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY		SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.				Stratum Elev. / Depth (ft.)			
51											
52											
53											
54											
55	S-11	5	54-54.4	100/5'				WEATHERED BEDROCK	S-11: Very dense, gray, weathered ARGILLITE fragments and Silty Clay. moist. (WEATHERED BEDROCK).		
56											
57											
58											
59								-34.0 / 59.0			
60	C-1	55	59-64		92/15	10			C-1: Medium Hard, fresh to severely weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, horizontal to vertically dipping closed and open joints.		
61						8					
62						9					
63						10					
64						10					
65	C-2	47	64-69		78/0	9			C-2: Medium Hard, fresh to severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, horizontal to vertically dipping open and closed joints.		
66						8					
67						7					
68						8					
69						8					
70	C-3	39	69-73		81/0	6			C-3: Soft to Medium Hard, very slightly to severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to vertical open and closed joints.		
71						7					
72						8					
73						8					
74	C-4	41	73-77		85/0	6			C-4: Soft to Medium Hard, very slightly to severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, horizontal to vertical open and closed joints.		
75						9					
Soil		Percentage	Non-Soil	NOTES:							
trace	5 - 10	very few	1) HQ Coring								
little	10 - 20	few	2) Borehole backfilled using drill cuttings								
some	20 - 35	several									
and	35 - 50	numerous									
Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.											

BOREHOLE LOG - NOBIS GINT DATA TEMPLATE OCT 7 2011.GDT - 12/12/13 09:37 - \\MA-NETAPP\MA FILE_STORAGE\ACTIVE\96320.00 MBTA GREEN LINE EXTENSION TASK 1\GEO\TECH\EXPLORATIONS\BORING LOGS\NOBIS BORING LOGS.GPJ

		BORING LOG				Boring No.: <u>NVB-C</u>					
		Project: <u>Green Line Extension Project</u>				Boring Location: _____					
Location: <u>Cambridge/ Somerville/ Medford, MA</u>				Checked by: _____		Date Start: <u>July 17, 2013</u>					
Nobis Project No.: _____				Date Finish: <u>July 23, 2013</u>							
Contractor: <u>New Hampshire Boring, Inc.</u>		Rig Type / Model: <u>Falling Strata Star 15</u>		Ground Surface Elev.: <u>(+/-) 25</u>							
Driller: <u>G. Leavitt</u>		Hammer Type: <u>Safety Hammer</u>									
Nobis Rep.: <u>E. Johnson</u>		Hammer Hoist: <u>Wire Winch</u>		Datum: <u>NAVD 88</u>							
Type	Drilling Method		Sampler		Groundwater Observations						
	Casing	Split-Spoon	Date	Time	Depth Below Ground (ft.)	Depth of Casing (ft.)	Depth to Bottom of Hole (ft.)	Stabilization Time			
Size ID (in.)	5"		1-3/8		▼ 07/19/13	07:05	17.5	45	59	17 hours	
Advancement	Drive and Wash		140-lb Hammer		▼ 07/22/13	07:05	17.4	45	89	2.5 days	
Depth (ft.)	SAMPLE INFORMATION				REC % / ROD %	Drilling Rate (min/ft)	Blows / 6 in.	LITHOLOGY		SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES
	Type & No.	Rec (in.)	Depth (ft.)	Blows / 6 in.				Stratum Elev. / Depth (ft.)	Graphic		
76							9				
77							9				
78	C-5	33	77-81			69/0	7			C-5: Soft to Medium Hard, very slightly to severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to vertically dipping open and closed joints.	
79							6				
80							8				
81							8				
82	C-6	33	81-84			92/17	9			C-6: Soft to Medium Hard, fresh to severely weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to steeply dipping open and closed joints.	
83							9				
84							8				
85	C-7	50	84-89			83/0	8			C-7: Medium Hard, fresh to severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to vertically dipping open and closed joints.	
86							6				
87							6				
88							6			BEDROCK	
89							8				
90	C-8	55	89-94			92/24	8			C-8: Soft to Medium Hard, fresh to moderately weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to moderately dipping open and closed joints.	
91							8				
92							8				
93							8				
94							7				
95	C-9	31	94-97			86/11	9			C-9: Soft to Medium Hard, very slightly to severely weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to steeply dipping open and closed joints.	
96							7				
97							8				
98	C-10	41	97-101			85/9	8			C-10: Soft to Medium Hard, fresh to severely weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, shallow to vertically dipping open and closed joints.	
99							8				
100							9				
Soil	Percentage	Non-Soil	NOTES:								
trace little some and	5 - 10 10 - 20 20 - 35 35 - 50	very few few several numerous	1) HQ Coring 2) Borehole backfilled using drill cuttings								
Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual.										Page No. <u>4</u> of <u>6</u>	

