2018 Ports Assessment: Port Ivory

Pre-front End Engineering Design Report

Final Report | NYSERDA Report Number 19-03 | February 2019

NEW YORK STATE OF OPPORTUNITY | NYSERDA

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2018 Ports Assessment:

Port Ivory

Pre-front End Engineering Design Report

Final Report

Prepared for:

New York State Energy Research and Development Authority

Albany, NY

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New York, NY

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Acronyms and Abbreviations

BFE	Base Flood Elevation
CM	Cubic meter
CY	Cubic Yard
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MSL	Mean Sea Level
MT	Metric Ton
NOAA	National Oceanic and Atmospheric Administration
OPC	Opinion of Probable Cost
OSW	Offshore Wind
PANYNJ	The Port Authority of New York and New Jersey
Pre-FEED	Pre-front End Engineering Design
PSF	Pounds per Square Foot
RSLR	Relative Sea Level Rise
SY	Square Yard
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WEA	Wind Energy Area

Executive Summary

The Port Ivory Pre-front End Engineering Design (Pre-FEED) is one of a series of targeted sites for Pre-FEED prepared on behalf of New York State as a part of the 2018 Ports Study. The 2018 Ports Study builds upon the Assessment of Ports and Infrastructure [1] completed in support of the New York State Offshore Wind Master Plan [2]. The objective of the 2018 study is to identify facilities with greatest feasibility for offshore wind use and develop concept designs of those facilities in order to illustrate their potential, while also developing a deeper understanding of activities, schedule, and costs required to develop each facility. Port of Ivory is one of the facilities selected by NYSERDA, inclusive of significant stakeholder input, for Pre-FEED.

The Port Ivory Pre-FEED is based on a combination of site characterization information provided by the terminal operator, publicly available information and an exploratory geotechnical investigation program completed for NYSERDA. It should be noted that there may be some scope of offshore wind operations that would require less infrastructure development than what is outlined in this Pre-FEED.

Port Ivory is located in the northwestern corner of Staten Island, NY, along the Arthur Kill Federal Channel and northwest of the Goethals Bridge and generally refers to the area formerly occupied by the Ivory Soap factory. The Port Ivory site consists of parcels B and C, which are owned by the Port Authority of New York and New Jersey (PANYNJ). Parcels B and C were subject of a Request for Proposals (RFP) in November 2016 [3], although no qualified bids had been received at the time of this report. As a result, some areas of parcel B are in use by the PANYNJ for Goethals Bridge Material, while parcel C is not currently in use. West of the Port Ivory site, the Howland Hook Marine Terminal is currently leased by the PANYNJ and is owned by the New York City, and leased to/operated by the Global Container Terminals. Facility plan is shown in Figure 2. Parcel C, the waterfront area envisioned for offshore wind, is a currently unused area and is returning to a natural state with trees and other vegetation growing.

The Port Ivory site, in general, can be characterized as undeveloped. Therefore, all new infrastructure will be necessary in order to support offshore wind operations. The Port Ivory Pre-FEED is based upon general preparation activities intended to facilitate a range of staging and installation, foundation fabrication, and substation fabrication activities. Additional offshore wind related uses beyond those identified are possible at Port Ivory, but the Pre-FEED is focused on those uses most commonly identified by supply chain and stakeholder input. The scope and associated cost and schedule are subject to refinement depending upon the ultimate use of the facility, as well as future stages of design. The Pre-FEEDs are intended to be conservative, yet realistic to address the long-term needs of the supply chain. Potential port developers should use the information and estimates in this report as it is relevant to their specific infrastructure needs. The following site development activities were identified, quantified, and incorporated into the Opinion of Probable Cost (OPC):

- Clearing and grubbing the site (9.6 hectares or 24 acres).
- Constructing a heavy load wharf with 30 MT/m² (6,000 PSF) of live load capacity. The wharf is pile-supported and 400 m (1,310 ft.) length of primary berthing face and 35 m (115 ft.) width.
- Grading the site to the design level surface elevation. This consists of a gross cut volume of approximately 81,230 m³ (106,240 CY) and a gross fill volume of approximately 115,330 m³ (150,850 CY), as well as hauling, and placement.
- Performing a ground improvement campaign, consisting of installing rigid inclusions achieve 30 MT/m² (6,000 PSF) live load capacity within the platform area behind the pile-supported heavy load wharf and 15 MT/m² (3,000 PSF) live load capacity within the platform area throughout the rest of the site.
- Procuring and installing 137,240 m³ (179,500 CY) of crushed stone to assist with ground improvement and provide 13.7 hectares (34 acres) of surface treatment.
- Dredging 142,860 m³ (186,850 CY) of sediment from the berth area.

The OPC to develop Port Ivory yields a total projected construction cost of approximately $340 million USD (2018-dollar value). The OPC includes both a $262 million estimate of primary activities, and a 30% design and construction contingency of $78 million due to the Pre-FEED level of the design.

Port Ivory is air draft restricted by the Verrazano-Narrows Bridge, having a clearance of 65.5 m (215 ft.) at center span, and the Bayonne Bridge, having a clearance of 65.5 m (215 ft.) at center span. Port Ivory is water depth restricted by the authorized depth of the Arthur Kill Federal Channel, which has minimum depth of approximately -16.15 m (-53 ft.) NAVD88, or -15.3 m (-50 ft.) MLLW, in the vicinity of Port Ivory. The air and water drafts may potentially affect the vessels calling at the facility and the ability to transport some components in a vertical mode. Some components may need to be transported horizontally due to the air draft restriction.

The offshore wind industry in New York is poised for rapid expansion. In his 2019 State of the State Address, Governor Andrew M. Cuomo announced an expansion of the State's Clean Energy Standard from 50% to 70% renewable electricity by 2030. As part of that announcement, New York also increased its commitment to offshore wind from 2,400 MW by 2030 to 9,000 MW by 2035. Achieving this goal will require thoughtful planning, design, and construction of highly capable, modern, and dedicated port facilities. The undeveloped parcel C at Port Ivory presents an opportunity to develop such an offshore wind port facility. Developing Port Ivory would provide an enormous benefit to the offshore wind industry by delivering a dedicated port facility, which will be critical to for the supply chain while creating new and local jobs in the greater New York area.

1 Introduction

The Port Ivory Pre-front End Engineering Design (Pre-FEED) is one of a collection of targeted sites taken from the 2018 Ports Study specifically selected for Pre-FEED prepared on behalf of New York State. The 2018 Ports Study builds upon the Assessment of Ports and Infrastructure [1] completed in support of the New York State Offshore Wind Master Plan [2].

The objective of the 2018 study is to identify the facilities with the greatest feasibility for offshore wind use and develop Pre-FEED designs of those facilities to illustrate their potential, while also developing a further understanding of the activities, schedules, and costs necessary to develop each facility. Port Ivory is one of the facilities selected by NYSERDA, inclusive of significant stakeholder input, for Pre-FEED.

The offshore wind industry in New York is poised for rapid expansion. In his 2019 State of the State Address, Governor Andrew M. Cuomo announced an expansion of the State's Clean Energy Standard from 50% to 70% renewable electricity by 2030. As part of that announcement, New York also increased its commitment to offshore wind from 2,400 MW by 2030 to 9,000 MW by 2035. Achieving this goal will require thoughtful planning, design, and construction of highly capable, modern, and dedicated port facilities. The undeveloped parcel C at Port Ivory presents an opportunity to develop such an offshore wind port facility. Developing Port Ivory would provide an enormous benefit to the offshore wind industry by delivering a dedicated port facility, which will be critical to for the supply chain while creating new and local jobs in the greater New York area.

1.1 Site Description

Port Ivory is located in the northwestern corner of Staten Island, NY, along the Arthur Kill Federal Channel and northwest of the Goethals Bridge and generally refers to the area formerly occupied by the Ivory Soap factory. A vicinity map can be seen in Figure 1. The Port Ivory site consists of parcels B and C, which are owned by the Port Authority of New York and New Jersey (PANYNJ). Parcels B and C were subject of a Request for Proposals (RFP) [3], although no qualified bids had been received at the time of this report. As a result, some areas of Parcel B are in use by the PANYNJ for Goethals Bridge Material, while parcel C is currently not in use. The Howland Hook Marine Terminal, west of the Port Ivory site, is currently leased by the PANYNJ and is owned by the New York City, and leased to/operated by the Global Container Terminals. Facility plan is shown in Figure 2. Parcel C, the area envisioned for offshore wind (and will be referred to as 'Port Ivory' for the purposes of this report), is currently an unused area and is returning to a natural state with trees and other vegetation growing.

Figure 1. Port Ivory Vicinity Map

Source: Google, borough boundaries by Geofrabrik

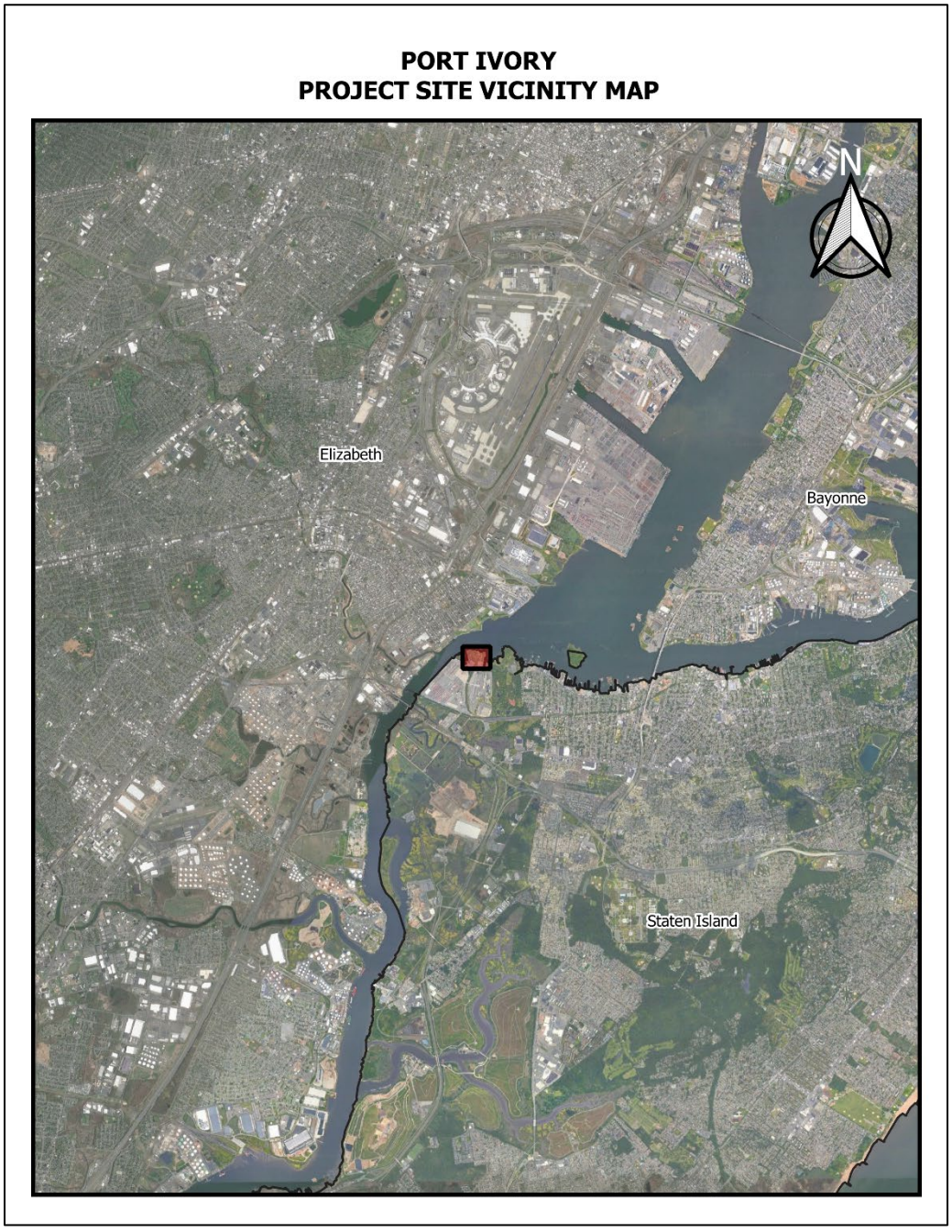
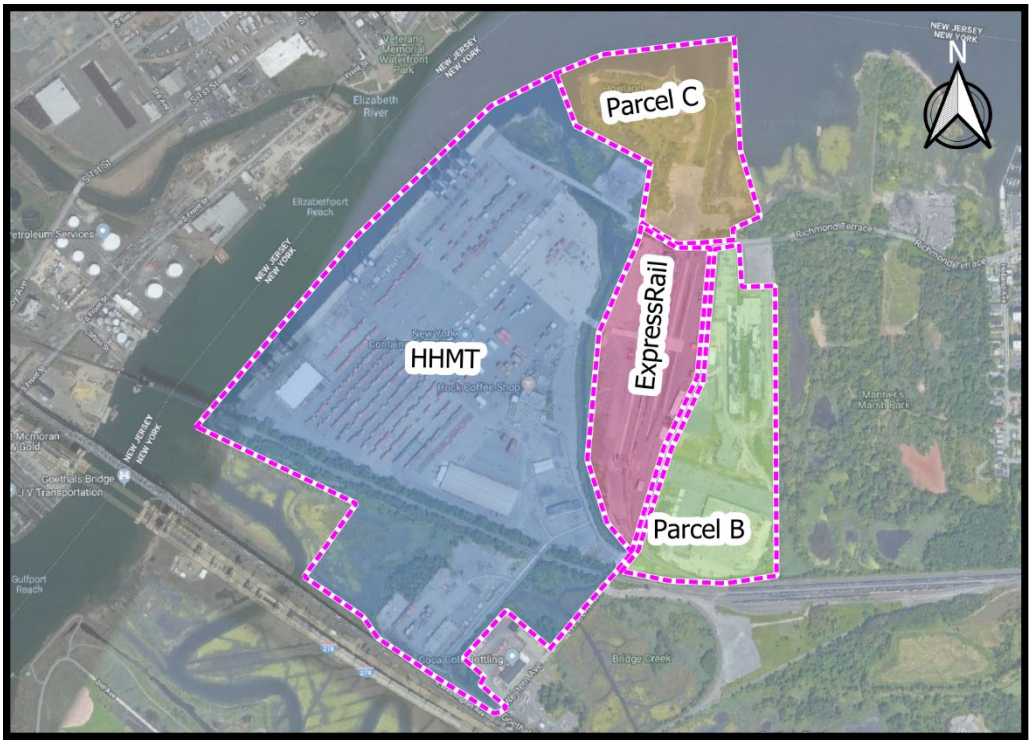


Figure 2. Port Ivory Facility Plan

Source: Google



Port Ivory, in general, can be characterized as relatively planar (uniform land elevations across the site) and undeveloped. The proposed platform is expected to occupy approximately 14.3 hectares (35.4 acres).

The site is in close proximity to all transportation modes; therefore, base materials may be delivered to the site by rail (New York Container Terminal line), road (adjacent to I-278 Interstate Highway), or barge (Arthur Kill Channel).

1.2 History

The site is largely owned by or leased to PANYNJ by the City of New York. At the west end of the facility, Global Container Terminals operates the Howland Hook Marine Terminal (HHMT), a marine container and break-bulk cargo-handling terminal. Over the last decade there have been proposals to redevelop Parcels B and C at Port Ivory to support marine terminal operations, although these plans have not been executed.

1.3 Potential Use

Offshore wind requires the support of several different types of port facilities, ranging from fabrication to transport to operations and maintenance facilities. Port Ivory is potentially capable of serving multiple purposes over the lifetime of one or multiple offshore wind farms. The NYSERDA 2018 Pre-FEED concept for Port Ivory is based upon general preparation activities, with the intention of being able to facilitate multiple potential uses. Accordingly, some aspects of the Pre-FEED may be overdesigned for

some uses, while other aspects may be under designed, depending on the ultimate functionality and use of the facility. In general, the Pre-FEED is intended to facilitate range of staging and installation, foundation fabrication and substation fabrication activities. Within these scenarios, activities at the terminal may include the following:

- Receive sub-components (e.g., steel sections, electrical modules, fabricated subcomponents) and raw materials (aggregate, cement), etc.
- Fabricate concrete and/or steel foundations
- Fabricate offshore electrical substations
- Install secondary steel sections (boat landings, access ladders, etc.) onto foundation components
- Apply protective coating and paints to fabricated components, and
- Receive completed offshore wind components (e.g., foundations, nacelles, towers, blades, etc.) manufactured or fabricated at alternative location(s)
- Store components until sufficient quantity are prepared for offshore installation
- Pre-assemble and stage components to prepare for load out
- Load wind components onto a transportation vessel, for transit to the offshore site

The activities identified here are an example of potential uses of Port Ivory. Additional offshore wind related uses beyond those identified are certainly possible at Port Ivory, but the Pre-FEED was focused on most appropriate uses while taking into consideration supply chain and stakeholder input and ideas.

Due to the air draft restriction below the Verrazano-Narrows Bridge of 65.5 m (215 ft) at center span, the latest generation Wind Turbine Installation Vessels (WTIV) are not be able to sail below the bridge in order to reach the Port Ivory site. This scenario, therefore, requires the use of feeder vessels and assumes the vessel may either take the form of a jack-up feeder vessel (with accommodating leg length) or of a floating inshore feeder barge.

1.4 Operational Characteristics

General facility characteristics were observed and published in the 2017 Ports Assessment. Leveraging that previous work, NYSERDA solicited feedback from the industry to confirm or update general characteristics for facilities that will support New York's offshore wind goals. Based on consolidated industry responses, the Pre-FEED seeks to provide the following:

- Two berth areas with a length of 200 m (660 ft.) each, one berth for dedicated load out, one (or more) multipurpose load in and load out.
- Live load capacity of 30 MT/m² (6,000 PSF) of uniform distributed live load at the wharves and a staging area for approximately 100 m (330 ft.) behind the offshore face of the wharf. The load rating is intended to allow for unrestricted movement of large crawler cranes and self-propelled modular trailers, as well as staging of assembled components.

- Live load capacity of 15 MT/m² (3,000 PSF) of uniform distributed live load within the storage areas of the site. The load rating is intended to allow for movement of self-propelled modular trailers and storage of components.
- A maximized area available for component laydown.

It should be noted that stakeholder input and responses varied widely depending on the particular stakeholder's role or interest. Some stakeholders had more comprehensive requirements while other stakeholder requirements were less significant. The Pre-FEED design is intended to cover conservative, yet realistic needs of the industry. Potential port developers should use the information and estimates in this report as it is relevant to their specific infrastructure needs.

1.5 Site Characteristics

Location	Address: 300 Western Ave, Staten Island, NY 10303 Latitude: 40o38'25" N Longitude:74o11'23" W
Owner	The Port Authority of New York and New Jersey (PANYNJ) (212) 435-3008 http://www.panynj.gov/
Significant Tenants	Global Container Terminals: (718) 568-1700 http://www.globalterminalsnewyork.com/ Express Rail 718 568-1700 https://www.panynj.gov/port/express-rail.html
Distance to Wind Energy Areas (WEAs)	Hudson North Area: 140 km (87 mi) Hudson South Area: 135 km (83 mi) Fairways North Area: 197 km (122 mi) Fairways South Area: 152 km (94 mi) Deepwater Wind South Fork Windfarm: 285 km (177 mi) Equinor Empire Wind Offshore Wind Farm: 90 km (55 mi)
Area	Total Facility (Incl. HHMT, Express Rail, and Parcels B and C)*: ~144 hectares (356 acres) Upland Area (above MHHW) included in Pre-FEED: 14.3 hectares (35.4 acres) Area below MHHW included in Pre-FEED: 4.2 hectares (10.5 acres) Parcel C: 15.4 hectares (38 acres) Parcel B: 10.5 hectares (26 acres) *Approximated based on owner provided documents
Water Frontage	Parcel C: Approx. 980 (3,230 ft.)

Wharf Length(s)	1 x 400 m (1,310 ft.) of primary berthing face @ 30 MT/m² (6,000 PSF), along north shoreline of site
Wharf Live Load Capacity	30 MT/m² (6,000 PSF) in staging/pre-assembly areas 15 MT/m² (3,000 PSF) in storage areas
Navigable Depth	Channel: 15.2 m (50 ft.) MLLW federally authorized for Arthur Kill Channel Berth:8.9 m (29 ft.) MLLW
Limiting Air Draft Restrictions (from facility to unrestricted offshore area)	Bayonne Bridge 63.4 m (208 ft.) between arch and roadway intersection points 65.5 m (215 ft.) maximum at mid-span (note centerline of channel is not in line with mid-span of bridge) Verrazano-Narrows Bridge: 60 m (198 ft.) for the center 610 m (2000 ft.) 65.5 m (215 ft.) maximum at the centerline
Intermodal Connections	Adjacent to Interstate I-278 On-Site rail access to the North American rail network
Surrounding Land Use	Industrial / Park

2 Design Basis

The Pre-FEED Design Basis for Port Ivory is found in Appendix A of this Design Report.

3 Proposed Site Design

The Port Ivory Pre-FEED is an indicative design, with facility characteristics compiled and consolidated from industry input and tailored to best suit the undeveloped site. The proposed site design is intended to provide a uniform and level use area with appropriate capacity live load rating, as well as a heavy load wharf to support offshore wind components. The slope under the wharf will be supported and protected from wave action and scour by a bulkhead-revetment system.

Due to the site being undeveloped, all new infrastructure is necessary. Key site improvement and major infrastructure items investigated for the proposed site design include:

- Demolish and dispose of existing concrete and asphalt pavements and derelict timber piles.
- Clear and grub existing site.
- Install one 30 MT/m² heavy load quay; primary berthing face of 400 m (1,310 ft.) long and 35 m (115 ft.) in width along the north shoreline, with two 50 m (165 ft.) returns (southerly) at the eastern and western extents.
- Grade existing site.
- Improve the subsurface ground bearing capacity across the entire site by installing rigid inclusions. Further, the rigid inclusions serve the purpose of significantly reducing future settlements across the site.
- Improve the ground bearing capacity across the surface of the site by placing crushed rock above existing grade with a thickness of 1 m (3.3 ft.). The crushed rock also provides the working surface treatment, so no additional surface treatment is required.
- Dredged berth area to allow safe vessel access to the site.

These items are described in further detail below and are incorporated into the Opinion of Probable Cost (OPC) in Section 5.

3.1 Demolition, Clearing, and Grubbing

The project site currently consists of remnant pavements and unmaintained vegetation, including trees and bushes ranging in size.

- Existing asphalt and concrete pavements are assumed to be 15 cm (0.5 ft) thick. The existing surface treatment is assumed to be removed prior to excavation operations. The demolished surface treatment materials are assumed to be disposed of, off site.
- Clearing and grubbing of the remainder of the site (9.6 hectares or 23 acres) is anticipated for the proposed design.

Demolition of derelict timber piles extending from the northeast corner of the site is also included the Pre-FEED to clear space for the proposed heavy load wharf (see Section 3.2.1).

3.2 Marine Structures

A heavy load wharf for loading and unloading OSW components from vessels is the key marine structure proposed within the Port Ivory Pre-FEED. Additional structures are necessary to support and protect the proposed wharf, as detailed in the following sections. A plan view identifying the location and extent of marine structures is seen in Pre-FEED Drawing S-01.

30 MT/m² Wharf

Based upon industry input, one continuous heavy load wharf with a 400 m (1,310 ft.) length, comprising two berths, each 200 m (655 ft.) long to accommodate two design vessels, is included in the Port Ivory Pre-FEED. The length of the wharf consists of 400 m (1,310 ft.) of primary berthing face and two 50 m (165 ft.) returns (southerly) at its eastern and western extents to ensure the structural and geotechnical stability of the structure while also providing area at the wharf for onloading/offloading components in these areas; installation of wharves in these areas was chosen in order to reduce the quantity of fill required below MHHW. The wharf was designed to support 30 MT/m² (~6,000 PSF) live load. A steel sheet pile bulkhead, in conjunction with the wharf, is included in the design to function as a cutoff wall.

The wharf platform consists of a heavily reinforced concrete slab supported by steel pipe piles. Pile bents are spaced every 3.2 m (10.5 ft.) on center longitudinally and every 3.65 m (12 ft.) on center laterally. Batter piles are included to ensure lateral stability. A rock anchor at the end of each pile is proposed as foundation underpinning due to the anticipated existence of shallow bed rock at the wharf. A cutoff wall is provided approximately 20 m (65 ft.) landward from the offshore face of the wharf. The cutoff wall effectively decreases the necessary width of pile-supported wharf. A cross-section of the heavy load wharf that identifies its extents, as well as its components' (piles, concrete deck, etc.) sizing, elevations, and location are shown in Pre-FEED Drawing S-02.

Mooring hardware and fendering systems were not designed within the Pre-FEED; however, for the purposes of the indicative Opinion of Cost, 100-ton mooring bollards and a continuous fender system with a rubber cell and steel panel are included along the face of the heavy load wharf. Both systems are assumed to be installed every 20 m (65 ft.) on center.

A stone revetment beneath the proposed wharf and returns (approximately 460 m or 1,510 LF in length) is included in the Pre-FEED. The revetment will stabilize the slope under the wharf and protect from scour.

The revetment consists of two layers of primary stone on top of an underlayer; at the base of the revetment, an embedded toe design was incorporated to prevent scour. Revetment elevations, stone sizing, layer thickness, and toe design are shown in Pre-FEED Drawing S-02.

Rip Rap Revetment

The site's existing east and west shorelines are not well defined; they are a combination of low-lying and wetland areas. In order to stabilize and protect the east and west shorelines at the proposed design platform elevation (see Section 3.3.1), rip rap revetment along these shorelines is included in the Pre-FEED. The rip rap stone will fill in the areas shoreward of the eastern and western platform extents

at a 1V:2H slope until reaching existing ground. Typical rip rap details (crest elevation, stone size, etc.) are shown in Pre-FEED Drawing S-03.

