

Memo

To: Ms. Bethany Leavitt, Director of Public Works
From: Daniel J. Bannon, P.E. and Darren Clark, P.E.
c: Chris Wharff, Harbormaster
Date: March 4, 2024
Re: Bar Harbor Town Pier Post-Storm Inspection
Test Pit Investigation
Bar Harbor, ME
GEI Project No. 2400335

Overview

GEI Consultants, Inc. observed four (4) test pits at the Town Pier in Bar Harbor, ME on February 21, 2024. The test pits were excavated by contractor KJ Dugas at the approximate locations denoted as TP-1 through TP-4 on Fig. 1 (Attachment 1).

The test pit observations followed a limited visual inspection performed by GEI on January 22, 2024. The Town requested this inspection after the pier was overtopped and impacted by wave action during the coastal storms on January 10 and 13, 2024, which brought high tides, storm surge, and strong wave action to the coast of Maine. The storms caused the pier's pavement surface to delaminate and crack in several locations, raising concerns that voids may have developed within the soil-filled stacked granite structure. Refer to GEI's report *Bar Harbor Town Pier Post-Storm Inspection* dated January 29, 2024, for more information on this inspection. Subsequent to GEI's inspection, a ground penetrating radar (GPR) and multi-channel analysis of surface waves (MASW) survey of the pier was completed by Hager-Richter Geoscience (HRGS), which indicated possible "disturbed soils" within portions of the pier. Refer to HRGS report *Geophysical Survey, Town Pier, Bar Harbor, Maine* dated February 2024.

Test Pit Exploration Program

KJ Dugas excavated four (4) shallow test pits at locations TP-1 through TP-4 on February 21, 2024. GEI was onsite to observe and document the test pits. GEI prepared test pit logs (Attachment 3), visually classified soils in the field following the Unified Soil Classification System (USCS) and collected representative soil samples from each unique layer in each test pit. The soil samples were returned to GEI's office for confirmation of USCS classification by a senior geotechnical engineer.

The test pits were excavated to the maximum practical depth below grade (ranging from 6 to 9 feet) based upon the equipment used and obstructions encountered. Test pit locations were identified based upon recent drone imagery collected by GEI and painted parking space locations on the pier.

Subsurface Conditions

The layers encountered in the four test pits are described below in order of increasing depth. Conditions are known only at the test pit locations, and conditions between test pits may differ from those indicated below.

Asphalt Pavement and Densely Compacted Base: The pier deck is surfaced with asphalt pavement, which was present at all four test pit locations with an estimated thickness of 3 to 4 inches. The asphalt pavement was underlain by a densely compacted base to a depth of approximately 1 foot below ground surface at all four test pits.

Base Gravel: Beneath the asphalt pavement and densely compacted base a layer of Base Gravel was encountered that classified as SW-SM (widely graded sand with silt and gravel) or SW-SC (widely graded sand with clay and gravel). The Base Gravel layer extended to approximately 2.5 to 5 feet below the ground surface. The Base Gravel Layer was observed in TP-1, TP-2, and TP-3 but was not observed in TP-4. A layer of woven geotextile was encountered at a depth of approximately 3 feet below ground surface in all four test pits

Fill: A layer of Fill was encountered that was generally more coarse in nature than the Base Gravel with a higher percentage of cobbles and larger sized cobbles than the Base Gravel. The Fill was classified as GM (silty gravel with sand) and GW-GM (widely graded gravel with silt and sand). Large cobbles and boulders were frequently encountered within this layer up to 30 inches in average diameter. In TP-1 and TP-2 the larger stones were typically rounded or subrounded, while in TP-3 and TP-4 larger stones were typically angular or subangular, possibly crushed rock. In TP-1 and TP-2, a geogrid mesh was encountered at approximately 5 feet below grade. This geogrid was not encountered within the limits of TP-3 or TP-4. The fill contained trace coal and wood fragments in TP-2.

Obstructions and Refusal: Various obstructions were encountered in the test pits:

- TP-1: An electrical line in conduit was encountered at 2 feet below grade. Two 12x12 creosoted timbers were encountered at 6 feet below grade.
- TP-3: The test pit was terminated at 7 feet below grade on possible bedrock.
- TP-4: A pipe was encountered at approximately 4 feet 3 inches below grade, which was suspected to be an abandoned water line.

