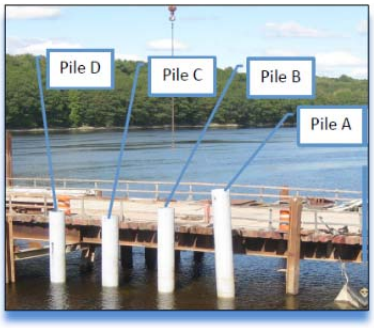
16 State House Station
Augusta, Maine 04333

MaineDOT

Transportation Research Division



Technical Report 15-07

Experimental Evaluation and Design of Unfilled and Concrete-Filled FRP Composite Piles

Task 2 - FRP Composite Pile Driving at the Richmond-Dresden Bridge over the Kennebec River

Final Report – Task 2, January 2014

Technical Report Documentation Page

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16. Abstract (Limit 200 words)

The overall goal of this project is the experimental evaluation and design of unfilled and concrete-filled FRP composite piles for load-bearing in bridges. This report covers Task 2, FRP Composite Pile Driving at the Richmond-Dresden Bridge over the Kennebec River.

Fiber reinforced polymer (FRP) piles manufactured by Harbor Technologies LLC were driven at the Richmond-Dresden bridge over the Kennebec River (PIN 12674) on August 28, 2013. All piles were 40 feet long with an additional 5 inch steel driving shoe and have an outside diameter of 23.5 inches. Driving was conducted using a Delmag D36---26 diesel hammer. This hammer has a rated energy of 90,560 foot-lbs., a 7930 lb. ram, and a variable fuel setting. The target ultimate load for the piles was 600 kips.

This report documents the pile driving activities including pile analysis and observations. The piles were later pulled and shipped to the University of Maine for further laboratory testing and analysis.

17. Document Analysis/Descriptors Bridge piles, fiber reinforced polymer composites, pile driving		18. Availability Statement	
19. Security Class (this report)	20. Security Class (this page)	21. No. of Pages 47	22. Price

Technical Report

FRP Composite Pile Driving at the Richmond-Dresden Bridge over the Kennebec River

by

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Keenan Goslin and Xenia Rofes

Prepared for: Maine Department of Transportation

Project: Experimental Evaluation and Design of Unfilled and Concrete-Filled FRP Composite Piles

January 30th, 2014

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Table of Contents

1. General Driving Information

Fiber reinforced polymer (FRP) piles manufactured by Harbor Technologies LLC were driven at the Richmond-Dresden bridge over the Kennebec River (PIN 12674) on August 28, 2013. All piles were 40 feet long with an additional 5 inch steel driving shoe and have an outside diameter of 23.5 inches. The driving site was located between Pier 5 and Pier 6 of the proposed bridge at approximate station 121+65. A restrike of Piles C and D was conducted on October 11, 2013. The configuration of the piles can be seen in Figure 1.

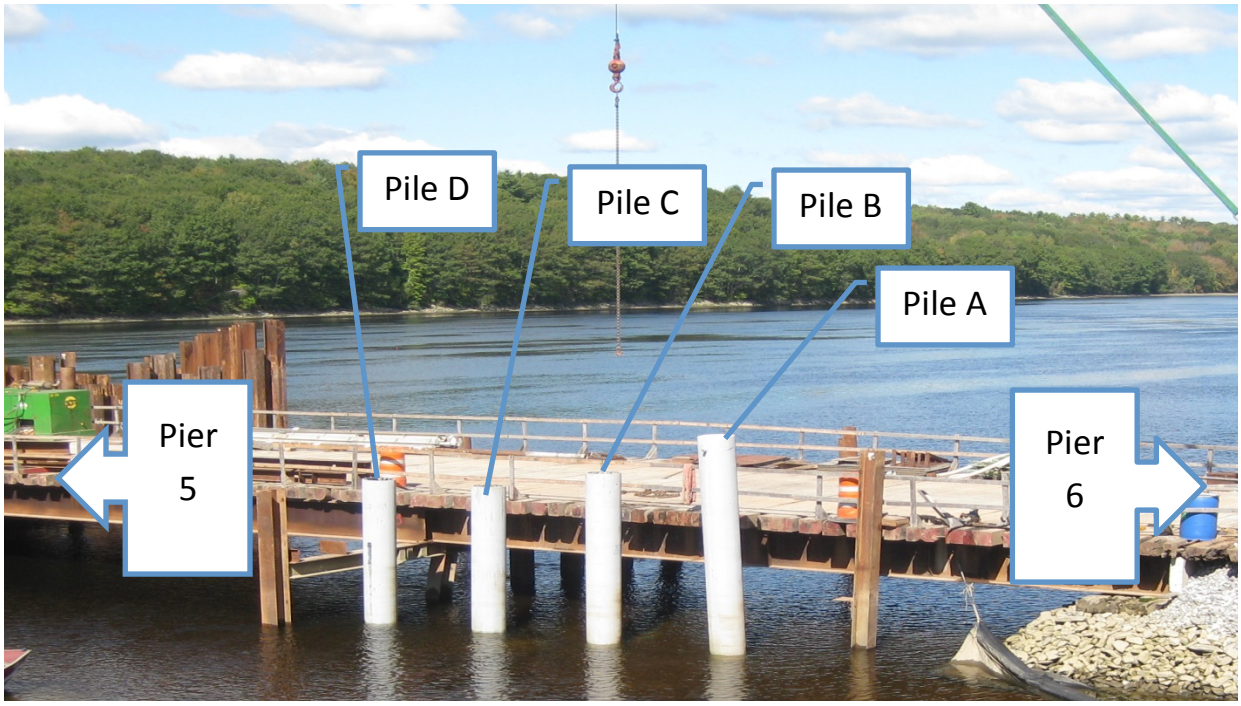


Figure 1: Overall Pile Configuration (Looking Upstream)

Pier 5's soil conditions are characterized by glaciomarine silty clay overlain by alluvium and a depth to bedrock of approximately 15 feet. Pier 6's soil conditions are characterized by glacial till overlain by marine nearshore deposits and a depth to bedrock of approximately 20 feet. See Appendix A for the initial subsurface investigation information. Two supplementary borings were taken at the driving site on November 20, 2013. The driller's logs for these supplementary borings are attached in Appendix B. The two logs show refusal at approximately 25 feet with possible medium dense to very dense glacial till (about 5 feet thick) above refusal. This is overlain by soft clay and loose to medium fine sand deposits.

Driving was conducted using a Delmag D36-26 diesel hammer. This hammer has a rated energy of 90,560 foot*lbs, a 7,930 lb ram, and a variable fuel setting. The target ultimate

load for the piles was 600 kips. Driving criteria, based on the use of fuel setting 2 by GZA (8/13/2013), indicated that pile compressive stresses would be less than the specified maximum allowable stress of 12 ksi set by Harbor Technologies.

All Piles were driven using a steel driving shoe designed by Harbor Technologies. Hollow piles were driven with an open shoe as seen in Figure 2. Filled piles were driven with a closed shoe as seen in Figure 3.

Figure 2: Driving Shoe for Hollow Piles

Figure 3: Driving Shoe for Filled Piles

All piles were driven using a steel driving cap designed and fabricated by Reed and Reed, Inc. as seen in Figure 4.

Figure 4: Steel Driving Cap

Pile A was driven with a 6 inch cushion of plywood between the steel cap and pile as seen in Figure 5. All other piles were driven with the steel cap directly touching the top of the pile as seen in Figure 6.

Figure 5: Driving Configuration for Pile A

Figure 6: Driving Configuration for Piles B-D

A new driving cap was designed for the restrike to prevent failure at the top of the pile. It can be seen in Figure 7. The restrike was conducted using the same driving hammer.

Figure 7: Redesigned Driving Cap for Restrike

The layout of the piles after the restrike is shown in Figure 8. The piles achieved maximum penetrations of 21.5 to 23.1 feet below the mud line. The piles were removed following the

restrike and shipped to the University of Maine for testing. Piles B and D arrived on October 15, 2013 which was 4 days after the restrike. However, Piles A and D stayed in the ground approximately 3 weeks longer and were removed on November 6, 2013.

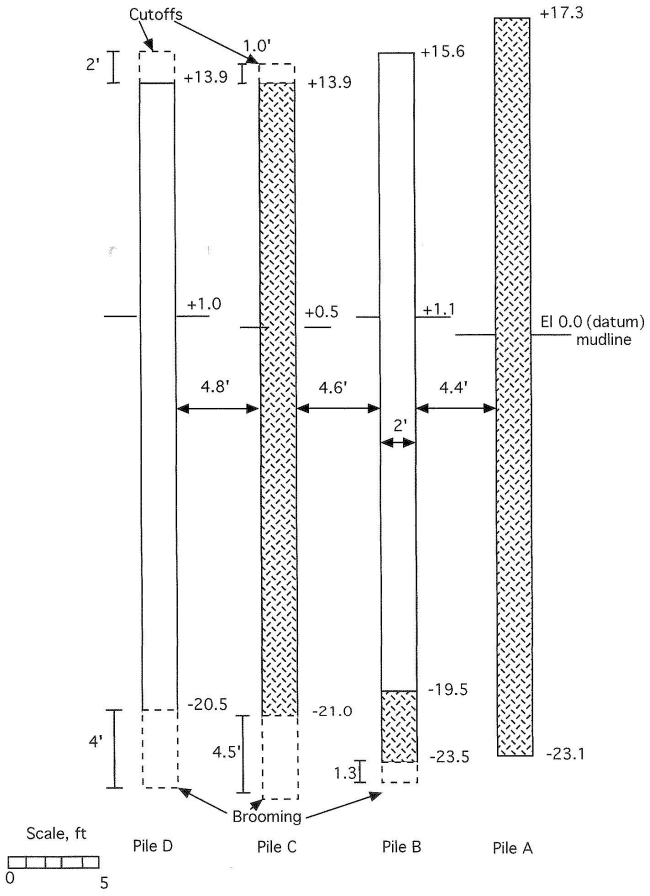


Figure 8: Pile Layout After Restrike

2. Pile A

2.1. Pile Description

Pile A has a 4 ply shell nominally 1/2 inch thick. This pile was completely filled with concrete on August 14, 2013. Class A concrete from MeDOT standard specifications was used.

2.2. Initial Driving

Pile A was driven on fuel setting 3 and stroke of 5 feet for 17 feet (including approximately 8 feet above the mud line). The pile was driven out of vertical alignment and driving was stopped to realign the pile. Pile A was then driven on fuel setting 2 to a penetration depth of 23 feet. Stopping criteria for this pile was 8 blows per inch on fuel

setting 2 with stroke of 6.2 feet. Driving was stopped at a final blow count of 4.5 blows per inch. The reported capacity of Pile A in the field based on the “Case Method” was 850 kips (see Appendix C, page C2). The PDA showed possible damage/separation near end of pile. After analysis of the data, GZA (9/25/2013) found that the dynamic pile testing data was not within reportable limits.

2.3. Restrike

There was no restrike for Pile A.

2.4. Damage

After being extracted, Pile A has a length of 40 feet with an additional 5 inches for the driving shoe. The driving shoe of this pile remained attached.

The bottom end of this pile showed no apparent damage. The bottom of Pile A can be seen in Figure 9.

Figure 9: Bottom of Pile A

The top of Pile A was damaged during removal. The top 9 inches of concrete cracked and was removed. The damage can be seen in Figure 10

Figure 10: Damage to Top of Pile A

Approximately 7 feet from the top of Pile A there are two gouges that measure 6 inches by 2 inches. These barely cut into the top layer of E-glass fabric reinforcement. The gouges can be seen in Figure 11.

Figure 11: Gouges Near Top of Pile A

There is a group of scrapes located 12 feet from the top of Pile A. This group measures 24 inches by 6 inches. The deepest portions of the group cut 3/4 of the way into the top layer of reinforcement. The scrapes can be seen in Figure 12.