3.3 Earthwork and Ground Improvement

Design Platform Elevation

As discussed in the Design Basis (Appendix A), the design platform elevation was investigated through comparison of several guidance and minimization of material (fill) cost. The existing average elevation of the site is +2.51 m (+8.23 ft.) NAVD88. This Pre-FEED proposes to raise the platform elevation in accordance with UFC guidance to elevation of +3.75 m (12.3 ft.) NAVD88. This results in a net average fill height across the site of approximately 0.24 m (0.8 ft.).

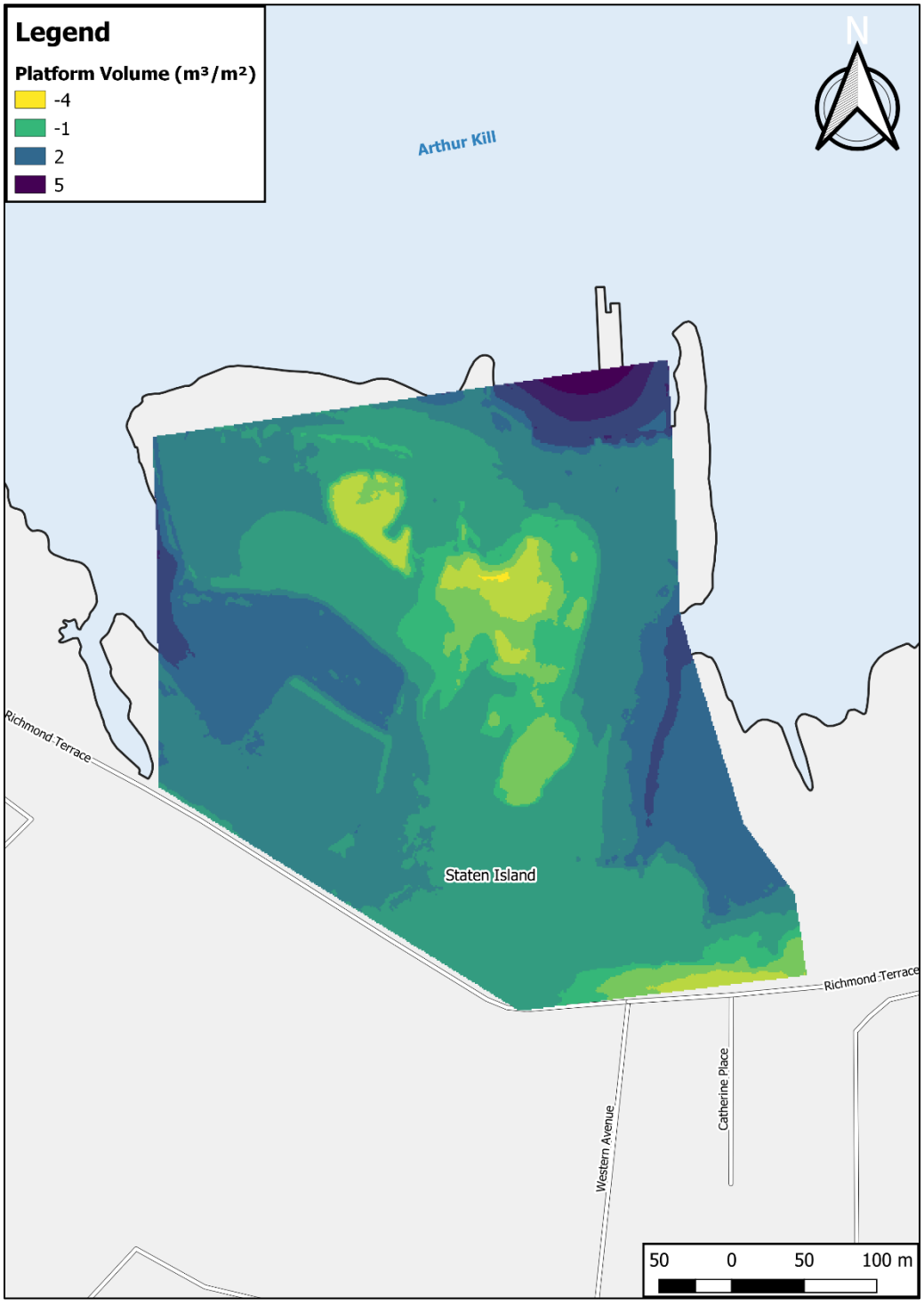
Grading

The existing elevations at Port Ivory vary; generally being greatest in the center of site and decreasing towards the site's shoreline. Grading the site is proposed as part of the process to prepare for ground bearing capacity improvements and to meet the site's design elevation. A design grade elevation of +2.75 m (+9.0 ft.) NAVD88 is proposed in order to meet the design platform elevation (see Section 3.3.1) after placement of surface treatment layer. A 1 m (3.3 ft.) thick layer of crushed stone, which functions as both bearing capacity improvement and surface treatment, is placed on top of the graded site and discussed further in the ground improvement and surface treatment sections.

Grading the site to the design grade elevation results in a net fill volume of approximately 34,100 m3 (44,600 CY). The net volume is derived from an anticipated gross cut volume of approximately 81,230 m3 (106,240 CY) and a gross fill volume of approximately 115,330 m3 (150,850 CY); this design assumes that required fill will consist of a combination of cut material and new fill material will be re-used on site. New fill material will be gravel/bank run and delivered to the site by truck, in which it will then be distributed with the re-used cut material. The areas designated for cut and fill are shown in Figure 3.

Figure 3. Proposed Earthwork Volume

Source: base imagery capturing existing land by NYC; streets by Geofabrik



Ground Improvement

Due to the subsurface conditions at Port Ivory, a ground improvement campaign is required in order for the upland portions of the site to support the vertical live loads from offshore wind components and to

reduce settlements. Based on the site's geotechnical properties (presence of organic silt with high water content, low strength and poor stiffness) and design loads, this Pre-FEED recommends the installation of rigid inclusions at regular spacing.

Rigid inclusions are modulus-controlled columns that function by transferring vertical applied loads through weaker soils to more competent soils below. The rigid inclusions proposed for Port Ivory consist of controlled low-strength material (CLSM) concrete columns that are installed at regular intervals in two directions at the least competent areas of the site. Ground improvement by means of rigid inclusions are adopted for parts of the site where organic and silty sediments are present over bedrock at shallow depth.

The spacing and depth of the rigid inclusions varies depending on both the soil conditions and the load requirement per site area. For the 15 MT/m² (3,000 PSF) area of the site, rigid inclusions are spaced at 1.7 (6 ft.) on center in both directions. For the 30 MT/m² (6,000 PSF) area of the site, rigid inclusions spaced at 1.2 m (4 ft.) on center in both directions is required. The depth of the rigid inclusions varies depending on the depth to the top of the grey sand/red clay layers, of which the rigid inclusions must be embedded approximately 2 m (6.6 ft.) into in order to transfer loading; approximate depths of these layers, as per the geotechnical investigation completed (see Appendix A), range between 6-15 m (20-49 ft.) Further details on ground improvement methods are shown in Pre-FEED Drawings S-01 and S-03.

3.4 Surface Treatment

Crushed stone is used for providing a surface treatment for operations in both the 15 MT/m² (3,000 PSF) and 30 MT/m² (6,000 PSF) areas of the site. Crushed stone is placed on top the site's design grade elevation (2.75 m or 9.0 ft. NAVD88) at a thickness of 1 m (3.3 ft.). This is sufficient to distribute loads to the soils and/or rigid inclusions below. Some settling of the stone is expected over the life of the facility, especially early into the operational phase. The crushed stone surface is readily repairable by minor grading or fill with new stone. The thickness of crushed stone was applied over the total platform area to determine the quantity of stone required.

Compacted bank run gravel, similar to what is used in roadway applications, was assumed to serve this purpose. Due to the quantities required, the surface treatment material is anticipated to be delivered to the site by barge.

3.5 Dredging

Berth Dredging

Vessels are anticipated to berth at the location of the heavy load wharf along the north shoreline of the site in parallel to the Arthur Kill Federal Navigation Channel. The berthing area, as well as the slope under the wharf to accommodate the revetment to be installed, will be dredged.

From south to north, the dredge footprint at the site extends from the face of the berth to the Arthur Kill channel. From east to west, the dredge footprint extends 400 m (1,310 ft.), spanning the length of

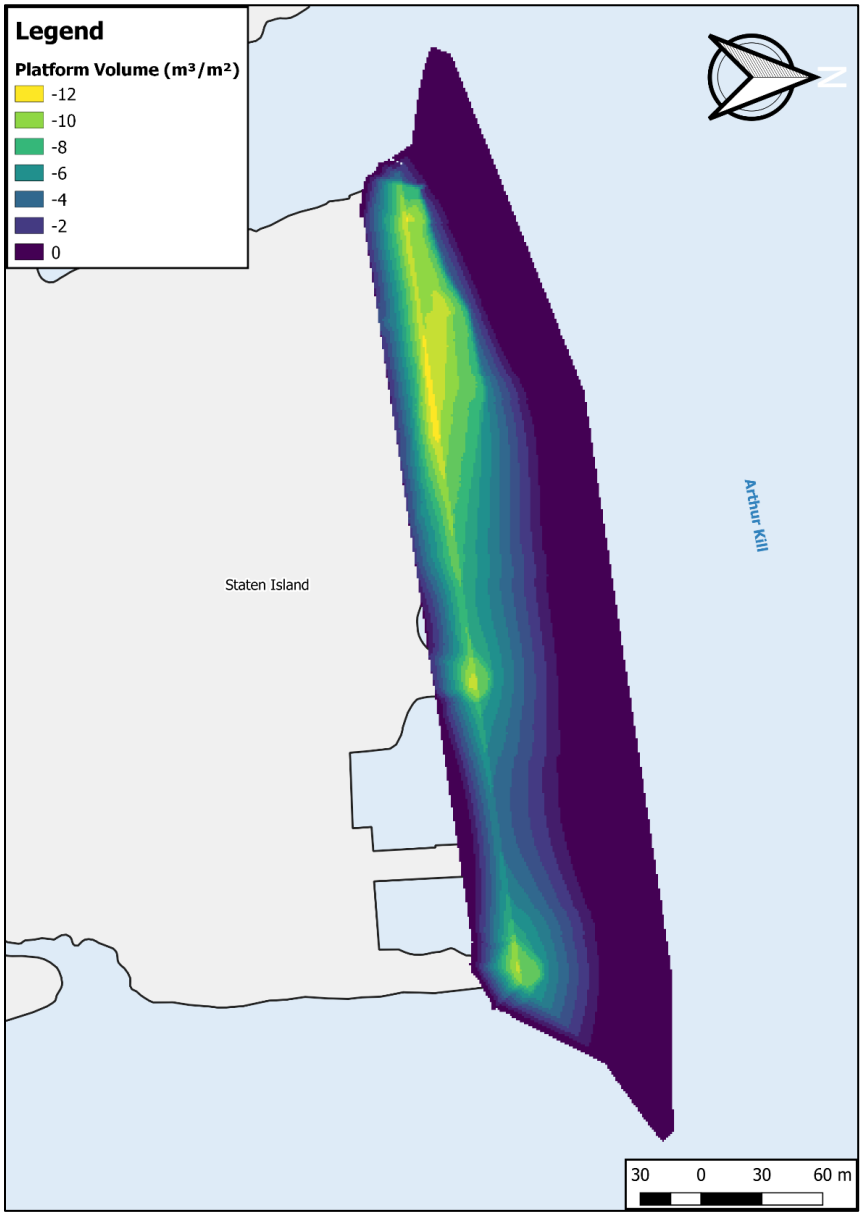
the proposed wharf. The dredge footprint also includes 45-degree angle flares extending from its landward extent until it reached the federal channel limits to accommodate approaching vessels. As per U.S. Army Corps of Engineers (USACE) regulation, a 1V:3H slope from the design depth of the dredge footprint's flares up to existing grade is included in the Pre-FEED. The design dredge elevation is -9.8 m (–32.0 ft.) NAVD88 to accommodate design vessels (with the inclusion of a 0.6 m or 2 ft. under keel clearance). See Pre-FEED Drawing S-01 for information on proposed dredging conditions.

Dredge volumes were calculated using the design dredge extents and difference in elevation between the planned dredge elevations and the site's existing bathymetry. The resulting berth dredge volume was found to be 142,860 m3 (186,850 CY). Dredging volume per area is shown in Figure 4.

Dredging is anticipated to be completed by mechanical means (crane with clamshell bucket, excavator, etc.) with upland disposal. If future site characterization activities determine the material to be of acceptable quality, it may be used for site grading and filling operations, potentially resulting in a significant cost savings to both dredging and grading costs.

Figure 4. Proposed Dredging Volume

Source: base imagery capturing existing land by NYC



Channel Dredging

The authorized depth of the Arthur Kill Federal Channel (-16.11 m or -53 ft. NAVD88) is the responsibility of the USACE. Therefore, existing depths in the project site vicinity were considered to be sufficient for design vessel operations without the need for channel dredging. It will be important to coordinate closely with USACE to understand the frequency or likelihood of channel maintenance dredging.

4 Site Analysis, Benefits, and Challenges

4.1 Navigation Considerations

In order to access the site from offshore, a vessel must travel though New York Harbor, Kill Van Kull Channel, and Arthur Kill Channel. This pathway includes travel beneath the Verrazano and Bayonne Bridges. The controlling air draft restriction posed on Port Ivory is due to the Verrazano-Narrows Bridge, having a 60 m (198 ft.) clearance for the center 610 m (2,000 ft.) of the main span and a 65.5 m (215 ft.) maximum clearance at the centerline. Water depths are limited by the Arthur Kill River authorized dredging depth of -16.2 m (-53 ft.) NAVD88.

4.2 Environmental Permitting

Port facilities will likely require either upland or shoreline improvements or both, in order to support offshore wind development. As such, the port developer or the port facility owner will be required to obtain all necessary federal, State, and local permits to undertake the required improvements. Further, in accordance with New York State environmental regulations, the site improvements will be subject to an environmental review (State Environmental Quality Review or City Environmental Quality Review). The environmental review and permitting process typically involves a public participation component and developers must be prepared to address public concerns.

Port developers need to account for both the time and the cost for completing the environmental review and permitting processes. In addition, port developers may need to account for additional costs associated with the review process, such as providing compensatory mitigation for project impacts.

Pre-application meetings with all involved federal, State, and local permitting agencies are always recommended to ensure port developers have a full understanding of all potential environmental issues related to the development of the port facility. For state level permitting, the New York State Department of Environmental Conservation (DEC) is an excellent initial point of contact regarding the environmental review and permit processes. The DEC can facilitate preapplication meetings and will often include the other state and federal agencies in the initial meetings to provide port developers a comprehensive picture of the environmental review and permitting processes.

The federal and State agencies likely to have jurisdiction or an interest in the port development, though some may be added or subtracted as plans develop, are as follows:

Federal

U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
NOAA/NMFS

State

NYS Department of Environmental Conservation
NYS Office of Parks, Recreation & Historic Preservation
NYS Office of General Service
NYS Department of State

The DEC has provided the following information inform potential development at Port Ivory:

Permitting Considerations

Federally Regulated Wetlands and Other Waters of the U.S.
Tidal Wetlands (site improvements will require extensive wetland fill)
Shoreline improvements require mitigation to compensate for habitat loss

Other Considerations

Considering sea level rise and the undeveloped nature of this site, marsh migration and blue carbon storage are preferable development options
A prior proposal for a port expansion project at this site was unsuccessful due to the extensive wetland fill required
Fill from the previous industrial use remains underground in the upland and could present serious geotechnical issues—Impacts of this magnitude are not likely to be approved or permitted by the DEC

Figure 5. DEC Environmental and Permitting Considerations Map

4.3 Benefits

- Negligible existing usage; site available
- Proximity to WEAs
- Proximity to other facilities
- Existing industrial and manufacturing base on Staten Island and surrounding areas
- Good transportation (railroad, road, water) access
- PANYNJ ownership, experienced operator and maritime labor force

4.4 Challenges

- Potential limitations imposed by the Verrazano-Narrows Bridge, air draft of 60.3 m (198 ft)
- As a filled area within a historically industrialized port, the possibility of groundwater or soil contamination exists and may be a challenge
- Regulatory challenges due to wetlands on site
- Site is not developed and requires additional preparation prior to development

4.5 Optimizations

For a detailed design of the port site, the following may provide room for optimization of the key site improvement and infrastructure items:

- The Pre-FEED design has been performed based on an exploratory geotechnical investigation consisting of three soil borings and associated laboratory testing program. Additional geophysical and geotechnical investigation in precise structure locations will increase certainty of design parameters and reduce conservatism, potentially allowing for a more optimized design.
- For the areas of the site where rigid inclusions are planned, alternative ground improvement methods such as preloading in combination with vertical drains and possible (vacuum loading) could be adopted. For the detailed design the preferred solution should be selected considering the restrictions of the project in terms of costs and time.
- There is a potential for reducing the costs of the geotechnical structures and in particular, the costs for the rigid inclusions by performing further ground investigations providing a better characterization of the stratigraphy across the site. For this characterization it is essential to better characterize the extent of the organic silt layer (depth to the bottom of layer and thickness of layer) across the site.
- Dredging activities assume upland disposal of dredged materials; grading onsite requires a net fill volume of material. It may be possible to reuse some of the dredge material as fill on site, potentially reducing cost associated with both dredge disposal and fill procurement. The potential to realize this cost savings would be evaluated as part of the dredge material classification process completed in later phases of design and permitting.

5 Opinion of Probable Cost

An opinion of probable cost (OPC) was prepared for the key infrastructure improvements identified in Section 3. As noted in Section 1.3, the Pre-FEED is intended to facilitate multiple potential offshore wind related uses. Therefore, depending on the ultimate use of the facility, some infrastructure improvement activities included within the Pre-FEED may be overdesigned, while other aspects may be under designed. Accordingly, the ultimate cost to complete offshore wind related infrastructure improvements may vary significantly, based upon the ultimate use of the facility and the improvements needed to facilitate that use.

The OPC for the Port Ivory Pre-FEED was developed using similar methods as marine contractors. COWI develops OPCs using much of the same methodology that contractors do. Most of the work items were estimated by preparing a detailed estimate of the materials, labor, and equipment anticipated to be used in execution of the work, with the exception of a few work items in which unit pricing was used. Direct wage rates and fringe benefit rates for all labor are consistent with current Prevailing Wage rates for New York City as published by the Office of the New York City Comptroller. COWI leveraged unit costs professional experience with waterfront construction in and around New York State as well as published cost data resources.

The OPC was prepared in accordance with AACE International 18R-97 guidelines for a Class 3 Estimate. Class 3 estimates are used for budget authorization where the current project definition is between 10% and 40% of full project definition with actual costs typically falling within 30% above to as little as 20% below the estimate.

The OPC Summary is found in Table 1. The unit cost data presented in the summary are developed based upon a detailed breakdown on construction activities can be found in Appendix C.

Published bare unit cost data (materials, labor, and equipment) were obtained in 2018-dollar values from published cost data references, marked up for general conditions (8%), overhead (10%), and profit (10%). Unit costs based on observed cost data of waterfront construction projects in the Northeast U.S. within the past 10 years were escalated to 2018 dollars; general conditions, overhead, and profit are included within observed costs and no additional markups were applied. A uniform contingency is applied to the project subtotal.

The authors of this report have no control over the cost of labor, materials, equipment, or services furnished by others, or over competitive bidding or market conditions. The OPC provided herein are made on the basis of best judgment as experienced and qualified professional engineers, familiar with the construction industry; the authors cannot and do not guarantee that actual project or construction costs will not vary from this OPC.

Table 1. OPC Summary Table

WORK ITEM DESCRIPTION		QUANTITY	UNITS	UNIT PRICE	TOTAL
MOBILIZATION AND DE-MOBILIZATION					
	Mobilization and Demobilization	1	Lump Sum	$1,687,000.00	$1,687,000.00
DEMOLITION, CLEARING AND GRUBBING					
	Clearing and Grubbing	95,620	Square Meter	$1.91	$183,000.00
	Demolition: Pavement	33,580	Square Meter	$46.40	$1,558,000.00
	Demolition: Piles	1,600	Square Meter	$4.02	$6,439.15
MARINE STRUCTURES					
	30T/m² Pile Supported Wharf	16,010	Square Meter	$8,060.27	$129,045,000.00
	Rip Rap Revetment	650	Linear Meter	$4,861.54	$3,043,000.00
EARTHWORK & GROUND IMPROVEMENT					
	Upland Excavation above MHW	81,230	Cubic Meter	$16.55	$1,344,000.00
	Upland Fill above MHW	115,330	Cubic Meter	$24.28	$2,800,000.00
	Rigid Inclusions	95,620	Square Meter	$733.04	$70,093,000.00
SURFACE TREATMENT					
	Gravel 30T/m² Staging Area	137,240	Square Meter	$132.33	$18,161,000.00
DREDGING					
	Berth Dredging	142,860	Cubic Meter	$111.19	$15,884,000.00
SUBTOTAL					**$261,649,000.00**
			DESIGN AND CONSTRUCTION CONTINGENCY:	30%	**$78,494,800.00**
TOTAL					**$340,145,000.00**

5.1 Exclusions

The following line items are excluded from the design and OPC:

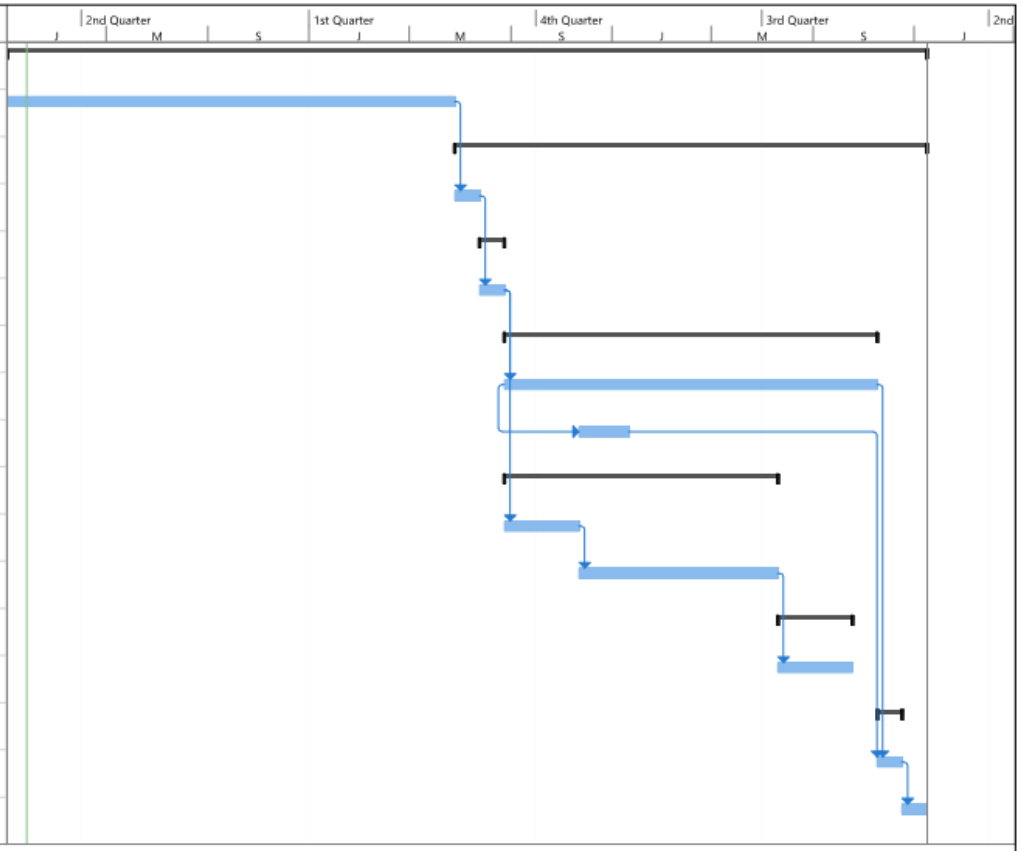
- Utilities
- Public Access
- Operating Infrastructure and Equipment
- Site Acquisition Costs
- Permits and Permit Acquisition Fees
- Professional Services (Design, Regulatory, Legal, etc.)
- Construction Management (CM) fees
- Environmental Mitigation/Remediation

6 Schedule

An estimate schedule was prepared for the key improvements developed for the Pre-FEED. As noted in section 1.3, the Pre-FEED is intended to facilitate multiple potential offshore wind related uses. Accordingly, the schedule to complete offshore wind related infrastructure improvements may vary significantly, based upon the ultimate use of the facility and the improvements needed to facilitate that use. The schedule presented in Figure 6 assumes a traditional design-bid-build project delivery. Alternative delivery methods (e.g., design-build) may reduce the time required to develop the site.

