Lubec Breakwater

Subsurface Geotechnical Investigation Report

Submitted to:
Maine Department of Transportation

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August 30, 2024

Project No:	E2X97600
Document Title:	Lubec Breakwater – Subsurface Geotechnical Investigation Report
Revision:	3
Date:	August 30, 2024
Client Name:	Maine Department of Transportation
Project Manager:	Erika Rosenstein
Author:	Michael Kullmann / Sam Nauss
File Name:	Subsurface Geotechnical Investigation Report – Lubec Breakwater.docx

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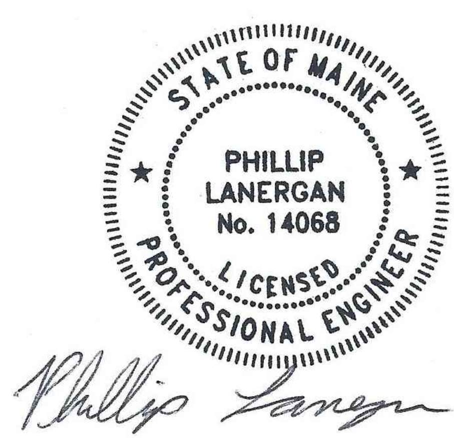
Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	09/28/23	Preliminary Geotechnical Report	MK	SN	PL	ER
1	12/1/23	Interim Geotechnical Data Report	MK	SN	PL	ER
2	05/17/24	Subsurface Geotechnical Investigation Report - Draft	MK	SY, SN	PL	ER
3	08/30/24	Subsurface Geotechnical Investigation Report - Final	MK	SY, SN	PL	ER



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APPENDICES

Executive Summary

Jacobs Engineering Group Inc. (Jacobs) is performing geotechnical engineering services for the Maine Department of Transportation (MaineDOT) as part of the design and construction of a breakwater structure in Johnson Bay, Lubec, Maine. The proposed breakwater will offer local fisherman improved marine infrastructure to facilitate their vessels and fishing economy. The breakwater will be made from two types of structures: a rubble-mound breakwater and a pile-supported platform with a precast concrete wave screen. The project also includes construction of pile guided floats that will be used for berthing the fishing vessels, and a ramp for placement and removal of the fishing vessels.

Two geotechnical investigations were performed to explore the subsurface soil conditions on-site and determine the nature and competency of the subsurface materials to support the breakwater structures. A preliminary investigation was performed in July 2023 for the initial breakwater layout and a supplemental investigation was performed in February 2024 after the breakwater layout was finalized. In total, fourteen (14) water borings and nine (9) onshore test pits were conducted in conjunction with geotechnical laboratory testing on representative soil and rock samples. Data collected from the two investigations were combined with data documented in the Haley and Aldrich (H&A) Geotechnical Design Memorandum from a subsurface investigation that was performed in September of 2020. Geotechnical evaluations were completed by assessing the subsurface soil conditions at the site for the purpose of developing foundation support for the proposed breakwater systems.

This report includes detailed information related to the subsurface geotechnical investigations conducted on site. The subsurface investigations consisted of drilling borings using a drill rig atop a floating barge and collection of soil and rock samples. Field data such as SPT N-values, soil and rock sample collection/description along with laboratory test data gathered from field investigation, were used to determine the engineering properties of the overburden soil and bedrock to discern the most feasible breakwater rubble-mound geometry and pile rock socket lengths.

Subsurface conditions at the project site consisted of very soft Organic Silt, underlain by very soft to very stiff Clay and Silt with varying amounts of sand and gravel. Below the Clay and Silt layer is a loose to very dense Glacial Till layer composed mostly of sand with varying amounts of gravel, clay, and silt. The natural overburden is underlain with Quoddy Formation siliceous shale, sandstone, and tuff. The bedrock is defined as moderately hard, extremely close to moderately fractured, and completely weathered to fresh rock.

This report also includes geotechnical evaluations performed by Jacobs to provide recommendations for the rubble-mound breakwater and pile-supported platform structures. Evaluations of the rubble mound breakwater include global stability analyses performed using the software Slide (developed by Rocscience) and settlement analyses performed using the software Settle3 (developed by Rocscience). It was determined that the proposed geometry of the rubble mound breakwater is stable against slope stability for both static and seismic loading conditions. Settlements of the rubble mound were predicted to be between 18 and 25 inches. These large settlements are mainly due to the presence of compressible, fine-grained material at seabed under the breakwater. Although these settlements are consolidation settlements, it is anticipated that they will mostly occur during the construction of the breakwater due to the rock displacing the soft sediment, and can be corrected by placement of additional armor stone.

Axial and lateral capacity analyses were performed for piles supporting the wave screen platform portion of the breakwater. Rock socketed steel pipe piles are required because the subsurface investigations indicated soft overburden soils overlying shallow bedrock. Based on unconfined compression strength data collected on the rock core samples and loads provided from Jacobs' Structural engineering team, rock socket lengths were determined to range from 8 ft to 25 ft. Pile lateral resistance was estimated using LPILE by Ensoft and presented in terms of a point of fixity for the structural team to accurately model the pile end conditions in STAAD.

Construction recommendations including onshore subgrade preparation, excavating, and backfilling, as well as pile driving and rock socket construction recommendations are also included in this report.

1. Introduction

The State of Maine Department of Transportation (MaineDOT) has retained Jacobs Engineering Group Inc. (Jacobs) for engineering services associated with the construction of the Lubec Breakwater. The Lubec Breakwater will be a new breakwater located in Johnson Bay, within the Town of Lubec, Washington County, Maine. As part of the scope of the project, Jacobs conducted two geotechnical investigation campaigns, in July of 2023 and in February of 2024, to support providing geotechnical design and construction recommendations for the proposed breakwater design.

This Subsurface Geotechnical Investigation Report summarizes the findings from the subsurface geotechnical investigations and geotechnical related recommendations for the design and construction of the Lubec Breakwater. The subsurface investigations included two separate field investigations: a preliminary phase conducted at the beginning of the project in early stages of design, and a final phase conducted once the final breakwater layout was determined. Field explorations included advancing fourteen (14) on-water soil test borings and nine (9) on-shore test pits. The results of these investigations will be combined with pile probe information collected as part of a Haley and Aldrich plan-level geotechnical investigation. Laboratory testing was also conducted on the soil and rock samples collected from the 14 on-water borings. Specific objectives of the geotechnical investigations include:

- Confirm and profile the types and depths of subsurface soils at the site;
- Characterize the encountered soils on the basis of the Burmister Classification System, Unified Soil Classification System (USCS), and the Munsell Color System, and determine the soils' index properties, including particle size distribution and plasticity;
- Define the top of rock elevation and estimate the bedrock properties for breakwater design;
- Provide design and engineering recommendations; and
- Provide construction recommendations.

The purpose of this report is to provide evaluations and recommendations based on the results of the geotechnical investigations performed at the site.

2. Site Description

The proposed Lubec Breakwater is located in the town of Lubec, Washington County, Maine. The site is west of the Main Street and South Street intersection, and southwest of Allen Lane. Lubec is known for its fishing industry which has been heavily impacted by environmental factors such as strong winds, a large tidal differential, and currents. As such, the town is in need of breakwater infrastructure to allow fisherman safe launching, mooring, and berthing of vessels.

The site surface elevations range from about 47 ft to 9 ft (NAVD 88) along the shore towards Johnson Bay. All elevations in this report refer to NAVD 88 Datum. The location of the project site is shown in Figure 2-1.

Figure 2-1. Lubec Breakwater Site Location

This geotechnical investigation was undertaken at locations highlighted in support of the Project described below in Section 3.

3. Project Description

The project consists of the construction of a new breakwater structure extending out into Johnson Bay, west of the Lubec shoreline. The breakwater will be designed to provide a safe harbor for launching, recovering, and tie up of 35 vessels, up to 40 ft in length. The proposed breakwater structure is approximately 925 ft in length with a top elevation of 23 ft above the North American Vertical Datum of 1988 (NAVD88). The structure will extend approximately 600 ft from land before turning at a 45° angle heading towards the southwest direction. From there, the structure will extend an additional 325 ft.

The first leg of the breakwater will be a rubble-mound embankment-type structure. The rubble-mound will be composed of three layers of rock armor stone. The structure is proposed to slope at 2H:1V towards the seaward side and 1.5H:1V towards the harbor side. The second leg of the breakwater will be a pile-supported platform with a precast concrete wave screen panel to protect the harbor from waves. The breakwater will be designed to have a 2-way access road along the crest and platform. This road can be used for transporting catch as well as for recreation. The access road will be provided with a concrete parapet wall for protection, and a turning area. The designed crest level will be sufficient for pedestrians and vehicles to use the access road safely during 1-year return period storms. The access road will be safe from overtopping waves only for vehicles during a 100-year return period storm.

In support of the final design of the Lubec Breakwater, Jacobs has conducted two geotechnical investigations, consisting of a total of fourteen (14) water borings located in Johnson Bay and nine (9) test pits on the adjacent shoreline. The geotechnical data collected during the investigation will provide information for the design of the breakwater structure. Laboratory testing was undertaken on representative soil and rock samples as part of the investigation. Boring locations for the geotechnical investigations are shown on Figure 3-1.

A previous geotechnical investigation program was performed at the project site by Haley & Aldrich on September 28th and 29th of 2020 as part of a planning level geotechnical design evaluation. The Haley & Aldrich investigation consisted of twenty-two (22) pile probes. The probes were located within the original footprint of proposed breakwater structure as well as within the toe of slope for the rubble-mound portion.

A detailed boring location and test pit plan is included in Appendix A.

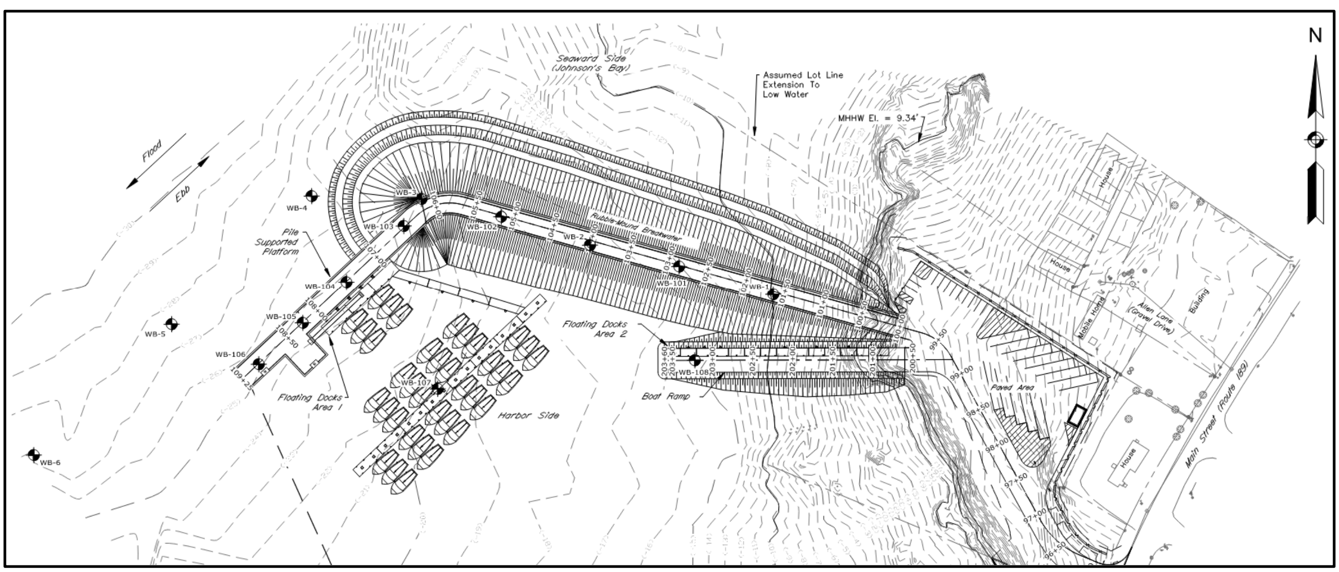


Figure 3-1. Lubec Breakwater Boring Location Plan

4. Geotechnical Investigation

4.1 Overview

Two geotechnical investigations were conducted to support the Lubec Breakwater project. The first investigation was performed from July 10th to July 17th of 2023 during the preliminary stages of design. After numerous iterations of the breakwater were evaluated, and its layout was finalized; a second investigation was performed from February 22nd to March 6th of 2024 mainly to address the revised layout. Between the two investigations, a total of fourteen (14) water borings, identified as WB-1 to WB-6 (initial investigation) and WB-101 to WB-108 (final investigation), were performed. Borings WB-1, WB-101, WB-2, WB-102 and WB-3 represent subsurface soil information beneath the rubble-mound embankment section of the breakwater. These borings were advanced to top of rock. Where rock was encountered, 5 ft of rock was cored. Borings WB-103, WB-104, WB-105, and WB-106 represent the subsurface soil information beneath the pile-supported platform section of the breakwater. These borings were advanced to top of rock, wherein 30 ft of rock was cored thereafter. Borings WB-4, WB-5, and WB-6 were advanced at locations for a previous iteration of the breakwater layout and were therefore given less consideration when conducting the final geotechnical evaluations. These borings were also advanced to top of rock, wherein 30 ft of rock was cored thereafter. Boring WB-107 was advanced to represent the subsurface conditions at the floating docks and WB-108 was advanced to represent the subsurface conditions at the boat launch ramp. All borings were performed by New England Boring and logged by a Jacobs Geologist.

In addition to the borings, nine test pits were excavated onshore adjacent to the breakwater. The test pits were conducted under the supervision of MaineDOT in support of environmental permitting needs for the Project. The data collected during the test pit investigation will be used to identify the top of bedrock and for the proposed parking lot design. This data will also assist in determining the quantity of overburden soil and bedrock required to be removed as part of the cut and fill operations.

4.2 On-Water Boring Exploration

Field activities associated with the geotechnical investigations were conducted with the general objective of defining the subsurface soil profile at the site, collecting disturbed/undisturbed samples and rock cores for laboratory testing, and identifying the depth from mudline to bedrock level. Actual borings depths are noted in Table 4-1.

Table 4-1. Boring Drilling Schedule

Boring ID	Proposed Structure	Approx. Mudline Elev. (ft, NAVD 88)	Approx. Bedrock Elev. (ft, NAVD 88)	Total Borehole Depth (ft)
WB-1	Rubble-Mound	-12.5	-45.5	40.3
WB-2	Rubble-Mound	-17.0	-22.7	12
WB-3	Rubble-Mound	-24.4	-29.4	10
WB-4	N/A	-27.7	-38.5	44
WB-5	N/A	-28.1	-69.6	75
WB-6	N/A	-28.6	-99.5	105
WB-101	Rubble-Mound	-14.8	-31.8	21.6
WB-102	Rubble-Mound	-19.1	-25.1	11
WB-103	Pile-Supported Platform	-23.2	-29.7	37
WB-104	Pile-Supported Platform	-24.8	-34.3	39.5
WB-105	Pile-Supported Platform	-24.8	-34.8	41
WB-106	Pile-Supported Platform	-25.3	-39.3	44
WB-107	Floating Docks	-20.5	-39.0	48.5
WB-108	Boat Launch Ramp	-15.3	-44.3	34.5

All borings were advanced using mud-rotary drilling techniques with a Gefco Stratastar 5 drill rig mounted with an automatic hammer mounted on a barge. Soil samples were obtained via a 24-inch long split-spoon sampler (2-inch O.D., 1-3/8-inch I.D.), driven by a 140-pound automatic hammer free falling 30 inches. The number of blows required for penetration of the middle 12 inches of the sampler is the Standard Penetration Test (SPT) N-value (blows per foot). Soil samples were obtained by SPT testing in accordance with ASTM D1586, "Standard Test Method for Penetration Testing and Split-Barrel Sampling of Soils". SPT testing was performed continuously to depths of approximately 12 feet and at 5-foot intervals thereafter until bedrock was encountered. Where soft cohesive soils were encountered, select undisturbed samples were acquired with a 3 in O.D. thin-walled Shelby Tube penetrating 24 inches in accordance with ASTM D1587, "Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purpose". Rock coring started once refusal was encountered, and was performed in accordance ASTM D2113, "Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration". Rock coring was performed using an NX size double core barrel to collect rock core samples.

All borings were advanced to the scheduled depths noted in Table 4-1.

Soil samples were visually classified in the field at the time of sampling by Jacobs personnel and described on borings logs using the Burmister System of Soil Identification (Burmister 1949). The Unified Soil Classification System symbols were also provided. Additionally, soil color was classified using the Munsell Color System notation to distinguish color chroma, value, and hue. Samples from the split-spoons were placed in appropriate jar containers for storage and transported to the laboratory for testing and detailed identification.

The boring logs, presenting the subsurface soil descriptions, type of sampling used, and additional field data are presented in Appendix B. Additionally, subsurface profiles depicting the subsurface strata are included in Appendix C.

4.3 Test Pit Exploration

Nine test pits, identified as TP-1 through TP-9, were excavated using a backhoe on land at the parking lot area adjacent to the proposed breakwater location. The depths of the test pits ranged from 5.5 feet to 10.5 feet below existing grade. The test pits were performed to support environmental permitting needs of the Project and also to identify the top of rock at the shoreline and assist the civil designers with the ideal cut and fill operations, and the required pavement section for the proposed parking lot. Table 4-2 below summarizes the test pits performed. The test pit locations are presented in Appendix A.

Table 4-2. Test Pit Schedule

Test Pit ID	Existing Ground Surface Elev. (ft, NAVD 88)	Approx. Bedrock Elev.	Total Borehole Depth (ft)
TP-1	47.78	Not Encountered	10.0
TP-2	45.80	38.30	7.5
TP-3	37.47	31.97	5.5
TP-4	38.91	Not Encountered	10.5
TP-5	37.21	27.21	10.0
TP-6	31.97	21.97	10.0
TP-7	29.64	21.64	8.0
TP-8	26.03	16.53	9.5
TP-9	29.66	23.66	6.0

4.4 Haley & Aldrich Plan-Level Geotechnical Memorandum (Nov 2020)

An initial subsurface investigation was conducted by Haley & Aldrich in September of 2020. The field investigation consisted of 22 pile probes, designated HA20-P1 through HA20-P22, that were used to collect subsurface information.

The pile probes were completed by Prock Marine Company, Inc (Prock) of Rockland, Maine. Prock utilized a Link-Belt LS-518 crawler crane and an H&M Model 3208T vibratory hammer placed on an approximate 50 ft by 120 ft spud barge. An HP12x53 steel H-pile approximately 55 ft long was used to probe each location.

The pile probes were advanced using the vibratory hammer to depths ranging from approximately 1 to 30 ft below estimated mudline and were terminated into dense/hard soil or refusal. The presence and thickness of soil layers and apparent refusal surface were judged by Haley & Aldrich based on visual observation of pile probe advancement and rate of penetration. Pile probe location plan is presented in Figure 4-1. However, note that the layout investigated was the initial footprint of the breakwater, which has since been revised. Therefore, the collected information is more applicable to the rubble mound breakwater portion of the revised structure where the footprint still overlaps the probes.

A separate Geotechnical Design Memorandum documenting the findings from the Haley & Aldrich investigation is provided in Appendix D.

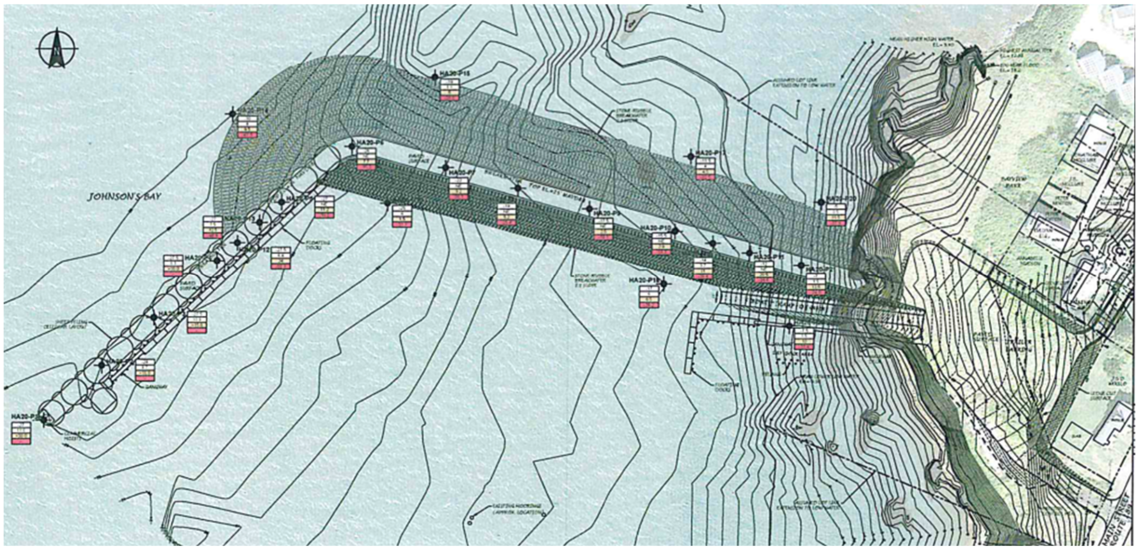


Figure 4-1. Haley & Aldrich Pile Probe Location Plan (from Haley & Aldrich 2020)

5. Geology and Seismicity

5.1 Area Geology

The Lubec Breakwater site is located within the Silurian Period aged Quoddy Formation. The Quoddy Formation is composed primarily of dark gray to black, fine grained siliceous siltstone, argillite, and shale with laminated to very thinly bedded, steeply dipping to vertical bedding planes. Minor tuff deposits and diabase mafic intrusions are also present within the Quoddy Formation. The Quoddy shale is prominently exposed in outcrops across Johnson Bay on Campobello Island, New Brunswick, Canada. Glaciomarine sediment comprising of layered fines and glacial till moraine deposits overly bedrock, and multiple northeast trending faults cut through the project site and Johnson Bay.

Figure 5-1. Quoddy Formation, Campobello Island, New Brunswick, Canada

5.2 Seismic Data

The subsurface soils encountered within the site are generally medium stiff to very stiff clays and loose to dense/very dense granular soils overlying bedrock of the Quoddy formation. Therefore, the site can be considered as Seismic Site Class D. The following Seismic Parameters were derived for the site from ASCE 7-16:

PGA – 0.126g for bedrock level
Design PGA – 0.130g for ground surface

S_s – 0.222g for bedrock level
S_1 – 0.062g for bedrock level
F_{pga} – 1.548
F_a – 1.6
F_v – 2.4
S_{DS} – 0.236 for ground surface
S_{D1} – 0.099 for ground surface

6. Subsurface Conditions

6.1 General

Detailed descriptions of the subsurface strata encountered in the borings are recorded on the individual boring logs included in Appendix B. The information includes sample depth, blow counts per 6-inches, and classification of individual samples in accordance with the Burmister Soil Classification Method. The Unified Soil Classification System (USCS) symbols are also provided. Colors were described in accordance with the Munsell Color System. Additionally, the encountered stratigraphy is provided on the boring logs.

6.2 Subsurface Profile

Four distinct layers were encountered and are described below in order of increasing depth.

6.2.1 Stratum 1 – Organic Silt

At the mudline, an Organic Silt layer is the prevalent surficial layer in all borings. The thickness of this layer ranges from 2 to 8 ft. The layer generally consisted of dark gray organic silt with varying amounts of sand. The SPT N-values within this layer generally ranged from 0 to 6 blows per foot, indicating a consistency of very soft to medium stiff. Due to its presence on the mudline, shells are found intermixed with the soil. Atterberg Limits performed on the organic silt indicated cohesive material with a Liquid Limit ranging from of 27% to 38%, Plastic Limits of 18% to 26%, and a Plasticity Index ranging from 6% to 15%.

6.2.2 Stratum 2 – Clay and Silt

This stratum was encountered immediately beneath the Organic Silt in all borings except for WB-3. This Clay and Silt layer consists of dark gray glaciomarine clay with varying amounts of silt, sand, and gravel. The thickness of this layer ranges from 2 to 38 ft. The SPT N-values within this layer generally ranged from 0 to 25 blows per foot, indicating a consistency of very soft to very stiff cohesive soil. Atterberg Limits performed on the Clay and Silt layer indicated low-plasticity clay with a Liquid Limits ranging from of 14% to 42%, Plastic Limits of 10% to 22%, and a Plasticity index of 4% to 25%.

6.2.3 Stratum 3 – Glacial Till

The glacial till layer is found beneath the Clay layer in all borings except WB-5. The till layer generally consists of coarse to fine, rounded to subangular dark gray gravel with varying amounts of silt, clay, and sand. The thickness of the till layer ranges from not present to 31 ft. The SPT N-values within this layer ranged from 9 blow per 12 inches to 100 blows over 6 inches indicating loose to very dense granular material. Particle Size Distribution tests performed on the till layer indicated a fines content ranging from 13.6% to 40.9%

6.2.4 Stratum 4 – Bedrock

Bedrock was encountered beneath the glacial till layer in all borings at depths ranging from 5 ft to 71.25 ft below mudline. The rock encountered at the site was predominantly medium gray to dark gray shale, sandstone, and tuff with calcite veining. The rock encountered at the rubble-mound breakwater was mostly shale, while the rock encountered at the revised pile-supported platform location is tuff.

The shale bedrock is laminated to thinly bedded, fine-grained, sedimentary rock and the rock cores were described as moderately hard, extremely close to moderately fractured, and ranged from completely weathered to fresh rock.

Vertical to highly steep bedding was prominent in most rock cores samples. Rock core recoveries of shale samples varied from 66% to 100%, and the Rock Quality Designation (RQD) ranged from 0% to 93%.

The tuff bedrock is massive, mafic intrusive rock and the rock cores were described as moderately hard, extremely to moderately fractured, and ranged from completely weathered to fresh rock. Shallow to steeply dipping joints with calcite veining were prominent in most rock cores samples. Rock core recoveries of tuff samples varied from 94% to 100%, and the Rock Quality Designation (RQD) ranged from 0% to 100%.

For rock cores classified as shale and sandstone, unconfined compressive strengths ranged from 828 psi to 9,043 psi. For rock cores classified as tuff, unconfined compressive strengths ranged from 3,818 psi to 22,085 psi.

6.3 Haley & Aldrich Subsurface Investigation Data

As part of the Haley & Aldrich geotechnical investigation, layer thickness and relative density was classified based on field observation of probe pile advancement. The classification was split up into "soft/loose" soils and "hard/dense" soils. Table 6-1 summarizes the classifications based on the pile probe advancement.

Table 6-1. Summary of the Haley & Aldrich Investigation

Probe ID	Approx Mudline Elev. (ft, NAVD 88)	Approximate Strata Thickness (ft) [1]			Approximate Elev. Of Refusal (ft, NAVD 88)[2]	Approximate Probe Depth Below Mudline (ft, NAVD 88)
		"Soft/Loose" Soil	"Hard/Dense" Soil	Total		
HA20-P1	-27.0	11.6	>21.0	>32.6	--	32.6
HA20-P2	-28.0	8.7	>18.0	>26.7	--	26.7
HA20-P3	-27.5	10.9	>15.0	>25.9	--	25.9
HA20-P4	-27.5	8.3	>16.0	>24.3	--	24.3
HA20-P5	-27.0	NE	11.2	12.8	-39.8	12.8
HA20-P6	-26.0	NE	7.7	9.3	-35.3	9.3
HA20-P7	-22.0	NE	9.2	8.1	-30.1	8.1
HA20-P8	-19.0	NE	5.2	6.4	-25.4	6.4
HA20-P9	-17.5	NE	2.5	1.6	-19.1	1.6
HA20-P10	-15.5	NE	2.9	2.8	-18.3	2.8
HA20-P11	-12.0	NE	20.5	22.6	-34.6	22.6
HA20-P12	-27.5	6.4	24.0	31.8	-59.3	31.8
HA20-P13	-27.0	7.5	12.5	21.9	-48.9	21.9
HA20-P14	-30.0	8.0	9.5	17.5	-47.4	17.5
HA20-P15	-19.0	1.1	0.0	1.6	-20.6	1.6

Probe ID	Approx Mudline Elev. (ft, NAVD 88)	Approximate Strata Thickness (ft) [1]			Approximate Elev. Of Refusal (ft, NAVD 88)[2]	Approximate Probe Depth Below Mudline (ft, NAVD 88)
		"Soft/Loose" Soil	"Hard/Dense" Soil	Total		
HA20-P16	-25.0	6.0	1.5	6.1	-31.1	6.1
HA20-P17	-11.5	4.0	4.5	11.0	-22.5	11.0
HA20-P18	-17.0	6.0	6.5	12.2	-29.2	12.2
HA20-P19	-14.0	3.7	11.0	15.4	-29.4	15.4
HA20-P20	-5.0	0.5	11.5	12.9	-17.9	12.9
HA20-P21	-7.0	1.5	13.6	17.0	-24.0	17.0
HA20-P22	-7.5	1.5	10.0	14.9	-22.4	14.9

Notes:
1. NE indicates soil layer Not Encountered.
2. Indicates probe not advanced deep enough to determine presence or thickness of stratum.

When comparing Jacobs boring investigation with Haley & Aldrich Pile probe pile investigation, the approximated elevation of bedrock from Jacobs' borings are relatively consistent with the elevation of refusal of Haley & Aldrich pile probes that are close in proximity to one another, especially when the bedrock was found to be relatively shallow. At locations where the bedrock is deep, the Haley & Aldrich probes were not very accurate due to the limitations of the method used for the investigation. Comparative bedrock elevations from both investigations are shown in Table 6-2. Borings WB-104 through WB-108 are not included in the table as no probes were conducted near those locations.

Table 6-2. Comparative Bedrock Data from Jacobs and Haley & Aldrich Investigations

Jacobs Boring	Approx. Elevation of Top of Bedrock (ft, NAVD 88)	Haley & Aldrich Probes	Approx. Elevation of Refusal (ft, NAVD 88)
WB-1	-45.5	HA20-P11	-34.6
		HA20-P19	-29.4
		HA20-P20	-17.9
		HA20-P21	-24
		HA20-P22	-22.4
WB-101	-31.8	HA20-P18	-29.2
		HA20-P17	-22.5
WB-2	-22.7	HA20-P9	-19.1
		HA20-P10	-18.3
WB-102	-25.1	HA20-P7	-30.1
		HA20-P8	-25.4
		HA20-P15	-20.6
WB-3 / WB-103	-29.4	HA20-P6	-35.3
WB-4	-38.5	HA20-P5	-39.8
		HA20-P13	-48.9
		HA20-P14	-47.5
		HA20-P16	-31.1

Jacobs Boring	Approx. Elevation of Top of Bedrock (ft, NAVD 88)	Haley & Aldrich Probes	Approx. Elevation of Refusal (ft, NAVD 88)
WB-5	-69.6	HA20-P3	--
		HA20-P4	--
		HA20-P12	-59.3
WB-6	-99.5	HA20-P1	--
		HA20-P2	--

6.4 Water Levels

Water level data from NOAA station (Station 841040 – Eastport, ME) is presented in Table 6-3.

Table 6-3. Tide levels at Eastport NOAA station No. 8410140

Datum	Description	Elevation (ft, NAVD88)
Highest Observed Tide	Historic highest water level observed (04/10/2020 08:54)	14.44
MHHW	Mean Higher-High Water	9.34
MHW	Mean High Water	8.86
NAVD 88	North American Vertical Datum of 1988	0.00
MSL	Mean Sea Level	-0.23
MLW	Mean Low Water	-9.49
MLLW	Mean Lower-Low Water	-9.93
Lowest Observed Tide	Historic Lowest water level observed (08/09/1972 00:00)	-14.61

7. Laboratory Testing

7.1 Overview

The objective of the laboratory testing program was to obtain data for assessing the physical and mechanical properties of the site soils and rock encountered during drilling. The testing program was performed in general accordance with applicable ASTM standard test methods. The laboratories of Geotechnical Services, Inc. and Geotesting Express conducted testing on collected soil and rock samples. The tests and quantity of each test performed for the program are summarized in Table 7-1.

Table 7-1. Schedule of Laboratory Testing Program

Test	ASTM Standard	Number of Test
Moisture Content	ASTM D2216	35
Atterberg Limits	ASTM D4318	27
Grain Size Analysis (Sieve Only)	ASTM D6913	6
Consolidation Test	ASTM D2435	5
Unconfined Compressive Strength (Soil)	ASTM D2166	3
Unconsolidated-Undrained Triaxial Compression	ASTM D2850	5
Unconfined Compressive Strength (Rock)	ASTM D7012	19

Samples chosen for testing were selected by Jacobs for the purpose of supporting the design recommendations of the Lubec Breakwater structure. The laboratory testing program was conducted to finalize the field classification of the soils encountered, and was based on soil gradation and index testing, as well as for developing shear strength and consolidation data of cohesive soils to support the geotechnical design of the proposed structures. Compressive strength data of the bedrock was also collected under the laboratory testing program.

All laboratory test results on selected soil and rock samples are included in Appendix E.

8. Geotechnical Design Parameters

Engineering design parameters of the encountered soil and rock were determined based on subsurface geotechnical investigation data, laboratory tests, and published correlations or based on engineering judgement. SPT-N values along with the soils' physical properties, including gradation and index properties such as Liquid Limit, Plastic Limit, and moisture contents were used for correlation of engineering parameters. Rock core recovery, Rock Quality Designation (RQD), and rock core laboratory testing results were used to determine the on-site bedrock engineering properties.

Table 8-1 below provides generalized engineering parameters for the soil and rock strata encountered at the site. It is to note that these parameters are best estimates for strata encountered and conditions may slightly vary at different locations. Therefore, this table may be used in conjunction with the information provided in Sections 6 and 7 to establish the soil and rock parameters to be used in specific areas of the site.

Table 8-1. Summary of Geotechnical Design Parameters

Stratum	Total Unit Weight (pcf)	Effective Friction Angle, ϕ' (Degrees)	Effective Cohesion, c' (psf)	Undrained Shear Strength, S_u (psf)	Unconfined Compressive Strength, q_u (psi)
Organic Silt	90	22	0	200	-
Clay[2]	110 – 125	24 - 30	0	300 – 1,000	-
Glacial Till	125	37	0	0	-
Decomposed to Weathered Bedrock (0% RQD)	145	45	0	0	-
Bedrock – Shale[3]	150	-	-	-	800 – 9000
Bedrock – Tuff[3]	170	-	-	-	4000 – 9000

Notes:

1. Undrained strength parameters are for short-term loading conditions. Effective strength parameters are for long-term (drained) loading conditions.
2. The clay layer varies across the site. Therefore, lower bound and upper bound engineering design parameters are provided. Individual boreholes and lab testing data shall be utilized when developing parameters for the clay layer at specific locations.
3. The lower and upper bound unconfined compressive strengths are provided for the bedrock strata.

9. Geotechnical Evaluations and Design Recommendations

The Lubec breakwater will be composed of two primary structures. The first leg of the breakwater, extending out perpendicular to the shoreline, will be a sloped rubble-mound embankment structure. The second leg of the breakwater will turn Southwest and be parallel with the shoreline and transition from the rubble-mound structure to a pile-supported platform with a precast wave screen panel. The proposed breakwater is depicted in Figure 9-1. In this section, a discussion is provided regarding the geotechnical design considerations and recommendations, which are based on the results from the subsurface investigation and subsequent analyses.

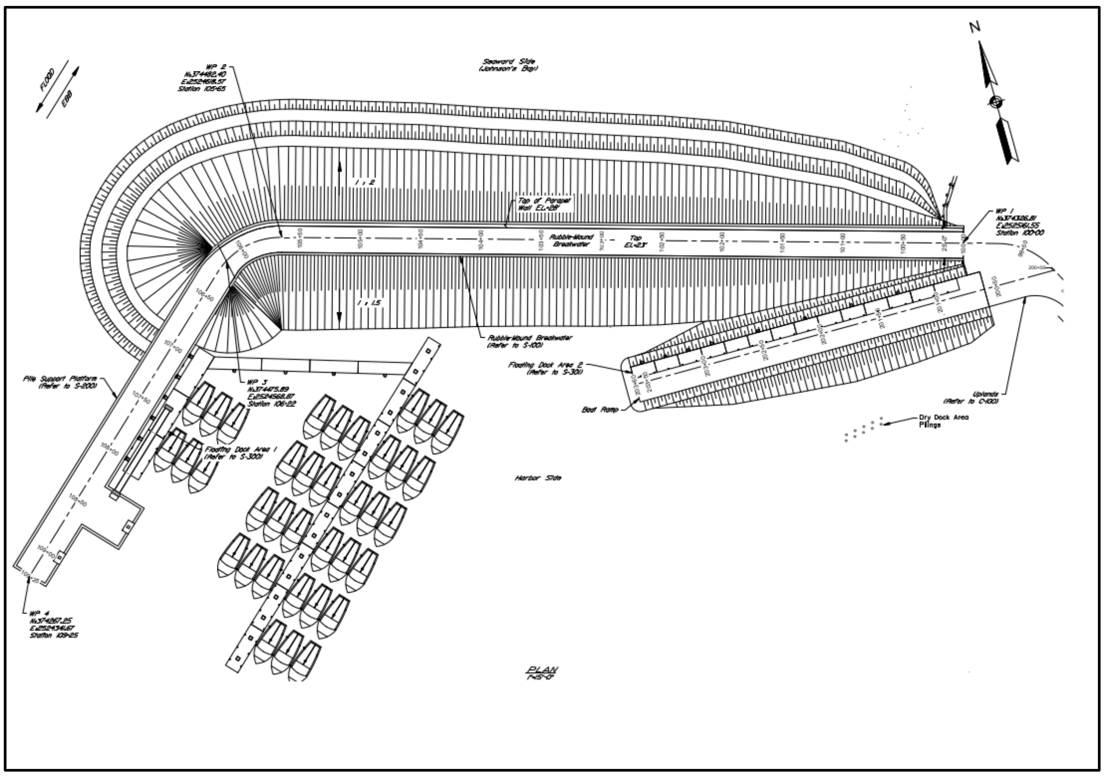


Figure 9-1. Lubec Breakwater Plan

9.1 Rubble-Mound Breakwater

The first leg of the breakwater is a rubble-mound structure composed of three different layers of varying rock sizes. In general, the rubble-mound will be made up of an outer armor layer, followed by an underlayer, and finally an inner core layer. The rubble-mound section is proposed to be sloped at 1.5H:1V toward the harbor side, and at 2H:1V toward the seaward side. A typical cross-section of the rubble-mound can be seen in Figure 9-2 below.

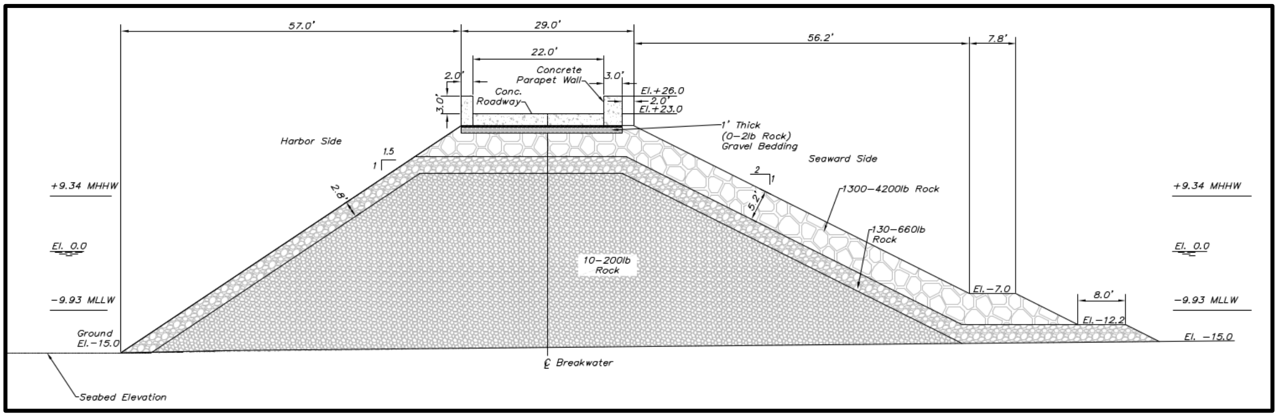


Figure 9-2. Typical Section of Rubble Mound Breakwater

Geotechnical considerations for the breakwater include its global slope stability under static and seismic loading conditions and anticipated settlement during its design life. This is further discussed below.

9.1.1 Rubble-Mound Global Slope Stability

The breakwater must remain stable under various loading situations expected during service. To assess the stability of the breakwater, geotechnical slope stability analyses were performed using Slide2, a two-dimensional limit-equilibrium slope stability software (Rocscience Inc., 2021). Three sections were analyzed in Slide since both the soil conditions and height of the breakwater vary along its alignment. The sections analyzed included the breakwater at STA 101+75 (mudline El. -12.5'), STA 103+00 (mudline El. -15), and STA 106+00 (mudline El. -23), which will be noted as Section 1, Section 2 and Section 3, respectively.

The analyses were conducted using non-circular slip surfaces evaluated with the Spencer method (which satisfies both force and moment equilibrium). The slope stability was analyzed for each section towards the harbor side and seaward side of the breakwater since the geometry of each side differs. The proposed concrete parapet walls and concrete roadway on top of the breakwater were modeled in the Slide as equivalent surcharges. Three load cases were analyzed for each section, which are as follows:

- Static Case: This case consisted of analyzing design sections for static loading against both drained and undrained soil conditions. For the static case, a design surcharge of 250 psf was considered on top of the breakwater since there will be a pavement on top of the breakwater to support vehicular traffic. The water level was modeled at MLLW or EL. -9.93' (NAVD 88).

- 100-yr Storm Case: This case consisted of analyzing design sections under static loading against both drained and undrained soil conditions. For the 100-yr storm case, the water level was modeled at El. +16.57 and no vehicular surcharge was considered.

- Seismic Case: This case consisted of analyzing design sections for one-half (1/2) of the design PGA applied as a horizontal seismic load. Undrained soil conditions were modeled and no vehicular surcharge was considered for the seismic load case. The water level was modeled at MLLW or EL. -9.93' (NAVD 88).

The minimum required factor of safety (FOS) values for static, 100-yr storm, and seismic loading conditions based on the limit-equilibrium analyses are 1.3, 1.1, and 1.0, respectively. For seismic loading, if the computed FOS is less than 1.0, Newmark Block seismic displacement analysis is to be used to estimate seismic-induced slope displacement. Slip surfaces less than 5 feet in depth were ignored as shallow surficial sloughing since they are unrealistic, and even if they would occur, would only require minor repairs.

It is to note that 2 to 4 feet of organic silt is present at the mudline. The geotechnical investigation indicated this material to be weight-of-hammer (WOH) material and therefore has very little strength. For the slope stability analyses of the rubble-mound breakwater, it was assumed that during construction of the breakwater, the armor stone will penetrate this layer and therefore increase its strength. For conservatism in the analyses, the organic silt below the rubble-mound breakwater was modeled with a friction angle of 32 degrees plus a small cohesion of 50 psf. In reality, the parameters of this layer could be much higher.

In summary, the rubble-mound breakwater shows acceptable factor of safety (FOS) against global failure for static, 100-year storm, and seismic cases. The results of the slope stability analyses are summarized in Table 9-1 below and Slide outputs are included in Appendix F.

Table 9-1. Rubble-Mound Breakwater Slope Stability Results

Breakwater Section[1]	Case	Slip Surface Direction	Global Minimum Factor of Safety (Spencer Method)[2]
Section 1 – Mudline Elevation at -12.5' (STA 101+75)	Static - Undrained	Towards the Harbor Side (Right to Left)	1.33
		Towards the Seaward Side (Left to Right)	1.37
	Static - Drained	Towards the Harbor Side (Right to Left)	1.50
		Towards the Seaward Side (Left to Right)	1.83
	100-yr Storm - Undrained	Towards the Harbor Side (Right to Left)	1.50
		Towards the Seaward Side (Left to Right)	1.75
	100-yr Storm - Drained	Towards the Harbor Side (Right to Left)	1.50
		Towards the Seaward Side (Left to Right)	1.99
	Seismic	Towards the Harbor Side (Right to Left)	1.20
		Towards the Seaward Side (Left to Right)	1.15
Section 2 – Mudline Elevation at -15' (STA 103+00)	Static - Undrained	Towards the Harbor Side (Right to Left)	1.32
		Towards the Seaward Side (Left to Right)	1.82
	Static - Drained	Towards the Harbor Side (Right to Left)	1.42
		Towards the Seaward Side (Left to Right)	1.81
	100-yr Storm - Undrained	Towards the Harbor Side (Right to Left)	1.51
		Towards the Seaward Side (Left to Right)	2.08

Breakwater Section[1]	Case	Slip Surface Direction	Global Minimum Factor of Safety (Spencer Method)[2]
	100-yr Storm - Drained	Towards the Harbor Side (Right to Left)	1.52
		Towards the Seaward Side (Left to Right)	1.96
	Seismic	Towards the Harbor Side (Right to Left)	1.16
		Towards the Seaward Side (Left to Right)	1.57
Section 3 – Mudline Elevation at -23' (STA 106+00)	Static - Undrained	Towards the Harbor Side (Right to Left)	1.45
		Towards the Seaward Side (Left to Right)	1.78
	Static - Drained	Towards the Harbor Side (Right to Left)	1.44
		Towards the Seaward Side (Left to Right)	1.80
	100-yr Storm - Undrained	Towards the Harbor Side (Right to Left)	1.51
		Towards the Seaward Side (Left to Right)	2.02
	100-yr Storm - Drained	Towards the Harbor Side (Right to Left)	1.50
		Towards the Seaward Side (Left to Right)	1.96
	Seismic	Towards the Harbor Side (Right to Left)	1.25
		Towards the Seaward Side (Left to Right)	1.49

Notes:
1. Multiple breakwater sections were analyzed due to the deepening mudline along the alignment of the breakwater and because the thickness of the clay stratum varies along the alignment of the breakwater.
2. The global minimum factor of safety considers deep seated failures and non-circular slip surfaces.
3. The water level in the SLIDE models was taken as El. -9.97', NAVD 88 (MLLW) for the static and seismic load cases, and El. +16.57', NAVD 88 for the 100-yr Storm load case.
4. For the seismic loading condition, the horizontal seismic coefficient, $k_h = 0.5 * PGA_m = 0.065$. No surcharge was considered.

9.1.2 Rubble-Mound Settlement

For a rubble-mound breakwater, settlement is largely an issue for the determination of the breakwater crest elevation. The expected settlement, especially the long-term settlement, is added to the design height of the structure as an over-build where necessary. From the subsurface investigation, it appears the rubble-mound breakwater will be placed on up to 20 ft of compressible soils, which will undergo long-term consolidation settlements. Settlement analyses was performed for the rubble-mound breakwater at three sections where specific borings were located along the breakwater:

- WB-01, STA 101+75 (mudline at El. 12.5') – profile includes 30 ft of compressible soils;
- WB-101, STA 103+00 (mudline at El. 15') – profile includes 8 ft of compressible soils;

- WB-102, STA 105+00 (mudline at El. 19') – profile includes 6 ft of compressible soils.

The software Settle3, by Rocscience Inc., was used for the analyses which accounts for varying subsurface conditions and modeling of the exact breakwater geometry. Settlement calculations were conducted to capture both the expected settlements within the organic silt layer, and long-term consolidation settlements within the clay and silt layer. However, it is proposed that during construction the rubble-mound breakwater rock is placed in the middle first and then placed outwards. Placement of the core material may create a "mud wave" of the very soft organic silt material, displacing the organic silt to the sides of the breakwater. Due to this phenomenon, the organic silt layer was modeled in Settle3 two different ways for each section to capture the possible range of settlements that may occur. The lower bound settlement was computed for the case that the rubble-mound rock completely displaces the organic silt when it is placed and therefore the organic silt layer was ignored in Settle3. The upper bound settlement was computed for the case that the rubble-mound rock is placed directly on the organic silt layer and no soil is displaced, therefore the organic silt layer was fully modeled in Settle3. Using this approach, the range of possible settlements can be fully captured.

To compute the long-term settlements of the rubble-mound breakwater, certain assumptions were made about construction sequence of the breakwater. It was assumed that the construction of the entire breakwater will take 24 months and the following sequence was used in Settle3 to estimate settlements:

1. 0 – 6 months: Construct rubble-mound core and underlayer
2. 6 – 9 months: Waiting period of 3 months for a significant portion of the settlement to be completed
3. 9 – 12 months: Adjust grade with additional underlayer as necessary, and construct rubble-mound armor layer
4. 12 – 18 months: Waiting a minimum period of 6 months
5. 18 – 24 months: Construct breakwater roadway and finish construction

The geotechnical design parameters used for the settlement analyses are summarized in Table 9-2. These parameters were determined based on subsurface information collected during the investigations including soil classifications and laboratory test results, and based on published correlations documented in NAVFAC DM 7.1 (1982) and EPRI (1990). The results of the Settle3 analyses are summarized in Table 9-3 and included in Appendix G.

Table 9-2. Geotechnical Parameters for Settle3 Model

Stratum	Total Unit Weight (pcf)	Elastic Modulus (ksf)	C_c	C_r	e_0	OCR	c_v (in^2/s)	C_α
Organic Silt	90	-	0.3	0.06	1.0	1	0.0001	0.01
Upper Silt and Clay	125	-	0.16	0.035	0.73	3	0.00048	0.005
Lower Clay and Silt[2]	115	-	0.25	0.05	0.73	1	0.0001	0.005
Till	125	1000	-	-	-	-	-	-
Bedrock[3]	170	-	-	-	-	-	-	-

Notes:
1. Abbreviations: Cc = Soil compression Index; Cr = Soil recompression Index; e_0 = Initial void ratio, OCR = Over-consolidation ratio; c_v = Coefficient of consolidation, Cα = Secondary compression Index.
2. In a few borings, the lower extent of the Clay and Silt Stratum shows very low blow counts. At these locations, the layer was split into two layers in the Settle3 models, and the lower Clay and Silt was modeled as normally consolidated (OCR = 1).
3. Bedrock was included in the Settle3 models for presentation purposes only. This layer is not expected to settle and therefore, no parameters were modeled.

Table 9-3. Results of Settle3 Analyses

Scenario	Section	Boring used in Analysis	Estimated Settlement at end of Construction² (in)	Estimated Post-Construction Settlement 1 year after Construction (in)	Estimated Post-Construction Settlement 5 years after Construction (in)	Estimated Post-Construction Settlement 50 years after Construction (in)
Lower Bound Scenario – Organic Silt Completely Displaced	STA 101+75 (Mudline El. -12.5')	WB-01	17.5	0.62	1.06	1.61
	STA 103+00 (Mudline El. -15')	WB-101	7.67	0.04	0.11	0.28
	STA 105+00 (Mudline El. -19')	WB-102	3.84	0.02	0.05	0.12
Upper Bound Scenario – Organic Silt Fully Present under Breakwater	STA 101+75 (Mudline El. -12.5')	WB-01	23.8	0.82	1.45	2.20
	STA 103+00 (Mudline El. -15')	WB-101	17.8	0.11	0.28	0.70
	STA 105+00 (Mudline El. -19')	WB-102	17.6	0.10	0.26	0.60

Notes:
1. Analyses were conducted assuming the water table is at MLLW or about El. -9'.
2. Construction of rubble-mound breakwater was assumed to take 24 months.
3. Settlements summarized above are maximum settlements which will occur at the center of the breakwater. Settlements will be much less toward the breakwater toe and can be seen in Appendix G.

As summarized in Table 9-3, a large range of total settlements of the Rubble-Mound breakwater is expected due to the varying thicknesses of the clay strata. For the portion of the breakwater closest to the shoreline, settlements range from 19 to 26 inches. For the portion of the breakwater further out from the shoreline, settlements range from 4 to 18 inches. These ranges summarized are due to how the organic silt is treated in the Settle3 models. Assuming the organic silt is displaced by the breakwater rock, the settlements may be much smaller and come only from the lower clay strata. Assuming the organic silt is not displaced by the breakwater rock, the settlements could be much larger due to the presence of the very soft organic silt underneath the breakwater. Regardless of how the organic silt is treated in Settle3, the organic silt settlements will happen during construction of the breakwater when rock is placed. Therefore, long-term post-construction settlements, assuming construction of the breakwater takes 24 months, have a much smaller range, and are estimated to range from 0.3 to 2.2 inches.

All settlements will be corrected by adding additional rock to the breakwater height during construction. To minimize anticipated repairs of the roadway due to settlement, it is recommended that the roadway be placed at least six months to 1 year after the rubble-mound breakwater is constructed, which is when consolidation settlements of the clay soils are estimated to be near complete. If the roadway is required to be constructed sooner, it will need to be designed with adequate reinforcement to withstand the estimated settlements and differential settlements of the breakwater.

9.2 Pile-Supported Platform

The second leg of the breakwater is a pile-supported platform structure with a precast concrete wave screen on the seaward side to protect the harbor from waves. The platform will be supported by bents of two plumb steel pipe piles with an intermediate battered steel pipe pile between each pile bent. The piles are proposed to be 36 inch diameter with 1 inch thick walls. All piles are required to be driven through the overburden soil, penetrated into the underlying bedrock and rock socketed thereafter. A typical cross-section of pile-supported platform can be seen in Figure 9-3 below.

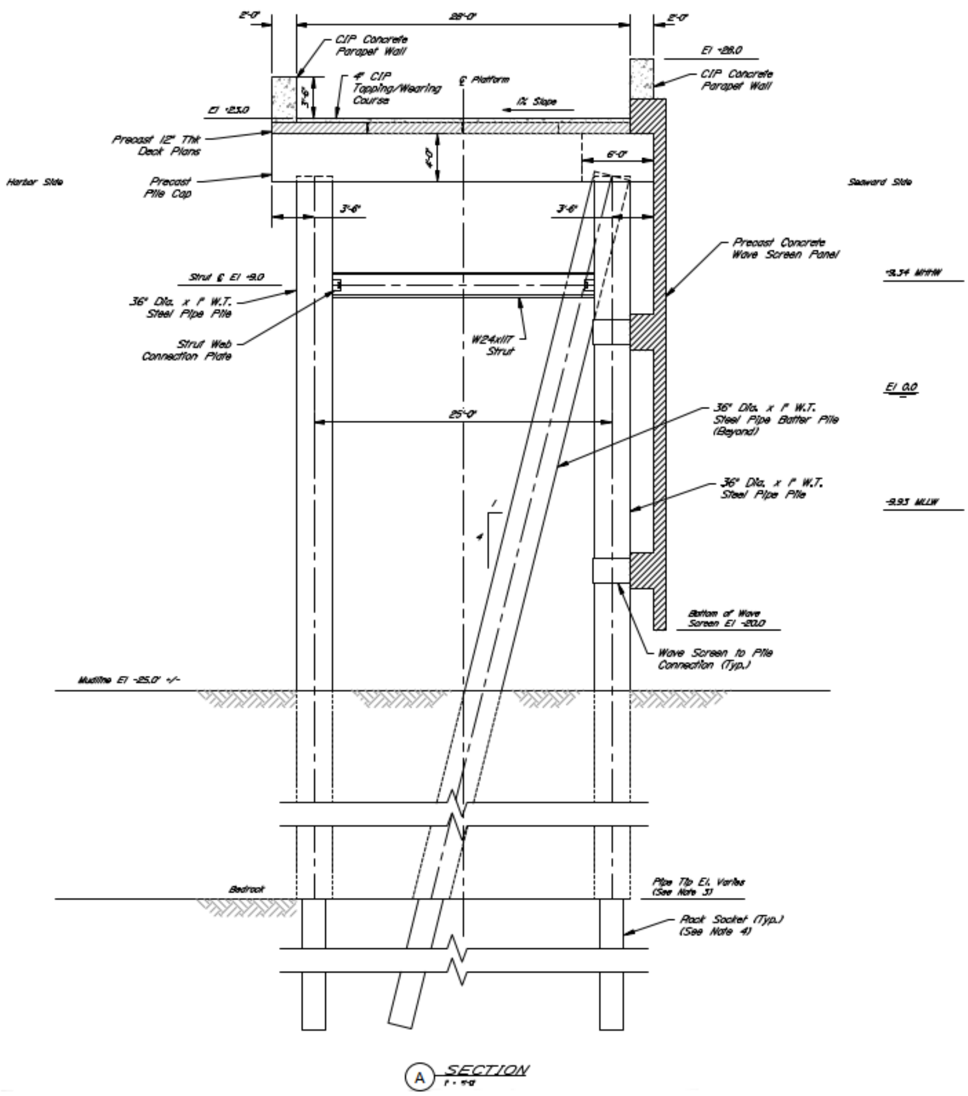


Figure 9-3. Typical Section of Pile-Supported Platform Breakwater

9.2.1 Axial Capacity of the Piles Supporting the Platform

The ultimate axial capacity of the piles that support the breakwater platform was evaluated based on the subsurface conditions encountered during the geotechnical investigations. The platform piles will be 36-inch diameter steel pipe piles with 1-inch wall thickness. All piles are required to be driven to and socketed into the underlying bedrock layer. Due to the soft overburden soils and very shallow bedrock elevations at the pile-supported platform, the axial capacity of the piles is derived from the drilled rocket sockets. The axial capacity analyses of the drilled rock sockets were performed using guidance from FHWA (2010). The analyses were based on the following assumptions:

- The steel pipe piles will be driven through the overburden soil, and to competent bedrock.
- The skin friction contribution of the steel pipe piles in the overburden soil for the ultimate axial capacity of the piles was conservatively ignored.
- The drilled rock sockets will have a diameter of 6 inches less the diameter of the steel pipe piles. The drilled rock sockets for the pile-supported platform piles are proposed to be 30 inches.
- The compressive capacity for the foundation system was taken as the ultimate skin friction of the rock socket. While a combination of both skin resistance and tip resistance would provide additional capacity, more settlement is required to mobilize tip resistance than side resistance. Therefore, tip resistance of the socket was conservatively ignored. A factor of safety (FS) of 2.5 was used for the determination of allowable axial compressive capacities of the rock sockets.
- The uplift loading capacity for the foundation systems was taken as the sum of the ultimate skin friction of the rock socket for each of the rock layers and the buoyant weight of the composite foundation system. A factor of safety (FS) of 3.0 was used for the determination of allowable axial tensile capacities of the rock sockets.

Due to minimal overburden soil encountered at pile locations (5 to 15 ft), the rock socket design must also be checked against the rock mass conical failure mode. For this evaluation, the uplift capacity of the rock socket is typically assumed to be equivalent to the effective weight of a cone-shaped failure mechanism, while the shear strength of the rock is ignored. If the weight of the rock within the inverted cone is greater than the design uplift load (FS = 1.0), the socket length is considered adequate.

The axial capacity evaluation is included in Appendix H. Table 9-4 provides the axial demand and capacity results for each of the pile types for the pile-supported platform. Table 9-4 also includes controlling unfactored working loads for each pile type.

Table 9-4. Axial Pile/Socket Capacity Results and Recommended Socket Lengths

Pile Type	Unfactored Working Loads (kips)	Minimum Socket Length for Uplift Loading (ft)	Minimum Socket Length for Compressive Loading (ft)	Minimum Socket Length for Conical Rock Mass Failure (ft)	Recommended Rock Socket Length (ft)
Seaside Plumb Pile	Compression = 479 Tension = 246	10	15	25	25
Seaside Battered Pile	Compression = 428 Tension = 276	11	14	25	25
Harbor Side Plumb Pile	Compression = 212 Tension = N/A	-	7	-	10[1]

Notes:

1. The recommended socket length determined for the harbor side plumb piles was increased from 7’ to 10’. The estimated 7’ socket length determined from the axial capacity analysis assumes the rock socket is drilled in competent bedrock. The top 3’ of the bedrock strata is highly weathered and was ignored in the analysis. Therefore, an additional 3’ was added to the socket length.

9.2.2 Lateral Resistance of the Pile Supporting the Platform

The pile-supported platform portion of the breakwater will be subject to large wave pressures due to the tidal swing of the Johnson Bay. Therefore, the lateral resistance of the composite steel pipe pile-rock socket foundation system was evaluated. The lateral resistance of the piles will be used by project structural engineers to determine structural demands and movement of the platform under loading conditions. Analysis of the piles under lateral loading was performed using LPILE v2022 (Ensoft, 2022), where the lateral soil resistance of the piles was modeled using p-y springs. Pile group effects were included in LPILE based on the proposed pile spacing. The parameters used in the LPILE analyses can be seen in Table 9-5.

Table 9-5. LPILE Parameters for Pile-Supported Platform Lateral Resistance Analyses

Stratum	Effective Unit Weight (pcf)	Soil Model	Effective Friction Angle, ϕ' (deg)	Coeff. of Subgrade Reaction, k (pci)	Undrained Shear Strength, S_u (psf)	Strain at 50% Stress, ε_{50}	Unconfined Compressive Strength, q_u (psf)
Organic Silt	31	Soft Clay (Matlock)	-	-	200	0.020	-
Clay and Silt	56	Soft Clay (Matlock)	-	-	800	0.010	-
Till	61	Sand (Reese)	37	125	-	-	-
Bedrock	96	Vuggy Limestone	-	-	-	-	4000

The lateral resistance estimate was presented in the form of a "point of fixity depth", which establishes a theoretical moment-fixed point in the pile due to beam action. To provide the "point of fixity", the pile response was analyzed under specified lateral displacements ranging from 0.5 to 6 inches. Using the deflections and computed shear in LPILE at the pile head, the pile length to the point of fixity was estimated by analyzing the pile as a beam with a fixed head. The upper and lower bound point of fixity recommended for structural modeling of the pile-supported platform is 5 ft to 8 ft below the top of bedrock, respectively .

9.3 Floating Dock Guide Piles

A system of floating docks with guide piles will be located within the protected harbor for vessels to dock in Johnson Bay. Two sizes of guide piles are proposed for the project: 24 inch diameter steel pipe pile with ½ inch wall thickness for the guide piles along the breakwater, and 36 inch diameter steel pipe pile with 1 inch wall thickness for the guide piles within the harbor. Similar to the pile-supported platform, guide piles are required to be driven through the overburden soil and rock socketed into the underlying bedrock. Guide piles will support lateral loads from fishing vessels as they berth along the floating docks. Jacobs recommends that the response of the piles to lateral loading be evaluated using the computer program LPILE, Version 2022 (Ensoft, 2022). The recommended soil parameters and layering presented in Table 9-6 should be used in the lateral capacity analyses. The horizontal spacing between the piles is great enough that pile group effects do not need to be considered in the analyses. It is to note that these piles will have minimal axial loads, so the rock socket lengths should be determined by the LPILE analyses at the point in which lateral fixity is achieved.

Table 9-6. Recommended Soil Layering and Parameters for Guide Pile LPILE Analyses

Stratum	Effective Unit Weight (pcf)	Soil Model	Effective Friction Angle, ϕ' (deg)	Coeff. of Subgrade Reaction, k (pci)	Undrained Shear Strength, S_u (psf)	Strain at 50% Stress, ε_{50}	Unconfined Compressive Strength, q_u (psf)
Organic Silt	31	Soft Clay (Matlock)	-	-	200	0.020	-
Clay and Silt	56	Soft Clay (Matlock)	-	-	800	0.010	-
Till	61	Sand (Reese)	37	90	-	-	-
Decomposed to Weathered Bedrock (0% RQD)[1]	76	Sand (Reese)	45	125	-	-	-
Bedrock	86	Vuggy Limestone	-	-	-	-	4000

Notes:
1. It is recommended that the top 3' of bedrock be modeled as decomposed to weathered bedrock.

10. Construction Support Recommendations

10.1 Onshore Earthwork

10.1.1 Subgrade Preparation and Proof Rolling

The subgrade should be prepared by exposing the existing soils as designated by the civil cut and filling, and the pavement design. A visual inspection of subgrade should be conducted by a Geotechnical Engineer to verify bearing capacity and the need for removal of any deleterious materials, organic, or unsuitable soil materials encountered within subgrade. Exposed subgrade should be proof rolled before placement of the Granular Fill and crushed stone base material. Proof rolling should consist of compacting in-situ subgrade soil with minimum of 12 passes of a 10-ton smooth-drum vibratory roller, and successive passes should be overlapped minimum 20%. Any remaining backfilling should be conducted with Granular Fill material and compaction is required. The replaced soil material shall be compacted to a minimum 95% of maximum dry density as determined by ASTM D1557, and the in-place density should be verified for each lift placed. The moisture content of Granular Fill material should be within ±2% of optimum moisture content as provided by the Modified Proctor.

10.1.2 Granular Fill Material Installation

Granular Fill material for onshore earthwork should be a well graded, free draining material with no more than 15% fines (material passing No. 200 sieve). Maximum particle size should not exceed 3 inches. Granular Fill material should be installed by placing maximum 10-inch loose lifts then compacting with vibratory smooth drum roller or other suitable compaction equipment. Granular Fill material shall be compacted to minimum 95% of maximum dry density as determined by ASTM D1557, and in place density should be verified. The moisture content of the Granular Fill material should be within ±2% of optimum moisture content as provided by the Modified Proctor to assure successful compaction.

The natural soil may be allowed to be reused as Granular Fill if only the predominately granular soils are used (encountered cohesive soils should not be reused).

Suggested gradation of the Granular Fill material can be seen in Table 10-1.

Table 10-1. Suggested Gradation of Granular Fill

Sieve Size	Percent Passing
37.5 mm (1.5 inch)	100
25 mm (1 inch)	100-90
4.75 mm (No. 4)	65-30
1.18 mm (No. 16)	40-20
75 µm (No. 200)	15-0

10.1.3 Common Fill Material Installation

The use of Common Fill using excavated in-situ soil may be permitted where necessary, and should be used in non-structural areas. However, organic and deleterious materials are not considered suitable materials and should not be used for backfilling. In addition, natural soils with excessive fines are also not recommended as Common Fill material. It is recommended that the Common Fill material be limited to 25% fines content. The maximum particle size should be limited to 6". The natural soil can be allowed to be reused as Common Fill if only the predominately granular soils are used (encountered cohesive soils should not be reused). The fill material should be installed in 10-inch loose lifts and compacted to minimum 90% of ASTM D1557 using appropriate compaction equipment.

In-place density should be verified. The moisture content of Common Fill should be within ±2% of optimum moisture content as provided by the Modified Proctor.

10.1.4 Excavation

Typically excavated side slopes should not be steeper than 1.5H:1V to maintain stability. All excavation benching and sloping on-site shall follow OSHA guidelines and open excavation side slopes shall be based on soil types as described in the OSHA manual. Generally, the following side slopes in Table 10-2 are considered acceptable. However, excavation slopes should be adjusted based on encountered soil materials and depths of the excavations or cuts. Any open excavation shall be protected from water intrusion to minimize stability issues where necessary. Water may be directed away from excavation to minimize standing water in excavated areas.

Table 10-2. Suggested Excavation Side Slopes based on OSHA Requirements

OSHA Soil Type	Soil Description	Compressive Strength	Slope
Type A	Cohesive soils: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam	1.5 tsf	3/4:1 (53 deg.)
Type B	Granular cohesionless soils: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.	0.5 to 1.5 tsf	1:1 (45 deg.)
Type C	Granular soils including gravel, sand, and loamy sand; or submerged soil or soil from which water is freely seeping; or submerged rock that is not stable,	< 0.5 tsf	1.5:1 (34 deg.)

10.1.5 Support of Excavation

Temporary support of excavation (SOE) systems may be necessary if there is limited amount space for open sloped excavation. SOE systems such as soldier pile and lagging, sheet piling, or trench boxes may be used to support the excavation sides. If water is encountered within the excavation, then the water should be removed immediately by pumping to maintain dry conditions to 2' below the bottom of the trench. SOE system shall be designed for the active earth pressure based on the subsurface soils expected, and a construction surcharge for the equipment proposed at top of SOE system. If the SOE system is braced or trench boxed, then the design shall consider "braced excavation" earth pressures. The SOE designer should verify with the general contractor their planned locations for soil stockpiles, equipment staging, and areas where piles may be stored on site. These conditions, as well as others, may dictate the construction surcharge design and minimum horizontal distance of construction activities from an open trench.

10.1.6 Dewatering

Where applicable, temporary dewatering may need to be maintained below the bottom of any excavation so that the bearing surface can be properly prepared. The contractor should be prepared to control groundwater levels in deep excavations and control runoff from precipitation by using a system of sump pits and pumps.

10.2 Rubble Mound Breakwater

10.2.1 Material Specification

The rubble mound breakwater is composed of three layers: an outer armor layer, an underlayer, and a core layer. Based on the proposed design criteria, armor stones of 1300-4200 lbs, underlayer stones of 130-660 lbs, and core stones of 10-200 lbs with standard gradation based on CIRIA 2007 guidelines are recommended for this project. These three layers were designed and sized by Jacobs' Coastal Engineers and are discussed in the following subsections. More details regarding the design of the three layers are discussed in the "Lubec Breakwater Preliminary Concept Design Study Report" (Jacobs 2023) and have been further optimized through physical model testing.

10.2.1.1 Rock Armor

The specified rock shall be subject to petrological testing and comply with several physical property criteria, the minimum values of which are tabulated in Table 10-3. The armor layer designed in this study is composed of standard graded 1,300-4,200 lbs rocks.

Table 10-3. Armor Rock Properties

Description	Value	Source
Particle density (lb/ft^3)	The average saturated surface-dry density shall be greater than 167.3 lb/ft^3 with 90% of the stones having a density of at least 165.4 lb/ft^3	CIRIA/CUR, 2007
Water Absorption	The maximum water absorption shall not exceed 2%	CIRIA/CUR, 2007
Methylene Blue Absorption	0.7 (oz/100oz)	CIRIA/CUR, 2007
Block Integrity Drop Test	Id<3%	CIRIA/CUR, 2007
Shape Index (L/d>2.0)	<50%	CIRIA/CUR, 2007
Crush Resistance	The force required to produce 10% of fines shall not be less than 22,481 lbf	
Magnesium Sulphate Soundness	<8%	BS 812: Part 121
Los Angeles Abrasion	<35%	ASTM C-131
Point Load Index	>580 psi	ISRM 1985
Compressive Strength	>7,252 psi	ASTM D-7012

10.2.1.2 Underlayer/Filter Rock and Core Material

Any filter or underlayer materials shall be subject to similar physical property restrictions as the primary armor layer as specified in Table 10-3. Being a filler, the core material would not require the same physical properties as the underlayer and armor; however, it shall still be subject to gradation restrictions. The underlayer rocks used in the current proposed design are standard graded 130 – 660 lbs rocks whereas the rocks used in the core are standard graded 10 – 200 lbs rocks.

10.3 Pile-Supported Platform

10.3.1 Pile Driving

Piles should be installed using a driving system capable of driving each type of pile to the required penetration without overstressing or damaging the piles. Prior to the installation of piles, Jacobs recommends the Contractor perform and submit WEAP analyses for the proposed driving hammers to assess pile drivability. Soil parameters for the WEAP analyses should be derived based on information provided in the boring logs included in Appendix B. The proposed hammers should be capable of installing piles to the estimated pile tip elevations without overstressing the piles (i.e., stresses shall not exceed 90% of the yield strength during pile driving).

Steel pipe piles shall be advanced to the required depth through the overburden soil and seated adequately into the top of competent bedrock. Methods used shall permit the pipe pile to be embedded a minimum of 2 feet into impervious material or bedrock to create a tight seal before drilling the rock socket to the required depth into competent bedrock.

10.3.2 Rock Socket Construction

The rock socket shall be drilled or broken using rock augers, down the hole hammers, or rotary core drills to the depths necessary to provide the required depth of socket in competent rock as recommended in this Report and shown on the drawings. The depth of competent rock will be defined as rock with RQD of 50% or larger. The Contractor shall remove all rock fragments, soil or other foreign material to provide a clean bearing surface at the bottom. Top of competent rock shall be determined at each socket installation by a licensed Professional Engineer with sufficient geotechnical expertise.

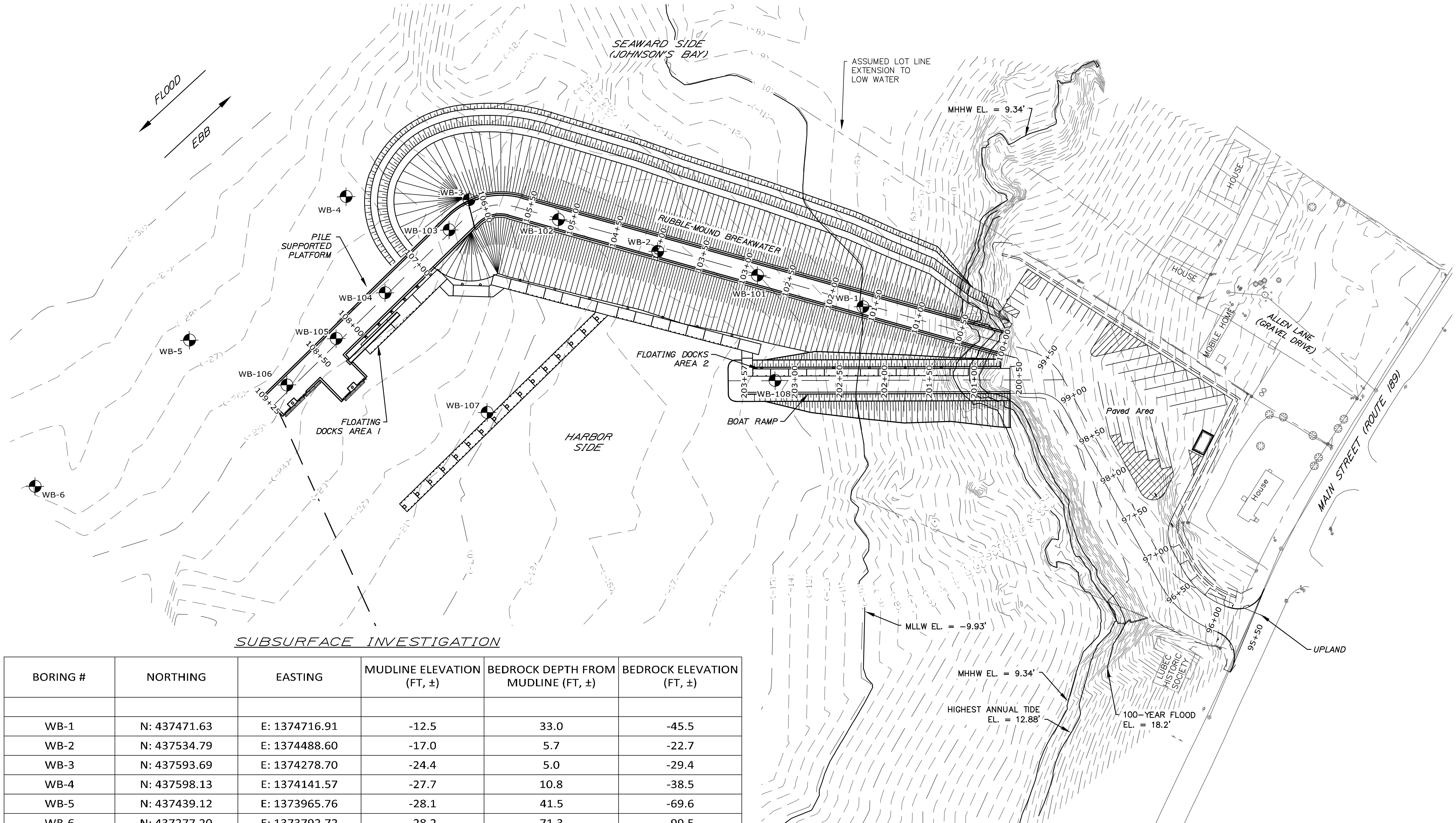
Immediately prior to positioning the steel wide flange section and pouring concrete, rock socket side walls and bottom shall be thoroughly cleaned and inspected using a SID (Shaft Inspection Device). Side walls shall be roughened using a “back scratcher” roughing tool as deemed adequate by the resident engineer prior to final cleanout and inspection. Furthermore, it is required that the socket bottom be cleaned such that a minimum of 50% of the base of each socket will have less than 0.5 inches of sediment and the maximum depth of sediment or other debris at any place on the base of the socket does not exceed 1.5 inches.

Concrete shall be placed within 48 hours of completion of the socket excavation, within 8 hours of final inspection approval, and after the reinforcement has been installed in the pile. Concrete shall be placed through a tremie and placed continuously from the bottom to the required top elevation.

11. Limitations

This report has been prepared by Jacobs for the exclusive use and application to the design and construction of structures for the Lubec Breakwater Project, in the Town of Lubec, ME. The report presents subsurface geotechnical data from the field and laboratory explorations of materials at specific locations, times and depths indicated, using methods described in this report and its appendices. No other representation is made. This data does not reflect variations that may exist between explored locations or the changes in strata and engineering properties that may occur with time. Subsurface conditions that may be interpreted from this report may not be construed as a guarantee or warranty of any subsurface condition.

Appendix A. Boring Location Plan



SUBSURFACE INVESTIGATION

BORING #	NORTHING	EASTING	MUDLINE ELEVATION (FT, ±)	BEDROCK DEPTH FROM MUDLINE (FT, ±)	BEDROCK ELEVATION (FT, ±)
WB-1	N: 437471.63	E: 1374716.91	-12.5	33.0	-45.5
WB-2	N: 437534.79	E: 1374488.60	-17.0	5.7	-22.7
WB-3	N: 437593.69	E: 1374278.70	-24.4	5.0	-29.4
WB-4	N: 437598.13	E: 1374141.57	-27.7	10.8	-38.5
WB-5	N: 437439.12	E: 1373965.76	-28.1	41.5	-69.6
WB-6	N: 437277.20	E: 1373792.72	-28.2	71.3	-99.5
WB-101	N: 437502.87	E: 1374598.97	-14.8	17.0	-31.8
WB-102	N: 437564.92	E: 1374376.94	-19.1	5.8	-24.9
WB-103	N: 437553.41	E: 1374255.24	-23.2	5.7	-28.9
WB-104	N: 437483.34	E: 1374183.77	-24.8	9.5	-34.3
WB-105	N: 437432.25	E: 1374129.25	-24.8	8.0	-32.8
WB-106	N: 437380.63	E: 1374074.35	-25.3	13.5	-38.8
WB-107	N: 437349.97	E: 1374297.60	-20.5	18.5	-39.0
WB-108	N: 437385.50	E: 1374618.51	-15.3	29.0	-44.3

NOTES

1. ALL ELEVATIONS REFER TO NAVD 88.
2. ALL UNITS IN FEET UNLESS OTHERWISE NOTED.
3. HORIZONTAL DATUM REFERS TO US STATE PLAN, MAINE EAST 1801, NAD83.

LEGEND

WB-# WATER BORING LOCATION

0 60 120 FT.
1"=60'

NOT FOR CONSTRUCTION

Jacobs

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

APPROVED	DATE
COMMISSIONER:	
CHIEF ENGINEER:	

PROJECT INFORMATION		SIGNATURE
PROGRAM	MULTIMODAL	
PROJECT MANAGER	AURELE GORNEAU II	
DESIGNER	PHIL LANERGAN	P.E. NUMBER
CONSULTANT	JACOBS	
PROJECT RESIDENT		DATE
CONTRACTOR		
PROJECT COMPLETION DATE		

MAINE DEPARTMENT OF TRANSPORTATION
LUBEC BREAKWATER
LUBEC, ME
WASHINGTON, COUNTY

BORING LOCATION PLAN

SHEET NUMBER
B-100

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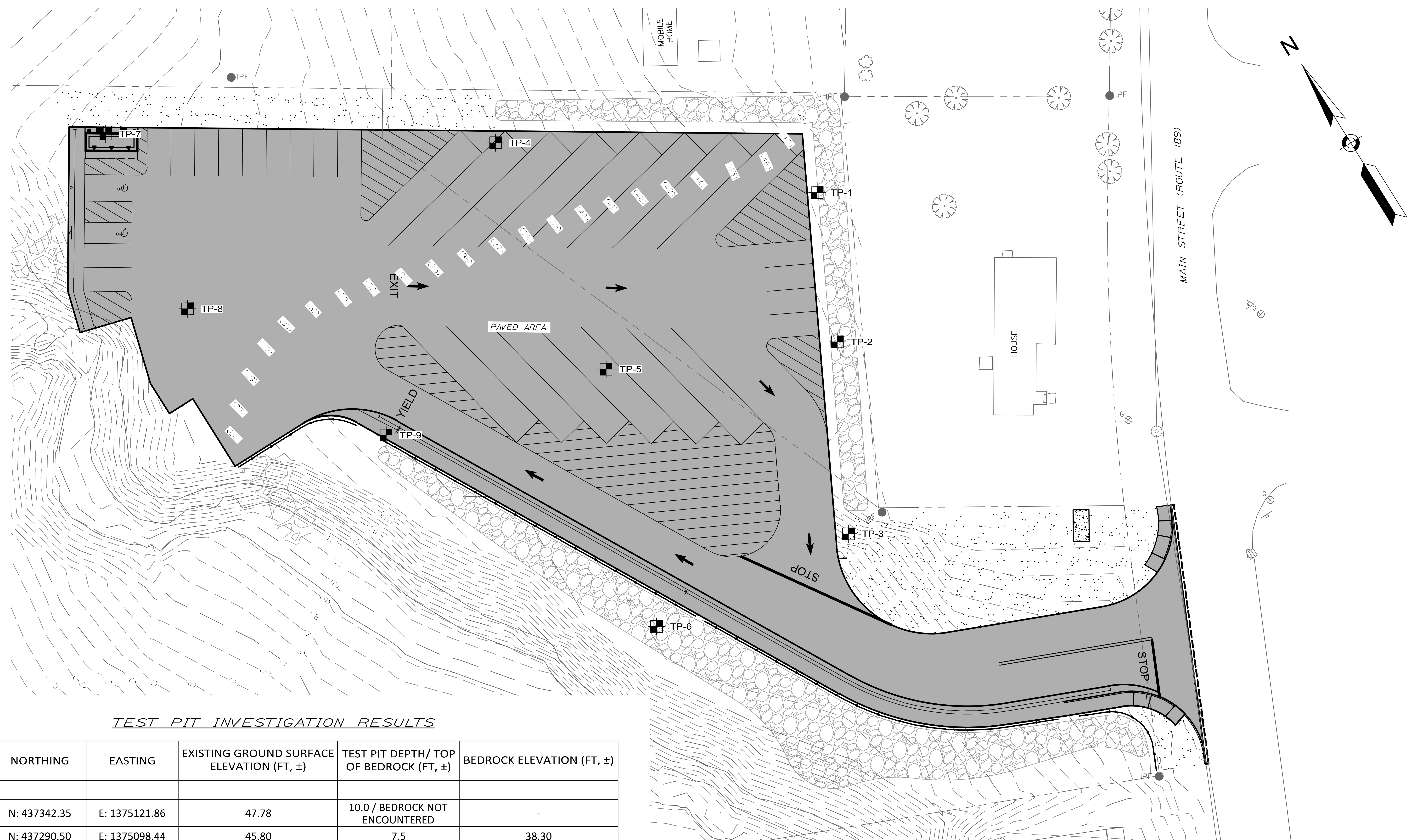

PLAN
1"=15'-0"

TEST PIT INVESTIGATION RESULTS

TEST PIT #	NORTHING	EASTING	EXISTING GROUND SURFACE ELEVATION (FT, ±)	TEST PIT DEPTH/ TOP OF BEDROCK (FT, ±)	BEDROCK ELEVATION (FT, ±)
TP-1	N: 437342.35	E: 1375121.86	47.78	10.0 / BEDROCK NOT ENCOUNTERED	-
TP-2	N: 437290.50	E: 1375098.44	45.80	7.5	38.30
TP-3	N: 437226.76	E: 1375063.56	37.47	5.5	31.97
TP-4	N: 437422.68	E: 1375028.80	38.91	10.5 / BEDROCK NOT ENCOUNTERED	-
TP-5	N: 437328.04	E: 1375018.88	37.21	10.0	27.21
TP-6	N: 437235.48	E: 1374983.51	31.97	10.0	21.97
TP-7	N: 437503.54	E: 1374905.65	29.64	8.0	21.64
TP-8	N: 437431.17	E: 1374896.87	26.03	9.5	16.53
TP-9	N: 437350.92	E: 1374935.19	29.66	6.0-9.0	23.66

NOTES

1. ALL ELEVATIONS REFER TO NAVD 88.
2. ALL UNITS IN FEET UNLESS OTHERWISE NOTED.
3. HORIZONTAL DATUM REFERS TO US STATE PLANE, MAINE EAST 1801, NAD3.

LEGEND

TP-# TEST PIT LOCATION

0 20 40 FT.
1"=20'

NOT FOR CONSTRUCTION

98% DESIGN
SUBMITTED DATE: August 30, 2024

Jacobs

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

APPROVED | DATE
COMMISSIONER:
CHIEF ENGINEER:

PROJECT INFORMATION

PROGRAM	MULTIMODAL	SIGNATURE	
PROJECT MANAGER	AURELE GORNEAU II		
DESIGNER	PHIL LANERGAN	P.E. NUMBER	
CONSULTANT	JACOBS		
PROJECT RESIDENT		DATE	
CONTRACTOR			
PROJECT COMPLETION DATE			

MAINE DEPARTMENT OF TRANSPORTATION
LUBEC BREAKWATER
WASHINGTON, COUNTY
LUBEC, ME

TEST PIT LOCATION PLAN

SHEET NUMBER
B-101

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Appendix B. Boring Logs

Suggested Methods of Test
For
Identification of Soils
By
Dr. D. M. Burmister

Soil Component	Descriptive Terms As Written on Log	Range of Proportions
PRINCIPAL COMPONENT (All Letters Capitalized)	-	50% or more
Minor Components (First Letter Capitalized)	and (a.)	35% to 50%
	some (s.)	20% to 35%
	little (l.)	10% to 20%
	trace (tr.)	1% to 10%

Coarse Grained Soils-Gradation of Components

Coarse to fine	cf	All sizes
Coarse to medium	cm	Less than 10% fine
Medium to fine	mf	Less than 10% coarse
Coarse	c	Less than 10% medium & fine
Medium	m	Less than 10% coarse & fine
Fine	f	Less than 10% coarse & mediu

Component	Symbol	Sieve Range
Boulders		9" and larger
Cobbles		3" to 9"
Gravel	G	
Coarse		1" to 3"
Medium		3/8" to 1"
Fine		#10 to 3/8"
Sand	S	
Coarse		#10 to #30
Medium		#30 to #60
Fine		#60 to #200

Fine Grained Soils-Plasticity of Components

Component	Symbol	Overall Plasticity	Plasticity Index
SILT	$\not{S}$	Non-Plastic	0
Clayey SILT	Cy$\not{S}$	Slight	1 to 5
SILT & CLAY	$\not{S}$ & C	Low	5 to 10
CLAY & SILT	C & $\not{S}$	Medium	10 to 20
Silty Clay	SyC	High	20 to 40
CLAY	C	Very High	over 40

LOG OF TEST BORING

Jacobs			BORING NO.	WB-1
	PROJECT	Lubec Breakwater		
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 1 OF 2

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring		DRILLER	Sam Cooley	ELEVATION		-12.5
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	GefcoStratastar5	DATUM		NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID	N	437471.63
40.3	Terminated						COORD	E	1374716.91
							DATE START		7/14/23
							DATE END		7/17/23

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	0	7 5 1/12"	6	S-1	0 - 2	24/4		OH	S-1: Wet, medium stiff, 5Y 3/1 very dark gray, ORGANIC SILT, trace fine to coarse Sand, trace Shells, strong organics odor (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	1
								2		
-15		3 3 4 6	7	S-2	2 - 4	24/6		CL	S-2: Wet, medium soft, 5Y 3/1 very dark gray, CLAY AND SILT, little fine to coarse Sand, trace fine subangular to subrounded Gravel (CL); PP: 0.0 kg/cm2; TV: 0.0 kg/cm2	
	5	3 3 3 2	6	S-3	4 - 6	24/8			S-3: Wet, medium soft, 2.5Y 5/1 gray, CLAY AND SILT, trace fine Sand (CL); PP: 2.0 kg/cm2; TV: 0.15 kg/cm2	
				U-1	6 - 8	24/24			U-1: Wet 5Y 4/1 dark gray, CLAY AND SILT (CL)	
-20		3 5 6 7	10	S-4	8 - 10	24/24			S-4: Wet, stiff, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.4 kg/cm2	
	10	3 5 6 7	11	S-5	10 - 12	24/24			S-5A (Top 22"): Wet, stiff, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), trace fine subangular to subrounded Gravel, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.15 kg/cm2	
-25									S-5B (Bottom 2"): Wet, 5Y 4/1 dark gray, CLAY AND SILT, some fine to coarse Sand, some fine subangular to subrounded Gravel (CL); Till-like	
	15	WOH WOH WOH 4	0	S-6	15 - 17	24/24			S-6: Wet, very soft, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown, bottom 9" exclusively 5Y 3/1 very dark gray (CL); PP: 2.25 kg/cm2; TV: 0.2 kg/cm2	
-30								18.5		
	20	15 11 13 13	24	S-7	20 - 22	24/11		TILL	S-7: Wet, medium dense, 7.5YR 4/1 dark gray, fine to coarse subangular to subrounded GRAVEL, some fine to coarse Sand, some Silty Clay (GC)	2
-35										
	25	10 18 34 45	52	S-8	25 - 27	24/3			S-8: Wet, very dense, 7.5YR 4/1 dark gray, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, some fine to coarse Sand (GC)	
-40										
	30	65 45 30 40	75	S-9	30 - 32	24/8			S-9: Wet, very dense, 7.5YR 4/1 dark gray, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, some fine to coarse Sand (GC)	
-45								33		
	35									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 07/17/23, 1020: Water Column Depth measured at 18.1 feet; All sample depths feet below mudline
2. Top of Glacial Til at 18.50 ft; Clay and fine subangular to subrounded Gravel observed in return water

LOG OF TEST BORING

PROJECT	Lubec Breakwater	BORING NO.	WB-1
LOCATION	Johnson Bay		
OWNER	Maine DOT		
JOB NUMBER	E2X95900		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		54 100//5"	> 100	S-10	35 - 35.9	11/11		BR	S-10: Wet, very dense, N3 dark gray, fine to coarse SAND, and CLAY AND SILT, little fine to coarse subangular to subrounded Gravel (SC, completely weathered Shale) [QUODDY FORMATION]	3
-50										
	40	100/4"	> 100	S-11	40 - 40.33	4/4		40.33	S-11: Wet, very dense, N3 dark gray, highly weathered SHALE, greater than half of the rock is decomposed or disintegrated to a soil with discernible rock fabric, fresh rock present at corestones [QUODDY FORMATION] Bottom of Borehole at 40.33 feet.	
-55										
	45									
-60										
	50									
-65										
	55									
-70										
	60									
-75										
	65									
-80										
	70									
-85										

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

3. Top of Weathered Bedrock at 33.0 feet below mudline

LOG OF TEST BORING

Jacobs				BORING NO.	WB-2
PROJECT	Lubec Breakwater				
LOCATION	Johnson Bay				
OWNER	Maine DOT				
JOB NUMBER	E2X95900				SHEET 1 OF 1

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-17
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Auto	GRID N	437534.79
7.0	NX Rock Core					COORD E	1374488.6
12.0	Wash Boring - Open Hole					DATE START	7/17/23
						DATE END	7/17/23

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOR WOR WOR WOR	0	S-1	0 - 2	24/20		OH	S-1: Wet, very soft, 5Y 3/1 very dark gray, ORGANIC SILT, some Shells (OH); Pocket Penetrometer: 0.0 kg/cm2; Torvane: 0.0 kg/cm2	1
-20		WOR 3 2 7	5	S-2	2 - 4	24/24		2.33 CL	S-2A (Top 4"): Wet, very soft, 5Y 3/1 very dark gray, ORGANIC SILT, some Shells (OH); PP: 0.0 kg/cm2; TV: 0.0 kg/cm2	
	5	1 7 30 100/2"	37	S-3	4 - 5.7	20/9		3.92 TL 5.7	S-2B (Middle 18"): Wet, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.1 kg/cm2	2
									S-2C (Bottom 2"): Wet, 7.5YR 5/1 gray, fine to coarse subangular to subrounded GRAVEL and SILTY CLAY, little fine to coarse Sand (GC)	
-25		RQD=0		C-1	7 - 8.7	20/20		BR	S-3: Wet, 10YR 5/1 gray, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, some fine to coarse Sand (GC)	3
	10	RQD=11		C-2	8.7 - 12	40/40		12	C-1: 7.0-8.7 ft, SHALE, N4 medium dark gray, silt to fine sand, moderately hard, medium strong, slightly weathered, very thinly to thinly bedded, moderately to steeply dipping bedding, steeply dipping to vertical quartz and calcite veining to 9 mm; very closely to closely spaced, steeply dipping bedding plane separations with patchy quartz and calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 8.5 - 4/8"	
-30									C-2: 8.7-12.0 ft, Siliceous SHALE, N4 medium dark gray, silt to fine sand, moderately hard, medium strong, slightly weathered, very thinly to thinly bedded, moderately to steeply dipping bedding, prominant horizontal to vertical quartz veining to > 50 mm; extremely closely to closely spaced, moderately to steeply dipping bedding plane separations with patchy quartz, calcite, and pyrite, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3/4" - 8 - 8 - 7	
	15								Bottom of Borehole at 12 feet.	
-35										
	20									
-40										
	25									
-45										
	30									
-50										
	35									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. All sample depths feet below mudline
2. Top of Bedrock at 5.7 feet below mudline
3. Core jammed likely due to high angle bedding plane separations

LOG OF TEST BORING

Jacobs

PROJECT	Lubec Breakwater	BORING NO.	WB-3
LOCATION	Johnson Bay		
OWNER	Maine DOT		
JOB NUMBER	E2X95900		SHEET 1 OF 1

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-24.4
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME / DEPTH(ft) / REMARKS		SPT HAMMER	140 lb Auto	GRID COORD N	437593.69
5.0	NX Rock Core					GRID COORD E	1374278.7
10.0	Terminated					DATE START	7/14/23
						DATE END	7/14/23

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-25	0	WOR WOR WOR WOR	0	S-1	0 - 2	24/10		OH (0-2)	S-1: Wet, very soft, 5Y 3/1 very dark gray, ORGANIC SILT, little Shells (OH); Pocket Penetrometer: 0.0 kg/cm2; Torvane: 0.0 kg/cm2	1
	2	6 7 100/0"	> 100	S-2	2 - 3	12/12		TILL (2-5)	S-2: Wet, hard, 2.5Y 4/1 dark gray, CLAY AND SILT, some fine subangular to subrounded Gravel (CL) 3.0-5.0 ft: Angular fragments of gray and red rock	2
-30	5	RQD=40		C-1	5 - 7.9	35/31		BR (5-10)	C-1: 5.0-7.9 ft, SANDSTONE, N5 medium gray, fine to medium sand, moderately hard, strong, slightly weathered, massive, steeply dipping bedding, horizontal to vertical quartz and calcite veining to 8 mm; closely to moderately spaced, steeply dipping bedding plane separations with patchy quartz and calcite, very closely to moderately spaced, shallow to moderately dipping joints with patchy quartz and calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 6.5 - 6.5 - 8.5	3
	7.9	RQD=64		C-2	7.9 - 10	25/25			C-2: 7.9-10.0 ft, SANDSTONE, N5 medium gray, fine to medium sand, moderately hard, strong, slightly weathered, massive, steeply dipping bedding, horizontal to vertical quartz and calcite veining to 10 mm, steeply dipping contact with ARGILLITE at 9.6-10.0 ft; closely to moderately spaced, steeply dipping bedding plane separations with patchy quartz and calcite, closely spaced, shallow dipping joints with patchy quartz and calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 9 - 8.5 Bottom of Borehole at 10 feet.	
-35	10									
-40	15									
-45	20									
-50	25									
-55	30									
	35									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 07/14/23, 0620: Water column depth measured at 23.75 feet; All samples depths feet below mudline.
2. Roller bit advancement
3. Top of bedrock at 5.0 ft below mudline

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-4
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 1 OF 2

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring Contractors	DRILLER	Sam Cooley	ELEVATION	-27.7
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88

METHOD OF DRILLING		GROUNDWATER READINGS DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID COORD	
0.0	Wash Boring w/Casing						N	437598.13
13.5	NX Rock Core						E	1374141.57
44.0	Terminated						DATE START	7/10/23
							DATE END	7/11/23

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	0	WOR WOR WOR WOR	0	S-1	0 - 2	24/22		OH	S-1: Wet, very soft, 5Y 3/1 very dark gray, ORGANIC SILT, some Shells (OH); Pocket Penetrometer (PP): 1.5 kg/cm2; Torvane (TV): 0.0 kg/cm2	1
-30	2									
	5	WOR WOR WOR 3	0	S-2	5 - 7	24/24		CL	S-2: Wet, very soft, 2.5Y 3/1 very dark gray, CLAY AND SILT, little Shells (CL); PP: 4.75 kg/cm2; TV: 0.15 kg/cm2	
-35				U-1	7 - 8	12/3			U-1: Wet, 2.5Y 3/1 very dark gray, CLAY AND SILT, little fine to coarse rounded Shale Gravel (CL)	2
		1 6 7 14	13	S-3	8 - 10	24/24			S-3A (Top 21"): Wet, 2.5Y 3/1 very dark gray, CLAY AND SILT, trace fine rounded Gravel (CL); PP: > 4.5 kg/cm2; TV: 0.175 kg/cm2	
	9.75								S-3B (Bottom 3"): Wet, 10YR 4/1 dark gray, CLAY AND SILT, some fine to coarse rounded Gravel, some fine to coarse Sand (CL)	3
	10	5 100/3"	> 100	S-4	10 - 10.75	9/9			S-4: Wet, very dense, 10YR 4/1 very dark gray, fine to coarse rounded GRAVEL, some Clay and Silt, some fine to coarse Sand (GC)	4
-40	10.75							BR	10.75 - 13.5 ft: Angular fragments of gray rock [QUODDY FORMATION]	
		RQD=78		C-1	13.5 - 18.5	60/57			C-1: 13.5-18.25 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, moderately to steeply dipping calcite veining to 1 mm, irregular calcite spherules to 5 mm; extremely closely to moderately spaced, moderately to steeply dipping joints with patchy calcite to 0.15 mm and partial epidote coatings to 0.1 mm thick [QUODDY FORMATION]; Drilling Rate (min/ft): 11.5 - 5 - 5 - 3.75 - 6 18.25-18.5 ft, NO RECOVERY	
-45	15									
	20	RQD=43		C-2	18.5 - 23.5	60/60			C-2: 18.5-23.5 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, shallow to steeply dipping calcite veining to 7 mm, irregular calcite spherules to 6 mm; very closely to closely spaced, moderately to steeply dipping joints with patchy calcite to 0.15 mm and partial epidote coatings to 0.1 mm thick [QUODDY FORMATION]; Drilling Rate (min/ft): 4.5 - 5 - 5 - 5 - 5	
-50		RQD=0		C-3	23.5 - 24.5	12/8			C-3: 23.5-24.15 ft, TUFF, N5 medium gray to 5B 7/1 light bluish gray, coarse tuff to lapilli tuff, very soft to moderately hard, extremely weak to medium strong, highly to slightly weathered, massive, moderately dipping calcite veining to 3 mm; extremely closely to closely spaced, moderately to steeply dipping joints with patchy calcite to 0.1 mm [QUODDY FORMATION]; Drilling Rate (min/ft): 5 24.15-24.50 ft, NO RECOVERY	5
-55	25	RQD=56		C-4	24.5 - 29.5	60/55.5			C-4: 24.5-29.1 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, steeply dipping calcite veining to 1 mm, irregular calcite spherules to 5 mm; very closely to moderately spaced, moderately dipping joints with patchy calcite to 2 mm and partial epidote coatings to 0.1 mm thick [QUODDY ORMATION]; Drilling Rate (min/ft): 4.5 - 4.5 - 4.5 - 5 - 6 29.1-29.5 ft, NO RECOVERY	
-60	30	RQD=60		C-5	29.5 - 33.5	48/48			C-5: 29.5-33.5 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, shallow to steeply dipping calcite veining to 5 mm, irregular calcite spherules to 5 mm; very closely to closely spaced, moderately to steeply dipping joints with patchy calcite to 0.1 mm [QUODDY FORMATION]; Drilling	6
	35			C-6	33.5 - 38.2	56/56				

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 07/10/23, 1740: Water column depth 36.9 feet, High Tide; All sample depths feet below mudline
2. Piston sampler did not fire/engage; 12" penetrated; 3" recovered and placed in jar for characterization
3. Top of BEDROCK at 10.75 feet below mudline
4. Roller bit advancement
5. Core jammed at 24.5 ft
6. Bottom 4 inches recovered in C-6 core run

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-4
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		RQD=63							Rate (min/ft): 3 - 4.25 - 5.75 - 6 C-6: 33.5-38.2 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, moderately dipping calcite veining to 6 mm, irregular calcite spherules to 4 mm; very closely to moderately spaced, moderately to steeply dipping joints with patchy calcite to 0.1 mm [QUODDY FORMATION]; Drilling Rate (min/ft): 5 - 25 - 5.5 - 6 - 6/8"	
-65	40	RQD=84		C-7	38.2 - 41.95	45/45			C-7: 38.2-41.95 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, moderately dipping quartz veining to 15 mm, irregular calcite spherules to 5 mm; very closely to moderately spaced, steeply dipping to vertical joints with calcite coatings to 3 mm thick [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5 - 3.5 - 3.5 - 3.5 - 2.5	
-70		RQD=92		C-8	41.95 - 43.95	24/24		43.95	C-8: 41.95-43.95 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, moderately to steeply dipping calcite veining to 8 mm, steeply dippling quartz veining to 15 mm; closely to moderately spaced, steeply dipping joints with partial epidote coatings to 0.1 mm thick [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5 - 2.5 Bottom of Borehole at 43.95 feet.	
-75	45									
-80	50									
-85	55									
-90	60									
-95	65									
-100	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-5	
	LOCATION	Johnson Bay			
	OWNER	Maine DOT		SHEET 1 OF 3	
	JOB NUMBER	E2X95900			

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring		DRILLER	Sam Cooley	ELEVATION	-28.09
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID COORD N	437439.12
45.0	NX Rock Core						E	1373965.76
75.0	Terminated						DATE START	7/11/23
							DATE END	7/12/23

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOR WOR WOR WOR	0	S-1	0 - 2	24/15		OH	S-1: Wet, very loose, 5Y 3/2 dark olive gray, ORGANIC SILT, some Shells (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	1
-30		4 3 4 8	7	S-2	2 - 4	24/22		3.25	S-2A (Top 15"): Wet, 5Y 3/2 dark olive gray, ORGANIC CLAY, some Shells (OH); PP: 0.0 kg/cm2; TV: 0.0 kg/cm2	
									S-2B (Bottom 7"): Wet, 10YR 5/2 grayish brown, CLAY AND SILT (CL); PP: 4.5 kg/cm2; TV: 0.75 kg/cm2	
				U-1	4 - 4.85	10/10			U-1: Wet, 5Y 3/2 dark olive gray, CLAY AND SILT (CL); PP: > 4.5 kg/cm2; TV: 0.75 kg/cm2	2
	5	8 9 16 21	25	S-3	5 - 7	24/24			S-3: Wet, very stiff, 10YR 5/2 grayish brown, CLAY AND SILT, trace Shells (CL); PP: > 4.5 kg/cm2; TV: 0.35 kg/cm2	
-35		3 7 10 13	17	S-4	7 - 9	24/24			S-4: Wet, very stiff, 5Y 5/1 gray, CLAY AND SILT, trace fine Sand (fine sand lenses to 0.1 mm thick) (CL); PP: > 4.5 kg/cm2; TV: 0.15 kg/cm2	
	10	8 8 11 10	19	S-5	9 - 11	24/24			S-5: Wet, very stiff, CLAY AND SILT, trace fine Sand (fine sand lenses to 0.1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.15 kg/cm2	
-40		5 9 10 14	19	S-6	11 - 13	24/24			S-6: Wet, very stiff, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.75 kg/cm2	
		10 10 9 10	19	S-7	13 - 15	24/24			S-7: Wet, very stiff, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.30 kg/cm2	
	15									
-45										
		WOH 3 4 7	7	S-8	18 - 20	24/24			S-8: Wet, medium soft, CLAY AND SILT, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.1 kg/cm2	
	20									
-50								CL		
		2 4 5 7	9	S-9	23 - 25	24/24			S-9: Wet, stiff, CLAY AND SILT, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: 4.5 kg/cm2; TV: 0.15 kg/cm2	
	25									
-55										
		WOH 2 3 4	5	S-10	28 - 30	24/24			S-10: Wet, medium stiff, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: 4.5 kg/cm2; TV: 0.65 kg/cm2	
	30									
-60										
		WOH WOH 5	5	S-11	33 - 35	24/24			S-11: Wet, medium soft, CLAY AND SILT, trace fine Sand (fine sand lenses to 3 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: 3.5 kg/cm2; TV: 0.2 kg/cm2	
	35									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 07/11/23, 0925: Water column depth 30.1 feet; All sample depths feet below mudline
2. Insufficient volume for testing

LOG OF TEST BORING

Jacobs			BORING NO.	WB-5
	PROJECT	Lubec Breakwater		
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	NOTES
-65		4							
		2 2 2 3	4	S-12	38 - 40	24/24			
	40								
-70								41.5	3
		100/3"	>100	S-13	43 - 43.25	3/0			4
	45			C-1	45 - 47	24/24			5
-75		RQD=0							
		RQD=0		C-2	47 - 48	12/12			5
		RQD=23		C-3	48 - 49.85	22/22			5
	50	RQD=0		C-4	49.85 - 50.85	12/12			5
-80		RQD=0		C-5	50.85 - 51.85	12/12			5
		RQD=0		C-6	51.85 - 54.85	36/36			5
	55	RQD=67		C-7	54.85 - 56.85	24/24			5
-85		RQD=19		C-8	56.85 - 58.85	24/24		BR	5
	60	RQD=93		C-9	58.85 - 63.85	60/60			
-90									
	65	RQD=67		C-10	63.85 - 68.4	60/55.5			
-95									
	70	RQD=19		C-11	68.85 - 70.85	24/24			5
-100		RQD=42		C-12	70.85 - 72.85	24/24			
		RQD=88		C-13	72.85 - 75	26/26			

SOIL AND ROCK DESCRIPTION

S-12: Wet, medium soft, CLAY AND SILT, little fine Sand (fine sand lenses to 40 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: 4.25 kg/cm2; TV: 0.25 kg/cm2

41.5 - 43.0 ft: Angular fragments of gray rock; Glacial Till or Bedrock

S-13: NO RECOVERY
43.25 - 45.0 ft: Angular fragments of gray rock [QUODDY FORMATION]

C-1: 45.0-47.0 ft, SHALE, N3 dark gray, clay to silt, laminated to very thinly bedded, steeply dippling to vertical bedding, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 6.5 - 9.5
C-2: 47.0-48.0 ft, SHALE, N3 dark gray, clay to silt, laminated to very thinly bedded, vertical bedding, extremely fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 7
C-3: 48.0-49.85 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, slightly weathered, very thinly bedded, steeply dipping bedding, moderately dipping quartz and calcite veining to 1 mm; extremely closely to closely spaced, steeply dipping bedding plane separations with patchy quartz and calcite, closely spaced, moderately dipping joints with patchy quartz and calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 7 - 9/10"
C-4: 49.85-50.85 ft, SHALE, N3 dark gray, clay to silt, laminated, vertical bedding, extremely fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 10
C-5: 50.85-51.85 ft, SHALE, N3 dark gray, clay to silt, laminated, vertical bedding, extremely fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 8
C-6: 51.85-54.85 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, slightly weathered, very thinly bedded, steeply dipping bedding, moderately dipping healed fractures with quartz and calcite infilling to < 1 mm with bedding displacement to 2 mm; closely spaced, steeply dipping bedding plane separations with patchy quartz and calcite, closely spaced, moderately dipping joints with patchy quartz and calcite, extremely fractured at 53.2-54.85 ft [QUODDY FORMATION]; Drilling Rate (min/ft): 6 - 6 - 5.5
C-7: 54.85-56.85 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, slightly weathered, laminated to very thinly bedded, steeply dipping bedding, moderately dipping to vertical quartz veining to 30 mm, pyrite inclusions to 25 mm; closely to moderately spaced, steeply dipping bedding plane separations with patchy quartz [QUODDY FORMATION]; Drilling Rate (min/ft): 5.5 - 13
C-8: 56.85-58.85 ft, SHALE, N3 dark gray, clay to silt, laminated to vey thinly bedded, steeply dipping to vertical bedding, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 7.25 - 12.5
C-9: 58.85-63.85 ft, SHALE, N3 dark gray, clay to silt, hard, strong, fresh, laminated to very thinly bedded, steeply dipping bedding, prominant quartz veining to > 50 mm throughout; extremely closely to moderately spaced, steeply dipping bedding plane separations with fresh surfaces [QUODDY FORMATION]; Drilling Rate (min/ft): 4.5 - 4.5 - 5.75 - 6.5 - 6.5
C-10: 63.85-68.4 ft, Siliceous SHALE, N3 dark gray, clay to silt, hard, strong, fresh, laminated to very thinly bedded, steeply dipping bedding, moderately dipping to vertical quartz veining to > 50 mm; very closely to moderately spaced, moderately to steeply dipping bedding plane separations with patchy quartz and calcite [QUODDY FORMATION];

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

3. Top of bedrock likely at 41.5 feet below mudline; Roller bit advancement
4. Roller bit advancement
5. Core jammed likely due to high angle bedding plane separations
5. Core jammed likely due to high angle bedding plane separations
5. Core jammed likely due to high angle bedding plane separations
5. Core jammed likely due to high angle bedding plane separations
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LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-5
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		SHEET 3 OF 3
	JOB NUMBER	E2X95900		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75							75	Drilling Rate (min/ft): 6 - 6 - 5.5 - 6.5 - 6.5 68.4-68.85 ft, NO RECOVERY C-11: 66.85-70.85 ft, SHALE, N3 dark gray, clay to silt, laminated to very thinly bedded, steeply dipping to vertical bedding, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 8 - 8 C-12: 70.85-72.85 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, fresh, laminated to very thinly bedded, steeply dipping to vertical bedding; extremely closely to moderately spaced, steeply dipping to vertical bedding plane separations with fresh surfaces, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 8.25 - 8.5 C-13: 72.85-75.0 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, fresh, laminated to very thinly bedded, steeply dipping to vertical bedding, horizontal to shallow dipping quartz veining to 1 mm; closely spaced, steeply dipping bedding plane separations with fresh surfaces, closely spaced, moderately dipping joints with patchy quartz and calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 9 - 9.5 - 2/2" Bottom of Borehole at 75 feet.	
-105										
	80									
-110										
	85									
-115										
	90									
-120										
	95									
-125										
	100									
-130										
	105									
-135										
	110									
-140										

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-6
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 1 OF 4

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring		DRILLER	Sam Cooley	ELEVATION	-28.2
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID N	437277.2
73.0	NX Rock Core						COORD E	1373792.72
105.0	Terminated						DATE START	7/12/23
							DATE END	7/13/23

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOR WOR WOR WOR	0	S-1	0 - 2	24/13		OH	S-1: Wet, very loose, 5Y 3/2 dark olive gray, ORGANIC SILT (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.05 kg/cm2	1
-30		WOH WOH WOH 2	0	S-2	2 - 4	24/24			S-2A (Top 18"): Wet, 5Y 3/2 dark olive gray, some Shells, ORGANIC SILT (OH); PP: 1.25 kg/cm2; TV: 0.05 kg/cm2	
								3.5	S-2B (Bottom 6"): Wet, 5Y gray, CLAY AND SILT (CL); PP: 4.25 kg/cm2; TV: 0.15 kg/cm2	
	5			U-1	4 - 6	24/24			U-1: Wet, 5Y 5/1 gray, CLAY AND SILT (CL)	
-35		3 4 4 7	8	S-3	6 - 8	24/24			S-3: Wet, medium soft, CLAY AND SILT, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.15 kg/cm2	
		3 6 7 8	13	S-4	8 - 10	24/24			S-4: Wet, stiff, CLAY AND SILT, little fine rounded Gravel, little Shells, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.20 kg/cm2	
-40	10	4 4 2 5	6	S-5	10 - 12	24/24			S-5: Wet, medium soft, CLAY AND SILT, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: 3.75 kg/cm2; TV: 0.20 kg/cm2	
-45	15	1 2 3 4	5	S-6	15 - 17	24/24			S-6: Wet, medium soft, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.20 kg/cm2	
-50	20	WOH 3 4 6	7	S-7	20 - 22	24/24		CL	S-7: Wet, medium soft, CLAY AND SILT, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.10 kg/cm2	
-55	25	WOH 3 5 6	8	S-8	25 - 27	24/24			S-8: Wet, stiff, CLAY AND SILT, horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: 4.5 kg/cm2; TV: 0.175 kg/cm2	
-60	30	WOH 3 5 5	8	S-9	30 - 32	24/24			S-9: Wet, stiff, CLAY AND SILT, trace fine Sand (fine sand lenses to 1 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.30 kg/cm2	
	35									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 07/12/23, 1328: Water column depth 19.7 feet, Low Tide; All sample depths feet below mudline

LOG OF TEST BORING

Jacobs			BORING NO.	WB-6
	PROJECT	Lubec Breakwater		
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 4

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-65		1 3 6 9	9	S-10	35 - 37	24/24			S-10: Wet, stiff, CLAY AND SILT, little fine Sand (fine sand lenses to 20 mm thick), horizons of 5Y 4/1 dark gray, 5Y 3/1 very dark gray, and 7.5YR 5/2 brown (CL); PP: > 4.5 kg/cm2; TV: 0.25 kg/cm2	
-70	40	4 13 22 19	35	S-11	40 - 42	24/10		40.25	S-11A (Top 3"): Wet, 5Y 4/1 dark gray, CLAY AND SILT (CL) S-11B (Bottom 7"): Wet, 5YR 5/1 gray, fine to coarse subangular to rounded GRAVEL, some fine to coarse Sand, some Clay and Silt (GC)	2
-75	45	16 22 26 23	48	S-12	45 - 47	24/6			S-12: Wet, dense, 5YR 5/1 gray, fine to coarse subangular to rounded GRAVEL, some fine to coarse Sand, little Silty Clay (GC)	
-80	50	22 22 33 33	55	S-13	50 - 52	24/6			S-13: Wet, dense, 7.5YR 5/1 gray, fine to coarse subangular to rounded GRAVEL, some fine to coarse Sand, some Silty Clay (GC)	
-85	55	41 28 20 34	48	S-14	55 - 57	24/0		TILL	S-14: NO RECOVERY	
-90	60	19 17 10 18	27	S-15	60 - 62	24/3			S-15: Wet, dense, 5YR 3/1 very dark gray, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, some fine to coarse Sand (GC)	
-95	65	7 5 4 4	9	S-16	65 - 67	24/2.5			S-16: Wet, loose, 5YR 3/1 very dark gray, fine to coarse subangular GRAVEL, some fine to coarse Sand, some Silty Clay (GC)	
-100	70	100/5"	100/5"	S-17	70 - 70.4	5/5		71.25	S-17A (Top 3"): Wet, dense, 5YR 3/1 very dark gray, fine to coarse subangular GRAVEL, some Silty Clay, some fine to coarse Sand (GC) S-17B (Bottom 3"): SHALE, N1 black, highly weathered, discernible rock fabric [QUODDY FORMATION]	3
		RQD=0		C-1	73 - 74.25	15/15			C-1: 73.0-74.25 ft, SHALE, N3 dark gray, clay to silt, extremely to moderately fractured, steeply dipping to vertical bedding plane	4

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

2. Top of Glacial Till at 40.25 ft
3. Top of bedrock at 71.25 feet below mudline
4. Core jammed likely due to high angle bedding plane separations
4. Core jammed likely due to high angle bedding plane separations

LOG OF TEST BORING

PROJECT	Lubec Breakwater	BORING NO.	WB-6
LOCATION	Johnson Bay		
OWNER	Maine DOT		SHEET 3 OF 4
JOB NUMBER	E2X95900		

ELEV. (ft): -105, -110, -115, -120, -125, -130, -135, -140

DEPTH (ft): 75, 80, 85, 90, 95, 100, 105, 110

SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	NOTES
RQD=35		C-2	74.25 - 76.15	23/23		BR	4
RQD=24		C-3	76.15 - 79.65	42/42		BR	4
RQD=58		C-4	79.65 - 84	52/52		BR	4
RQD=82		C-5	84 - 89	60/60		BR	
RQD=29		C-6	89 - 90.75	21/21		BR	4
RQD=76		C-7	90.75 - 94.6	46/46		BR	4
RQD=49		C-8	94.6 - 97.5	35/35		BR	4
RQD=0		C-9	97.5 - 100	30/30		BR	4
RQD=42		C-10	100 - 102	24/24		BR	4
RQD=42		C-11	102 - 103	12/12		BR	
RQD=71		C-12	103 - 105	24/24		BR (to 105)	

SOIL AND ROCK DESCRIPTION

separations [QUODDY FORMATION]; Drilling Rate (min/ft): 5.5 - 4.5/9"

C-2: 74.25-76.15 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, slightly weathered, laminated to thinly bedded, steeply dipping to vertical bedding, steeply dipping epidote veining to 0.1 mm; very closely to closely spaced, steeply dipping to vertical bedding plane separations with patchy epidote [QUODDY FORMATION]; Drilling Rate (min/ft): 5/3" - 8 - 3/2"

C-3: 76.15-79.65 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, slightly weathered, laminated to very thinly bedded, steeply dipping to vertical bedding, shallow to steeply dipping quartz and calcite veining to 6 mm, steeply dipping epidote veining to 1 mm; very closely to moderately spaced, steeply dipping to vertical bedding plane separations with patchy quartz, calcite, and epidote, very closely to closely spaced, moderately dipping joints with patchy quartz and calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 3.5/8" - 5 - 6 - 5

C-4: 79.65-84.0 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, fresh, laminated, moderately to steeply dipping bedding, steeply dipping quartz and calcite veining to 3 mm; extremely closely to moderately spaced, moderately to steeply dipping bedding plane separations with fresh surfaces [QUODDY FORMATION]; Drilling Rate (min/ft): 2/4" - 5 - 5 - 5 - 5

C-5: 84.0-89.0 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, fresh, laminated, moderately dipping to vertical bedding, shallow to moderately dipping quartz and calcite veining to 1 mm; closely to moderately spaced, moderately dipping to vertical bedding plane separations with fresh surfaces [QUODDY FORMATION]; Drilling Rate (min/ft): 6 - 6 - 6 - 6 - 6

C-6: 89.0-90.75 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, fresh, laminated, steeply dipping to vertical bedding, steeply dipping quartz and calcite veining to 2 mm; extremely closely to closely spaced, steeply dipping to vertical bedding plane separations with fresh surfaces, closely spaced, moderately dipping joints with patchy calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 5.5 - 5/9"

C-7: 90.75-94.6 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, slightly weathered, laminated, steeply dipping to vertical bedding, shallow dipping to vertical dipping quartz and calcite veining to 6 mm; extremely closely to widely spaced, steeply dipping to vertical bedding plane separations with fresh surfaces, moderately spaced, shallow to moderately dipping joints with iron oxide staining and patchy calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 3/3" - 7 - 7 - 7 - 6.75/7"

C-8: 94.6-97.5 ft, Siliceous SHALE, N3 dark gray, clay to fine sand, hard, strong, slightly weathered, laminated to very thinly bedded, steeply dipping to vertical bedding, horizontal to shallow dipping quartz, calcite, and pyrite veining to 1 mm, prominant vertical quartz veining to > 50 mm; very closely to closely spaced, horizontal to shallow dripping joints with partial calcite coatings to 0.1 mm thick, closely spaced, steeply dipping to vertical bedding plane separations with patchy pyrite and calcite, extremely fractured at 97.25-97.50 ft [QUODDY FORMATION]; Drilling Rate (min/ft): 2.25/5" - 7.25 - 5.25 - 4.5/6"

C-9: 97.5-100.0 ft, SHALE, N3 black, clay to silt, laminated, extremely to moderately fractured, steeply dipping to vertical bedding plane separations with fresh surfaces [QUODDY FORMATION]; Drilling Rate (min/ft): 4.75/6" - 6.75 - 5

C-10: 100.0-102.0 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, fresh, laminated, vertical bedding, shallow dipping to vertical quartz and calcite veining to 1 mm; extremely closely to moderately spaced, vertical bedding plane separations with fresh surfaces, very closely to closely spaced, shallow to moderately dipping joints with patchy quartz and calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 6.75 - 15

C-11: 102.0-103.0 ft, SHALE, N3 dark gray, clay to silt, moderately hard, medium strong, slightly weathered, laminated to very thinly bedded, vertical bedding, shallow to moderately dipping quartz and calcite veining to 1 mm; extremely closely to closely spaced, vertical bedding

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

4. Core jammed likely due to high angle bedding plane separations
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LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-6
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 4 OF 4

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	115								plane separations with patchy calcite, very closely to closely spaced, moderately dipping joints with patchy calcite and quartz [QUODDY FORMATION]; Drilling Rate (min/ft): 9 C-12: 103.0-105.0 ft, SHALE, N3 dark gray, clay to fine sand, moderately hard, medium strong, slightly weathered, laminated to very thinly bedded, steeply dipping to vertical bedding, steeply dipping quartz, calcite, and pyrite veining to 1 mm; closely to moderately spaced, shallow to moderately dipping joints with patchy calcite, vertical bedding plane separations with fresh surface at 104.15 ft [QUODDY FORMATION]; Drilling Rate (min/ft): 8.25 - 8.25 Bottom of Borehole at 105 feet.	
-145										
	120									
-150										
	125									
-155										
	130									
-160										
	135									
-165										
	140									
-170										
	145									
-175										
	150									
-180										

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-101	
	LOCATION	Johnson Bay			
	OWNER	Maine DOT			
	JOB NUMBER	E2X95900		SHEET 1 OF 1	

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-14.8
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME / DEPTH(ft) / REMARKS		SPT HAMMER	140 lb Auto	GRID COORD N	437502.87
17.0	NX Rock Core					GRID COORD E	1374598.97
21.6	Terminated					DATE START	2/22/24
						DATE END	2/22/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-15		WOR WOR WOR 1	0	S-1	0 - 2	24/15		OH	S-1A (Top 13"): Wet, very soft, 5Y 3/1 dark gray, ORGANIC SILT, some Shells (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2 S-1B (Bottom 2"): Wet, very soft, 5Y 3/2 dark olive, gray, CLAY AND SILT (CL)	1
		WOR WOR 6 6	6	S-2	2 - 4	24/17		CL (3.1)	S-2A (Top 13"): Wet, 5Y 3/2 dark olive gray, CLAY AND SILT, trace fine to coarse Sand (CL); Pocket Penetrometer (PP): 4.5 kg/cm2; Torvane (TV): 0.05 kg/cm2 S-2B (Bottom 4"): Wet, 2.5Y 3/1 dark gray, fine to coarse subrounded GRAVEL, some Clay and Silt, some fine to coarse Sand (GC)	
-20	5	3 2 7 8	9	S-3	4 - 6	24/7		TILL	S-3: Wet, loose, 5Y 3/2 dark grayish brown, fine to coarse SAND, some fine to coarse subangular to subrounded Gravel, some Clay and Silt (SC)	
		4 5 6 10	11	S-4	6 - 8	24/7		TILL	S-4: Wet, stiff, 2.5Y 4/2 dark grayish brown, SILT AND CLAY, little fine to coarse subangular to subrounded Gravel, little fine to coarse Sand (CL-ML)	
		14 15 9 7	24	S-5	8 - 10	24/5		TILL	S-5: Wet, medium dense, 2.5Y 4/2 dark grayish brown, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, some fine to coarse Sand (GC)	
-25	10	8 12 16 40	28	S-6	10 - 12	24/9		TILL	S-6: Wet, medium dense, 2.5Y 4/2 dark grayish brown, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, some fine to coarse Sand (GC)	
		19 100/0"	>100	S-7	14 - 14.5	6/3		TILL (14.5)	S-7: Wet, very dense, 2.5Y 4/2 dark grayish brown and 2.5Y 3/1 dark gray, fine to coarse subangular to subrounded GRAVEL, little Silty Clay, little fine to coarse Sand (GC)	2
-30	15							W/R (17)	14.5 - 17.0 ft, weathered gray SHALE [QUODDY FORMATION]	
		RQD=0		C-1	17 - 18.6	19/19		BEDROCK	C-1: 17.0-18.6 ft, SHALE, N3 dark gray, clay to very fine sand, moderately hard, medium strong, slightly weathered, laminated to very thinly bedded, steeply dipping bedding, plane separations with patchy calcite and pyrite; closely spaced, shallow to moderately dipping joints with patchy calcite and pyrite, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 4.5 - 3.5/7"	3
		RQD=29		C-2	18.6 - 20	17/17		BEDROCK	C-2: 18.6-20.0 ft, SHALE, N3 dark gray, clay to very fine sand, moderately hard, medium strong, slightly weathered, laminated to very thinly bedded, steeply dipping bedding, steeply dipping calcite fracture infilling to 1 mm; closely spaced, steeply dipping bedding plane separation with oxide staining, and patchy calcite; closely spaced vertical joints with patchy calcite and pyrite, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3/5" - 4	4
-35	20	RQD=0		C-3	20 - 21.6	19/19		BEDROCK (21.6)	C-3: 20.0-21.6 ft, SHALE, N3 dark gray, clay to very fine sand, moderately hard, medium strong, slightly weathered, laminated to very thinly bedded, steeply dipping bedding, very closely to closely spaced, moderately dipping joints with patchy calcite, very closely spaced healed fractures parallel to joint set, extremely fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 4.5 - 4/7" Bottom of Borehole at 21.6 feet.	5
-40	25									
-45	30									
	35									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 23' 2" water column measured at 8:40 on 02/22/2024.
2. Angular fragments of gray weathered bedrock observed in return water.
3. Top of bedrock at 17.0 ft below mudline.
4. Core jammed likely due to high angle bedding.
5. Borehole total depth 21.6 ft.

LOG OF TEST BORING

Jacobs

PROJECT	Lubec Breakwater	BORING NO.	WB-102
LOCATION	Johnson Bay		
OWNER	Maine DOT		SHEET 1 OF 1
JOB NUMBER	E2X95900		

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-19.1
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Auto	GRID COORD N	437564.92
6.0	NX Rock Core					GRID COORD E	1374376.94
11.0	Terminated					DATE START	2/22/24
						DATE END	2/23/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-19.1	0	WOR WOR WOR WOR	0	S-1	0 - 2	24/15		OH/ML	S-1: Wet, very soft, 5Y 3/1 dark gray, ORGANIC SILT, trace Shells (OH); Pocket Penetrometer (PP): 1.0 kg/cm2; Torvane (TV): 0.05 kg/cm2	1
	2	WOH WOH WOH WOH	0	S-2	2 - 4	24/15			S-2: Wet, very soft, 5Y 3/1 dark gray, CLAY AND SILT (ML); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	
	4			U-1	4 - 5.1	13/0		4 / CL	U-1: No recovery.	2
	5.1	WOH/7" 100/3"	>100	S-3	5.1 - 5.91	10/10		5.5	S-3A (Top 5"): Wet, 5Y 3/1 dark gray, CLAY AND SILT (CL); Pocket Penetrometer (PP): 4.5 kg/cm2; Torvane (TV): 0.3 kg/cm2 S-3B (Bottom 5"): Wet, 5Y 3/1 dark gray, fine to coarse subangular to subrounded GRAVEL, some Clay and Silt, little fine to coarse Sand (GC) 5.91-6.0 ft, gray SHALE [QUODDY FORMATION]	3 4
	6	RQD=72		C-1	6 - 11	60/57.5		BEDROCK	C-1: 6-10.8 ft, SHALE, N5 medium gray, siliceous, silt to fine sand, moderately hard to hard, medium strong to strong, fresh, laminated to thinly bedded, steeply dipping to vertical bedding, steeply dipping to vertical quartz veining to 10 mm parallel to bedding; closely to mederately spaced, steeply dipping bedding plane separations with patchy calcite, vertical bedding plane separation with patchy calcite at 10.2 ft, very closely to moderately spaced, shallow to moderately dipping joints with patchy calcite and partial calcite coating to 0.1 mm, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3-3.5-3.5-3.5-5.5 Bottom of Borehole at 11 feet.	
	11							11		

Elevation scale: -20, -25, -30, -35, -40, -45, -50. Depth scale: 5, 10, 15, 20, 25, 30, 35.

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 11' 10" water column measured at 15:20 on 02/22/2024.
2. Shelby Tube refusal at 5.1', Shelby Tube bent during advancement.
3. Angular fragments of gray bedrock observed in return water; top of bedrock at 5.8 ft below mudline.
4. 10.8-11.0 ft: No recovery. Borehole total depth 11.0 ft.

LOG OF TEST BORING

Jacobs			BORING NO.	WB-103
	PROJECT	Lubec Breakwater		
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 1 OF 2

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-23.2
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Auto	GRID COORD N	437553.41
5.7	Rollerbit					GRID COORD E	1374255.24
6.5	NX Rock Core					DATE START	2/26/24
37.0	Terminated					DATE END	2/26/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	0	WOR WOR WOR WOR	0	S-1	0 - 2	24/24		OH/ML	S-1: Wet, very soft, 5Y 3/1 dark gray, ORGANIC SILT, little Shells (OH); Pocket Penetrometer (PP): 0.5 kg/cm2; Torvane (TV): 0.0 kg/cm2	1
-25		WOR WOR WOR 2	0	S-2	2 - 4	24/24		3.67	S-2A (Top 20"): Wet, 5Y 3/1 dark gray, SILT AND CLAY, little Shells (CL-ML); Pocket Penetrometer (PP): 1.5 kg/cm2; Torvane (TV): 0.15 kg/cm2; S-2B (Bottom 4"): Wet, 5Y 3/1 dark gray, CLAY AND SILT (CL)	
	5			U-1	4 - 5.6	19/16.5		CL 5.6	U-1: Wet, 5Y 3/1 dark gray, CLAY AND SILT (CL)	
		100/1"	>100	S-4	5.6 - 5.7	1/1		5.7	S-3: Wet, very dense, 5Y 3/2 dark olive gray, fine to coarse angular GRAVEL, some Silty Clay (GC)	2 3
-30		RQD=40		C-1	6.5 - 9.1	31/31		BEDROCK	5.7-6.5 ft: Weathered gray TUFF [QUODDY FORMATION] C-1: 6.5-9.1 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, hard to moderately hard, medium strong, fresh, massive, shallow to vertical quartz and calcite veining to 7 mm, very closely to closely spaced, shallow to steeply dipping joints with partial calcite coatings to 0.5 mm thick, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3.5-5-6/7"	
-35	10	RQD=67		C-2	9.1 - 13.2	49/49			C-2: 9.1-13.2 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to steeply dipping quartz and calcite veining to 10 mm, very closely to moderately spaced, shallow to steeply dipping joints with patchy calcite, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-3.5-3-3/13"	
-40	15	RQD=100		C-3	13.2 - 18.2	60/60			C-3: 13.2-18.2 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard to hard, medium strong to strong, slightly weathered, massive, prominant steeply dipping to vertical quartz and calcite veining to 30 mm, closely to widely spaced, moderately to steeply dipping joints with patchy calcite, moderately fractured to sound [QUODDY FORMATION]; Drilling Rate (min/ft): 1-3.5-4-3-3.5	
-45	20	RQD=80		C-4	18.2 - 23	58/56			C-4: 18.2-23.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to vertical quartz and calcite veining to 10 mm, elongated calcite spherules ranging 5-10 mm in length, very closely to moderately spaced, shallow to moderately dipping joints with calcite coating to 0.2 mm thick, moderately to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3-2.5-2.5-3.5-3	4
-50	25	RQD=89		C-5	23 - 28	60/57			C-5: 23.0-28.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to vertical quartz and calcite veining to 5 mm, elongated calcite spherules to 7 mm in length, closely to moderately spaced, shallow to moderately dipping joints with calcite coating to 0.1 mm thick [QUODDY FORMATION]; Drilling Rate (min/ft): 1.5-3-3-3-3	5
-55	30	RQD=58		C-6	28 - 33	60/60			C-6: 28.0-33.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to vertical quartz and calcite veining to 5 mm, extremely closely to moderately spaced, shallow to steeply dipping joints with patchy calcite, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2.5-2-3-3	
	35			C-7	33 - 37	48/48			C-7: 33.0-37.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to steeply dipping quartz and calcite veining to 10 mm, very closely to moderately	6

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 23' 9" water column measured at 9:05 on 02/26/2024.
2. Top of bedrock at 5.7 ft below mudline.
3. Angular fragments of gray rock observed in return water during rollerbit advancement.
4. 22.8-23.0 ft: No recovery.
5. 27.75-28.0 ft: No recovery.
6. Borehole terminated at 37.0 ft.

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-103
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-60		RQD=82						37	spaced, shallow to moderately dipping joints with partial calcite coating to 2 mm thick, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-2.5-2.5-2.5 Bottom of Borehole at 37 feet.	
	40									
-65										
	45									
-70										
	50									
-75										
	55									
-80										
	60									
-85										
	65									
-90										
	70									
-95										

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO. WB-104
	LOCATION	Johnson Bay	
	OWNER	Maine DOT	
	JOB NUMBER	E2X95900	SHEET 1 OF 2

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-24.8
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Auto	GRID COORD N	437483.34
9.5	NX Rock Core					GRID COORD E	1374183.77
39.5	Terminated					DATE START	3/4/24
						DATE END	3/5/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-25		WOR WOR WOR WOR	0	S-1	0 - 2	24/19		OH	S-1: Wet, very soft, 2.5Y 3/1 dark gray, ORGANIC SILT, little Shells (OH); Pocket Penetrometer (PP): 1.25 kg/cm2; Torvane (TV): 0.05 kg/cm2	1
		WOR WOR WOR WOR	0	S-2	2 - 4	24/19		3.79	S-2A (Top 14"): Wet, 2.5Y 3/1 dark gray, ORGANIC SILT (OH); Pocket Penetrometer (PP): 1.25 kg/cm2; Torvane (TV): 0.05 kg/cm2 S-2B (Bottom 5"): Wet, 2.5Y 3/1 dark gray, CLAYEY SILT, little fine to coarse Sand, little fine to coarse rounded Gravel, little shells (CL-ML)	
-30	5	WOR WOR 2 5	2	S-3	4 - 6	24/14		CL 6	S-3: Wet, 10YR 4/1 dark gray, CLAY AND SILT, some fine to coarse Sand, little fine rounded Gravel (CL)	
		4 3 7 100/3"	10	S-4	6 - 7.75	21/7		TILL 7.6	S-4A (Top 5"): Wet, 10YR 4/1 dark gray, CLAY AND SILT and fine to coarse subrounded GRAVEL, trace fine to coarse Sand (CL) S-4B (Bottom 2"): Wet, gley 5/1 greenish gray, Weathered TUFF, rock fabric discernible	2
								W/R 9.5		
-35	10	RQD=0		C-1	9.5 - 12.4	34/32		BEDROCK	C-1: 9.5-12.4 ft, TUFF, N6 medium light gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, highly weathered at 11.8-11.9 ft, massive, shallow to vertical quartz and calcite veining to 3 mm, extremely closely to closely spaced, shallow to vertical joints with partial calcite, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3-3-3/10"	3
		RQD=92		C-2	12.4 - 14.5	26/26			C-2: 12.4-14.5 ft, TUFF, N4 medium dark gray and 5G 6/1 greenish gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, vertical quartz and calcite veining to 20 mm, irregular quartz and calcite spherules to 5 mm, very closely to moderately spaced, steeply dipping joints with banded appearance patchy calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 1/2"-3-3.5	
-40	15	RQD=60		C-3	14.5 - 19.5	60/60			C-3: 14.5-19.5 ft, TUFF, N4 medium dark gray and 5G 6/1 greenish gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, steeply dipping to vertical quartz and calcite veining to 30 mm, irregular calcite spherules to 5 mm, extremely closely to moderately spaced, moderately dipping to vertical joints with patchy calcite to partial calcite coatings to 3 mm thick, extremely to slightly fractured, extremely fractured at 18.8-19.5 ft with banded appearance [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-2-3-3-3	
-45	20	RQD=42		C-4	19.5 - 24.5	60/60			C-4: 19.5-24.5 ft, TUFF, N4 medium dark gray and 5G 6/1 greenish gray, coarse tuff to lapilli tuff, moderately soft to moderately hard, weak to medium strong, moderately to slightly weathered, massive, steeply dipping to vertical quartz and calcite veining to 20 mm, irregular calcite spherules to 10 mm, extremely closely to moderately spaced, steeply dipping to vertical joints with patchy calcite and disintegrated rock to 3 mm thick, extremely to slightly fractured with banded appearance [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2-3-3-3	
-50	25	RQD=0		C-5	24.5 - 27	30/30			C-5: 24.5-27.0 ft, TUFF, N4 medium dark gray and 5G 6/1 greenish gray, coarse tuff to lapilli tuff, soft to moderately hard, weak to medium strong, moderately to slightly weathered, massive, moderately dipping to vertical quartz and calcite veining to 7 mm, irregular calcite spherules to 4 mm, steeping dipping joint with banded appearance at 26.0-26.6 ft partially broken/pulverized into particals ranging 1-25 mm; extremely closely to closely spaced, steeply dipping to vertical joints with patchy calcite [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-3-2/6"	4
		RQD=20		C-6	27 - 29.5	30/30			C-6: 27.0-29.5 ft, TUFF, N4 medium dark gray and 5G 6/1 greenish gray, coarse tuff to lapilli tuff, soft to moderately hard, weak to medium strong, moderately to slightly weathered, massive, steeply dipping to vertical quartz and calcite veining to 10 mm, closely to moderately spaced, steeply dipping joints with partial calcite coating to 1 mm thick, moderately to slightly fractured with banded appearance [QUODDY	
-55	30	RQD=73		C-7	29.5 - 34.5	60/60				
	35									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 26' 8" water column measured at 14:55 on 3/4/2024. 31' 11" 8" water column measured at 6:20 on 3/5/2024.
2. 7.6-9.5 ft: Weathered Bedrock.
3. Top of bedrock at 9.5 ft below mudline.
4. Core jammed at 27 ft.
5. Borehole terminated at 39.5 ft.

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-104
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-60		RQD=95		C-8	34.5 - 39.5	60/60			FORMATION]; Drilling Rate (min/ft): 2/6"-2-2.5 C-7: 29.5-34.5 ft, TUFF, N4 medium dark gray and 5G 6/1 greenish gray, coarse tuff to lapilli tuff, soft to moderately hard, weak to medium strong, moderately to slightly weathered, massive, steeply dipping to vertical quartz and calcite veining to 40 mm, closely to moderately spaced, steeply dipping joints and disintegraded rock to 1 mm thick, moderately to slightly fractured with banded appearance [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-2.5-2.5-2-2.5 C-8: 34.5-39.5 ft, TUFF, N4 medium dark gray and 5G 6/1 greenish gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, steeply dipping to vertical quartz and calcite veining to 10 mm, irregular calcite spherules to 5 mm, closely to moderately spaced, steeply dipping joints with patchy calcite, widely spaced, vertical joints with patchy calcite to disintegraded rock to 5 mm thick, moderately to slightly fractured with banded appearance [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2-2-3-3 Bottom of Borehole at 39.5 feet.	5
								39.5		
-65	40									
-70	45									
-75	50									
-80	55									
-85	60									
-90	65									
-95	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

Jacobs				
PROJECT	Lubec Breakwater	BORING NO.	WB-105	
LOCATION	Johnson Bay			
OWNER	Maine DOT			
JOB NUMBER	E2X95900		SHEET 1 OF 2	

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-24.8
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Auto	GRID N	437432.25
7.9	Rollerbit					COORD E	1374129.25
10.0	NX Rock Core					DATE START	2/27/24
41.0	Terminated					DATE END	2/27/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-25		WOR WOR WOR WOR	0	S-1	0 - 2	24/14		OH	S-1: Wet, very soft, 2.5Y 4/1 dark gray, ORGANIC SILT, trace Shells (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	1
		WOR WOR WOR WOR	0	S-2	2 - 4	24/12		OH	S-2: Wet, very soft, 2.5Y 4/1 dark gray, ORGANIC SILT, trace Shells (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	
								4		
-30	5	WOH WOH 1 3	1	S-3	4 - 6	24/17		CL	S-3: Wet, very soft, 5Y 3/1 dark gray and 7.5YR 5/2 brown CLAY AND SILT, trace fine Sand (Sand lenses to 2 mm thick) (CL); Pocket Penetrometer (PP): >4.5 kg/cm2; Torvane (TV): 0.4 kg/cm2	
				U-1	6 - 7.6	19/18		CL	U-1: Wet, 5Y 3/1 dark gray, CLAY AND SILT (CL)	
								7.6		
		100/3"	>100	S-4	7.6 - 7.85	3/3		7.9 W/R	S-4: Wet, very dense, 5Y 4/1 dark gray, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, some fine to coarse Sand, weathered Tuff [QUODDY FORMATION] (GC)	2 3
-35	10							10		
		RQD=72		C-1	10 - 15	60/60		BEDROCK	C-1: 10.0-15.0 ft, TUFF, N4 medium dark gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, irregular calcite spherules to 5 mm; very closely to closely spaced, moderately to steeply dipping joints with patchy calcite, extremely to moderately fractured, shallow to moderately dipping quartz and calcite veining to 1 mm, 13.9-15.0 ft recovered in C-2 core run [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-2-2-2-2.5	
-40	15	RQD=59		C-2	15 - 19.6	55/55		BEDROCK	C-2: 15.0-19.6 ft, TUFF, N4 medium dark gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to steeply dipping quartz and calcite veining to 4 mm, irregular calcite spherules to 10 mm, very closely to moderately spaced, shallow to steeply dipping joints with patchy calcite, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-3.5-3-2-2/7"	
-45	20	RQD=79		C-3	19.6 - 23	41/41		BEDROCK	C-3: 19.6-23.0 ft, TUFF, N4 medium dark gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, moderately dipping to vertical quartz and calcite veining to 15 mm, very closely to moderately spaced, shallow to steeply dipping joints with patchy calcite to calcite coating to 1 mm, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-2.5-2-4/4"	4
-50	25	RQD=95		C-4	23 - 28	60/57		BEDROCK	C-4: 23.0-28.0 ft, TUFF, N4 medium dark gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to moderately dipping quartz and calcite veining to 10 mm, very closely to moderately spaced, shallow to steeply dipping joints with patchy calcite coating to 1 mm thick, irregular calcite to spherules to 5 mm, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-2.5-2-4/4"	
-55	30	RQD=88		C-5	28 - 33	60/60		BEDROCK	C-5: 28.0-33.0 ft, TUFF, N4 medium dark gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, moderately to steeply dipping quartz and calcite veining to 6 mm, irregular calcite spherules to 5 mm, very closely to moderately spaced, shallow to steeply dipping joints with fresh surface to patchy calcite, extremely to moderately fractured [QUODDY FORMATION]	
	35			C-6	33 - 38	60/60		BEDROCK	C-6: 33.0-38.0 ft, TUFF, N4 medium dark gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, prominant moderately dipping quartz and calcite at 33.2 ft and 37.25 ft; very closely to	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 16' 3" water column measured at 7:05 on 2/27/2024.
2. Top of bedrock likely at 8.0 ft below mudline.
3. 7.9-10.0 ft: Angular fragments of gray TUFF [QUODDY FORMATION]
4. Core jammed at 23.0 ft.

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-105
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		SHEET 2 OF 2
	JOB NUMBER	E2X95900		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
-60		RQD=93							moderately spaced, shallow to moderately steeply dipping joints with partial calcite to 1 mm thick, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2.5-2.5-2.5-2.5	
				C-7	38 - 41	36/36			C-7: 38.0-41.0 ft, TUFF, N4 medium dark gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, prominant moderately dipping quartz and calcite veining at 37.9-38.45 ft; shallow dipping joint with patchy calcite at 40.8 ft, sound [QUODDY FORMATION]; Drilling Rate (min/ft): 2.5-2.5-2.5	6
-65	40	RQD=82						41	Bottom of Borehole at 41 feet.	
-70	45									
-75	50									
-80	55									
-85	60									
-90	65									
-95	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

6. Borehole terminated at 41.0 ft.

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-106
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 1 OF 2

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-25.3
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Auto	GRID COORD N	437380.63
14.0	NX Rock Core					GRID COORD E	1374074.35
41.0	Terminated					DATE START	2/27/24
						DATE END	3/4/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOR WOR WOR WOR	0	S-1	0 - 2	24/24		OH	S-1: Wet, very soft, 5Y 3/1 dark gray, ORGANIC SILT, trace fine rounded Gravel, trace Shells (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	1
		WOR WOR WOR WOR	0	S-2	2 - 4	24/14		OH	S-2: Wet, very soft, 5Y 3/1 dark gray, ORGANIC SILT, trace fine subangular to subrounded Gravel, trace Shells (OH); Pocket Penetrometer (PP): 0.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	
-30	5			U-1	4 - 5.92	22/22		OH	U-1: Wet, 5Y 3/1 dark gray, ORGANIC SILT to CLAY AND SILT, trace Shells, trace fine subrounded Gravel (OH/CL)	
		8 8 12 14	20	S-3	6 - 8	24/24		6 / CL	S-3: Wet, very stiff, 5Y 3/1 dark gray, and 7.5 YR 5/2 brown, CLAY AND SILT, little fine sand (fine Sand lenses to 10 mm thick) (CL); Pocket Penetrometer (PP): >4.5 kg/cm2; Torvane (TV): 0.1 kg/cm2	
				U-2	8 - 10	24/24		CL	U-2: Wet, 5Y 4/1 dark gray, CLAY AND SILT, trace fine subrounded Gravel (CL)	
-35	10	6 8 13 24	21	S-4	10 - 12	24/15		CL	S-4A (Top 5"): Wet, 5Y 3/1 dark gray, and 7.5 YR 5/2 brown, CLAY AND SILT, little fine Sand (fine Sand lenses to 10 mm thick) (CL); Pocket Penetrometer (PP): >4.5 kg/cm2; Torvane (TV): 0.1 kg/cm2	2
								12 / 13.5	S-4B (Bottom 10"): Wet, 5Y 3/1 dark gray, fine to coarse SAND, some fine to coarse subangular to subrounded Gravel, some Clay and Silt (SC)	
								14	13.5-14.0 ft: Weathered gray TUFF [QUODDY FORMATION]	3
-40	15	RQD=95		C-1	14 - 19	60/60		BEDROCK	C-1: 14.0-19.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard to hard, strong, fresh, massive, shallow to steeply dipping quartz and calcite veining to 5 mm, irregular calcite spherules to 13 mm; extremely closely to moderately spaced, dipping joints with patchy calcite and coating to 0.1 mm thick, extremely to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 4-3.5-3-2.5-4	
-45	20	RQD=85		C-2	19 - 24	60/60		BEDROCK	C-2: 19.0-24.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard to hard, strong, fresh, massive, shallow to steeply dipping quartz and calcite veining to 15 mm, irregular calcite spherules to 10 mm; closely to moderately spaced, shallow to steeply dipping joints with patchy calcite to partial calcite coating to 2 mm thick, moderately to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3-3-3-2.5-2	
-50	25	RQD=83		C-3	24 - 29	60/60		BEDROCK	C-3: 24.0-29.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, strong, fresh, massive, shallow to moderately dipping quartz and calcite veining to 25 mm, irregular calcite spherules to 10 mm; very closely to moderately spaced, shallow to steeply dipping joints with partial calcite coatings to 1 mm thick, extremely to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2.5-3-3-2.5	
-55	30	RQD=73		C-4	29 - 34	60/60		BEDROCK	C-4: 29.0-34.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, shallow to steeply dipping quartz and calcite veining to 55 mm, irregular calcite spherules to 20 mm; extremely closely to moderately spaced, shallow to steeply dipping joints with partial calcite coatings to 1 mm thick, extremely to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2.5-2.5-2.5-2.5	
-60	35			C-5	34 - 39	60/60		BEDROCK	C-5: 34.0-39.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff,	4

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 34' 2" water column measured at 13:20 on 02/27/2024.
2. 4" casing refusal at 13.5 ft.
3. Top bedrock likely at 13.5 ft below mudline, angular fragments of gray TUFF observed in return water advancing roller bit at 13.5-14.0 ft.
4. 38.9-39.0 ft recovered in C-5 core run.

LOG OF TEST BORING

			BORING NO.	WB-106
Jacobs	PROJECT	Lubec Breakwater		
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		RQD=80							moderately hard, medium strong, slightly weathered, massive, shallow to vertical quartz and calcite veining to 60 mm, irregular calcite spherules to 5 mm, subrounded 10 YR 5/4 moderate yellowish brown clasts (weathered spherules) to 15 mm; extremely closely to moderately spaced, shallow to steeply dipping joints with patchy calcite and iron oxide staining, extremely to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3-2.5-3-3-2.5	
-65	40	RQD=80		C-6	39 - 44	60/60		44	C-6: 39.0-44.0 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, slightly weathered, massive, shallow to vertical quartz and calcite veining to 18 mm, irregular calcite spherules to 10 mm, subrounded 10 YR 5/4 moderate yellowish brown clasts (weathered spherules) to 10 mm; extremely closely to moderately spaced, shallow to steeply dipping joints with patchy calcite, extremely to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2-2-2.5-2.5	5
-70	45								Bottom of Borehole at 44 feet.	
-75	50									
-80	55									
-85	60									
-90	65									
-95	70									
-100										

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

5. Borehole terminated at 44.0 ft.

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-107	
	LOCATION	Johnson Bay			
	OWNER	Maine DOT			
	JOB NUMBER	E2X95900		SHEET 1 OF 2	

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION	-20.5
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM	NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID N 437349.97
18.5	NX Rock Core						COORD E 1374297.6
41.0	Terminated						DATE START 3/6/24
							DATE END 3/6/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOR WOR WOR WOR	0	S-1	0 - 2	24/20		OH	S-1: Wet, very soft, 5Y 4/1 dark gray, ORGANIC SILT, trace Shells (OH); Pocket Penetrometer (PP): 0.75 kg/cm2; Torvane (TV): 0.05 kg/cm2	1
		WOR WOR WOR WOR	0	S-2	2 - 4	24/19			S-2: Wet, very soft, 5Y 4/1 dark gray, ORGANIC SILT, trace Shells (OH); Pocket Penetrometer (PP): 1.25 kg/cm2; Torvane (TV): 0.10 kg/cm2	
-25	5	WOR WOR WOR WOR	0	S-3	4 - 6	24/19		6	S-3: Wet, very soft, 5Y 4/1 dark gray, ORGANIC SILT, little Shells, trace fine to coarse subrounded Gravel (OH); Pocket Penetrometer (PP): 0.5 kg/cm2; Torvane (TV): 0.025 kg/cm2	
		WOR WOR WOR WOH	0	S-4	6 - 8	24/9		CL	S-4: Wet, very soft, 5Y 3/1 dark gray, and 7.5 YR 5/2 brown, CLAY AND SILT, trace fine Sand (fine Sand lenses to 1 mm thick) (CL); Pocket Penetrometer (PP): >4.5 kg/cm2; Torvane (TV): 0.4 kg/cm2	
				U-1	8 - 9.83	20/16			U-1: Wet, 5Y 4/1 dark gray, CLAY AND SILT, trace Gravel (CL)	
-30	10	5 5 4 6	9	S-5	10 - 12	24/23		10.5 TILL	S-5A (Top 5"): Wet, 5Y 4/1 dark gray, CLAY AND SILT, some fine to coarse subangular to subrounded Gravel (CL) S-5B (Bottom 18"): Wet, 7.5YR 4/1 dark gray, fine to coarse subangular to subrounded GRAVEL, and CLAY AND SILT, little fine to coarse Sand (GC)	2
-35	15	5 4 6 7	10	S-6	14 - 16	24/18		16	S-6: Wet, medium dense, 7.5YR 4/1 dark gray, fine to coarse SAND, some fine to coarse subangular to subrounded Gravel, some Clay and Silt (SC)	
-40	20	RQD=38		C-1	18.5 - 23.5	60/60		BEDROCK	C-1: 18.5-23.5 ft, TUFF, 5G 4/1 dark greenish gray, coarse tuff to lapilli tuff, moderately hard, weak to medium strong, fresh, massive, moderately to steeply dipping quartz and calcite veining to 10 mm; extremely closely to closely spaced, shallow to steeply dipping joints with partial calcite coating to 2 mm, extremely to moderately fractured [QUODDY FORMATION]; breaks easily when handled, Drilling Rate (min/ft): 2-1.5-1.5-2.5-2.5	3
-45	25	RQD=53		C-2	23.5 - 28.5	60/60			C-2: 23.5-28.5 ft, TUFF, 6Y 4/1 dark greenish gray, coarse tuff to lapilli tuff, moderately hard, weak to medium strong, fresh, massive, moderately dipping to vertical quartz and calcite veining to 10 mm; extremely closely to moderately spaced, shallow to steeply dipping joints with patchy calcite to partial calcite coating to 1 mm thick, extremely to moderately fractured [QUODDY FORMATION]; breaks easily when handled, Drilling Rate (min/ft): 2-2-2-2-2	
-50	30	RQD=68		C-3	28.5 - 33.5	60/60			C-3: 28.5-33.5 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, weak to medium strong, fresh, massive, shallow to steeply dipping quartz and calcite veining to 25 mm; extremely closely to moderately spaced, moderately to steeply dipping joints with patchy calcite to calcite coatings to 3 mm thick, extremely to moderately fractured [QUODDY FORMATION]; breaks easily when handled, Drilling Rate (min/ft): 2-1.5-2-2.5-2.5	
-55	35			C-4	33.5 - 38.5	60/60			C-4: 33.5-38.5 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, weak to medium strong, fresh, massive, shallow to	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Depth to seafloor measured at 29.75' from water surface on 3/6/2024 at 6:25.
2. Shelby tube refusal at 9.7', bottom of Shelby tube damaged during penetration.
3. Top of bedrock at 18.5 ft below mudline.

LOG OF TEST BORING

Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-107
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		RQD=71							vertical quartz and calcite veining to 25 mm; extremely closely to moderately spaced, moderately to steeply dipping joints with patchy calcite, extremely to slightly fractured [QUODDY FORMATION]; breaks easily when handled, Drilling Rate (min/ft): 1.5-2-2-2-2	
-60	40	RQD=76		C-5	38.5 - 43.5	60/60			C-5: 38.5-43.5 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to vertical quartz and calcite veining to 10 mm; very closely to moderately spaced, shallow to steeply dipping joints with patchy calcite to calcite coatings to 1 mm thick, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2-2.5-2-2.5	
-65	45	RQD=83		C-6	43.5 - 48.5	60/60			C-6: 43.5-48.5 ft, TUFF, N5 medium gray, coarse tuff to lapilli tuff, moderately hard, medium strong, fresh, massive, shallow to vertical quartz and calcite veining to 10 mm; extremely closely to moderately spaced, shallow to steeply dipping joints with patchy calcite to calcite coating to 1 mm, extremely to slightly fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 2-2.5-2.5-3-2.5	4
								48.5	Bottom of Borehole at 48.5 feet.	
-70	50									
-75	55									
-80	60									
-85	65									
-90	70									
-95										

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

4. Borehole terminated at 48.5 ft.

LOG OF TEST BORING

Jacobs				
PROJECT	Lubec Breakwater	BORING NO.	WB-108	
LOCATION	Johnson Bay			
OWNER	Maine DOT			
JOB NUMBER	E2X95900		SHEET 1 OF 2	

INSPECTOR	Don Melcher	CONTRACTOR	New England Boring	DRILLER	Sam Cooley	ELEVATION		-15.3
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	GefcoStratastar5	DATUM		NAVD 88
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Auto	GRID	N	437385.5
29.0	NX Rock Core					COORD	E	1374618.51
34.5	Terminated					DATE START		3/5/24
						DATE END		3/5/24

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOR WOR WOR WOR	0	S-1	0 - 2	24/8		OH	S-1: Wet, very soft, 5Y 3/1 dark gray, ORGANIC SILT, little Shells (OH); Pocket Penetrometer (PP): 0.50 kg/cm2; Torvane (TV): 0.05 kg/cm2	1
		WOR WOR WOR WOR	0	S-2	2 - 4	24/12		OH (4)	S-2: Wet, very soft, 5Y 3/1 dark gray, ORGANIC SILT, some Shells (OH); Pocket Penetrometer (PP): 1.0 kg/cm2; Torvane (TV): 0.0 kg/cm2	
-20	5			U-1	4 - 6	24/24		CL	U-1: Wet, 5Y 3/1 dark gray, CLAY AND SILT (CL); Pocket Penetrometer (PP): 4.5 kg/cm2; Torvane (TV): 0.4 kg/cm2	
		2 3 3 5	6	S-3	6 - 8	24/24		CL	S-3: Wet, medium stiff, 5Y 3/1 dark gray and 7.5YR 5/2 little brown, CLAY AND SILT, trace fine to coarse subangular to subrounded Gravel, trace Shells (CL); Pocket Penetrometer (PP): >4.5 kg/cm2; Torvane (TV): 0.4 kg/cm2	
				U-2	8 - 10	24/24		CL	U-2: Wet, 5Y 3/1 dark gray, CLAY AND SILT (CL)	
-25	10	1 3 4 5	7	S-4	10 - 12	24/24		CL	S-4: Wet, medium stiff, 5Y 3/1 dark gray and 7.5YR 5/2 brown, CLAY AND SILT, trace fine Sand (fine Sand lenses to 1 mm thick) (CL); Pocket Penetrometer (PP): >4.5 kg/cm2, Torvane (TV): 0.35 kg/cm2	
-30	15	WOH 3 3 3	6	S-5	14 - 16	24/24		CL	S-5: Wet, medium stiff, 5Y 3/1 dark gray and 7.5YR 5/2 brown, SILTY CLAY, trace fine Sand (fine Sand lenses to 10 mm thick) (CL); Pocket Penetrometer (PP): >4.5 kg/cm2, Torvane (TV): 0.35 kg/cm2	
-35	20	WOH 2 3 4	5	S-6	19 - 21	24/24		CL	S-6: Wet, medium stiff, 5Y 3/1 dark gray and 7.5YR 5/2 brown, SILTY CLAY, some fine Sand (fine Sand lenses to 10 mm thick), trace fine subrounded Gravel (CL); Pocket Penetrometer (PP): >4.5 kg/cm2, Torvane (TV): 0.3 kg/cm2	
-40	25	6 4 8 11	12	S-7	24 - 26	24/19		CL (25) / TILL (27)	S-7A (Top 11"): Wet, 5Y 3/1 dark gray and 7.5YR 5/2 brown, SILTY CLAY, little fine Sand (fine Sand lenses to 10 mm thick), (CL); Pocket Penetrometer (PP): >4.5 kg/cm2, Torvane (TV): 0.15 kg/cm2 S-7B (Bottom 8"): Wet, 5Y 4/1 dark gray, fine to coarse subangular to subrounded GRAVEL, some Silty Clay, little fine to coarse Sand (GC)	
								W/R (29)	27-29 ft: Weathered gray TUFF [QUODDY FORMATION]	
-45	30	RQD=32		C-1	29 - 31.9	34/34		BEDROCK	C-1: 29.0-31.9 ft, TUFF, N4 medium dark gray, fine tuff to coarse tuff, moderately hard, medium strong, fresh, massive, shallow to moderately dipping quartz and calcite veining to 1 mm; very closely to closely spaced, shallow to steeply dipping joints with partial calcite coating to 1 mm thick, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3-3-3/10"	2
-50	35	RQD=42		C-2	31.9 - 34.5	31/31		BEDROCK (34.5)	C-2: 31.9-34.5 ft, TUFF, N4 medium dark gray, fine tuff to coarse tuff, moderately hard, medium strong, fresh, massive, shallow to moderately dipping quartz and calcite veining to 5 mm; very closely to moderately	3

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. 8' 8" water column measured at 12:35 on 3/5/2024.
2. Top of bedrock at 29 ft below mudline.
3. Borehole terminated at 34.5 ft.

LOG OF TEST BORING

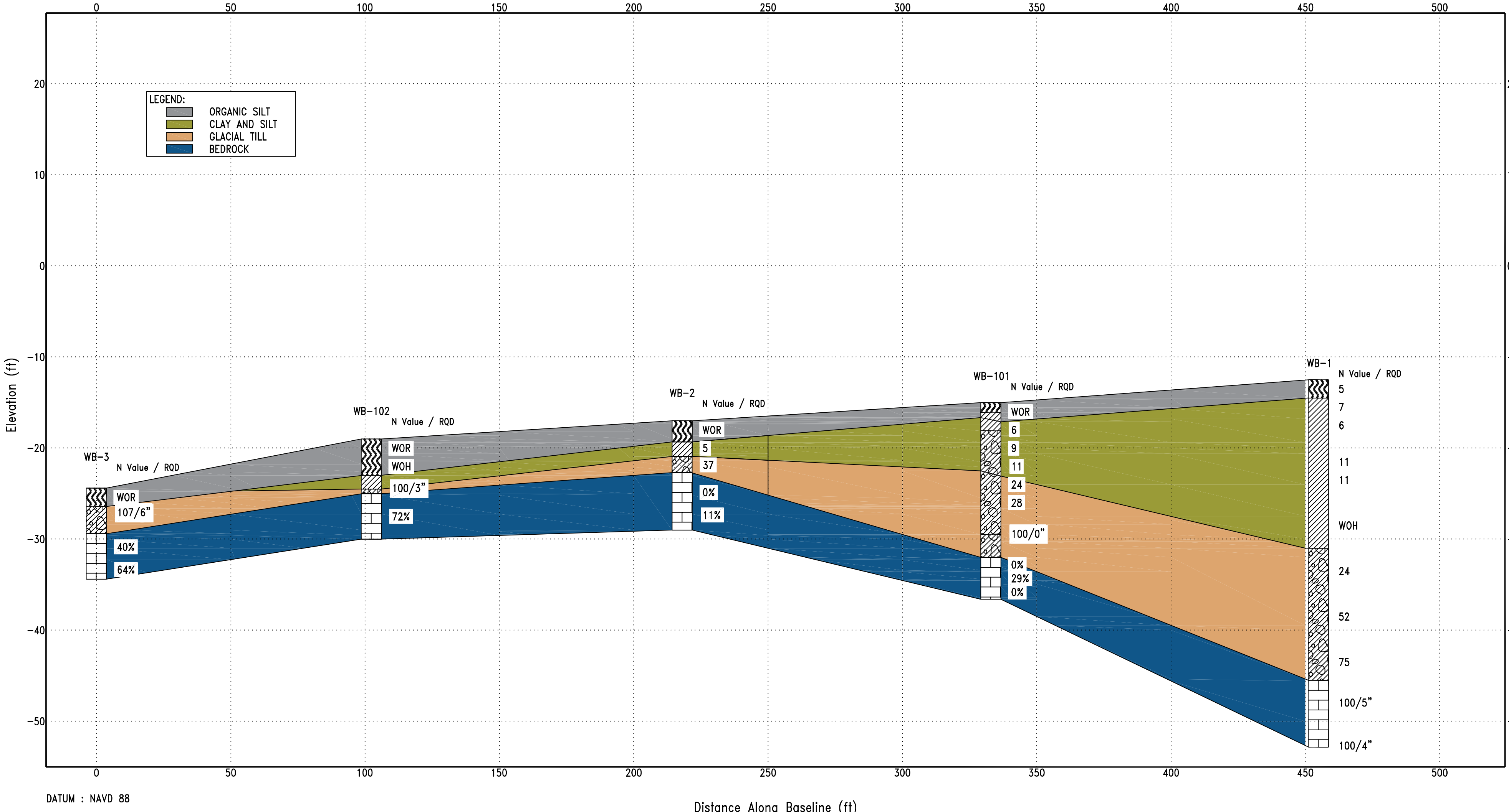
Jacobs	PROJECT	Lubec Breakwater	BORING NO.	WB-108
	LOCATION	Johnson Bay		
	OWNER	Maine DOT		
	JOB NUMBER	E2X95900		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
									spaced, shallow to steeply dipping joints with partial calcite coating to 1 mm thick, extremely to moderately fractured [QUODDY FORMATION]; Drilling Rate (min/ft): 3-3-2/7" Bottom of Borehole at 34.5 feet.	
-55	40									
-60	45									
-65	50									
-70	55									
-75	60									
-80	65									
-85	70									
-90										

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

Appendix C. Subsurface Profiles



DATUM : NAVD 88

HAMMER TYPE: Auto Hammer

STRATIGRAPHY & GW - B SIZE LUBEC PROFILES.GPJ CH2M GEOTECH.GDT 3/18/24

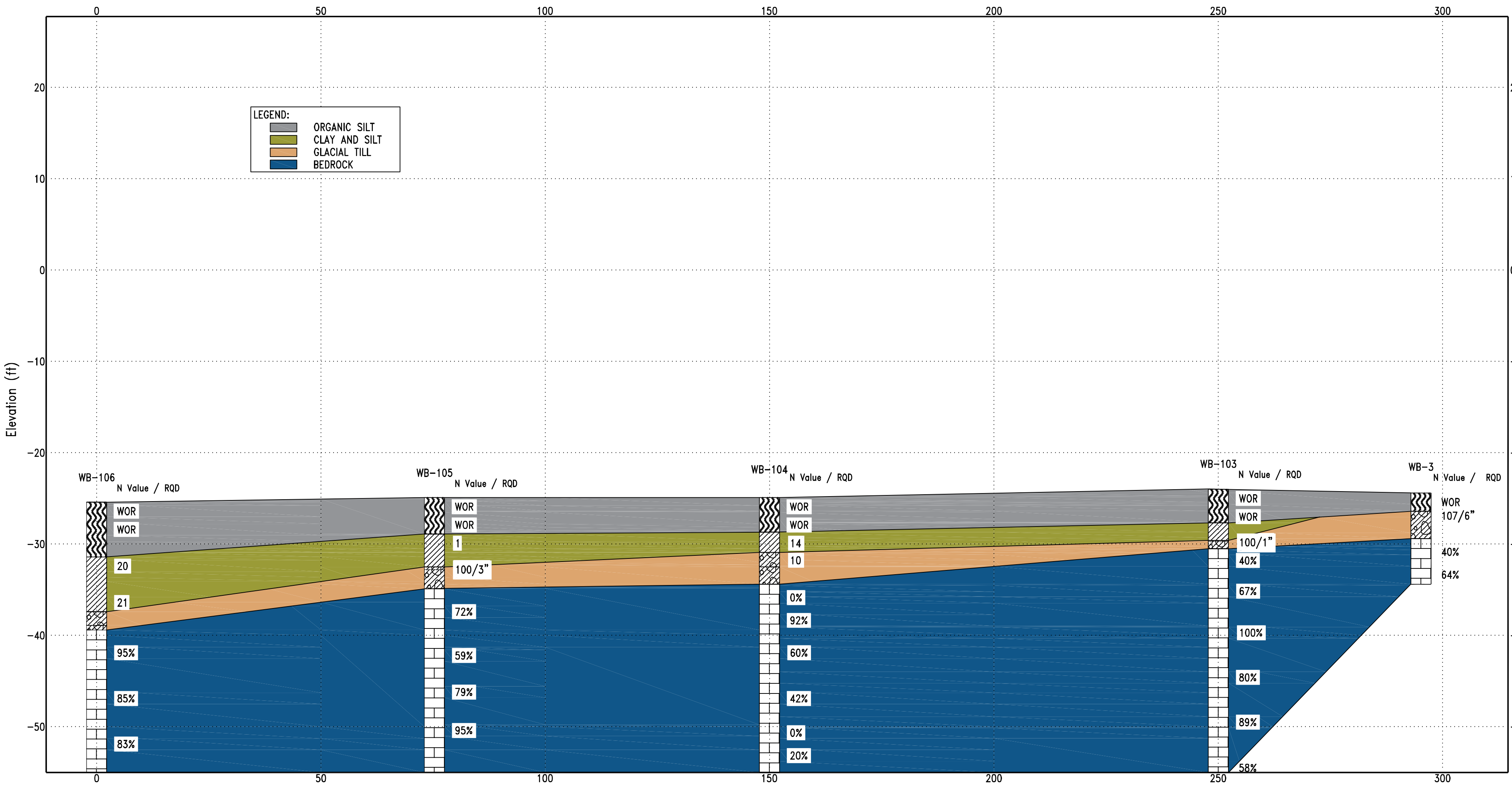
Jacobs

LITHOLOGY GRAPHICS

Organic Silt | Clay and Silt | Glacial Till | Bedrock

Rubble-Mound Breakwater
Lubec Breakwater
Lubec, Maine

Project Number: E2X95900



DATUM : NAVD 88

HAMMER TYPE: Auto Hammer

Jacobs

LITHOLOGY GRAPHICS

- Organic Silt
- Clay and Silt
- Glacial Till
- Bedrock

Pile-Supported Platform
Lubec Breakwater
Lubec, Maine

Project Number: E2X95900

STRATIGRAPHY & GW - B SIZE LUBEC PROFILES.GPJ CH2M GEOTECH.GDT 3/18/24

Appendix D. Haley & Aldrich Geotechnical Design Memorandum

HALEY ALDRICH

HALEY & ALDRICH, INC.
75 Washington Avenue
Suite 1A
Portland, ME 04101
207.482.4600

MEMORANDUM

25 November 2020
File No. 133699-002

TO:	Town of Lubec Carol Dennison, Chair, Town of Lubec Board of Selectmen
C:	Down to Earth Professional Land Services, Inc. Oscar Emerson, P.E., PLS, LSE, CPESC
FROM:	Haley & Aldrich, Inc. Justin DuBois, P.E.; Bryan C. Steinert, P.E.; Wayne A. Chadbourne, P.E.
SUBJECT:	Planning-Level Geotechnical Design Memorandum Proposed Breakwater - Safe Harbor Project Lubec, Maine

STATE OF MAINE
WAYNE A. CHADBOURNE
No. 10620
LICENSED
PROFESSIONAL ENGINEER

Haley & Aldrich, Inc. (Haley & Aldrich) is pleased to submit this planning-level geotechnical design memorandum, which presents the results of an initial subsurface investigation program and initial discussion regarding the overall technical feasibility of the project as it is currently envisioned. This work was undertaken at your request in accordance with our proposal dated 28 July 2020, which was authorized by you on 12 August 2020.