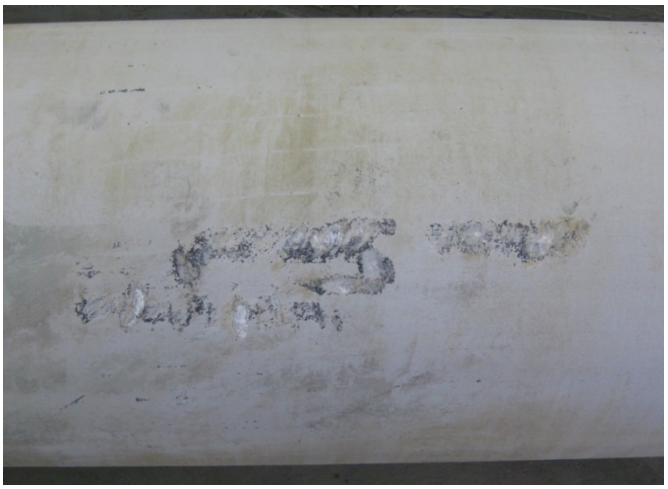


Figure 12: Group of Scrapes on Pile A

There is also a series of five gouges that measure 7 inches by 2 inches each. These gouges run in the tangential direction of the pile and cut 1/4 of the way into the top layer of reinforcement. These can be seen in Figure 13.

Figure 13: Series of Gouges on Pile A

Pile A has a longitudinal scratch that runs the entire length of the pile. The scratch appears to only be cosmetic damage over most of the pile, but the scratch cuts into the reinforcement from 7 to 10 and 21 to 28 feet from the top of the pile. The scratch from 7 feet to 10 feet cuts through 1 ½ layers of reinforcement and the scratch from 21 to 28 feet cuts 3/4 of the way into the top layer of reinforcement. At its largest point, the scratch is about 1/4 inch wide. The scratch can be seen in Figure 14 and Figure 15.

Figure 14: Scratch from 7 to 10 feet

Figure 15: Scratch from 21 to 28 Feet

2.5. Testing Plan

Pile A will be tested in four point bending to failure or to the capacity of the test equipment.

3. Pile B

3.1. Pile Description

Pile B has an 8 ply shell and is nominally 1 inch thick. This pile has a 4 foot concrete plug at the bottom of the pile. The plug was cast on August 14, 2013 with the same batch of concrete used to fill Pile A.

3.2. Initial Driving

Pile B was driven for 25 feet (including approximately 8 feet above the mud line) on fuel setting 2 and stroke of 4.6 feet. Stopping criteria for this pile was 8 blows per inch at fuel setting 2 and stroke of 8.7 feet. Driving was stopped at 6.8 blows per inch. It was found that this corresponded to a penetration depth of 25.9 feet with 1.3 feet of brooming. The reported capacity of Pile A in the field based on the "Case Method" was 600 kips (see Appendix C, page C3). However, after further analysis GZA (9/25/2013) revised the "Case Method" capacity to 530 kips and calculated a Case Pile Wave Analysis Program (CAPWAP) capacity of 510 kips (30 kips side friction, 480 kips end bearing).

3.3. Restrike

There was no restrike for Pile B.

3.4. Damage

After being extracted, Pile B has a length of 39 feet and 1 inch. The driving shoe of this pile remained attached. The steel shoe is no longer square to the pile and appears to have bent into a concave shape.

The most significant damage to Pile B occurred at the bottom end of the pile. During driving, the plug and driving shoe were forced upwards approximately 1.3 feet. This caused the end of the pile to broom. This can be seen in Figure 16.

Figure 16: Damage at Tip of Pile B

The driving end of the pile sustained a 13 inch longitudinal crack at approximately 38 feet from the top of the pile. This can be seen in Figure 17.

Figure 17: Crack near Tip of Pile B

There is also some damage at the top of the pile. Several circular gouges are located 3-4 feet from the top of the pile. These gouges cut through the top 2 layers of reinforcing. This can be seen in Figure 18. Note that there is a circular hole of the pile purposely made to facilitate extraction

Figure 18: Circular Gouges at Top of Pile B

Pile B has noticeable scrapes to the blue gel coat along the length of the pile. These scrapes become more concentrated at the bottom of the pile. It is estimated that these scrapes cover 2-3% of the pile's surface area. These appear to only be cosmetic damage and should not affect the structural capacity of the pile.

When Pile B was being prepared for flexural testing the concrete plug was cut off. The bottom portion of the plug is mainly sand and coarse aggregate, even though the same concrete used for this plug was used to fill Pile A. The upper 6 inches of the plug resembles chalk and is lightweight. The upper portion of the plug can be broken by hand. The removed concrete can be seen in Figure 19. It is believed that water infiltrated the piles, potentially through the driving shoe, during concrete placement and saturated the concrete preventing it from properly curing. By Inspection, the concrete in the plug did not meet the specified strength. The concrete was also tested with a Schmidt Concrete Test Hammer. This equipment was not calibrated but was verified against concrete with known design strengths at the Advanced Structures and Composites Center. The concrete did not register on the test hammer's scale, which has a minimum value of 1,450 psi. The removed plug can be seen in Figure 20.

from

Figure 20: Concrete Plug from Pile B

3.5. Testing Plan

Pile B will be cut to a length of 35 feet and tested in four point bending to failure. The end with the concrete plug will be removed before the flexural test.

4. Pile C

4.1. Pile Description

Pile C has an 8 ply shell nominally 1 inch thick. This pile was driven hollow, cleaned out and filled with concrete on October 2, 2013. A restrike was conducted on October 11, 2013.

4.2. Initial Driving

Pile C was driven for 33 feet (including approximately 10 feet above the mud line). At this depth, the PDA showed damage approximately 5 feet from the end of the pile. Driving continued to a penetration depth of 26 feet when the top of the pile failed. The failure can be seen in Figure 21. Stopping criteria for this pile was 11 blows per inch at fuel setting 2 and stroke of 8.5 feet. At failure, the blow count was 2 blows per 1/2 inch. The reported capacity of Pile C in the field based on the “Case Method” was 470 kips (see Appendix C, page C4). After further analysis, GZA (9/25/2013) revised the “Case Method” capacity to 520 kips and calculated a CAPWAP capacity of 470 kips (60 kips side friction, 410 kips end bearing).

Figure 21: Driving Damage to Pile C

4.3. Restrike

The damaged end of this pile was removed to the bottom of the lifting hole seen in Figure 21 (approximately 1 foot). Pile C was cleaned out and filled with MeDOT Class A concrete prior to the restrike. During the cleanout process, the contractor encountered an object approximately 5 feet from the end of the pile that could not be broken or removed. The object was believed to be a boulder, but potentially may have been the detached steel driving shoe. It was initially driven at fuel setting 2 for 4 blows. Then the fuel setting was increased to 3 and the pile was driven 8 more inches. The reported capacity of Pile C in the field based on the "Case Method" was 750 kips (see Appendix D, page D2). After further analysis, GZA (11/13/2013) determined the average "Case Method" capacity to be 731 kips.

4.4. Damage

After being extracted, Pile C has a length of 34 feet and 11 inches. Based on reference marks for monitoring pile driving depths, the bottom 4 feet 6 inches of the pile broke during driving and was not recovered. The rest of this change in length can be attributed to cutting off the damaged portion at the top of the pile after driving. The driving shoe detached during driving, but was recovered.

The bottom of Pile C suffered significant damage from driving. Approximately 4 feet 6 inches of the bottom of the pile broke off during driving. This can be seen in Figure 22.

Figure 22: Damage to Bottom of Pile C

There are several scrapes about 5 feet from the top of Pile C. The largest is 16 inches by 5 inches. These scrapes cut 3/4 of the way into the top layer of reinforcement. These can be seen in Figure 23.

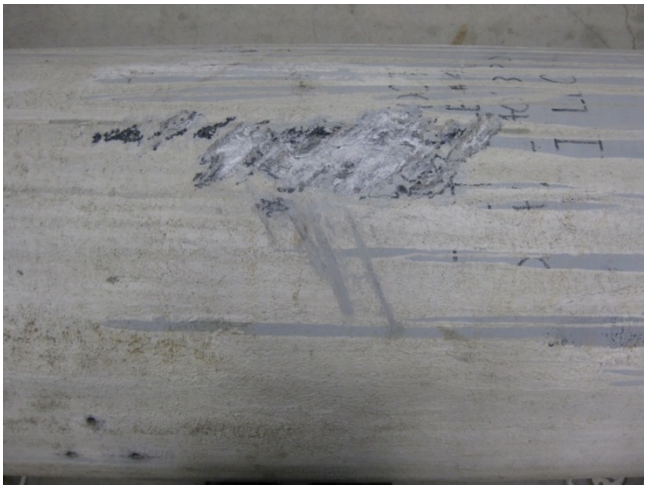


Figure 23: Scrapes at Top of Pile C

There is a series of long scratches that run from 15 feet to 30 feet from the top of Pile C. These scratches barely cut into the top layer of reinforcement. They can be seen in Figure 24.

Figure 24: Long Scratches on Pile C

Pile C has an 8 inch gouge approximately 15 feet from the top. This gouge cuts 3/4 of the way into the top layer of reinforcement. It can be seen in Figure 25.

Figure 25: Gouge on Pile C

Pile C has a series of 9 gouges that measure approximately 8 to 10 inches long by 1 inch wide. These gouges are located between 15 and 22 feet from the top of the pile. At the deepest point, these gouges cut 3/4 of the way into the top layer of reinforcement. They can be seen in Figure 26 and Figure 27. The similar gouge pictured in Figure 25 is at the same distance from the top of the pile, but on the opposite side.

Figure 26: Series of Gouges on Pile C

Figure 27: Series of Gouges on Pile C

4.5. Testing Plan

Pile C will be tested in four point bending to failure or to the capacity of the test equipment.

5. Pile D

5.1. Pile Description

Pile D has an 8 ply shell nominally 1 inch thick. This pile was driven hollow. A restrike was conducted on October 11, 2013.

5.2. Initial Driving

Pile D was driven for 35 feet (including approximately 10 feet above the mud line). At this depth, the PDA showed damage 20 feet from the top of the pile. Driving continued to a penetration depth 25.5 feet when the top of the pile failed. The failure can be seen in Figure 28. Stopping criteria for this pile was 11 blows per inch at fuel setting 2 and stroke of 8.5 feet. At failure, the blow count was 2 blows per inch. The reported capacity of Pile D in the field based on the “Case Method” was 600 kips (see Appendix C, page C5). After further analysis, GZA (9/25/2013) revised the “Case Method” capacity to 510 kips and calculated a CAPWAP capacity of 440 kips (60 kips side friction, 380 kips end bearing).

Figure 28: Driving Damage to Pile D

5.3. Restrike

Pile D was driven on fuel setting 2 for 7 inches and showed plugging at a depth of 30 feet. The fuel setting was then increased to 3 and driven for an additional 7 inches. During driving the pile was visibly flexing. The reported capacity of Pile D in the field based on the "Case Method" was 650 kips (see Appendix D, page D3). After further analysis, GZA (11/13/2013) revised the "Case Method" capacity to 460 kips and calculated a CAPWAP capacity of 440 kips (60 kips side friction, 380 kips end bearing).

5.4. Damage

After being extracted, Pile D has a length of 34 feet and 5 inches. Approximately 2 feet of this change in length can be attributed to cutting off the damaged portion at the top of the pile after driving. The driving shoe of this pile detached and was not recovered.

The bottom of Pile D suffered significant damage from driving. Approximately 4 feet of the pile broke off during driving. This can be seen in Figure 29.

Figure 29: Damage to Bottom of Pile D

A longitudinal crack extends from the damaged end of the pile approximately 43 inches from the bottom of the pile. This can be seen in Figure 30.

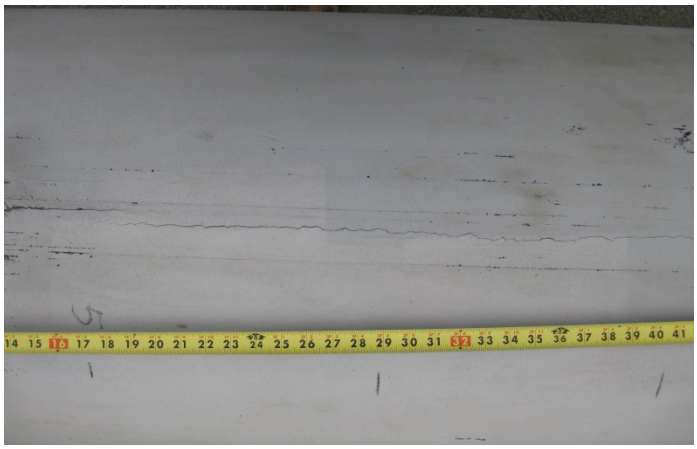


Figure 30: Longitudinal Cracking at Bottom of Pile D

There is a large gouge in the side of this pile about 15 feet from the top of the pile. This occurred during the extraction process, when the contractor drove a wedge next to the pile to free it from the surrounding soil. This damage went through the wall, as seen in Figure 31.