Figure 6. Project Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**PROJECT TOTAL**	**37 mons**	**Wed 1/2/19**	**Sun 1/16/22**	
2	**Planning, Engineering and Permitting**	18 mons	Wed 1/2/19	Thu 6/25/20	
3	**Construction Phase**	**19 mons**	**Thu 6/25/20**	**Sun 1/16/22**	
4	**Mobilization**	1 mon	Thu 6/25/20	Sat 7/25/20	2
5	**Demolition, Clearing**	**1 mon**	**Sat 7/25/20**	**Mon 8/24/20**	
6	Clearing and Grubbing	1 mon	Sat 7/25/20	Mon 8/24/20	4
7	**Marine Structures**	**15 mons**	**Mon 8/24/20**	**Wed 11/17/21**	
8	30 MT/SM Wharf	15 mons	Mon 8/24/20	Wed 11/17/21	6
9	Revetment	2 mons	Sun 11/22/20	Thu 1/21/21	8SS+3 mons
10	**Earthwork & Ground Improvement**	**11 mons**	**Mon 8/24/20**	**Tue 7/20/21**	
11	Grading	3 mons	Mon 8/24/20	Sun 11/22/20	6
12	Rigid Inclusions	8 mons	Sun 11/22/20	Tue 7/20/21	11
13	**Surface Treatment**	**3 mons**	**Tue 7/20/21**	**Mon 10/18/21**	
14	Crushed Stone	3 mons	Tue 7/20/21	Mon 10/18/21	12
15	**Dredging**	**1 mon**	**Wed 11/17/2**	**Fri 12/17/21**	
16	Berth Dredging	1 mon	Wed 11/17/21	Fri 12/17/21	8,9
17	Demobilization	1 mon	Fri 12/17/21	Sun 1/16/22	16



Project: NYSERDA 2018 Ports - Date: Fri 1/25/19

Task	Project Summary	Manual Task	Start-only	Deadline	
Split	Inactive Task	Duration-only	Finish-only	Progress	
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress	
Summary	Inactive Summary	Manual Summary	External Milestone		

Page 1

7 References

[1] COWI, "Assessment of Ports and Infrastructure," COWI, New York, 2017.

[2] NYSERDA, "New York State Offshore Wind Master Plan," NYSERDA, New York, 2017.

[3] THE PORT AUTHORITY OF NY & NJ, "Request for Proposals," THE PORT AUTHORITY OF NY & NJ, PROCUREMENT DEPARTMENT, New York, 2016.

Appendix A: Pre-FEED Design Basis

Table of Contents

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1 Project Description

1.1 Key Infrastructure Improvements

In order prepare the site for use as a staging and installation facility, the following key infrastructure improvements are proposed within the Pre-FEED:

- Demolish and dispose of existing asphalt and concrete pavement and structures on site, including existing derelict pier extending out approximately 110 m (360 ft.) and other existing structures as shown in Figure 1.
- Clear and grub the site (9.6 hectare or 24 acres acres) of unmaintained vegetation (e.g., trees, bushes, etc.). Clearing and grubbing will provide access for site grading and ground improvement activities.
- Install marine structures along the waterfront edges of the site, in order to provide at least two heavy load wharves to load and unload components. The top elevation of marine structures (e.g., top of deck elevation) will match the design platform elevation as discussed in Section 4.10. The bottom elevation of waterfront structures will be based upon the design dredge elevation in berthing areas as discussed in Section 4.11 and the existing seabed/land elevation in non-berthing areas. The proposed marine structures for the Port Ivory site include:
    - Construct pile-supported wharf along the northern end of the site, as shown in Figure 2. The wharf will provide a heavy load capacity berthing area for vessels.
- Install stone revetment, if necessary, along the waterfront perimeter of the site, as shown in Figure 2, in order to stabilize the shoreline. Stone revetment will protect the site shoreline from wave and current exposure, as well as potentially allowing loads to be placed closer to the crest of shoreline slopes.
- Improve the ground bearing capacity and grade areas within the site (13.7 hectare or 34). Ground bearing capacity improvements provide a compact base for the proposed surface treatment in order to meet the required load capacities associated with different areas on site (see Section 2.2). Grading provides a level working surface across the site onto which the surface treatment will then be installed. The method(s) to complete ground improvements will be determined during the Pre-FEED.
- Install surface treatment within laydown areas of the site. Crushed stone will be used as surface treatment in order to accommodate weight of design components and to reduce maintenance costs. Surface treatment design may vary depending on the live load requirement and will be determined during the Pre-FEED.
- Dredge the berthing area to provide sufficient depth for design vessels to safely access the site. Vessels are anticipated to berth at the heavy load area of the wharf along the northern shoreline of the site. For the purposes of the Pre-FEED, which will be based on this Design Basis, the design dredge elevation is chosen to be -9.8 m (-32 ft.) NAVD88 [-8.9 m (-29 ft.) in MLLW

Datum] to accommodate the design vessels identified in Section 4.11. Dredge footprints are shown in Figure 2.

The authorized depth of the Arthur Kill Federal Channel is -16.15 m (-53 ft.) NAVD88. Dredging the federal channel is the responsibility of the U.S. Army Corps of Engineers (USACE), and is, therefore, not considered by this Pre-FEED. The minimum depth of the Arthur Kill channel in the vicinity of Port Ivory is approximately -16.15 m (-53 ft.) NAVD88 at the site as per the February 2018 Controlling Depth Report published by USACE.

1.2 Definition of load areas

The heavy load area is located along the wharf along the northern end of the site and will have 30 MT/m² (6,000 PSF) capacity to support the on-loading/offloading and pre-assembly of components, as well as the required equipment. The rest of the site will have 15 MT/m² (3,000 PSF) capacity to support staging activities and required equipment. Figure 2 shows the proposed load areas.

Figure 1. Proposed Demolition Plan

Source: Google

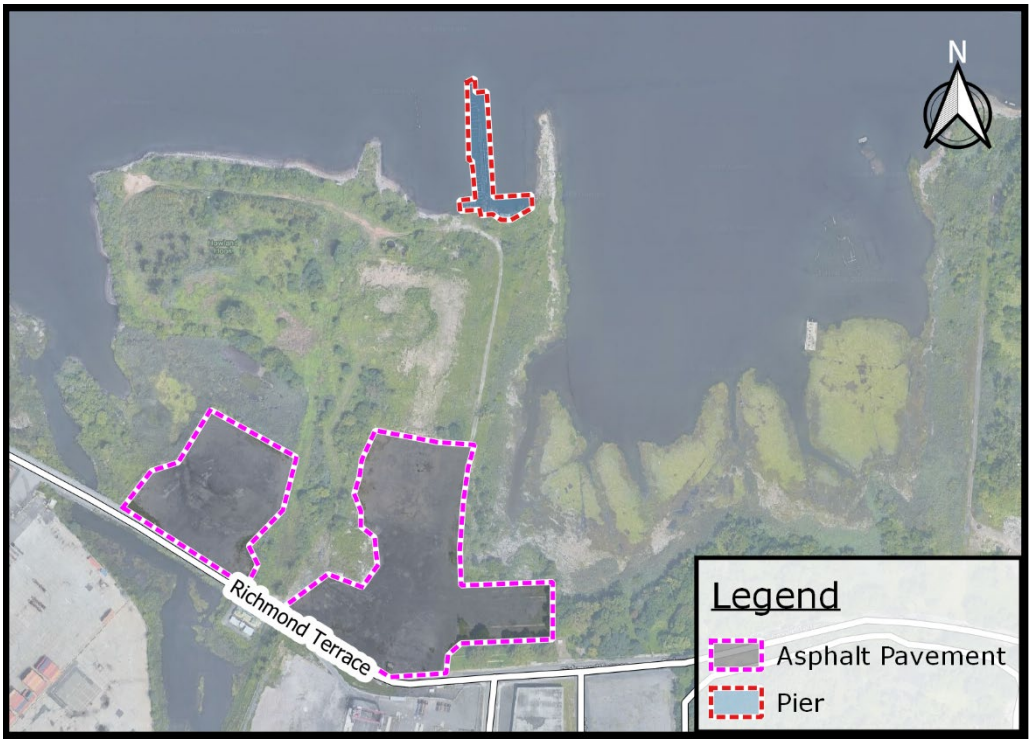
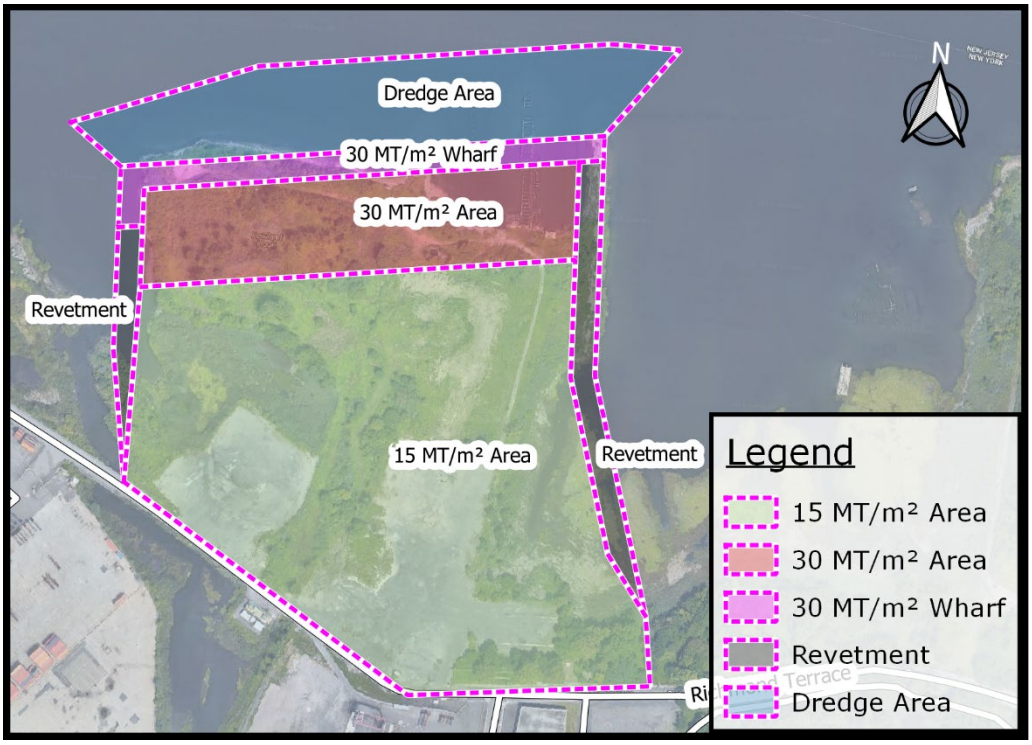


Figure 2. Proposed Layout and Waterfront Development Plan

Source: Google



2 Project Definition

2.1 Service Life

The design service life of facilities proposed in the Pre-FEED is 50 years, starting in 2020 and ending 2070.

2.2 Codes and Design Guidelines

The following codes and guidelines were used for the design of the proposed key improvements at the site:

- Dredging:
  - United States Army Corps of Engineers Engineering Manual 1110-2-1611, "Layout and Design of Shallow-Draft Waterways," dated December 31, 1980
  - United States Army Corps of Engineers Engineering Manual 1110-2-1613, "Hydraulic Design of Deep Draft Navigation Projects," dated May 31, 2006
- Marine Structures
  - Unified Facilities Criteria (UFC), "Geotechnical Engineering," UFC 3-220-01, dated November 1, 2012
  - Unified Facilities Criteria (UFC), "Design: Piers and Wharves", UFC 4-152-01, dated January 24, 2017
  - American Society of Civil Engineers, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures," ASCE/SEI 7-16
  - Specifications for Structural Steel Buildings, ANSI/AISC 360-16
  - American Concrete Institute, "Building Code Requirements for Structural Concrete," ACI 318-14
- Coastal Revetments
  - United States Army Corps of Engineers Coastal Engineering Manual 1110-2-1100, dates vary
  - The Rock Manual, "The use of rock in hydraulic engineering (2nd edition)" 2007

2.3 Horizontal and Vertical Control

All horizontal coordinates and references will be based on the North American Datum of 1983 (NAD83) Adjustment of 2011 NAD83(2011). The coordinate reference system (CRS) for this project will be the projected coordinate system NAD83(2011)/UTM Zone 18N, EPSG 6347, with horizontal units being meters.

The vertical reference level/datum for the project will be the North American Vertical Datum of 1988 (NAVD88). See Table 1 for conversions between NAVD88 and local tidal datums.

2.4 Units

Designs for this project will be completed using SI units, unless otherwise specified. Conversions to U.S. customary units will be provided where appropriate.

3 Site Characterization

3.1 Topographic and Hydrographic Data

Topographic and hydrographic data obtained via publicly-available resources will be used to establish existing site elevations, to prepare infrastructure design, and to estimate dredging and earthwork quantities for the purpose of material and cost estimation. The Topo-Bathymetric Elevation Model of New England, a part of the Coastal National Elevation Database (CoNED) project by the USGS [2], will be used to establish existing Port Ivory site elevations. The CoNED elevation model excludes buildings and vegetation and provides bare earth elevations required to develop facility design and to prepare cost estimates.

The USACE Hydrographic Survey data for the February 2018 Arthur Kill channel survey will be used to update seabed elevations within the CoNED model.

3.2 Tidal Datums

Tidal datums for Port Ivory were obtained from the NOAA Station 8519483, Bergen Point, NY, located approximately 4.5 km (2.9 mi) East of the project site. These tidal datums were used in defining the design platform elevation as well as the design dredge elevation. MLLW to NAVD88 conversion was performed using NOAA Online VDatum tool for the project site: $El_{NAVD88} = EL_{MLLW} - 3'$.

Table 1. Station 8519483 Tidal Datums

1983-2001 Tidal Epoch

Tidal Datum	NAVD '88	MLLW Datum
Mean Higher High Water (MHHW)	0.77 m (2.51 ft.)	1.68 m (5.51 ft.)
Mean High Water (MHW)	0.67 m (2.19 ft.)	1.58 m (5.19 ft.)
NAVD '88	0.00 m (0.00 ft.)	0.91 m (3.00 ft.)
Mean Sea Level (MSL)	-0.07 m (-0.23 ft.)	0.84 m (2.77 ft.)
Mean Tide Level (MTL)	-0.09 m (-0.30 ft.)	0.82 m (2.70 ft.)
Mean Low Water (MLW)	-0.85 m (-2.79 ft.)	0.06 m (0.21 ft.)
Mean Lower Low Water (MLLW)	-0.91 m (-3.00 ft.)	0.00 m (0.00 ft.)

3.3 Relative Sea-Level Rise

Relative sea-level rise (RSLR) was calculated using NOAA data to account for RSLR from 1992–2002 and Climate Change in New York State by NYSERDA (ClimAID) [3] data for Region 4 (New York City) to account for RSLR from 2002–2070. The 2002–2070 RLSR value was determined by applying cubic spline interpolation to the ClimAID data. Year 1992 is the baseline for the RSLR calculation because it is the middle of the current tidal epoch (1983–2001). Low (10th percentile), middle (50th percentile), and high (90th percentile) estimates were considered within the design berth elevation analysis. The RSLR value chosen for this project is the ClimAID High estimate of 1.28 m (4.21 ft.).

Table 2. Relative Sea-Level Rise

RSLR	1992-2002[a]	2002-2070	1992-2070
Low Estimate	0.05 m (0.17 ft.)	0.29 m (0.96 ft.)	0.34 m (1.13 ft.)
Middle Estimate		0.62 m (2.03 ft.)	0.67 m (2.19 ft.)
High Estimate		1.23 m (4.05 ft.)	1.28 m (4.21 ft.)

Note(s):
[a] As per mean relative sea level trend provided by NOAA for Station 8519483, Bergen Point, NY; 5.03 mm/yr. (upper 95% confidence bound)

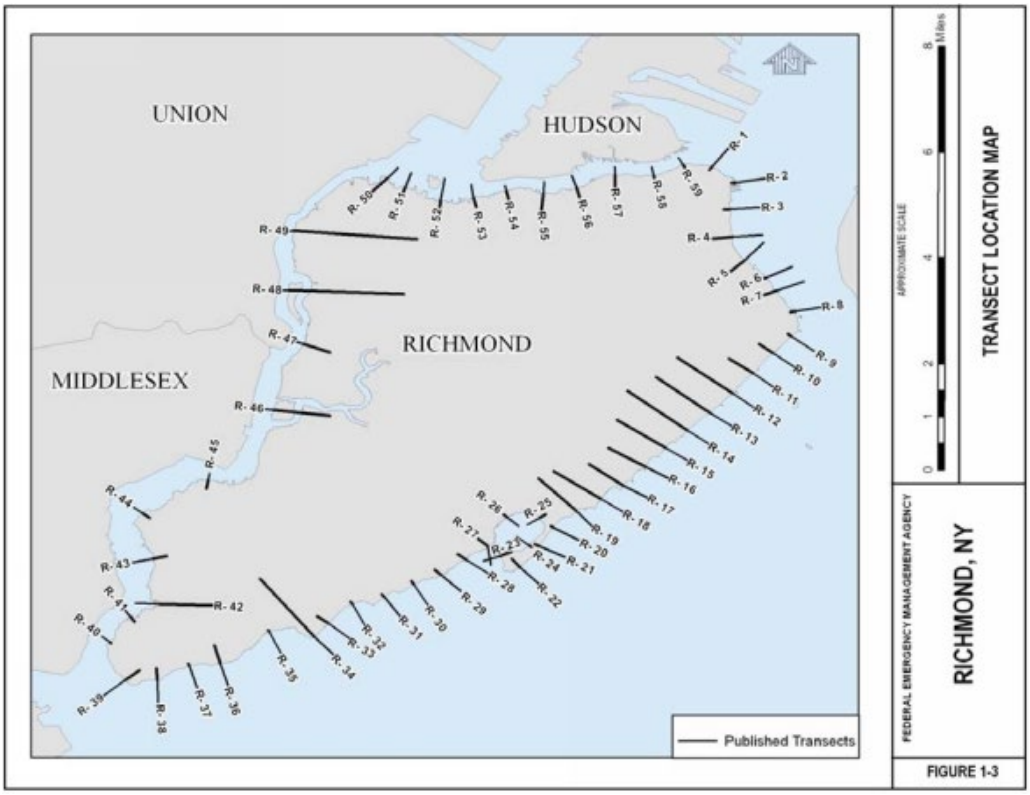
3.4 Waves

Design wave parameters provided in this section will be used to design various components of the proposed facility such as wharf, sheet pile wall, supporting piles, and riprap stone revetment. Wave data was obtained from the regionally applicable FEMA Preliminary Flood Insurance Study (FIS) Report 360497V000B [4], Transect R-50 (see Figure 3):

- 1% Annual Chance elevation $El = 3.66\ m\ (12\ ft.)\ NAVD88$, Zone AE as per preliminary FIRM Panel 3604970168G
- Significant wave height $H_s = 0.7\ m\ (2.29\ ft)$
- Peak wave period $T_p = 3.06\ s$

Figure 3. Preliminary FEMA Flood Insurance Study (FIS) for the City of New York

Transect Location Map



3.5 Currents

Currents do not typically control the design of marine structures, such as stone revetment, sheet pile bulkhead, or pile-supported wharf discussed in this report and to be designed within the Pre-FEED. Detailed tidal and wave current velocity inference would be required for a detailed facility design and is outside of scope of this Design Basis and the Pre-FEED.

The nearest active current station is the NOAA Station n03020 "The Narrows," which is located approximately 16 km (10 mi) southeast of the Port Ivory site. Due to the distance and shape of the flow path from the site to the station within the Upper Bay, current velocities reported by "The Narrows" station cannot be assumed to be indicative of currents at the Port Ivory site.

The nearest current prediction station is the "Elizabethport" NOAA station, ACT3946. Highest weekly current speeds that can be used as a point of reference for typical conditions are as follows:

- ebb: -1.3 knots
- flood: 1.9 knots

3.6 Wind

The location and elevation of the structures proposed within this Design Basis and the Pre-FEED are such that the wind load on the structures would have no significant impact on the structures' capacities and wind climate and loads are not investigated.

The Applied Technology Council (ATC) provides an online resource that can be used to identify wind speeds for design. As a point of reference, the 100-year mean recurrence interval (MRI) wind speed (3-second gust, at 10m or 33 ft. above ground, as per ASCE 7-16) at the Port Ivory site is 42.9 m/s (96 mph).

3.7 Snow and Ice

Vertical loads due to snow and ice loads do not typically control the design of marine structures in the New York Harbor area and are not considered in this Design Basis and the Pre-FEED.

The Applied Technology Council (ATC) provides an online resource that can be used to identify ground snow loads for design. As a point of reference, a ground snow load at the Port Ivory site is 0.1 MT/m² (20 PSF) for any elevation as per ASCE 7-16.

3.8 Seismic Activity

Seismic design is not considered in this Pre-FEED. Seismic performance of proposed structures will be confirmed in later phases of design.

The Applied Technology Council (ATC) provides an online resource that can be used to identify a range of seismic parameters per ASCE 7-16 and can be used as a point of reference if sought out in later phases.

3.9 River Ice

River ice does not affect the pre-FEED design of infrastructure improvements at the site, though may affect day-to-day operations depending on the ultimate end use.

The National Oceanic and Atmospheric Administration (NOAA) provides air freezing index (AFI) values that can be used to predict ice loads. As a point of reference, the 100-year AFI for the Port Ivory site is 521°F-Days.

3.10 Design Platform Elevation

Several alternative methods of determining the design platform elevation have been reviewed, including estimates of existing platform/terrain elevation, FEMA base flood elevation (BFE), and the United Facilities Criteria (UFC) formula. These values were used to inform the final decision, when selecting an optimal platform elevation for the site, and are summarized in Table 3.

Table 3. Design Platform Elevation Alternatives

Method	Elevation (NAVD88)
Existing Land Elevation, Average	2.51 m (8.23 ft.)
UFC Guidance	3.75 m (12.25 ft.)
FEMA Base Flood Elevation (BFE)	3.66 m (12 ft.)

The United Facilities Criteria (UFC) formula:

Equation 1. UFC deck elevation formula

$$\mathrm{E_{deck}} = \mathrm{MHHW} + \frac{2}{3} \cdot \mathrm{H_s} + \mathrm{B} + \mathrm{RSLR} = 3.75\ \mathrm{m}\ (12.25\ \mathrm{ft.}),$$ *where:*

- $MHHW$: mean higher igh-water elevation, 0.77 m (2.51 ft.) NAVD88,
- H_s: significant wave height 0.7 m (2.29 ft.),
- B: freeboard 1.22 m (4 ft.),
- $RSLR$: relative sea level rise 1.28 m (4.21 ft.).

In order to reduce the scope of improvements associated with cut/fill volumes, the Pre-FEED will use a platform elevation that incorporates consideration of the site's average elevation, the designed surface treatment thickness (based on geotechnical conditions and design loads), and UFC and FEMA guidance.

3.11 Design Vessel

The design vessel parameters are used to determine required berth and dredging depths within the Pre-FEED. These depths are dependent on intended use of facility, as well as under keel clearance (0.6 m or 2 ft.).

As a Staging and Installation facility, Port Ivory may have several types of vessels berthing at the site. Table 4 provides the list of potential vessels and their associated characteristics.

Table 4. Design Vessel Characteristics

	Jack-Up Feeder Vessel[a]	Heavy Lift Cargo Vessel[b]	Transport Barge[c]	Inshore Feeder Barge[d]
LOA	70.5 m (231 ft.)	152.6 m (501 ft.)	91.4 m (300 ft.)	122.0 m (400 ft.)
Beam	38.0 m (125 ft.)	27.4 m (90 ft.)	17.1 m (56 ft.)	36.6 m (120 ft.)
Operational Draft	7.9 m (19 ft.)	8.1 m (27 ft.)	3.7 m (12 ft.)	8.0 m (27 ft.)

Note(s):

[a] Based on the jack-up feeder vessel provided in the "U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study" prepared by GustoMSC in October 2017.
[b] Based on the JUMBO heavy lift cargo vessel HLV Fairmaster, K3000 Class.
[c] Based on typical intracoastal barges used for inshore waterways in the U.S.
[d] Based on the inshore feeder barge provided in the "Inshore Feeder Barge Conceptual Feasibility Study" prepared by COWI in 2018.

3.12 Design Depth

Based on a comparison between the design vessels' draft requirements and the authorized dredging depth, the authorized channel dredging depth is greater than required for the design vessels. In order to account for operational drafts of the design vessels at the proposed berths, the design depth at the Port Ivory facility is chosen to be -8.9 m (-29 ft.) MLLW or -9.8 m (-32 ft.) NAVD88, which includes the greatest operational draft of the vessels previously identified, along with 0.6 m (2 ft.) of under keel clearance.

3.13 Geotechnical Conditions

A geotechnical site investigation has been performed by TRC Engineers, cf. [5], and consists of the following:

- Three boreholes to 61 ft (18.6 m), 71 ft (21.6 m) and 76.5 ft (23.3 m) depth below ground level for boreholes PTIV-1, PTIV-2 and PTIV-3, respectively.
- For all boreholes Standard Penetration Tests are performed per approximately every 5 ft (1.5 m) interval.
- Laboratory testing consists of the following:
  - 8 Atterberg limit tests
  - 2 Unconsolidated undrained triaxial tests
  - 1 Unit weight of Soil
  - 16 Sieve tests
  - 19 Moisture content tests
  - 7 Hydrometer tests
  - 5 Unconfined compressive strength tests of rock
  - 4 Organic content tests
  - 4 Organic liquid limit tests (oven-dried liquid limit)

The location of the boreholes is shown in Figure 4 and coordinates are given in Table 5.

Figure 4. Overview of Borehole Locations

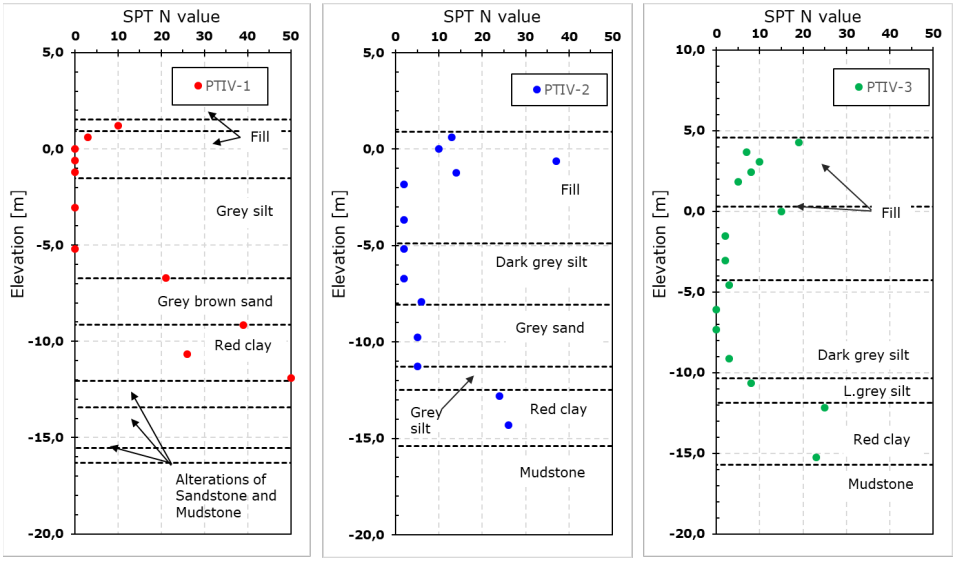
Table 5. Borehole Coordinates and Estimated Ground Surface Elevation at Borehole Locations

Borehole ID	Latitude	Longitude	Estimated ground surface elevation*
PTIV-1	40.644533°	-74.183169°	+1.5 m (+5 ft.)
PTIV-2	40.642672°	-74.179875°	+1.0 m (+3 ft.)
PTIV-3	40.643625°	-74.180200°	+4.5 m (15 ft.)