Horizontal Coordinate System and Elevation Datum

Elevations referenced herein and shown on the attached figures are in feet and reference the North American Vertical Datum of 1988 (NAVD 88). Tidal datum for the site relates to NAVD 88 (in feet) as follows:

El. 0 (MLLW) = El. -9.93
El. 0 (MLW) = El. -9.49
El. 0 (MHW) = El. 8.86
El. 0 (MHHW) = El. 9.34

Please note that this tidal information is not specific to this site and is taken from National Oceanic Atmospheric Administration (NOAA) tidal station No. 8410140 located at Passamaquoddy Bay, Eastport, Maine, approximately 2.5 miles north of the site. This is the NOAA tidal station closest to the site.

Project Background

Based on our discussions with you and our review of the concept plan prepared by Down to Earth Professional Land Services, Inc., dated 1 March 2019 (revised on 27 March 2019), it is our understanding that the Town of Lubec (Town) is evaluating the overall feasibility of constructing an approximate 24-ft wide, 1,300-ft long breakwater structure (top at El. 25) that extends into Johnson Cove from an area behind the Lubec Historical Society building on Main Street (see Figure 1, Project Locus).

The breakwater structure is proposed to consist of a combination of a rockfill embankment and cellular cofferdam structure. The project will also include installation of a new mooring field, boat launch and floating docks that will provide a sheltered area that can be used by mariners to launch, recover and moor vessels during times of inclement weather. A conceptual plan showing existing site conditions and the proposed breakwater is shown on the attached Figure 2, Site and Subsurface Exploration Location Plan. Select digital photographs of the site, taken by Haley & Aldrich during the planning-level geotechnical investigation, are provided in Appendix A.

As shown on Figure 2, the existing mudline elevation withing the project limits varies from approximately El. 5 near the existing shoreline to approximately El. -28 near the end of the cellular cofferdam portion of the breakwater. Based on the existing bathymetric data, we anticipate that approximately 50 to 55 ft (approximate) of fill will be required to construct the rockfill embankment and cellular cofferdam portions of the proposed breakwater (proposed top of breakwater at El. 25).

Haley & Aldrich Scope of Work

Haley & Aldrich is under contract with the Town to provide planning-level geotechnical consulting services specific to the subject project. Specific work scope items that have been completed in preparation of this memorandum are as follows:

- Developed, planned, coordinated and executed a planning-level geotechnical field investigation program, consisting of "pile probes," to obtain planning-level subsurface information along the proposed breakwater alignment.
- Develop initial opinions on the overall technical feasibility of constructing the breakwater and potential premium cost items based on the subsurface conditions encountered in the "pile probes".
- Prepare and submit this memorandum and prepare for and participate in one conference call with the Town to present and discuss the findings and opinions summarized herein.

Regional Surficial and Bedrock Geology

Surficial geologic units mapped at and in the vicinity of the project site are terminal moraine deposits, which consist of ice contact stratified sand, gravel and cobbles, and/or glacial till deposits, which consist of an unstratified, unsorted mixture of clay, silt, sand, gravel, cobbles and boulders. Glacial marine deposits consisting of clay, silt and sand are also mapped regionally along the flanks of the terminal moraine deposits and in low lying areas.

According to Maine Geological Survey's Eastport Quadrangle Map (1975), bedrock mapped at the site consists of igneous rocks composed of diabase and gabbro, which intruded rocks of the Quoddy Formation as a result of marine volcanism in Silurian and early Devonian time. The Quoddy Formation consists of siliceous shale, argillite and a few volcanic tuff beds. An inferred fault is mapped along the center of Lubec Neck trending northeast-southwest. The Quoddy Formation is mapped adjacent to the fault, extending to the southeast. Intrusive igneous rocks are also mapped adjacent to the contact, extending to the northwest and includes the area in which the proposed breakwater is being planned.

Planning-level Geotechnical Field Investigation and Subsurface Conditions

PLANNING-LEVEL GEOTECHNICAL FIELD INVESTIGATION

A planning-level geotechnical field investigation consisting of 22 "pile probes", designated HA20-P1 through HA20-P22, was completed under the direction of a Haley & Aldrich geotechnical engineer on 28 and 29 September 2020.

The "pile probe" locations were determined in the field by Haley & Aldrich using global positioning system (GPS) survey equipment. Mudline elevations at "pile probe" locations were estimated by interpolating between bathymetric data shown on Figure 2. The mudline elevations were also estimated by Haley & Aldrich during the field investigation by subtracting manual depth soundings (using a weighted tape) from the tide elevation at the time an individual "pile probe" was completed. The plan locations of and approximate mudline elevations at each "pile probe" are summarized in Table I and are shown graphically on Figure 2.

The "pile probes" were completed by Prock Marine Company, Inc. (Prock) of Rockland, Maine using a Link-Belt LS-518 crawler crane and an H&M Model 3208T vibratory hammer (vibratory hammer) placed on an approximate 50 ft by 120 ft spud barge. An approximate 55-ft long HP12x53 steel H-pile was used at each probe location (see attached Photograph Nos. 5 and 6).

The "pile probes" were advanced using the vibratory hammer to depths ranging from approximately 1 to 30 ft below mudline (BGS) and were terminated in apparent "dense/hard" soil (HA20-P1 through HA20-P4) or on an apparent refusal surface (HA20-P5 through HA20-P22) that was judged by Haley & Aldrich to be the probable top of bedrock surface. The presence and thickness of "loose/soft" and "dense/hard" soils and apparent refusal surfaces were judged by Haley & Aldrich based on visual observation of the "pile probe" advancement and, at some "pile probe" locations, measurement of penetration rates. Actual soil types, consistency and soil unit thicknesses will vary from those reported herein and shown on the Tables and Figure 2.

Please note that no sampling or in-situ testing was completed during the program. Representative soil samples were collected from material that adhered to the "pile probe" at some locations and were preserved in sealed plastic bags. The samples are currently being stored at the Haley & Aldrich laboratory facility in Portland, Maine.

SUBSURFACE CONDITIONS

Based on the pile probe results, we anticipate that the subsurface conditions encountered at the site consist of "soft/loose" marine deposit soils overlying "dense/hard" marine deposit soils or firm glacial till and bedrock. A summary of the anticipated soil units and approximate thicknesses encountered at each "pile probe" location is provided on Table II and are shown graphically on Figure 2. A generalized description of soil conditions encountered during the planning-level geotechnical field investigation is provided below.

- "Soft/loose" marine deposits were encountered at many "pile probe" locations and ranged in thickness from approximately 1 to 12 ft. Based on our visual observation of soil present at mudline during low tide, this material generally consisted of well graded SAND with variable amounts of silt and gravel.
- "Dense/hard" marine deposit or glacial till soil was encountered at each "pile probe" location except HA20-P15 and ranged in thickness from approximately 2 to 24 ft. The full thickness of the stratum was not determined at "pile probe" locations HA20-P1 through HA20-P4 because the pile probe was not long enough to reach "refusal" surface. Based on our visual observation of soil that adhered to the "pile probe", this material generally consisted of CLAY (CL) with variable amounts of sand and gravel.
- Apparent refusal surfaces, that were judged by Haley & Aldrich to be the probable top of bedrock surface were encountered at each "pile probe" location except HA20-P1 through HA20-P4. Where encountered, the apparent top of bedrock surface was present at depths ranging from approximately 1 to 33 ft BGS (El. -18 to El. -40).

Please note that the terms "loose/soft" and "hard/dense" used herein and on the attachments are intended to be relative terms and do not in any way describe or represent that actual consistency of the soils present at the site. Split-spoon sampling and in-situ and laboratory testing will be needed to determine the actual physical and strength properties of the soil materials present at the site. Images of the "typical" soil type that adhered to the "pile probes" are shown in Photograph Nos. 7 and 8 in Appendix A.

Impacts of Subsurface Conditions on Proposed Development

Based on the observations made during the planning-level geotechnical field investigation and our current understanding of the project, we offer the following general geotechnical "observations" regarding construction of the proposed improvements for the subject project:

- A one horizontal to one vertical (1H:1V) slope is currently shown on the south side of the rockfill embankment portion of the breakwater structure. It is our opinion that constructing a steep slope in a marine environment could be difficult and may require, at a minimum, methodical and careful placement of very large, angular rock. We suggest that consideration be given to flattening the inclination of the proposed slope to 1.5H:1V (maximum) or flatter. Similarly, consideration should be given to steepening the slope on the north side of the breakwater from the 2H:1V shown in Figure 2 to 1.5H:1V (maximum).

- Because of the limited thickness of "soft/loose" soil and the apparent consistency of the underlying "hard/dense" soil encountered during the planning-level geotechnical field investigation, it is our opinion that the potential for and premium costs associated with mitigating settlement and global stability issues caused by construction of the rockfill breakwater is relatively low.
- The pile probing program completed for this initial, planning-level evaluation is not sufficient to develop final geotechnical design requirements for the breakwater and associated structures. A design-level field investigation consisting of geotechnical test borings, in-situ testing (i.e., at a minimum SPT N-values and vane shear testing) and laboratory testing will be required.
- It is possible that the results of technical evaluations completed using subsurface information collected from the design-level field investigation may show that post-construction magnitudes of settlement and/or global stability factors of safety are unacceptable. If that is the case, implementation of special measures would be required to mitigate any global embankment stability and/or settlement issues. These special measures could include but may not be limited to the following: 1.) lengthening the cellular cofferdam portion of the proposed breakwater closer to the shoreline to limit the height of the rockfill portion of the breakwater, 2.) constructing the rockfill embankment portion of the breakwater using staged construction to allow settlement to occur and the underlying in-situ soils to gain strength prior to completing embankment construction, or 3.) installing ground improvement elements (i.e., rigid inclusions) through the compressible and low strength soils [if present], which would allow the load (weight) of the embankment to be transferred to a suitable bearing stratum (soil or bedrock).

Recommendations for Future Work

Based on the information summarized herein and our understanding of the project, it is our opinion that additional work will be required to determine design and construction requirements for the proposed breakwater. Additional work items that should be considered include but are not limited to the following:

- Development and execution of a design-level subsurface investigation program (test borings) that includes soil and rock sampling. It is our opinion that this investigation is needed to characterize the subsurface conditions present within and adjacent to the proposed breakwater, which along with the results of a laboratory testing program (see next bullet) will serve as the basis of technical evaluations needed to determine foundation support and geotechnical recommendations for the project.
- Development and execution of a laboratory testing program on soil and rock samples collected during the design phase subsurface exploration program (see previous bullet). Determination of engineering properties (e.g., strength, compressibility) are critical input parameters to the technical evaluations needed to determine foundation support and geotechnical recommendations for the project.

- Completion of technical evaluations, specifically settlement and global stability evaluations, to determine the anticipated magnitudes of post-construction settlement and global stability factors of safety related to the rockfill portions of the breakwater. Foundation and geo-structural analyses will also be needed to determine the design requirements for the pier and cellular cofferdam portion of the breakwater.

Limitations of Recommendations

This memorandum is prepared for the exclusive use of the Town of Lubec relative to the Safe Harbor project in Lubec, Maine. There are no intended beneficiaries other than the Town of Lubec. Haley & Aldrich shall owe no duty whatsoever to any other person or entity on account of the Agreement or the memorandum. Use of this memorandum by any person or entity other than the Town of Lubec for any purpose whatsoever is expressly forbidden unless such other person or entity obtains written authorization from The Town of Lubec and from Haley & Aldrich. Use of this memorandum by such other person or entity without the written authorization the Town of Lubec and Haley & Aldrich shall be at such other person's or entities sole risk, and shall be without legal exposure or liability to Haley & Aldrich.

Use of this memorandum by any person or entity, including by the Town of Lubec, for a purpose other than the Safe Harbor project in Lubec, Maine is expressly prohibited unless such person or entity obtains written authorization from Haley & Aldrich indicating that the memorandum is adequate for such other use. Use of this memorandum by any other person or entity for such other purpose without written authorization by Haley & Aldrich shall be at such person's or entities sole risk and shall be without legal exposure or liability to Haley & Aldrich.

The information provided herein is based, in part, upon the data obtained from the referenced "pile probes". The nature and extent of variations between "pile probes" may not become evident until additional subsurface explorations are completed or until construction. If variations then appear, it may be necessary to reevaluate the opinions provided in this memorandum.

Closure

We greatly appreciate the opportunity to provide planning-level geotechnical engineering consulting services on this project and trust this meets your present needs. Please do not hesitate to contact us if you require additional information or have questions regarding any of the information presented herein.

Attachments:
Table I – Subsurface Exploration Location Data
Table II – Subsurface Exploration Subsurface Data
Figure 1 – Project Locus (1 page)
Figure 2 – Site and Subsurface Exploration Location Plan (1 page)
Appendix A – Site Photographs (5 pages)

TABLE I
Subsurface Exploration Location Data
Proposed Safe Harbor Project
Lubec, Maine

Haley & Aldrich, Inc. File No.: 133699-002

Probe No.[1]	Approximate Mudline Elevation		Horizontal Coordinates[2] (ft)	
	Bathymetry[3,5]	Manual[4,5]	Northing (Y)	Easting (X)
HA20-P1	-27.0	-29.6	437,262.59	1,373,785.22
HA20-P2	-28.0	-30.7	437,332.98	1,373,858.58
HA20-P3	-27.5	-31.3	437,394.51	1,373,925.19
HA20-P4	-27.5	-28.8	437,467.97	1,374,005.16
HA20-P5	-27.0	-28.6	437,543.10	1,374,086.53
HA20-P6	-26.0	-27.6	437,614.98	1,374,176.00
HA20-P7	-22.0	-20.9	437,587.77	1,374,296.23
HA20-P8	-19.0	-20.2	437,561.28	1,374,389.41
HA20-P9	-17.5	-16.6	437,534.73	1,374,481.71
HA20-P10	-15.5	-15.4	437,505.80	1,374,591.65
HA20-P11	-12.0	-14.1	437,477.85	1,374,687.75
HA20-P12	-27.5	-28.9	437,490.91	1,374,030.91
HA20-P13	-27.0	-28.9	437,517.24	1,374,058.85
HA20-P14	-30.0	-30.0	437,656.51	1,374,023.67
HA20-P15	-19.0	-19.5	437,703.83	1,374,281.49
HA20-P16	-25.0	-23.6	437,542.04	1,374,222.22
HA20-P17	-11.5	-14.0	437,601.94	1,374,611.45
HA20-P18	-17.0	-16.7	437,437.77	1,374,577.86
HA20-P19	-14.0	-14.7	437,490.32	1,374,640.52
HA20-P20	-5.0	-5.9	437,542.95	1,374,779.26
HA20-P21	-7.0	-9.0	437,462.01	1,374,754.31
HA20-P22	-7.5	-10.9	437,383.51	1,374,739.63

Notes:
1 Probe locations are shown on Figure 2, Site and Subsurface Exploration Location Plan.
2 Horizontal coordinates of probes were determined by Haley & Aldrich, Inc. using GPS survey equipment, are measured in feet and reference U.S. Ste Plane 1983, Maine East 1801, NAD83 coordinate system.
3 Mudline elevations at probe locations were estimated by Haley & Aldrich, Inc. by interpolating between bathymetric contours shown on Figure 2 and were rounded up to the nearest 0.5 ft.
4 Mudline elevations at probe locations were calculated by Haley & Aldrich, Inc. by subtracting manual depth soundings using a weighted tape from the tide elevation at the time the probe was completed.
5 Elevations reference the North American Vertical Datum of 1988 (NAVD 88).

	Individual	Date
Prepared By:	JAD	9/29/2020
Checked By:	BCS	9/29/2020
Reviewed By:	WAC	11/23/2020

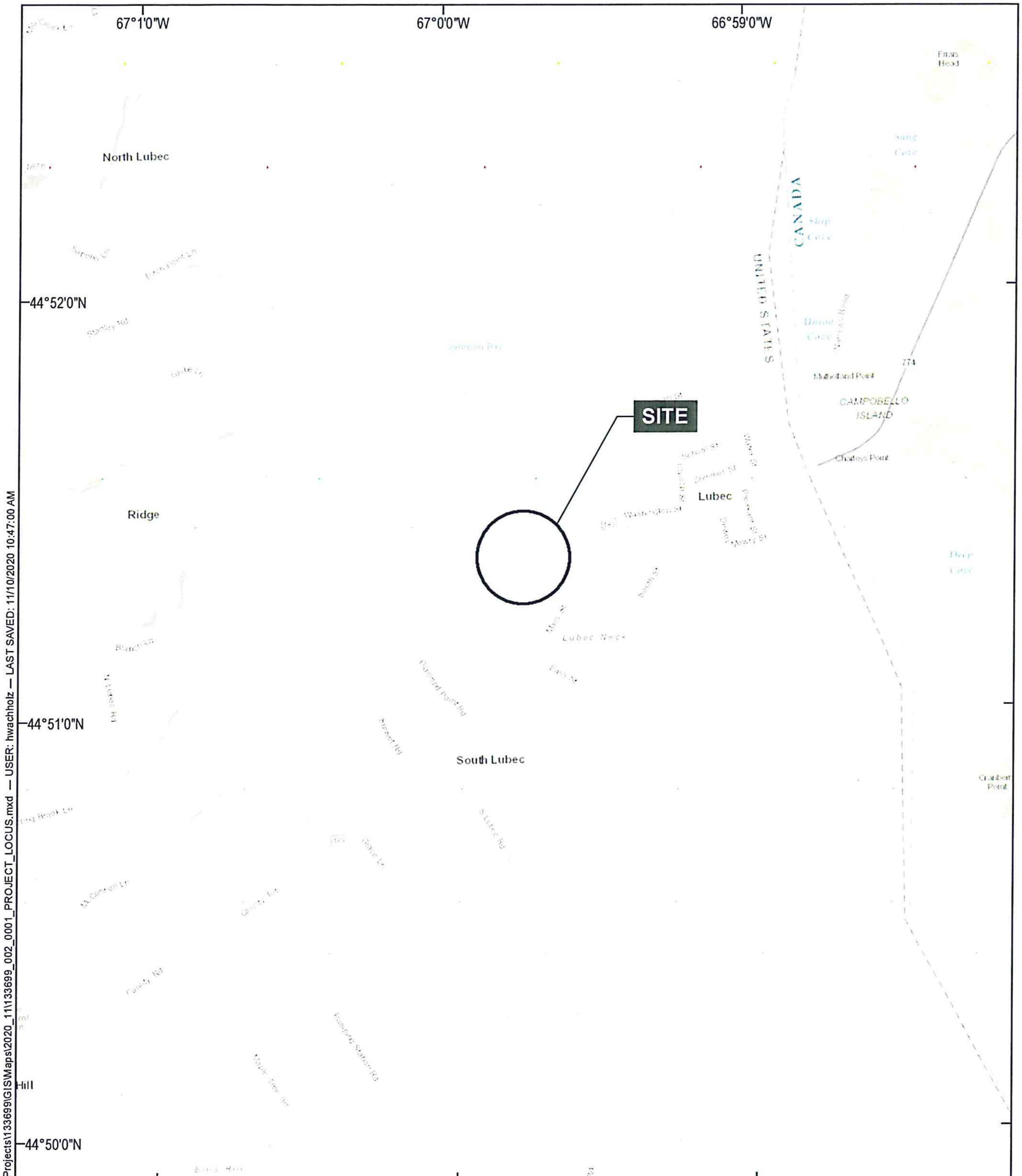
TABLE II
Subsurface Exploration Subsurface Data
Proposed Safe Harbor Project
Lubec, Maine

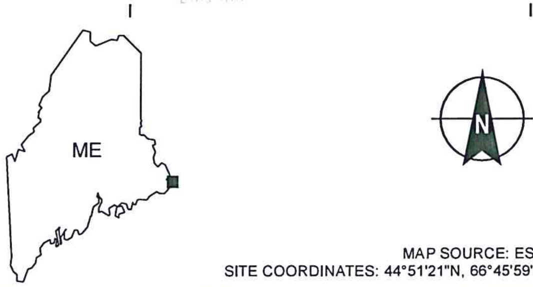
Haley & Aldrich, Inc. File No.: 133699-002

Probe No.[1]	Approximate Mudline Elevation[2,3]	Approximate Strata Thickness[4,5] (ft)			Approximate Elevation of Refusal Surface[3,5,6]	Approximate Probe Depth Below Mudline[7]	Comments
		"Soft/Loose" Soil	"Hard/Dense" Soil	Total			
HA20-P1	-27.0	11.6	>21.0	>32.6	--	32.6	Very hard driving, penetration rate of approx. 1 ft per minute.
HA20-P2	-28.0	8.7	>18.0	>26.7	--	26.7	Very hard driving, penetration rate of approx. 1 ft per minute.
HA20-P3	-27.5	10.9	>15.0	>25.9	--	25.9	Very hard driving, penetration rate of approx. 1 ft per minute.
HA20-P4	-27.5	8.3	>16.0	>24.3	--	24.3	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement
HA20-P5	-27.0	NE	11.2	12.8	-39.8	12.8	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement
HA20-P6	-26.0	NE	7.7	9.3	-35.3	9.3	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement
HA20-P7	-22.0	NE	9.2	8.1	-30.1	8.1	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement
HA20-P8	-19.0	NE	5.2	6.4	-25.4	6.4	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement
HA20-P9	-17.5	NE	2.5	1.6	-19.1	1.6	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement
HA20-P10	-15.5	NE	2.9	2.8	-18.3	2.8	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement
HA20-P11	-12.0	NE	20.5	22.6	-34.6	22.6	Probe pile was placed with vibratory hammer on prior to taking a "soft/Loose" soil thick. measurement. Last 4 ft of pen. was harder.
HA20-P12	-27.5	6.4	24.0	31.8	-59.3	31.8	Hard driving, soil sample collected from pile tip
HA20-P13	-27.0	7.5	12.5	21.9	-48.9	21.9	
HA20-P14	-30.0	8.0	9.5	17.5	-47.5	17.5	Difficult extraction
HA20-P15	-19.0	1.1	0.0	1.6	-20.6	1.6	
HA20-P16	-25.0	6.0	1.5	6.1	-31.1	6.1	
HA20-P17	-11.5	4.0	4.5	11.0	-22.5	11.0	
HA20-P18	-17.0	6.0	6.5	12.2	-29.2	12.2	
HA20-P19	-14.0	3.7	11.0	15.4	-29.4	15.4	Soil sample collected from pile tip.
HA20-P20	-5.0	0.5	11.5	12.9	-17.9	12.9	Difficult extraction
HA20-P21	-7.0	1.5	13.6	17.0	-24.0	17.0	Difficult extraction
HA20-P22	-7.5	1.5	10.0	14.9	-22.4	14.9	Difficult extraction, no soil on pile tip

Notes:
1 Probe locations are shown on Figure 2, Site and Subsurface Exploration Location Plan.
2 Mudline elevations at probe locations were estimated by Haley & Aldrich, Inc. by interpolating between bathymetric contours shown on Figure 2 and were rounded up to the nearest 0.5 ft.
3 Elevations are measured in feet and reference the North American Vertical Datum of 1988 (NAVD 88).
4 Estimated by Haley & Aldrich, Inc. by observing "pile probe" behavior during advancement. Actual material types, consistency and thicknesses will vary from those shown.
5 "NE" indicates stratum not encountered; "--" indicates probe not advanced deep enough to determine presence or thickness of stratum.
6 Determined by subtracting the refusal surface depth from the tide elevation at the time the probe was completed.
7 Determined by subtracting the "Approximate Elevation of Refusal Surface" from the "Approximate Mudline Elevation" where refusal surfaces were encountered. Where refusal surfaces were not encountered, determined by subtracting the length of the probe (55 ft) from the tide elevation at the time the probe was completed.

	Individual	Date
Prepared By:	JAD	9/29/2020
Checked By:	BCS	9/29/2020
Reviewed By:	WAC	11/23/2020





MAP SOURCE: ESRI
SITE COORDINATES: 44°51'21"N, 66°45'59"W

HALEY ALDRICH

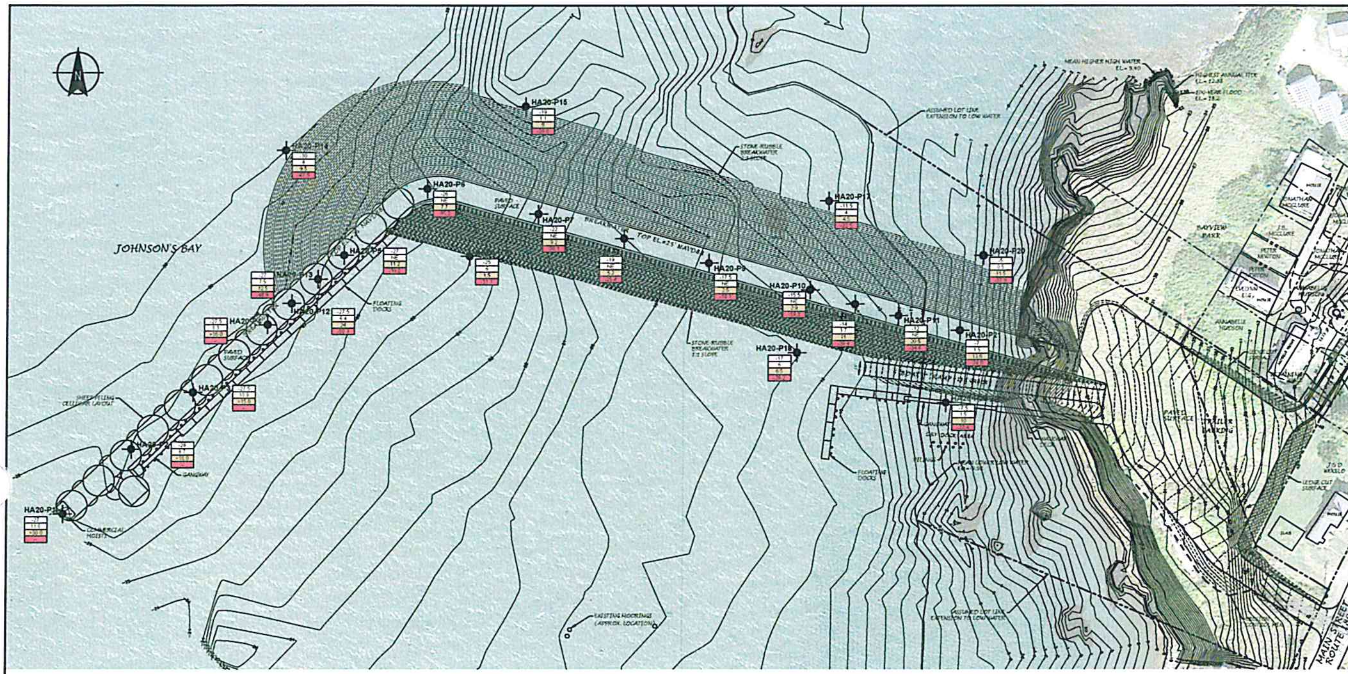
PROPOSED BREAKWATER
SAFE HARBOR PROJECT
LUBEC, MAINE

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
NOVEMBER 2020

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\133699\GIS\Maps\2020_11\133699_002_0001_PROJECT_LOCUS.mxd — USER: hwachholz — LAST SAVED: 11/10/2020 10:47:00 AM



HALEY & ALDRICH, INC.
75 Washington Avenue, Suite 203
Portland, ME 04101-2617
Tel: 207.482.4600
Fax: 207.775.7666
www.haleyaldrich.com

LEGEND

HA20-P1 — DESIGNATION AND LOCATION OF PROBE COMPLETED BY PROCK MARINE COMPANY, INC. OF ROCKLAND, MAINE ON 28 AND 29 SEPTEMBER 2020

-27	APPROXIMATE MUDLINE ELEVATION
9	APPROXIMATE THICKNESS OF "SOFT/LOOSE" SOIL
>30.0	APPROXIMATE THICKNESS OF "HARD/DENSE" SOIL
NE	APPROXIMATE ELEVATION OF REFUSAL SURFACE

-- = DENOTES TEST BORING NOT DRILLED DEEP ENOUGH TO DETERMINE PRESENCE OF STRATUM

NE = DENOTES STRATA NOT ENCOUNTERED

-21 — BATHYMETRIC ELEVATION CONTOUR OF EXISTING MUDLINE

NOTES

1. THE LOCATION AND ORIENTATION OF PROPOSED STRUCTURES AND THE EXISTING EXISTING BATHYMETRIC INFORMATION SHOWN ARE TAKEN FROM THE ELECTRONIC AUTOCAD FILE ENTITLED, "LSH GPS proposed.dwg," PROVIDED BY DOWN TO EARTH PROFESSIONAL LAND SERVICES, INC. ON 1 SEPTEMBER 2020.
2. BATHYMETRIC ELEVATION CONTOURS ARE IN FEET AND REFERENCE THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). BASED ON DATA FROM THE NOAA TIDAL STATION 8410140 LOCATED AT PASSAMAQUODDY BAY, EASTPORT, MAINE, NAVD 88 AND MEAN LOWER LOW WATER (MLLW) DATUM RELATE AS FOLLOWS: EL. 0 NAVD 88 = EL. 9.93 MLLW (IN FEET).
3. MUDLINE ELEVATIONS AT PROBE LOCATIONS WERE ESTIMATED BY HALEY & ALDRICH, INC. BY INTERPOLATING BETWEEN BATHYMETRIC CONTOURS SHOWN AND WERE ROUNDED UP TO THE NEAREST 0.5 FT.
4. LOCATIONS OF PROBES WERE DETERMINED IN THE FIELD BY HALEY & ALDRICH PERSONNEL USING GPS SURVEY EQUIPMENT.
5. PROBES WERE MONITORED IN THE FIELD BY A HALEY & ALDRICH, INC. GEOTECHNICAL ENGINEER.
6. IMAGE, DATED 28 SEPTEMBER 2019, TAKEN ELECTRONICALLY FROM GOOGLE EARTH PRO.

0 50 100 150 200
SCALE IN FEET

Project No.:	133699-002
Scale:	AS SHOWN
Date:	23 NOVEMBER 2020
Drawn By:	TM
Designed By:	TM
Checked By:	BCS
Approved By:	WAC
Stamp:	

Rev	Description	By	Date

PROPOSED BREAKWATER - SAFE HARBOR PROJECT LUBEC, MAINE

FIGURE 2

Sheet: 1 of 1

APPENDIX A

Site Photographs

Photo 1: View of Johnson Bay looking southwest.

Photo 2: View of Johnson Bay looking west.

Photo 3: View of Johnson Bay looking northwest.

Photo 4: View of shoreline from Johnson Bay looking east.

Photo 5: Link-Belt LS-518 crawler crane used to advance HP12x53 steel H-pile probe.

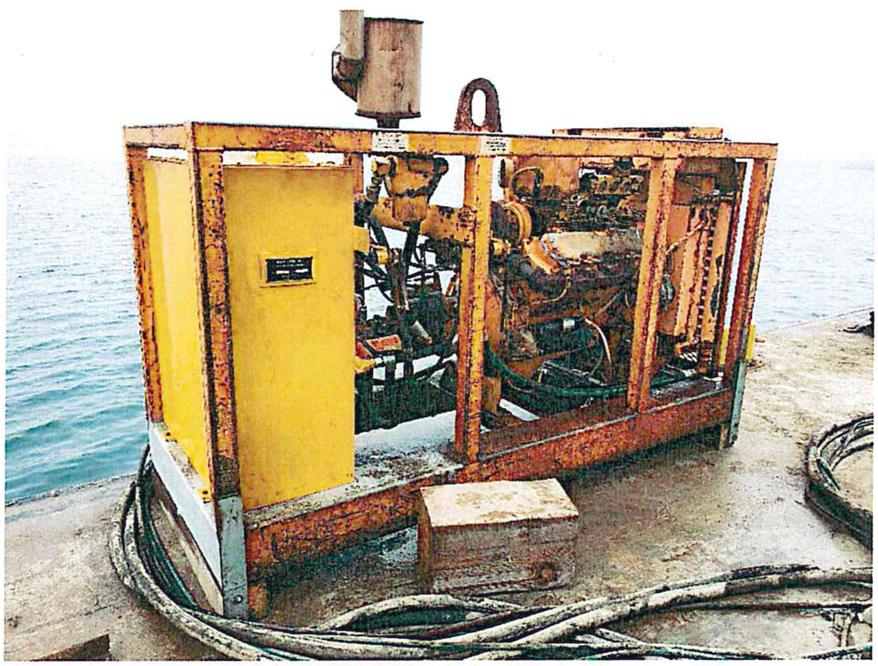


Photo 6: H&M Model 3208T vibratory hammer used to advance HP12x53 steel H-pile probe.

Photo 7: Soil adhered to HP12x53 steel H-pile probe.

Photo 8: Soil adhered to HP12x53 steel H-pile probe.

State of Maine Department of Administrative and Financial Services

Document Type
Contract

Department
13A-Department of Marine Resources

Short Description of Goods or Services
Marine Resource Services

Contractor Name
Town of Lubec

Contract Start Date
8/20/2019

Contract End Date
12/31/20

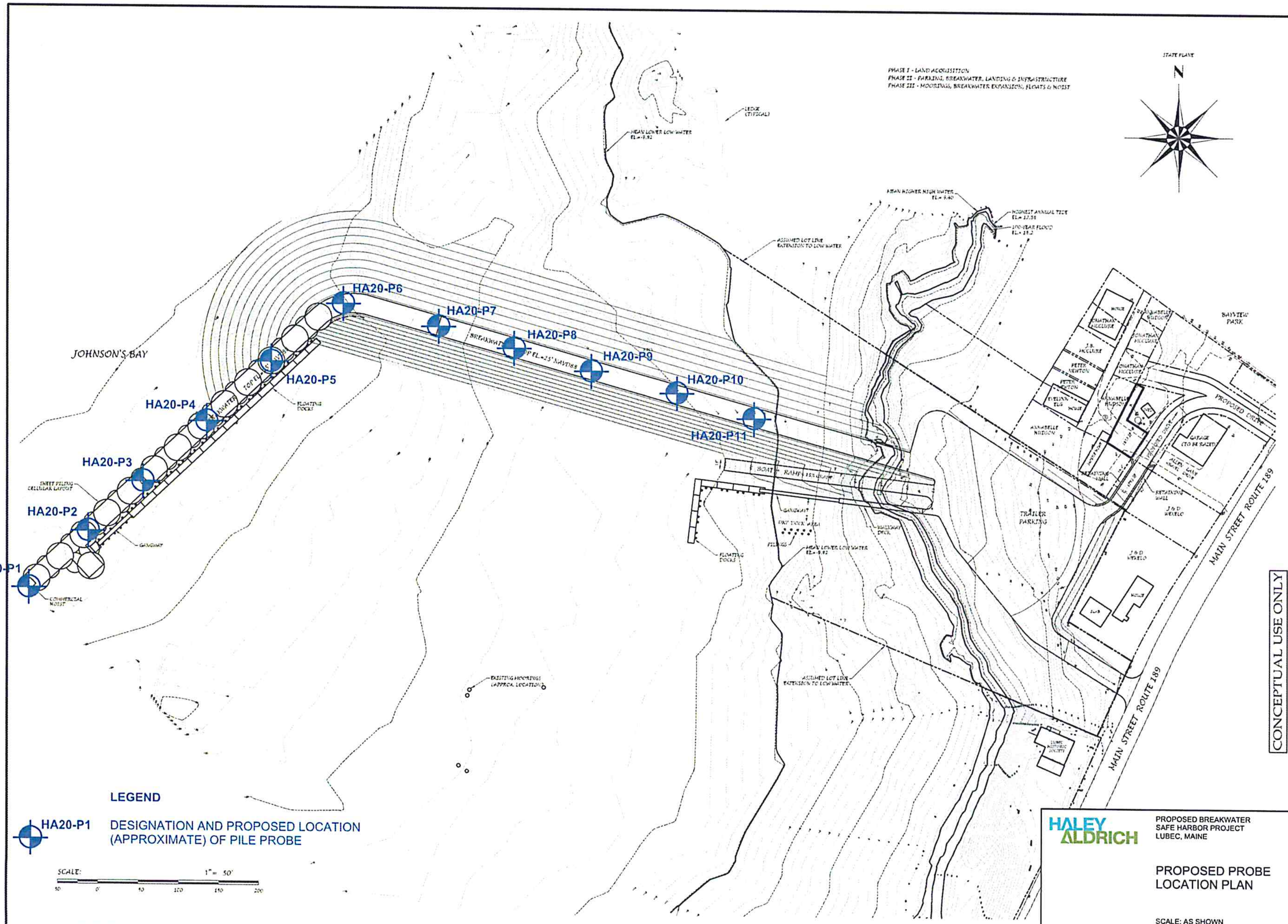
Advantage CT or RQS Number
20190806000000000424

Internal Department Contract Number

Contract Amount
$30,000.00

Approval Date Time
8/12/19 2:26 PM

This contract has been approved by the Division of Purchases, Chair of the State Procurement Review Committee and encumbered by the Office of the State Controller.



SAFE HARBOR CONCEPT
COLUMBIA COVE PROTECTED HARBOR
MAIN STREET, LUBEC, MAINE
WASHINGTON COUNTY

DOWN to EARTH
PROFESSIONAL LAND SERVICES, INC.
P.O. BOX 443
BRADLEY, MAINE 04411-0443
TEL.207-827-6733

HALEY ALDRICH

PROPOSED BREAKWATER
SAFE HARBOR PROJECT
LUBEC, MAINE

PROPOSED PROBE
LOCATION PLAN

SCALE: AS SHOWN
JULY 2020

FIGURE 1

\\haleyaldrich.com\share\CF\Projects\133699\001\Figure 1.pdf
bsteinert

Haley & Aldrich, Inc.
75 Washington Avenue
Suite 1A
Portland, ME 04101
207.482.4600

28 July 2020
File No. 133699-001

Town of Lubec
40 School Street
Lubec, Maine 04652

Attention: Carol Dennison

Subject: Proposal for Planning-Level Geotechnical Engineering Services
Proposed Breakwater – Safe Harbor Project
Main Street, Lubec, Maine

Dear Carol:

In accordance with your request, Haley & Aldrich, Inc. (Haley & Aldrich) is pleased to submit this proposal to the Town of Lubec (Town) to provide planning-level geotechnical engineering services, including a field investigation, for the proposed Safe Harbor project. We appreciate the opportunity to submit this proposal and support the Town in evaluating the overall technical feasibility of the subject project.

Project Background

Based on our discussions with you and our review of the concept plan prepared by Down to Earth Professional Land Services, Inc., dated 1 March 2019 (revised on 27 March 2019), it is our understanding that the Town is evaluating the overall feasibility of constructing an approximate 24-ft wide, 1,300-ft long breakwater structure (top at El. 25; NAVD 88 vertical datum) that consists of a combination of a "rockfill" embankment and a cellular cofferdam structure. Floating dock structures are also being planned, which would be accessed from the cellular cofferdam portion of the breakwater. A conceptual plan showing the proposed breakwater is shown on the attached Figure 1.

As discussed with you, the critical subsurface soil unit that could impact the overall feasibility and cost to construct the breakwater, as currently envisioned, will be near-surface, harbor bottom deposits and low strength, compressible marine clay soils. As presented below, we are proposing to advance a series of "pile probes" along the proposed breakwater alignment to help identify the presence of these soils and the depth to "firm" material (e.g., glacial till soils or bedrock). Please note that we would typically drill conventional test borings that would allow us to physically collect, identify/classify, and evaluate soil and rock samples. However, due to the limited funds available at this time, we are proposing to advance "pile probes" that will allow us, from a high level, to determine the presence of and depth to "soft" or "firm" soils. Conventional test boring explorations including soil and rock sampling and laboratory testing will ultimately be needed to develop geotechnical design and foundation support recommendations for the breakwater. This work could be done during the preliminary or final design phases of the project, or earlier if additional funds become available.

It is our understanding that this work is being completed so that the Town can confirm that the project is technical feasible from a geotechnical and constructability perspective. It is also our understanding that the Town plans to deliver the project under a design-build contract. Based on our discussions with you, you have confirmed that Haley & Aldrich will not be precluded from participating on a design-build team once an RFQ/RFP is issued.

Proposed Scope of Work

We propose the following work scope items:

1. Develop a geotechnical field investigation program (program) to obtain planning-level subsurface information along the proposed breakwater alignment that will be used to help determine the presence of and thickness of "soft" soils/depth to top of "firm" soils/rock. This information will allow us to initially assess the overall technical feasibility of constructing the breakwater as currently envisioned. As currently envisioned, the program will consist of performing approximately eleven "pile probes" spaced at approximate 100-ft intervals along the proposed breakwater alignment. Approximate proposed "pile probe" locations are shown on the attached Figure 1.
2. Arrange to have the "pile probes" completed by a marine contractor. As discussed with you, we currently plan to use Prock Marine Company, Inc. (Prock) of Rockland, Maine to complete the "pile probes". Prock is planning to mobilize a 48 ft x 120 ft x 10 ft spud barge to the site. The barge has a draft of approximately 2 ft, and has two, 80 to 85-ft long spuds. The barge will be equipped with a 100-ton capacity crane and a 1700 H+M vibratory hammer that will be used to advance an HP12x53 steel H-pile (i.e., "pile probe").
3. Coordinate with Prock and the Town prior to starting the work, as needed, to efficiently mobilize to the site to conduct the field investigation work.
4. Determine coordinate locations for the "pile probes" using the AutoCAD file provided by you and upload the location data into our handheld GPS survey equipment. These coordinates will be used to navigate the barge to the proposed "pile probe" boring locations. We plan on locating the "pile probes" "real-time" using our GPS survey equipment. This will be done during mobilization/moving the barge to each "pile probe" location. Mudline elevations at "pile probe" locations will be estimated using bathymetry data provided by you as shown on Figure 1.
5. Coordinate and obtain DigSafe utility clearances and prepare and enforce a project-specific health and safety plan for conducting the field work. Conduct an internal kickoff meeting prior to the start of the field investigation.
6. Provide technical monitoring of the "pile probes" so that depths, locations and other observations can be made and recorded. For budgeting purposes and based on our discussion with Prock, we have included an allowance of two, 8-hour days (time on site) to complete as many "pile probes" as possible. Please note that this duration does not include allowances for weather related delays (i.e., weather days [days when it is not safe for the crew to be on the barge and drill] and lay days [days when it is not safe to have the barge on the water at all; barge moved to land and secured]). We will notify the Town immediately if this situation arises.
7. Conduct daily health and safety tailgate check in meetings at the site each morning during the execution of the work. Communicate with the Town, as needed, during the conduct of our field investigation.

8. Prepare a brief geotechnical memorandum summarizing the results of the field investigation and our initial opinion on the overall technical feasibility of constructing the breakwater as currently envisioned. We will provide a high-level discussion on geotechnical potential premium costs associated with construction of the proposed breakwater. The memorandum will include a table and an exploration location plan that summarizes the conditions encountered in the "pile probes".
9. Prepare for and participate in one conference call with the Town to present and discuss our findings and opinions. For budgeting purposes, we have assumed that the conference call will be approximately 1-hour long.

Work Scope Assumptions/Exclusions

- "Pile probes" will be conducted during normal work hours (likely 0700 to 1700). Daily hours worked on-site will not exceed 8 hours. If the exploration work requires more than 8 hours per day or if night or weekend work is required, we will notify the Town immediately.
- A contingency to cover the costs for weather or lay days has not been included in this proposal. If needed, we will notify the Town to address the potential additional costs in a separate contract amendment.
- The scope of work does not include obtaining permits for completing the over-water work in the harbor.
- The scope of work does not include coordination with the local harbor master and the Coast Guard. Based on discussions with you, we understand that the Town will coordinate with the necessary stakeholders, including the harbor master and Coast Guard.
- We have assumed that no underground utilities are located within the limits of the submerged land. We request that the Town confirm this in an email prior to the start of the field program.
- An assessment of oil or hazardous materials at the site, the characterization of excavated soil or groundwater which will be generated as a result of the planned construction activity for the purpose of assessing possible requirements for management of contaminated media, or assessment of the impact that contamination or pollutants could have on the proposed construction are not included in our scope of work.

Requested Information

We request that the following items be provided to us:

- Permission to enter the property to access and conduct the field explorations.
- Confirmation that underground utilities are not present at the proposed "pile probe" locations. We have not included private utility locating or vac excavation costs in our budget.
- Electronic (AutoCAD) files showing existing site features, proposed marina structures, topography and bathymetry. We have assumed that the file has been set up in a real coordinate system (e.g., Maine State Plane). We did not include budget to "fix" the site plan in real coordinate space using our survey equipment as this would require us to make an additional site visit prior to the start of the field investigation.

Staffing, Anticipated Fees and Anticipated Schedule

We anticipate that Bryan C. Steinert, P.E. will serve as the Project Manager and Wayne A. Chadbourne, P.E. will serve as the Officer-in-Charge of the project.

For your present budget purposes, we estimate the total cost of the geotechnical work scope outlined herein to be $37,500, which includes allowances of $1,000 and $23,500 for direct and subcontractor expenses, respectively.

The services outlined herein will be provided in accordance with the attached "Standard Terms and Conditions, 2013" which is integral to this proposal. We reserve the right to negotiate adjustments to the fee amount should the assumptions, information, schedule or authorized scope change from those noted herein.

We are prepared to begin the work scope outlined herein upon receipt of a fully executed version of the proposal. Based on our discussions with Prock, it is likely that this work will occur in mid to late August. We will inform you of the actual schedule in the upcoming weeks.

Closure

This proposal is valid for a period of 30 days from the date of this letter. If acceptance and authorization to proceed are not received within that period, we reserve the right to renegotiate the estimated costs, schedule for completion, personnel commitments and scope of work. If the above arrangements are satisfactory to you, please indicate your acceptance by signing and returning one copy of this proposal along with the attachments. When accepted by you, this proposal together with the attached terms and conditions document will constitute our Agreement.

If you have any comments or questions about the scope, schedule or budget for the engineering services outlined herein, please do not hesitate to contact us.

Sincerely yours,
HALEY & ALDRICH, INC.

Bryan C. Steinert

Bryan C. Steinert, P.E.
Project Manager

Wayne A. Chadbourne, P.E.
Principal Consultant

This proposal and the attached "Standard Terms and Conditions, 2013" document, are understood and accepted:

TOWN OF LUBEC.

By Carol Dennison
(authorized signature)

By Carol Dennison
(print or type name)

Title Selectboard Chair

Date 8/12/20

Attachments:
Figure 1 – Proposed Probe Location Plan (1 page)
Standard Terms and Conditions, 2013 (4 pages)

1. INTRODUCTION. These Standard Terms and Conditions, together with the accompanying proposal and any attachments thereto ("Proposal"), constitute the Agreement between Haley & Aldrich, Inc., including its affiliates and subsidiaries ("Haley & Aldrich"), and the entity or person to whom the proposal is addressed ("Client") for the project at the project site ("Site") as may be referenced in the Proposal.

2. PERFORMANCE OF SERVICES. Client agrees that Haley & Aldrich has been engaged to provide professional services only, and that Haley & Aldrich does not owe a fiduciary responsibility to Client. Haley & Aldrich's services will be performed in accordance with generally accepted practices of engineers and/or scientists providing similar services at the same time, in the same locale, and under like circumstances ("Standard of Care"). No other warranty, expressed or implied, is included or intended by this Agreement.

3. CLIENT RESPONSIBILITIES. Except as otherwise agreed, Client will secure the approvals, Site access, permits, licenses and consents necessary for performance of Haley & Aldrich's services under this Agreement. Client shall provide Haley & Aldrich with a plan delineating the boundaries of the Site and all documents, reports, surveys, plans, drawings, information concerning known or suspected Site conditions, above and below ground, information related to hazardous materials or other environmental or geotechnical conditions at the Site, utility information and other information that is reasonably foreseeable to be pertinent to Haley & Aldrich's services under this Agreement. If Client is not the owner of the Site, Client will make all reasonable attempts to obtain these same documents and provide them to Haley & Aldrich. Unless otherwise agreed to in writing by Haley & Aldrich, Haley & Aldrich shall be entitled to rely on documents and information Client provides.

4. PAYMENT. Invoices will generally be submitted monthly. Payment will be due within thirty (30) days of invoice date. Interest will be added to accounts in arrears at the rate of one and one-half (1.5) percent per month on the outstanding balance. In the event Haley & Aldrich must engage counsel to enforce overdue payments, Client will reimburse Haley & Aldrich for all reasonable attorney's fees and court costs.

5. INSURANCE. Haley & Aldrich will maintain: workers' compensation insurance as required under the laws of the state in which the services will be performed; commercial general liability insurance with a combined single limit of $1,000,000 per occurrence and $2,000,000 in the aggregate for bodily injury, including death and property damage; automobile liability insurance with a combined single limit of $1,000,000 per occurrence; professional liability insurance in the amount of $1,000,000 per claim and in the aggregate; and contractor's pollution liability insurance in the amount of $1,000,000 per occurrence and in the aggregate. Haley & Aldrich will furnish Client with a certificate of insurance evidencing the coverages listed above.

6. OWNERSHIP OF DOCUMENTS AND PROCESSES. All documents and all processes created, prepared, or furnished under this Agreement by Haley & Aldrich are its instruments of service and all ownership and copyright rights of the same shall remain with Haley & Aldrich. Client may make and retain copies of Haley & Aldrich's instruments of service, opinions, or reports or otherwise related documents ("Instruments of Services") for the project at the Site. Any reuse or modification of Haley & Aldrich's Instruments of Services without written verification or adaption by Haley & Aldrich for the specific purpose intended shall be at Client's and/or any third party's sole risk and without liability or legal exposure to Haley & Aldrich. Client shall indemnify, defend, and hold harmless Haley & Aldrich from all claims, damages, losses, and expenses, including attorney's fees, arising out of or resulting therefrom. Client agrees that any such verification or adaptation of Haley & Aldrich's documents and processes shall entitle Haley & Aldrich to all just and proper compensation.

7. SUSPENSION OF WORK AND TERMINATION. Client may, at any time, suspend further work by Haley & Aldrich or terminate this Agreement. Suspension or termination shall be by written notice effective three (3) business days after receipt by Haley & Aldrich. Client agrees to compensate Haley & Aldrich for all services performed and commitments made prior to the effective date of the suspension or termination, together with reimbursable expenses including those of subcontractors, subconsultants, and vendors. Client acknowledges that its failure to pay all invoices on time and in full may result in a suspension of services. In the event of a suspension of services due to Client's failure to pay all invoices on time and in full, Haley & Aldrich shall have no liability to Client for delay or damage to Client or others because of such suspension of services.

8. FORCE MAJEURE. Except for Client's obligation to pay for services rendered, no liability will attach to either party from delay in performance or nonperformance caused by circumstances or events beyond the reasonable control of the party affected, including, but not limited to, acts of God, fire, flood, unanticipated Site or subsurface conditions, explosion, war, terrorism, request or intervention of a governmental authority (foreign or domestic), court order (whether at law or in equity), labor relations, accidents, delays or inability to obtain materials, equipment, fuel or transportation.

9. SUBSURFACE RISKS. Client recognizes that inherent risks occur in the exploration and evaluation of subsurface conditions. Even a comprehensive sampling and testing program, implemented with appropriate equipment and personnel under the direction of a professional performing in accordance with the Standard of Care, may fail to detect certain underlying conditions. Conditions that Haley & Aldrich may infer to exist between sampling points may differ significantly from those that actually exist. Client also recognizes that due to natural occurrences or direct or indirect human intervention at or near the Site, actual conditions may change with passage of time.

10. DISCLOSURE OF HAZARDS (RIGHT-TO-KNOW). Haley & Aldrich will take reasonable precautions for the health and safety of Haley & Aldrich's employees while at the Site. Client will obtain from Site owner, and others as applicable, and furnish to Haley & Aldrich, prior to Haley & Aldrich beginning services under this Agreement, all available information concerning Site conditions, including, but not limited to: subsurface conditions, oil, hazardous material, toxic mold and biological conditions, radioactive or asbestos material in, on or near the Site. If such a material or condition is discovered that had not been disclosed to Haley & Aldrich, then, upon notification, Client and Haley & Aldrich shall seek an equitable adjustment to be made to this Agreement. In addition, Client agrees to assume all liability and shall indemnify, defend and hold Haley & Aldrich harmless from any claims, losses, liabilities or damages arising out of personal injury or death resulting from such hazardous material or condition.

11. PUBLIC RESPONSIBILITY. Client acknowledges that Client or the Site owner, as the case may be, is now and shall remain in control of the Site for all purposes at all times. Client agrees to notify each federal, state, county, and local public agency, as they each may require, of the existence of any condition at the Site that may present a potential danger to public health, safety, or the environment and as required by applicable statutes and/or regulations and as required by applicable statutes and/or regulations.

    Notwithstanding the provisions of the foregoing, Haley & Aldrich will comply with subpoenas; judicial orders or government directives; federal, state, county, and local laws, regulations, and ordinances; and codes regarding the reporting to the appropriate public agencies of findings with respect to potential dangers to public health, safety, or the environment. Haley & Aldrich shall have no liability to Client or to any other person or entity for reports or disclosures made in accordance with such requirements.

12. SAMPLES. Samples of soil, rock, water, waste, or other materials collected from the Site may be disposed of sixty (60) days from sampling date unless Client advises otherwise in writing or unless applicable law requires their retention. Haley & Aldrich will dispose of such samples with a qualified waste disposal contractor. Client shall pay all costs associated with the storage, transport, and disposal of samples, and agrees to indemnify, defend and hold Haley & Aldrich harmless for any liability arising therefrom. If samples must be stored by Haley & Aldrich for longer than sixty (60) days from sampling date, Client shall pay all costs associated with the additional storage time. Client recognizes and agrees that Haley & Aldrich is a bailee and assumes neither title to said waste or samples nor any responsibility as generator of said waste or samples.

13. CONFIDENTIALITY. Haley & Aldrich will hold confidential all business and technical information obtained or generated in performing of services under this Agreement. Haley & Aldrich will not disclose such information without Client's consent except to the extent required for: (1) performance of services under this Agreement; (2) compliance with professional standards of conduct for preservation of the public safety, health, and welfare; (3) compliance with any court order, statute, law, or governmental directive; and/or (4) protection of Haley & Aldrich against claims or liabilities arising from the performance of services under this Agreement. Haley & Aldrich's obligations hereunder shall not apply to information in the public domain or lawfully obtained on a non-confidential basis from others.

14. HAZARDOUS MATERIALS. Before any hazardous or contaminated materials are removed from the Site, Client shall sign manifests naming Client as the Generator of the waste (or, if Client is not the Generator, Client will arrange for the Generator to sign the manifest). Client shall select the treatment or disposal facility to which any waste is taken. Haley & Aldrich shall not be the Generator, Owner, Arranger, Operator, nor will it possess, take title to, or assume any legal liability for any hazardous or contaminated materials at or removed from the Site. Haley & Aldrich shall not have responsibility for or control of the Site or of operations or activities at the Site other than its own. Haley & Aldrich shall not undertake, arrange for or control the handling, treatment, storage, disposal, removal, shipment, transportation or disposal of any hazardous or contaminated materials at or removed from the Site, other than laboratory samples it collects or tests (which shall be returned to Client for disposal). Client agrees to defend, indemnify and hold harmless Haley & Aldrich for any costs or liability incurred by Haley & Aldrich in defense of or in payment for any legal actions in which it is alleged that Haley & Aldrich is the Owner, Operator, Generator, Arranger, Treater, Storer or Disposer of hazardous waste. Capitalized terms used herein shall have the meanings assigned to them in RCRA and CERCLA.

15. SERVICES DURING CONSTRUCTION. Haley & Aldrich shall not, during construction Site visits, shop drawing review, or as a result of observations of construction work, supervise, direct, or have control over any contractors' means, methods, work sequences or procedures of construction selected by contractors. Haley & Aldrich shall not be liable for any of contractors' work, safety precautions or programs incident to contractors' work. Haley & Aldrich shall not have any liability whatsoever for any failure of contractors to comply with any laws, rules, regulations, ordinances, codes or orders. Haley & Aldrich neither guarantees nor warrants the performance of any contractors' work, and does not assume responsibility for any contractors' failure to furnish any labor, materials, equipment or related work in accordance with any agreement or contract documents.

16. RELIANCE. Haley & Aldrich's Instruments of Services, which when rendered pursuant to this Agreement, are prepared solely for Client and made available to Client only for the purpose set forth in the Proposal. Client acknowledges and agrees that the unauthorized use of, or reliance upon, Haley & Aldrich's Instruments of Services by any other party, or for any other project or purpose, shall be at Client's sole risk and without any liability to Haley & Aldrich, except and unless the Client obtains the prior written authorization of Haley & Aldrich. Client agrees to indemnify, defend, and hold Haley & Aldrich harmless to the fullest extent permitted by law for any claims, losses, or damages allegedly suffered by third parties due to the unauthorized reliance on any of Haley & Aldrich's Instruments of Services provided hereunder.

17. THIRD-PARTY RELIANCE. Environmental site assessment ("ESA") reports prepared by Haley & Aldrich are for the sole and exclusive use of its Client. Any third-party and each of their respective successors and assigns ("Relying Parties") may not rely on Haley & Aldrich's ESAs without the prior written authorization of Haley & Aldrich in the form outlined below. Haley & Aldrich may authorize third-party reliance by providing reliance letters to third party(ies) only with regard to ESA reports prepared for its Client, provided the Relying Party(ies) agree: (1) to use the ESA report only for the purpose of assessing the potential or existing environmental contamination liabilities associated with real property; (2) to be bound by the terms and conditions and limitations contained herein and in the ESA report; (3) to accept the form and substance of Haley & Aldrich's reliance letter; and (4) to deliver to Haley & Aldrich a signed copy of a reliance letter by an authorized representative of the Relying Party, within 30 days after said reliance letter is provided to the Relying Party, signifying the Relying Parties' acceptance of these terms and conditions. Upon Haley & Aldrich's receipt of the signed reliance letter by the Relying Party(ies), the Relying Party(ies) will be authorized to rely on Haley & Aldrich's ESA for the limited purpose of identifying potential or existing environmental contamination liabilities associated with real property. Notwithstanding anything contained herein, Haley & Aldrich shall not be liable for any claim or damage arising from environmental contamination liabilities that occurred on the subject property after the effective date of the ESA. Likewise, Haley & Aldrich shall not be liable for any existing or future property owner's failure to satisfy any continuing obligation for CERCLA liability protection or under the Federal Environmental Protection Agency's All Appropriate Inquiries rule.

18. WAIVER OF CONSEQUENTIAL DAMAGES. Neither party, nor their parent, affiliated or subsidiary companies, nor the officers, directors, agents, employees, or contractors of any of the foregoing, shall be liable to the other in any action or claim for incidental, indirect, special, collateral, punitive, exemplary or consequential damages, including, but not limited to financial loss, loss of profits, loss of revenue, delay, disruption, loss of anticipated profits or revenue, loss of use of any structure, system or equipment, or non-operation or increased cost of operation arising out of or related to the services, whether the action in which recovery of damages is sought is based upon contract, tort (including, to the greatest extent permitted by law, the sole, concurrent or other negligence, whether active or passive, and strict liability of any protected individual or entity), statute or otherwise.

19. HAZARDOUS SUBSTANCE CLAIMS. By authorizing Haley & Aldrich to proceed with the services, Client confirms that Haley & Aldrich has not created nor contributed to the presence of any hazardous substances or conditions at or near the Site. Client recognizes that there is an inherent risk in drilling borings, pushing or driving probes, excavating trenches, or implementing other methods of exploration or remediation at or near a site contaminated by hazardous materials. Further, Client recognizes that these are inherent risks even through the exercise of the Standard of Care. Client accepts this risk and agrees to indemnify and hold Haley & Aldrich, and each of Haley & Aldrich's subcontractors, consultants, officers, directors, and employees harmless against any and all claims for damages, costs, or expenses direct or consequential, in connection with a release of hazardous substances, except to the extent that such claims, damages, or losses are adjudicated to have resulted from Haley & Aldrich's gross negligence or willful misconduct in the performance of the services.

20. DIFFERING SITE CONDITIONS. If, during the course of performance of this Agreement, conditions or circumstances are discovered, which were not contemplated or anticipated by Haley & Aldrich, or otherwise provided to Haley & Aldrich by the Client, at the commencement of this Agreement or which differ materially from those indicated in Haley & Aldrich's Proposal, Haley & Aldrich may notify Client in writing of the newly discovered conditions or circumstances, and Client and Haley & Aldrich shall renegotiate, in good faith, the scope of work and terms and conditions of this Agreement. If amended terms and conditions cannot be agreed upon within thirty (30) days after notice, Haley & Aldrich may terminate this Agreement.

21. ADDITIONAL SERVICES. Haley & Aldrich's compensation hereunder shall be subject to adjustment to recognize any increase in costs due to additional services requested or authorized by Client. Such additional services shall include, but not be limited to, additions in the manner or method of Haley & Aldrich's performance of Services or due to changes in schedule or circumstances not solely caused by or under the control of Haley & Aldrich. These additional services shall be verified in writing by the parties and performed on the basis of mutually agreed rates, or other such basis agreed to by the parties.

22. LIMITATION OF REMEDIES. To the fullest extent permitted by law, the total aggregate liability of Haley & Aldrich, its officers, directors, and employees to Client, and anyone claiming by, through, or under Client, including all authorized Relying Parties, as applicable, for any and all injuries, claims, losses, expenses, or damages whatsoever arising out of or in any way related to Haley & Aldrich's services, from any cause or causes whatsoever, including, but not limited to, negligence, errors, omissions, strict liability or contract, shall be limited to an aggregate amount of $50,000 or Haley & Aldrich's fee, whichever is greater.

    If Client prefers not to limit Haley & Aldrich's liability to this sum, Haley & Aldrich may increase this limitation upon Client's written request. If Haley & Aldrich approves the request, Haley & Aldrich will agree to increase the limitation to $100,000, provided that Client agrees to pay $2,500 for this change. The additional fee is for the additional risk assumed by Haley & Aldrich and is not a charge for additional liability insurance.

23. DISPUTE RESOLUTION. If a dispute arises out of or relates to this Agreement or the breach thereof, the parties will attempt in good faith to resolve the dispute through negotiation. Except for payment matters, if a dispute is not resolved by these negotiations, the matter will be submitted to non-binding mediation with a mutually agreed upon mediator. The parties agree that they will participate in the mediation in good faith and that they will share equally in its costs. Except for payment matters or to preserve mechanics' lien rights, neither party will commence a civil action until after the completion of an initial mediation session.

24. LEGAL ACTION. All legal actions by either party against the other for any cause or causes, including, but not limited to, breach of this Agreement, negligence, misrepresentations, breach of warranty or failure to perform in accordance with the Standard of Care, however denominated, shall be barred two (2) years from the day after completion of Haley & Aldrich's Services. Client agrees to compensate Haley & Aldrich for services performed in response to any legal action, subpoena, or court order arising out of or related to Haley & Aldrich's services under this Agreement at Haley & Aldrich's Standard Fee Schedule then in effect.

25. PRECEDENCE. These Terms and Conditions shall take precedence over any inconsistent or contradictory provisions contained in any proposal, contract, purchase order, requisition, notice to proceed, or like document.

26. HEADINGS. The headings used in these terms and conditions are inserted for the convenience of the parties and shall not define, limit or describe the scope or the intent of the provisions set forth herein.

27. SEVERABILITY. If any of these Terms and Conditions are finally determined to be invalid or unenforceable in whole or part, the remaining provisions shall remain in full force and effect, and be binding upon the parties. The parties agree to reform these Terms and Conditions to replace any such invalid or unenforceable provision with a valid and enforceable provision that comes as close as possible to the intention of the stricken provision.

28. SURVIVAL. All Terms and Conditions contained herein shall survive the completion of Haley & Aldrich's services on this project or the termination of services for any cause.

29. GOVERNING LAW AND JURISDICTION. This Agreement shall be solely governed, and construed and enforced in accordance with the laws of the Commonwealth of Massachusetts, without regard to its conflict of laws rules. Client agrees to submit and consent to the jurisdiction of the courts present in Massachusetts in any action brought to enforce (or otherwise arising from or relating to) this Agreement.

END OF TERMS AND CONDITIONS

Appendix E. Laboratory Test Results

Lubec Breakwater - Laboratory Test Results

Table E.1 - Soil Index Test Data

Borehole No.	Sample No.	Sample Depth	USCS	Water Content	Atterberg Limits			Particle Size Distribution		
					LL	PL	PI	Gravel	Sand	Fines
-	-	ft	-	%	%	%	%	%	%	%
WB-1	U-1	6 - 8	CL	24.8	32	20	12	-	-	-
	S-6	15 - 17	CL	21.6	27	17	10	-	-	-
	S-10	35 - 35.9	SC	11.5	-	-	-	10.1	49	40.9
WB-4	S-2	5 - 7	CL	25.6	29	19	10	-	-	-
WB-5	S-2	2 - 4	CL	24.6	37	22	15	-	-	-
	S-4	7 - 9	CL	26.3	34	14	20	-	-	-
	S-8	18 - 20	CL	27.2	36	17	19	-	-	-
	S-10	28 - 30	CL	27.9	30	12	18	-	-	-
	S-12	38 - 40	CL	28.3	32	14	18	-	-	-
WB-6	U-1	4 - 6	CL	27.1	32	20	12	-	-	-
	S-6	15 - 17	CL	31.1	34	15	19	-	-	-
	S-7	20 - 22	CL	26.4	30	14	16	-	-	-
	S-10	35 - 37	CL	24.4	28	10	18	-	-	-
	S-12	45 - 47	GC	8	-	-	-	54.3	31.1	13.6
	S-13	50 - 52	GC	7.3	-	-	-	53.8	24.5	21.7
WB-101	S-2A	2 - 4	CL	29.8	29	16	13	-	-	-
	S-3	4 - 6	SC	10.7	-	-	-	32.7	37	30.3
	S-4	6 - 8	CL-ML	21.4	19	13	6	-	-	-
WB-102	S-1	0 - 2	OH	37.7	-	-	-	-	-	-
	S-2	2 - 4	ML	40.3	38	26	12	-	-	-
WB-103	S-2A	2 - 4	CL-ML	22.8	27	21	6	-	-	-
	U-1	4 - 6	CL	22.2	27	17	10	-	-	-
WB-104	S-2	2 - 4	OH	31.7	-	-	-	-	-	-
	S-3	4 - 6	CL-ML	13.7	14	10	4	-	-	-
WB-105	S-3	4 - 6	CL	25.8	28	18	10	-	-	-
	U-1	6 - 7.6	CL	23.4	30	19	11	-	-	-
WB-106	U-1	6 - 8	CL	15.3	36	16	20	-	-	-
	U-2	8 - 10	CL	20.8	27	17	10	-	-	-
	S-4B	10 - 12	SC	7.1	-	-	-	31.7	40.8	27.5
WB-107	S-4	6 - 8	CL	29.7	34	19	15	-	-	-
	U-1	8 - 10	CL	22.7	25	14	11	-	-	-
	S-6	14 - 16	SC	9.1	-	-	-	22.8	43.5	33.7
WB-108	U-1	4 - 6	CL	24.6	30	17	13	-	-	-
	U-2	8 - 10	CL	27.9	36	16	20	-	-	-
	S-5	14 - 16	CL	23.1	42	17	25	-	-	-

Client:	Geotechnical Services Inc.				
Project:	Lubec Breakwater				
Location:	Lubec, ME			Project No:	GTX-317770
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	09/18/23	Checked By:	ank
Depth :	---	Test Id:	732223		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
WB-1/U-1	L- 314-23	6-8'	Moist, dark gray clay	24.8
Wb-6/U-1	L- 332-23	4-6'	Moist, dark grayish brown clay	27.1

Notes: Temperature of Drying : 110º Celsius

Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	03/18/24	Checked By:	ank
Depth :	---	Test Id:	761922		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
WB-101	S- 2A	2-4	Moist, brown clay	29.8
WB-101	S- 3	4-6	Moist, light brownish gray silty sand with gravel	10.7
WB-101	S- 4	6-8	Moist, gray silty clay	21.4
WB-102	S- 1	0-2	Moist, very dark grayish brown silt with sand	37.7
WB-102	S- 2	2-4	Moist, gray silt	40.3
WB-103	S- 2A	2-4	Moist, grayish brown silty clay	22.8
WB-103	U- 1	4-6	Moist, gray clay	22.2
WB-104	S- 2	2-4	Moist, dark gray silty sand with gravel	31.7
WB-104	S- 3	4-6	Moist, brown silty clay with gravel	13.7

Notes: Temperature of Drying : 110º Celsius

Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	03/18/24	Checked By:	ank
Depth :	---	Test Id:	761930		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
WB-105	S- 3	4-6	Moist, brown clay	25.8
WB-105	U- 1	6-7.6	Moist, gray clay	23.4
WB-106	U- 1	6-8	Moist, gray clay with gravel	15.3
WB-106	U- 2	8-10	Moist, gray clay with sand	20.8
WB-106	S- 4B	10-12	Moist, dark gray silty sand with gravel	7.1
WB-107	S- 4	6-8	Moist, grayish brown clay	29.7
WB-107	U- 1	8-10	Moist, gray clay	22.7
WB-107	S- 6	14-16	Moist, gray silty sand with gravel	9.1

Notes: Temperature of Drying : 110º Celsius

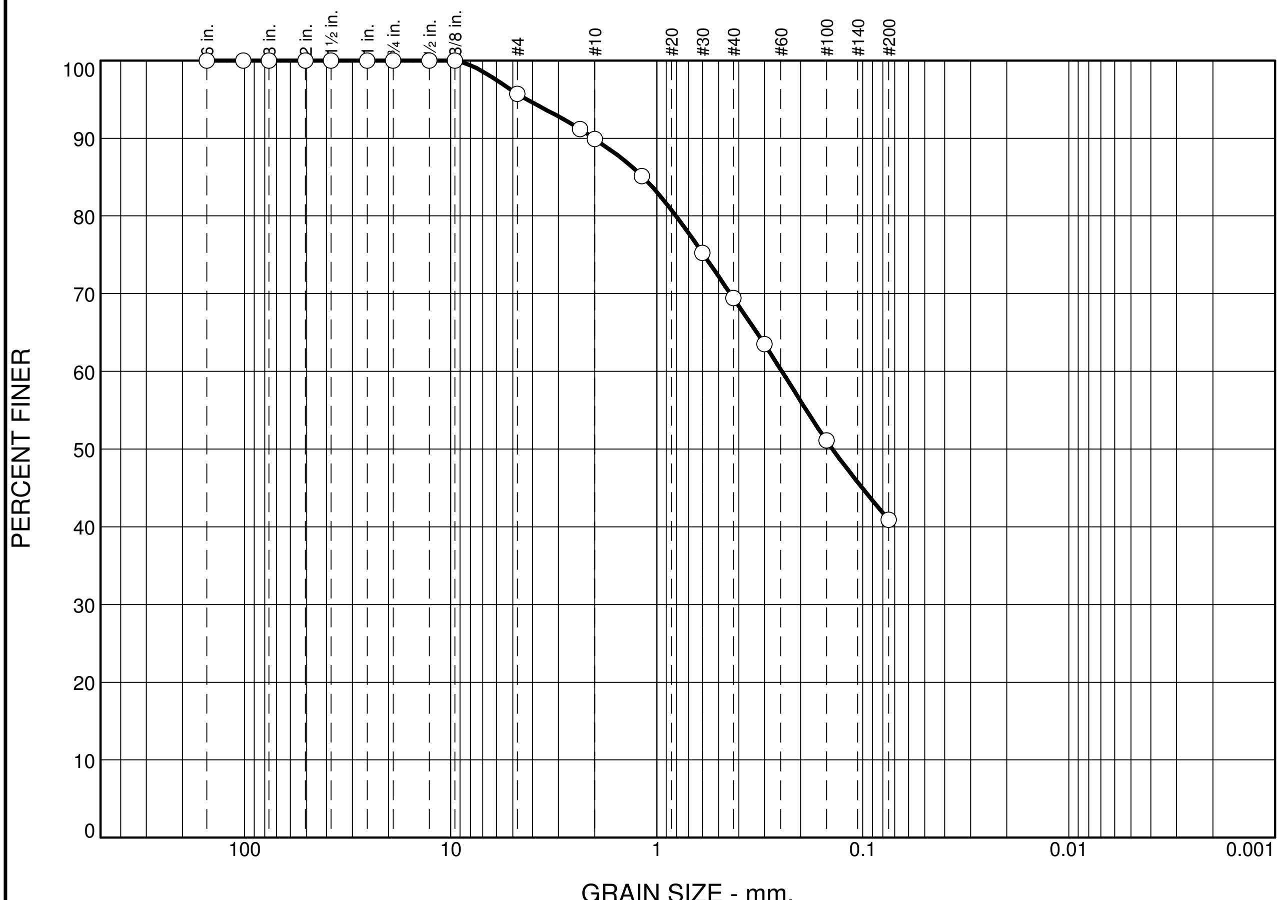
Client: Jacobs Engineering Group			
Project: Lubec Breakwater			
Location: ---		Project No:	GTX-318760
Boring ID: ---	Sample Type: ---	Tested By:	ckg
Sample ID: ---	Test Date: 03/26/24	Checked By:	ank
Depth : ---	Test Id: 761933		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
WB-108	U- 2	8-10	Moist, gray clay	24.6
WB-108	S- 5	14-16	Moist, brown clay	27.9
WB-108	U- 1	4-6	Moist, gray clay	23.1

Notes: Temperature of Drying : 110º Celsius

Particle Size Distribution Report



% +3"	% Gravel			% Sand			% Fines
	Coarse	Medium	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	10.1	14.7	15.0	19.3	40.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6"	100.0		
4"	100.0		
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	100.0		
0.5"	100.0		
0.375"	100.0		
#4	95.7		
#8	91.2		
#10	89.9		
#16	85.1		
#30	75.2		
#40	69.4		
#50	63.5		
#100	51.1		
#200	40.9		

* (no specification provided)

Material Description

coarse to fine Sand, and Silt, little fine Gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.1659 D_{60}= 0.2471 D_{50}= 0.1403
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Moisture Content = 11.5%

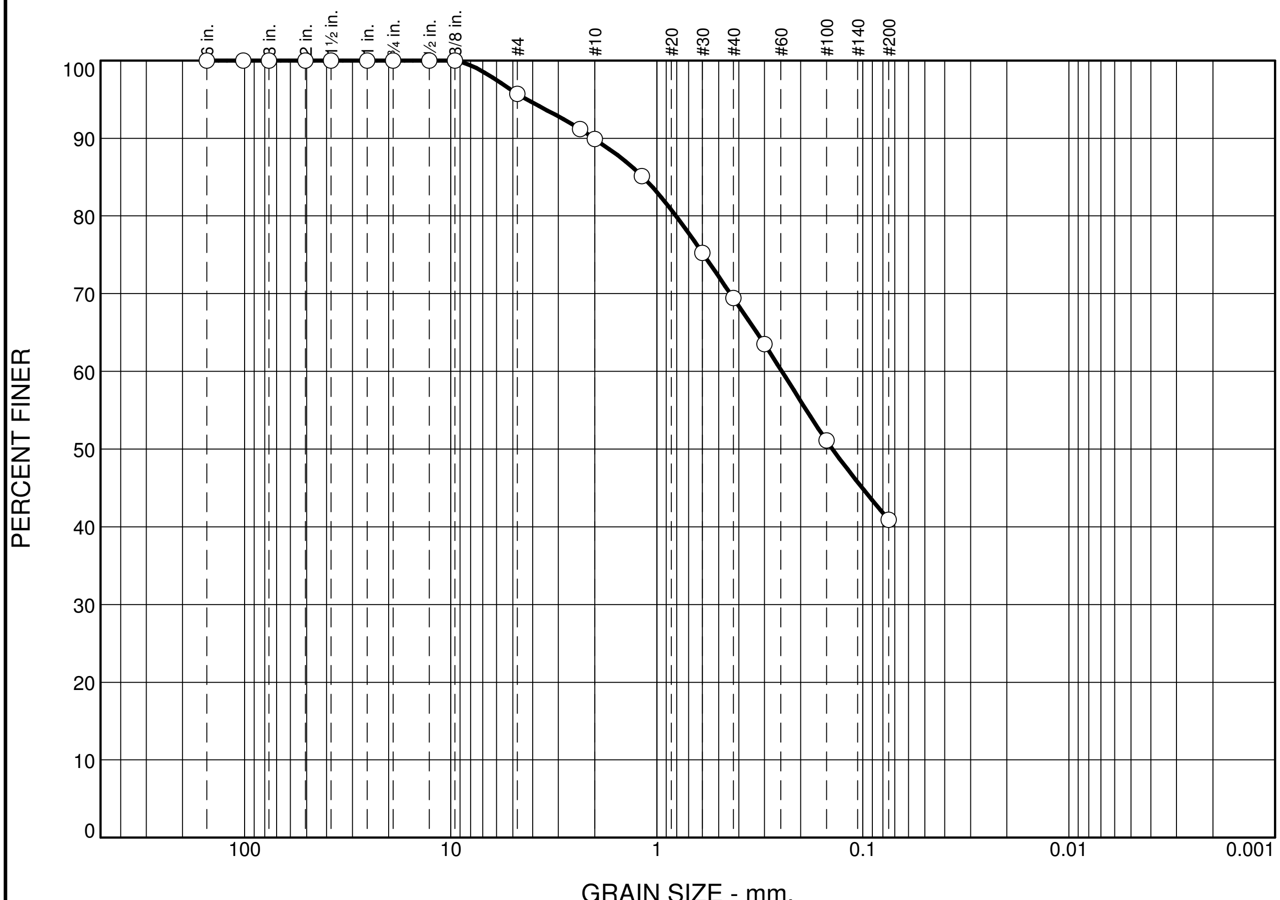
Sample No.: L-317-23 **Source of Sample:** On-Site Material **Date:** 8/15/2023
Location: WB-1 / S-10 **Elev./Depth:** 35' to 35.9'

GEOTECHNICAL SERVICES, INC.

Weare, New Hampshire

Client: N.E. Borings
Project: Lubec Breakwater
Lubec, Maine
Project No: 223199 **Figure**

Particle Size Distribution Report



% +3"	% Gravel			% Sand			% Fines
	Coarse	Medium	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	10.1	14.7	15.0	19.3	40.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6"	100.0		
4"	100.0		
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	100.0		
0.5"	100.0		
0.375"	100.0		
#4	95.7		
#8	91.2		
#10	89.9		
#16	85.1		
#30	75.2		
#40	69.4		
#50	63.5		
#100	51.1		
#200	40.9		

* (no specification provided)

Material Description

coarse to fine Sand, and Silt, little fine Gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.1659 D_{60}= 0.2471 D_{50}= 0.1403
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Moisture Content = 11.5%

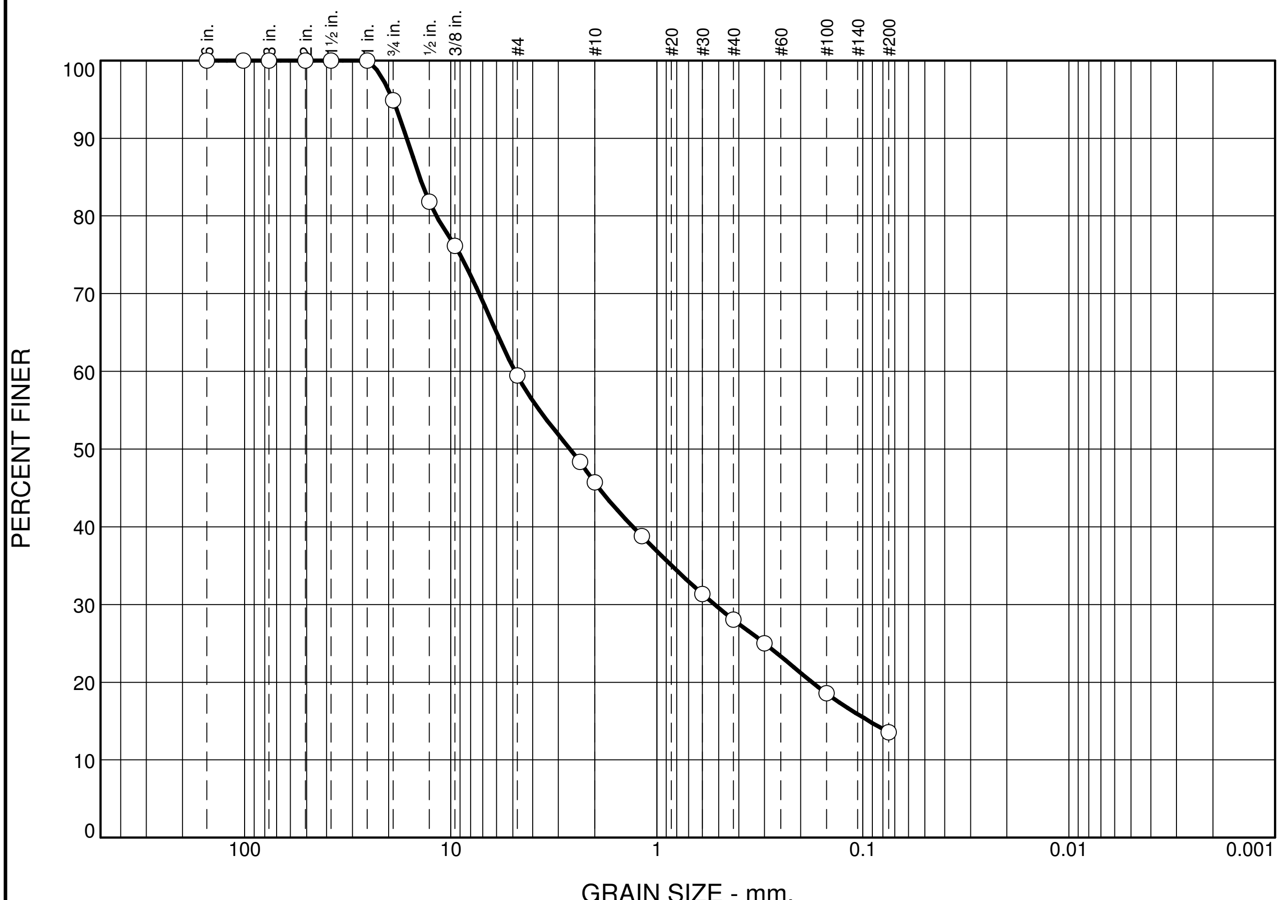
Sample No.: L-317-23 **Source of Sample:** On-Site Material **Date:** 8/15/2023
Location: WB-1 / S-10 **Elev./Depth:** 35' to 35.9'

GEOTECHNICAL SERVICES, INC.

Weare, New Hampshire

Client: N.E. Borings
Project: Lubec Breakwater
Lubec, Maine
Project No: 223199 **Figure**

Particle Size Distribution Report



% +3"	% Gravel			% Sand			% Fines
	Coarse	Medium	Fine	Coarse	Medium	Fine	
0.0	0.0	23.9	30.4	14.4	8.0	9.7	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6"	100.0		
4"	100.0		
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	94.9		
0.5"	81.8		
0.375"	76.1		
#4	59.5		
#8	48.3		
#10	45.7		
#16	38.8		
#30	31.3		
#40	28.1		
#50	25.0		
#100	18.6		
#200	13.6		

* (no specification provided)

Material Description

med to fine GRAVEL and, coarse to fine Sand, little Silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 14.1306 D_{60}= 4.8661 D_{50}= 2.6357
D_{30}= 0.5241 D_{15}= 0.0932 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Moisture Content = 8.0%

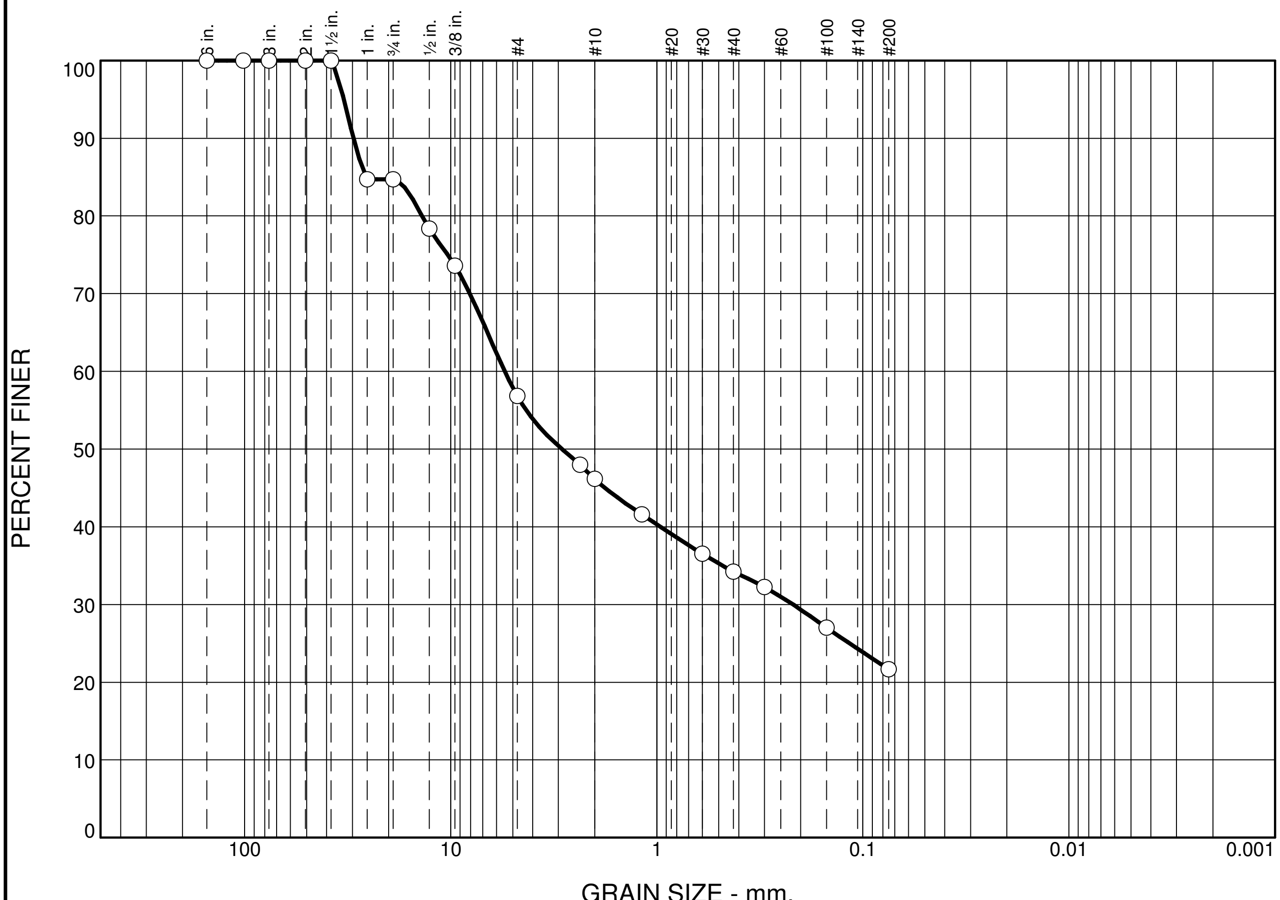
Sample No.: L-336-23 **Source of Sample:** On-Site Material **Date:** 8/17/2023
Location: WB-6 / S-12 **Elev./Depth:** 45' to 47'

GEOTECHNICAL SERVICES, INC.

Weare, New Hampshire

Client: N.E. Borings
Project: Lubec Breakwater
Lubec, Maine
Project No: 223199 **Figure**

Particle Size Distribution Report



% +3"	% Gravel			% Sand			% Fines
	Coarse	Medium	Fine	Coarse	Medium	Fine	
0.0	15.3	11.1	27.4	9.7	5.5	9.3	21.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6"	100.0		
4"	100.0		
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	84.7		
0.75"	84.7		
0.5"	78.4		
0.375"	73.6		
#4	56.8		
#8	48.0		
#10	46.2		
#16	41.6		
#30	36.5		
#40	34.2		
#50	32.2		
#100	27.0		
#200	21.7		

* (no specification provided)

Material Description

coarse to fine GRAVEL and, coarse to fine Sand, some Silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 25.7519 D_{60}= 5.4667 D_{50}= 2.8807
D_{30}= 0.2185 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Moisture Content = 7.3%

Sample No.: L-337-23 **Source of Sample:** On-Site Material **Date:** 8/17/2023
Location: WB-6 / S-13 **Elev./Depth:** 50' to 52'

GEOTECHNICAL SERVICES, INC.

Weare, New Hampshire

Client: N.E. Borings
Project: Lubec Breakwater
Lubec, Maine
Project No: 223199 **Figure**

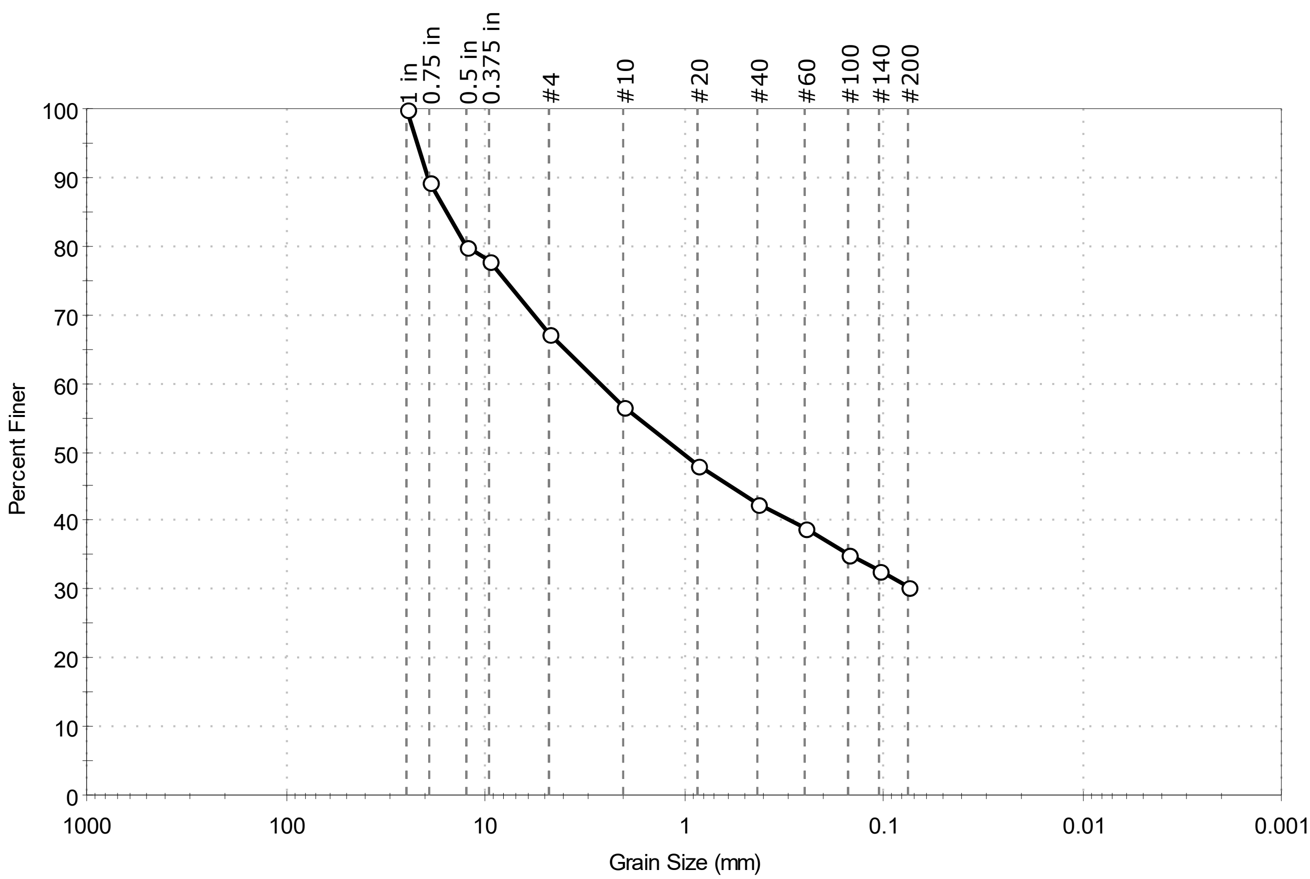
Client: Jacobs Engineering Group			
Project: Lubec Breakwater			
Location: ---		Project No:	GTX-318760
Boring ID: WB-101	Sample Type: Unspecified	Tested By:	ckg
Sample ID: S-3	Test Date: 03/15/24	Checked By:	ank
Depth : 4-6	Test Id: 761934		

Test Comment: ---

Visual Description: Moist, light brownish gray silty sand with gravel

Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	32.7	37.0	30.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	89		
0.5 in	12.50	80		
0.375 in	9.50	78		
#4	4.75	67		
#10	2.00	57		
#20	0.85	48		
#40	0.42	43		
#60	0.25	39		
#100	0.15	35		
#140	0.11	33		
#200	0.075	30		

Coefficients

D_{85} =15.7092 mm D_{30} =N/A

D_{60} =2.6227 mm D_{15} =N/A

D_{50} =1.0394 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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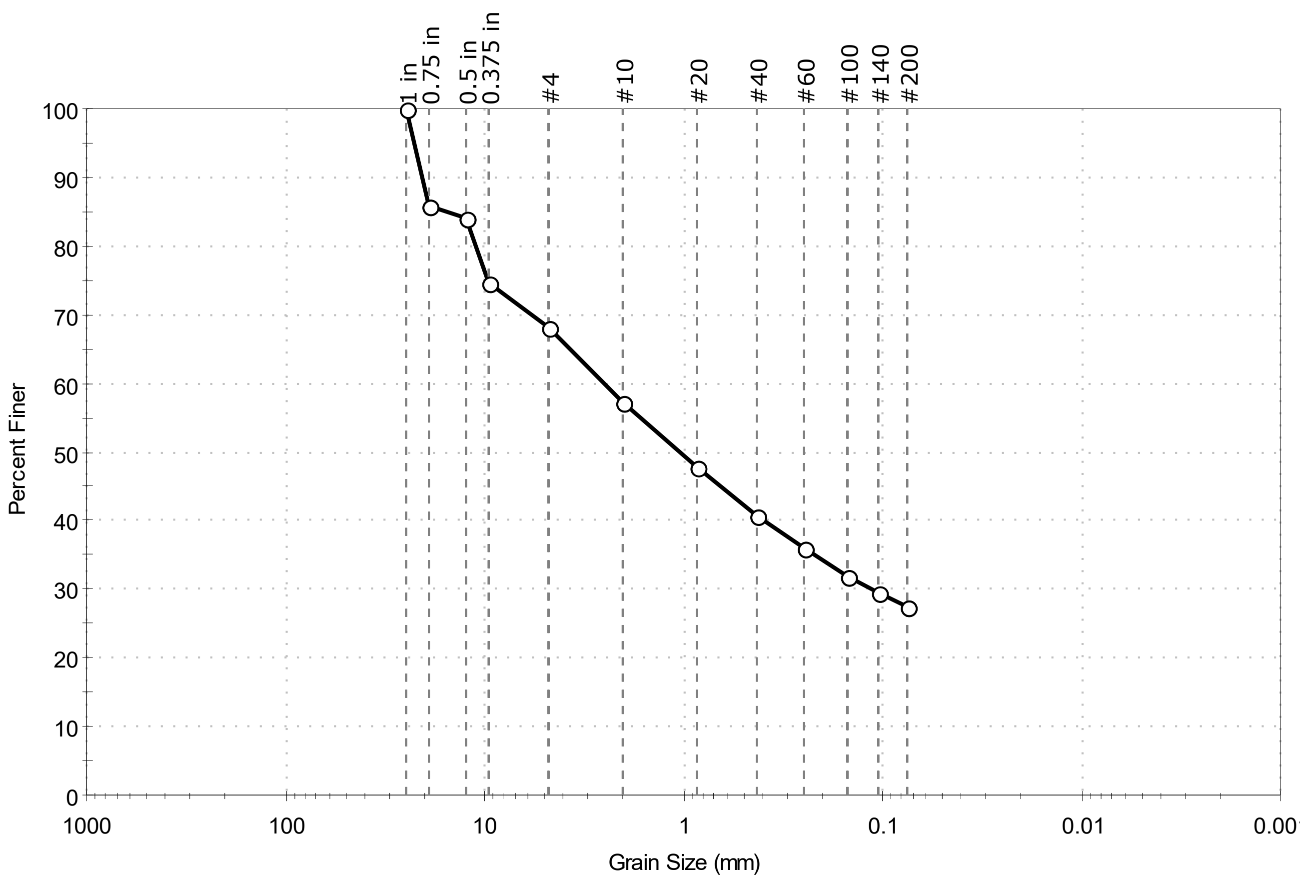
Client:	Jacobs Engineering Group		
Project:	Lubec Breakwater		
Location:	---	Project No:	GTX-318760
Boring ID: WB-106	Sample Type: Unspecified	Tested By:	ckg
Sample ID: S-4B	Test Date: 03/15/24	Checked By:	ank
Depth : 10-12	Test Id: 761935		
Test Comment:	---		
Visual Description:	Moist, dark gray silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	31.7	40.8	27.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	86		
0.5 in	12.50	84		
0.375 in	9.50	75		
#4	4.75	68		
#10	2.00	57		
#20	0.85	48		
#40	0.42	41		
#60	0.25	36		
#100	0.15	32		
#140	0.11	29		
#200	0.075	28		

Coefficients

D_{85} =15.3777 mm
D_{30} =0.1145 mm
D_{60} =2.4862 mm
D_{15} =N/A
D_{50} =1.0456 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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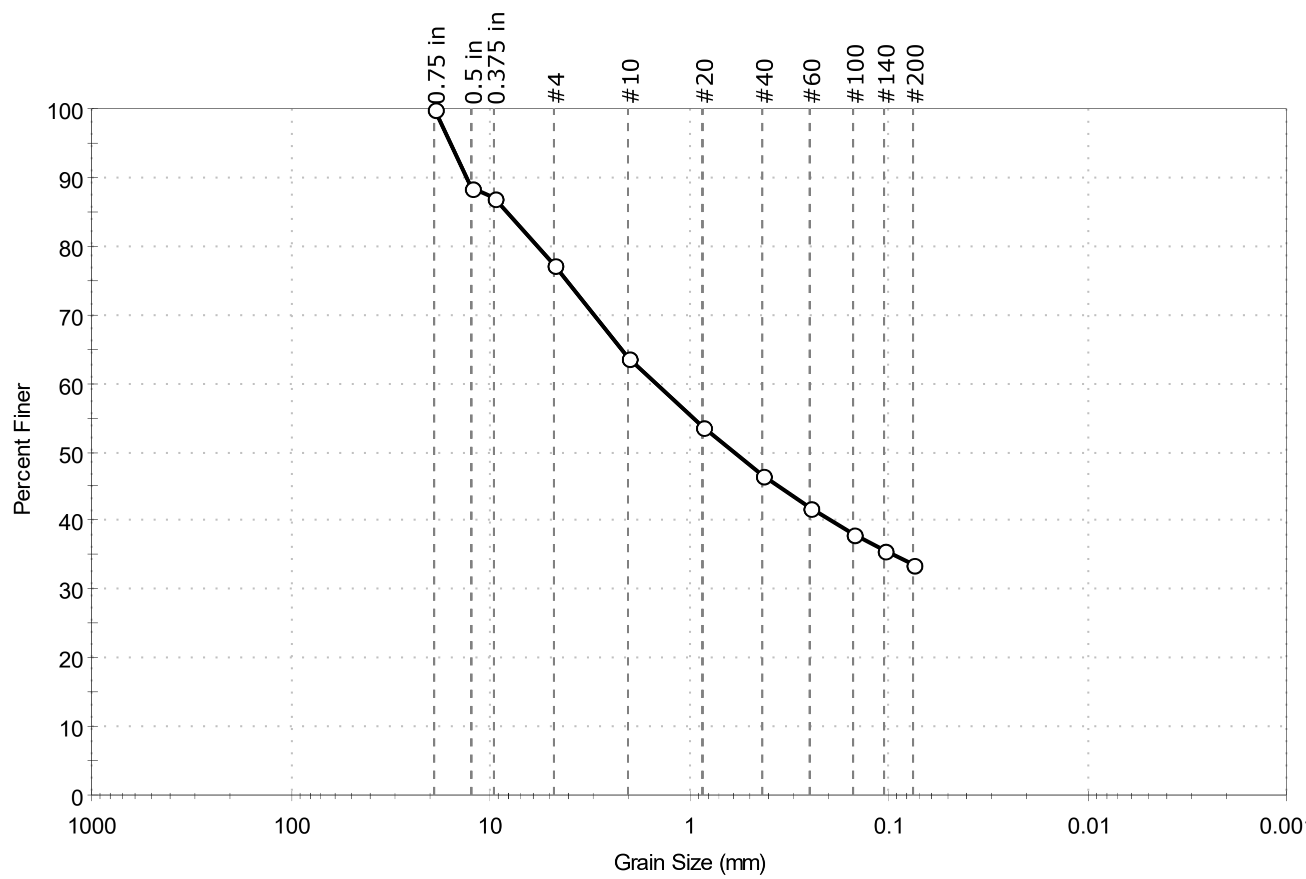
Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	WB-107	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	S-6	Test Date:	03/15/24	Checked By:	ank
Depth :	14-16	Test Id:	761936		

Test Comment: ---
Visual Description: Moist, gray silty sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	22.8	43.5	33.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	88		
0.375 in	9.50	87		
#4	4.75	77		
#10	2.00	64		
#20	0.85	54		
#40	0.42	47		
#60	0.25	42		
#100	0.15	38		
#140	0.11	36		
#200	0.075	34		

Coefficients

D_{85} =8.2501 mm　　D_{30} =N/A
D_{60} =1.4512 mm　　D_{15} =N/A
D_{50} =0.5870 mm　　D_{10} =N/A
C_u =N/A　　C_c =N/A

Classification

ASTM　N/A

AASHTO　Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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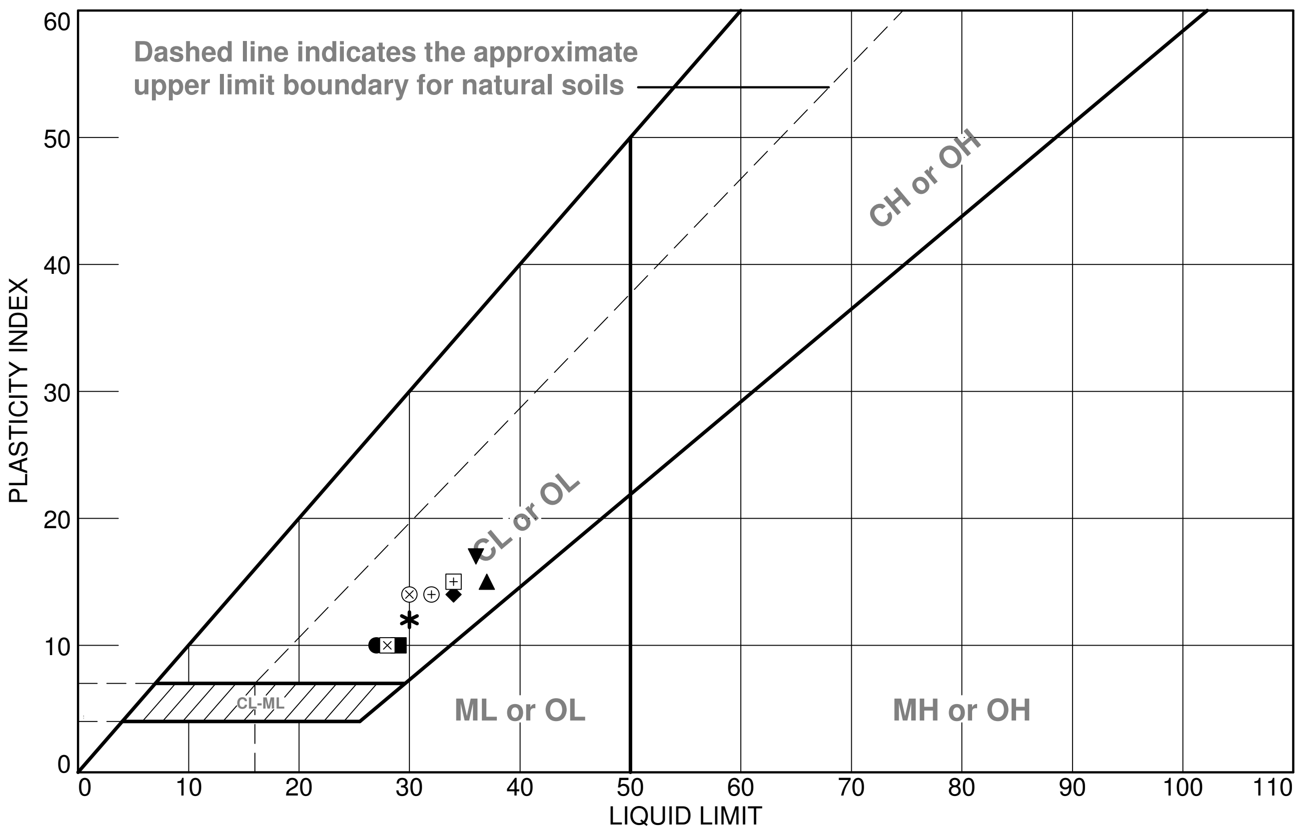
LIQUID AND PLASTIC LIMITS TEST REPORT



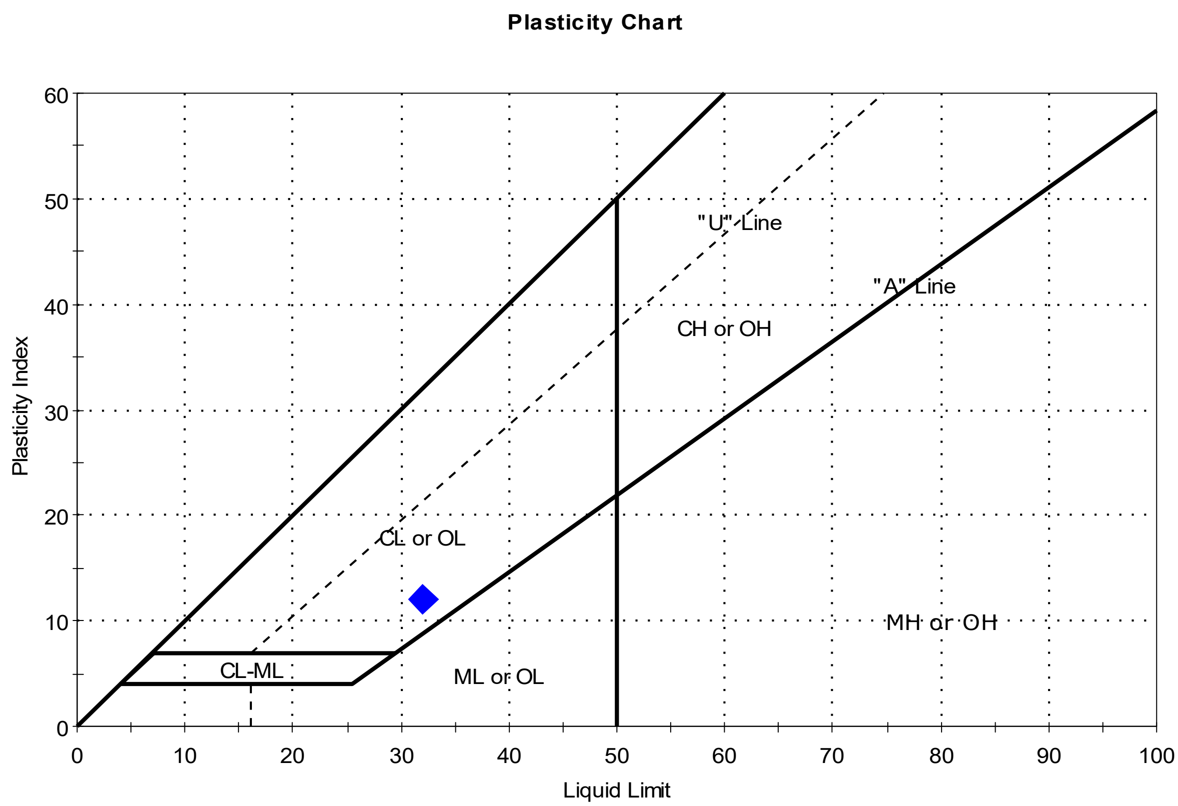
SOIL DATA									
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX	USCS
●	On-Site Material	L-315-23	15' to 17'	21.6	17	27	10	0.5	
■	On-Site Material	L-319-23	5' to 7'	25.6	19	29	10	0.7	
▲	On-Site Material	L-323-23	2' to 4'	24.6	22	37	15	0.2	
◆	On-Site Material	L-325-23	7' to 9'	26.3	20	34	14	0.5	
▼	On-Site Material	L-326-23	18' to 20'	27.2	19	36	17	0.5	
✱	On-Site Material	L-327-23	28' to 30'	27.9	18	30	12	0.8	
⊕	On-Site Material	L-328-23	38' to 40'	28.3	18	32	14	0.7	
⊞	On-Site Material	L-333-23	15' to 17'	31.1	19	34	15	0.8	
⊗	On-Site Material	L-334-23	20' to 22'	26.4	16	30	14	0.7	
⊠	On-Site Material	L-335-23	35' to 37'	24.4	18	28	10	0.6	

GEOTECHNICAL SERVICES, INC. **Weare, New Hampshire**	**Client:** N.E. Borings **Project:** Lubec Breakwater Lubec, Maine **Project No.:** 223199 **Figure**

Tested By: ○ A.Osborne □ A.Osborne △ A.Osborne ◇ A.Osborne ▽ A.Osborne ✱ A.Osborne ⊕ C.Burbank ⊞ C.Burbank

Client:	Geotechnical Services Inc.				
Project:	Lubec Breakwater				
Location:	Lubec, ME			Project No:	GTX-317770
Boring ID:	WB-1/U-1	Sample Type:	tube	Tested By:	cam
Sample ID:	L-314-23	Test Date:	09/19/23	Checked By:	ank
Depth :	6-8'	Test Id:	732220		
Test Comment:	---				
Visual Description:	Moist, dark gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	L-314-23	WB-1/U-1	6-8'	25	32	20	12	0.4	

Sample Prepared using the WET method

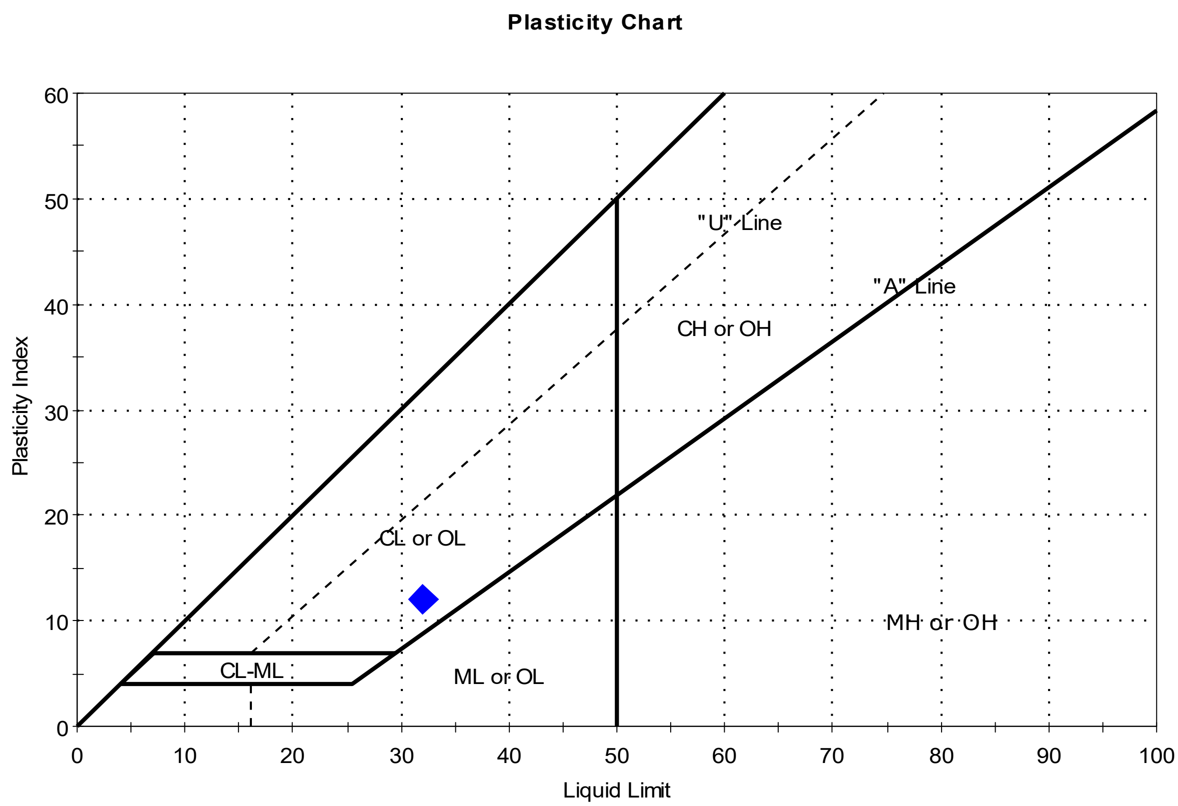
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Geotechnical Services Inc.				
Project:	Lubec Breakwater				
Location:	Lubec, ME			Project No:	GTX-317770
Boring ID:	Wb-6/U-1	Sample Type:	tube	Tested By:	cam
Sample ID:	L-332-23	Test Date:	09/19/23	Checked By:	ank
Depth :	4-6'	Test Id:	732221		
Test Comment:	---				
Visual Description:	Moist, dark grayish brown clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	L-332-23	Wb-6/U-1	4-6'	27	32	20	12	0.6	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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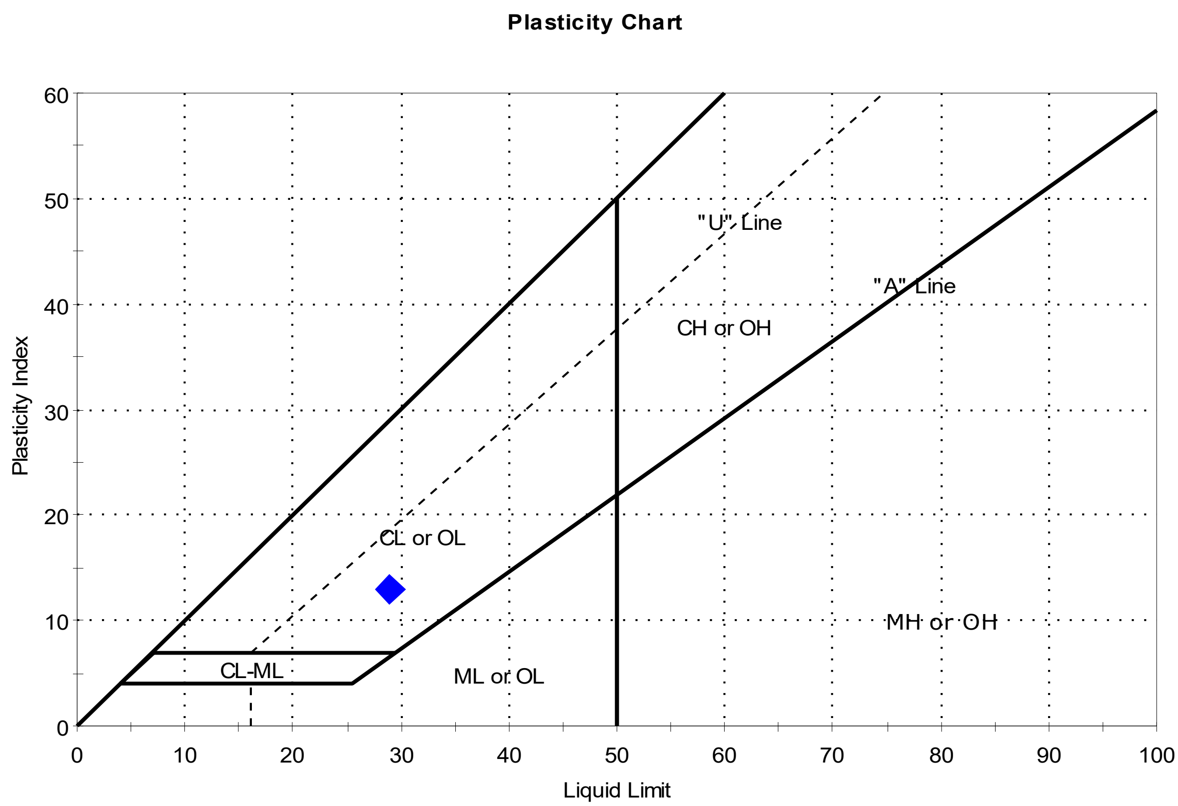
Client:	Jacobs Engineering Group			
Project:	Lubec Breakwater			
Location:	---		Project No:	GTX-318760
Boring ID:	WB-101	Sample Type: Unspecified	Tested By:	ckg
Sample ID:	S-2A	Test Date: 03/22/24	Checked By:	ank
Depth :	2-4	Test Id: 761937		

Test Comment: ---

Visual Description: Moist, brown clay

Sample Comment: ---

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-2A	WB-101	2-4	30	29	16	13	1.1	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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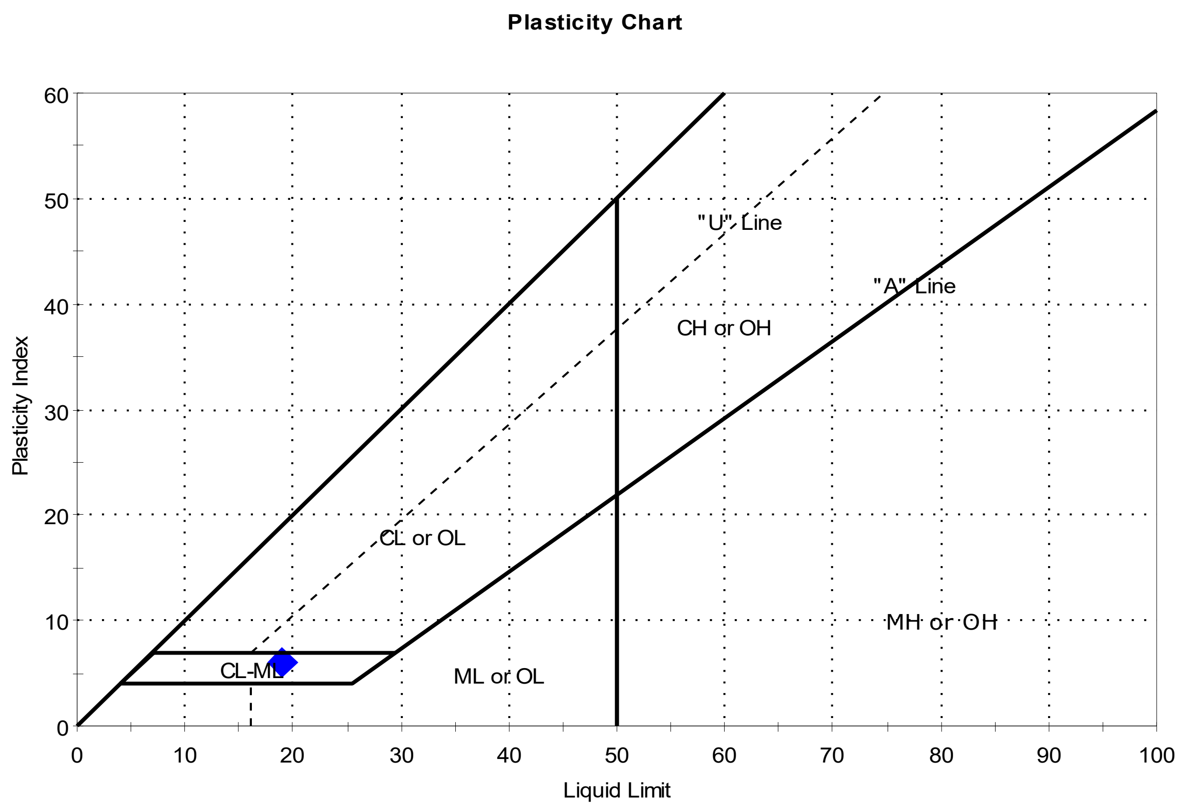
Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	WB-101	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	S-4	Test Date:	03/27/24	Checked By:	ank
Depth :	6-8	Test Id:	761938		
Test Comment:	---				
Visual Description:	Moist, gray silty clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-4	WB-101	6-8	21	19	13	6	1.4	

Sample Prepared using the WET method

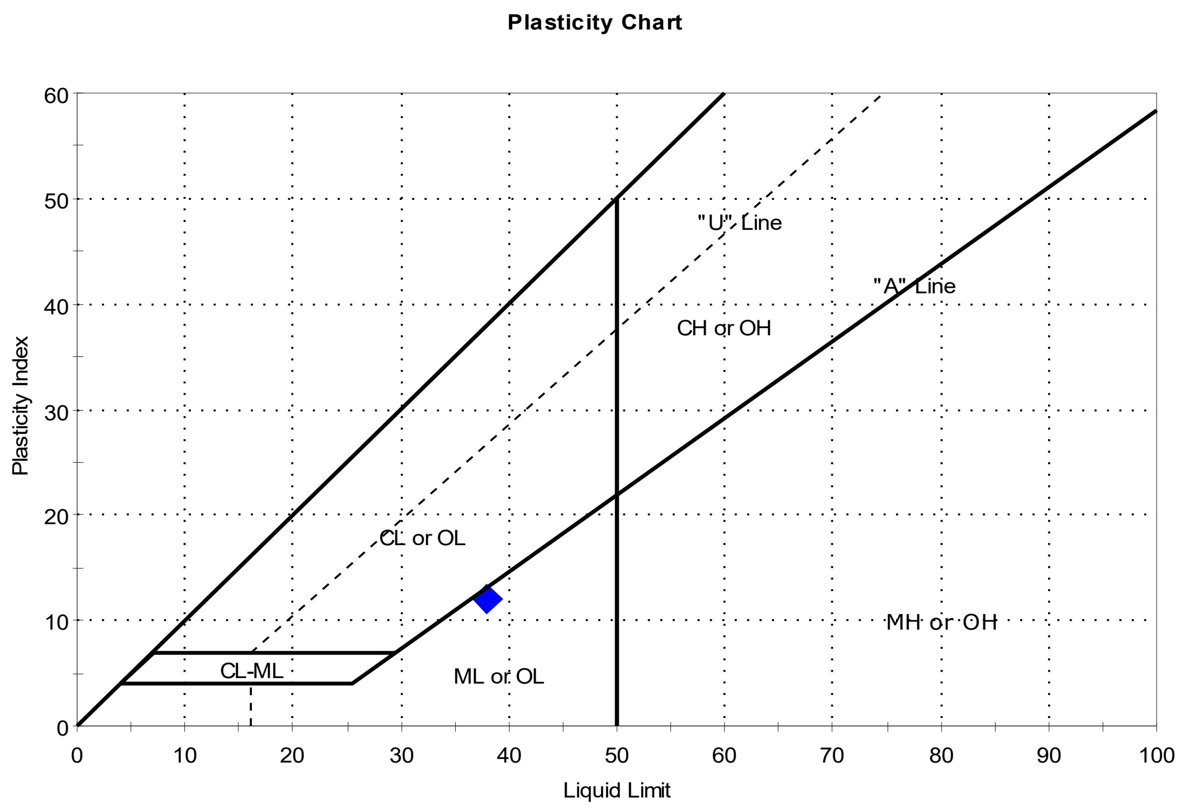
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Jacobs Engineering Group		
Project:	Lubec Breakwater		
Location:	---	Project No:	GTX-318760
Boring ID:	WB-102	Sample Type: Unspecified	Tested By: ckg
Sample ID:	S-2	Test Date: 03/27/24	Checked By: ank
Depth :	2-4	Test Id: 761939	
Test Comment:	---		
Visual Description:	Moist, gray silt		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-2	WB-102	2-4	40	38	26	12	1.2	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

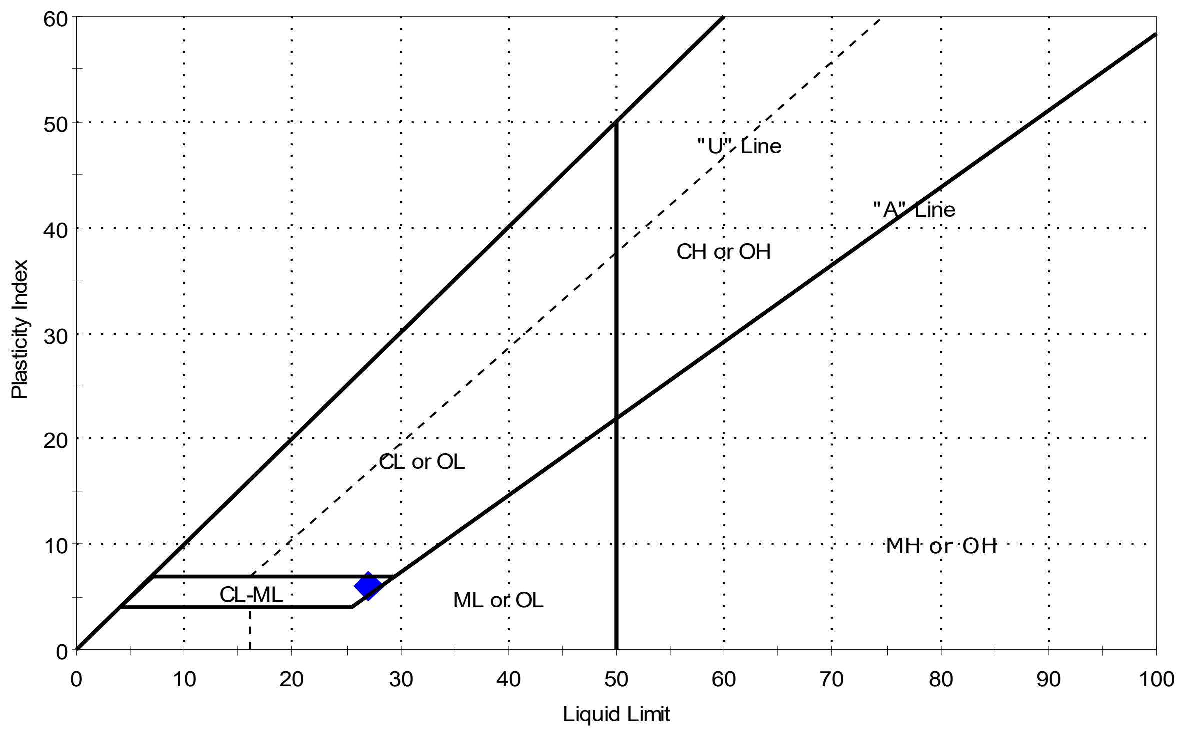
Dilatancy: SLOW

Toughness: LOW

Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	WB-103	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	S-2A	Test Date:	03/27/24	Checked By:	ank
Depth :	2-4	Test Id:	761940		

Test Comment: ---
Visual Description: Moist, grayish brown silty clay
Sample Comment: ---

Atterberg Limits - ASTM D4318



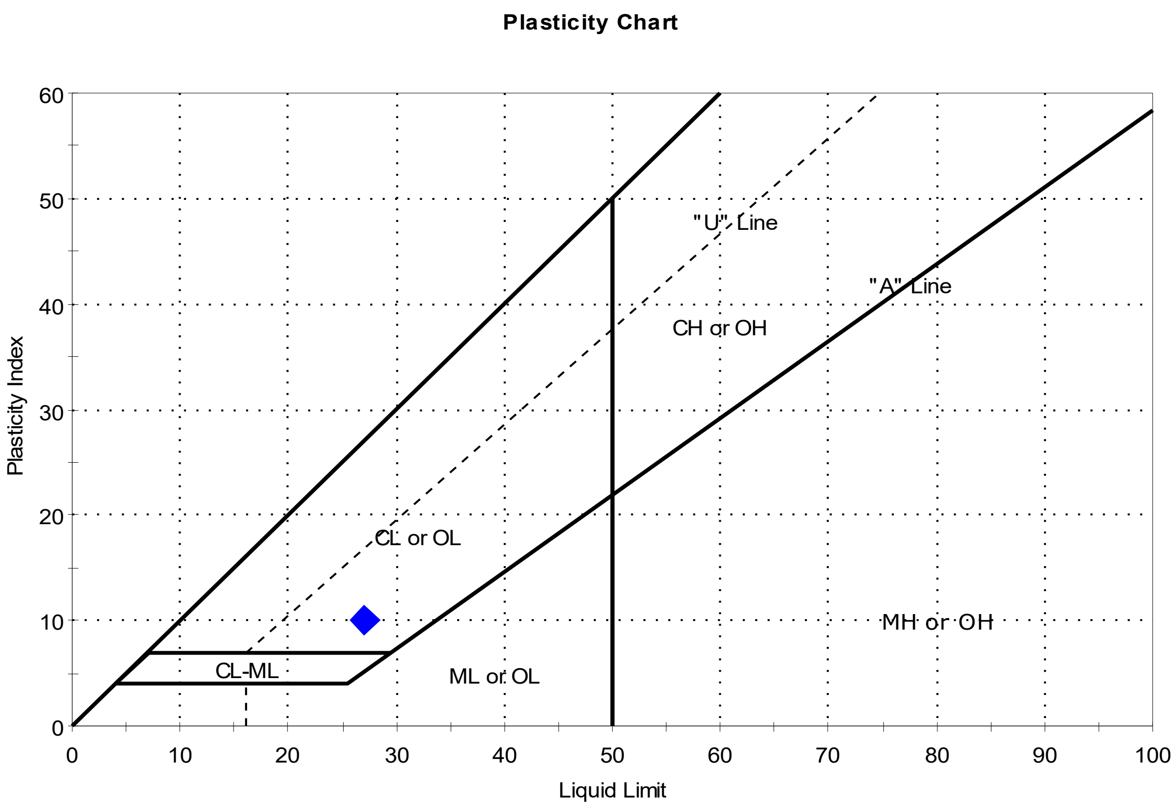
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-2A	WB-103	2-4	23	27	21	6	0.3	

Sample Prepared using the WET method

Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	WB-103	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	U-1	Test Date:	03/26/24	Checked By:	ank
Depth :	4-6	Test Id:	761941		
Test Comment:	---				
Visual Description:	Moist, gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U-1	WB-103	4-6	22	27	17	10	0.5	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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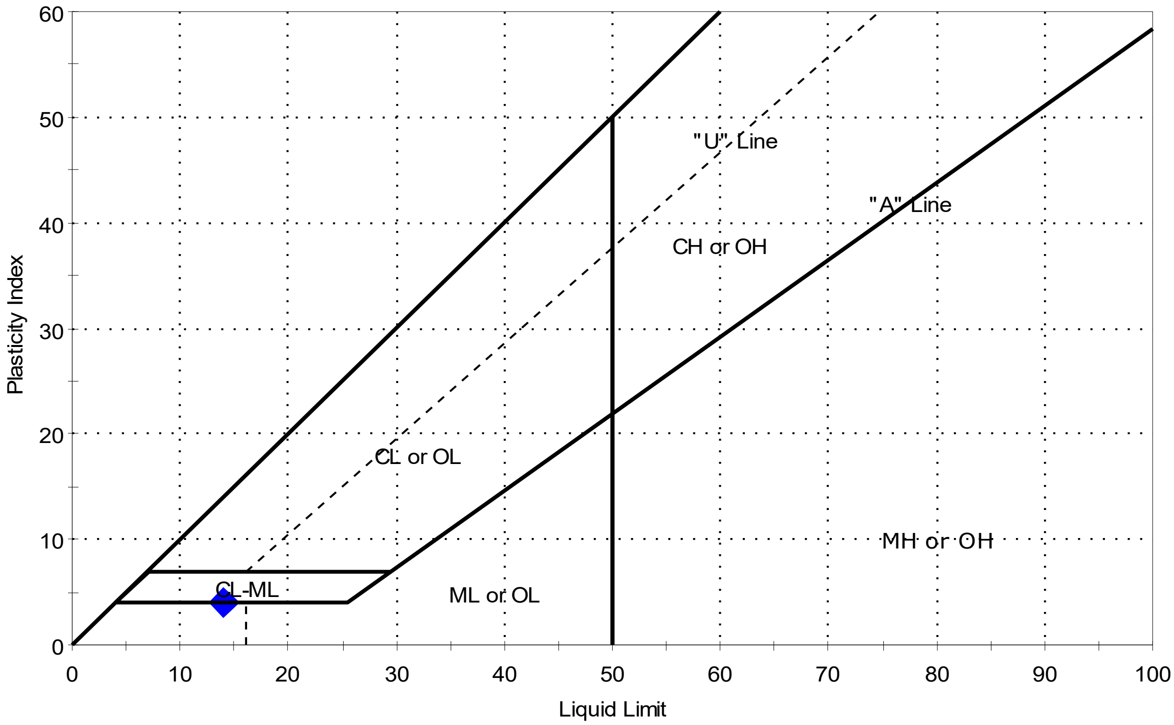
Client:	Jacobs Engineering Group		
Project:	Lubec Breakwater		
Location:	---	Project No:	GTX-318760
Boring ID:	WB-104	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	S-3	Test Date:	03/27/24	Checked By:	ank
Depth :	4-6	Test Id:	761942		
Test Comment:	---		
Visual Description:	Moist, brown silty clay with gravel		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-3	WB-104	4-6	14	14	10	4	0.9	

Sample Prepared using the WET method

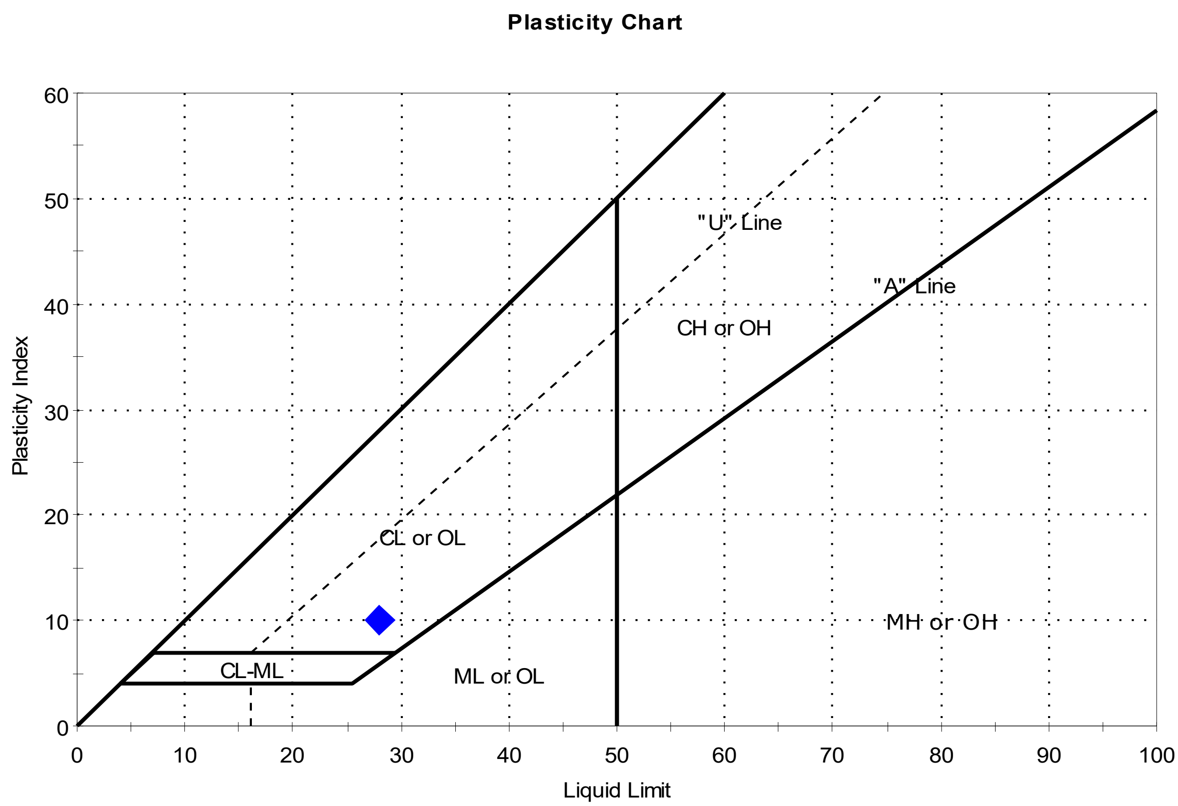
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Jacobs Engineering Group		
Project:	Lubec Breakwater		
Location:	---	Project No:	GTX-318760
Boring ID:	WB-105	Sample Type: Unspecified	Tested By: ckg
Sample ID:	S-3	Test Date: 03/20/24	Checked By: ank
Depth :	4-6	Test Id: 761943	
Test Comment:	---		
Visual Description:	Moist, brown clay		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-3	WB-105	4-6	26	28	18	10	0.8	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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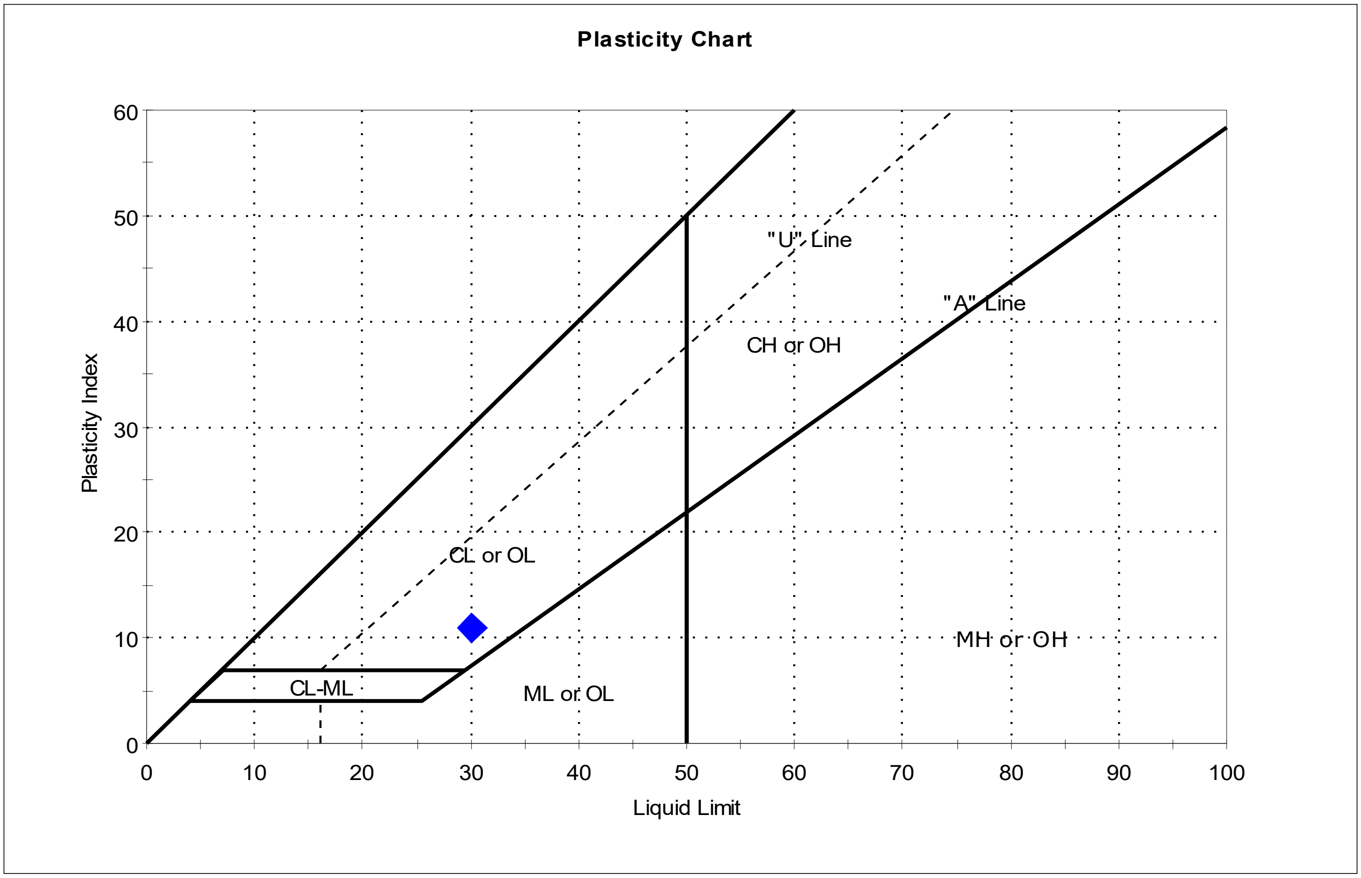
Client:	Jacobs Engineering Group
Project:	Lubec Breakwater
Location:	---
Project No:	GTX-318760
Boring ID:	WB-105
Sample Type:	Unspecified
Tested By:	ckg
Sample ID:	U-1
Test Date:	03/25/24
Checked By:	ank
Depth :	6-7.6
Test Id:	761944
Test Comment:	---
Visual Description:	Moist, gray clay
Sample Comment:	---

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U-1	WB-105	6-7.6	23	30	19	11	0.4	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

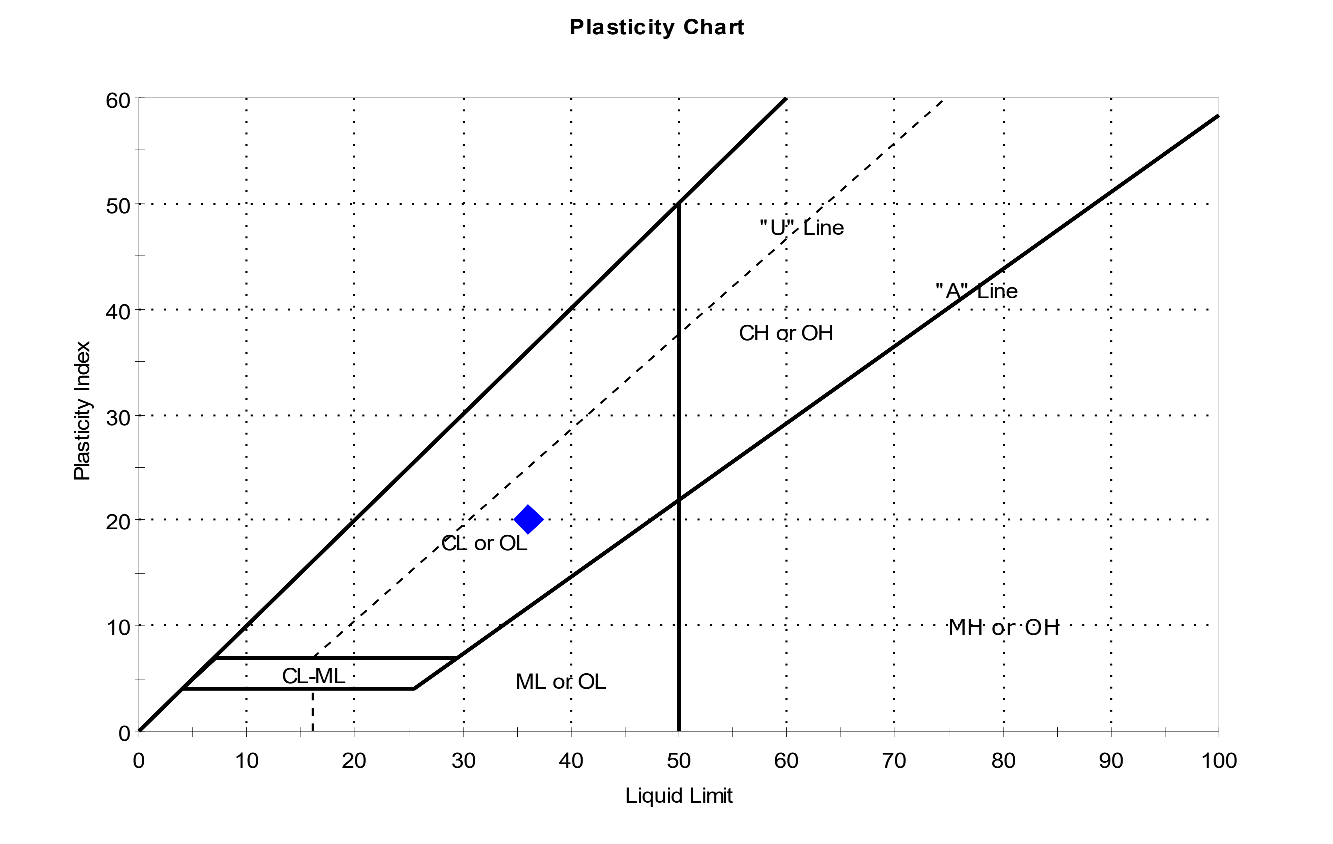
Dilatancy: SLOW

Toughness: LOW

GeoTesting EXPRESS
A SERCEL COMPANY

Client:	Jacobs Engineering Group		
Project:	Lubec Breakwater		
Location:	---	Project No:	GTX-318760
Boring ID:	WB-106	Sample Type: Unspecified	Tested By: ckg
Sample ID:	U-1	Test Date: 03/27/24	Checked By: ank
Depth :	6-8	Test Id: 761945	
Test Comment:	---		
Visual Description:	Moist, gray clay with gravel		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U-1	WB-106	6-8	15	36	16	20	0	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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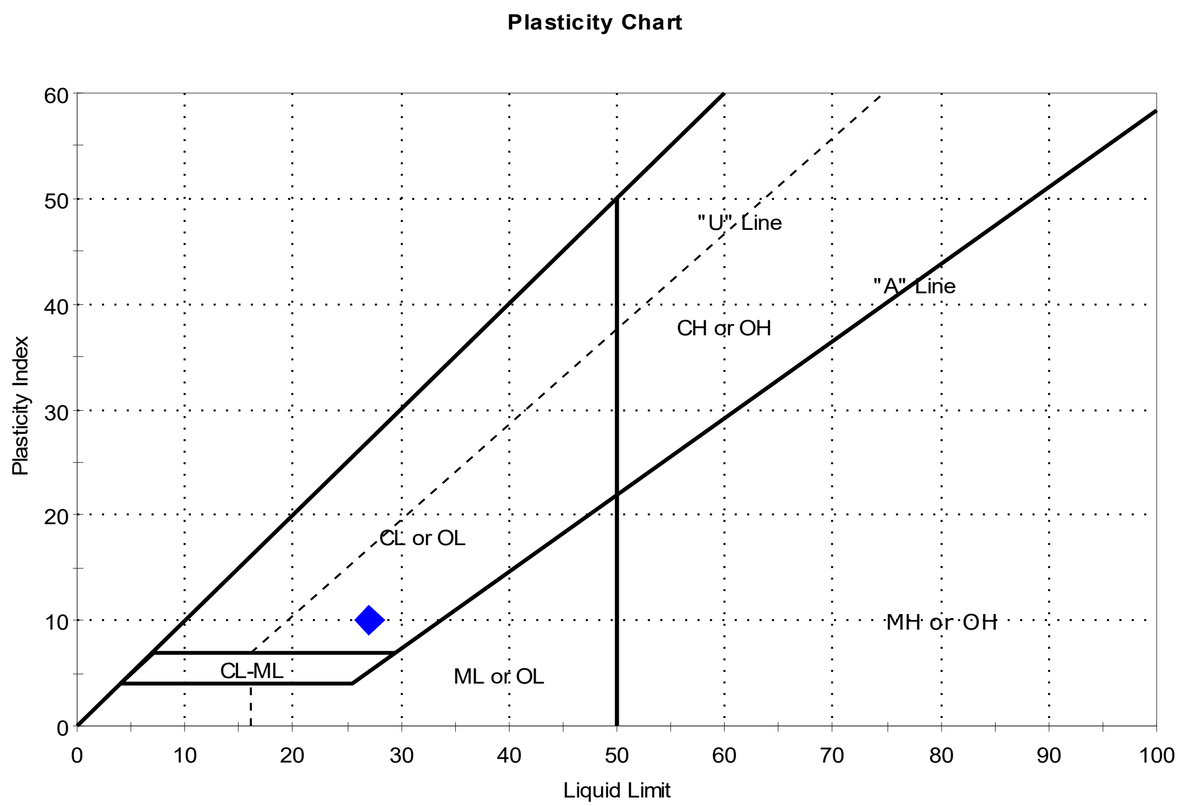
Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	WB-106	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	U-2	Test Date:	03/25/24	Checked By:	ank
Depth :	8-10	Test Id:	761946		
Test Comment:	---				
Visual Description:	Moist, gray clay with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U-2	WB-106	8-10	21	27	17	10	0.4	

Sample Prepared using the WET method

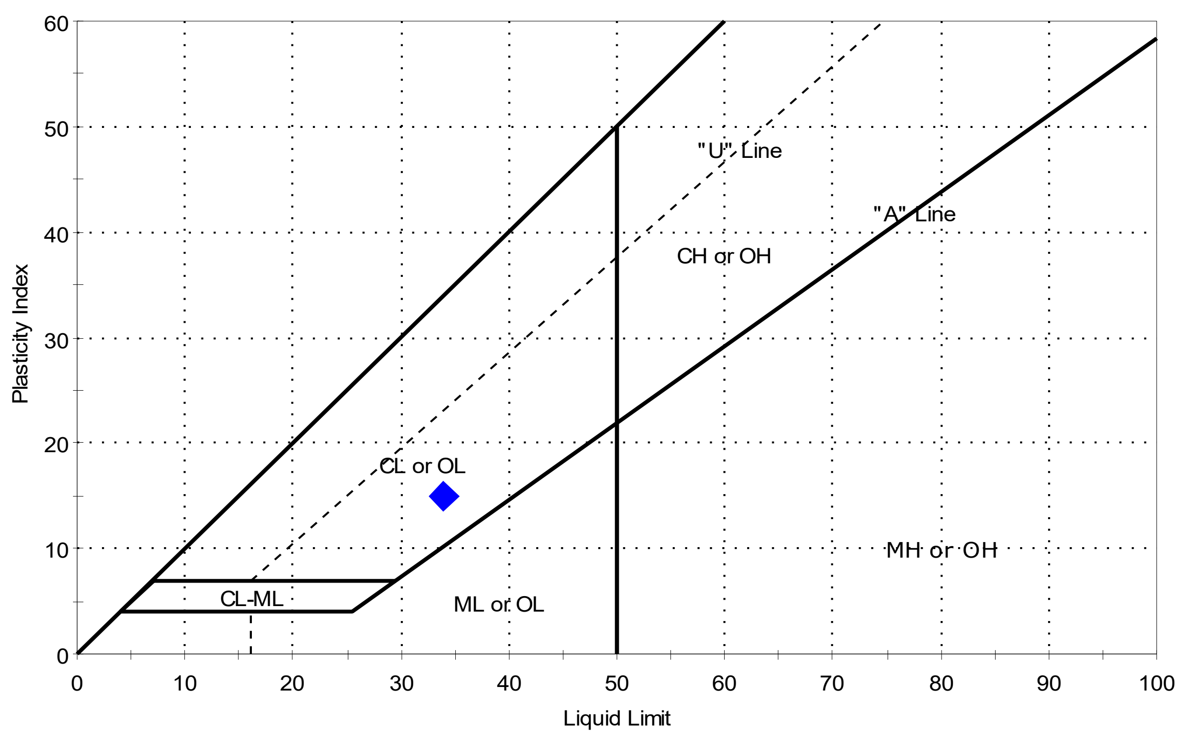
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Jacobs Engineering Group			
Project:	Lubec Breakwater			
Location:	---		Project No:	GTX-318760
Boring ID:	WB-107	Sample Type: Unspecified	Tested By:	ckg
Sample ID:	S-4	Test Date: 03/20/24	Checked By:	ank
Depth :	6-8	Test Id: 761947		
Test Comment:	---			
Visual Description:	Moist, grayish brown clay			
Sample Comment:	---			

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-4	WB-107	6-8	30	34	19	15	0.7	

Sample Prepared using the WET method

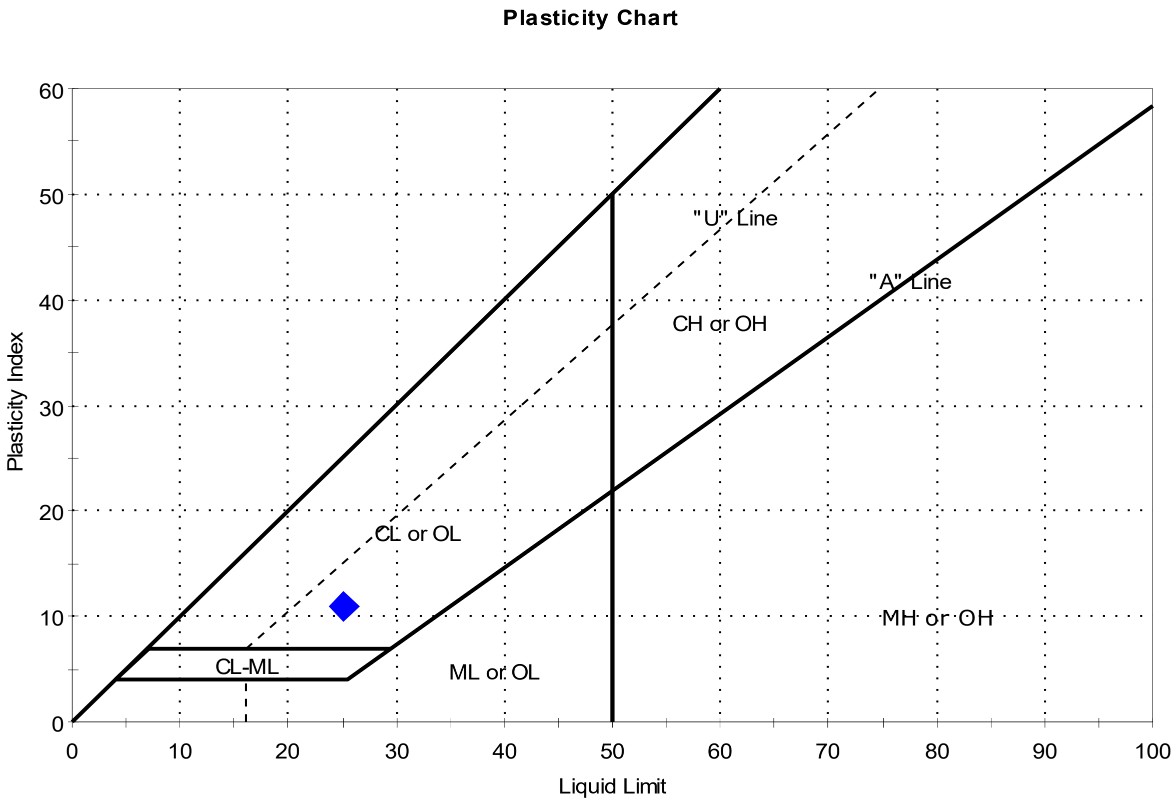
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client: Jacobs Engineering Group			
Project: Lubec Breakwater			
Location: ---		Project No: GTX-318760	
Boring ID: WB-107	Sample Type: Unspecified	Tested By: ckg	
Sample ID: U-1	Test Date: 03/27/24	Checked By: ank	
Depth : 8-10	Test Id: 761948		
Test Comment: ---			
Visual Description: Moist, gray clay			
Sample Comment: ---			

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U-1	WB-107	8-10	23	25	14	11	0.8	

Sample Prepared using the WET method

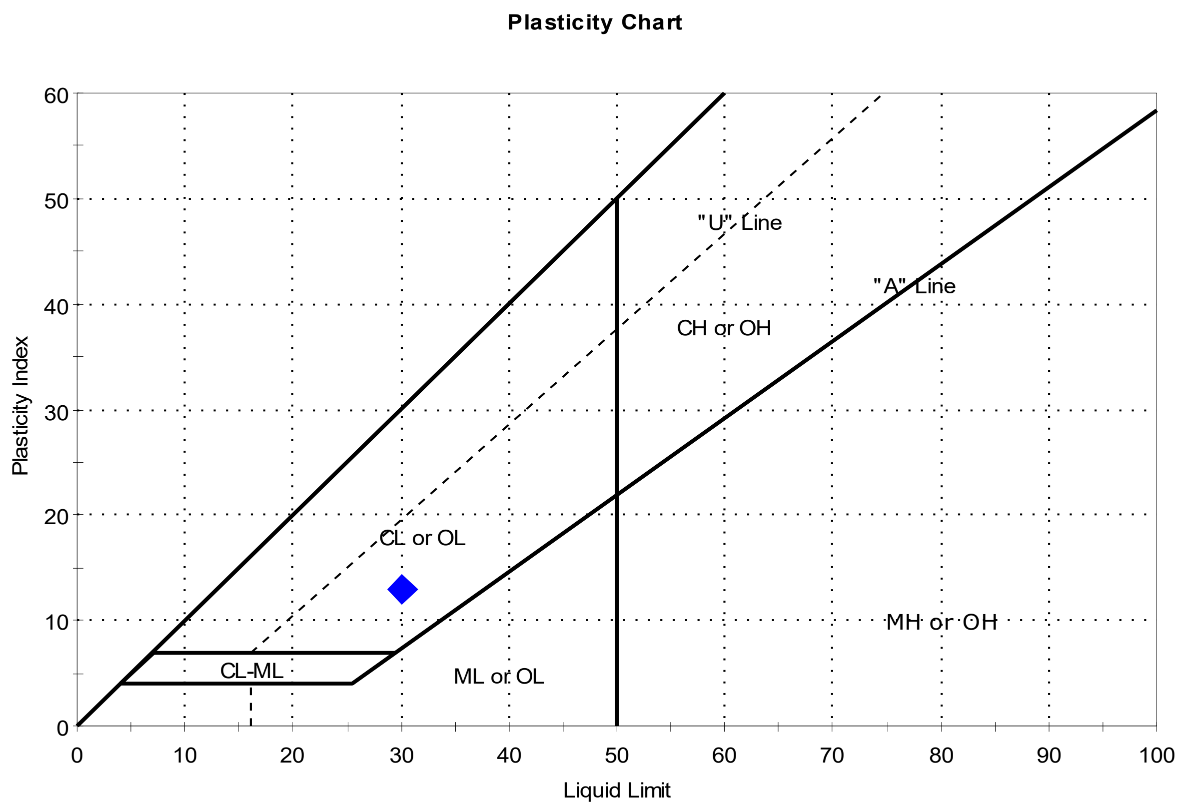
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	WB-108	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	U-1	Test Date:	03/26/24	Checked By:	ank
Depth :	4-6	Test Id:	761949		
Test Comment:	---				
Visual Description:	Moist, gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U-1	WB-108	4-6	23	30	17	13	0.5	

Sample Prepared using the WET method

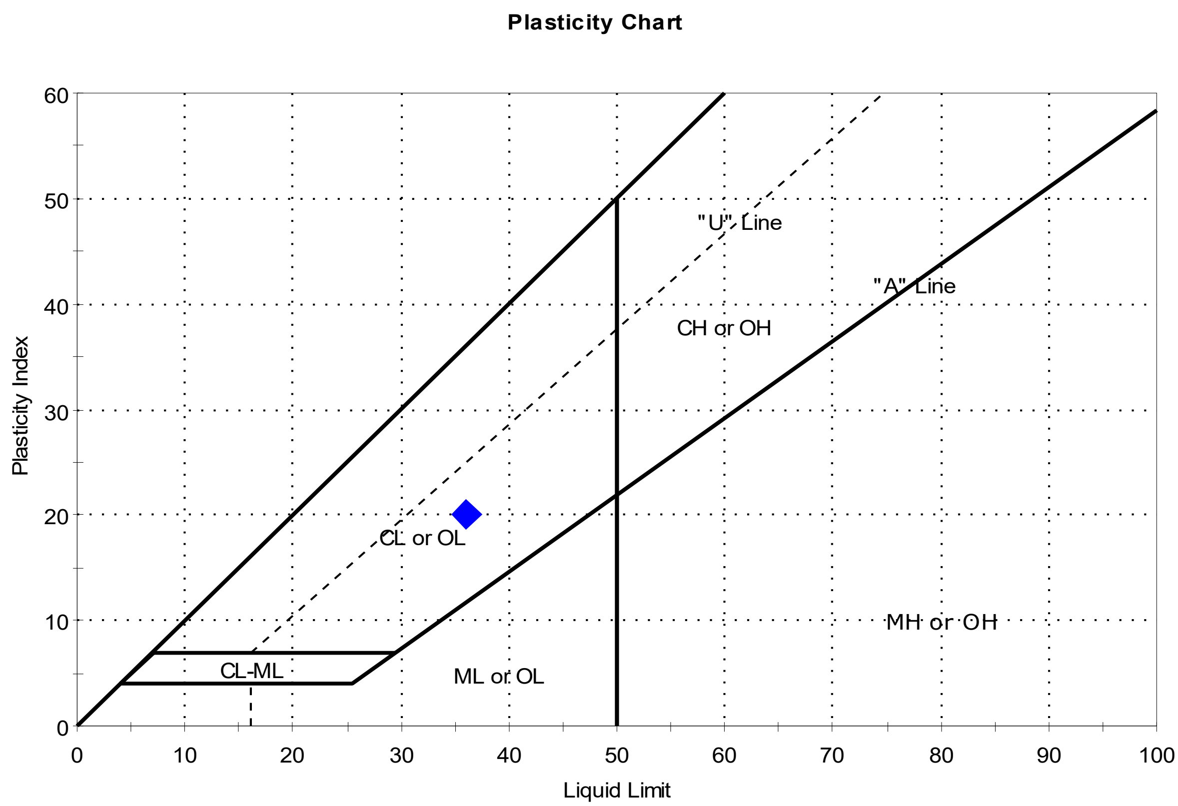
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:	---			Project No:	GTX-318760
Boring ID:	WB-108	Sample Type:	Unspecified	Tested By:	ckg
Sample ID:	U-2	Test Date:	03/26/24	Checked By:	ank
Depth :	8-10	Test Id:	761950		
Test Comment:	---				
Visual Description:	Moist, gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U-2	WB-108	8-10	25	36	16	20	0.4	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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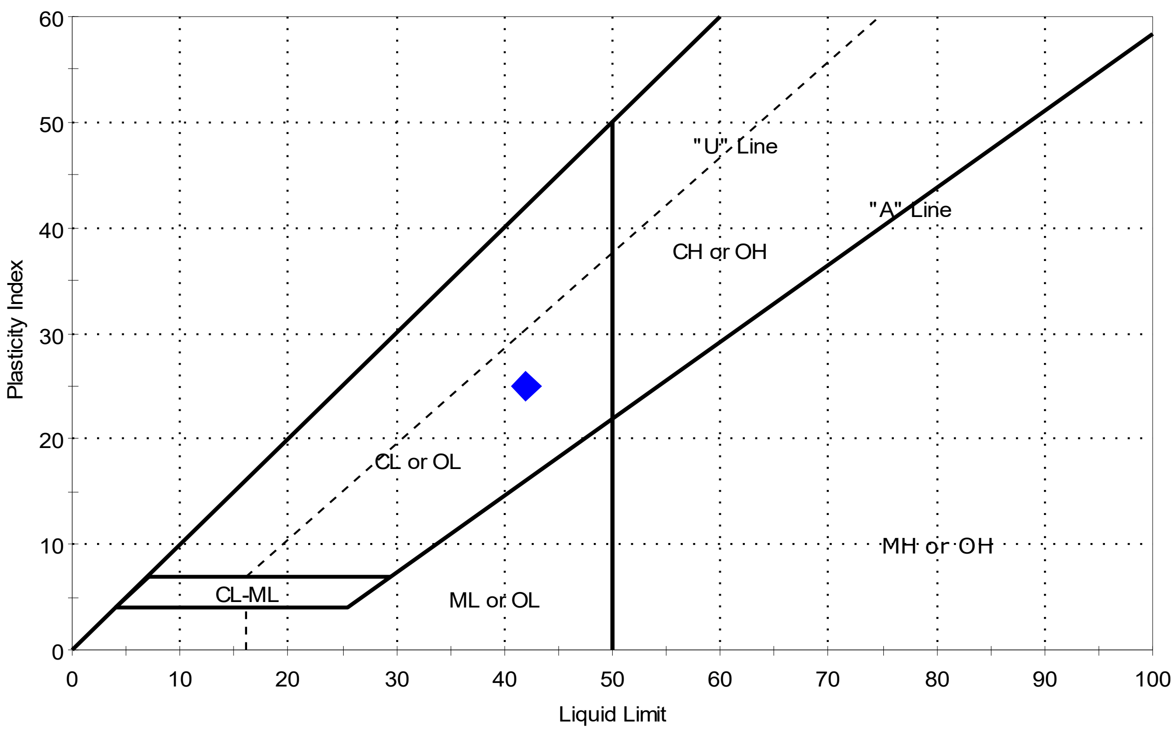
Client:	Jacobs Engineering Group		
Project:	Lubec Breakwater		
Location:	---	Project No:	GTX-318760
Boring ID:	WB-108	Sample Type:	Unspecified
Tested By:	ckg		
Sample ID:	S-5	Test Date:	03/20/24
Checked By:	ank		
Depth :	14-16	Test Id:	761951
Test Comment:	---		
Visual Description:	Moist, brown clay		
Sample Comment:	---		

Atterberg Limits - ASTM D4318

Plasticity Chart



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S-5	WB-108	14-16	28	42	17	25	0.4	

Sample Prepared using the WET method

Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

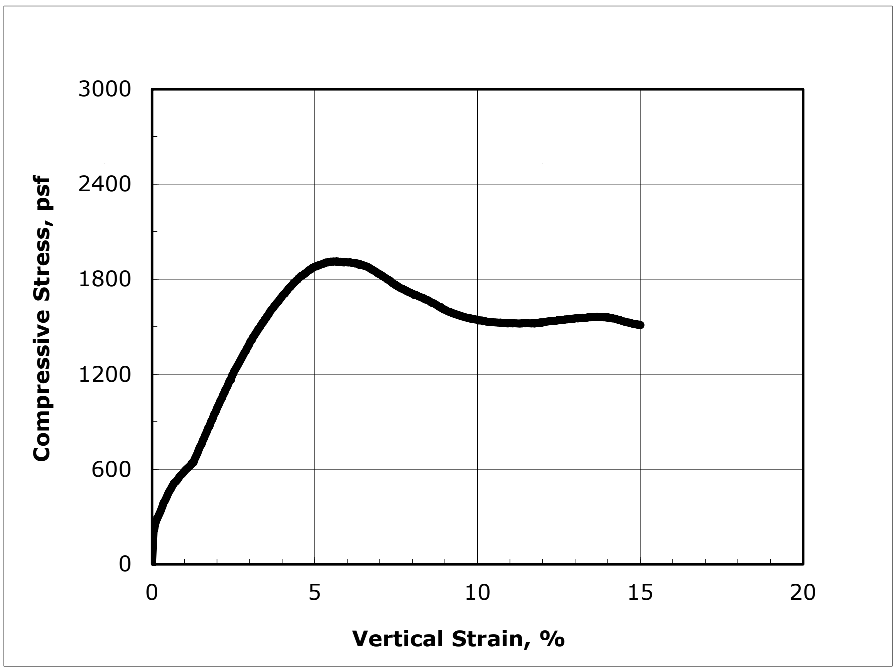
Lubec Breakwater - Laboratory Test Results

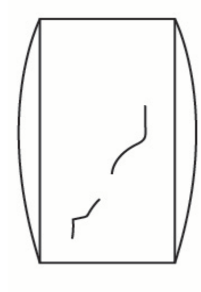
Table E.2 - Undisturbed Sample Strength Testing Data

Borehole No.	Sample No.	Sample Depth	USCS	Approximate Effective Overburden Stress	Unconfined Compressive Strength		UU Trixial Test
					Compressive Strength, q_u	Shear Strength	Undrained Shear Strength, S_u
-	-	ft	-	psf	psf	psf	psf
WB-1	U-1	6 - 8	CL	327	1913	957	-
WB-6	U-1	4 - 6	CL	225	-	-	329.0
WB-103	U-1	4 - 6	CL	240	1625	813	-
WB-105	U-1	6 - 7.6	CL	352	-	-	1267.5
WB-106	U-1	4 - 6	CL	240	5045	2523	-
	U-2	8 - 10	CL	464	-	-	1886.4
WB-107	U-1	8 - 10	CL	464	-	-	501.0
WB-108	U-2	8 - 10	CL	464	-	-	1132.8

Client:	Geotechnical Services Inc.
Project Name:	Lubec Breakwater
Project Location:	Lubec, ME
GTX #:	317770
Test Date:	09/15/23
Tested By:	jab/sjt
Checked By:	anm
Boring ID:	WB-1/U-1
Sample ID:	L-314-23
Depth, ft:	6-8
Visual Description:	Moist, dark gray clay
Test No.:	UC-1

Unconfined Compressive Strength by ASTM D2166





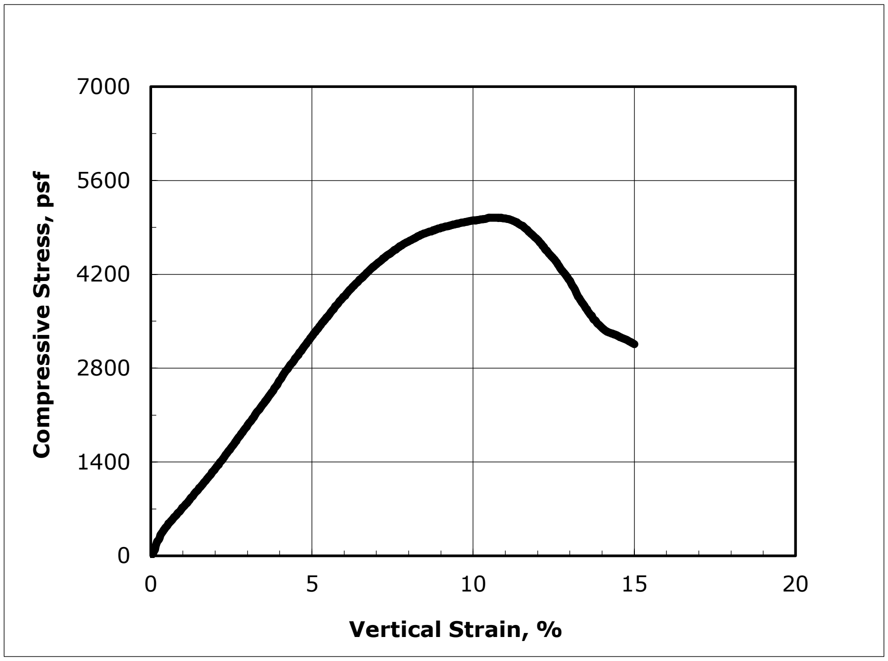
Failure Sketch

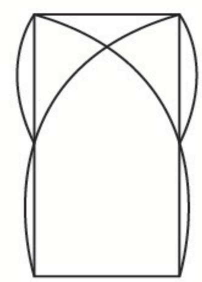
Initial Diameter, in:	2.03	Compressive Strength, psf	1913
Initial Height, in:	4.70	Shear Strength, psf:	957
Height to Diameter Ratio:	2.32	Strain Rate, %/min:	1
Initial Mass, grams:	498	Strain at Failure, %:	5.7
Initial Bulk Density, pcf:	124.8	Sample Type:	intact
Initial Moisture Content, %:	24.8	Liquid Limit:	32
Initial Dry Density, pcf:	100.0	Plastic Limit:	20
Initial Degree of Saturation:	97.7	Plasticity Index:	12
Initial Void Ratio:	0.68	% Passing #200 sieve:	---
Estimated Specific Gravity:	2.7	Soil Classification:	---
		Group Symbol:	---

Notes: Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D2216
Atterberg Limits determined by ASTM D4318
Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.
"---" indicates testing required to determine these values was not requested

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	03/26/24
Tested By:	sjt
Checked By:	anm
Boring ID:	WB-106
Sample ID:	U-1
Depth, ft:	6-8
Visual Description:	Moist, gray clay with gravel
Test No.:	UC-1

Unconfined Compressive Strength by ASTM D2166





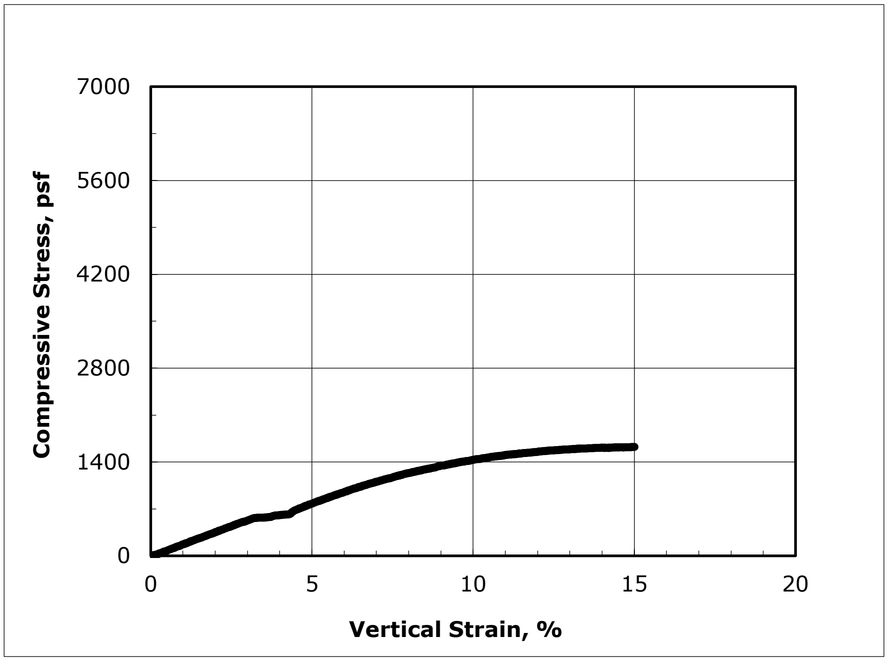
Failure Sketch

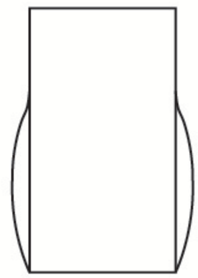
Initial Diameter, in:	2.03	Compressive Strength, psf	5045
Initial Height, in:	4.50	Shear Strength, psf:	2523
Height to Diameter Ratio:	2.22	Strain Rate, %/min:	1
Initial Mass, grams:	528	Strain at Failure, %:	10.5
Initial Bulk Density, pcf:	138.1	Sample Type:	intact
Initial Moisture Content, %:	15.7	Liquid Limit:	36
Initial Dry Density, pcf:	119.4	Plastic Limit:	16
Initial Degree of Saturation:	99.5	Plasticity Index:	20
Initial Void Ratio:	0.43	% Passing #200 sieve:	---
Estimated Specific Gravity:	2.74	Soil Classification:	---
		Group Symbol:	---

Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D2216
Atterberg Limits determined by ASTM D4318
Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.
"---" indicates testing required to determine these values was not requested

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	03/26/24
Tested By:	sjt
Checked By:	anm
Boring ID:	WB-103
Sample ID:	U-1
Depth, ft:	4-6
Visual Description:	Moist, gray clay
Test No.:	UC-2

Unconfined Compressive Strength by ASTM D2166



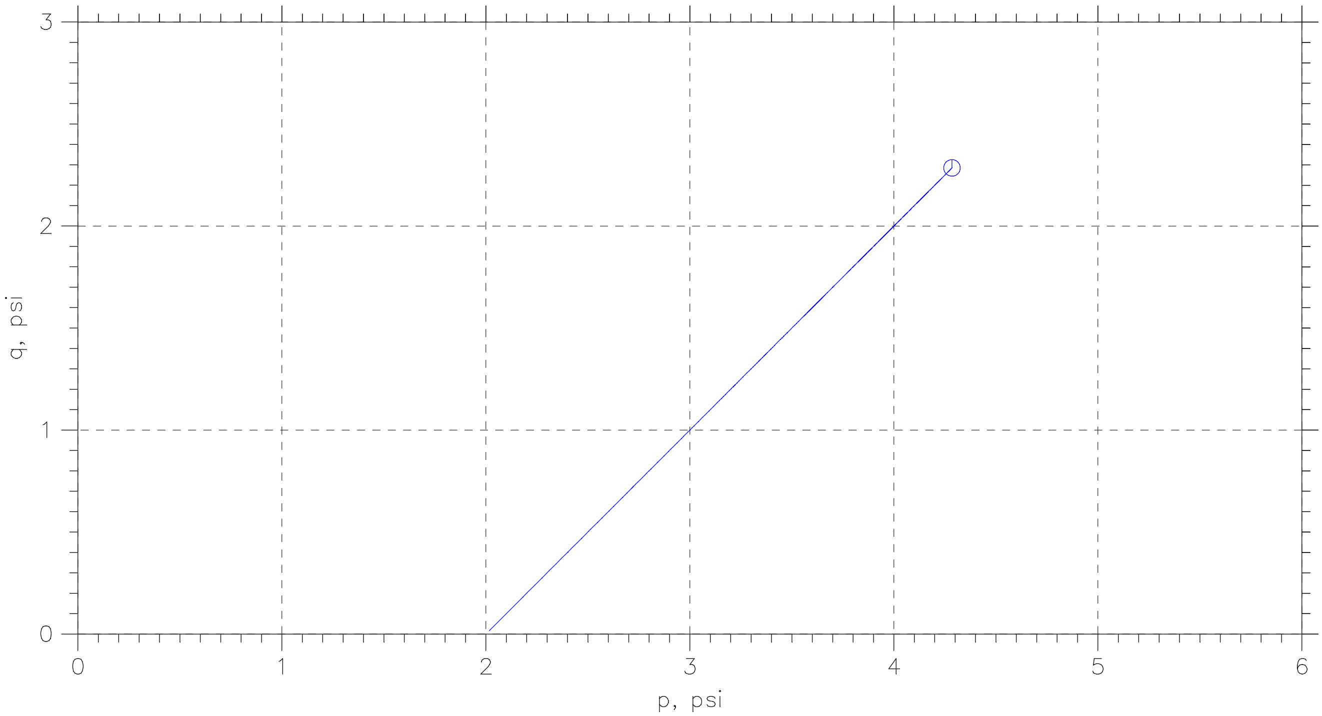


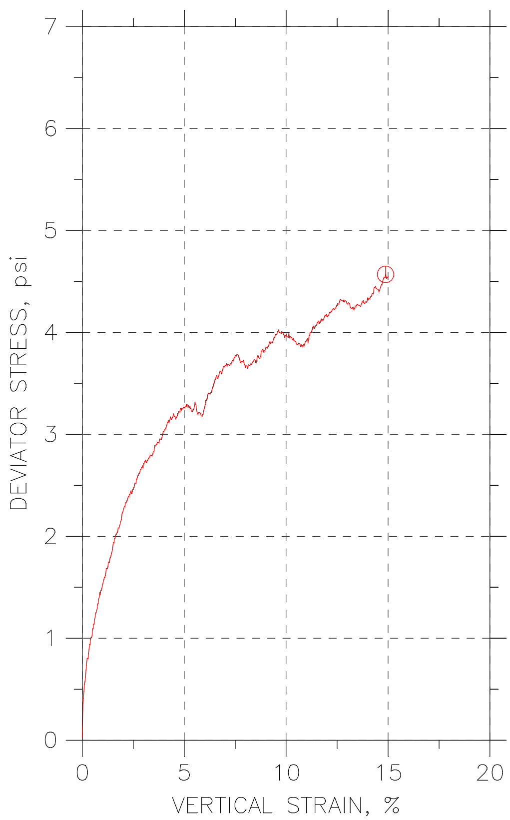
Failure Sketch

Initial Diameter, in:	2.02	Compressive Strength, psf	1625
Initial Height, in:	4.35	Shear Strength, psf:	813
Height to Diameter Ratio:	2.15	Strain Rate, %/min:	1
Initial Mass, grams:	478	Strain at Failure, %:	15
Initial Bulk Density, pcf:	130.7	Sample Type:	intact
Initial Moisture Content, %:	21.5	Liquid Limit:	27
Initial Dry Density, pcf:	107.6	Plastic Limit:	17
Initial Degree of Saturation:	100.0	Plasticity Index:	10
Initial Void Ratio:	0.59	% Passing #200 sieve:	---
Estimated Specific Gravity:	2.74	Soil Classification:	---
		Group Symbol:	---

Notes: Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D2216
Atterberg Limits determined by ASTM D4318
Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.
"---" indicates testing required to determine these values was not requested

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850

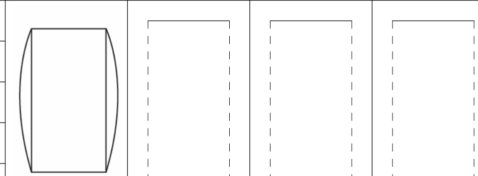




Symbol	⏀			
Sample No.	L-332-23			
Test No.	UU-1			
Depth	4-6'			
Tested by	sjt			
Test Date	9/18/23			
Checked by	mcm			
Check Date	9/20/23			
Diameter, in	2.04			
Height, in	4.12			
Water Content, %	27.1			
Dry Density, pcf	92.85			
Saturation, %	89.6			
Void Ratio	0.815			
Confining Stress, psi	2			
Undrained Strength, psi	2.285			
Max. Dev. Stress, psi	4.57			
Strain at Failure, %	14.9			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	32			
Plastic Limit	20			
Plasticity Index	12			

GeoTesting EXPRESS

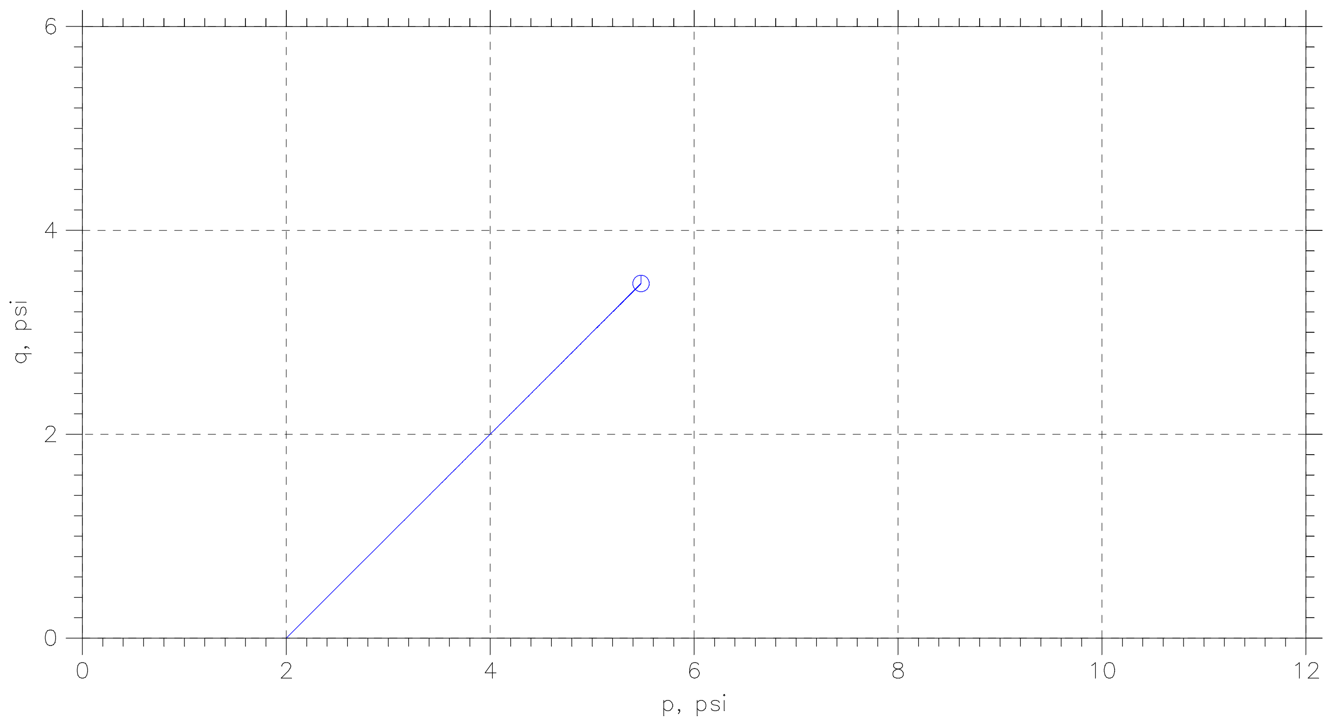
Project: Lubec Breakwater	
Location: Lubec, ME	
Project No.: GTX-317770	
Boring No.: Wb-6/U-1	
Sample Type: intact	
Description: Moist, dark grayish brown clay	
Remarks: TX-028	

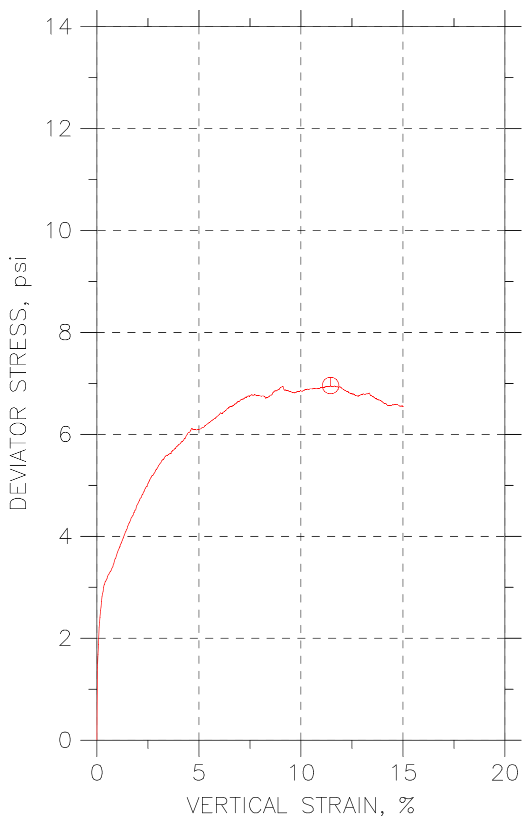


Phase calculations based on start of test.