Figure 31: Hole in Pile D Due to Extraction

Pile D has noticeable scrapes to the blue gel coat along the length of the pile. These scrapes become more concentrated at the bottom of the pile. It is estimated that these scrapes cover 4-5% of the piles surface. These appear to only be cosmetic damage and will not affect the bending capacity of the pile.

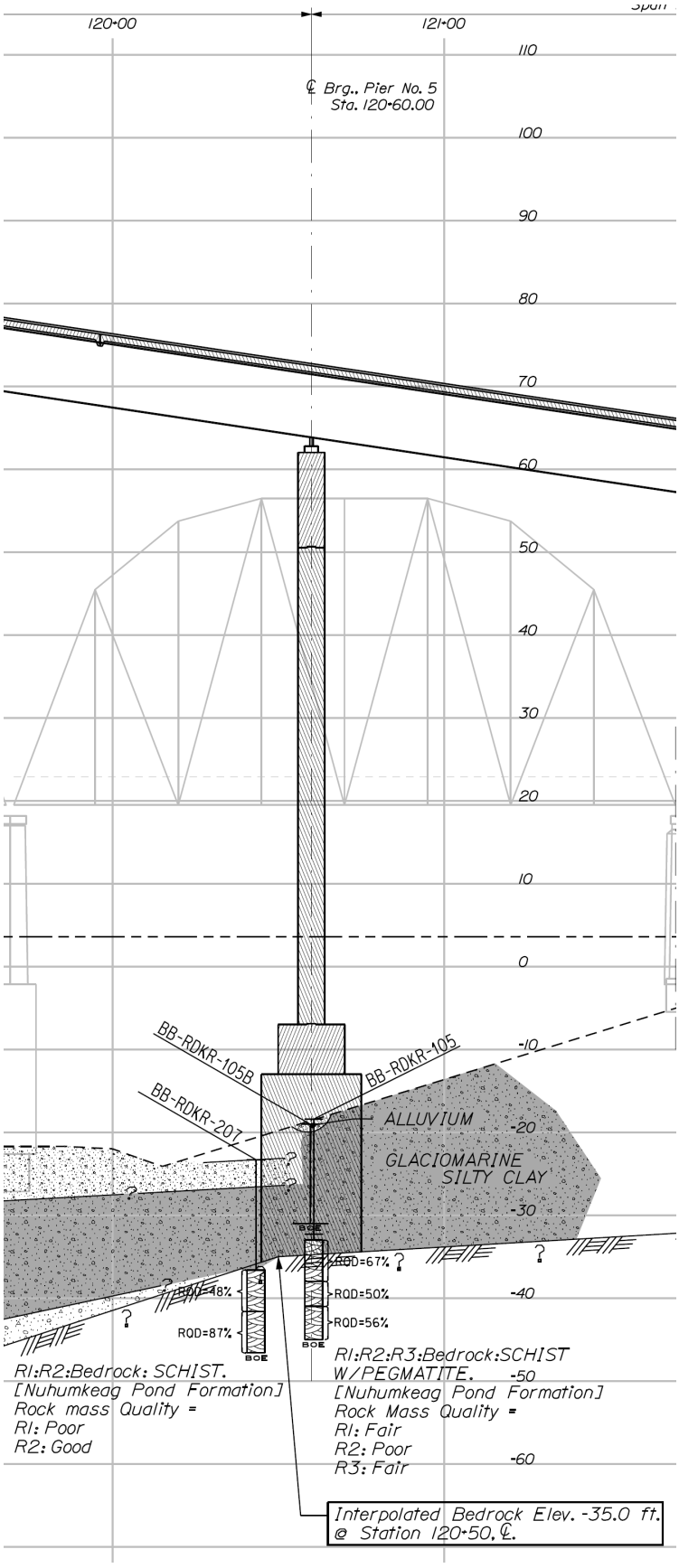
5.5. Testing Plan

Pile D will not be tested in four point bending. It will be cut into 3 sections to be tested in axial compression.

References

GZA. (2013 August 13). Wave Equation Analysis Submittal – HarborPile Test Program.
GZA. (2013 September 25). Dynamic Pile Testing Results – HarborPile Test Program.
GZA. (2013 November 13). Dynamic Pile Restrike Testing Results – HarborPile Test Program.

Appendix A: Original Richmond-Dresden Subsurface Information


120+00
121+00
℄ Brg., Pier No. 5
Sta. 120+60.00
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
BB-RDKR-105B
BB-RDKR-105
BB-RDKR-207
ALLUVIUM
GLACIOMARINE
SILTY CLAY
RQD=67%
RQD=18%
RQD=50%
RQD=56%
RQD=87%
BOE
R1:R2:Bedrock: SCHIST.
[Nuhumkeag Pond Formation]
Rock mass Quality =
R1: Poor
R2: Good
R1:R2:R3:Bedrock:SCHIST
W/PEGMATITE.
[Nuhumkeag Pond Formation]
Rock Mass Quality =
R1: Fair
R2: Poor
R3: Fair
Interpolated Bedrock Elev. -35.0 ft.
@ Station 120+50, ℄.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-105
WIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-18.4	**Auger ID/OD:**	-
Operator:	B.Enos	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon / 3" Tube
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 cas'g
Date Start/Finish:	12/6-12/7/11	**Drilling Method:**	Cased Wash Boring with Mud	**Core Barrel:**	NQ-2
Boring Location:	120+60.7, 12.6 ft Rt.	**Casing ID/OD:**	HW/NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/17	0.00 - 2.00	1/2/2/WOH	4	4	12	-18.80		Top 5" Brown-gray, wet, loose, Silty fine to medium SAND (Alluvium).	G#267545 A-6/CL LL=34, PL=19, PI=15 WC=6.9%
							15			0.40 Bottom 12": Gray, wet, Silty CLAY, trace fine sand (Presumpscot Formation).	
	2D	24/24	2.00 - 4.00	2/WOH/WOH/WOH	---		HP[a]			Gray, wet, very soft, Silty CLAY, trace fine sand (Presumpscot Formation).	G#267546 A-6/CL LL=34, PL=21, PI=13 WC=3.5%
	MV1		4.00 - 4.36	Would not push						MV1: Would not push.	
5	3D MU1	24/24	5.00 - 7.00	3/WOH/WOH/WOH	Note 2					Gray with trace black staining, wet, very soft, Silty CLAY with trace fine gravel (Presumpscot Formation). MU1: Tube unable to deploy.	
	MV2 4D MU2	24/12	8.00 - 8.36 8.00 - 10.00	Would not push 2/WOH/WOH/WOH	Note 2		OPEN			MV2: Would not push. Gray, wet, very soft, SILT, some clay, little fine sand (Presumpscot Formation). Sand in lense 1/16" thick at 10.2'. MU2: Tube unable to deploy.	G#267547 A-6/CL LL=33, PL=22, PI=11 WC=7.8%
10	3U	24/24	10.00 - 12.00	Hydraulic Push						Gray, wet, Silty CLAY (Presumpscot Formation).	#225863 C#IP-1A A-6/CL LL=32, PL=17, PI=15 WC=40%
	5D MV3	23/12	12.00 - 13.92 12.60 - 12.96	WOR/23" Would not turn	---					Gray, wet, very soft, Silty CLAY (Presumpscot Formation). Driller did not advance full 24". MV3: Failed vane attempt. Pushed through gravel to 13' - would not turn.	
								-32.30		13.90 Top of Bedrock at Elev. -32.3 ft.	
	R1	60/60	14.60 - 19.60	RQD = 67%			NQ-2			Roller cone ahead to 14.6 ft (Elev. -33.0 ft). R1: (14.5-15.2 ft) Light gray to white, coarse to very coarse grained (up to 1 inch diameter), very strong (R5) fresh to slightly weathered, massive to slightly foliated, plagioclase-quartz PEGMATITE [Nehumkeag Pond Formation]. No discontinuities. (15.2-19.6 ft.) Medium to dark gray, fine to medium grained, very strong to extremely strong (R5-R6), fresh to slightly weathered, strongly foliated, muscovite-plagioclase-quartz-biotite SCHIST [Nehumkeag Pond Formation]. Discontinuities are very close to moderately close, mostly parallel to foliation, subhorizontal to moderately dipping, planar, undulating, rough to very rough, with some quartz veins parallel to foliation, up to 1 inch thick. Rock Mass Quality = Fair R1: Core Times (min:sec) 14.6-15.6': (6:10) 15.6-16.6': (4:15) 16.6-17.6': (3:05) 17.6-18.6': (3:15) 18.6-19.6': (3:15) 100% Recovery	
15											
	R2	36/33	19.60 - 22.60	RQD = 50%							$PLTp_q$=11,500 psi
20											$UCTp_q$=5,882 psi
	R3	48/48	22.60 - 26.60	RQD = 56%							
25										R2: Medium to dark gray, fine to medium grained, very strong to extremely strong (R5-R6), fresh to slightly weathered, strongly foliated, muscovite-plagioclase-quartz-biotite SCHIST [Nehumkeag Pond	

Remarks:

1. MaineDOT provided coordinates of test boring locations in NAD83 (96) ME 2000 West Zone Coordinate System and ground surface elevations in NAVD88. 2. Blow counts for spoons driven through a disturbed field vane test location cannot be used to determine N-value. 3. Shelby tubes collected using a GUS sampler. 4. Drilling mud consisting of bentonite and barite weight material was used. 5. $PLTq_p$ = Peak compressive strength estimated from Point Load Index Test. 6. $UCTq_p$ = Peak compressive strength from Uniaxial Compressive Strength Test.

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-105
WIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-18.4	**Auger ID/OD:**	-
Operator:	B.Enos	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon / 3" Tube
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 cas'g
Date Start/Finish:	12/6-12/7/11	**Drilling Method:**	Cased Wash Boring with Mud	**Core Barrel:**	NQ-2
Boring Location:	120+60.7, 12.6 ft Rt.	**Casing ID/OD:**	HW/NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt

R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person

S_u = Insitu Field Vane Shear Strength (psf)
T_V = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected

$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25								-45.00		Formation]. Discontinuities are very close to moderately close, mostly parallel to foliation, subhorizontal to moderately dipping, planar, undulating, rough to very rough, with some quartz veins parallel to foliation, up to 1 inch thick. Rock Mass Quality = Poor R2: Core Times (min:sec) 19.6-20.6': (3:05) 20.6-21.6': (2:30) 21.6-22.6': (2:15) 92% Recovery Picked up 1.4' of R1 R3: Medium to dark gray, fine to medium grained, very strong to extremely strong (R5-R6), fresh to slightly weathered, strongly foliated, muscovite-plagioclase-quartz-biotite SCHIST [Nehumkeag Pond Formation]. Discontinuities are close to moderately close, mostly parallel to foliation, subhorizontal to moderately dipping, planar, undulating, rough to very rough, with some quartz veins parallel to foliation, up to 1 inch thick. Rock Mass Quality = Fair. R3: Core Times (min:sec) 22.6-23.6': (2:15) 23.6-24.6': (2:30) 24.6-25.6': (2:40) 25.6-26.6': (2:25) 100% Recovery	
30											
35											
40											
45											
50											

-26.60

Bottom of Exploration at 26.60 feet below ground surface.

Remarks:

1. MaineDOT provided coordinates of test boring locations in NAD83 (96) ME 2000 West Zone Coordinate System and ground surface elevations in NAVD88. 2. Blow counts for spoons driven through a disturbed field vane test location cannot be used to determine N-value. 3. Shelby tubes collected using a GUS sampler. 4. Drilling mud consisting of bentonite and barite weight material was used. 5. $PLTq_p$ = Peak compressive strength estimated from Point Load Index Test. 6. $UCTq_p$ = Peak compressive strength from Uniaxial Compressive Strength Test.