The presence and depth below grade of layers observed within the four test pits are summarized in Table 1.

Table 1. Summary of Layers Observed in Test Pits

Layer	TP-1	TP-2	TP-3	TP-4
Asphalt & Densely Compacted Base	0 – 1 foot	0 – 1 foot	0 – 1 foot	0 – 1 foot
Base Gravel SW-SM & SW-SC	1 – 2.5 feet	1 – 5 feet	1 – 3 feet	Not observed
Fill GM & GW-GM	2.5 – 6 feet	5 – 9 feet	3 – 7 feet	1 – 8 feet

Groundwater Levels

Groundwater was not observed in the test pits. We expect that groundwater levels will be influenced by the tides. The following tidal elevations are applicable to the site (elevations are reported in NAVD88 datum):

- Mean Higher High Water (MHHW): El. +5.40 feet
- Mean Sea Level (MSL): El. -0.30 feet
- Mean Lower Low Water (MLLW): El. -5.97 feet

Given the top of pier elevation of approximately 10.75 feet and the depth of test pits ranging from 6 to 9 feet below grade, the test pits would have extended within the upper portion of the tidal elevation range. The test pits were completed between approximately 10:30AM and 2:30PM on February 21. Given the time of high-tide of 8:37AM and low tide of 3:04PM on the day of the work, the test pits would have likely remained above the tidal water elevation when they were excavated.

Observations and Discussion

Based on GEI's observations of the four test pits that were completed in February 2024, we make the following observations:

The layer of Base Gravel present in TP-1, TP-2, and TP-3 appears to be of adequate quality and characteristics for the construction. The layer of Fill below the Base Gravel in TP-1, TP-2, and TP-3, and below the Asphalt Pavement and Densely Compacted Base in TP-4, is a gravelly material with many large cobbles and boulders of varying size and composition. The material appears to be of adequate quality and characteristics for the construction. The presence of a woven geotextile at a depth of approximately 3 feet below the ground surface in all test pits will provide strength and load distribution within the pier fill, and also suggests a recent-era history of pier improvements given that this type of geotextile would not have been in use when the pier was originally built (believed to be c. 1940-1950 based on historical aerial imagery and USGS Topo Maps). No significant voids or evidence of loss of material from within the pier were observed in the test pits within the limits of exploration.

The presence of a geogrid mesh within TP-1 and TP-2, which was not observed in TP-3 and TP-4, as well as the differences in composition of the Fill, with more rounded cobbles and boulders in TP-1 and TP-2 and more angular cobbles and boulders in TP-3 and TP-4, suggest there may have been different eras of construction or sources of material between sections of the pier.

GEI's observations do not provide a definitive explanation for the variations in shear wave velocity in the areas identified by HRGS as "possible disturbed soils." We suspect that the geophysical results may be influenced by the increased depth of bedrock toward the northern end of the pier, variations in the composition of the fill, variations in the level of compaction that was achieved during construction or consolidation that has occurred since, or the groundwater levels at the time of the surveys.

GEI has not observed conditions that would indicate large scale instability, signs of voids within the pier, loss of structural capacity, or elevated risk to safety that would preclude the continued use of the pier. GEI has not conducted a full detailed inspection or structural analysis to define safe loading limits, which are beyond our scope of work. As a result we are unable to draw conclusions about the

overall capacity of the pier. However, we have not observed conditions that would indicate the current capacity has been reduced by the effects of the January 2024 storms.

We understand that the Town closed the pier to use after the January storms as a precautionary measure. Based upon GEI's observations, it is our opinion that the pier does not need to remain closed to use.

Next Steps and Closing

If upon review of the contents of this memo the Town has any questions or comments, please contact Dan Bannon by email at dbannon@geiconsultants.com or by phone at (207) 347-2372. A meeting or phone call can be scheduled to review GEI's findings.

We appreciate the opportunity to provide these services to the Town of Bar Harbor. Please do not hesitate to contact us with any questions or further requests.