BOREHOLE LOG - NOBIS GINT DATA TEMPLATE OCT 7 2011.GDT - 12/12/13 09:37 - \\MA-NETAPP\MA_FILE_STORAGE\ACTIVE\96320_00\MBTA_GREEN_LINE_EXTENSION_TASK_TAGGED\TECH\EXPLORATIONS\BORING_LOGS\NOBIS_BORING_LOGS.GPJ

		BORING LOG				Boring No.: <u>NVB-C</u>																									
		Project: <u>Green Line Extension Project</u>				Boring Location: _____																									
Location: <u>Cambridge/ Somerville/ Medford, MA</u>				Checked by: _____		Date Start: <u>July 17, 2013</u>																									
Nobis Project No.: _____				Date Finish: <u>July 23, 2013</u>																											
Contractor: <u>New Hampshire Boring, Inc.</u>			Rig Type / Model: <u>Falling Strata Star 15</u>			Ground Surface Elev.: <u>(+/-) 25</u>																									
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Depth (ft.)	SAMPLE INFORMATION				REC % / RQD %	Drilling Rate (min/ft)	Ground Water	LITHOLOGY		SAMPLE DESCRIPTION AND REMARKS (Classification System: Modified Burmister)	NOTES																				
	Type & No.	Rec (in.)	Depth (ft.)	Blows/ 6 in.				Stratum Elev. / Depth (ft.)																							
101																															
102	C-11	57	101-106		95/48					C-11: Soft to Medium Hard, fresh to severely weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, horizontal to steeply dipping open and closed joints.																					
103																															
104																															
105																															
106																															
107	C-12	31	106-111		52/7					C-12: Soft to Medium Hard, fresh to severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, moderately to steeply dipping open and closed joints.																					
108																															
109																															
110																															
111																															
112	C-13	13	111-114		36/0					C-13: Soft to Very Soft, moderately to very severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, very close, horizontal to vertical open joints.																					
113																															
114																															
115	C-14	40	114-118		83/15					C-14: Soft to Medium Hard, slightly to severely weathered, slightly to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, horizontal to vertically dipping open and closed joints.																					
116																															
117																															
118																															
119	C-15	12	118-119		100/0					C-15: Soft, slightly to extremely weathered, extremely fractured, gray, very fine grained, ARGILLITE, very close, horizontal to vertical open and closed joints.																					
120	C-16	54	119-124		90/0					C-16: Soft to Medium Hard, fresh to moderately weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close shallow to steeply dipping open and closed joints.																					
121																															
122																															
123																															
124																															
125	C-17	30	124-126.5		100/13					C-17: Soft to Medium Hard, fresh to severely weathered, moderately to extremely fractured, gray, very fine grained, ARGILLITE, close to very close, moderately to steeply																					
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>Soil</th> <th>Percentage</th> <th>Non-Soil</th> <th>NOTES:</th> </tr> <tr> <td>trace</td> <td>5 - 10</td> <td>very few</td> <td>1) HQ Coring</td> </tr> <tr> <td>little</td> <td>10 - 20</td> <td>few</td> <td>2) Borehole backfilled using drill cuttings</td> </tr> <tr> <td>some</td> <td>20 - 35</td> <td>several</td> <td></td> </tr> <tr> <td>and</td> <td>35 - 50</td> <td>numerous</td> <td></td> </tr> </table>												Soil	Percentage	Non-Soil	NOTES:	trace	5 - 10	very few	1) HQ Coring	little	10 - 20	few	2) Borehole backfilled using drill cuttings	some	20 - 35	several		and	35 - 50	numerous	
Soil	Percentage	Non-Soil	NOTES:																												
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Soil descriptions are based on visual classifications and should be considered approximate. Stratification lines are approximate boundaries between strata; transitions may be gradual. Page No. 5 of 6