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-105B
WIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-19.1	**Auger ID/OD:**	-
Operator:	B.Enos	**Datum:**	NAVD88	**Sampler:**	3" Tube
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	-
Date Start/Finish:	12/7/11	**Drilling Method:**	Cased Wash Boring with Mud	**Core Barrel:**	NQ-2
Boring Location:	120+59.8, 14.3 ft Rt.	**Casing ID/OD:**	HW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							HP[a]	-19.60		Note 2. [a] HP = Hydraulic Push Gravel based on drill behavior. 0.50 Gray, wet, Silty CLAY. Wash to 3' to seat casing in clay.	
	V1		3.64 - 4.00	Su=604/69 psf						65x130 mm vane raw torque readings: V1: 22.0/2.5 ft-lbs V2: 24.0/2.5 ft-lbs	
	V2		4.64 - 5.00	Su=659/69 psf							
5	U1	24/23	5.00 - 7.00	Hydraulic Push						Gray, wet, medium stiff, Silty CLAY (Presumpscot Formation).	#225862 A-6/CL LL=39, PL=19, PI=20 WC=35%
	V3		7.64 - 8.00	Su=687/82 psf			OPEN			65x130 mm vane raw torque readings: V3: 25.0/3.0 ft-lbs V4: 24.5/3.0 ft-lbs	
	V4		8.64 - 9.00	Su=673/82 psf							
10	V5		10.64 - 11.00	Su=687/82 psf						Wash to 10', trace gravel in wash. 65x130 mm vane raw torque readings: V5: 25.0/3.0 ft-lbs	
	V6		11.64 - 12.00	Su=673/82 psf				-31.10		V6: 24.5/3.0 ft-lbs 12.00 **Bottom of Exploration at 12.00 feet below ground surface.**	
15											
20											
25											

Remarks:

1. MaineDOT provided coordinates of test boring locations in NAD83 (96) ME 2000 West Zone Coordinate System and ground surface elevations in NAVD88.
2. Supplementary boring to compliment BB-RDKR-10, with field vane shear test data in silty clay soils.
3. Shelby tubes collected using a GUS sampler.
4. Drilling mud consisting of bentonite and barite weight material was used.

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

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

Boring No.: BB-RDKR-105B

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-207
PIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-23.3	**Auger ID/OD:**	-
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 Cas'g
Date Start/Finish:	7/2-3/12	**Drilling Method:**	Cased Wash Boring with Water	**Core Barrel:**	NQ-2
Boring Location:	120+43.3, 7.9 ft Lt.	**Casing ID/OD:**	HW/NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor: 0.6		**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
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MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. hammer
WOR/C = Weight of rods or casing
W1P/W2P = Weight of one/two person(s)
S_U = Insitu Field Vane Shear Strength (psf)
T_V = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/80%)*N-uncorrected
$S_{U(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							WOC			Casing sunk into river bottom to 1.6 ft. Gray silt and sand in wash to 3.0 ft. HP_a=Casing pushed with drill rig hydraulics.	
							HP_a				
								-26.3		3.0	
	1D	24/24	3.0 - 5.0	W1P/W1P/W2P/W2P	---					Gray, wet, very soft, Silty CLAY, trace fine sand (Presumpscot Formation). Driller overdrove spoon to 5.5 ft. Sand in 1/4" lens at 3.3 ft. T_V=200,220 psf	G#267513 A-6, CL LL=33, PL=20, PI=13 WC=37.4%
5											
	2D	24/24	7.0 - 9.0	WOR/WOR/W1P/W1P	Note 2					Gray with trace black staining, wet, medium stiff, Silty CLAY (Presumpscot Formation). 1" thick silt lens at 8.3 ft.	#267514 WC=32.7%
	V1		7.6 - 8.0	Su=714/96 psf						65x130mm vane raw torque readings: V1: 26/3.5 ft-lbs	
	V2		8.6 - 9.0	Su=714/82 psf						65x130mm vane raw torque readings: V2: 26/3.0 ft-lbs	
10	3D	24/24	10.0 - 12.0	WOR/WOR/WOR/ W1P	Note 2					Gray, wet, medium stiff, Silty CLAY, trace fine sand (Presumpscot Formation). Sand in lenses 1/8" thick. T_V=420, 220 psf	
	V3		10.6 - 11.0	Su=769/82 psf						65x130mm vane raw torque readings: V3: 28/3.0 ft-lbs	
	V4		11.6 - 12.0	Su=810/55 psf						V4: 29.5/2.0 ft-lbs	
	4D	16/16	12.0 - 13.3	WOR/WOR/50(4")	Note 2		1			Gray, wet, stiff, Clayey SILT, little fine sand, trace gravel (Presumpscot Formation). Increasing sand with depth. 1" of weathered rock in spoon tip.	G#267515 A-4, CL-ML LL=22, PL=16, PI=6 WC=26.8%
	V5		12.6 - 13.0	Su=1044/96 psf				-36.6		65x130mm vane raw torque readings: V5: 38/3.5 ft-lbs	
	MV6	/	13.0 - 13.1	Su=NA			44_b			MV6: Failed vane attempt. Could not push past 13.1 ft.	
	R1	60/60	13.3 - 18.3	RQD = 48%			NQ-2			$_b$=44 blows from 13.0-13.3 ft.	
15										13.3	
										Spoon refusal at 13.3 ft. Casing refusal at 13.3 ft. Top of Bedrock at Elev. -36.6 ft.	
	R2	60/56	18.3 - 23.3	RQD = 87%						R1: Medium dark gray (N4) to medium light gray (N6), fine to medium grained, strong (R4), slightly to moderately weathered, strongly foliated, biotite-quartz-feldspar-chlorite SCHIST [Nuhumkeag Pond Formation]. Discontinuities are very close to close, generally parallel to foliation planar to irregular, smooth to rough horizontal to steep, tight. Quartz veins parallel to foliation up to 1" thick. Foliation 50 deg to vertical.	UCTq_p=6,620 psi
20										Rock Mass Quality = Poor	
								-46.6		R1: Core Times: (min:sec) 13.3-14.3': (4:10) 14.3-15.3': (5:20)	
25											

Remarks:

1. MaineDOT provided the surveyed location of the test boring referencing Station and Offset relative to the project baseline. Ground surface elevations are based on the North American Vertical Datum of 1988 (NAVD88).
2. Blow counts for spoons driven through a disturbed field vane test location cannot be used to determine N-value.
3. UCTq_p = Peak compressive strength from Uniaxial Compressive Strength Test.

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

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

Boring No.: BB-RDKR-207

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-207
PIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-23.3	**Auger ID/OD:**	-
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 Cas'g
Date Start/Finish:	7/2-3/12	**Drilling Method:**	Cased Wash Boring with Water	**Core Barrel:**	NQ-2
Boring Location:	120+43.3, 7.9 ft Lt.	**Casing ID/OD:**	HW/NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
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MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. hammer
WOR/C = Weight of rods or casing
W1P/W2P = Weight of one/two person(s)
S_u = Insitu Field Vane Shear Strength (psf)
T_V = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

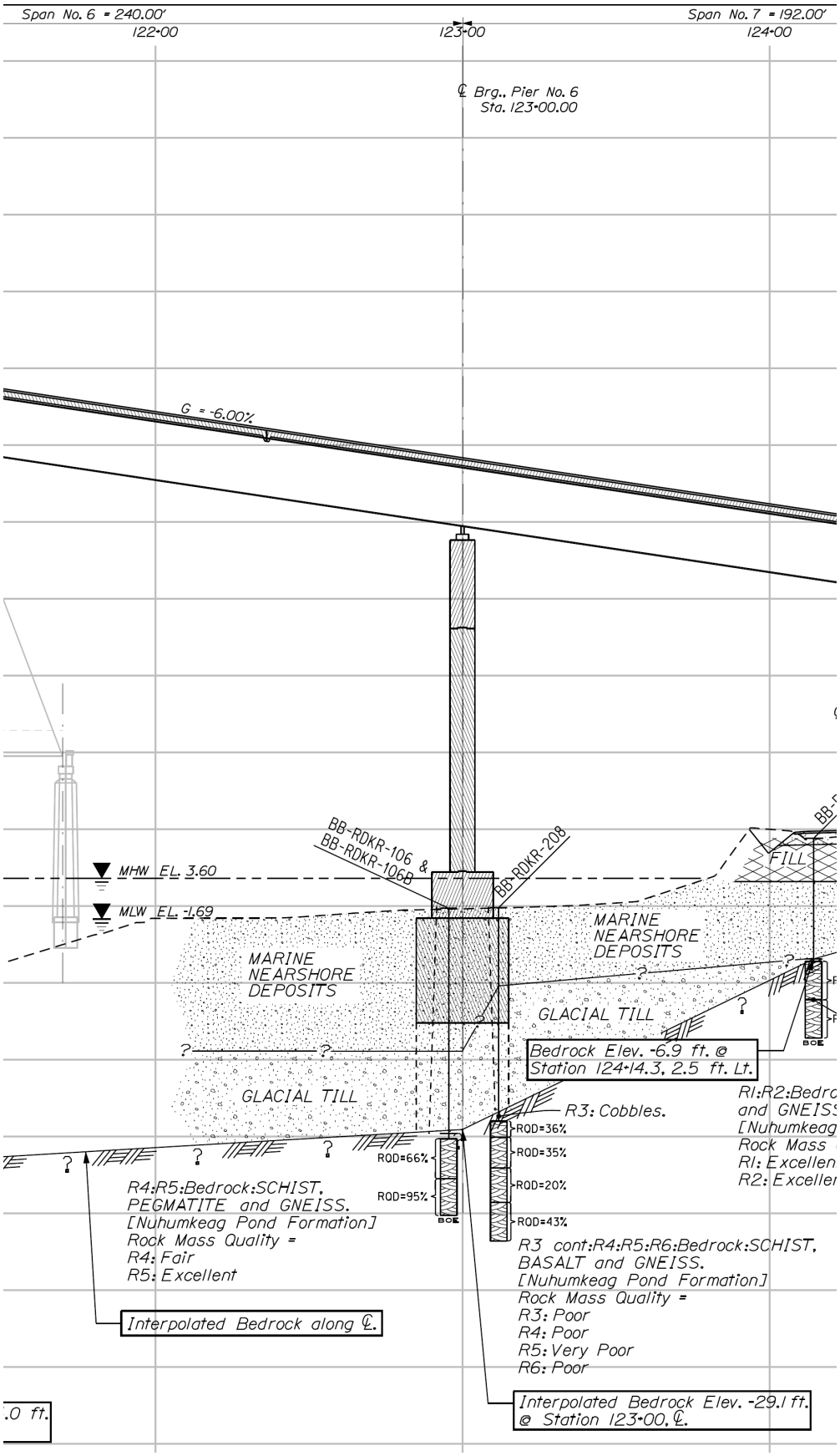
Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										15.3-16.3': (2:35) 16.3-17.3': (1:50) 17.3-18.3': Not timed. Recovery = 100% R2: Medium dark gray (N4) to medium light gray (N6), fine to medium grained, strong (R4), slightly weathered to fresh, biotite-quartz-feldspar SCHIST [Nuhumkeag Pond Formation]. Discontinuities are very close to moderately close, mostly parallel to foliation, planar, smooth to rough, horizontal to moderately dipping, tight. Foliation dipping 40 - 50 deg. Rock Mass Quality = Good R2: Core Times (min:sec) 18.3-19.3': (2:10) 19.3-20.3': (4:15) 20.3-21.3': (1:55) 21.3-22.3': (1:40) 22.3-23.3': (1:40) Recovery = 93%	
30											
35											
40											
45											
50										-23.3 **Bottom of Exploration at 23.3 feet below ground surface.**	

Remarks:

1. MaineDOT provided the surveyed location of the test boring referencing Station and Offset relative to the project baseline. Ground surface elevations are based on the North American Vertical Datum of 1988 (NAVD88).
2. Blow counts for spoons driven through a disturbed field vane test location cannot be used to determine N-value.
3. UCTq_p = Peak compressive strength from Uniaxial Compressive Strength Test.