Attachments:

1. Fig. 1 - Test Pit Locations
2. Photos
3. Test Pit Logs

[JAG/DJB/DDC:bdp]

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Attachment 1

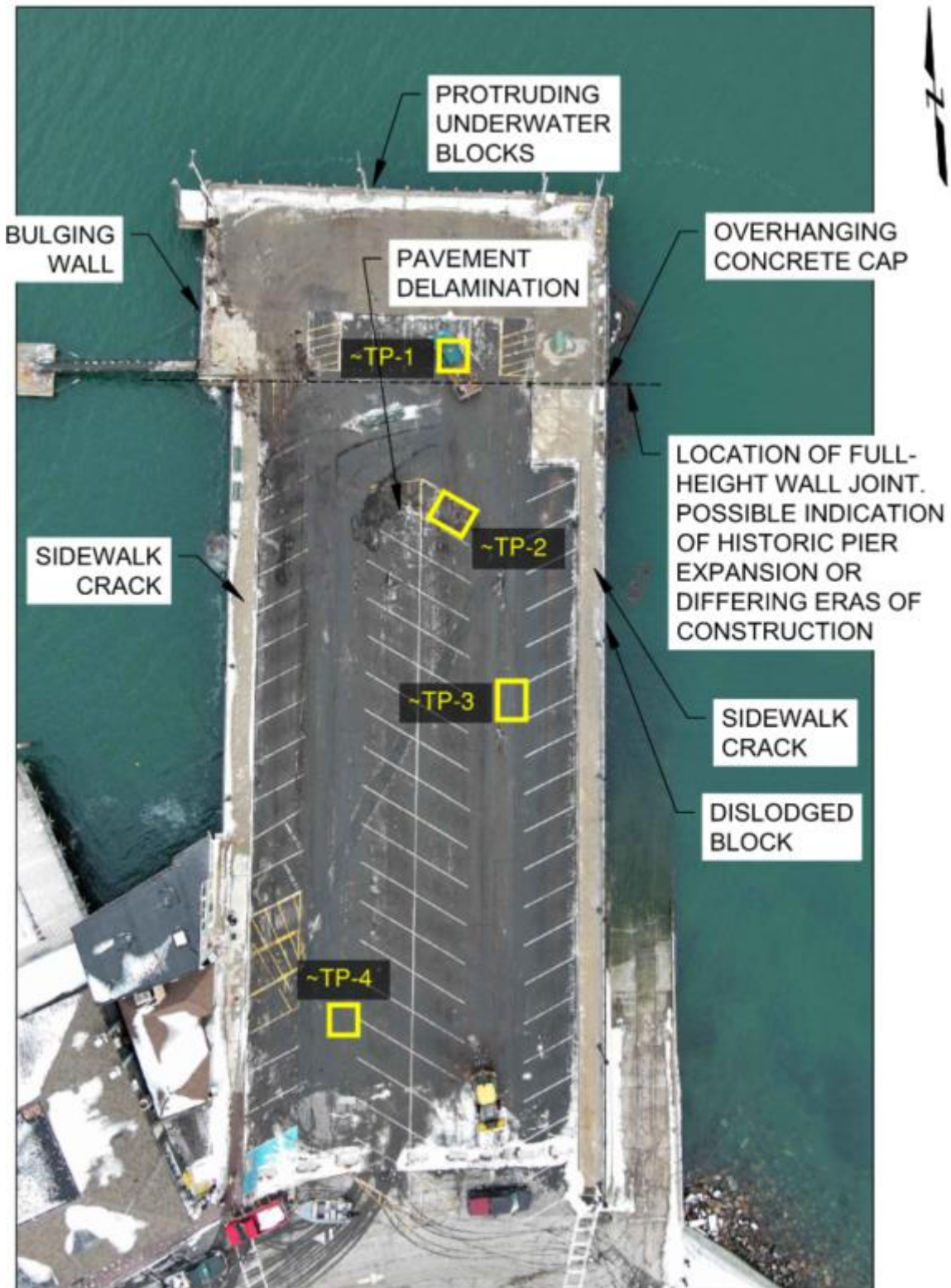


Fig. 1 – Test Pit Locations

Attachment 2

Photos



Photo 1 – TP-1



Photo 2 – TP-1



Photo 3 – TP-2



Photo 4 – TP-2



Photo 5 – TP-3



Photo 6 – TP-3



Photo 7 – TP-4



Photo 8 – TP-4

Attachment 3


Test Pit Logs

TEST PIT LOG

TP-1

Project	Bar Harbor Town Pier		PG.	1	OF	2
City/Town	Bar Harbor, ME		Location	See Fig. 1		
Client	Town of Bar Harbor					
Equipment/Reach	Volvo EW170 / 26'		Ground El.	+/- 10.75'		
Weather	20's-30's F, Sunny		Datum	NAVD88		
Contractor	KJ Dugas	Operator	Ken Dugas			
Observed By	N. Louis	Date	2/21/2024			
Checked By	M. Johnescu	Date	2/29/2024			
			Project No.	2400335		
			Start Date	2/21/2024		
			End Date	2/21/2024		