* Ground surface elevation estimated based on information from google earth.

The stratigraphy encountered at the three available boreholes and the measured SPT-N values are shown in Figure 4. It should be noted that exact ground at each borehole location is only estimated based on information from Google Earth.

Figure 5. SPT-N Measurements and Interpreted Stratigraphy from the Three Boreholes



The soil conditions consist of various fill material, silt, sand, clay and rock (sandstone and mudstone):

- Fill material at the top is of different origin (Gypsum, sand, gavel, silt, brick, and concrete debris and with traces of coal and cinders). Near shore (PTIV-1) the fill is approximately 3 m (10 ft.) in thickness and there are indications of gypsum with low strength (SPT-N values of zero). Upland (PTIV-2 and PTIV-3) the fill material is thicker varying between 6 m (20 ft.) to 9 m (30 ft.) in thickness. It appears that the top 2–3 m (7–10 ft.) have higher SPT N values in the order of 5–20 while further below the fill is particularly week with SPT values around 2. The high values at the top might be caused by the influence of bricks or other debris material.
    - Below the fill material there is a layer of grey silt with practically negligible strength. The grey silt layer is 5.5 m (18 ft.) thick near shore with SPT values of zero. The grey silt layer is around 7.5 m (25 ft.) thick upland and there is indication of traces of organic material. In PTIV-2 there is a 3 m (10 ft.) thick pocket of more sandy material within the silt. The grey silt appears to be less competent in in the top 3–4 m (10–13 ft.) of the layer with SPT values of *N*=0–3. With depth the SPT increases slightly. This can be considered an effect of the increasing depth.
- A layer of grey brown sand is present below the grey silt for boreholes PTIV-1 and PTIV-2. The layer has a thickness of 2.5–3 m (8–10 ft.). Traces of silt and gravel are reported for this layer.
- Below the grey silt and grey brown sand, red clay is encountered. The layer is approximately 3–4 m (10–13 ft.) thick and is characterized by SPT N-values in the range 20–50 with the majority of the measurements between 25 and 30. Traces of sand and rock fragments are encountered in this layer.
- Below the red clay, bedrock is encountered. Bedrock consists of weathered soft to medium hard mudstone. For borehole PTIV-1 the mudstone is interbedded with moderately weathered soft to medium hard sandstone. The rock quality designation (RQD) varies between 13% and 78% with the majority of the values being in the range 30–60%.

Soil parameters to be applied for design purposes have been predicted based on the available laboratory test data and recommendations of Kulhawy and Mayne, cf. [5], for the soils (based primarily on SPT-measurements) and based on unconfined compressive strength tests.

In general, the sieve tests confirmed to quite a large extend the SI borehole descriptions and theyin general imply materials with strength properties in line with the SPT measurements in the respective depths.

The tests performed in soil samples from the grey silt layer confirmed that this layer has practically no strength since very high-water contents were measured for the majority of the samples tested. In fact, the tests revealed the organic nature of the deposit, which seems consistent across the site. The organic content varies, but it has been found that can be as high as 63%. The very low strength of this material was also confirmed by the two UU tests where the undrained shear strength was measured to be in the order to 20-30kPa.

With regard to the red clay, the Atterberg limit tests confirm the borehole description and it seems that this clay is quite hard.

Soil parameters adopted for design purposes are presented in Table 5, Table 6, and Table 7. It should be noted that for the interpretation of fill soil parameters an additional level of conservatism was inherently adopted since some of the high N-SPT values may represent the presence of brick or other debris material.

The tests in the rock samples result in unconfined compressive strengths that vary from 5 MPa up to 28 MPa approximately varying across the site and between the dolostone and the mudstone. The RQD values in all boreholes clearly indicate the weathered nature of the rock material. The depth of the weathered zone is not known and in general the strength of the rock is expected to be controlled by its fractures (orientation and infill material).

The water level has been encountered at depths below ground level of 0.9 m (3 ft.), 1.2 m (4 ft.) and 6.1 m (20 ft.) for PTIV-1, PTIV-2, and PTIV-3, respectively. These measurements correspond well with the approximate ground elevations at the three boreholes indicating that the water level at the borehole locations is similar to the water level in the River. The water level is expected to fluctuate slightly due to seasonal and tidal variations. Due to the description of the fill material, very limited variation in water level is expected across the site.

Table 6. Representative Soil Profile the Area Near Borehole PTIV-1

Elevation, top of layer	Elevation, bottom of layer	Layer description	SPT-N, representative value	Bulk/ effective unit weight, γ/γ'	Undrained shear strength, su	Peak internal angle of friction, ϕ'	Effective cohesion, c'	Unconfined compressive strength, qu
m (ft.)	m (ft.)		-	kN/m³ (pcf)	kPa (psf)	°	kPa (psf)	MPa (tsf)
1.5 (0.5)	0.9 (0.3)	Fill (Silty sand)	10	17/7 (109.2/45)	N.A.	29	0 (0)	N.A.
0.9 (0.3)	-1.5 (-0.5)	Fill (Gypsum)	1	15/5 (96.3/32.1)	N.A.	26	0 (0)	N.A.
-1.5 (-0.5)	-6.7 (-2.0)	Dark grey silt (organic)	1	15/5 (96.3/32.1)	10 (210)	N.A.	N.A.	N.A.
-6.7 (-2.0)	-9.1 (-2.9)	Grey brown sand	30	19/9 (122/57.8)	N.A.	42	0 (0)	N.A.
-9.1 (-2.9)	-12 (-3.7)	Red clay	26	18/8 (115.6/51.4)	180 (3760)	N.A.	N.A.	N.A.
-12.0 (-3.7)	-16.3 (-5.0)	Alterations of weathered Red Sandstone and mudstone	N.A.	N.A.	N.A.	N.A.	N.A.	5 (46)
-16.3 (-5.0)	Non-proven	Moderately weathered Red mudstone	N.A.	N.A.	N.A.	N.A.	N.A.	12 (111)

Table 7. Representative Soil Profile the Area Near Borehole PTIV-2

Depth below ground, top of layer	Depth below ground, bottom of layer	Layer description	SPT-N, representative value	Bulk/ effective unit weight, γ/γ'	Undrained shear strength, s_u	Peak internal angle of friction, φ'	Effective cohesion, c'	Unconfined compressive strength, q_u
m (ft.)	m (ft.)		-	kN/m³ (pcf)	kPa (psf)	°	kPa (psf)	MPa (tsf)
0.9 (0.3)	-4.9 (1.5)	Fill (sandy)	8	17/7 (109.2/45)	N.A.	29	0 (0)	N.A.
-4.9 (1.5)	-8.1 (2.5)	Dark grey silt (organic)	2	15/5 (96.3/32.1)	10 (210)	N.A.	N.A.	N.A.
-8.1 (2.5)	-11.3 (-3.4)	Grey sand	5	18/8 (115.6/51.4)	N.A.	30	0 (0)	N.A.
-11.3 (-3.4)	-12.5 (-36.1)	Grey Silt	5	15/5 (96.3/32.1)	10 (210)	N.A.	N.A.	N.A.
-12.5 (-3.8)	-15.4 (-4.7)	Red Clay	26	18/8 (115.6/51.4)	180 (3760)	N.A.	N.A.	N.A.
-15.4 (-4.7)	Non-proven	Moderately weathered Red mudstone	N.A.	N.A.	N.A.	N.A.	N.A.	16 (149)

Table 8. Representative Soil Profile the Area Near Borehole PTIV-3

Depth below ground, top of layer	Depth below ground, bottom of layer	Layer description	SPT-N, representative value	Bulk/ effective unit weight, γ/γ'	Undrained shear strength, s_u	Peak internal angle of friction, φ'	Effective cohesion, c'	Unconfined compressive strength, q_u
m (ft.)	m (ft.)		-	kN/m³ (pcf)	kPa (psf)	°	kPa (psf)	MPa (tsf)
4.6 (1.4)	0.3 (0.1)	Fill (sandy)	11	17/7 (109.2/45)	N.A.	29	0 (0)	N.A.
0.3 (0.1)	-4.3 (-1.3)	Fill (gravelly traces of cinder)	2	15/5 (96.3/32.1)	50 (1045)	26	0 (0)	N.A.
-4.3(-1.3)	-10.4 (-3.2)	Dark grey silt (organic)	1	15/5 (96.3/32.1)	10 (210)	N.A.	N.A.	N.A.
-10.4 (-3.2)	-11.9 (-3.6)	Light grey silt	3	15/5 (96.3/32.1)	10 (210)	N.A.	N.A.	N.A.
-11.9 (-3.6)	-15.7 (-4.8)	Red clay	37	18/8 (115.6/51.4)	180 (3760)	N.A.	N.A.	N.A.
-15.7 (-4.8)	Non-proven	Dolostone (bedrock)	N.A.	N.A.	N.A.	N.A.	N.A.	12 (111)

4 Live Loads

Based on solicited participation from industry and other stakeholders, including manufacturers, developers, government agencies, etc., the design loads were determined to be 30 MT/m² (6,000 PSF) for onloading and offloading areas, and 15 MT/m² (3,000 PSF) for storage and handling areas.

The higher live load areas at the dock are intended to handle the loads associated with crawler cranes. Whereas the lesser live loads are intended to handle the loads associated with Self Propelled Modular Transporters (SPMTs) and other equipment.

5 Materials

5.1 Concrete

All new structural concrete will conform to the following:

- Concrete will be normal weight with a minimum compressive strength of 5,000 PSI at 28 days
- Concrete reinforcement will conform to ASTM A 615, Grade 60 and will be epoxy coated in accordance with ASTM A 775
- Concrete cover will be 3 in. minimum
- Maximum water to cementitious materials (w/cm) ratio allowed will be 0.4

5.2 Steel

All new structural steel work will conform to the following:

- Steel pipe pile and steel sheet pile material will be fabricated in accordance with API 5L with material either API5LX52, ASTM A572 Grade 50 or approved alternative with a minimum yield strength of 50 KSI or greater
- Structural pipe will conform to ASTM A500 Grade B
- All welding will conform to the Structural Welding Code for Steel as adopted by the American Welding Society (AWS)

5.3 Stone

Acceptable rock material will be any of the following: granite, quartzite, basalt, diabase, gabbro, dolomite, or rhyolite. Stone will weigh more than 165 pounds per cubic foot, have a specific gravity, saturated surface dry (SSD), greater than 2.60.

5.4 Fill

Where possible, fill material will be re-used cut material on site, and/or dredge material.

5.5 Corrosion Protection

Corrosion protection will be considered in the design of waterfront facilities. Corrosion protection will involve a combination of protective coating and sacrificial steel.

6 Exclusions

The following items are not included in the Pre-FEED:

- Design of mooring/berthing structures (e.g., fender system, bollards, etc.). Representative cost of these items will be included in the Opinion of Probable Cost (OPC)
- Utilities
- Ancillary structures (e.g., office buildings, etc.)
- Operational Infrastructure and Equipment
- Intermodal Connections
- Property Ownership
- Professional services
- Permitting

7 References

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[3] NYSERDA, "Climate Change in New York State (ClimAID)," NYSERDA, New York, 2014.

[4] FEMA, "FLOOD INSURANCE STUDY, CITY OF NEW YORK," FEMA, New York, 2013.

[5] I. TRC Engineers, "NYSERDA Port Study Investigation, Port Ivory, New York," Mount Laurel, New Jersey, 2018.

[6] Kulhawy, F.H. and Mayne, P.W., Manual on Estimating Soil Properties for Foundation Design, Cornell University, 1990.

[7] N. Georgas, J. K. Miller, Y. Wang, Y. Jiang and D. D'Agostino, "Tidal Hudson River Ice Cover Climatology," Stevens Institute of Technology, TR-2949; in association with and published by the Hudson River Sustainable Shorelines Project, Staatsburg, NY 12580, 2015.

[8] THE PORT AUTHORITY OF NY & NJ, "Request for Proposals," THE PORT AUTHORITY OF NY & NJ, PROCUREMENT DEPARTMENT, New York, 2016.

Attachment A

Geotechnical Data Report

TRC Engineers, Inc. "NYSERDA Port Study Investigation, Port Ivory, Staten Island, New York," February 6, 2019.

GEOTECHNICAL DATA REPORT

NYSERDA Port Study Investigation
Port Ivory
Staten Island, New York

Prepared by

TRC Engineers, Inc.
16000 Commerce Parkway
Suite B
Mount Laurel, New Jersey 08054

February 6, 2019
TRC Project No. 317660

Submitted to

BTMI Engineering, P.C./COWI, Inc.
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New York, NY 10001

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February 6, 2019

Mr. Brent D. Cooper, PE
Project Manager
BTMI Engineering, P.C./COWI
276 Fifth Avenue, Suite 1006
New York, New York 10001

Re: Geotechnical Services-Data Report
NYSERDA Port Study Investigation
Port Ivory
Staten Island, New York
TRC Project No. 317660

Dear Mr. Cooper,

TRC Engineers (TRC) is pleased to present our geotechnical data report for this project. This report contains a summary of the results of our field investigation, and our subsequent analysis.

We trust that this report contains the information required and we thank you for the opportunity to assist you on this project. If you have any questions regarding the contents of this report, please call our office.

Sincerely,

TRC Engineers, Inc.

Angelo A. Algieri
Geotechnical Engineer

Petro W. Kazaniwsky, PE
Chief Geotechnical Engineer

cc: J. Benjamin, TRC

Contents

Appendices

1.0 PROPOSED WORK AND OBJECTIVES

The project site is located at the undeveloped northern portion of the Port Ivory Marine Terminal located in the northwest corner of Staten Island, New York. The New York State Energy Research and Development Authority (NYSERDA) proposes improvement of waterfront facilities to support the development of offshore wind facilities. The proposed site was identified by BTMI/COWI (COWI), the design engineer, and will require infrastructure upgrades to be determined related to the offshore wind activities.

The objectives of TRC's work were to provide information relative to the subsurface conditions based on field testing at locations requested by COWI and conduct a laboratory testing program selected by COWI.

2.0 FIELD AND LABORATORY TESTING

2.1 Test Borings

The field investigation for this project included advancing three (3) test borings (PTIV-1 to PTIV-3) to rock, with rock coring performed in each boring ranging from approximately 10.0 to 17.5 ft. Test Boring PTIV-1 was drilled along the offshore edge of a proposed new wharf while PTIV-2 and PTIV-3 were drilled behind the 500 ft setback area from the proposed wharf along the eastern half of the site. Prior to drilling, the test borings were marked in the field by TRC using a hand-held GPS at the drill rig accessible locations selected in the field by TRC based on requested locations by COWI. The as-drilled boring locations based on GPS coordinates are identified on the boring logs.

Test borings were completed by TRC's in-house drilling division during the period from December 10 to 11, 2018. Test Borings were advanced using an Acker track mounted drill rig with an automatic hammer. Drilling and sampling were performed in general accordance with ASTM D 1586, D 1587, and D 2213. Continuous split spoon sampling was performed in the upper 10 ft and at 5 ft intervals thereafter. Four (4) thin walled, Shelby tube samples were attempted to obtain undisturbed samples. Rock coring was performed in general accordance with ASTM D 2113. Test borings were logged in the field by one of our geotechnical engineers.

Copies of the Test Boring Layout sketch and test boring logs are attached for your reference.

2.2 Laboratory Testing

Upon completion of the field investigation, soil and rock samples were delivered to our ASTM/AASHTO certified soil mechanics laboratory. Laboratory testing was performed on soil and rock samples selected by COWI. The following table outlines the laboratory testing performed.

Table 1. Laboratory Testing Performed

Laboratory Test	***Reference Standard***	***Quantity of Tests Performed***
Moisture Content	ASTM D 2216	19
Atterberg Limits	ASTM D 4318	8
Organic Liquid Limits	ASTM D 4318	2
Grain Size Analysis (Sieve)	ASTM D 422	16
Grain Size Analysis (Hydrometer)	ASTM D 422	7
Organic Content	ASTM D 2974	4
Unit Weight of Soil	ASTM D 7263	2
UU Triaxial Testing	ASTM D 2850	2
Unconfined Compression of Rock	ASTM D 7012	5

Laboratory test results are summarized in Section 3.0 below, and are also attached for your reference.

3.0 SITE CONDITIONS

3.1 Location and Features

The site is located along the northwestern coastline of Staten Island along the Newark Bay adjacent to the New York Container Terminal. Test boring locations were conducted in an area just north of the developed area of the marine terminal. The three test borings had a relative elevation change of on the order of approximately 10 to 15 feet higher moving from the shoreline (borings PTVI-1 and PTIV-2) to the center (PTIV-3) of the site.

3.2 Site Geology

Published geologic data indicates the project site is underlain by the Passaic Formation. This geologic formation primarily consists of red beds containing argillaceous siltstone, silty mudstone, argillaceous, very fine grained sandstone, and shale which is mostly reddish-brown to brownish-purple, and grayish-red.

3.3 Subsurface Conditions

The subsoils encountered have been grouped into distinct strata based on their physical and engineering properties as observed in the test borings and laboratory test data. The general strata encountered at the project site in the test borings are described below. Please refer to the individual test boring logs for more detailed soil descriptions.

FILL – Fill material generally composed of sand and gravel silt, clay, and gravel mixtures with varying percentages of silt and brick, coal, and concrete debris was encountered in each of the borings. This stratum was encountered from the existing ground surface extending to depths ranging from 10 ft to 29 ft bgs. Standard Penetration Test (SPT) N-values indicate this layer ranges from "very loose" to "very dense" in relative density. However, the higher range of SPT N-values is likely the result of oversized gravel or debris particles. In addition, at test boring location PTIV-1, the fill layer consists of an approximately 8 ft thick layer of possible white to light gray, very soft gypsum fill-like material having a paste-like consistency.

ORGANIC SILT/PEAT– This stratum was encountered underlying the FILL at each test boring location, extending to depths ranging from 27 ft to 49 ft bgs and generally ranged from approximately 10 ft to 20 ft in thickness. SPT N-values indicates the consistency of this stratum ranges from "very soft" to "soft". Laboratory testing performed on selected samples indicates USCS classifications OH. Results of Atterberg limits testing indicate plastic limits ranging from 45% to 317%, liquid limits ranging from 92% to 485%, organic liquid limits ranging from 48% to 49%, and plasticity indices ranging from 47 to 168. Generally, the very high Plastic and Liquid limits are associated with Peat sample tested. Two Unconsolidated Undrained Triaxial (UU) tests were performed on select undisturbed samples from this layer. Results of this testing indicate total cohesion of the samples ranged from 6.2 psi to 8.4 psi. Laboratory determined moisture contents range from approximately 67% to 440%. A dry unit weight of approximately 12.5 pounds per cubic foot (pcf) is indicative of the Peat. Organic contents ranged from approximately 6% to 63%, with the higher values indicative of the Peat. This stratum is highly compressible and secondary consolidation creep as a result of the breakdown of organic matter will continue over the life of the facility.

SAND – This stratum was encountered underlying the ORGANIC SILT/PEAT to depths of 35 ft and 40 ft bgs at borings PTIV-1 and PTIV-2, respectively. This layer consists of sand with varying percentages of gravel and silt. SPT N-values indicate this layer ranges from "loose" to "medium dense" in relative density. Laboratory determined moisture contents ranged from approximately 15% to 18%.

SILT /Sandy Silt– This stratum was encountered underlying the sand at boring PTCY-2 and underlying the organic silt at PTIV-3 to depths of 44 ft and 54 ft bgs, respectively. This stratum generally consists of low to non-plastic silts and sandy silts. SPT N-values indicate this layer ranges from "medium stiff" to "stiff" in consistency.

Clayey-Silty SAND and GRAVEL – This stratum was encountered underlying the SAND or SILT at each test boring location extending to depths ranging from approximately 44.5 ft to 66.5 ft bgs. This stratum generally consists of gravel-sized rock fragments and/or sand with varying amounts of low-plasticity clay and silt. SPT N-values indicate the relative density of this layer is typically "medium dense" to very dense." Results of laboratory testing on select samples indicate USCS classifications of GC-GM and SC, plastic limits of 19% to 20%, liquid limits of 26% to 28%, and plasticity indices of 6% to 9% for the fine-grained portions, and moisture contents ranging from approximately 11% to 15%.

WEATHERED ROCK – This stratum was encountered underlying the silty-clayey sand and gravel at each boring extending to the boring termination depths 61 ft to 76.5 ft bgs. The rock samples obtained from the core runs in this layer consist of red, moderately to severely weathered mudstone with interbedded sandstone. Core recoveries ranged from 80% to 100%. RQD values ranged from 13% to 78%. Results of unconfined compressive testing indicate a compressive strength ranging from 103 tsf to 497 tsf and unit weights ranging from approximately 134 pcf to 161 pcf, as follows:

Rock Core Summary Results					
Test Boring	**Core Run**	**Depth (ft)**	**Unit Weight (pcf)**	**Unconfined Compressive Strength (tsf)**	**Rock Type**
PTIV-1	R-3	54.0-55.0	160.3	577	Mudstone
PTIV-1	R-4	56.6-57.3	133.7	103	Sandstone
PTIV-2	R-1	55.0-56.0	161.2	497	Mudstone
PTIV-2	R-2	57.5-58.0	159.6	325	Mudstone
PTIV-3	R-2	73.0-73.5	155.7	246	Mudstone

Groundwater readings were obtained during drilling in each test boring. Test boring data shows groundwater was first encountered at depths ranging from 3 ft to 5 ft ft bgs in test borings PTIV-1 and PTIV-2 and at approximately 20 ft bgs in test boring PTIV-3. However, based on aerial photographs, the estimated ground surface elevation at test boring PTIV-3 is approximately 10 ft higher than the other boring locations, also corroborated by the additional depth/height of the fill stratum. The water readings are for the dates noted on the logs and may not reflect daily, seasonal, or long-term fluctuations in the groundwater, tidal influences within the Newark Bay, or perched water levels.

The tables below contain recommended soil parameters at each boring location. These parameters are based on the results of the subsurface investigation, laboratory testing of representative samples and TRC's experience with similar subsurface conditions.

RECOMMENDED SOIL PARAMETERS: Boring PTIV-1				
Parameter	**Loose Gypsum FILL** (0-10 ft)	**Organic SILT & PEAT** (10-27 ft)	**Medium Dense SAND** (27-35 ft)	**Medium Dense Silty-Clayey GRAVEL** (35-44.5 ft)
γ (pcf)[1]	60	90	125	130
ϕ *	0°	8°	32°	34°
c (psf)	0	100	0	0
c_a (psf)	0	100	0	0
δ (concrete)	0	0	24°	24°
δ (steel)	0	0	17°	14°

1. Unit weight indicates total unit weight of the subsurface soils at in-situ moisture contents.
2. * Indicates effective friction angle.

RECOMMENDED SOIL PARAMETERS: Boring PTIV-2					
Parameter	**Very Loose to Medium Dense FILL** (0-19 ft)	**Organic SILT & PEAT** (19-29.5 ft)	**Loose SAND** (29.5-40 ft)	**Medium Stiff SILT** (40-44 ft)	**Medium Dense to Dense Clayey SAND** (44-53.5 ft)
γ (pcf)[1]	120	90	120	125	130
ϕ *	30°	8°	30°	30°	34°
c (psf)	0	100	0	0	0
c_a (psf)	0	100	0	0	0
δ (concrete)	17°	0	19°	17°	22°
δ (steel)	11°	0	17°	11°	14°

1. Unit weight indicates total unit weight of the subsurface soils at in-situ moisture contents.
2. * Indicates effective friction angle.

RECOMMENDED SOIL PARAMETERS: Boring PTIV-3				
Parameter	**Very Loose to Loose FILL** (0-29 ft)	**Organic SILT & PEAT** (29-49 ft)	**Stiff Sandy SILT** (49-54 ft)	**Medium Dense Silty-Clayey GRAVEL** (54-66.5 ft)
γ (pcf)[1]	115	90	125	130
ϕ *	28°	8°	30°	34°
c (psf)	0	100	0	0°
c_a (psf)	0	100	0	0
δ (concrete)	17°	0	17°	24°
δ (steel)	11°	0	11°	14°

1. Unit weight indicates total unit weight of the subsurface soils at in-situ moisture contents.

4.0 LIMITATIONS

This report has been prepared for the exclusive use of COWI and their agents for specific application to the above referenced project. The work has been performed in general accordance with our authorized scope of work and in accordance with generally accepted practice in the field of geotechnical engineering. This warranty is in lieu of all other warranties either expressed or implied. The discussions as presented in this report are based on the data revealed by this investigation based on specific borings as selected by COWI. We are not responsible for any conclusions or opinions drawn from the data included herein, other than those specifically stated. An attempt has been made to provide for normal contingencies but the possibility remains that unexpected conditions may be encountered during future investigations or construction. If this should occur, or if additional or contradictory data are revealed in the future, we should be notified so that modifications to this report can be made, if necessary.