Wed, 20-SEP-2023 15:22:23

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏀			
Sample No.	U-1			
Test No.	UU-1			
Depth	8-10			
Tested by	te			
Test Date	3/27/24			
Checked by	anm			
Check Date	4/04/24			
Diameter, in	2.03			
Height, in	4.61			
Water Content, %	25.3			
Dry Density, pcf	99.73			
Saturation, %	99.1			
Void Ratio	0.69			
Confining Stress, psi	2			
Undrained Strength, psi	3.479			
Max. Dev. Stress, psi	6.957			
Strain at Failure, %	11.5			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	25			
Plastic Limit	14			
Plasticity Index	11			

GeoTesting EXPRESS A SERCEL COMPANY

Project: Lubec Breakwater

Location: ---

Project No.: GTX-318760

Boring No.: WB-107

Sample Type: intact

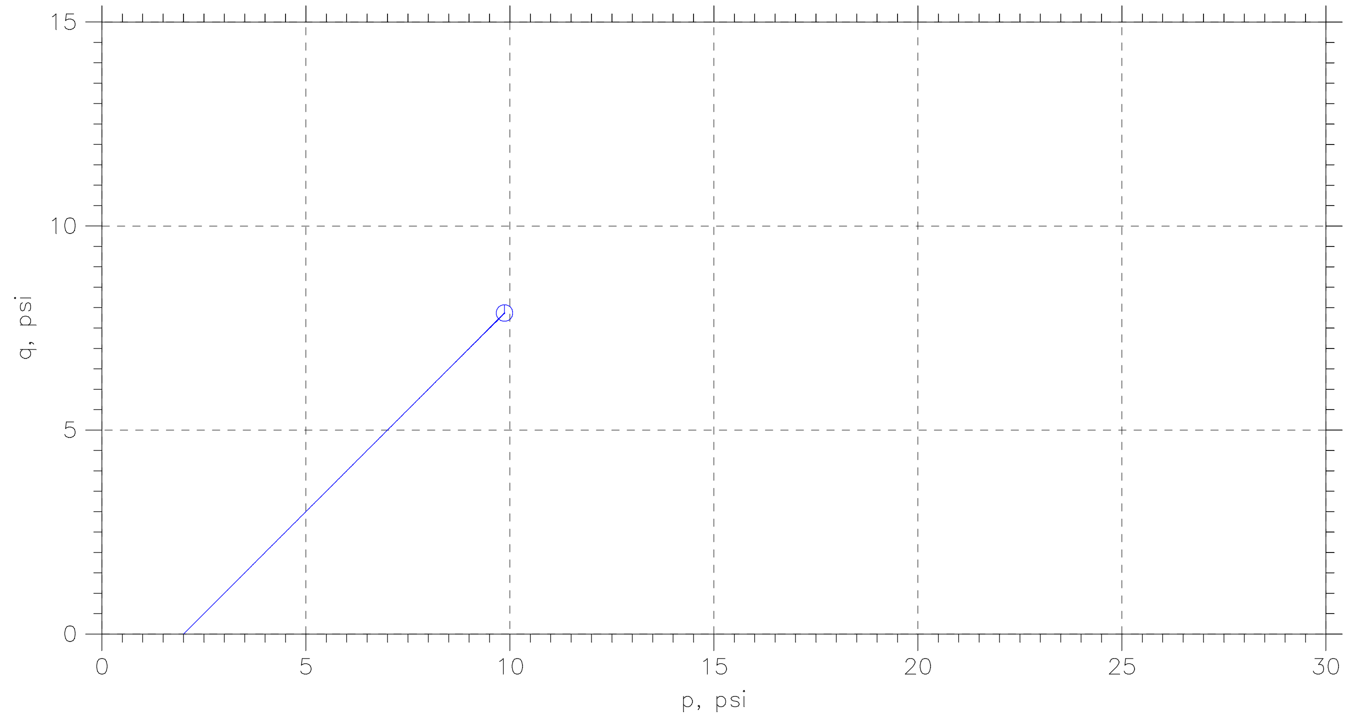
Description: Moist, gray clay

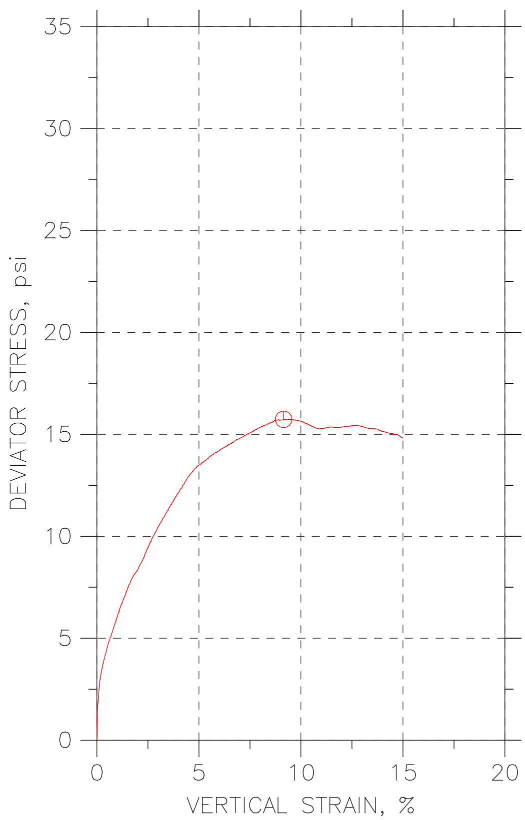
Remarks: TX-027

Phase calculations based on start of test.

Thu, 04-APR-2024 10:23:27

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	○			
Sample No.	U-2			
Test No.	UU-2			
Depth	8-10			
Tested by	te			
Test Date	3/27/24			
Checked by	anm			
Check Date	4/04/24			
Diameter, in	2.03			
Height, in	4.6			
Water Content, %	23.1			
Dry Density, pcf	101.6			
Saturation, %	94.4			
Void Ratio	0.659			
Confining Stress, psi	2			
Undrained Strength, psi	7.867			
Max. Dev. Stress, psi	15.73			
Strain at Failure, %	9.15			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	36			
Plastic Limit	16			
Plasticity Index	20			

GeoTesting EXPRESS

A SERCEL COMPANY

Project: Lubec Breakwater

Location: ---

Project No.: GTX-318760

Boring No.: WB-108

Sample Type: intact

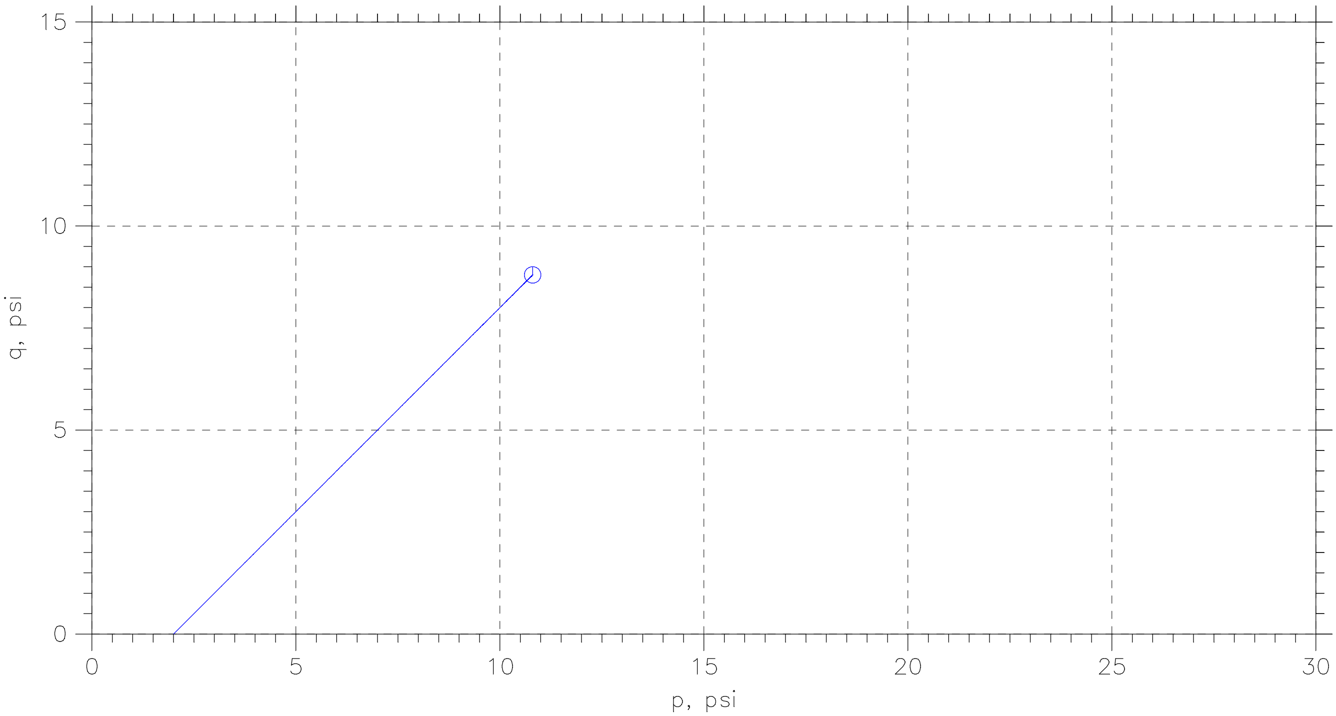
Description: Moist, gray clay

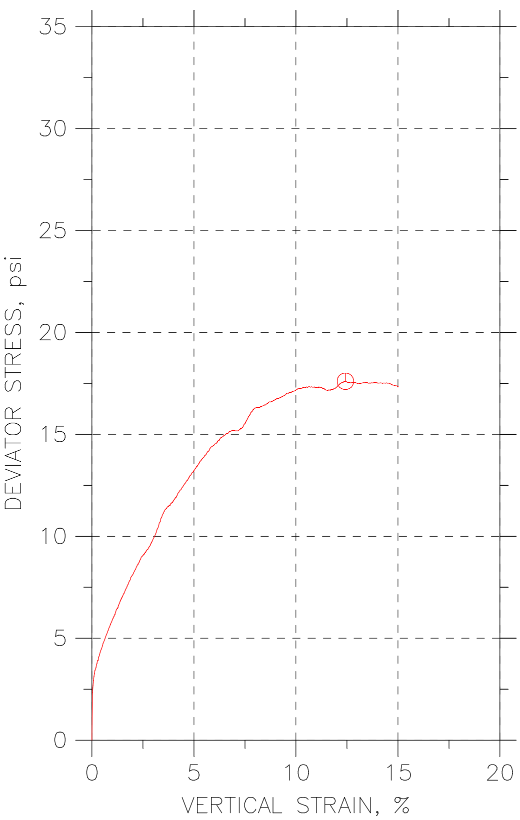
Remarks: TX-028

Phase calculations based on start of test.

Thu, 04-APR-2024 11:10:08

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⏀			
Sample No.	U-1			
Test No.	UU-3			
Depth	6-7.6			
Tested by	te			
Test Date	3/27/24			
Checked by	anm			
Check Date	4/04/24			
Diameter, in	2.05			
Height, in	4.5			
Water Content, %	19.9			
Dry Density, pcf	109.5			
Saturation, %	99.5			
Void Ratio	0.54			
Confining Stress, psi	2			
Undrained Strength, psi	8.802			
Max. Dev. Stress, psi	17.6			
Strain at Failure, %	12.4			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	30			
Plastic Limit	19			
Plasticity Index	11			

GeoTesting EXPRESS A SERCEL COMPANY

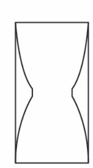
Project: Lubec Breakwater

Location: ---

Project No.: GTX-318760

Boring No.: WB-105

Sample Type: intact



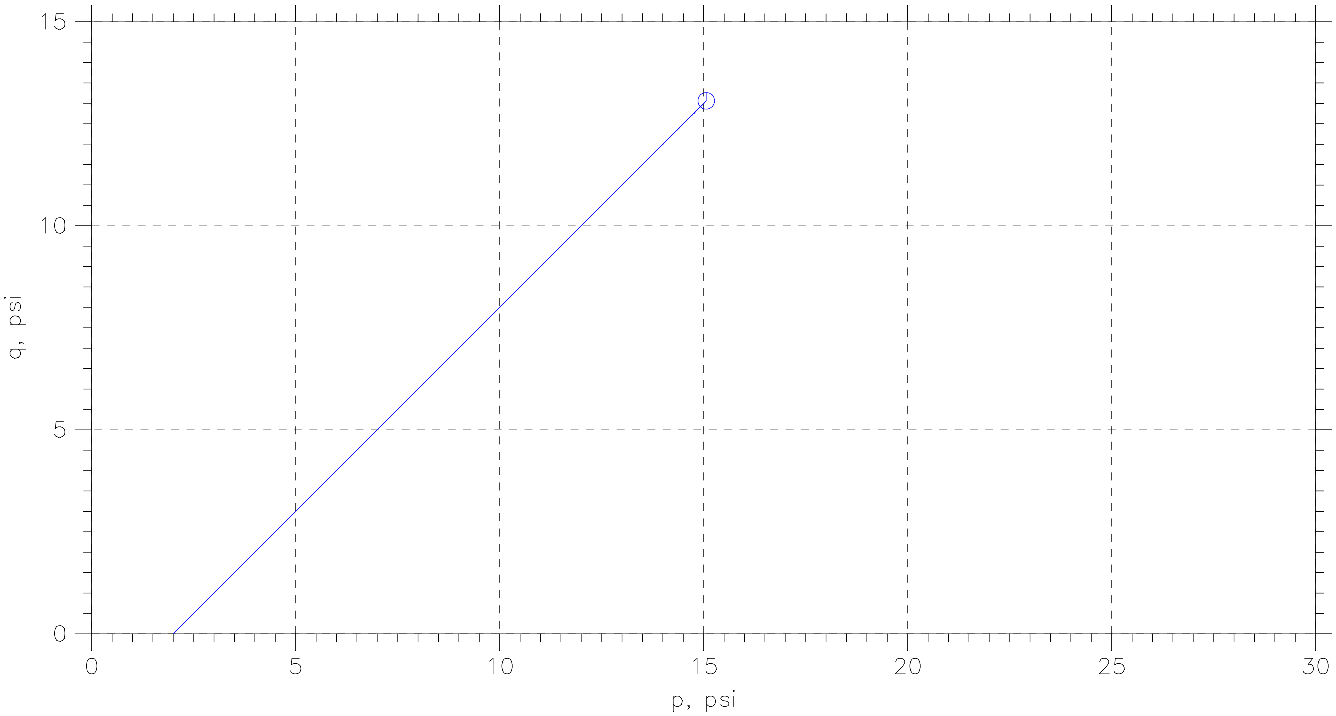
Description: Moist, gray clay

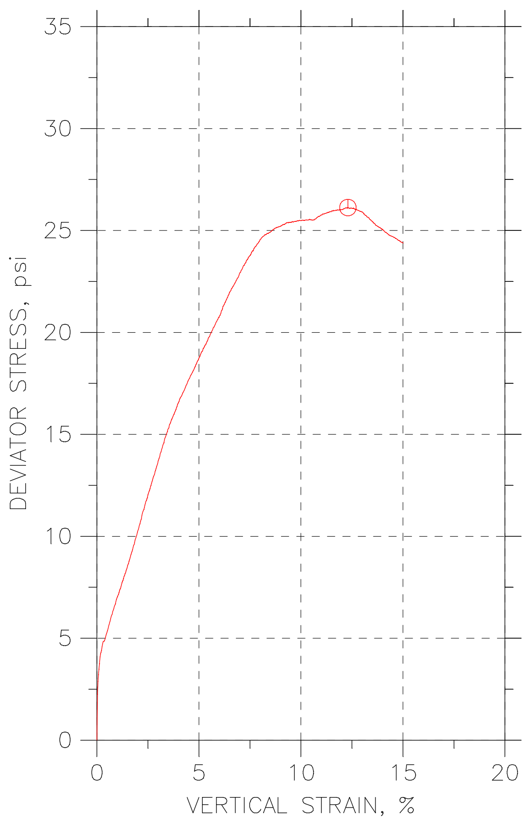
Remarks: TX-027

Phase calculations based on start of test.

Thu, 04-APR-2024 11:26:43

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⦶			
Sample No.	U-2			
Test No.	UU-4			
Depth	8-10			
Tested by	te			
Test Date	3/27/24			
Checked by	anm			
Check Date	4/04/24			
Diameter, in	2.05			
Height, in	4.46			
Water Content, %	16.4			
Dry Density, pcf	111.2			
Saturation, %	85.7			
Void Ratio	0.516			
Confining Stress, psi	2			
Undrained Strength, psi	13.06			
Max. Dev. Stress, psi	26.13			
Strain at Failure, %	12.3			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.7			
Liquid Limit	27			
Plastic Limit	17			
Plasticity Index	10			

GeoTesting EXPRESS
A SERCEL COMPANY

Project: Lubec Breakwater
Location: ---
Project No.: GTX-318760
Boring No.: WB-106
Sample Type: intact
Description: Moist, gray clay with sand
Remarks: TX-028 , quarter inch layer of sand in sample
Phase calculations based on start of test.

Thu, 04-APR-2024 12:00:52

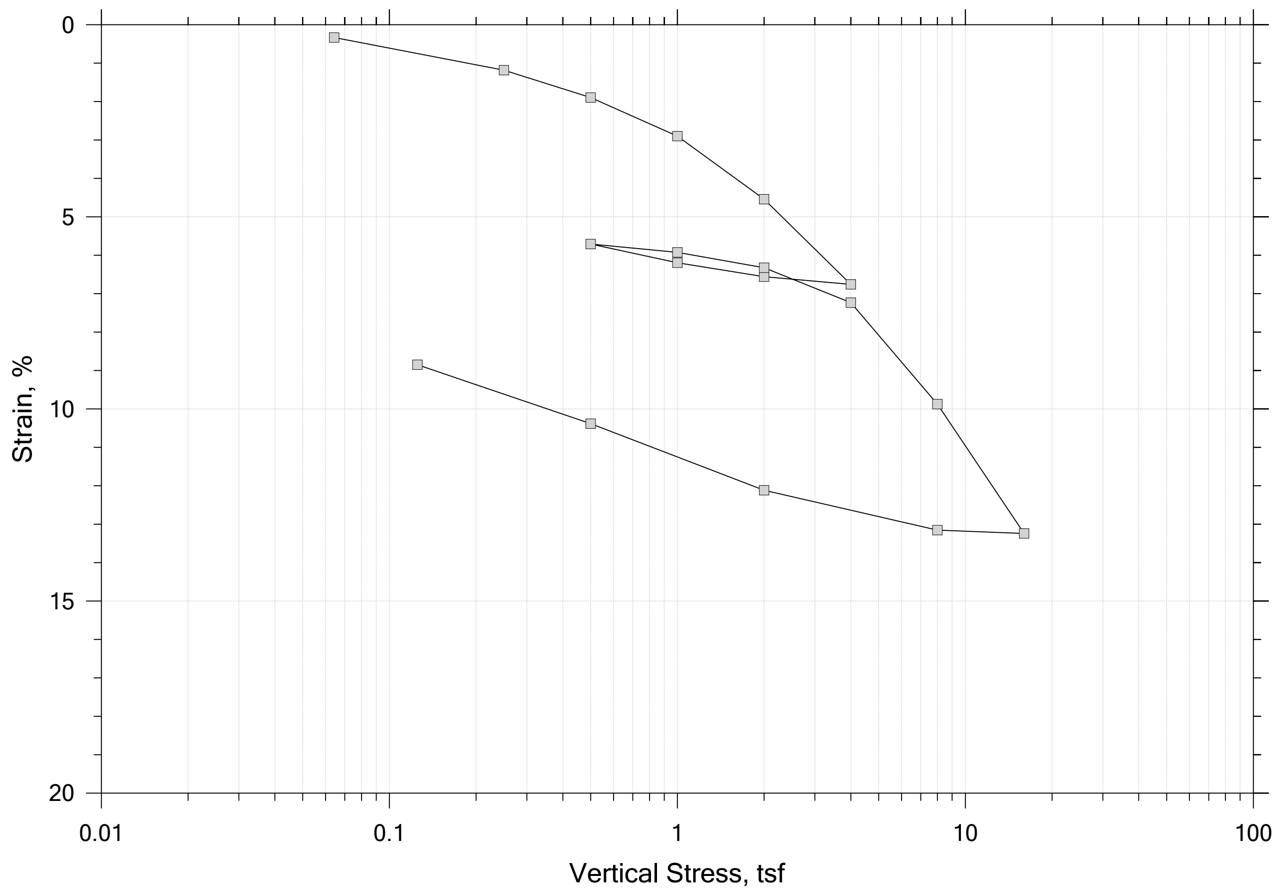
Lubec Breakwater - Laboratory Test Results

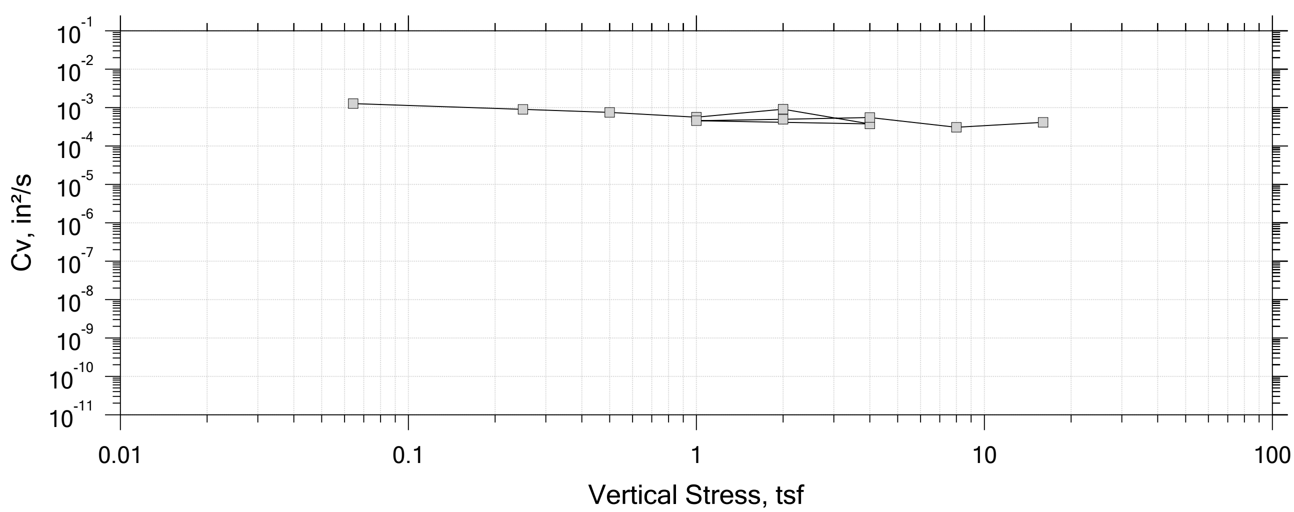
Table E.3 - Undisturbed Sample Consolidation Test Data

Borehole No.	Sample No.	Sample Depth	USCS	Approximate Effective Overburden Stress	Water Content	Atterberg Limits		Initial Void Ratio, e_0	Compression Index, C_c	Recompression Index, C_r	Estimated Preconsolidation Pressure, p'_c	OCR	Coefficient of Consolidation, c_v, at various stress levels				
						LL	PL						138 psf	500 psf	1000 psf	2000 psf	4000 psf
-	-	ft	-	psf	%	%	%	-	-	-	psf	-	in^2/s				
WB-1	U-1	6 - 8	CL	327	24.8	32	20	0.7	0.179	0.047	2000	6.12	1.27E-03	9.01E-04	7.46E-04	5.63E-04	9.06E-04
WB-6	U-1	4 - 6	CL	225	27.1	32	20	0.76	0.153	0.033	-	-	2.08E-05	7.61E-05	5.89E-05	8.82E-05	1.16E-04
WB-106	U-2	8 - 10	CL	464	20.8	27	17	0.52	0.076	0.020	2000	4.31	4.84E-05	1.33E-04	1.96E-04	3.05E-04	3.05E-04
WB-108	U-1	4 - 6	CL	240	24.6	30	17	0.64	0.113	0.020	2500	10.42	6.41E-04	4.77E-04	7.05E-04	5.38E-04	3.62E-04
WB-108	U-2	8 - 10	CL	464	27.9	36	16	0.67	0.103	0.023	2200	4.74	6.76E-05	1.47E-04	2.93E-04	1.86E-04	3.02E-04

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

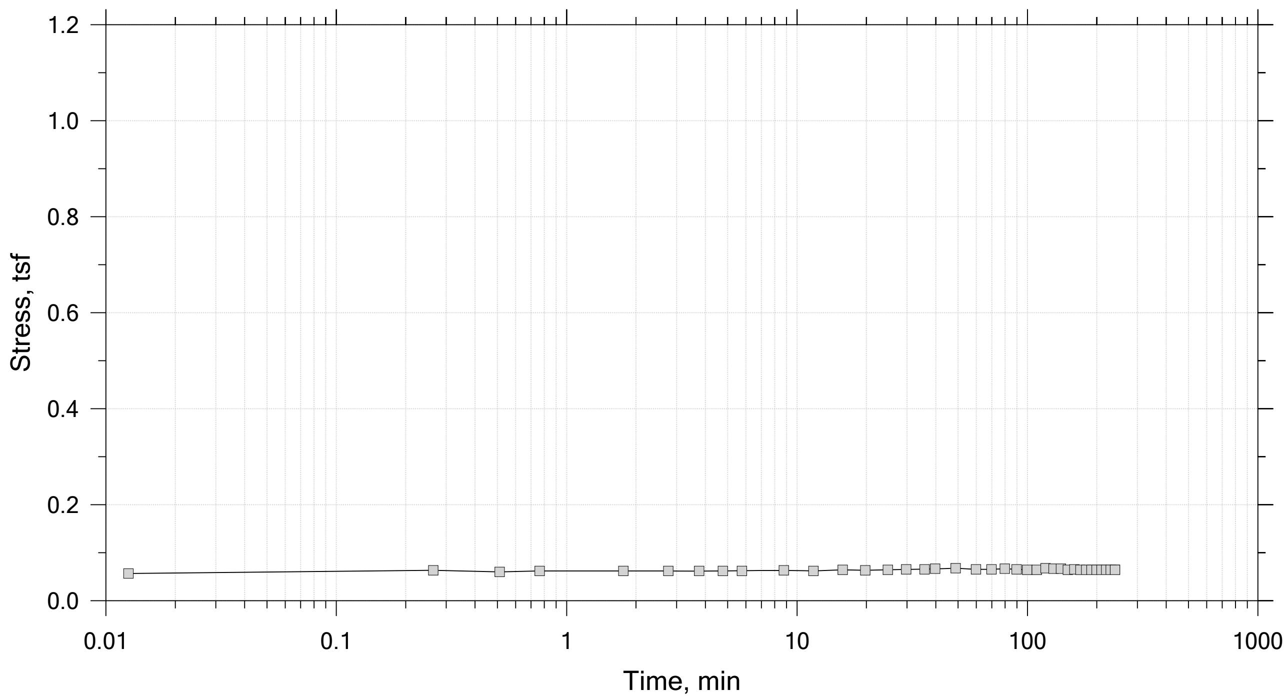


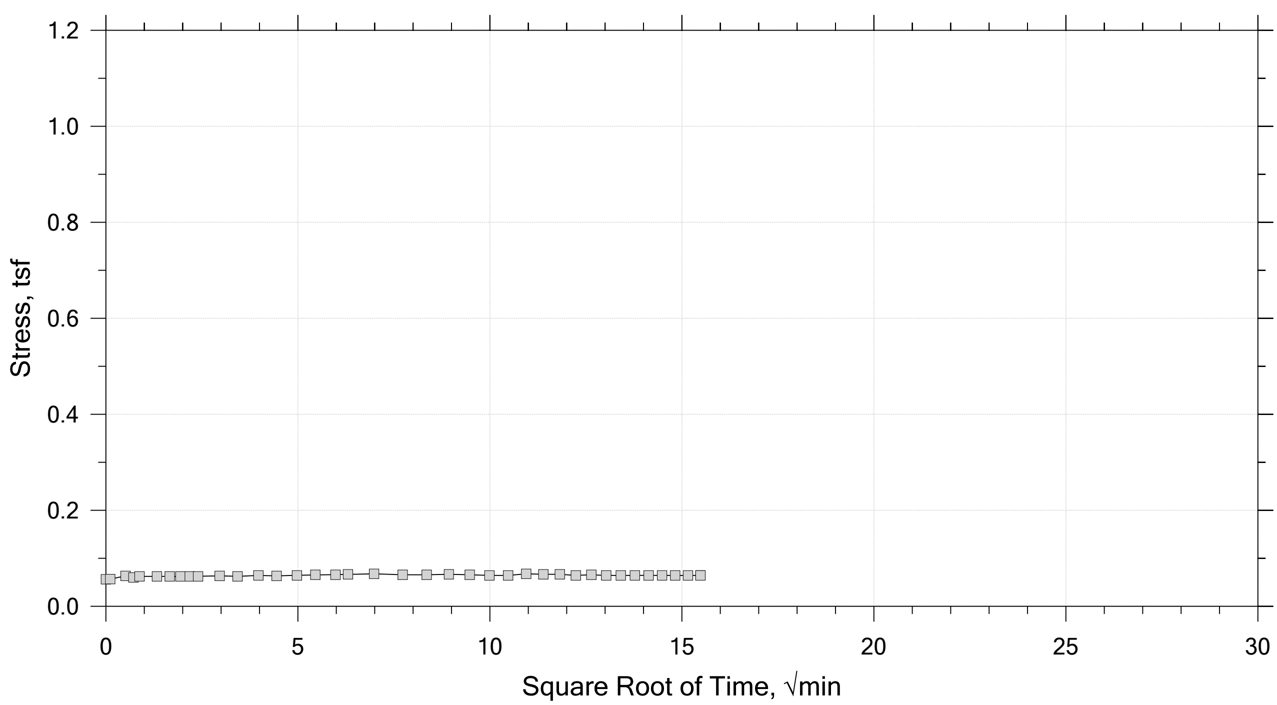


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 18
Constant Volume Step
Stress: 0.0643 tsf

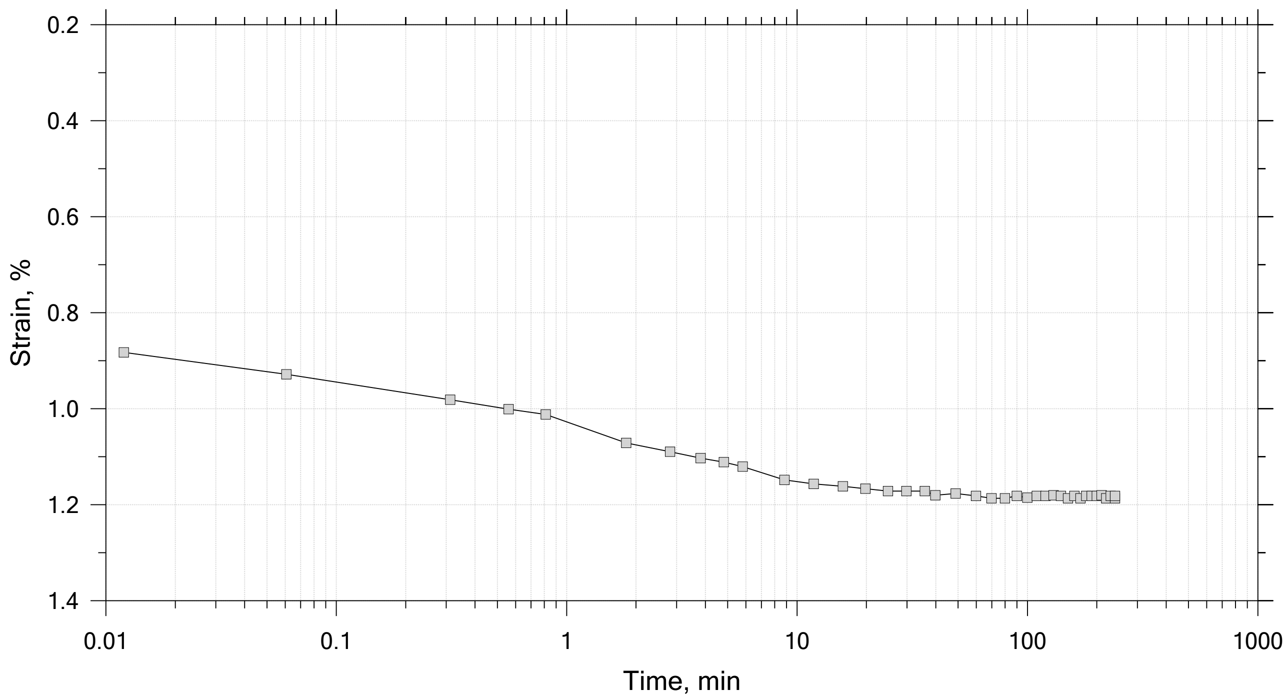


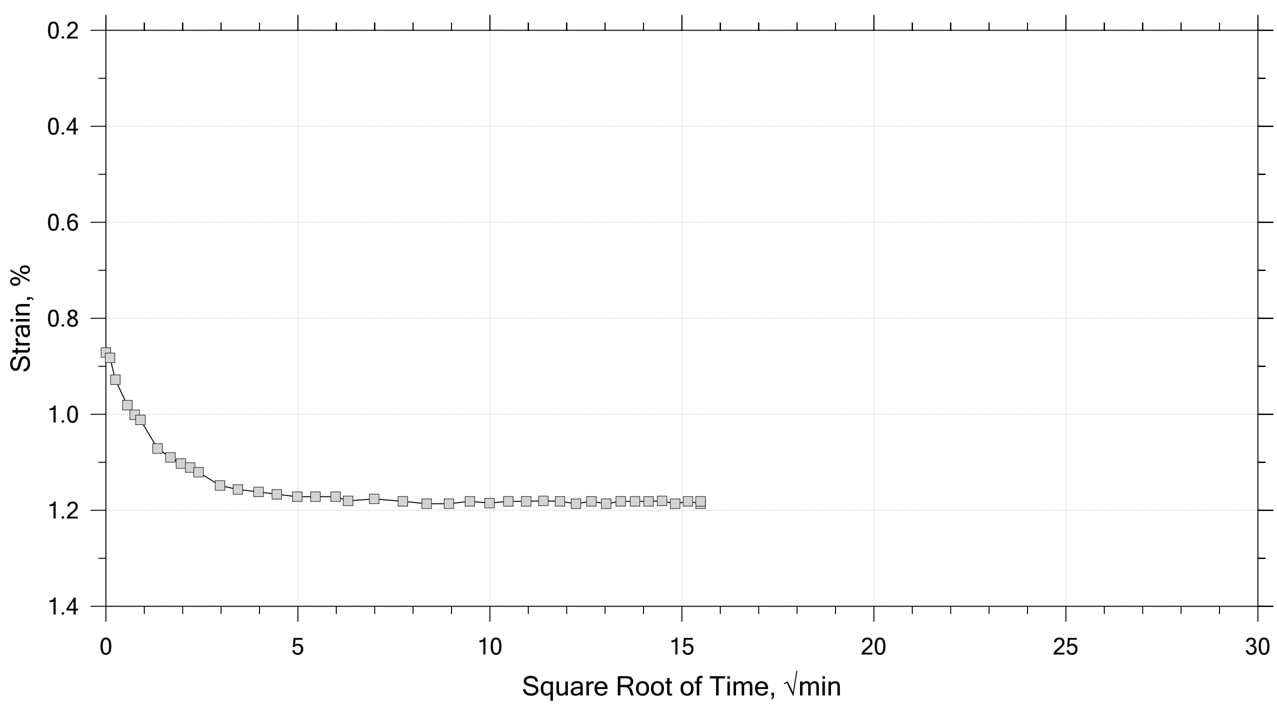


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 18
Constant Load Step
Stress: 0.25 tsf





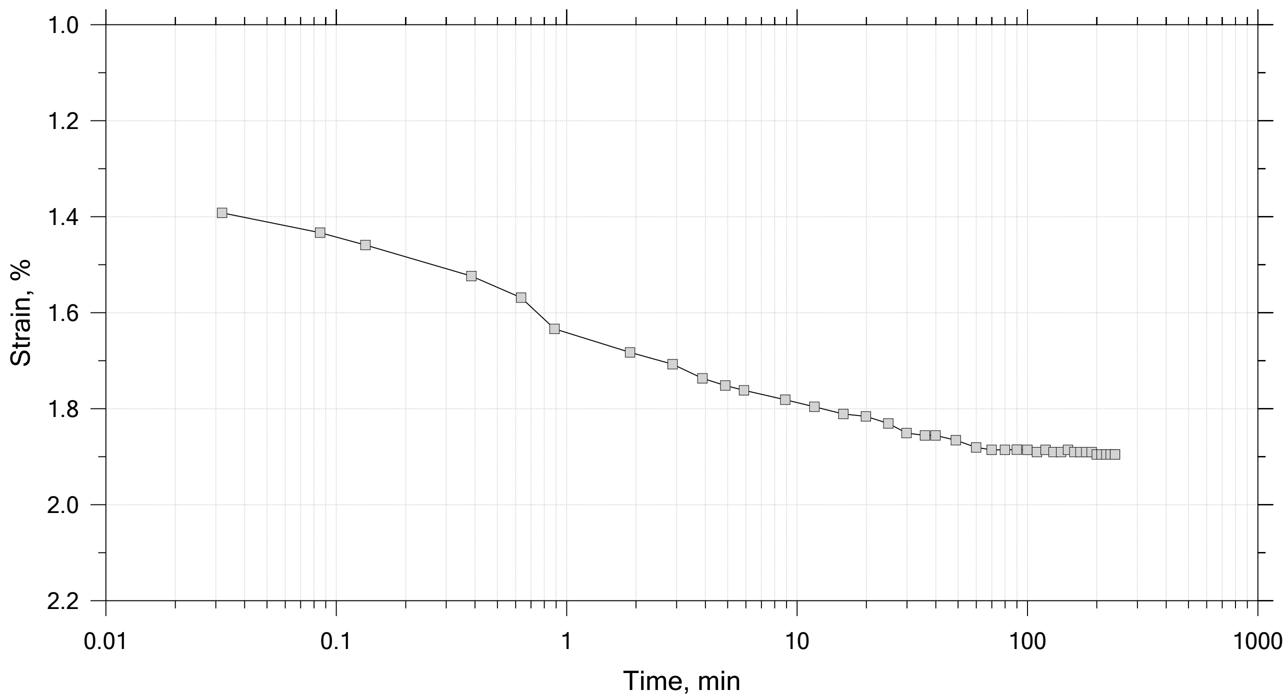
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

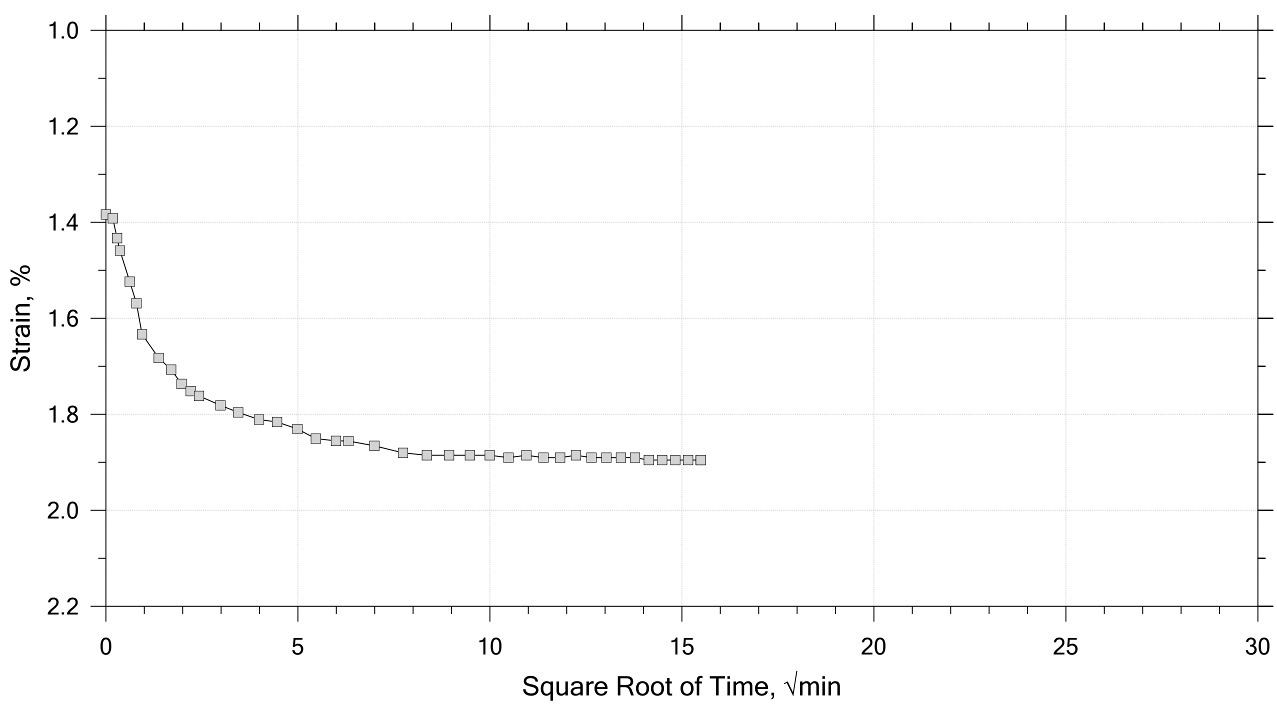
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 18

Constant Load Step

Stress: 0.5 tsf





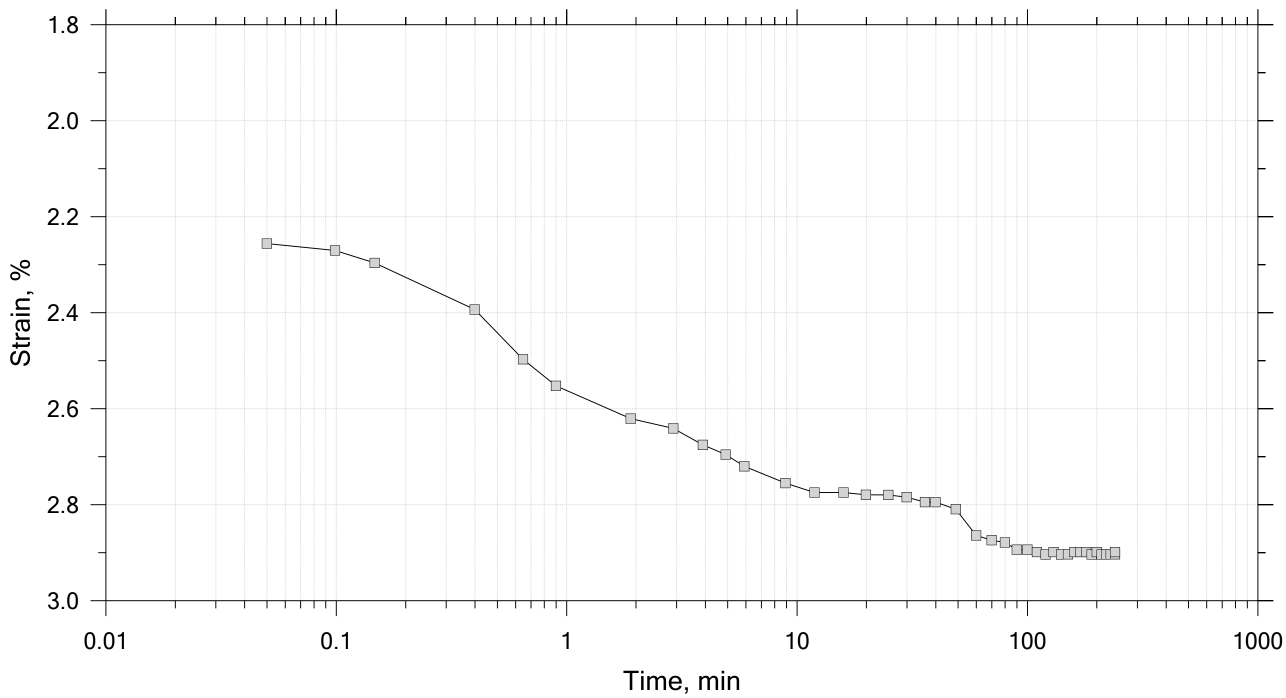
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

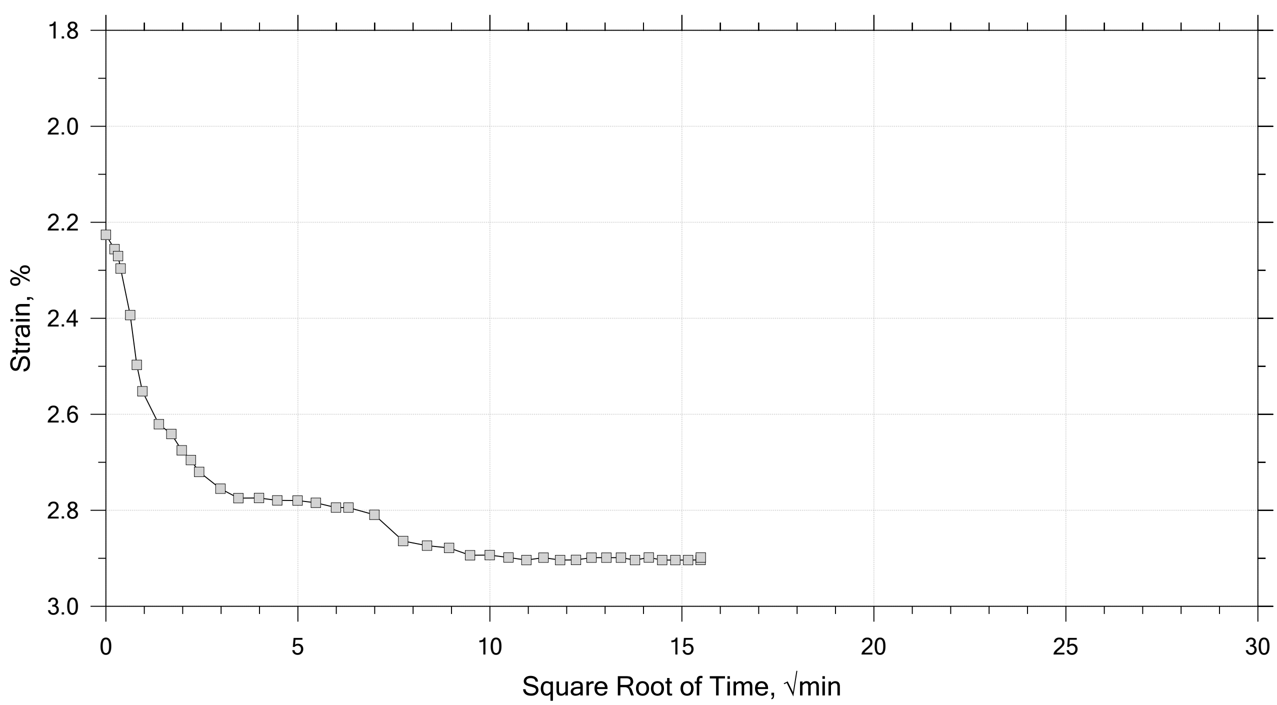
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 18

Constant Load Step

Stress: 1 tsf

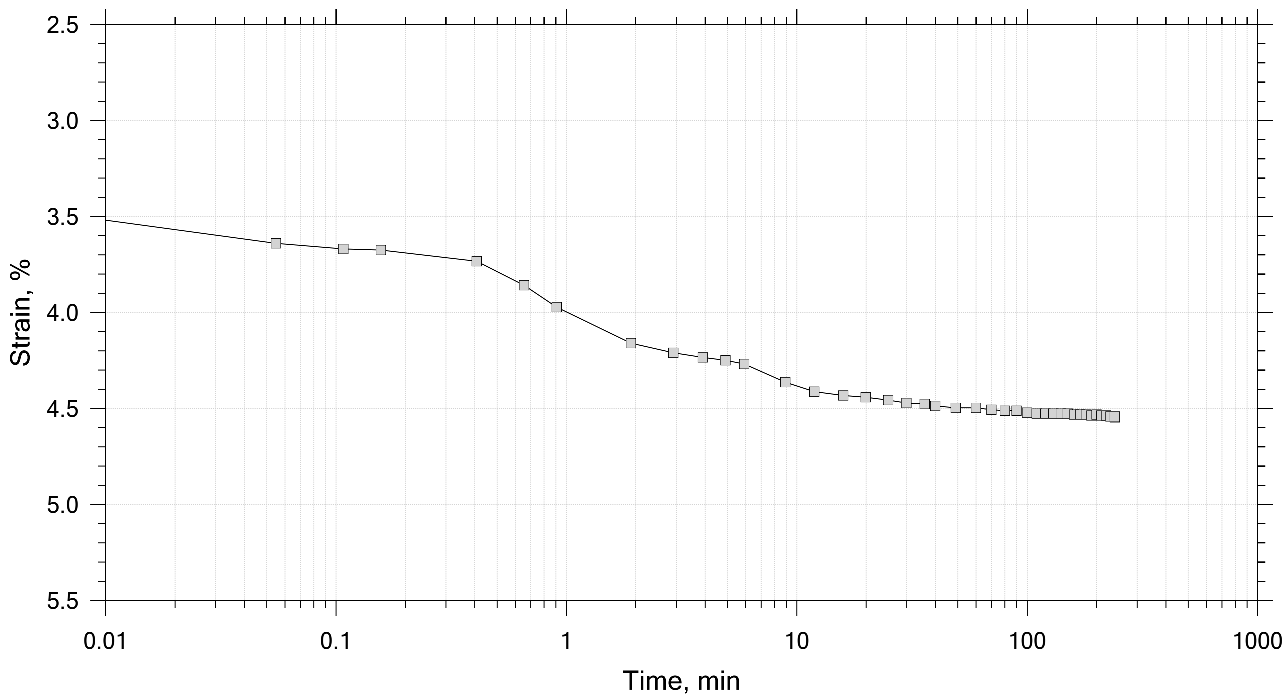


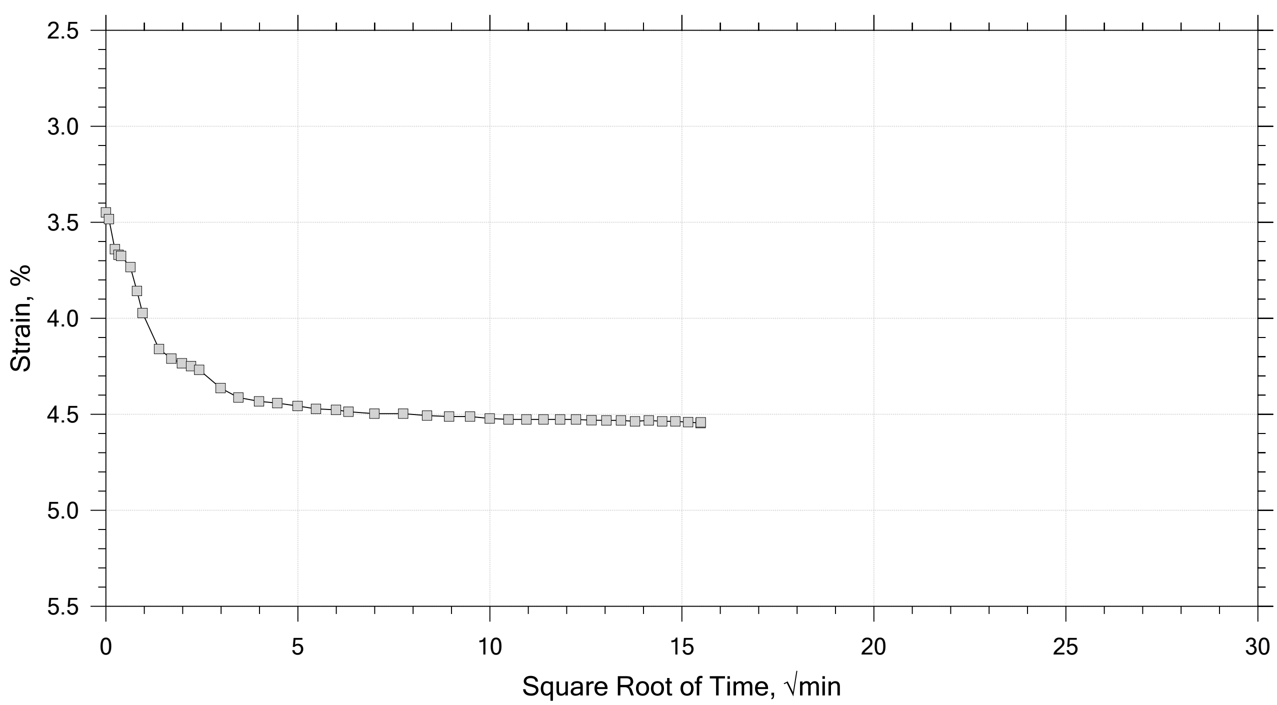


GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 18
Constant Load Step
Stress: 2 tsf





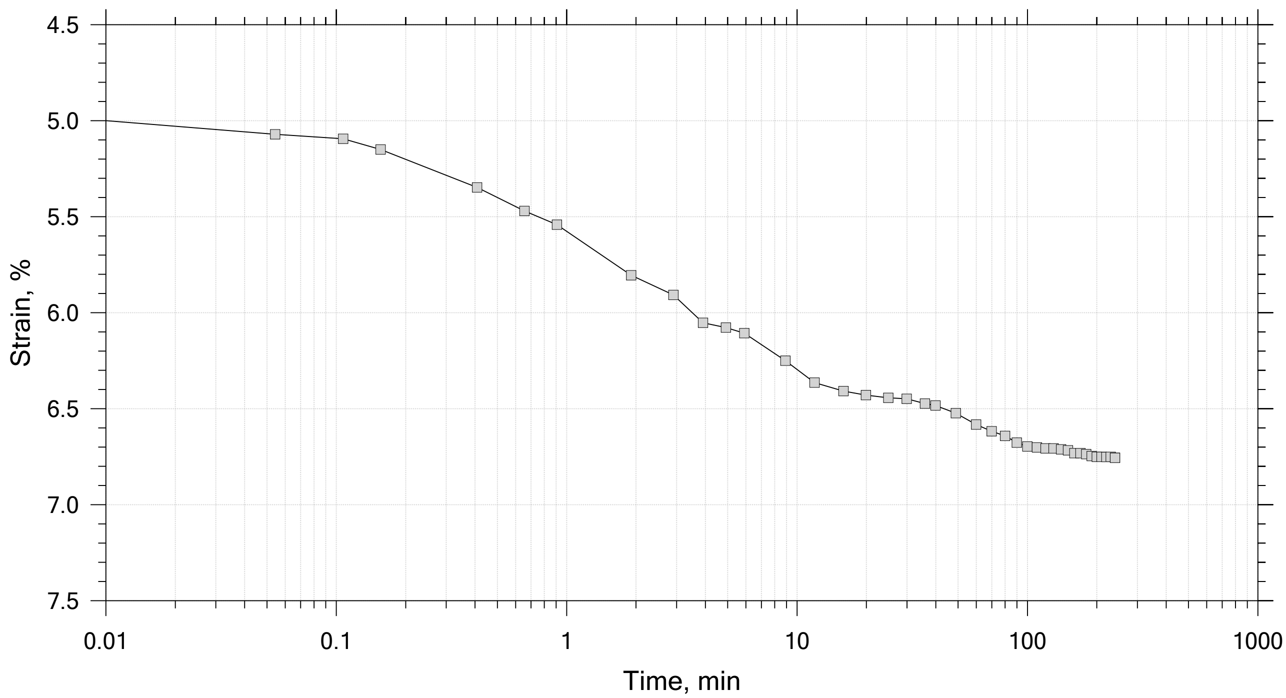
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

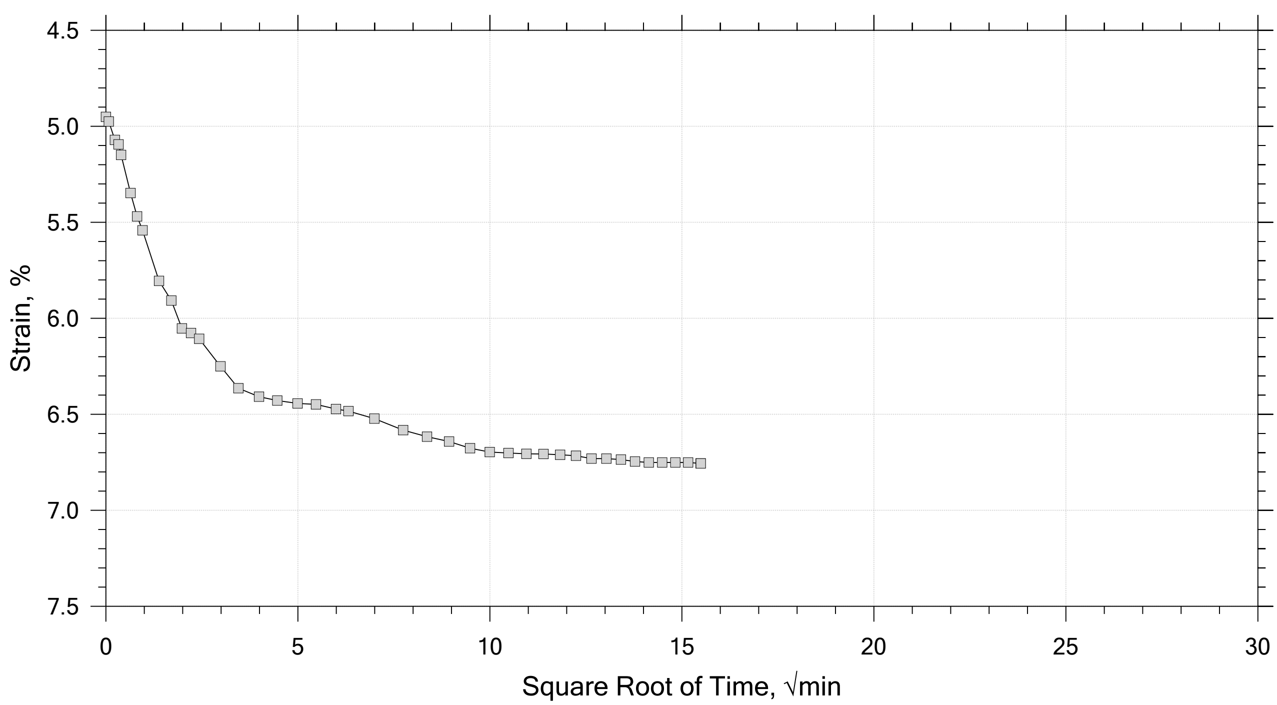
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 18

Constant Load Step

Stress: 4 tsf

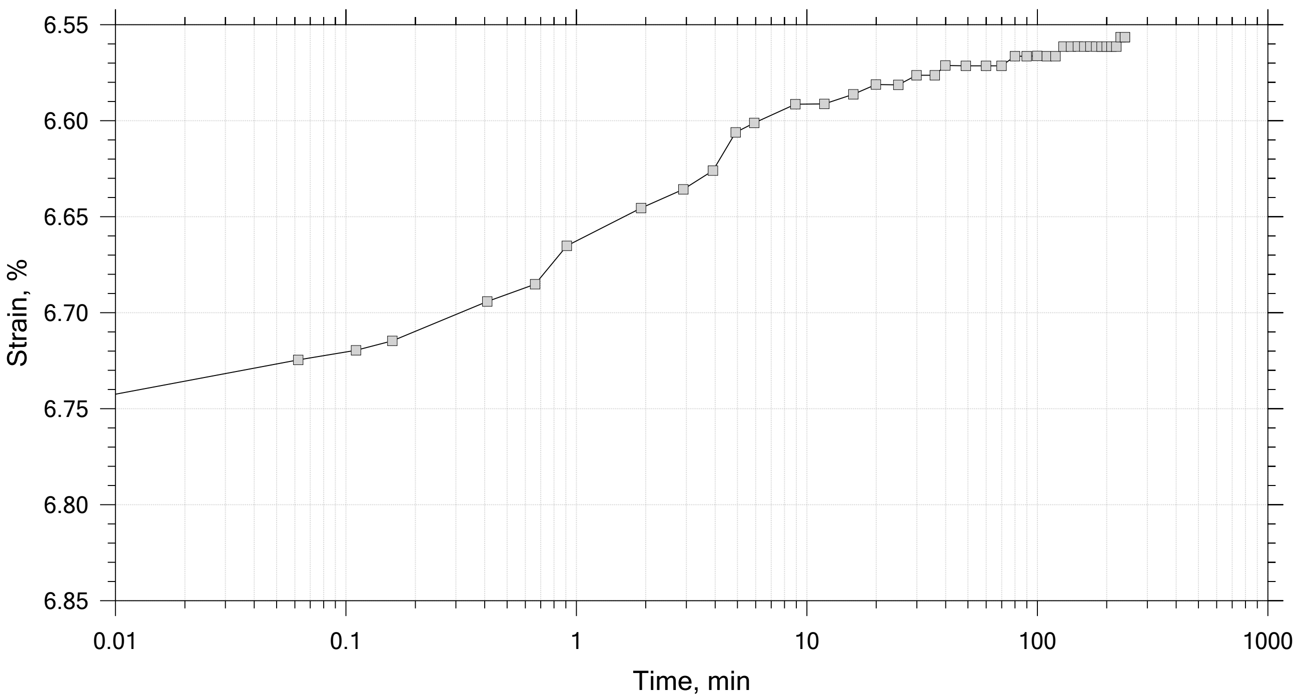


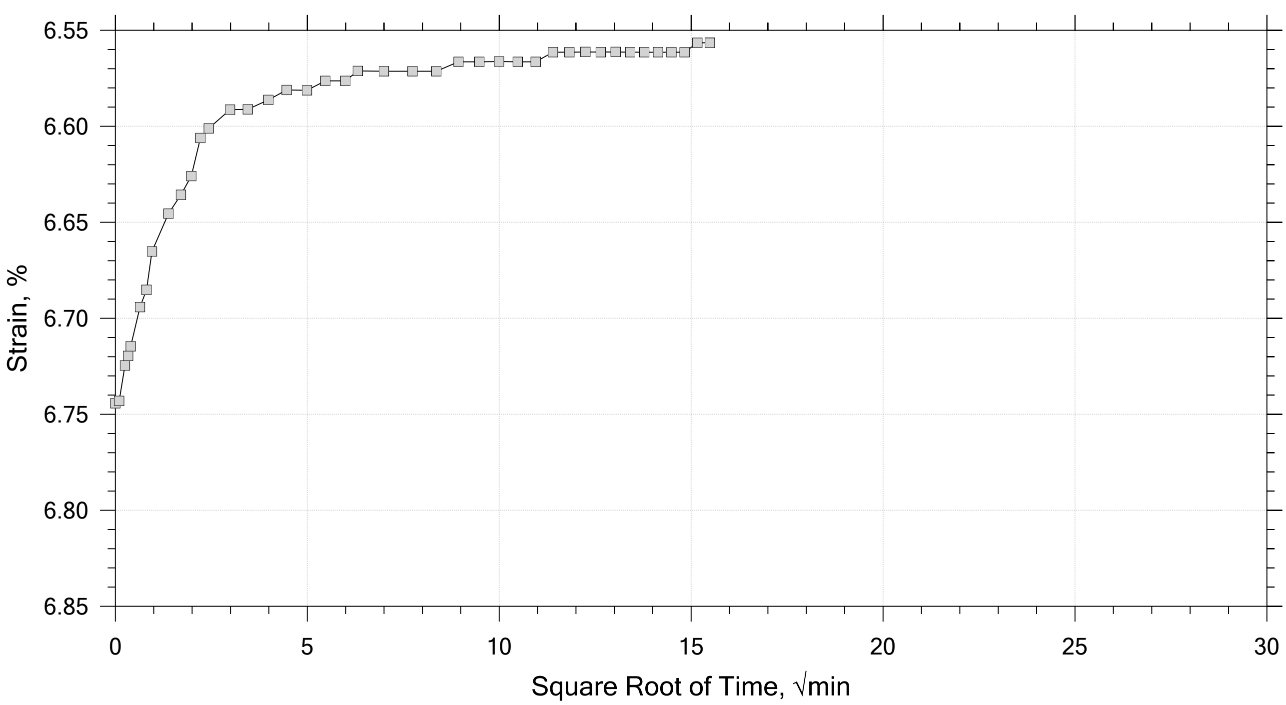


GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 18
Constant Load Step
Stress: 2 tsf





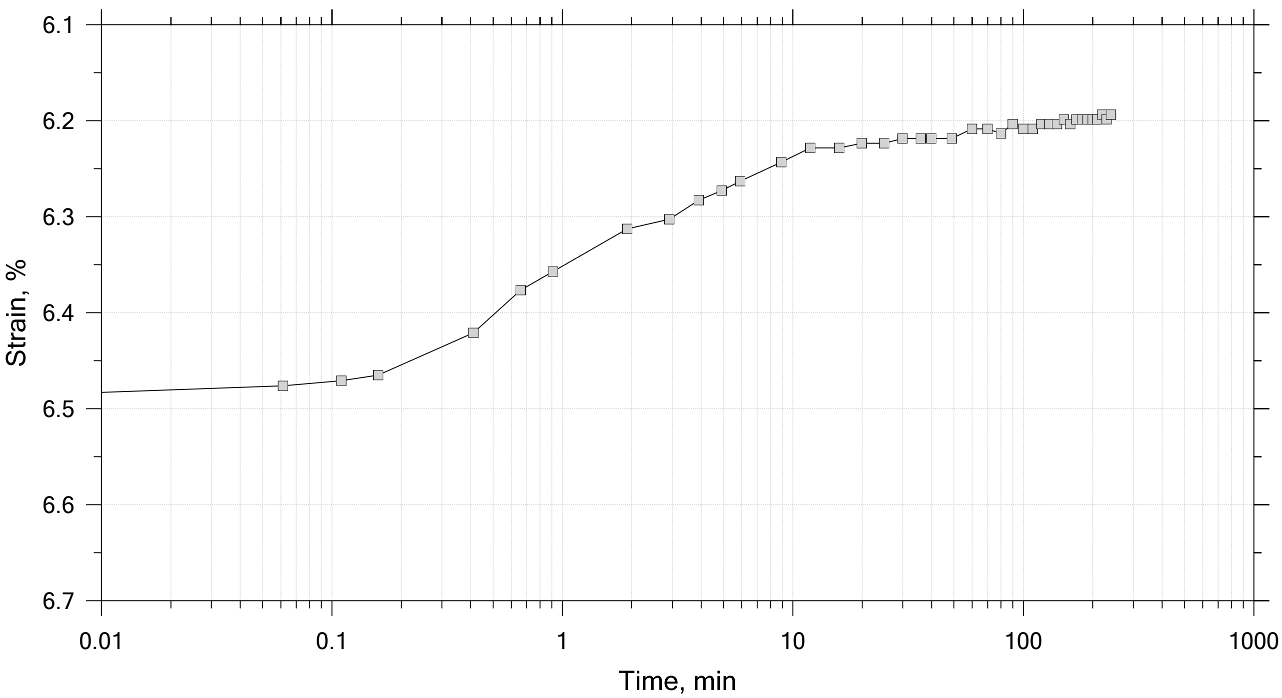
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

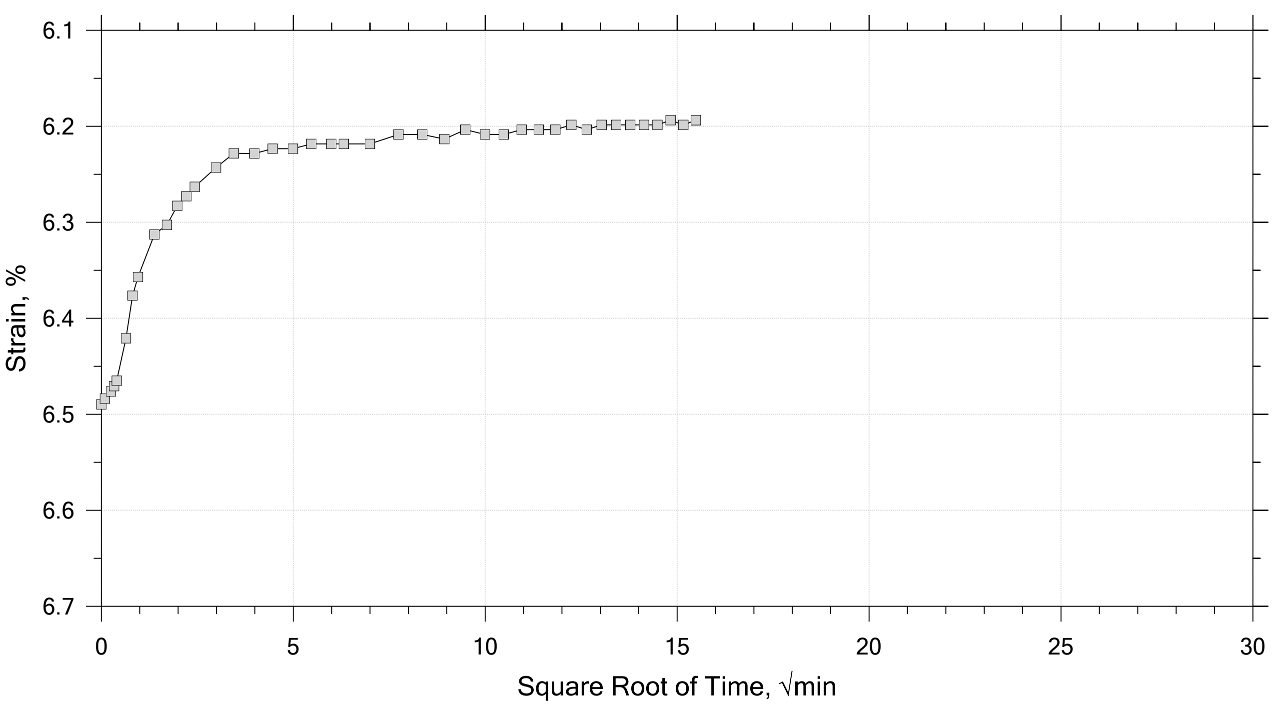
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 18

Constant Load Step

Stress: 1 tsf





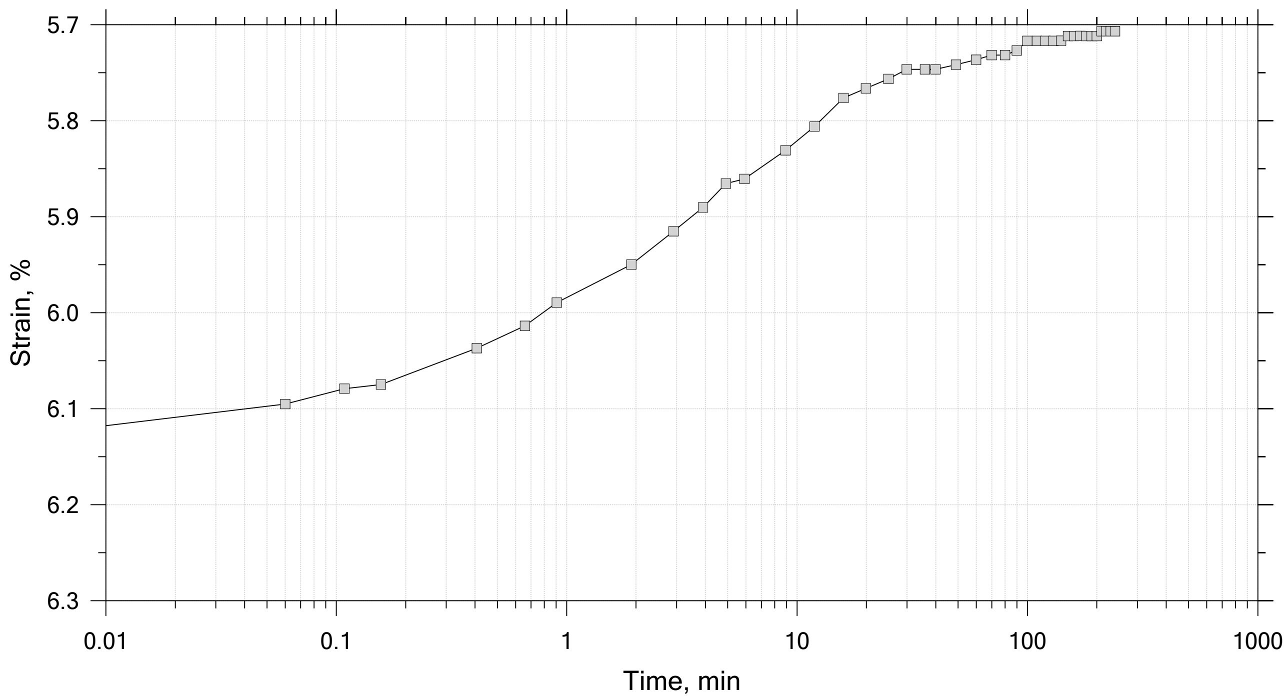
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

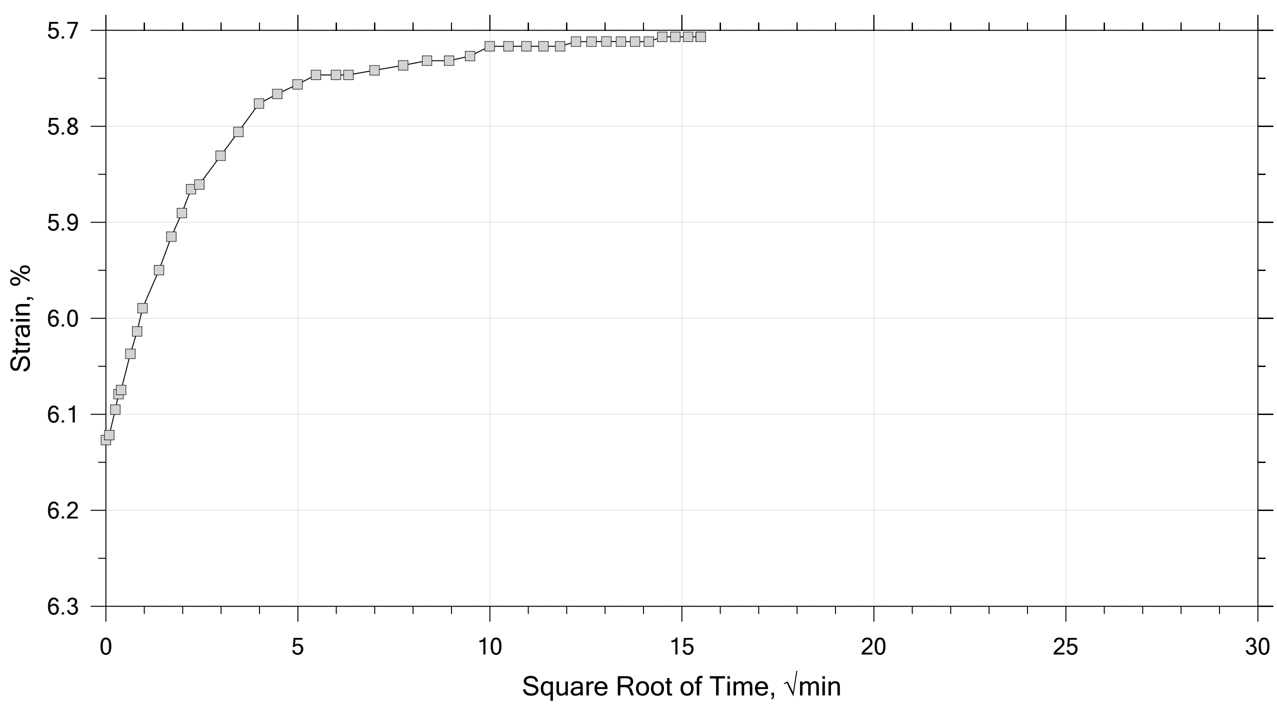
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 18

Constant Load Step

Stress: 0.5 tsf





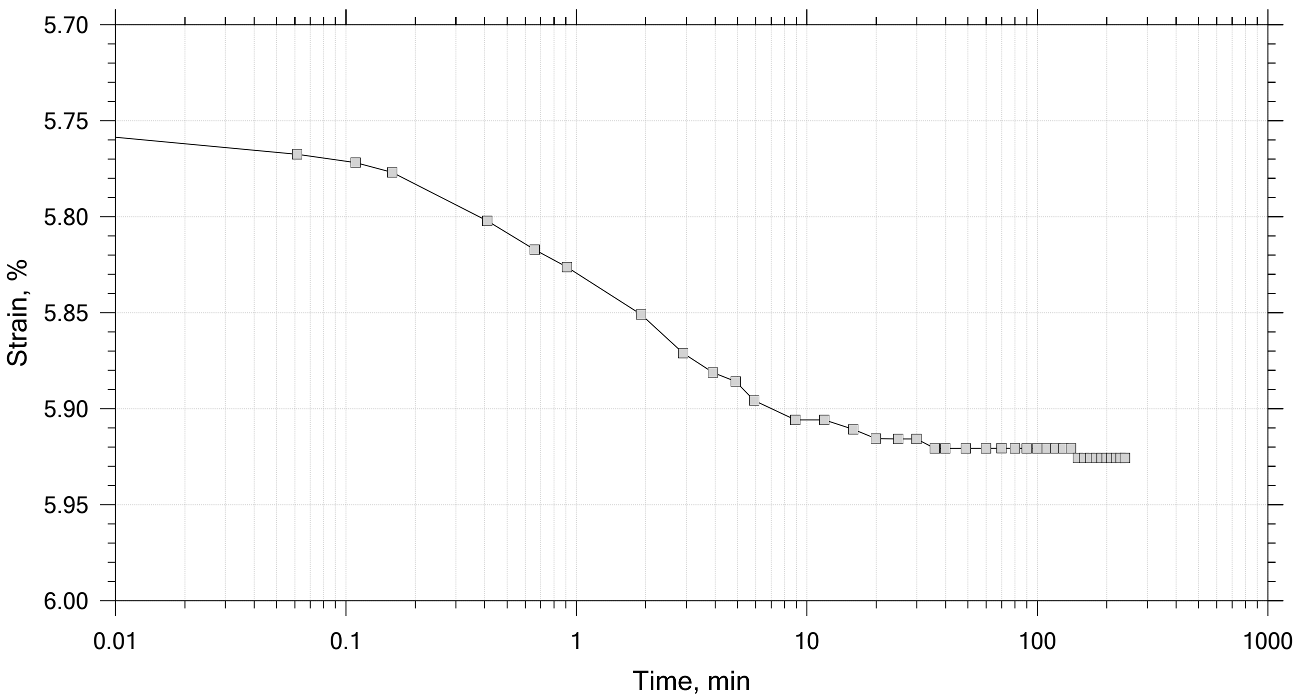
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

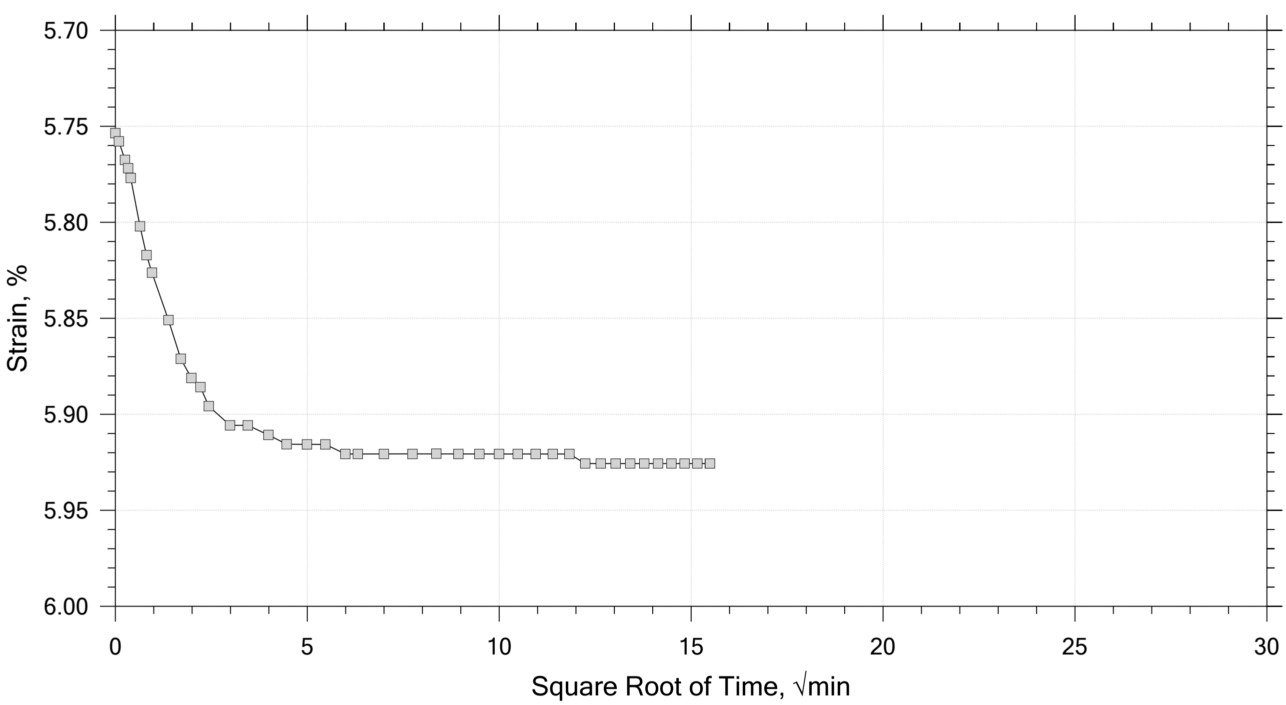
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 18

Constant Load Step

Stress: 1 tsf

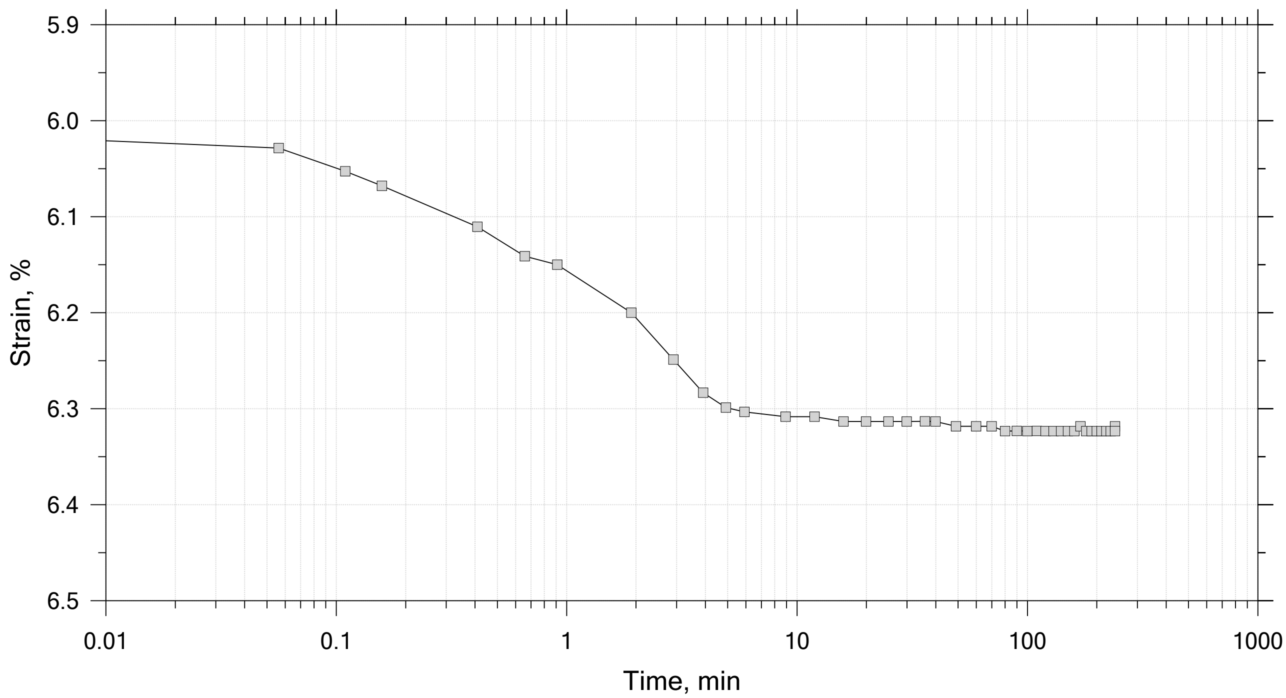


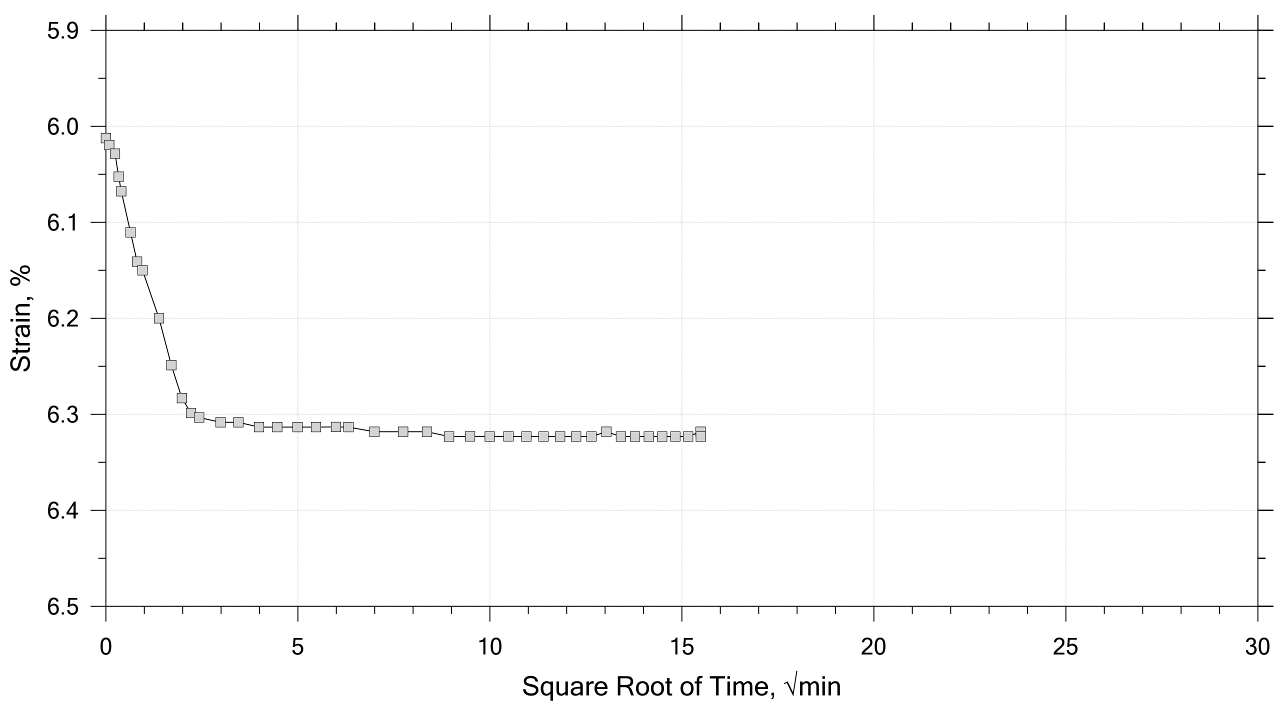


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 18
Constant Load Step
Stress: 2 tsf





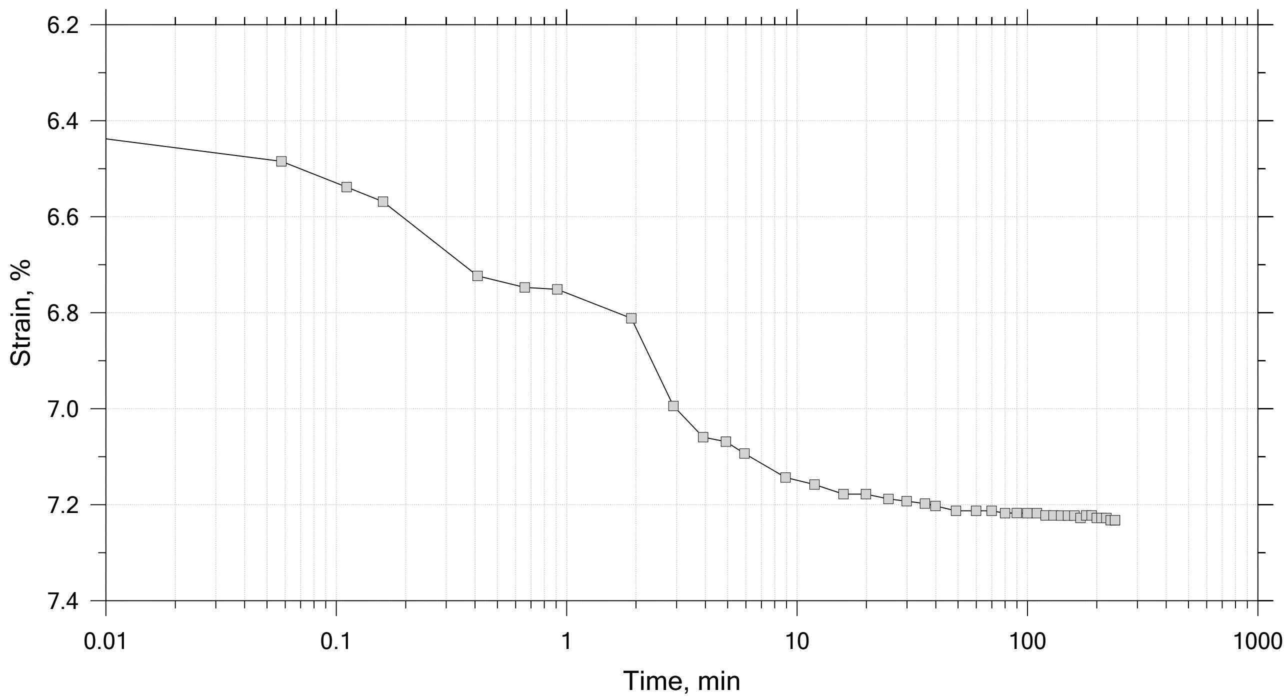
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

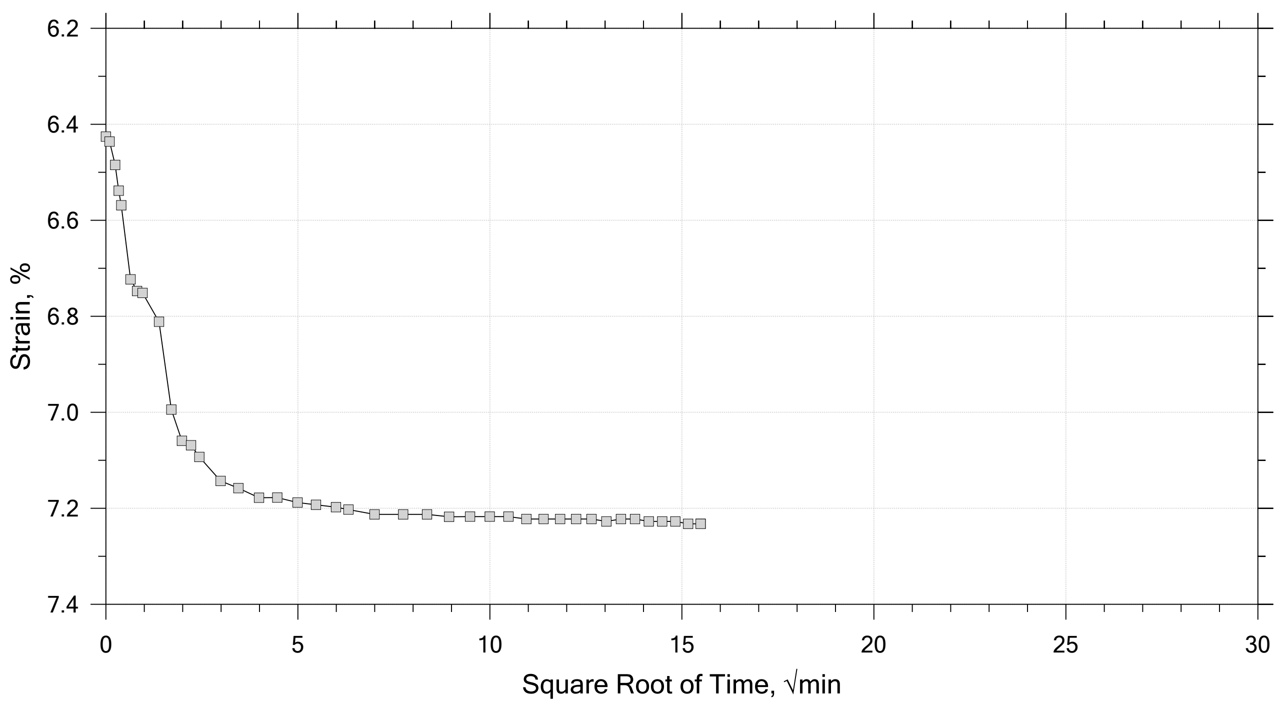
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 12 of 18

Constant Load Step

Stress: 4 tsf

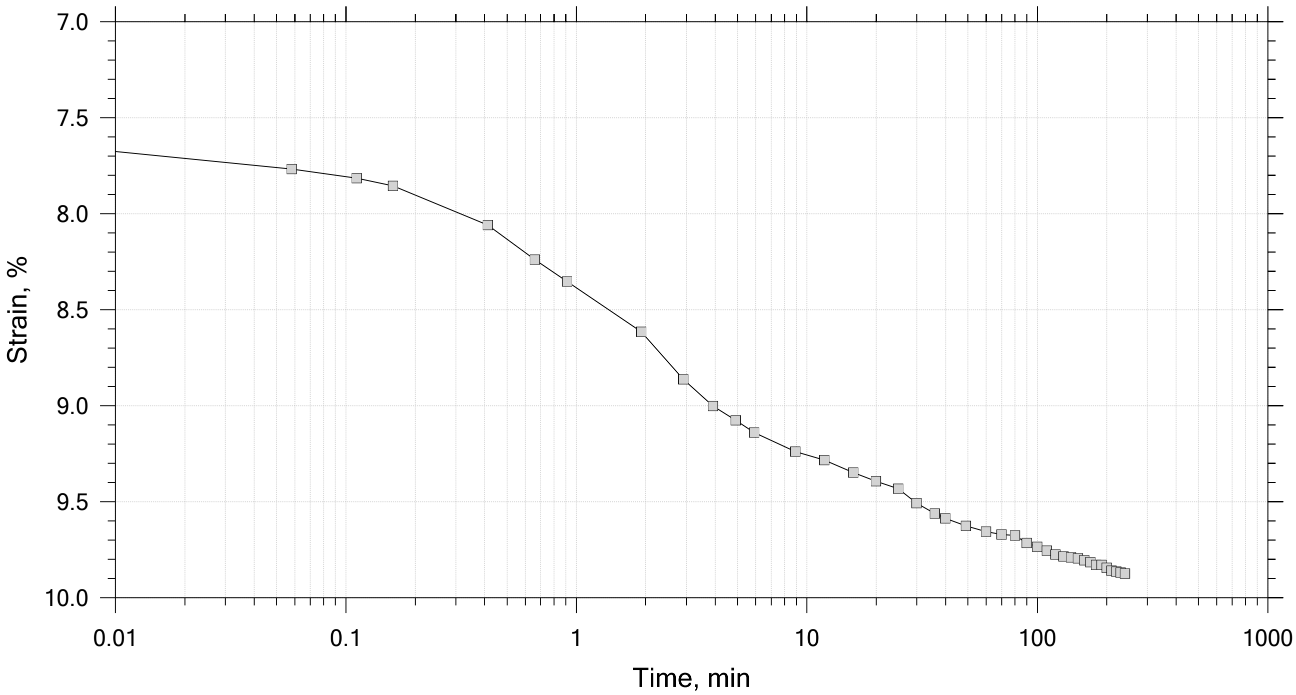


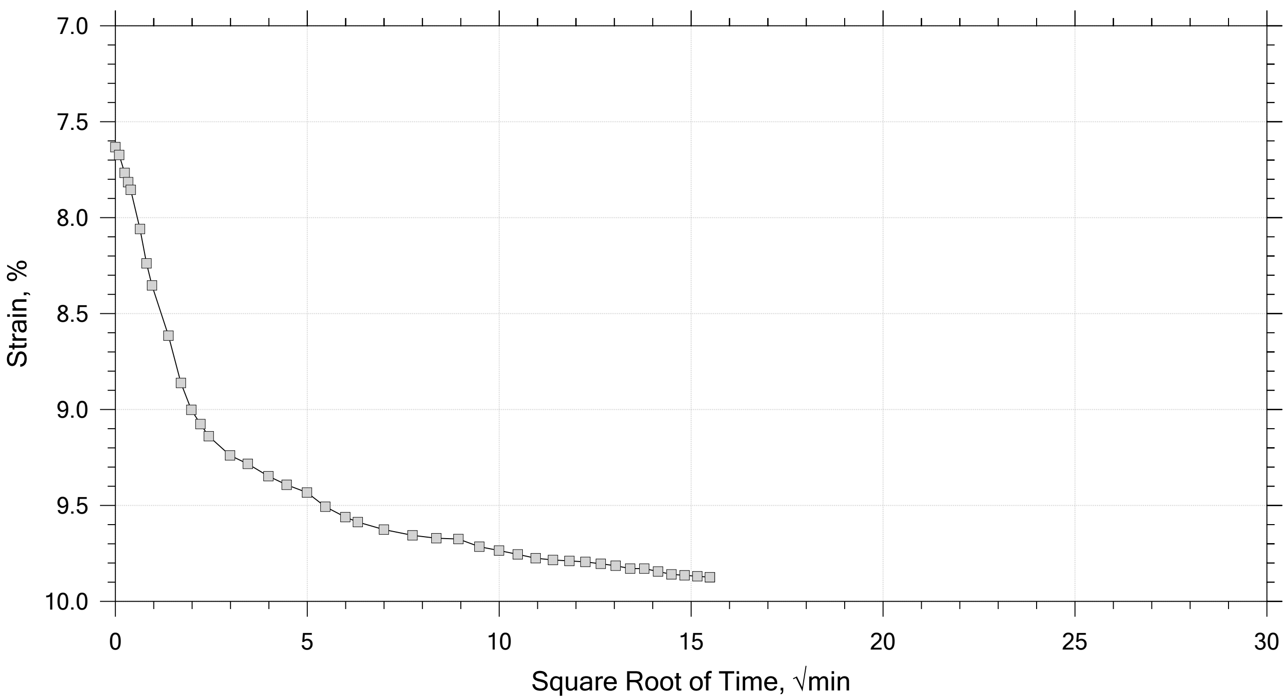


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 13 of 18
Constant Load Step
Stress: 8 tsf





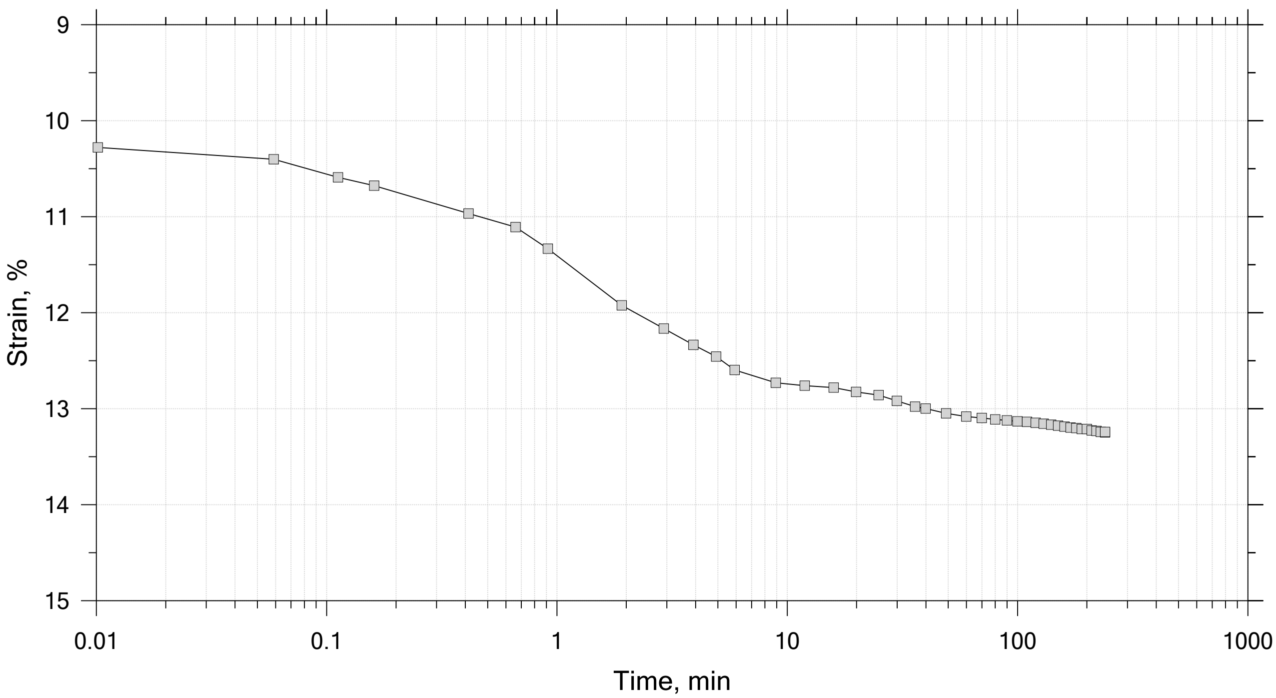
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

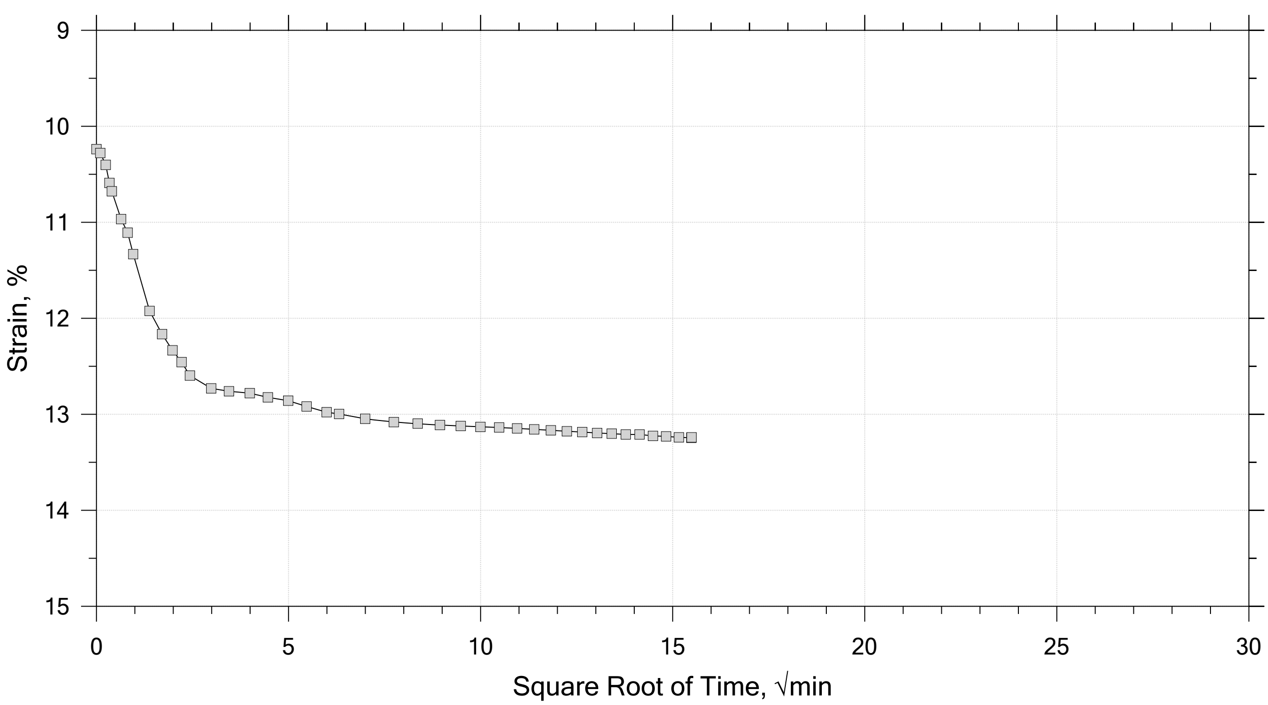
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 14 of 18

Constant Load Step

Stress: 16 tsf





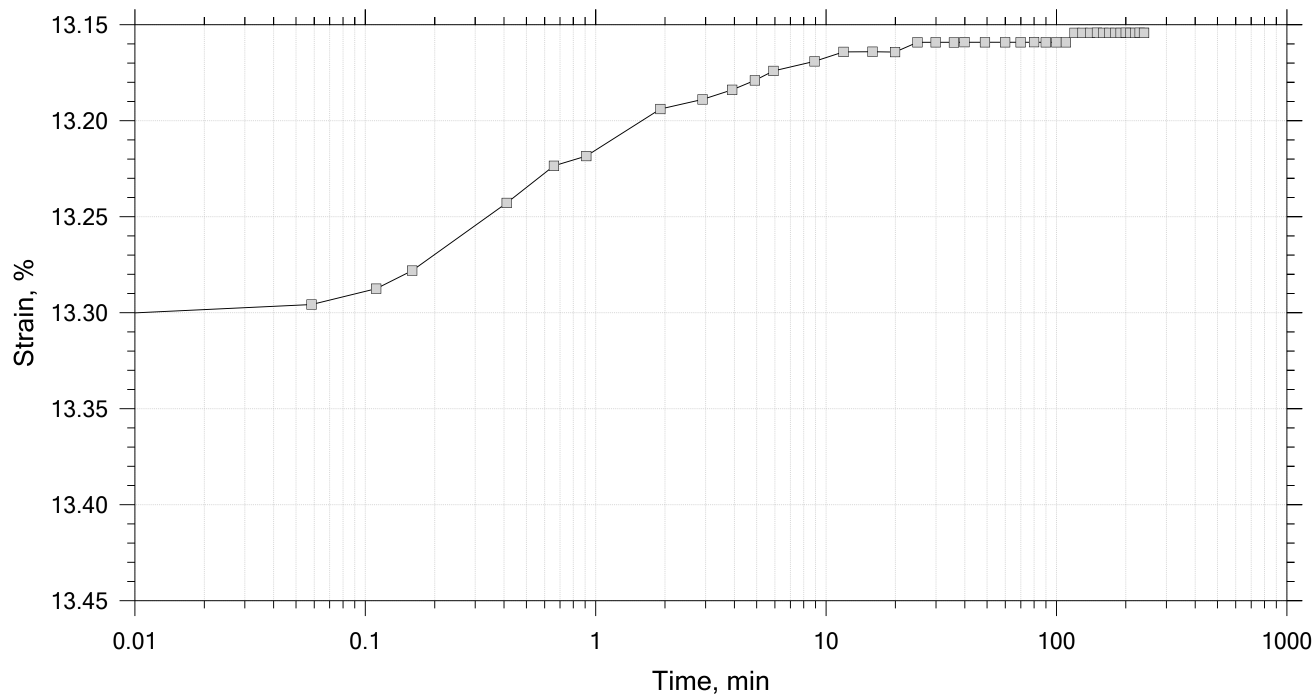
GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

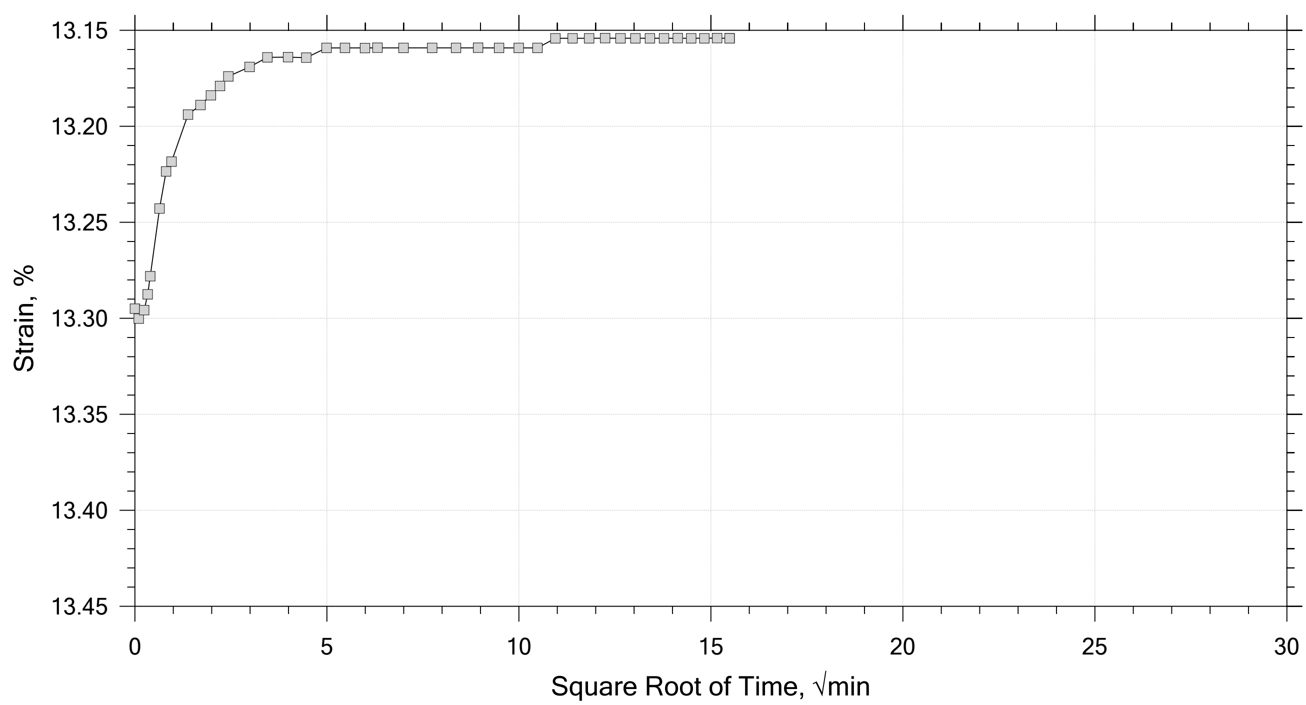
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 15 of 18

Constant Load Step

Stress: 8 tsf





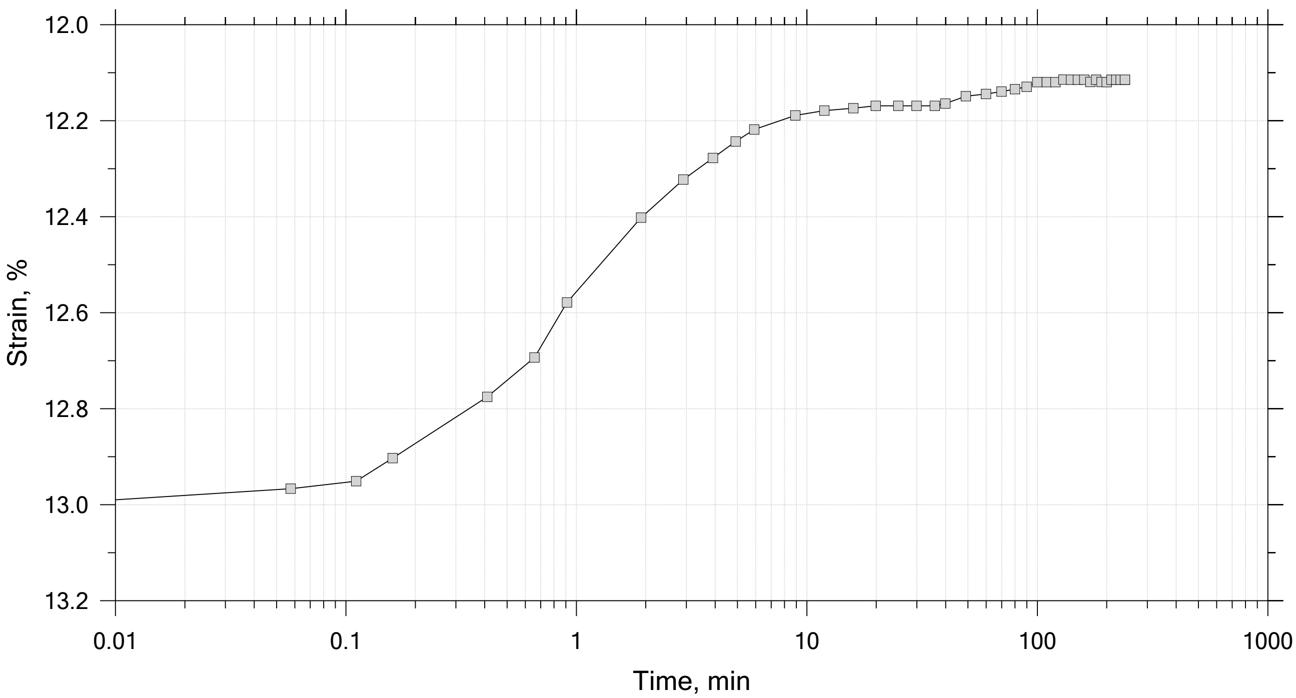
GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

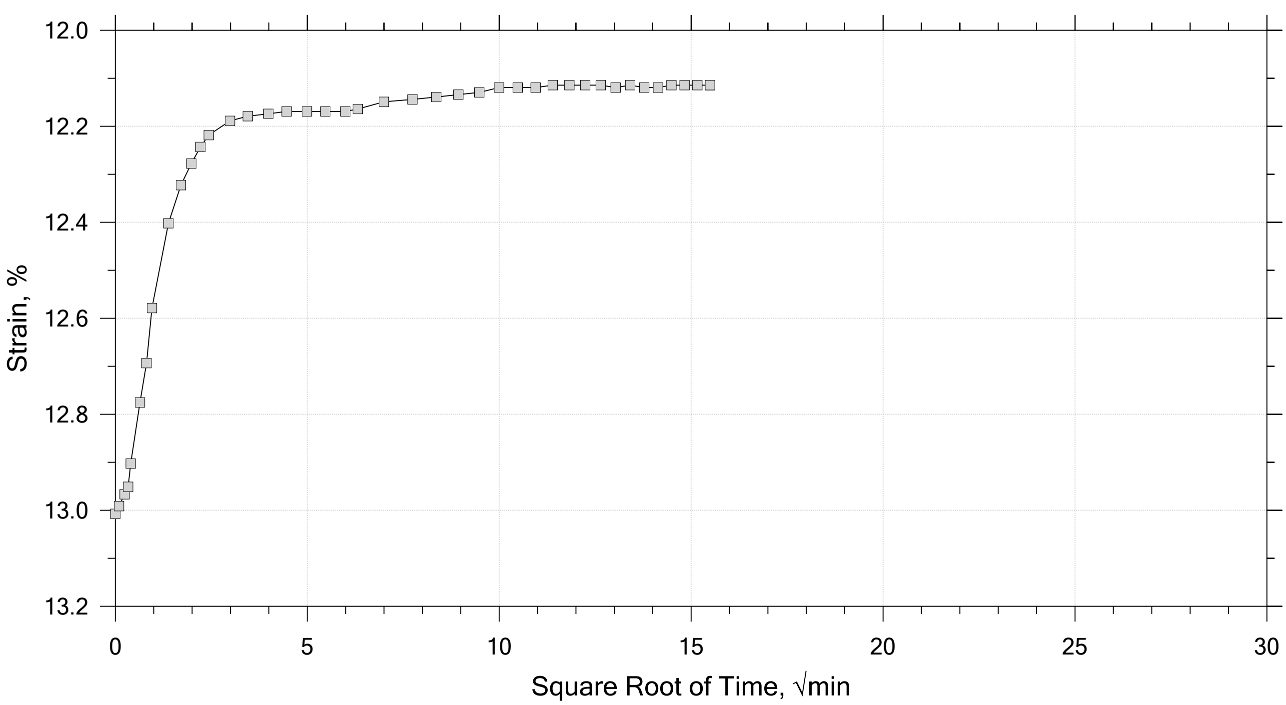
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 16 of 18

Constant Load Step

Stress: 2 tsf





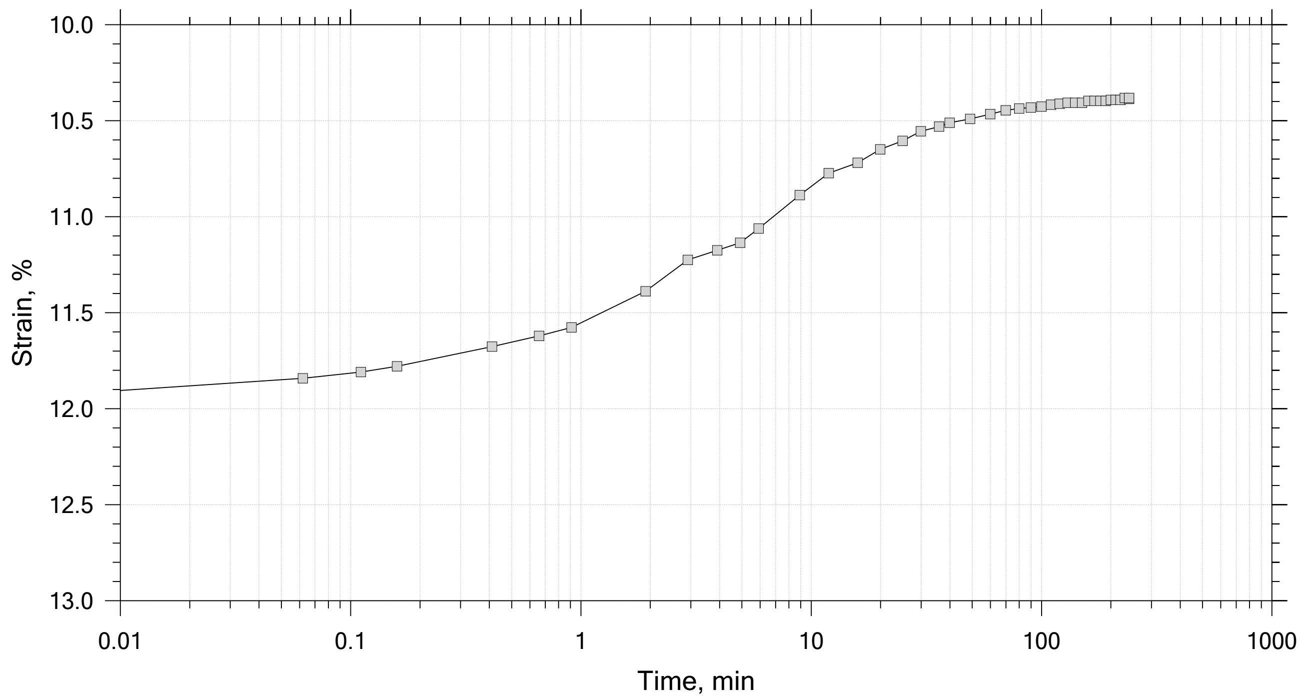
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

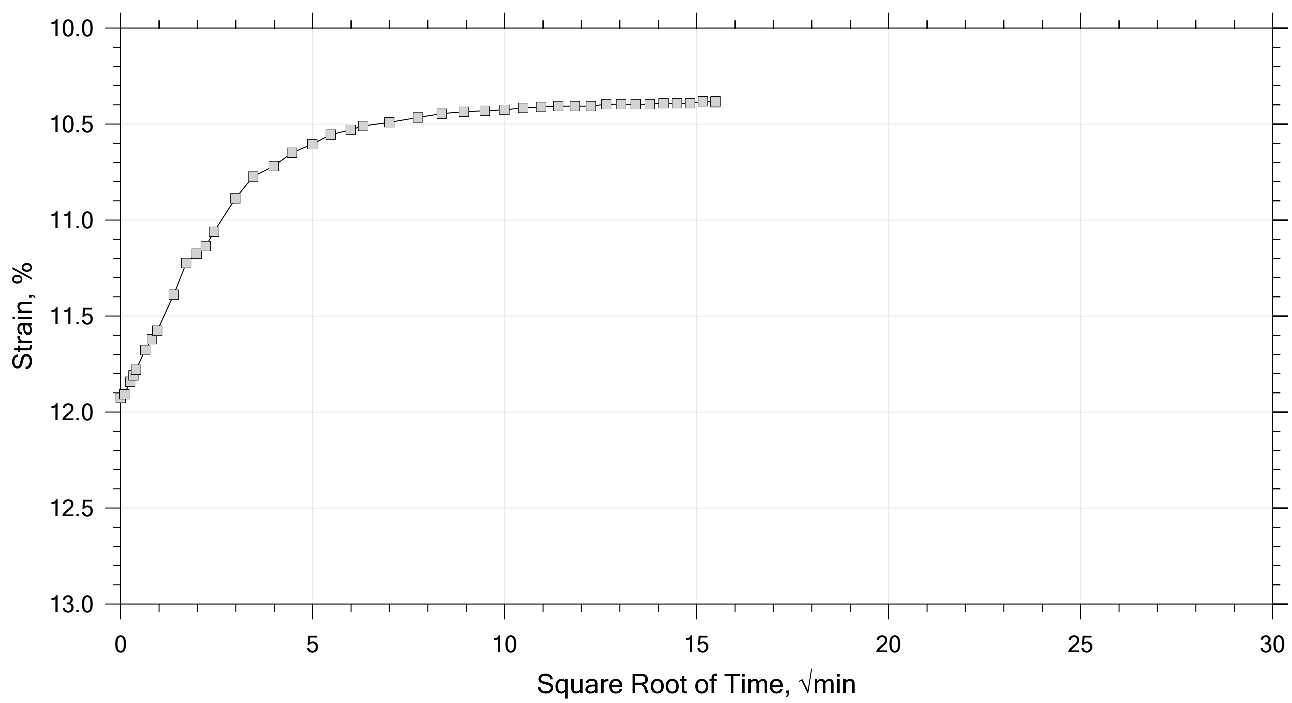
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 17 of 18

Constant Load Step

Stress: 0.5 tsf

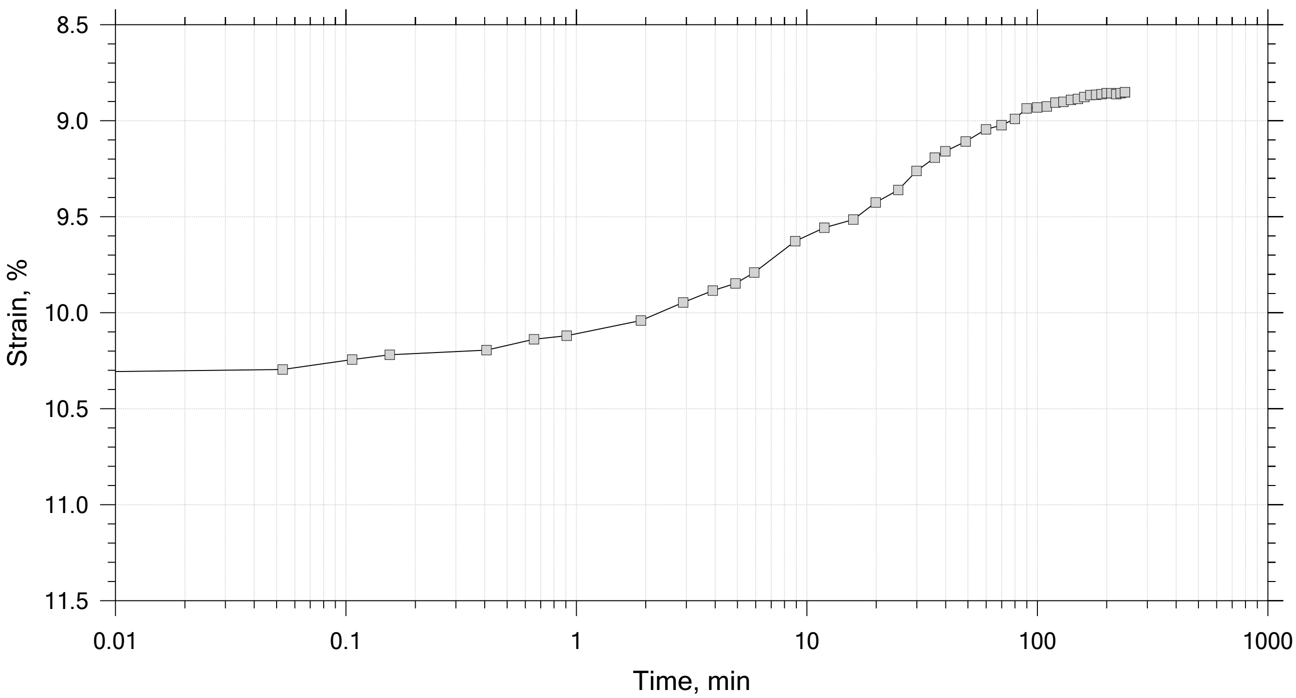


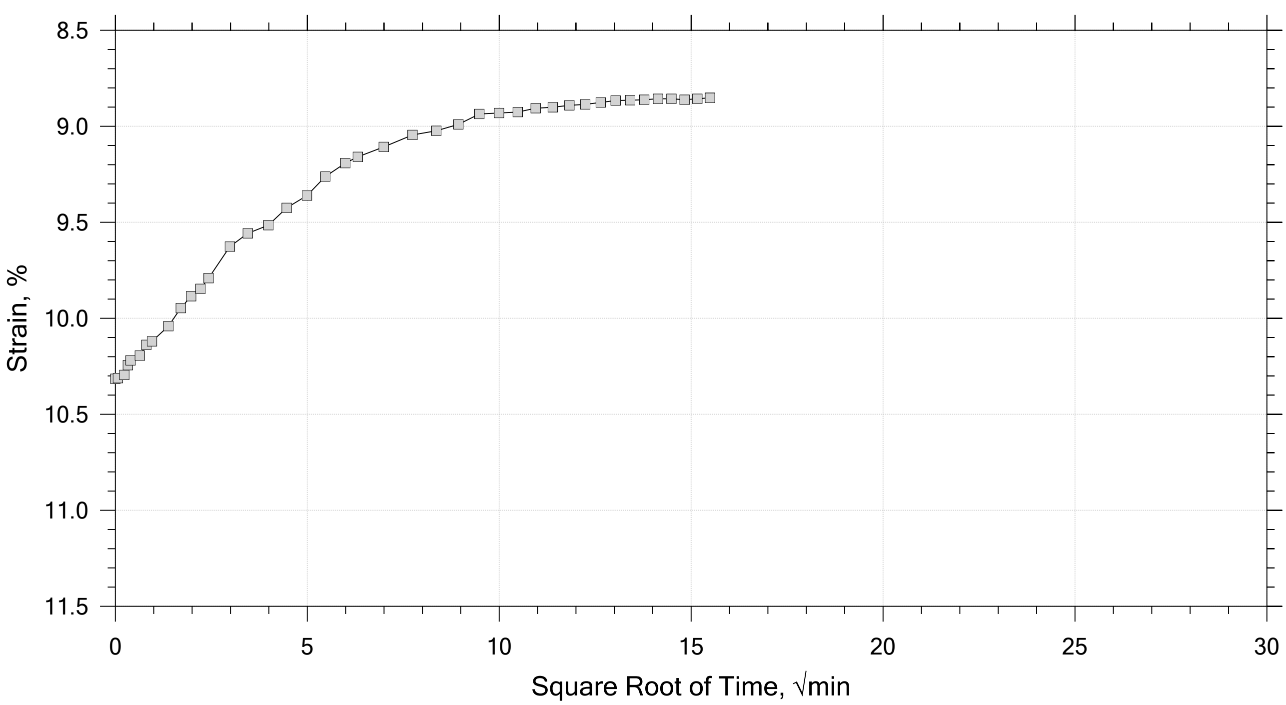


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 18 of 18
Constant Load Step
Stress: 0.125 tsf





GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.74	Liquid Limit: 32
Initial Height: 1.00 in	Initial Void Ratio: 0.705	Plastic Limit: 20
Final Height: 0.91 in	Final Void Ratio: 0.554	Plasticity Index: 12

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	D2982	RING		E7133
Mass Container, gm	8.53	109.93	109.93	8.42
Mass Container + Wet Soil, gm	151.01	269.14	265.16	76.55
Mass Container + Dry Soil, gm	122.71	239.03	239.03	65.08
Mass Dry Soil, gm	114.18	129.1	129.1	56.66
Water Content, %	24.79	23.33	20.24	20.24
Void Ratio	---	0.70	0.55	---
Degree of Saturation, %	---	90.56	100.00	---
Dry Unit Weight, pcf	---	100.19	109.92	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test.
Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

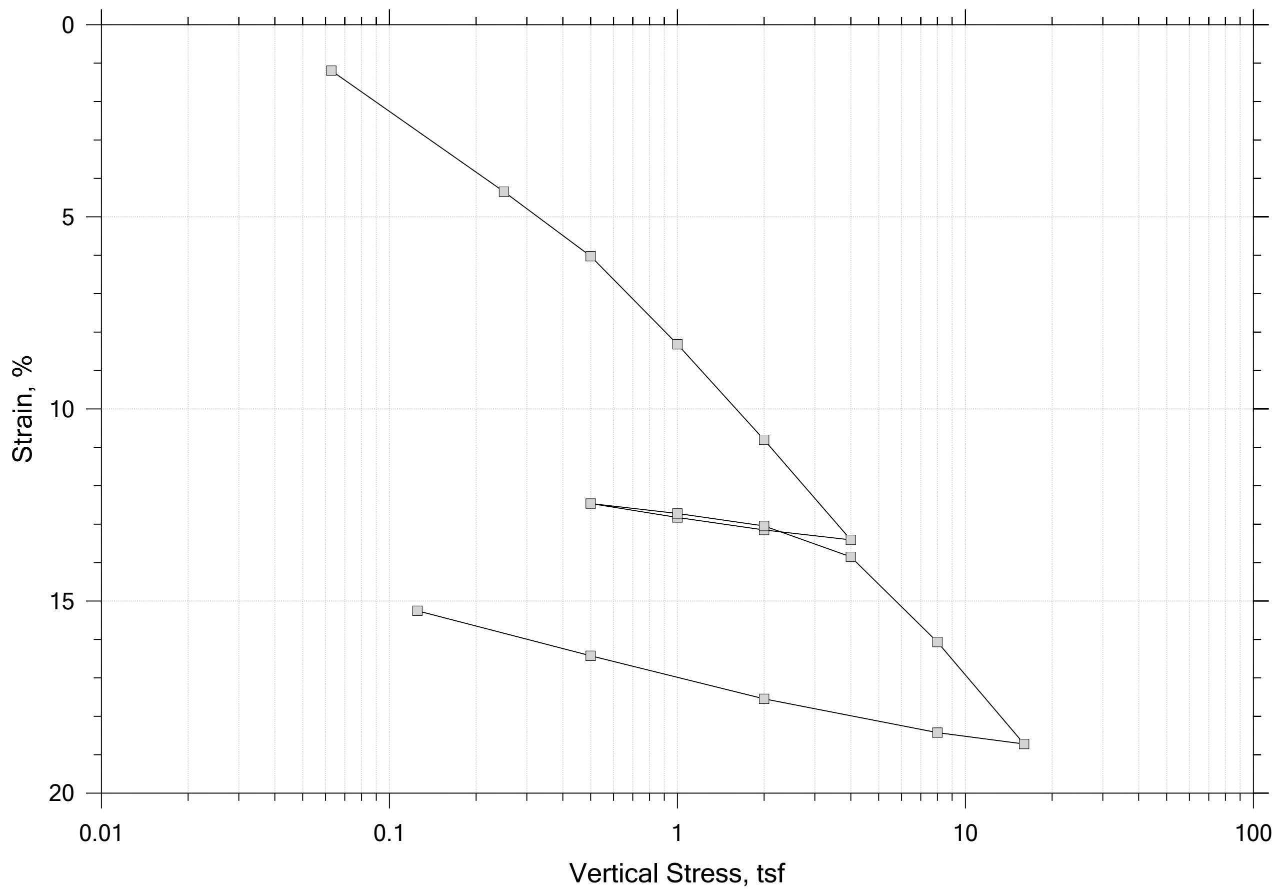
Square Root of Time Coefficients

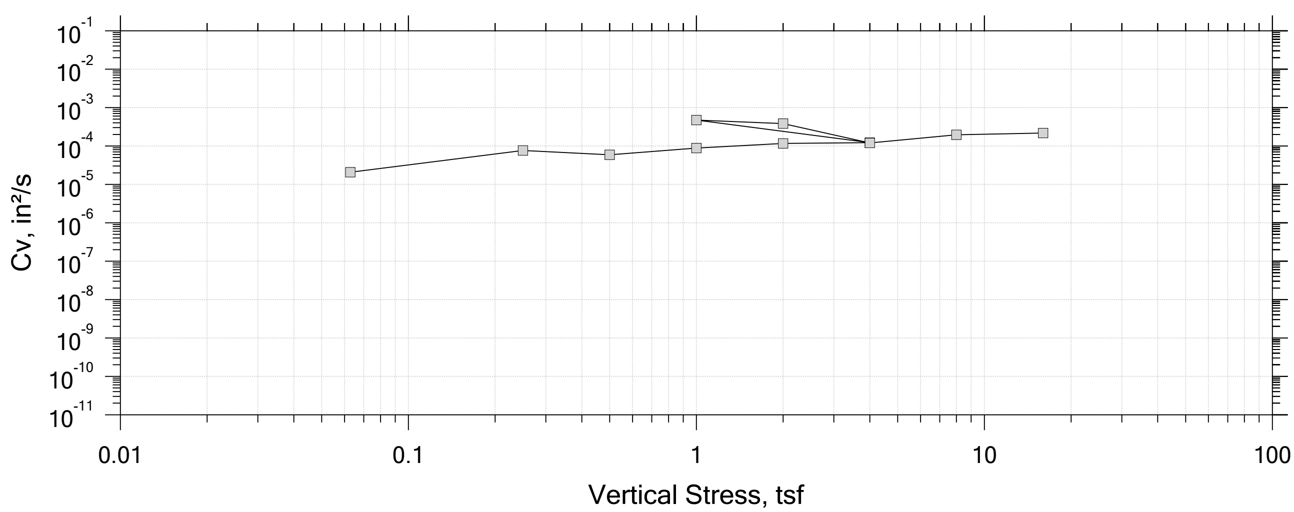
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.0643	0.003318	0.699	0.332	2.763	1.27e-03	5.16e-02	1.23e-03
2	0.250	0.01182	0.685	1.18	3.860	9.01e-04	4.58e-02	7.73e-04
3	0.500	0.01895	0.672	1.90	4.594	7.46e-04	2.86e-02	3.99e-04
4	1.00	0.02898	0.655	2.90	5.979	5.63e-04	2.01e-02	2.12e-04
5	2.00	0.04542	0.627	4.54	3.616	9.06e-04	1.64e-02	2.79e-04
6	4.00	0.06756	0.590	6.76	8.396	3.75e-04	1.11e-02	7.77e-05
7	2.00	0.06556	0.593	6.56	5.940	5.18e-04	9.98e-04	9.69e-06
8	1.00	0.06194	0.599	6.19	6.004	5.16e-04	3.63e-03	3.51e-05
9	0.500	0.05707	0.607	5.71	9.086	3.44e-04	9.74e-03	6.27e-05
10	1.00	0.05926	0.604	5.93	6.893	4.55e-04	4.38e-03	3.73e-05
11	2.00	0.06323	0.597	6.32	6.302	4.94e-04	3.98e-03	3.68e-05
12	4.00	0.07232	0.581	7.23	5.561	5.52e-04	4.55e-03	4.70e-05
13	8.00	0.09874	0.536	9.87	9.660	3.06e-04	6.60e-03	3.78e-05
14	16.0	0.1324	0.479	13.2	6.722	4.11e-04	4.21e-03	3.24e-05
15	8.00	0.1315	0.480	13.2	3.995	6.66e-04	1.08e-04	1.35e-06
16	2.00	0.1211	0.498	12.1	5.739	4.70e-04	1.73e-03	1.53e-05
17	0.500	0.1038	0.528	10.4	13.830	2.01e-04	1.16e-02	4.35e-05
18	0.125	0.08851	0.554	8.85	38.387	7.52e-05	4.08e-02	5.75e-05

GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: WB-1/U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-314-23	Test Date: 09/15/23	Depth: 6-8'
	Test No.: IP-1	Sample Type: Intact	Elevation: ---
	Description: Moist, dark gray clay		
	Remarks: TX-011, Swell Pressure = 0.0643 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report





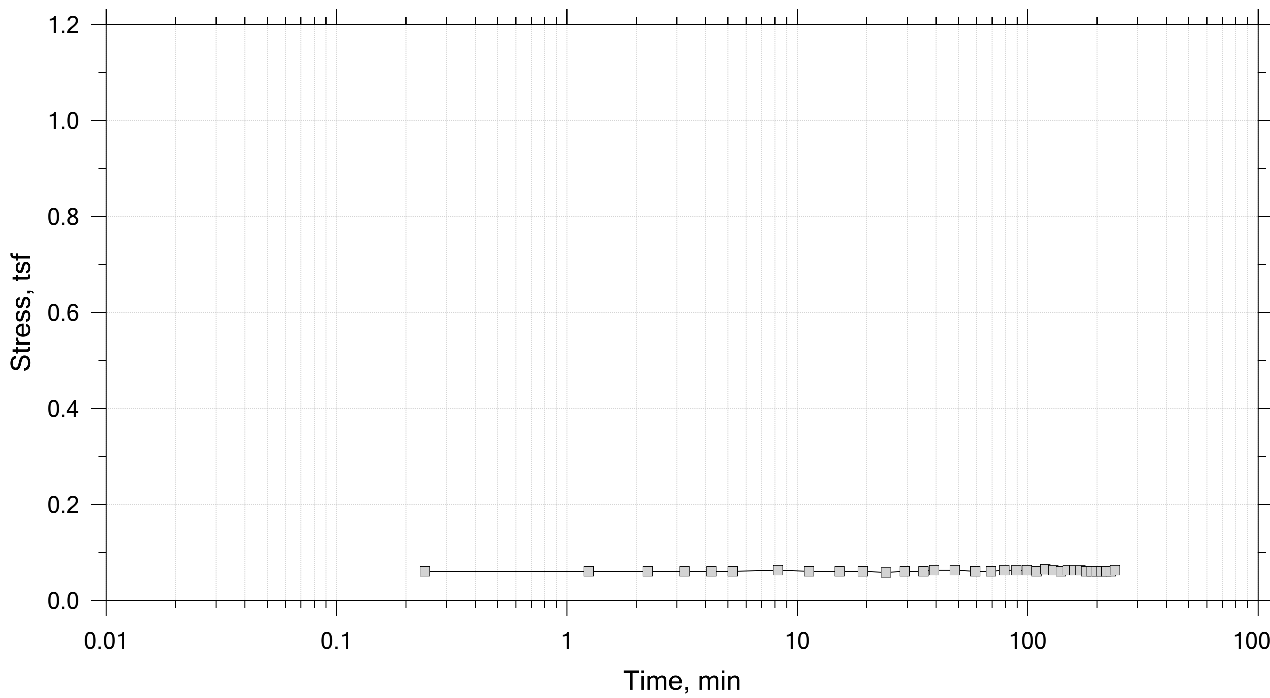
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		
	Displacement at End of Increment		

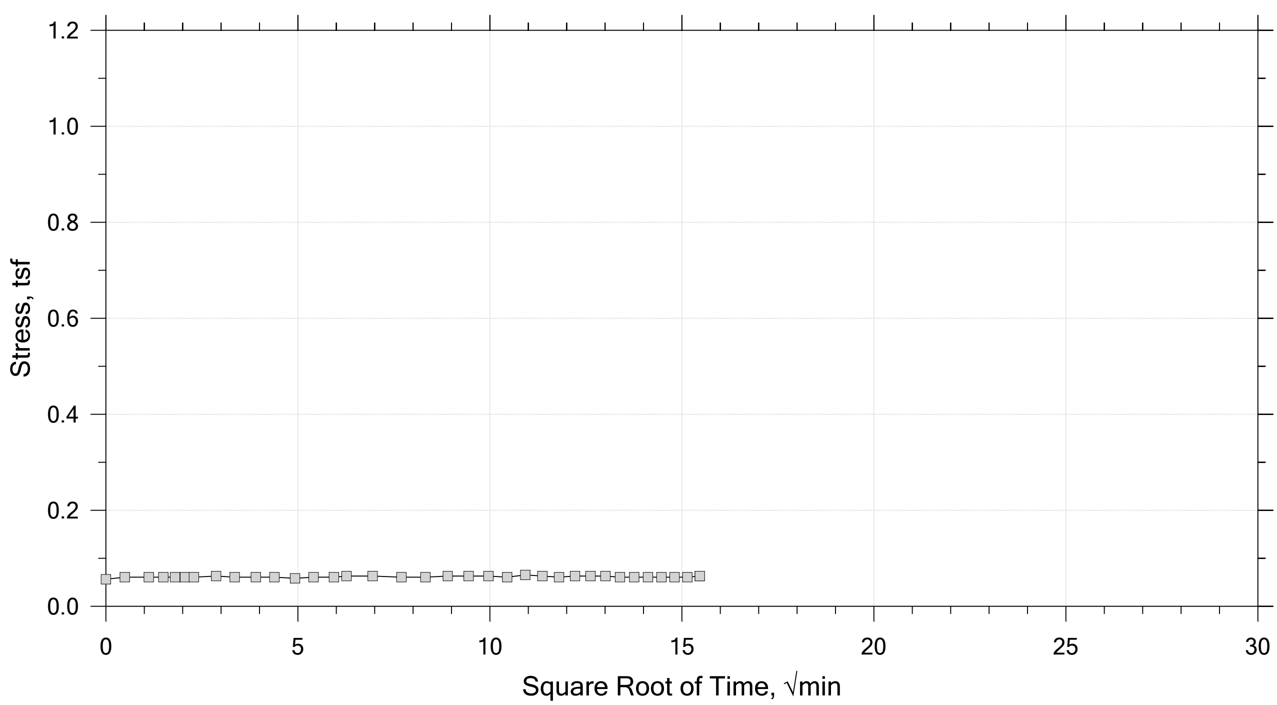
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 18