Depth (ft)	Sample No. and Type	Sample Depth (ft)	Soil Description
1		0 - 1	ASPHALT PAVEMENT & DENSELY COMPACTED BASE
2	G-1 @ 1400	1 - 2.5	1-2.5': WIDELY GRADED SAND WITH SILT and GRAVEL (SW-SM): ~60% medium to coarse sand, ~30% gravel up to 2", ~10% fines, brown, moist, BASE GRAVEL. Encountered presumed electrical line at 2.0'
3			2.5-6': SILTY GRAVEL WITH SAND (GM): ~55% gravel up to 2.5", ~30% medium-coarse sand, ~15% silt, brown, wet, FILL. Many smooth, round cobbles. Timber/creosote odor in air. Encountered layer of geotextile at 3.0' Encountered layer of geogrid at 5.0' Encountered two 12"x12" timbers at 6.0'
4	G-2 @ 1430	2.5 - 6	
5			
6			
7			Bottom of test pit at ~6 ft. Refusal on large timbers. Test pit spoil pile ~40% cobbles and boulders, rounded-subrounded, up to 1.5' in diameter. Test pit backfilled with excavated soil tamped down with excavator bucket in lifts.
8			

<p>Notes:</p> <ul style="list-style-type: none"> 1 - No water table encountered 2 - Test pit backfilled with excavated soil upon completion 3 - Test pit was also partially backfilled with crushed gravel 	<p>Pit Dimensions (ft)</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Length</td> <td style="text-align: center; padding: 2px;">10.5</td> </tr> <tr> <td style="padding: 2px;">Width</td> <td style="text-align: center; padding: 2px;">6</td> </tr> <tr> <td style="padding: 2px;">Depth</td> <td style="text-align: center; padding: 2px;">6</td> </tr> </table>	Length	10.5	Width	6	Depth	6	
Length	10.5							
Width	6							
Depth	6							

TEST PIT LOG

TP-1

Project	Bar Harbor Town Pier		
City/Town	Bar Harbor, ME		
Client	Town of Bar Harbor		
Equipment/Reach	Volvo EW170 / 26'		
Weather	20's-30's F, Sunny		
Contractor	KJ Dugas	Operator	Ken Dugas
Observed By	N. Louis	Date	2/21/2024
Checked By	M. Johnescu	Date	2/29/2024

PG.	2	OF	2
Location	See Fig. 1		
Ground El.	+/- 10.75'		
Datum	NAVD88		
Project No.	2400335		
Start Date	2/21/2024		
End Date	2/21/2024		



Photo 1: TP-1 excavation



Photo 2: TP-1 excavated material

Notes:

- 1 - No water table encountered
- 2 - Test pit backfilled with excavated soil upon completion
- 3 - Test pit was also partially backfilled with crushed gravel

Pit Dimensions (ft)

Length	10.5
Width	6
Depth	6




TEST PIT LOG

TP-2

Project	Bar Harbor Town Pier		PG.	1	OF	2
City/Town	Bar Harbor, ME		Location	See Fig. 1		
Client	Town of Bar Harbor					
Equipment/Reach	Volvo EW170 / 26'		Ground El.	+/- 10.75'		
Weather	20's-30's F, Sunny		Datum	NAVD88		
Contractor	KJ Dugas	Operator	Ken Dugas			
Observed By	N. Louis	Date	2/21/2024			
Checked By	M. Johnescu	Date	2/29/2024			
			Project No.	2400335		
			Start Date	2/21/2024		
			End Date	2/21/2024		