APPENDIX A
FIELD DATA

Project No.	317660
Date:	February 1, 2019
For:	COWI New York, NY

TRC
16000 Commerce Parkway, Mt. Laurel, New Jersey 08054
PH. (856) 273-1224 FAX. (856) 273-9244

APPROXIMATE TEST BORING LOCATION

NYSERDA Subsurface Investigation Program

Port Ivory, Staten Island, New York

FIGURE

1

TEST BORING LOG

PROJECT: NYSERDA - PORT IVORY
LOCATION: STATEN ISLAND, NY

BORING **PTIV-1**
G.S. ELEV.
FILE 317660
SHEET 1 OF 2

GROUNDWATER DATA			
FIRST ENCOUNTERED 3.0 '			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	44.1 '
c2	FROM	44.1 '	TO	61.0 '

DRILLER J. DOTZLER
HELPER M. JOHNSON
INSPECTOR A. ALGERI
DATE STARTED 12/11/2018
DATE COMPLETED 12/11/2018

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-1	6 6 4 3		***BROWN SILTY F/M/C SAND, SM GRAVEL (FILL)***		
	S-2	2 2 1 1		2.0		
5	S-3	WH/2.0'		***GRAY-WHITE POSSIBLE GYPSUM (FILL)***		
	S-4	WH/2.0'				
10	S-5	WH/2.0'		10.0		
15	S-6	WH/2.0'		***GRAY ORGANIC SILT, TR TO SM SAND***		
20	U-1					
	S-7	WH/2.0'				
25	U-2					
	S-8	8 11 10 12		27.0		
30				***GRAY-BROWN F/M/C SAND, SM GRAVEL, TR SILT***		
35				35.0		

N: 40.644533; E: -74.183169

DRN. AAA
CKD. JPB

NEW PROJECTS TEST BORING LOG 317660 NYSERDS - IVORY POINT.GPJ SITE BLAUVELT.GDT 1/31/19

TEST BORING LOG

PROJECT: NYSERDA - PORT IVORY
LOCATION: STATEN ISLAND, NY

BORING **PTIV-1**
G.S. ELEV.
FILE 317660
SHEET 2 OF 2

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-9	12 22 17 16				
40	S-10	13 12 14 17		***RED SILTY, CLAYEY ROCK FRAGMENTS, SM F/M/C SAND***		
	S-11	50/0.1'		44.5		AUGER REFUSAL AT 44.5'
45	R-1	REC =100% RQD =30%		***RED, MODERATELY WEATHERED, SOFT TO MEDIUM HARD, SANDSTONE, VERY CLOSE TO CLOSE, HORIZONTAL TO 45 DEGREE FRACTURES***		
				49.0		
50	R-2	REC =100% RQD =52%				
				RED, MODERATELY WEATHERED, SOFT TO MEDIUM HARD, MUDSTONE, VERY CLOSE TO CLOSE, HORIZONTAL TO 45 DEGREE FRACTURES		NEAR VERTICAL FRACTURES 51.6' TO 52.3'
55	R-3	REC =100% RQD =66%		56.0		
				RED, MODERATELY WEATHERED, SOFT TO MEDIUM HARD, SANDSTONE, VERY CLOSE TO CLOSE, HORIZONTAL TO 45 DEGREE FRACTURES		
				58.5		
60	R-4	REC =100% RQD =78%		***RED, MODERATELY WEATHERED, SOFT TO MEDIUM HARD, MUDSTONE, VERY CLOSE TO CLOSE, HORIZONTAL TO 45 DEGREE FRACTURES***		
				61.0		
				END OF BORING AT 61'		
65						
70						
75						

NEW PROJECTS TEST BORING LOG 317660 NYSERDS - IVORY POINT.GPJ SITE BLAUVELT.GDT 1/31/19

TEST BORING LOG

PROJECT: NYSERDA - PORT IVORY
LOCATION: STATEN ISLAND, NY

BORING	**PTIV-2**
G.S. ELEV.	
FILE	317660
SHEET	1 OF 2

GROUNDWATER DATA			
FIRST ENCOUNTERED 4.0 '			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	53.5 '
c2	FROM	53.5 '	TO	71.0 '

DRILLER	J. DOTZLER
HELPER	T. HALECKI
INSPECTOR	A. ALGERI
DATE STARTED	12/10/2018
DATE COMPLETED	12/10/2018

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-1	2 4 9 15		1.0 ***GRAY SILTY SAND, SM ORGANICS (TOPSOIL)***		
	S-2	7 6 4 4				
5	S-3	7 9 28 13				
	S-4	7 8 6 3				
10	S-5	2 1 1/1'		***DARK GRAY GRAVELLY F/M/C SAND, TR SILT (FILL)***		
15	S-6	1 1 1/1'				
				19.0		
20	S-7	WH 1 1 1				
				DARK GRAY PEAT, SM ORGANIC SILT, TR F/M SAND, TR GRAVEL		
25	S-8	WH/1' 2 1				
	U-1					
				29.5		
30	S-9	1 3 3 4		***GRAY F/M/C SAND, TR TO SM SILT***		
35						

N: 40.642672; E: -74.179875

DRN.	AAA
CKD.	JPB

NEW PROJECTS TEST BORING LOG 317660 NYSERDS - IVORY POINT.GPJ SITE BLAUVELT.GDT 1/31/19

TEST BORING LOG

PROJECT: NYSERDA - PORT IVORY
LOCATION: STATEN ISLAND, NY

BORING **PTIV-2**
G.S. ELEV.
FILE 317660
SHEET 2 OF 2

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-10	2 3 2 3		***GRAY F/M/C SAND, TR TO SM SILT***		
40				40.0		
	S-11	2 2 3 5		***GRAY SILT***		
				44.0		
45	S-12	9 10 14 17		***RED CLAYEY F/M/C SAND, TR TO SM ROCK FRAGMENTS***		
50	S-13	11 26 50		53.5		AUGER REFUSAL AT 53.5'
55	R-1	REC =100% RQD =60%		***RED, MODERATELY WEATHERED, SOFT TO MEDIUM HARD, MUDSTONE, CLOSE TO VERY CLOSE, HORIZONTAL TO LOW ANGLE FRACTURES***		
60	R-2	REC =80% RQD =33%				NEAR VERTICAL FRACTURE 60.5' TO 60.9
65	R-3	REC =100% RQD =36%		66.0		
				RED, MODERATELY WEATHERED, MEDIUM HARD, MUDSTONE, CLOSE TO MODERATELY CLOSE, HORIZONTAL TO LOW ANGLE FRACTURES		
70	R-4	REC =100% RQD =60%		71.0		
				END OF BORING AT 71'		
75						

NEW PROJECTS TEST BORING LOG 317660 NYSERDS - IVORY POINT.GPJ SITE BLAUVELT.GDT 1/31/19

TEST BORING LOG

PROJECT: NYSERDA - PORT IVORY
LOCATION: STATEN ISLAND, NY

BORING **PTIV-3**
G.S. ELEV.
FILE 317660
SHEET 1 OF 2

GROUNDWATER DATA			
FIRST ENCOUNTERED 20.0 '			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	66.5 '
c2	FROM	66.5 '	TO	76.5 '

DRILLER J. DOTZLER
HELPER M. JOHNSON
INSPECTOR A. ALGERI
DATE STARTED 12/11/2018
DATE COMPLETED 12/11/2018

DEPTH		A	B	C	DESCRIPTION	Wn	REMARKS
		S-1	6 9 10 5				
		S-2	5 4 3 4				
5		S-3	3 4 6 7		***BROWN SILTY F/M SAND, SM GRAVEL, TR BRICK AND CONCRETE DEBRIS (FILL)***		
		S-4	6 5 3 3				
10		S-5	3 3 2 2				
					14.0		
15		S-6	3 8 7 6				
20	▽	S-7	1 1 1 1		***BLACK GRAVELLY SAND, SM SILT, TR COAL AND CINDERS (FILL)***		
25		S-8	4 1 1 2				
					29.0		
30		S-9	2 1 2 1		***DARK GRAY ORGANIC SILT***		
35							

N: 40.643625; E: -74.1802

DRN. AAA
CKD. JPB

NEW PROJECTS TEST BORING LOG 317660 NYSERDS - IVORY POINT.GPJ SITE BLAUVELT.GDT 1/31/19

TEST BORING LOG

PROJECT: NYSERDA - PORT IVORY
LOCATION: STATEN ISLAND, NY

BORING	**PTIV-3**
G.S. ELEV.	
FILE	317660
SHEET	2 OF 2

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-10	WH/2.0'				
	U-1					
40	S-11	WH/1.5' 2				
				DARK GRAY ORGANIC SILT		
45	S-12	WH 1 2 3				
				49.0		
50	S-13	7 0 8 10		***LIGHT GRAY F/ SANDY SILT***		S-13: PP = 1.5 TSF
				54.0		
55	S-14	7 12 13 14				
				RED-BROWN TO RED CLAYEY ROCK FRAGMENTS, TR TO SM SAND, TR SILT		
60	S-15	33 38 26 24				
65	S-16	17 12 11 24		66.5		AUGER REFUSAL AT 66.5 FT
						VERY SEVERELY WEATHERED FROM 66.5 TO 67.5 FT
70	R-1	REC =100% RQD =13%		***RED, MODERATELY TO SEVERELY WEATHERED, SOFT, MUDSTONE, VERY CLOSE TO CLOSE JOINTS, HORIZONTAL TO LOW ANGLE FRACTURES***		
75	R-2	REC =100% RQD =78%		76.5		

END OF BORING AT 76.5'

NEW PROJECTS TEST BORING LOG 317660 NYSERDS - IVORY POINT.GPJ SITE BLAUVELT.GDT 1/31/19

KEY TO SYMBOLS

Symbol Description

Strata symbols


Fill (made ground)


Silty, Clayey Gravel


Silt with Low Plasticity


USCS Sandy Silt


Mudstone


High Plasticity Organic Silt or Clay


Peat


Sandstone


Clayey Sand


Silty Sand


Poorly-graded Sand


Topsoil

Symbol Description

Misc. Symbols


Water table first encountered


Water table first reading after drilling


Water table second reading after drilling


Water table third reading after drilling

NR Not Recorded

MH Moh's Hardness

Sample Type


Rock Core


Split Barrel


Undisturbed Sample

Lab Symbols

FINES = Fines %

LL = Liquid Limit %

PI = Plasticity Index %

U_c = Unconfined Compressive Strength

W/V = Unit Weight

Notes:

COLUMN A) Soil sample number.

COLUMN B) FOR SOIL SAMPLE (ASTM D 1586): indicates number of blows obtained for each 6 ins. penetration of the standard split-barrel sampler. FOR ROCK CORING (ASTM D2113): indicates percent recovery (REC) per run and rock quality designation (RQD). RQD is the % of rock pieces that are 4 ins. or greater in length in a core run.

COLUMN C) Strata symbol as assigned by the geotechnical engineer.

DESCRIPTION) Description including color, texture and classification of subsurface material as applicable (see Descriptive Terms). Estimated depths to bottom of strata as interpolated from the borings are also shown.

DESCRIPTIVE TERMS: F = fine M = medium C = coarse

RELATIVE PROPORTIONS:

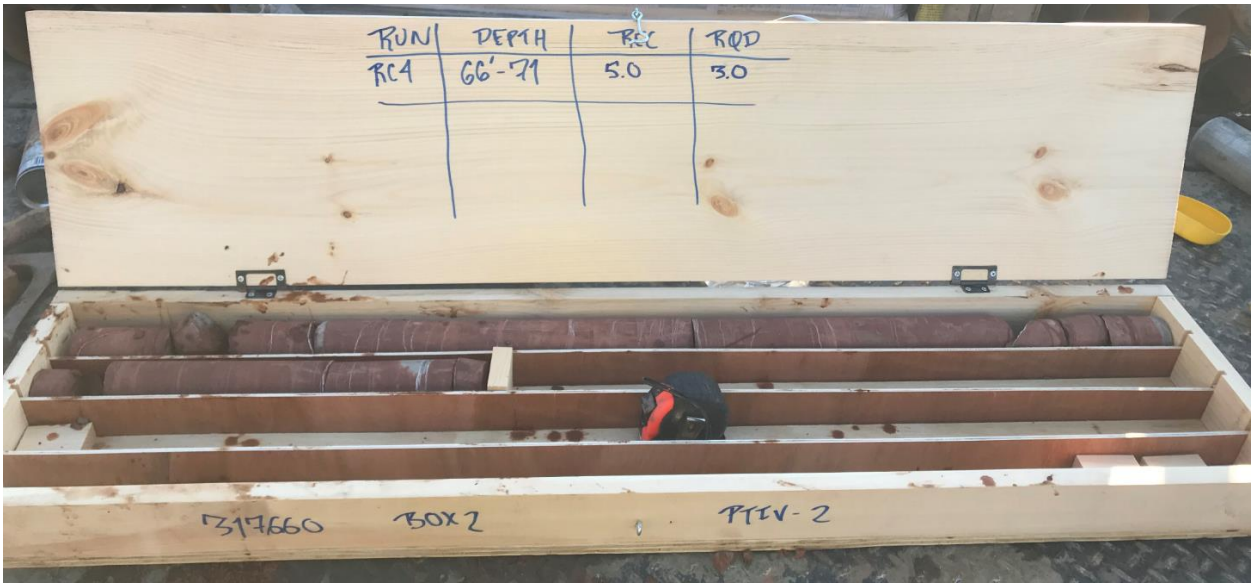
-Descriptive Term-	-Symbol-	-Est. Percentages-
Trace	TR	1-10
Trace to Some	TR to SM	10-15
Some	SM	15-30
Silty, Sandy, Clayey, Gravelly	-	30-40
And	and	40-50

REMARKS) Special conditions or test data as noted during investigation. Note that W.O.P. indicates water observation pipes.

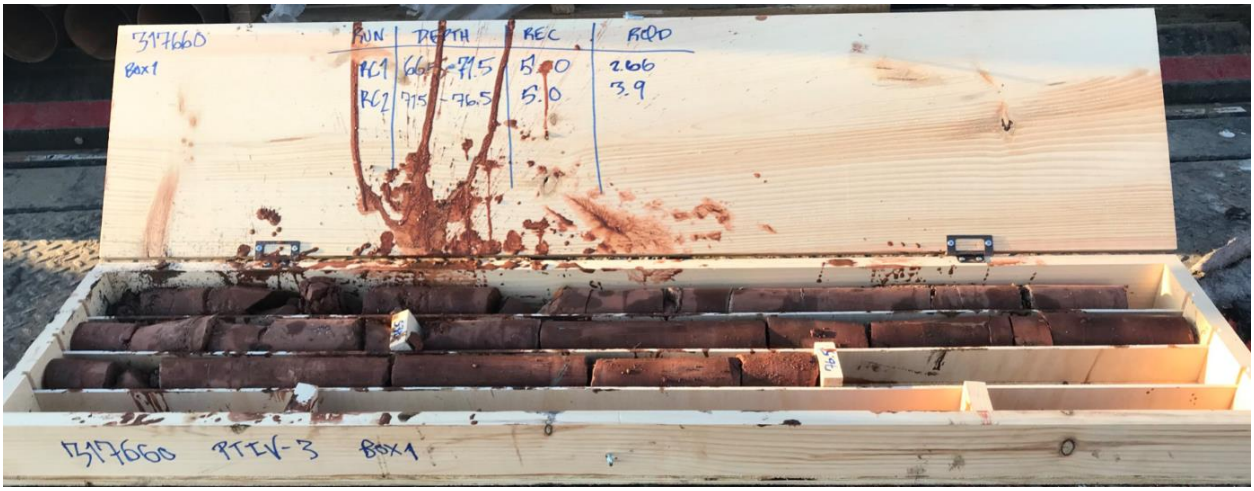
* Free water level as noted may not be indicative of daily, seasonal, tidal, flood, and/or long term fluctuations.

PTIV-1, Box 1 of 1

PTIV-2, Box 1 of 2



PTIV-2, Box 2 of 2



PTIV-3, Box 1 of 1

APPENDIX B
LABORATORY DATA

SUMMARY OF LABORATORY TEST DATA

Project Name: NYSERDA - Port Ivory
Client Name: COWI North America, Inc.
TRC Project #: 317660

SAMPLE IDENTIFICATION			SOIL GROUP (USCS)	MOISTURE CONTENT (%)	GRAIN SIZE DISTRIBUTION				PLASTICITY					Organic Content (%)	Unit Weight (PCF)	Unconfined Compressive Strength (TSF)
Boring #	Sample #	Depth (ft)			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Organic Liquid Limit	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)			
PTIV-1	S-4	6.0-8.0	[1]	77.6	0.0[1]	0.4[1]	99.6[1]		-	-	-	-	-	-	-	-
PTIV-1	S-7	21.0-23.0	OH	74.0	0.0	2.3	82.7	15.0	92	48	45	47	0.6	6.3	-	-
PTIV-1	U-2	24.0-26.0	OH	153.7	0.0	21.7	66.0	12.3	128	-	77	51	1.5	-	-	-
PTIV-1	S-9	34.0-36.0	SC-SM	14.8	30.0	41.5	28.5		-	-	-	-	-	-	-	-
PTIV-1	S-10	39.0-41.0	GC-GM	10.7	38.8	26.3	34.9		-	-	-	-	-	-	-	-
PTIV-1	RC-3	54.0-55.0	-	-	-	-	-		-	-	-	-	-	-	160.3	577
PTIV-1	RC-4	56.6-57.3	-	-	-	-	-		-	-	-	-	-	-	133.7	103
PTIV-2	S-4	6.0-8.0	SP-SM	27.2	25.9	62.5	11.6		-	-	-	-	-	-	-	-
PTIV-2	S-6	14.0-16.0	SP-SM	54.4	29.1	60.1	10.8		-	-	-	-	-	-	-	-
PTIV-2	S-8	24.0-26.0	OH/Pt	345.9	-	-	-		485	-	317	168	0.2	57.0	-	-
PTIV-2	U-1	26.0-28.0	-	440.1	-	-	-		-	-	-	-	-	-	12.5	-
PTIV-2	S-10	34.0-36.0	SM	18.4	7.2	72.7	20.1		-	-	-	-	-	-	-	-
PTIV-2	S-12	44.0-46.0	SC	12.9	25.5	34.3	27.7	11.5	26	-	18	8	-0.6	-	-	-
PTIV-2	S-13	49.0-51.0	SC	12.9	34.8	38.9	17.7	8.6	26	-	18	8	-0.6	-	-	-
PTIV-2	RC-1	55.0-56.0	-	-	-	-	-		-	-	-	-	-	-	161.2	497
PTIV-2	RC-2	57.5-58.0	-	-	-	-	-		-	-	-	-	-	-	159.6	325
PTIV-3	S-4	6.0-8.0	GM	8.0	44.4	38.5	17.1		-	-	-	-	-	-	-	-
PTIV-3	S-6	14.0-16.0	SM	15.8	27.4	54.0	18.6		-	-	-	-	-	-	-	-
PTIV-3	S-7	19.0-21.0	SM	63.8	40.0	48.6	11.4		-	-	-	-	-	-	-	-
PTIV-3	S-10	34.0-36.0	OH	66.5	0.0	3.1	75.4	21.5	94	49	46	48	0.4	5.6	-	-

DRAWN BY: TBT 02/06/19

CHECKED BY: JPB 02/06/19

SUMMARY OF LABORATORY TEST DATA

Project Name: NYSERDA - Port Ivory
Client Name: COWI North America, Inc.
TRC Project #: 317660

SAMPLE IDENTIFICATION			SOIL GROUP (USCS)	MOISTURE CONTENT (%)	GRAIN SIZE DISTRIBUTION				PLASTICITY					Organic Content (%)	Unit Weight (PCF)	Unconfined Compressive Strength (TSF)
Boring #	Sample #	Depth (ft)			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Organic Liquid Limit	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)			
PTIV-3	S-12	44.0-46.0	-	255.1	-	-	-	-	-	-	-	-	-	62.7	-	-
PTIV-3	S-15	59.0-61.0	GC-GM	13.1	39.9	13.5	31.3	15.3	26	-	20	6	-1.2	-	-	-
PTIV-3	S-16	64.0-66.0	GC	12.5	46.1	37.6	9.1	7.2	28	-	19	9	-0.7	-	-	-
PTIV-3	RC-2	73.0-73.5	-	-	-	-	-		-	-	-	-	-	-	155.7	246

[1]*Possible Gypsum (fill) - Sample completely dissolved in water during the sieve wash process.*

DRAWN BY: TBT 02/06/19

CHECKED BY: JPB 02/06/19

SUMMARY OF LABORATORY TEST DATA

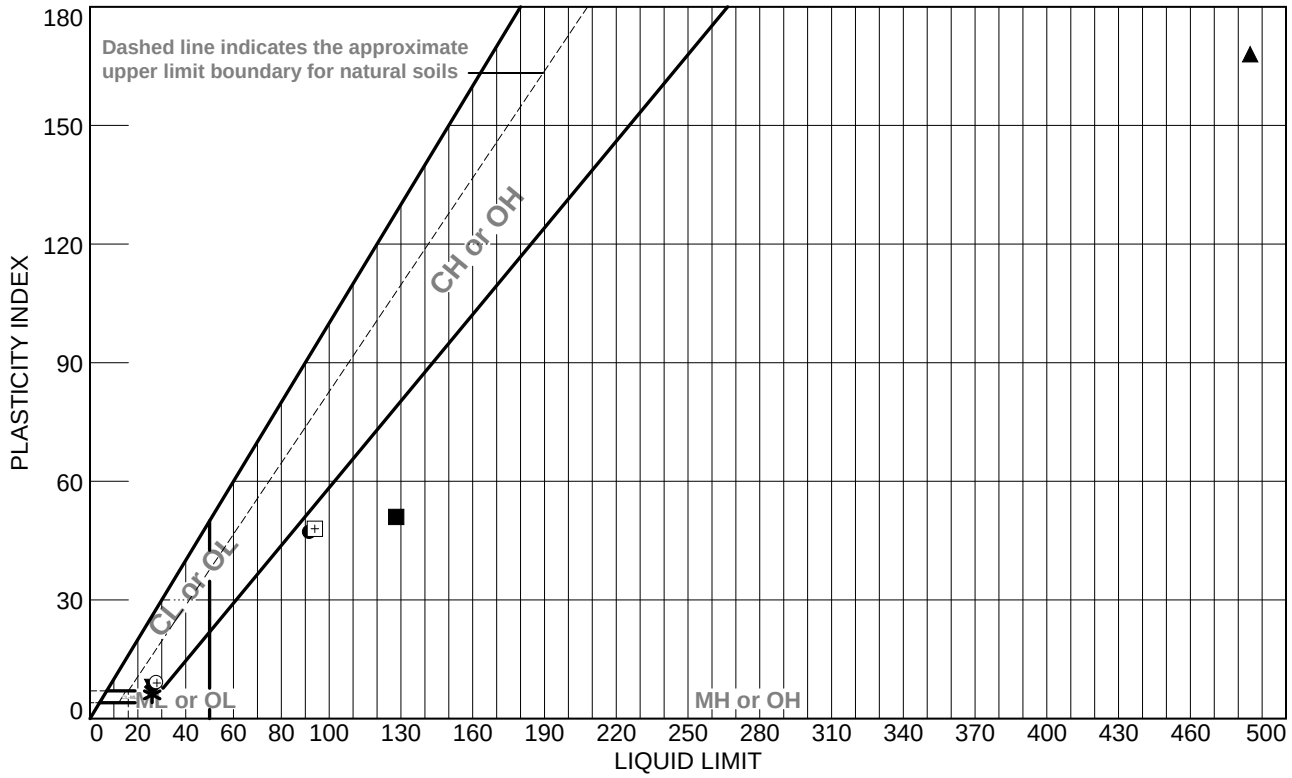
Project Name: NYSERDA - Port Ivory
Client Name: COWI North America, Inc.
TRC Project #: 317660

SAMPLE IDENTIFICATION			ASSUMED SPECIFIC GRAVITY	INITIAL MOISTURE CONTENT (%)	AT TEST MOISTURE CONTENT (%)	VOLUMETRIC PROPERTIES			SHEAR STRENGTH PROPERTIES			
Boring #	Sample #	Depth (ft)				Dry Unit, PCF	Void Ratio	Degree of Saturation (%)	Type of Test	Normal Stress (PSI)	Strain (%)	Failure Stress (PSI)
PTIV-1	U-2	24.0-26.0	2.49	94.7	94.5	46.3	2.36	100.0	UU	10.4	9.9	6.2
PTIV-2	U-1	26.0-28.0	1.72	440.1	438.5	12.5	7.57	100.0	UU	10.4	13.6	8.4