Constant Volume Step

Stress: 0.0629 tsf

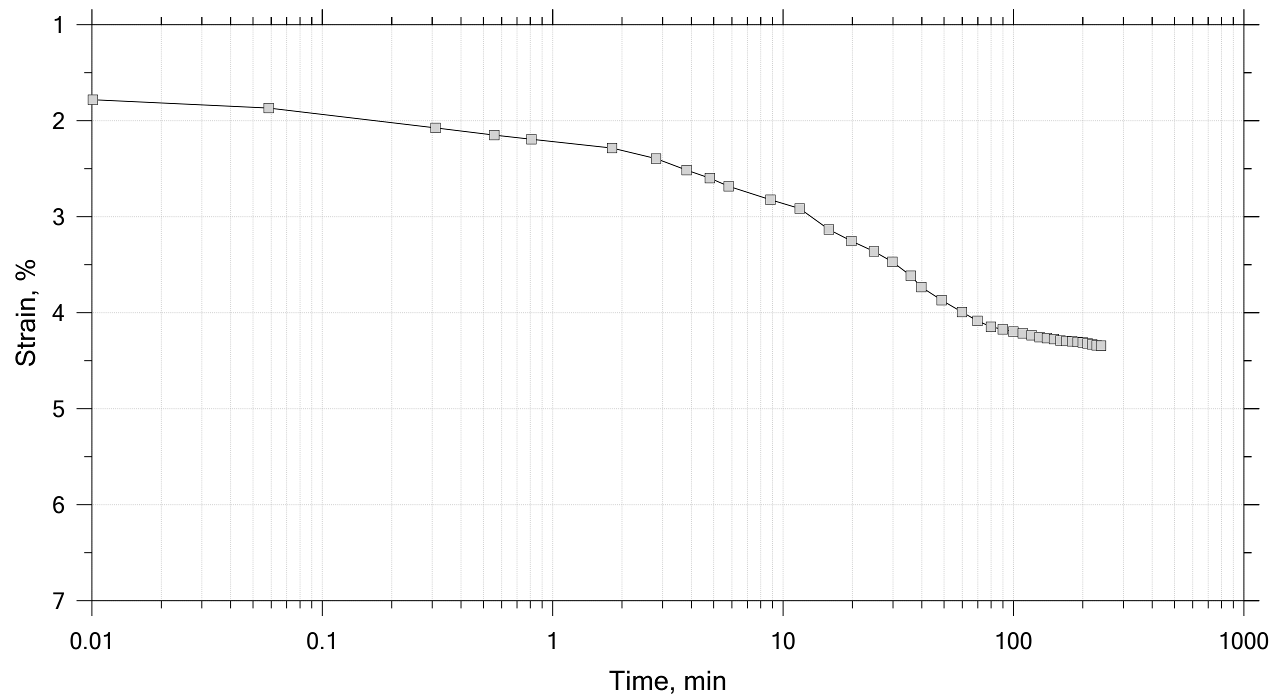


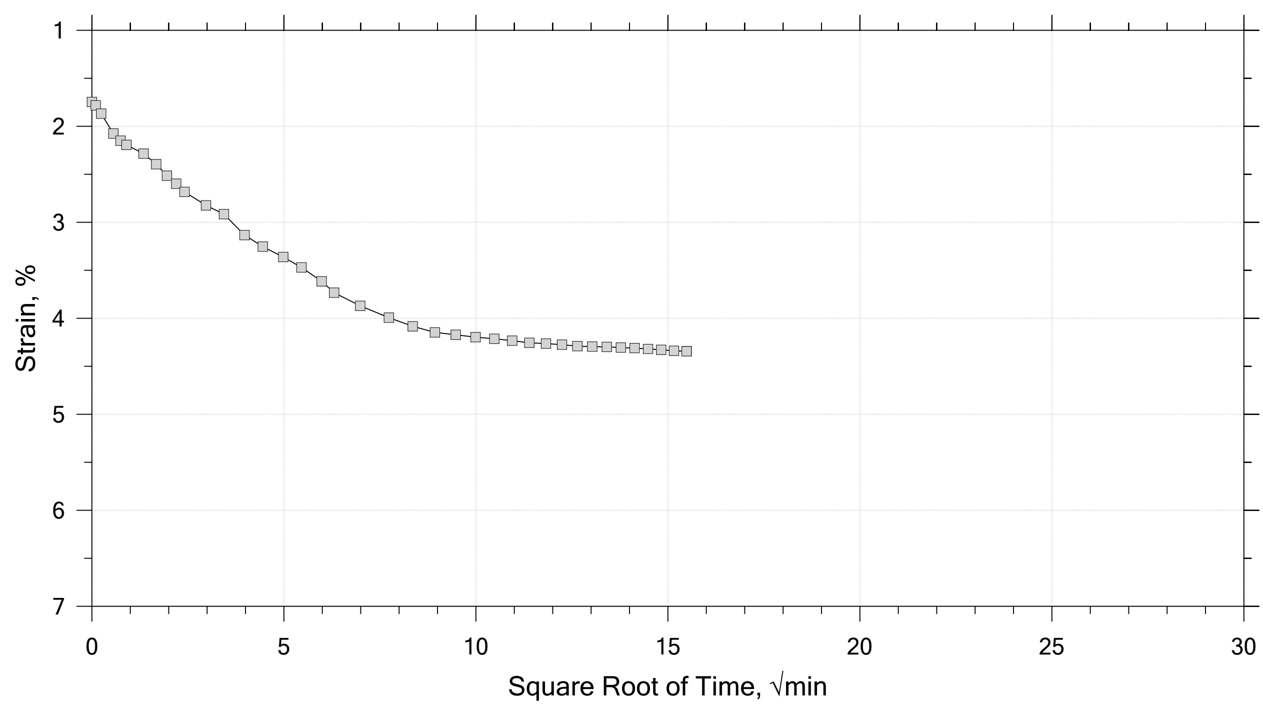


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 18
Constant Load Step
Stress: 0.25 tsf





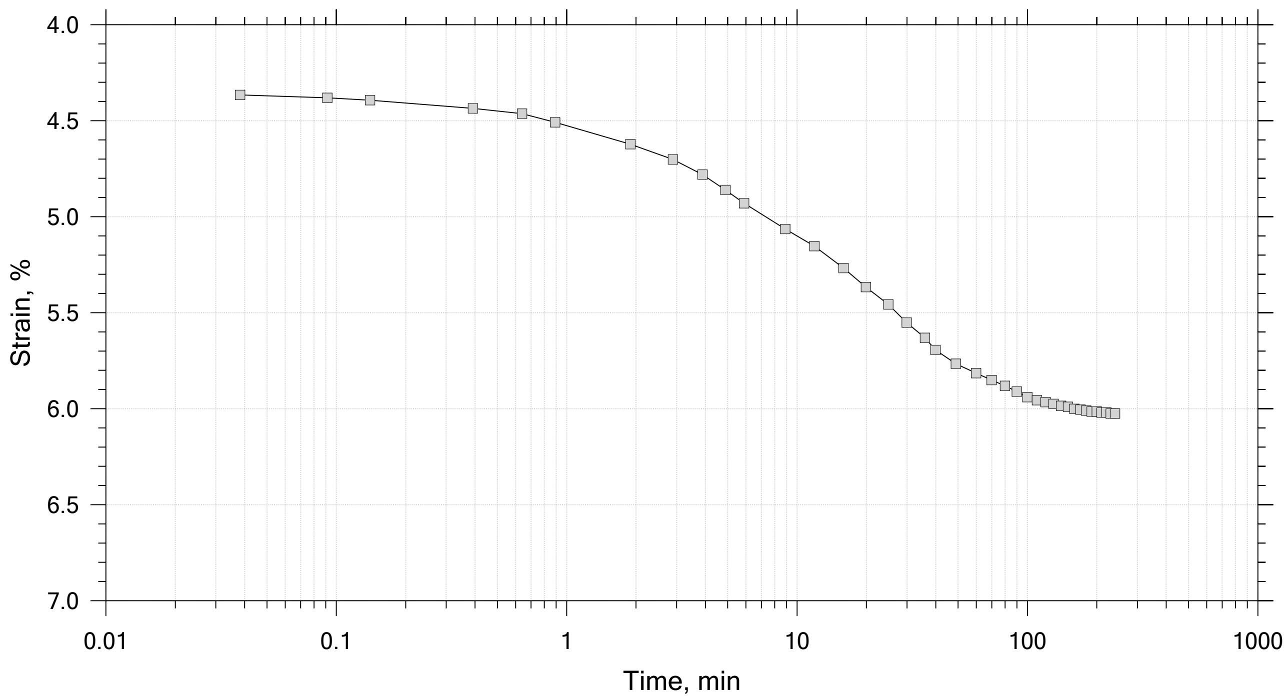
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

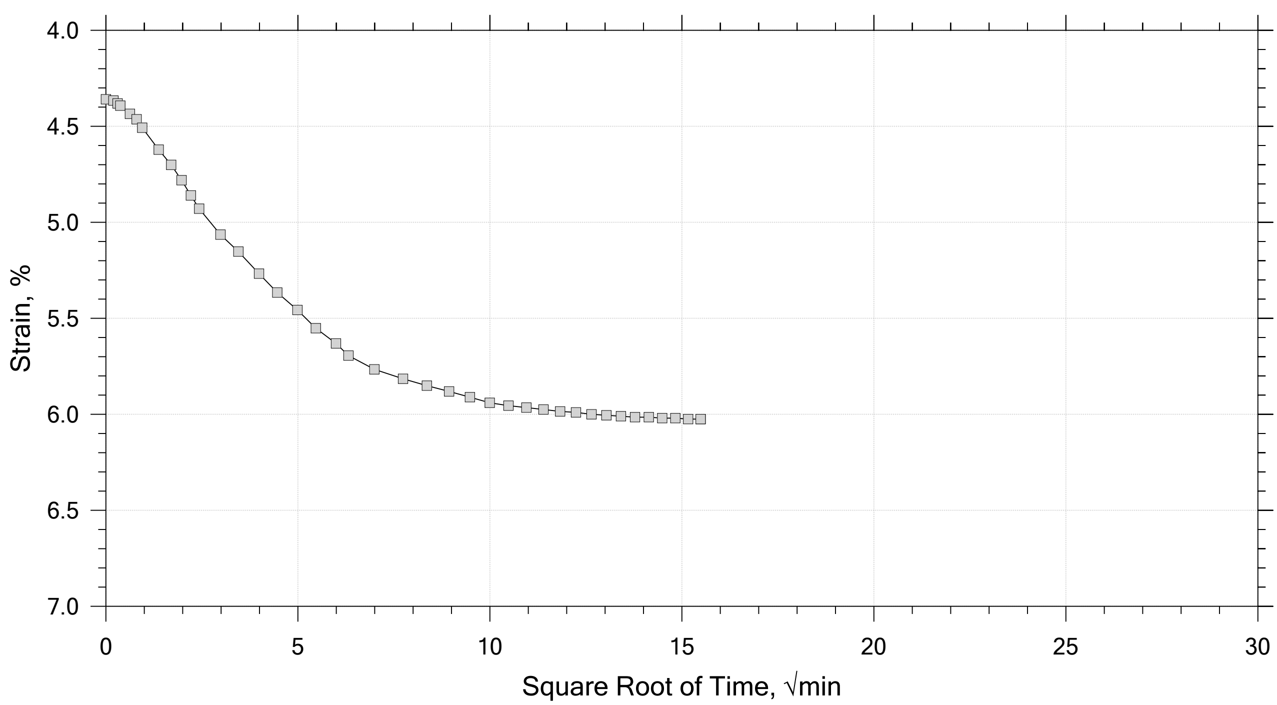
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 18

Constant Load Step

Stress: 0.5 tsf

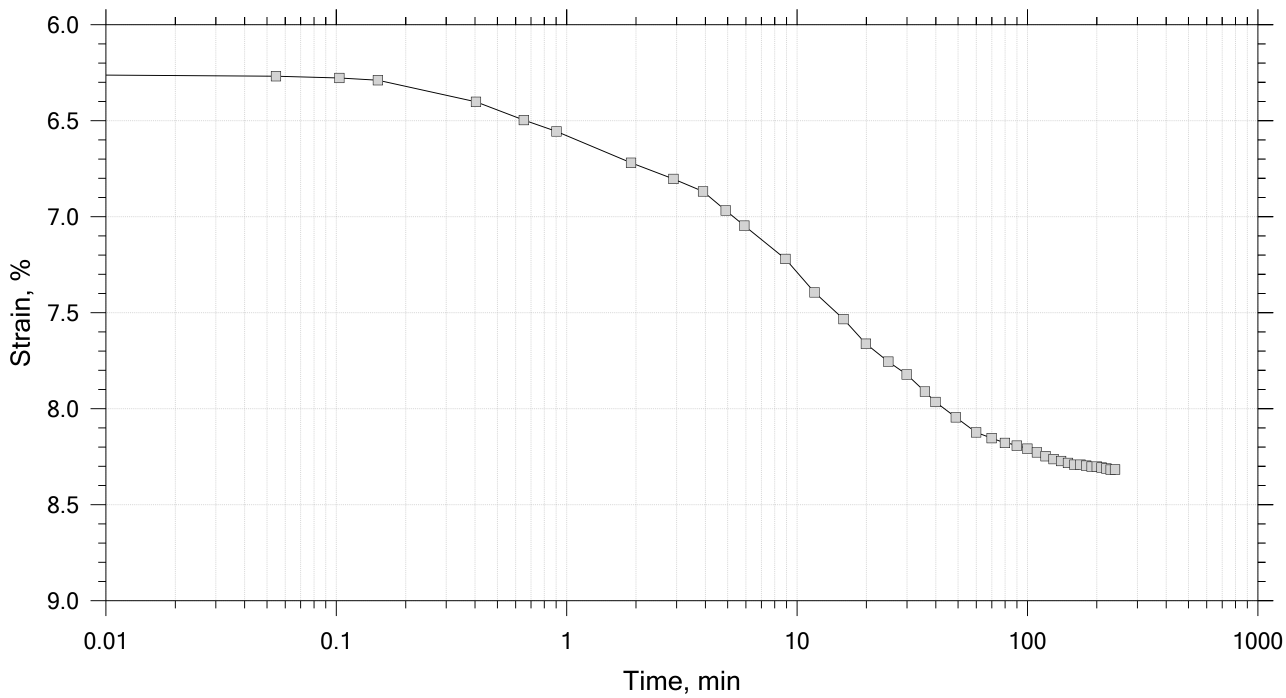


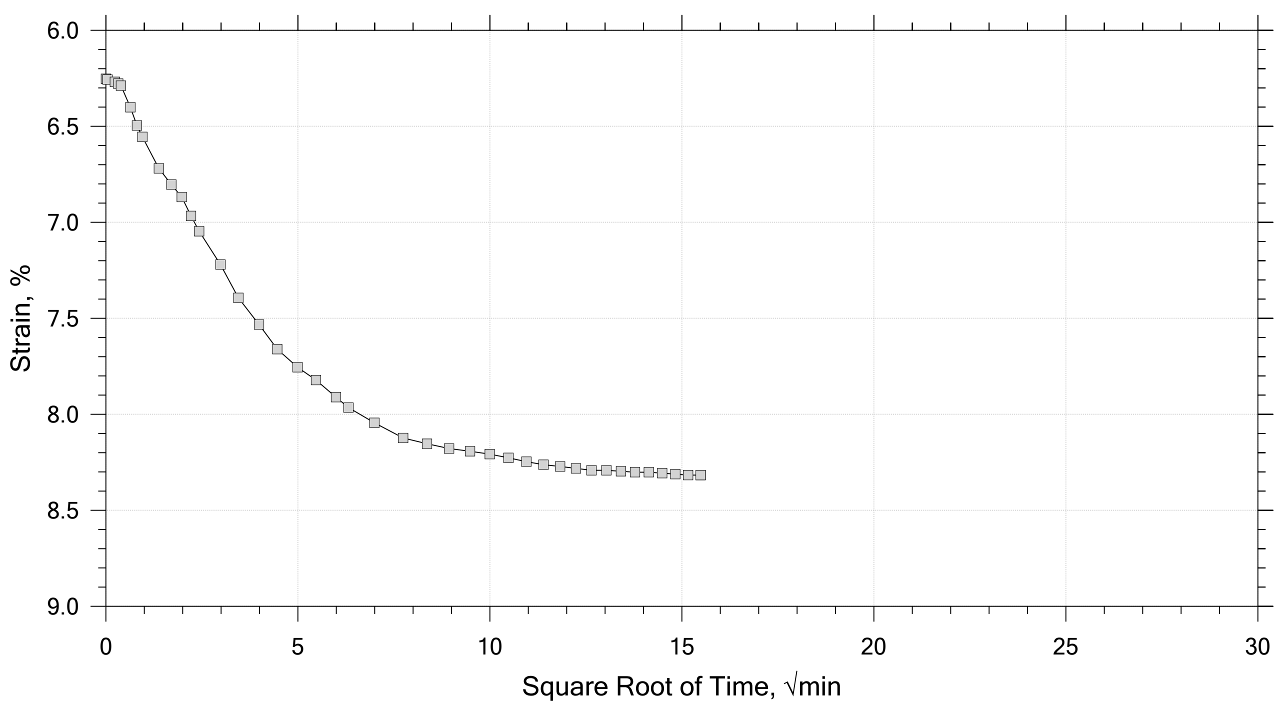


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 18
Constant Load Step
Stress: 1 tsf

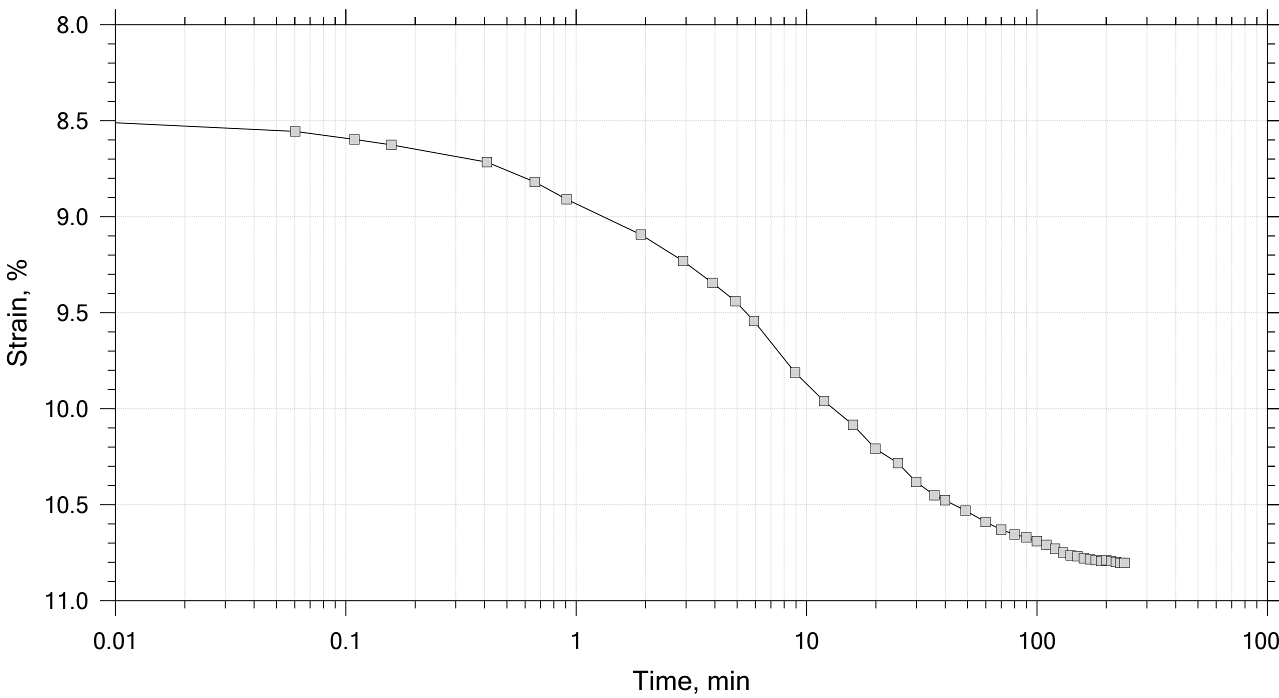


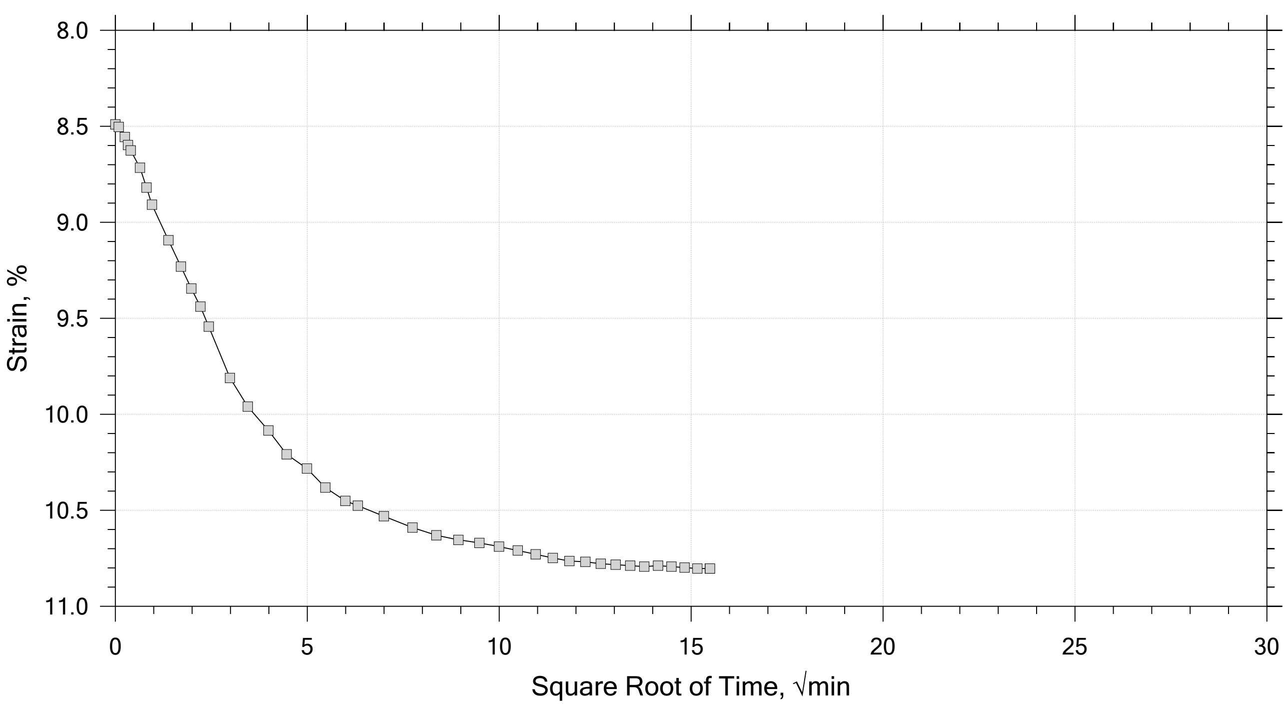


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 18
Constant Load Step
Stress: 2 tsf





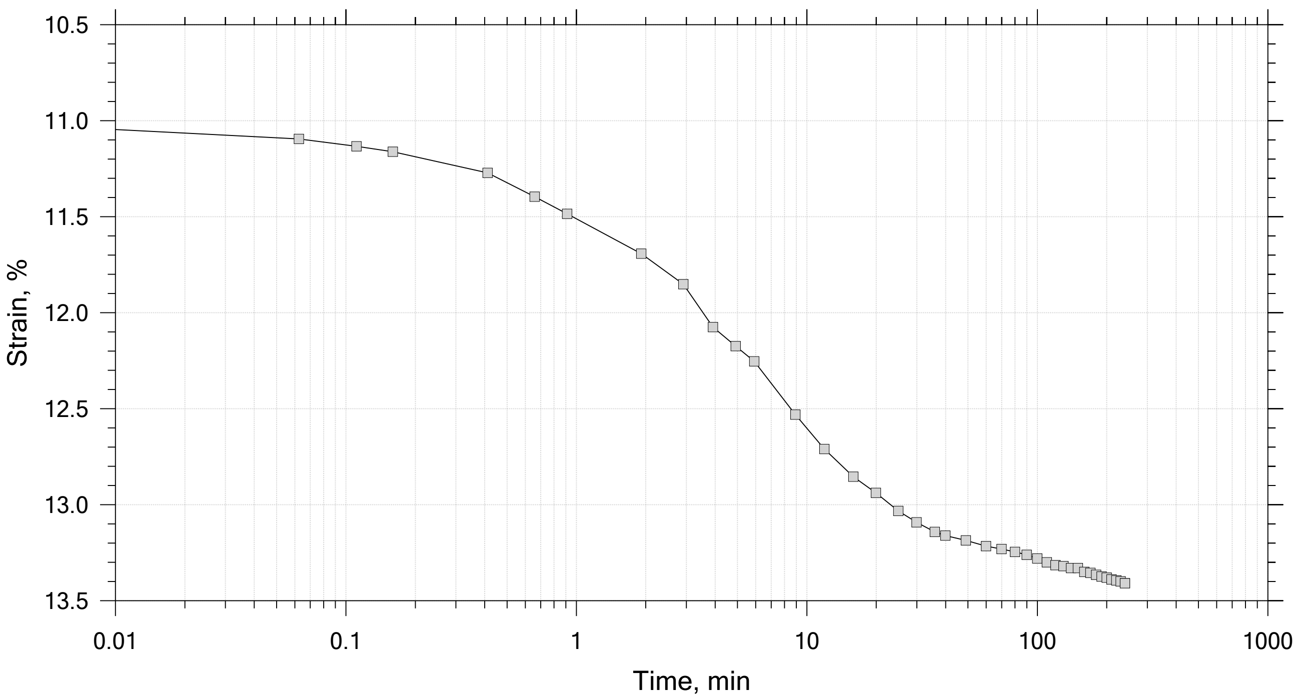
GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

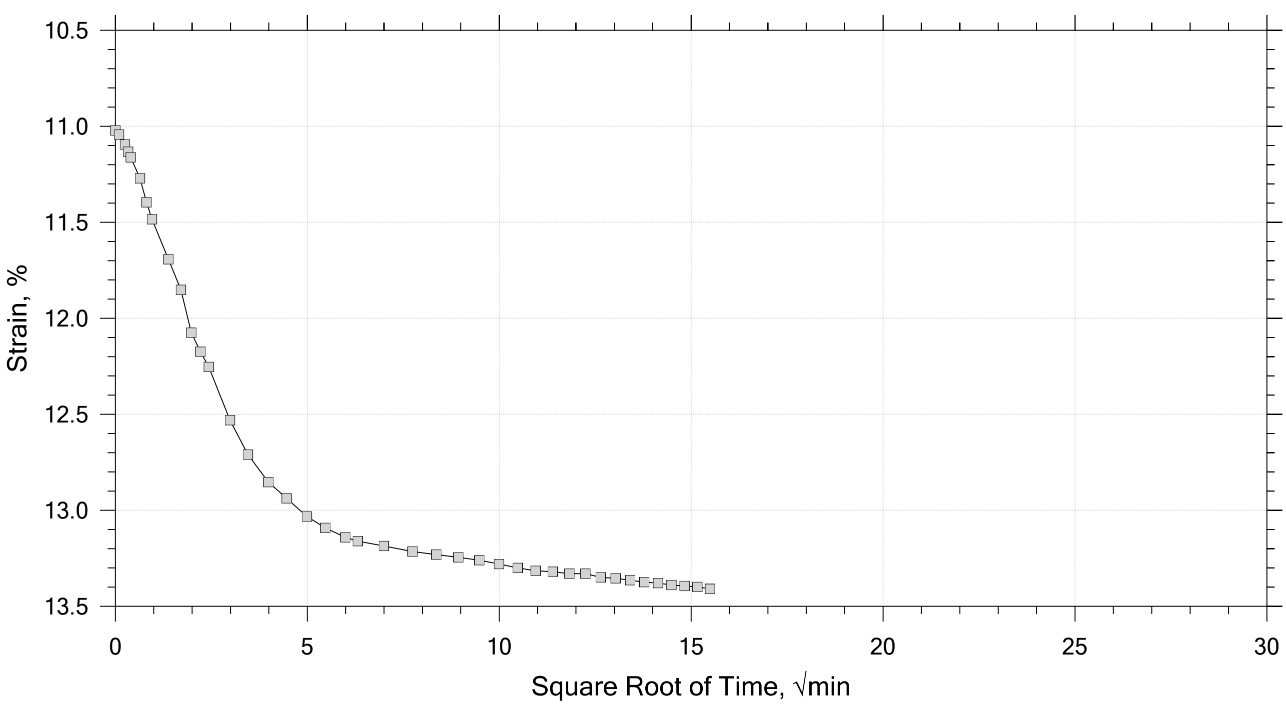
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 18

Constant Load Step

Stress: 4 tsf

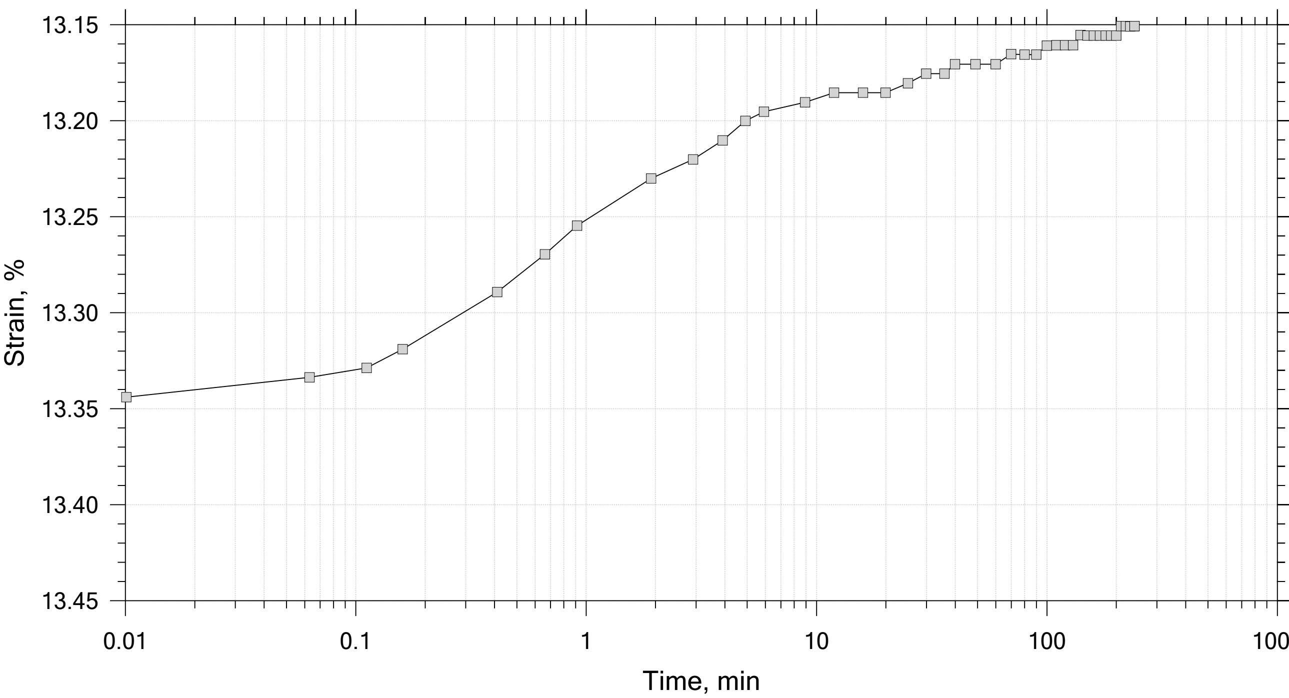


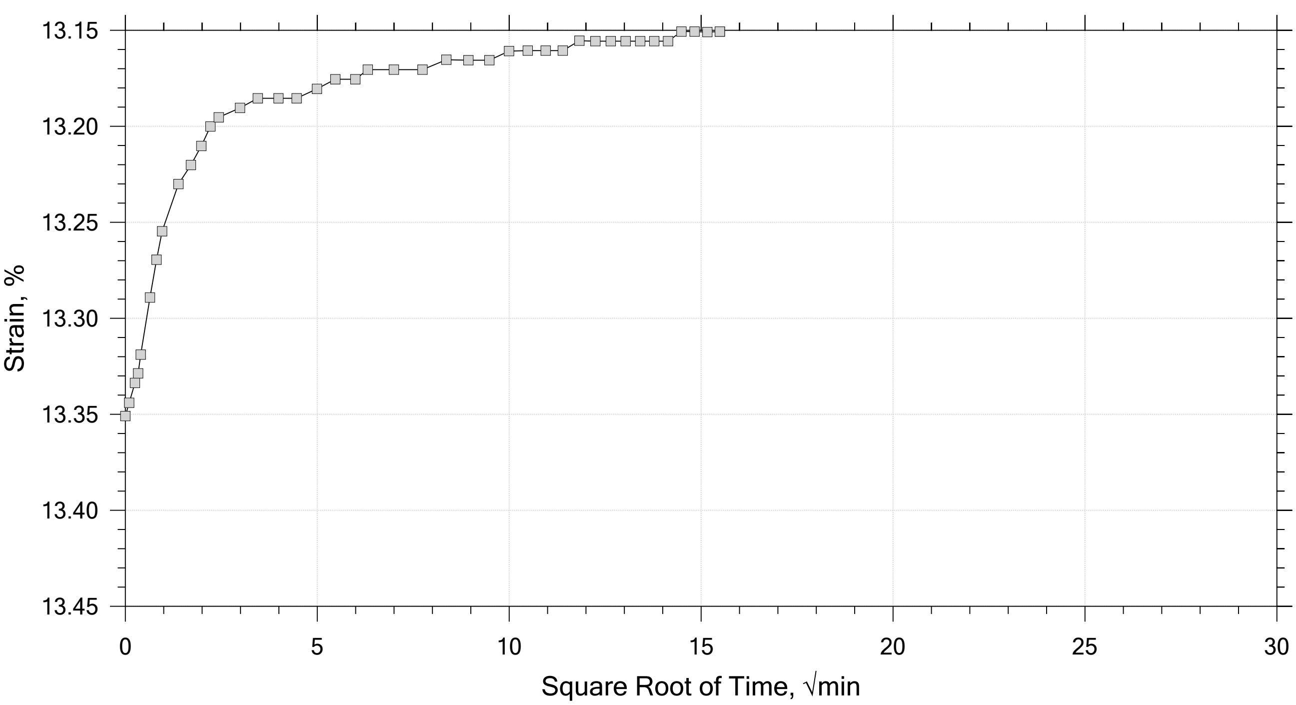


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 18
Constant Load Step
Stress: 2 tsf





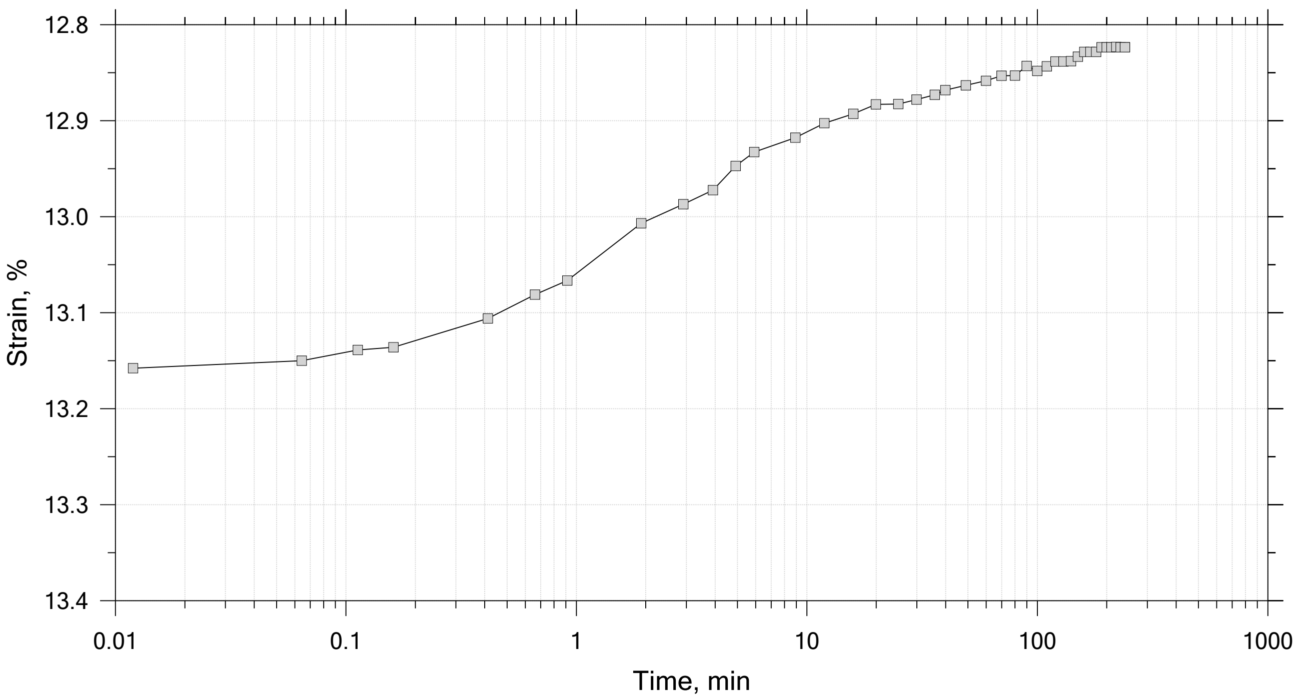
GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

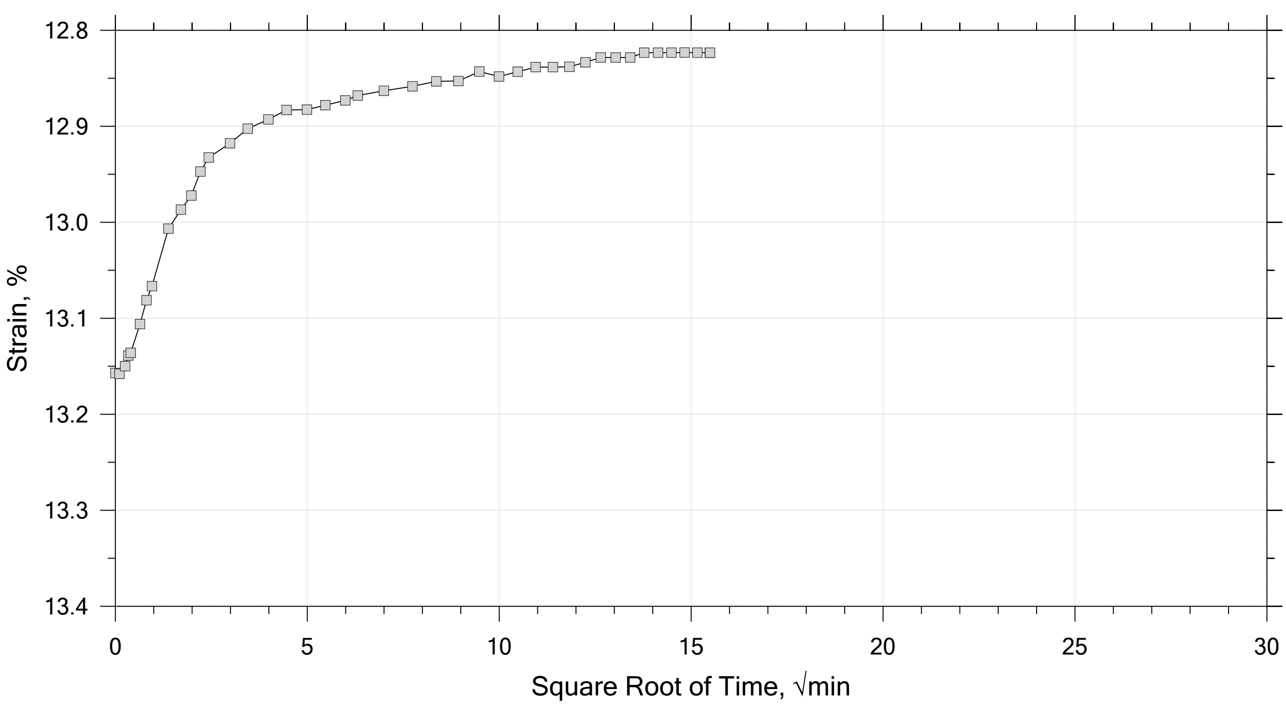
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 18

Constant Load Step

Stress: 1 tsf

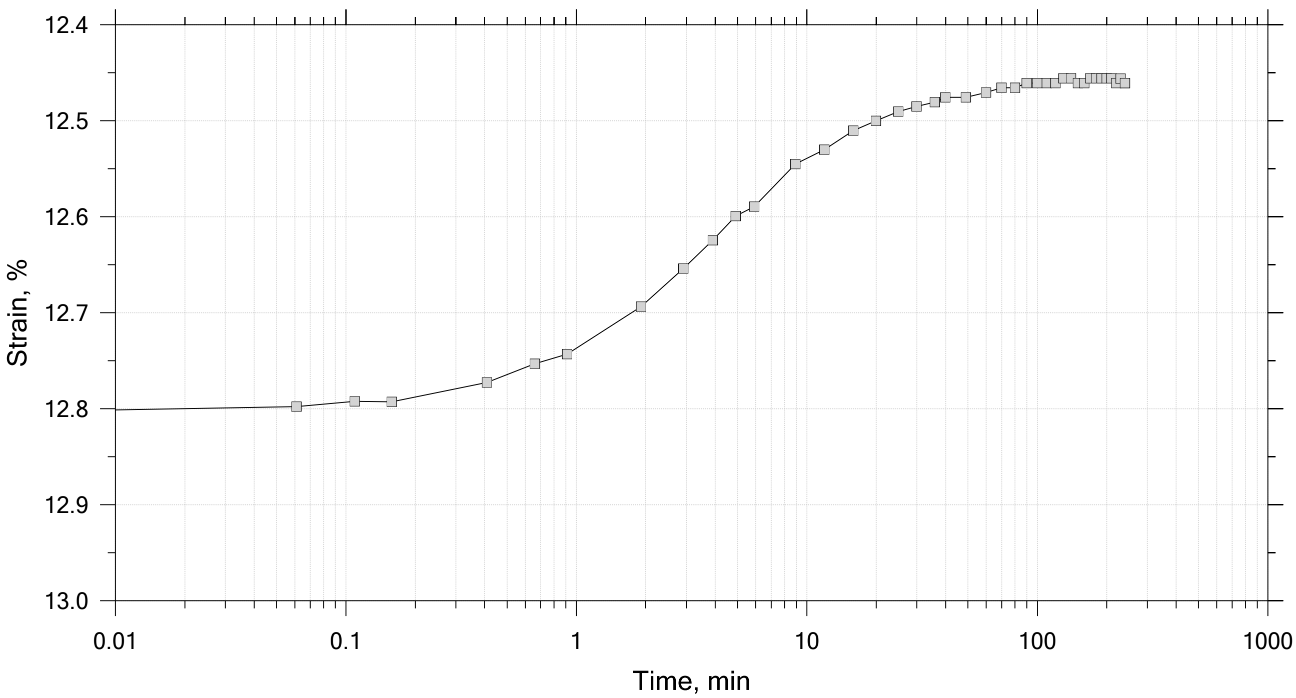


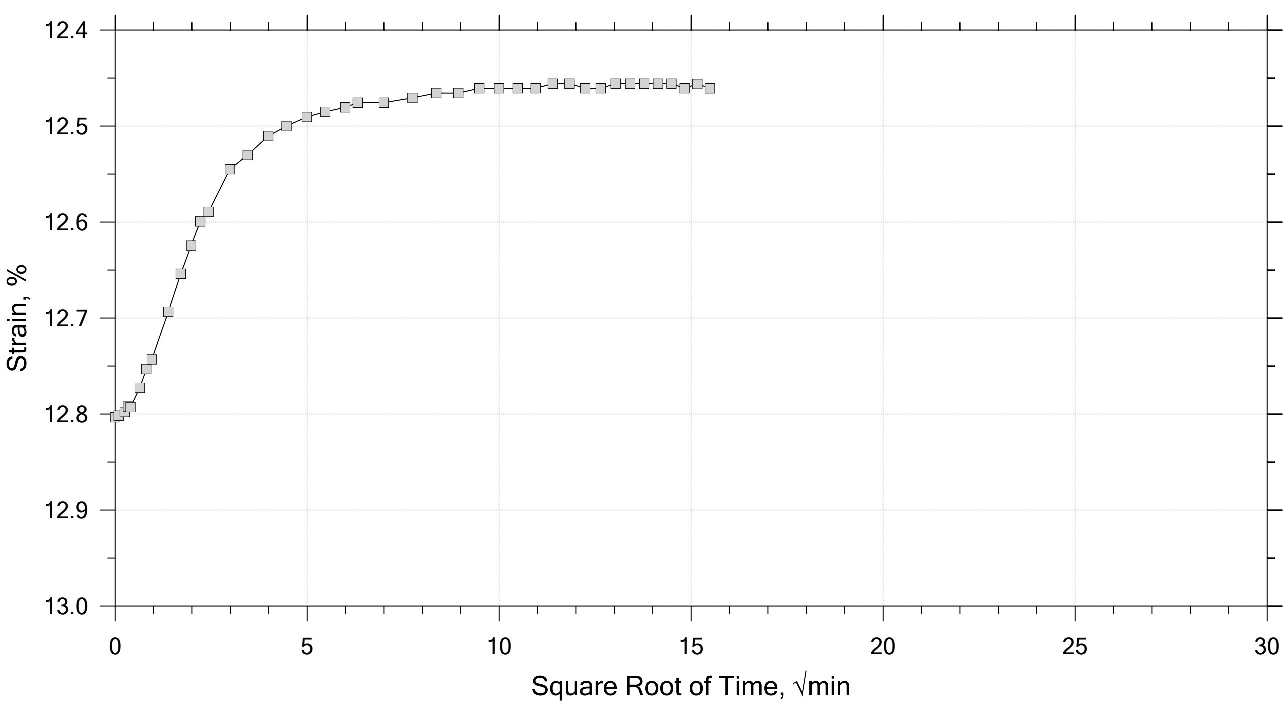


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 18
Constant Load Step
Stress: 0.5 tsf

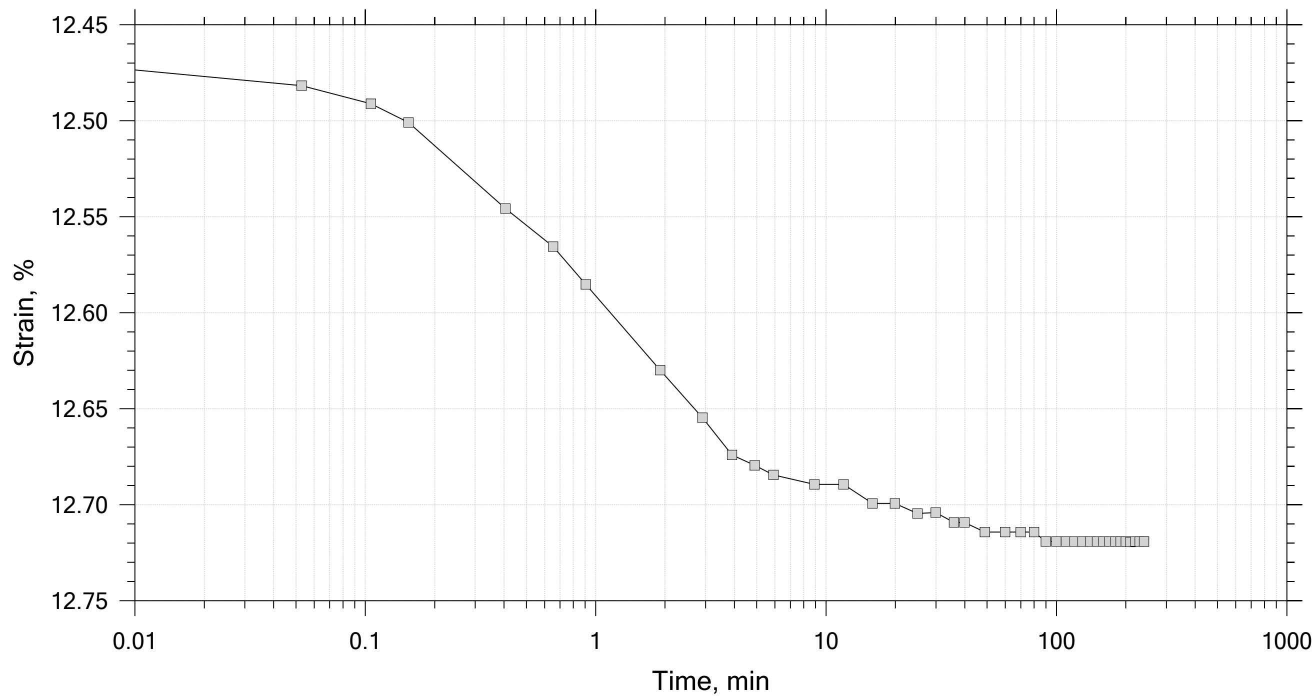


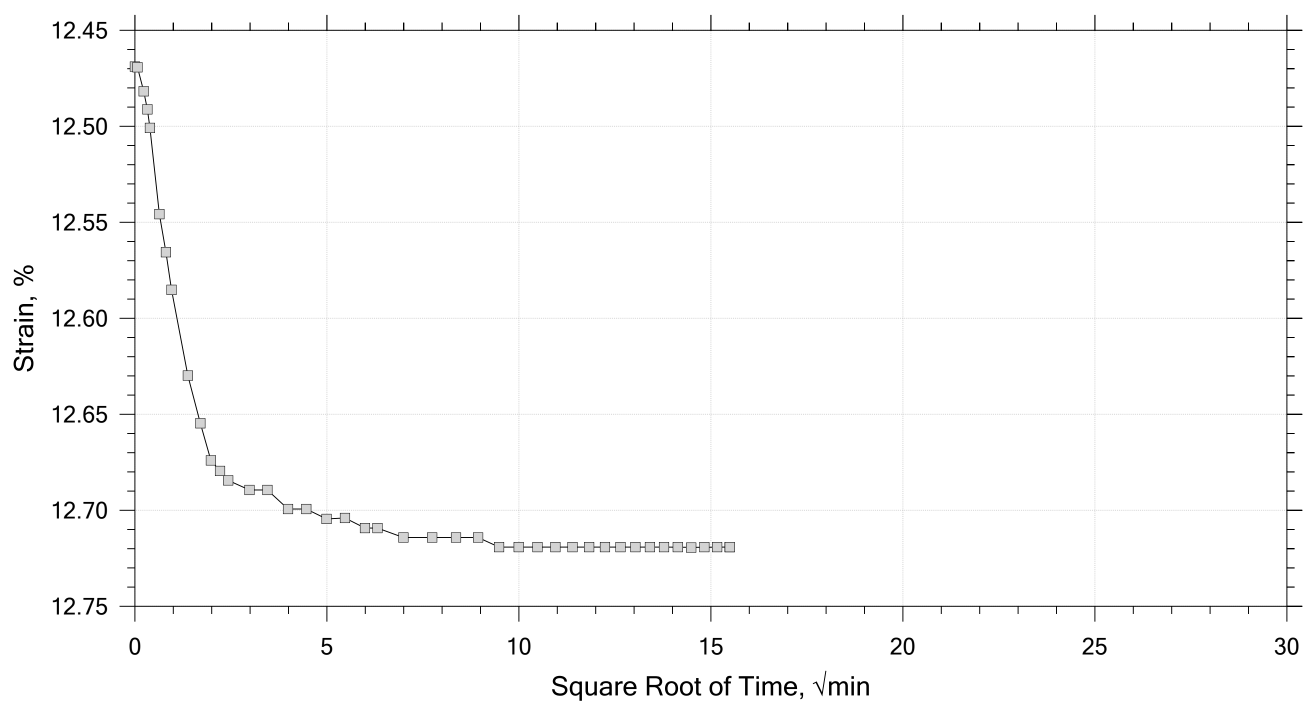


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 18
Constant Load Step
Stress: 1 tsf





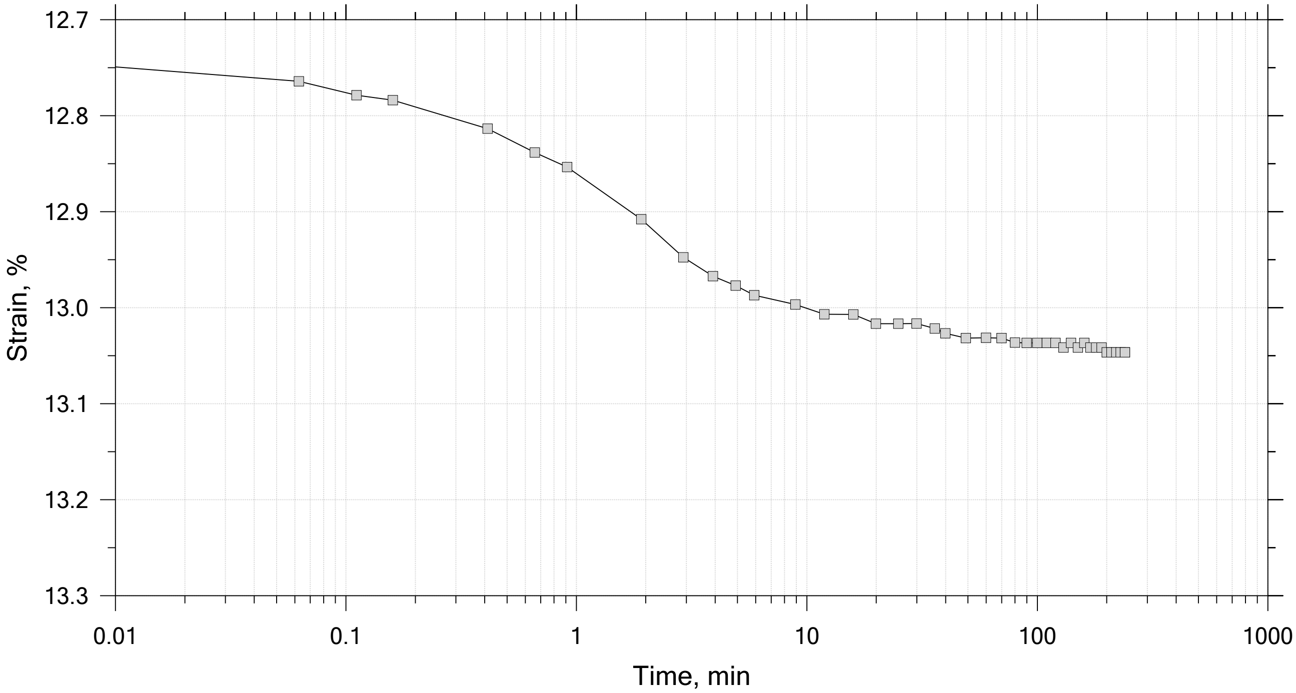
GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

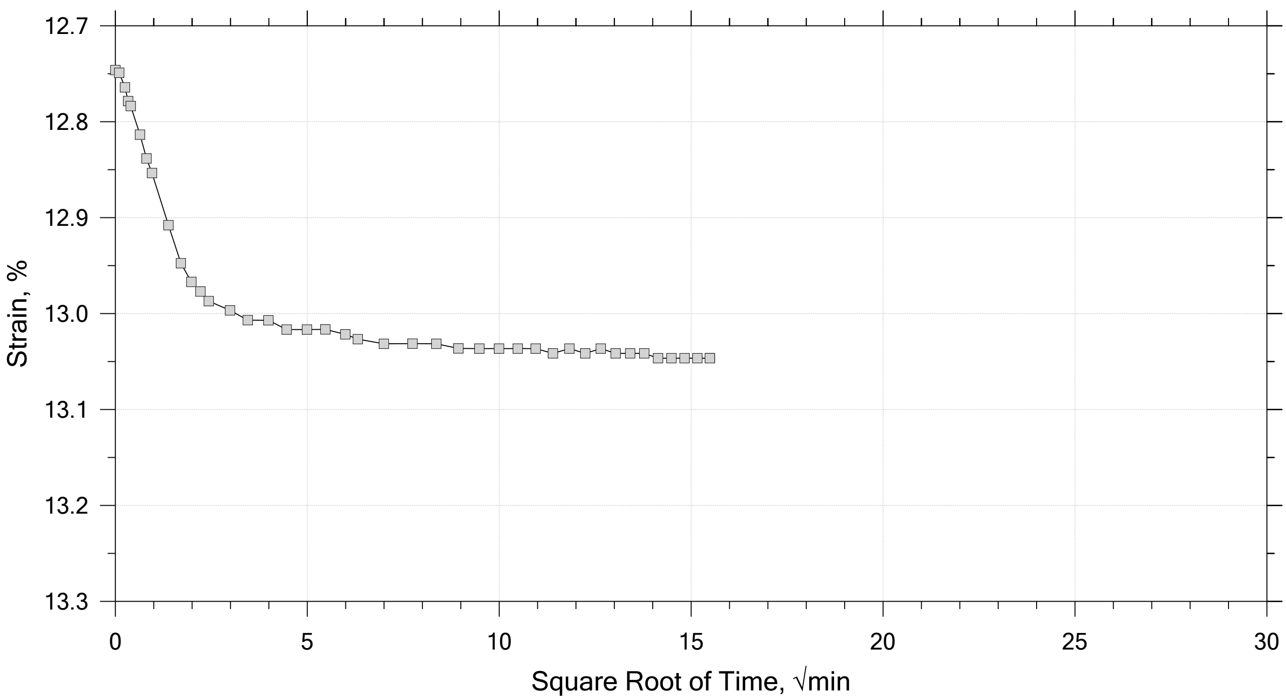
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 18

Constant Load Step

Stress: 2 tsf

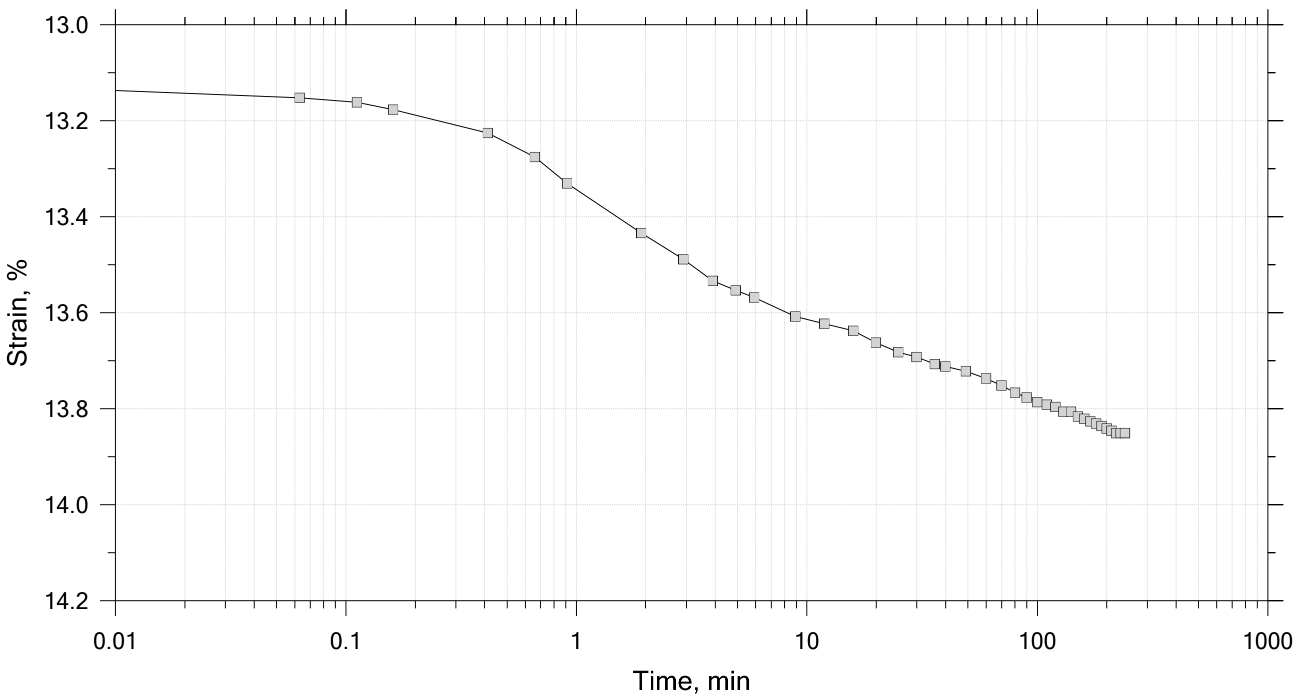


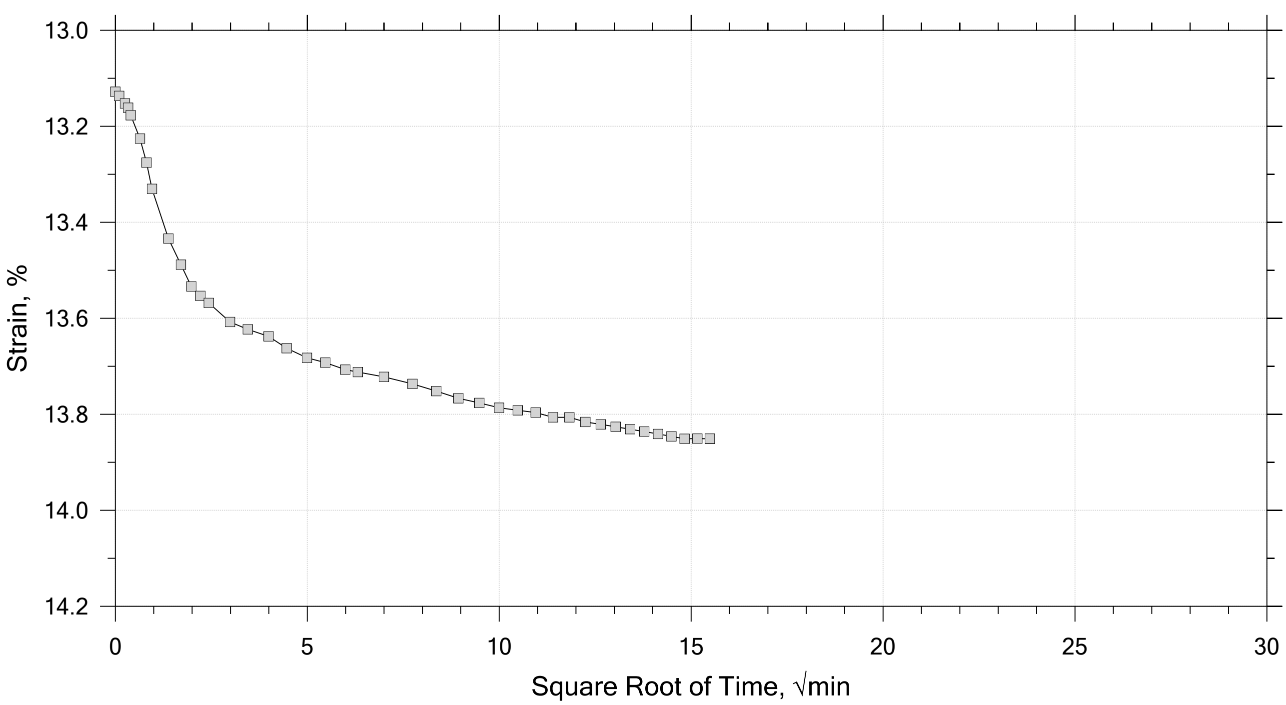


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 12 of 18
Constant Load Step
Stress: 4 tsf





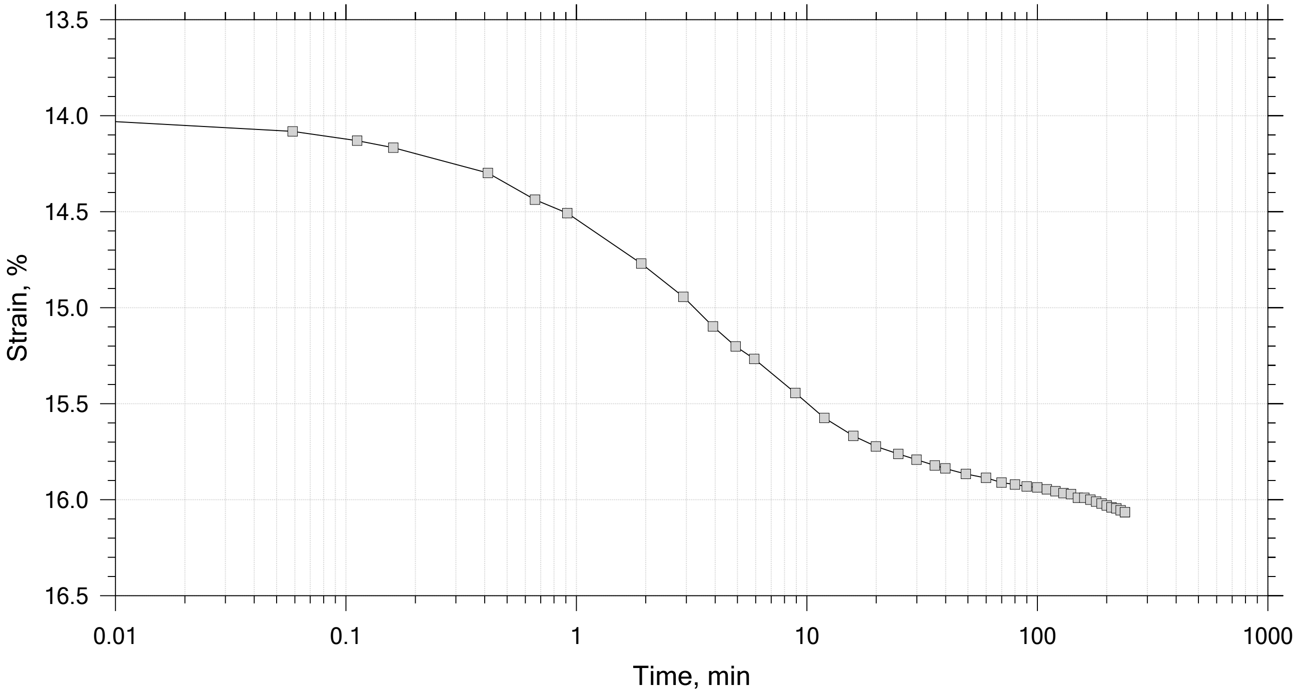
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

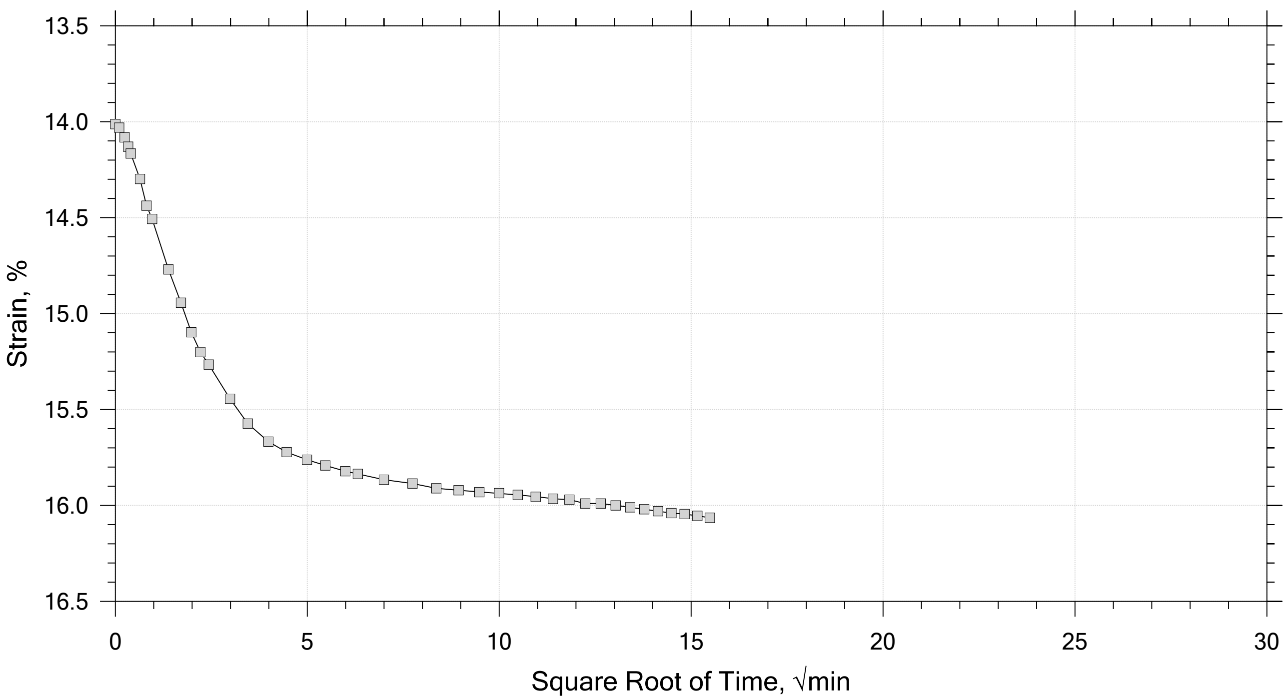
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 13 of 18

Constant Load Step

Stress: 8 tsf





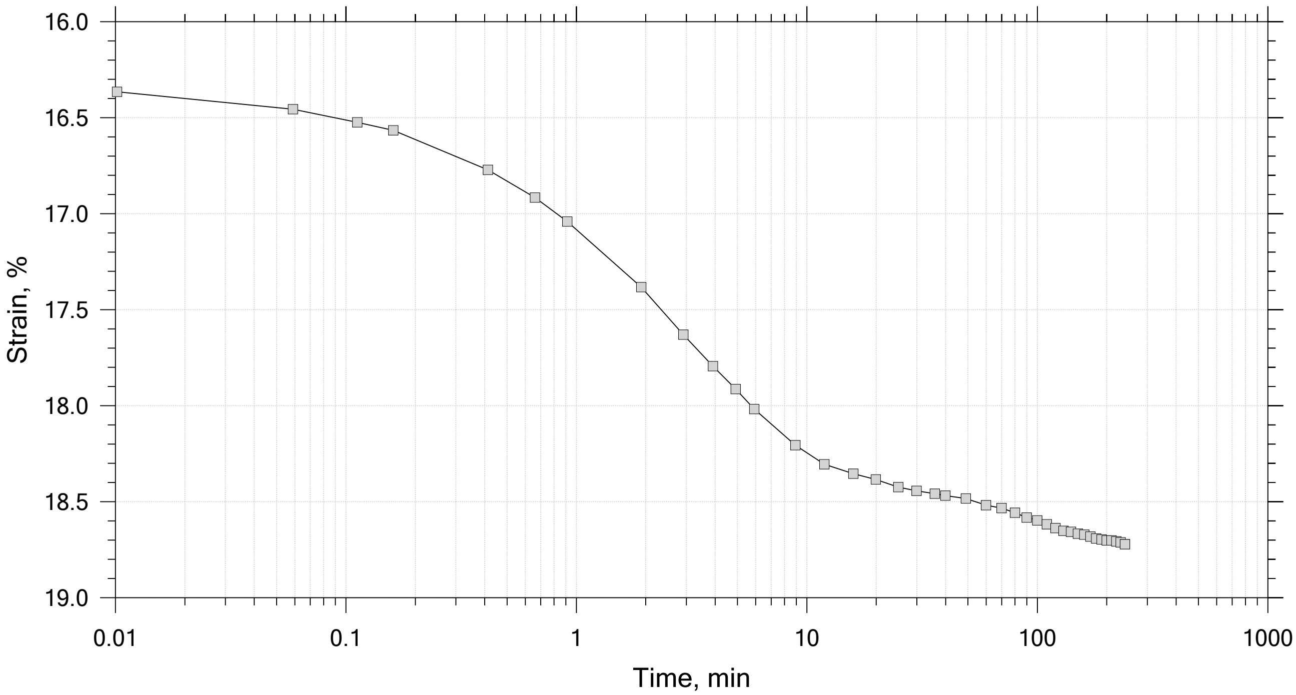
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

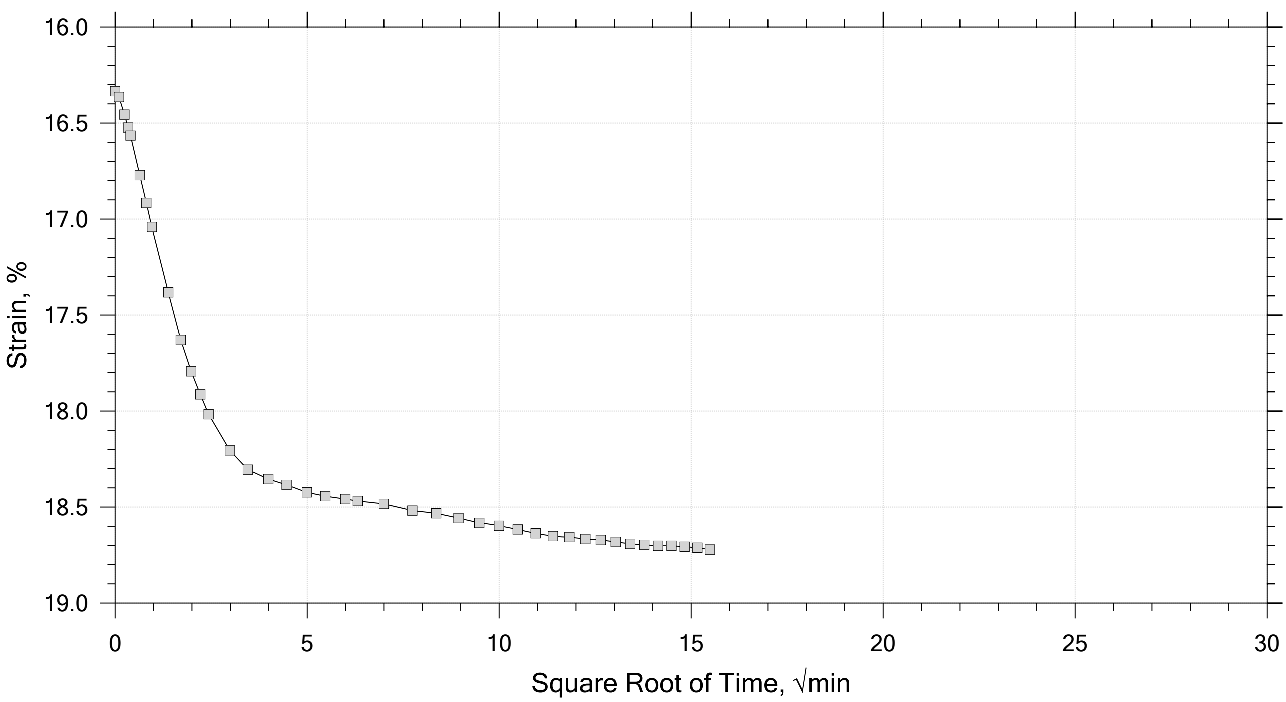
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 14 of 18

Constant Load Step

Stress: 16 tsf

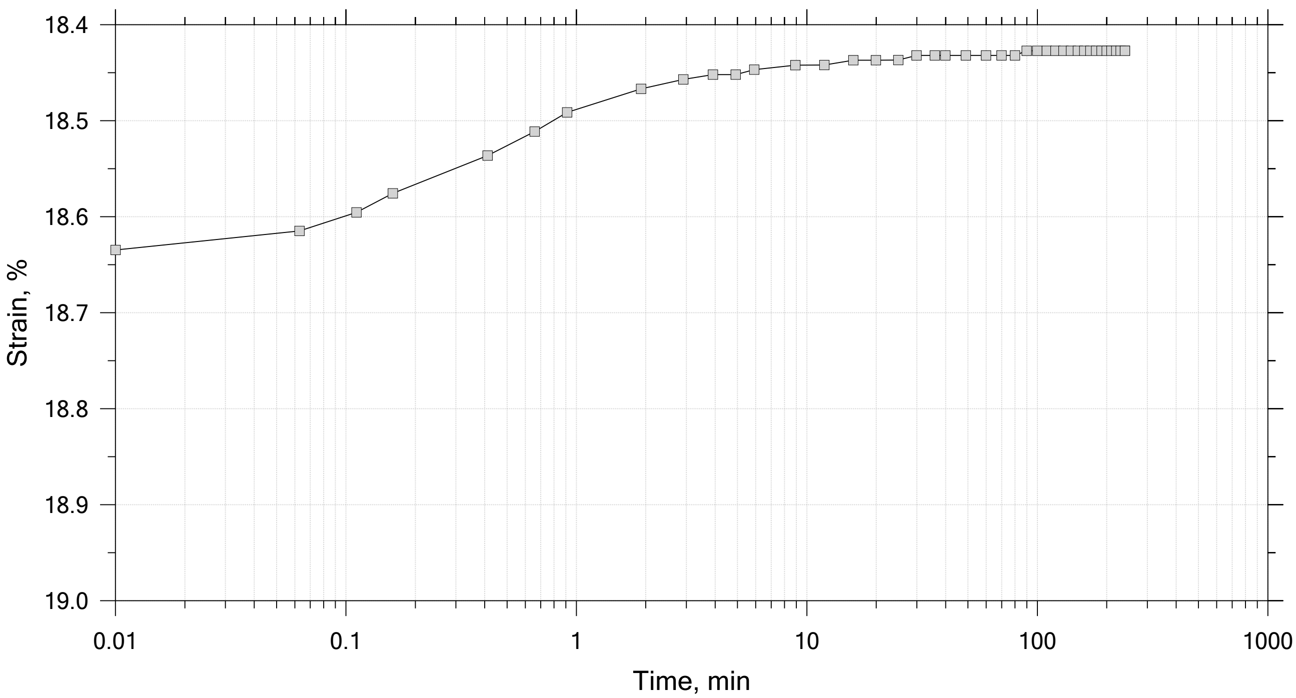


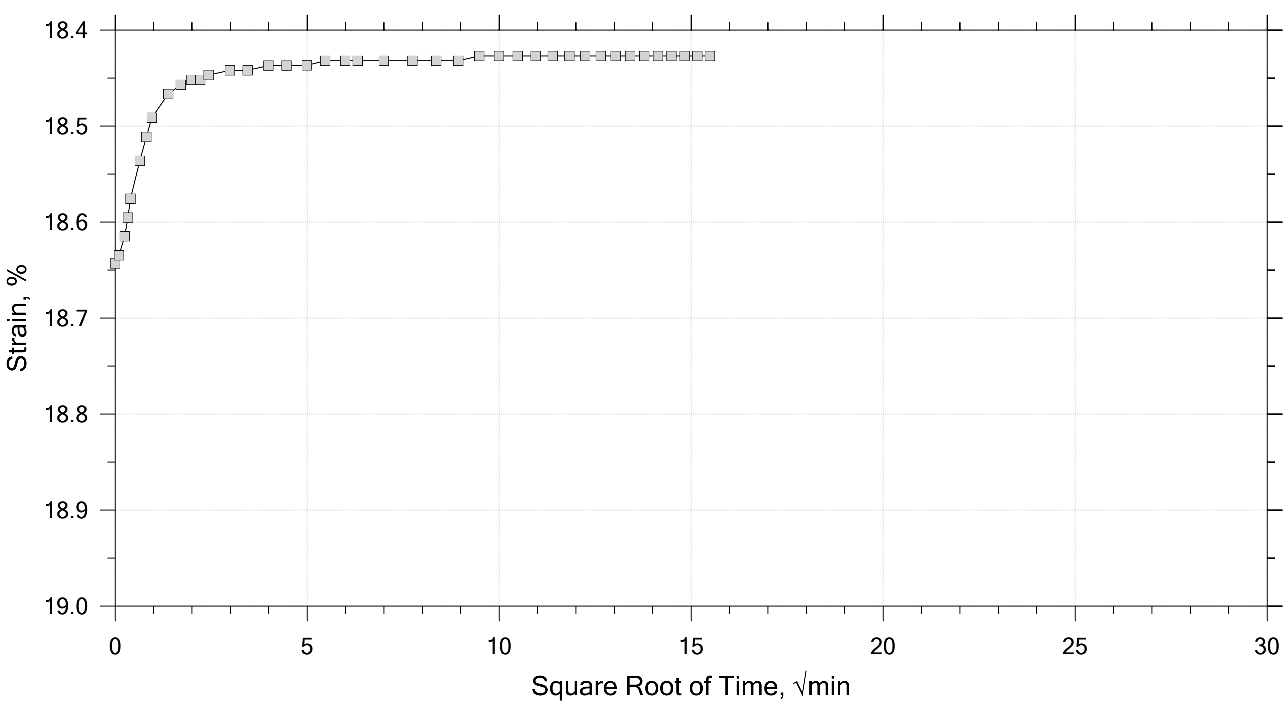


GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 15 of 18
Constant Load Step
Stress: 8 tsf





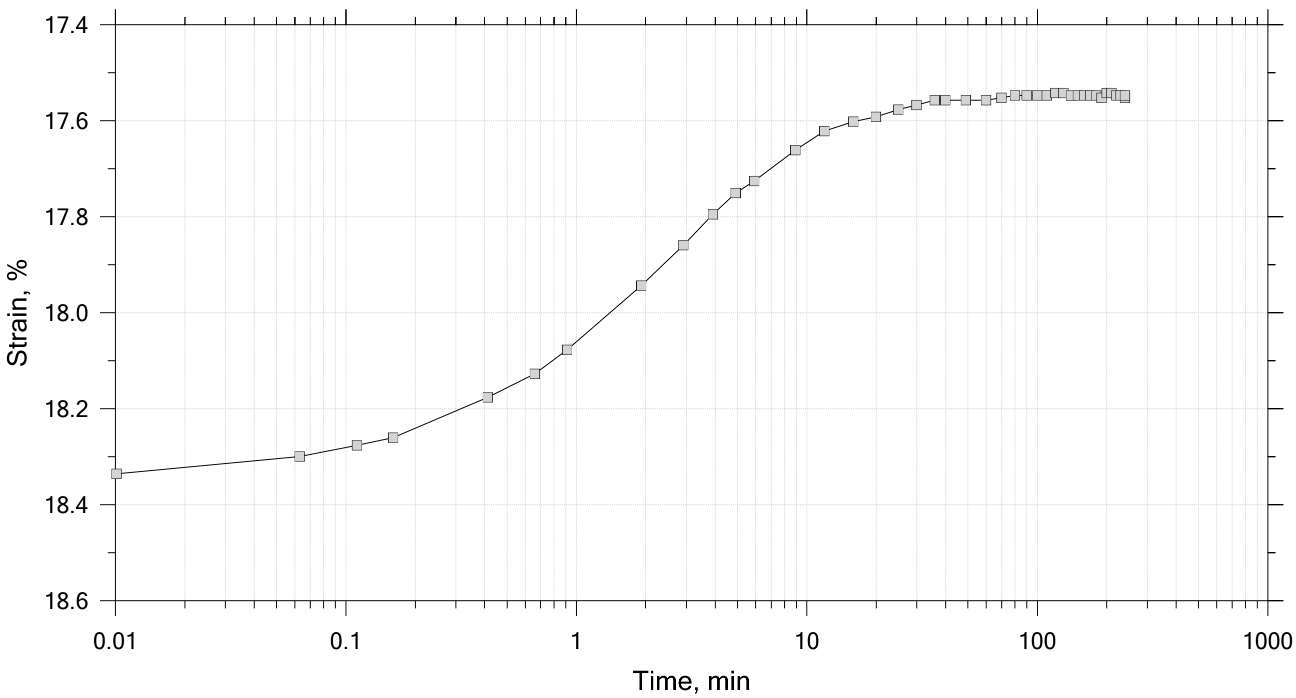
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

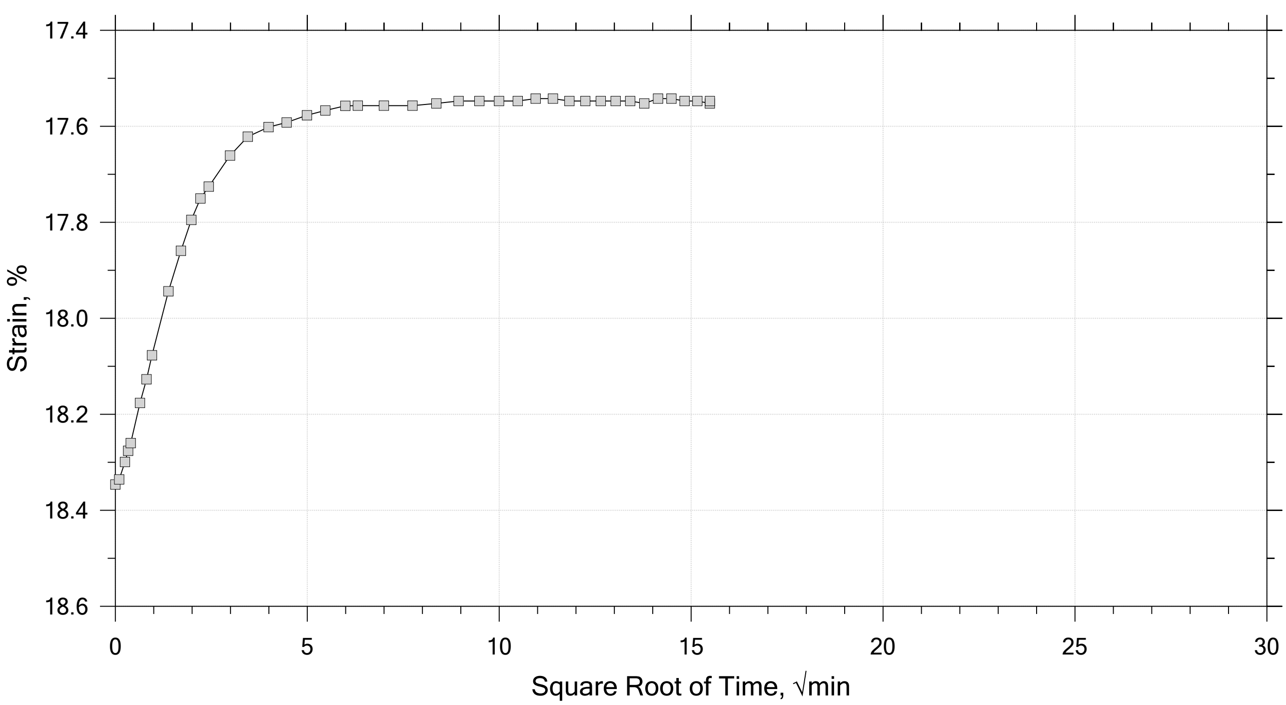
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 16 of 18

Constant Load Step

Stress: 2 tsf





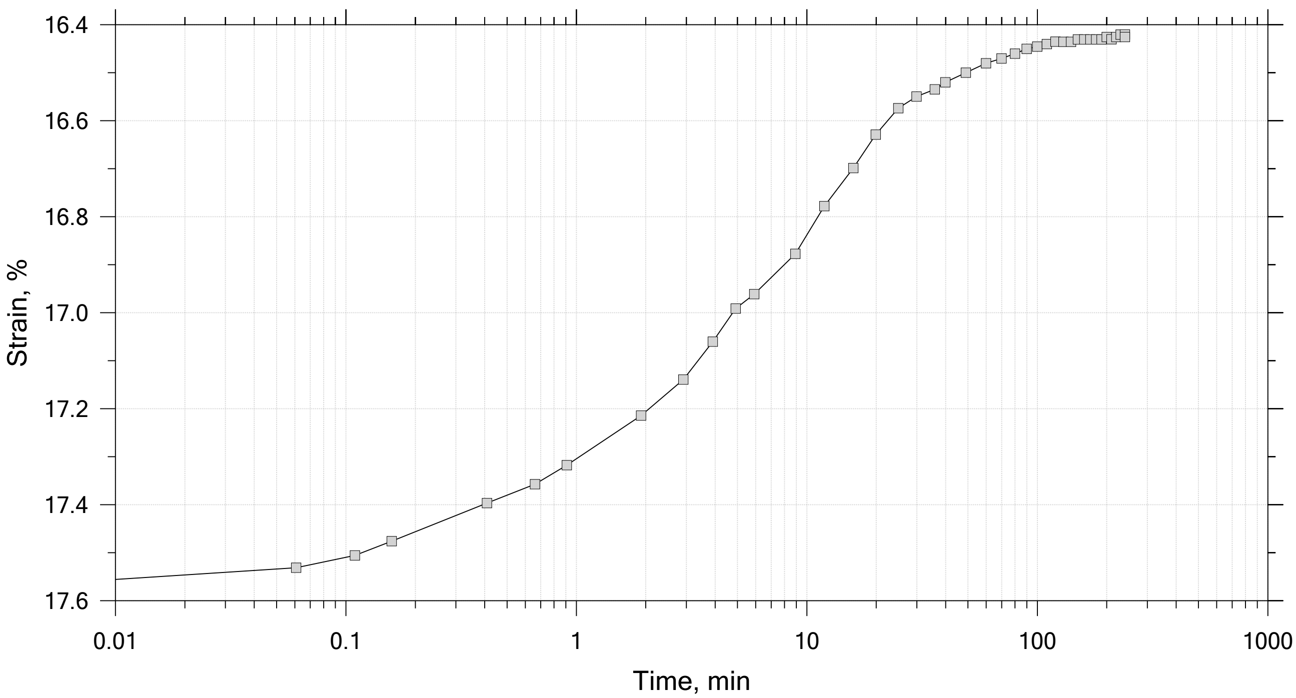
Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
Test No.: IP-2	Sample Type: Intact	Elevation: ---
Description: Moist, dark grayish brown clay		
Remarks: TX-012, Swell Pressure = 0.0629 tsf		

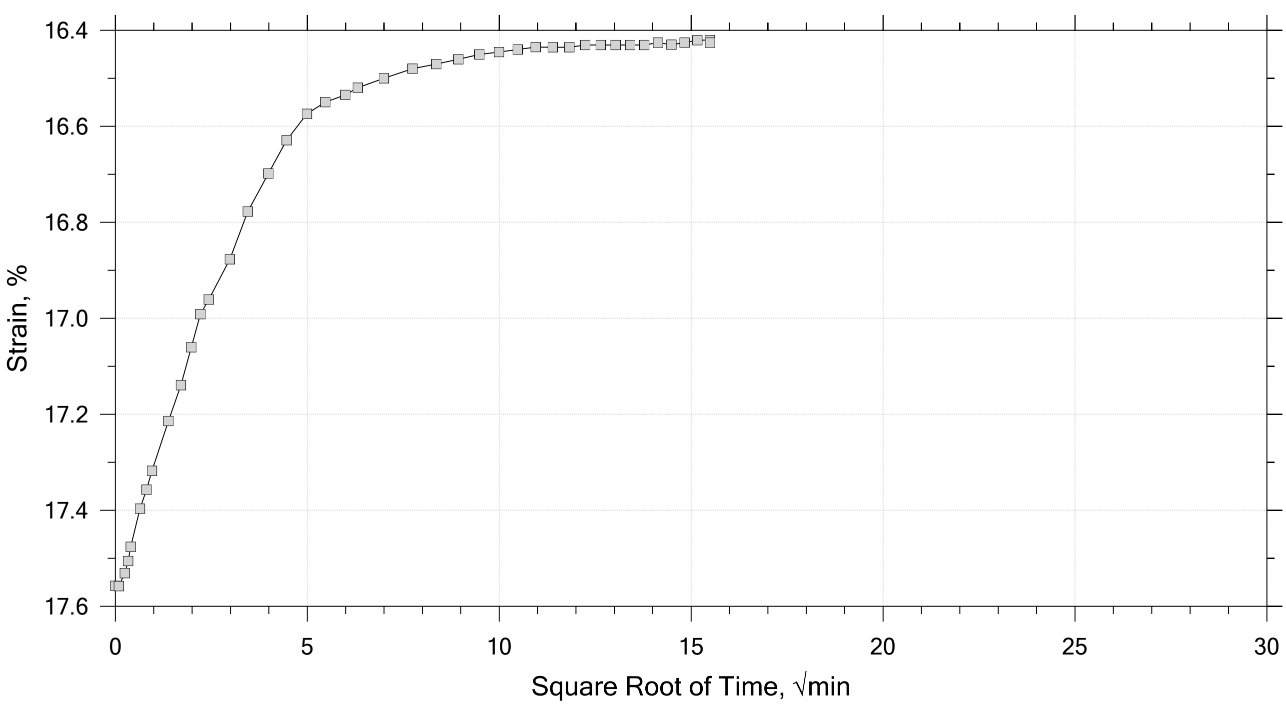
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 17 of 18

Constant Load Step

Stress: 0.5 tsf





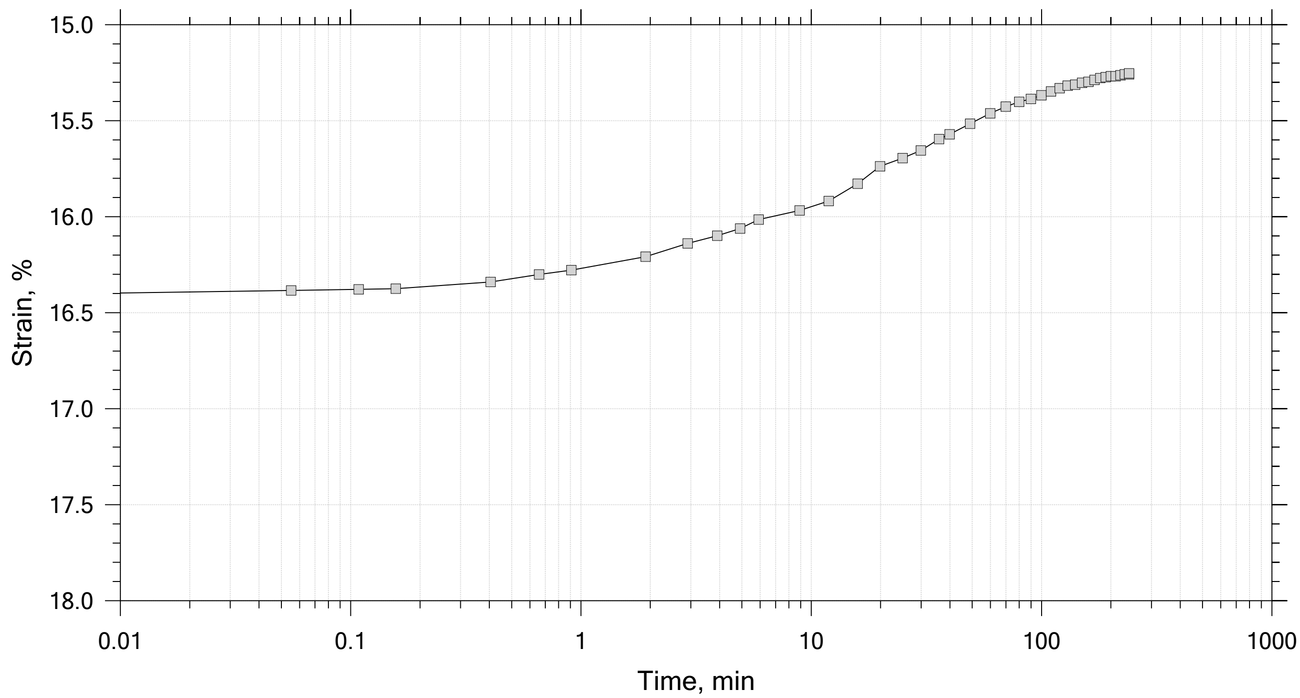
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		

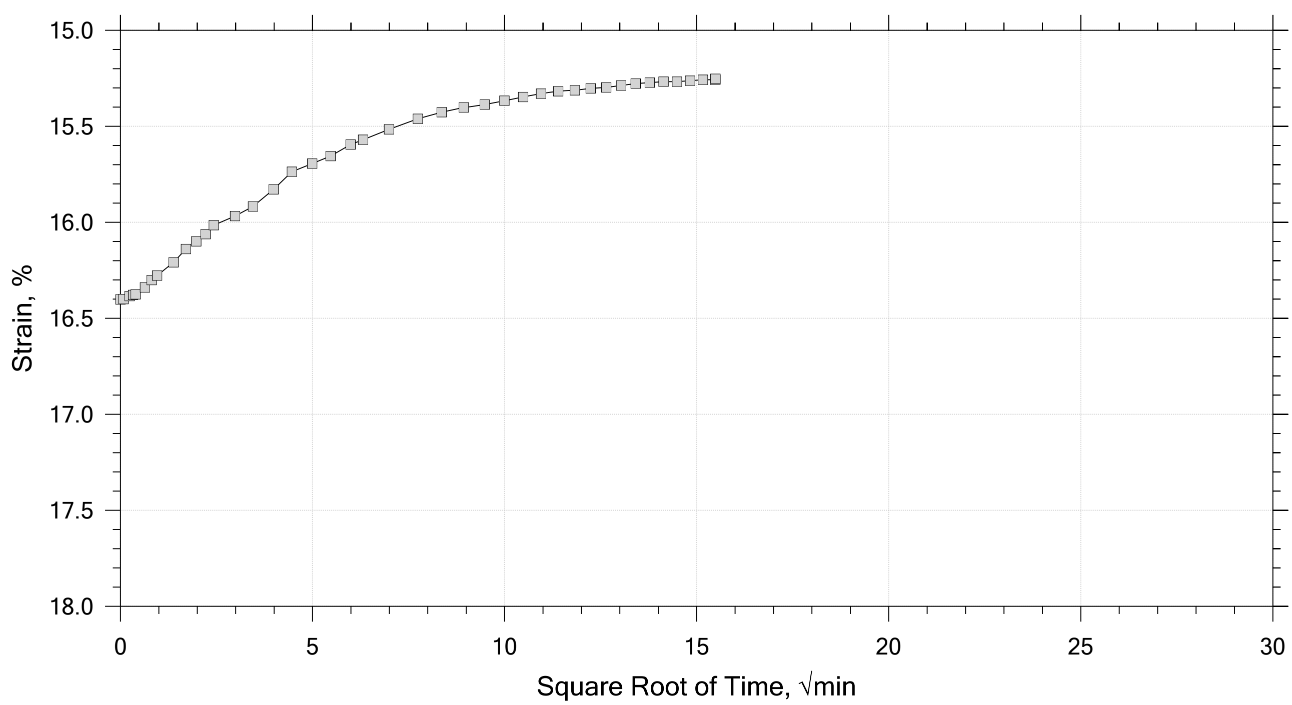
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 18 of 18

Constant Load Step

Stress: 0.125 tsf





Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
Test No.: IP-2	Sample Type: Intact	Elevation: ---
Description: Moist, dark grayish brown clay		
Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.74	Liquid Limit: 32
Initial Height: 1.00 in	Initial Void Ratio: 0.758	Plastic Limit: 20
Final Height: 0.85 in	Final Void Ratio: 0.49	Plasticity Index: 12

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	E3616	RING		E6553
Mass Container, gm	8.53	109.73	109.73	7.94
Mass Container + Wet Soil, gm	223.49	267.92	257.49	65.2
Mass Container + Dry Soil, gm	177.83	235.07	235.07	56.51
Mass Dry Soil, gm	169.3	125.34	125.34	48.57
Water Content, %	26.97	26.21	17.89	17.89
Void Ratio	---	0.76	0.49	---
Degree of Saturation, %	---	94.70	100.00	---
Dry Unit Weight, pcf	---	97.271	114.78	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test.
Therefore, values may not represent actual values for the specimen.

Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
Test No.: IP-2	Sample Type: Intact	Elevation: ---
Description: Moist, dark grayish brown clay		
Remarks: TX-012, Swell Pressure = 0.0629 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

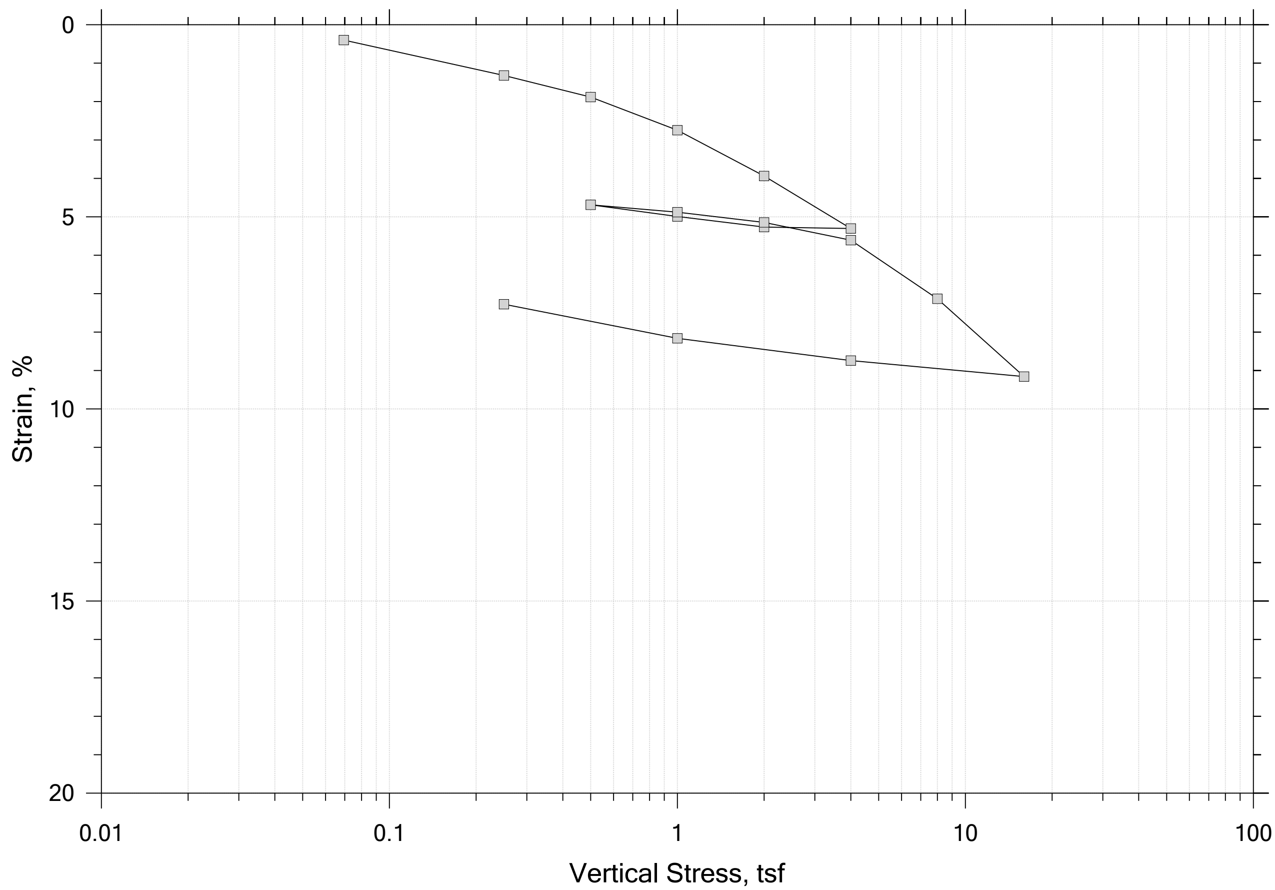
Square Root of Time Coefficients

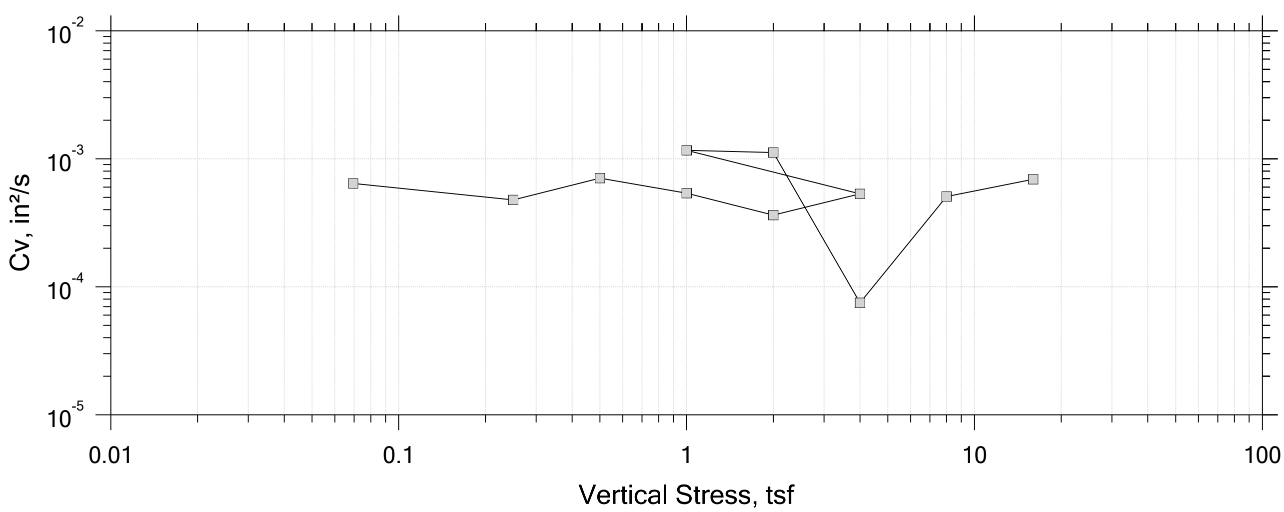
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in^2/s	Mv 1/tsf	k ft/day
1	0.0629	0.01194	0.737	1.19	168.081	2.08e-05	1.90e-01	7.39e-05
2	0.250	0.04343	0.682	4.34	43.890	7.61e-05	1.68e-01	2.40e-04
3	0.500	0.06025	0.652	6.02	53.917	5.89e-05	6.73e-02	7.42e-05
4	1.00	0.08317	0.612	8.32	34.511	8.82e-05	4.58e-02	7.57e-05
5	2.00	0.1080	0.568	10.8	24.825	1.16e-04	2.49e-02	5.42e-05
6	4.00	0.1341	0.523	13.4	22.302	1.22e-04	1.30e-02	2.99e-05
7	2.00	0.1315	0.527	13.2	5.027	5.29e-04	1.29e-03	1.28e-05
8	1.00	0.1282	0.533	12.8	8.060	3.32e-04	3.27e-03	2.03e-05
9	0.500	0.1246	0.539	12.5	19.775	1.36e-04	7.25e-03	1.85e-05
10	1.00	0.1272	0.535	12.7	5.708	4.73e-04	5.17e-03	4.58e-05
11	2.00	0.1305	0.529	13.0	7.038	3.81e-04	3.27e-03	2.34e-05
12	4.00	0.1385	0.515	13.9	22.098	1.20e-04	4.02e-03	9.02e-06
13	8.00	0.1606	0.476	16.1	13.055	1.96e-04	5.53e-03	2.03e-05
14	16.0	0.1872	0.429	18.7	11.076	2.18e-04	3.32e-03	1.35e-05
15	8.00	0.1843	0.434	18.4	2.942	7.96e-04	3.68e-04	5.49e-06
16	2.00	0.1755	0.450	17.5	8.311	2.86e-04	1.47e-03	7.85e-06
17	0.500	0.1643	0.470	16.4	15.165	1.61e-04	7.48e-03	2.25e-05
18	0.125	0.1525	0.490	15.3	47.174	5.31e-05	3.13e-02	3.11e-05

GeoTesting EXPRESS	Project: Lubec Breakwater	Location: Lubec, ME	Project No.: GTX-317770
	Boring No.: Wb-6/ U-1	Tested By: sjt/ jlw	Checked By: mcm
	Sample No.: L-332-23	Test Date: 9/15/23	Depth: 4-6'
	Test No.: IP-2	Sample Type: Intact	Elevation: ---
	Description: Moist, dark grayish brown clay		
	Remarks: TX-012, Swell Pressure = 0.0629 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report





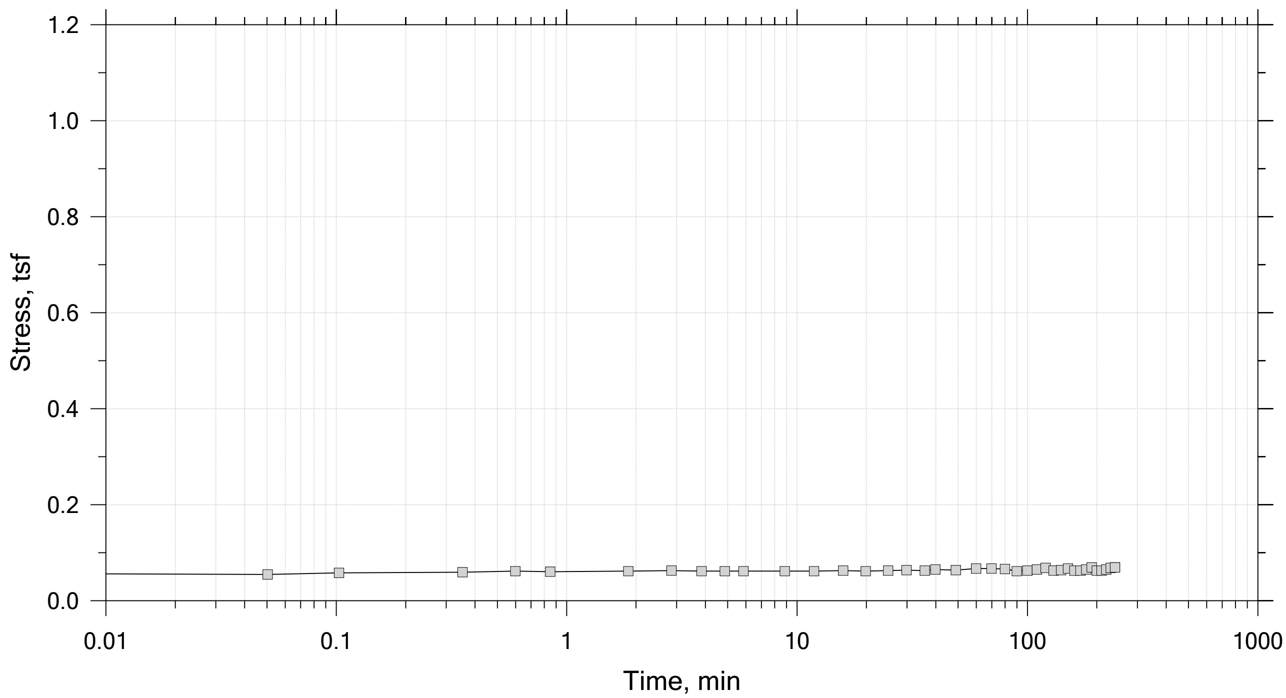
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		
	Displacement at End of Increment		

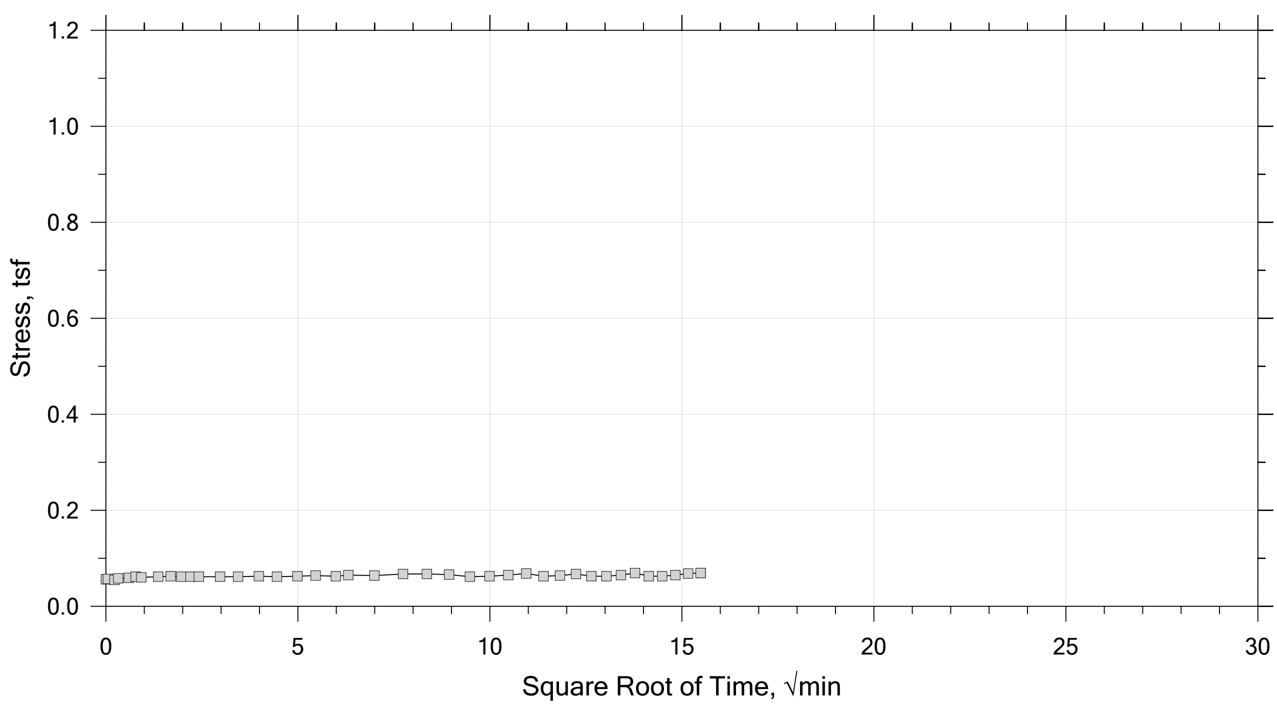
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 17

Constant Volume Step

Stress: 0.0694 tsf





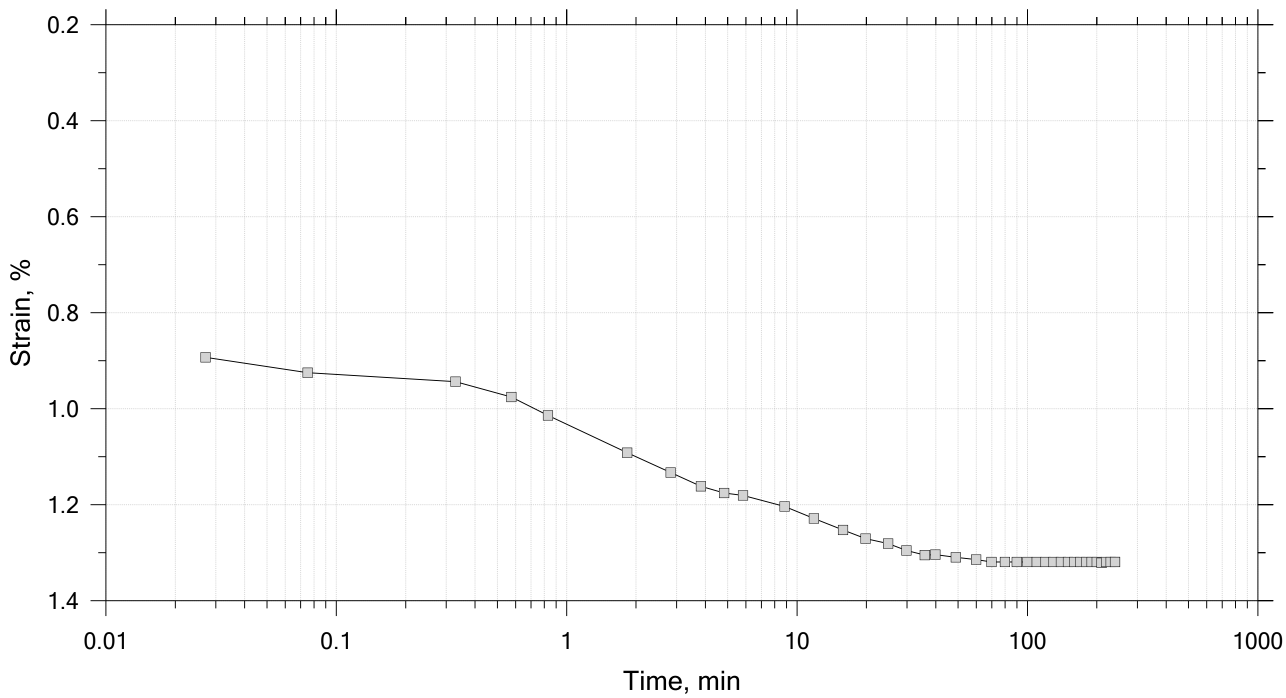
	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

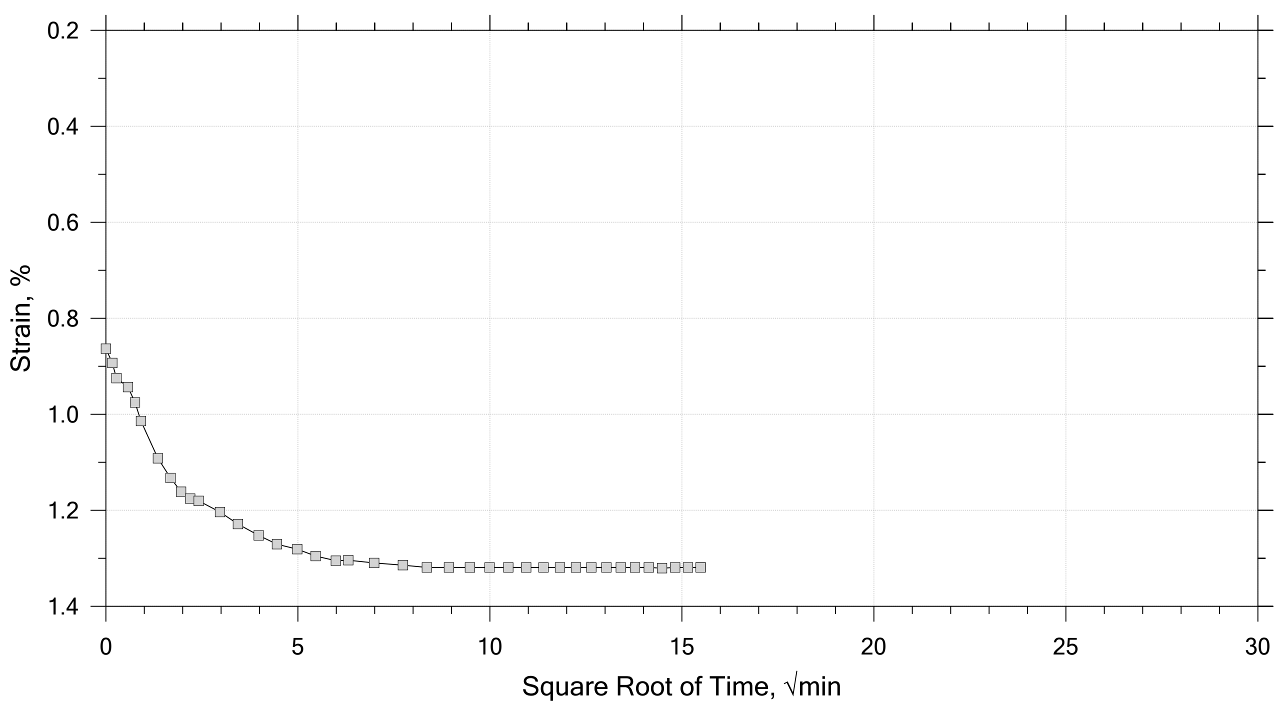
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 17

Constant Load Step

Stress: 0.25 tsf





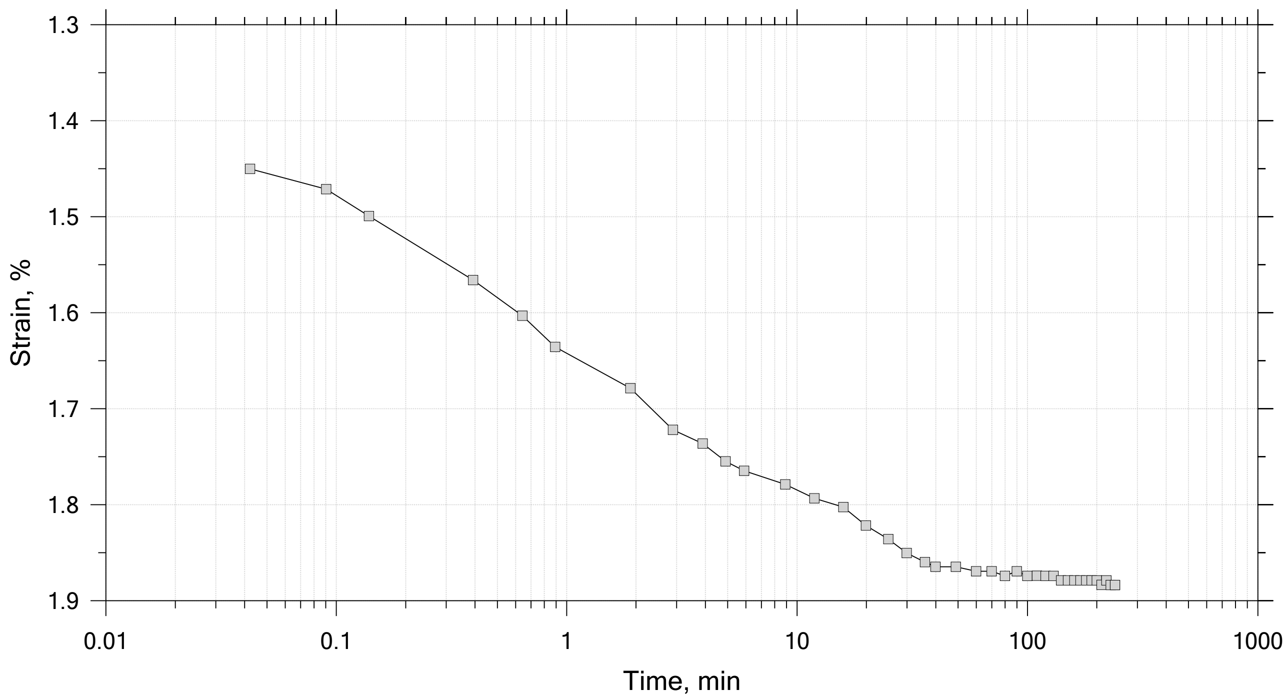
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

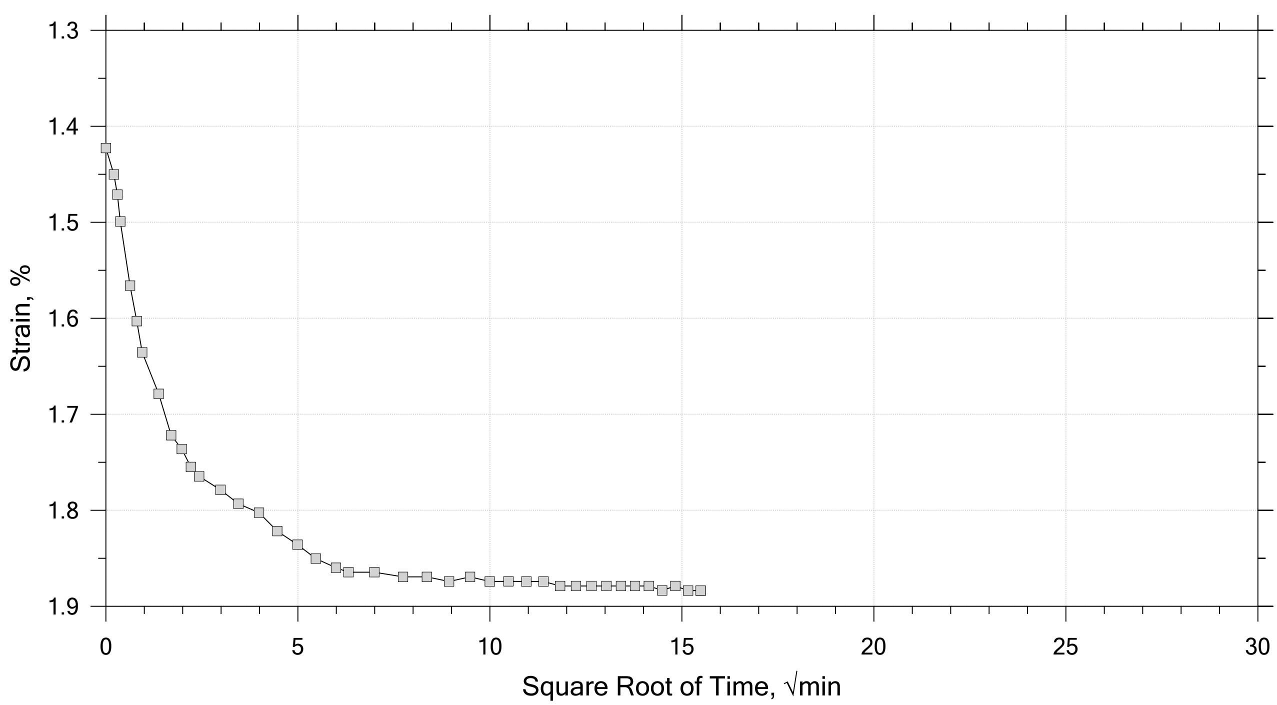
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 17

Constant Load Step

Stress: 0.5 tsf

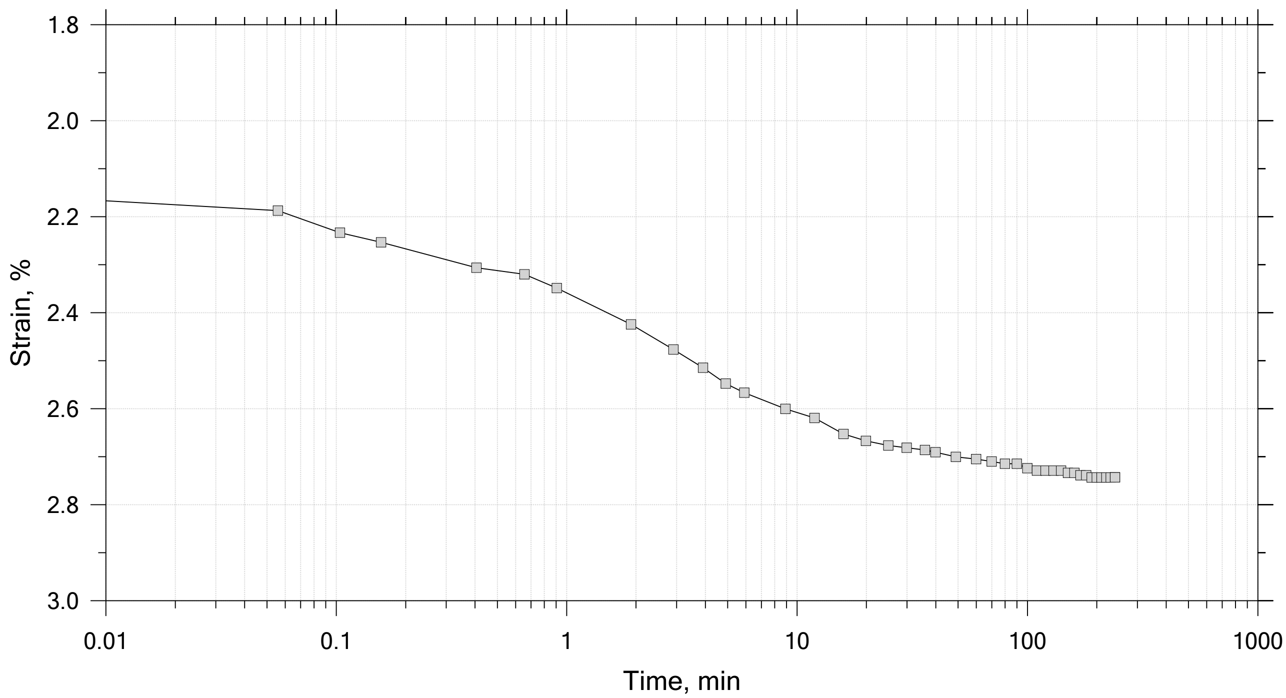


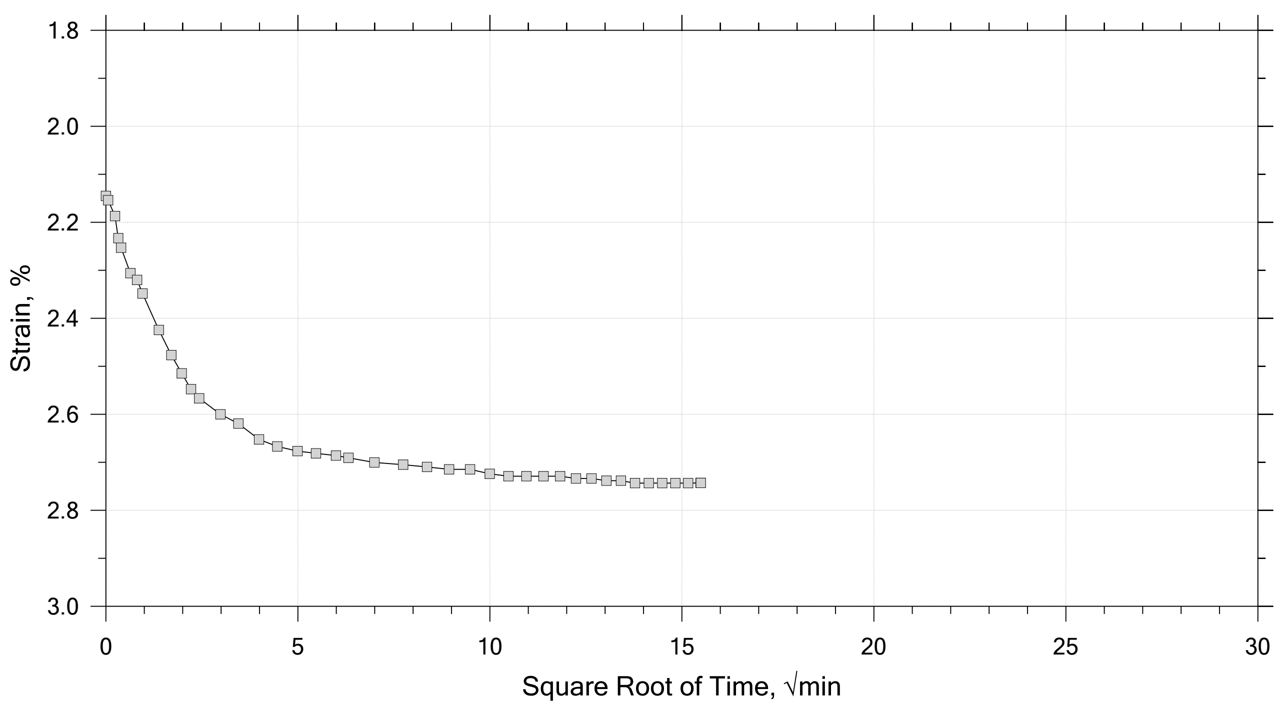


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 17
Constant Load Step
Stress: 1 tsf





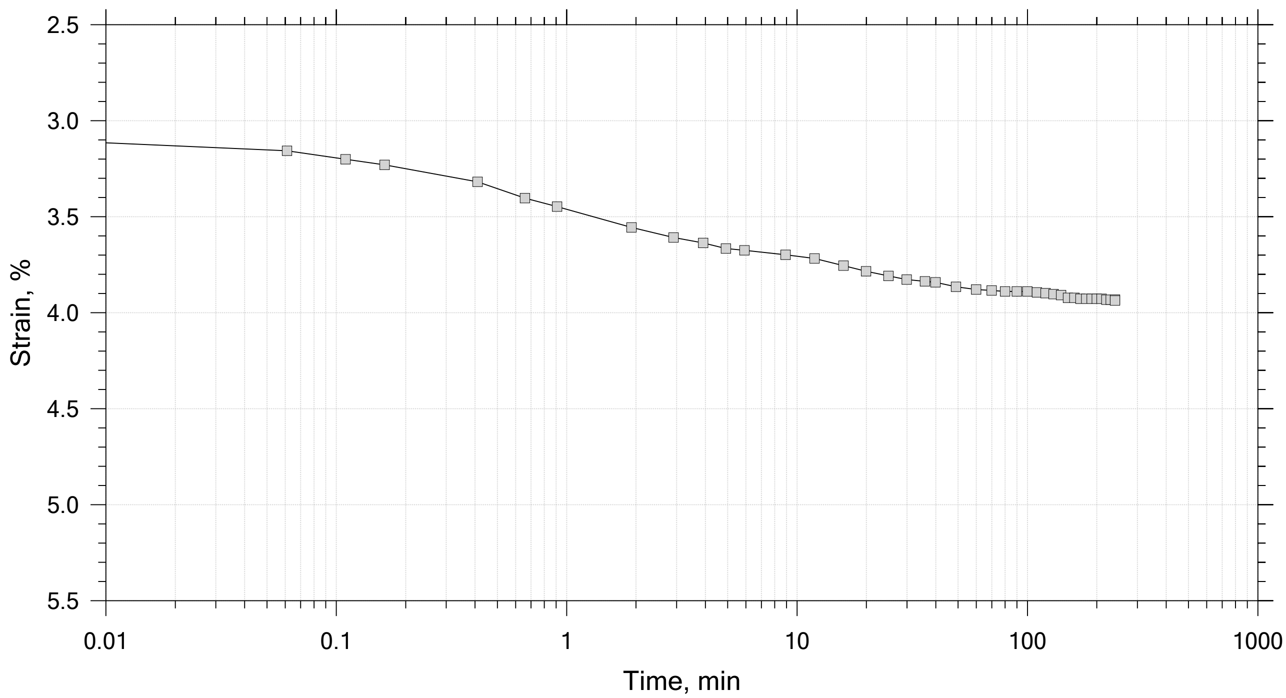
Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
Boring No.: WB-108	Tested By: sjt	Checked By: anm
Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
Test No.: IP-3R	Sample Type: intact	Elevation: ---
Description: Moist, gray clay		
Remarks: TX-018, Swell Pressure = 0.0694 tsf		

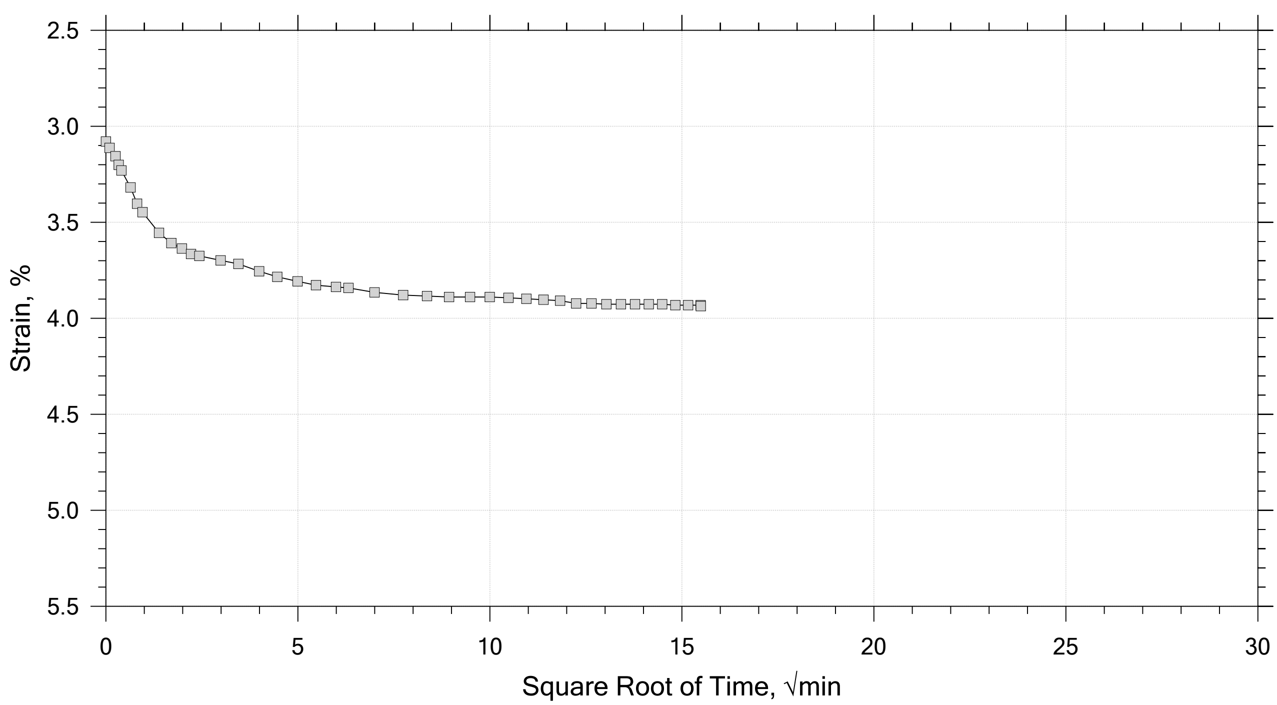
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 17

Constant Load Step

Stress: 2 tsf





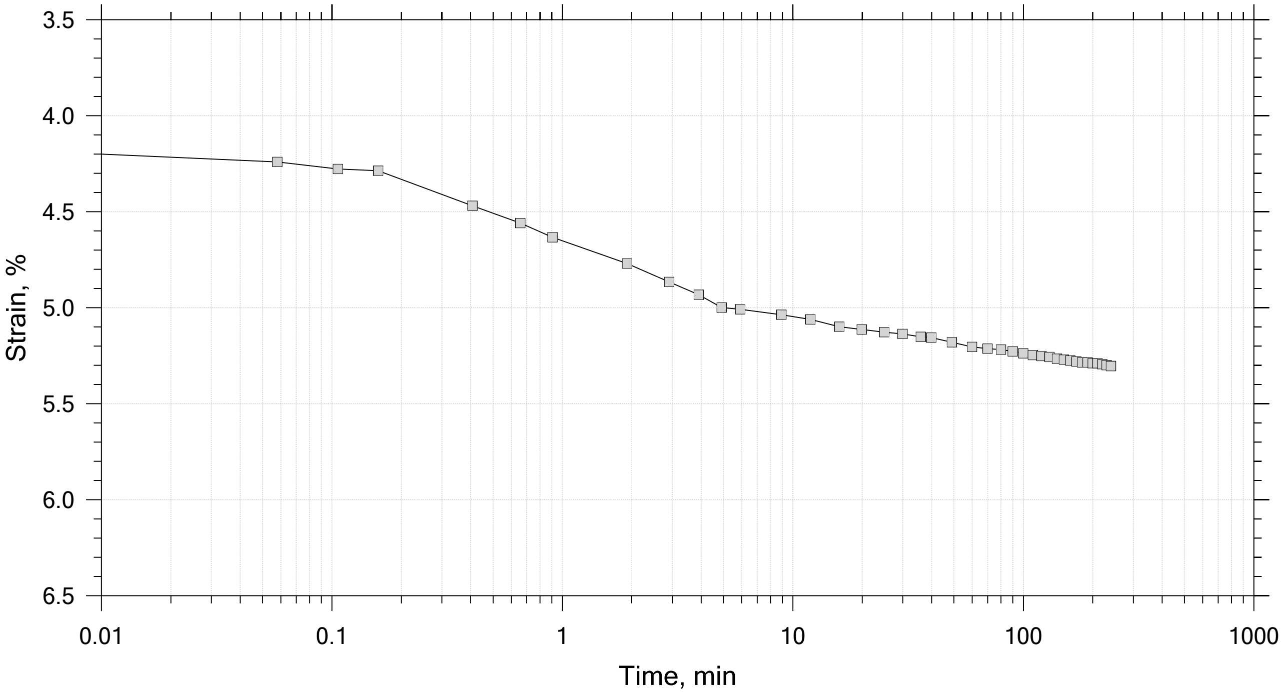
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

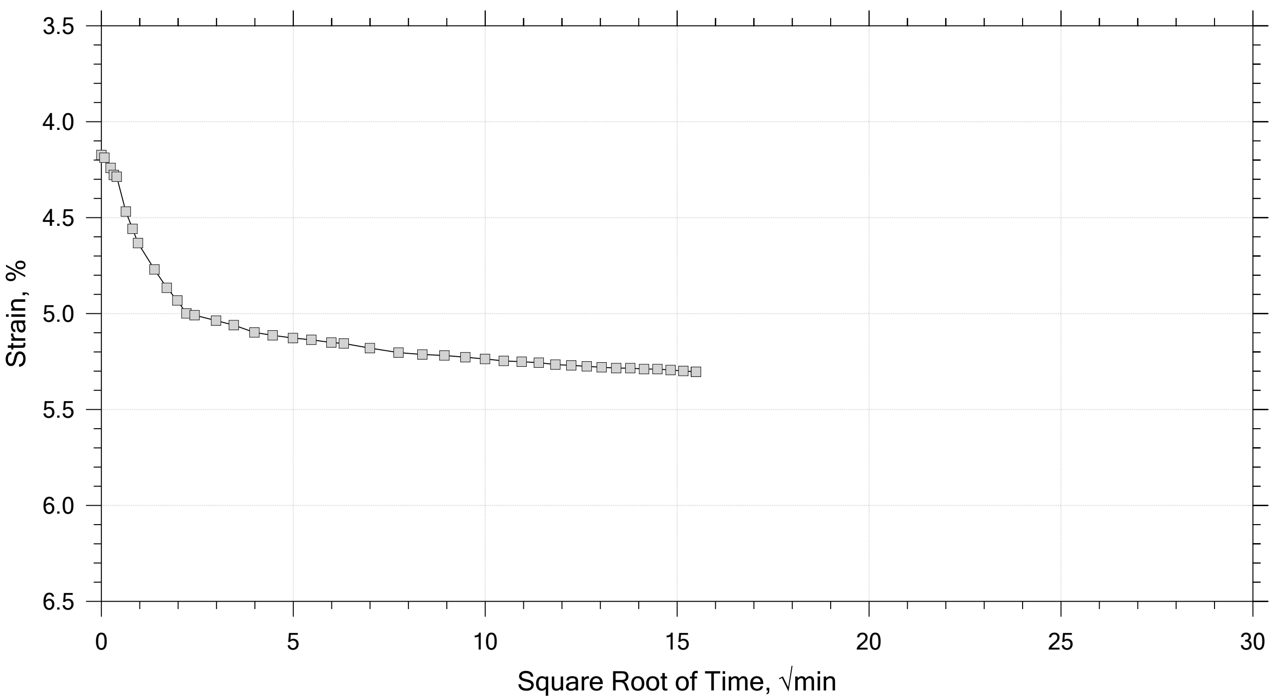
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 17

Constant Load Step

Stress: 4 tsf





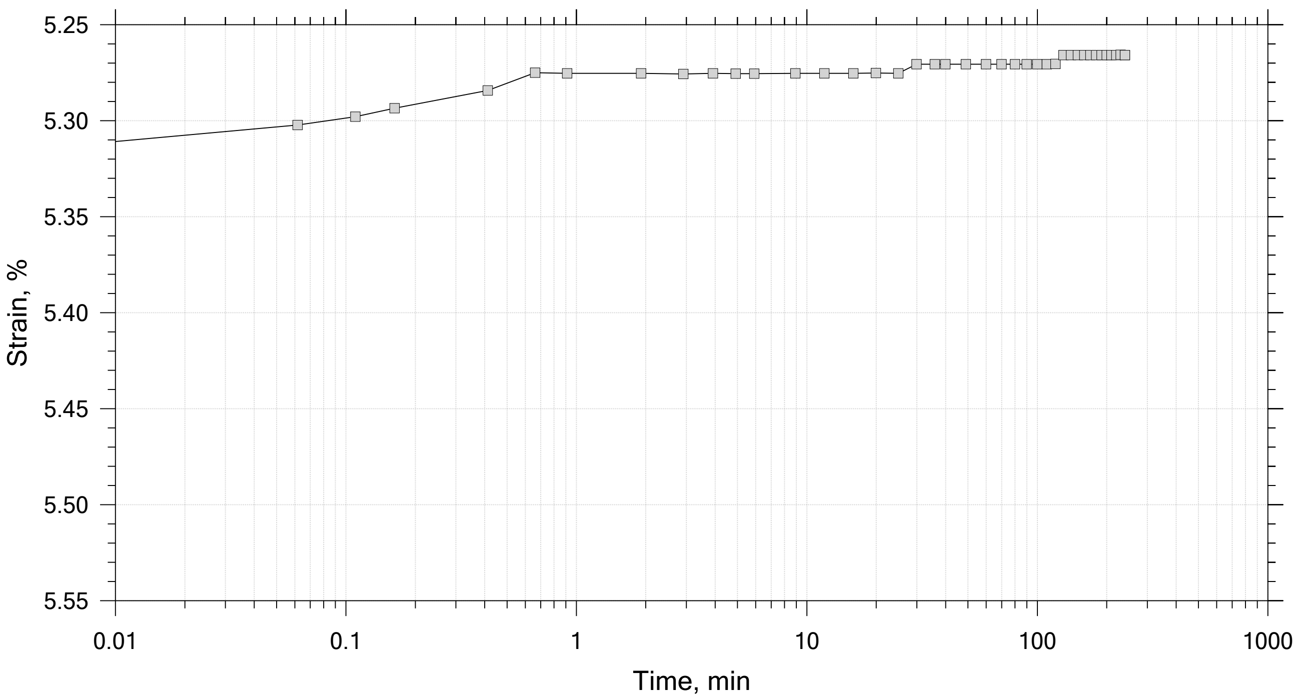
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

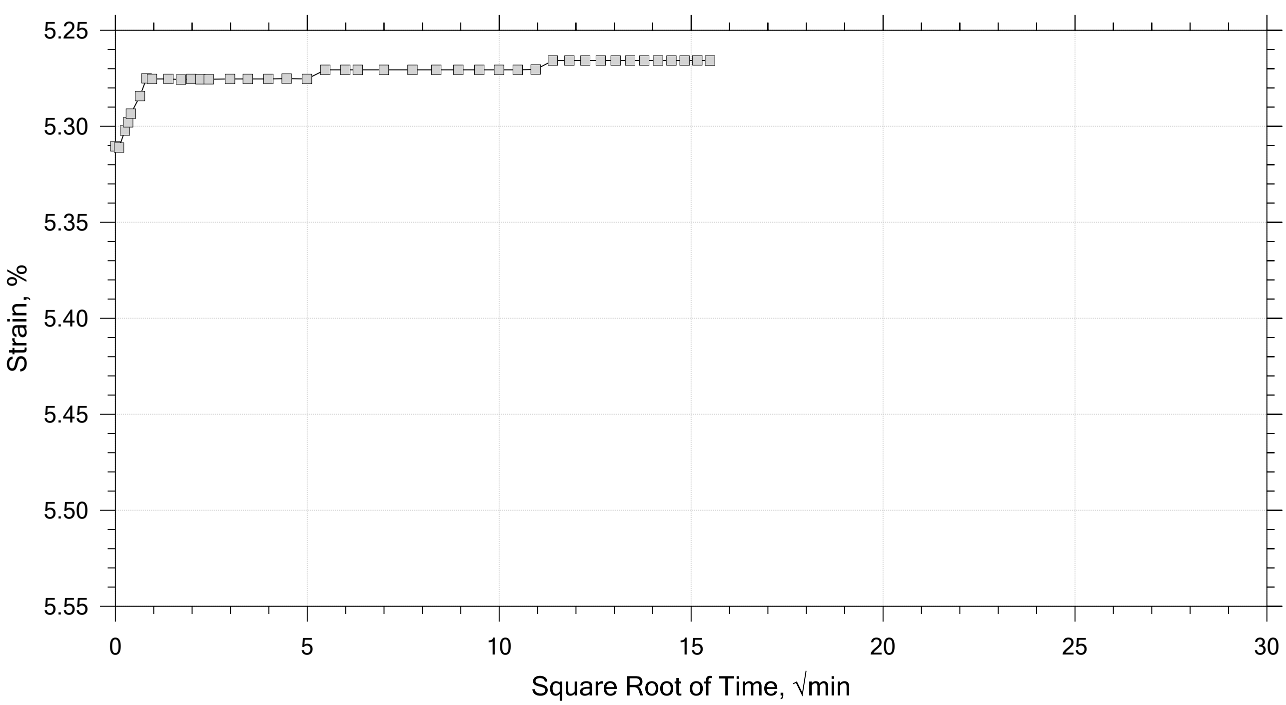
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 17

Constant Load Step

Stress: 2 tsf





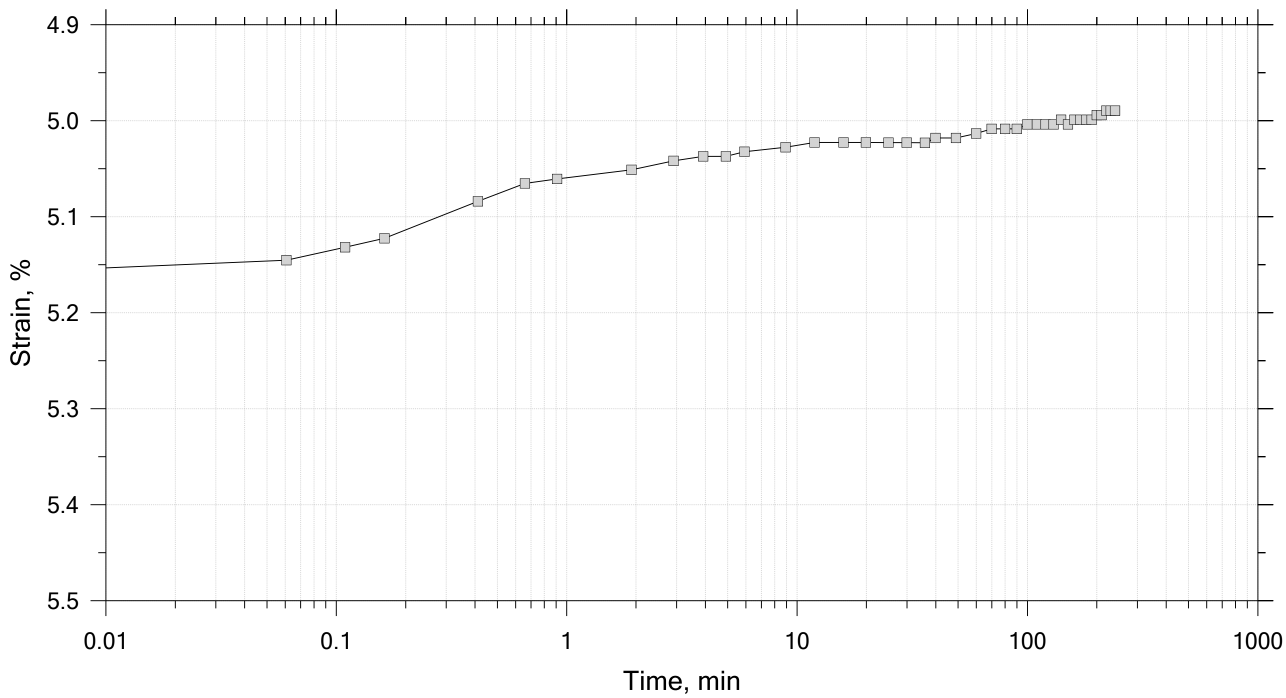
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

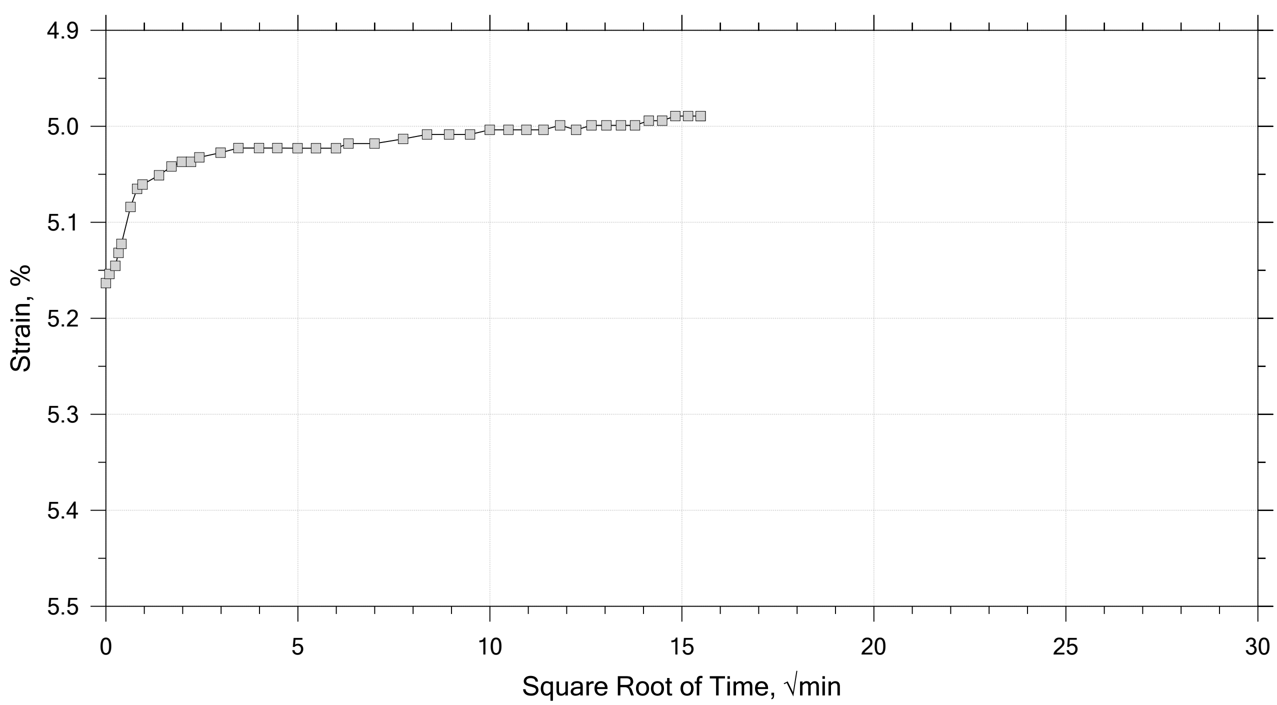
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 17

Constant Load Step

Stress: 1 tsf





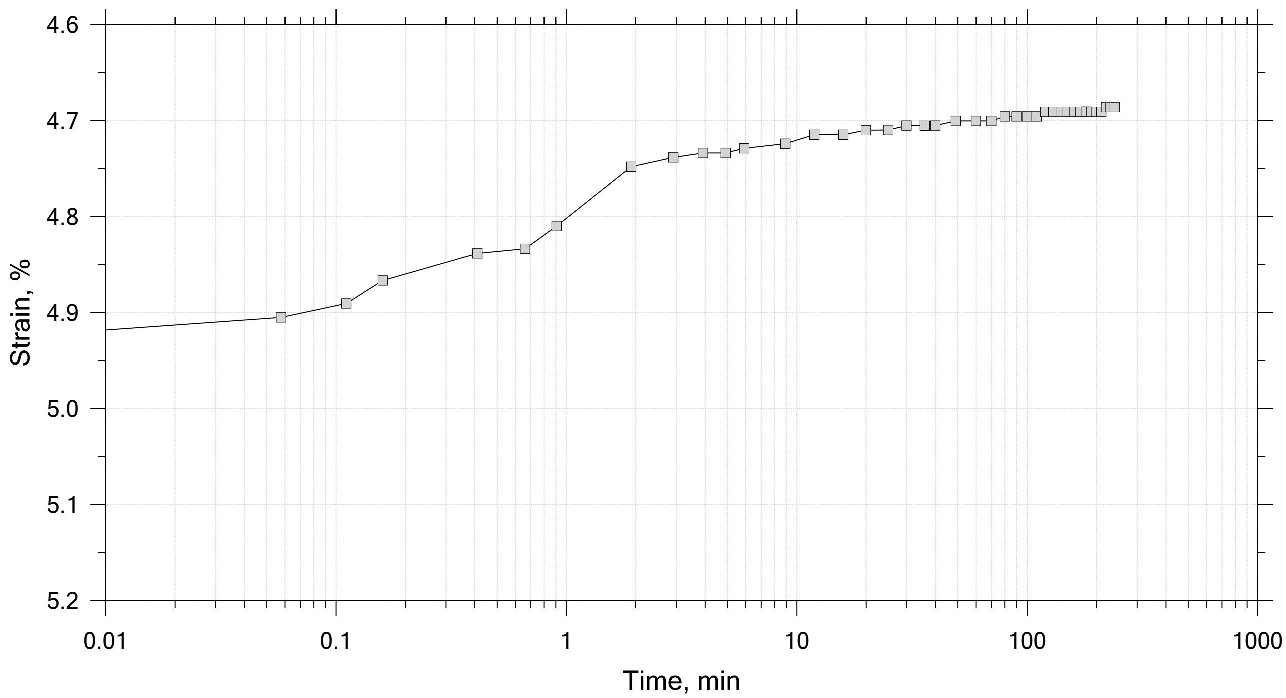
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

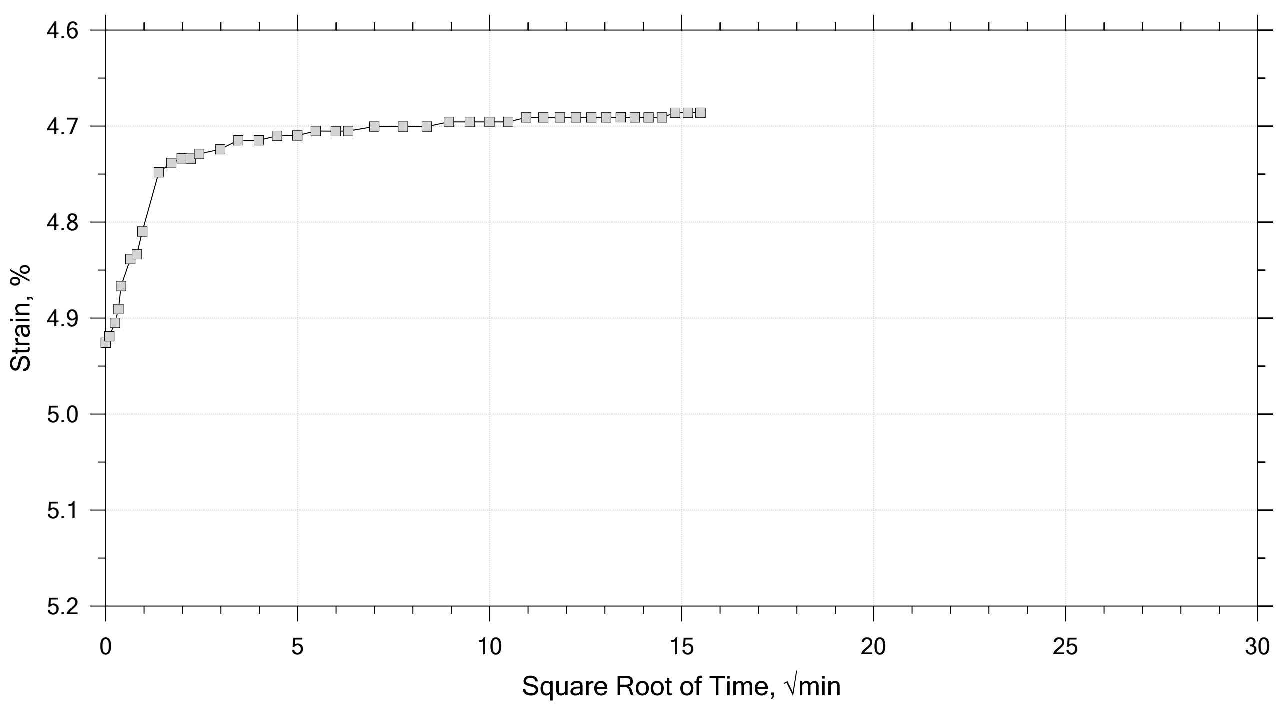
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 17

Constant Load Step

Stress: 0.5 tsf





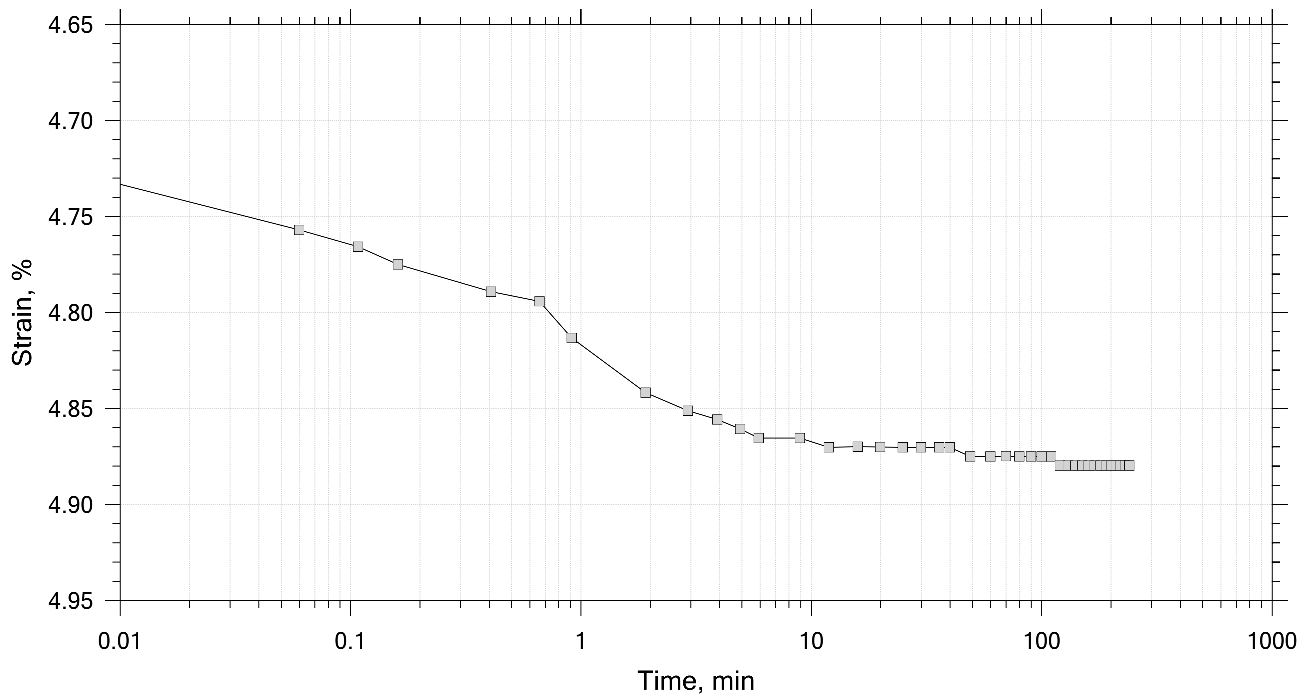
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

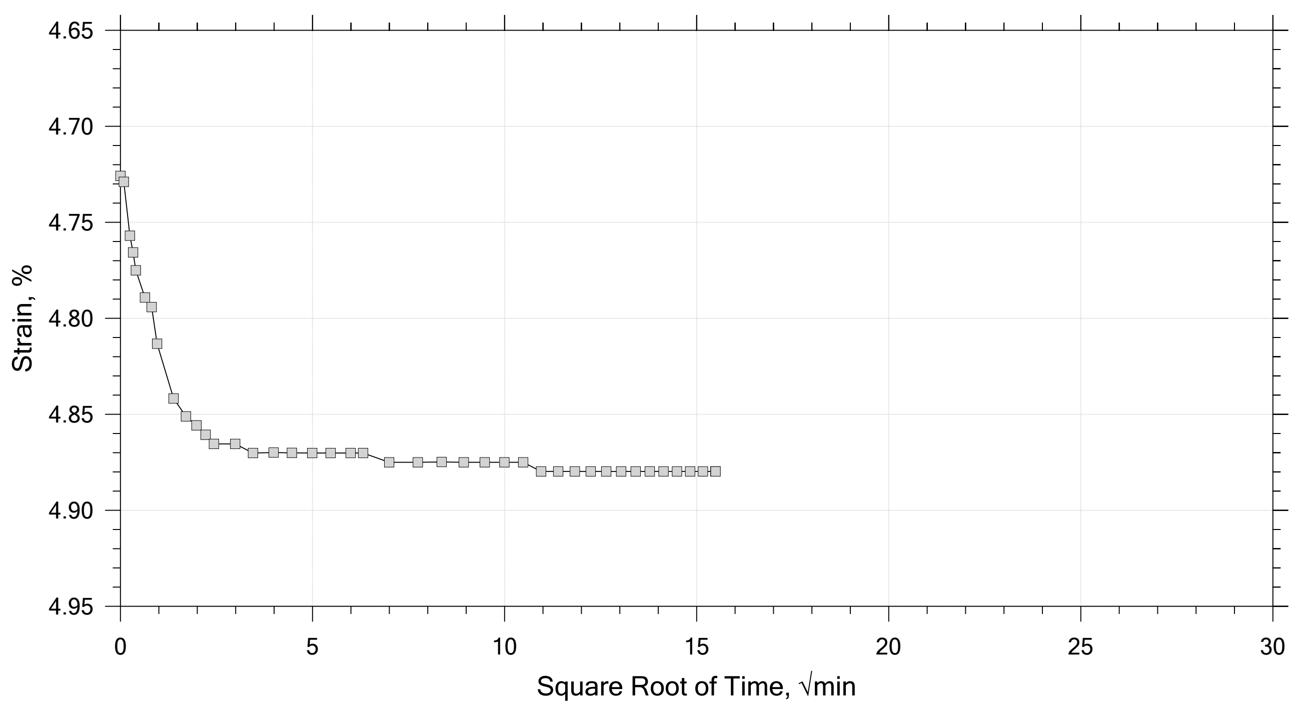
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 17

Constant Load Step

Stress: 1 tsf





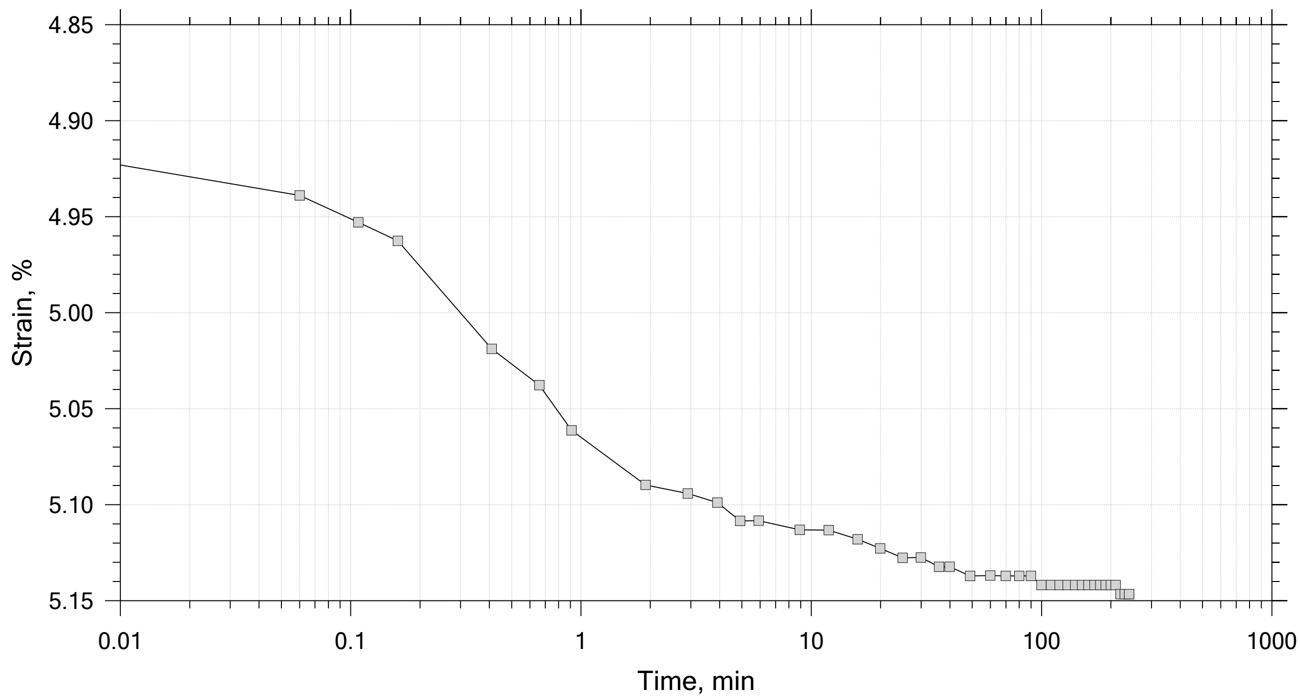
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