Depth (ft)	Sample No. and Type	Sample Depth (ft)	Soil Description
1		0 - 1	ASPHALT PAVEMENT & DENSELY COMPACTED BASE
2			1-5': WIDELY GRADED SAND WITH SILT and GRAVEL (SW-SM): ~50% medium to coarse sand, ~40% gravel up to 3.75", ~10% fines, brown, moist, BASE GRAVEL. Many large, smooth (rounded) cobbles. Encountered layer of geotextile at 3.0' Encountered layer of geogrid at 4.83'
3	G-1 @ 1235	1 - 5	
4			
5			5-9': SILTY GRAVEL WITH SAND (GM): ~50% gravel up to 2", ~30% medium-coarse sand, ~20% silt, brown, wet, FILL. Trace coal fragments, trace wood fragments, organic odor. Many large, rounded, smooth cobbles. Bottom of test pit at ~9 ft. Test pit spoil pile ~40% cobbles, rounded-subrounded, up to 1' in diameter. Test pit backfilled with excavated soil tamped down with excavator bucket in lifts.
6			
7	G-2 @ 1250	5 - 9	
8			
9			

<p>Notes:</p> <ul style="list-style-type: none"> 1 - No water table encountered 2 - Test pit backfilled with excavated soil upon completion 3 - Test pit was also partially backfilled with crushed gravel 	<p>Pit Dimensions (ft)</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Length</td> <td style="text-align: center; padding: 2px;">11</td> </tr> <tr> <td style="padding: 2px;">Width</td> <td style="text-align: center; padding: 2px;">5</td> </tr> <tr> <td style="padding: 2px;">Depth</td> <td style="text-align: center; padding: 2px;">9</td> </tr> </table>	Length	11	Width	5	Depth	9	
Length	11							
Width	5							
Depth	9							

TEST PIT LOG

TP-2

Project Bar Harbor Town Pier
City/Town Bar Harbor, ME
Client Town of Bar Harbor
Equipment/Reach Volvo EW170 / 26'
Weather 20's-30's F, Sunny
Contractor KJ Dugas **Operator** Ken Dugas
Observed By N. Louis **Date** 2/21/2024
Checked By M. Johnescu **Date** 2/29/2024

PG. 2 **OF** 2
Location See Fig. 1
Ground El. +/- 10.75'
Datum NAVD88
Project No. 2400335
Start Date 2/21/2024
End Date 2/21/2024



Photo 1: TP-2 excavation



Photo 2: TP-2 excavated material

Notes:

- 1 - No water table encountered
- 2 - Test pit backfilled with excavated soil upon completion
- 3 - Test pit was also partially backfilled with crushed gravel

Pit Dimensions (ft)

Length 11

Width 5

Depth 9



TEST PIT LOG

TP-3

Project	Bar Harbor Town Pier		
City/Town	Bar Harbor, ME		
Client	Town of Bar Harbor		
Equipment/Reach	Volvo EW170 / 26'		
Weather	20's-30's F, Sunny		
Contractor	KJ Dugas	Operator	Ken Dugas
Observed By	N. Louis	Date	2/21/2024
Checked By	M. Johnescu	Date	2/29/2024

PG.	1	OF	2
Location	See Fig. 1		
Ground El.	+/- 10.75'		
Datum	NAVD88		
Project No.	2400335		
Start Date	2/21/2024		
End Date	2/21/2024		

Depth (ft)	Sample No. and Type	Sample Depth (ft)	Soil Description
1		0 - 1	ASPHALT PAVEMENT & DENSELY COMPACTED BASE
2	G-1 @ 1100	1 - 3	1-3': WIDELY GRADED SAND WITH CLAY and GRAVEL (SW-SC): ~20% gravel up to 1", ~70% medium-coarse sand, ~10% fines, brown, moist, BASE GRAVEL. Encountered geotextile layer at 3.0'
3			
4			
5	G-2 @ 1120	3 - 7	3-7': WIDELY GRADED GRAVEL WITH SILT AND SAND (GW-GM): ~50% gravel up to 2.5", ~40% medium-coarse sand, ~10% fines, brown, wet, FILL. Many rocks and crushed bedrock in this layer ~50% of weight or more (very angular).
6			
7			
8			Bottom of test pit at ~7 ft. Refusal on possible bedrock. Test pit spoil pile ~50% cobbles and boulders, angular, 6"-28" in diameter. Test pit backfilled with excavated soil tamped down with excavator bucket in lifts.