DRAWN BY: TBT 02/06/19

CHECKED BY: JPB 02/06/19

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

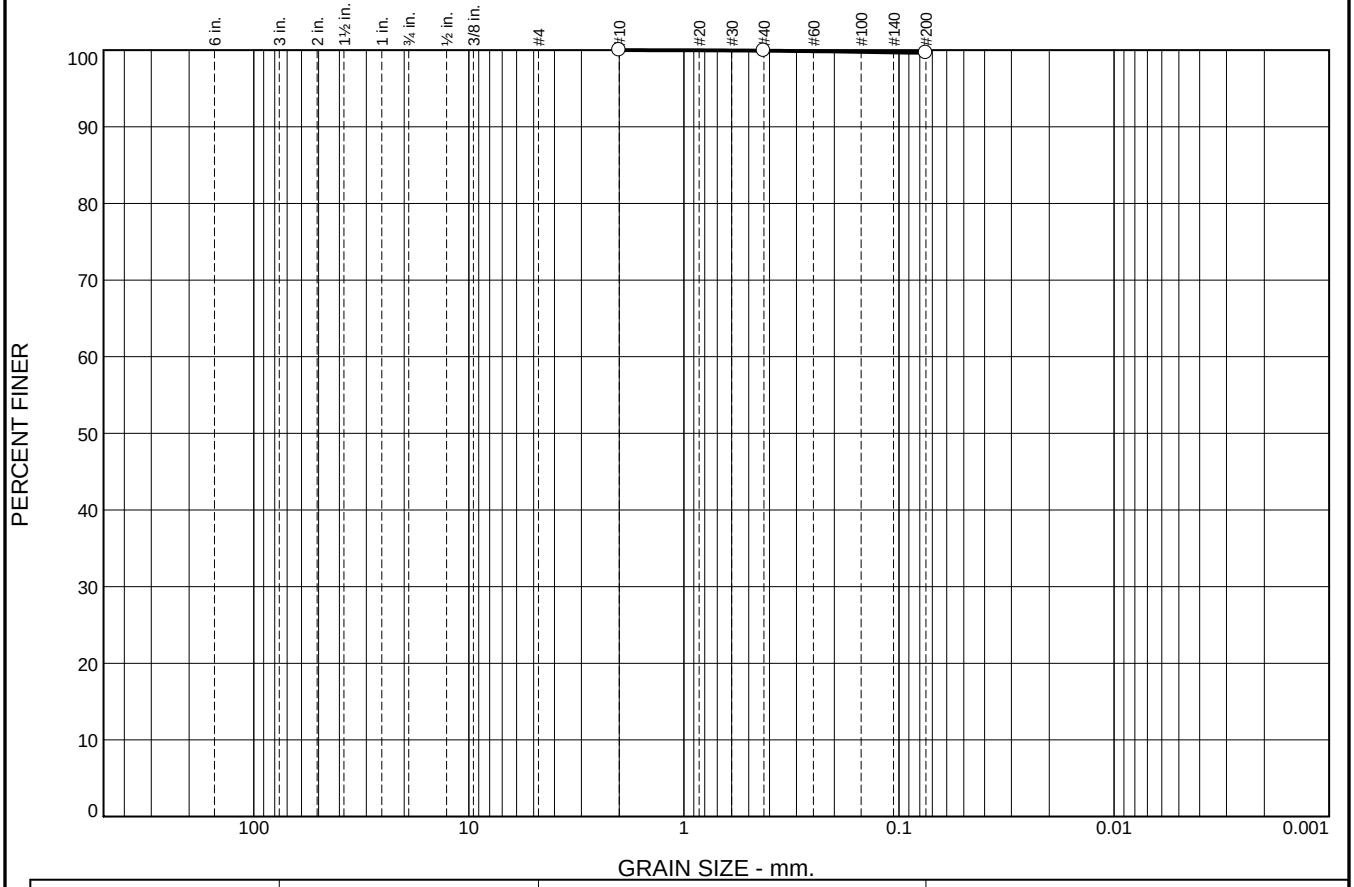
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX	USCS
●	PTIV-1	S-7	21.0-23.0 FT	74.0	45	92	47	0.6	OH
■	PTIV-1	U-2	24.0-26.0 FT	153.7	77	128	51	1.5	MH
▲	PTIV-2	S-8	24.0-26.0 FT	345.9	317	485	168	0.2	OH/Pt
◆	PTIV-2	S-12	44.0-46.0 FT	12.9	18	26	8	-0.6	SC
▼	PTIV-2	S-13	49.0-51.0 FT	12.9	18	26	8	-0.6	SC
✱	PTIV-3	S-15	59.0-61.0 FT	13.1	20	26	6	-1.2	GC-GM
⊕	PTIV-3	S-16	64.0-66.0 FT	12.5	19	28	9	-0.7	GC
⊞	PTIV-3	S-10	34.0-36.0 FT	66.5	46	94	48	0.4	OH

TRC Engineers, Inc. Mt. Laurel, NJ

Client: COWI NORTH AMERIC, INC.
Project: NYSERDA - PORT IVORY

Project No.: 317660 **Figure** 1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.1	0.3	99.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ GRAY-WHITE GYMPSUM (FILL)*	01/09/19		77.6

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-1 **Depth:** 6.0-8.0 FT **Sample Number:** S-4

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

*MATERIAL COMPLETELY DISSOLVED IN WATER

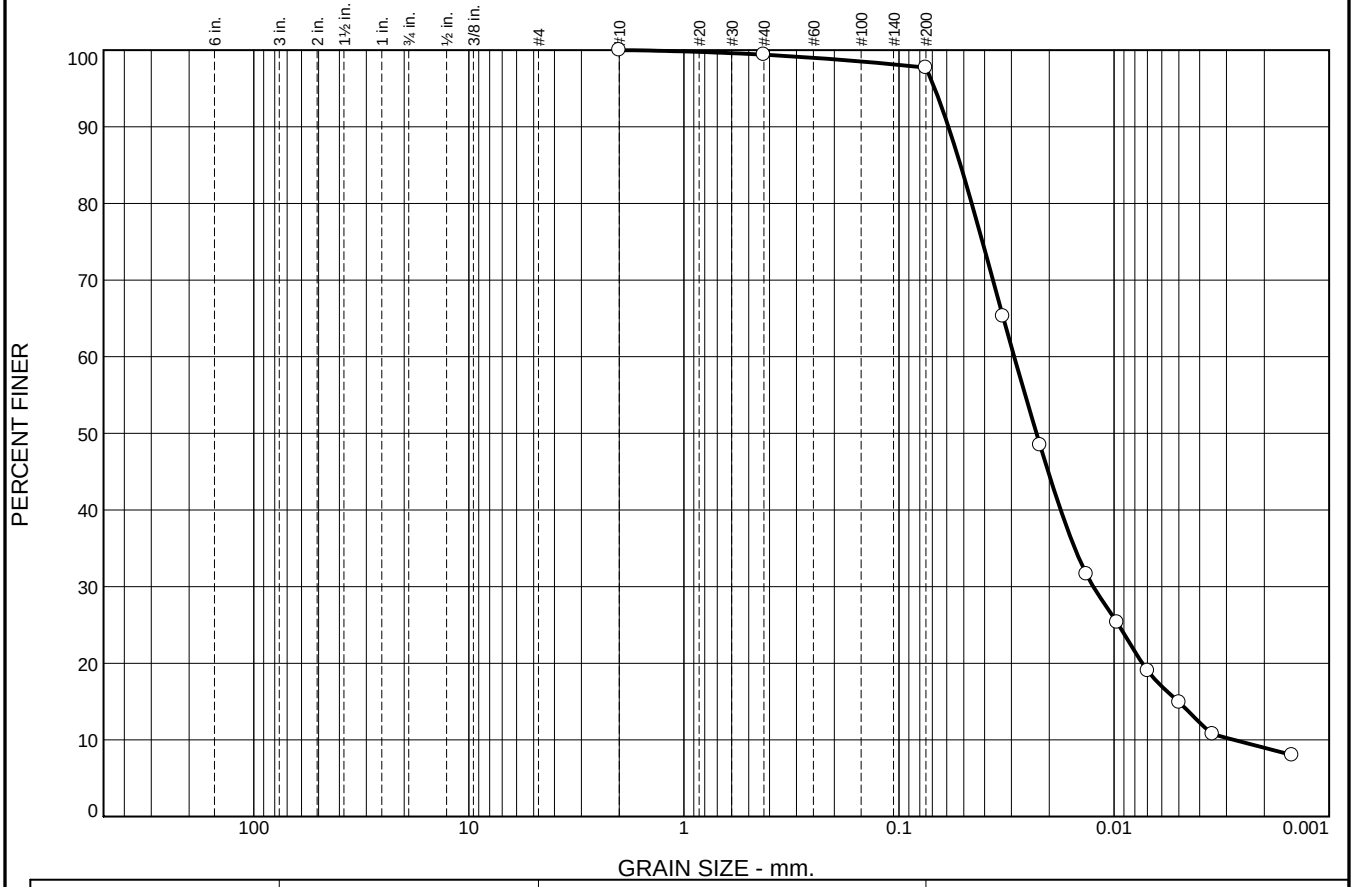
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 2

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.6	1.7	82.7	15.0

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	92	45	0.0518	0.0291	0.0229	0.0125	0.0050	0.0028	1.94	10.55

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ DARK BROWN TO BLACK ORGANIC SILT*	01/16/19	OH	74.0

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-1 **Depth:** 21.0-23.0 FT **Sample Number:** S-7

TRC Engineers, Inc.

Mt. Laurel, NJ

Remarks:

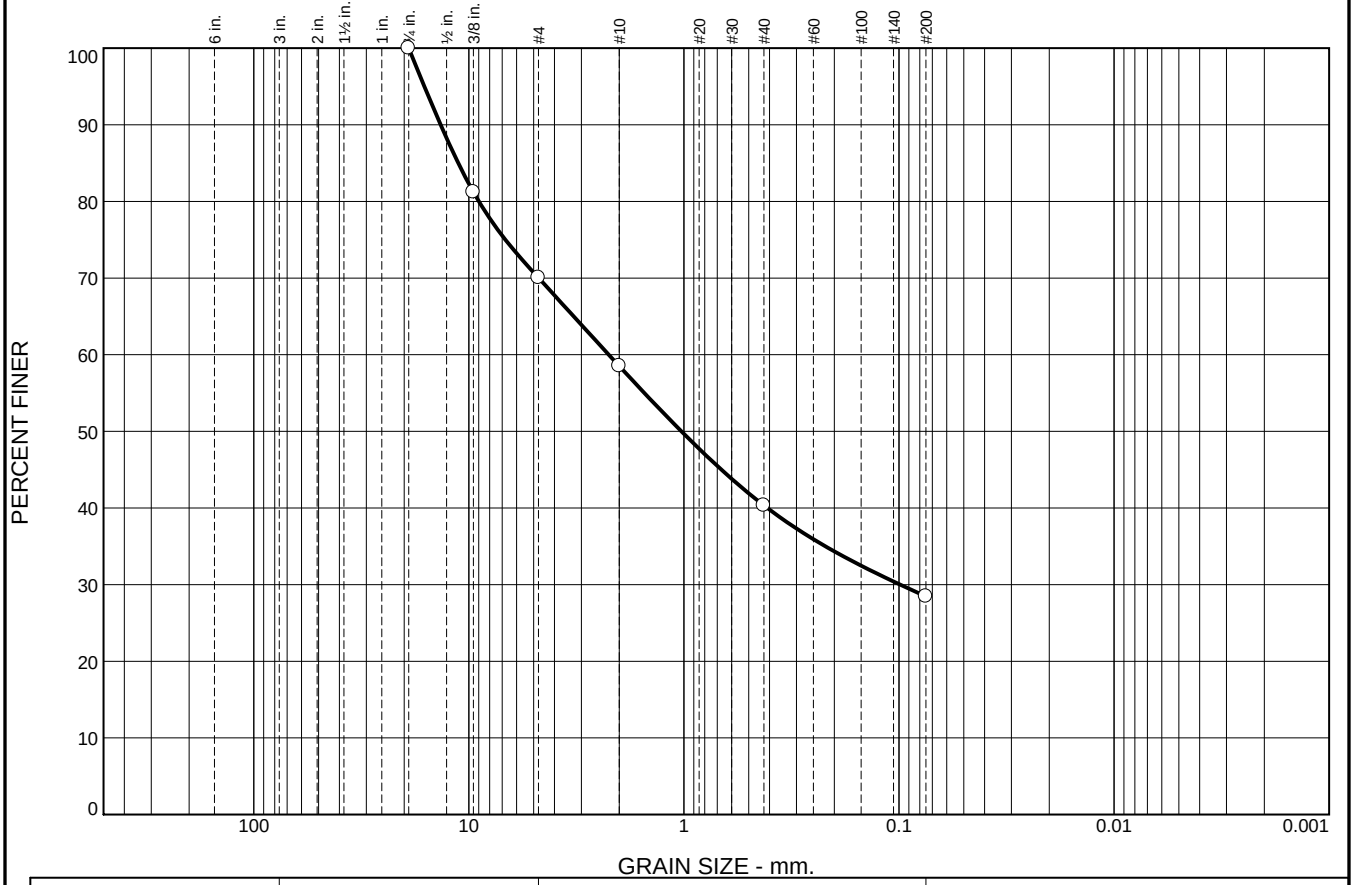
○SAMPLE DESCRIPTION BASED ON USCS

*SEE SUMMARY TABLE NOTE

Figure 3

Tested By: CWZ 01/16/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	30.0	11.5	18.2	11.8	28.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			11.2018	2.2362	1.0271	0.0987				

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ RED-BROWN SILTY, CLAYEY SAND WITH GRAVEL	01/09/19	SC-SM	14.8

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-1 **Depth:** 34.0-36.0 FT **Sample Number:** S-9

Remarks:
○SAMPLE DESCRIPTION BASED ON USCS

TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 4

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.9	27.9	8.8	10.1	7.4	34.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			16.6503	4.3739	1.4526					

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ RED-BROWN SILTY, CLAYEY GRAVEL WITH SAND	01/09/19	GC-GM	10.7

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-1 **Depth:** 39.0-41.0 FT **Sample Number:** S-10

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

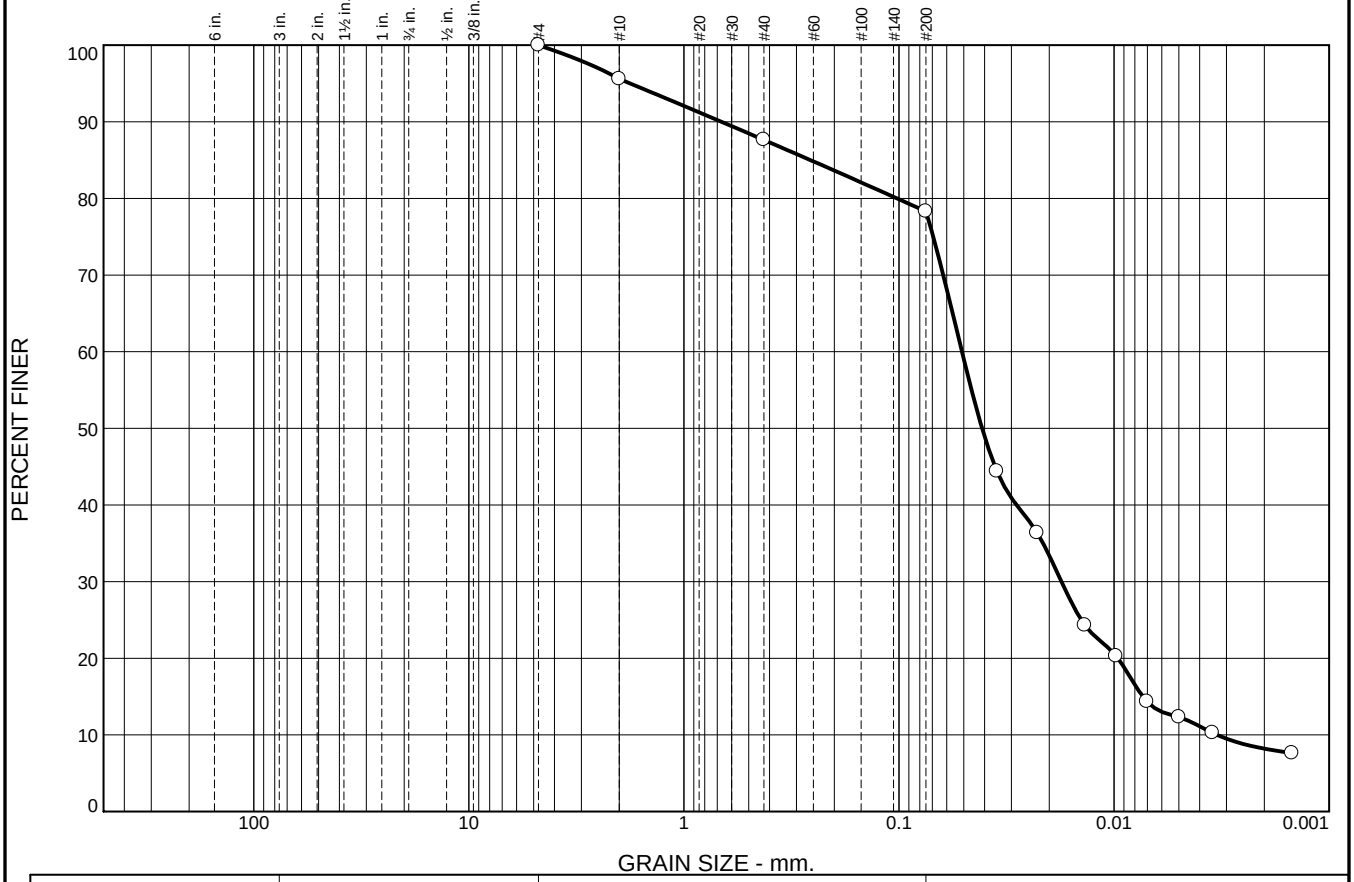
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 5

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	4.4	8.0	9.3	66.0	12.3

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	128	77	0.2581	0.0510	0.0411	0.0176	0.0073	0.0033	1.83	15.37

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ DARK BROWN TO BLACK ORGANIC SILT WITH SAND*	01/16/19	MH	153.7

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-1 **Depth:** 24.0-26.0 FT **Sample Number:** U-2

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

*SEE SUMMARY TABLE NOTE

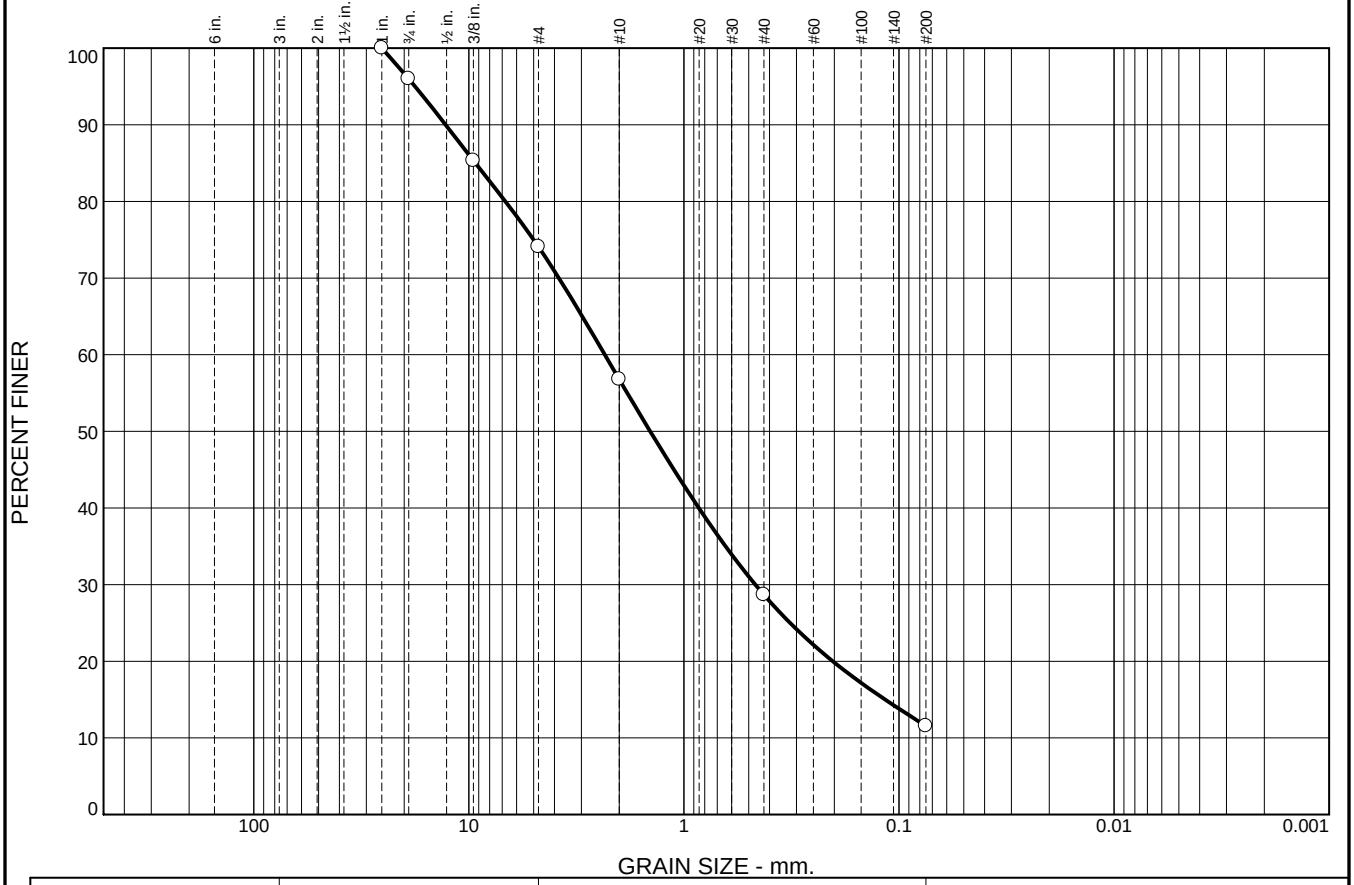
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 6

Tested By: CWZ 01/16/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.0	21.9	17.3	28.1	17.1	11.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			9.3264	2.3336	1.4352	0.4659	0.1159			

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ BROWN TO DARK BROWN SAND WITH SILT AND GRAVEL	01/09/19	SP-SM	27.2

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-2 **Depth:** 6.0-8.0 FT **Sample Number:** S-4

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

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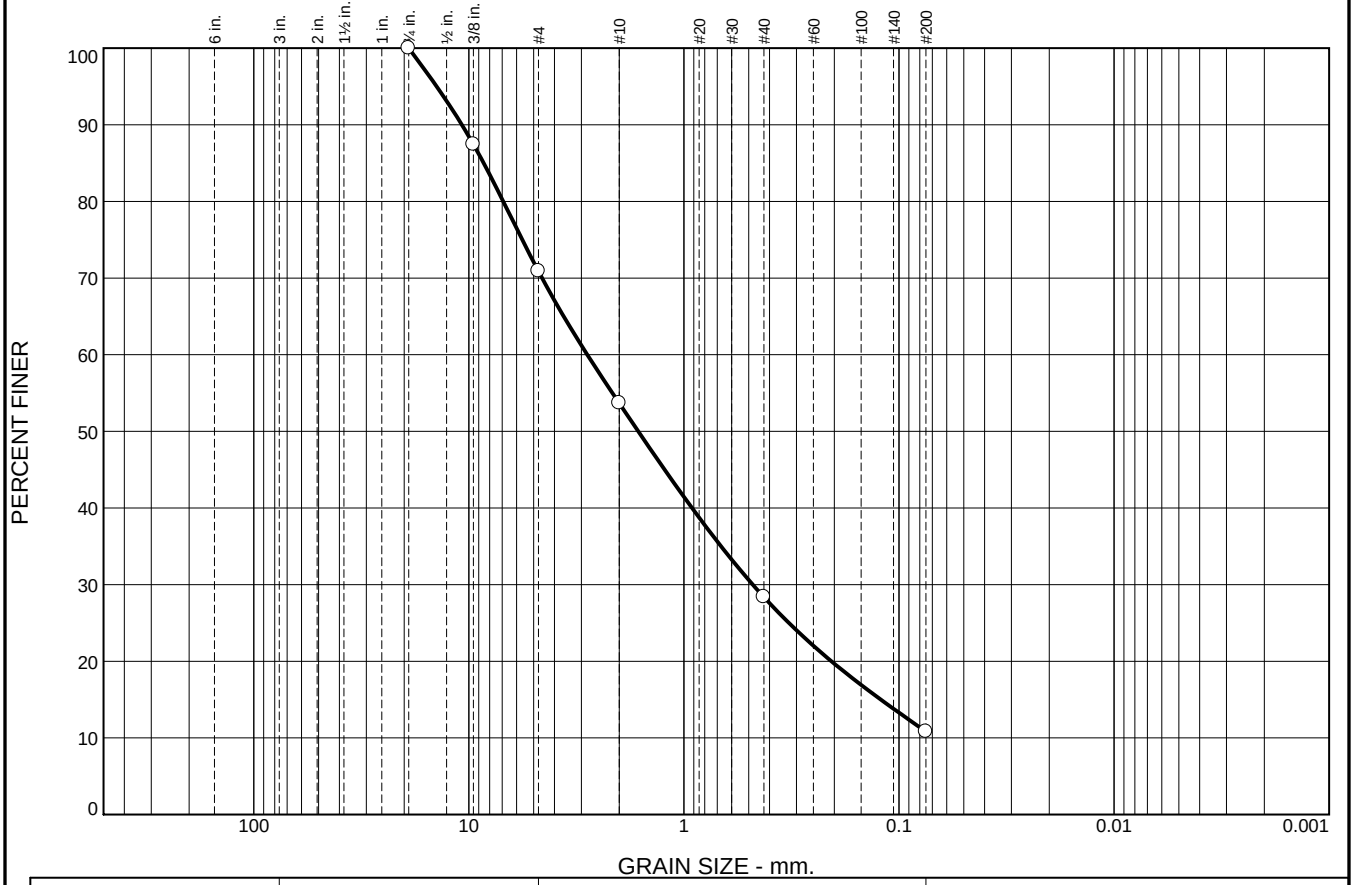
Figure 7

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	29.1	17.2	25.3	17.6	10.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			8.5353	2.8137	1.6311	0.4786	0.1214			

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ DARK BROWN SAND WITH SILT AND GRAVEL		SP-SM	54.4

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-2 **Depth:** 14.0-16.0 FT **Sample Number:** S-6

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

TRC Engineers, Inc.