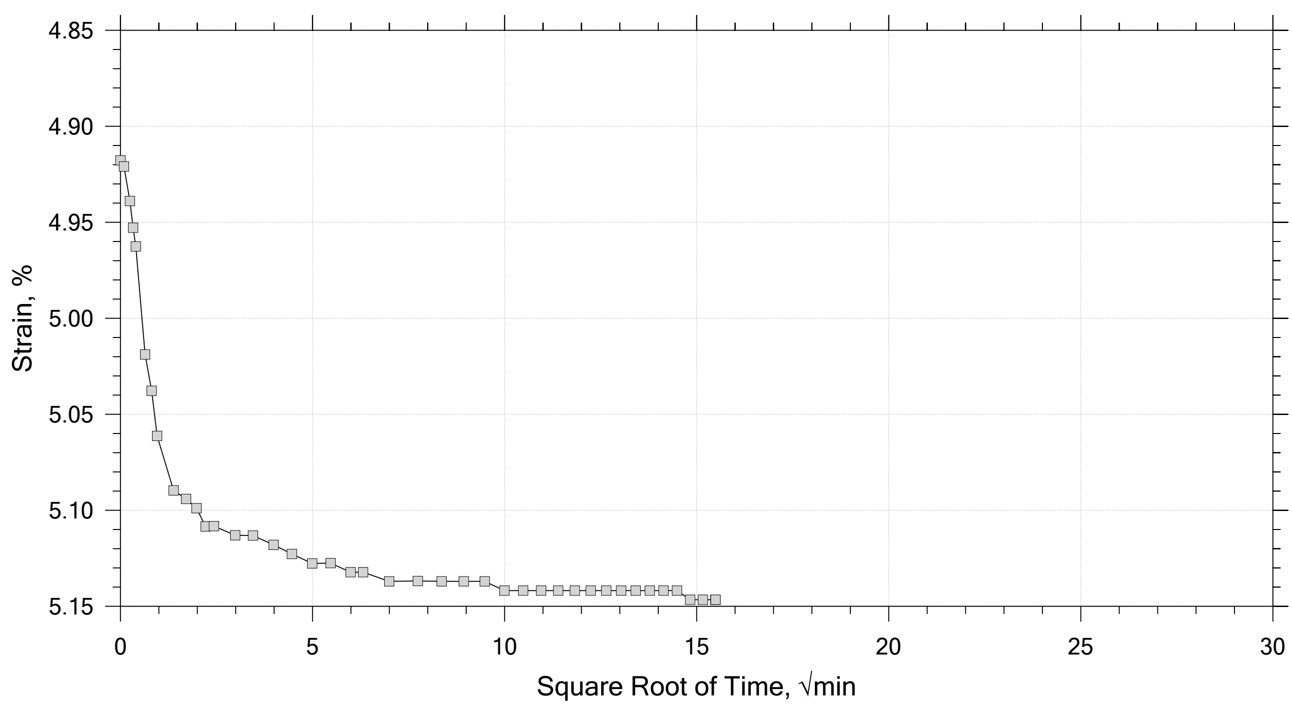
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 17

Constant Load Step

Stress: 2 tsf

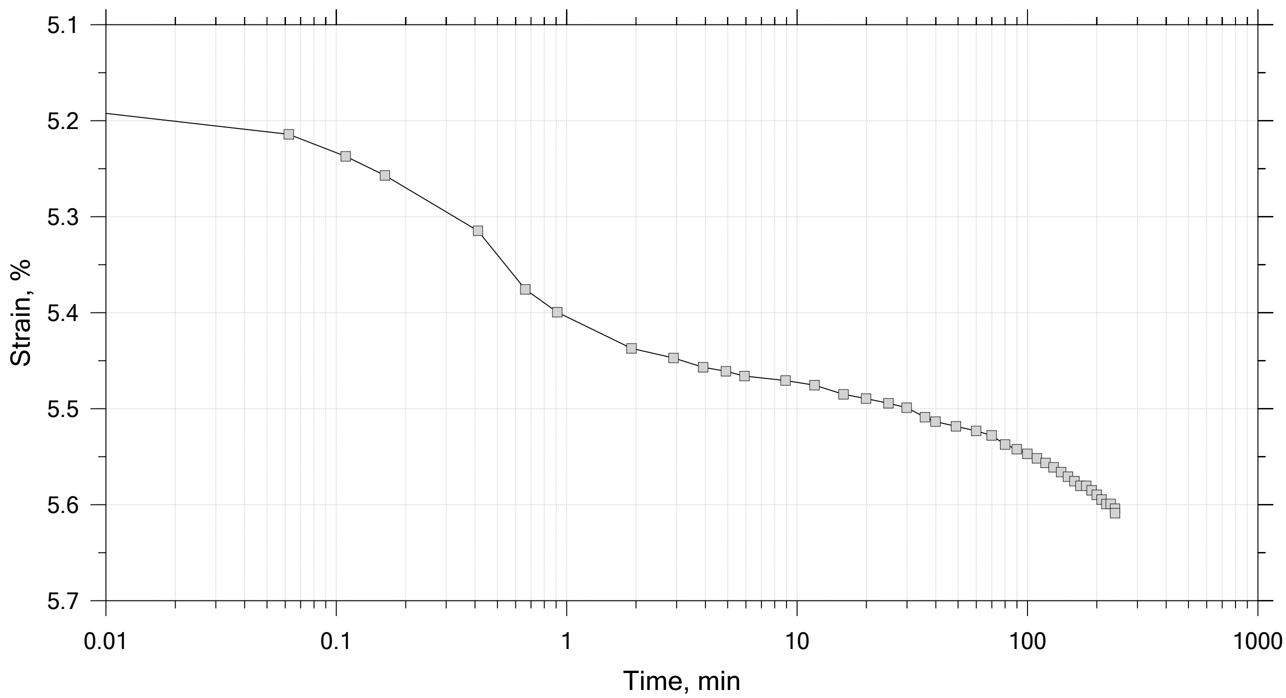


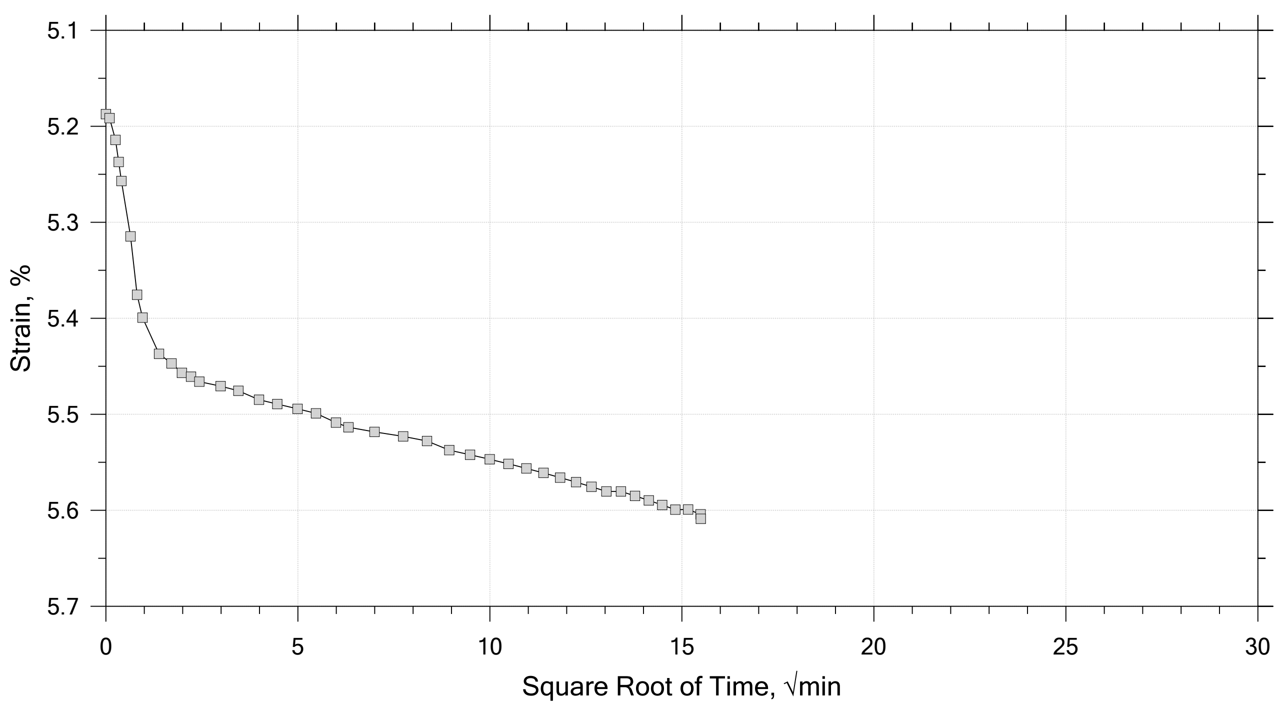


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 12 of 17
Constant Load Step
Stress: 4 tsf





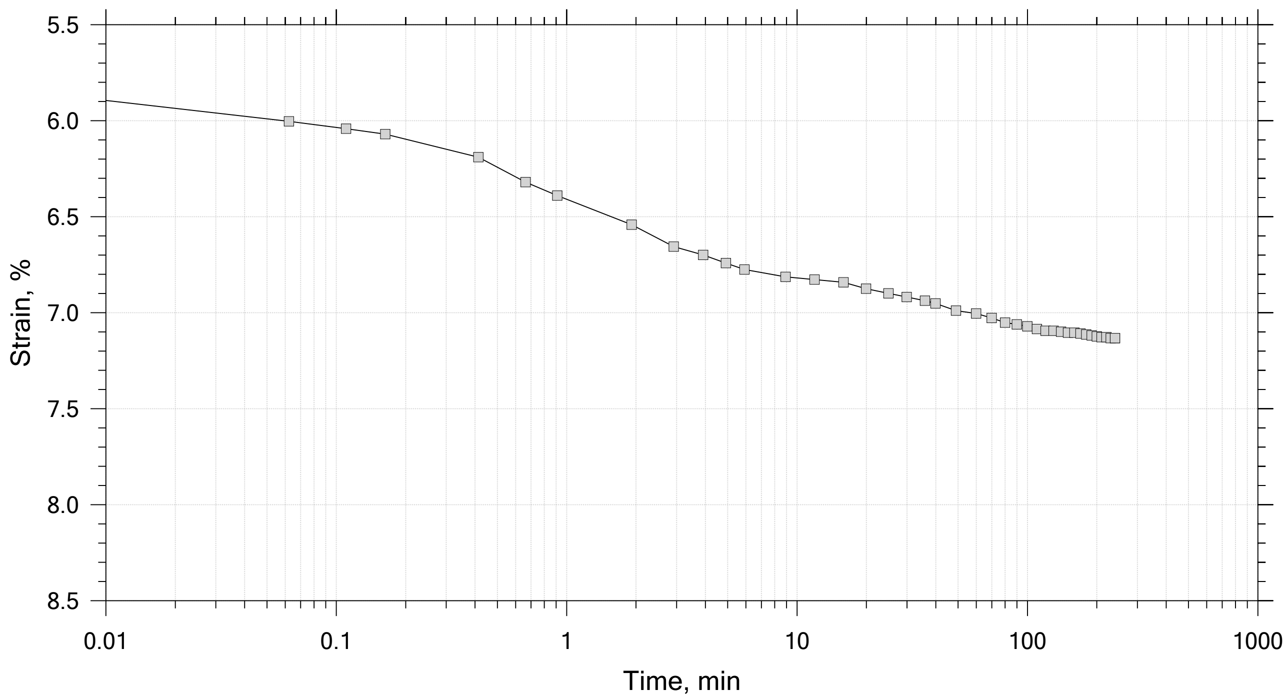
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

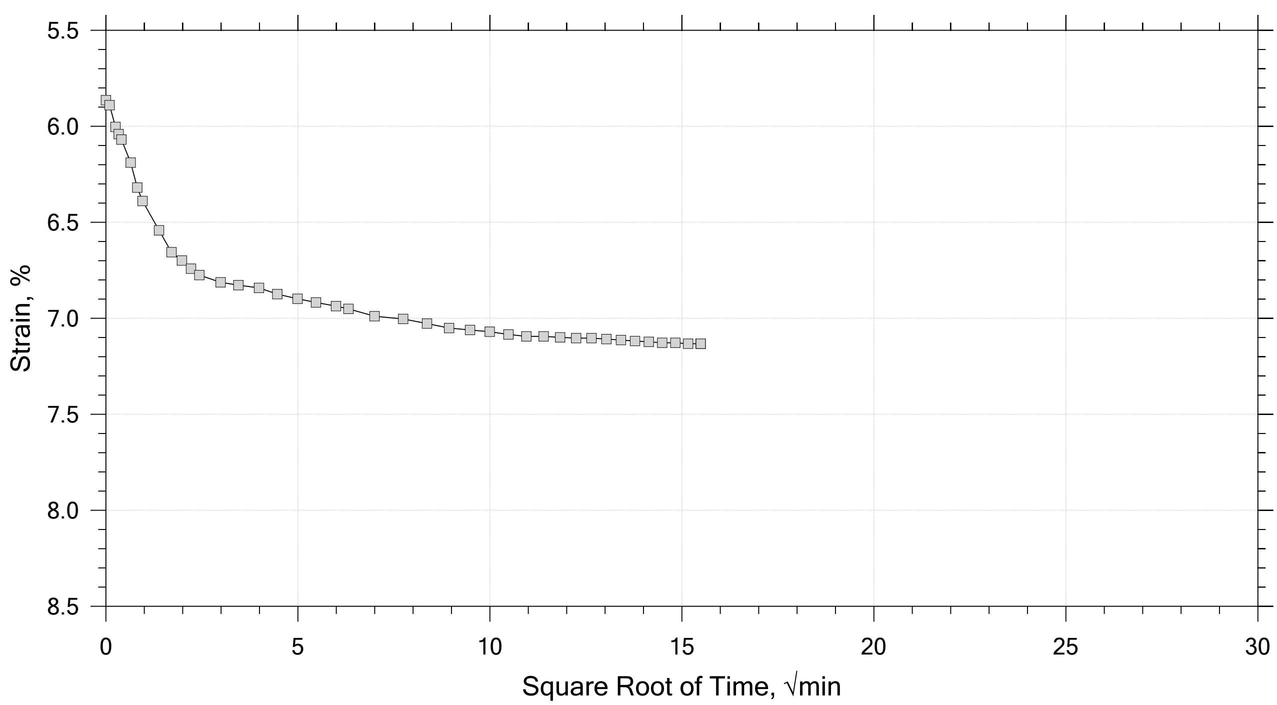
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 13 of 17

Constant Load Step

Stress: 8 tsf





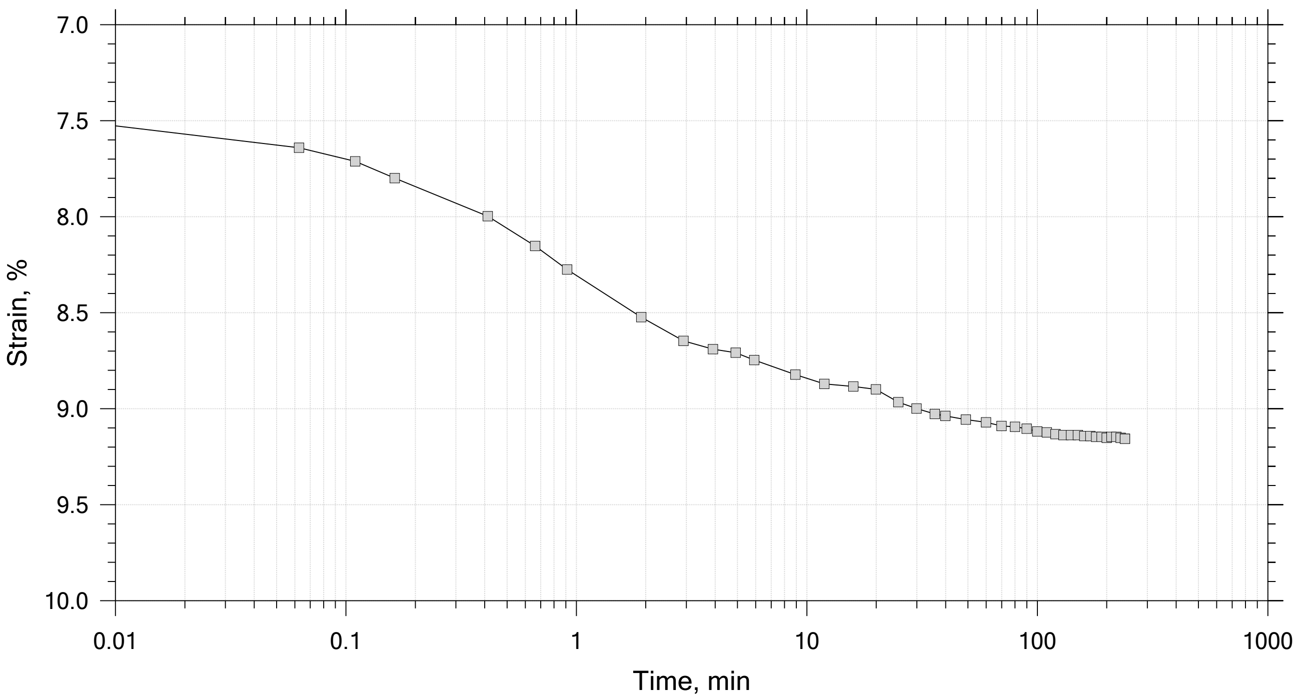
	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

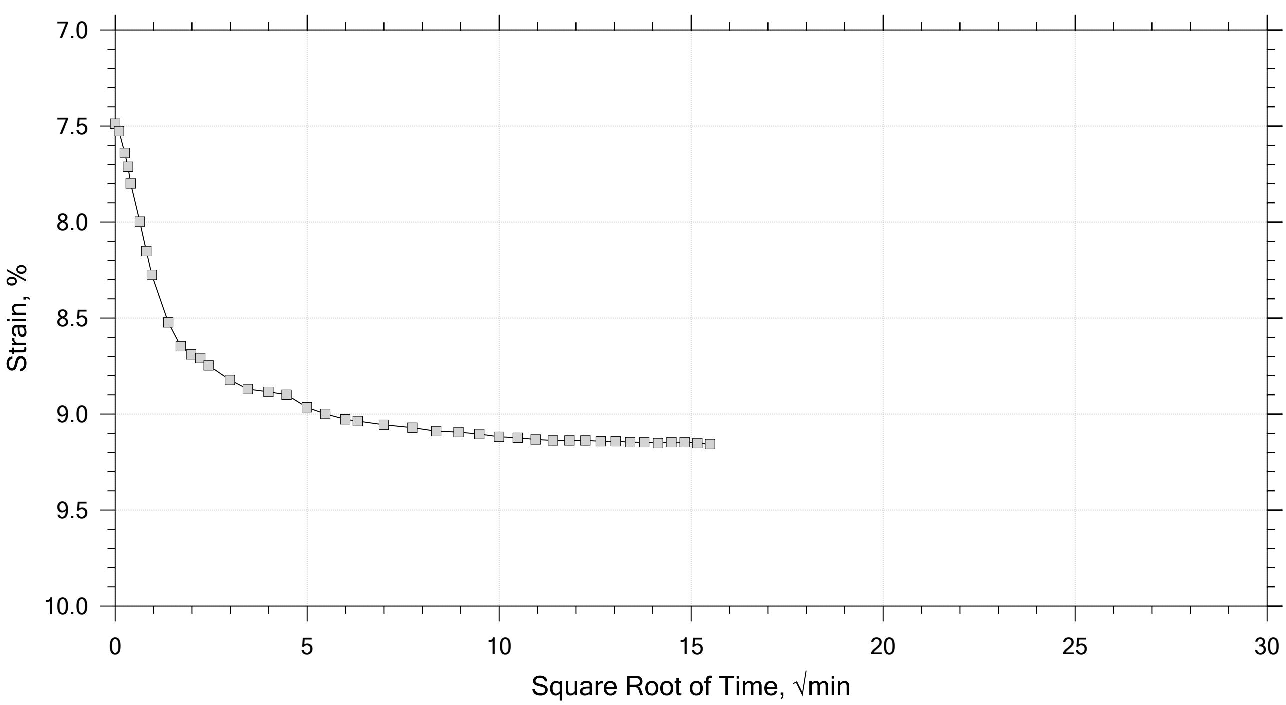
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 14 of 17

Constant Load Step

Stress: 16 tsf





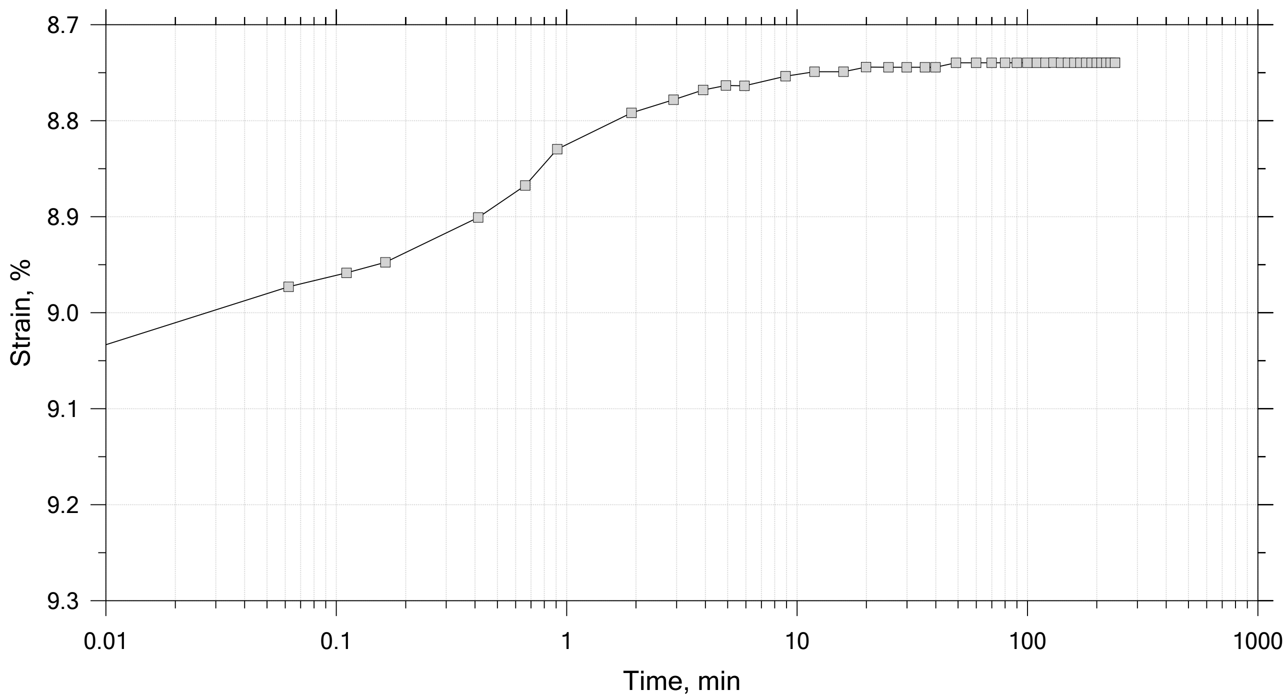
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

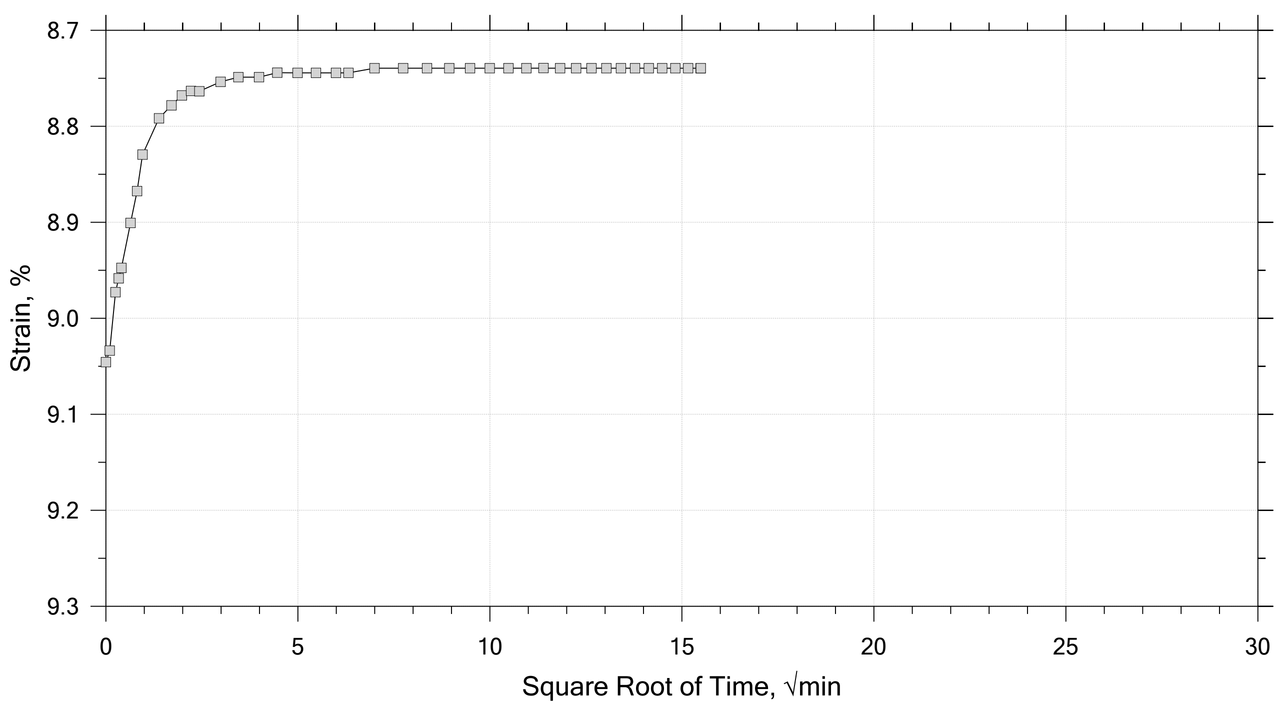
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 15 of 17

Constant Load Step

Stress: 4 tsf

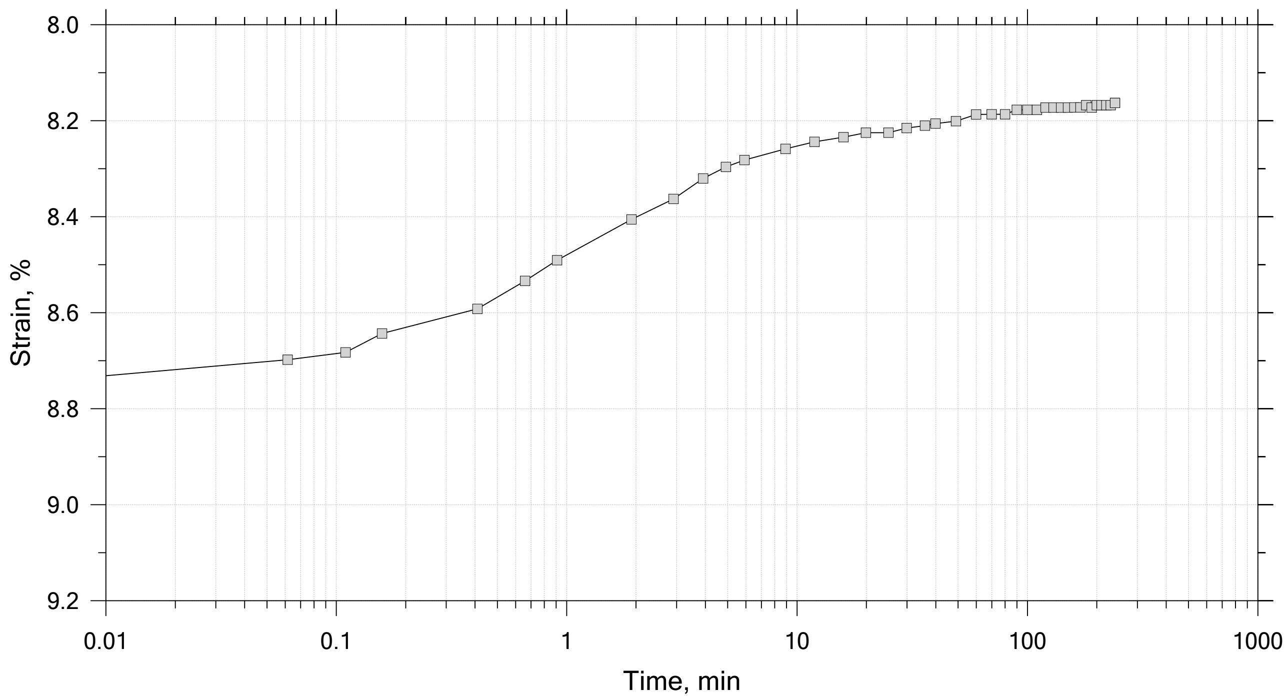


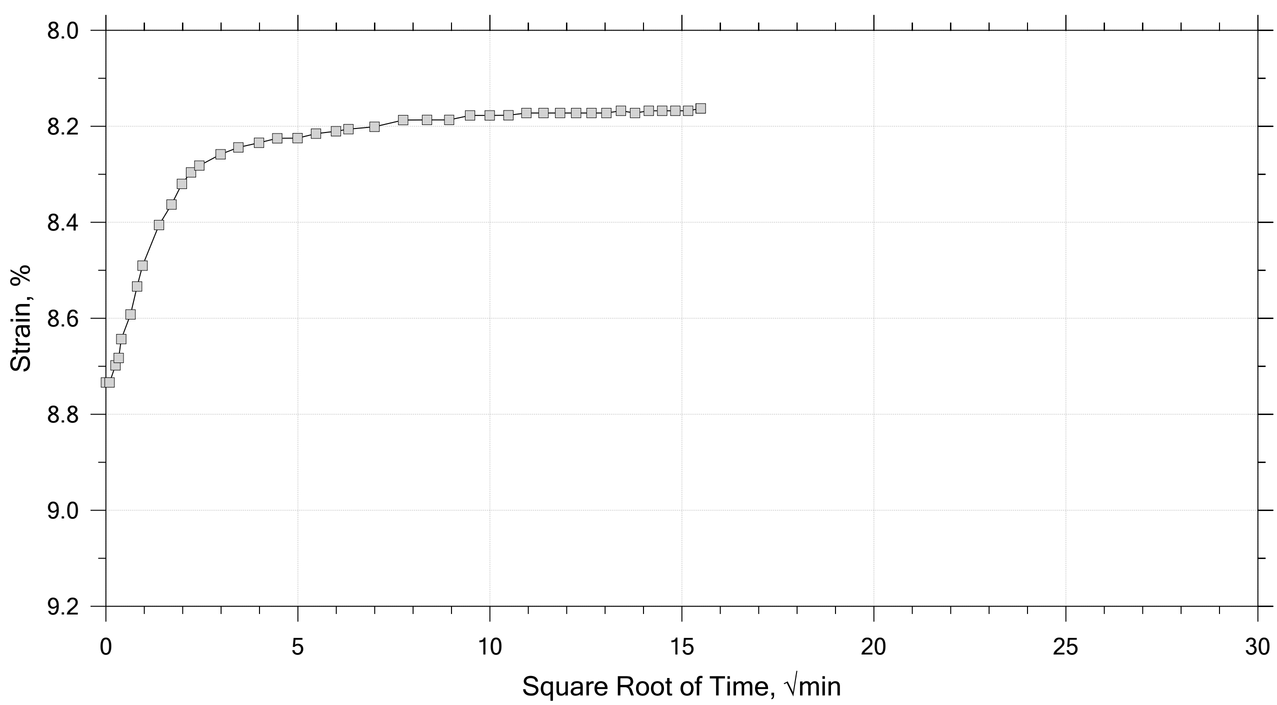


GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 16 of 17
Constant Load Step
Stress: 1 tsf





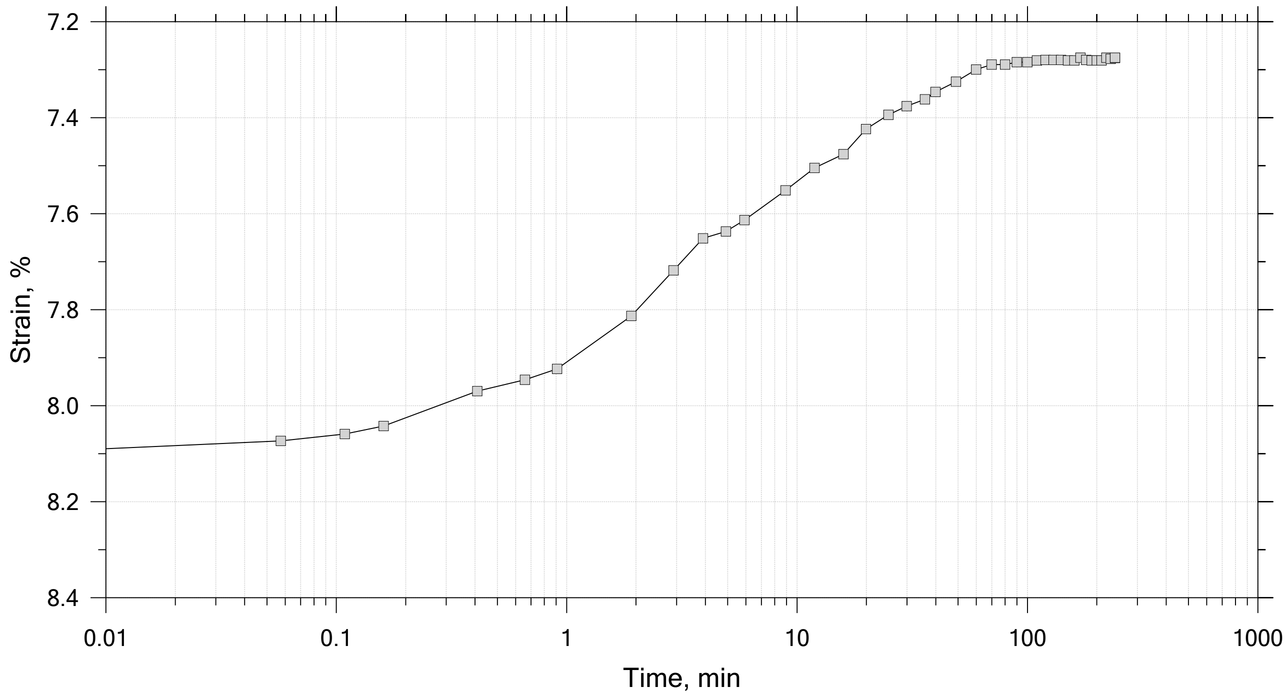
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

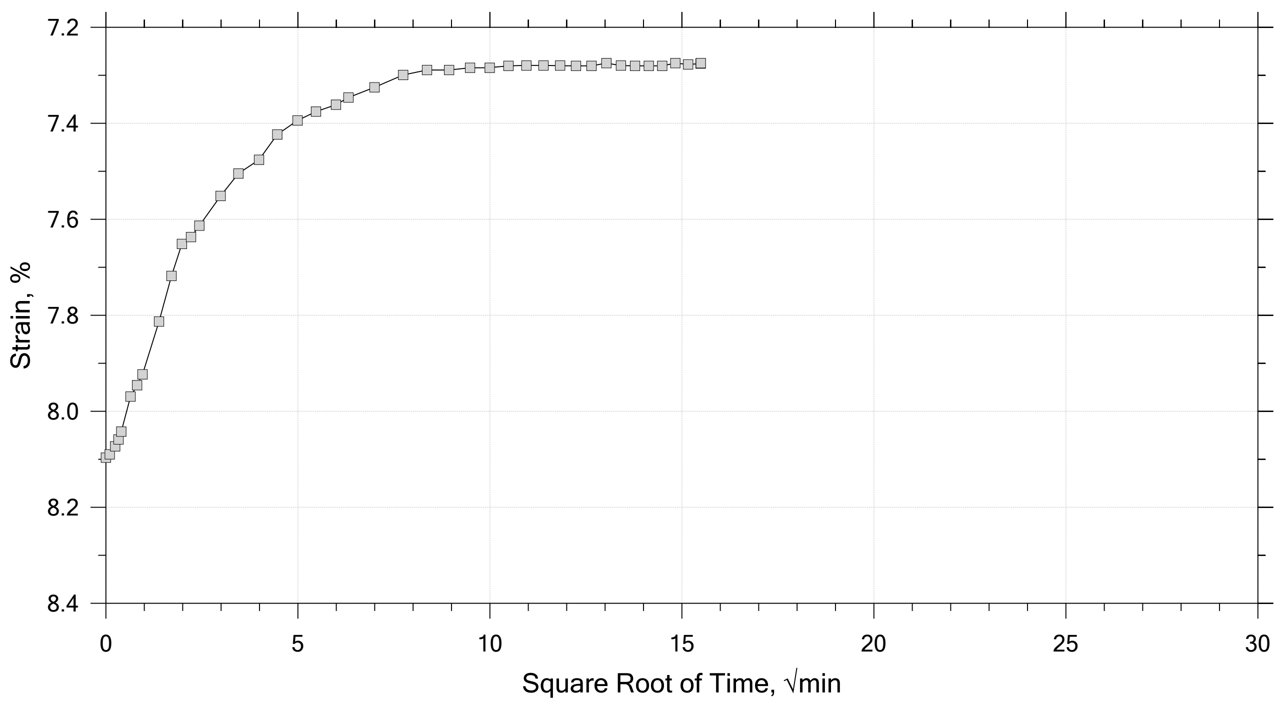
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 17 of 17

Constant Load Step

Stress: 0.25 tsf





GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.74	Liquid Limit: 30
Initial Height: 1.00 in	Initial Void Ratio: 0.638	Plastic Limit: 17
Final Height: 0.93 in	Final Void Ratio: 0.523	Plasticity Index: 13

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	E3372	RING		E9426
Mass Container, gm	8.92	108.81	108.81	8.38
Mass Container + Wet Soil, gm	194.42	274.36	269	168.71
Mass Container + Dry Soil, gm	159.85	243.31	243.31	143
Mass Dry Soil, gm	150.93	134.5	134.5	134.62
Water Content, %	22.90	23.08	19.10	19.10
Void Ratio	---	0.64	0.52	---
Degree of Saturation, %	---	99.14	100.00	---
Dry Unit Weight, pcf	---	104.39	112.24	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test.
Therefore, values may not represent actual values for the specimen.

Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
Boring No.: WB-108	Tested By: sjt	Checked By: anm
Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
Test No.: IP-3R	Sample Type: intact	Elevation: ---
Description: Moist, gray clay		
Remarks: TX-018, Swell Pressure = 0.0694 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

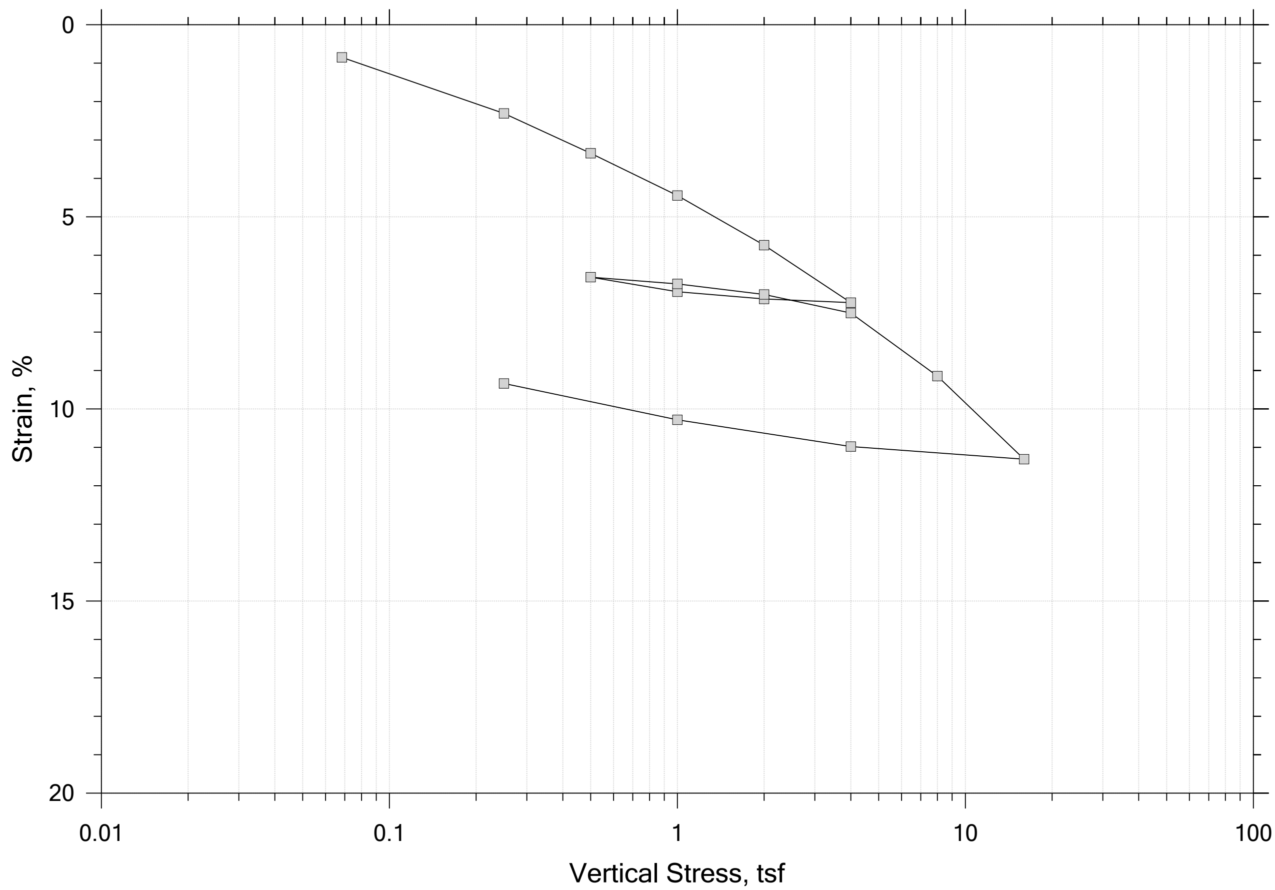
Square Root of Time Coefficients

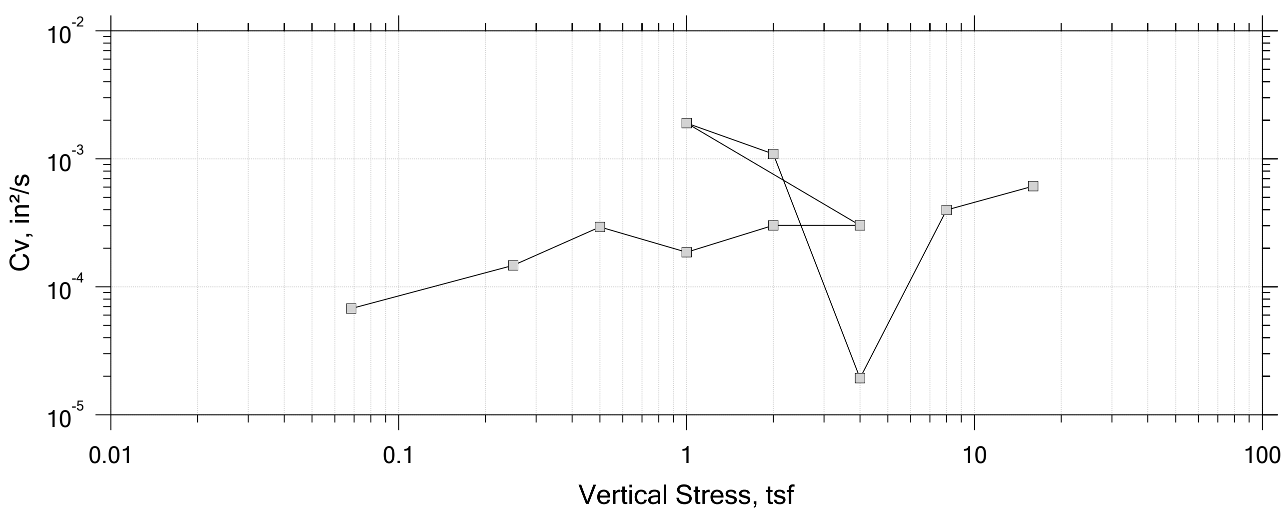
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.0694	0.003967	0.631	0.397	5.491	6.41e-04	5.72e-02	6.86e-04
2	0.250	0.01319	0.616	1.32	7.282	4.77e-04	5.11e-02	4.56e-04
3	0.500	0.01884	0.607	1.88	4.850	7.05e-04	2.26e-02	2.98e-04
4	1.00	0.02743	0.593	2.74	6.267	5.38e-04	1.72e-02	1.73e-04
5	2.00	0.03937	0.573	3.94	9.110	3.62e-04	1.19e-02	8.10e-05
6	4.00	0.05304	0.551	5.30	6.038	5.32e-04	6.84e-03	6.82e-05
7	2.00	0.05266	0.551	5.27	0.652	4.86e-03	1.90e-04	1.73e-05
8	1.00	0.04989	0.556	4.99	3.910	8.13e-04	2.76e-03	4.21e-05
9	0.500	0.04686	0.561	4.69	3.902	8.20e-04	6.06e-03	9.31e-05
10	1.00	0.04880	0.558	4.88	2.752	1.16e-03	3.87e-03	8.44e-05
11	2.00	0.05147	0.553	5.15	2.850	1.12e-03	2.67e-03	5.59e-05
12	4.00	0.05609	0.546	5.61	42.217	7.49e-05	2.31e-03	3.24e-06
13	8.00	0.07132	0.521	7.13	6.113	5.07e-04	3.81e-03	3.61e-05
14	16.0	0.09157	0.488	9.16	4.313	6.91e-04	2.53e-03	3.28e-05
15	4.00	0.08740	0.494	8.74	2.180	1.34e-03	3.47e-04	8.74e-06
16	1.00	0.08163	0.504	8.16	5.375	5.51e-04	1.92e-03	1.98e-05
17	0.250	0.07275	0.518	7.27	11.606	2.59e-04	1.18e-02	5.75e-05
18	0.000	0.06650	0.529	6.65	56.281	5.43e-05	2.50e-02	2.54e-05

GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-1	Test Date: 03/21/24	Depth: 4-6
	Test No.: IP-3R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-018, Swell Pressure = 0.0694 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report





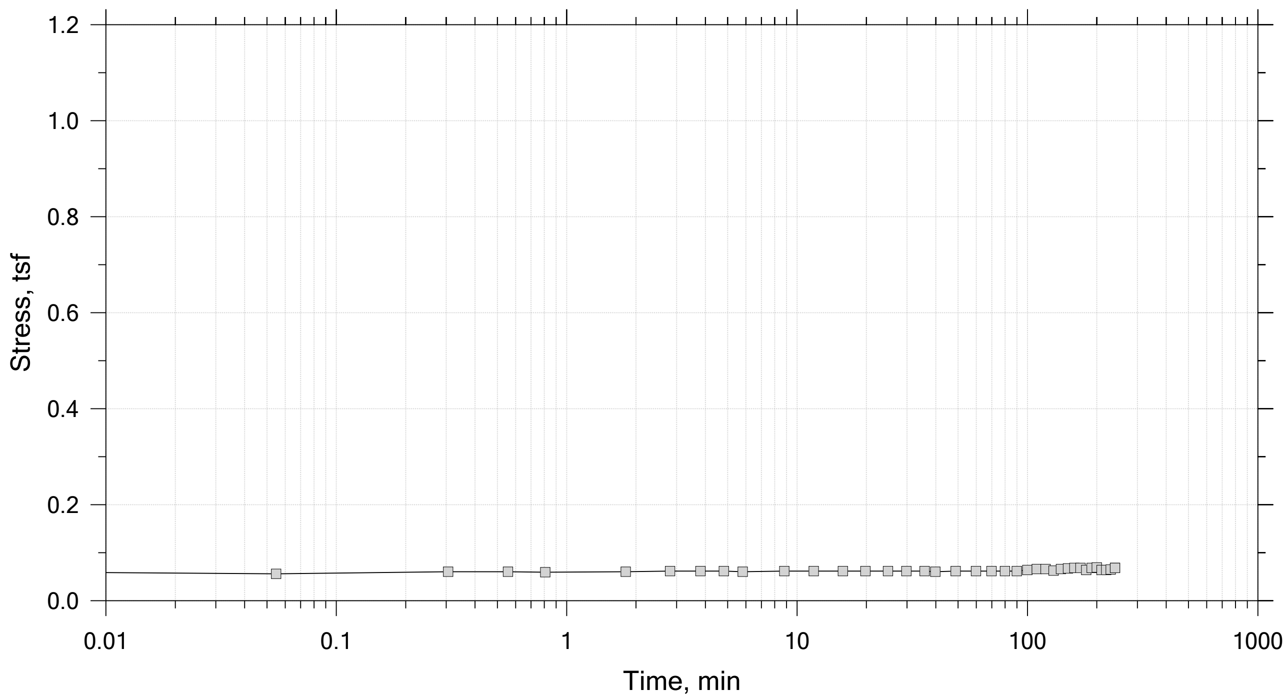
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		
	Displacement at End of Increment		

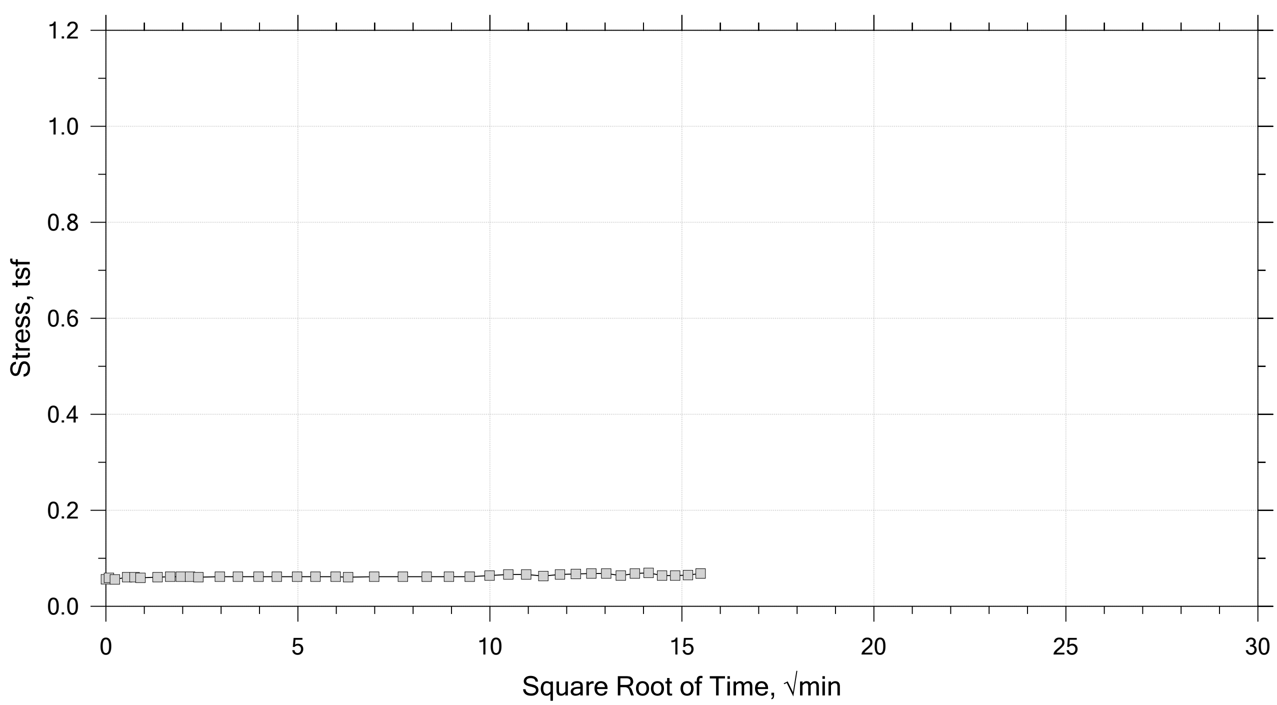
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 17

Constant Volume Step

Stress: 0.0684 tsf

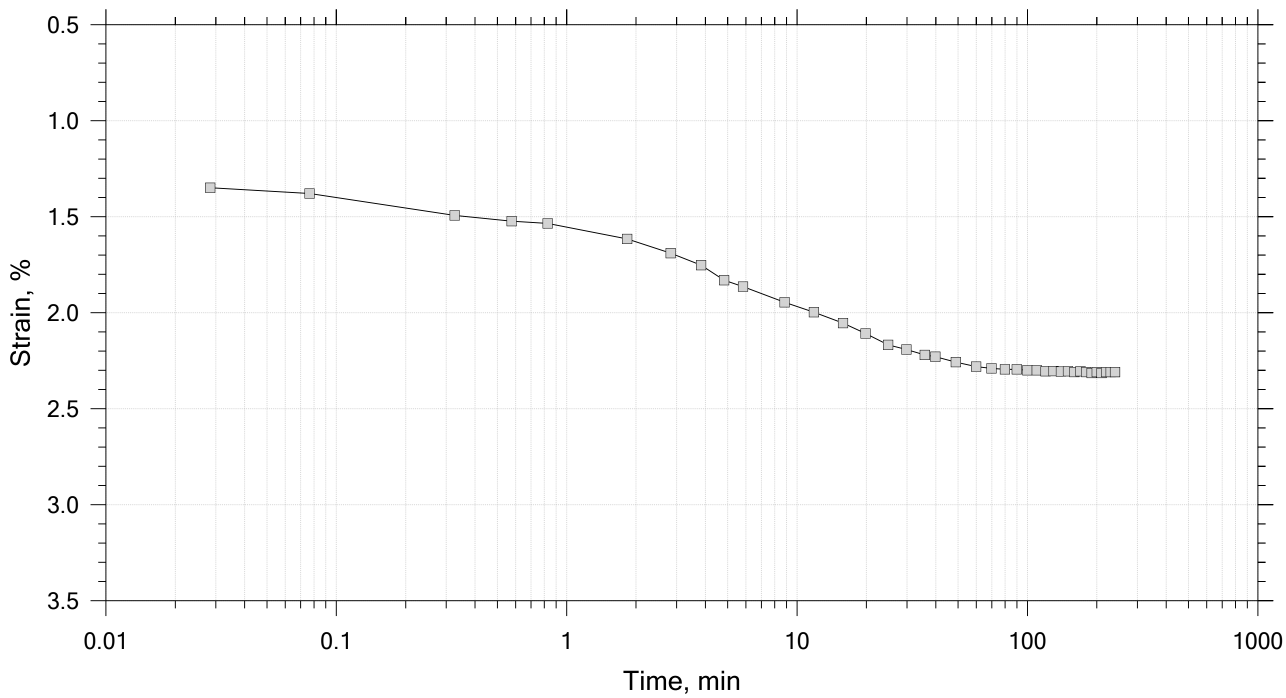


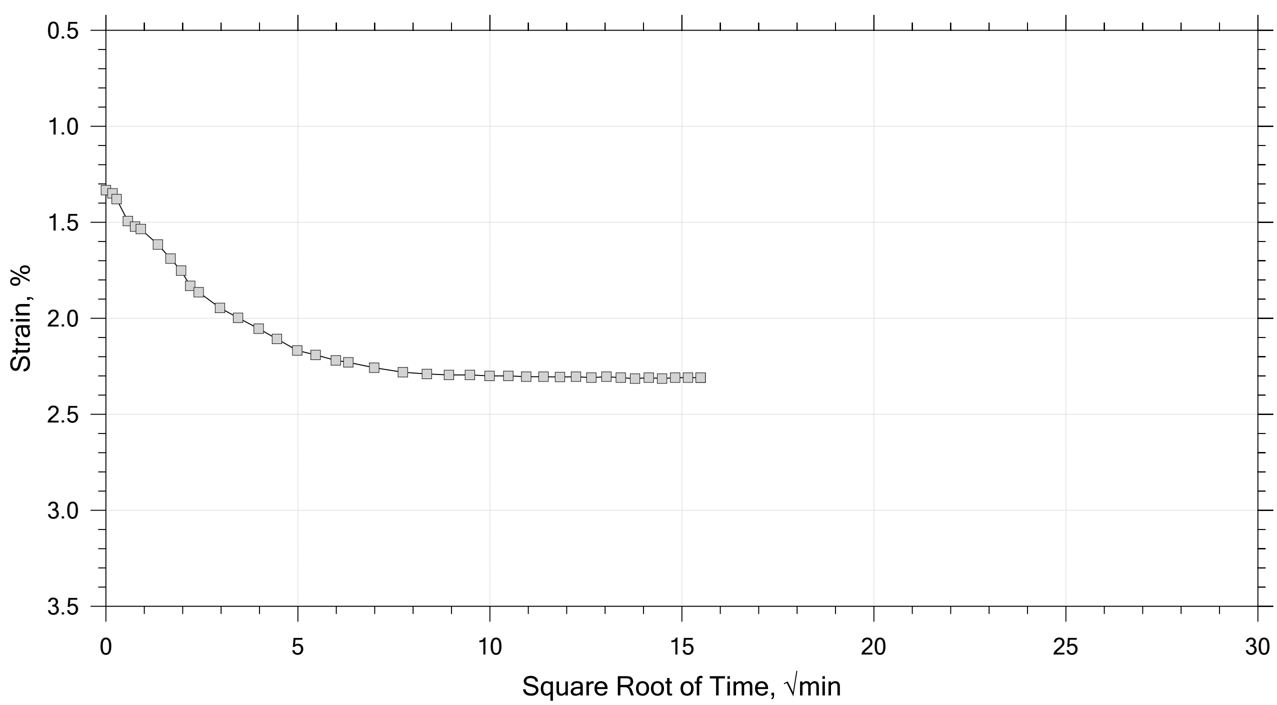


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 17
Constant Load Step
Stress: 0.25 tsf





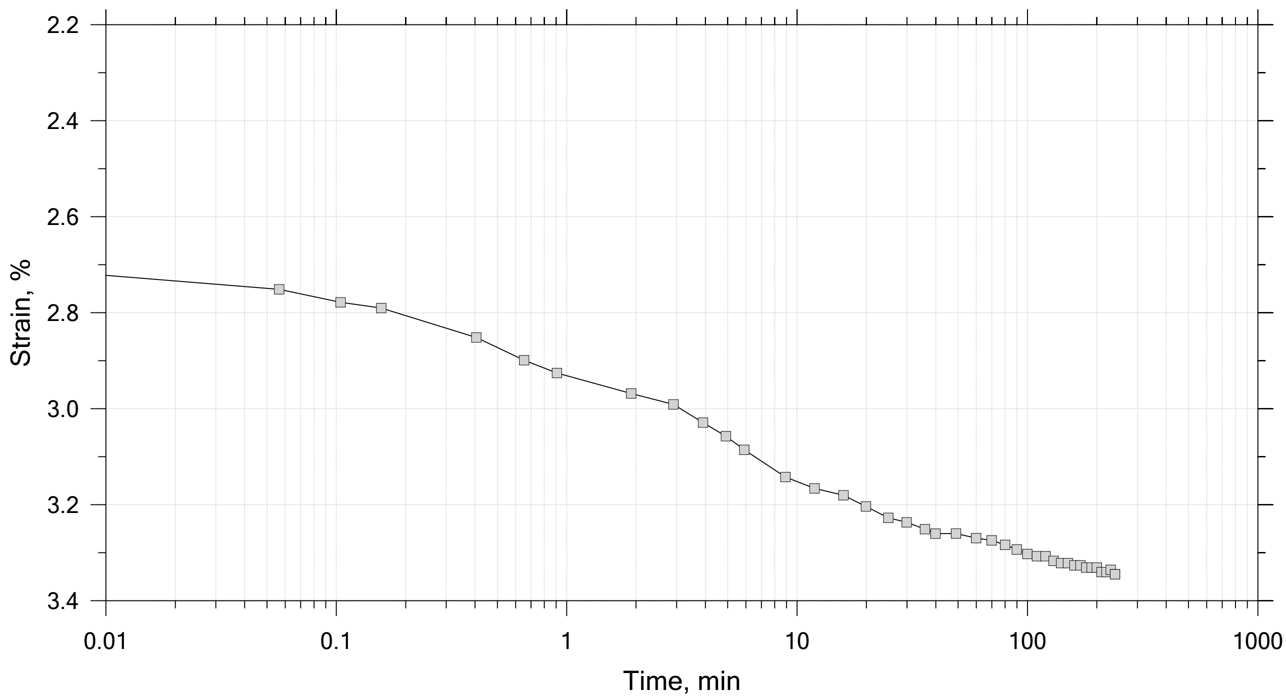
GeoTesting EXPRESS A BENZEL COMPANY	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

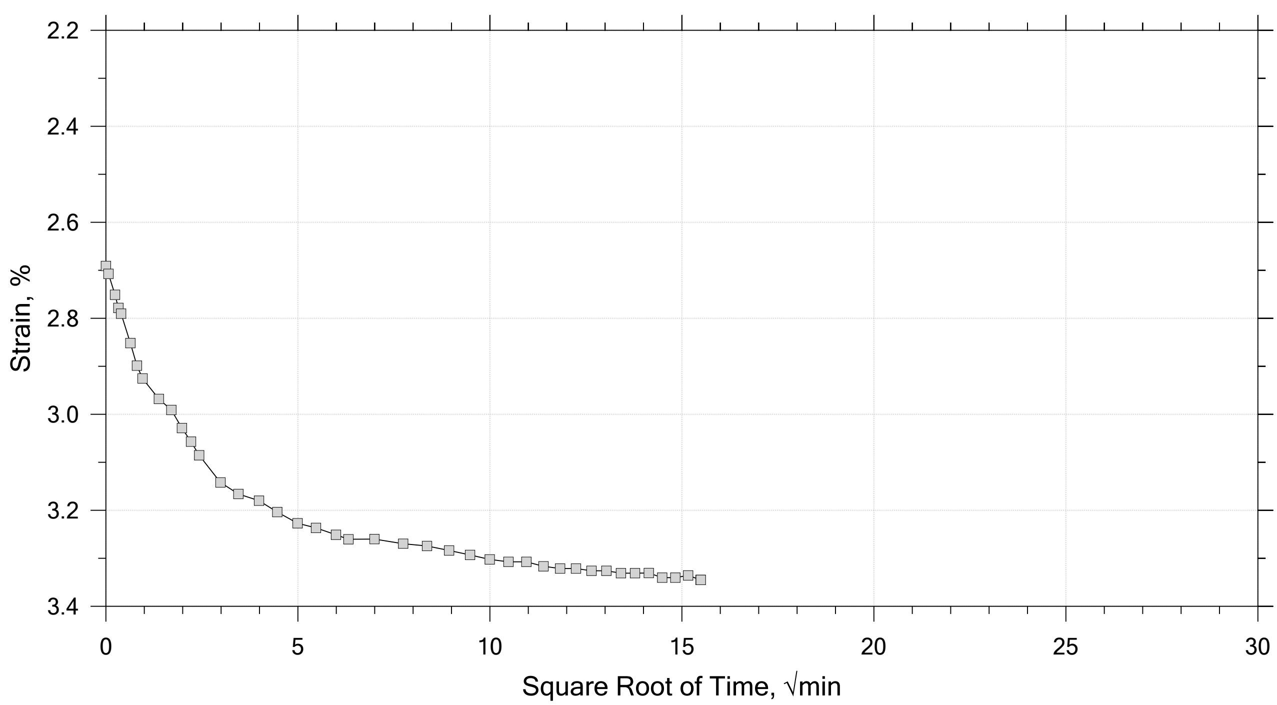
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 17

Constant Load Step

Stress: 0.5 tsf





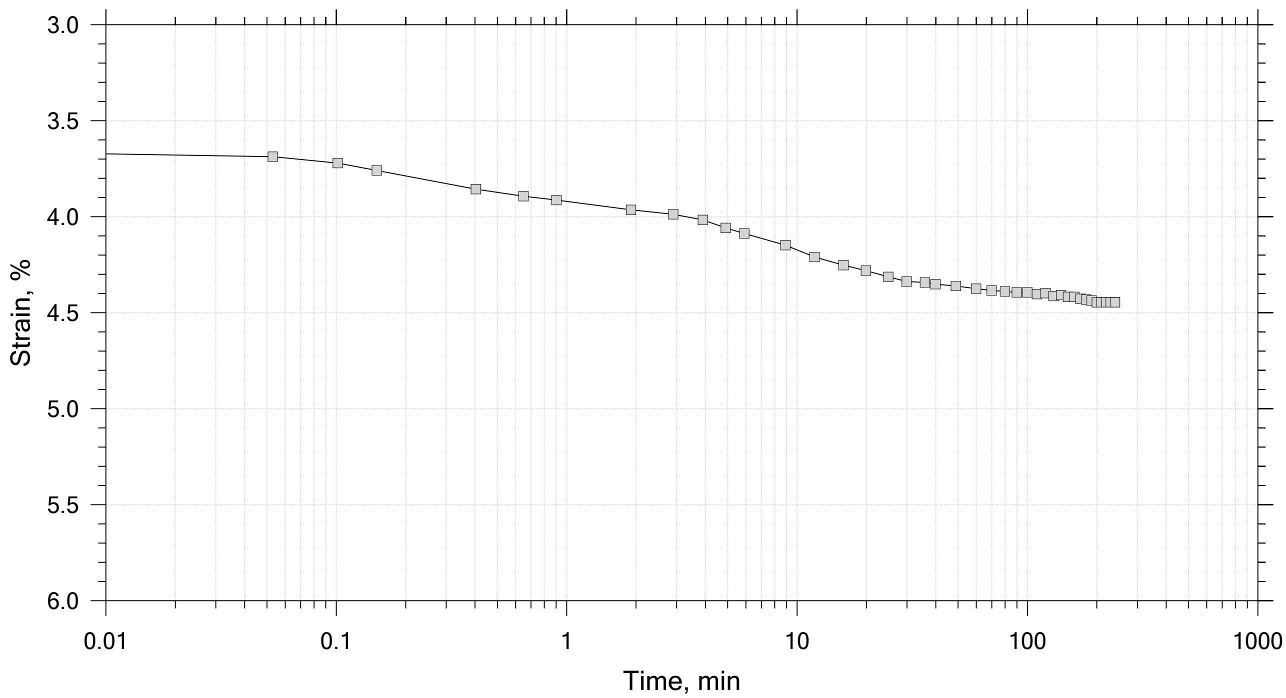
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

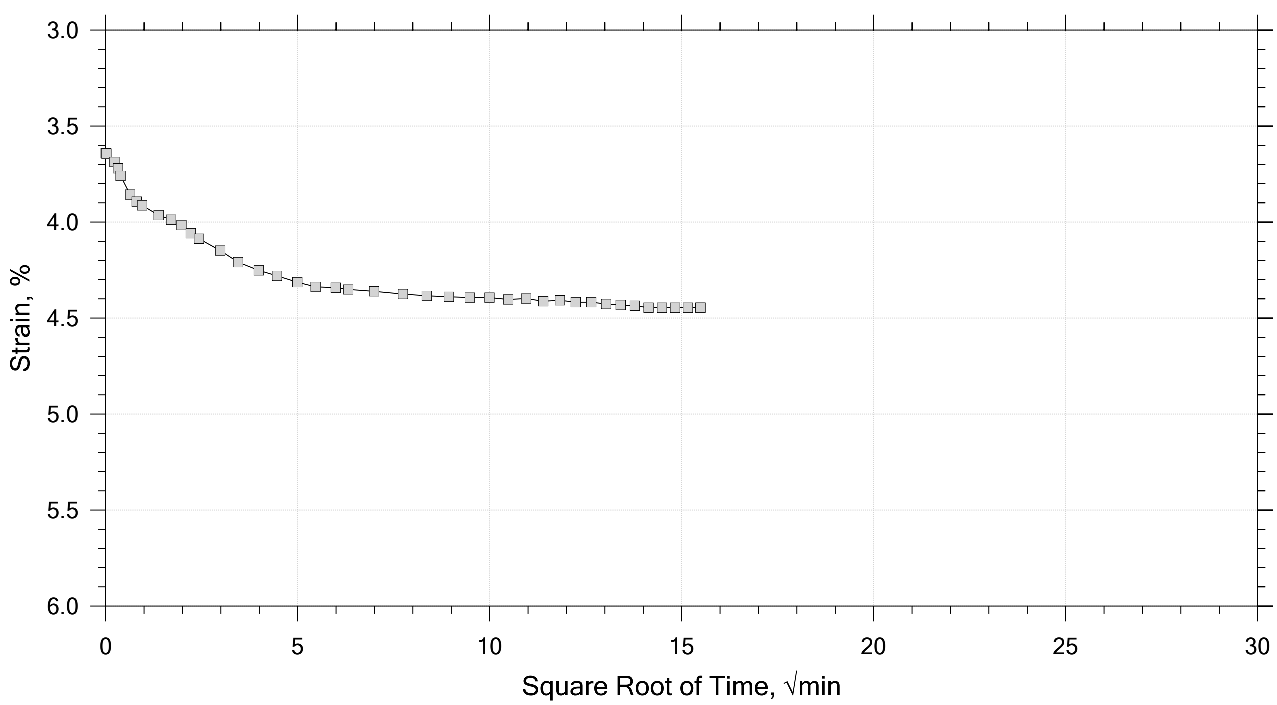
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 17

Constant Load Step

Stress: 1 tsf

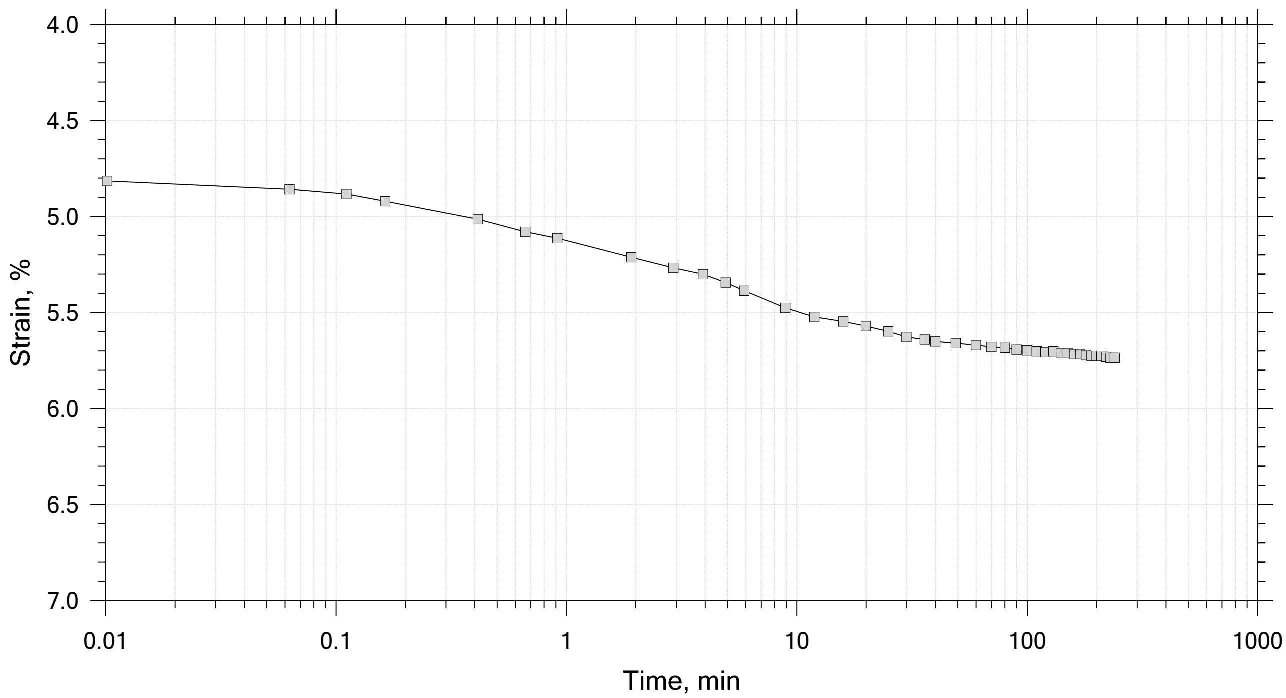


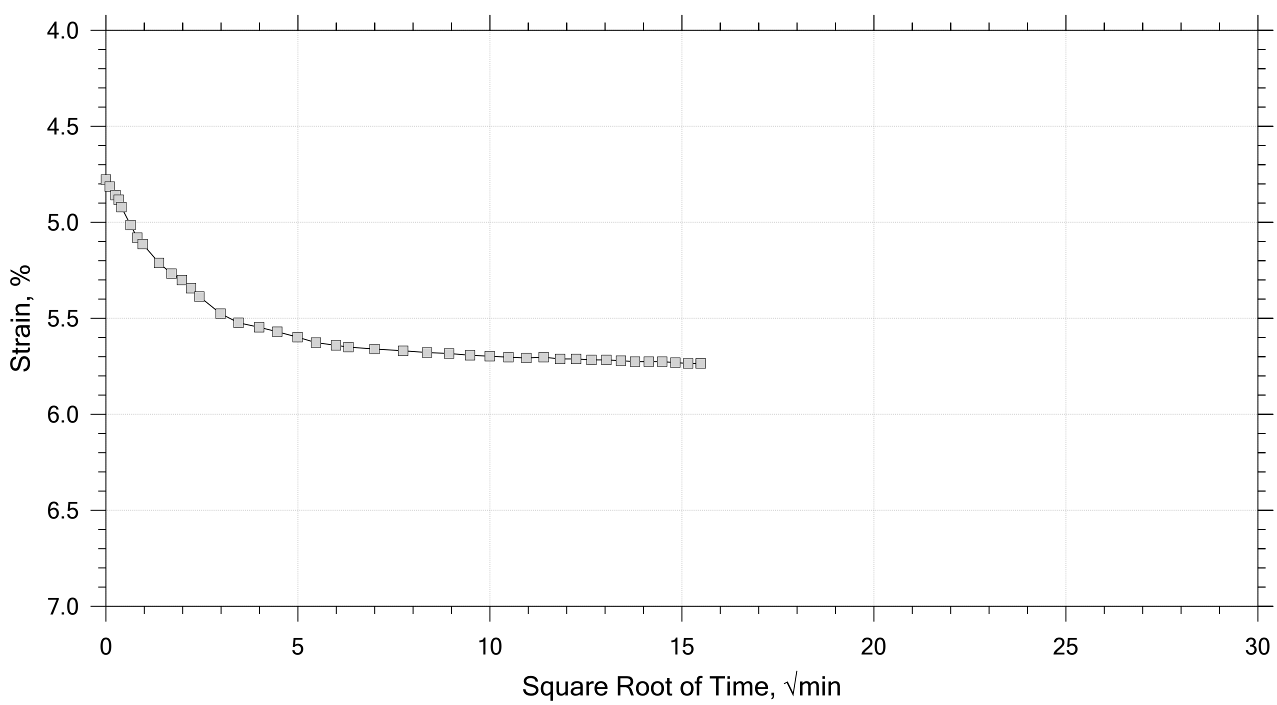


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 17
Constant Load Step
Stress: 2 tsf





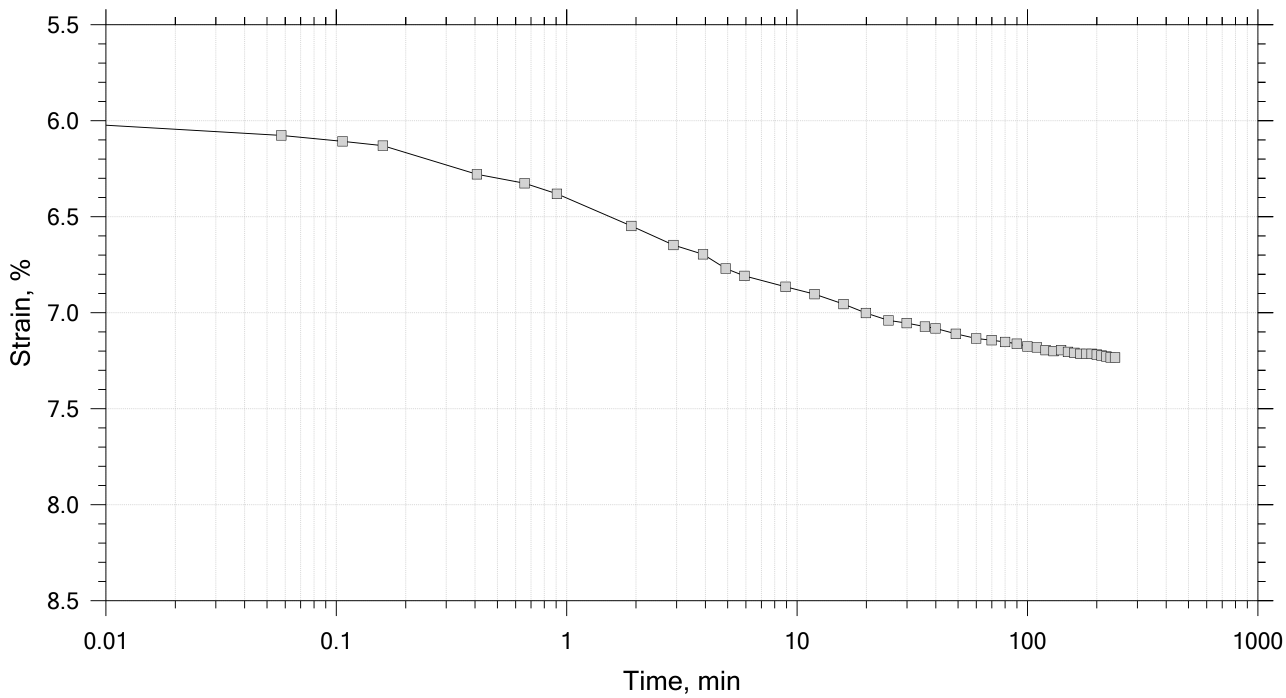
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

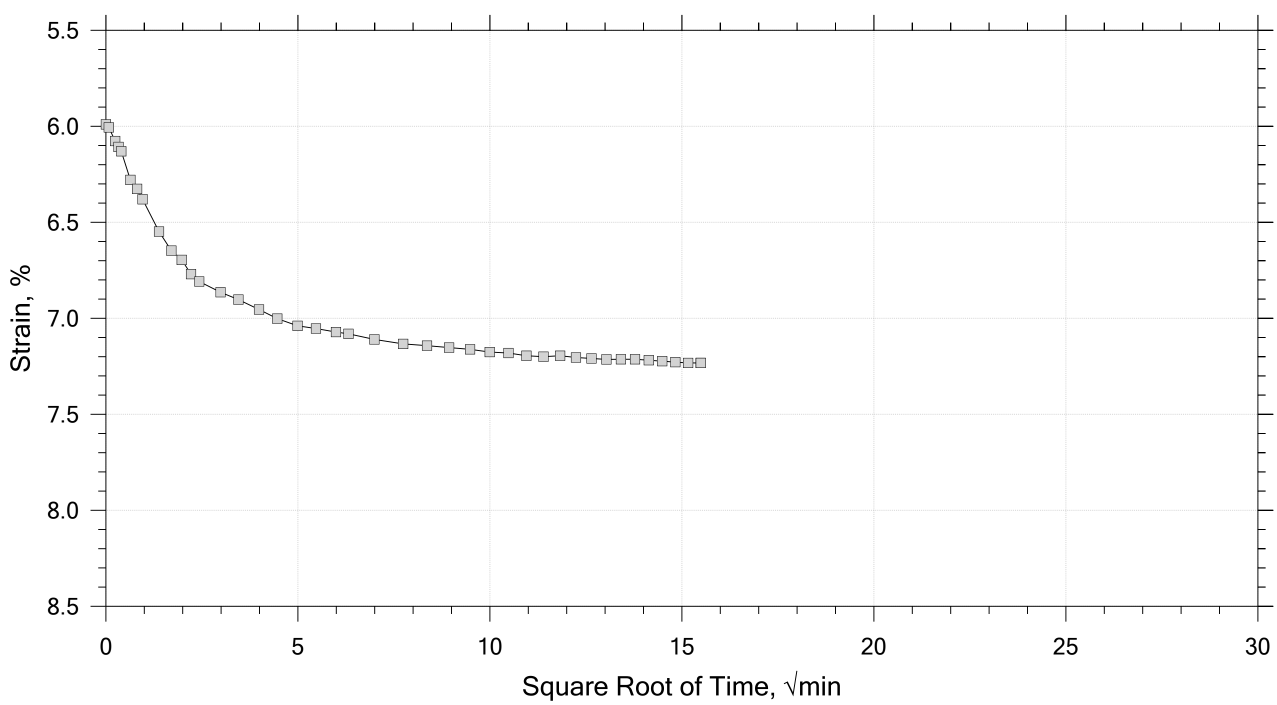
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 17

Constant Load Step

Stress: 4 tsf





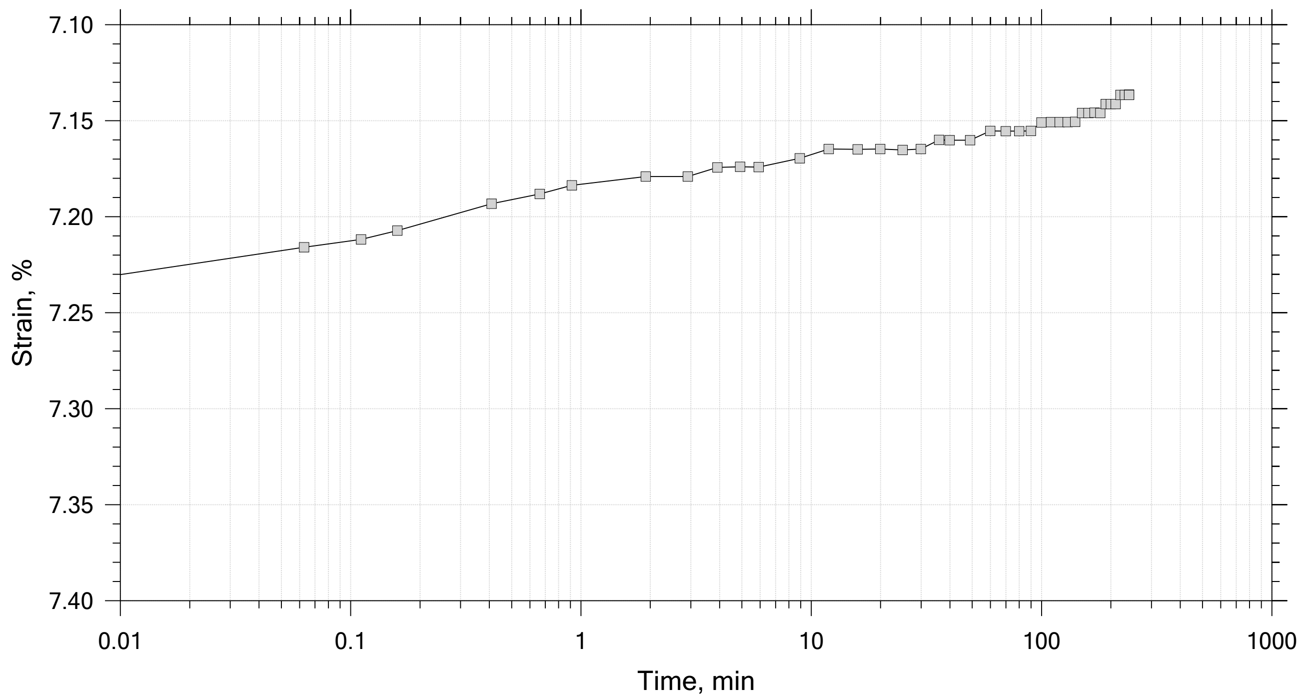
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

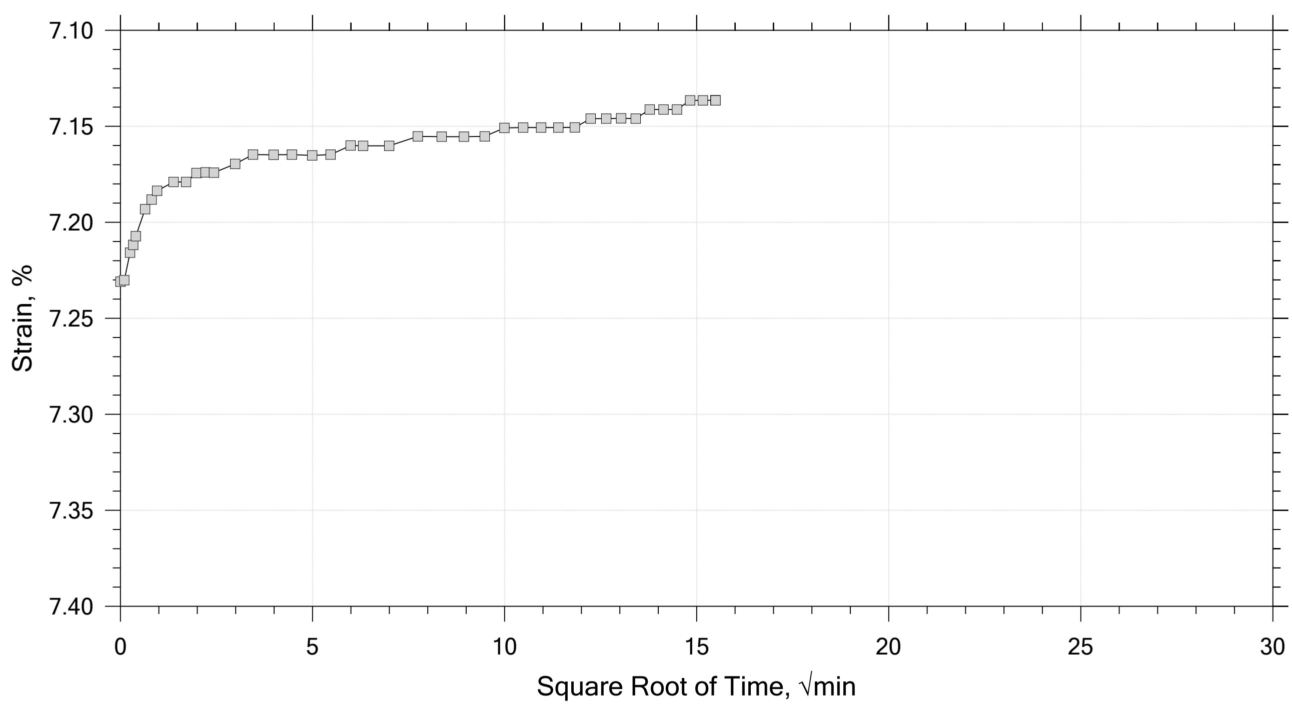
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 17

Constant Load Step

Stress: 2 tsf





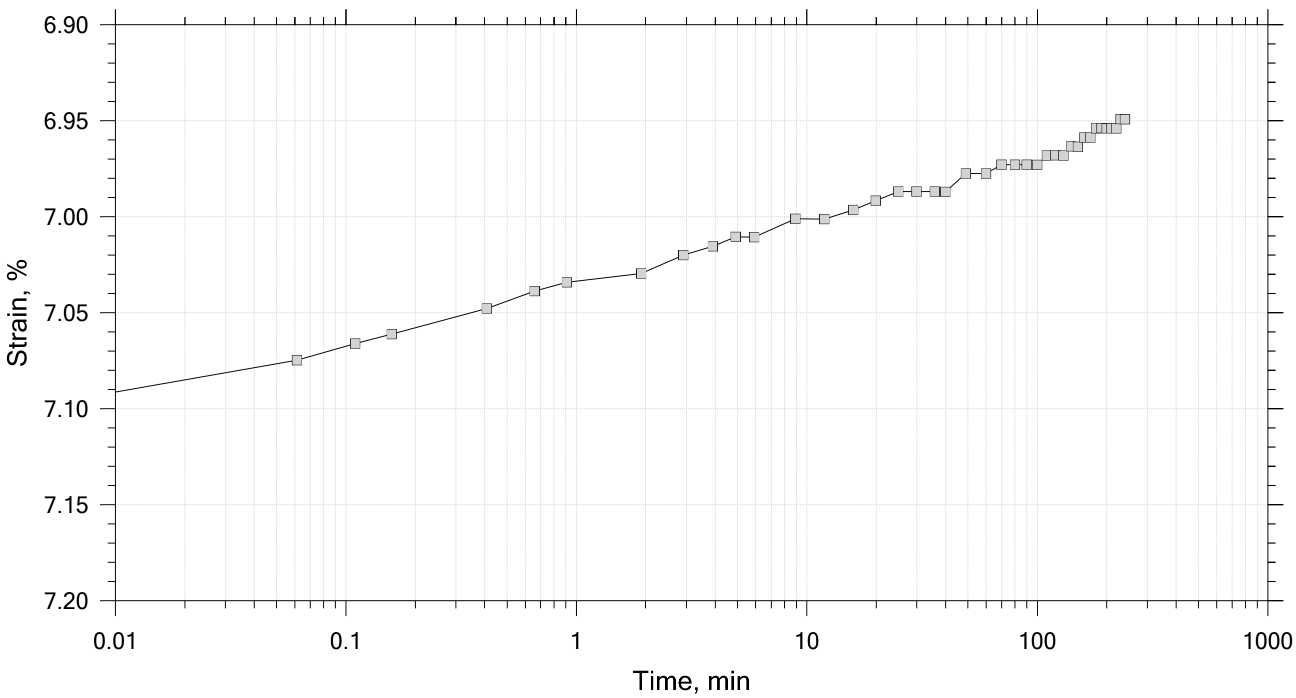
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

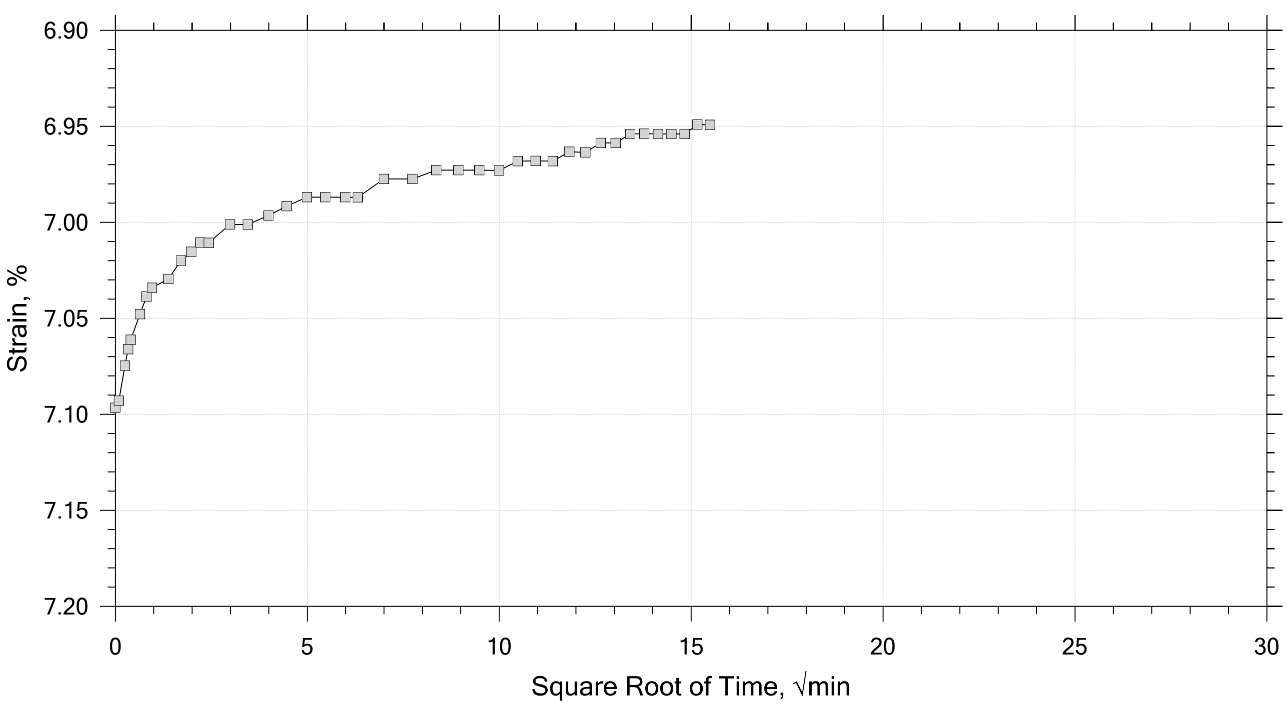
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 17

Constant Load Step

Stress: 1 tsf





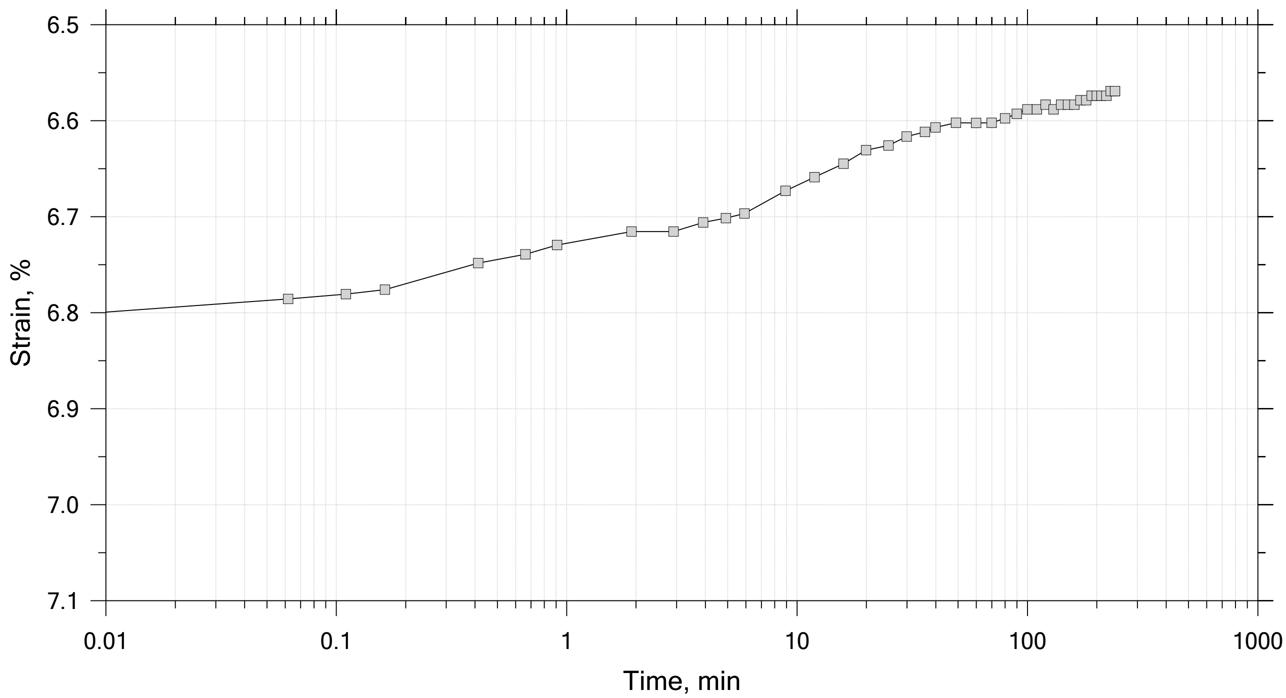
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

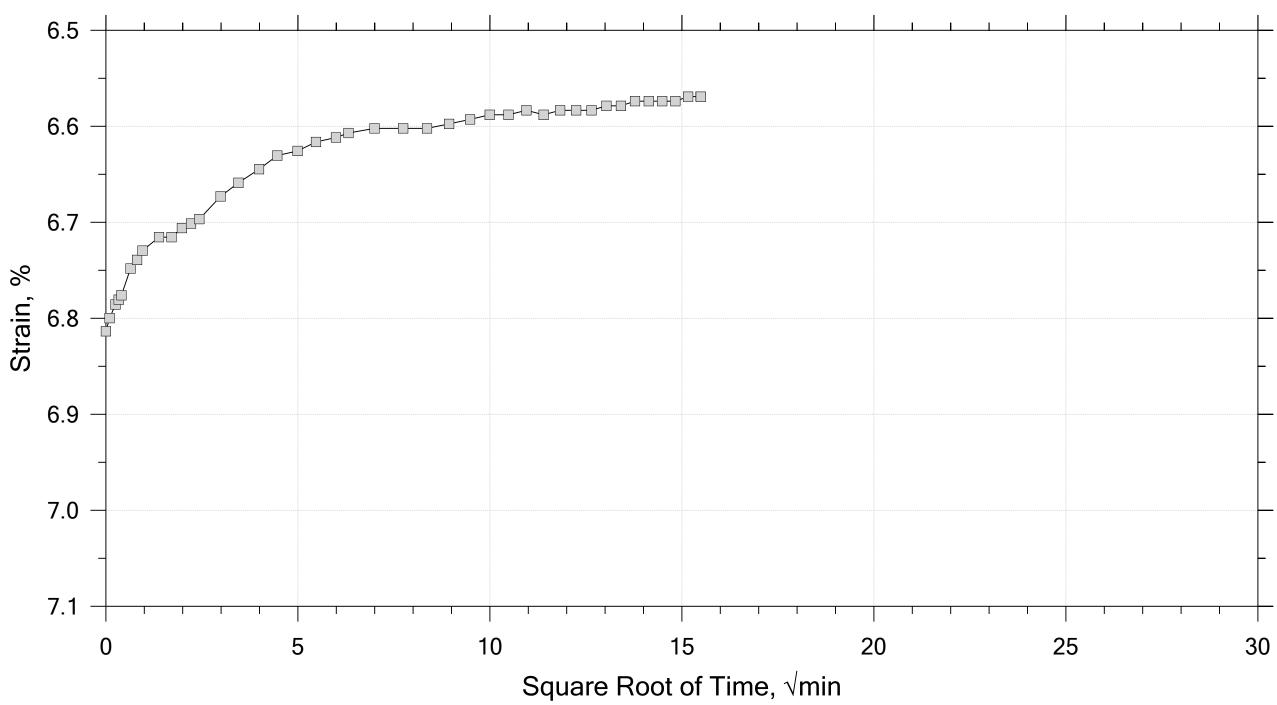
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 17

Constant Load Step

Stress: 0.5 tsf





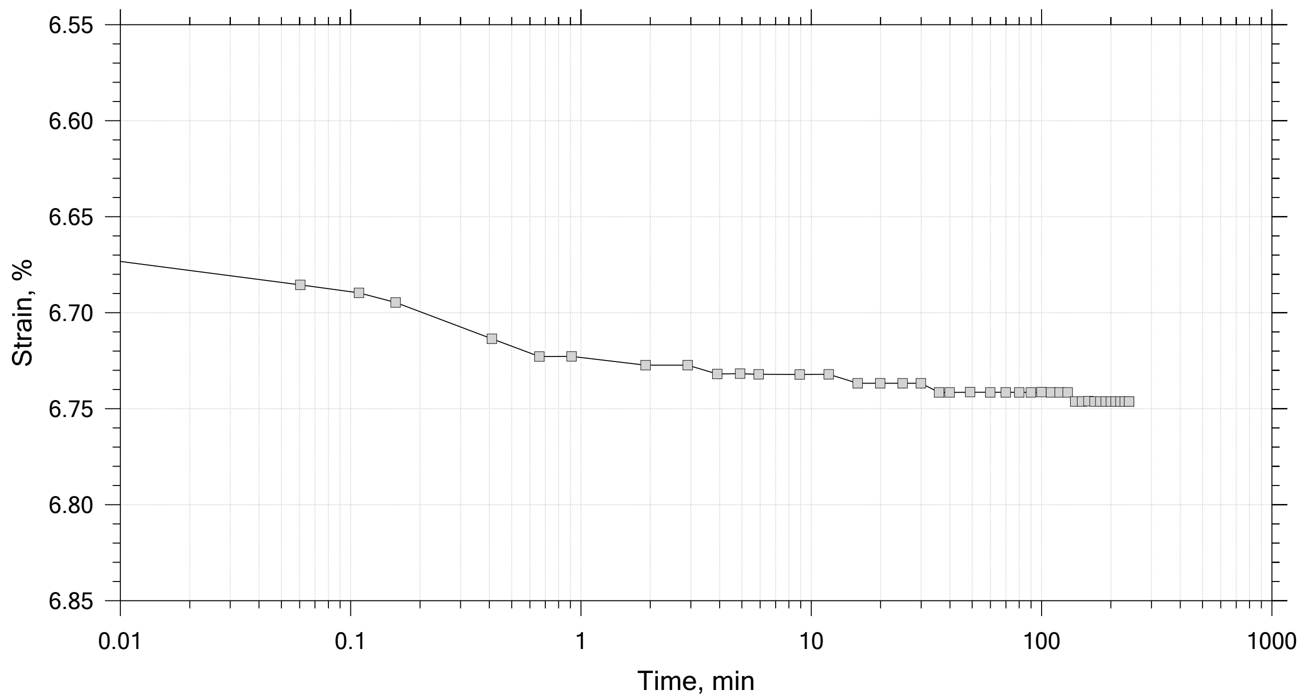
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

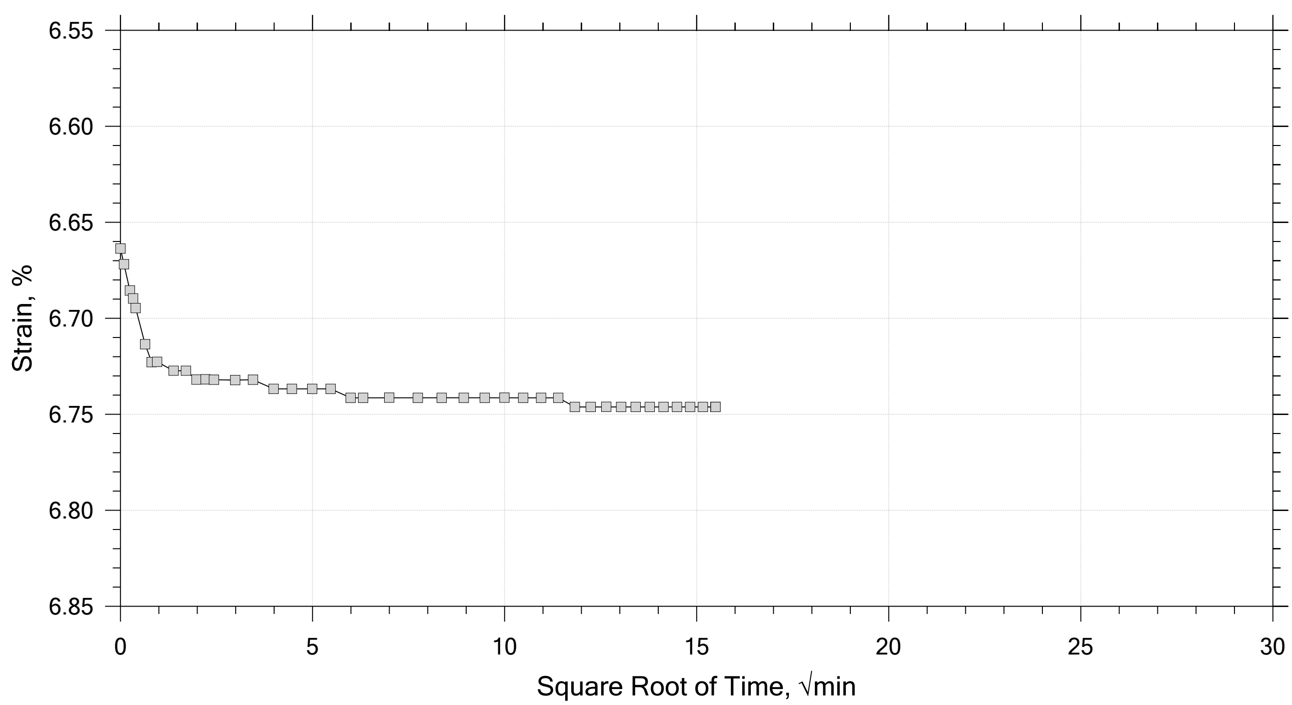
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 17

Constant Load Step

Stress: 1 tsf





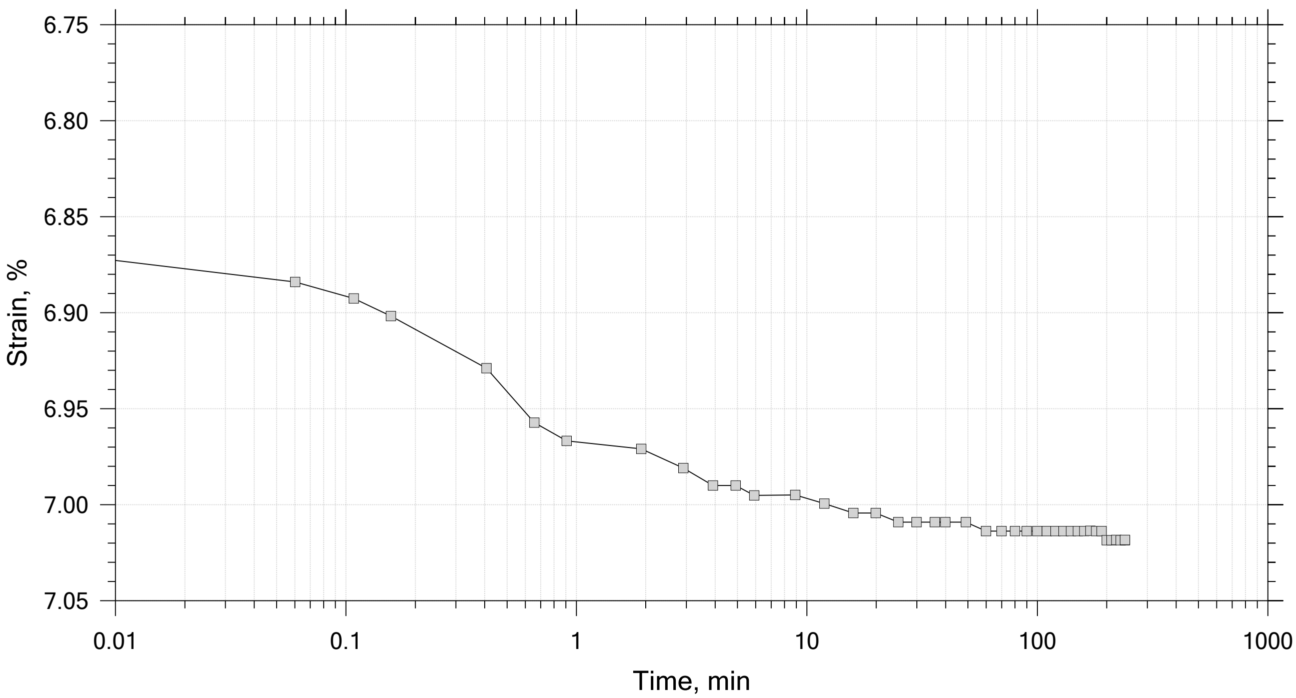
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

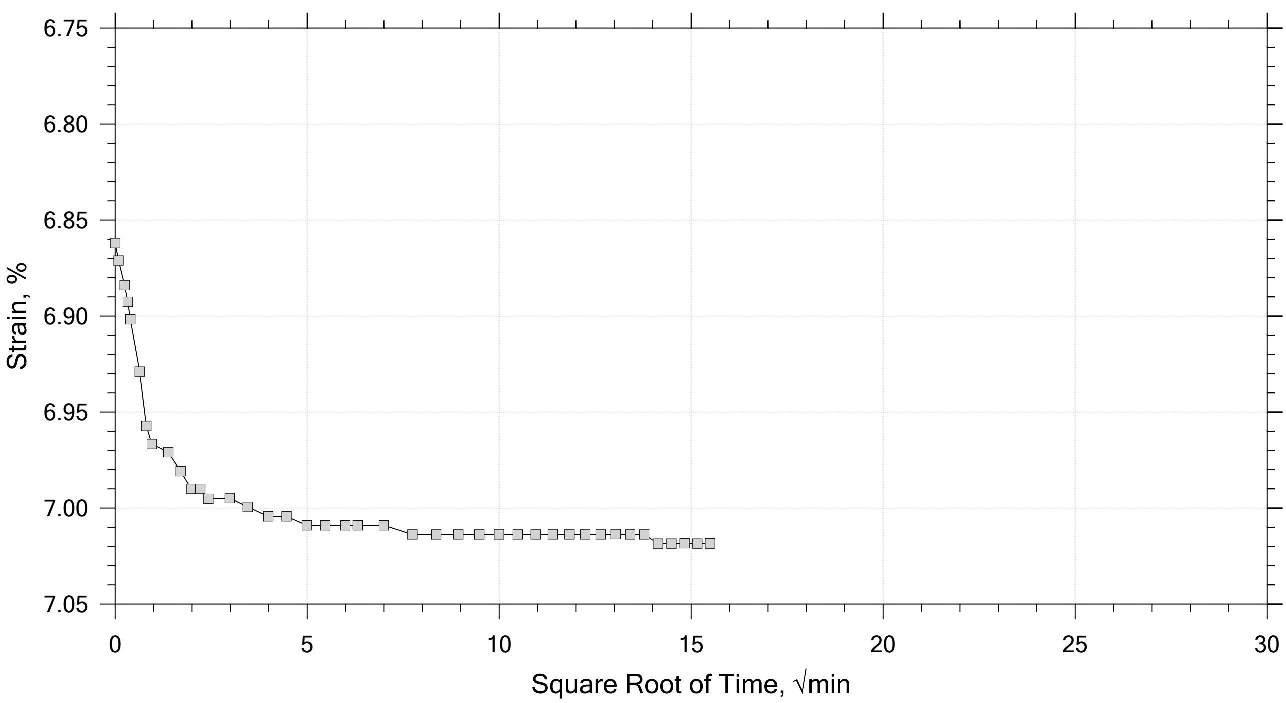
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 17

Constant Load Step

Stress: 2 tsf

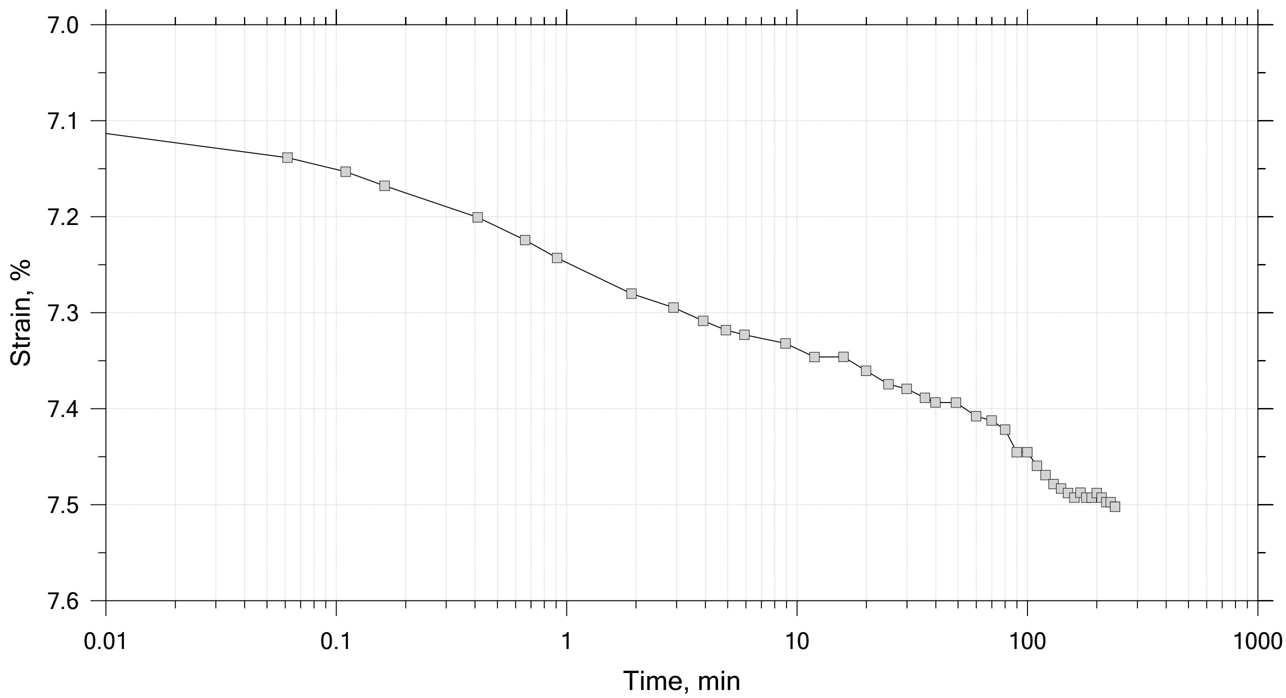


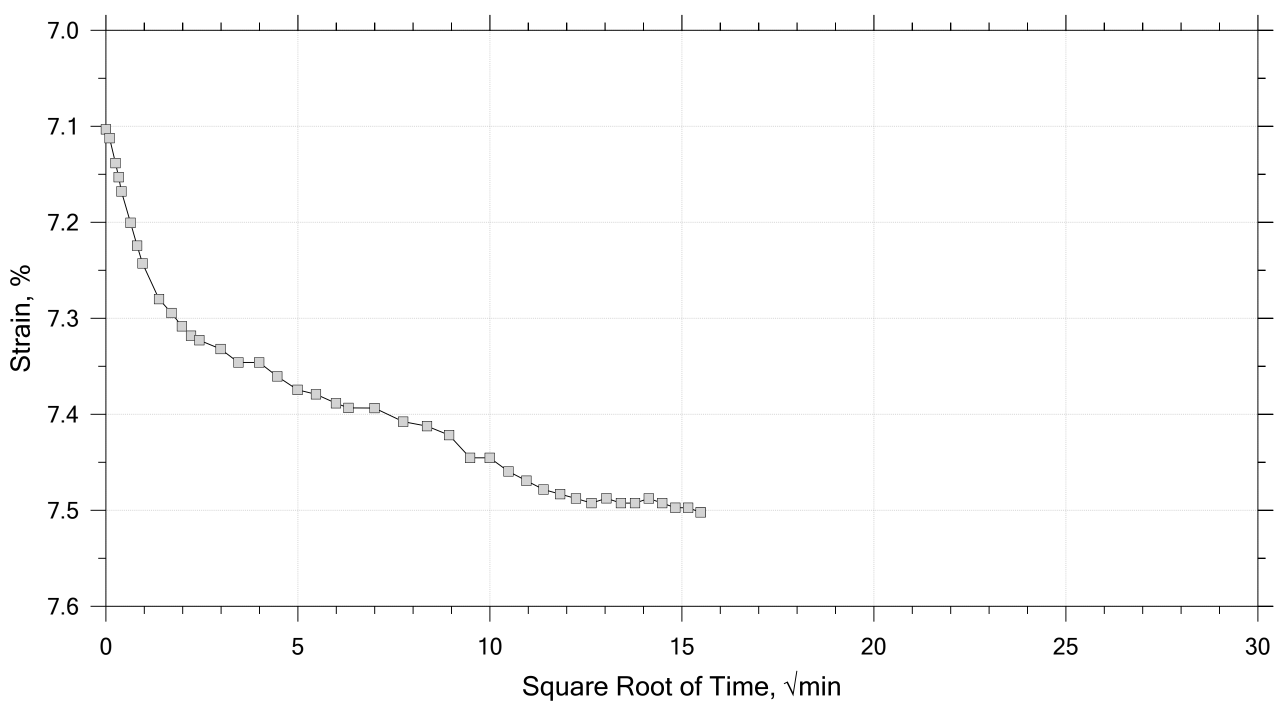


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 12 of 17
Constant Load Step
Stress: 4 tsf





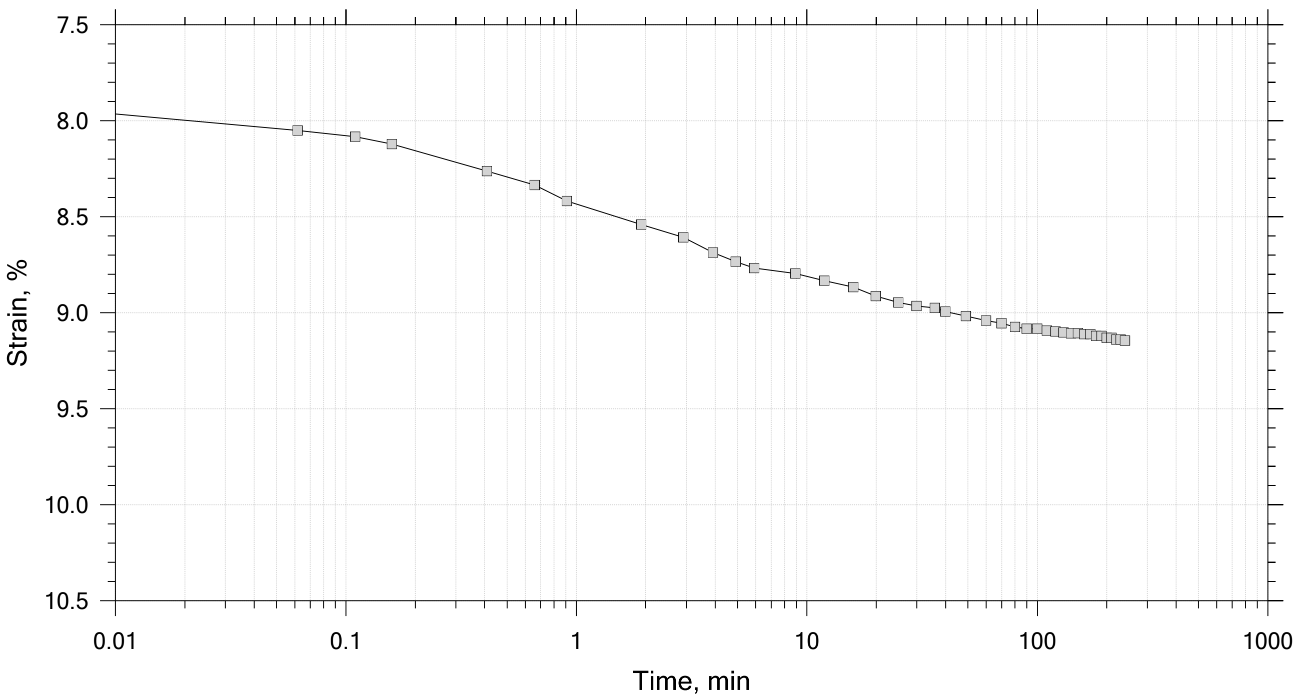
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

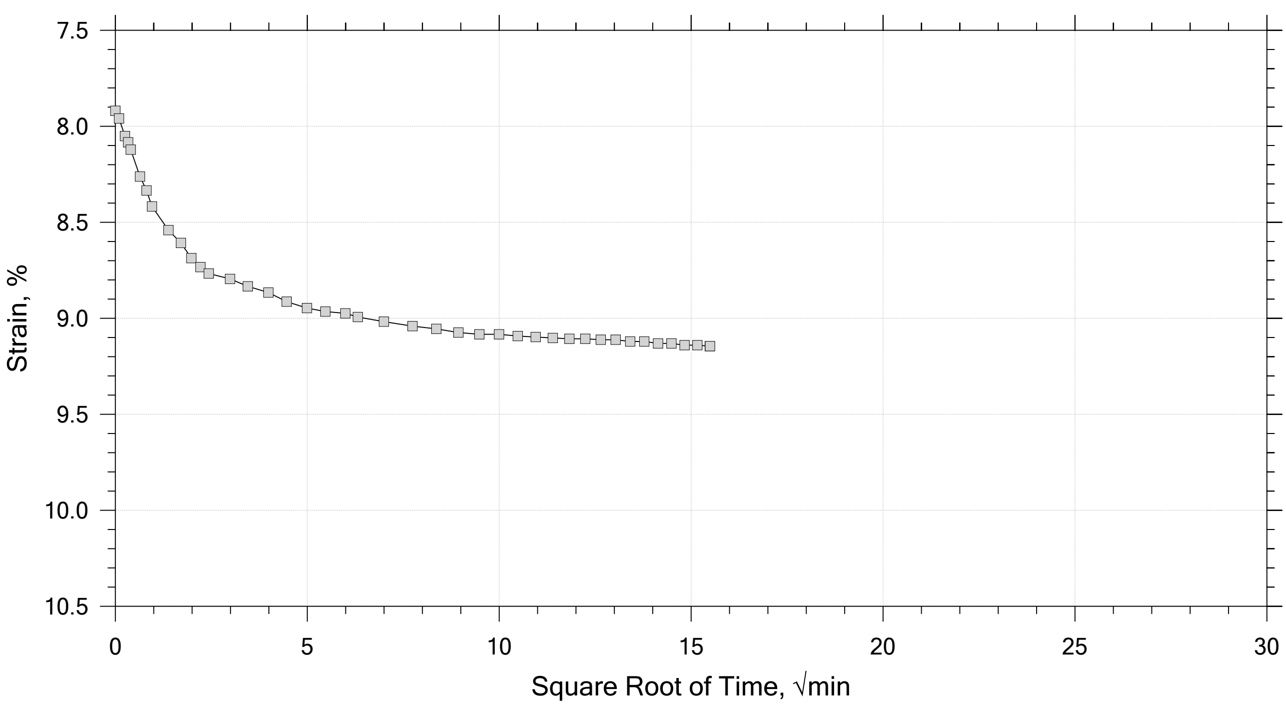
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 13 of 17

Constant Load Step

Stress: 8 tsf





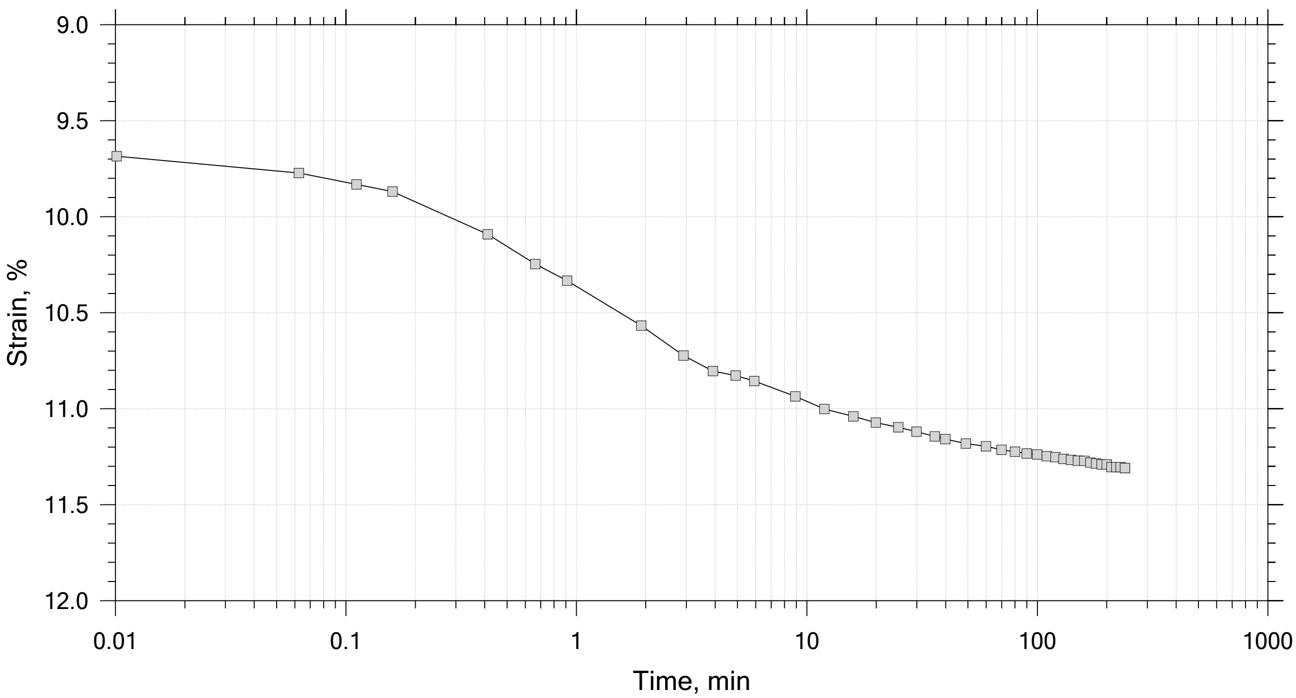
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

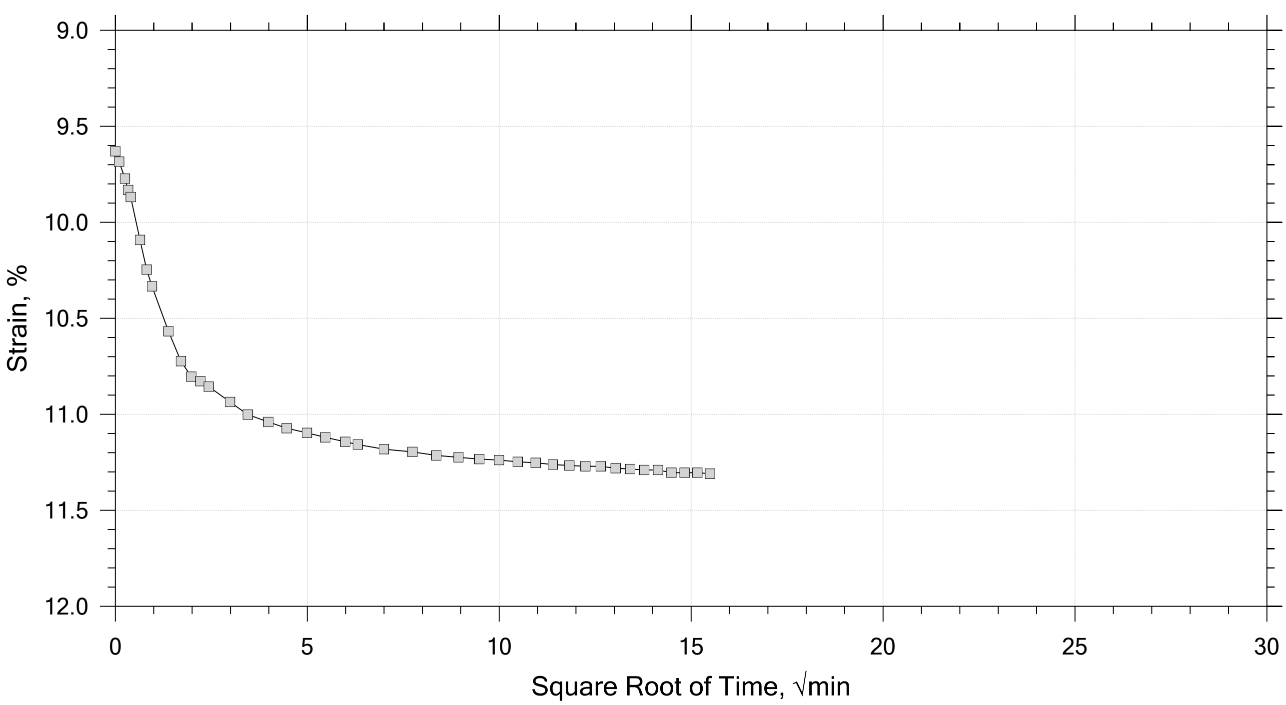
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 14 of 17

Constant Load Step

Stress: 16 tsf





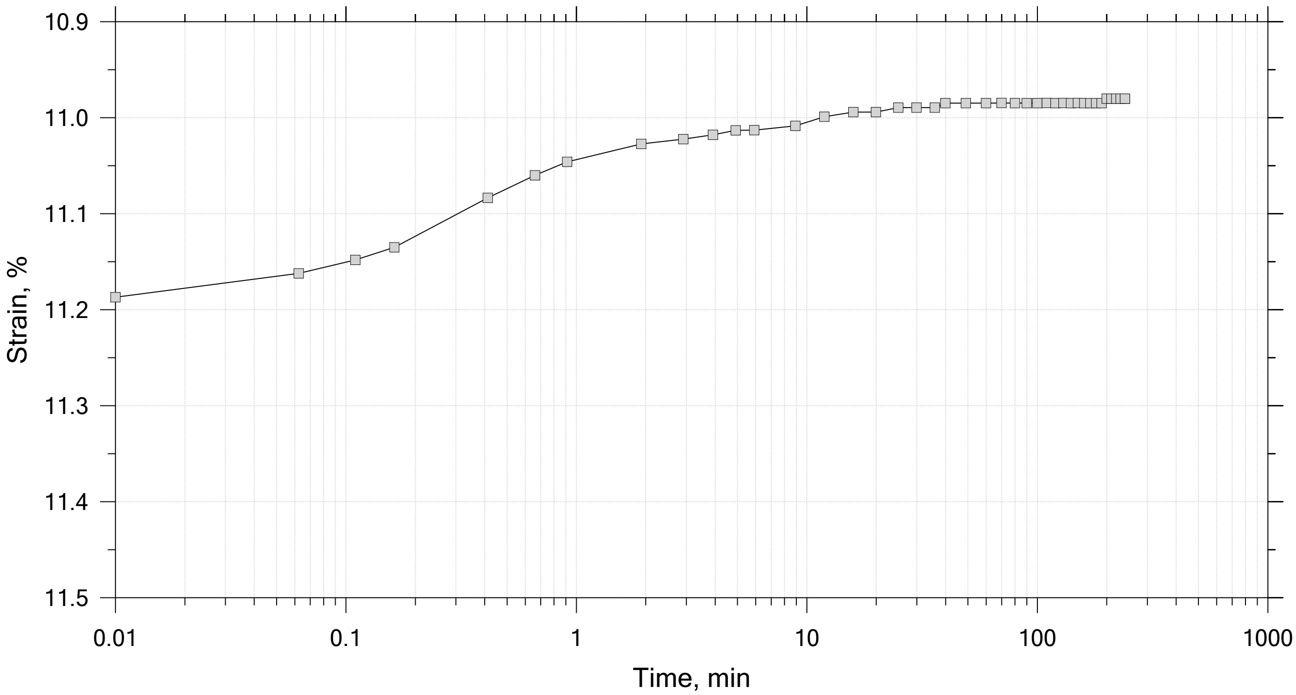
GeoTesting EXPRESS			
	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

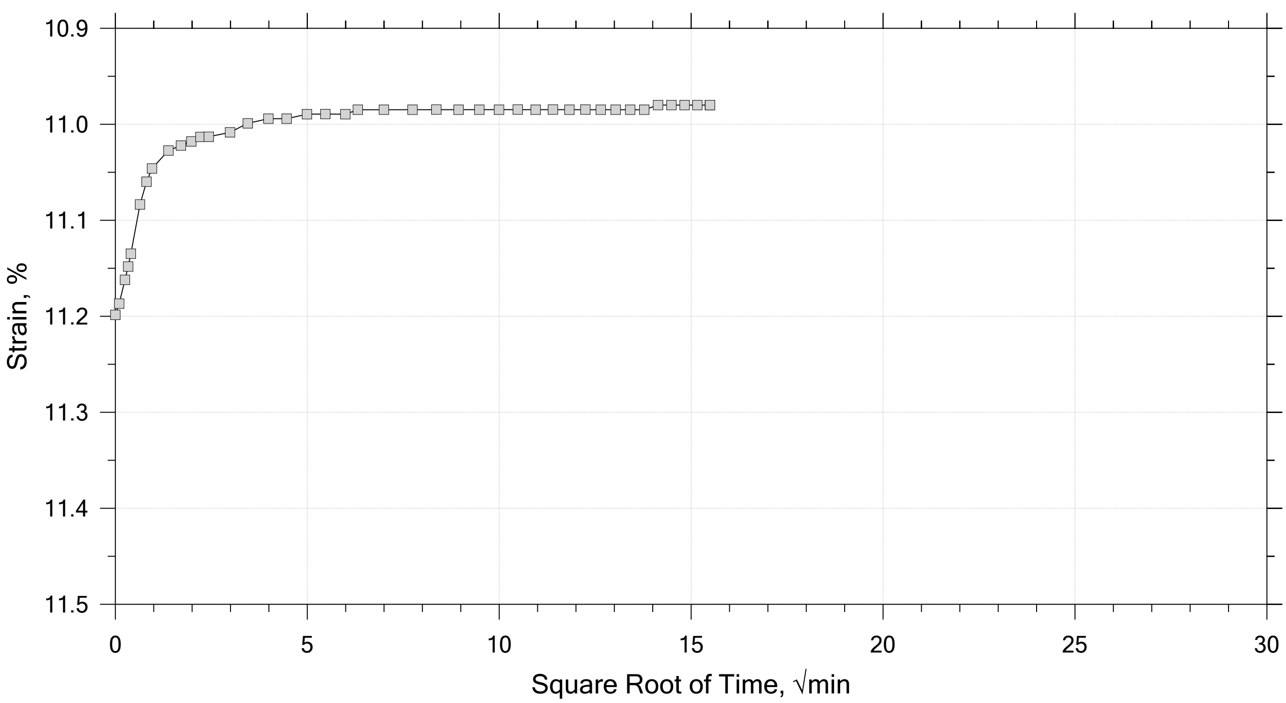
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 15 of 17

Constant Load Step

Stress: 4 tsf

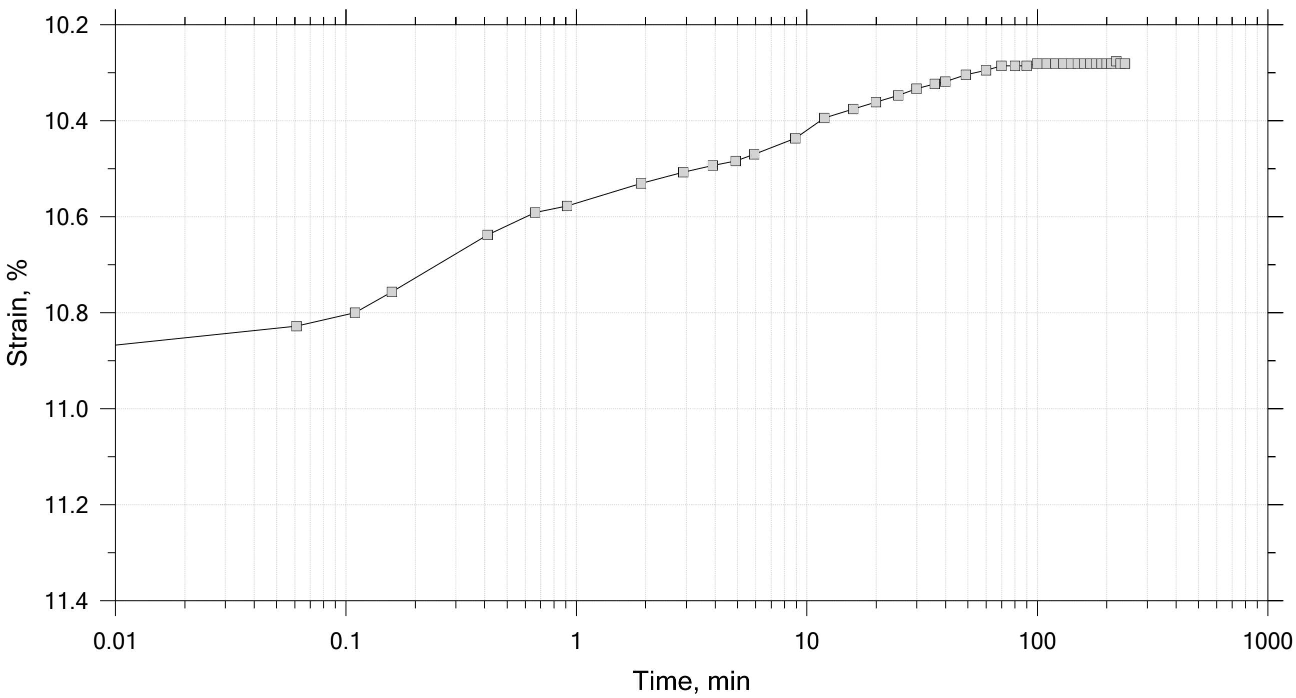


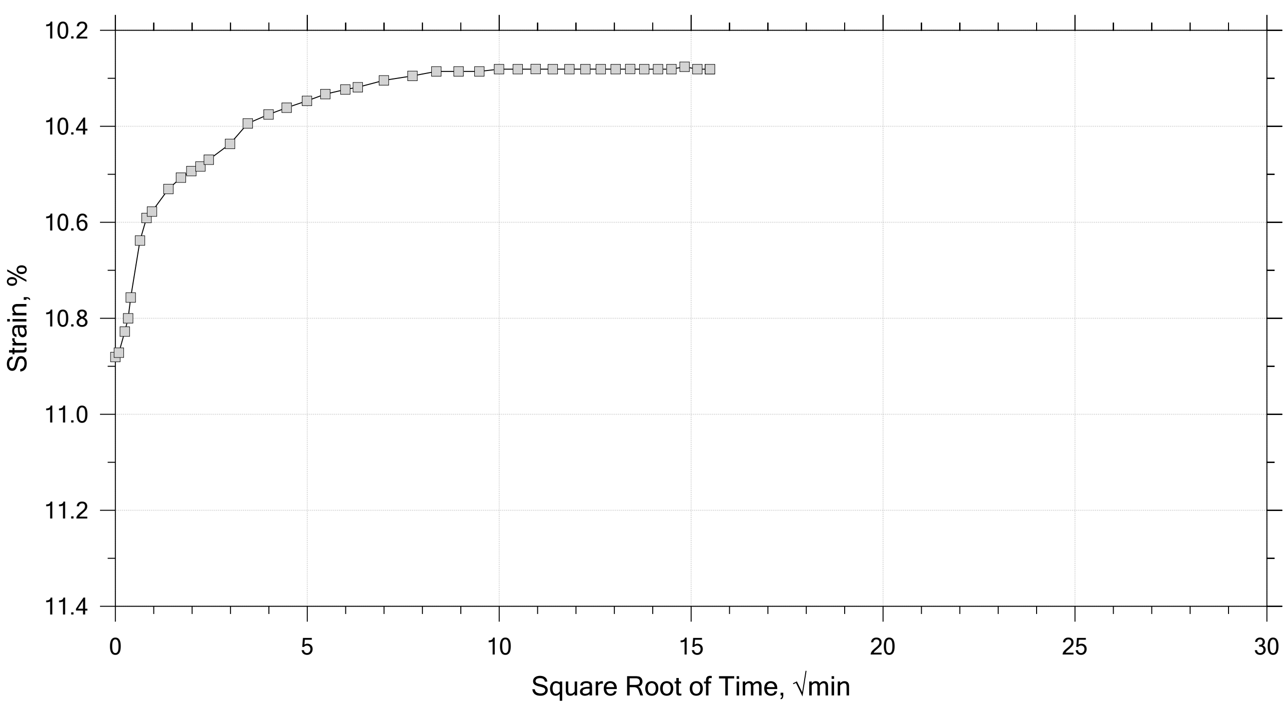


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 16 of 17
Constant Load Step
Stress: 1 tsf





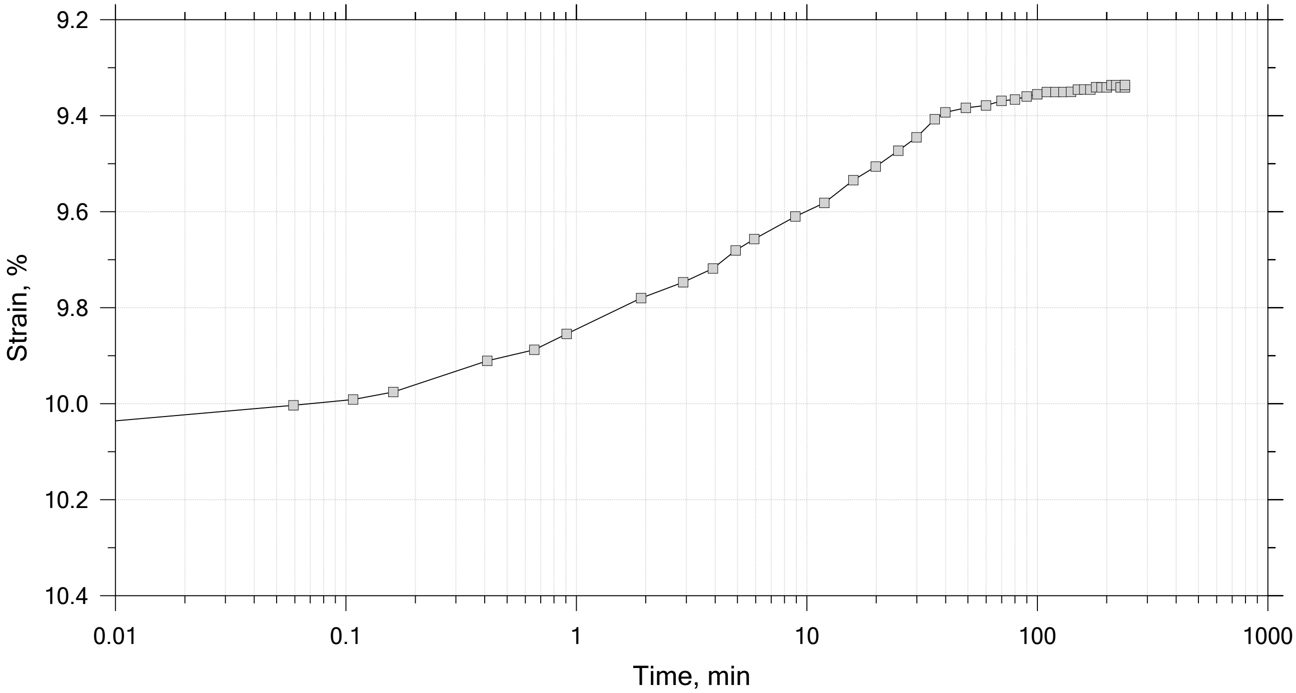
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

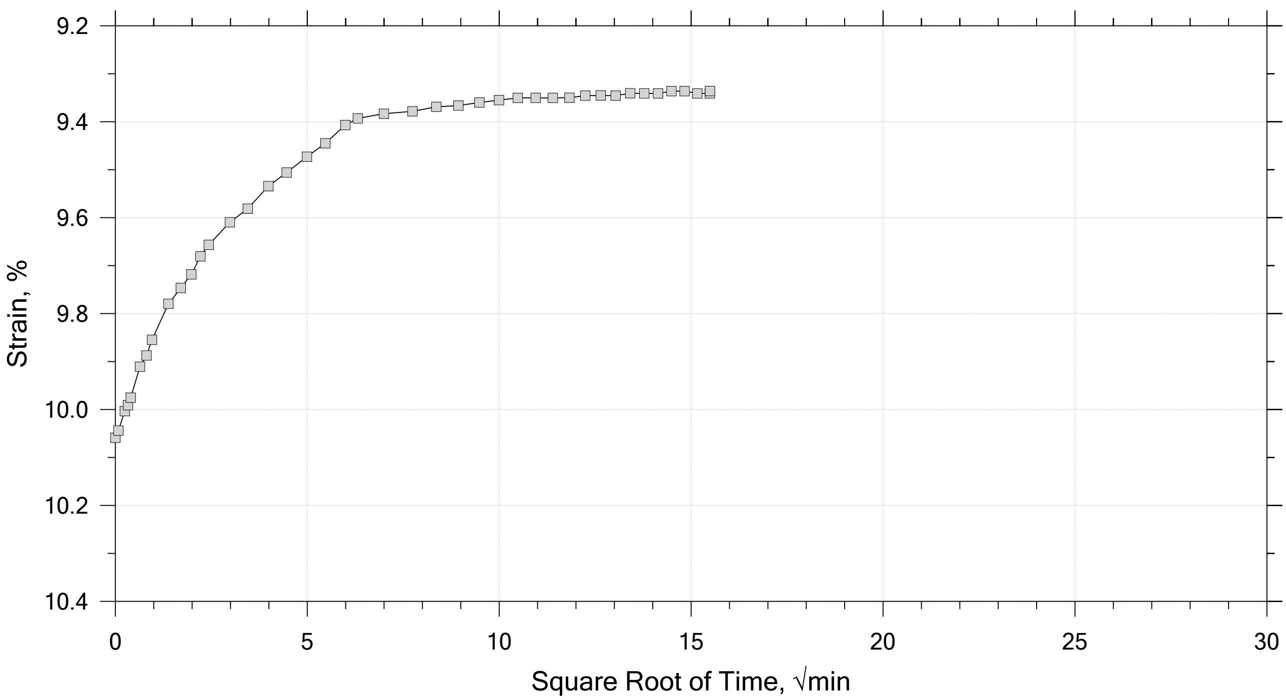
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 17 of 17

Constant Load Step

Stress: 0.25 tsf





GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.74	Liquid Limit: 36
Initial Height: 1.00 in	Initial Void Ratio: 0.665	Plastic Limit: 16
Final Height: 0.90 in	Final Void Ratio: 0.499	Plasticity Index: 20

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	E9246	RING		E8594
Mass Container, gm	8.59	111.34	111.34	8.42
Mass Container + Wet Soil, gm	191.98	275.28	268	166.27
Mass Container + Dry Soil, gm	157.57	243.91	243.91	142
Mass Dry Soil, gm	148.98	132.57	132.57	133.58
Water Content, %	23.10	23.66	18.17	18.17
Void Ratio	---	0.67	0.50	---
Degree of Saturation, %	---	97.62	100.00	---
Dry Unit Weight, pcf	---	102.89	114.32	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test.
Therefore, values may not represent actual values for the specimen.

Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
Boring No.: WB-108	Tested By: sjt	Checked By: anm
Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
Test No.: IP-2R	Sample Type: intact	Elevation: ---
Description: Moist, gray clay		
Remarks: TX-017, Swell Pressure = 0.0684 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

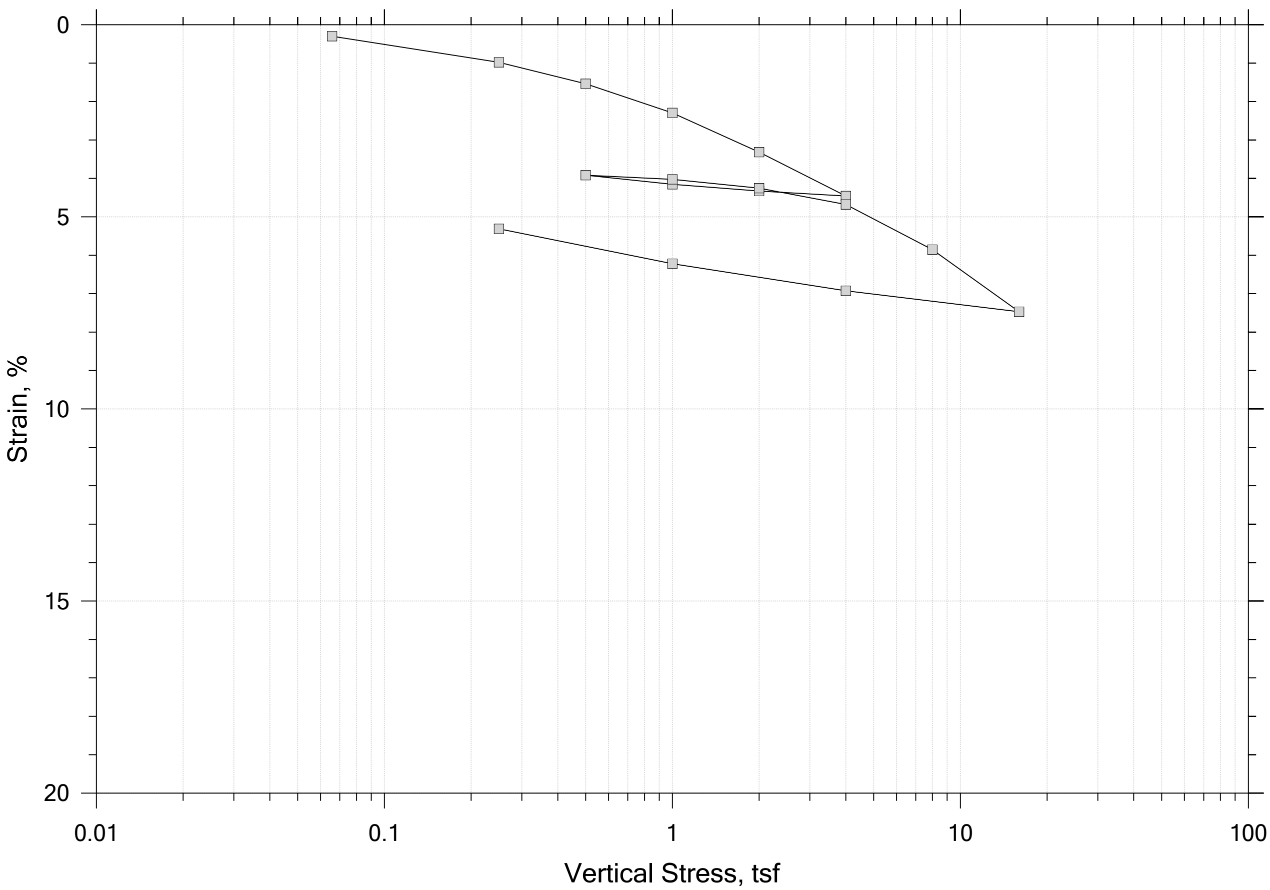
Square Root of Time Coefficients

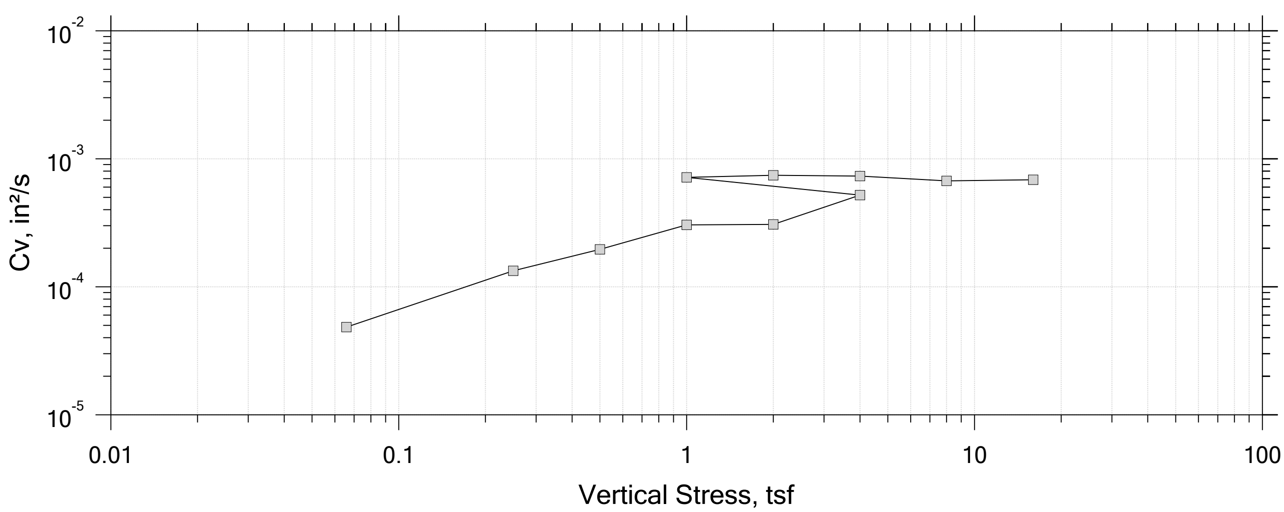
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.0684	0.008502	0.651	0.850	51.846	6.76e-05	1.24e-01	1.57e-04
2	0.250	0.02309	0.627	2.31	23.313	1.47e-04	8.03e-02	2.21e-04
3	0.500	0.03345	0.609	3.35	11.381	2.93e-04	4.14e-02	2.28e-04
4	1.00	0.04446	0.591	4.45	17.547	1.86e-04	2.20e-02	7.67e-05
5	2.00	0.05736	0.570	5.74	10.531	3.02e-04	1.29e-02	7.30e-05
6	4.00	0.07233	0.545	7.23	10.233	3.02e-04	7.49e-03	4.23e-05
7	2.00	0.07137	0.546	7.14	183.653	1.66e-05	4.82e-04	1.49e-07
8	1.00	0.06949	0.549	6.95	24.912	1.23e-04	1.87e-03	4.30e-06
9	0.500	0.06569	0.556	6.57	22.542	1.36e-04	7.60e-03	1.94e-05
10	1.00	0.06746	0.553	6.75	1.620	1.90e-03	3.54e-03	1.26e-04
11	2.00	0.07018	0.548	7.02	2.815	1.09e-03	2.72e-03	5.55e-05
12	4.00	0.07502	0.540	7.50	157.265	1.93e-05	2.42e-03	8.76e-07
13	8.00	0.09145	0.513	9.14	7.464	3.98e-04	4.11e-03	3.06e-05
14	16.0	0.1131	0.477	11.3	4.664	6.10e-04	2.71e-03	3.09e-05
15	4.00	0.1098	0.482	11.0	2.725	1.02e-03	2.74e-04	5.26e-06
16	1.00	0.1028	0.494	10.3	14.508	1.95e-04	2.33e-03	8.49e-06
17	0.250	0.09336	0.510	9.34	14.459	1.99e-04	1.26e-02	4.69e-05
18	0.000	0.08432	0.525	8.43	58.880	4.98e-05	3.62e-02	3.37e-05

GeoTesting EXPRESS A BENZEL COMPANY	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-108	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-2R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay		
	Remarks: TX-017, Swell Pressure = 0.0684 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report





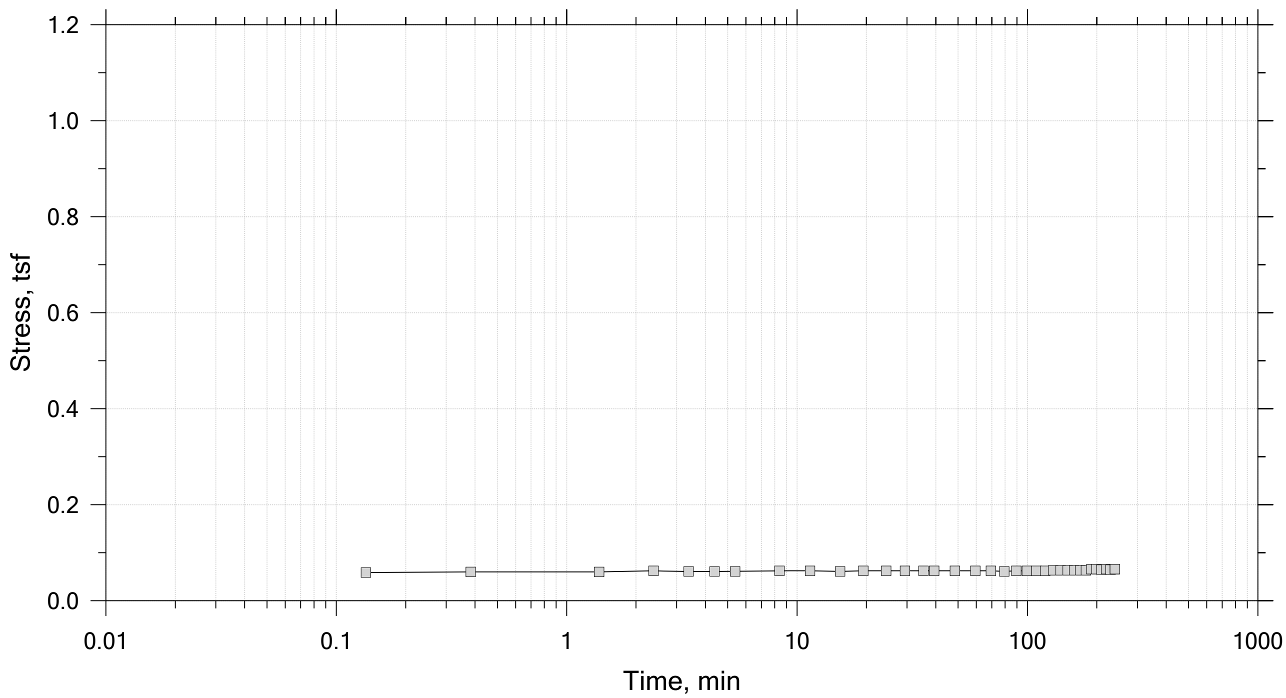
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		
	Displacement at End of Increment		

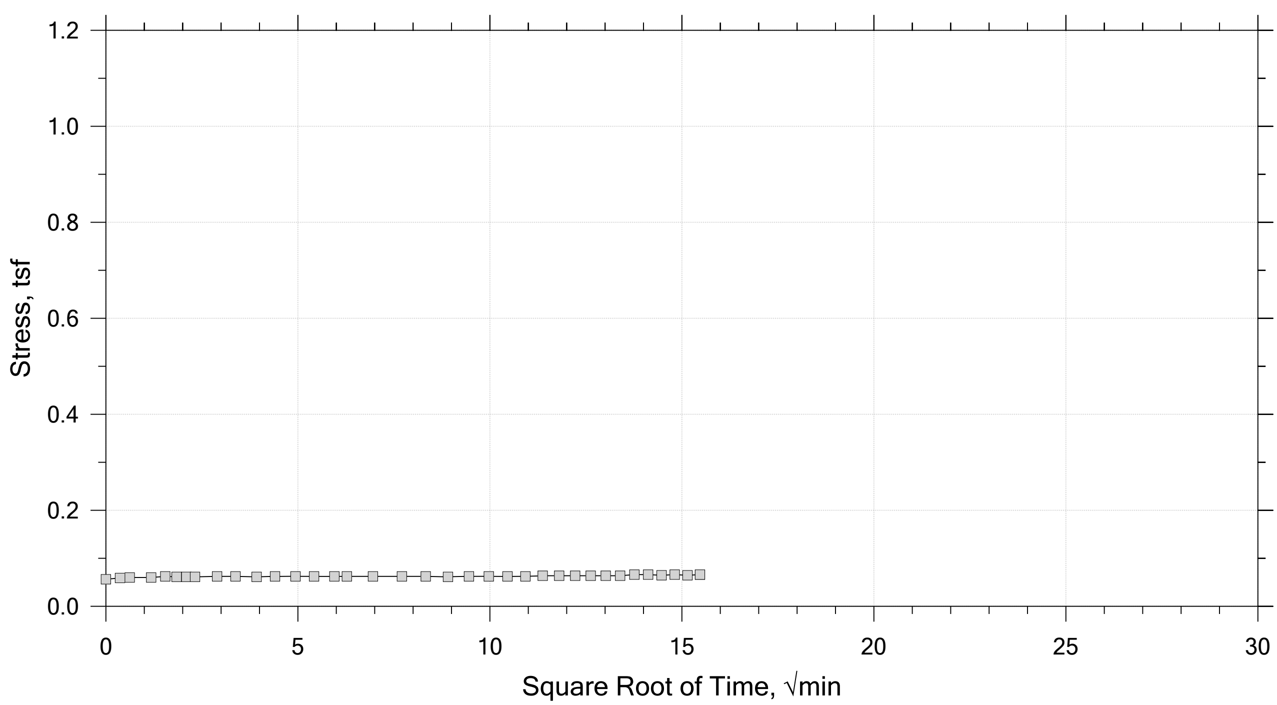
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 17

Constant Volume Step

Stress: 0.0658 tsf

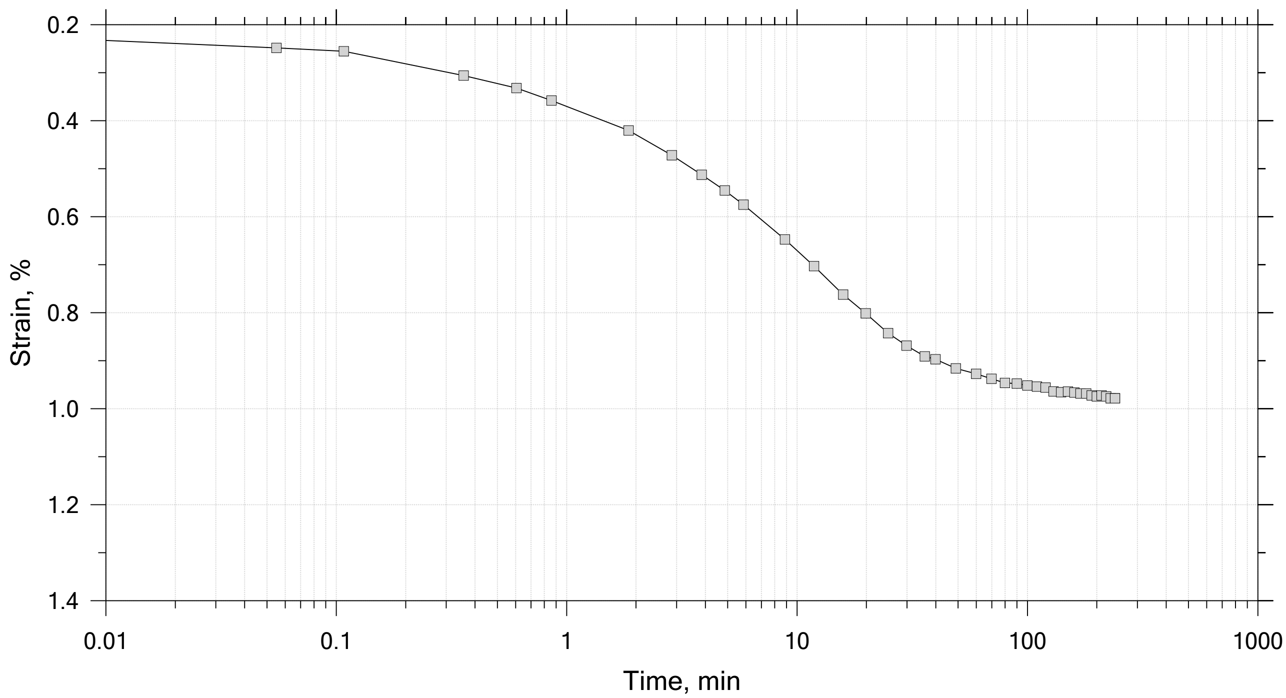


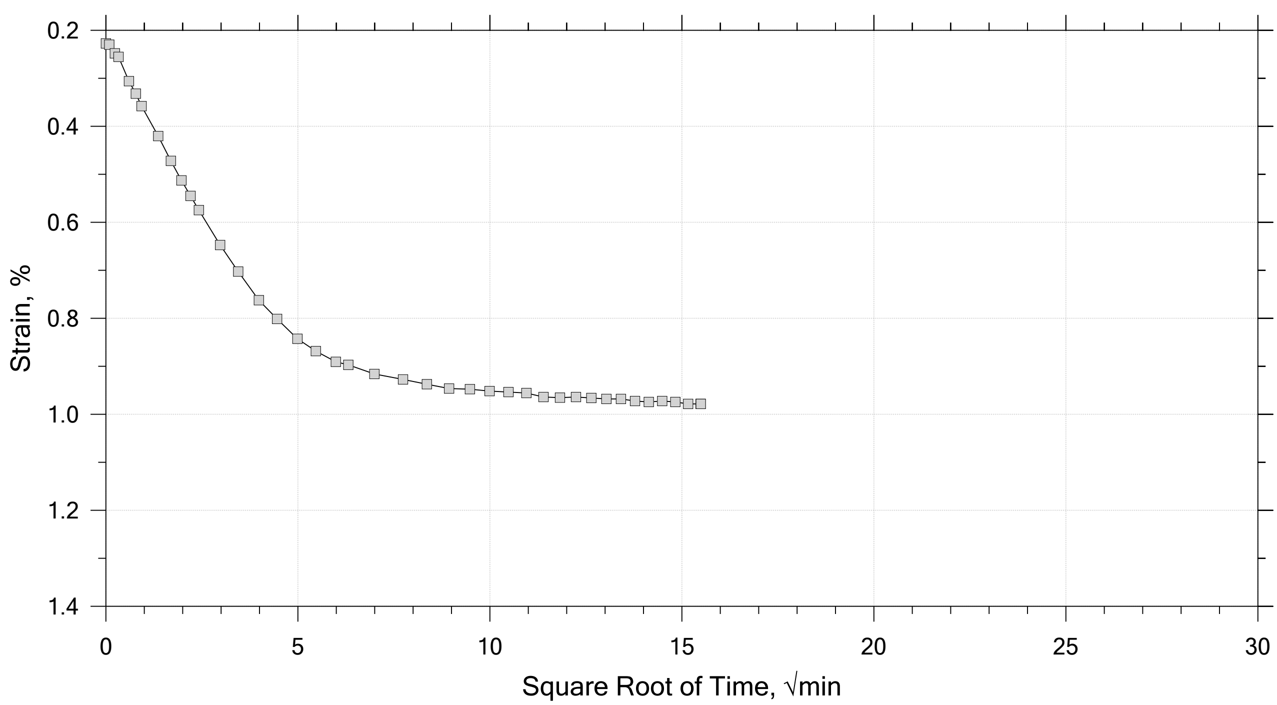


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 17
Constant Load Step
Stress: 0.25 tsf

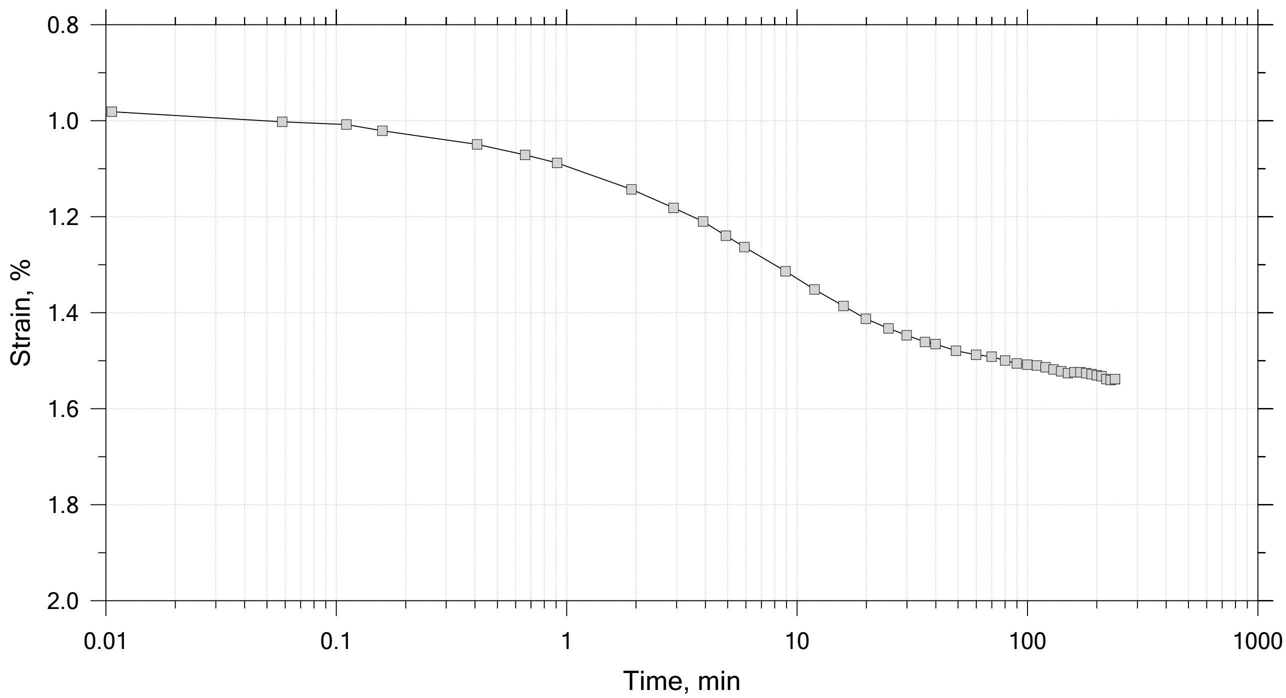


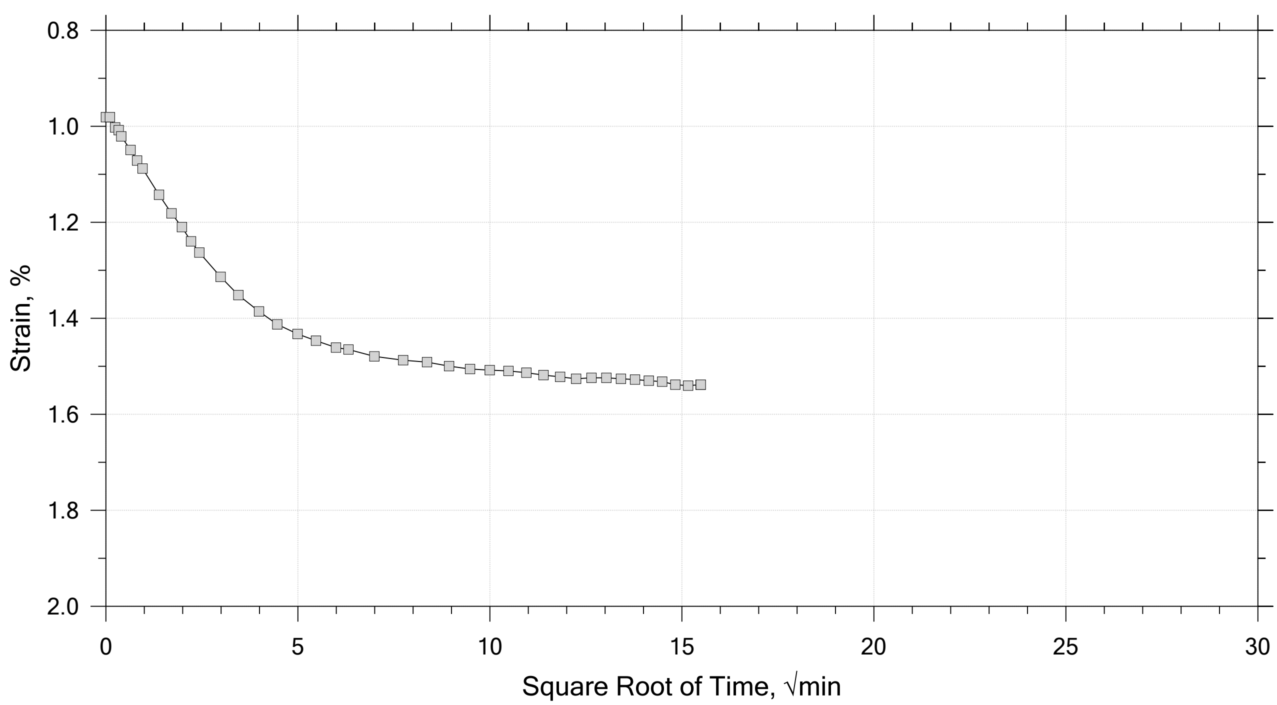


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 17
Constant Load Step
Stress: 0.5 tsf





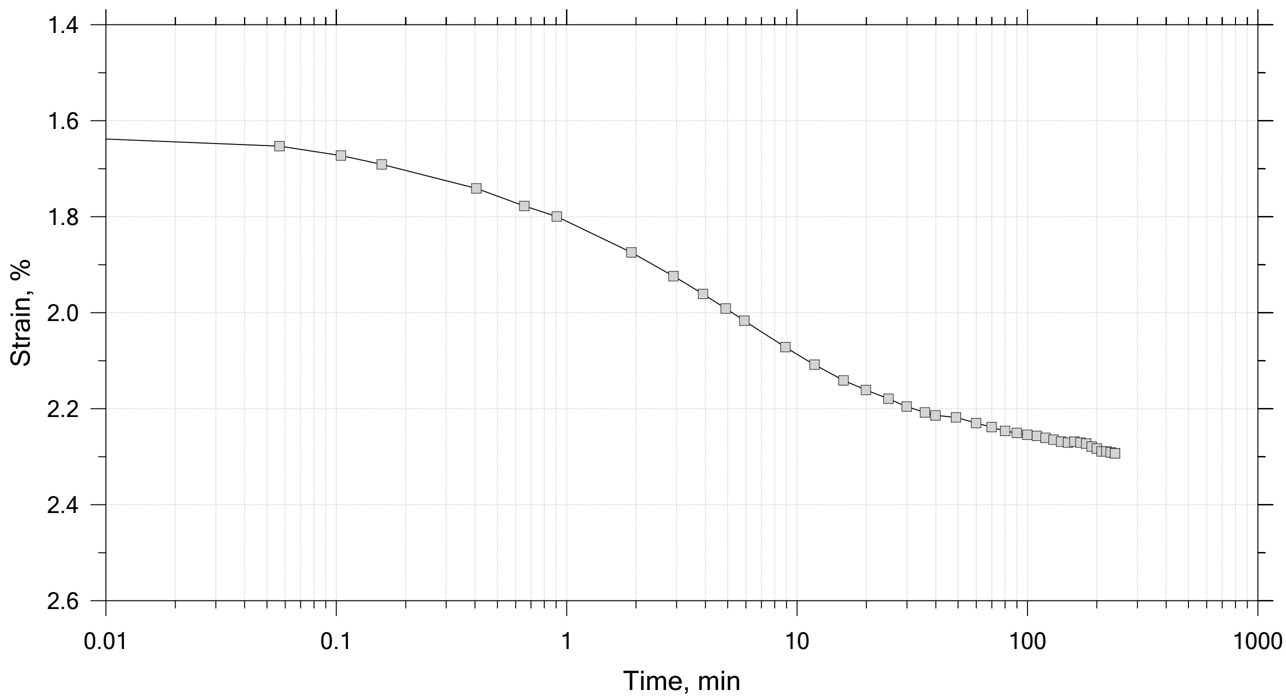
	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

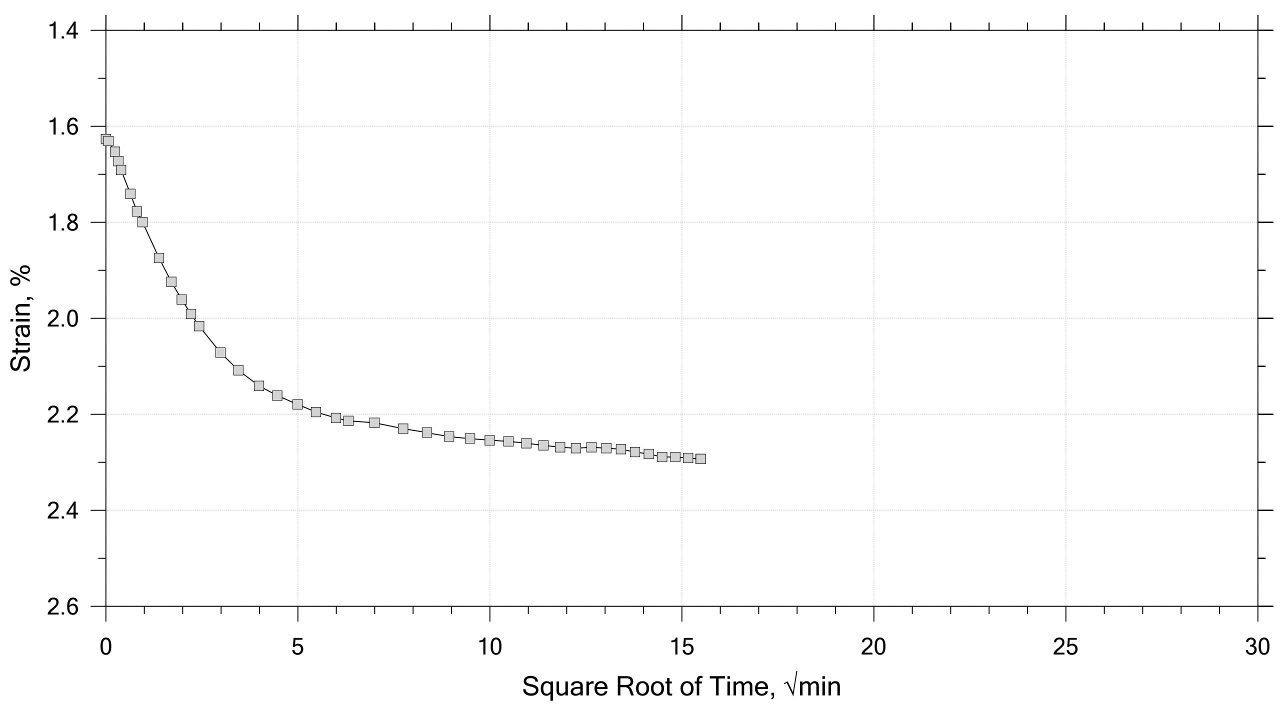
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 17

Constant Load Step

Stress: 1 tsf





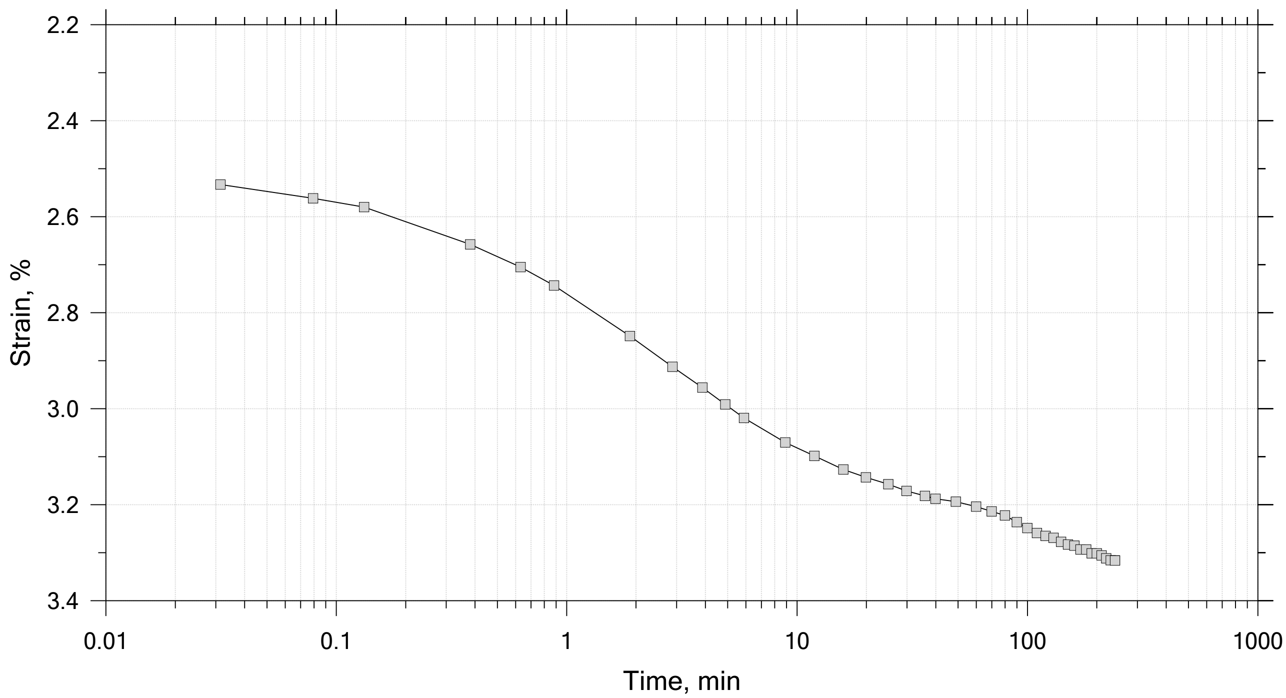
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

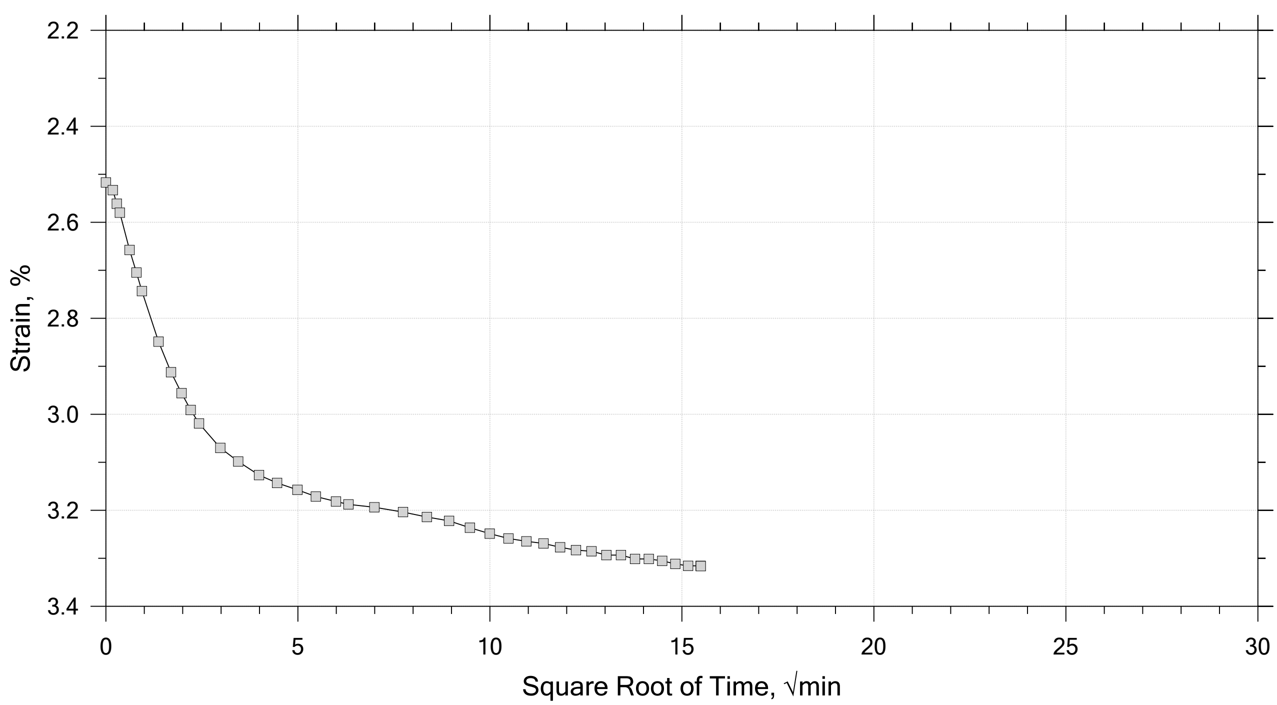
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 17

Constant Load Step

Stress: 2 tsf





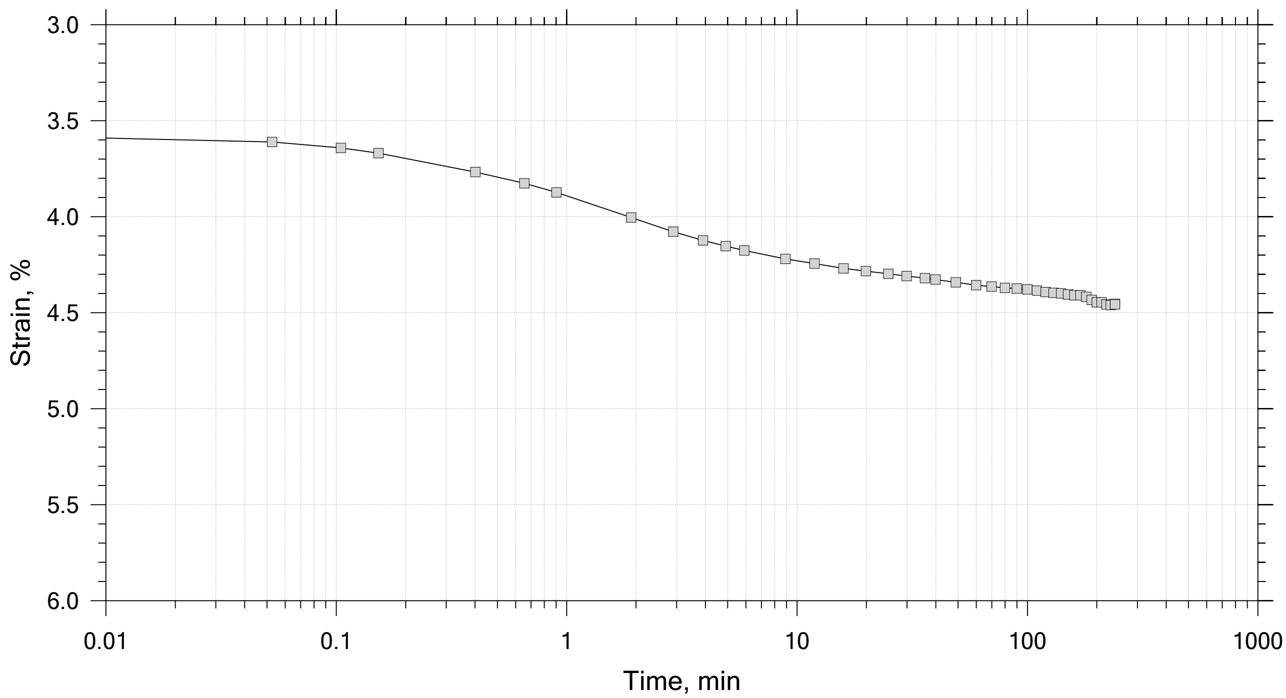
Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
Boring No.: WB-106	Tested By: sjt	Checked By: anm
Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
Test No.: IP-1R	Sample Type: intact	Elevation: ---
Description: Moist, gray clay with sand		
Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

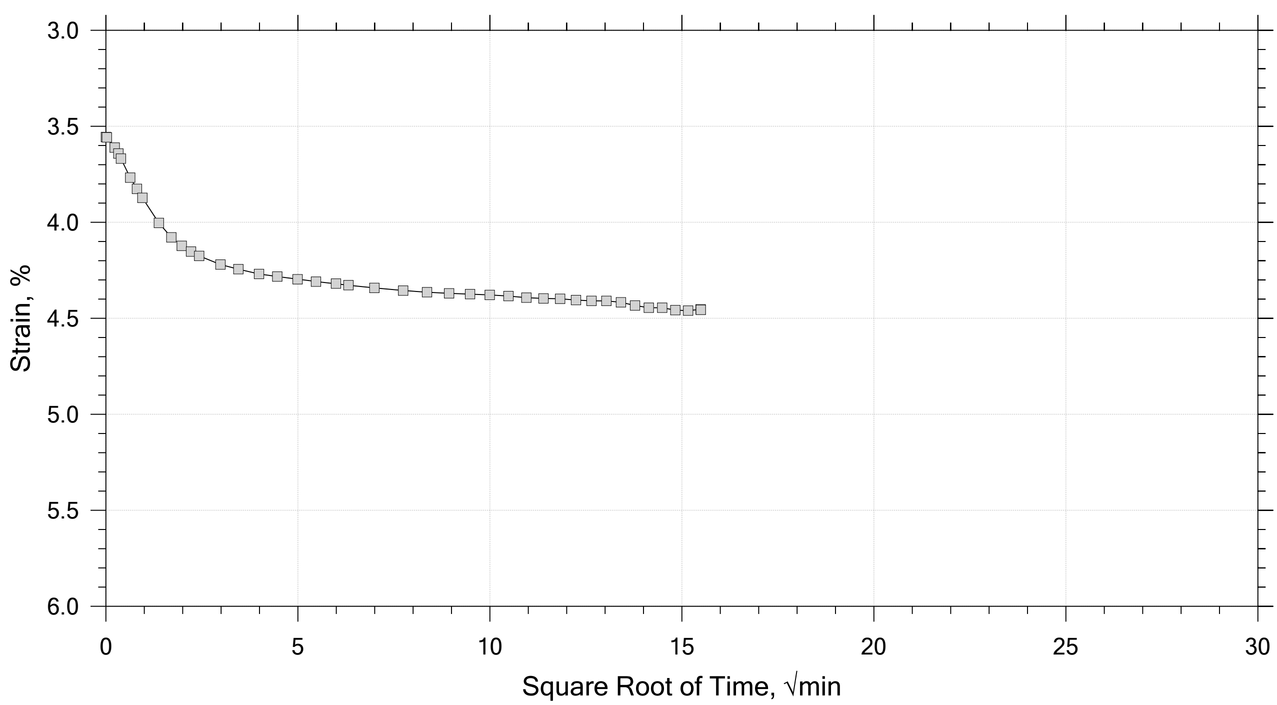
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 17

Constant Load Step

Stress: 4 tsf





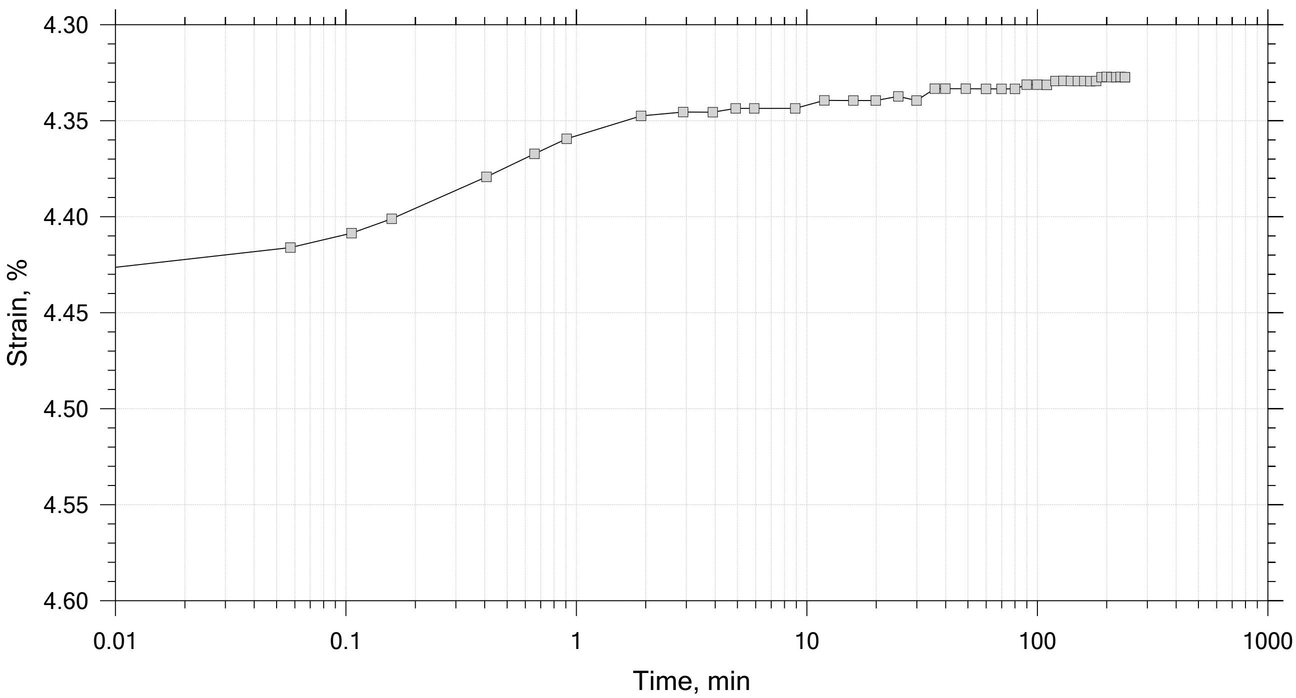
Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
Boring No.: WB-106	Tested By: sjt	Checked By: anm
Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
Test No.: IP-1R	Sample Type: intact	Elevation: ---
Description: Moist, gray clay with sand		
Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

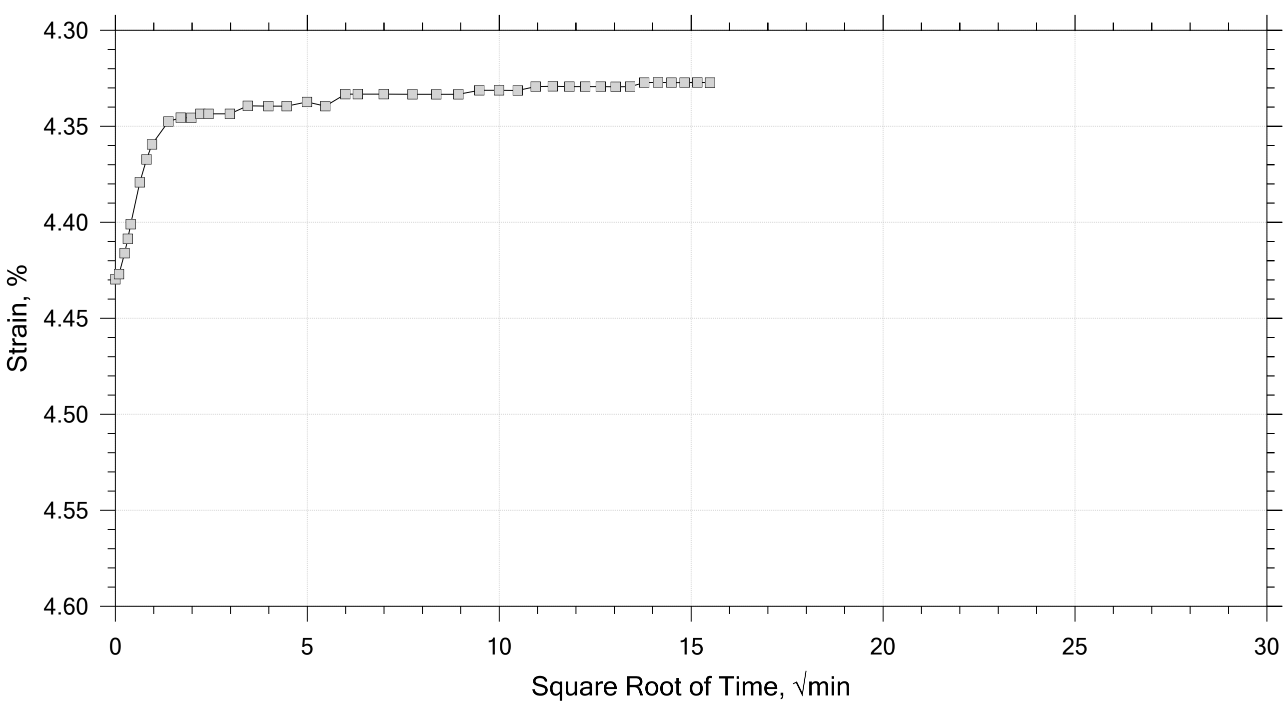
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 17

Constant Load Step

Stress: 2 tsf





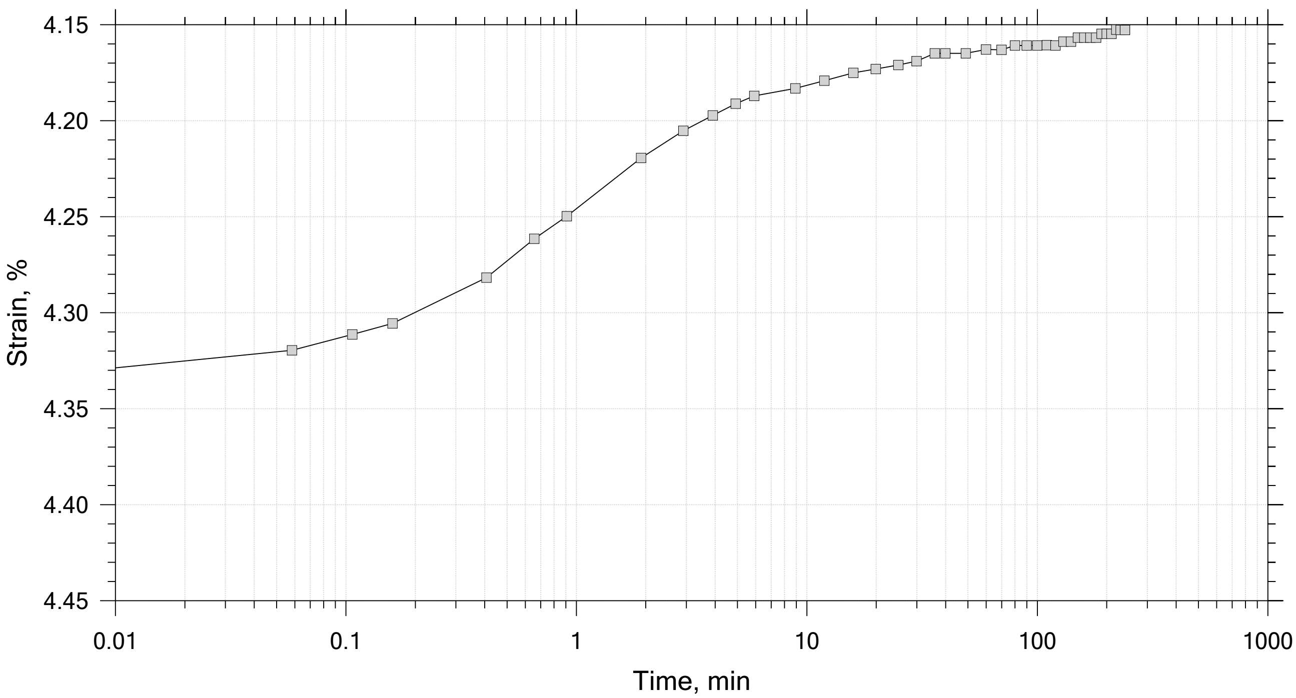
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

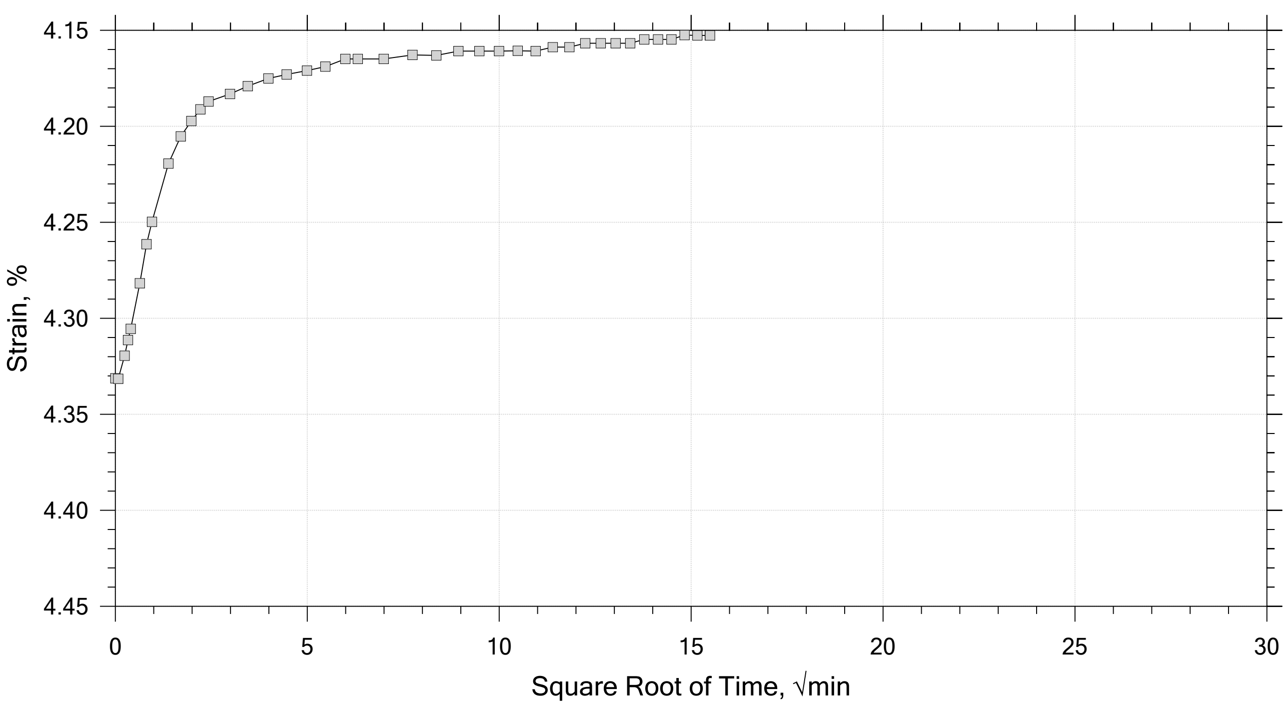
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 17

Constant Load Step

Stress: 1 tsf





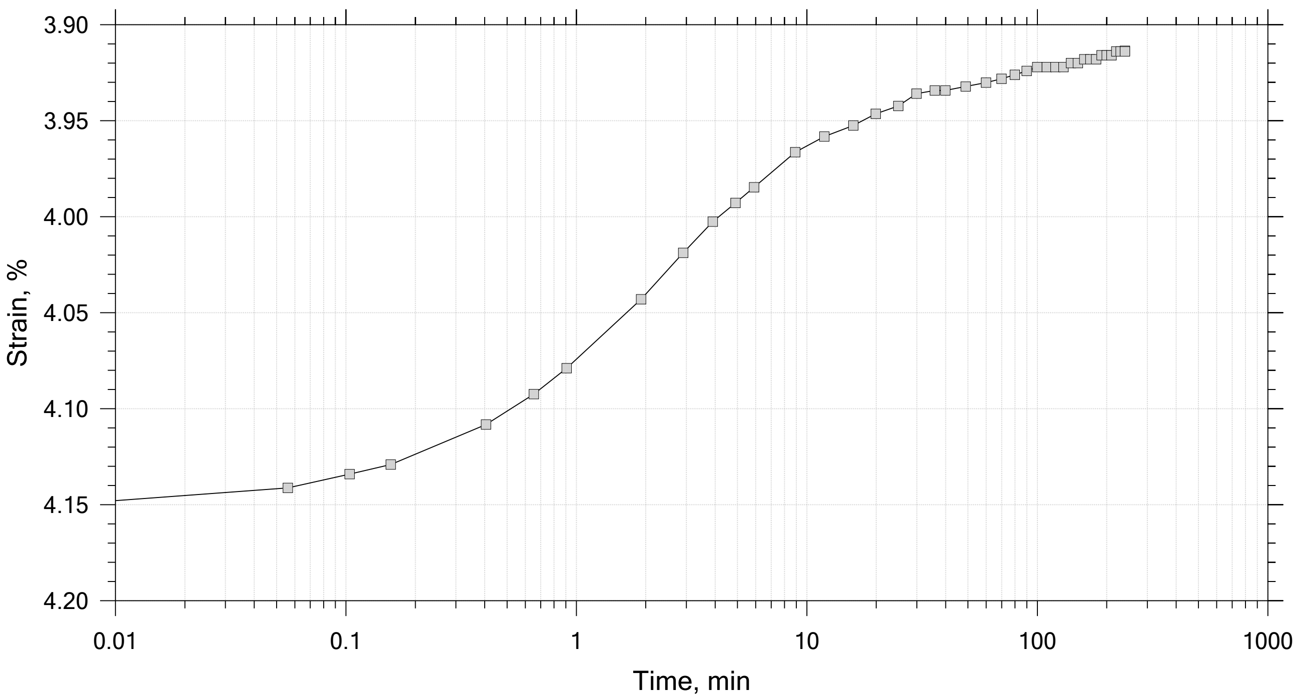
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

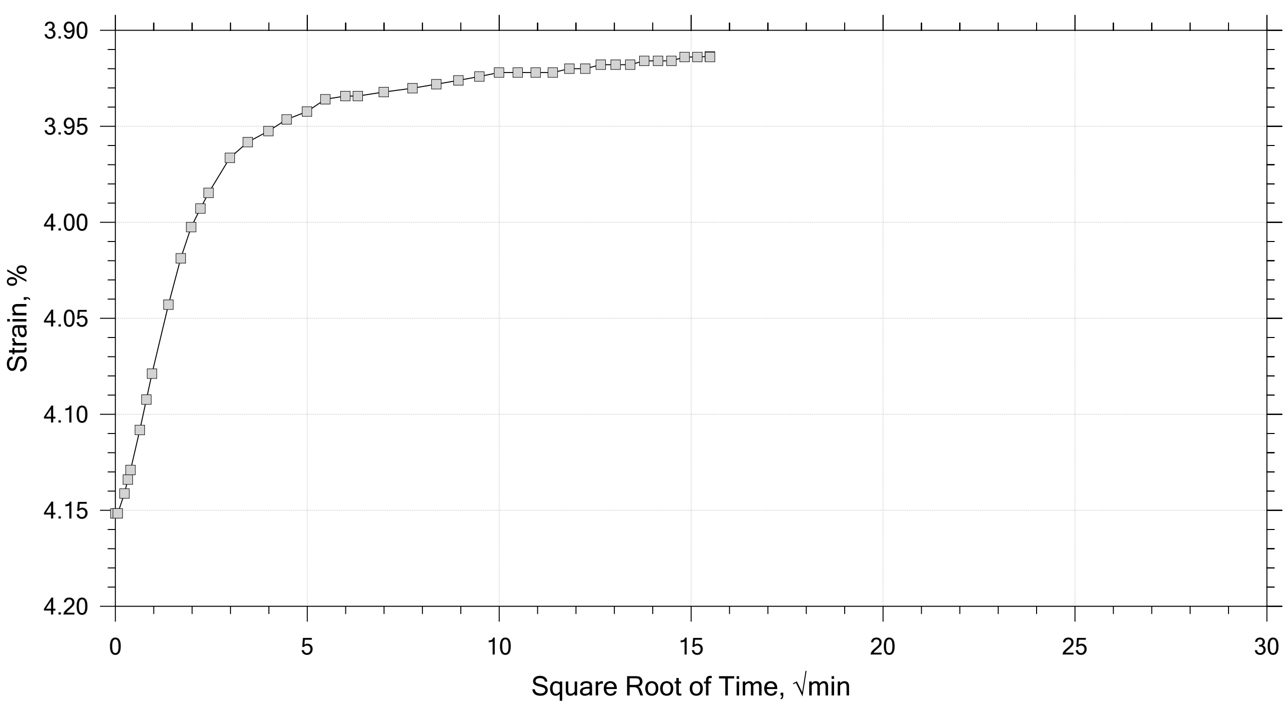
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 17

Constant Load Step

Stress: 0.5 tsf

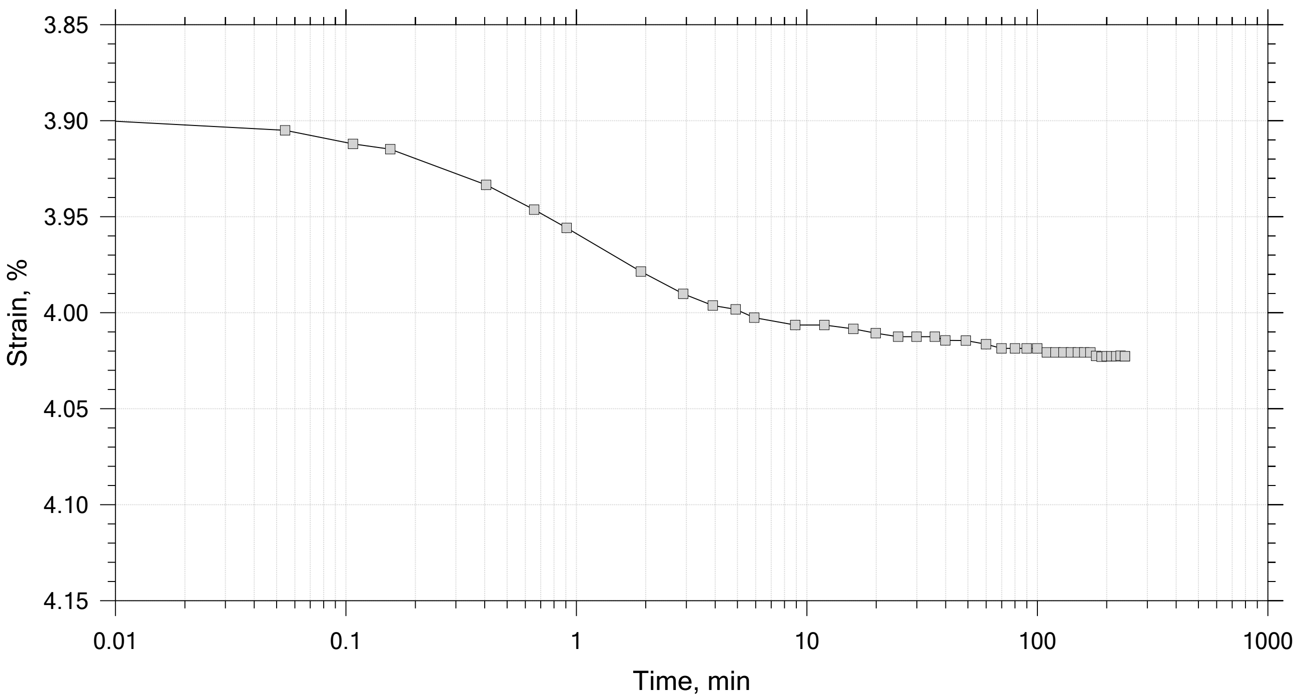


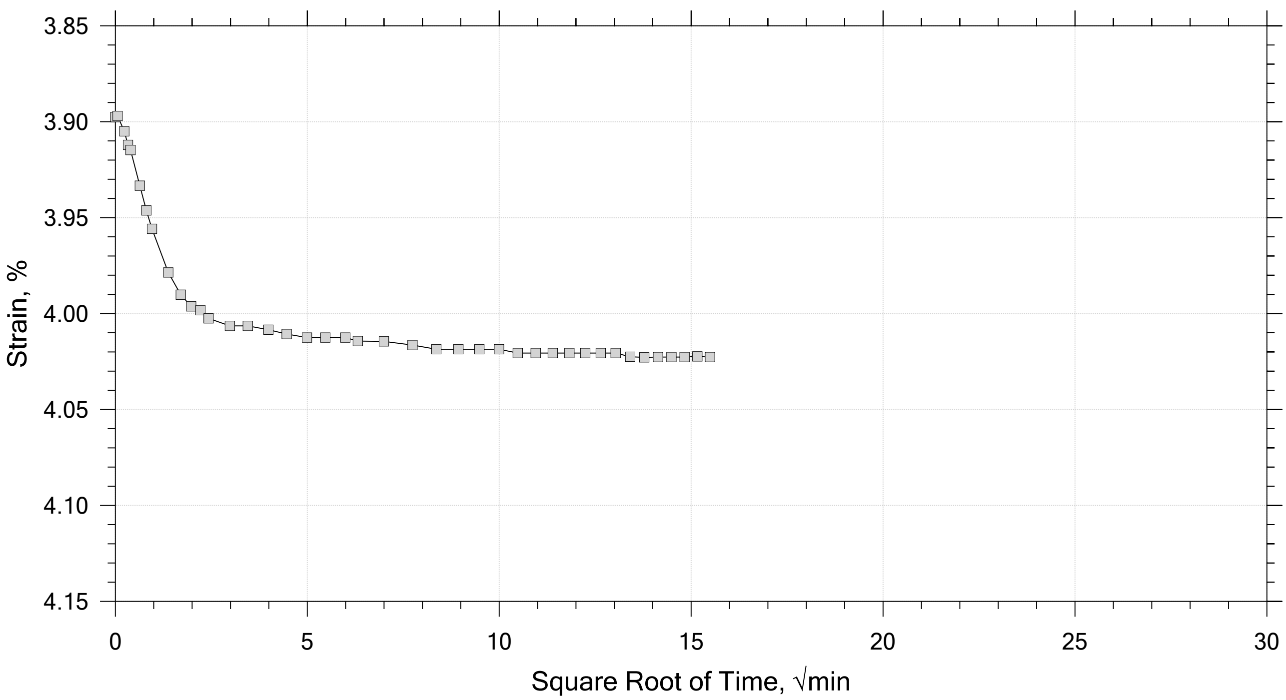


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 17
Constant Load Step
Stress: 1 tsf





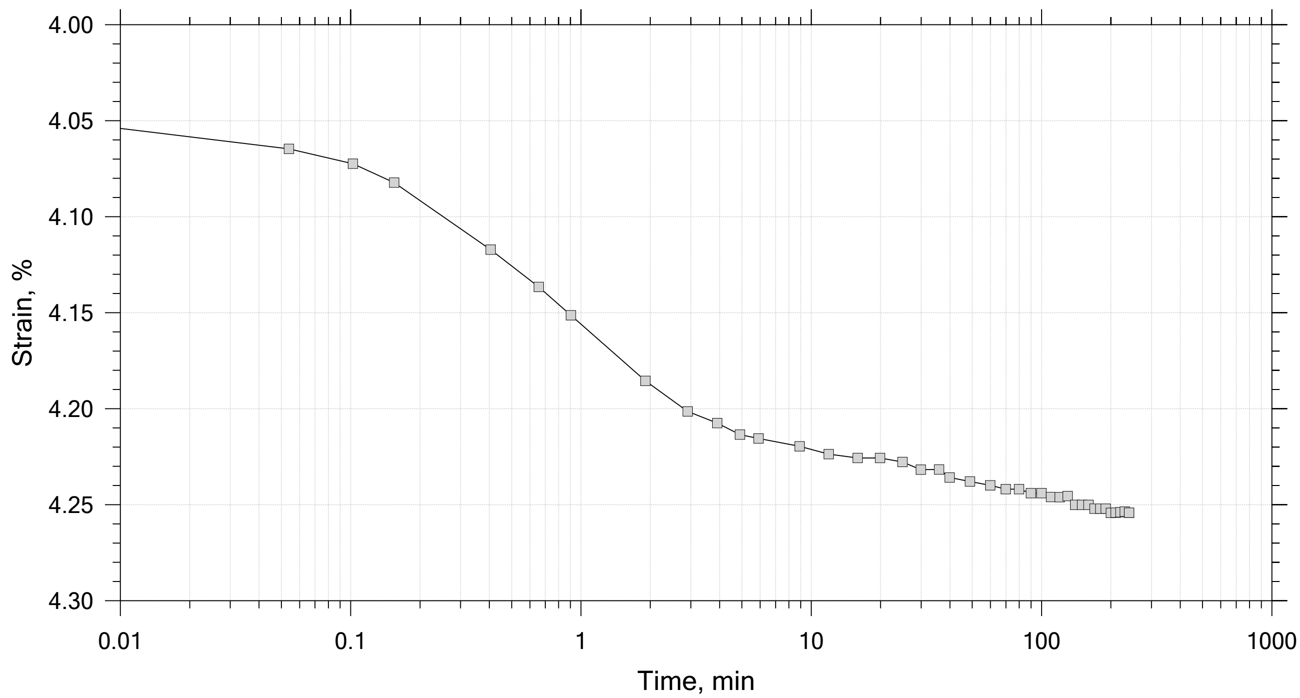
	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

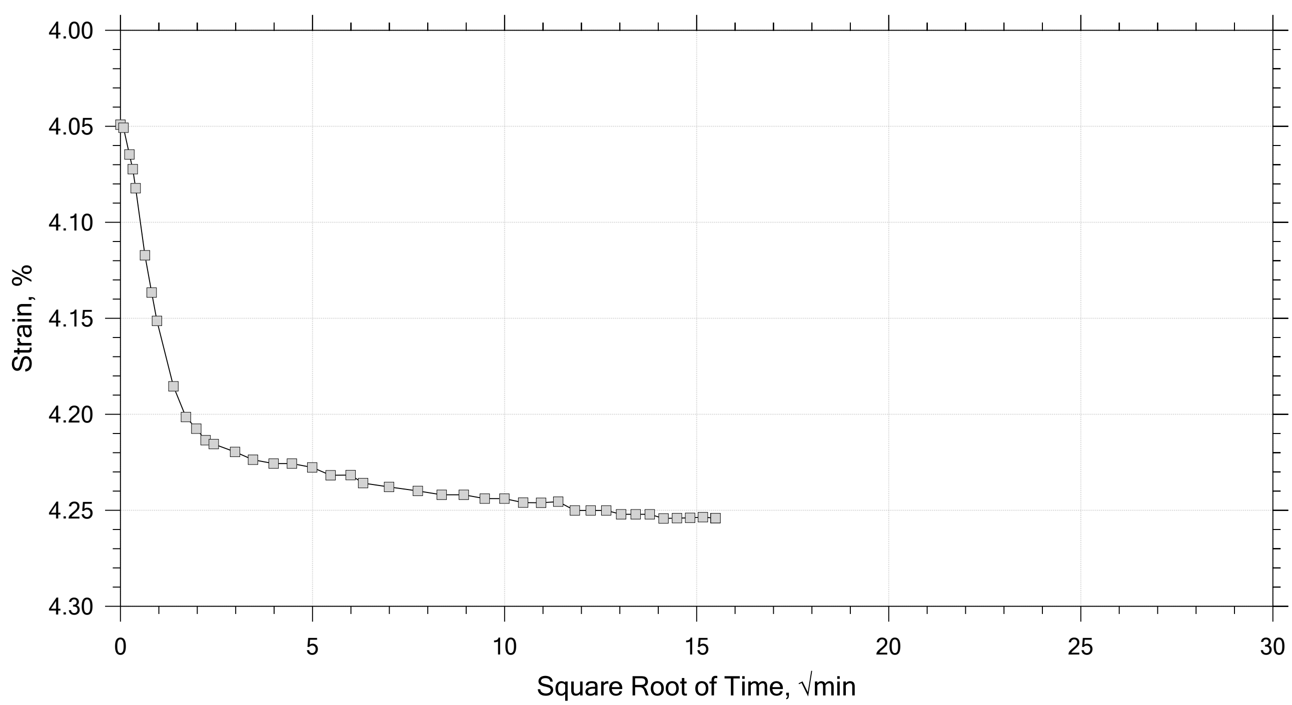
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 17

Constant Load Step

Stress: 2 tsf





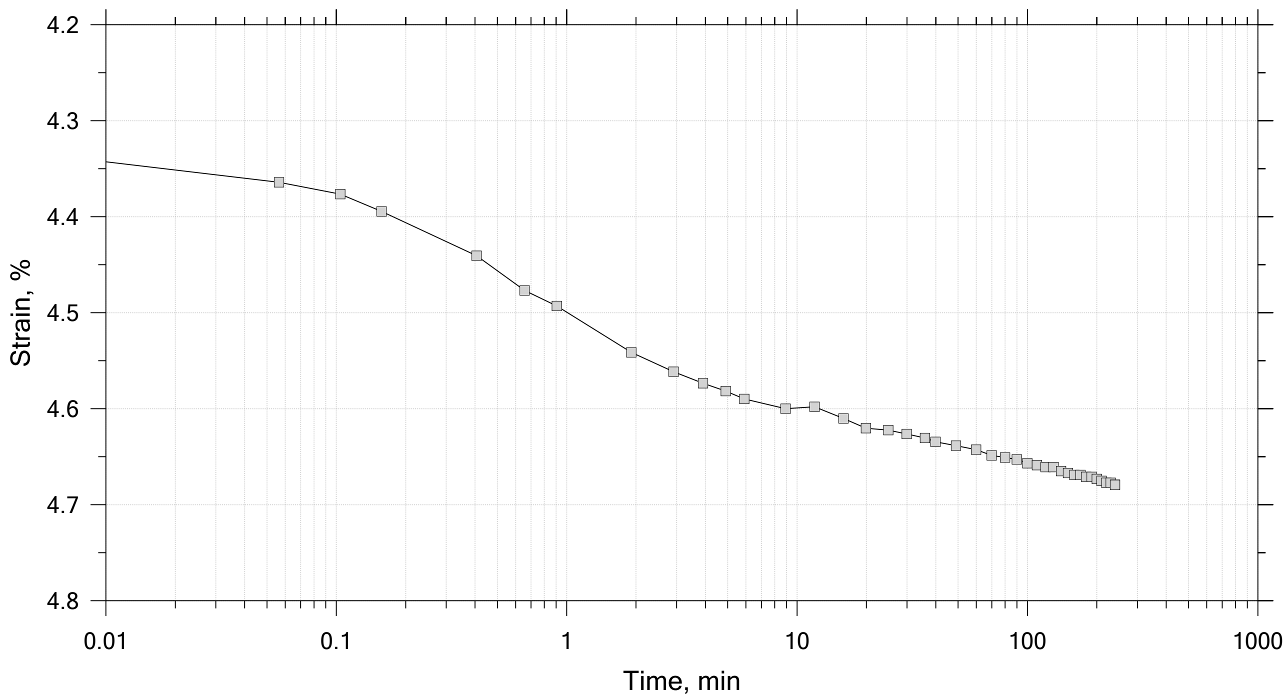
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

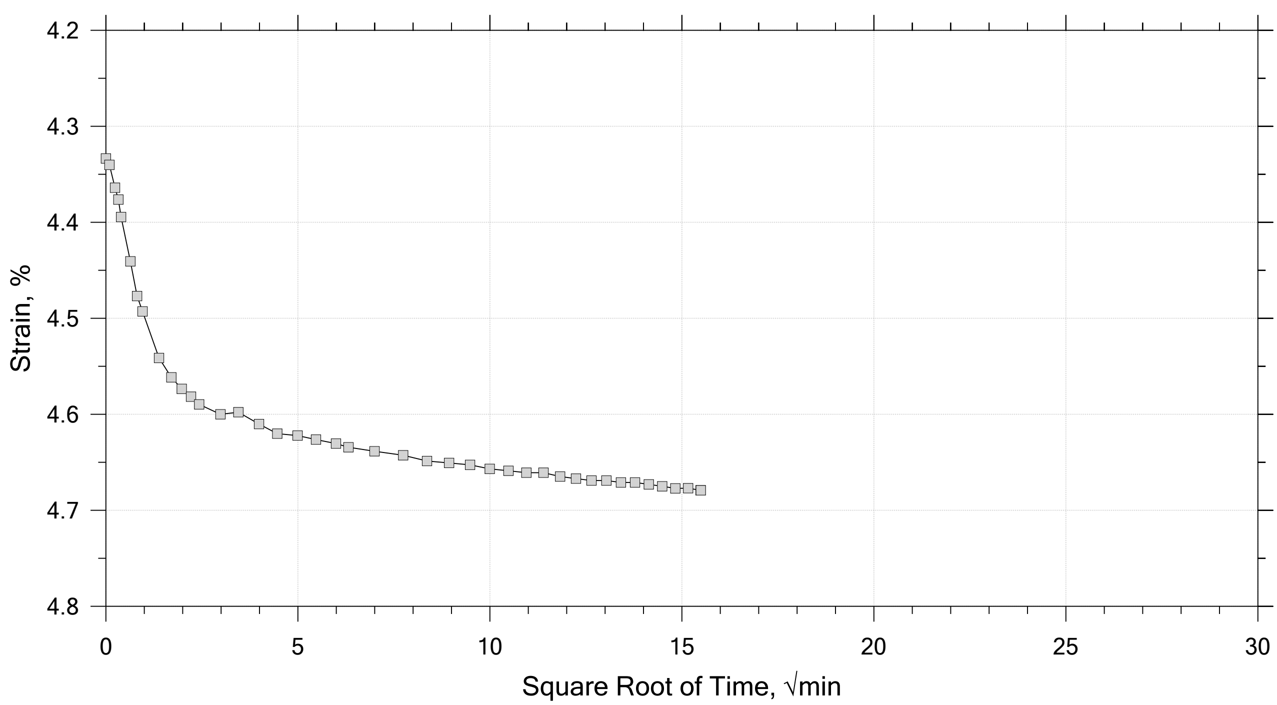
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 12 of 17

Constant Load Step

Stress: 4 tsf

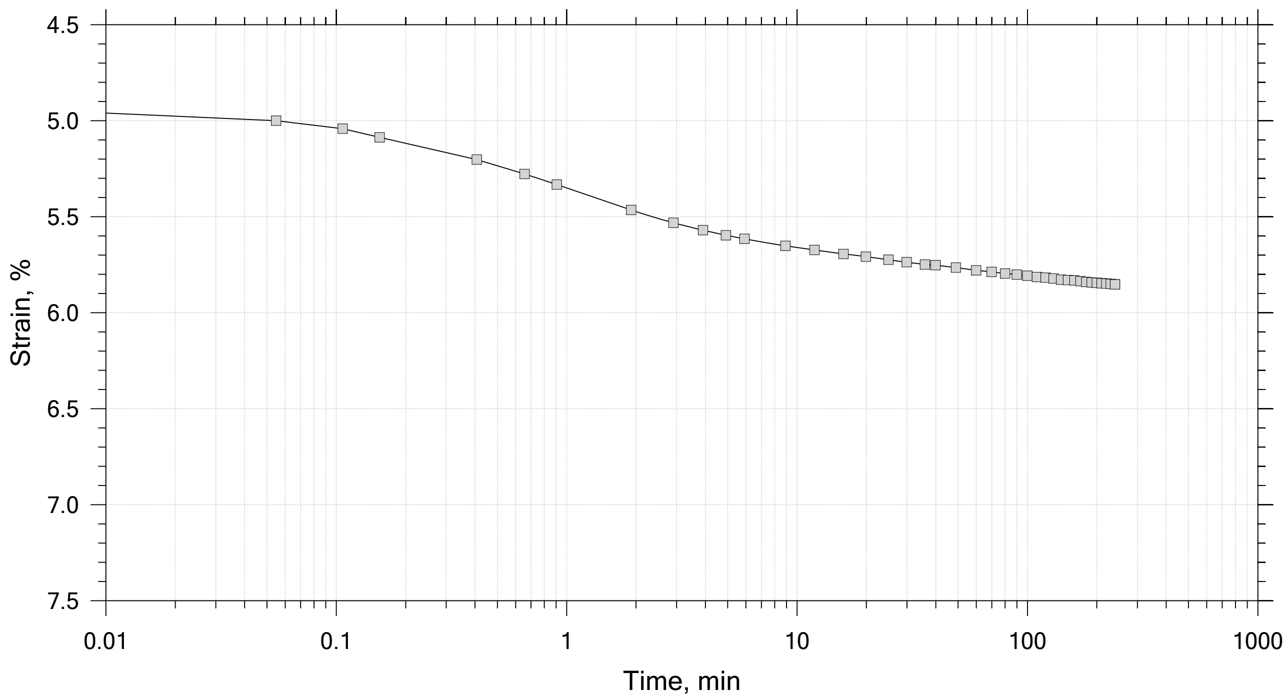


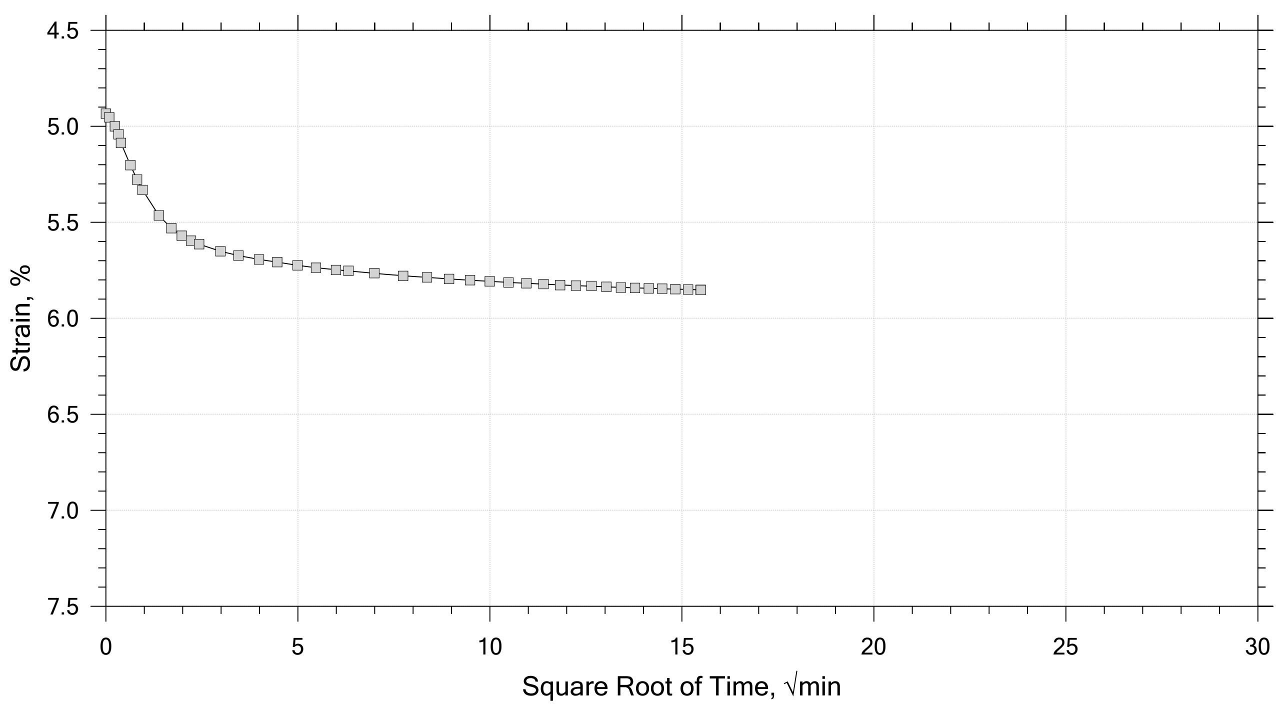


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 13 of 17
Constant Load Step
Stress: 8 tsf

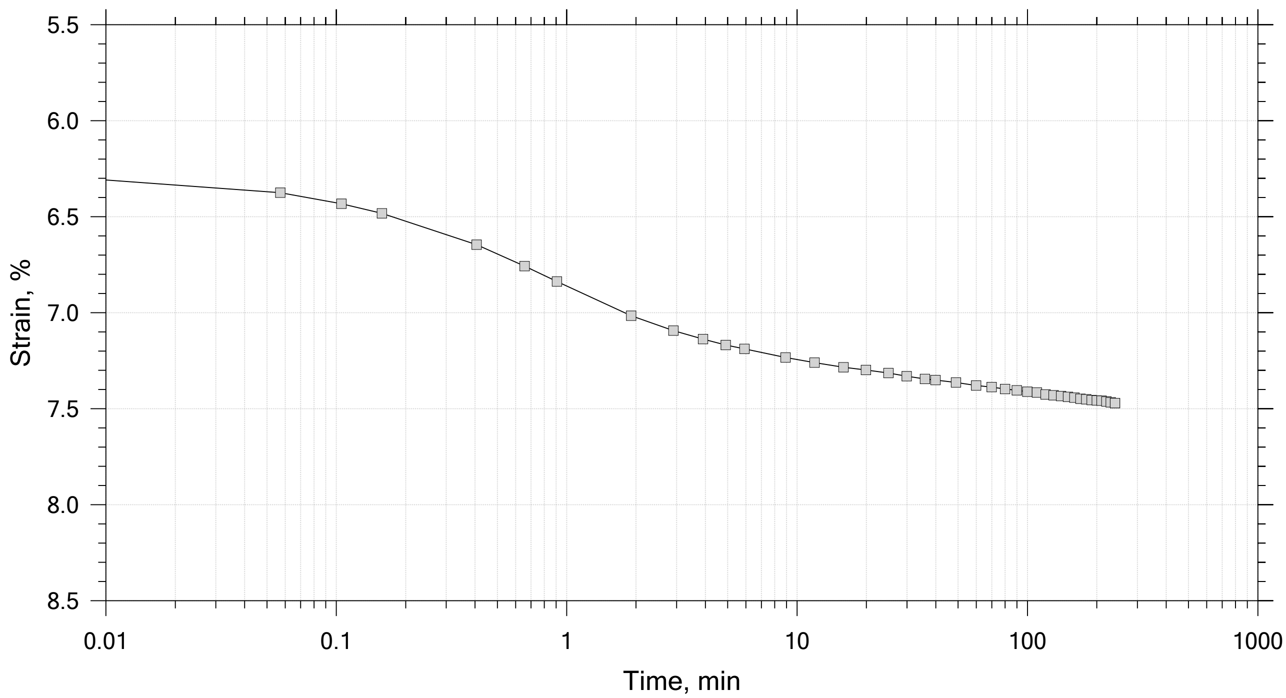


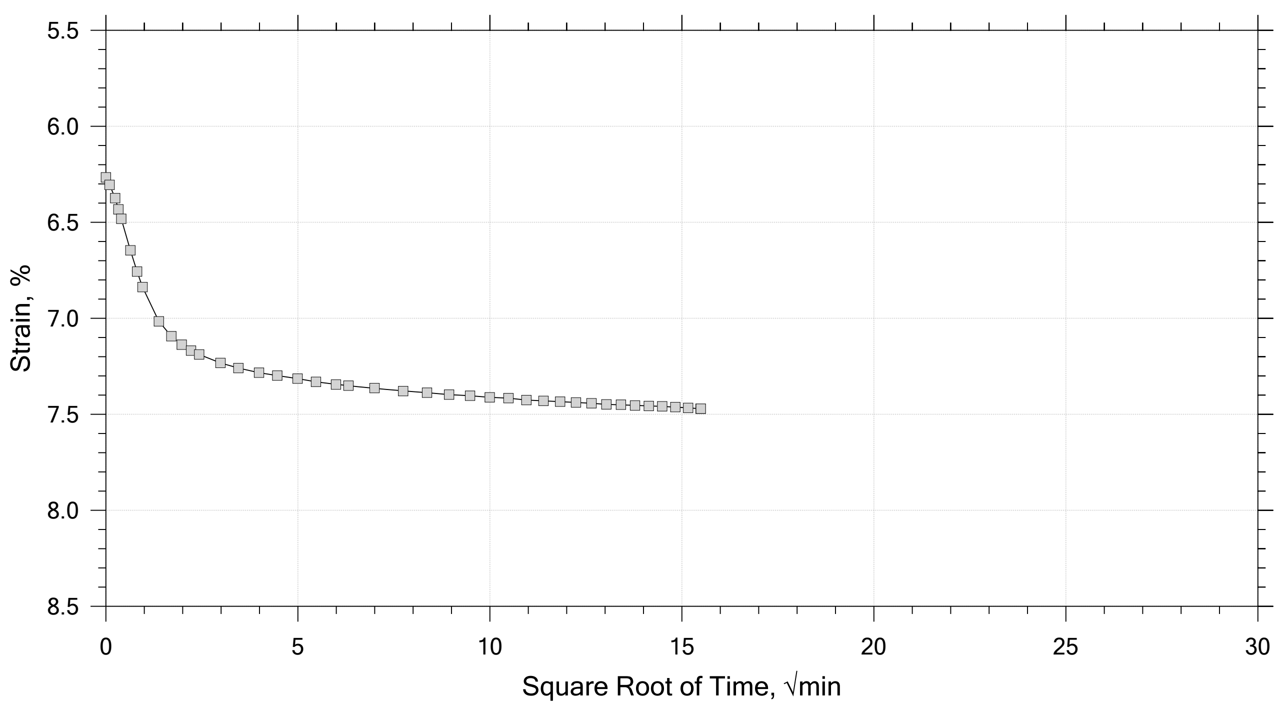


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 14 of 17
Constant Load Step
Stress: 16 tsf

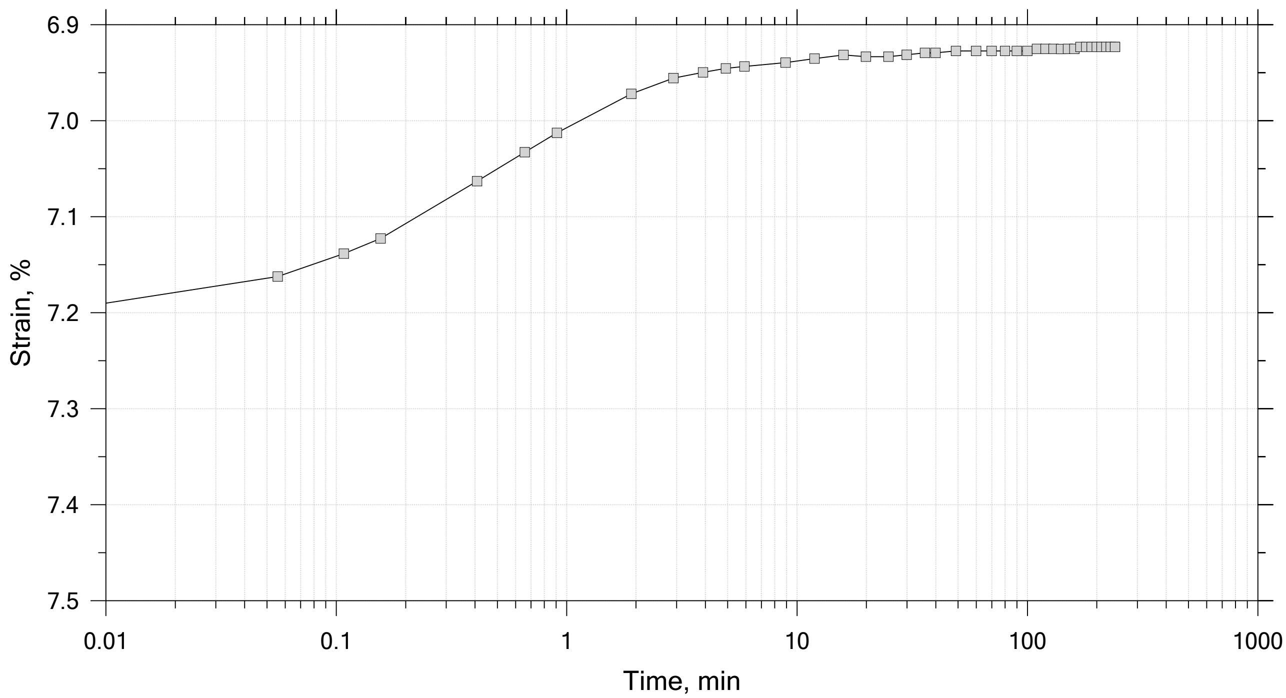


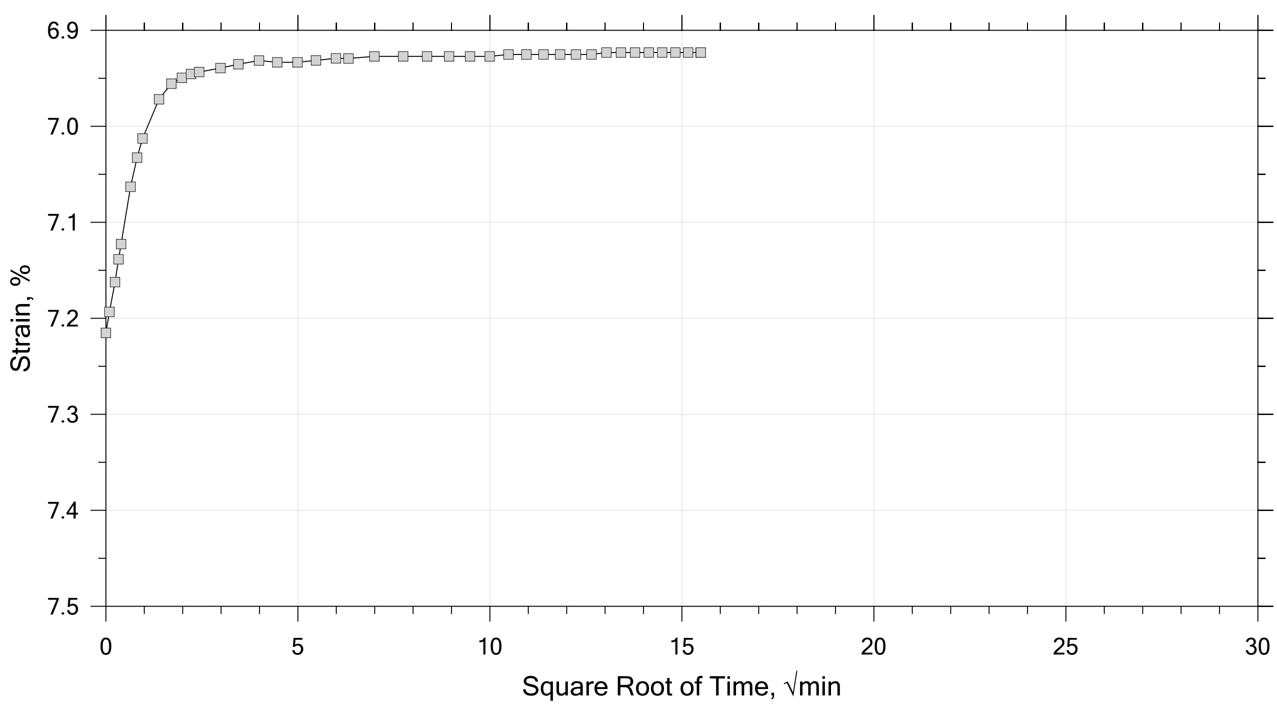


GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 15 of 17
Constant Load Step
Stress: 4 tsf





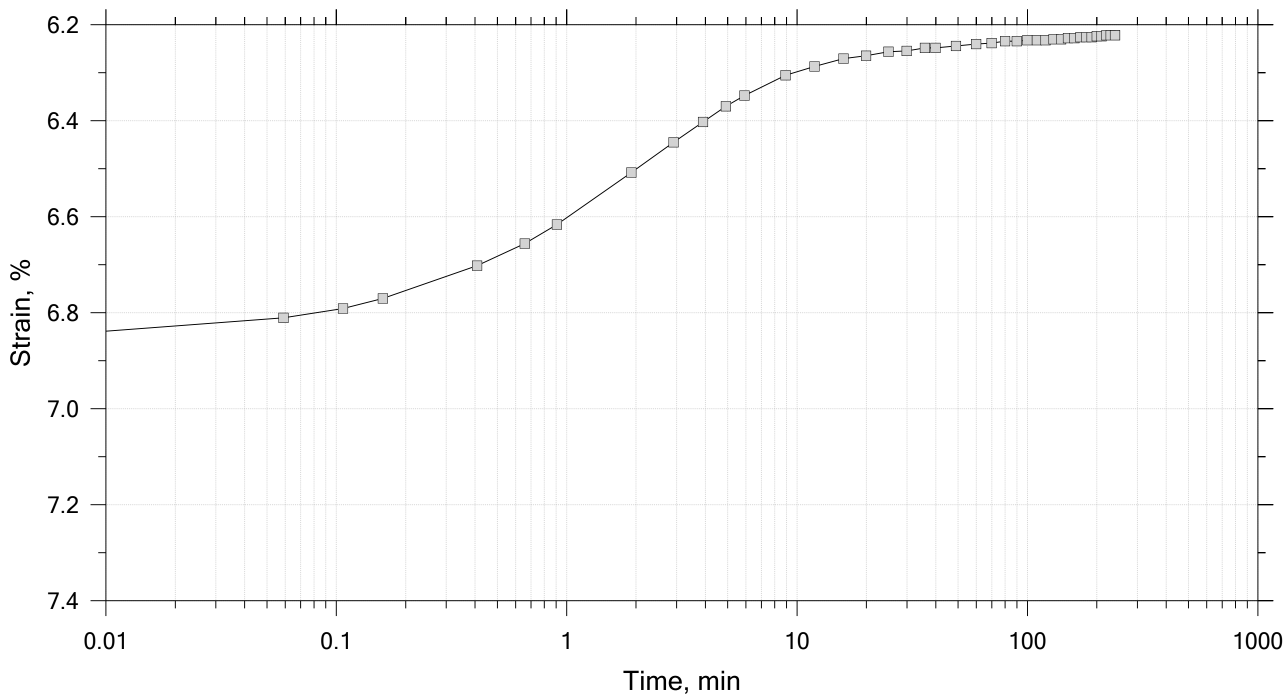
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

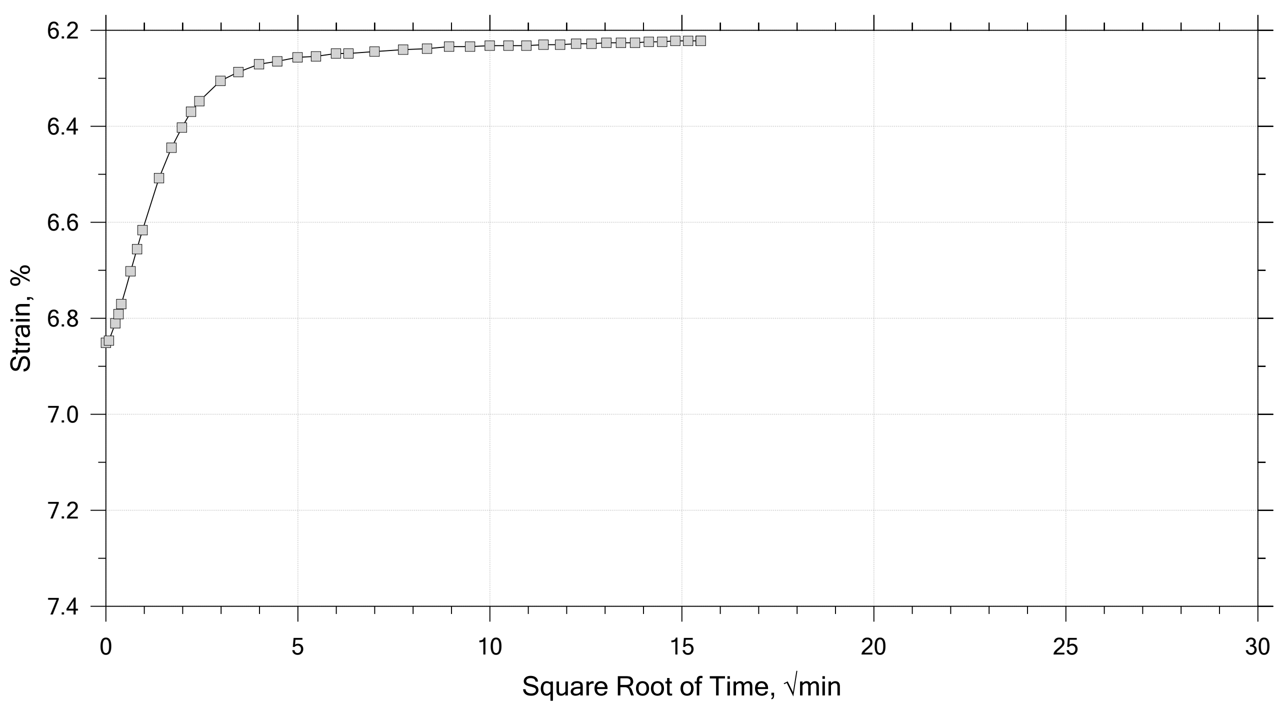
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 16 of 17

Constant Load Step

Stress: 1 tsf





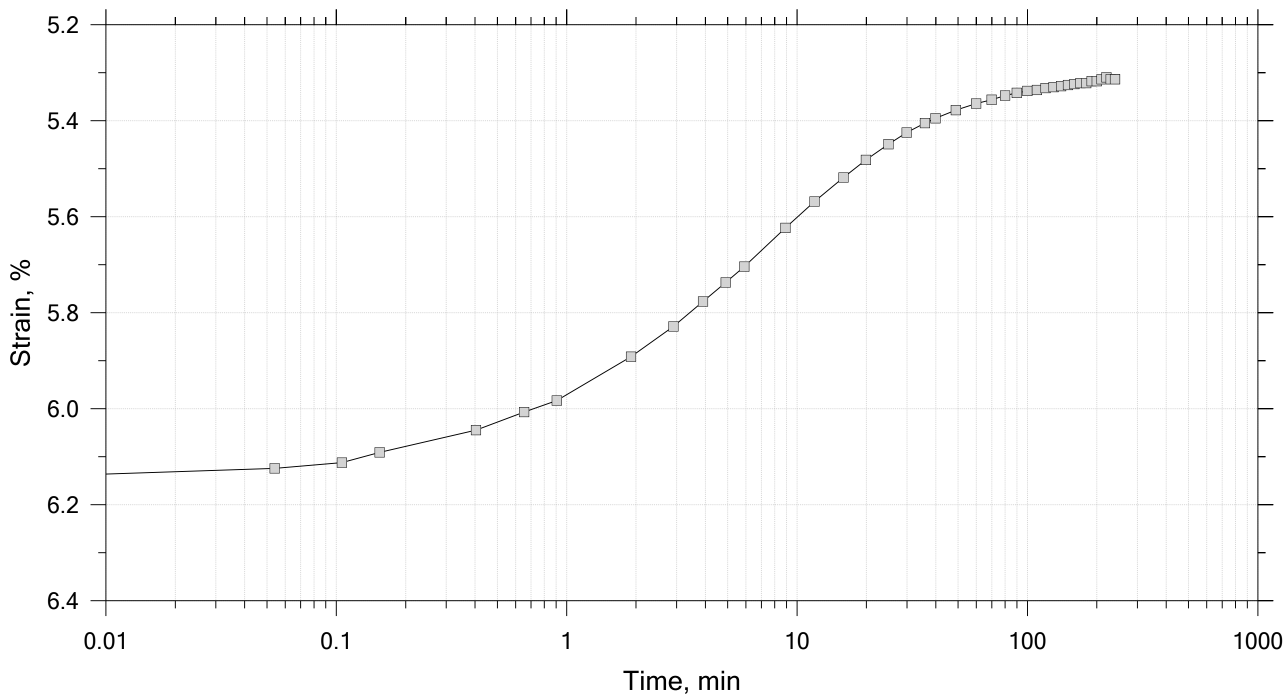
GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

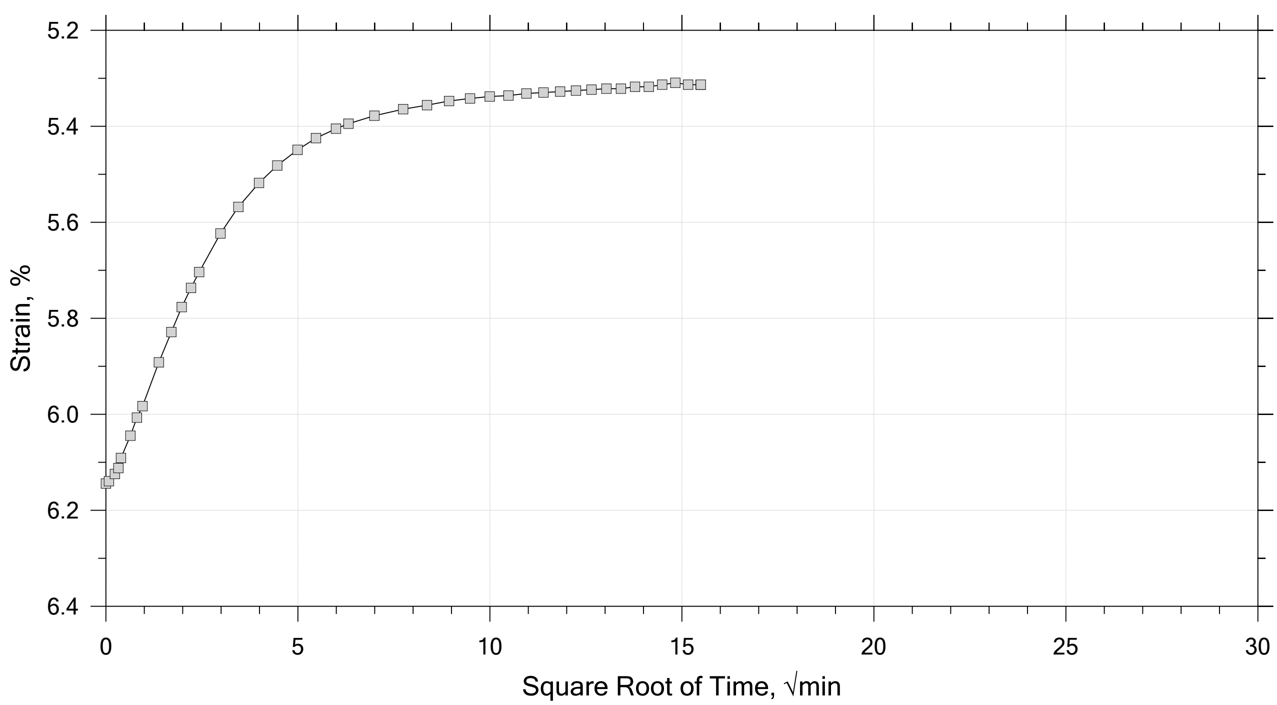
One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 17 of 17

Constant Load Step

Stress: 0.25 tsf





GeoTesting EXPRESS	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.73	Liquid Limit: 27
Initial Height: 1.00 in	Initial Void Ratio: 0.517	Plastic Limit: 17
Final Height: 0.96 in	Final Void Ratio: 0.456	Plasticity Index: 10

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	E6989	RING		E9675
Mass Container, gm	8.56	109.02	109.02	8.28
Mass Container + Wet Soil, gm	358.19	280.58	278	174.84
Mass Container + Dry Soil, gm	307.81	253.81	253.81	151
Mass Dry Soil, gm	299.25	144.79	144.79	142.72
Water Content, %	16.84	18.49	16.70	16.70
Void Ratio	---	0.52	0.46	---
Degree of Saturation, %	---	97.67	100.00	---
Dry Unit Weight, pcf	---	112.37	117.05	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test.
Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS A BENZEL COMPANY	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.0658	0.002988	0.512	0.299	72.768	4.84e-05	4.54e-02	4.12e-05
2	0.250	0.009784	0.502	0.978	26.184	1.33e-04	3.69e-02	9.20e-05
3	0.500	0.01538	0.493	1.54	17.575	1.96e-04	2.24e-02	8.22e-05
4	1.00	0.02293	0.482	2.29	11.160	3.05e-04	1.51e-02	8.61e-05
5	2.00	0.03316	0.466	3.32	10.880	3.07e-04	1.02e-02	5.88e-05
6	4.00	0.04456	0.449	4.46	6.275	5.20e-04	5.70e-03	5.55e-05
7	2.00	0.04327	0.451	4.33	2.793	1.16e-03	6.45e-04	1.40e-05
8	1.00	0.04153	0.454	4.15	4.716	6.87e-04	1.75e-03	2.25e-05
9	0.500	0.03914	0.457	3.91	8.387	3.88e-04	4.78e-03	3.47e-05
10	1.00	0.04023	0.456	4.02	4.546	7.17e-04	2.18e-03	2.92e-05
11	2.00	0.04254	0.452	4.25	4.371	7.43e-04	2.31e-03	3.22e-05
12	4.00	0.04679	0.446	4.68	4.400	7.33e-04	2.13e-03	2.92e-05
13	8.00	0.05852	0.428	5.85	4.726	6.71e-04	2.93e-03	3.69e-05
14	16.0	0.07471	0.403	7.47	4.485	6.86e-04	2.02e-03	2.60e-05
15	4.00	0.06923	0.412	6.92	3.071	9.91e-04	4.56e-04	8.47e-06
16	1.00	0.06222	0.422	6.22	6.810	4.53e-04	2.34e-03	1.98e-05
17	0.250	0.05314	0.436	5.31	19.091	1.64e-04	1.21e-02	3.73e-05
18	0.000	0.04514	0.448	4.51	46.571	6.86e-05	3.20e-02	4.11e-05

GeoTesting EXPRESS A BENZEL COMPANY	Project: Lubec Breakwater	Location: ---	Project No.: GTX-318760
	Boring No.: WB-106	Tested By: sjt	Checked By: anm
	Sample No.: U-2	Test Date: 03/28/24	Depth: 8-10
	Test No.: IP-1R	Sample Type: intact	Elevation: ---
	Description: Moist, gray clay with sand		
	Remarks: System LTIII-G, Swell Pressure = 0.0658 tsf		
	Displacement at End of Increment		

GEOTECHNICAL SERVICES INC.

Geotechnical Engineering ◢ Environmental Studies ◢ Materials Testing ◢ Construction Monitoring

PROJECT:	Lubec Breakwater	**SAMPLED BY:**	NE Borings	**DATE SAMPLED:**	7/10-12/2023
PROJECT NO.:	223199	**TESTED BY:**	C.Burbank	**DATE TESTED:**	9/6/2023
LOCATION:	Lubec, ME	**PLOTTED BY:**	A.Osborne	**DATE PLOTTED:**	9/7/2023

Rock Core Compressive Strength Test Results

GSI Sample	Boring	Sample	Depth (ft)	Diameter (in)	Area (in2)	Length Cut (in)	Length Capped (in)	L/D Ratio	Total Load (lbs.)	Stength (psi)
L-318-23	WB-3	C-1	5-7.9	2.0	3.142	3.94	4.133	2.067	13,880	4,418
L-320-23	WB-4	C-1	13.5-18.5	2.0	3.142	3.94	4.015	2.008	47,690	15,181
L-321-23	WB-4	C-2	18.5-23.5	2.0	3.142	3.94	4.173	2.087	49,870	15,875
L-322-23	WB-4	C-4	24.5-29.5	2.0	3.142	3.94	4.094	2.047	30,780	9,798
L-329-23	WB-5	C-7	54.85-56.85	2.0	3.142	3.94	4.074	2.037	28,410	9,043
L-330-23	WB-5	C-9	58.85-63.85	2.0	3.142	3.94	4.251	2.126	16,890	5,376
L-331-23	WB-5	C-10	63.85-68.4	2.0	3.142	3.94	4.251	2.126	17,280	5,501
L-338-23	WB-6	C-3	76.15-79.65	2.0	3.142	2.75	2.795	1.398	2,600	828
L-339-23	WB-6	C-4	79.65-84	2.0	3.142	3.94	4.035	2.018	16,560	5,271
L-340-23	WB-6	C-5	84-89	2.0	3.142	3.94	4.144	2.072	4,040	1,286

Notes:
GSI sample numbers L-338-23 and L-340-23 exibited distinct fracture lines in the core specimens. Tested compressive strength results may not accurately reflect actual.

Lubec Breakwater - Laboratory Test Results

Table E.4 - Rock Core Unconfined Compression Test Data

Boring ID	Sample ID	Depth	Classification	Recovery	RQD	UCS	E
-	-	ft	-	%	%	psi	psi
WB-103	C-2	11.14-11.51	TUFF	100	67	8693	-
WB-103	C-4	18.61-18.98	TUFF	97	80	8192	-
WB-104	C-3	15.26-15.64	TUFF	100	60	4813	9090000
WB-104	C-7	29.62-30.00	TUFF	100	73	5247	6070000
WB-105	C-3	19.63-20.00	TUFF	100	59	6545	1420000
WB-105	C-4	23.06-23.42	TUFF	100	79	22085	8320000
WB-106	C-2	19.34-19.72	TUFF	100	85	19633	7300000
WB-106	C-4	31.33-31.82	TUFF	100	73	5296	1150000
WB-107	C-3	29.71-30.05	TUFF	100	68	3818	-

Client:	Jacobs Engineering Group				
Project:	Lubec Breakwater				
Location:				Project No:	GTX-318760
Boring ID:	---	Sample Type:	---	Tested By:	te
Sample ID:	---	Test Date:	03/29/24	Checked By:	smd
Depth :	---	Test Id:	761991		

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
WB-103	C-2	11.14-11.51 ft	172	8693	1	No	1,*
WB-103	C-4	18.61-18.98 ft	175	8192	3	No	1,*
WB-107	C-3	29.71-30.05 ft	179	3818	3	No	1,*

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure (See attached photographs)

1: Best effort end preparation. See Tolerance report for details.
2: The as-received core did not meet the ASTM side straightness tolerance due to irregularities in the sample as cored.
3: Specimen L/D < 2.
4: The as-received core did not meet the ASTM minimum diameter tolerance of 1.875 inches.
5: Specimen diameter is less than 10 times maximum particle size.
6: Specimen diameter is less than 6 times maximum particle size.

*Because the indicated tested specimens did not meet the ASTM D4543 standard tolerances, the results reported here may differ from those for a test specimen within tolerances.

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-103		
Sample ID:	C-2		
Depth (ft):	11.14-11.51		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.29	4.29	4.29		
Specimen Diameter, in:	1.98	1.98	1.98		
Specimen Mass, g:	599.06				
Bulk Density, lb/ft^3	172			**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.2			**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020
Diameter 2, in (rotated 90°)	-0.00120	-0.00100	-0.00080	-0.00050	-0.00030	-0.00020	0.00000	0.00000	0.00020	0.00030	0.00040	0.00060	0.00070	0.00090	0.00110

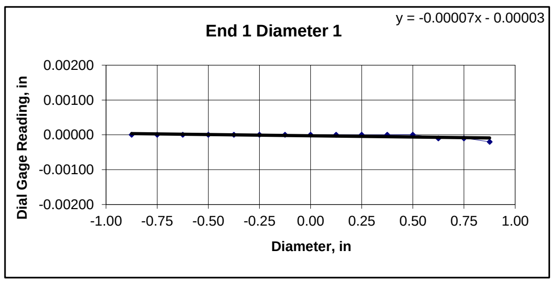
Difference between max and min readings, in:
0° = 0.00020 90° = 0.00230

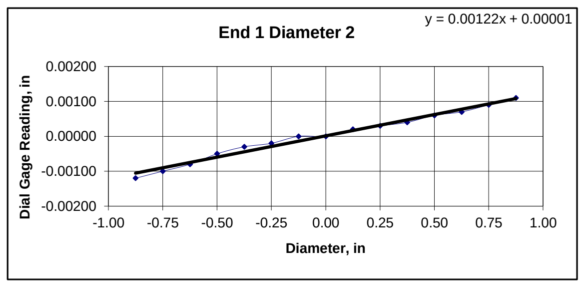
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00030	-0.00030
Diameter 2, in (rotated 90°)	0.00100	0.00090	0.00080	0.00060	0.00040	0.00030	0.00010	0.00000	0.00000	-0.00010	-0.00040	-0.00070	-0.00080	-0.00120	-0.00130

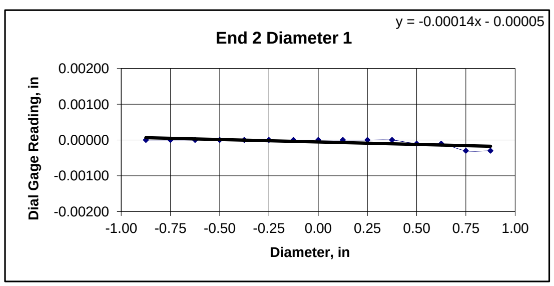
Difference between max and min readings, in:
0° = 0.0003 90° = 0.0023

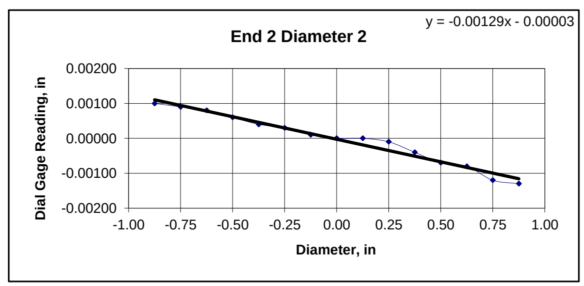
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00115

Flatness Tolerance Met? **NO**









DIAMETER 1

End 1:		
	Slope of Best Fit Line	0.00007
	Angle of Best Fit Line:	0.00409
End 2:		
	Slope of Best Fit Line	0.00014
	Angle of Best Fit Line:	0.00786
Maximum Angular Difference:		0.00377

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:		
	Slope of Best Fit Line	0.00122
	Angle of Best Fit Line:	0.06990
End 2:		
	Slope of Best Fit Line	0.00129
	Angle of Best Fit Line:	0.07399
Maximum Angular Difference:		0.00409

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	1.980	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00230	1.980	0.00116	0.067	YES
END 2					
Diameter 1, in	0.00030	1.980	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00230	1.980	0.00116	0.067	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-103	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-2		
Depth (ft):	11.14-11.51		
Visual Description:	See photographs		

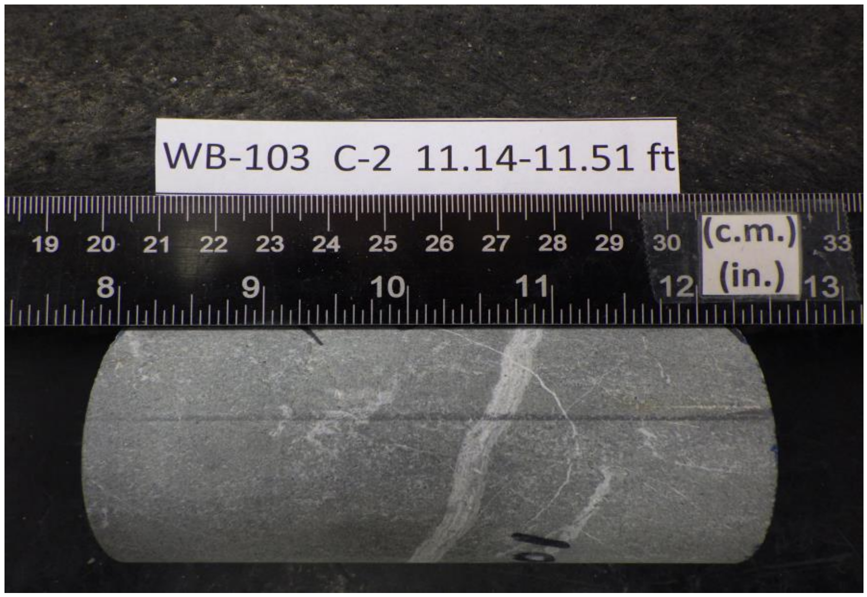
BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

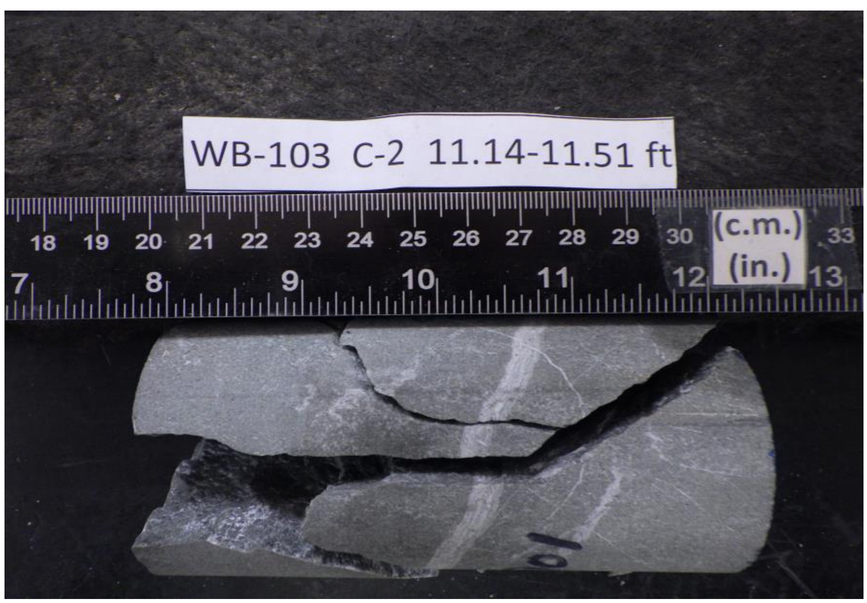
END 1		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES
END 2		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	3/29/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-103
Sample ID:	C-2
Depth, ft:	11.14-11.51



After cutting and grinding



After break

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-103		
Sample ID:	C-4		
Depth (ft):	18.61-18.98		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.30	4.30	4.30		
Specimen Diameter, in:	1.98	1.98	1.98		
Specimen Mass, g:	610.7				
Bulk Density, lb/ft^3	175	**Minimum Diameter Tolerence Met?**		**YES**	
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**		**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00080	0.00070	0.00050	0.00040	0.00030	0.00020	0.00010	0.00000	-0.00020	-0.00030	-0.00050	-0.00070	-0.00070	-0.00100	-0.00100
Diameter 2, in (rotated 90°)	-0.00090	-0.00060	-0.00050	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00040	0.00040	0.00050	0.00060	0.00060	0.00070

Difference between max and min readings, in:

0° = 0.00180 90° = 0.00160

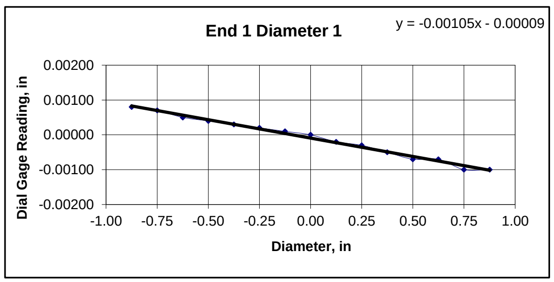
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00030	-0.00030	-0.00040	-0.00040
Diameter 2, in (rotated 90°)	0.00090	0.00080	0.00060	0.00040	0.00030	0.00010	0.00000	0.00000	-0.00010	-0.00030	-0.00050	-0.00070	-0.00100	-0.00120	-0.00150

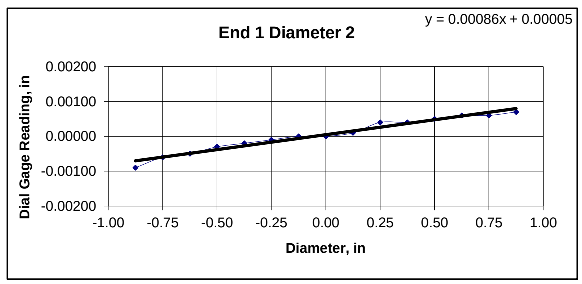
Difference between max and min readings, in:

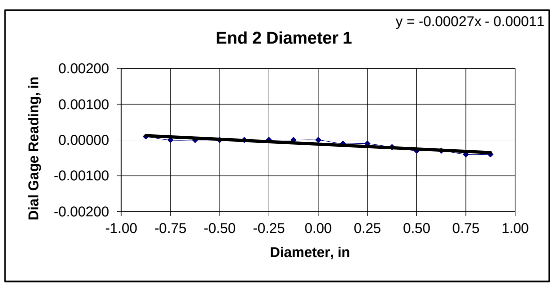
0° = 0.0005 90° = 0.0024

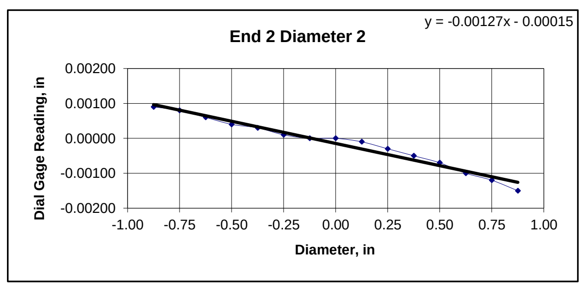
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00120

Flatness Tolerance Met? **NO**









DIAMETER 1

End 1:	
Slope of Best Fit Line	0.00105
Angle of Best Fit Line:	0.06041
End 2:	
Slope of Best Fit Line	0.00027
Angle of Best Fit Line:	0.01555
Maximum Angular Difference:	0.04485

Parallelism Tolerance Met? **NO**

Spherically Seated

DIAMETER 2

End 1:	
Slope of Best Fit Line	0.00086
Angle of Best Fit Line:	0.04911
End 2:	
Slope of Best Fit Line	0.00127
Angle of Best Fit Line:	0.07285
Maximum Angular Difference:	0.02374

Parallelism Tolerance Met? **NO**

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00180	1.980	0.00091	0.052	YES
Diameter 2, in (rotated 90°)	0.00160	1.980	0.00081	0.046	YES
END 2					
Diameter 1, in	0.00050	1.980	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00240	1.980	0.00121	0.069	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-103	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-4		
Depth (ft):	18.61-18.98		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

END 1

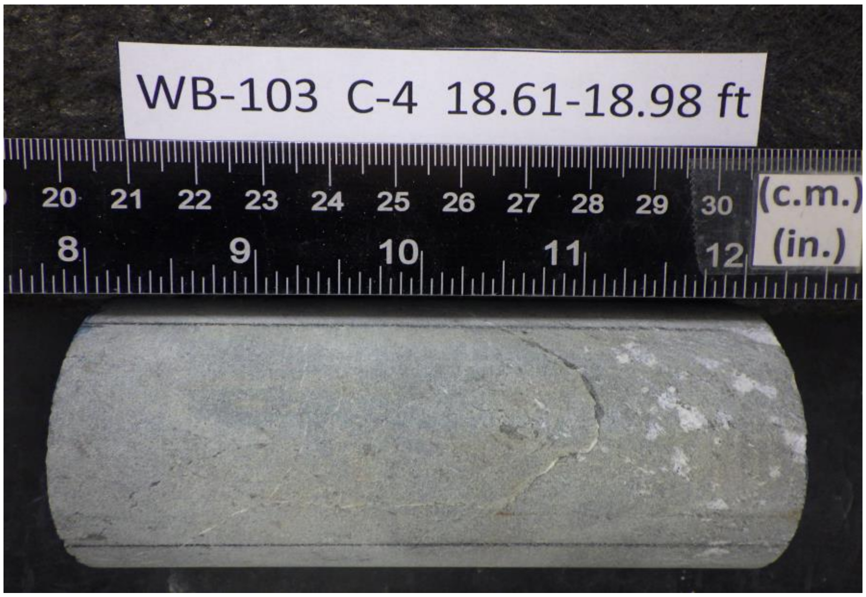
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm$0.001 in.?	YES

END 2

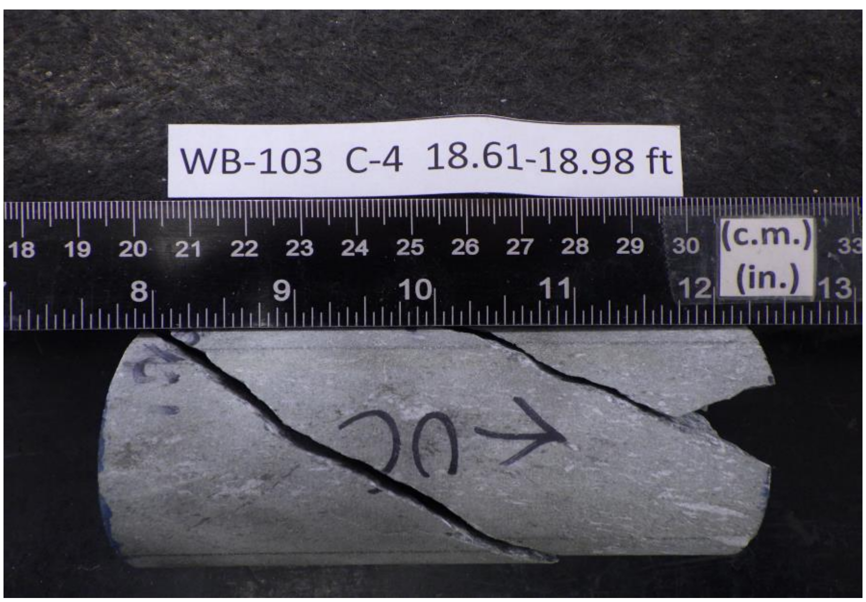
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm$0.001 in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	3/29/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-103
Sample ID:	C-4
Depth, ft:	18.61-18.98



After cutting and grinding



After break

GeoTesting EXPRESS

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-107		
Sample ID:	C-3		
Depth (ft):	29.71-30.05		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.12	4.12	4.12		
Specimen Diameter, in:	1.98	1.98	1.98		
Specimen Mass, g:	595.74				
Bulk Density, lb/ft^3	179	**Minimum Diameter Tolerence Met?**		**YES**	
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**		**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	-0.00120	-0.00120	-0.00090	-0.00070	-0.00040	-0.00020	0.00000	0.00000	0.00010	0.00040	0.00050	0.00070	0.00080	0.00080	0.00120

Difference between max and min readings, in:

0° = 0.00040 90° = 0.00240

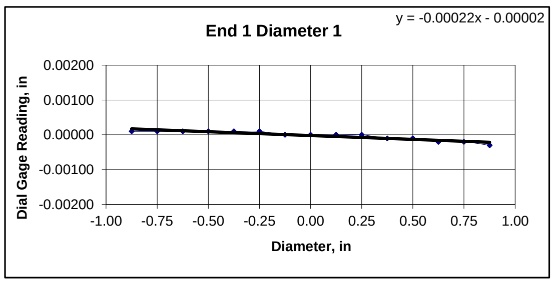
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	0.00130	0.00120	0.00100	0.00080	0.00060	0.00040	0.00030	0.00000	0.00000	-0.00020	-0.00030	-0.00030	-0.00080	-0.00080	-0.00120

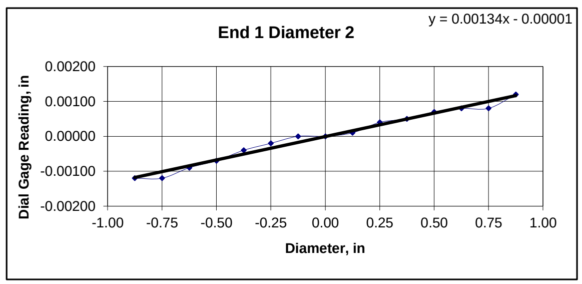
Difference between max and min readings, in:

0° = 0.0001 90° = 0.0025

Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00125

Flatness Tolerance Met? **NO**





DIAMETER 1

End 1:

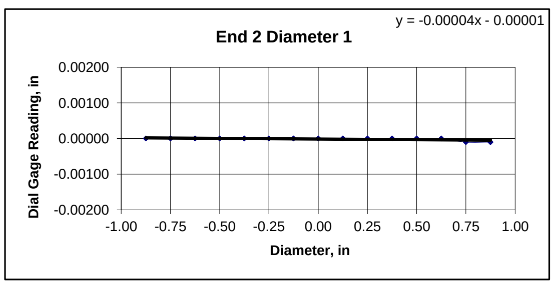
Slope of Best Fit Line	0.00022
Angle of Best Fit Line:	0.01261

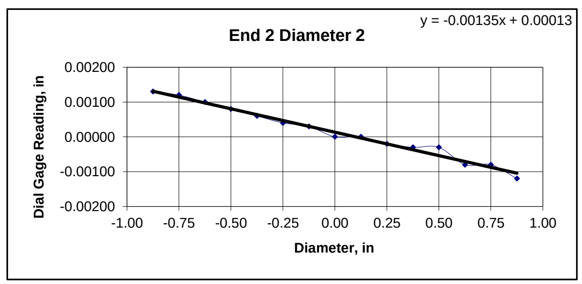
End 2:

Slope of Best Fit Line	0.00004
Angle of Best Fit Line:	0.00213

Maximum Angular Difference: 0.01048

Parallelism Tolerance Met? **NO**
Spherically Seated





DIAMETER 2

End 1:

Slope of Best Fit Line	0.00134
Angle of Best Fit Line:	0.07678

End 2:

Slope of Best Fit Line	0.00135
Angle of Best Fit Line:	0.07710

Maximum Angular Difference: 0.00033

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	1.980	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00240	1.980	0.00121	0.069	YES
END 2					
Diameter 1, in	0.00010	1.980	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00250	1.980	0.00126	0.072	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-107	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-3		
Depth (ft):	29.71-30.05		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

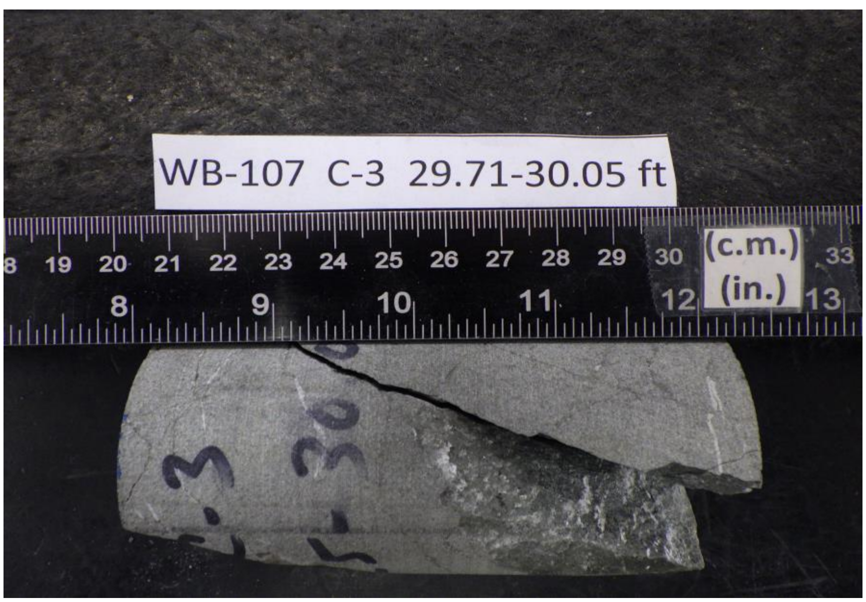
END FLATNESS

END 1		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES
END 2		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	3/29/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-107
Sample ID:	C-3
Depth, ft:	29.71-30.05

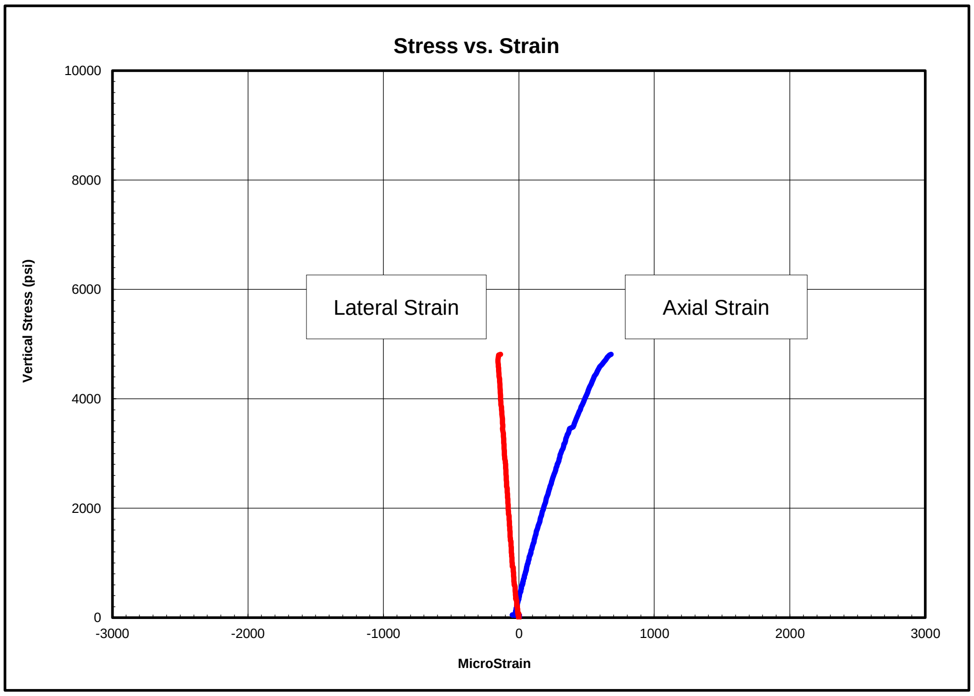
After cutting and grinding



After break

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	te
Checked By:	jsc
Boring ID:	WB-104
Sample ID:	C-3
Depth, ft:	15.26-15.64
Sample Type:	rock core
Sample Description:	See photographs Intact material and discontinuity failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 4,813 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
500-1800	9,090,000	0.32
1800-3000	7,830,000	0.22
3000-4300	5,460,000	0.15

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

GeoTesting EXPRESS
A SERCEL COMPANY

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-104		
Sample ID:	C-3		
Depth (ft):	15.26-15.64		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.39	4.39	4.39
Specimen Diameter, in:	1.99	1.98	1.99
Specimen Mass, g:	633.64		
Bulk Density, lb/ft^3	177	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

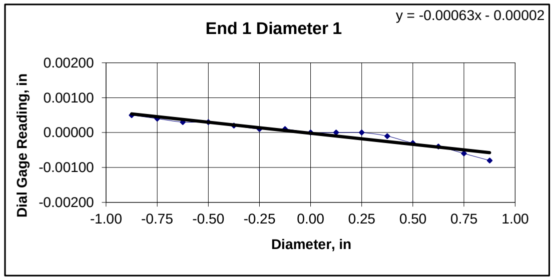
END FLATNESS AND PARALLELISM (Procedure FP1)

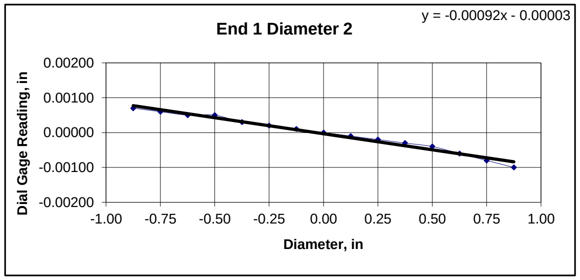
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00050	0.00040	0.00030	0.00030	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00030	-0.00040	-0.00060	-0.00080
Diameter 2, in (rotated 90°)	0.00070	0.00060	0.00050	0.00050	0.00030	0.00020	0.00010	0.00000	-0.00010	-0.00020	-0.00030	-0.00040	-0.00060	-0.00080	-0.00100

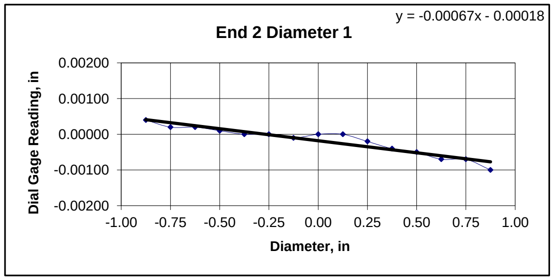
Difference between max and min readings, in:
0° = 0.00130 90° = 0.00170

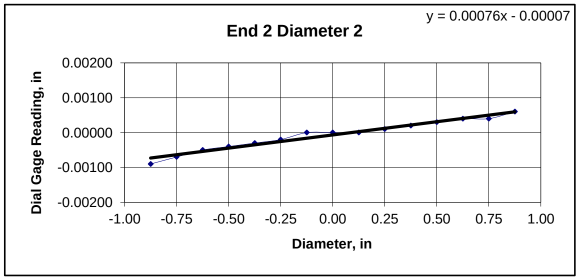
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00040	0.00020	0.00020	0.00010	0.00000	0.00000	-0.00010	0.00000	0.00000	-0.00020	-0.00040	-0.00050	-0.00070	-0.00070	-0.00100
Diameter 2, in (rotated 90°)	-0.00090	-0.00070	-0.00050	-0.00040	-0.00030	-0.00020	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00040	0.00040	0.00060

Difference between max and min readings, in:
0° = 0.0014 90° = 0.0015
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00085
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00063
Angle of Best Fit Line: 0.03634

End 2:
Slope of Best Fit Line 0.00067
Angle of Best Fit Line: 0.03863

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00092
Angle of Best Fit Line: 0.05271

End 2:
Slope of Best Fit Line 0.00076
Angle of Best Fit Line: 0.04338

Maximum Angular Difference: 0.00933

Parallelism Tolerance Met? **NO**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00130	1.985	0.00065	0.038	YES
Diameter 2, in (rotated 90°)	0.00170	1.985	0.00086	0.049	YES
END 2					
Diameter 1, in	0.00140	1.985	0.00071	0.040	YES
Diameter 2, in (rotated 90°)	0.00150	1.985	0.00076	0.043	YES

Maximum angle of departure must be $\leq$ 0.25°
Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-104	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-3		
Depth (ft):	15.26-15.64		
Visual Description:	See photographs		

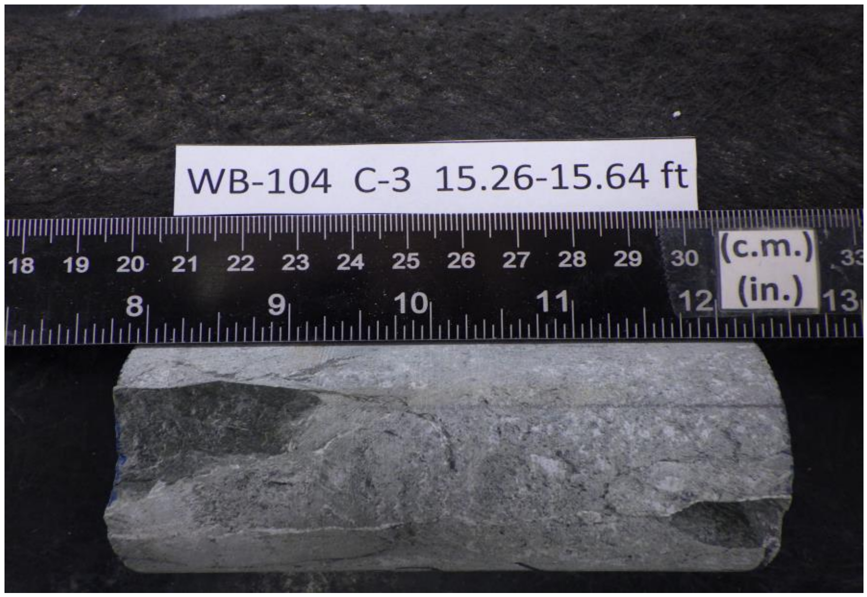
BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

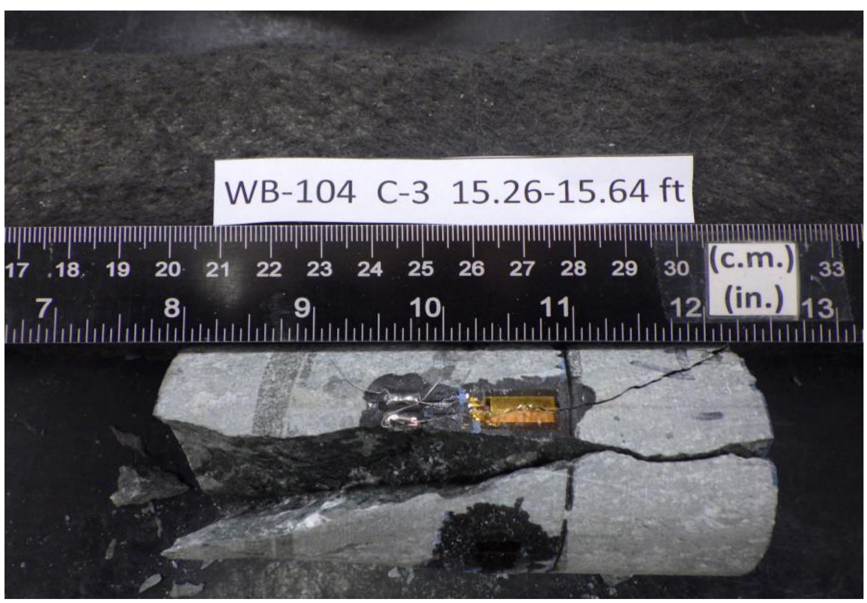
END 1		
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90^{o})	Is the maximum gap $\leq \pm$0.001 in.?	YES
END 2		
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90^{o})	Is the maximum gap $\leq \pm$0.001 in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-104
Sample ID:	C-3
Depth, ft:	15.26-15.64



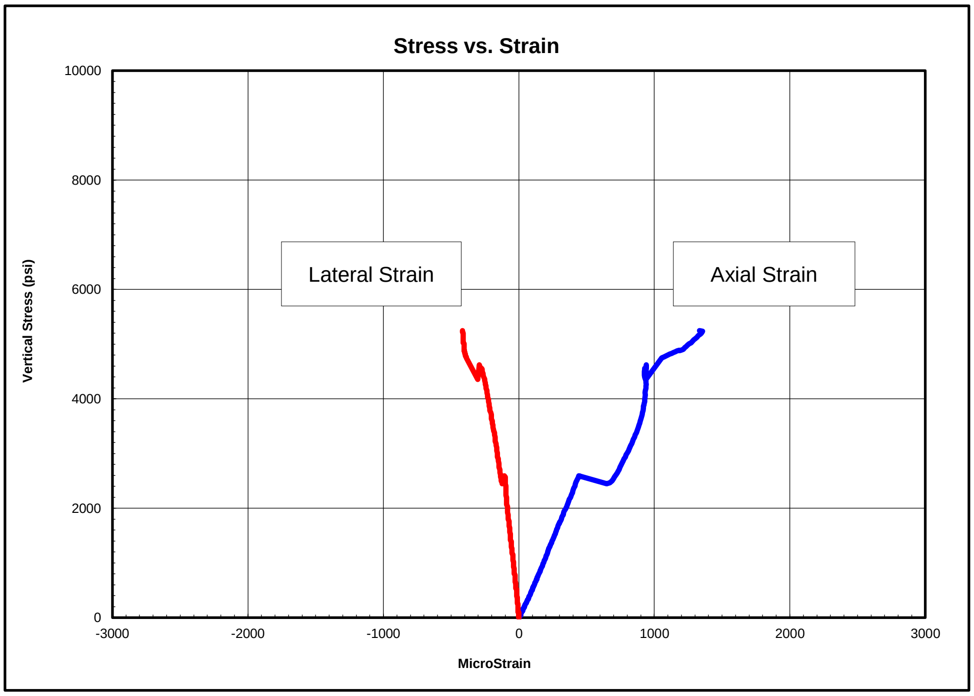
After cutting and grinding



After break

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	te
Checked By:	jsc
Boring ID:	WB-104
Sample ID:	C-7
Depth, ft:	29.62-30.00
Sample Type:	rock core
Sample Description:	See photographs Intact material and discontinuity failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 5,247 psi

The strain values recorded within the second and third stress ranges for this test produce values of Poisson's Ratio that exceed maximum values found in rocks.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
500-1900	6,070,000	0.27
1900-3300	1,740,000	0.15
3300-4700	---	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-104		
Sample ID:	C-7		
Depth (ft):	29.62-30.00		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average	
Specimen Length, in:	4.38	4.38	4.38	
Specimen Diameter, in:	1.98	1.99	1.99	
Specimen Mass, g:	650.91			
Bulk Density, lb/ft^3	183	**Minimum Diameter Tolerence Met?**		**YES**
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**		**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00080	0.00070	0.00070	0.00050	0.00050	0.00020	0.00010	0.00000	-0.00010	-0.00040	-0.00050	-0.00070	-0.00080	-0.00090	-0.00100
Diameter 2, in (rotated 90°)	-0.00080	-0.00080	-0.00060	-0.00060	-0.00030	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030	0.00050	0.00060

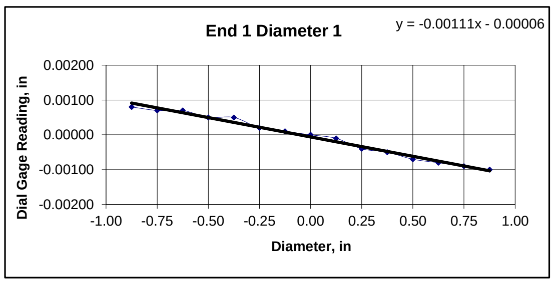
Difference between max and min readings, in:
0° = 0.00180 90° = 0.00140

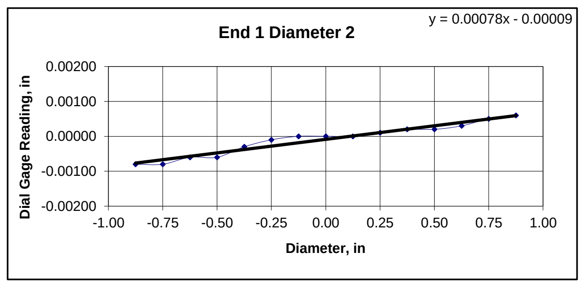
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00080	0.00080	0.00060	0.00050	0.00040	0.00010	0.00010	0.00000	0.00000	-0.00030	-0.00050	-0.00060	-0.00070	-0.00080	-0.00090
Diameter 2, in (rotated 90°)	0.00060	0.00050	0.00040	0.00020	0.00020	0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00030	-0.00050	-0.00070	-0.00070	-0.00090

Difference between max and min readings, in:
0° = 0.0017 90° = 0.0015

Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00090

Flatness Tolerance Met? **YES**





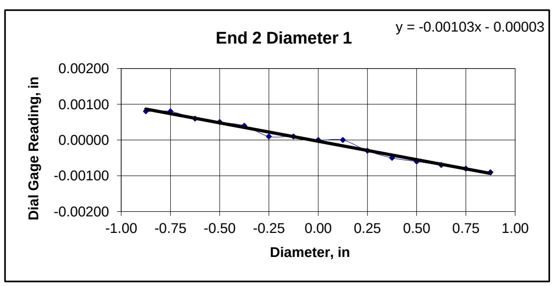
DIAMETER 1

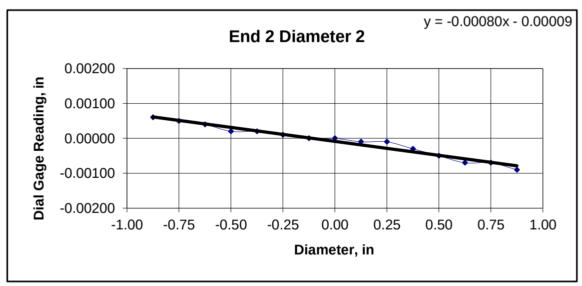
End 1:
Slope of Best Fit Line 0.00111
Angle of Best Fit Line: 0.06368

End 2:
Slope of Best Fit Line 0.00103
Angle of Best Fit Line: 0.05893

Maximum Angular Difference: 0.00475

Parallelism Tolerance Met? **NO**
Spherically Seated





DIAMETER 2

End 1:
Slope of Best Fit Line 0.00078
Angle of Best Fit Line: 0.04453

End 2:
Slope of Best Fit Line 0.00080
Angle of Best Fit Line: 0.04584

Maximum Angular Difference: 0.00131

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00180	1.985	0.00091	0.052	YES
Diameter 2, in (rotated 90°)	0.00140	1.985	0.00071	0.040	YES
END 2					
Diameter 1, in	0.00170	1.985	0.00086	0.049	YES
Diameter 2, in (rotated 90°)	0.00150	1.985	0.00076	0.043	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-104	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-7		
Depth (ft):	29.62-30.00		
Visual Description:	See photographs		

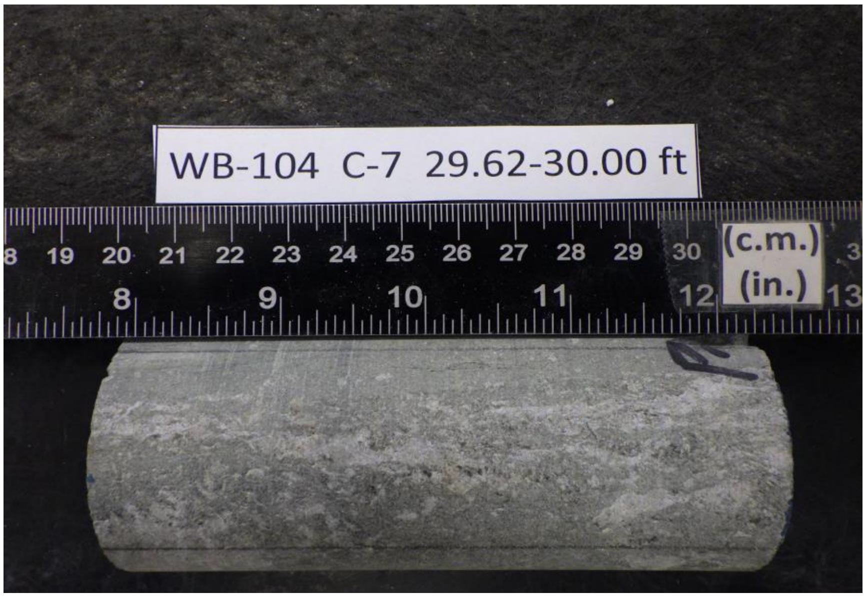
BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

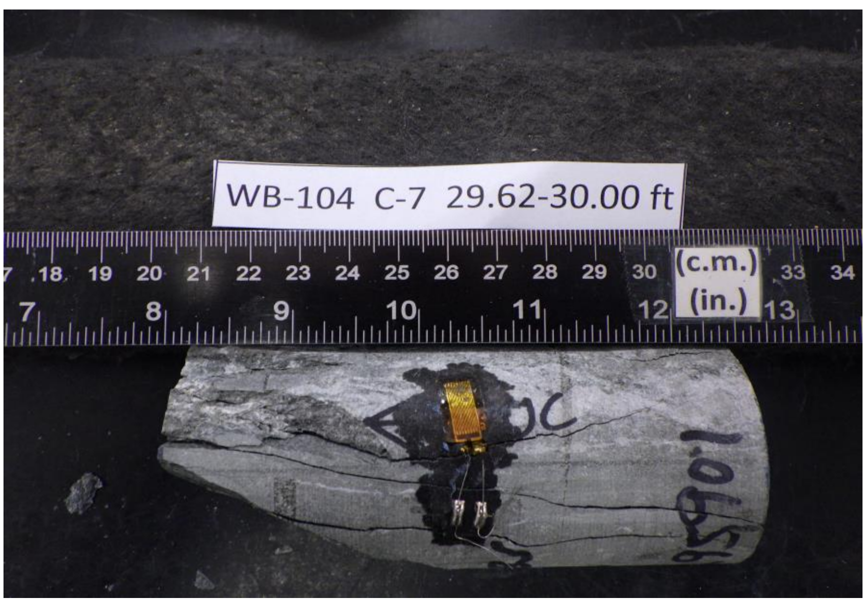
END 1		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES
END 2		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-104
Sample ID:	C-7
Depth, ft:	29.62-30.00



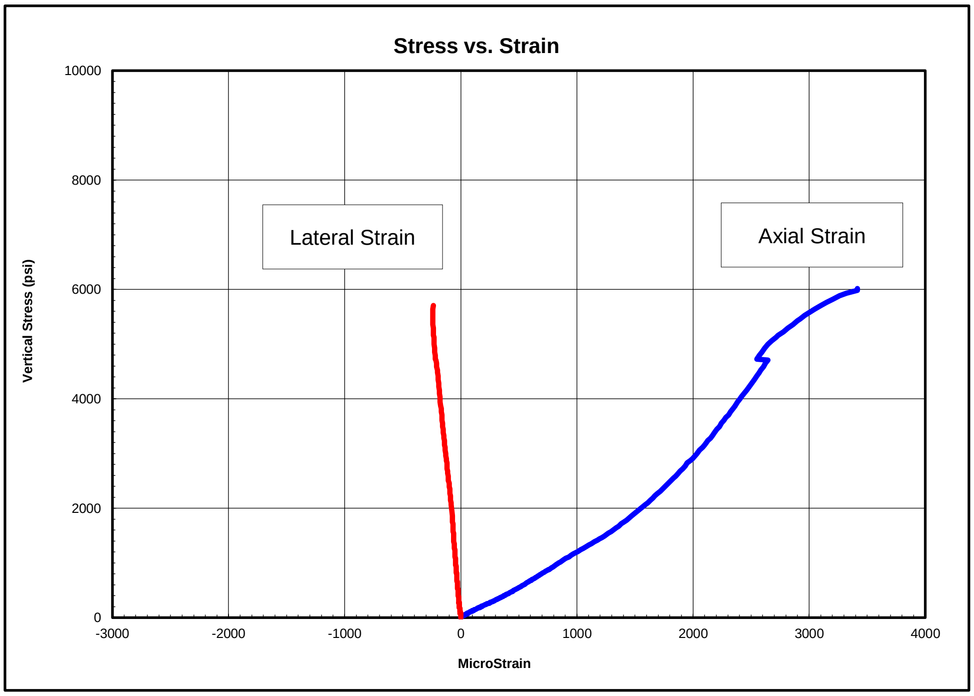
After cutting and grinding



After break

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	te
Checked By:	jsc
Boring ID:	WB-105
Sample ID:	C-3
Depth, ft:	19.63-20.00
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 6,545 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
700-2400	1,420,000	0.05
2400-4100	2,500,000	0.13
4100-5900	2,190,000	0.08

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-105		
Sample ID:	C-3		
Depth (ft):	19.63-20.00		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.27	4.27	4.27		
Specimen Diameter, in:	1.98	1.98	1.98		
Specimen Mass, g:	586.91				
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**		**YES**	
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**		**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? NO

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **NO**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00100	-0.00090	-0.00070	-0.00060	-0.00020	-0.00010	-0.00010	0.00000	0.00010	0.00040	0.00050	0.00050	0.00060	0.00070	0.00100
Diameter 2, in (rotated 90°)	-0.00130	-0.00130	-0.00100	-0.00080	-0.00050	-0.00030	-0.00010	0.00000	0.00010	0.00020	0.00050	0.00050	0.00050	0.00050	0.00050

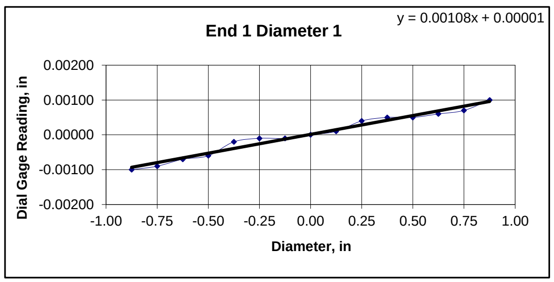
Difference between max and min readings, in:
0° = 0.00200 90° = 0.00180

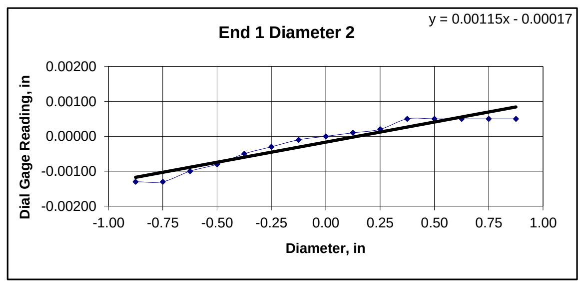
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00140	-0.00140	-0.00120	-0.00090	-0.00070	-0.00040	-0.00010	0.00000	0.00000	0.00020	0.00050	0.00050	0.00050	0.00050	0.00050
Diameter 2, in (rotated 90°)	0.00000	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010

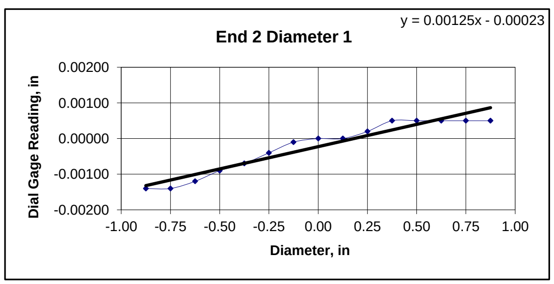
Difference between max and min readings, in:
0° = 0.0019 90° = 0.0002

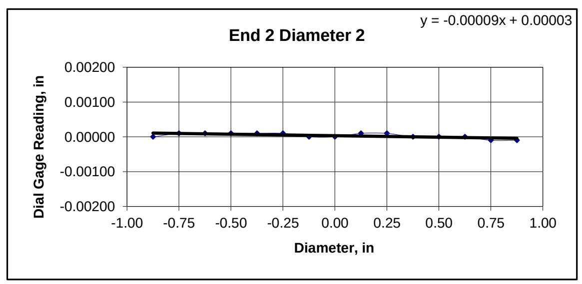
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00100

Flatness Tolerance Met? **NO**









DIAMETER 1

End 1:		
	Slope of Best Fit Line	0.00108
	Angle of Best Fit Line:	0.06188
End 2:		
	Slope of Best Fit Line	0.00125
	Angle of Best Fit Line:	0.07154
Maximum Angular Difference:		0.00966

Parallelism Tolerance Met? **NO**
Spherically Seated

DIAMETER 2

End 1:		
	Slope of Best Fit Line	0.00115
	Angle of Best Fit Line:	0.06597
End 2:		
	Slope of Best Fit Line	0.00009
	Angle of Best Fit Line:	0.00491
Maximum Angular Difference:		0.06106

Parallelism Tolerance Met? **NO**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00200	1.980	0.00101	0.058	YES
Diameter 2, in (rotated 90°)	0.00180	1.980	0.00091	0.052	YES
END 2					
Diameter 1, in	0.00190	1.980	0.00096	0.055	YES
Diameter 2, in (rotated 90°)	0.00020	1.980	0.00010	0.006	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-105	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-3		
Depth (ft):	19.63-20.00		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

END 1

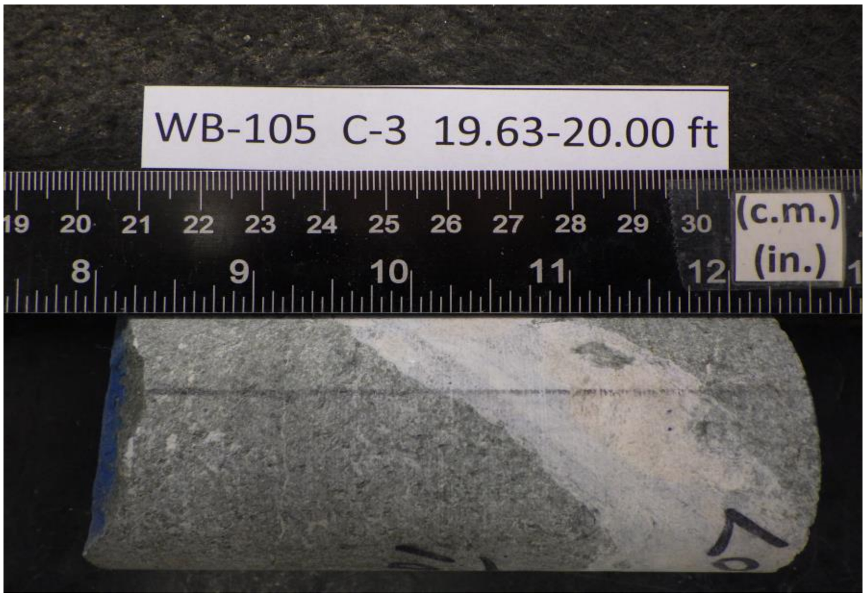
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm$0.001 in.?	YES

END 2

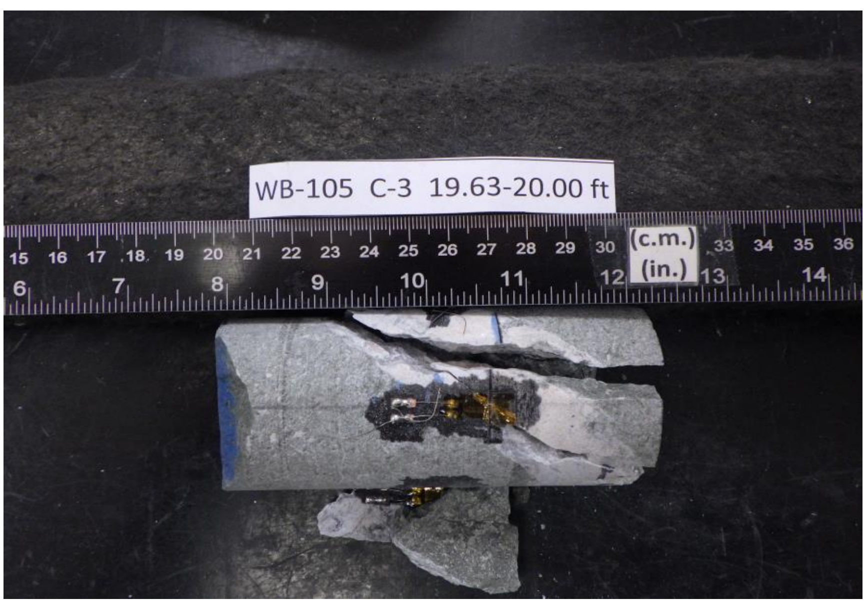
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm$0.001 in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-105
Sample ID:	C-3
Depth, ft:	19.63-20.00



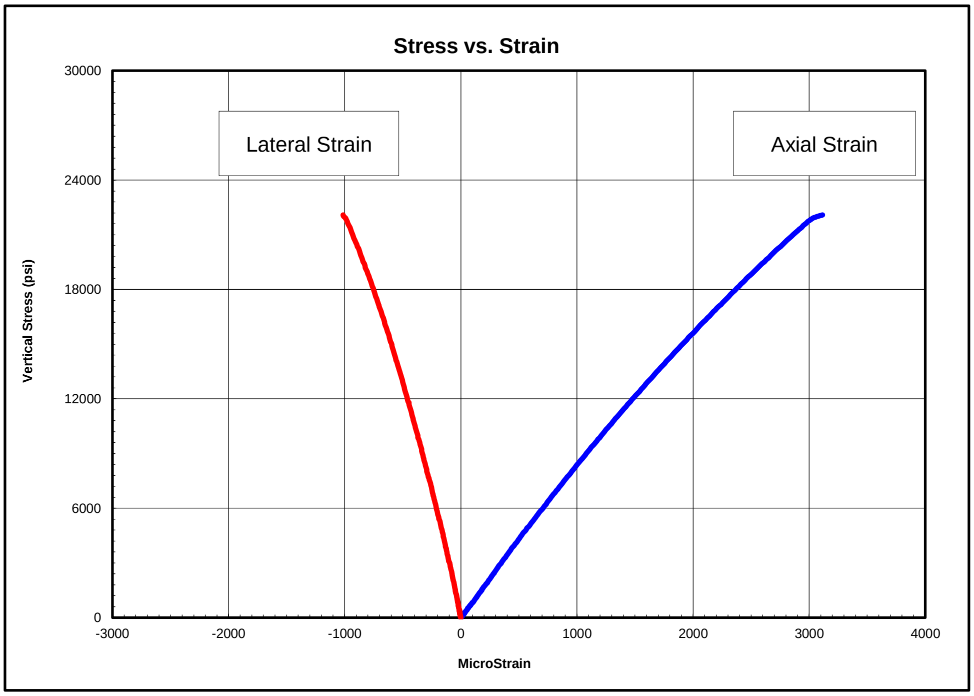
After cutting and grinding



After break

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	te
Checked By:	jsc
Boring ID:	WB-105
Sample ID:	C-4
Depth, ft:	23.06-23.42
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 22,085 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
2200-8100	8,320,000	0.31
8100-14000	7,410,000	0.32
14000-19900	6,480,000	0.34

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-105		
Sample ID:	C-4		
Depth (ft):	23.06-23.42		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average	
Specimen Length, in:	4.38	4.38	4.38	
Specimen Diameter, in:	1.98	1.98	1.98	
Specimen Mass, g:	639.69			
Bulk Density, lb/ft^3	180	**Minimum Diameter Tolerence Met?**	**YES**	
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00070	-0.00070	-0.00050	-0.00040	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00030	0.00030
Diameter 2, in (rotated 90°)	0.00080	0.00080	0.00070	0.00050	0.00040	0.00020	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00050	-0.00060	-0.00060	-0.00100

Difference between max and min readings, in:

0° = 0.00100 90° = 0.00180

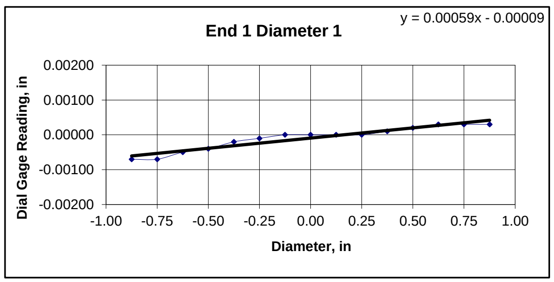
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00070	-0.00070	-0.00050	-0.00050	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00020	0.00030	0.00040	0.00050	0.00060
Diameter 2, in (rotated 90°)	-0.00040	-0.00040	-0.00040	-0.00040	-0.00040	-0.00020	0.00000	0.00000	0.00010	0.00030	0.00050	0.00050	0.00060	0.00060	0.00070

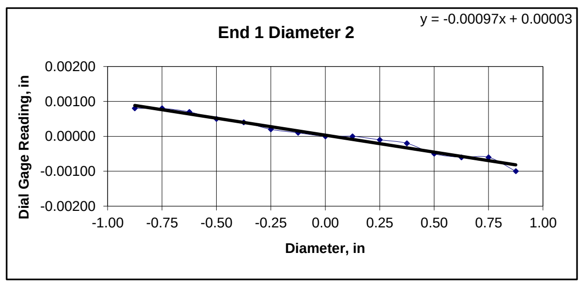
Difference between max and min readings, in:

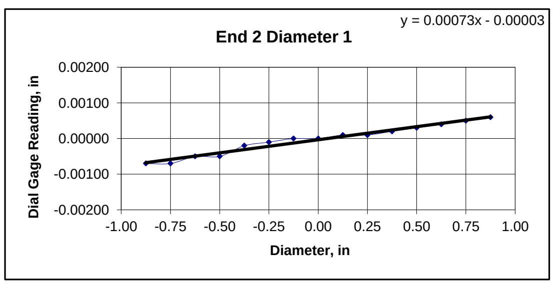
0° = 0.0013 90° = 0.0011

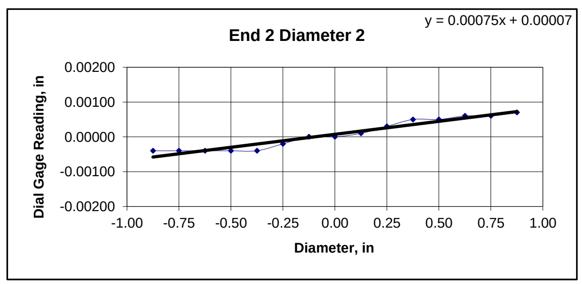
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00090

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00059
Angle of Best Fit Line:	0.03356

End 2:

Slope of Best Fit Line	0.00073
Angle of Best Fit Line:	0.04207

Maximum Angular Difference: 0.00851

Parallelism Tolerance Met? **NO**

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00097
Angle of Best Fit Line:	0.05566

End 2:

Slope of Best Fit Line	0.00075
Angle of Best Fit Line:	0.04273

Maximum Angular Difference: 0.01293

Parallelism Tolerance Met? **NO**

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00100	1.980	0.00051	0.029	YES
Diameter 2, in (rotated 90°)	0.00180	1.980	0.00091	0.052	YES
END 2					
Diameter 1, in	0.00130	1.980	0.00066	0.038	YES
Diameter 2, in (rotated 90°)	0.00110	1.980	0.00056	0.032	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-105	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-4		
Depth (ft):	23.06-23.42		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

END 1

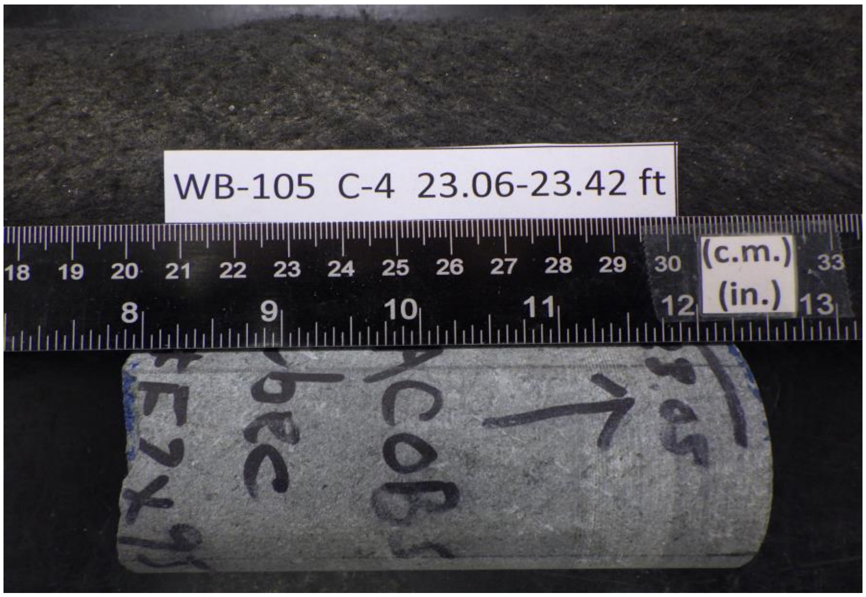
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90^o)	Is the maximum gap $\leq \pm$0.001 in.?	YES

END 2

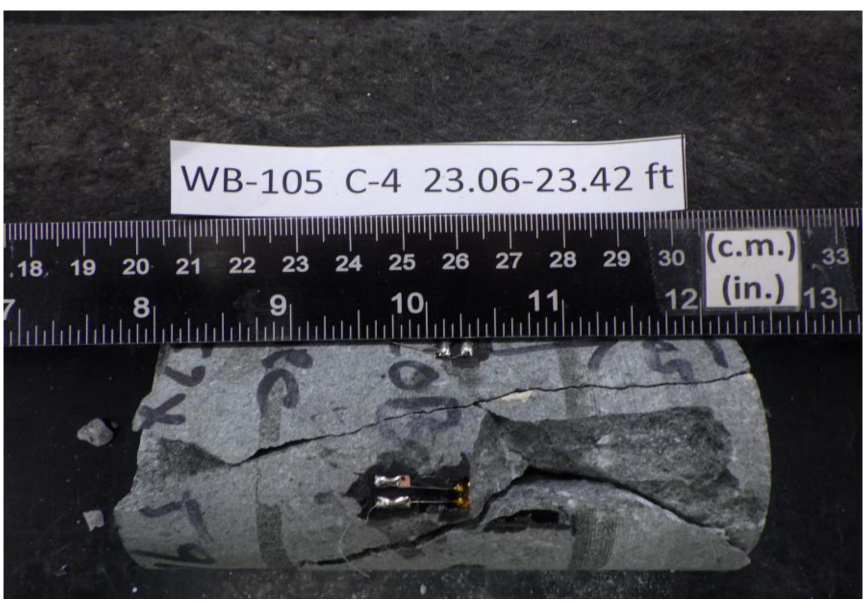
Diameter 1	Is the maximum gap $\leq \pm$0.001 in.?	YES
Diameter 2 (rotated 90^o)	Is the maximum gap $\leq \pm$0.001 in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-105
Sample ID:	C-4
Depth, ft:	23.06-23.42



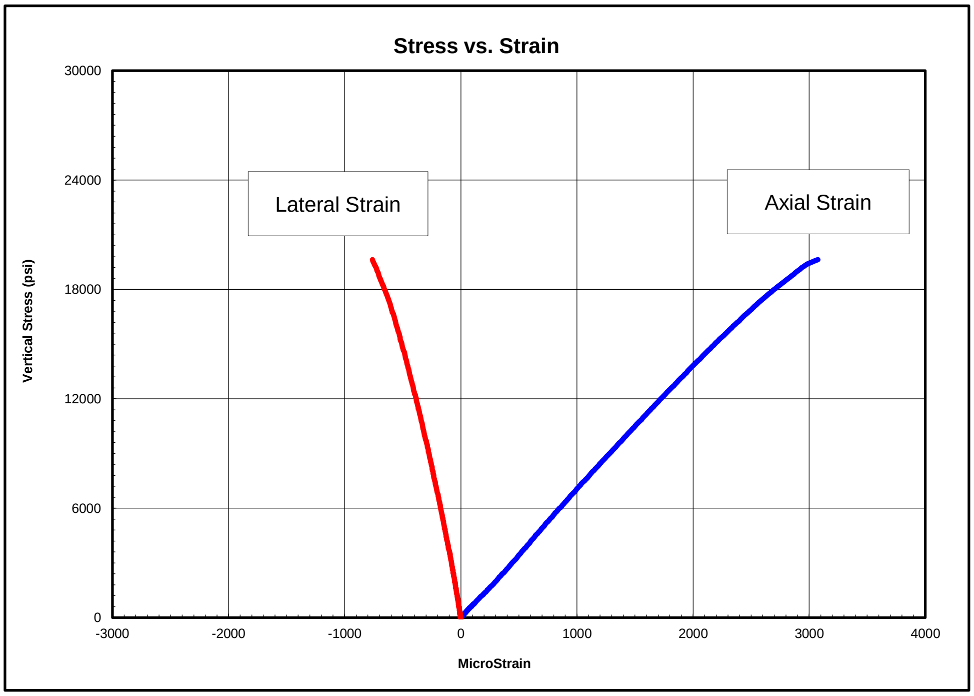
After cutting and grinding



After break

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	te
Checked By:	jsc
Boring ID:	WB-106
Sample ID:	C-2
Depth, ft:	19.34-19.72
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 19,633 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
2000-7200	7,300,000	0.23
7200-12400	6,830,000	0.25
12400-17700	6,210,000	0.27

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-106		
Sample ID:	C-2		
Depth (ft):	19.34-19.72		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.29	4.29	4.29		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	623.24				
Bulk Density, lb/ft^3	178			**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.2			**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00050	0.00040	0.00030	0.00030	0.00030	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040	-0.00050	-0.00060
Diameter 2, in (rotated 90°)	-0.00100	-0.00090	-0.00060	-0.00060	-0.00050	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00030	0.00050	0.00060	0.00060	0.00090

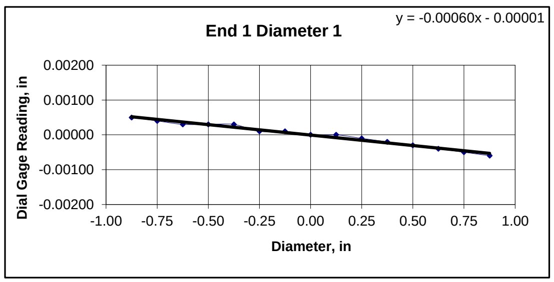
Difference between max and min readings, in:
0° = 0.00110 90° = 0.00190

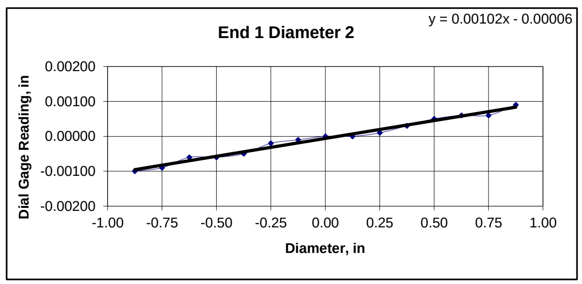
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00050	0.00050	0.00040	0.00040	0.00020	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00030	-0.00040	-0.00050	-0.00080	-0.00080
Diameter 2, in (rotated 90°)	0.00070	0.00060	0.00050	0.00040	0.00030	0.00020	0.00010	0.00000	-0.00020	-0.00030	-0.00050	-0.00050	-0.00080	-0.00100	-0.00120

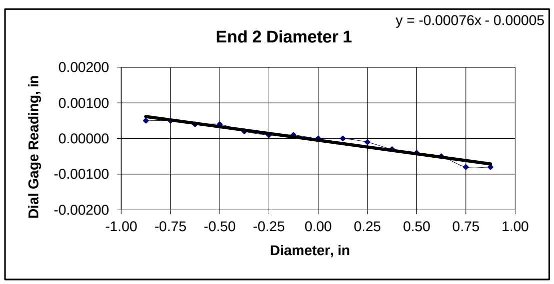
Difference between max and min readings, in:
0° = 0.0013 90° = 0.0019

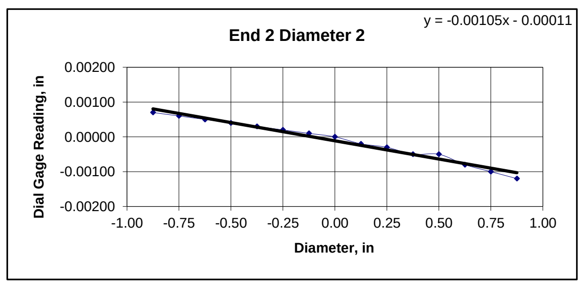
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00095

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00060
	Angle of Best Fit Line:	0.03438
End 2:	Slope of Best Fit Line	0.00076
	Angle of Best Fit Line:	0.04354
Maximum Angular Difference:		0.00917

Parallelism Tolerance Met? **NO**
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	0.00102
	Angle of Best Fit Line:	0.05861
End 2:	Slope of Best Fit Line	0.00105
	Angle of Best Fit Line:	0.06008
Maximum Angular Difference:		0.00147

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00110	1.990	0.00055	0.032	YES
Diameter 2, in (rotated 90°)	0.00190	1.990	0.00095	0.055	YES
END 2					
Diameter 1, in	0.00130	1.990	0.00065	0.037	YES
Diameter 2, in (rotated 90°)	0.00190	1.990	0.00095	0.055	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-106	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-2		
Depth (ft):	19.34-19.72		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

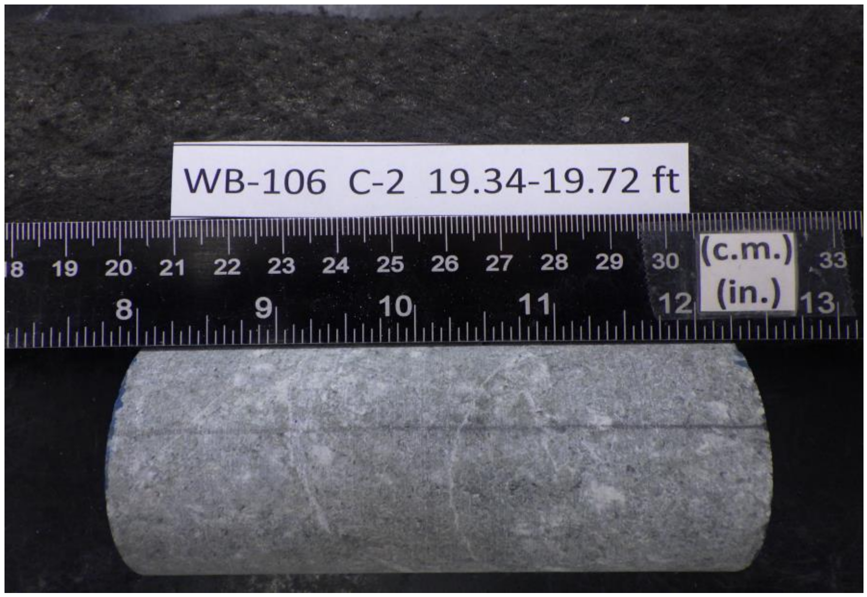
END FLATNESS

END 1		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

END 2		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-106
Sample ID:	C-2
Depth, ft:	19.34-19.72

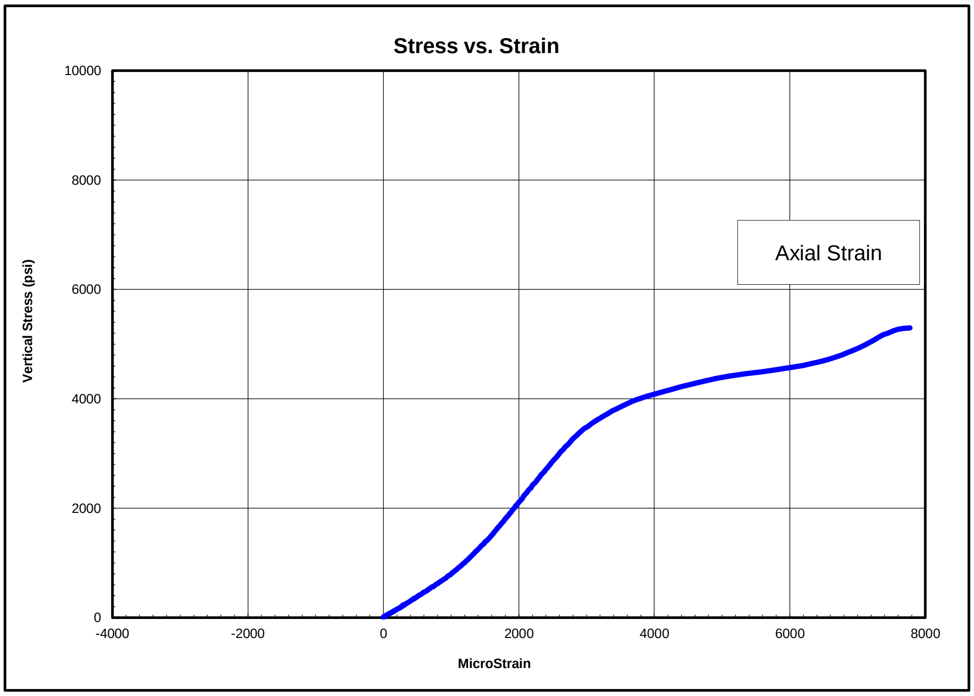


After cutting and grinding

After break

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	te
Checked By:	jsc
Boring ID:	WB-106
Sample ID:	C-4
Depth, ft:	31.44-31.82
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 5,296 psi

The lateral strain gauges failed to record meaningful data. Poisson's Ratio could not be determined.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
500-1900	1,150,000	---
1900-3400	1,460,000	---
3400-4800	325,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-106		
Sample ID:	C-4		
Depth (ft):	31.44-31.82		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.41	4.41	4.41		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	623.58				
Bulk Density, lb/ft^3	173	**Minimum Diameter Tolerence Met?**		**YES**	
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**		**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

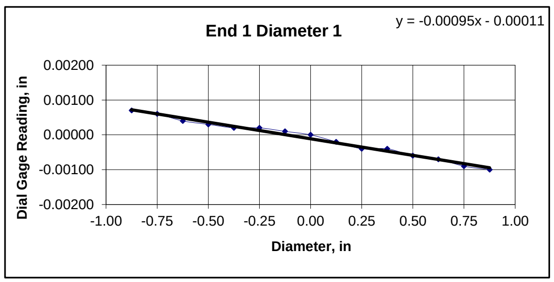
END FLATNESS AND PARALLELISM (Procedure FP1)

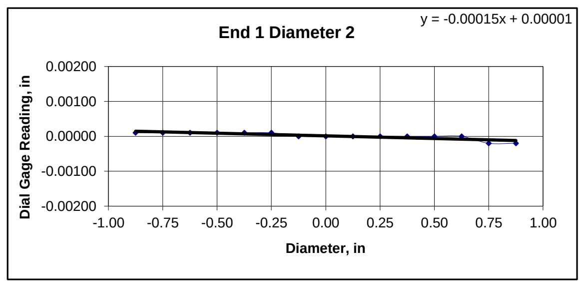
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00070	0.00060	0.00040	0.00030	0.00020	0.00020	0.00010	0.00000	-0.00020	-0.00040	-0.00040	-0.00060	-0.00070	-0.00090	-0.00100
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00020	-0.00020

Difference between max and min readings, in:
0° = 0.00170 90° = 0.00030

END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00050	0.00050	0.00030	0.00030	0.00020	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00030	-0.00050	-0.00060	-0.00070
Diameter 2, in (rotated 90°)	-0.00090	-0.00080	-0.00070	-0.00040	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00040	0.00070	0.00070	0.00080

Difference between max and min readings, in:
0° = 0.0012 90° = 0.0017
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00085
Flatness Tolerance Met? **YES**





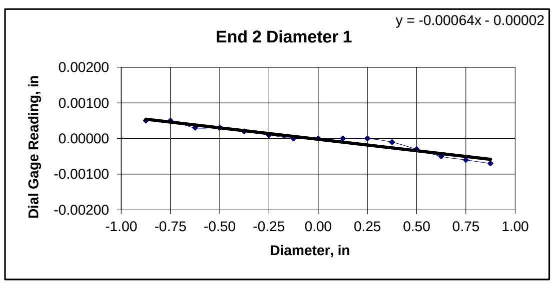
DIAMETER 1

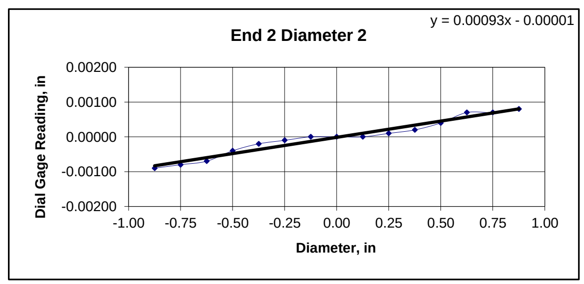
End 1:
Slope of Best Fit Line 0.00095
Angle of Best Fit Line: 0.05451

End 2:
Slope of Best Fit Line 0.00064
Angle of Best Fit Line: 0.03683

Maximum Angular Difference: 0.01768

Parallelism Tolerance Met? **NO**
Spherically Seated





DIAMETER 2

End 1:
Slope of Best Fit Line 0.00015
Angle of Best Fit Line: 0.00868

End 2:
Slope of Best Fit Line 0.00093
Angle of Best Fit Line: 0.05353

Maximum Angular Difference: 0.04485

Parallelism Tolerance Met? **NO**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00170	1.990	0.00085	0.049	YES
Diameter 2, in (rotated 90°)	0.00030	1.990	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00120	1.990	0.00060	0.035	YES
Diameter 2, in (rotated 90°)	0.00170	1.990	0.00085	0.049	YES

Maximum angle of departure must be $\leq$ 0.25°
Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Engineering Group	Test Date:	3/29/2024
Project Name:	Lubec Breakwater	Tested By:	rik
Project Location:	---	Checked By:	smd
GTX #:	318760		
Boring ID:	WB-106	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	C-4		
Depth (ft):	31.44-31.82		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

END 1

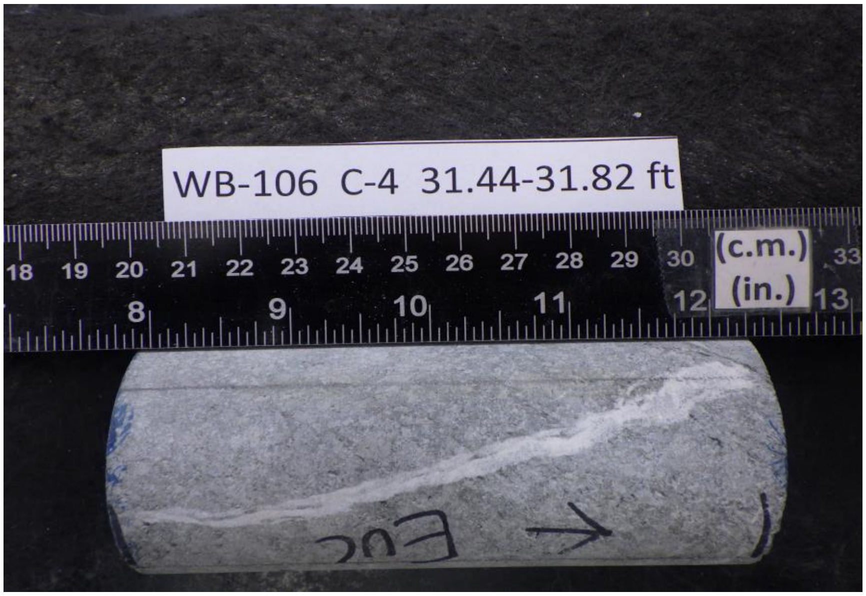
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

END 2

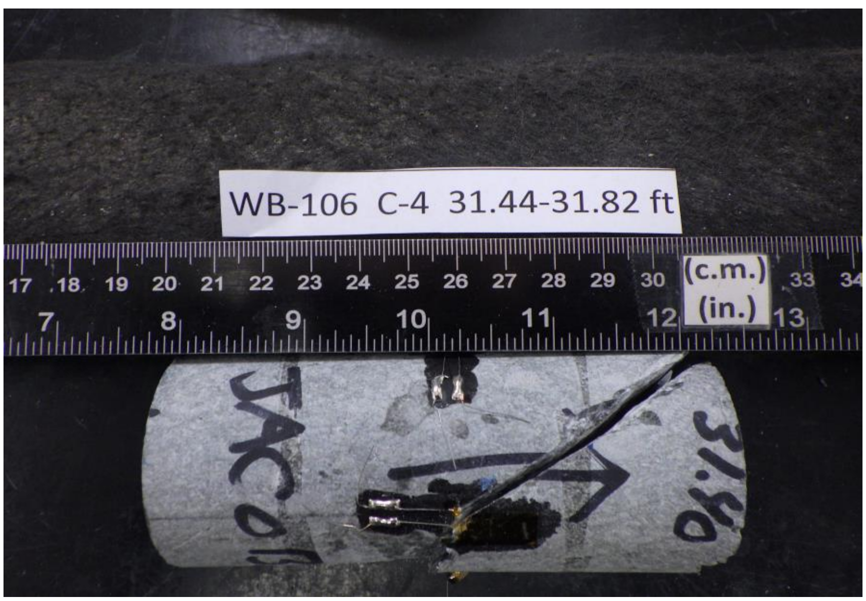
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	Jacobs Engineering Group
Project Name:	Lubec Breakwater
Project Location:	---
GTX #:	318760
Test Date:	4/2/2024
Tested By:	gp
Checked By:	smd
Boring ID:	WB-106
Sample ID:	C-4
Depth, ft:	31.44-31.82

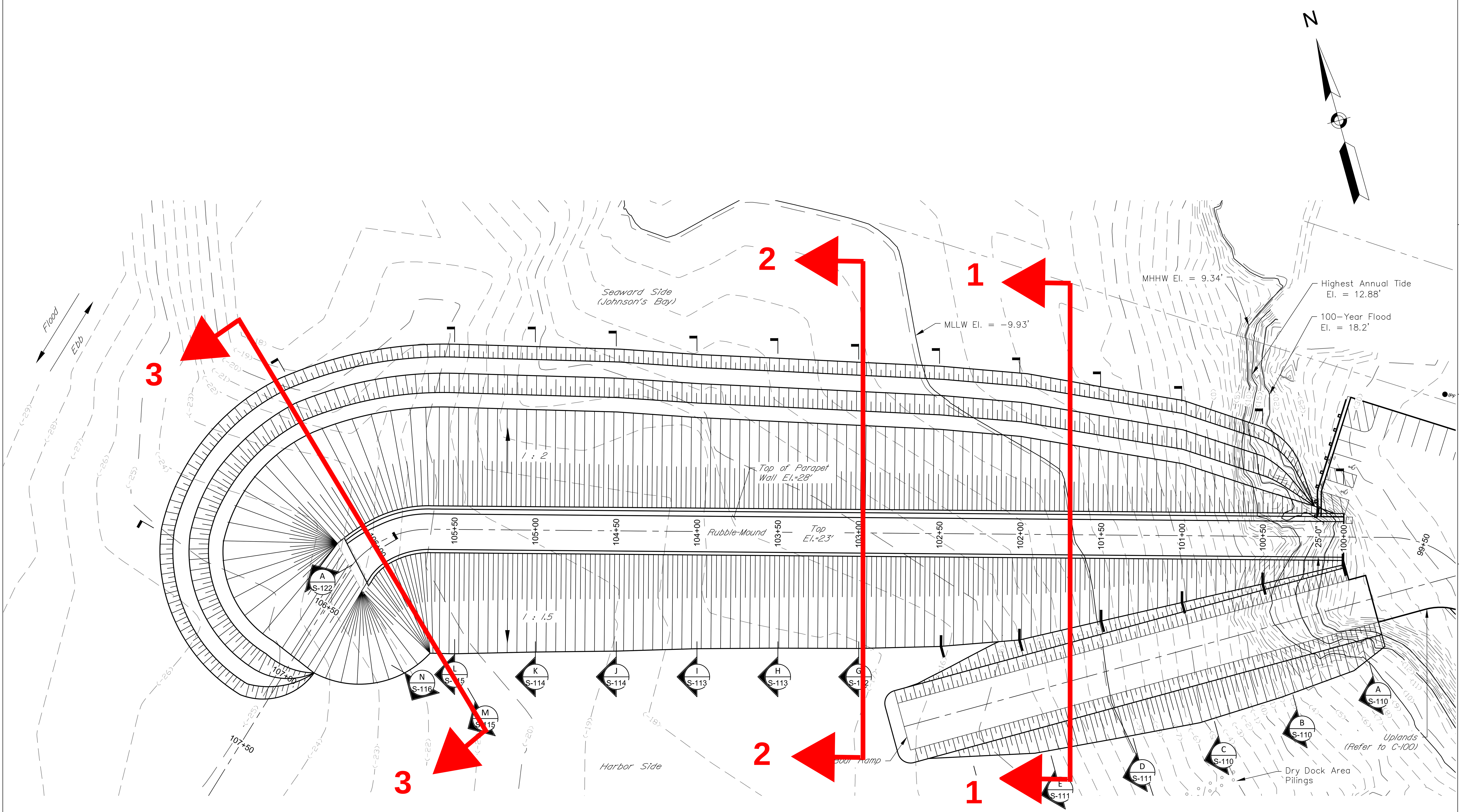


After cutting and grinding



After break

Appendix F. Rubble-Mound Breakwater Slope Stability



Section 1 - STA 101+75, Mudline at El. -12.5'

Section 2 - STA 103+00, Mudline at El. -15'

Section 3 - STA 106+00, Mudline at El. -23'

Notes

1. All elevation refers to NAVD 88.
2. All units in feet unless otherwise noted.
3. See guide pile schedule and details S-310 through S-320.