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

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


Span No. 6 = 240.00'
Span No. 7 = 192.00'
122+00
123+00
124+00
℄ Brg., Pier No. 6
Sta. 123+00.00
G = -6.00%
MHW EL. 3.60
MLW EL. -1.69
BB-RDKR-106 &
BB-RDKR-106B
BB-RDKR-208
FILL
MARINE
NEARSHORE
DEPOSITS
MARINE
NEARSHORE
DEPOSITS
GLACIAL TILL
GLACIAL TILL
Bedrock Elev. -6.9 ft. @
Station 124+14.3, 2.5 ft. Lt.
R3: Cobbles.
RQD=36%
RQD=35%
RQD=20%
RQD=43%
RQD=66%
RQD=95%
BOE
R1:R2:Bedrc
and GNEISS
[Nuhumkeag
Rock Mass
R1: Excellen
R2: Excelle
R4:R5:Bedrock:SCHIST,
PEGMATITE and GNEISS.
[Nuhumkeag Pond Formation]
Rock Mass Quality =
R4: Fair
R5: Excellent
Interpolated Bedrock along ℄.
R3 cont:R4:R5:R6:Bedrock:SCHIST,
BASALT and GNEISS.
[Nuhumkeag Pond Formation]
Rock Mass Quality =
R3: Poor
R4: Poor
R5: Very Poor
R6: Poor
Interpolated Bedrock Elev. -29.1 ft.
@ Station 123+00, ℄.
.0 ft.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-106
WIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-0.3	**Auger ID/OD:**	-
Operator:	B.Enos	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 cas'g
Date Start/Finish:	12/5/11	**Drilling Method:**	Cased Wash Boring with Water	**Core Barrel:**	NQ-2
Boring Location:	122+95.5, 6.5 ft Rt.	**Casing ID/OD:**	NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/14	0.00 - 2.00	WOR/1/3/12	4	4	1	-0.50		Top 2": Dark gray brown, wet, very soft, SILT, little organics (roots) (Alluvium).	G#267535 A-4/ML Non-Plastic WC=9.2% Org. Cont. = 3.4%
							14			0.20	
	2D	24/10	2.00 - 4.00	9/10/20/17	30	30	13			Bottom 12": Gray-brown, wet, soft, fine Sandy SILT, trace organics (roots), trace gravel, trace clay (Marine Nearshore Deposits). Gray to light brown, wet, medium dense, fine to coarse SAND, some silt, little clay, trace gravel (Marine Nearshore Deposits).	
							25				G#267536 A-4/SC-SM Non-Plastic WC=12.5%
5	3D	24/4	4.00 - 6.00	11/13/24/22	37	37	20			Light brown, wet, dense, fine to coarse SAND, some gravel, little silt, trace clay (Marine Nearshore Deposits).	G#267537 A-1-b/SC-SM WC=12.5%
							37				
	4D	24/10	6.00 - 8.00	19/16/11/6	27	27	36			Top 2": Light brown, wet, dense, fine to coarse SAND, some silt, little gravel (Marine Nearshore Deposits). Gravel in wash. Bottom 8": Gray, wet, medium dense, fine to coarse GRAVEL, little fine to coarse sand, trace silt, trace clay (Marine Nearshore Deposits).	G#267538 A-1-a/SP WC=12.1%
							17				
							30				
	5D	24/3	9.00 - 11.00	5/4/5/5	9	9	16			Gray, wet, loose, SILT, little gravel, trace fine to coarse sand, trace clay (Marine Nearshore Deposits).	G#267539 A-4/SC-SM WC=19.4%
10							28				
							31				
	6D	24/8	12.00 - 14.00	10/8/7/22	15	15				Gray and light brown, wet, medium dense, fine to coarse SAND, some gravel, some silt, trace clay (Marine Nearshore Deposits).	G#267540 A-2-4/SC-SM WC=4.5%
								-14.30		14.00	
15										**Bottom of Exploration at 14.00 feet below ground surface.** Note 2.	
20											
25											

Remarks:

1. MaineDOT provided coordinates of test boring locations in NAD83 (96) ME 2000 West Zone Coordinate System and ground surface elevations in NAVD88.
2. 3" Casing broke at 7' after drilling to 12'. End of BB-RKDR-106, see BB-RDKR-106B. 5 ft. of NW casing abandoned in place at 7 to 12 ft.

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

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-106B
WIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-0.1	**Auger ID/OD:**	-
Operator:	B.Enos	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 cas'g
Date Start/Finish:	12/5-12/6/11	**Drilling Method:**	Cased Wash Boring with Mud	**Core Barrel:**	NQ-2
Boring Location:	122+95.9, 7.1 ft Rt.	**Casing ID/OD:**	NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐	Rope & Cathead ☒	

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							CWB[a]			Continuation from BB-RDKR-106 (Note 2) [a]= Cased wash boring, blows not recorded.	
5											
10											
15							10			HW Casing refusal at 14 feet, driller suspects steeply inclined boulder surface based on casing/drill behavior. Begin NW Casing. Roller cone through rock 14.0-14.8'.	
	1D	24/13	15.00 - 17.00	11/7/4/8	11	11	29			Light brown, wet, medium dense, fine to coarse SAND, some silt, little gravel, trace clay (Marine Nearshore Deposits).	G#267541 A-4/SC-SM WC=6.0%
							17				
	2D	24/9	17.00 - 19.00	14/11/10/12	21	21	24			Top 7": Light brown, wet, medium dense fine to coarse SAND, little silt, trace gravel (Marine Nearshore Deposits).	
							24	-18.60		18.50 Bottom 2": Gray, wet, medium dense, fine to coarse SAND, little silt, trace gravel (Glacial Till).	
20							32				
	3D	22/13	20.00 - 21.83	10/15/25/50(4")	40	40	25			Gray, wet, dense fine to coarse SAND, some gravel, little silt (Glacial Till).	G#267542 A-1-b/SM WC=8.4%
							59				
	R1	24/0	22.00 - 24.00	RQD = N/A			33			Boulder R1: Core Times (min:sec) 22.0-21.0': (2:25) 21.0-22.0': (1:05) 0% Recovery Cobble based on drill behavior 24.6-25.1'.	
							37				
25							117				

Remarks:

1. MaineDOT provided coordinates of test boring locations in NAD83 (96) ME 2000 West Zone Coordinate System and ground surface elevations in NAVD88.
2. Continuation of BB-RDKR-106. BB-RDKR-106 terminated at 14.0 ft due to broken NW casing.
3. UCTq_p = Peak compressive strength from Uniaxial Compressive Strength Test.

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Boring No.: BB-RDKR-106B

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-106B
WIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-0.1	**Auger ID/OD:**	-
Operator:	B.Enos	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 cas'g
Date Start/Finish:	12/5-12/6/11	**Drilling Method:**	Cased Wash Boring with Mud	**Core Barrel:**	NQ-2
Boring Location:	122+95.9, 7.1 ft Rt.	**Casing ID/OD:**	NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	4D	6/6	25.20 - 25.70	63(6")	---		53			Gray, wet, very dense SILT, some gravel, some fine to coarse sand, trace clay (Glacial Till).	G#267544 A-4/SC-SM WC=11.1%
	R2	29/5	26.60 - 29.02	RQD = N/A			98			Casing refusal at 26.2', roller cone ahead to 26.6' Boulder R2: Core Times (min:sec) 26.2-26.6': (2:37) 26.6-27.6': (1:40) 27.6-29.0': (1:02) 17% Recovery Cobbles/gravel plugged core barrel	
							21				
							50b				
	R3	6/4	29.00 - 29.50	RQD = N/A				-29.60		Casing refusal on cobble at 28.8 ft. b = blows counted for 28-28.8'. Cobble R3: Core times (min:sec) 29.0-29.5' (4:05)	
30	R4	62/62	30.00 - 35.17	RQD = 66%							UCTq_p=27,924 psi
										29.50	
										Top of Bedrock at Elev. -29.6 ft. Roller cone ahead to 30.0 ft (Elev. -30.1 ft). R4: (30.0-31.7 ft.) Light gray, fine to medium grained, very strong to extremely strong (R5-R6), fresh to slightly weathered, slightly foliated, plagioclase-quartz SCHIST [Nehumkeag Pond Formation]. Discontinuities are very close to moderately close, subhorizontal to moderately dipping, planar to irregular, rough with dark green to black mineral coatings (MnOx).	
35	R5	58/58	35.20 - 40.03	RQD= 95%						(31.7-33.1 ft.) Light gray to white, medium to very coarse grained, extremely strong (R6), fresh, massive to slightly foliated, plagioclase-quartz PEGMATITE [Nehumkeag Pond Formation]. Discontinuities are close to very close, subhorizontal to moderately dipping, planar and rough to very rough.	
										(33.1-35.0 ft) Light to medium gray, fine to medium grained, very strong to extremely strong (R5-R6), fresh, banded/strongly foliated, biotite-muscovite-plagioclase-quartz GNEISS [Nehumkeag Pond Formation]. Discontinuities are very close to moderately close, subhorizontal to gently dipping, planar and rough to very rough. Rare red garnet crystals to 0.2 inch diameter. Rock Mass Quality = Fair. R4: Core Times (min:sec) 30.0-31.0': (3:45) 31.0-32.0': (3:40) 32.0-33.0': (4:00) 33.0-34.0': (3:30) 34.0-35.2': (3:55) 100% Recovery	
40								-40.10		R5: Light to medium gray, fine to medium grained, very strong to extremely strong (R5-R6), fresh, banded/strongly foliated, biotite-muscovite-plagioclase-quartz GNEISS [Nehumkeag Pond Formation]. Discontinuities are moderately close, subhorizontal to gently dipping, planar and rough to very rough. Rare red garnet crystals to 0.2 inch diameter. Rock Mass Quality = Excellent R5: Core Times (min:sec) 35.2-36.2': (2:00) 36.2-37.2': (2:30) 37.2-38.2': (2:50) 38.2-39.2': (2:30)	
45											
50											

Remarks:

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2. Continuation of BB-RDKR-106. BB-RDKR-106 terminated at 14.0 ft due to broken NW casing.
3. UCTq_p = Peak compressive strength from Uniaxial Compressive Strength Test.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-106B
WIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-0.1	**Auger ID/OD:**	-
Operator:	B.Enos	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 cas'g
Date Start/Finish:	12/5-12/6/11	**Drilling Method:**	Cased Wash Boring with Mud	**Core Barrel:**	NQ-2
Boring Location:	122+95.9, 7.1 ft Rt.	**Casing ID/OD:**	NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor:	0.6	**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

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

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50										39.2-40.0': (3:15) 100% Recovery	
										40.00	
										Bottom of Exploration at 40.00 feet below ground surface.	
55											
60											
65											
70											
75											

Remarks:

1. MaineDOT provided coordinates of test boring locations in NAD83 (96) ME 2000 West Zone Coordinate System and ground surface elevations in NAVD88.
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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-208
PIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-0.2	**Auger ID/OD:**	-
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 Cas'g
Date Start/Finish:	7/5-6/12	**Drilling Method:**	Cased Wash Boring with Water	**Core Barrel:**	NQ-2
Boring Location:	123+11.8, 17.2 ft Lt.	**Casing ID/OD:**	HW/NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor: 0.6		**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
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R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = Weight of 140lb. hammer; WOR/C = Weight of rods or casing; W1P/W2P = Weight of one/two person(s)
S_u = Insitu Field Vane Shear Strength (psf); T_V = Pocket Torvane Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw field SPT N-value; Hammer Efficiency Factor = Annual Calibration Value; N_{60} = SPT N-uncorrected corrected for hammer efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf); WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or ROD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/6	0.0 - 2.0	3/7/11/9	18	18	HP_a			Gray, wet, medium dense, Silty fine SAND, little organics (bark, roots) (Marine Nearshore Deposits). Decreasing silt with depth. HP_a=Casing pushed with drill rig hydraulics. Gravel in lenses from 1 to 2 ft. based on drill behavior. Brown and gray mottled, wet, medium dense, fine to medium SAND, some silt, some gravel, trace coarse sand (Marine Nearshore Deposits).	G#267516 A-2-4, SC-SM WC=12.8%
							21				
	2D	24/15	2.0 - 4.0	3/6/8/9	14	14	20				
							34				
							77				
5	3D	24/12	5.2 - 7.2	21/17/18/21	35	35	27			Gravel at 4.5 ft., lost water return at 5.0 ft, washed to 5.2 ft. Gray, wet, dense, fine SAND, some gravel, little silt, trace clay (Marine Nearshore Deposits).	G#267517 A-1-b, SC-SM WC=10.8%
							96				
							99				
	4D	24/13	8.0 - 10.0	14/25/17/11	42	42	67			Brown, wet, dense, fine to coarse SAND, some gravel, little silt (Marine Nearshore Deposits).	
							63				
10	5D	24/12	10.0 - 12.0	10/8/11/17	19	19	40	-10.2		10.0 Gray, wet, medium dense, fine to medium SAND, some gravel, some silt, trace clay (Glacial Till).	G#267518 A-2-4, SC-SM WC=9.1%
							63				
	6D	21/14	12.0 - 13.8	14/48/51/50(3")	99	99	84			Gray, wet, very dense, fine SAND, some gravel, trace coarse sand, trace silt (Glacial Till). 2" gravel lens in bottom of spoon.	
							146_b			$_b$=Casing refusal at 13.7 ft. on cobble. Driller washes ahead to 14.0 ft.	
	R1	48/0	14.0 - 18.0	RQD = NA%			WOC			R1: Pieces of cobbles and gravel recovered. R1: Core Times: (min:sec) 14.0-15.0': (3:20) 15.0-16.0': (3:50) 16.0-17.0': (1:10) 17.0-18.0': (2:30) Recovery = 0% Sand in return from approximately 15-18 ft. Casing refusal at 19.0 ft, wash ahead to 19.1 ft.	
15							24				
							58				
							96				
							170				
	R2	36/14	19.1 - 22.1	RQD = NA%			OPEN			R2: Boulder 19.0-20.2 ft. Sand in wash 20.2-23 ft. R2: Core Times: (min:sec) 19.1-20.1': (1:50) 20.1-21.1': (0:55) 21.1-22.1': (0:45) Recovery = 39% Pull NW casing and advance HW casing and roller bit through boulder to 23.0 ft. Boring stayed open to 21.5 ft. Resume driving NW.	
20											
							35				
							102				
	7MD	5/0	23.0 - 23.4	100(5")			38			Spoon refusal on cobble based on drill behavior.	
25							145				