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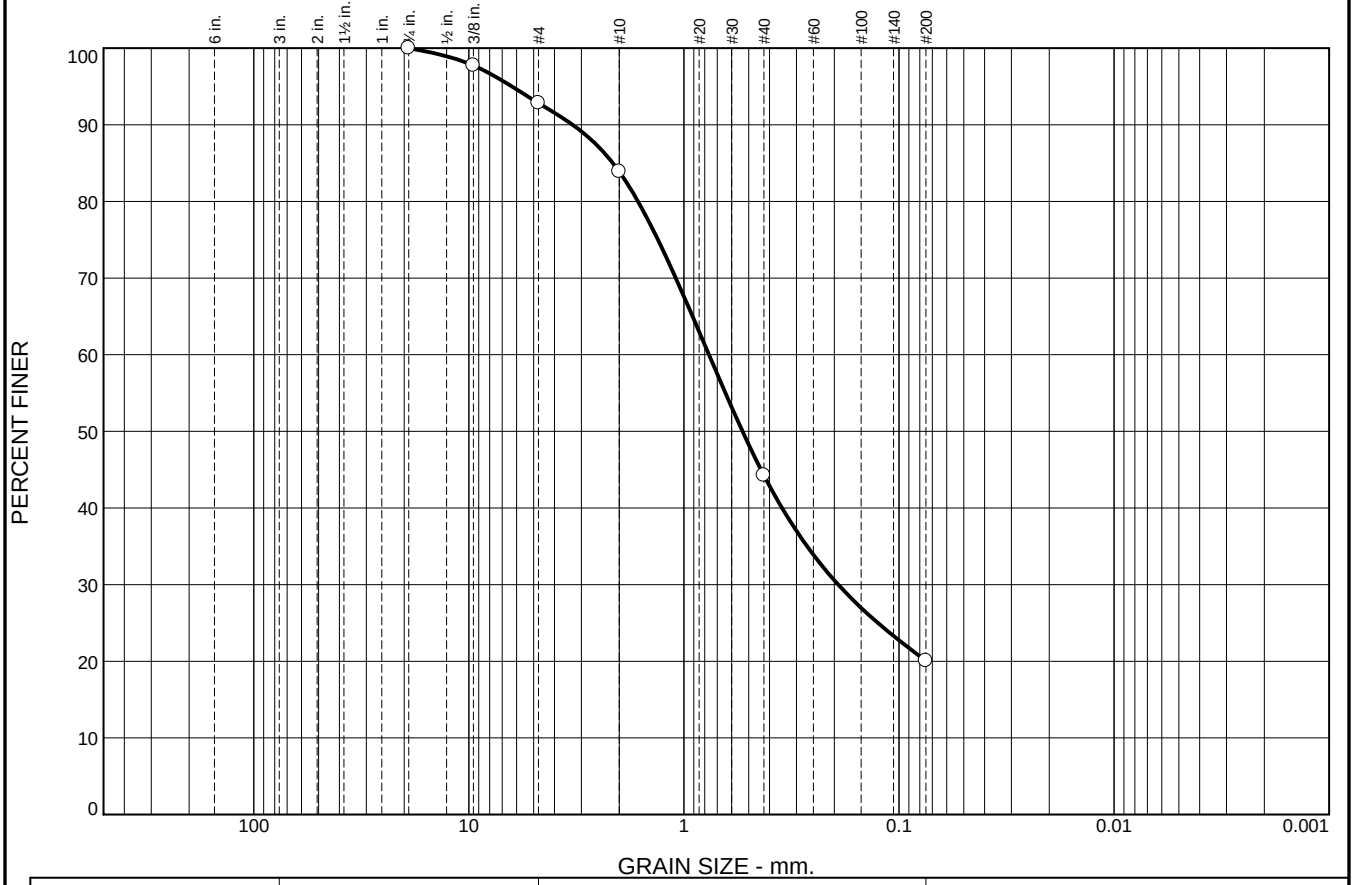
Figure 8

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	7.2	8.9	39.6	24.2	20.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.1395	0.7649	0.5340	0.1917				

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ GRAY SILTY SAND	01/09/19	SM	18.4

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-2 **Depth:** 34.0-36.0 FT **Sample Number:** S-10

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

TRC Engineers, Inc.

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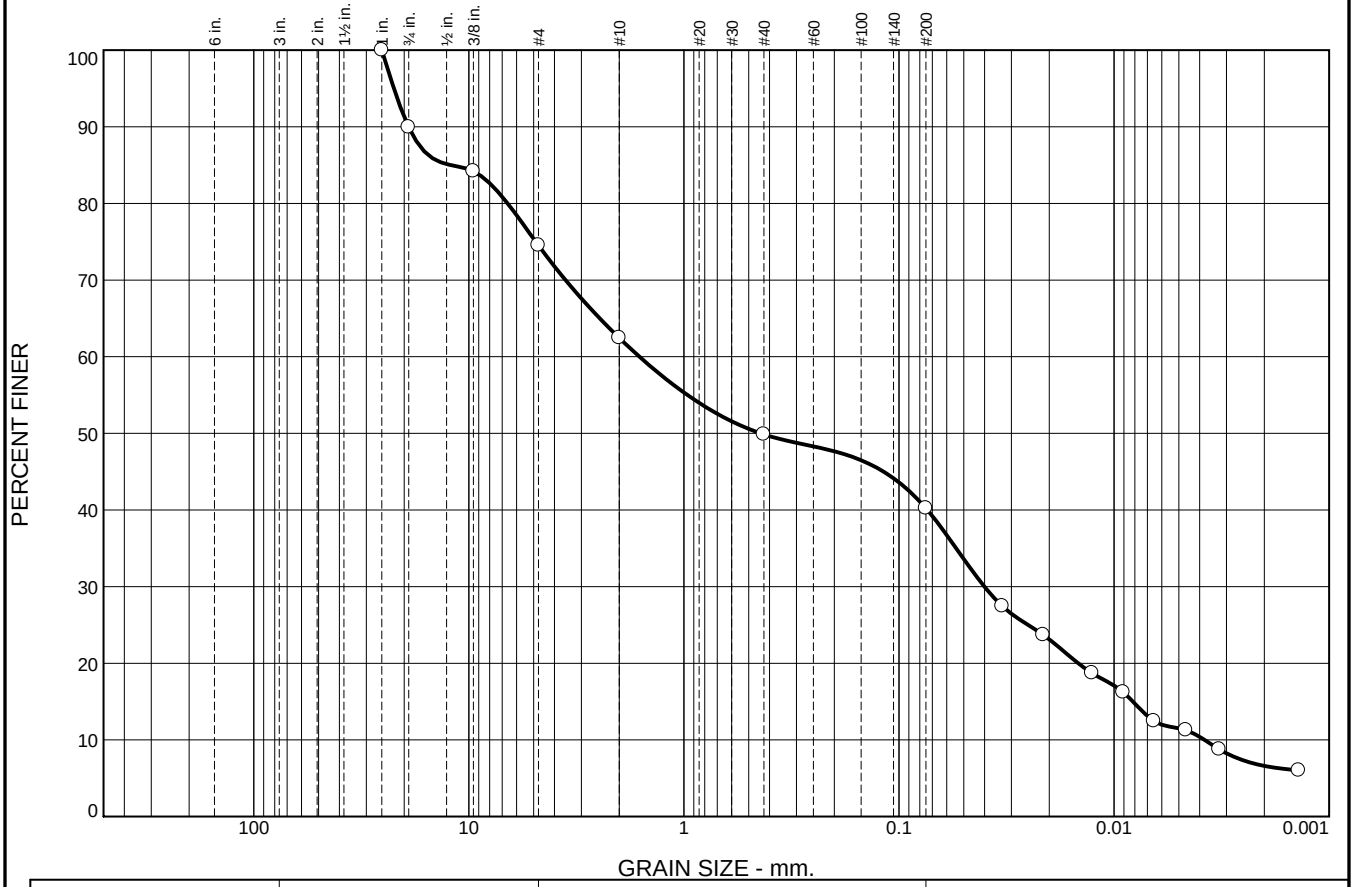
Figure 9

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.1	15.4	12.0	12.6	9.7	28.7	11.5

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	26	18	12.1292	1.6100	0.4403	0.0401	0.0082	0.0038	0.26	423.94

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ RED-BROWN CLAYEY SAND WITH GRAVEL	01/10/19	SC	12.9

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-2 **Depth:** 44.0-46.0 FT **Sample Number:** S-12

TRC Engineers, Inc.

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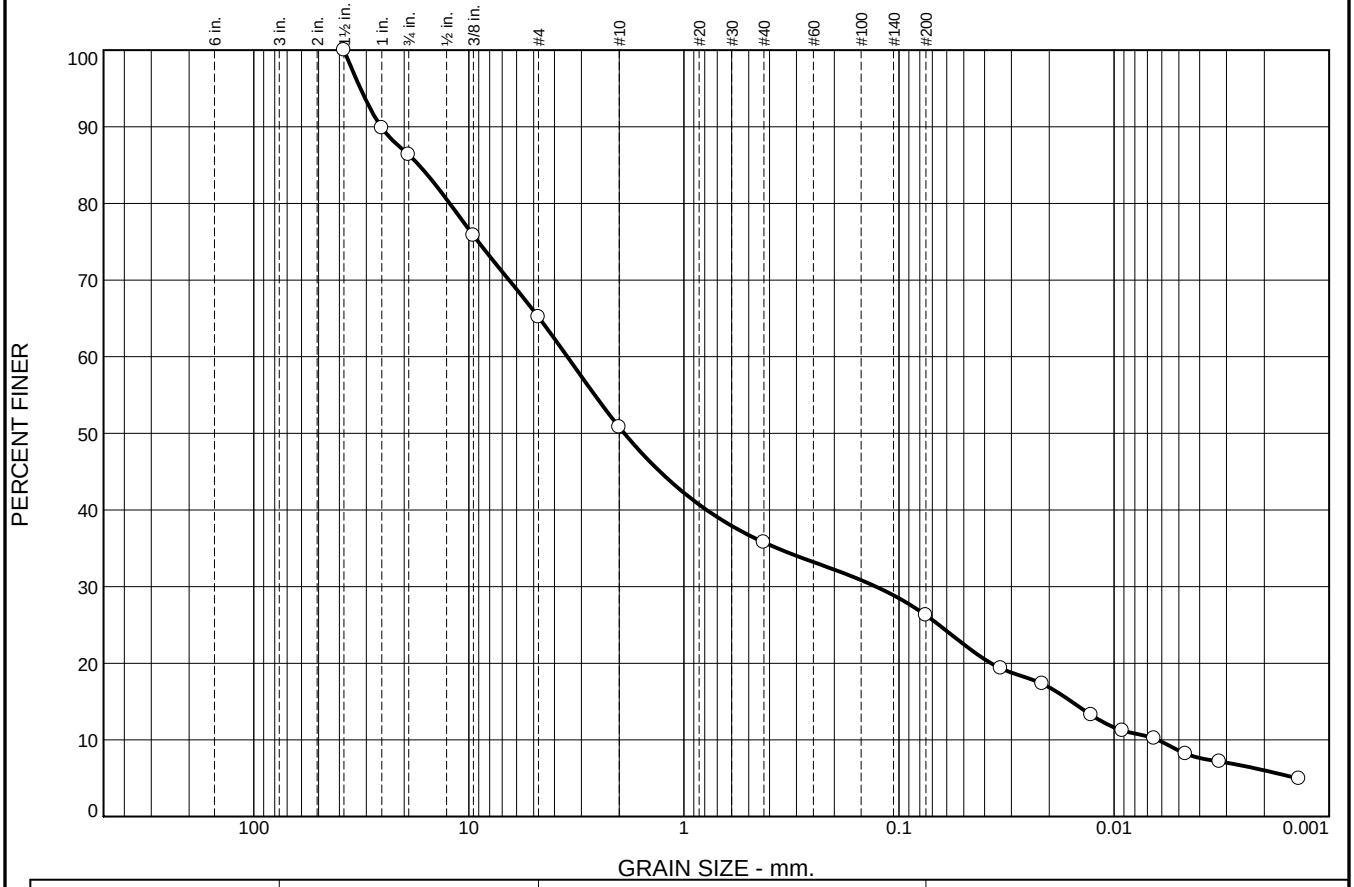
Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

Figure 10

Tested By: CWZ 01/10/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	13.6	21.2	14.4	15.0	9.5	17.7	8.6

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	26	18	17.0577	3.4831	1.8929	0.1279	0.0158	0.0063	0.75	555.45

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ RED-BROWN CLAYEY SAND WITH GRAVEL	01/10/19	SC	12.9

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-2 **Depth:** 49.0-51.0 FT **Sample Number:** S-13

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

TRC Engineers, Inc.

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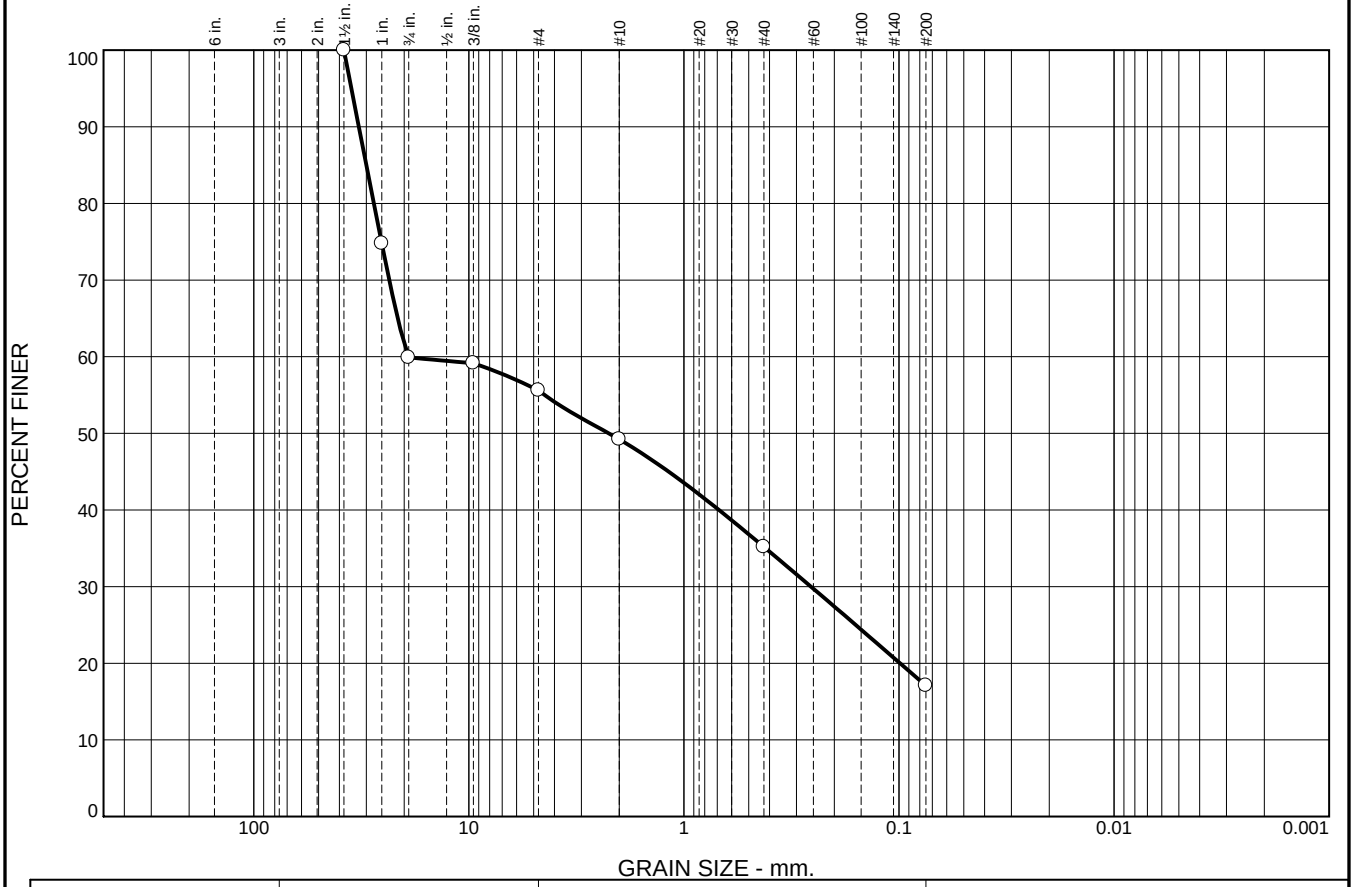
Figure 11

Tested By: CWZ 01/10/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	40.1	4.3	6.4	14.0	18.1	17.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			29.9849	19.1081	2.2364	0.2566				

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ BROWN SILTY MICACEOUS GRAVEL WITH SAND	01/09/19	GM	8.0

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-3 **Depth:** 6.0-8.0 FT **Sample Number:** S-4

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

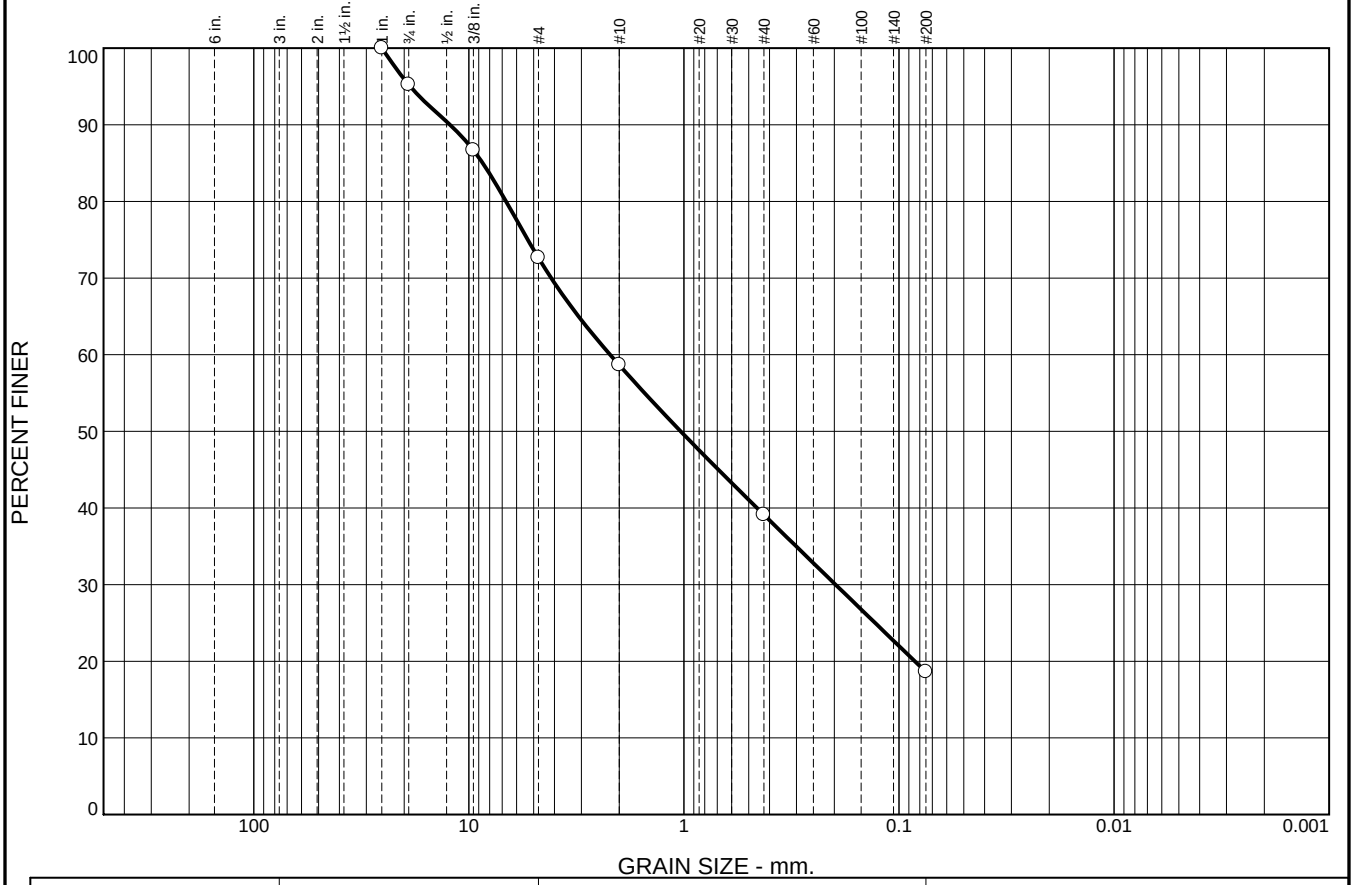
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 12

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.8	22.6	13.9	19.6	20.5	18.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			8.6289	2.2032	1.0349	0.1972				

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ BLACK SILTY SAND WITH GRAVEL	01/09/19	SM	15.8

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-3 **Depth:** 14.0-16.0 FT **Sample Number:** S-6

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

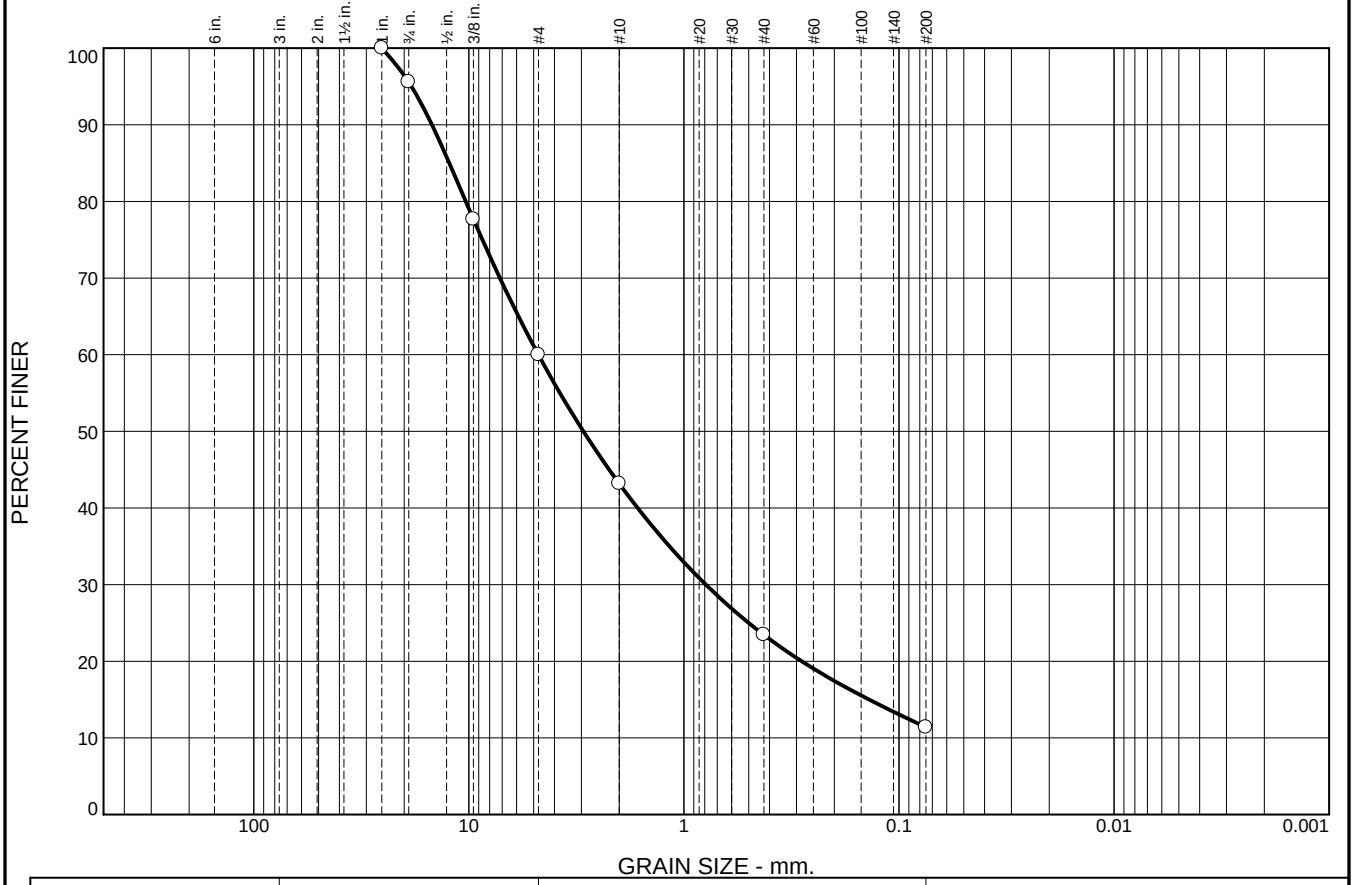
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 13

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.4	35.6	16.8	19.7	12.1	11.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			12.3306	4.7509	2.9343	0.7908	0.1377			

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ BLACK SILTY SAND WITH GRAVEL*	01/09/19	SM	63.8

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-3 **Depth:** 19.0-21.0 FT **Sample Number:** S-7

TRC Engineers, Inc.