0 30 60 FT.
1"=30'

60% DESIGN
SUBMITTED DATE: MARCH 29, 2024

NOT FOR CONSTRUCTION

Jacobs

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

APPROVED	DATE
COMMISSIONER:	
CHIEF ENGINEER:	

PROJECT INFORMATION

		SIGNATURE	P.E. NUMBER	DATE
PROGRAM	MULTIMODAL			
PROJECT MANAGER	AURELE GORNEAU II			
DESIGNER	CRAIG MORIN			
CONSULTANT	JACOBS			
PROJECT RESIDENT				
CONTRACTOR				
PROJECT COMPLETION DATE				

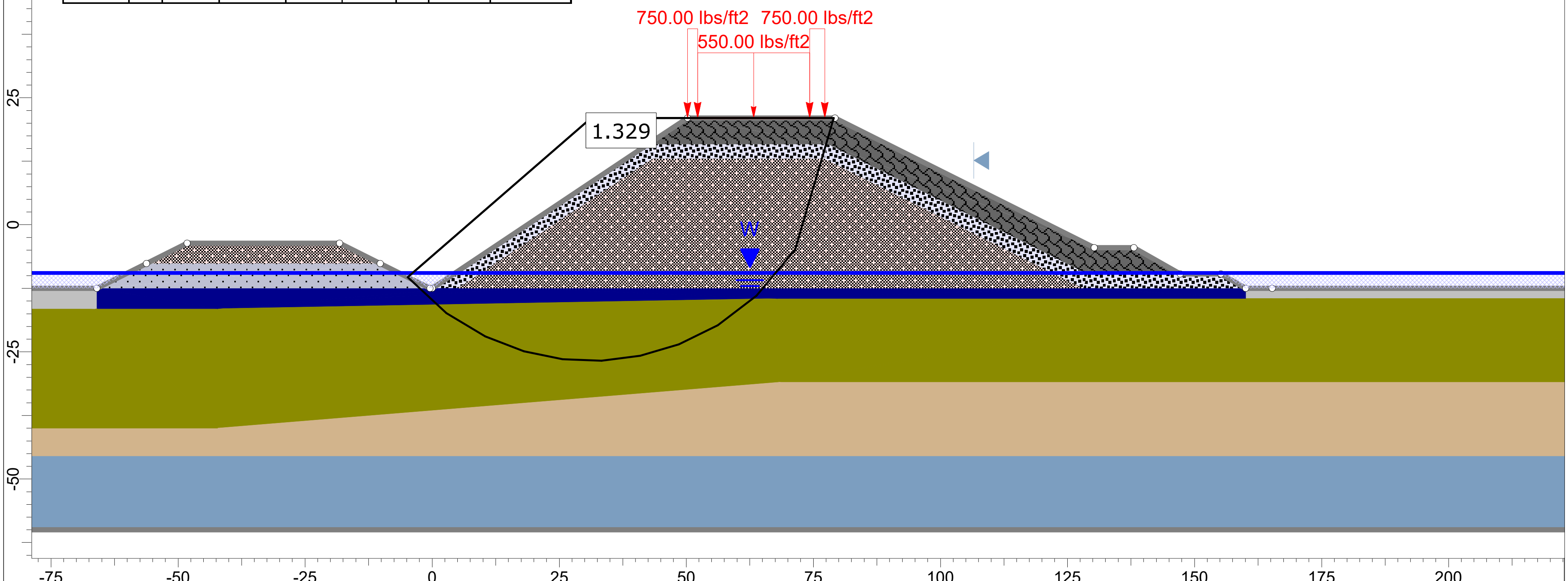
MAINE DEPARTMENT OF TRANSPORTATION
LUBEC BREAKWATER
WASHINGTON, COUNTY
LUBEC, ME

RUBBLE-MOUND PLAN

SHEET NUMBER
S-100

File: C:\Users\Maguirc\OneDrive - Jacobs\Project Documents\30 WIP\Drawings\Drawing_60% Submission\31-S-100 (Rubble-Mound Breakwater Plan) ; Plotted: 3/29/2024 11:28 AM by MAGUIRE, CASEY ; Saved: 3/29/2024 9:09 AM by SAMMONR

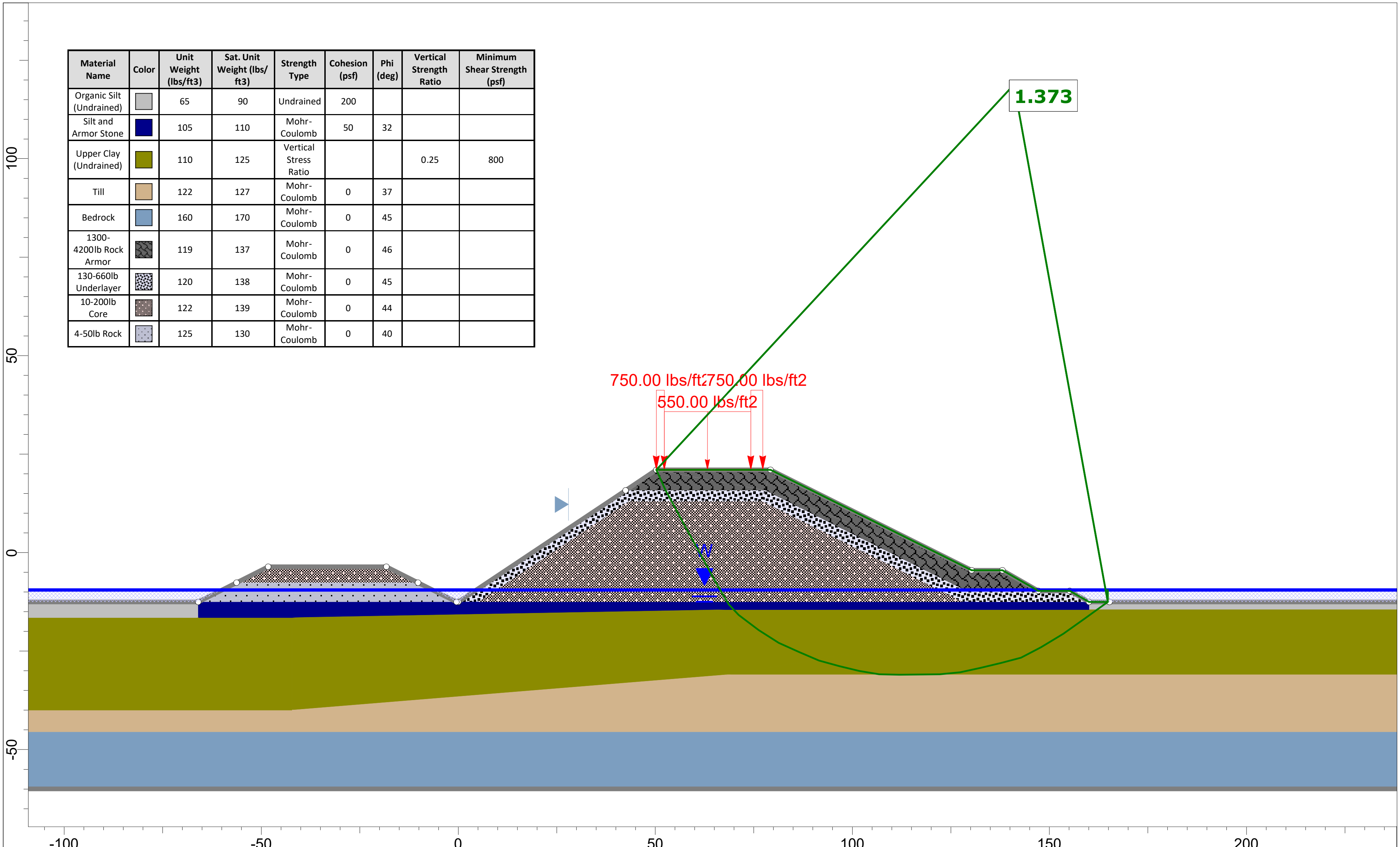
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Upper Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		
4-50lb Rock		125	130	Mohr-Coulomb	0	40		



Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-12.5' - Undrained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Jacobs

SLIDEINTERPRET 9.009



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
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Till		122	127	Mohr-Coulomb	0	37		
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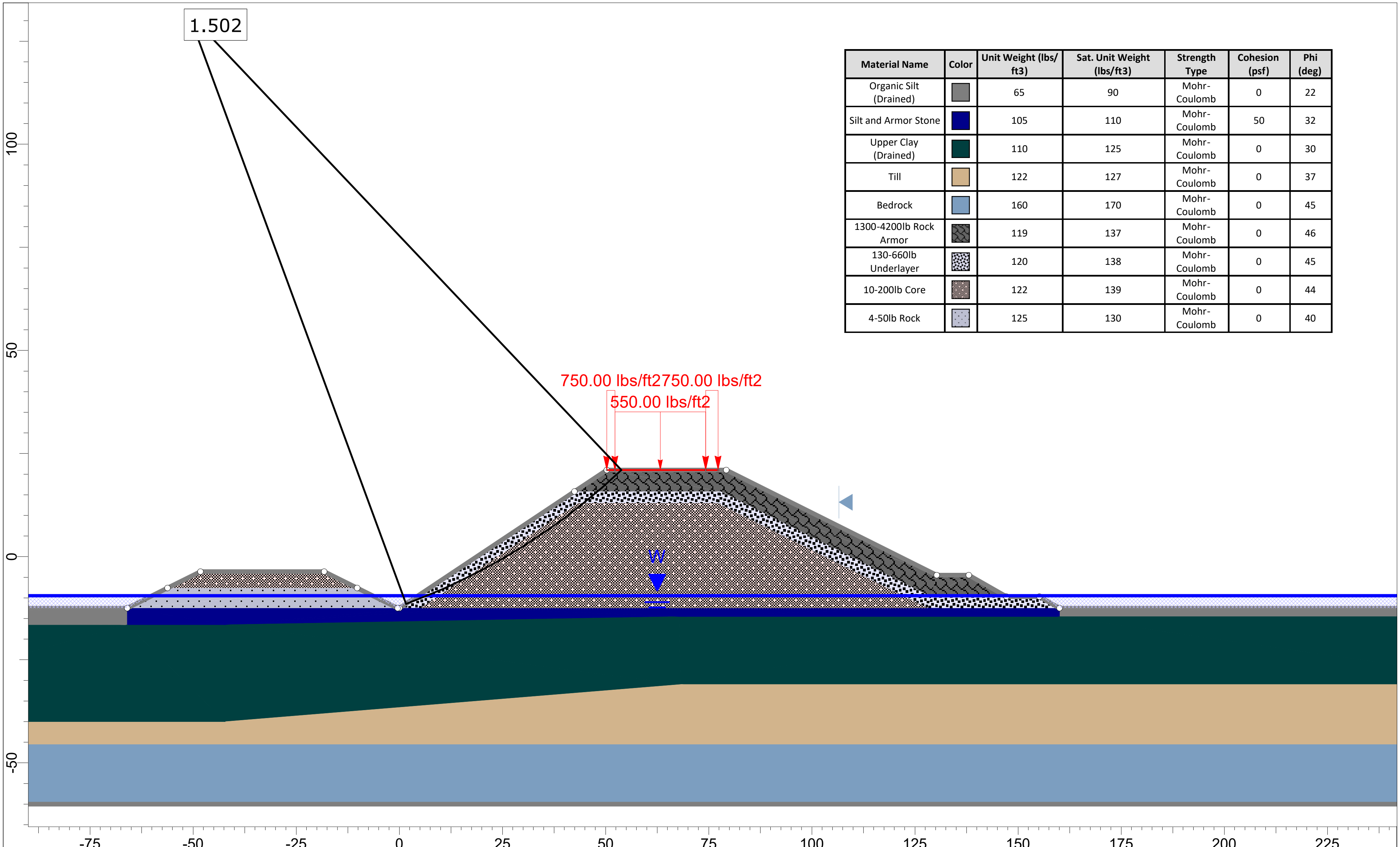
4-50lb Rock		125	130	Mohr-Coulomb	0	40		

Jacobs	*Project* Lubec Breakwater		
	Group Seaward Side, Mudline El.-12.5' - Undrained	*Scenario* Master Scenario	
	Drawn By M. Kullmann	*Company* Jacobs	
SLIDEINTERPRET 9.009	*Date* 5/17/2024	*Analysis* Rubble Mound Global Stability	



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Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
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4-50lb Rock		125	130	Mohr-Coulomb	0	40

Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-12.5' - Drained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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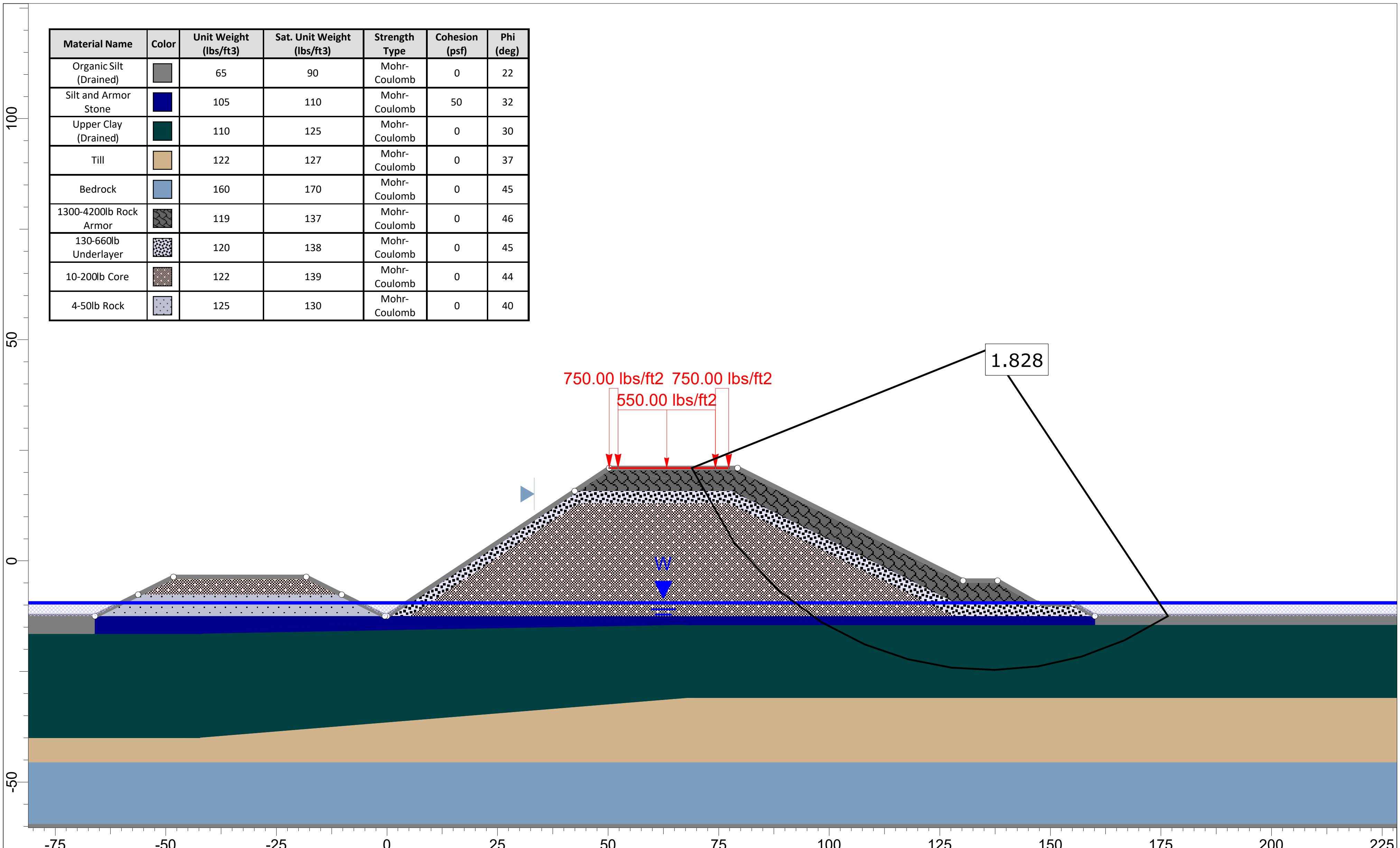
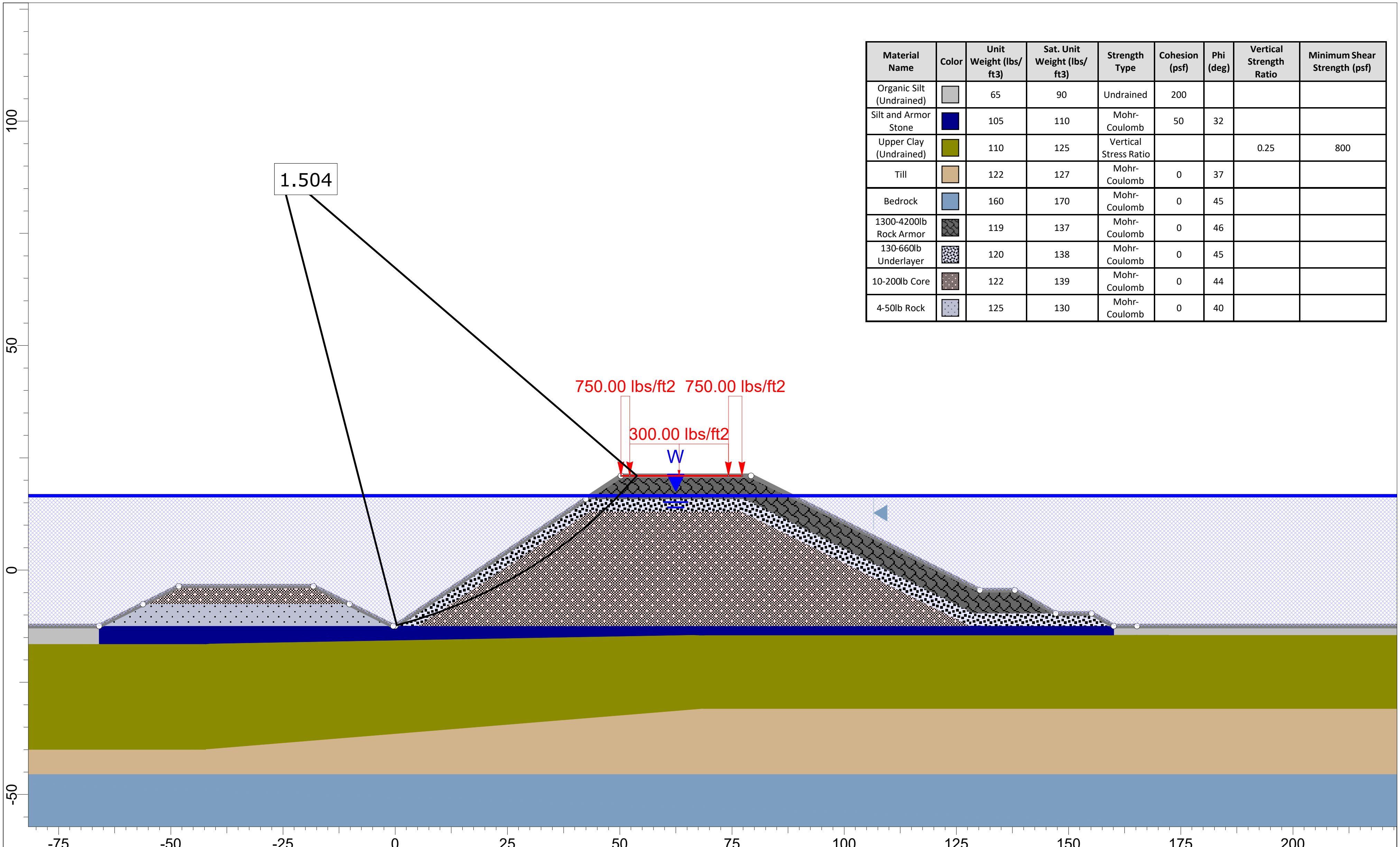
10-200lb Core		122	139	Mohr-Coulomb	0	44
4-50lb Rock		125	130	Mohr-Coulomb	0	40



Jacobs

Project	Lubec Breakwater
Group	Seaward Side, Mudline El.-12.5' - Drained
Scenario	Master Scenario
Drawn By	M. Kullmann
Company	Jacobs
Date	5/17/2024
Analysis	Rubble Mound Global Stability

SLIDEINTERPRET 9.009



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
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4-50lb Rock		125	130	Mohr-Coulomb	0	40		

Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-12.5' - 100-yr Storm, Undrained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Upper Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Till		122	127	Mohr-Coulomb	0	37		
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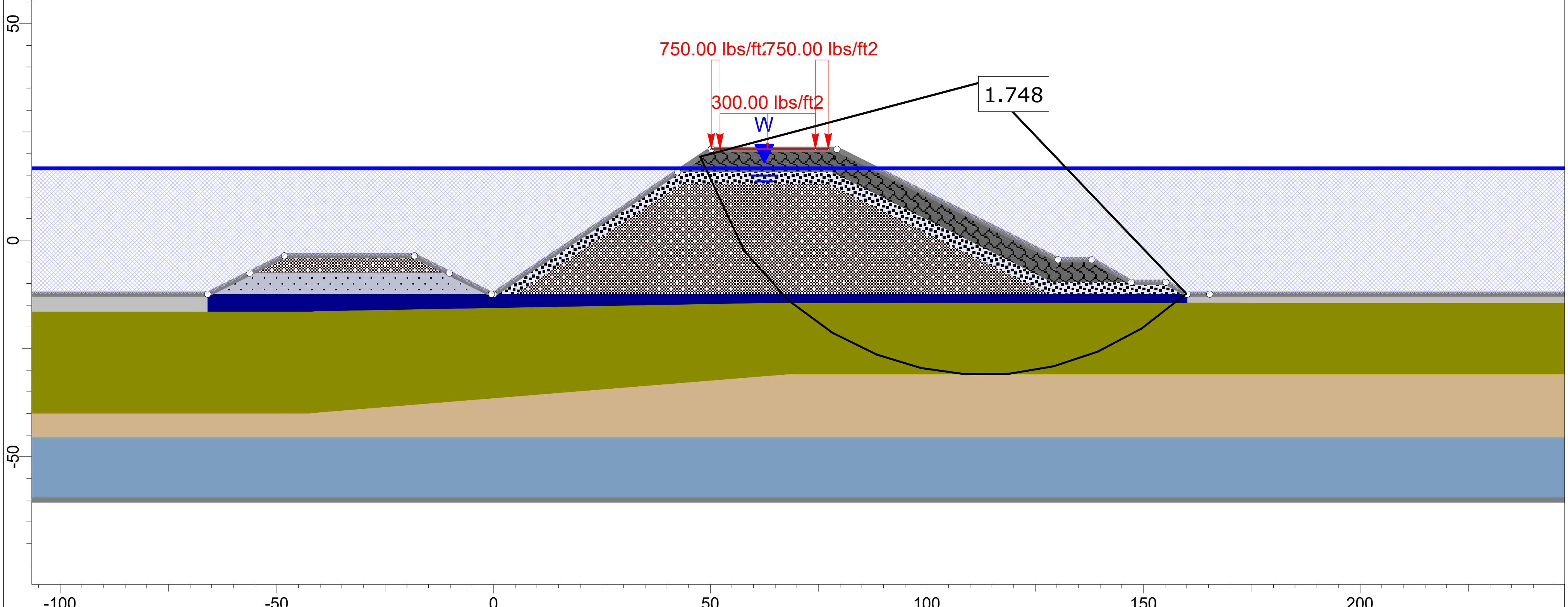
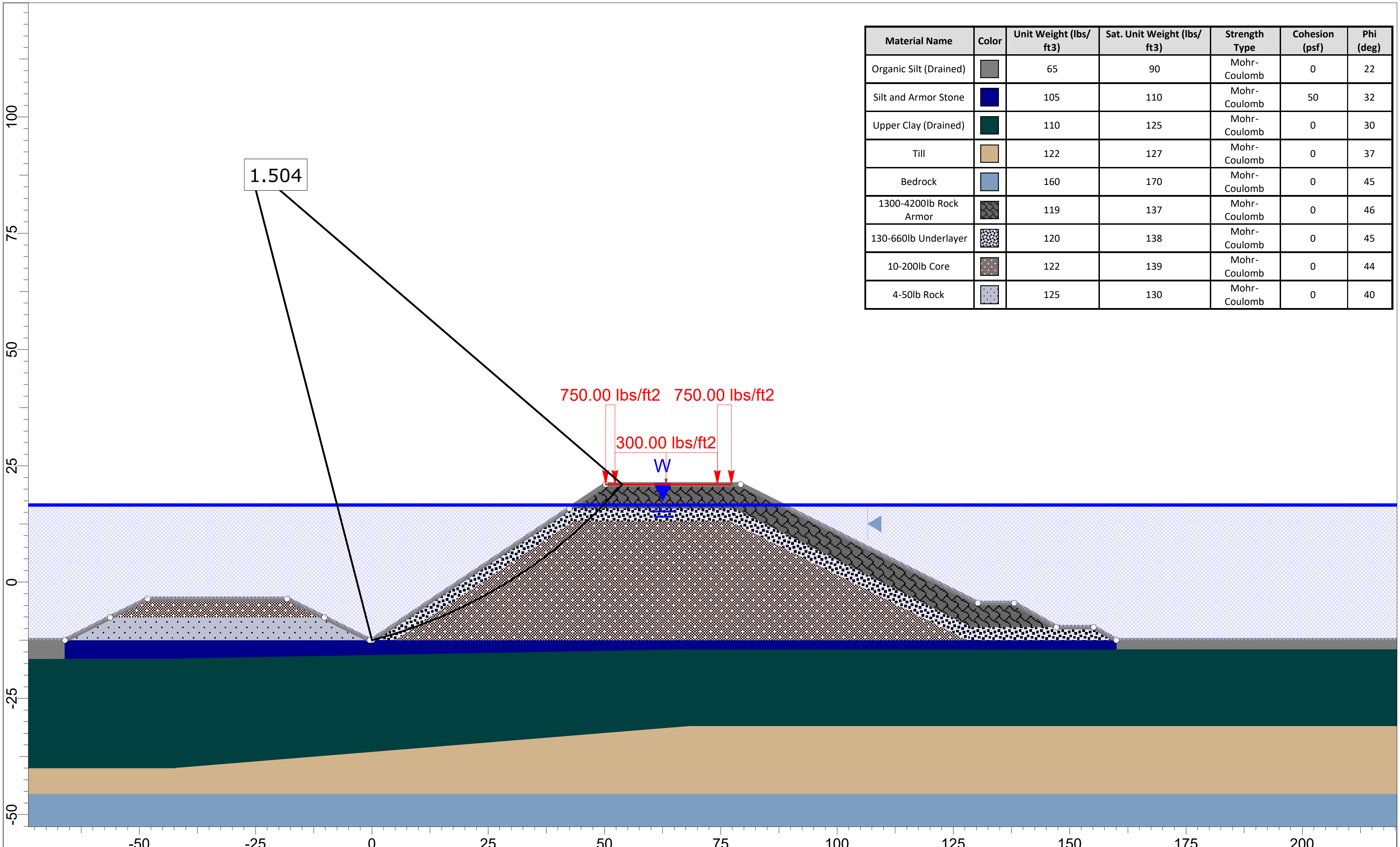
10-200lb Core		122	139	Mohr-Coulomb	0	44		
4-50lb Rock		125	130	Mohr-Coulomb	0	40		



Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater
Group	Seaward Side, Mudline El.-12.5' - 100-yr Storm, Undrained
Scenario	Master Scenario
Drawn By	M. Kullmann
Company	Jacobs
Date	5/17/2024
Analysis	Rubble Mound Global Stability



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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4-50lb Rock		125	130	Mohr-Coulomb	0	40

Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-12.5' - 100-yr Storm, Drained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ ft3)	Sat. Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
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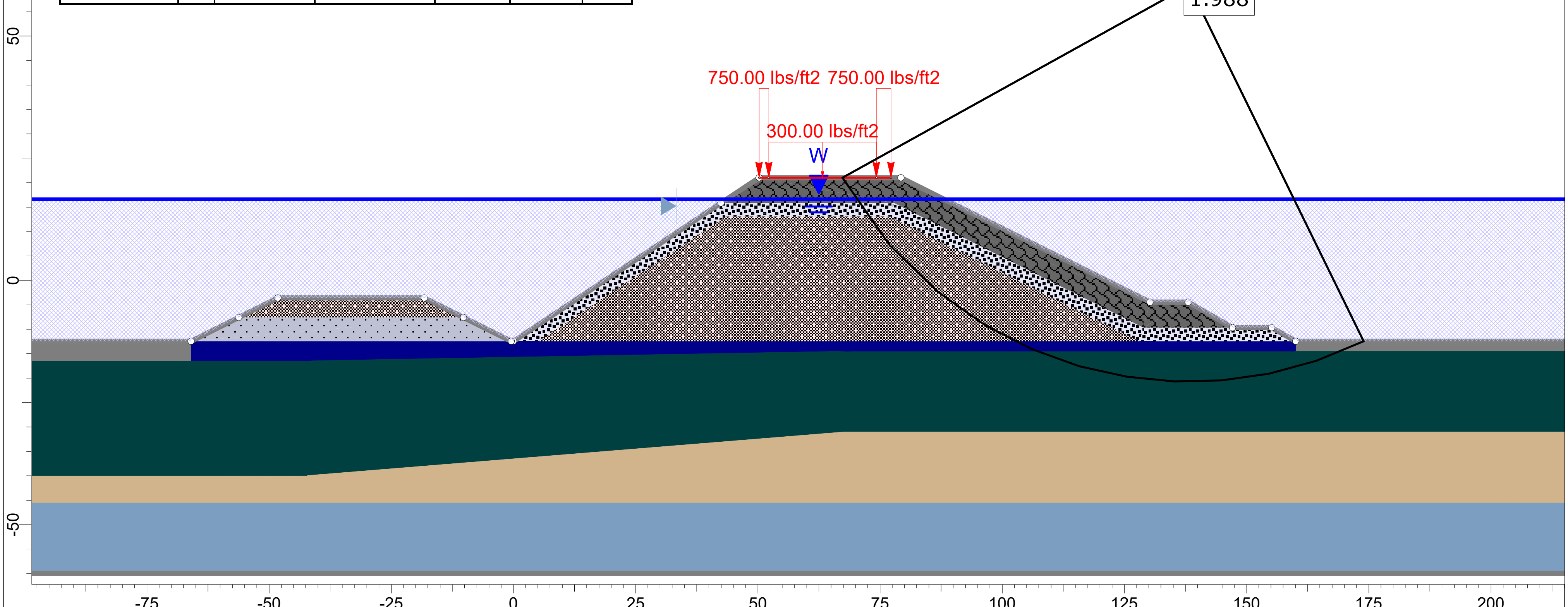

Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater
Group	Seaward Side, Mudline El.-12.5' - 100-yr Storm, Drained
Scenario	Master Scenario
Drawn By	M. Kullmann
Company	Jacobs
Date	5/17/2024
Analysis	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
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10-200lb Core		122	139	Mohr-Coulomb	0	44		
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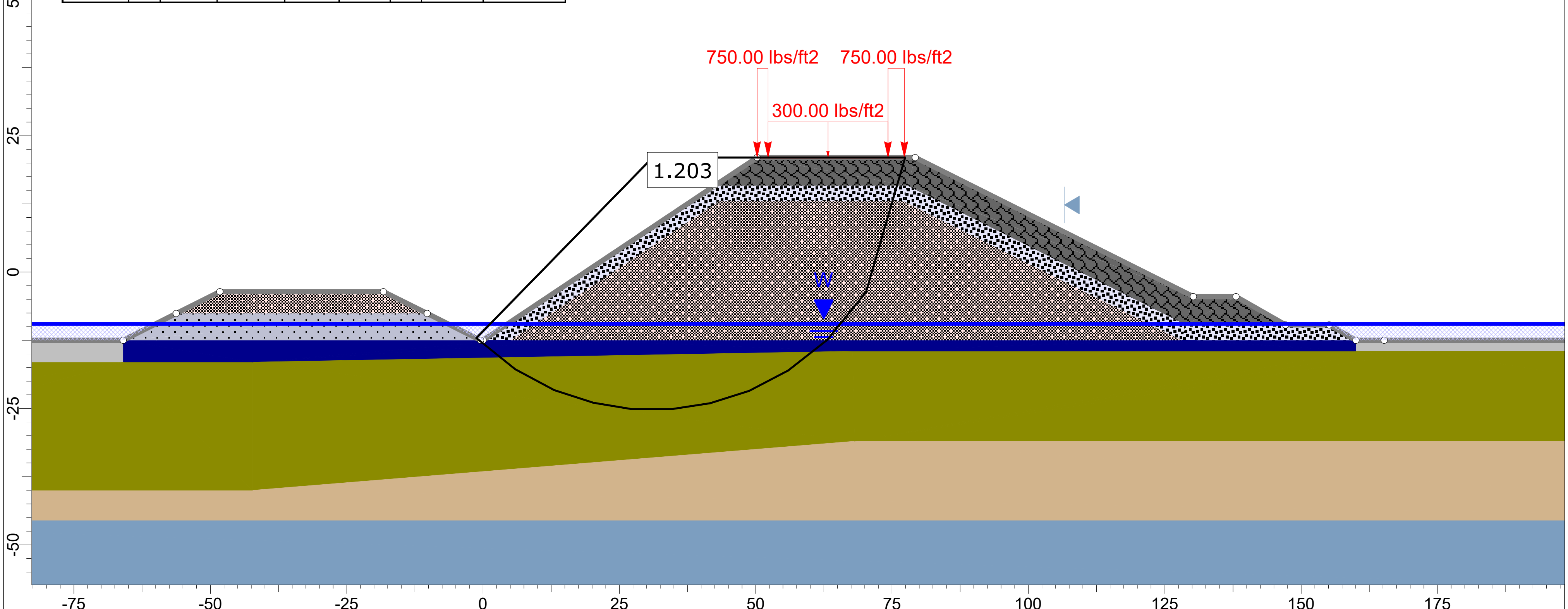

Jacobs	*Project* Lubec Breakwater		
	Group Harbor Side, Mudline El.-12.5' - Seismic	*Scenario* Master Scenario	
	Drawn By M. Kullmann	*Company* Jacobs	
SLIDEINTERPRET 9.009	*Date* 5/17/2024	*Analysis* Rubble Mound Global Stability	

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Upper Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
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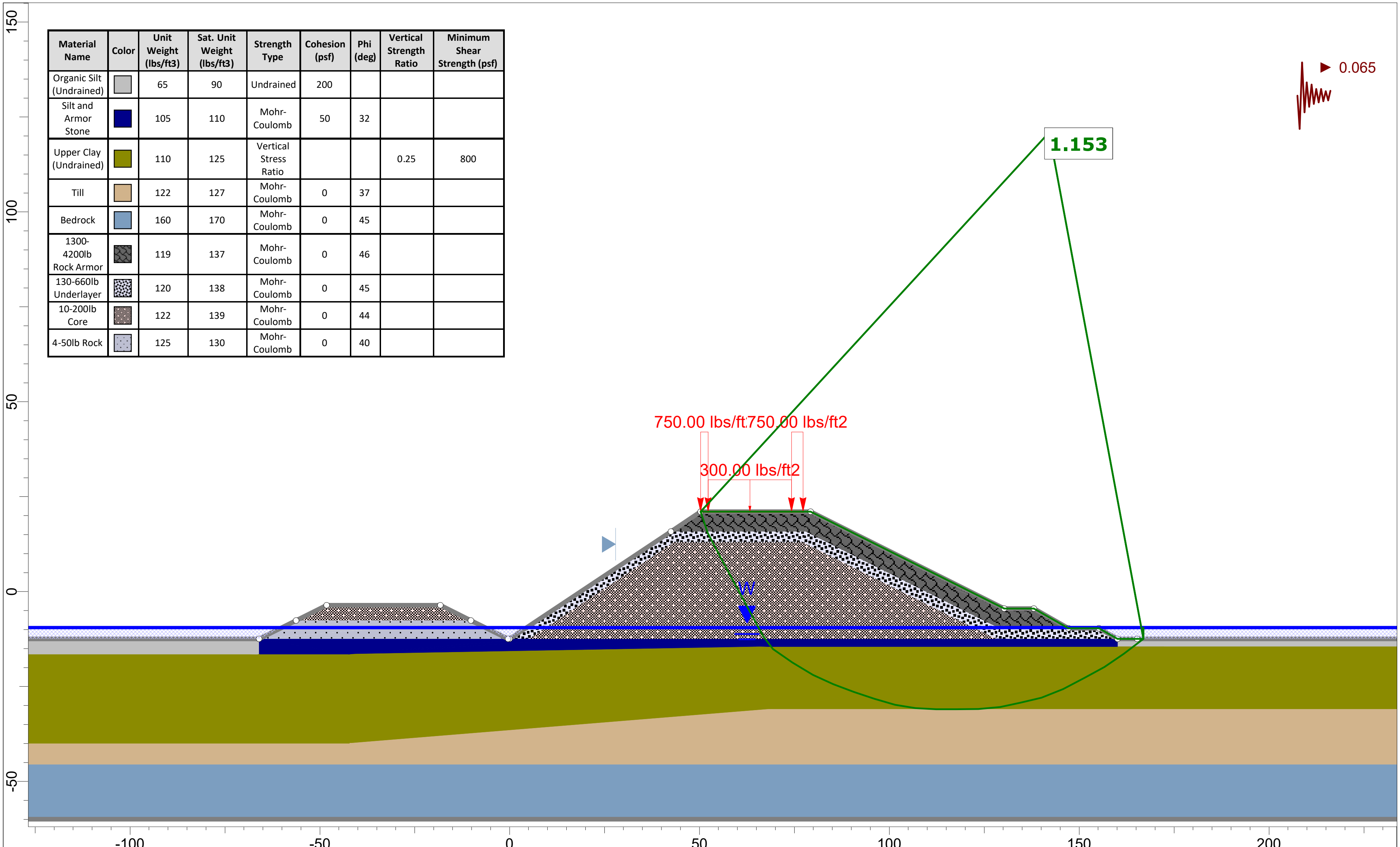

Jacobs	*Project*	Lubec Breakwater	
	Group Seaward Side, Mudline El.-12.5' - Seismic	*Scenario* Master Scenario	
	Drawn By M. Kullmann	*Company* Jacobs	
SLIDEINTERPRET 9.009	*Date* 5/17/2024	*Analysis* Rubble Mound Global Stability	

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
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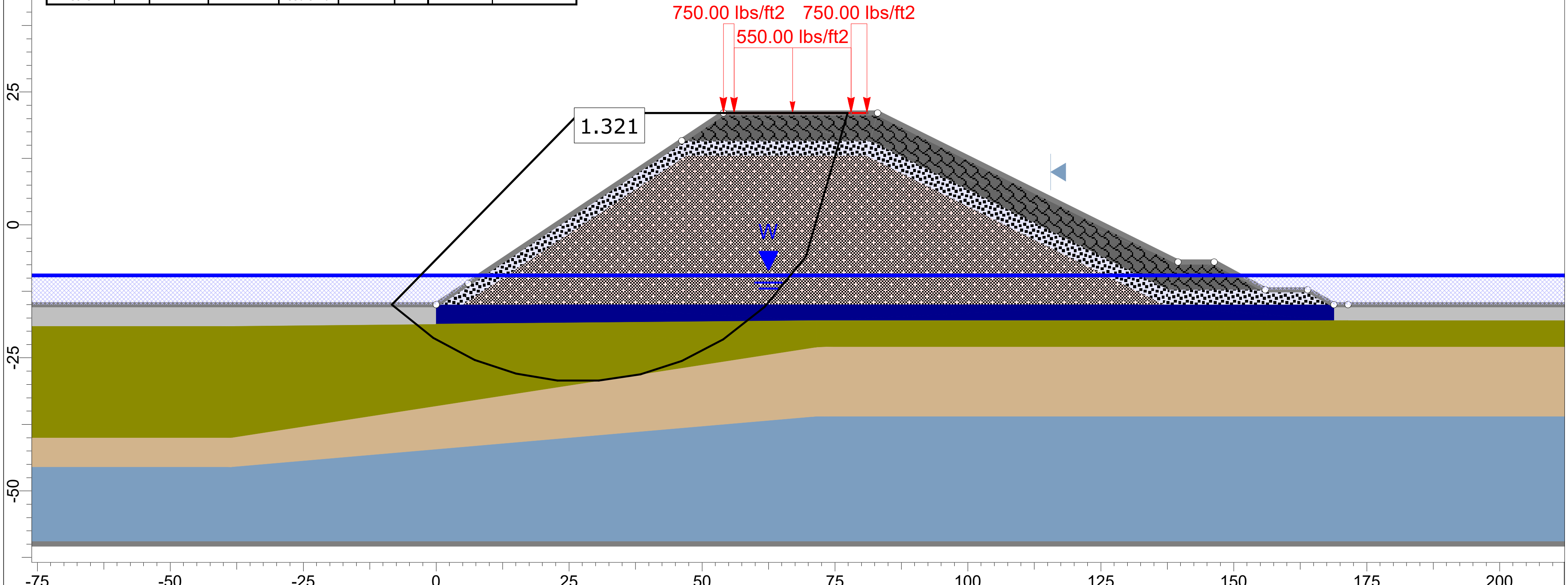

Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater
Group	Harbor Side, Mudline El.-15' - Undrained
Scenario	Master Scenario
Drawn By	M. Kullmann
Company	Jacobs
Date	5/17/2024
Analysis	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
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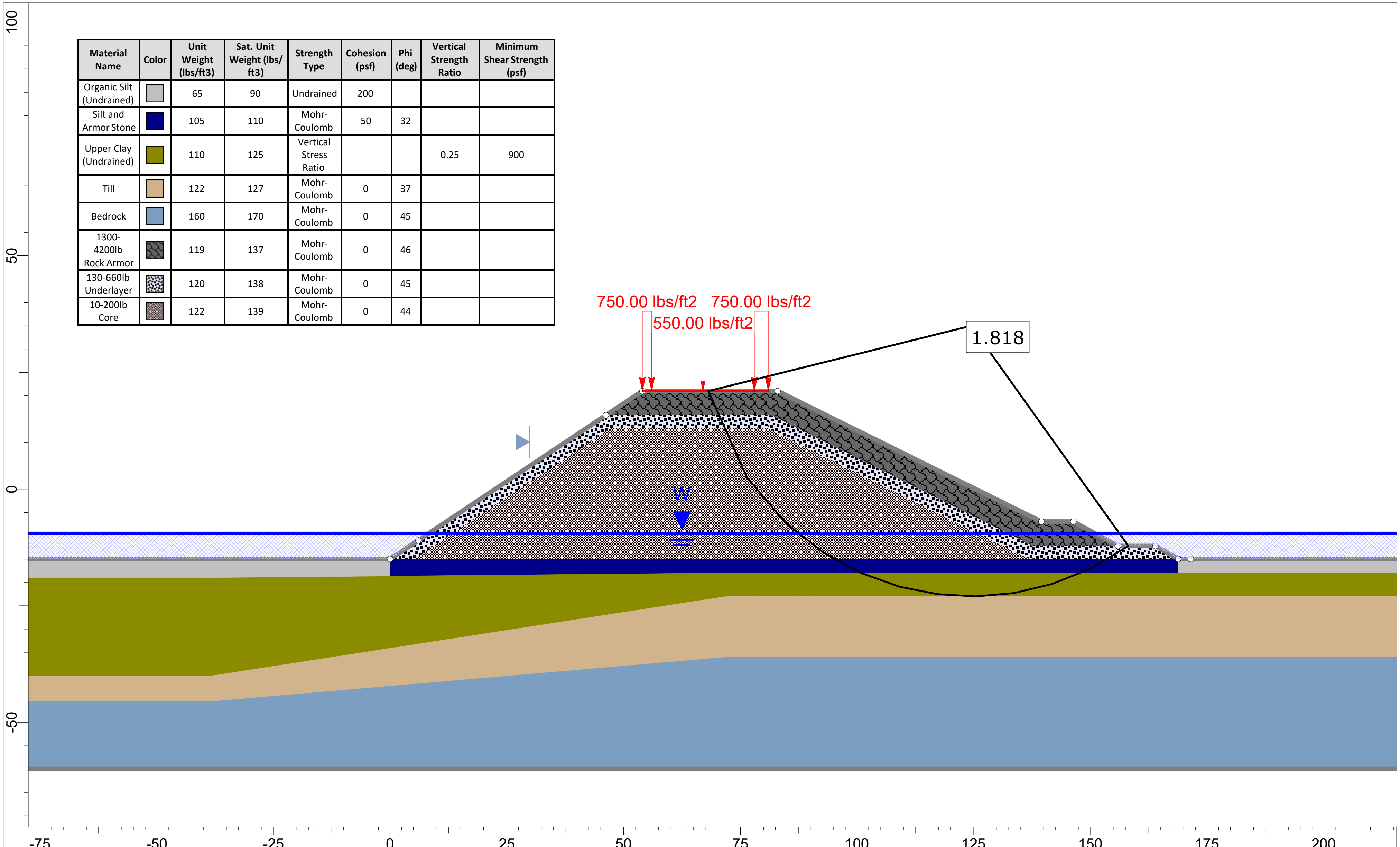
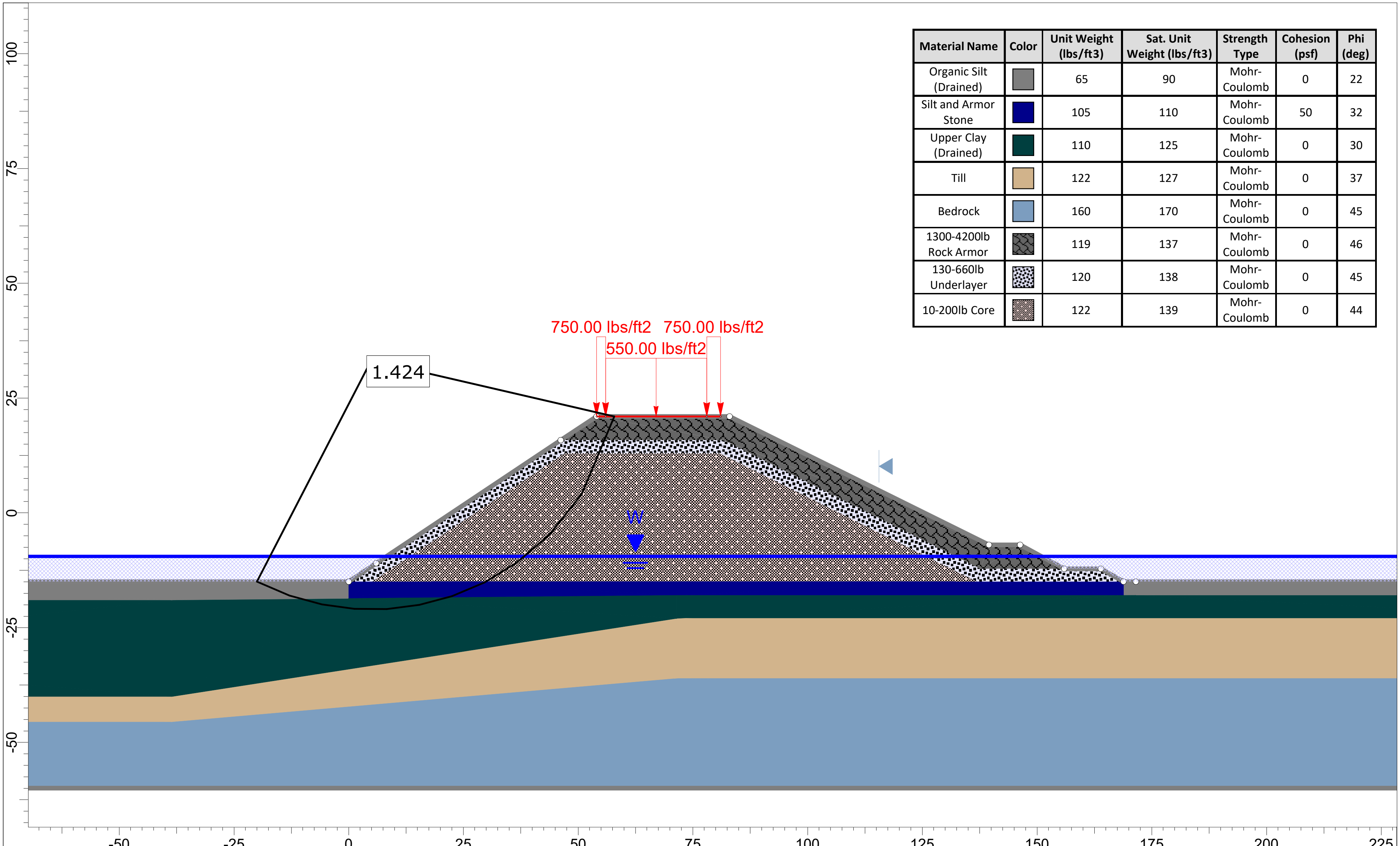


Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Seaward Side, Mudline El.-15' - Undrained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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Jacobs

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-15' - Drained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

SLIDEINTERPRET 9.009

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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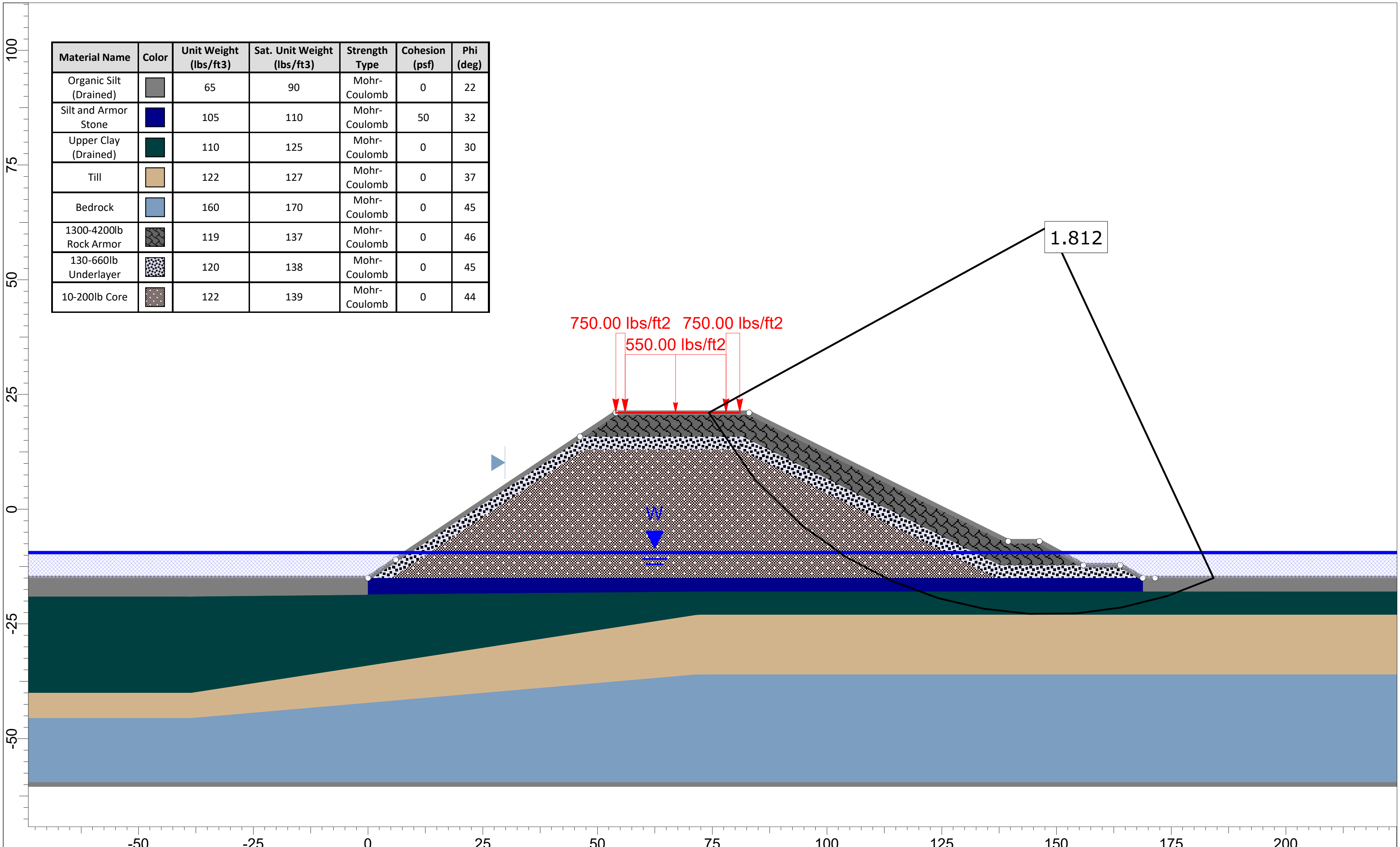
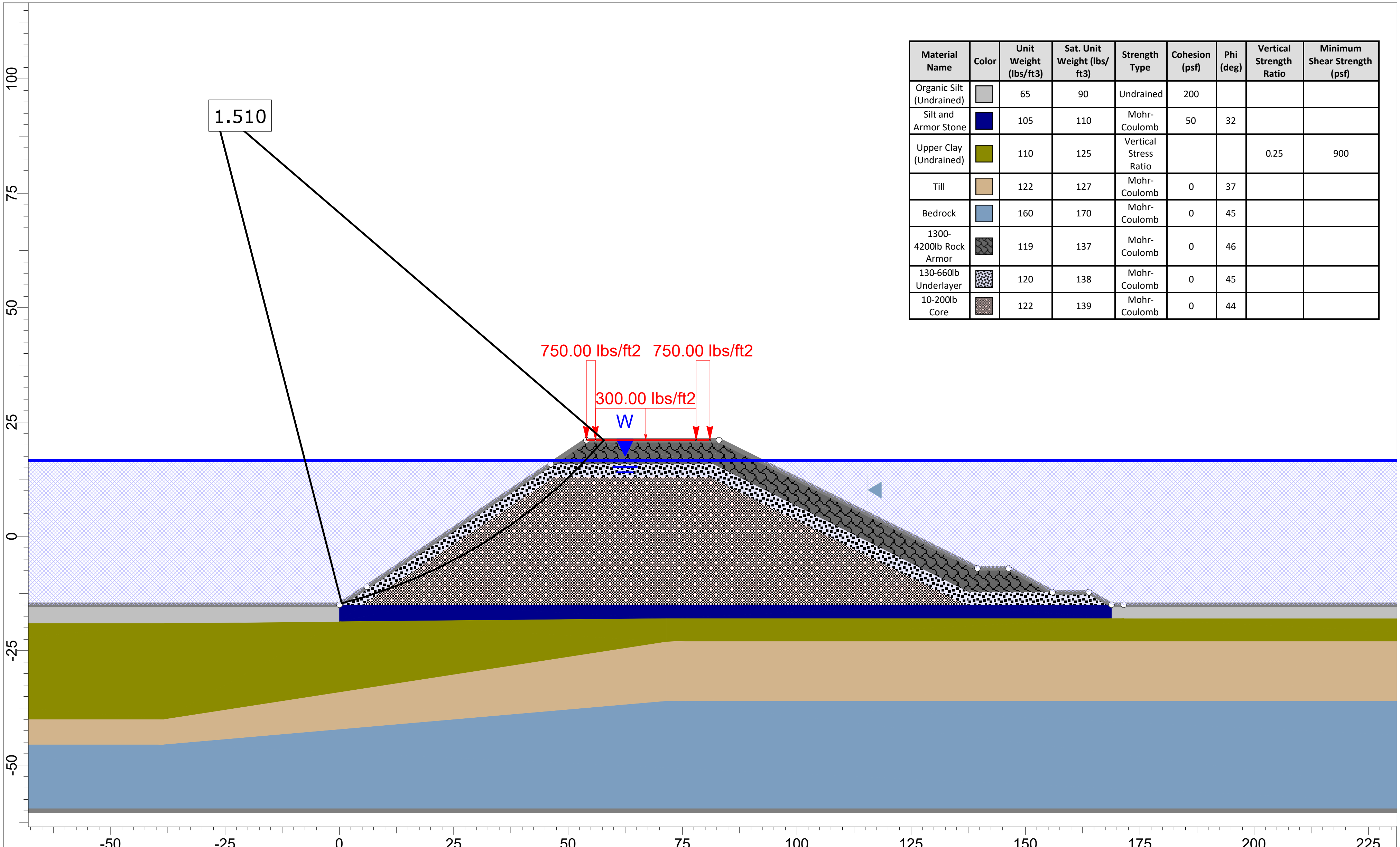


Project: Lubec Breakwater

Group	Seaward Side, Mudline El.-15' - Drained	Scenario	Master Scenario
Drawn By	M. Kullmann	Company	Jacobs
Date	5/17/2024	Analysis	Rubble Mound Global Stability

Jacobs

SLIDEINTERPRET 9.009



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Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-15' - 100-yr Storm, Undrained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
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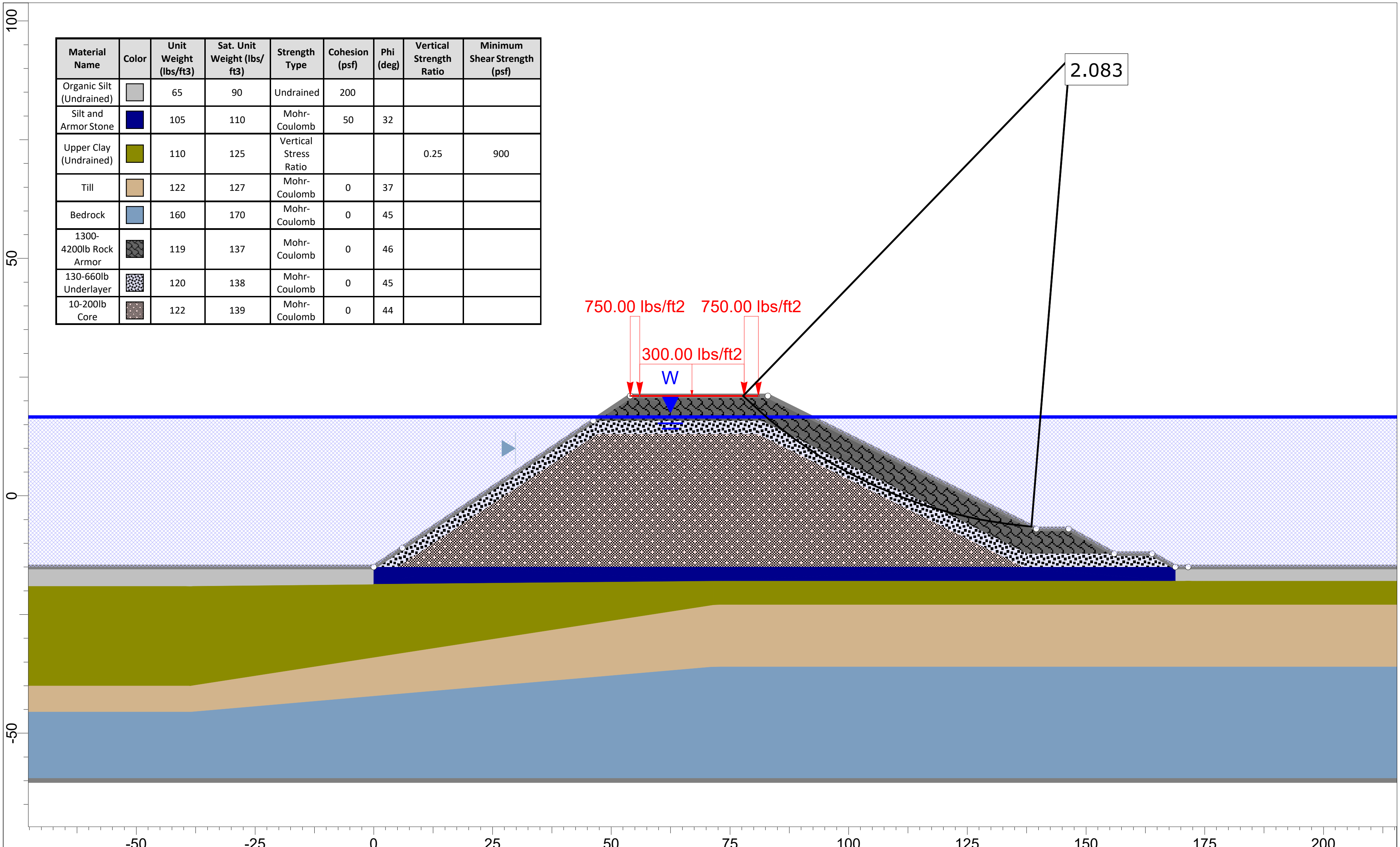
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		



Project: Lubec Breakwater

Group: Seaward Side, Mudline El.-15' - 100-yr Storm, Undrained

Scenario: Master Scenario

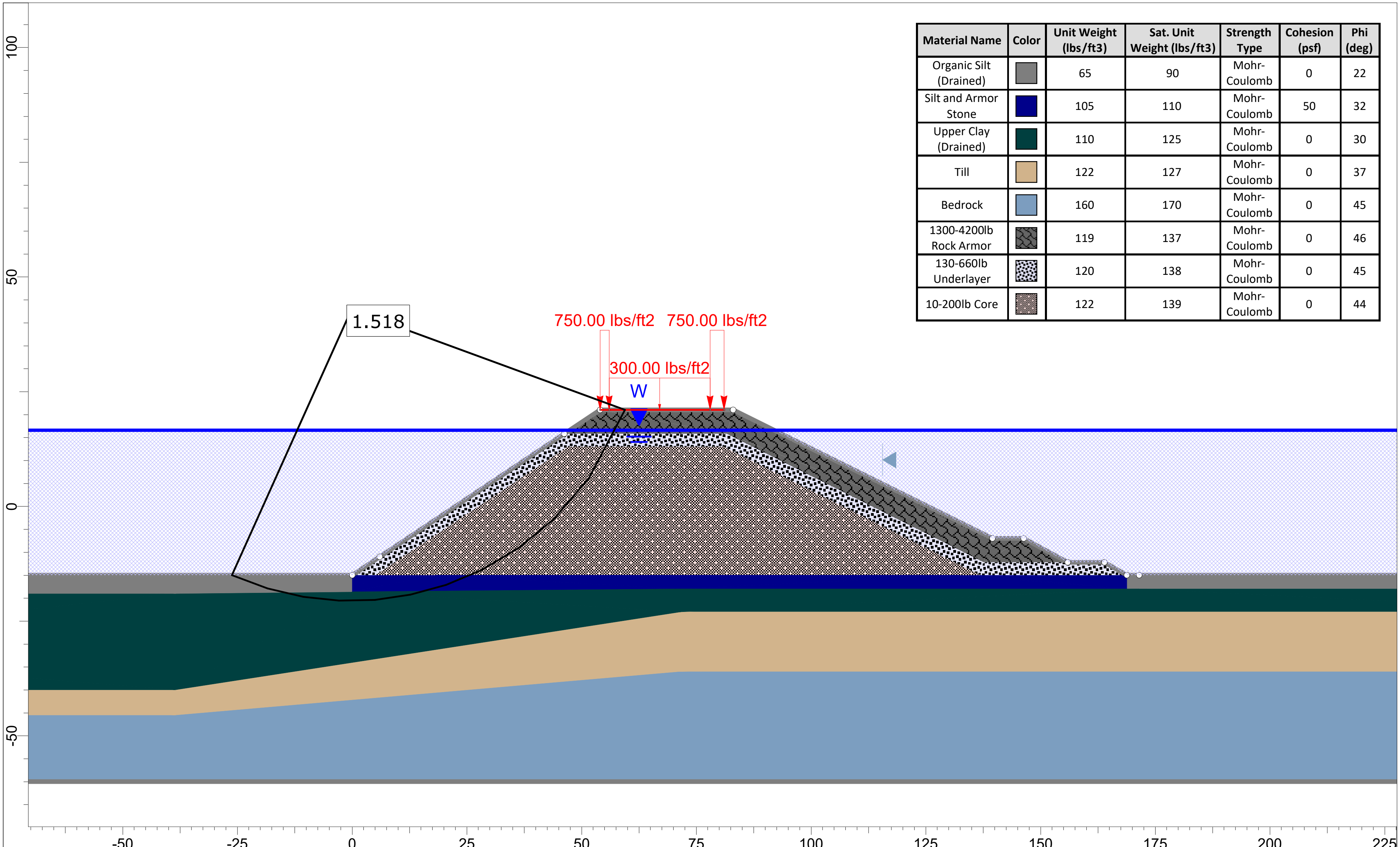
Drawn By: M. Kullmann

Company: Jacobs

Date: 5/17/2024

Analysis: Rubble Mound Global Stability

SLIDEINTERPRET 9.009

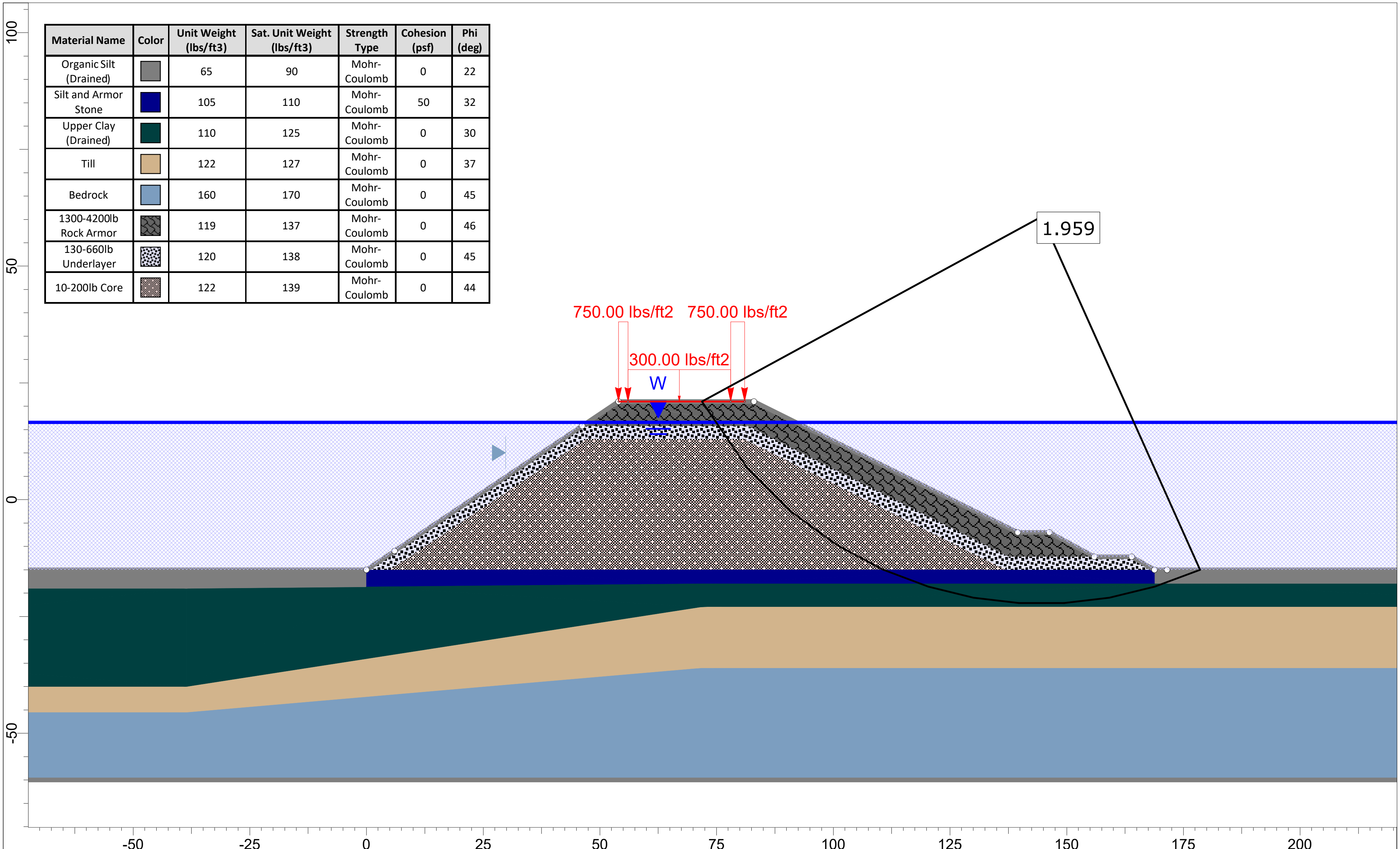


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32
Upper Clay (Drained)		110	125	Mohr-Coulomb	0	30
Till		122	127	Mohr-Coulomb	0	37
Bedrock		160	170	Mohr-Coulomb	0	45
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45
10-200lb Core		122	139	Mohr-Coulomb	0	44

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-15' - 100-yr Storm, Drained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

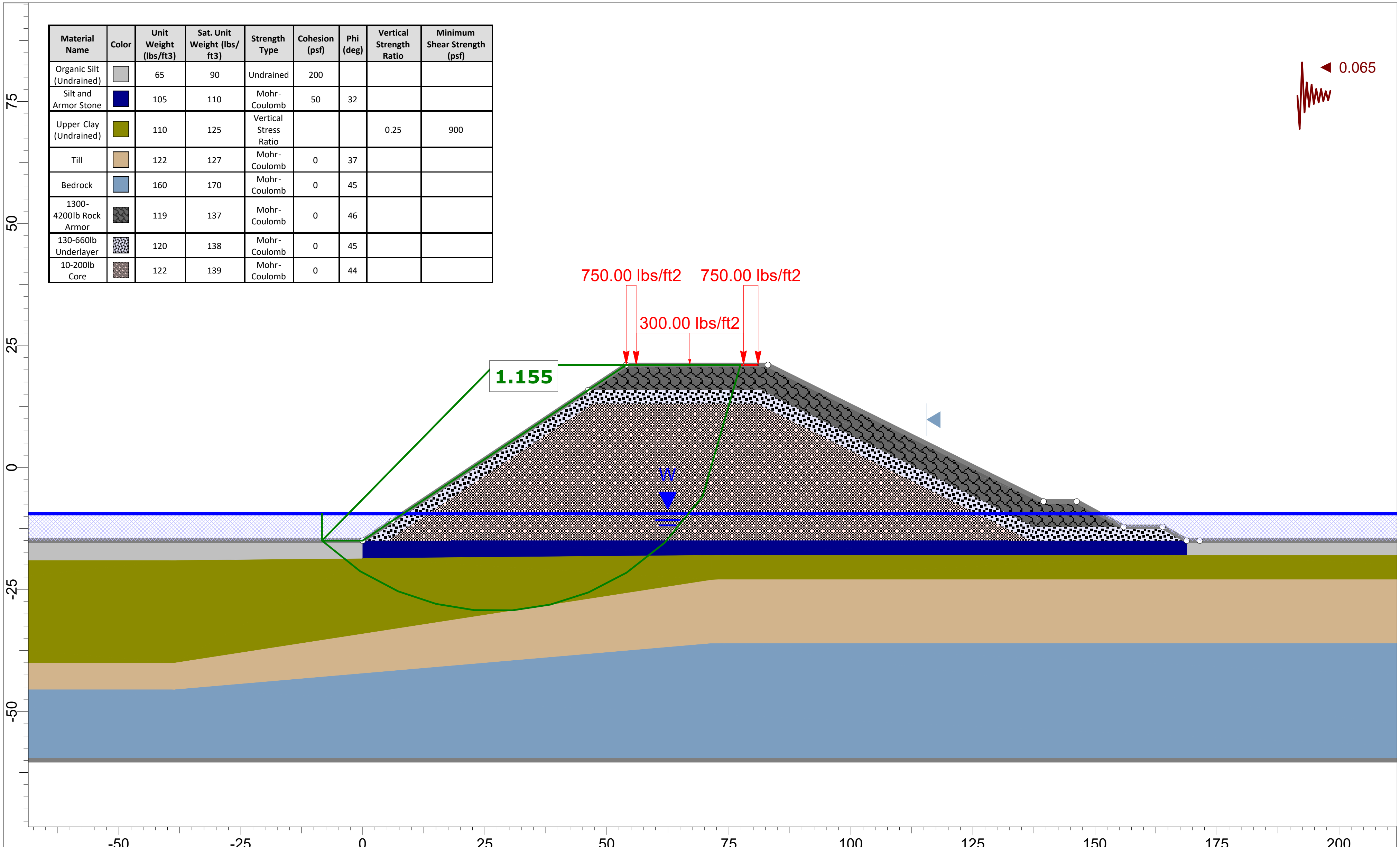
SLIDEINTERPRET 9.009

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32
Upper Clay (Drained)		110	125	Mohr-Coulomb	0	30
Till		122	127	Mohr-Coulomb	0	37
Bedrock		160	170	Mohr-Coulomb	0	45
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45
10-200lb Core		122	139	Mohr-Coulomb	0	44



Jacobs	*Project* Lubec Breakwater		
	Group Seaward Side, Mudline El.-15' - 100-yr Storm, Drained	*Scenario* Master Scenario	
	Drawn By M. Kullmann	*Company* Jacobs	
SLIDEINTERPRET 9.009	*Date* 5/17/2024	*Analysis* Rubble Mound Global Stability	

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Upper Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	900
Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		

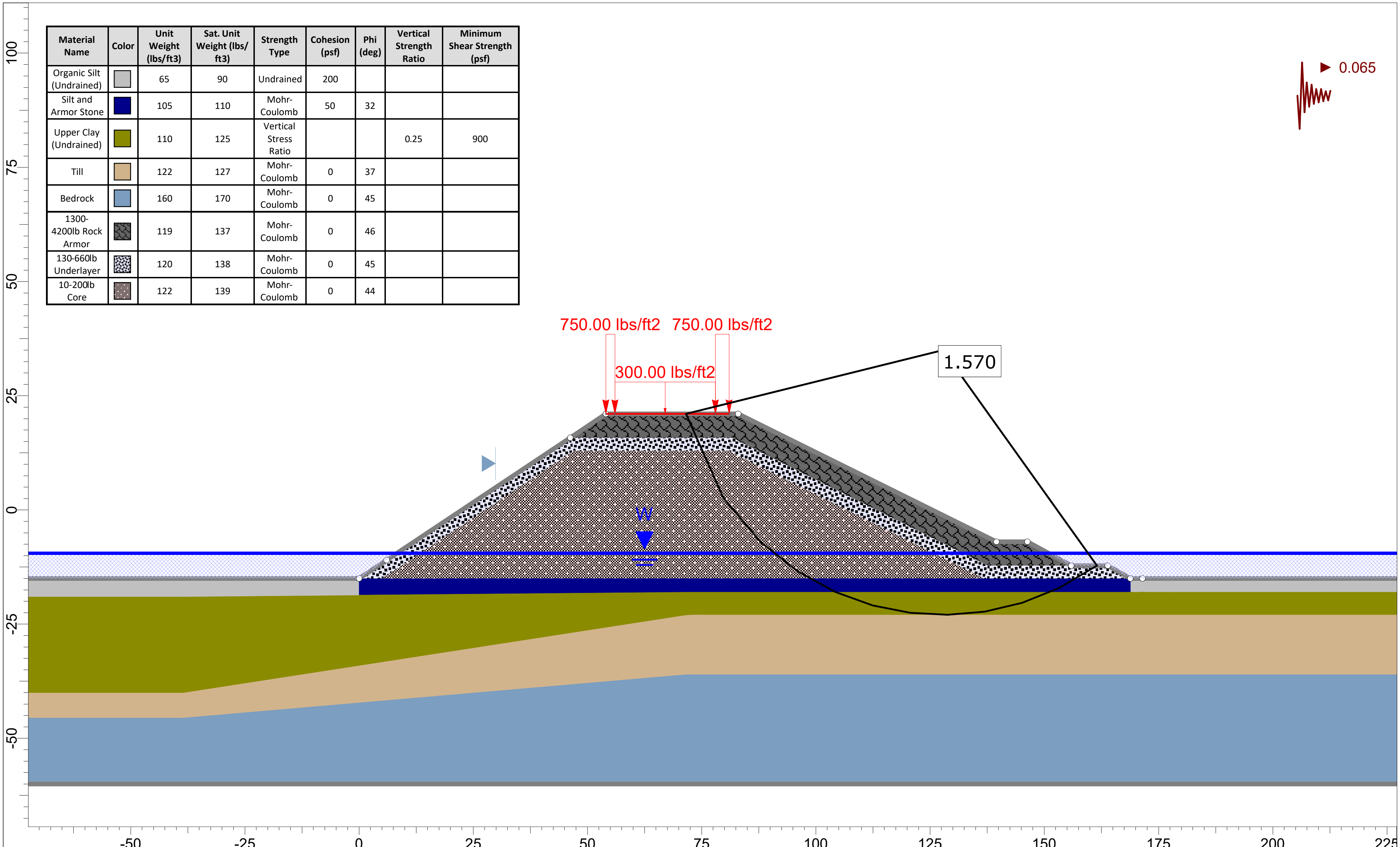


Jacobs

SLIDEINTERPRET 9.009

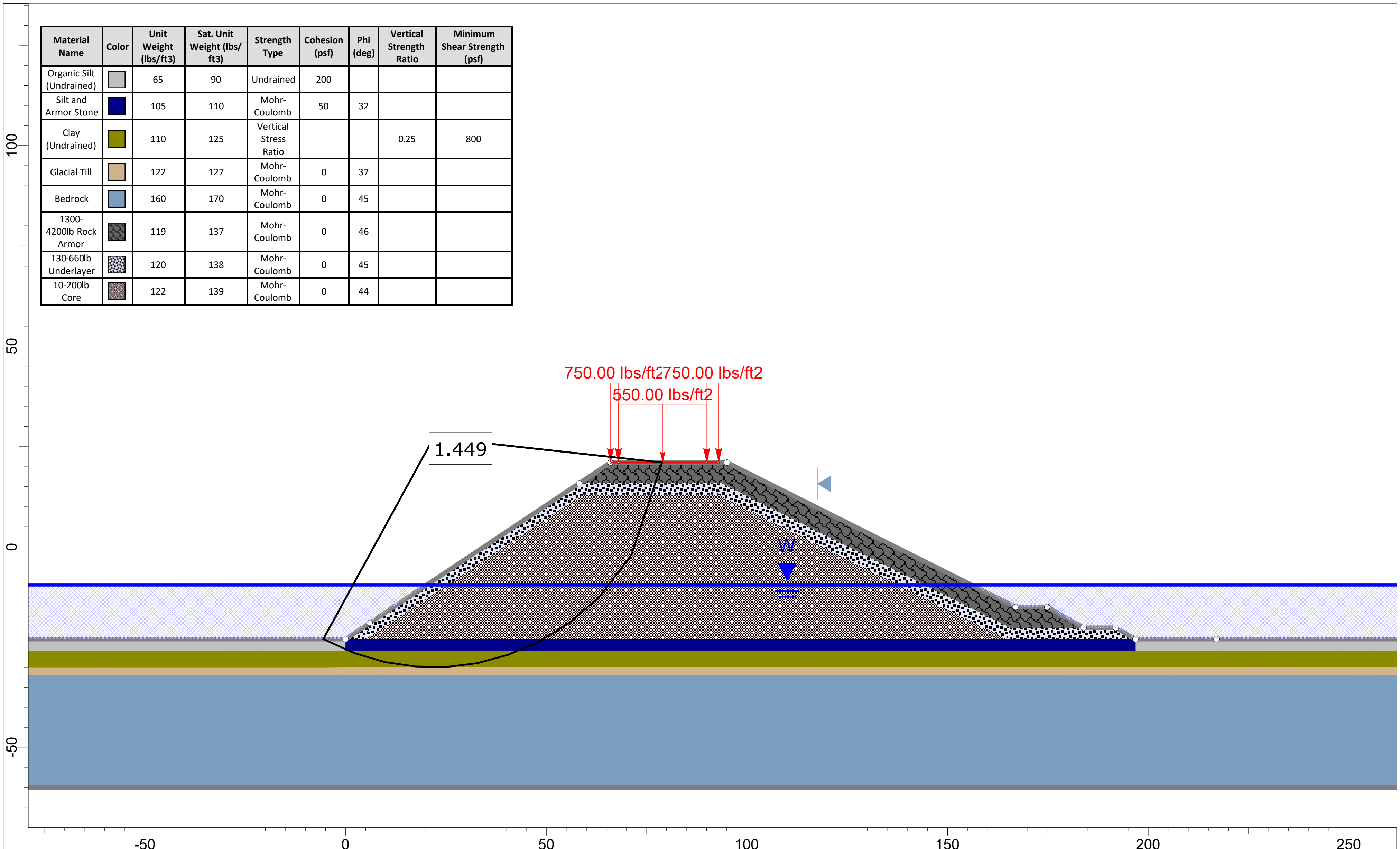
Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-15' - Seismic	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Upper Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	900
Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		



Jacobs	*Project* Lubec Breakwater		
	Group Seaward Side, Mudline El.-15' - Seismic	*Scenario* Master Scenario	
	Drawn By M. Kullmann	*Company* Jacobs	
SLIDEINTERPRET 9.009	*Date* 5/17/2024	*Analysis* Rubble Mound Global Stability	

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Glacial Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		

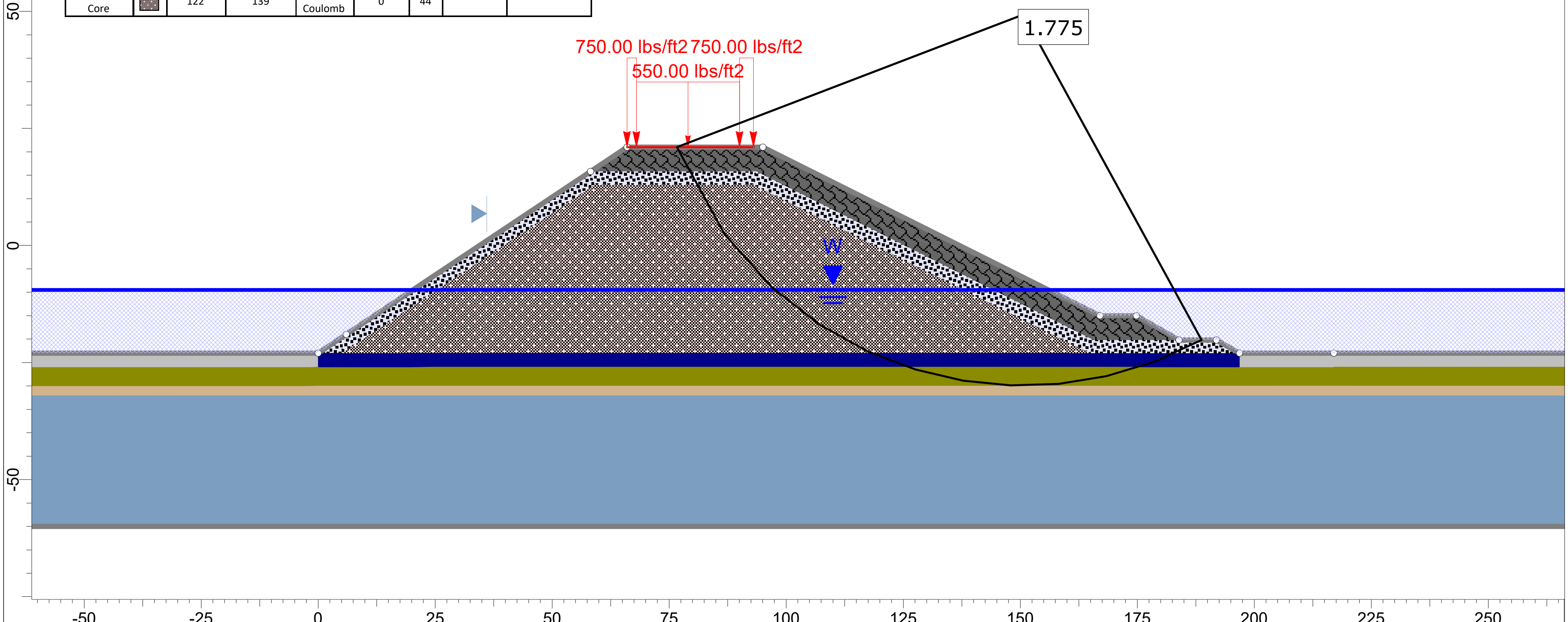


Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-23' - Undrained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Glacial Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		



Project	Lubec Breakwater		
Group	Seaward Side, Mudline El.-23' - Undrained	Scenario	Master Scenario
Drawn By	M. Kullmann	Company	Jacobs
Date	5/17/2024	Analysis	Rubble Mound Global Stability

Jacobs

SLIDEINTERPRET 9.009

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32
Clay (Drained)		110	125	Mohr-Coulomb	0	30
Glacial Till		122	127	Mohr-Coulomb	0	37
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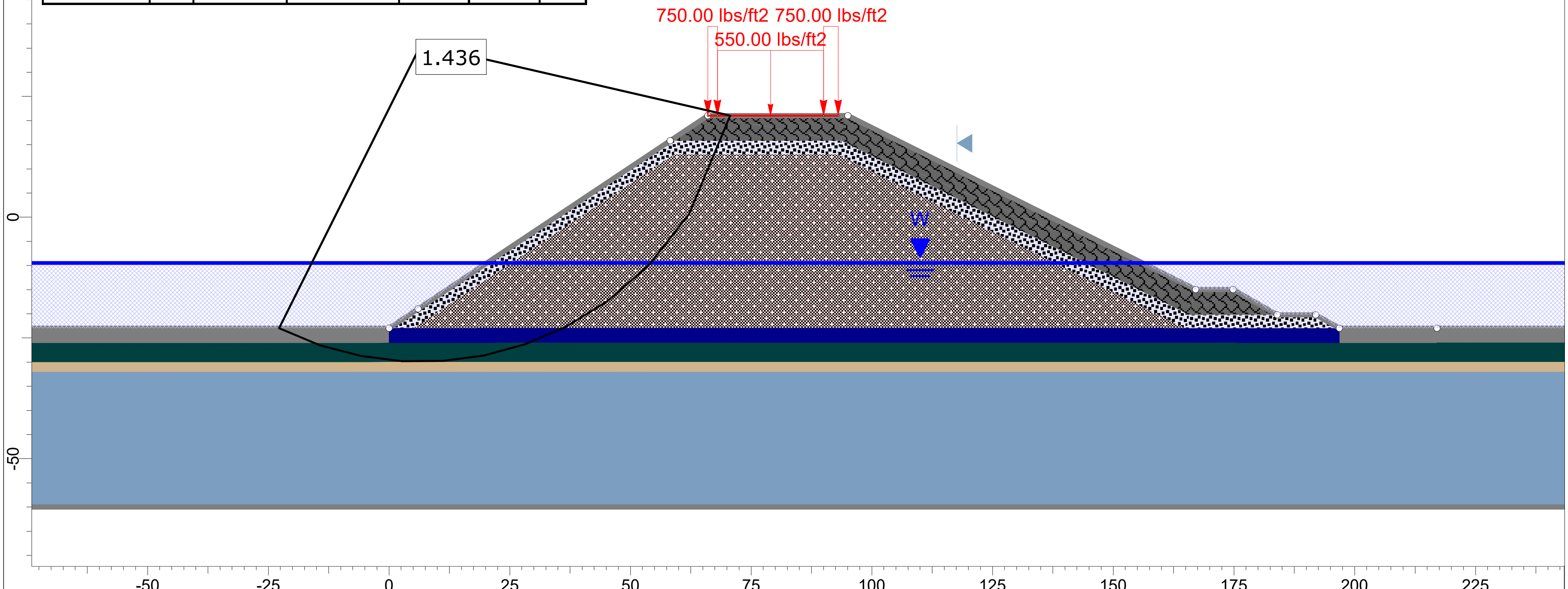
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45
10-200lb Core		122	139	Mohr-Coulomb	0	44

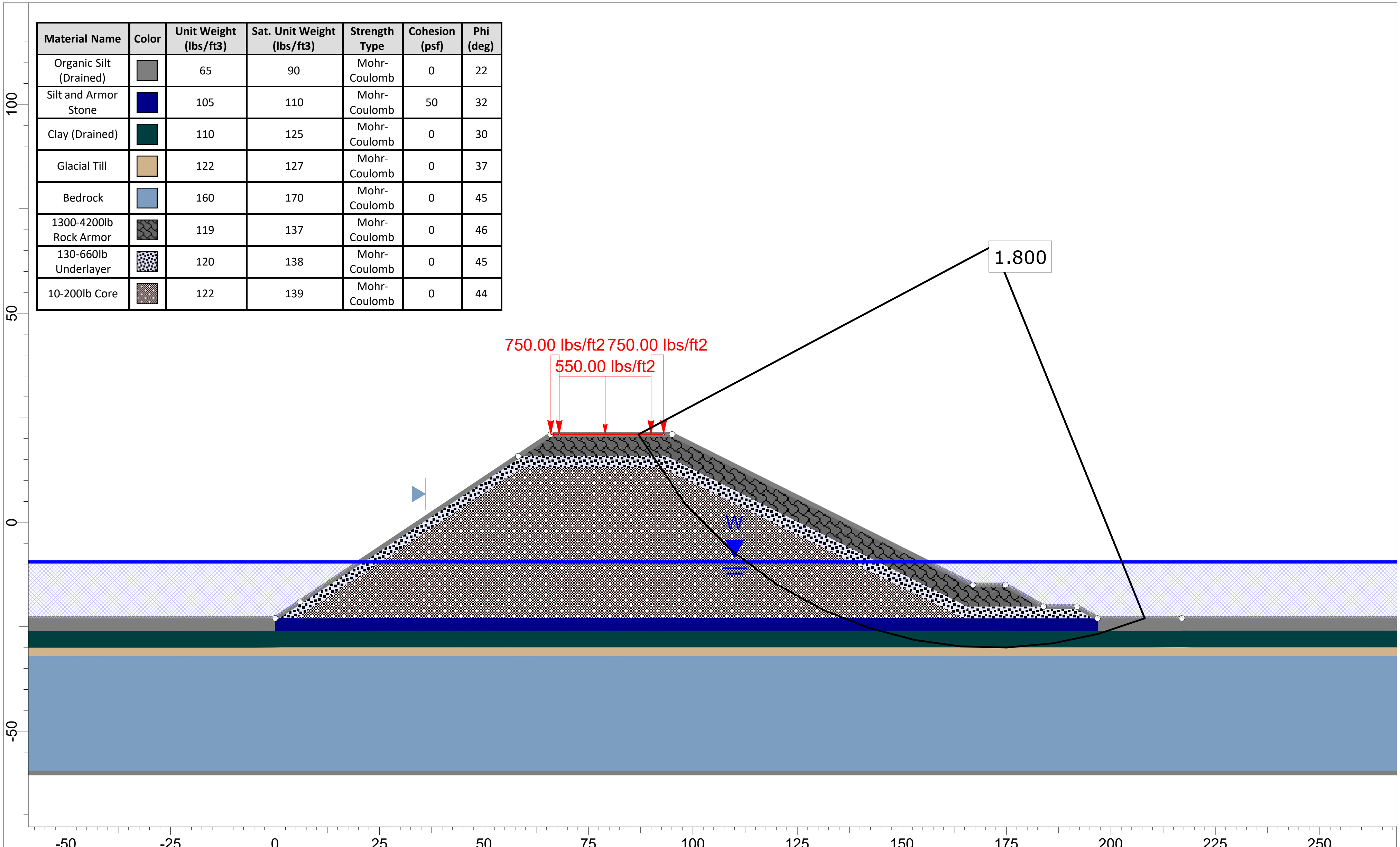


Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater
Group	Harbor Side, Mudline El.-23' - Drained
Scenario	Master Scenario
Drawn By	M. Kullmann
Company	Jacobs
Date	5/17/2024
Analysis	Rubble Mound Global Stability

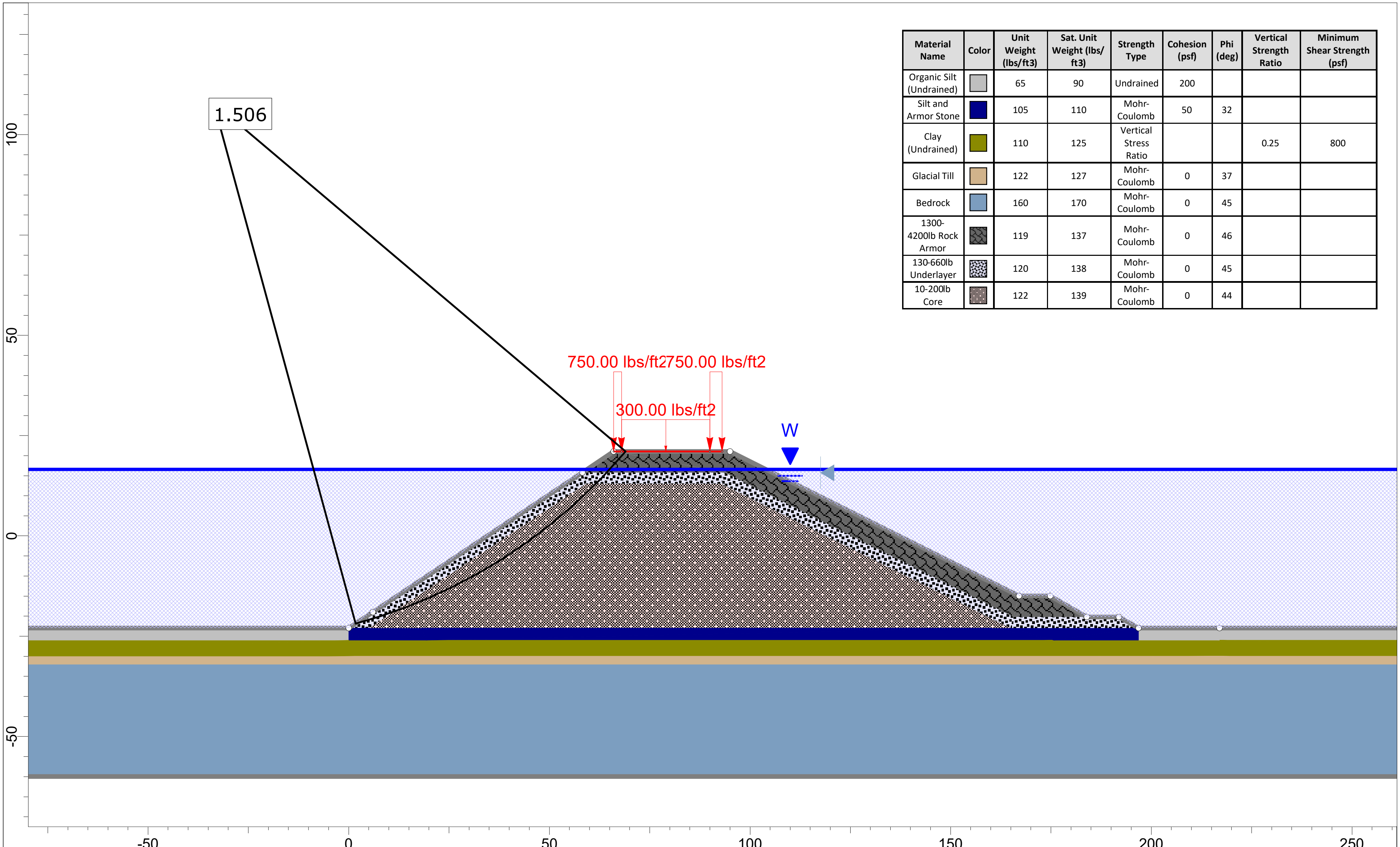
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32
Clay (Drained)		110	125	Mohr-Coulomb	0	30
Glacial Till		122	127	Mohr-Coulomb	0	37
Bedrock		160	170	Mohr-Coulomb	0	45
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45
10-200lb Core		122	139	Mohr-Coulomb	0	44



Jacobs

SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Seaward Side, Mudline El.-23' - Drained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability



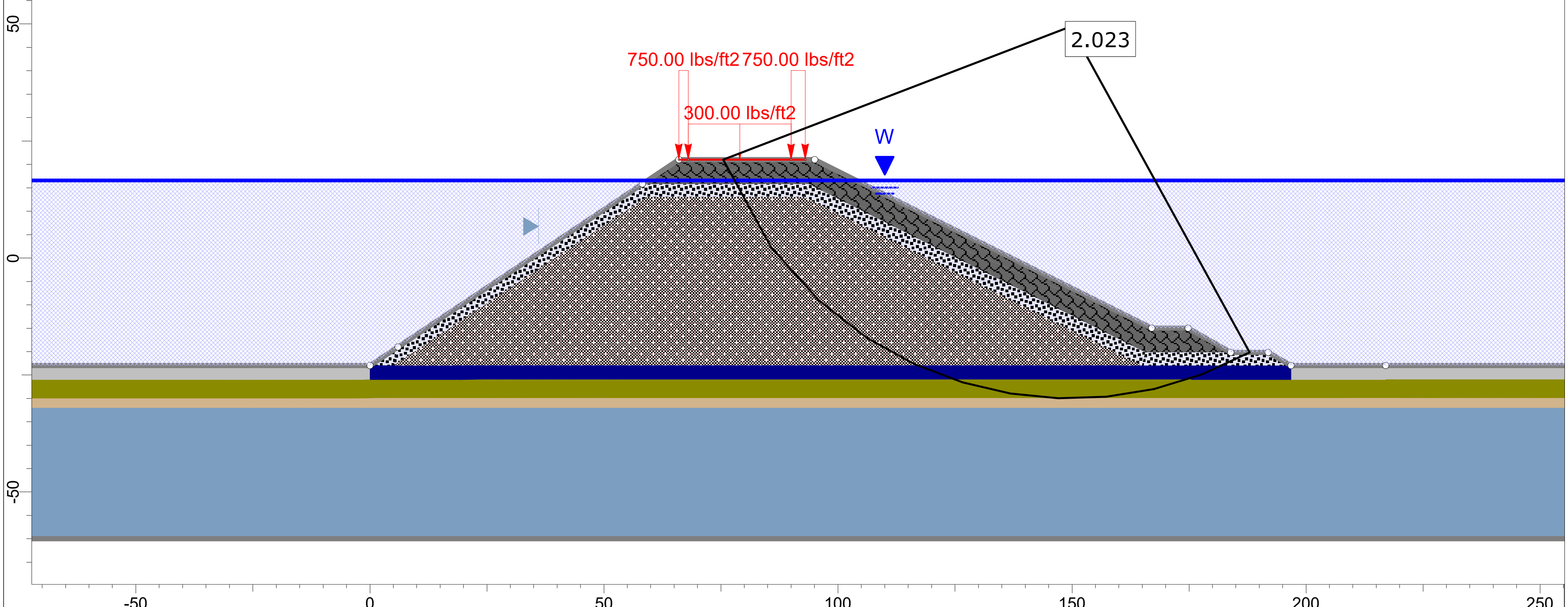
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Glacial Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		

Jacobs

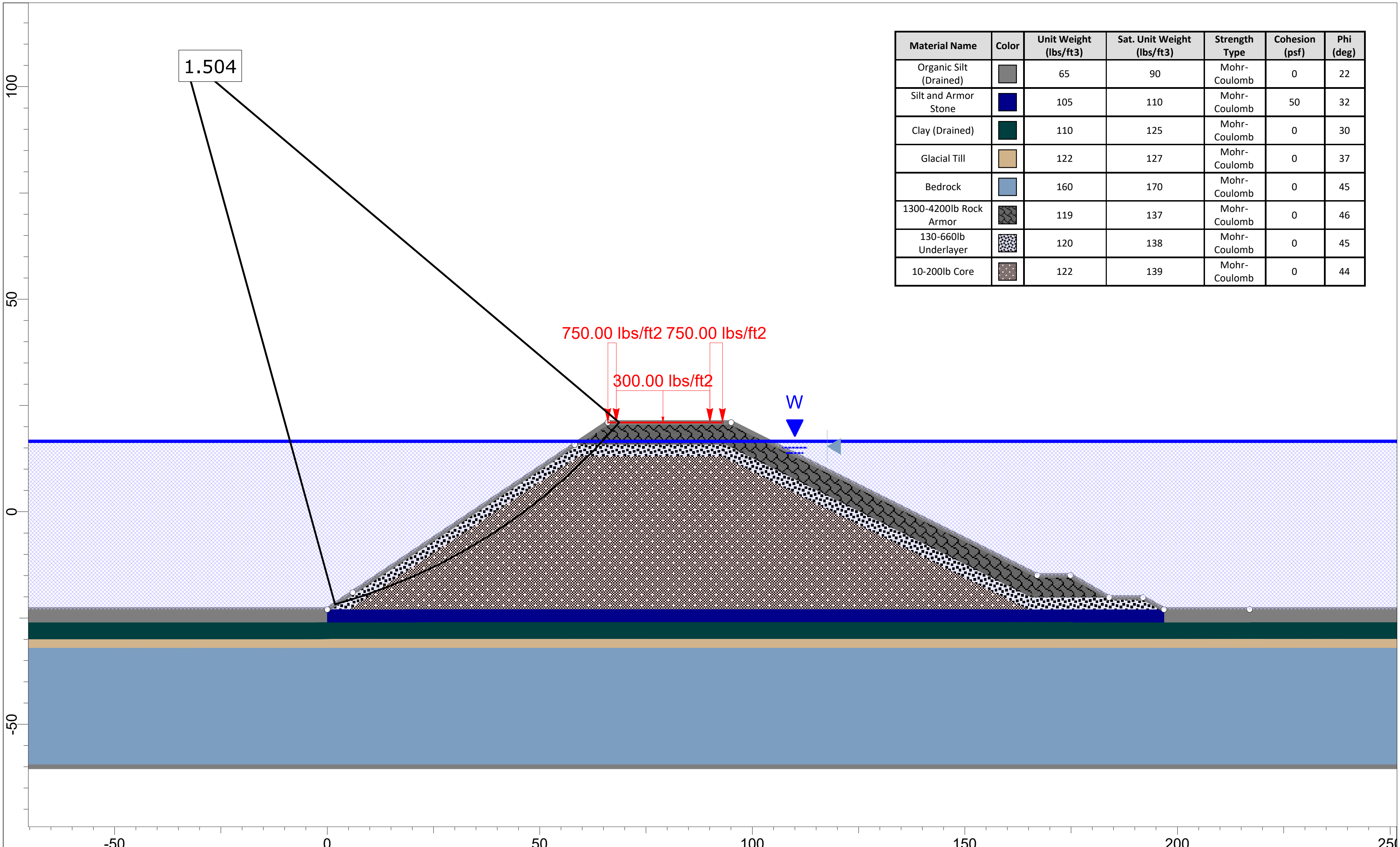
SLIDEINTERPRET 9.009

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-23' - 100-yr Storm, Undrained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Glacial Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		



Jacobs	*Project*	Lubec Breakwater	
	Group Seaward Side, Mudline El.-23' - 100-yr Storm, Undrained	*Scenario* Master Scenario	
	Drawn By M. Kullmann	*Company* Jacobs	
SLIDEINTERPRET 9.009	*Date* 5/17/2024	*Analysis* Rubble Mound Global Stability	



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
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130-660lb Underlayer		120	138	Mohr-Coulomb	0	45
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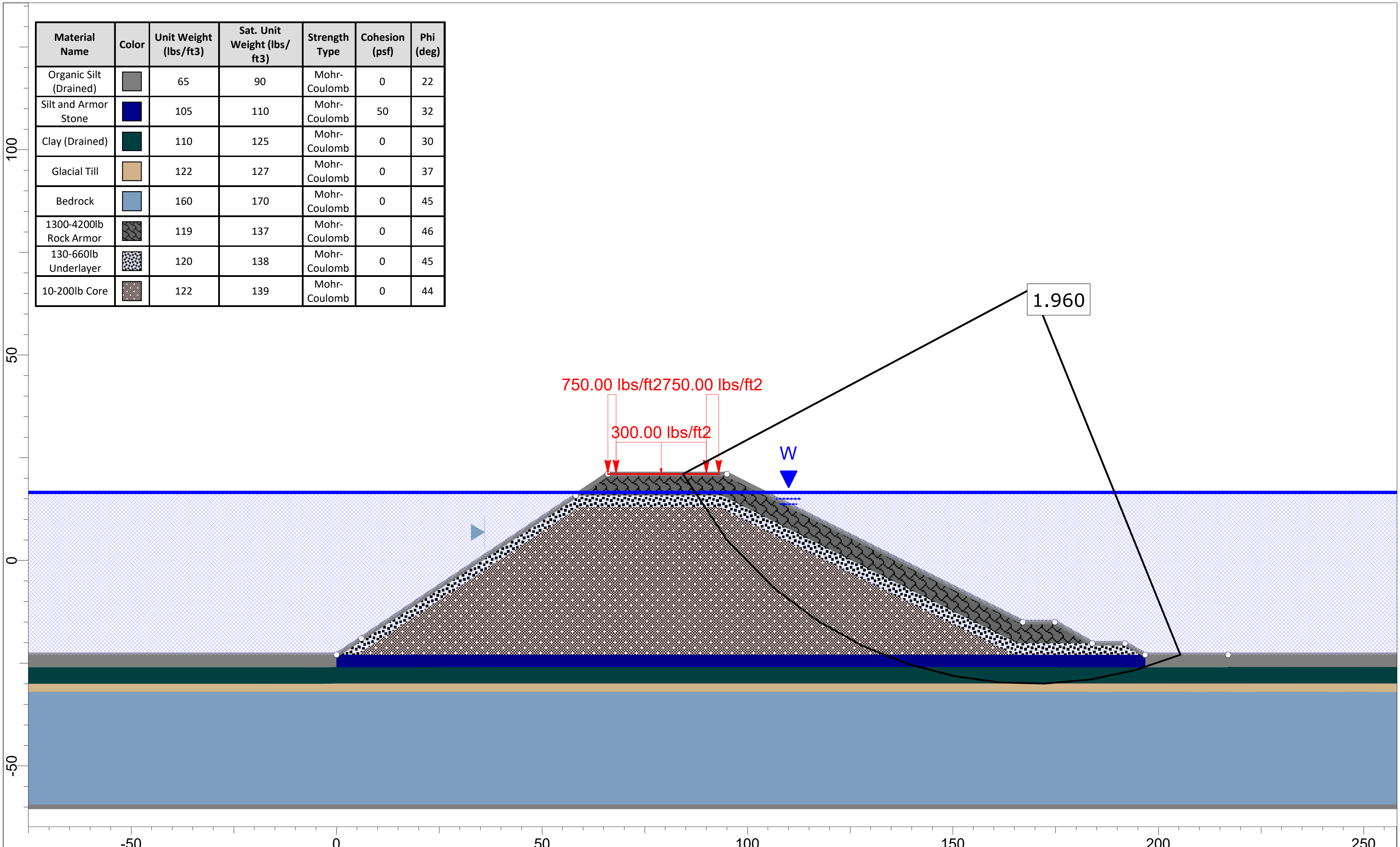
Jacobs

Project	Lubec Breakwater		
Group	Harbor Side, Mudline El.-23' - 100-yr Storm, Drained	*Scenario*	Master Scenario
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*Analysis*	Rubble Mound Global Stability

SLIDEINTERPRET 9.009

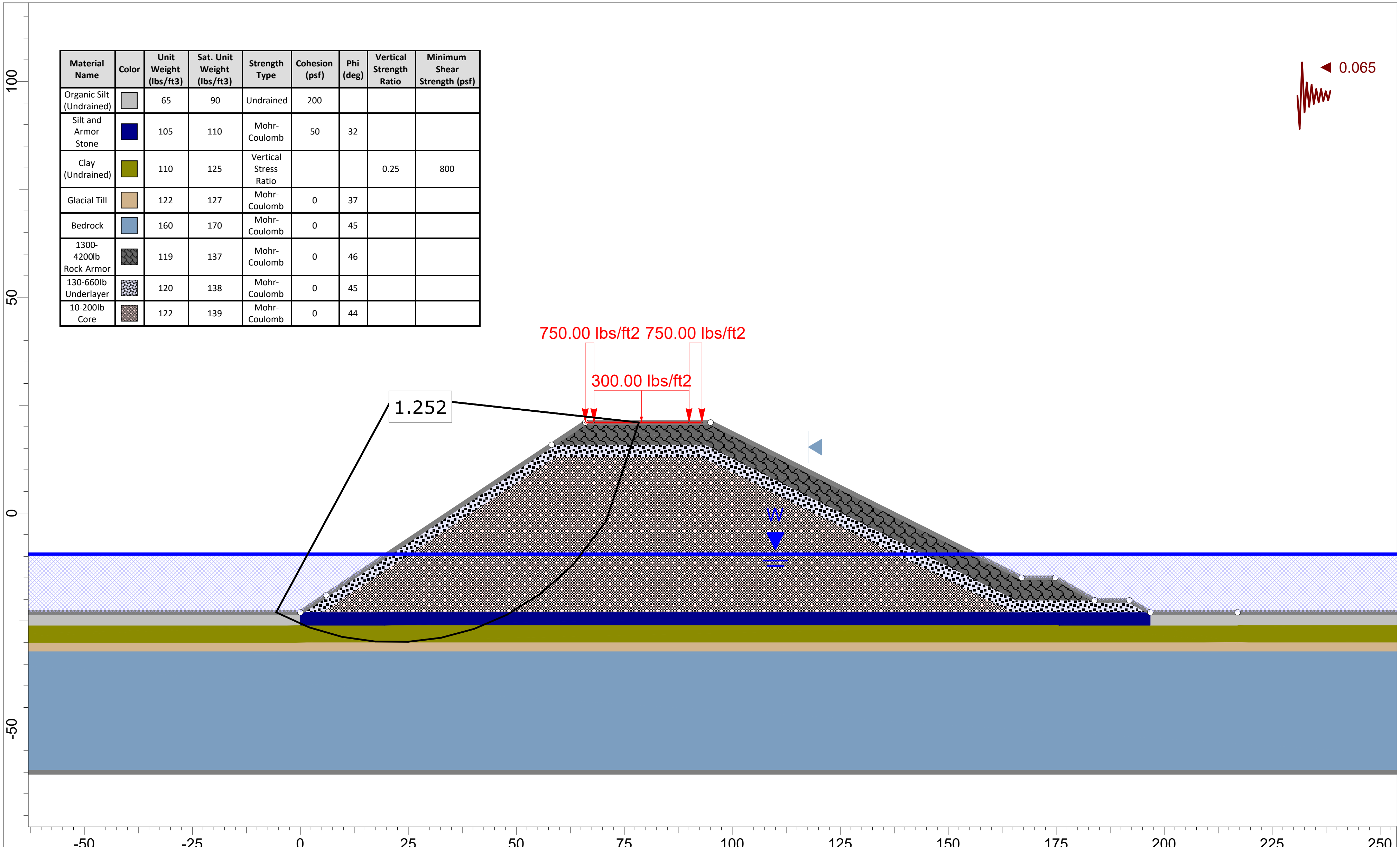
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Organic Silt (Drained)		65	90	Mohr-Coulomb	0	22
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32
Clay (Drained)		110	125	Mohr-Coulomb	0	30
Glacial Till		122	127	Mohr-Coulomb	0	37
Bedrock		160	170	Mohr-Coulomb	0	45
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45
10-200lb Core		122	139	Mohr-Coulomb	0	44



Project	Lubec Breakwater		
Group	Seaward Side, Mudline El.-23' - 100-yr Storm, Drained	Scenario	Master Scenario
Drawn By	M. Kullmann	Company	Jacobs
Date	5/17/2024	Analysis	Rubble Mound Global Stability

SLIDEINTERPRET 9.009

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Glacial Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		



Jacobs

SLIDEINTERPRET 9.009

Project Lubec Breakwater

Group Harbor Side, Mudline El.-23' - Seismic

Scenario Master Scenario

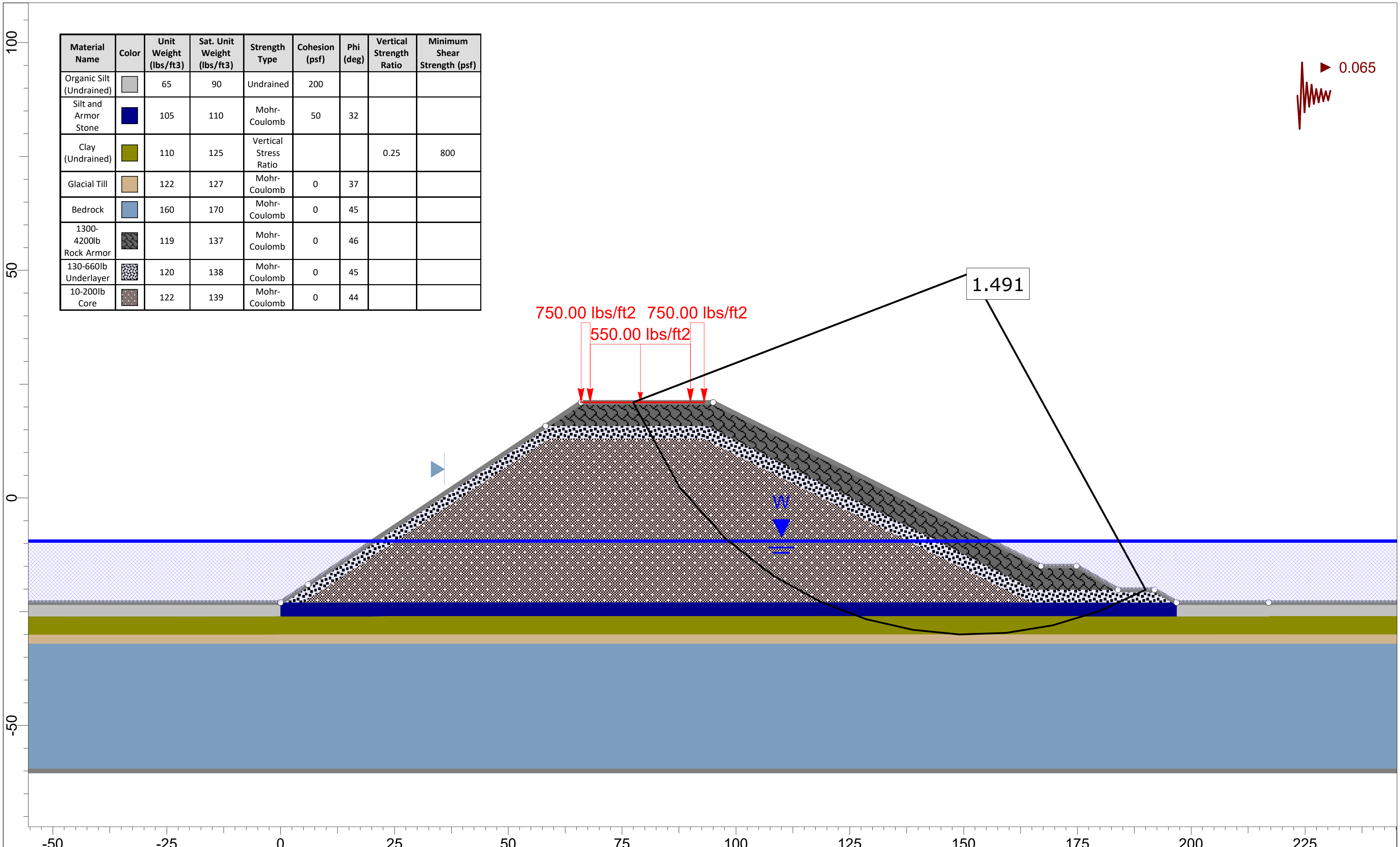
Drawn By M. Kullmann

Company Jacobs

Date 5/17/2024

Analysis Rubble Mound Global Stability

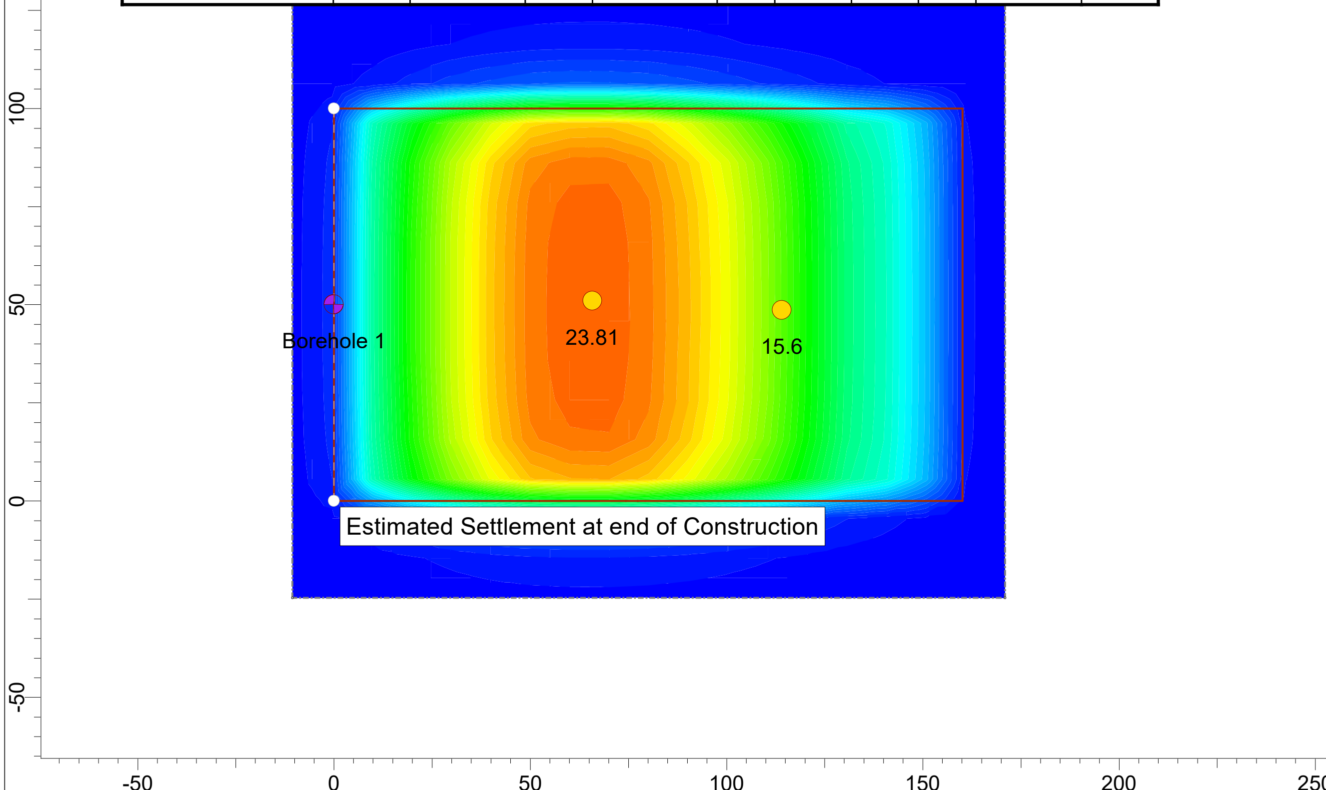
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Organic Silt (Undrained)		65	90	Undrained	200			
Silt and Armor Stone		105	110	Mohr-Coulomb	50	32		
Clay (Undrained)		110	125	Vertical Stress Ratio			0.25	800
Glacial Till		122	127	Mohr-Coulomb	0	37		
Bedrock		160	170	Mohr-Coulomb	0	45		
1300-4200lb Rock Armor		119	137	Mohr-Coulomb	0	46		
130-660lb Underlayer		120	138	Mohr-Coulomb	0	45		
10-200lb Core		122	139	Mohr-Coulomb	0	44		

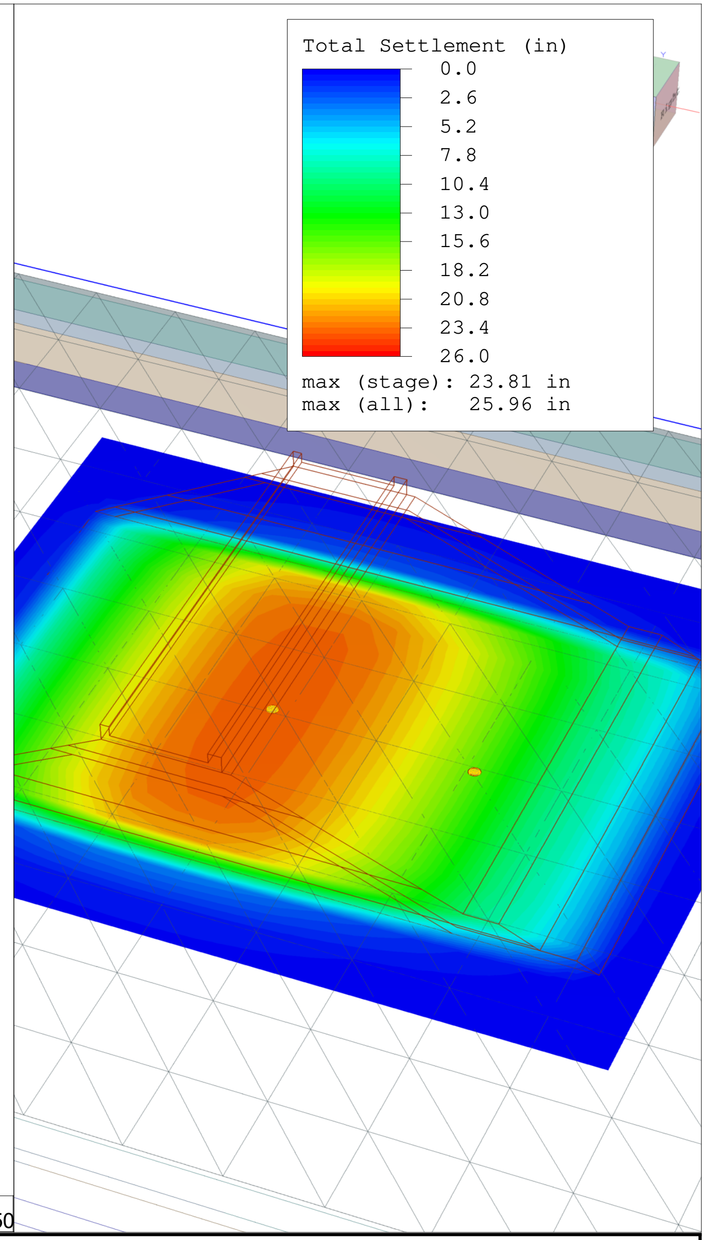


Jacobs	*Project* Lubec Breakwater		
	Group Seaward Side, Mudline El.-23' - Seismic	*Scenario* Master Scenario	
	Drawn By M. Kullmann	*Company* Jacobs	
SLIDEINTERPRET 9.009	*Date* 5/17/2024	*Analysis* Rubble Mound Global Stability	

Appendix G. Rubble-Mound Breakwater Settlement

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

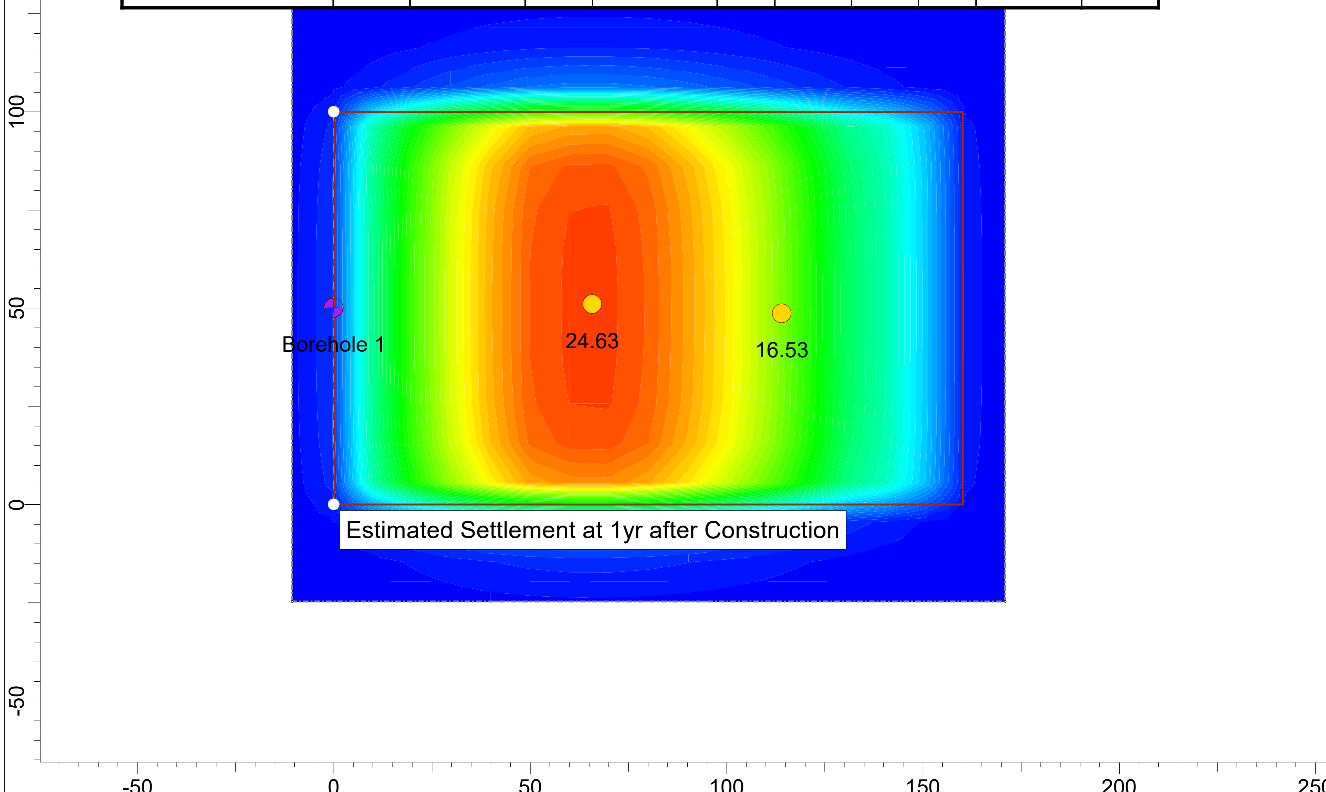


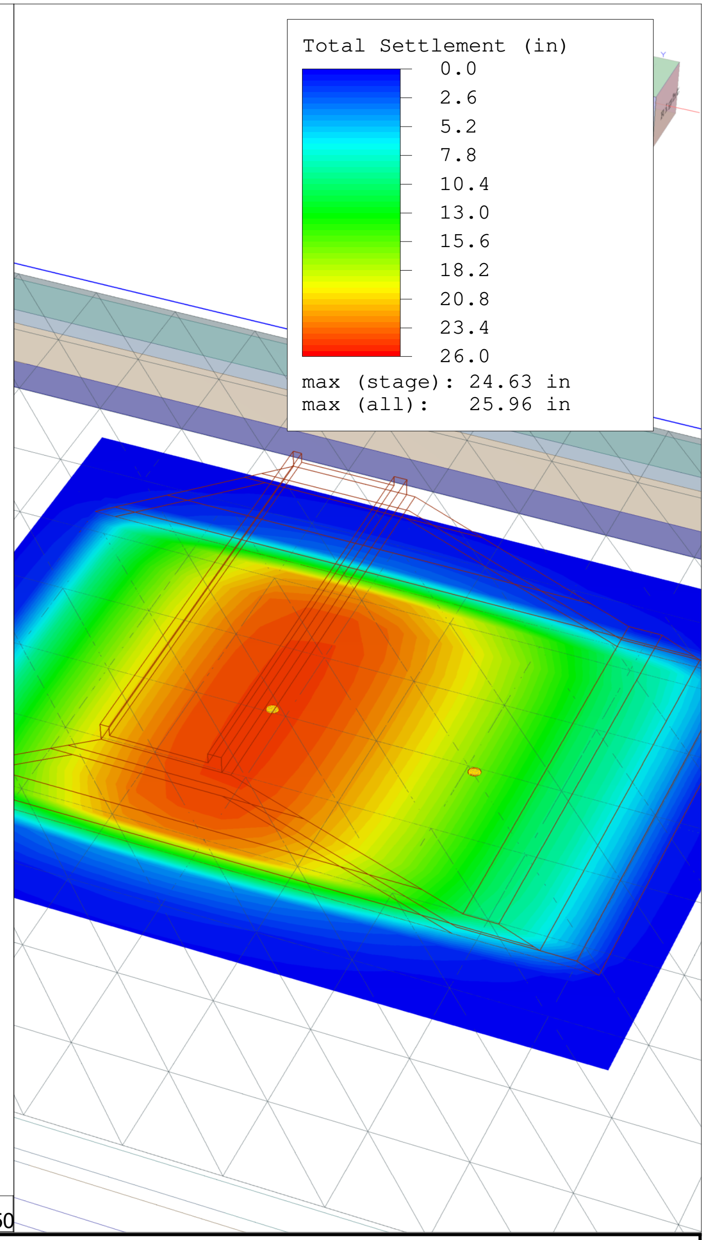


Project	Lubec Breakwater		
Analysis Description	Rubble Mound Settlement - STA 101+75		
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*File Name*	Lubec Breakwater_WB-01_El. -12.5_MLLW_staged.s3z

SETTLE3 5.010

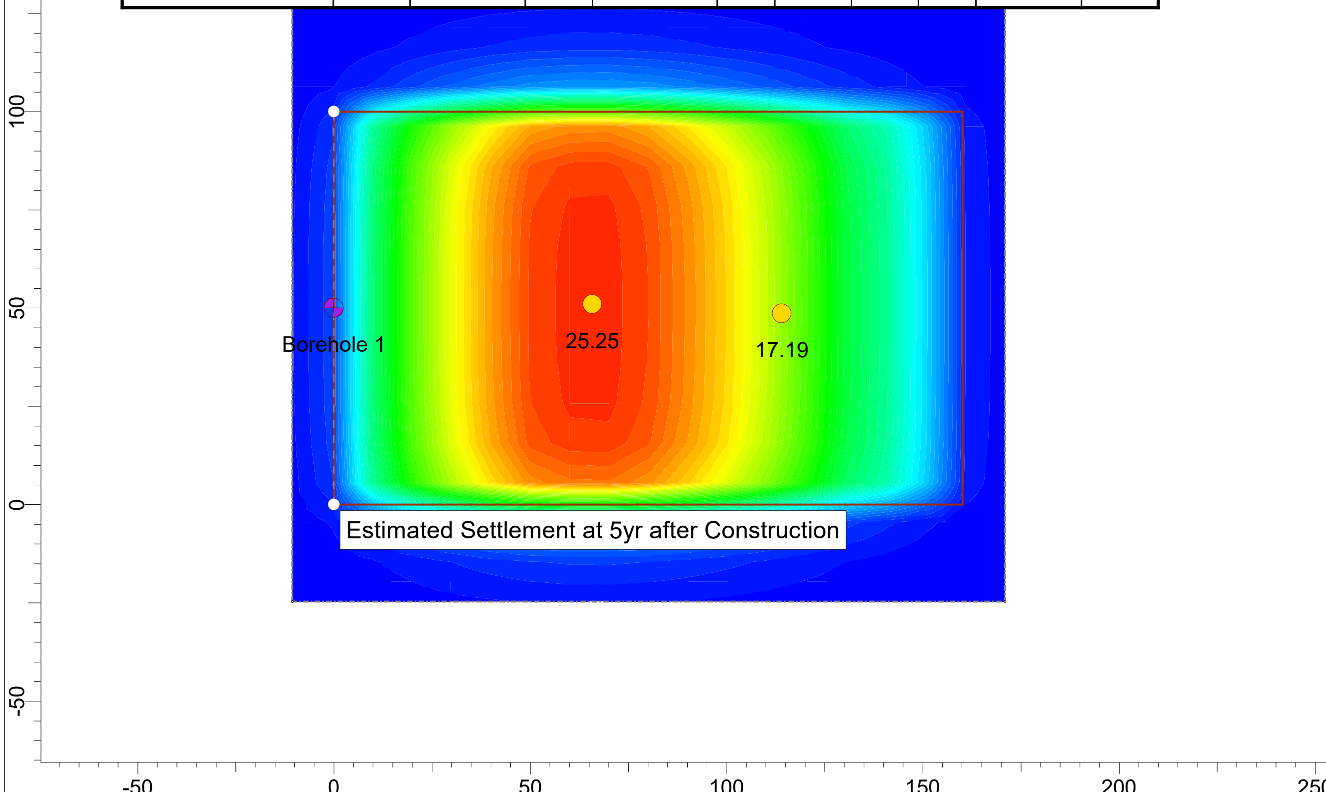
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

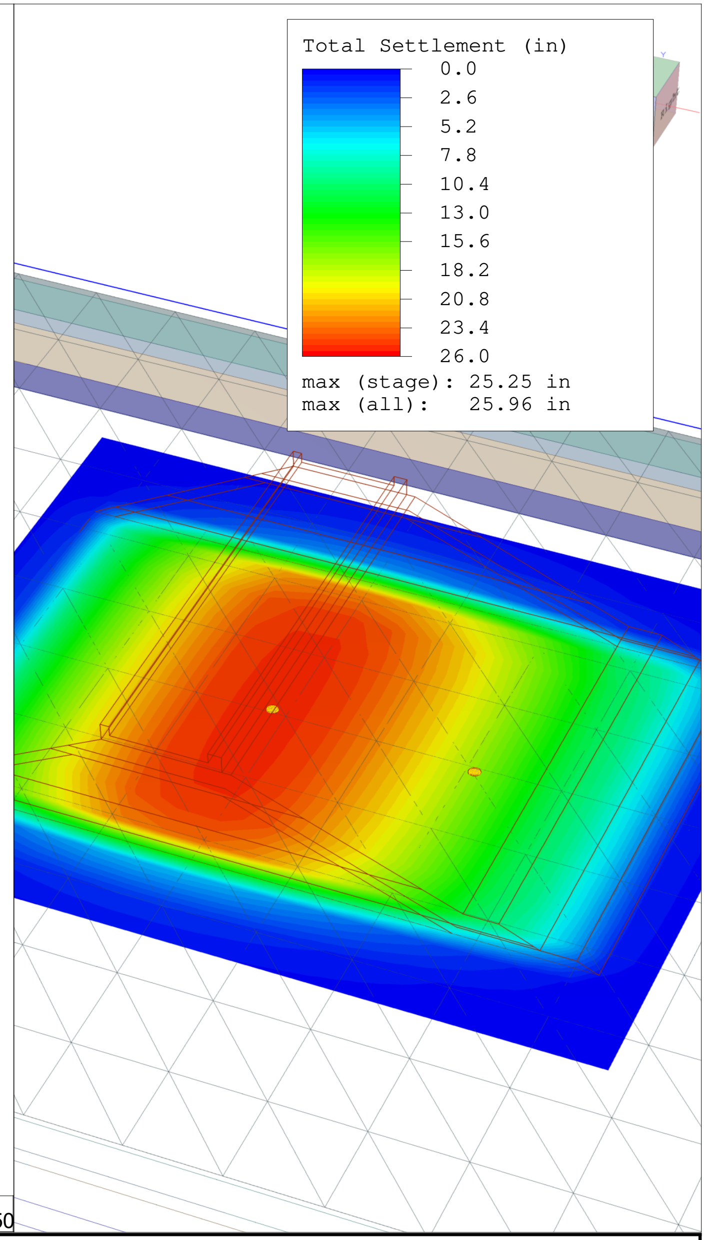




Jacobs	*Project*	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 101+75	
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-01_El. -12.5_MLLW_staged.s3z	

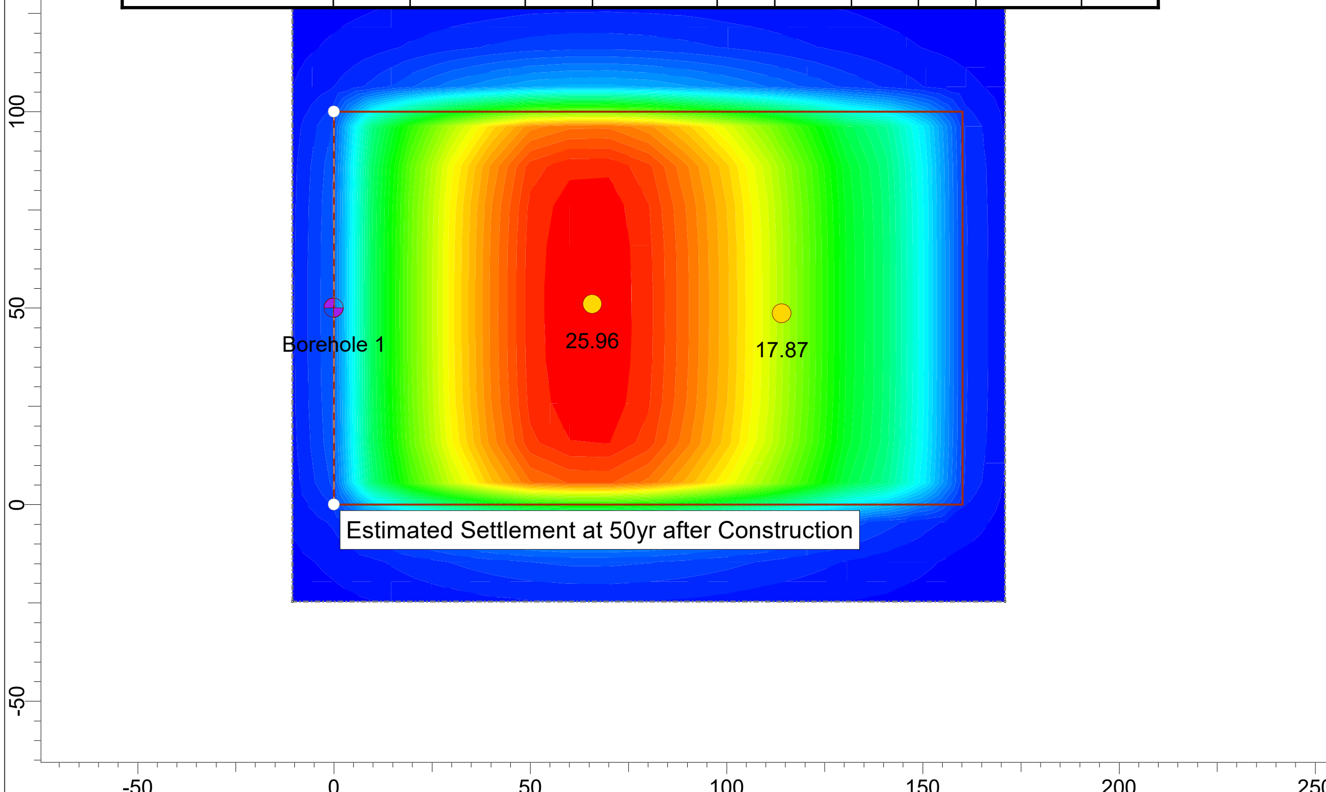
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

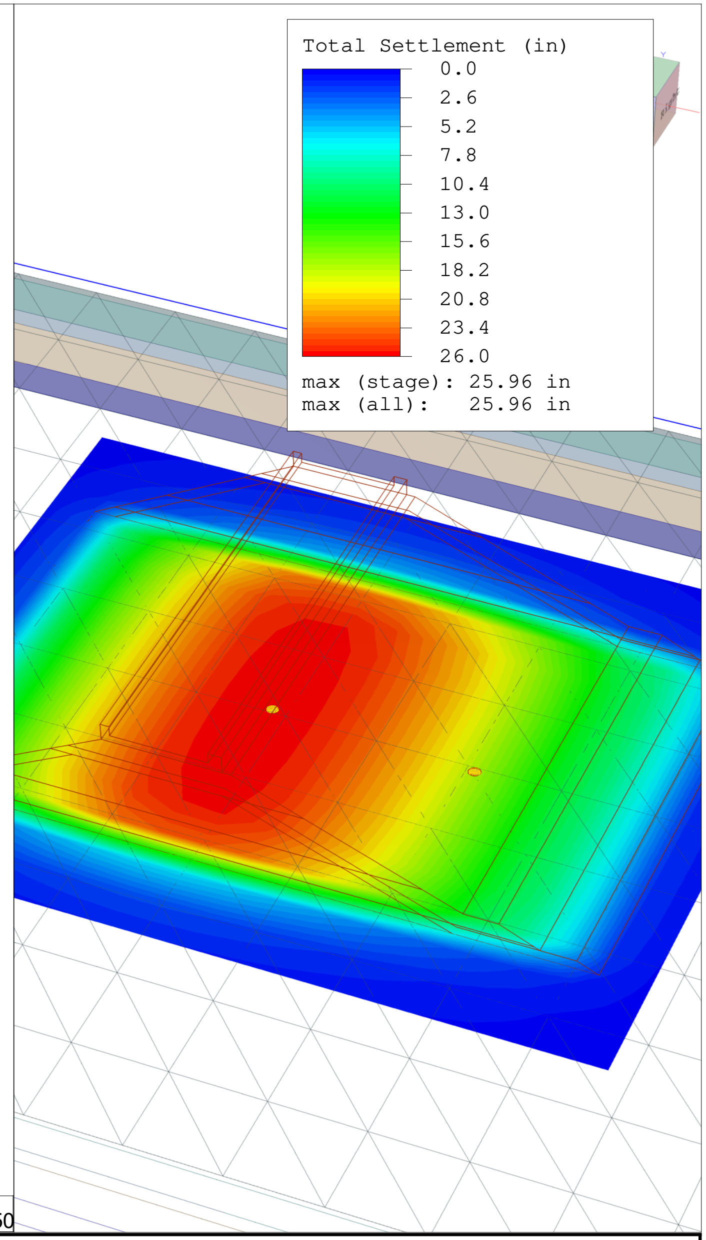




Jacobs	*Project* Lubec Breakwater		
	Analysis Description Rubble Mound Settlement - STA 101+75		
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-01_El. -12.5_MLLW_staged.s3z	

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

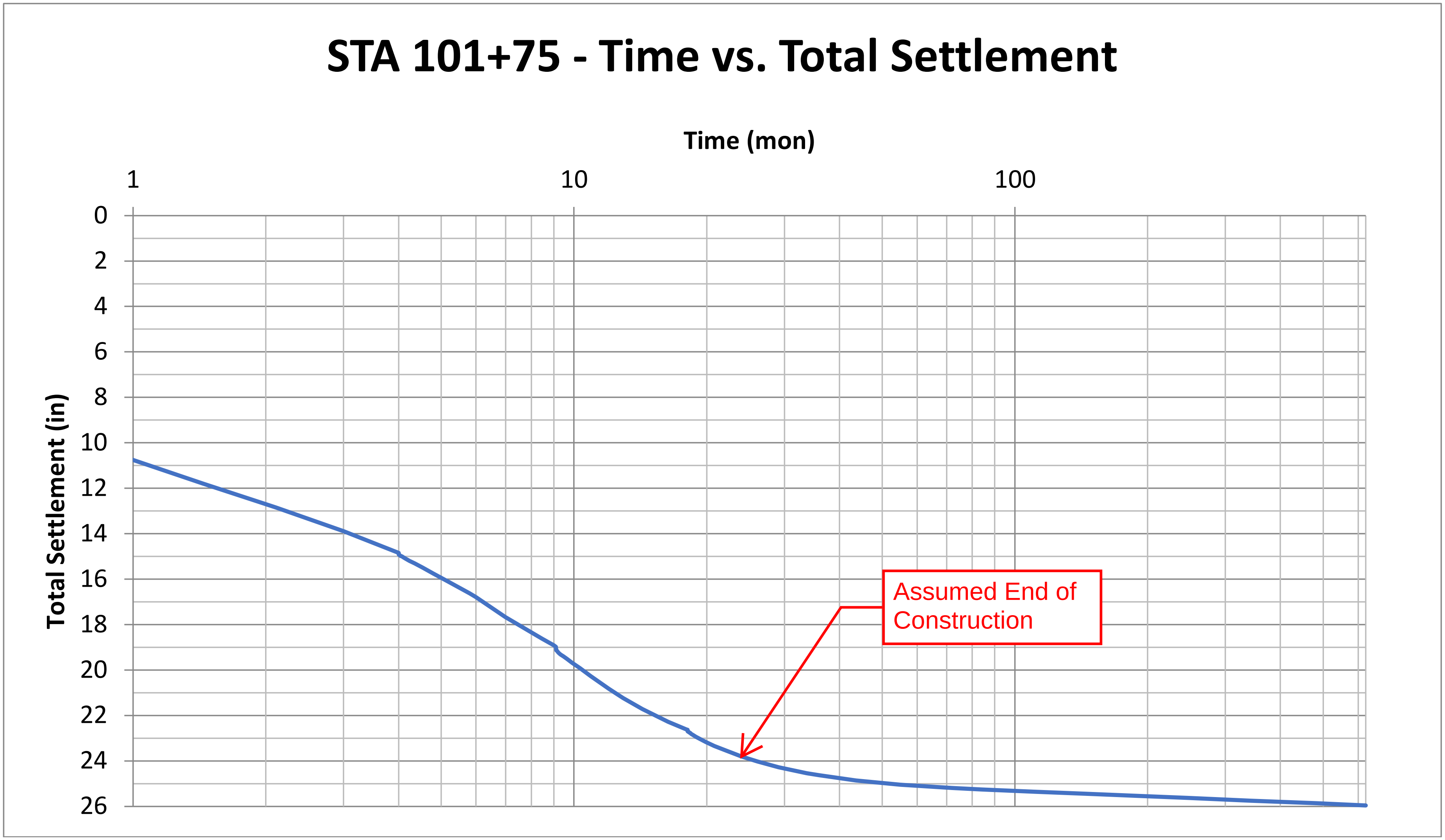




Jacobs

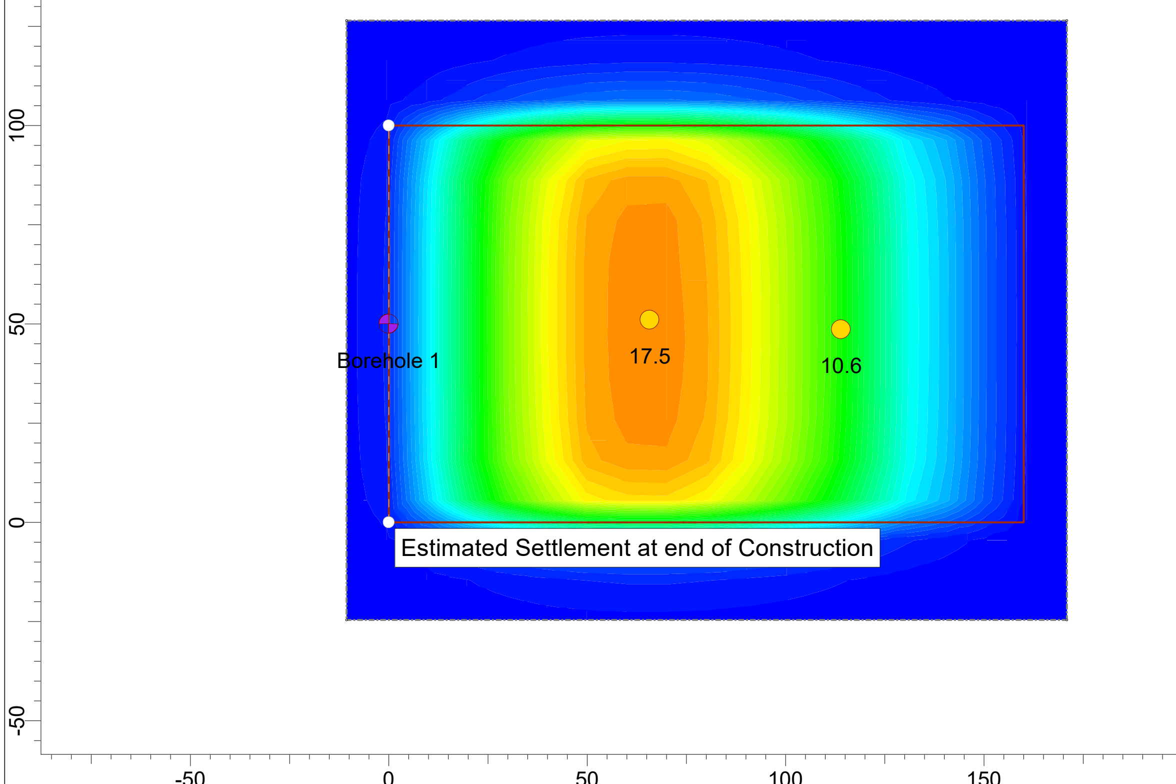
SETTLE3 5.010

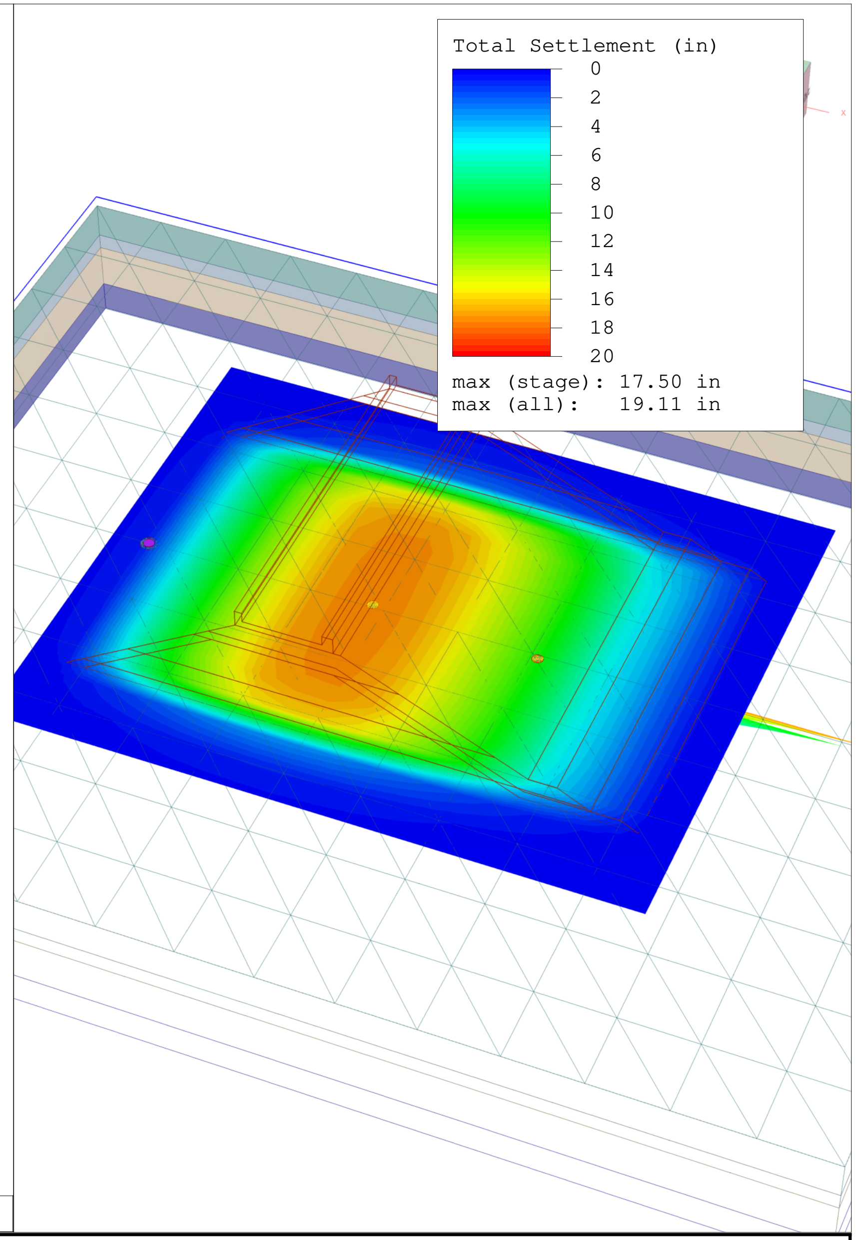
Project	Lubec Breakwater		
Analysis Description	Rubble Mound Settlement - STA 101+75		
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*File Name*	Lubec Breakwater_WB-01_El. -12.5_MLLW_staged.s3z



STA 101+75 - Time vs. Total Settlement
Time (mon)
1
10
100
Total Settlement (in)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Assumed End of Construction

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

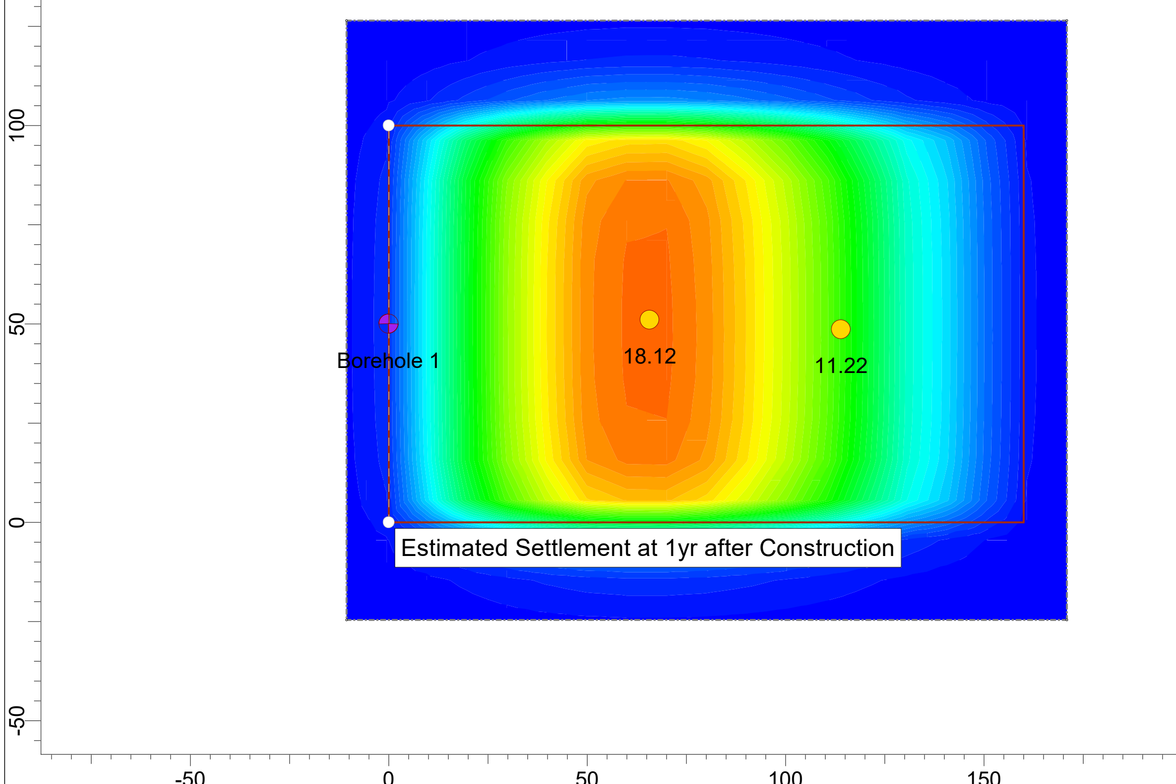


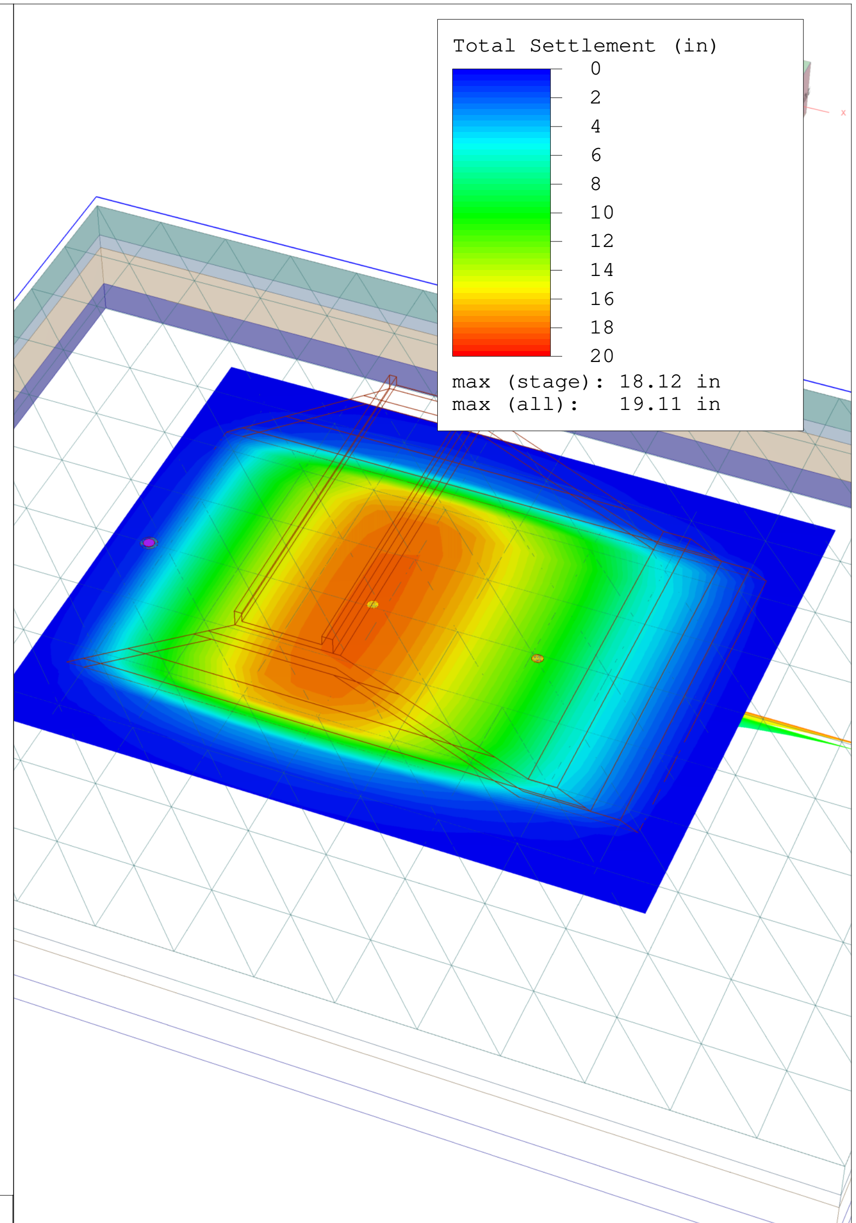


Project	Lubec Breakwater		
Analysis Description	Rubble Mound Settlement - STA 101+75		
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*File Name*	Lubec Breakwater_WB-01_El. -12.5_MLLW_staged_no silt.s3z