Remarks:

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2. Blow counts for spoons driven through a disturbed field vane test location cannot be used to determine N-value.
3. PLTq_p = Peak compressive strength estimated from Point Load Index Test.
4. UCTq_p = Peak compressive strength from Uniaxial Compressive Strength Test.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-208
PIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-0.2	**Auger ID/OD:**	-
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 Cas'g
Date Start/Finish:	7/5-6/12	**Drilling Method:**	Cased Wash Boring with Water	**Core Barrel:**	NQ-2
Boring Location:	123+11.8, 17.2 ft Lt.	**Casing ID/OD:**	HW/NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor: 0.6		**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

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R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = Weight of 140lb. hammer; WOR/C = Weight of rods or casing; W1P/W2P = Weight of one/two person(s)
S_u = Insitu Field Vane Shear Strength (psf); T_v = Pocket Torvane Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Rawfield SPT N-value; Hammer Efficiency Factor = Annual Calibration Value; N_{60} = SPT N-uncorrected corrected for hammer efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf); WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	8MD	1/0	25.0 - 25.1	50(1")			NR			Spoon refusal on boulder at 25.1 ft. Wash ahead of casing to 27.6 ft through boulder.	
	R3	28/10	27.6 - 29.9	RQD = 36%			NQ-2	-28.0		R3: 27.6-27.8': Cobble. 27.8 Top of Bedrock at Elev. -28.0 ft. R3: 27.8-29.9': Medium dark gray (N4) to dark greenish gray (5GY 4/1), very fine to fine grained, medium weak (R3) moderately weathered, moderately foliated, biotite-quartz SCHIST [Nuhumkeag Pond Formation]. Discontinuities are very close to close, moderately dipping to vertical planar to rough, tight. Contact metamorphosed by basalt dike below. Rock Mass Quality = Poor R3: Core Times (min:sec) 27.6-28.6': (2:05) 28.6-29.6': (2:15) 29.6-29.9': (2:00) Recovery = 38% Core barrel plugged at 29.9 ft.	PLTq_p=13,200 psi
	R4	48/41	29.9 - 33.9	RQD = 35%							
30											
	R5	54/54	33.9 - 38.4	RQD = 20%							
35											
	R6	60/59	38.4 - 43.4	RQD = 43%							
40										R4: 29.9 - 30.4 ft.: Dark greenish gray (5GY 4/1), very fine grained, weak (R2), moderately to highly weathered, non-foliated, BASALT [Mesozoic Intrusives]. Discontinuities are very close, moderately dipping to steep, planar, smooth to rough. 30.4 - 33.9 ft.: Medium gray (N5) to dark greenish gray (5GY 4/1), fine grained, weak (R2) to medium weak (R3), moderately to highly weathered, foliated, quartz-biotite GNEISS [Nuhumkeag Pond Formation], contact metamorphized by basalt dike above. Discontinuities are very close, horizontal to steep, planar to irregular, smooth to rough with FeOx staining. Rock Mass Quality = Poor R4: Core Times (min:sec) 29.9-30.9': (1:15) 30.9-31.9': (1:10) 31.9-32.9': (1:50) 32.9-33.9': (1:30) Recovery = 85%	UCTq_p=4,859 psi
								-43.6			
45										R5: 33.9 - 35.0 ft.: Grayish black (N2) to light gray (N7), fine grained, medium weak (R3), moderately weathered, moderately foliated, biotite-quartz GNEISS [Nuhumkeag Pond Formation], contact metamorphosed by basalt dike below. Discontinuities are very close to close, planar to stepped to irregular, moderately weathered, horizontal to steep, tight to open, with rusty mineral coating (FeOx). 35.0 - 37.5 ft.: Dark gray (N3) to olive gray (5Y 4/1), very fine grained very weak (R2), moderately to highly weathered, non-foliated BASALT [Mesozoic Intrusives]. Discontinuities are very close, planar	
50											

Remarks:

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3. PLTq_p = Peak compressive strength estimated from Point Load Index Test.
4. UCTq_p = Peak compressive strength from Uniaxial Compressive Strength Test.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Maine Kennebec Bridge #2506
Location: Richmond-Dresden, Maine

Boring No.: BB-RDKR-208
PIN: 12674.00

Driller:	Maine Test Borings	**Elevation (ft.)**	-0.2	**Auger ID/OD:**	-
Operator:	M. Porter	**Datum:**	NAVD88	**Sampler:**	2" Split Spoon
Logged By:	M. Henrick	**Rig Type:**	CME-45 Skid on Anchor Barge	**Hammer Wt./Fall:**	140/30 SS; 300/15 Cas'g
Date Start/Finish:	7/5-6/12	**Drilling Method:**	Cased Wash Boring with Water	**Core Barrel:**	NQ-2
Boring Location:	123+11.8, 17.2 ft Lt.	**Casing ID/OD:**	HW/NW	**Water Level*:**	Water Boring - Tidal
Hammer Efficiency Factor: 0.6		**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; MU = Unsuccessful Thin Wall Tube Sample attempt; V = Insitu Vane Shear Test, PP = Pocket Penetrometer; MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = Weight of 140lb. hammer; WOR/C = Weight of rods or casing; W1P/W2P = Weight of one/two person(s)
S_u = Insitu Field Vane Shear Strength (psf); T_V = Pocket Torvane Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw field SPT N-value; Hammer Efficiency Factor = Annual Calibration Value; N_{60} = SPT N-uncorrected corrected for hammer efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf); WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50										to irregular, horizontal to vertical with rusty mineral coatings (FeOx). Contains inclusions of highly altered gneiss wallrock (xenoliths). 37.5 - 38.4 ft.: Grayish black (N2) to light gray (N7), fine grained, medium weak (R3), moderately weathered, moderately foliated, biotite-quartz GNEISS [Nuhumkeag Pond Formation], contact metamorphosed by basalt dike above. Discontinuities are very close to close, planar to stepped to irregular, horizontal to steep, tight to open, with rusty mineral coating (FeOx). Rock Mass Quality = Very Poor R5: Core Times (min:sec) 33.9-34.9': (1:35) 34.9-35.9': (1:40) 35.9-36.9': (2:05) 36.9-37.9': (3:05) 37.9-38.4': (2:00) Recovery = 100% Core barrel plugged at 38.4 ft. R6: 38.4 - 40.2 ft.: Medium light gray (N6) to light gray (N7), fine to coarse grained, weak to strong (R3-R4), moderately weathered, strongly foliated/banded, quartz-feldspar-biotite-garnet GNEISS [Nuhumkeag Pond Formation]., hydrothermally altered by basalt dikes. 40.2 - 40.6 ft.: Dark gray, very fine grained very weak (R2), moderately to highly weathered BASALT [Mesozoic Intrusives]. No discontinuities. 40.6 - 43.4 ft.: Medium light gray (N6) to light gray (N7), fine to coarse grained, weak to strong (R3-R4), moderately weathered, strongly foliated/banded, quartz-feldspar-biotite-garnet GNEISS [Nuhumkeag Pond Formation]. Discontinuities are very close to close, moderately dipping to steep, planar to irregular to stepped, rough, tight to open. Thin white quartzite vein at 38.8 ft., 1/4" thick, steeply dipping. Garnets up to 1/4" diameter. Rock Mass Quality = Poor R6: Core Times (min:sec) 38.4-39.4': (5:53) 39.4-40.4': (2:15) 40.4-41.4': (1:20) 41.4-42.4': (2:40) Recovery = 98%	
55											
60											
65											
70											
75										43.4 **Bottom of Exploration at 43.4 feet below ground surface.**	

Remarks:

1. MaineDOT provided the surveyed location of the test boring referencing Station and Offset relative to the project baseline. Ground surface elevations are based on the North American Vertical Datum of 1988 (NAVD88).
2. Blow counts for spoons driven through a disturbed field vane test location cannot be used to determine N-value.
3. PLTq_p = Peak compressive strength estimated from Point Load Index Test.
4. UCTq_p = Peak compressive strength from Uniaxial Compressive Strength Test.

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

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

Appendix B: Driller's Logs for Supplementary Borings

MAINE TEST BORINGS

Complete Test Boring Service
18 MACK LANE, HERMON MAINE 04401 • 207-848-7041 • FAX 207-848-7042
www.mainetest.com

Reed & Reed	November 20, 2013
PO Box 370	#13-150 • PO #173705
Woodwich, ME 04579	Route 97 Bridge • Dresden, ME
Charlie Guerette	cguerette@reed-reed.com

Boring # DR1 **Casing: N** **Rod: NWJ** **Core: NQ2**

Casing Record: # "					Sample Record (ft)			Hammer 140 Lbs. Fall 30"					Stratum Record	
PC.	TOT	Blows	Fr	To	Fr	To	Number	Rec.	Blows per 6"				Dpth	Description
		Hydraulic Push	0	1	0	2	1D	14"	H	1	9	15		Brown fine sand organics silt with some wood
			1	2										
			2	3										
		12	3	4									4'	Gray fine sand silt
		13	4	5										
		14	5	6	5	7	2D	16"	10	7	6	5		
		10	6	7										
		16	7	8										
		17	8	9										
		13	9	10										
		16	10	11	10	12	3D	24"	1	2	1	2		
		11	11	12										
		10	12	13									13'	Gray silt clay with fine to medium sand layers aome shells
		7	13	14										
		8	14	15										
		6	15	16	15	17	4D	24	R	R	H	H		
		7	16	17									17'	Gray fine to coarse sand gravel trace of silt
		19	17	18										
		21	18	19										
		32	19	20										
		28	20	21	20	21	5D	8"	16	16	15	8		.
		18	21	22									21.5'	Brown fine sand with some gravel trace of silt
		27	22	23										
		50	23	24										
		Refusal	24	25									24.5'	Bottom of Boring - Refusal

MAINE TEST BORINGS

Complete Test Boring Service
18 MACK LANE, HERMON MAINE 04401 • 207-848-7041 • FAX 207-848-7042
www.mainetest.com

Reed & Reed	November 20, 2013
PO Box 370	#13-150 • PO #173705
Woodwich, ME 04579	Route 97 Bridge • Dresden, ME
Charlie Guerette	cguerette@reed-reed.com