Notes:
 1 - No water table encountered
 2 - Test pit backfilled with excavated soil upon completion
 3 - Test pit was also partially backfilled with crushed gravel

Pit Dimensions (ft)	
Length	10
Width	6
Depth	7



TEST PIT LOG

TP-3

Project	Bar Harbor Town Pier		
City/Town	Bar Harbor, ME		
Client	Town of Bar Harbor		
Equipment/Reach	Volvo EW170 / 26'		
Weather	20's-30's F, Sunny		
Contractor	KJ Dugas	Operator	Ken Dugas
Observed By	N. Louis	Date	2/21/2024
Checked By	M. Johnescu	Date	2/29/2024

PG.	2	OF	2
Location	See Fig. 1		
Ground El.	+/- 10.75'		
Datum	NAVD88		
Project No.	2400335		
Start Date	2/21/2024		
End Date	2/21/2024		



Photo 1: TP-3 excavation



Photo 2: TP-3 excavated material

Notes:

- 1 - No water table encountered
- 2 - Test pit backfilled with excavated soil upon completion
- 3 - Test pit was also partially backfilled with crushed gravel

Pit Dimensions (ft)

Length	10
Width	6
Depth	7




TEST PIT LOG

TP-4

Project	Bar Harbor Town Pier		PG.	1	OF	2
City/Town	Bar Harbor, ME		Location	See Fig. 1		
Client	Town of Bar Harbor					
Equipment/Reach	Volvo EW170 / 26'		Ground El.	+/- 10.75'		
Weather	20's-30's F, Sunny		Datum	NAVD88		
Contractor	KJ Dugas	Operator	Ken Dugas			
Observed By	N. Louis	Date	2/21/2024			
Checked By	M. Johnescu	Date	2/29/2024			
			Project No.	2400335		
			Start Date	2/21/2024		
			End Date	2/21/2024		

Depth (ft)	Sample No. and Type	Sample Depth (ft)	Soil Description
1		0 - 1	ASPHALT PAVEMENT & DENSELY COMPACTED BASE
2			<p>1'-8': WIDELY GRADED GRAVEL WITH SILT and SAND (GW-GM): ~60% gravel, cobbles, and boulders up to 2.5', ~30% medium-coarse sand, ~10% fines, brown, moist, FILL. Many rocks, boulders, and crushed ledge in this layer.</p> <p style="text-align: center;">Encountered layer of geotextile at 3.0'</p> <p style="text-align: center;">Encountered old pipe at 4.25' - assumed to be abandoned water line. Excavator dug around it without making contact.</p>
3			
4			
5	G-1 @ 1210	1 - 8	
6			
7			
8			Bottom of test pit at ~8 ft. Test pit spoil pile ~50% cobbles and boulders, angular-subangular, up to 2.5' in diameter. Test pit backfilled with excavated soil tamped down with excavator bucket in lifts.

<p>Notes:</p> <ul style="list-style-type: none"> 1 - No water table encountered 2 - Test pit backfilled with excavated soil upon completion 3 - Test pit was also partially backfilled with crushed gravel 	<p>Pit Dimensions (ft)</p> <p>Length 11.5</p> <p>Width 9</p> <p>Depth 8</p>	
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TEST PIT LOG

TP-4

Project	Bar Harbor Town Pier		
City/Town	Bar Harbor, ME		
Client	Town of Bar Harbor		
Equipment/Reach	Volvo EW170 / 26'		
Weather	20's-30's F, Sunny		
Contractor	KJ Dugas	Operator	Ken Dugas
Observed By	N. Louis	Date	2/21/2024
Checked By	M. Johnescu	Date	2/29/2024

PG.	2	OF	2
Location	See Fig. 1		
Ground El.	+/- 10.75'		
Datum	NAVD88		
Project No.	2400335		
Start Date	2/21/2024		
End Date	2/21/2024		



Photo 1: TP-4 excavation



Photo 2: TP-4 excavated material

Notes:

- 1 - No water table encountered
- 2 - Test pit backfilled with excavated soil upon completion
- 3 - Test pit was also partially backfilled with crushed gravel

Pit Dimensions (ft)

Length 11.5

Width 9

Depth 8