SETTLE3 5.010

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

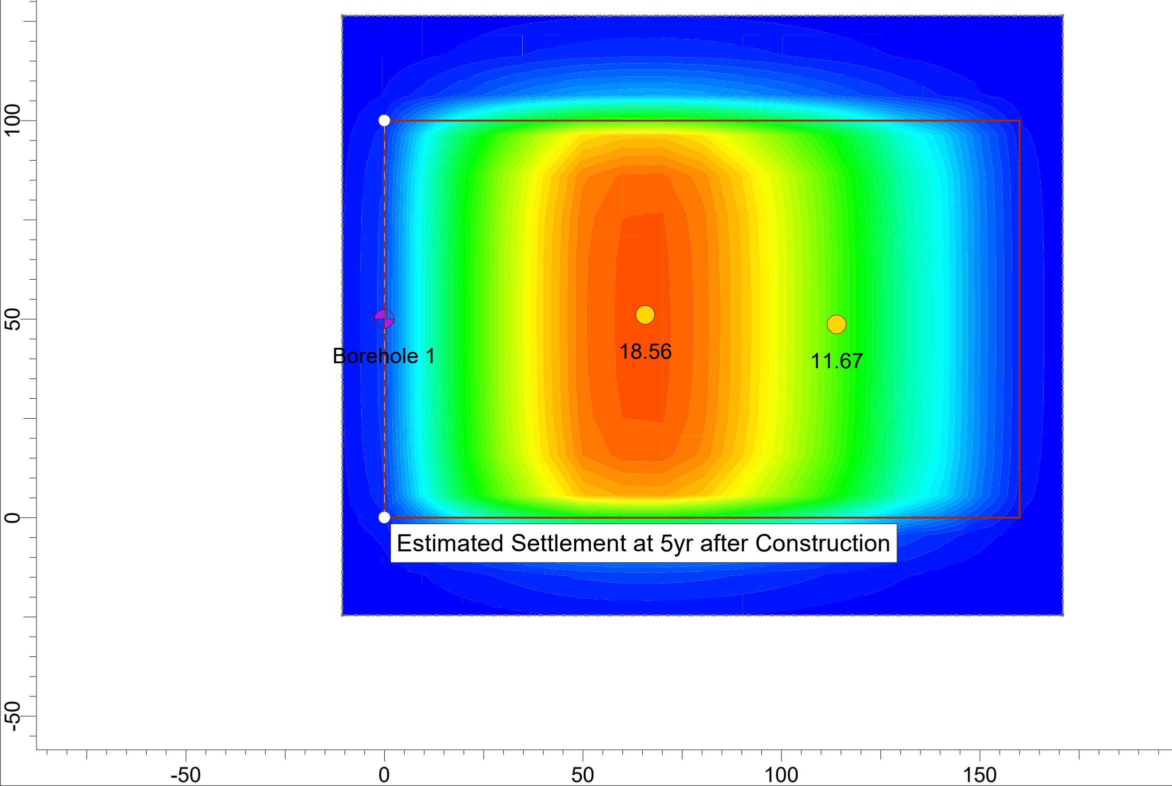


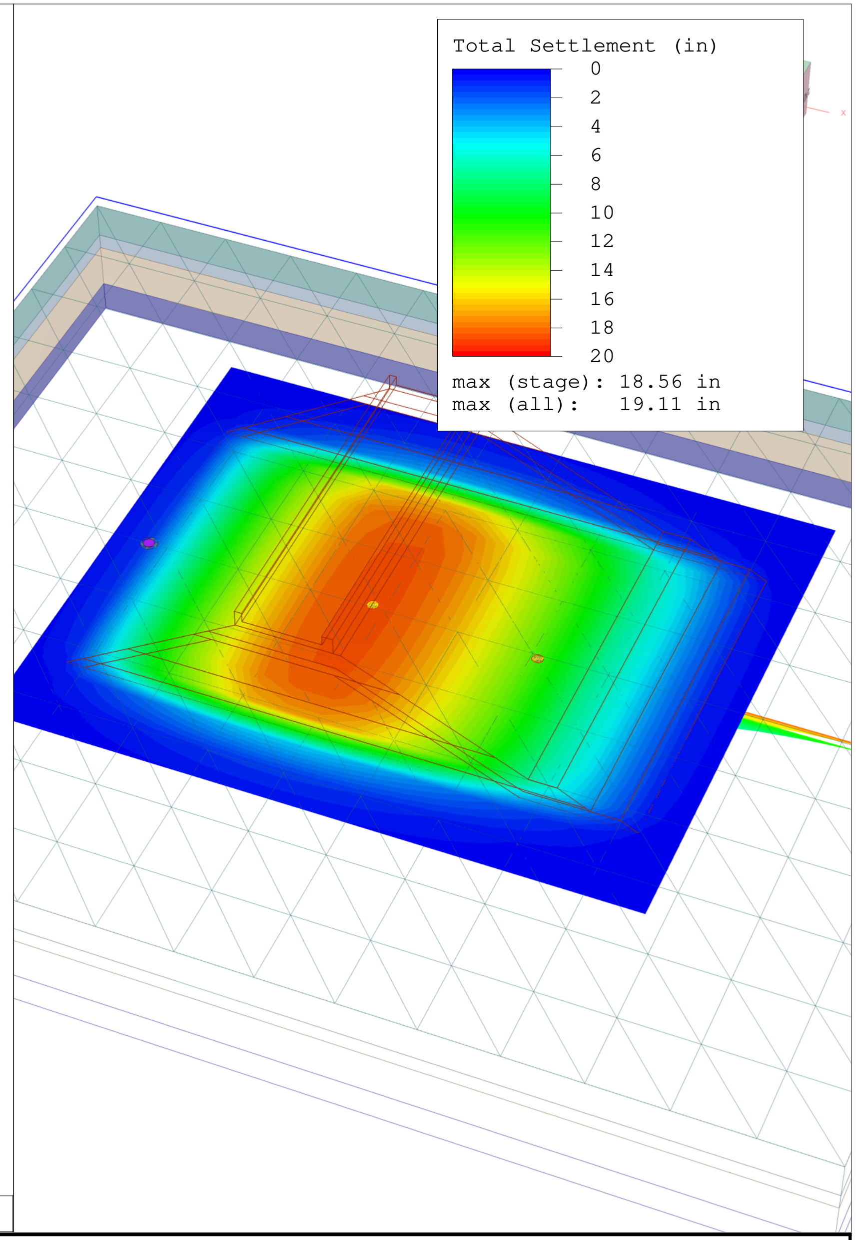


SETTLE3 5.010

Jacobs	*Project*	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 101+75	
	Drawn By M. Kullmann	*Company* Jacobs	
	Date 5/17/2024	*File Name* Lubec Breakwater_WB-01_El. -12.5_MLLW_staged_no silt.s3z	

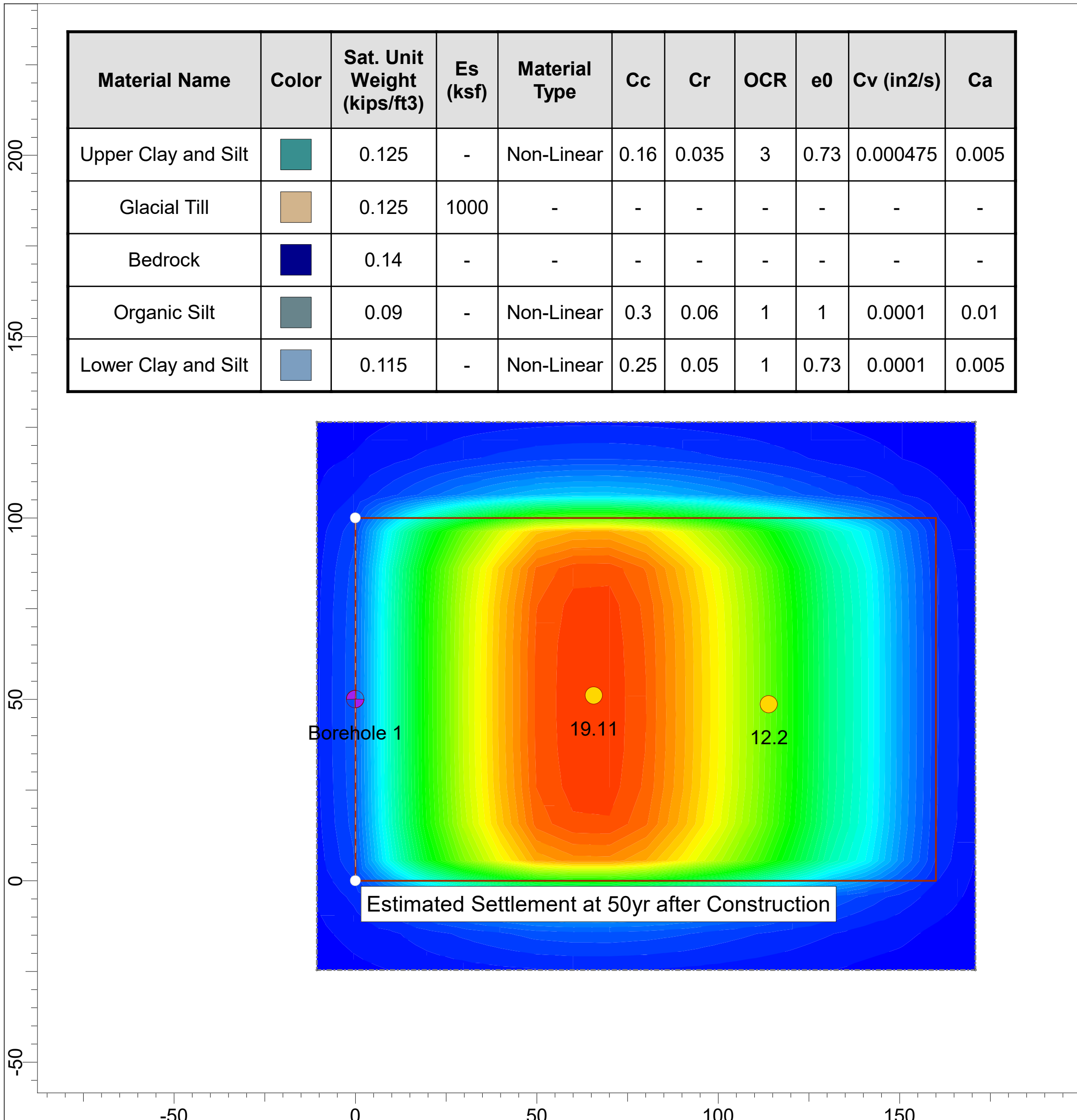
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

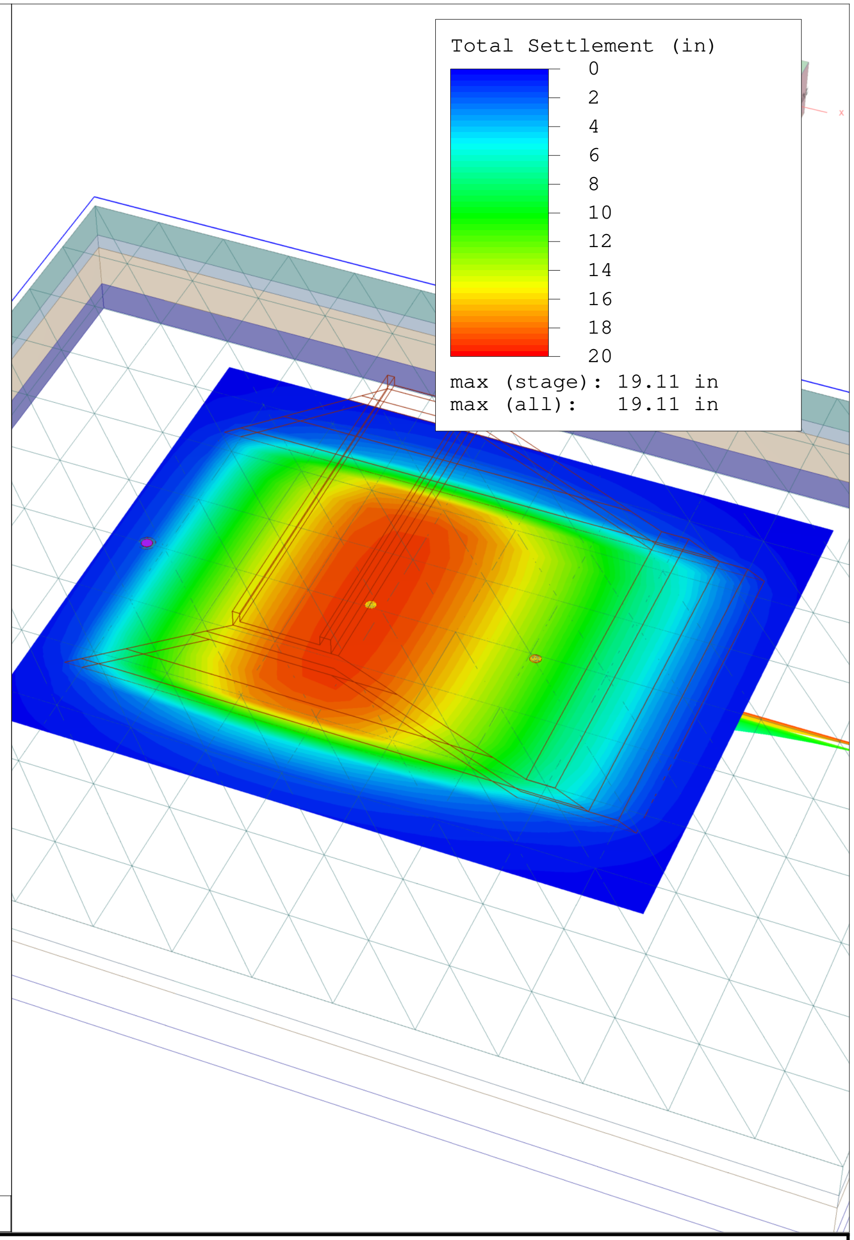




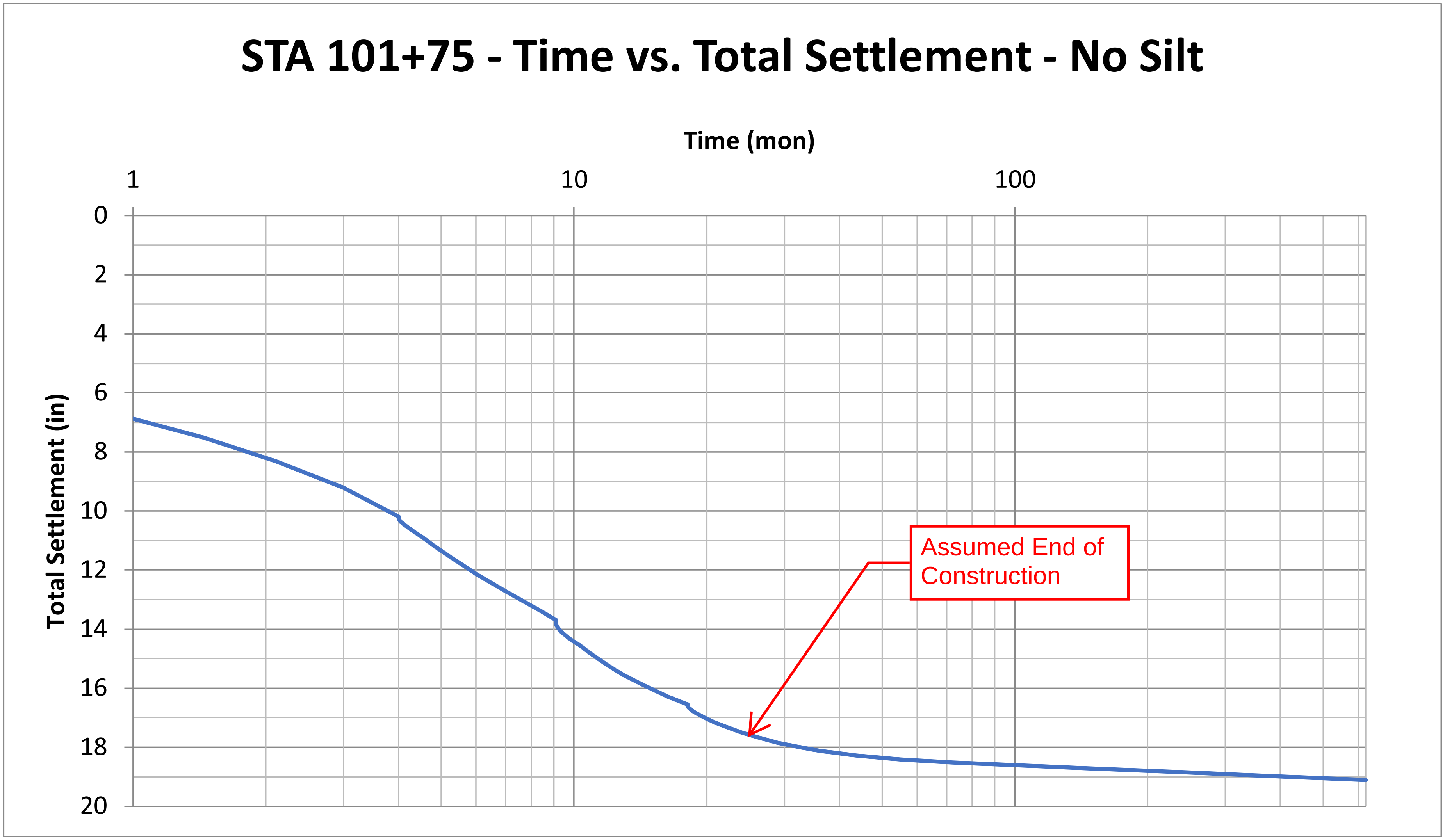
Jacobs	*Project*	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 101+75	
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-01_El. -12.5_MLLW_staged_no silt.s3z	

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

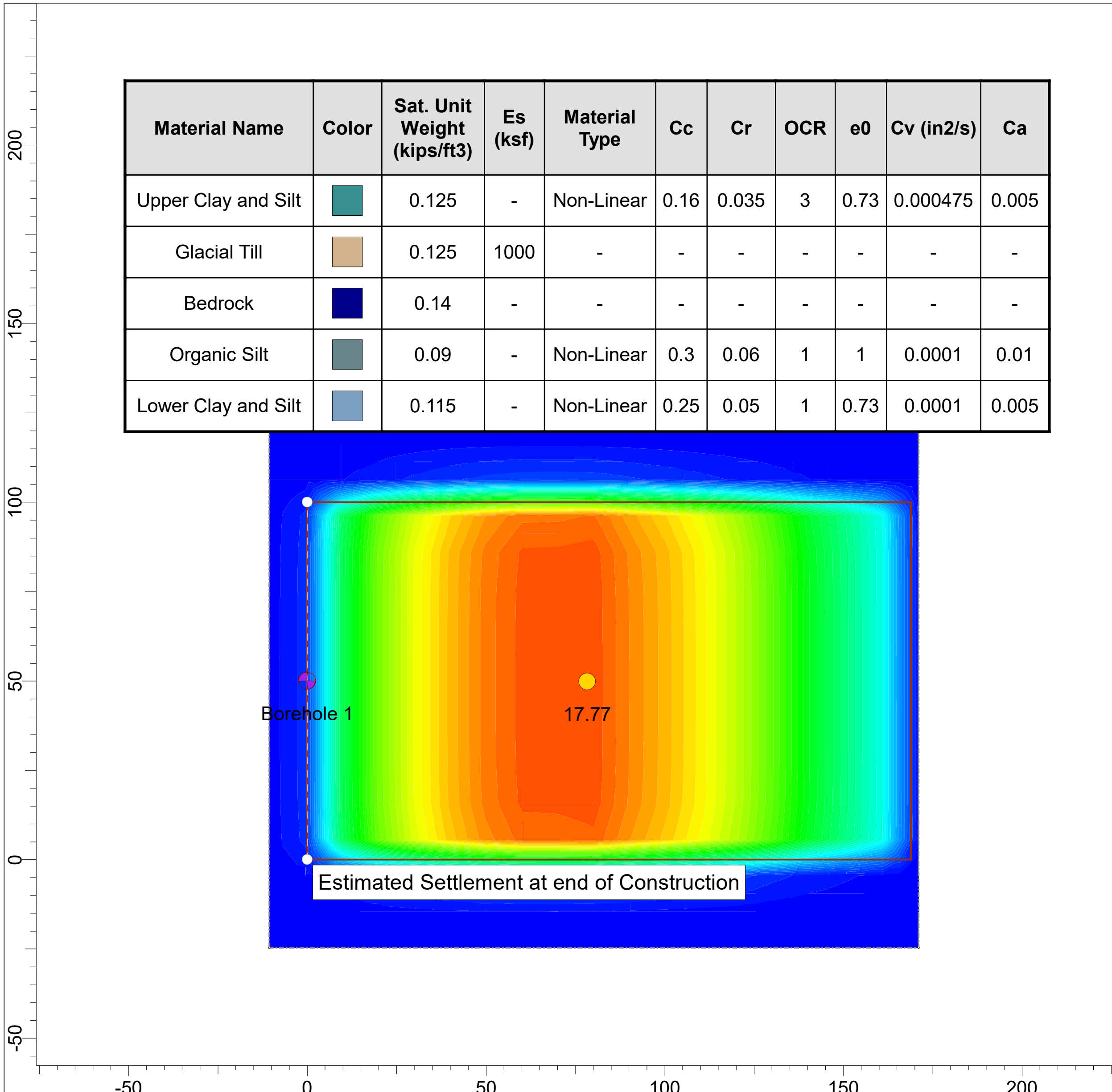


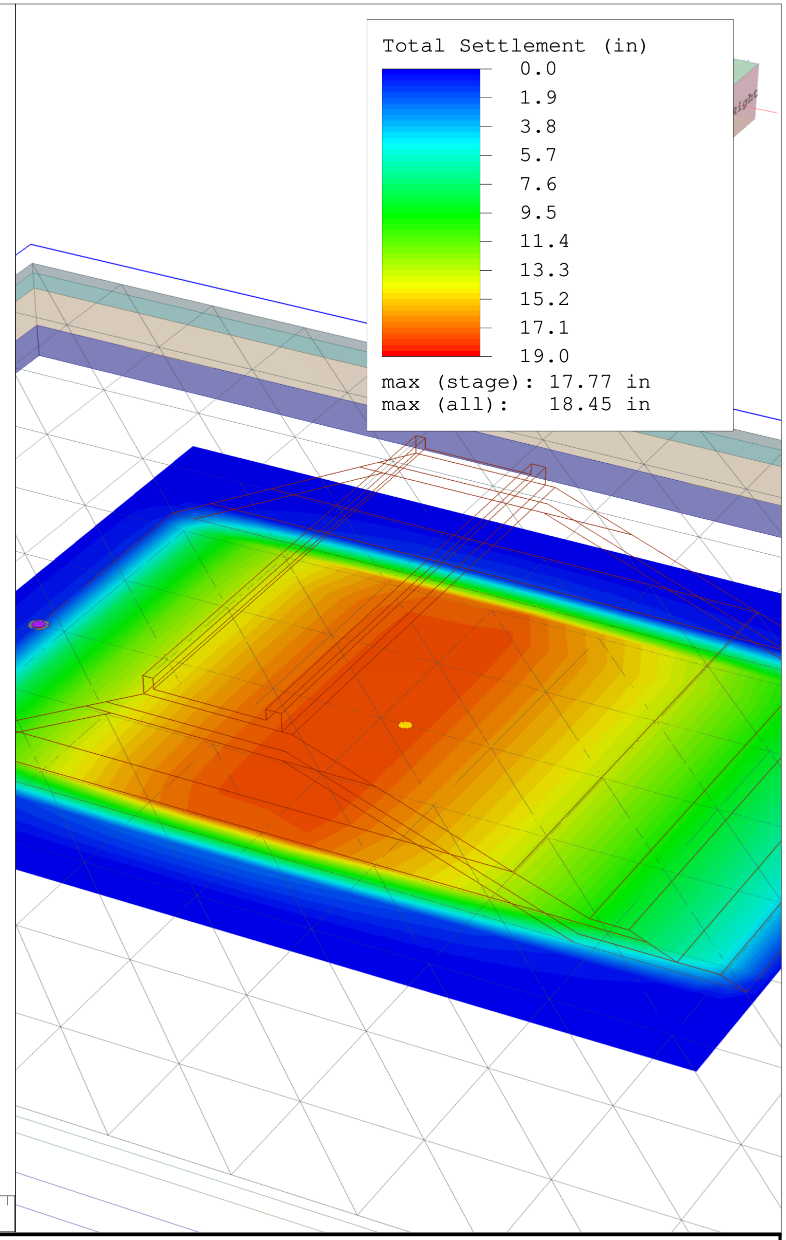


Jacobs	*Project* Lubec Breakwater		
	Analysis Description Rubble Mound Settlement - STA 101+75		
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-01_El. -12.5_MLLW_staged_no silt.s3z	


STA 101+75 - Time vs. Total Settlement - No Silt
Time (mon)
1
10
100
Total Settlement (in)
0
2
4
6
8
10
12
14
16
18
20
Assumed End of Construction

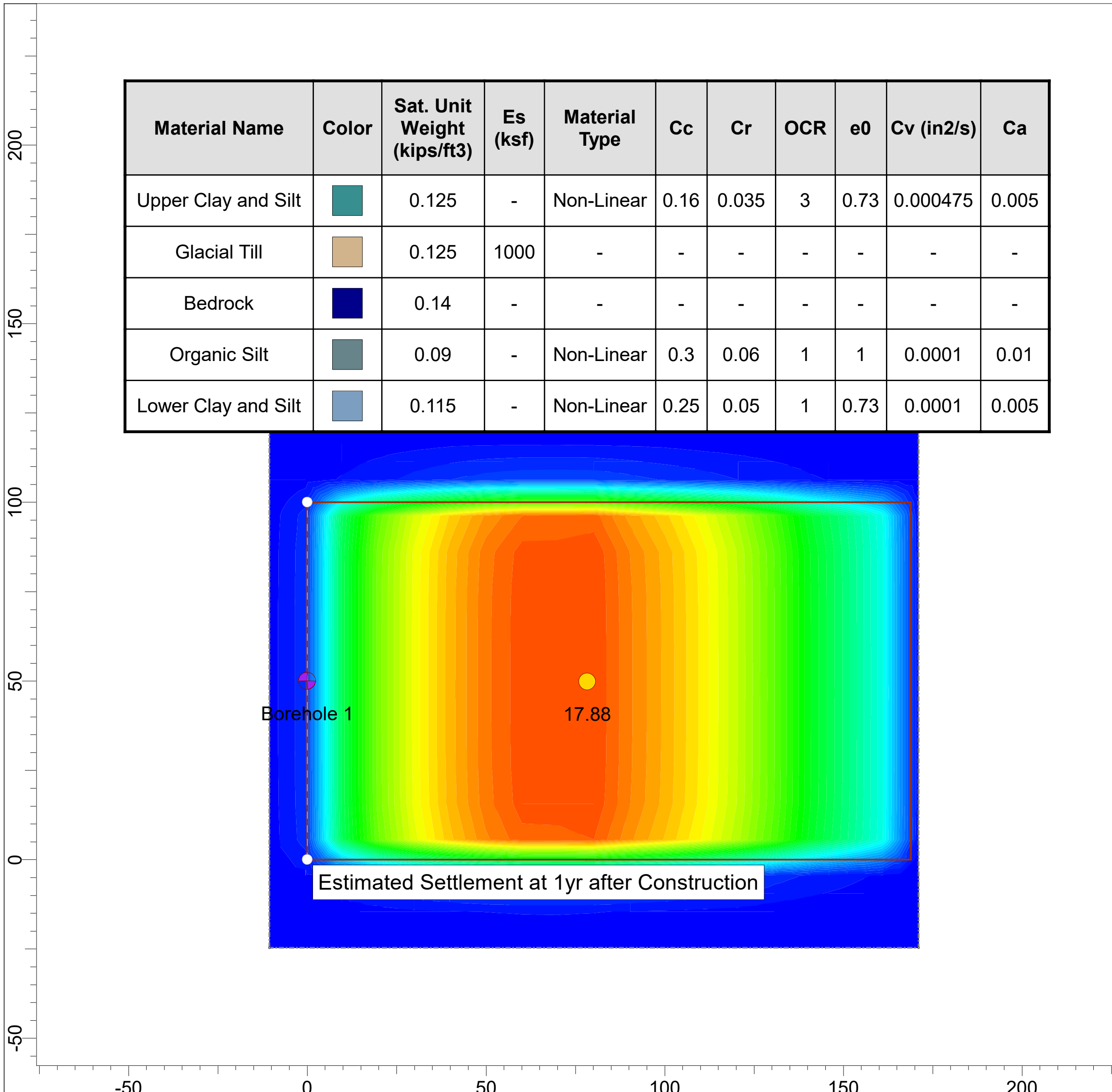
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

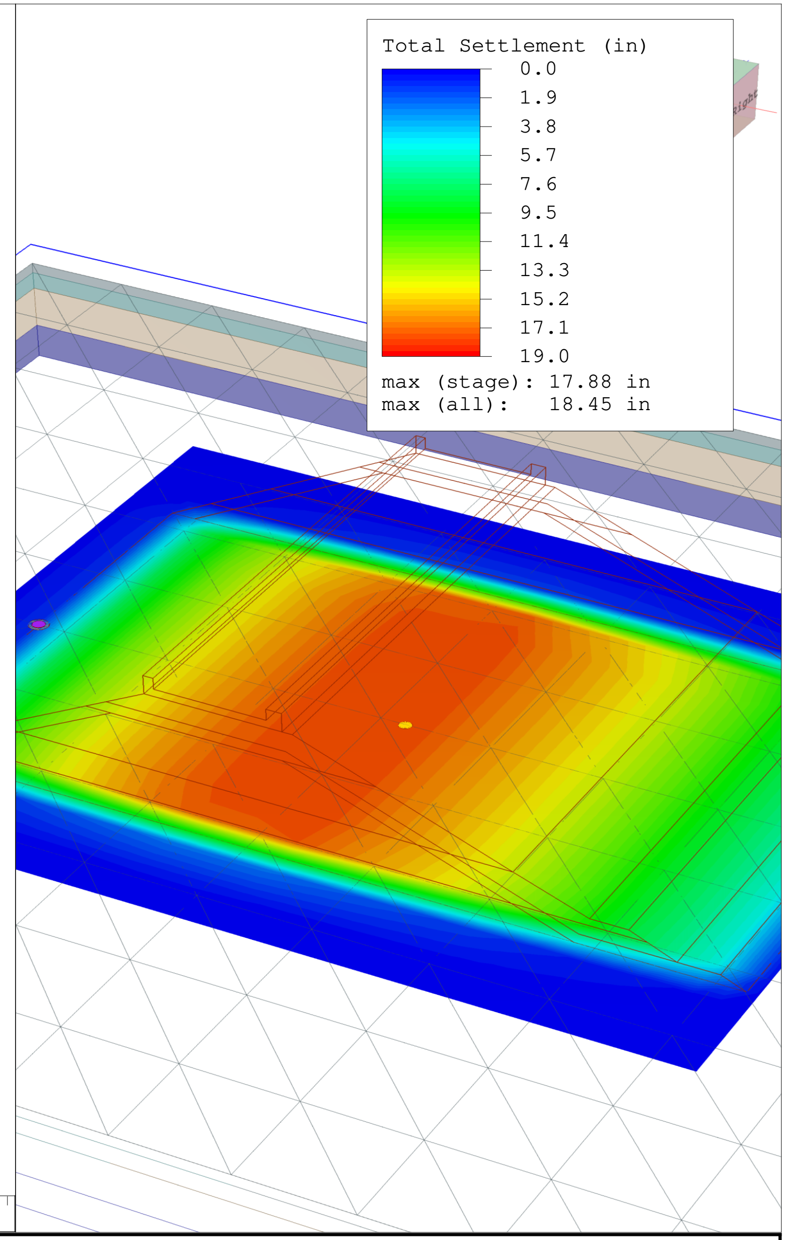




Jacobs	Project: Lubec Breakwater		
	Analysis Description: Rubble Mound Settlement - STA 103+00		
	Drawn By: M. Kullmann	Company: Jacobs	
SETTLE3 5.010	Date: 5/17/2024	File Name: Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z	

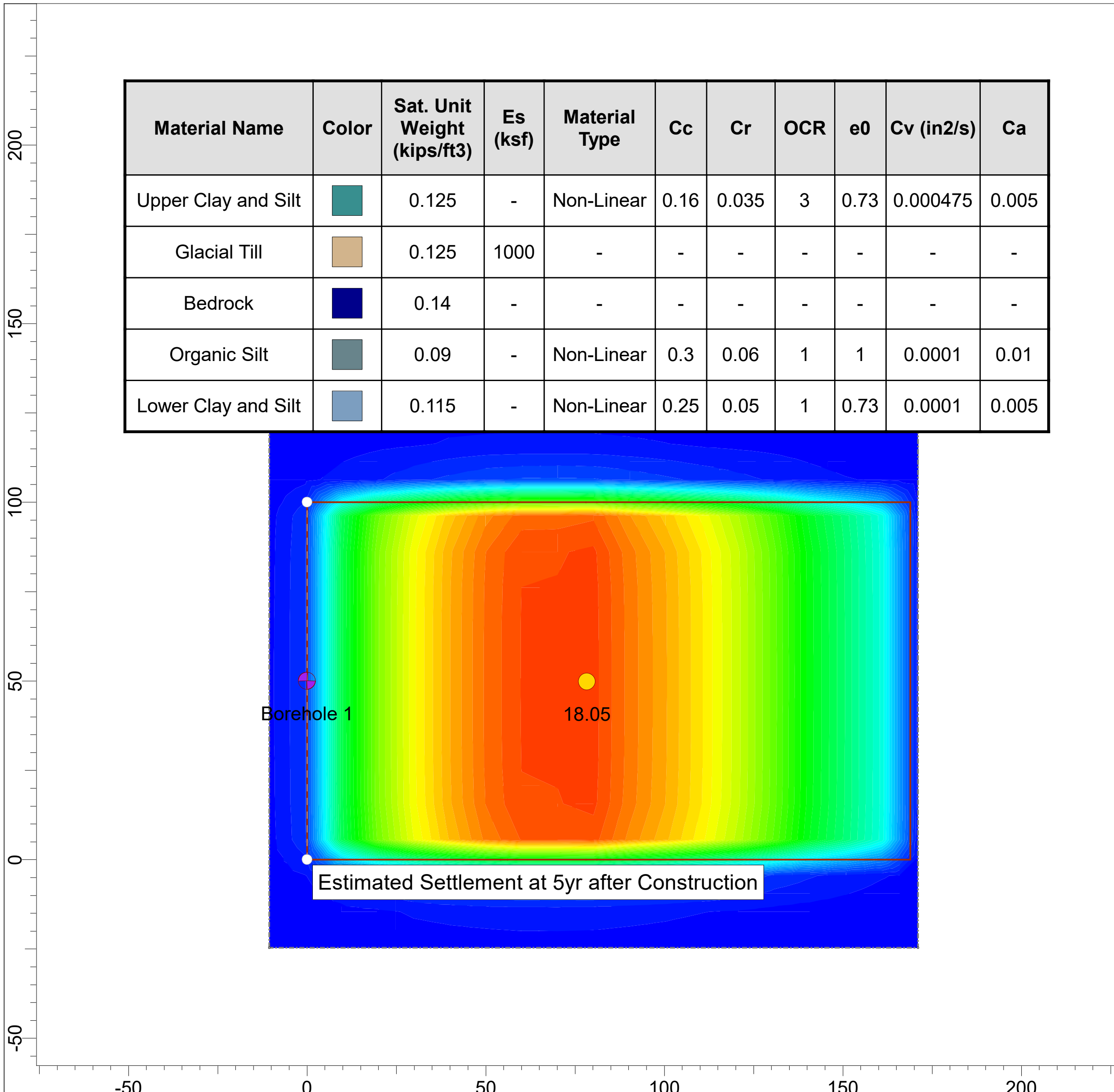
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

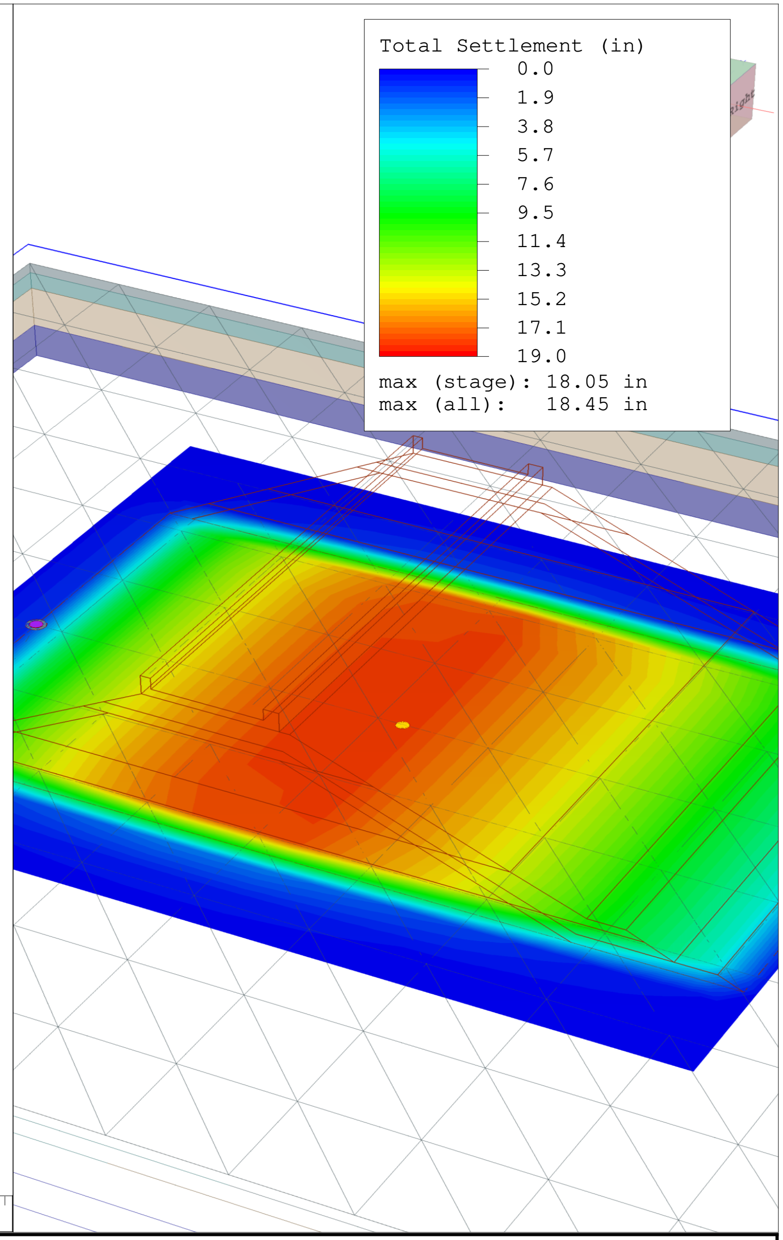




Jacobs	Project	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 103+00	
	Drawn By: M. Kullmann	Company: Jacobs	
SETTLE3 5.010	Date: 5/17/2024	File Name: Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z	

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005



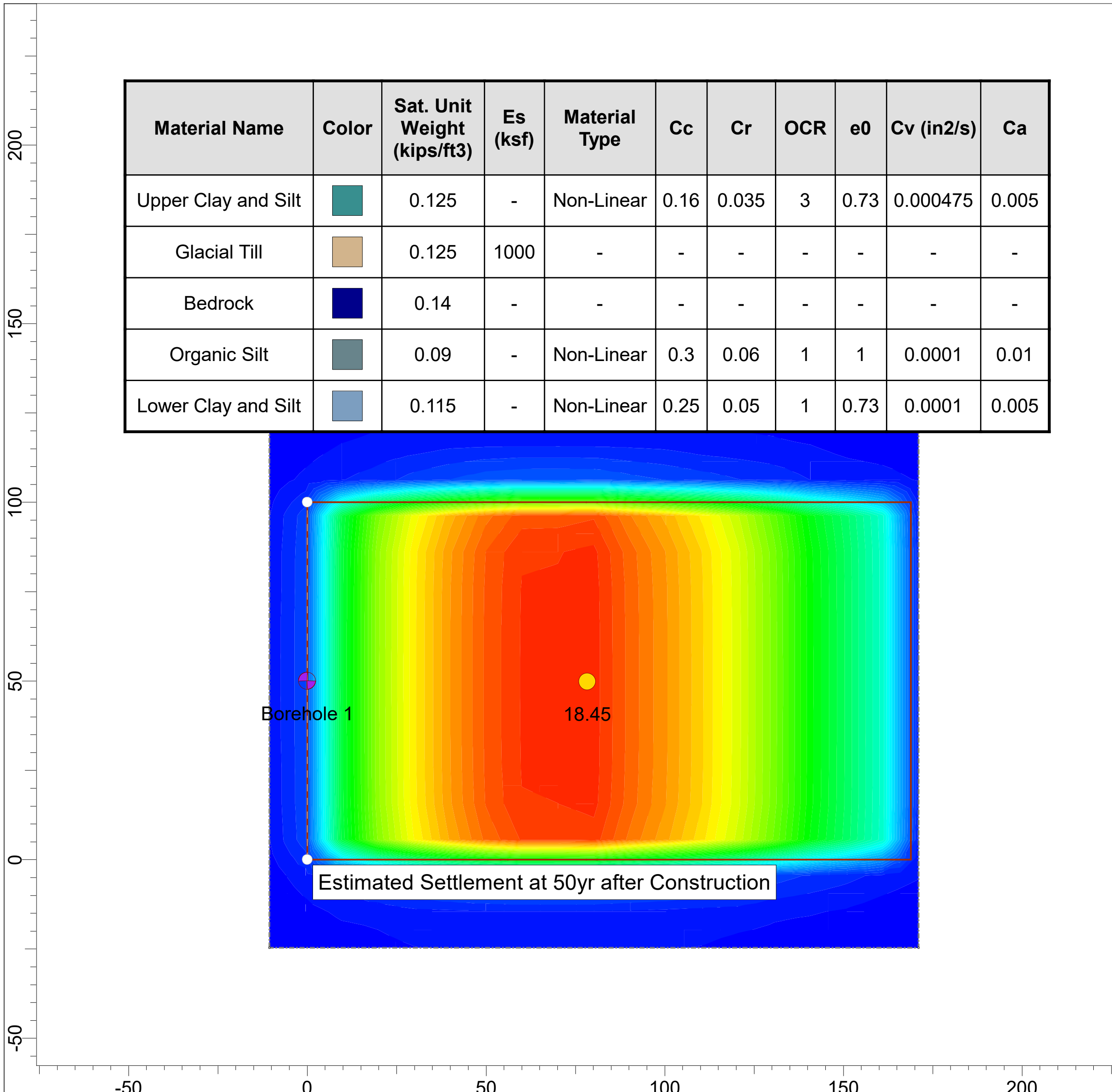


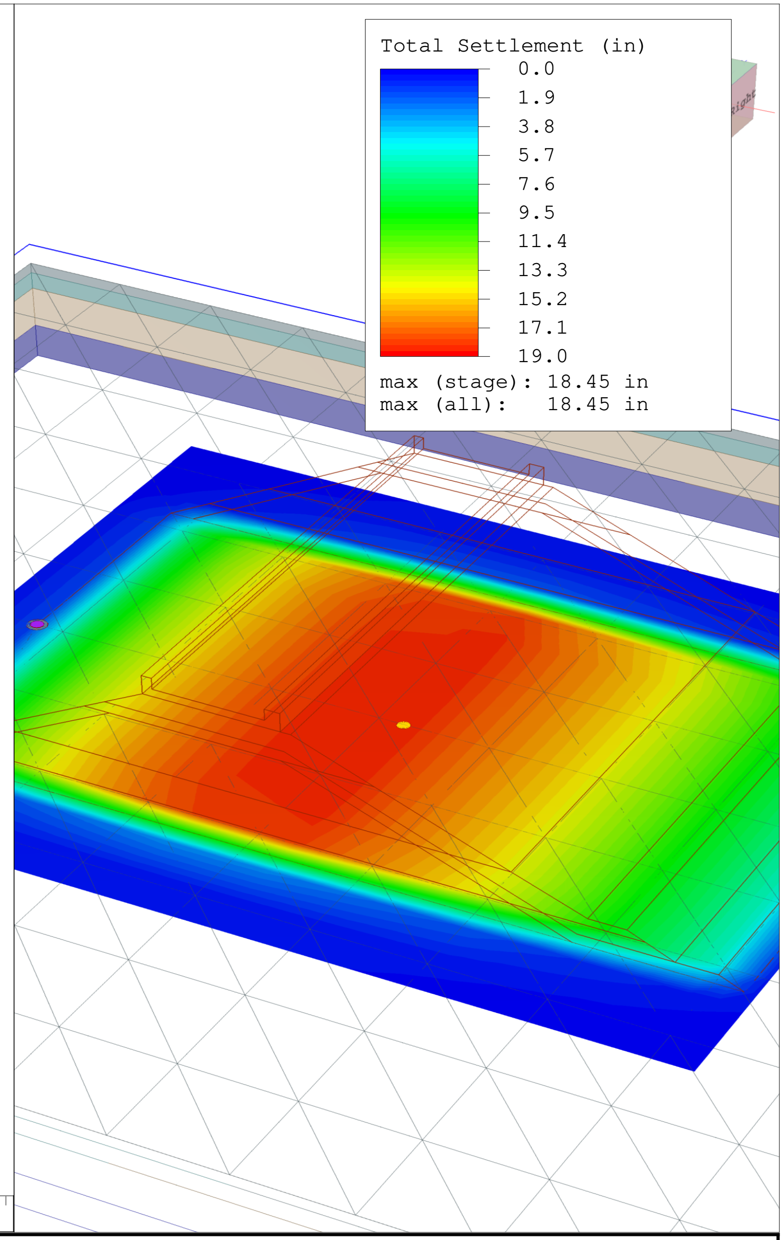
Jacobs

SETTLE3 5.010

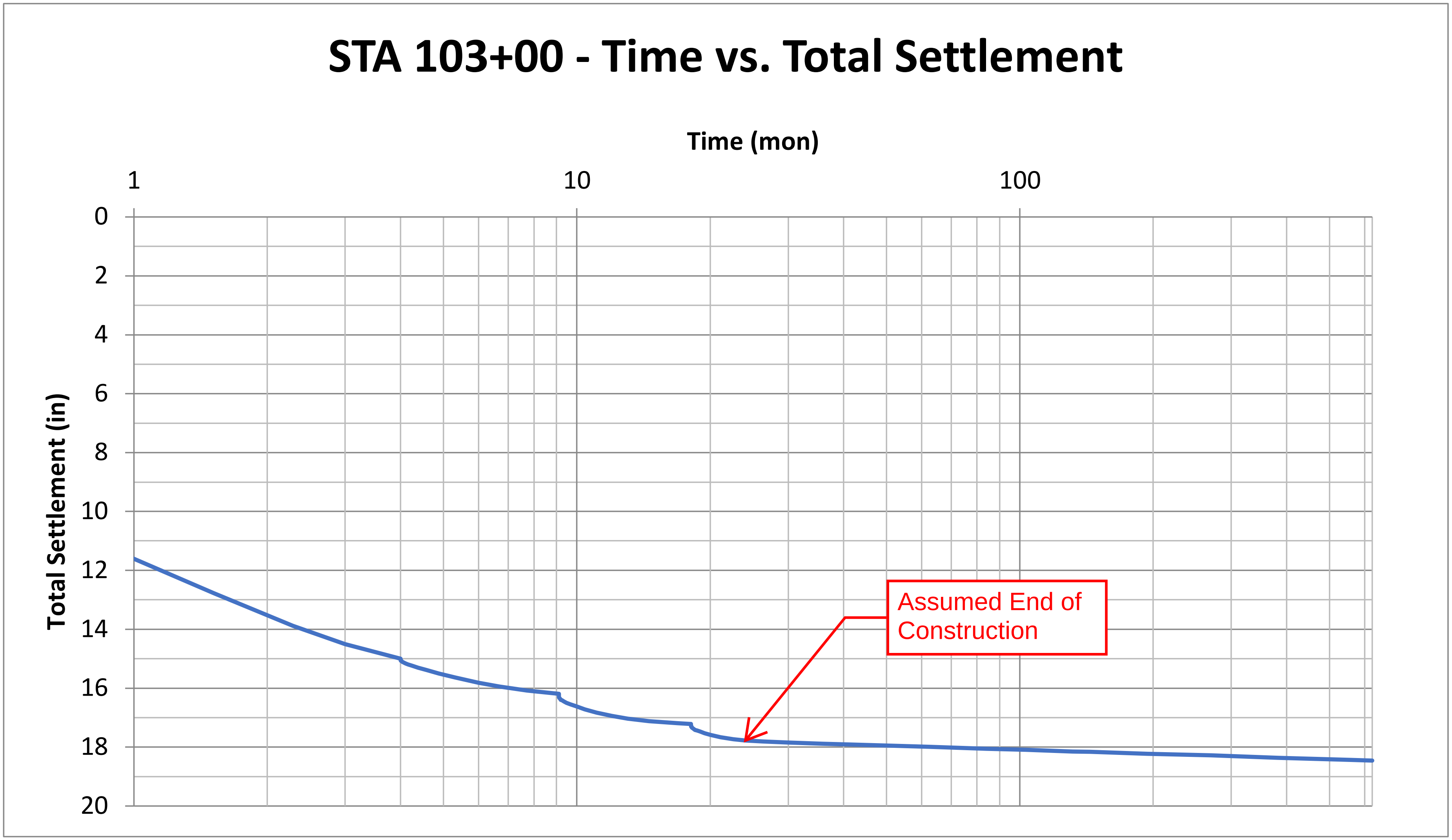
Project	Lubec Breakwater
Analysis Description	Rubble Mound Settlement - STA 103+00
Drawn By M. Kullmann	*Company* Jacobs
Date 5/17/2024	*File Name* Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

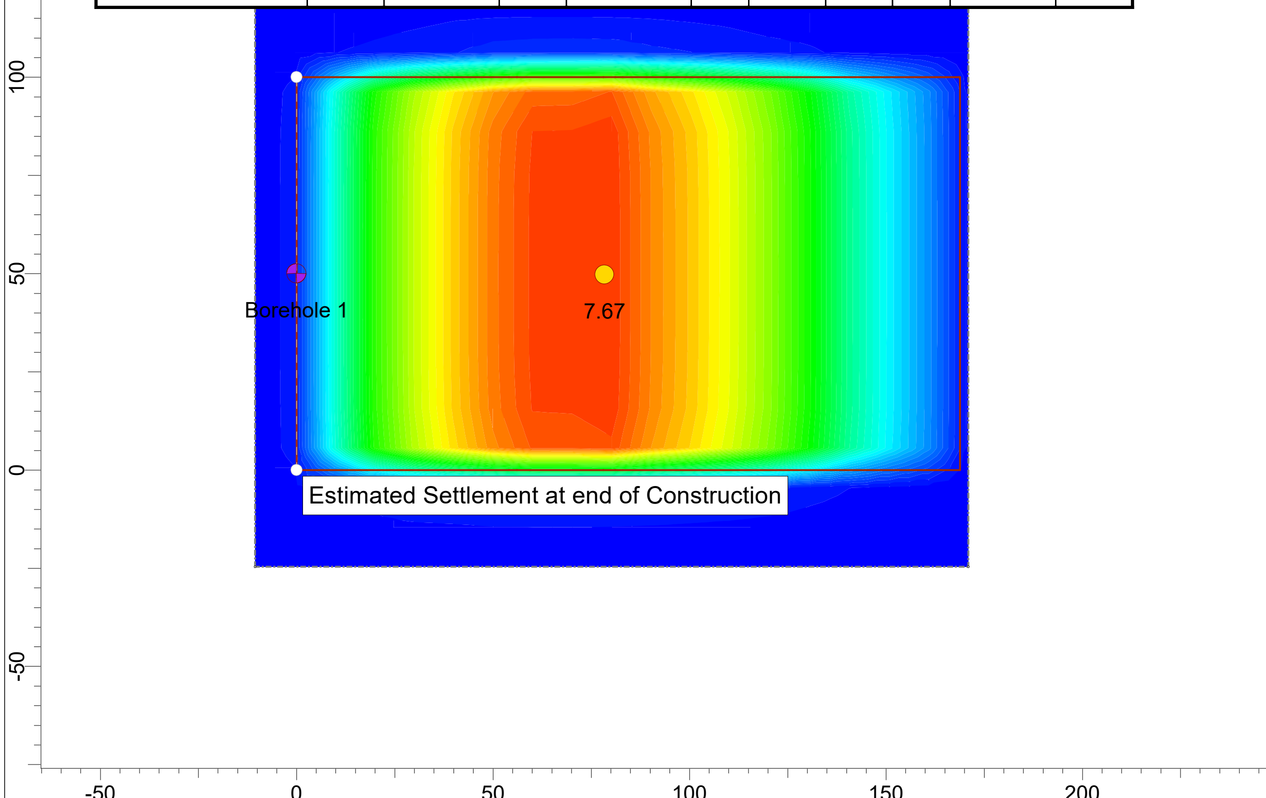


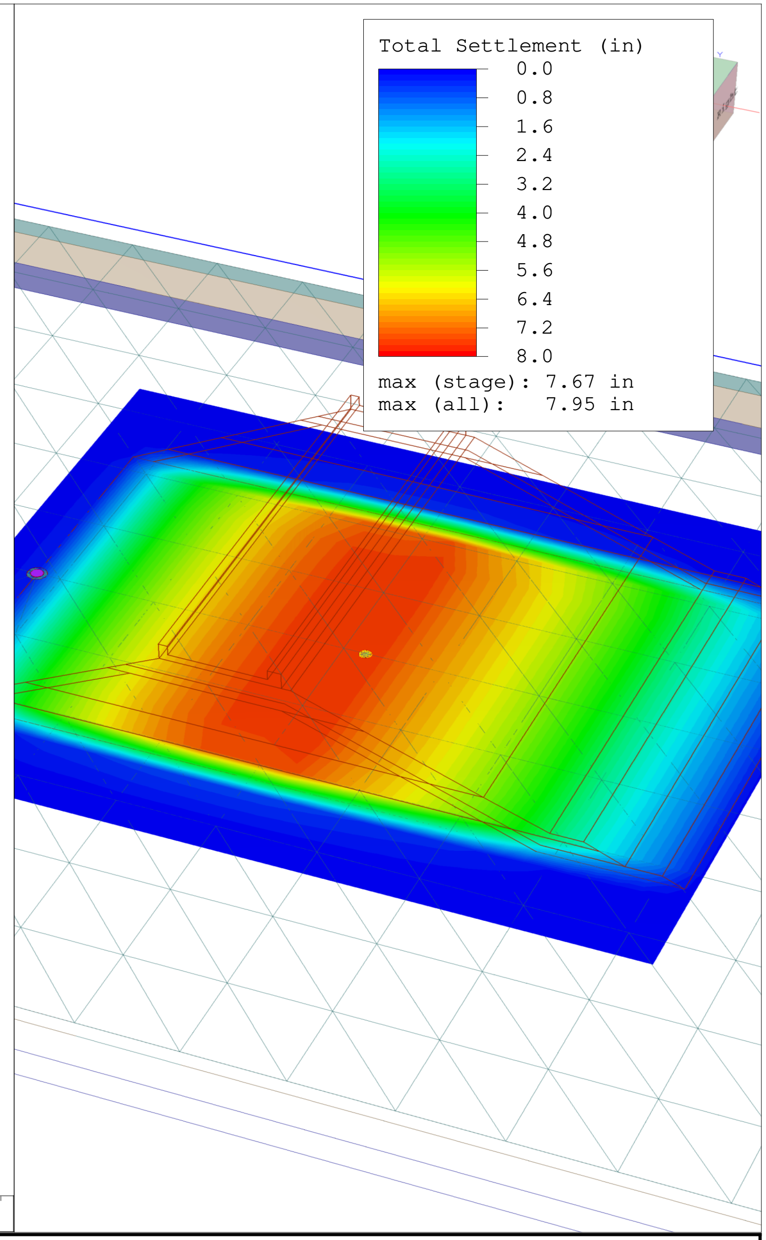


Jacobs			
	Project Lubec Breakwater		
	Analysis Description Rubble Mound Settlement - STA 103+00		
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z	


STA 103+00 - Time vs. Total Settlement
Time (mon)
1
10
100
Total Settlement (in)
0
2
4
6
8
10
12
14
16
18
20
Assumed End of Construction

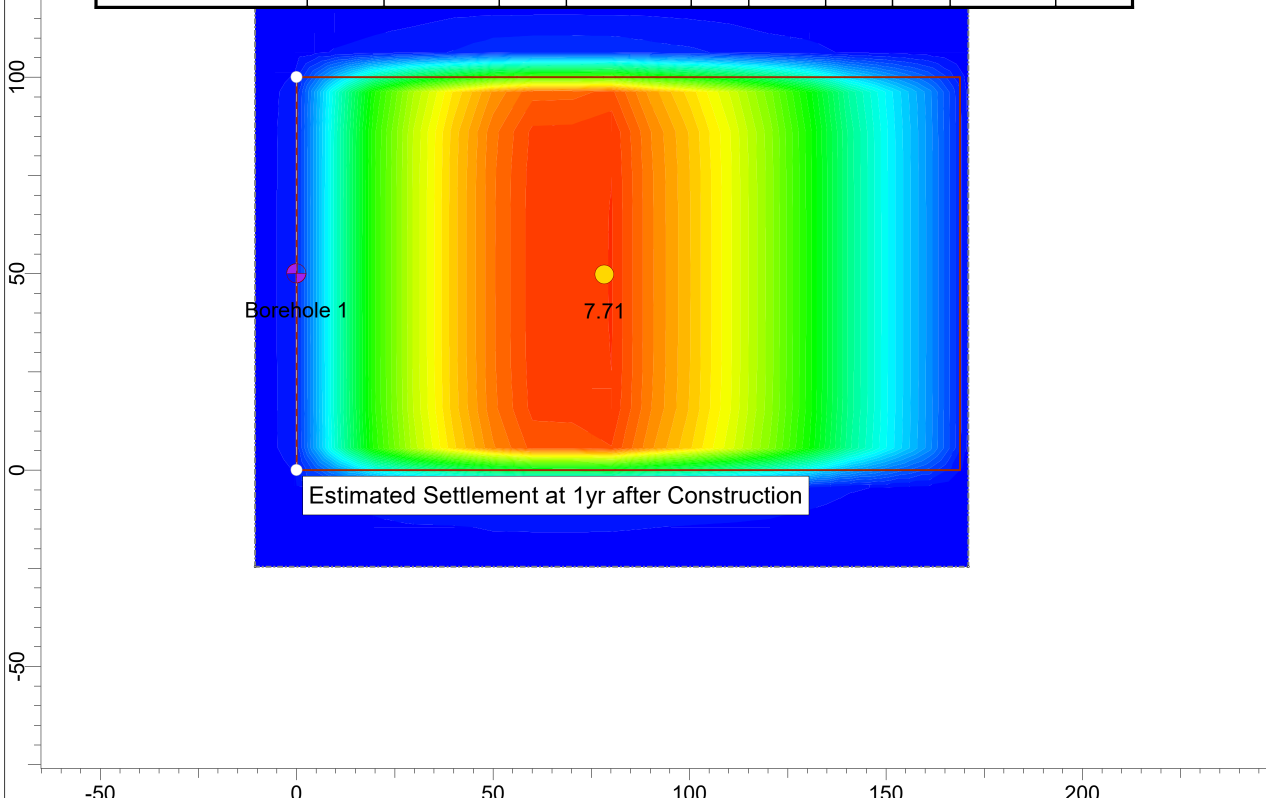
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

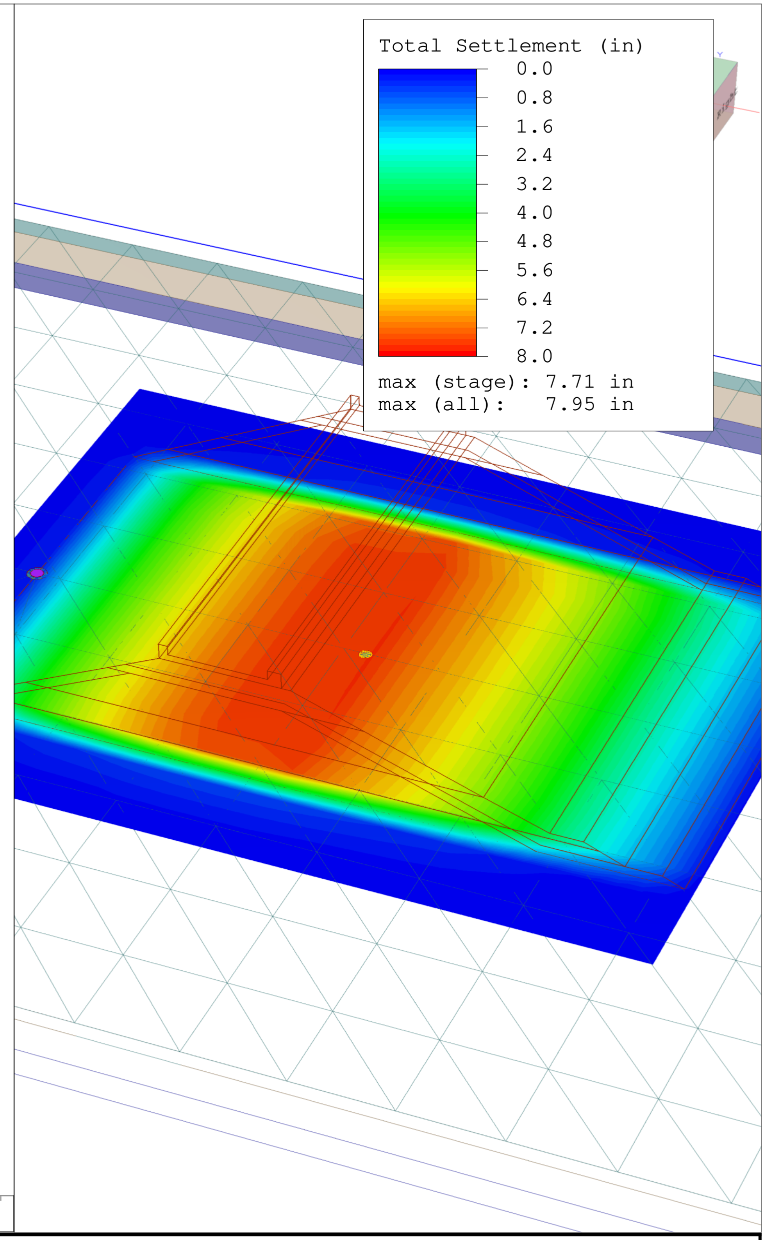




Jacobs	*Project*	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 103+00	
	Drawn By	M. Kullmann	*Company* Jacobs
SETTLE3 5.010	*Date*	5/17/2024	*File Name* Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z

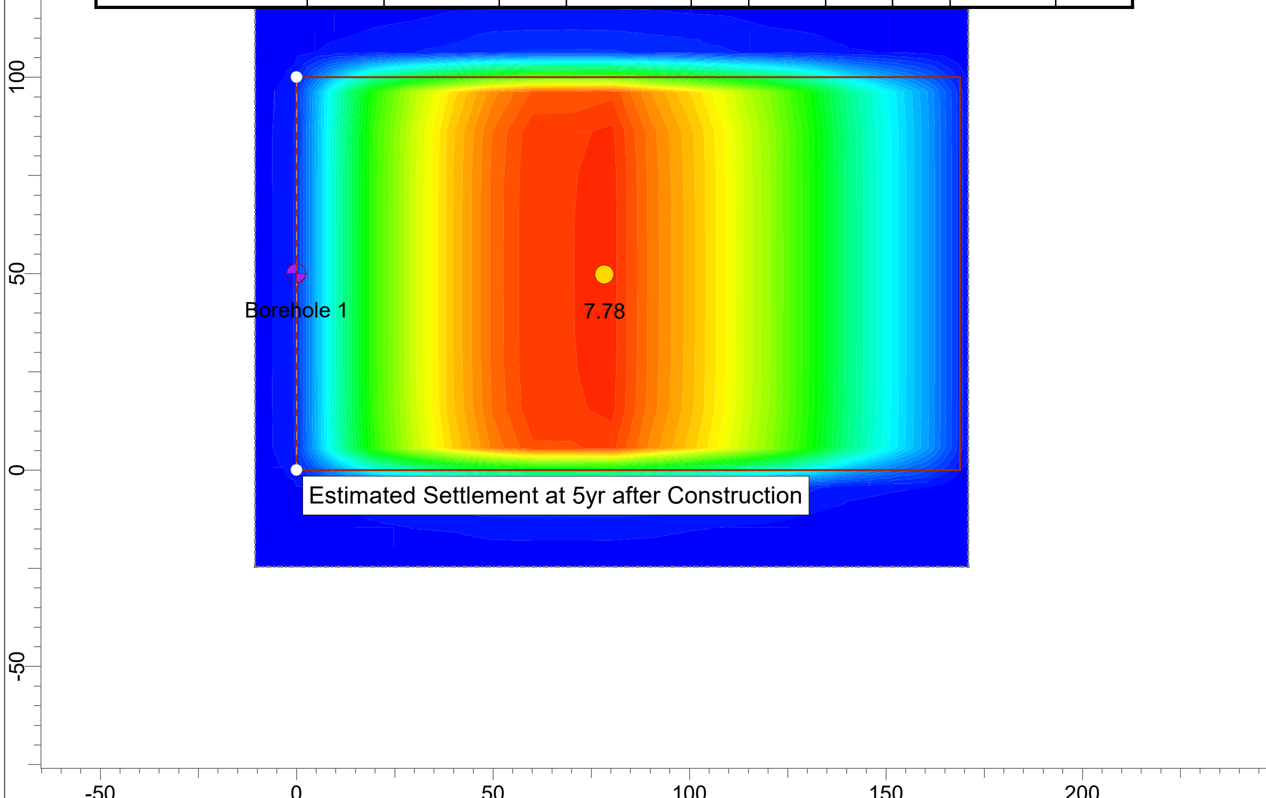
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

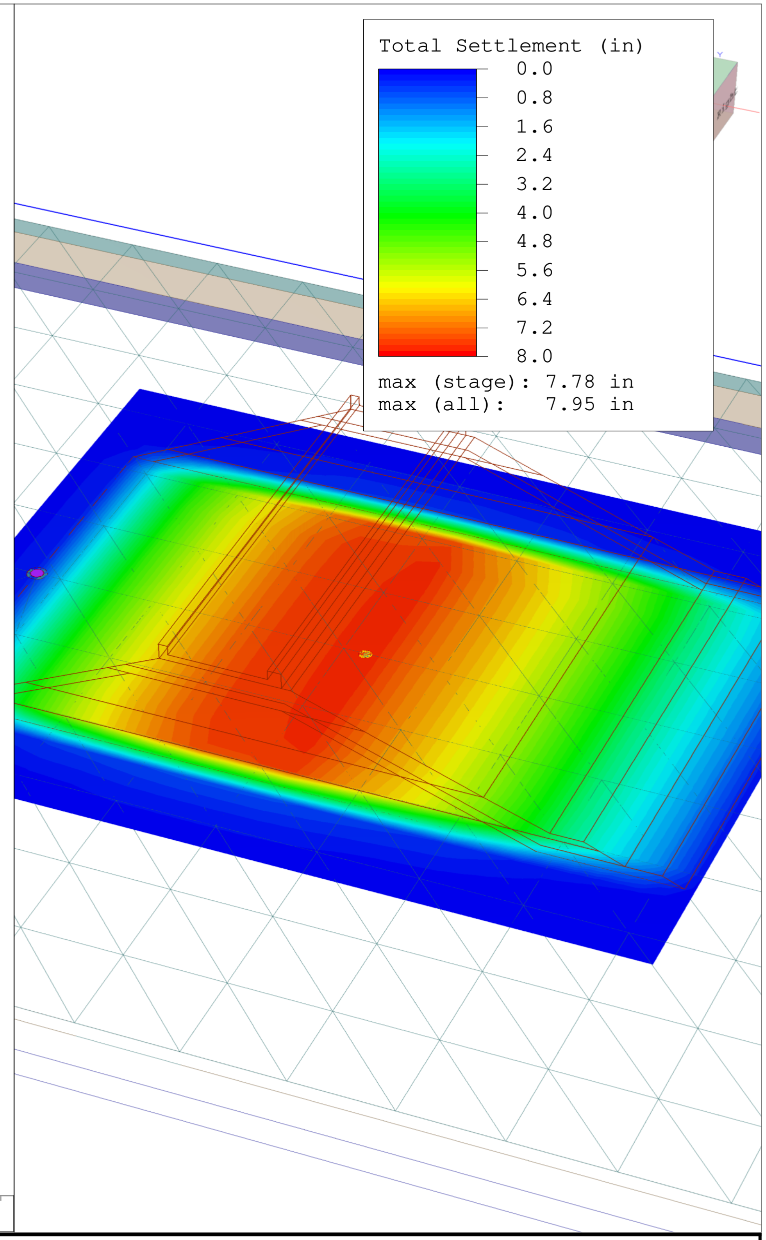




Jacobs	*Project* Lubec Breakwater		
	Analysis Description Rubble Mound Settlement - STA 103+00		
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z	

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005



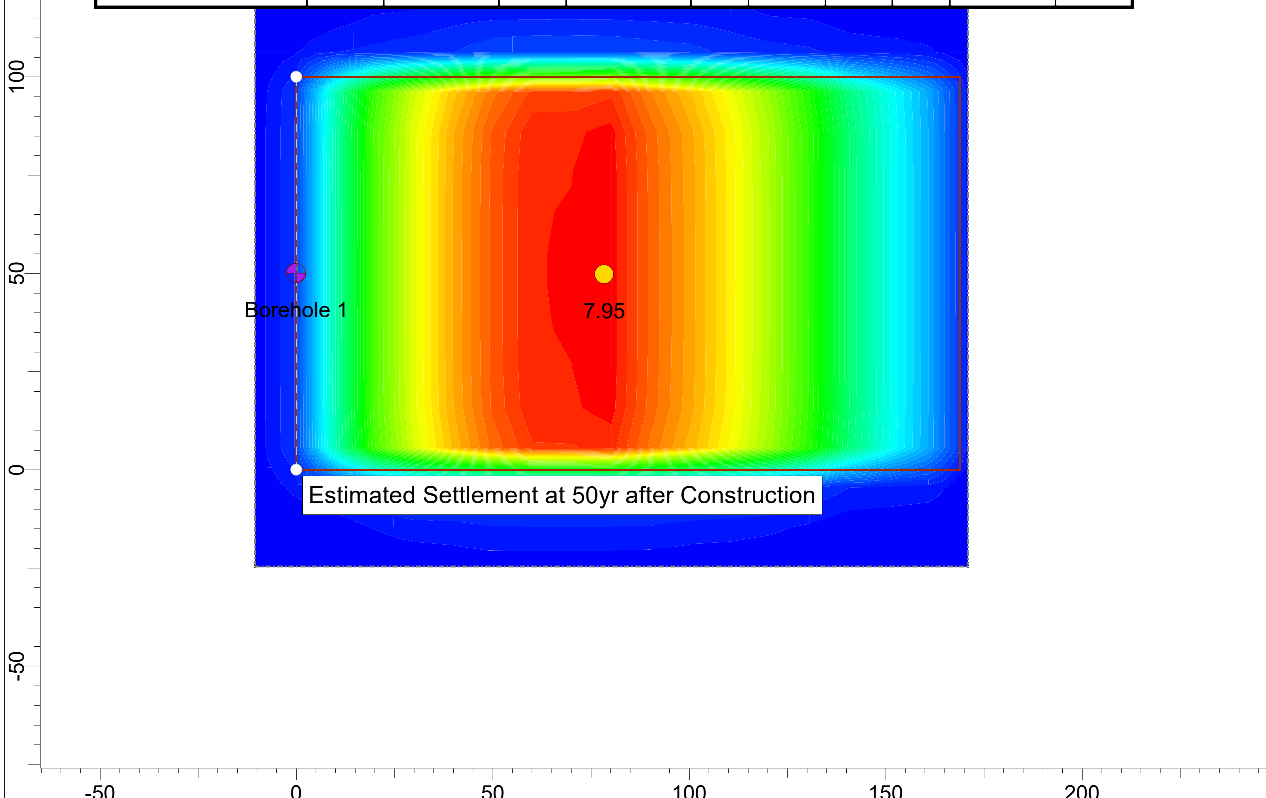


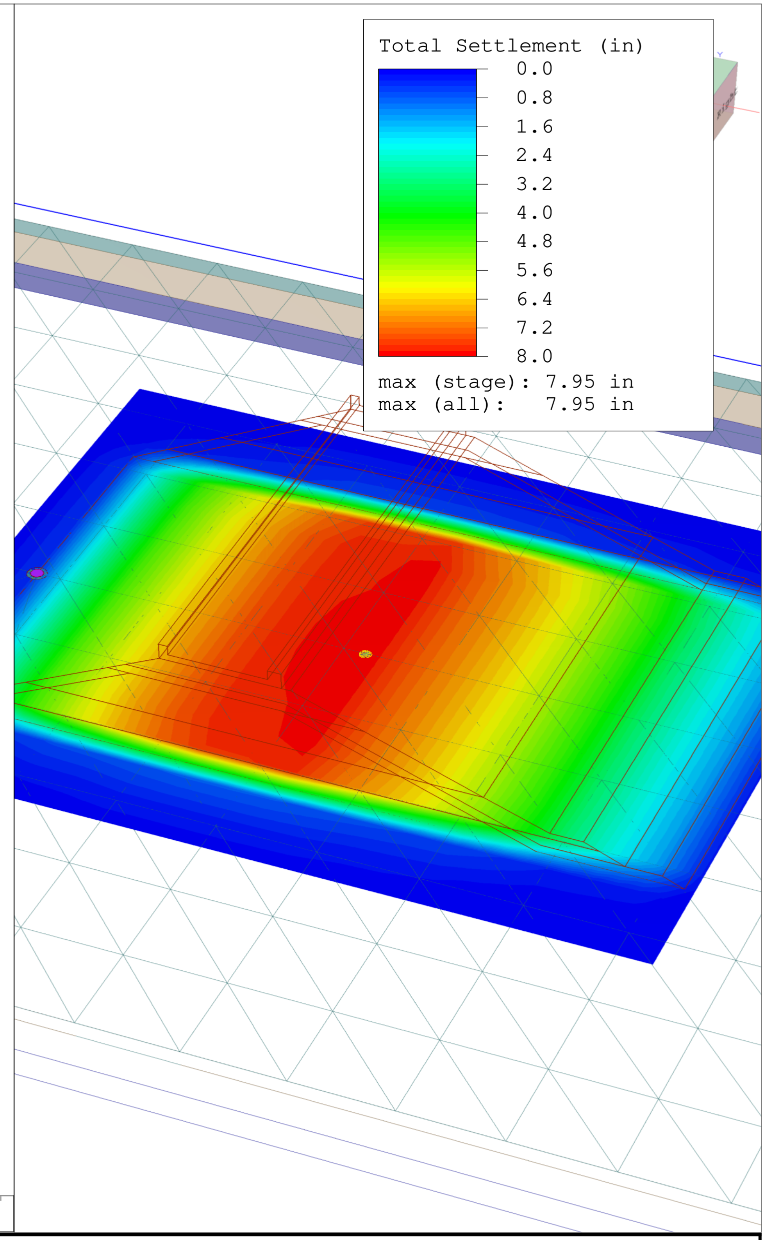
Jacobs

SETTLE3 5.010

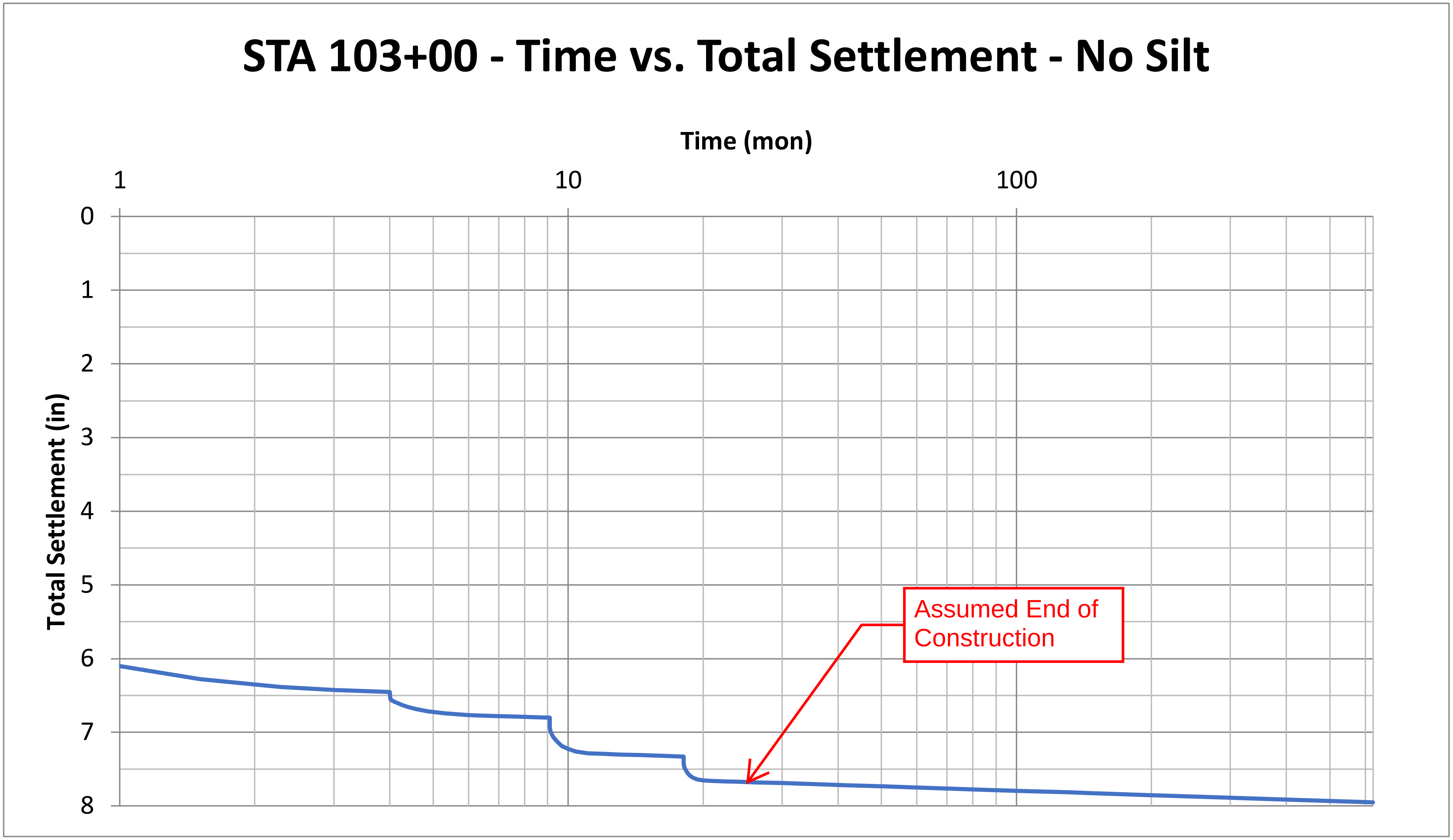
Project	Lubec Breakwater		
Analysis Description	Rubble Mound Settlement - STA 103+00		
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*File Name*	Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

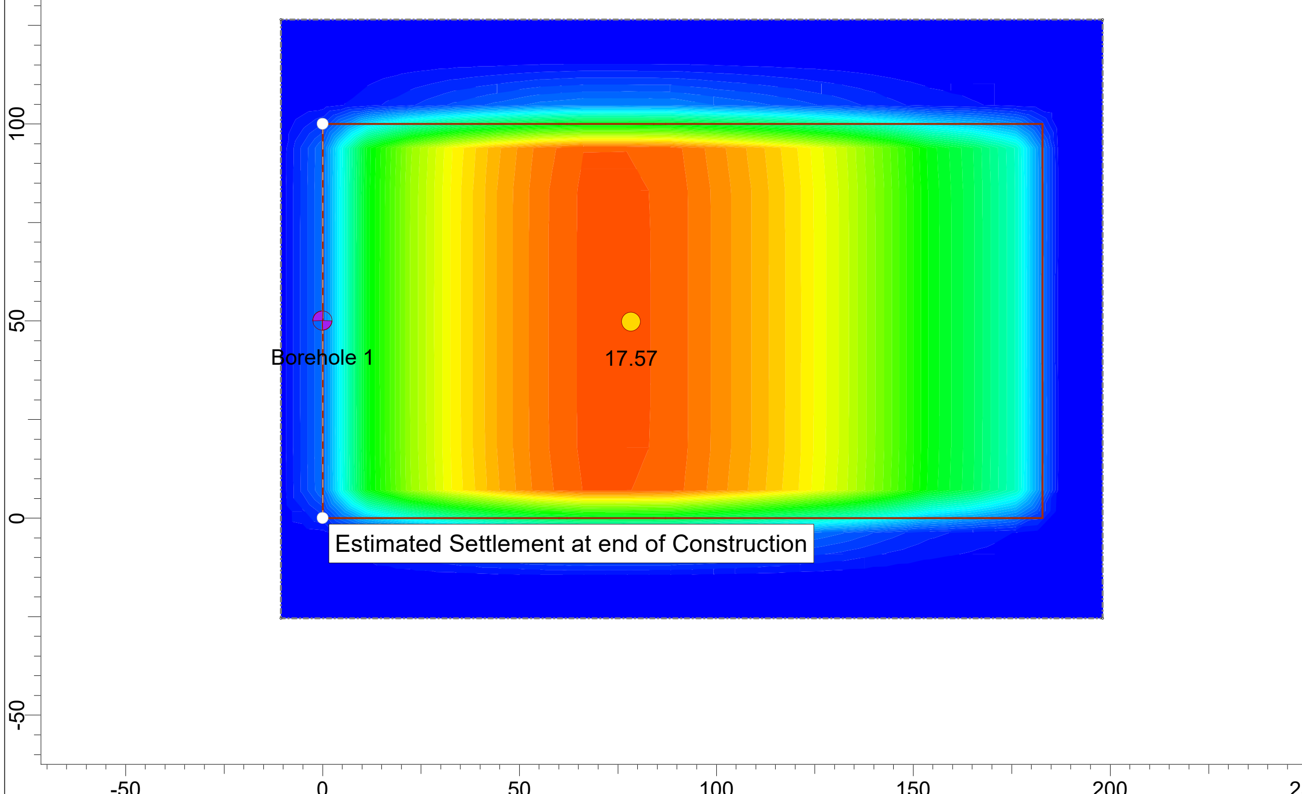


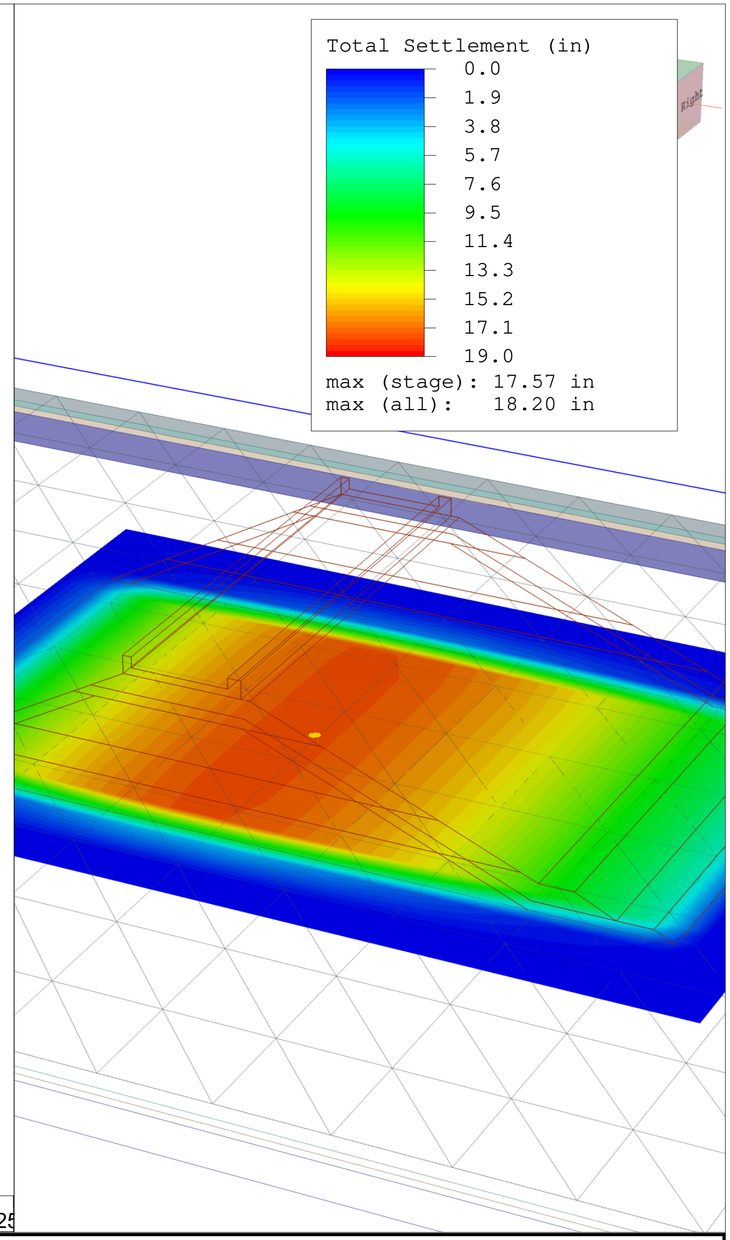


Jacobs	*Project*	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 103+00	
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-101_El. -15_MLLW_staged.s3z	


STA 103+00 - Time vs. Total Settlement - No Silt
Time (mon)
1
10
100
Total Settlement (in)
0
1
2
3
4
5
6
7
8
Assumed End of
Construction

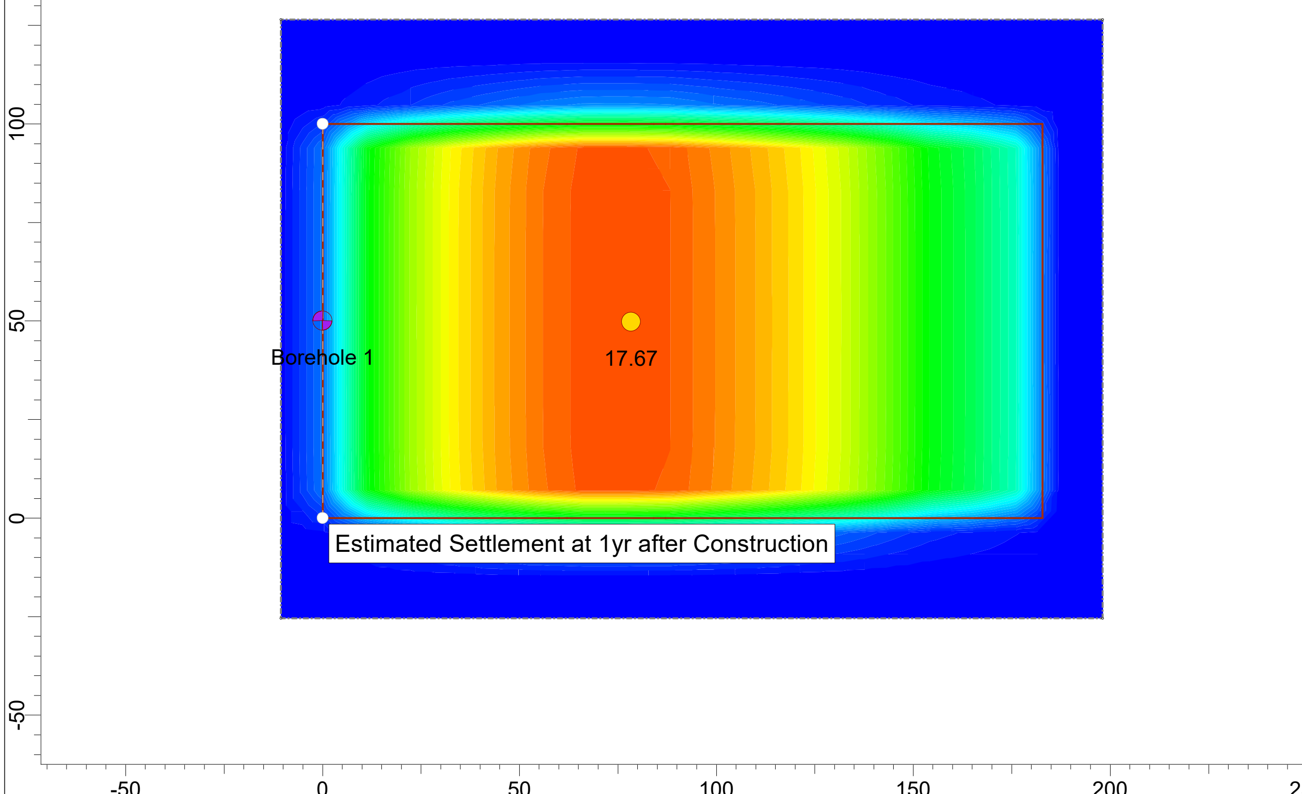
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

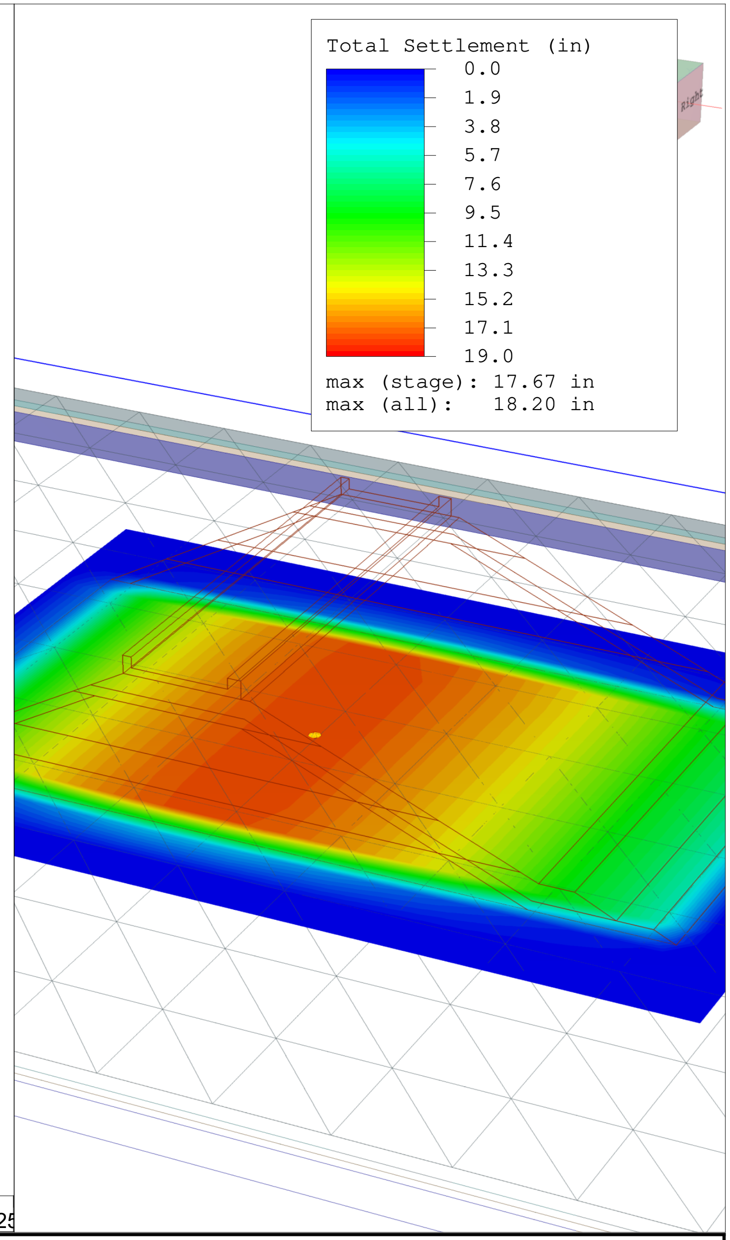




Jacobs	Project	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 105+00	
	Drawn By: M. Kullmann	Company: Jacobs	
SETTLE3 5.010	Date: 5/17/2024	File Name: Lubec Breakwater_WB-102_El. -19_MLLW_staged.s3z	

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005



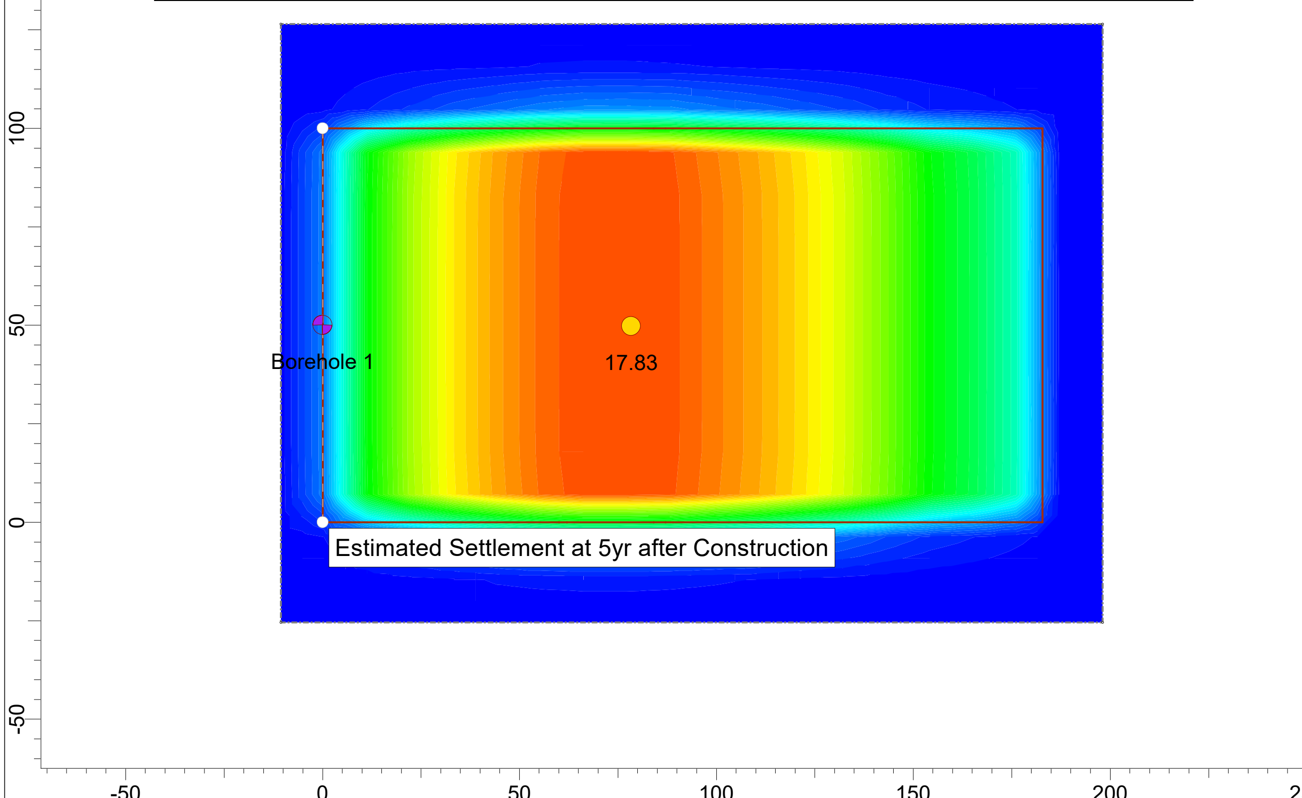


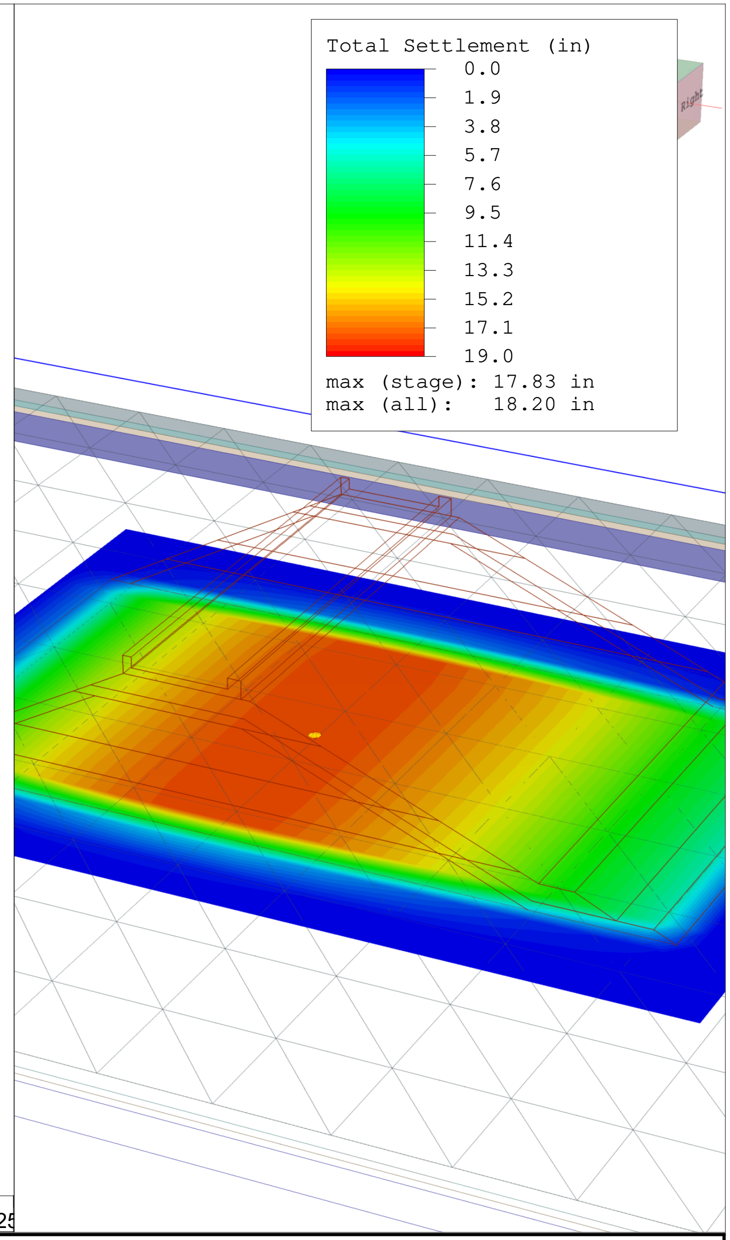
Jacobs

SETTLE3 5.010

Project	Lubec Breakwater
Analysis Description	Rubble Mound Settlement - STA 105+00
Drawn By	M. Kullmann
Company	Jacobs
Date	5/17/2024
File Name	Lubec Breakwater_WB-102_El. -19_MLLW_staged.s3z

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005



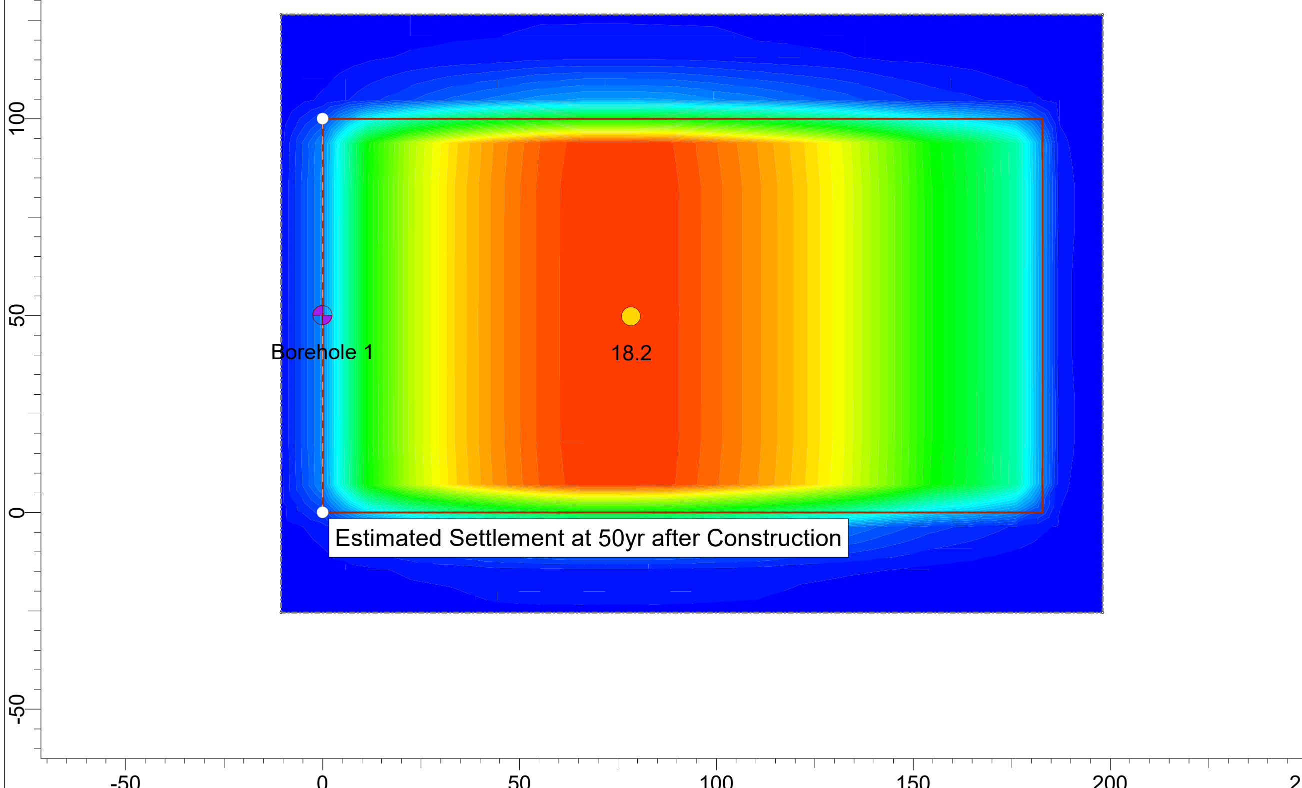


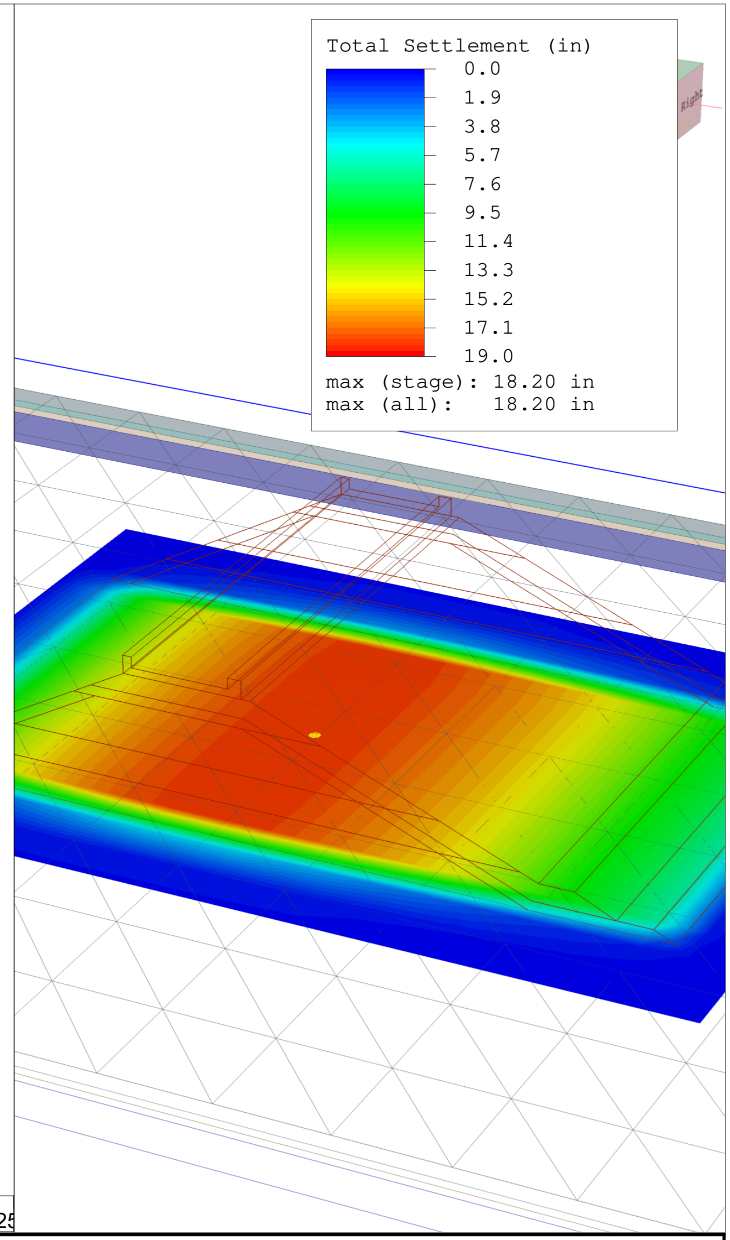
Jacobs

SETTLE3 5.010

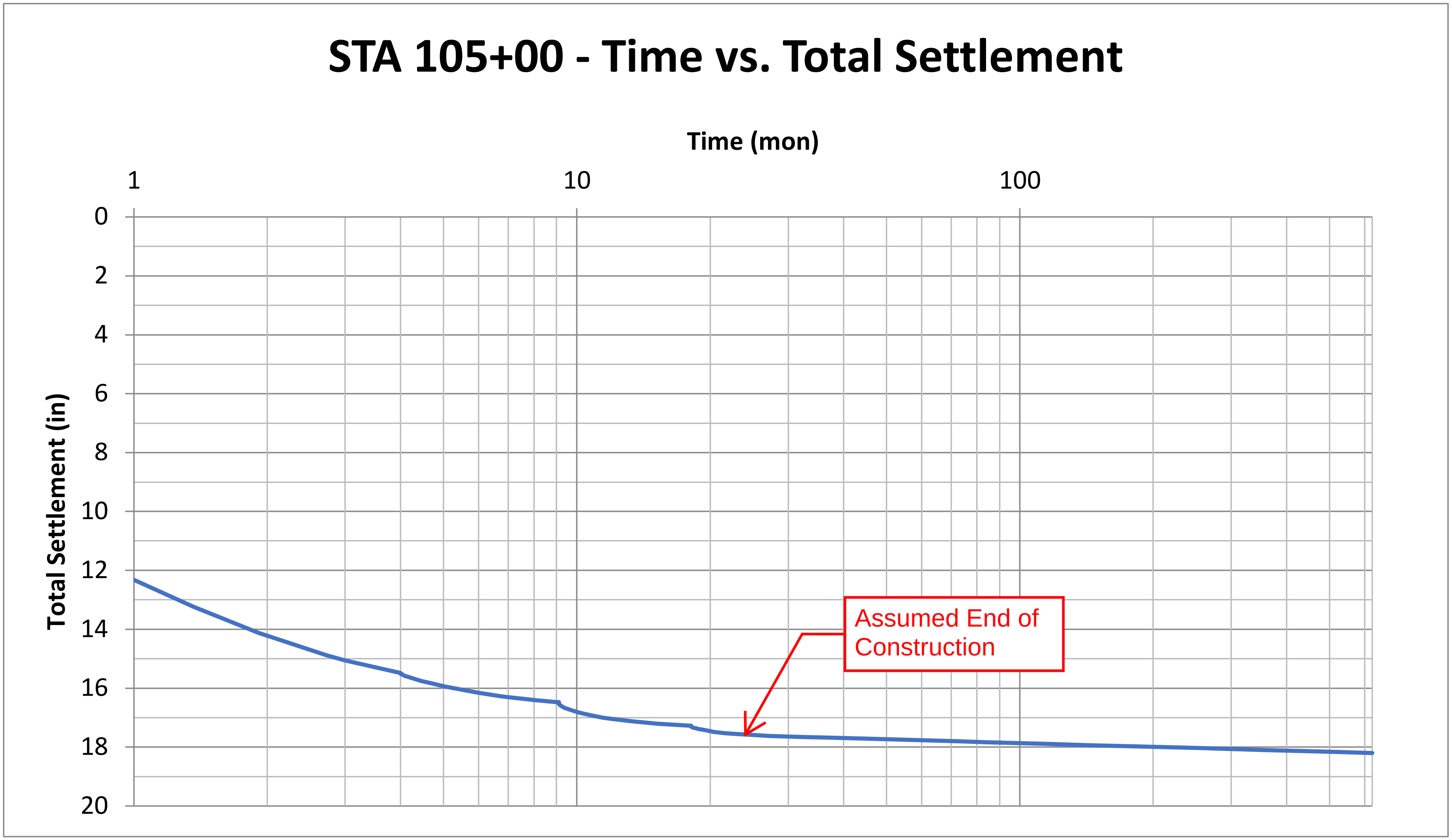
Project	Lubec Breakwater		
Analysis Description	Rubble Mound Settlement - STA 105+00		
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*File Name*	Lubec Breakwater_WB-102_El. -19_MLLW_staged.s3z

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

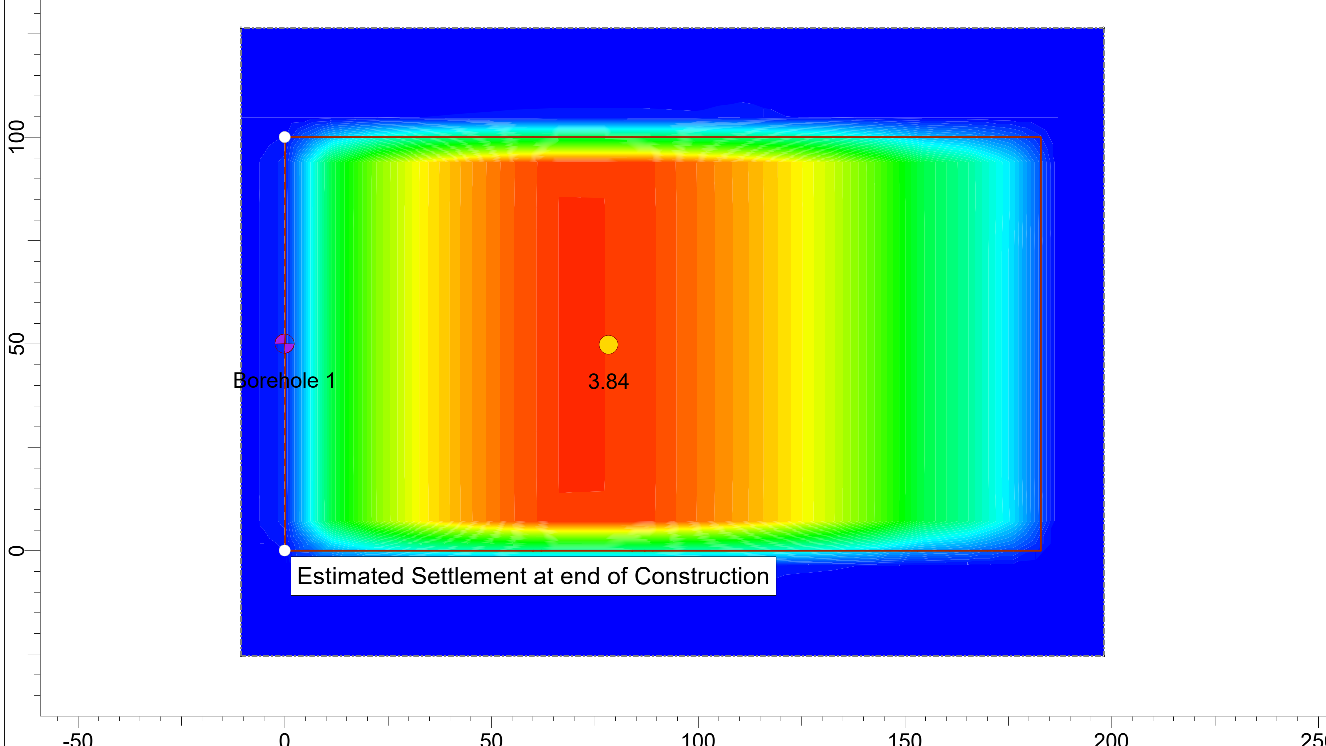


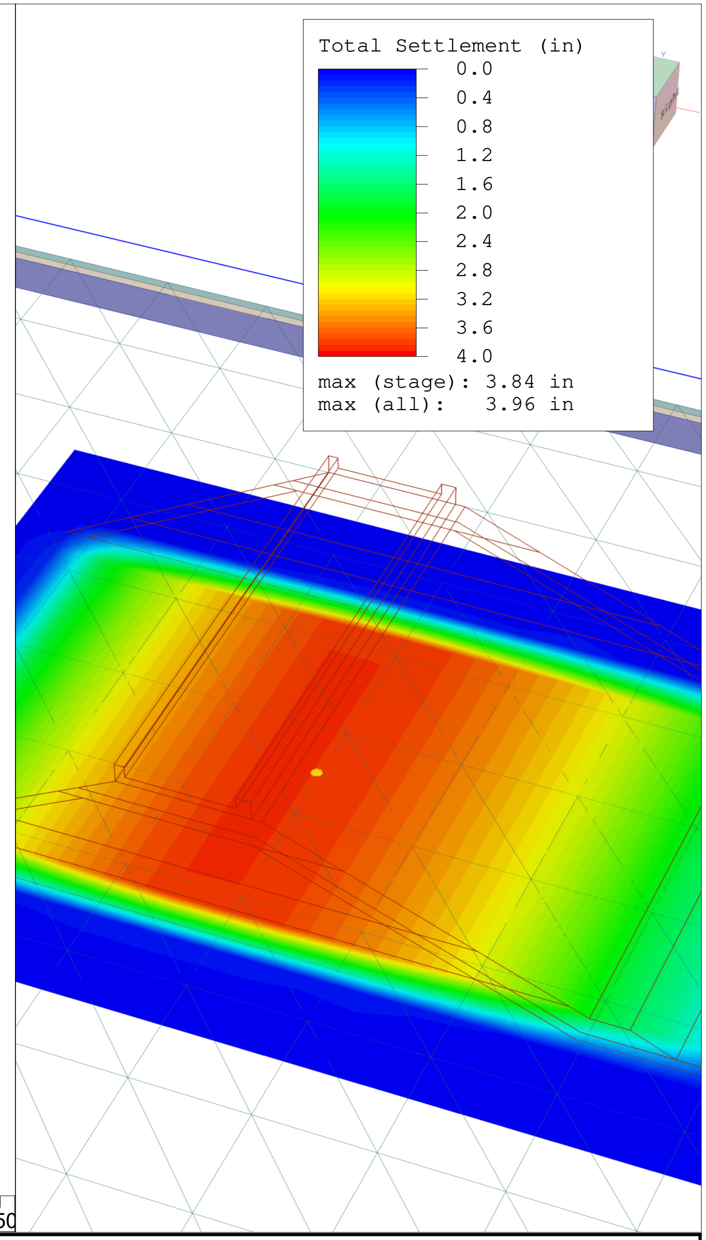


Jacobs	Project	Lubec Breakwater	
	Analysis Description	Rubble Mound Settlement - STA 105+00	
	Drawn By	M. Kullmann	Company: Jacobs
SETTLE3 5.010	Date	5/17/2024	File Name: Lubec Breakwater_WB-102_El. -19_MLLW_staged.s3z


STA 105+00 - Time vs. Total Settlement
Time (mon)
1
10
100
Total Settlement (in)
0
2
4
6
8
10
12
14
16
18
20
Assumed End of Construction

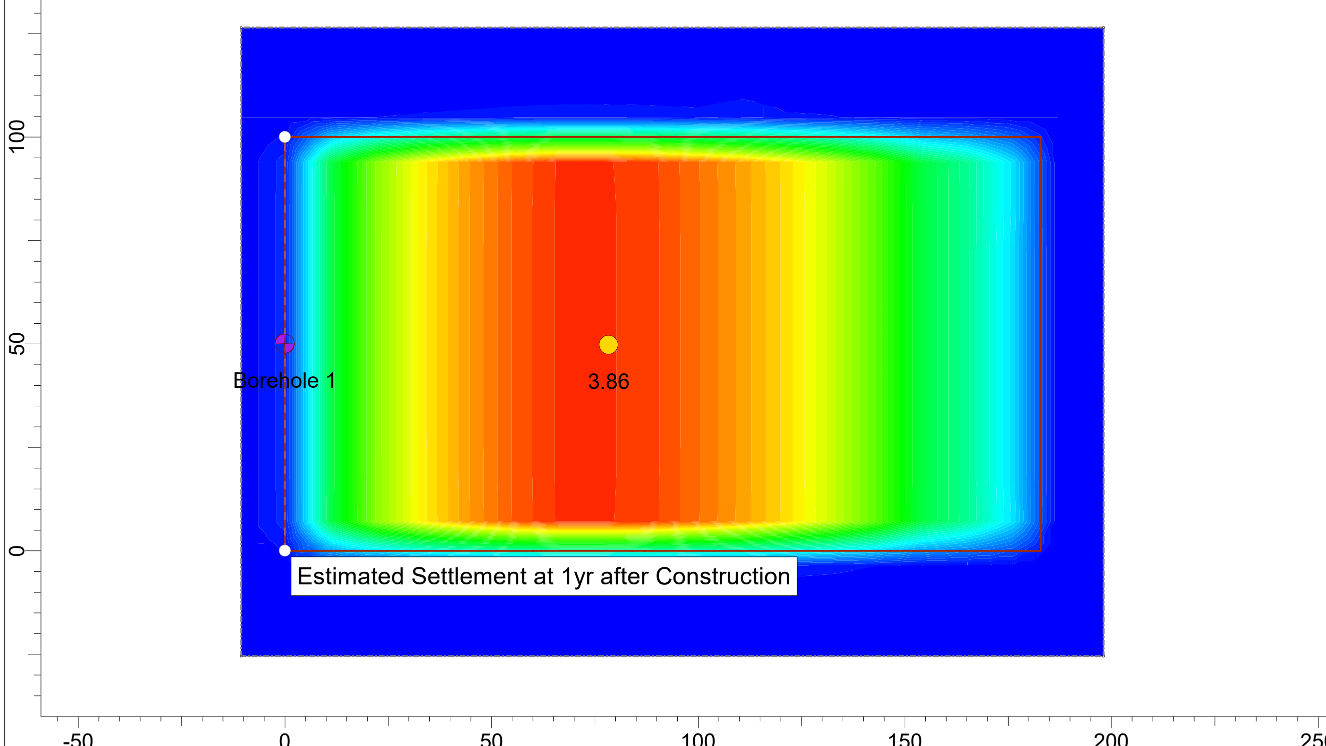
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

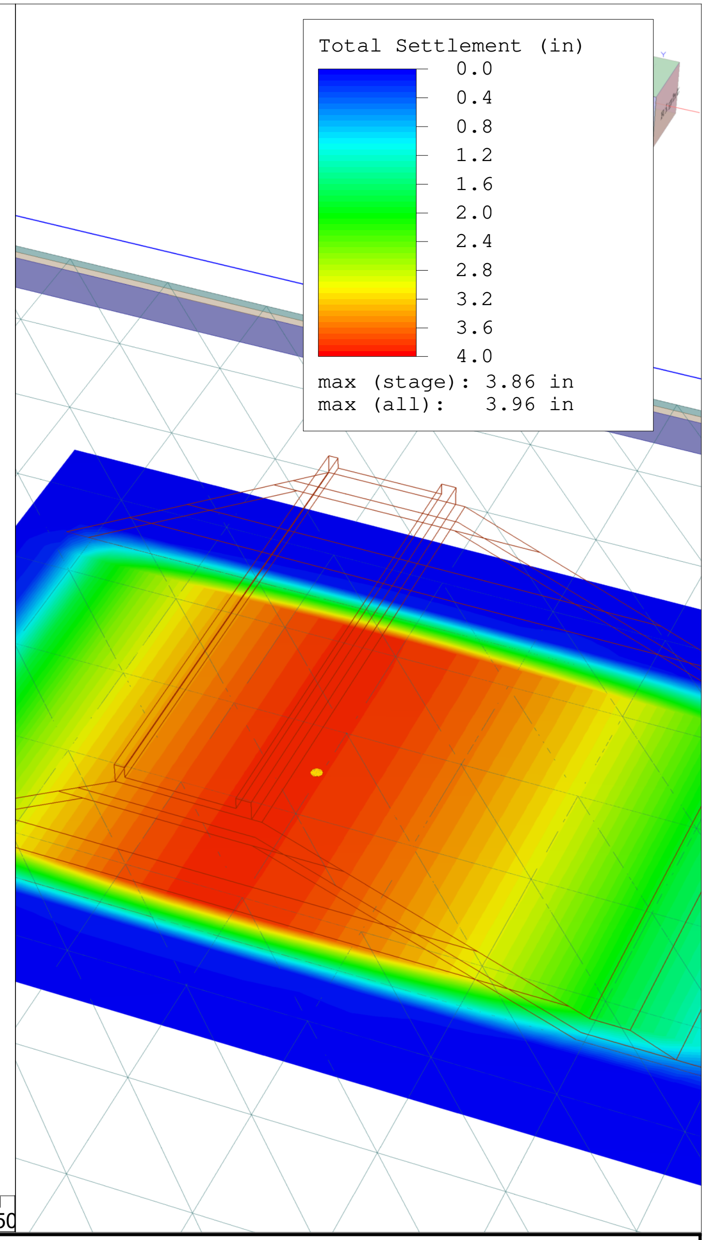




Jacobs	*Project* Lubec Breakwater
SETTLE3 5.010	*Analysis Description* Rubble Mound Settlement - STA 105+00
	Drawn By M. Kullmann · *Company* Jacobs
	Date 5/17/2024 · *File Name* Lubec Breakwater_WB-102_El. -19_MLLW_staged_no silt.s3z

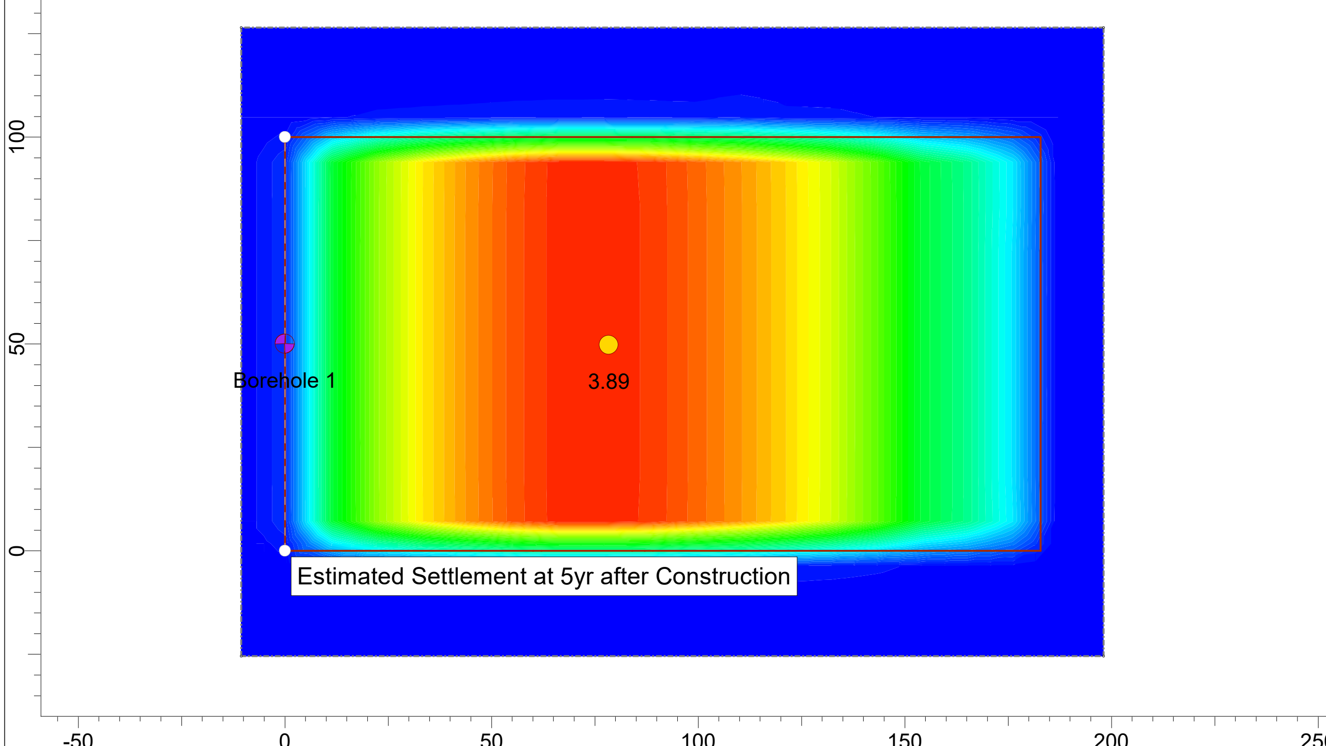
Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005

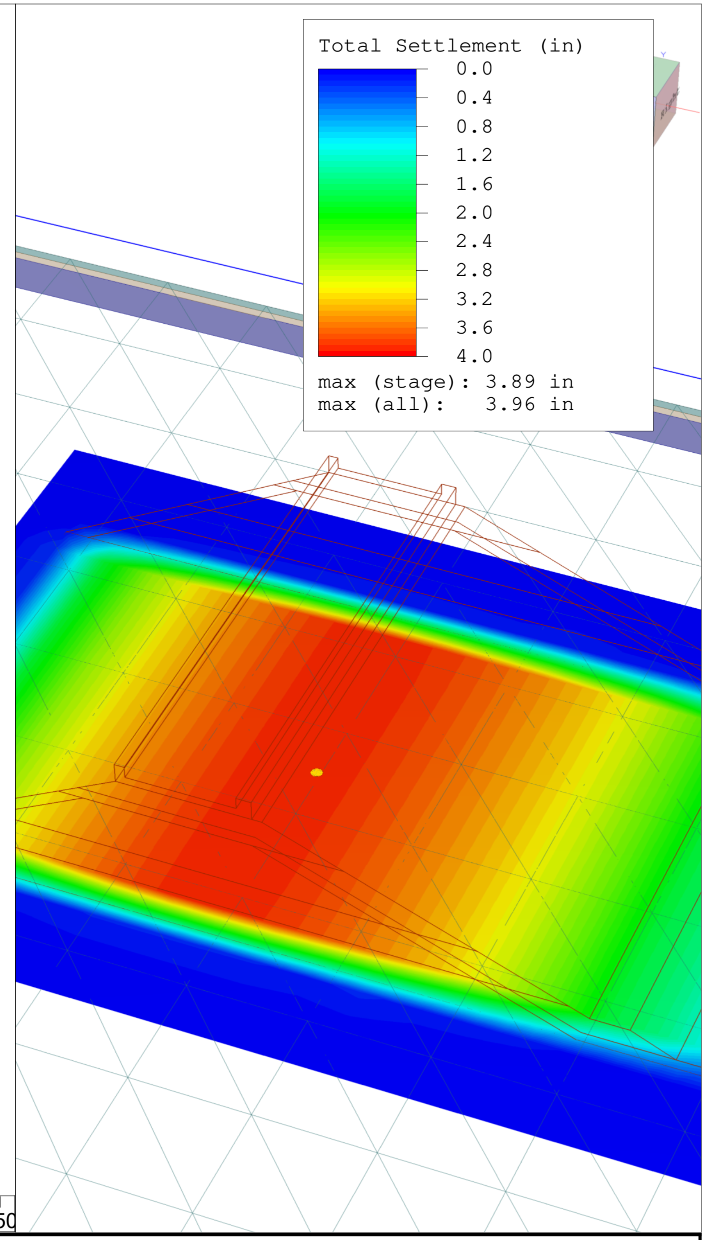




Jacobs	*Project* Lubec Breakwater		
	Analysis Description Rubble Mound Settlement - STA 105+00		
	Drawn By M. Kullmann	*Company* Jacobs	
SETTLE3 5.010	*Date* 5/17/2024	*File Name* Lubec Breakwater_WB-102_El. -19_MLLW_staged_no silt.s3z	

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005



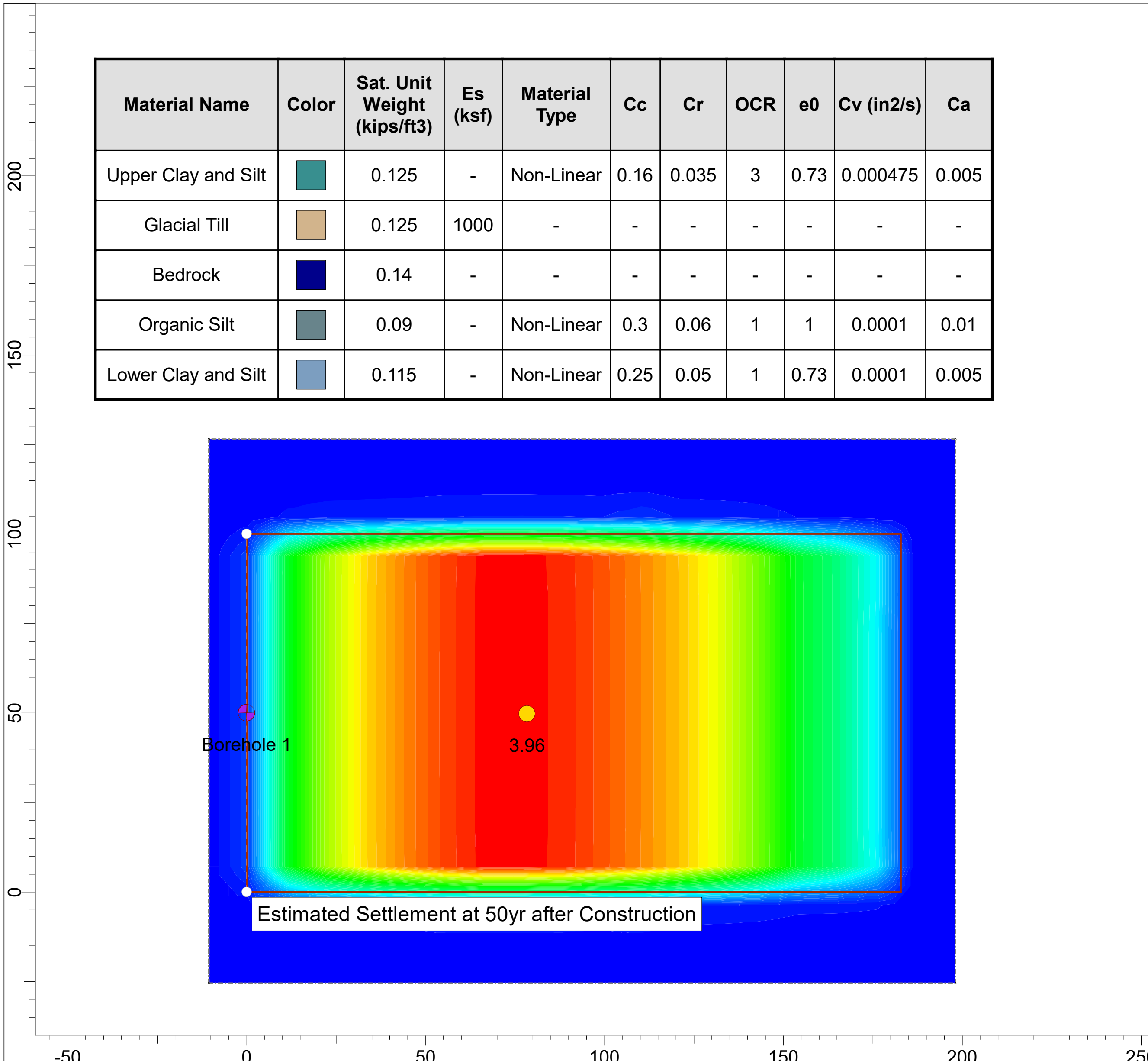


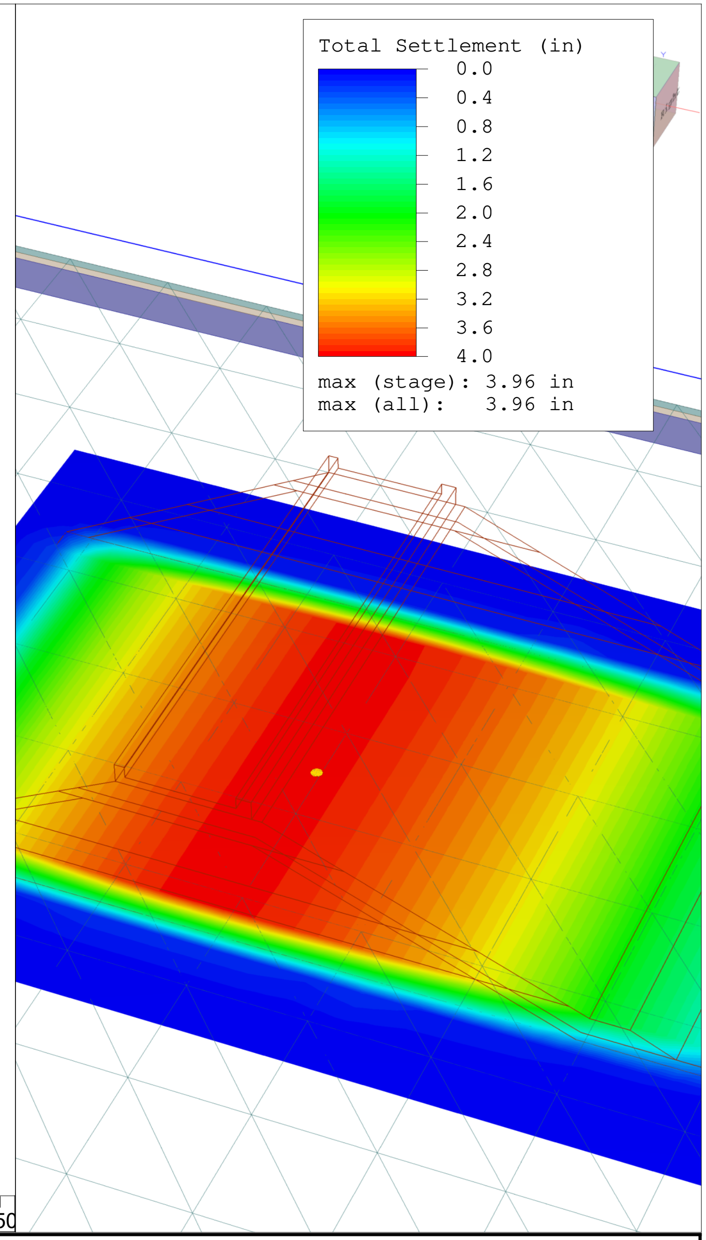
Jacobs

SETTLE3 5.010

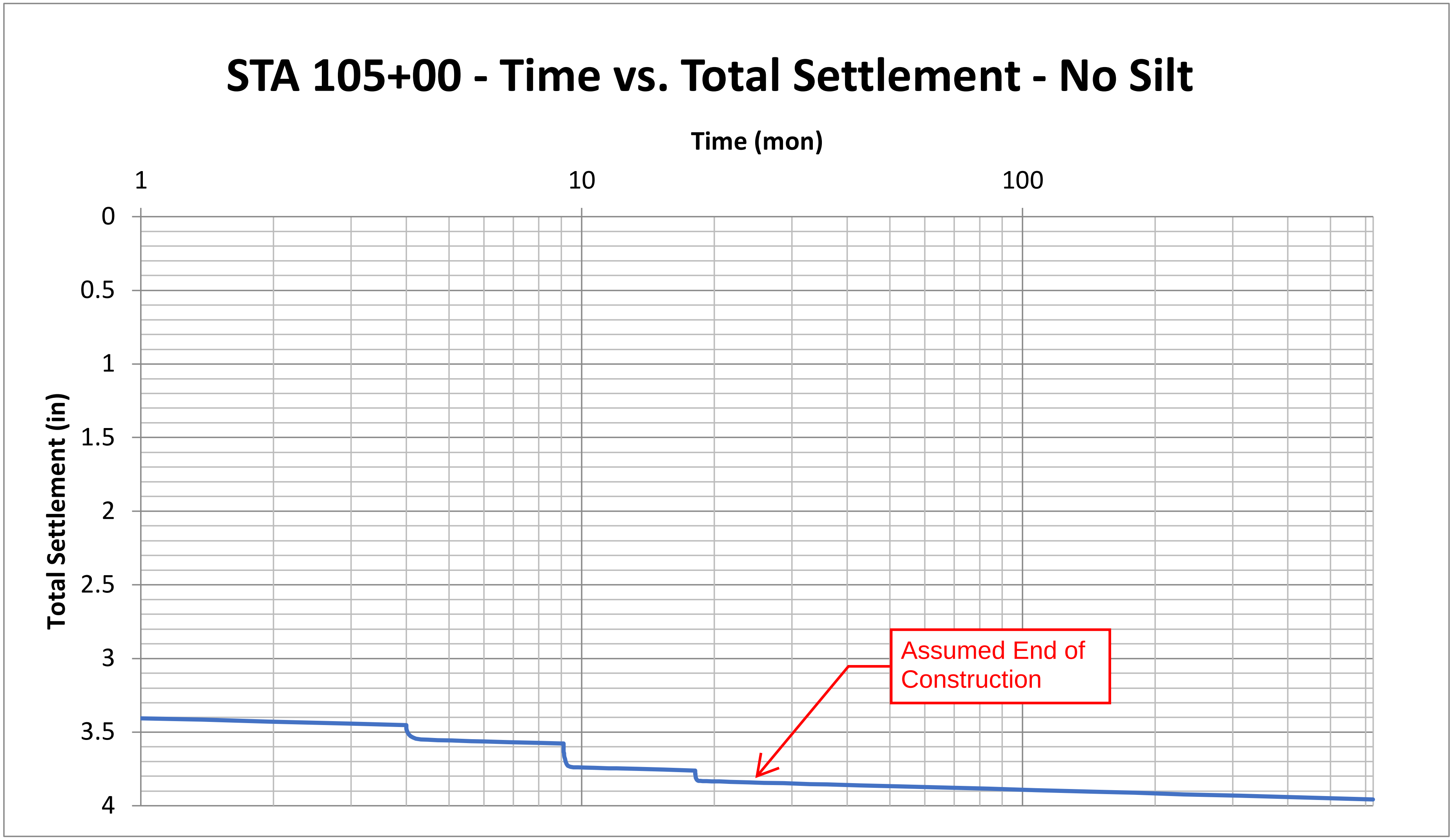
Project	Lubec Breakwater		
Analysis Description	Rubble Mound Settlement - STA 105+00		
Drawn By	M. Kullmann	*Company*	Jacobs
Date	5/17/2024	*File Name*	Lubec Breakwater_WB-102_El. -19_MLLW_staged_no silt.s3z

Material Name	Color	Sat. Unit Weight (kips/ft3)	Es (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (in2/s)	Ca
Upper Clay and Silt		0.125	-	Non-Linear	0.16	0.035	3	0.73	0.000475	0.005
Glacial Till		0.125	1000	-	-	-	-	-	-	-
Bedrock		0.14	-	-	-	-	-	-	-	-
Organic Silt		0.09	-	Non-Linear	0.3	0.06	1	1	0.0001	0.01
Lower Clay and Silt		0.115	-	Non-Linear	0.25	0.05	1	0.73	0.0001	0.005





Jacobs SETTLE3 5.010	*Project* Lubec Breakwater		
	Analysis Description Rubble Mound Settlement - STA 105+00		
	Drawn By M. Kullmann	*Company* Jacobs	
	Date 5/17/2024	*File Name* Lubec Breakwater_WB-102_El. -19_MLLW_staged_no silt.s3z	


STA 105+00 - Time vs. Total Settlement - No Silt
Time (mon)
1
10
100
Total Settlement (in)
0
0.5
1
1.5
2
2.5
3
3.5
4
Assumed End of Construction

Appendix H. Rock Socket Axial Capacity Evaluation

LUBEC BREAKWATER - ROCK SOCKET DESIGN

By: M. Kullmann
Chkd: S. Yang

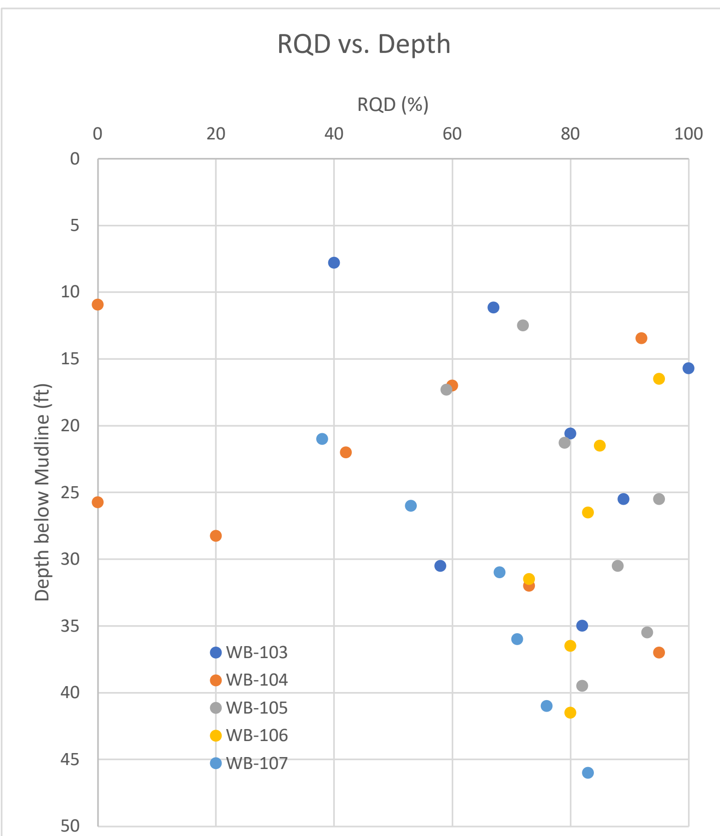
Purpose
The purpose of this calculation is to estimate rock socket ultimate skin friction capacity for the Lubec Breakwater

Rock Core Data

Table 1. Unconfined Compressive Strength Test Results of Rock Cores

Boring ID	Sample ID	Depth	Classification	Recovery	RQD	q_u	E
-	-	ft	-	%	%	psi	psi
WB-103	C-2	11.14-11.51	TUFF	100	67	8693	-
WB-103	C-4	18.61-18.98	TUFF	97	80	8192	-
WB-104	C-3	15.26-15.64	TUFF	100	60	4813	9090000
WB-104	C-7	29.62-30.00	TUFF	100	73	5247	6070000
WB-105	C-3	19.63-20.00	TUFF	100	59	6545	1420000
WB-105	C-4	23.06-23.42	TUFF	100	79	22085	8320000
WB-106	C-2	19.34-19.72	TUFF	100	85	19633	7300000
WB-106	C-4	31.33-31.82	TUFF	100	73	5296	1150000
WB-107	C-3	29.71-30.05	TUFF	100	68	3818	-

Average Bedrock Unconfined Compression, q_u	6086.2857	psi	*Excluding WB-105 C-4 and WB-106 C-2
Standard Devation of UCS Data	1804.3808	psi	
Design Bedrock Unconfined Compression, q_u	**4281.905**	**psi**	



Rock Socket Design Assumptions

1.) The steel pipe piles will be driven through the overburden soil and extend into competent bedrock.
2.) The skin friction contribution of the steel pipe piles in the overburden soil above bedrock is conservatively ignored.
3.) It is assumed that the rock is not subject to rapid deterioration due to construction.
4.) Per AASHTO 10.8.3.5.4a, the resistance of rock sockets can be comprised of side resistance (skin friction), tip resistance (end bearing), or a combination of both. Although a combination of both would provide additional capacity, more settlement is required to mobilize tip resistance than side resistnace. Therefore, the socket capacity will be based on skin friction only.

Ultimate Skin Friction Calculation

The design of the rock socket unit skin friction is based on AASHTO 10.8.3.5.4b for fractured rock (Reese 1999)

$$\frac{q_S}{p_a} = 0.65\alpha_E\sqrt{\frac{q_u}{p_a}} \qquad (10.8.3.5.4b\text{-}2)$$

The joint modification factor, α_E is given in Table 10.8.3.5.4b-1 based on RQD and visual inspection of joint surfaces.

Table 10.8.3.5.4b-1—Estimation of α_E (O'Neill and Reese, 1999)

RDQ (%)	Joint Modification Factor, α_E Closed Joints	Joint Modification Factor, α_E Open or Gouge-Filled Joints
100	1.00	0.85
70	0.85	0.55
50	0.60	0.55
30	0.50	0.50
20	0.45	0.45

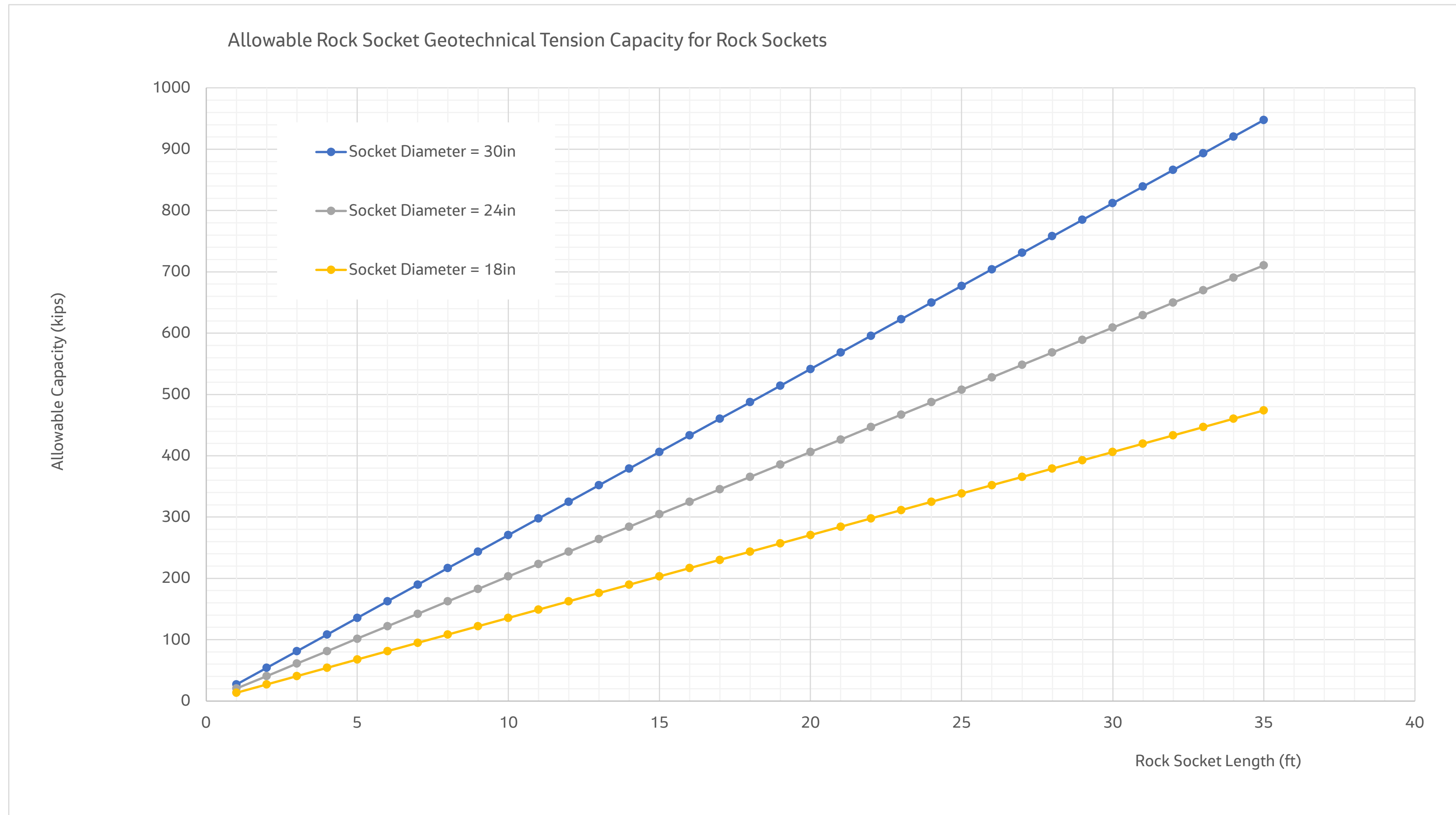
			Notes:
p_a	2.12	ksf	Atmospheric Pressure
α_E	0.55		Joint Modification Factor assuming open joints (AASHTO Table 10.8.3.5.4b-1)
q_u	616.6	ksf	Design Unconfined Compressive Strength of Bedrock, q_u (ksf)
q_S	**12.9**	**ksf**	Ultimate Unit Skin Friction (ksf); AASHTO eq. 10.8.3.5.4b-2

Required Rock Socket Length for Socket - Tension Capacity
By: M. Kullmann
Chkd: S. Yang

Ultimate Unit Skin Friction of Tuff Rock 12.9 ksf

Pipe Pile Diameter (in)	Rock Socket Diameter (in)
36	30
30	24
24	18

	Rock Socket Allowable Tension Capacity (kip) with FOS =3.0		
	Rock Socket Diameter (in)		
Rock Socket Length (ft)	30	24	18
1	27	20	14
2	54	41	27
3	81	61	41
4	108	81	54
5	135	102	68
6	162	122	81
7	189	142	95
8	217	162	108
9	244	183	122
10	271	203	135
11	298	223	149
12	325	244	162
13	352	264	176
14	379	284	189
15	406	305	203
16	433	325	217
17	460	345	230
18	487	365	244
19	514	386	257
20	541	406	271
21	568	426	284
22	596	447	298
23	623	467	311
24	650	487	325
25	677	508	338
26	704	528	352
27	731	548	365
28	758	568	379
29	785	589	393
30	812	609	406
31	839	629	420
32	866	650	433
33	893	670	447
34	920	690	460
35	947	711	474



Notes:
(1) Factor of Safety of 3.0 included to determine allowable tension capacity of rock socket
(2) Capacities assume rock sockets are drilled in competent bedrock below upper 5' of weathered bedrock

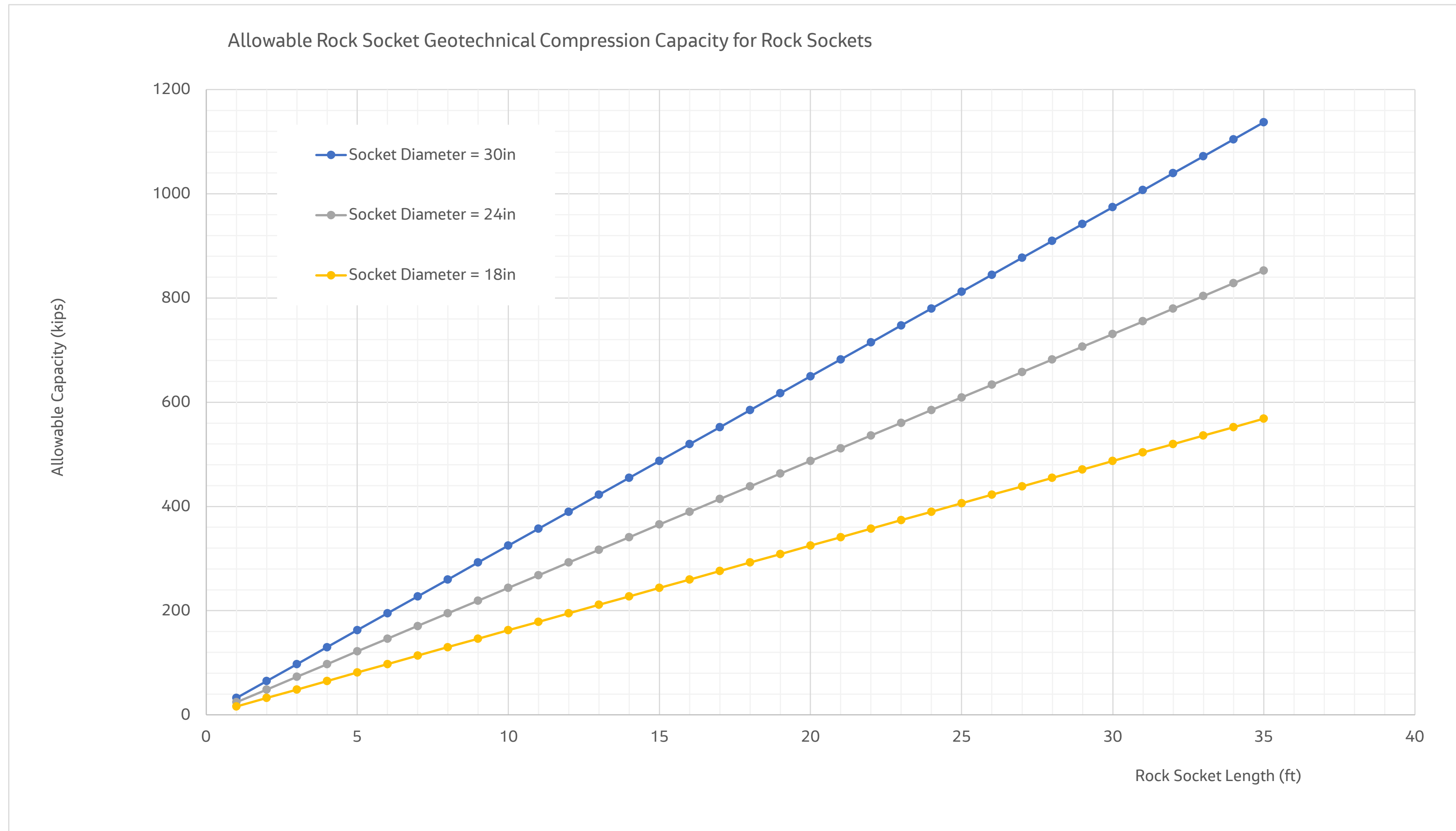
Required Rock Socket Length for Socket - Compression Capacity

By: M. Kullmann
Chkd: S. Yang

Ultimate Unit Skin Friction of Tuff Rock 12.9 ksf

Pipe Pile Diameter (in)	Rock Socket Diameter (in)
36	30
30	24
24	18

Rock Socket Length (ft)	Rock Socket Allowable Compression Capacity (kip) with FOS =2.5 — Rock Socket Diameter (in) 30	24	18
1	32	24	16
2	65	49	32
3	97	73	49
4	130	97	65
5	162	122	81
6	195	146	97
7	227	171	114
8	260	195	130
9	292	219	146
10	325	244	162
11	357	268	179
12	390	292	195
13	422	317	211
14	455	341	227
15	487	365	244
16	520	390	260
17	552	414	276
18	585	439	292
19	617	463	309
20	650	487	325
21	682	512	341
22	715	536	357
23	747	560	374
24	780	585	390
25	812	609	406
26	845	633	422
27	877	658	439
28	910	682	455
29	942	707	471
30	975	731	487
31	1007	755	504
32	1040	780	520
33	1072	804	536
34	1104	828	552
35	1137	853	568



Notes:
(1) Factor of Safety of 2.5 included to determine allowable compression capacity of rock sockets
(2) Capacities assume rock sockets are drilled in competent bedrock below upper 5' of weathered bedrock

Rock Socket Cone Failure Check - Bedrock at El. -30'

By: M. Kullmann
Chkd: S. Yang

Purpose

Since minimal overburden soil was encountered at the pile-supported platform for the Lubec Breakwater, the rock sockets must be checked against rock mass cone failure
Reference: Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems, Pub. No. FHWA-IF-99-015 (FHWA 1999)

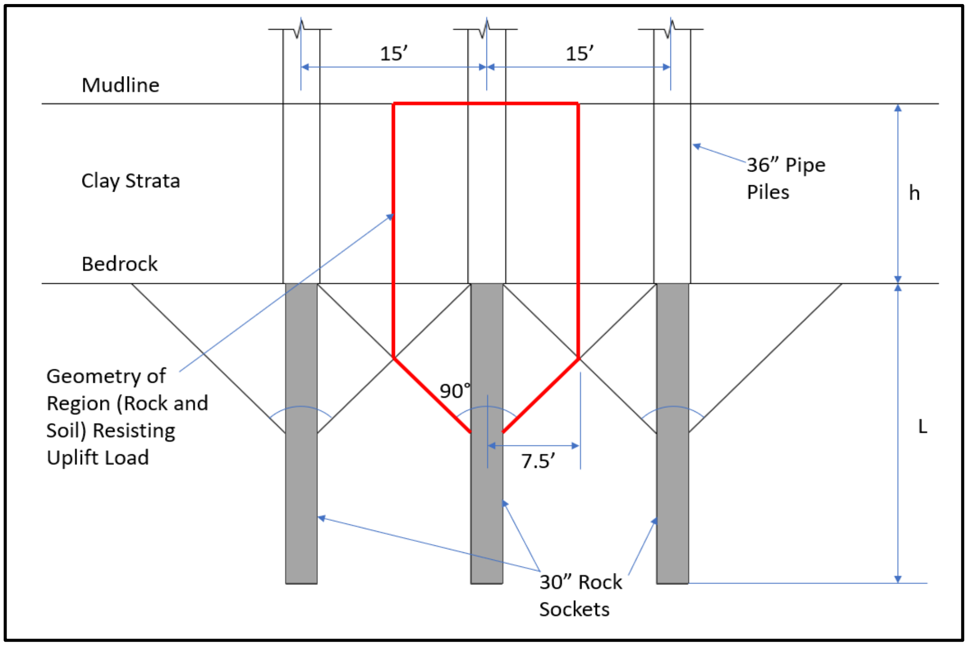


Figure 1. Geometry of Cone Failure Mechanism

Assumptions

1) Rock is mass is moderately hard, with high RQD. Cone angle assumed to be 90 deg.
2) Cone assmed to start at the 2/3*length of socket
3) Calculation based on WB-3

Height of Clay Strata, h	0	ft
Length of Rock Socket, L	25	ft
Height of Rock Cone, 2/3*L	16.667	ft
Unit Weight of Rock	172	pcf
Unit Weight of Clay	100	pcf
Radius of Resisting Cone	7.5	ft
Volume of Soil Overburden	0	ft3
Volume of Rock Cone	441.79	ft3
Volume of Rock above Cone Intersection	1619.9	ft3
Weight of Soil Overburden	0	kip
Weight of Rock Cone	222.66	kip
Total Effective Weight	222.66	kip
Max Tension Load on Socket from Structural Engineer for Bedrock at El. -30'	**222**	**kips**
Factor of Safety	**1.003**	***OK***

Rock Socket Cone Failure Check - Bedrock at El. -35'

By: M. Kullmann
Chkd: S. Yang

Purpose

Since minimal overburden soil was encountered at the pile-supported platform for the Lubec Breakwater, the rock sockets must be checked against rock mass cone failure

Reference: Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems, Pub. No. FHWA-IF-99-015 (FHWA 1999)

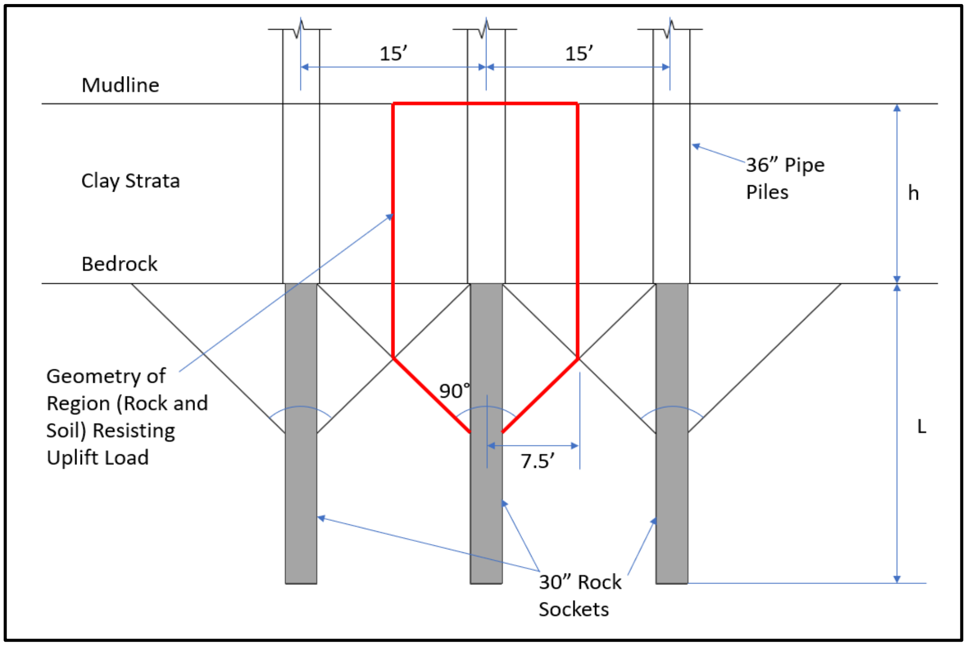


Figure 1. Geometry of Cone Failure Mechanism

Assumptions

1) Rock is mass is moderately hard, with high RQD. Cone angle assumed to be 90 deg.
2) Cone assmed to start at the 2/3*length of socket
3) Calculation based on WB-105

Height of Clay Strata, h	10	ft
Length of Rock Socket, L	25	ft
Height of Rock Cone, 2/3*L	16.667	ft
Unit Weight of Rock	172	pcf
Unit Weight of Clay	100	pcf
Radius of Resisting Cone	7.5	ft
Volume of Soil Overburden	1767.1	ft3
Volume of Rock Cone	441.79	ft3
Volume of Rock above Cone Intersection	1619.9	ft3
Weight of Soil Overburden	63.617	kip
Weight of Rock Cone	222.66	kip
Total Effective Weight	286.28	kip
Max Tension Load on Socket from Structural Engineer for Bedrock at El. -35'	**251**	**kips**
Factor of Safety	**1.141**	***OK***

Rock Socket Cone Failure Check - Bedrock at El. -40'

By: M. Kullmann
Chkd: S. Yang

Purpose

Since minimal overburden soil was encountered at the pile-supported platform for the Lubec Breakwater, the rock sockets must be checked against rock mass cone failure
Reference: Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems, Pub. No. FHWA-IF-99-015 (FHWA 1999)

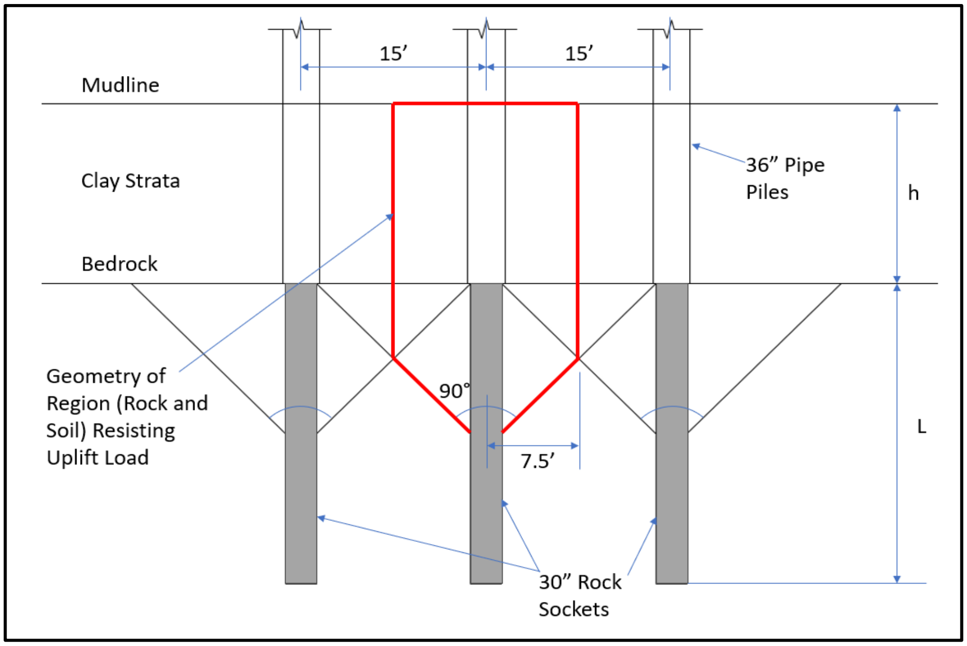


Figure 1. Geometry of Cone Failure Mechanism

Assumptions

1) Rock is mass is moderately hard, with high RQD. Cone angle assumed to be 90 deg.
2) Cone assmed to start at the 2/3*length of socket
3) Calculation based on WB-106

Height of Clay Strata, h	15	ft
Length of Rock Socket, L	25	ft
Height of Rock Cone, 2/3*L	16.667	ft
Unit Weight of Rock	172	pcf
Unit Weight of Clay	100	pcf
Radius of Resisting Cone	7.5	ft
Volume of Soil Overburden	2650.7	ft3
Volume of Rock Cone	441.79	ft3
Volume of Rock above Cone Intersection	1619.9	ft3
Weight of Soil Overburden	95.426	kip
Weight of Rock Cone	222.66	kip
Total Effective Weight	318.09	kip
Max Tension Load on Socket from Structural Engineer for Bedrock at El. -40'	**276**	**kips**
Factor of Safety	**1.152**	***OK***