Boring # UR1 — **Casing: N** — **Rod: NWJ** — **Core: NQ2**

Casing Record: # "			Sample Record (ft)			Hammer 140 Lbs. Fall 30"					Stratum Record	
PC.	TOT	Blows	Fr	To	Fr	To	Number	Rec.	Blows per 6"				Dpth	Description
			0	1	0	2	1D	16"	A	2	3	6		Brown organics silt with fine sand some wood
		Hydraulic Push	1	2										
			2	3										
			3	4										
		16	4	5										
		26	5	6	5	7	2D	20"	6	11	11	12	5.5'	Gray fine sand silt with some clay
		34	6	7										
		31	7	8										
		21	8	9										
		19	9	10										
		22	10	11	10	12	3D	16"	2	1	3	2		
		24	11	12										
		22	12	13									13'	Gray fine to coarse sand with trace of silt
		19	13	14										
		26	14	15									14.7'	Gray silt clay with fine sand layers
		22	15	16	15	17	4D	24"	1	H	1	1		
		17	16	17										
		16	17	18										
		28	18	19										
		23	19	20										
		35	20	21	20	22	5D	8"	8	11	13	17		
		59	21	22										
		33	22	23										
		41	23	24										
			24	25									24.5'	Brown fine sand with some gravel trace of silt
			25	26	25	26	6D	7"	18	98	50			
		Refusal	26	27									26'	Bottom of Boring - Refusal

Appendix C: Driving Logs for Initial Pile Driving

PILE DRIVING LOG

PILE NO. A — Column-Location

PROJECT & PIN	Richmond-Dresden WIN 12674.10 Pay Item 501.55
LOCATION	Template CL approx 121 + 65 (to be confirmed)
FOUNDATION I.D.	Between proposed Pier 5 and Pier 6
GEN. CONTRACTOR	Reed & Reed
PILE CONTRACTOR	Reed & Reed and GZA, Pile Testing Subcontractor
RESIDENT ENGR	Peter Brown
TEAM GEOTECH	L. Krusinski
INSPECTOR	

TOP ANGLE IRON @ +6.5 FEET

	Heat No.	Pile ID No.	Date Driven	Section	Measured Lengths (ft)
1/2"	Concrete filled	A		BOTTOM	
				MIDDLE	
				TOP	
Heave				Total length	
Measurement	Date shot	Elevation (ft)	Movement (ft)	Length deducted	
End of Driving			0.00	Length deducted	
				Total deducted	
Final Check				Net length	

Approx. Grnd Surf. El. ____ ft
Initial Top El. ____ ft
Length Of Pile 40 ft
Tip El. ____ ft
Cut-off El. ____ ft
Initial Pay Length ____ ft
Net Change In Tip El. ____ ft
~~Final Tip El.~~ ____ ft
Final Pay Length ____ ft

@ END OF DRIVE 31'10" @ TOP MARK

Necessary to redrive: ☐ Yes ☐ No
Redrive Blows Per Inch: ___ ___ ___ ___ ___ ___

Per Foot Marks on PILE.

Deviation from design location: N ____ S ____ E ____ W ____

Final Inspection: Date ____ ☐ Pile Accepted ☐ Pile Rejected

Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)
1	-2	26	12	51		76	
2	-3	27	19	52		77	
3		28	13	53		78	
4		29	14	54		79	
5	-6	30	9/4"	55		80	
6		~~31~~ then	22/? "	56		81	
7		~~32~~		57		82	
8		33		58		83	
9	7/19"	34		59		84	
10	3/6"	35		60		85	
11	6 +	36		61		86	
12	12	37		62		87	
13	10	38		63		88	
14	12	39		64		89	
15	8	40		65		90	
16	7	41		66		91	
17	7	42		67		92	
18	5	43		68		93	
19	Warm up	44		69		94	
20	4	45		70		95	
21	4	46		71		96	
22	3	47		72		97	
23	4	48		73		98	
24	4	49		74		99	
25	12	50		75		100	

Approx. Depth Preaugered: ____
Time Finish: Bottom ____ Middle ____ Top ____
Time Start: Bottom ____ Middle ____ Top ____

STOP - INSTRUMENTS GOING TO HITLEADS. 140 KIP, 5' STROKE, σ = 2 KSI

RANGE OF CAPACITIES 700 - 1200 KIP DURING FINAL INCHES OF INDICATIONS OF DAMAGE / SEPARATION JIM: SAY 850 KIPS

Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)
?	1	8		1			1	
	2	8		2			2	
	3	11		3			3	
	4	12		4			4	
	5	2 / 0.5"		5			5	
	6			6			6	
	7			7			7	
	8			8			8	
	9			9			9	
	10			10			10	
	11			11			11	
	12			12			12	
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							

Remarks:
- ☐ Rejected
- ☐ Added due to mislocated pile
- ☐ Added due to broken pile
- ☐ Added due to design change
- ☐ Deleted due to design change
- ☐ Possibly broken
- ☐ Completed with follower
- ☐ stopped driving to splice at ____ ft
- ☐ stopped driving at ____ ft
- ☐

FUEL SETTING 3, STROKE 5' POOR PROPORTIONALITY / OUT OF ALIGNMENT

fuel setting 2

* Strain gage loose + spinning
* not hitting it square

PILE:
Type ☒ End Bearing ☐ Friction
Size 24" dia, Pile A 1/2" wall B, C, D 1" wall
Max. Factored Load ____ kip (kN)
Nominal Resistance 600 kip

HAMMER:
Type Delmag D36-26
Rated Energy 90,560 ft-lbs
Measured Energy ____ ft-lbs
Stopping Criteria 8 bpi at Fuel Setting 2 and 6.2 ft stroke

YK
Field Representative Signature

Blows for final 4.5" **in.:** 8 8 11 12 2 1/2" **Blows/in. Avg.:** ____ **Req. Avg.:** ____

PILE NO. A

Form 4013 (Regular)

PILE DRIVING LOG

8/28/13
12:52 PM

PILE NO. B
Column-Location

PROJECT & PIN	Richmond-Dresden WIN 12674.10 Pay Item 501.55
LOCATION	Template CL approx 121 + 65 (to be confirmed)
FOUNDATION I.D.	Between proposed Pier 5 and Pier 6
GEN. CONTRACTOR	Reed & Reed
PILE CONTRACTOR	Reed & Reed and GZA, Pile Testing Subcontractor
RESIDENT ENGR	Peter Brown
TEAM GEOTECH	L. Krusinski
INSPECTOR	

TOP OF [illegible] AT 34'3" MARK ON PILE

	Heat No.	Pile ID No.	Date Driven	Section	Measured Lengths (ft)
1" WALL	4' CONCRETE PLUG			BOTTOM	
				MIDDLE	
				TOP	
				Total length	
				Length deducted	
				Length deducted	
				Total deducted	
				Net length	

Approx. Grnd Surf. El. ____ ft
Initial Top El. ____ ft
Length Of Pile ____ ft
Tip El. ____ ft
Cut-off El. ____ ft
Initial Pay Length ____ ft
Net Change In Tip El. ____ ft
Final Tip El. ____ ft
Final Pay Length ____ ft

Heave Measurement

	Date shot	Elevation (ft)	Movement (ft)
End of Driving	TOP OF [illegible]	@ 34'3" MARK ON PILE	0.00
	(EL. 16.5')		
Final Check			

Necessary to redrive: ☐ Yes ☐ No
Redrive Blows Per Inch: ___ ___ ___ ___ ___ ___ = MARKS ON PILE

Deviation from design location: N ____ S ____ E ____ W ____

Final Inspection: Date ____ ☐ Pile Accepted ☐ Pile Rejected

Approx. Depth Preaugered: ____ Time Start: ____ Finish: ____

Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)
1		26	5	51		76	
2		27	6	52		77	
3		28	5	53		78	
4		29		54		79	
5		30	9	55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9	1 1/8"	34		59		84	
10	2	35		60		85	
11	1	36		61		86	
12	2	37		62		87	
13	3	38		63		88	
14	5	39		64		89	
15	3	40		65		90	
16	4	41		66		91	
17	2	42		67		92	
18	1?	43		68		93	
19	4	44		69		94	
20	3	45		70		95	
21	3	46		71		96	
22	2	47		72		97	
23	3	48		73		98	
24	5	49		74		99	
25	4	50		75		100	

changed visual reference,

MOVE TO FUEL SET 3, 600 KIP θ = 7 KSI

STOP- GOING TO KILL INSTRUMENTS

7.5' STROKE 530 KIP θ = 7 KSI

Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)
34'	1	5		1			1	
	2	8		2			2	
	3	15		3			3	
	4	15		4			4	
	5	10		5			5	
	6	15		6			6	
	7	13/0.8"		7			7	
	8	9		8			8	
	9	3 1/2"		9			9	
	10			10			10	
	11			11			11	
	12			12			12	
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							

Remarks:
- ☐ Rejected
- ☐ Added due to mislocated pile
- ☐ Added due to broken pile
- ☐ Added due to design change
- ☐ Deleted due to design change
- ☐ Possibly broken
- ☐ Completed with follower
- ☐ stopped driving to splice at ____ ft
- ☐ stopped driving at ____ ft
- ☐

PAUSE: FUEL SET 2, θ = 2.9 KSI, 100 KIP, 4.6' STROKE

PILE:
Type ☒ End Bearing ☐ Friction
Size 24" dia, Pile A 1/2" wall B, C, D 1" wall
Max. Factored Load ____ kip (kN)
Nominal Resistance 600 kip

HAMMER:
Type Delmag D36-26
Rated Energy 90,560 ft-lbs
Measured Energy ____ ft-lbs
Stopping Criteria 8 bpi at Fuel Setting 2 and 8' ft stroke

[signature]
Field Representative Signature

PILE NO. B

Blows for final 6.8" **in.:** 8 15 15 15 10 15 **Blows/in. Avg.:** ____ **Req. Avg.:** ____

13/0.8"

Form 4013 (Regular)

PILE DRIVING LOG

2:45 PM
8/28/13

PILE NO. C
Column-Location

PROJECT & PIN	Richmond-Dresden WIN 12674.10 Pay Item 501.55	**RESIDENT ENGR**	Peter Brown
LOCATION	Template CL approx 121 + 65 (to be confirmed)	**TEAM GEOTECH**	L. Krusinski
FOUNDATION I.D.	Between proposed Pier 5 and Pier 6	**INSPECTOR**	
GEN. CONTRACTOR	Reed & Reed		
PILE CONTRACTOR	Reed & Reed and GZA, Pile Testing Subcontractor		

	Heat No.	Pile ID No.	Date Driven	Section	Measured Lengths (ft)
1.0" WALL	w/ STEEL	OPEN SHOE		BOTTOM	
				MIDDLE	
				TOP	
				Total length	
				Length deducted	
				Length deducted	
				Total deducted	
				Net length	

Heave Measurement

	Date shot	Elevation (ft)	Movement (ft)
End of Driving	TOP	@ 34'10"	0.00
		PILE	MARK
Final Check			

Approx. Grnd Surf. El.	ft
Initial Top El.	ft
Length Of Pile	ft
Tip El.	ft
Cut-off El.	ft
Initial Pay Length	ft
Net Change In Tip El.	ft
Final Tip El.	ft
Final Pay Length	ft

Necessary to redrive: ☐ Yes ☐ No
Redrive Blows Per Inch: ___ ___ ___ ___ ___ ___

Deviation from design location:
N ____ S ____ E ____ W ____

Final Inspection: **Date** _____ ☐ **Pile Accepted** ☐ **Pile Rejected**

Time Start: Bottom / Middle / Top — Time Finish: Bottom / Middle / Top — Approx. Depth Preaugered:

Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)
1		26	?	51		76	
2		27	2	52		77	
3		28	5	53		78	
4		29	9	54		79	
5		30	13	55		80	
6		31	28	56		81	
7		32	30	57		82	
8		33	15+	58		83	
9		34	pause	59		84	
10		35		60		85	
11	/	36		61		86	
12	/	37		62		87	
13	/	38		63		88	
14	2	39		64		89	
15	2	40		65		90	
16	2	41		66		91	
17	2	42		67		92	
18	2	43		68		93	
19	2	44		69		94	
20	/	45		70		95	
21	/	46		71		96	
22	/	47		72		97	
23	/	48		73		98	
24	/+	49		74		99	
25	/	50		75		100	

Reported DAMAGE 5' FROM TIP

PILE TOP MUSHROOMED. 470 KIP θ=7.7 STR=7.5' B drop to 0.50 then incr.

140 KIP ST=4' θ=2.5 KSI

Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)
33	1		34	1	2		1	
	2			2	2		2	
	3			3	2		3	
	4			4	3		4	
	5			5	4		5	
	6			6	3		6	
	7			7	3		7	
	8			8	3/0.5"		8	
	9	2		9			9	
	10	2		10			10	
	11	2		11			11	
	12	2		12			12	
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							

Remarks:
- ☐ Rejected
- ☐ Added due to mislocated pile
- ☐ Added due to broken pile
- ☐ Added due to design change
- ☐ Deleted due to design change
- ☐ Possibly broken
- ☐ Completed with follower
- ☐ stopped driving to splice at ____ ft
- ☐ stopped driving at ____ ft
- ☐

PILE:
Type ☒ End Bearing ☐ Friction
Size 24" dia. Pile A 1/2" wall B, C, D 1" wall
Max. Factored Load _____ kip (kN)
Nominal Resistance 600 kip

HAMMER:
Type Delmag D36-26
Rated Energy 90,560 ft-lbs
Measured Energy _____ ft-lbs
Stopping Criteria 11 bpi at Fuel Setting 2 and 8.5' ft stroke

LK
Field Representative Signature

Blows for final 5 1/2 **in.:** 2 3 4 3 3 3/½" **Blows/in. Avg.:** _____ **Req. Avg.:** _____

PILE NO. C

Form 4013 (Regular)

PILE DRIVING LOG

PILE NO. D
Column-Location

PROJECT & PIN	Richmond-Dresden WIN 12674.10 Pay Item 501.55	**RESIDENT ENGR**	Peter Brown
LOCATION	Template CL approx 121 + 65 (to be confirmed)	**TEAM GEOTECH**	L. Krusinski
FOUNDATION I.D.	Between proposed Pier 5 and Pier 6	**INSPECTOR**	
GEN. CONTRACTOR	Reed & Reed		
PILE CONTRACTOR	Reed & Reed and GZA, Pile Testing Subcontractor		

	Heat No.	Pile ID No.	Date Driven	Section	Measured Lengths (ft)
1.0" WALL	; STEEL OPEN SHOE			BOTTOM	
				MIDDLE	
				TOP	
				Total length	
				Length deducted	
				Length deducted	
				Total deducted	
				Net length	

Approx. Grnd Surf. El. ____ ft
Initial Top El. ____ ft
Length Of Pile ____ ft
Tip El. ____ ft
Cut-off El. ____ ft
Initial Pay Length ____ ft
Net Change In Tip El. ____ ft
Final Tip El. ____ ft
Final Pay Length ____ ft

Heave Measurement

	Date shot	Elevation (ft)	Movement (ft)
(End of Driving)	TOP OF 6	@ 33'	0.00
		MARK ON PILE	
Final Check			

Necessary to redrive: ☐ Yes ☐ No
Redrive Blows Per Inch: ___ ___ ___ ___ ___ ___

Deviation from design location:
N ____ S ____ E ____ W ____

Final Inspection: **Date** ____ ☐ **Pile Accepted** ☐ **Pile Rejected**

Time Start: Top / Middle / Bottom — Time Finish: Top / Middle / Bottom — Approx. Depth Preaugered: ____

Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)
1		26	1	51		76	
2		27	—	52		77	
3		28	—	53		78	
4		29	1	54		79	
5		30	2	55		80	
6		31	2	56		81	
7		32	6	57		82	
8		33	?	58		83	
9		34	18	59		84	
10		35	18/6"	60		85	
11	1	36		61		86	
12	1	37		62		87	
13	2	38		63		88	
14	3	39		64		89	
15	3	40		65		90	
16	2	41		66		91	
17	2	42		67		92	
18	2	43		68		93	
19	1	44		69		94	
20	1	45		70		95	
21	1	46		71		96	
22	1	47		72		97	
23	1	48		73		98	
24	1	49		74		99	
25	1	50		75		100	

515 KIP. σ=7.7 KSI UP TO 600 when CRUSHED TOP.

Pause. 1" marks. 460 KIP 7' STROKE JIM: DAMAGE 20' FROM GAGES

Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)
	1	2		1	7		1	
	2	2		2	2/ TOP		2	
	3	2		3	CRUSHING			
	4	3		4			4	
	5	2		5			5	
	6	4		6			6	
	7	3		7			7	
	8	3		8			8	
	9	3		9			9	
	10	4		10			10	
	11	3		11			11	
	12	4		12			12	
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							

Remarks:
- ☐ Rejected
- ☐ Added due to mislocated pile
- ☐ Added due to broken pile
- ☐ Added due to design change
- ☐ Deleted due to design change
- ☐ Possibly broken
- ☐ Completed with follower
- ☐ stopped driving to splice at ____ ft
- ☐ stopped driving at ____ ft
- ☐

PILE:
Type ☒ End Bearing ☐ Friction
Size 24" dia, Pile A 1/2" wall B, C, D 1" wall
Max. Factored Load ____ kip (kN)
Nominal Resistance 600 kip

HAMMER:
Type Delmag D36-26
Rated Energy 90,560 ft-lbs
Measured Energy ____ ft-lbs
Stopping Criteria 11 bpi at Fuel Setting 2 and ____ ft stroke

Field Representative Signature

PILE NO. D

Blows for final 5 **in.:** 3 4 3 4 7 2 **Blows/in. Avg.:** ____ **Req. Avg.:** ____

TOP CRUSHING W/ THESE FINAL BLOWS

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Appendix D: Driving Logs for Pile Restrikes

PILE DRIVING LOG

Re-strike 10/11/2013

PILE NO. C
Column-Location

PROJECT & PIN	Richmond-Dresden WIN 12674.10 Pay Item 501.55
LOCATION	Template CL approx 121 + 65 (to be confirmed)
FOUNDATION I.D.	Between proposed Pier 5 and Pier 6
GEN. CONTRACTOR	Reed & Reed
PILE CONTRACTOR	Reed & Reed and GZA, Pile Testing Subcontractor

RESIDENT ENGR Peter Brown
TEAM GEOTECH L. Krusinski
INSPECTOR
w/ PILE CUSHIONING AND STEEL CAP

Heat No.	Pile ID No.	Date Driven	Section	Measured Lengths (ft)
1" WALL W/ STEEL OPEN SHOE			BOTTOM	
CONCRETE - FILLED ON		10/2/2013	MIDDLE	
W/ 36'-37'	OF CONCRETE		TOP	

Heave "SOMETHING IN BOTTOM OF PILE"

Measurement	Date shot	Elevation (ft)	Movement (ft)
End of Driving			0.00
Final Check			

Total length
Length deducted
Length deducted
Total deducted
Net length

Approx. Grnd Surf. El. ft
Initial Top El. ft
Length Of Pile 40 ft
Tip El. ft
Cut-off El. 6" ft
Initial Pay Length ft
Net Change In Tip El. ft
Final Tip El. ft
Final Pay Length 39.5' ft

Necessary to redrive: ☐ Yes ☐ No 4 BLOWS AT FUEL SETTING 2 THEN
Redrive Blows Per Inch: ___ ___ ___ ___ ___ ___ ↑ TO FUEL SETTING 3

Deviation from design location:
N ___ S ___ E ___ W ___

Final Inspection: Date ☐ Pile Accepted ☐ Pile Rejected

Approx. Depth Preaugered: ___ Time Start: ___ Bottom ___ Middle ___ Top ___ Time Finish: ___ Bottom ___ Middle ___ Top ___

Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)	Depth (ft)	(in)	Blows (per in.)
	1	9		1		1		13 / 3/4"
	2	10		2		2		
	3	11		3		3		
	4	12		4		4		
	5	13		5		5		
	6	12		6		6		
	7	13		7		7		
750 KIPS	8	5 / 3/8"		8		8		
	9			9		9		
	10			10		10		
	11			11		11		
	12			12		12		
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							

Remarks:
- ☐ Rejected
- ☐ Added due to mislocated pile
- ☐ Added due to broken pile
- ☐ Added due to design change
- ☐ Deleted due to design change
- ☐ Possibly broken
- ☐ Completed with follower
- ☐ stopped driving to splice at ___ ft
- ☐ stopped driving at ___ ft
- ☐

PILE:
Type ☒ End Bearing ☐ Friction
Size 24" dia, Pile A 1/2" wall B, C, D 1" wall
Max. Factored Load ___ kip (kN)
Nominal Resistance 600 kip

HAMMER:
Type Delmag D36-26
Rated Energy 90,560 ft-lbs
Measured Energy ___ ft-lbs
Stopping Criteria ___ bpi at Fuel Setting 2 and ___ ft stroke

Field Representative Signature

Blows for final ___ in.: ___ ___ ___ ___ ___ ___ Blows/in. Avg.: ___ Req. Avg.: ___

PILE NO. C

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PILE DRIVING LOG

10/11/13 Re-strike

PILE NO. D — Column-Location

PROJECT & PIN	Richmond-Dresden WIN 12674.10 Pay Item 501.55
LOCATION	Template CL approx 121 + 65 (to be confirmed)
FOUNDATION I.D.	Between proposed Pier 5 and Pier 6
GEN. CONTRACTOR	Reed & Reed
PILE CONTRACTOR	Reed & Reed and GZA, Pile Testing Subcontractor
RESIDENT ENGR	Peter Brown
TEAM GEOTECH	L. Krusinski
INSPECTOR	

	Heat No.	Pile ID No.	Date Driven	Section	Measured Lengths (ft)
24" ∅, 1"-WALL, HOLLOW, STEEL				BOTTOM	
SHOE (OPEN).		PLYWOOD CUSHION/PLUG		MIDDLE	
+ STEEL CAP		@ TOP.		TOP	

Heave Measurement

	Date shot	Elevation (ft)	Movement (ft)
End of Driving			0.00
Final Check			

Total length
Length deducted
Length deducted
Total deducted
Net length

Approx. Grnd Surf. El. ft
Initial Top El. ft
Length Of Pile 40 ft
Tip El. ft
Cut-off El. 6-10" ft
Initial Pay Length ft
Net Change In Tip El. ft
Final Tip El. ft
Final Pay Length ~39.5 ft

Necessary to redrive: ☐ Yes ☐ No
Redrive Blows Per Inch: ___ ___ ___ ___ ___ ___

FUEL SETTING 2

Deviation from design location: N ___ S ___ E ___ W ___

Gages @ x 36.0'

Final Inspection: Date ___ ☐ Pile Accepted ☐ Pile Rejected

Flexing as it drives

Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)	Depth (ft)	Blows (per ft.)
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

Approx. Depth Preaugered: ___ Bottom ___ Middle ___ Top

Time Finish: ___

Time Start: ___

∅=8 KSI, P@30', P@30', PLUGGING @ 598-615 KIP

INCREASE TO FUEL SETTING 3

9.5 KSI 650 KIPS

Depth (ft)	Depth (in)	Blows (per in.)	Depth (ft)	Depth (in)	Blows (per in.)	Depth (ft)	Depth (in)	Blows (per in.)
	1	6					1	
	2	10					2	
	3	7					3	
	4	3					4	
	5	8					5	
	6	8.					6	
	7	15					7	
	8						8	
	9						9	
	10						10	
	11						11	
	12						12	
1		4						
2		3						
3		3						
4		7						
5		4						
6		6						
7		6						
8								
9								
10								
11								
12								

Remarks:

- ☐ Rejected
- ☐ Added due to mislocated pile
- ☐ Added due to broken pile
- ☐ Added due to design change
- ☐ Deleted due to design change
- ☐ Possibly broken
- ☐ Completed with follower
- ☐ ∅ stopped driving to splice at ___ ft
- ☐ ♦ stopped driving at ___ ft
- ☐

PILE:
Type ☒ End Bearing ☐ Friction
Size 24" dia, Pile A 1/2" wall B, C, D 1" wall
Max. Factored Load ___ kip (kN)
Nominal Resistance 600 kip

HAMMER:
Type Delmag D36-26
Rated Energy 90,560 ft-lbs
Measured Energy ___ ft-lbs
Stopping Criteria ___ bpi at Fuel Setting 2 and ___ ft stroke

Field Representative Signature

Blows for final ___ **in.:** ___ ___ ___ ___ ___ ___ **Blows/in. Avg.:** ___ **Req. Avg.:** ___

PILE NO. D

Form 4013 (Regular)