Mt. Laurel, NJ

Remarks:

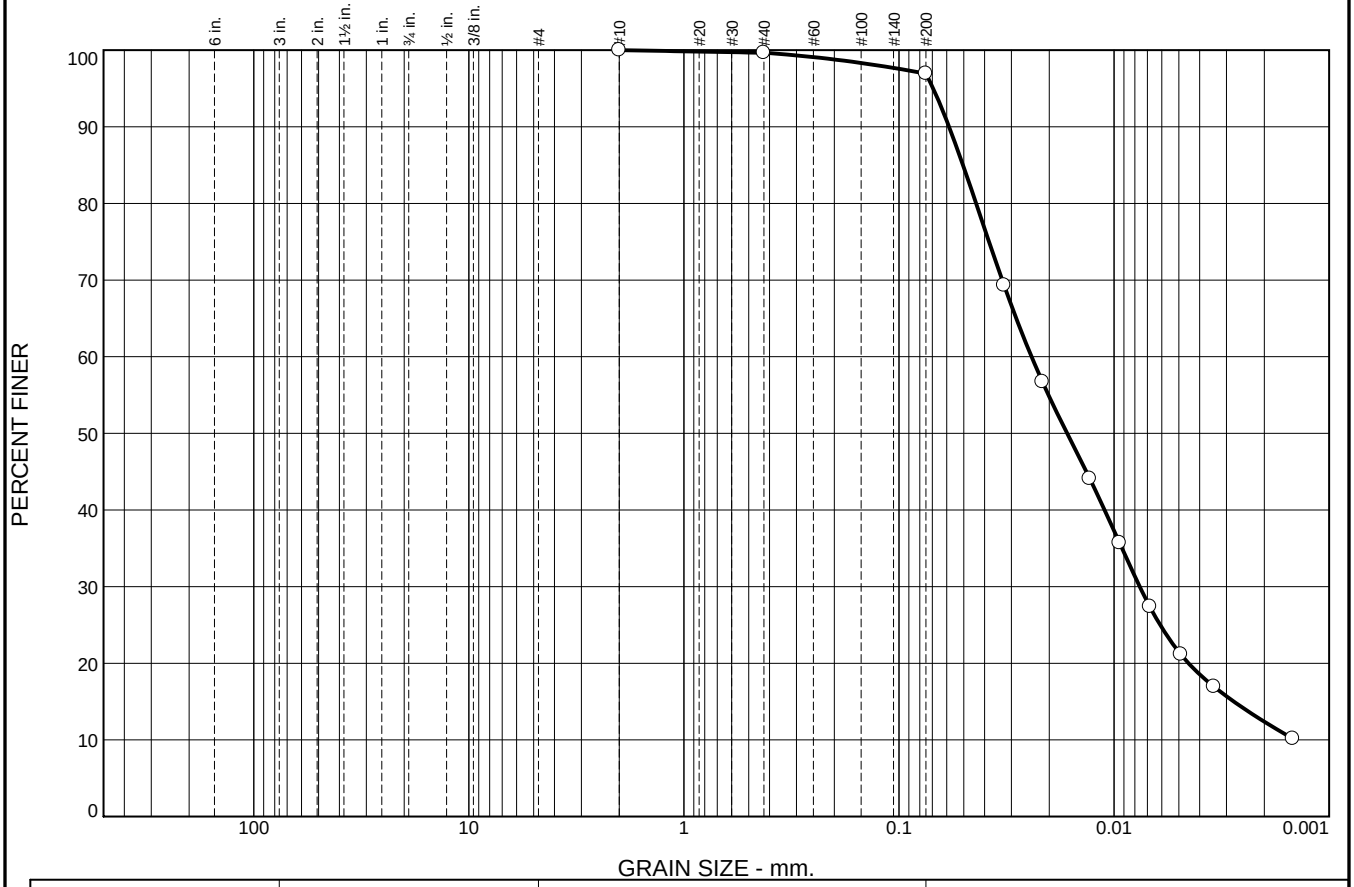
○SAMPLE DESCRIPTION BASED ON USCS

*SAMPLE COMPLETELY SATURATED WITH STANDING WATER IN JAR

Figure 14

Tested By: CWZ 01/09/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.3	2.8	75.4	21.5

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	94	46	0.0504	0.0242	0.0165	0.0076	0.0028			

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ GRAY TO DARK GRAY ORGANIC SILT*	01/16/19	OH	66.5

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-3 **Depth:** 34.0-36.0 FT **Sample Number:** S-10

TRC Engineers, Inc.

Mt. Laurel, NJ

Remarks:

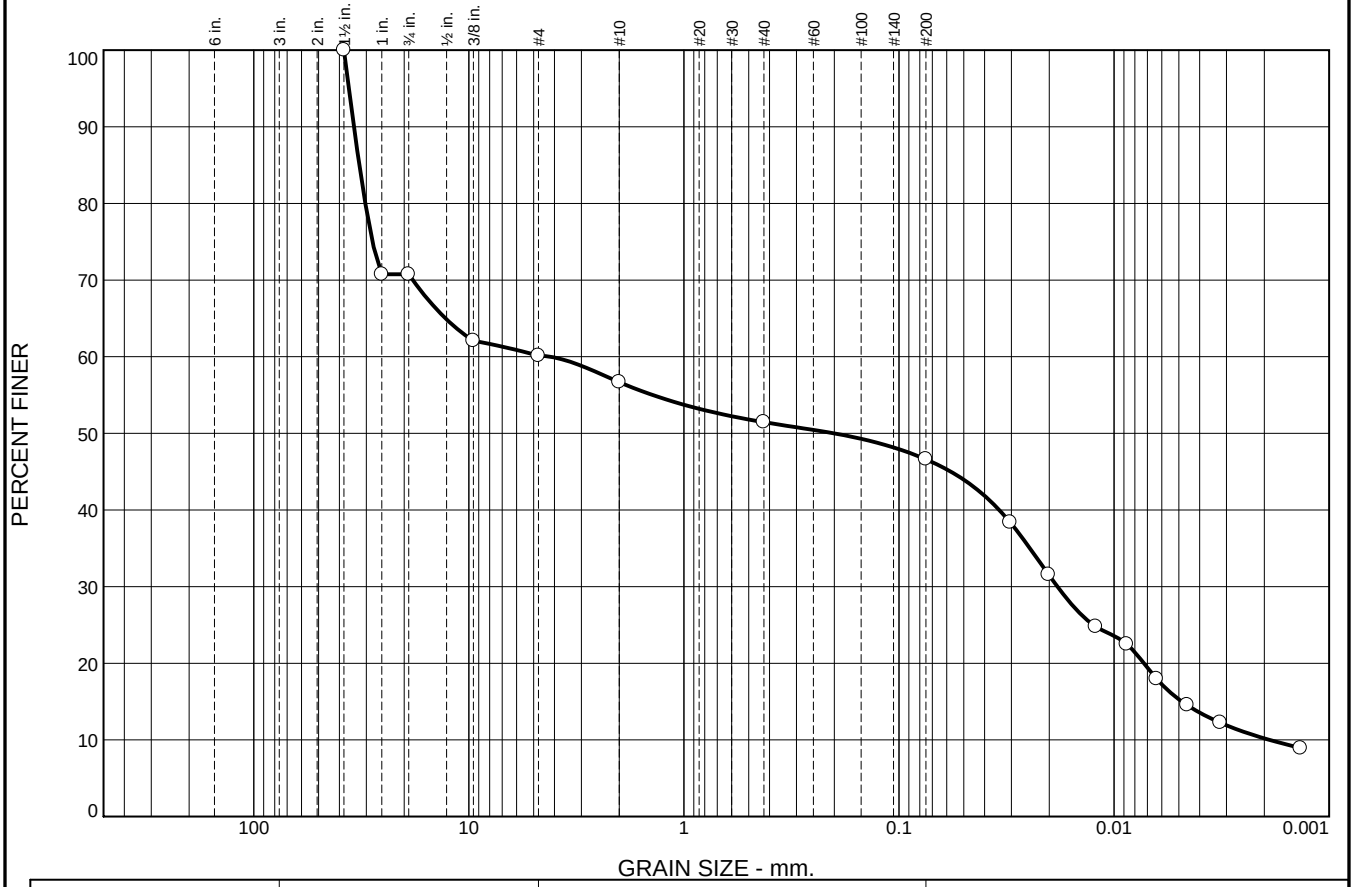
○SAMPLE DESCRIPTION BASED ON USCS

*SEE SUMMARY TABLE NOTE

Figure 15

Tested By: CWZ 01/16/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	29.2	10.7	3.4	5.2	4.9	31.3	15.3

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	26	20	32.3081	4.1973	0.2009	0.0183	0.0048	0.0019	0.04	2221.42

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ RED-BROWN TO GRAY SILTY CLAYEY GRAVEL		GC-GM	13.1

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-3 **Depth:** 59.0-61.0 FT **Sample Number:** S-15

Remarks:
○SAMPLE DESCRIPTION BASED ON USCS

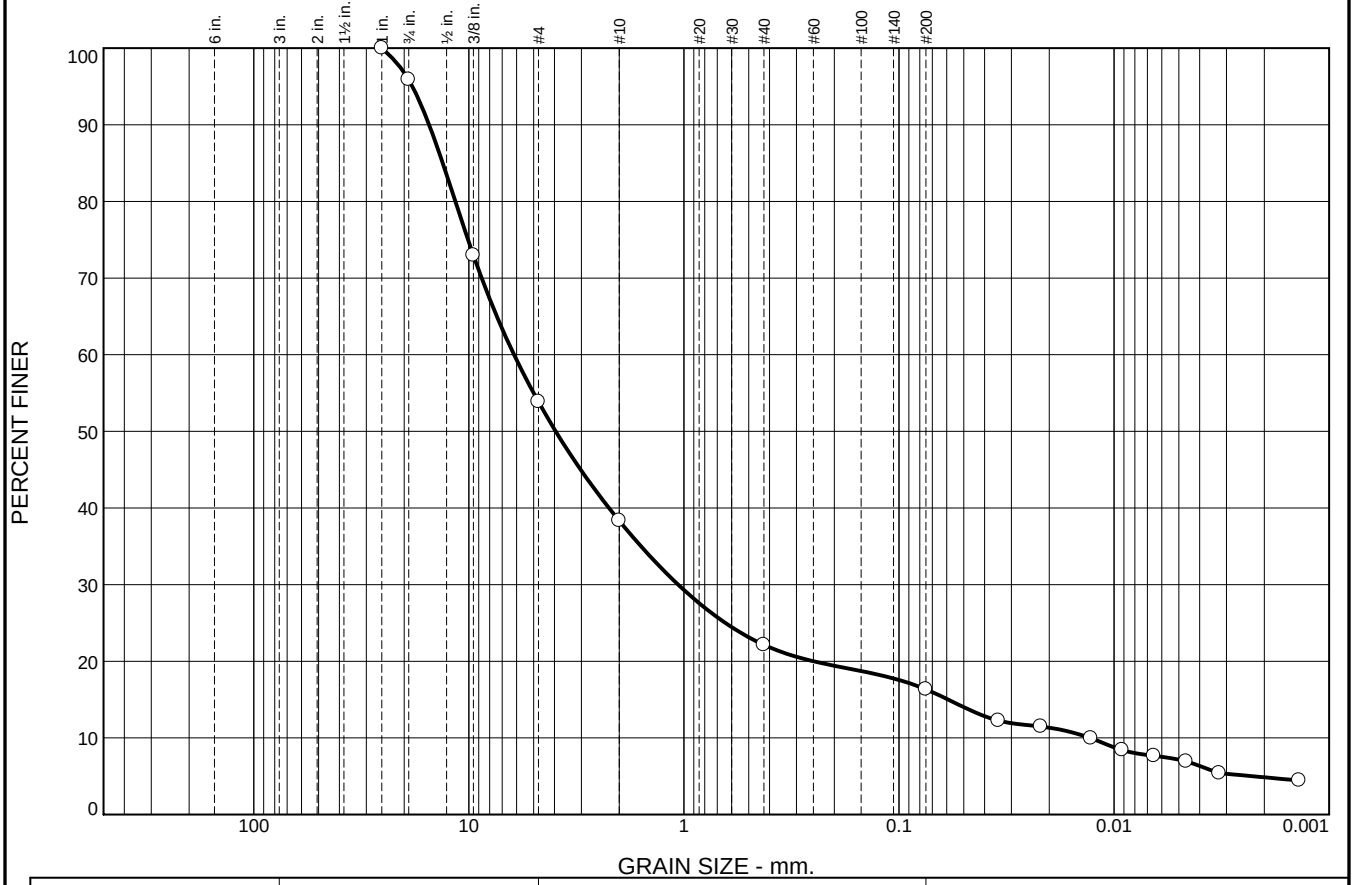
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 16

Tested By: CWZ 01/15/19 **Checked By:** JPB 01/24/19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.1	42.0	15.6	16.2	5.8	9.1	7.2

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	28	19	13.2299	6.1644	3.9470	1.0639	0.0591	0.0130	14.18	475.93

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ RED-BROWN CLAYEY GRAVEL WITH SAND	01/10/19	GC	12.5

Project No. 317660 **Client:** COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

○ **Source of Sample:** PTIV-3 **Depth:** 64.0-66.0 FT **Sample Number:** S-16

Remarks:

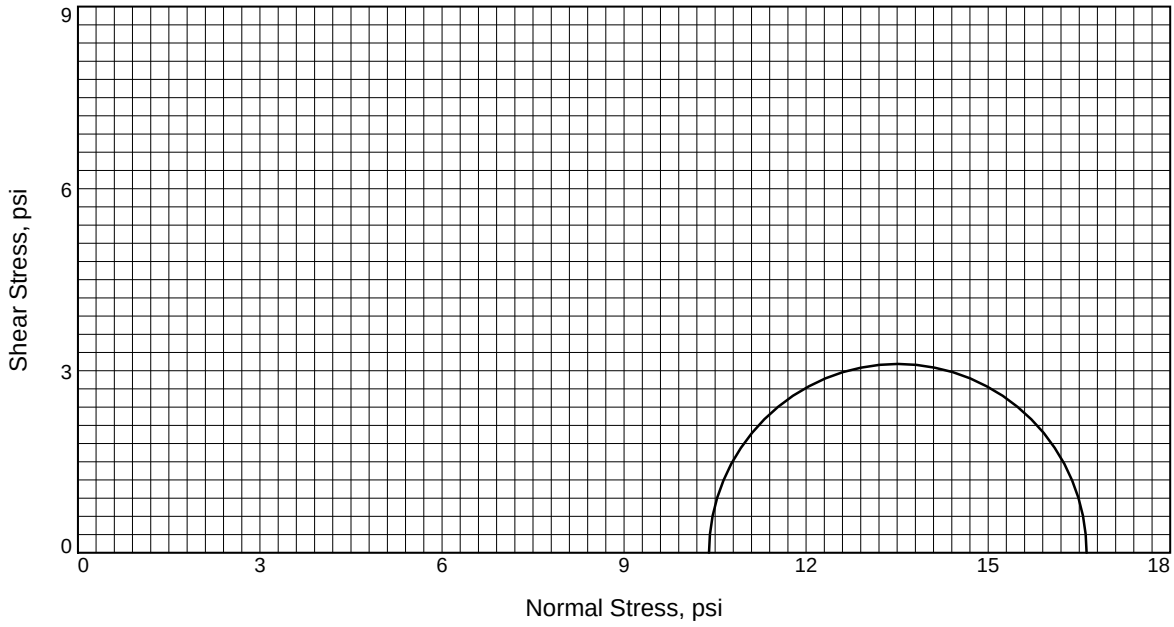
○SAMPLE DESCRIPTION BASED ON USCS

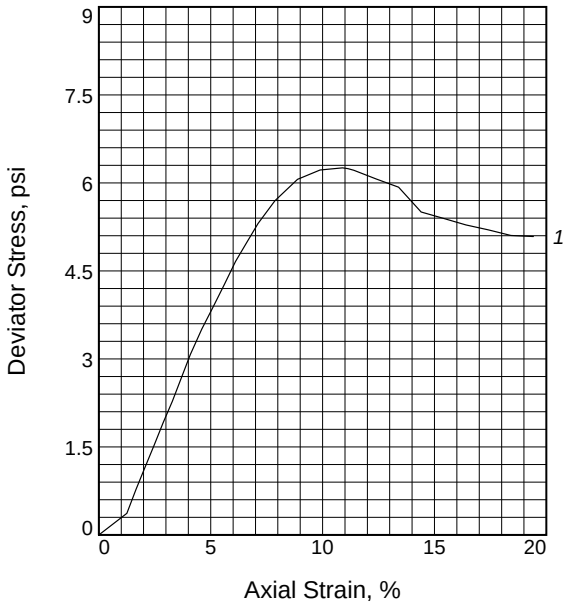
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 17

Tested By: CWZ 01/10/19 **Checked By:** JPB 01/24/19





Sample No.		1
Initial	Water Content, %	94.7
	Dry Density, pcf	46.3
	Saturation, %	100.0
	Void Ratio	2.3577
	Diameter, in.	2.792
	Height, in.	5.584
At Test	Water Content, %	94.5
	Dry Density, pcf	46.3
	Saturation, %	99.8
	Void Ratio	2.3577
	Diameter, in.	2.792
	Height, in.	5.584
Strain rate, in./min.		1.000
Back Pressure, psi		0.0
Cell Pressure, psi		10.4
Fail. Stress, psi		6.2
Strain, %		9.9
Ult. Stress, psi		
Strain, %		
σ_1 Failure, psi		16.6
σ_3 Failure, psi		10.4

Type of Test:
Unconsolidated Undrained
Sample Type: SHELBY TUBE
Description: DARK BROWN TO BLACK ORGANIC SILT WITH SAND*
LL= 128 **PL=** 77 **PI=** 51
Assumed Specific Gravity= 2.49
Remarks: SAMPLE DESCRIPTION BASED ON USCS

Figure 18

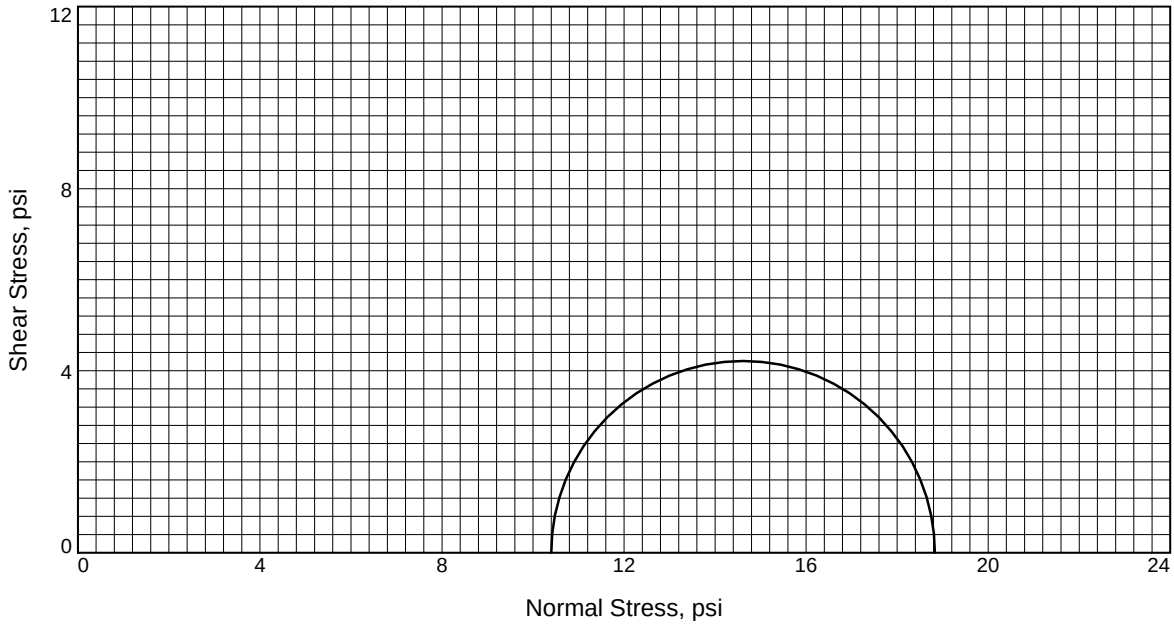
Client: COWI NORTH AMERIC, INC.

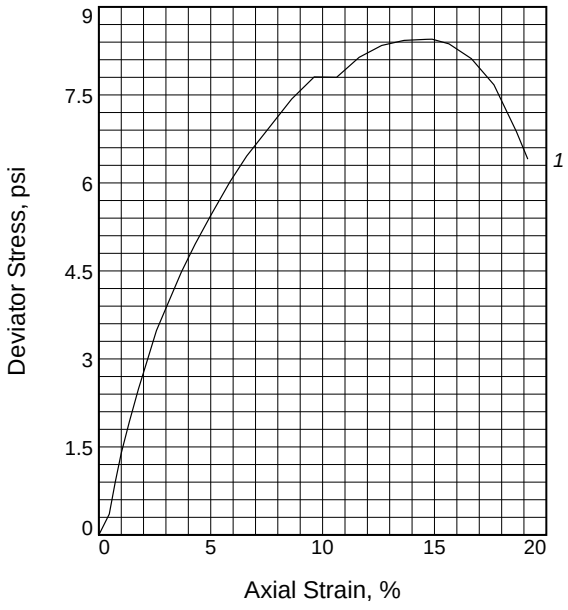
Project: NYSERDA - PORT IVORY

Source of Sample: PTIV-1 **Depth:** 24.0-26.0 FT
Sample Number: U-2
Proj. No.: 317660 **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT
TRC Engineers, Inc.
Mt. Laurel, NJ

Tested By: TBT 01/08/19 **Checked By:** JPB 01/24/19





Sample No.		1
Initial	Water Content, %	440.1
	Dry Density, pcf	12.5
	Saturation, %	100.0
	Void Ratio	7.5667
	Diameter, in.	2.784
	Height, in.	5.575
At Test	Water Content, %	438.5
	Dry Density, pcf	12.5
	Saturation, %	99.7
	Void Ratio	7.5667
	Diameter, in.	2.784
	Height, in.	5.575
Strain rate, in./min.		1.000
Back Pressure, psi		0.0
Cell Pressure, psi		10.4
Fail. Stress, psi		8.4
Strain, %		13.6
Ult. Stress, psi		
Strain, %		
σ_1 Failure, psi		18.8
σ_3 Failure, psi		10.4

Type of Test:
Unconsolidated Undrained
Sample Type: SHELBY TUBE
Description: DARK BROWN TO BLACK PEAT

Assumed Specific Gravity= 1.72
Remarks: SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION

Figure 19

Client: COWI NORTH AMERIC, INC.

Project: NYSERDA - PORT IVORY

Source of Sample: PTIV-2 **Depth:** 26.0-28.0 FT
Sample Number: U-1
Proj. No.: 317660 **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT
TRC Engineers, Inc.
Mt. Laurel, NJ

Tested By: TBT 01/14/19 **Checked By:** JPB 01/24/19

TRC Engineers, Inc.
Soil Mechanics Laboratory

Unconfined Compression Strength Test of Rock Core

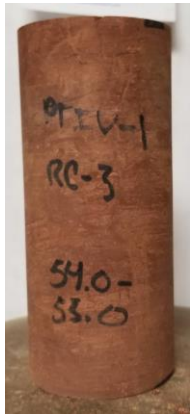
Project Name: NYSERDA - PORT IVORY
Project No.: 317660.0000
Boring No.: PTIV-1
Sample No: RC-3
Depth (ft): 54.0-55.0

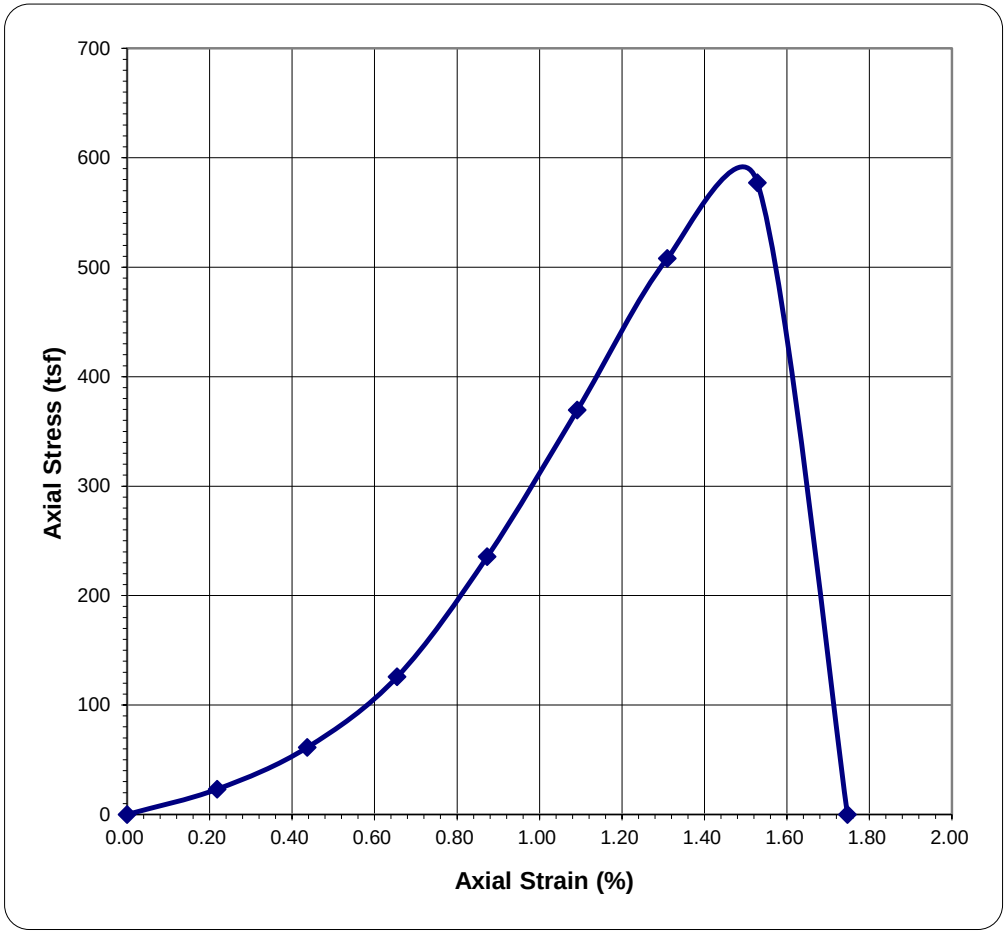
Average Sample Diameter (in.): 1.993
Cross Sectional Area (sq. in.) 3.118
Average Sample Height (in.): 4.580
Sample Mass (g): 600.9
Unit Weight (PCF) 160.3

Sample Description:
RED-BROWN
WEATHERED MUDSTONE

Test Data

Strain Dial (in.)	Load (lb)	Strain (%)	Stress (tsf)
0.000	0	0.00	0
0.010	1000	0.22	23
0.020	2650	0.44	61
0.030	5450	0.65	126
0.040	10200	0.87	236
0.050	16000	1.09	369
0.060	22000	1.31	508
0.070	25000	1.53	577
0.080	0	1.75	0





TRC Engineers, Inc.
Soil Mechanics Laboratory

Unconfined Compression Strength Test of Rock Core

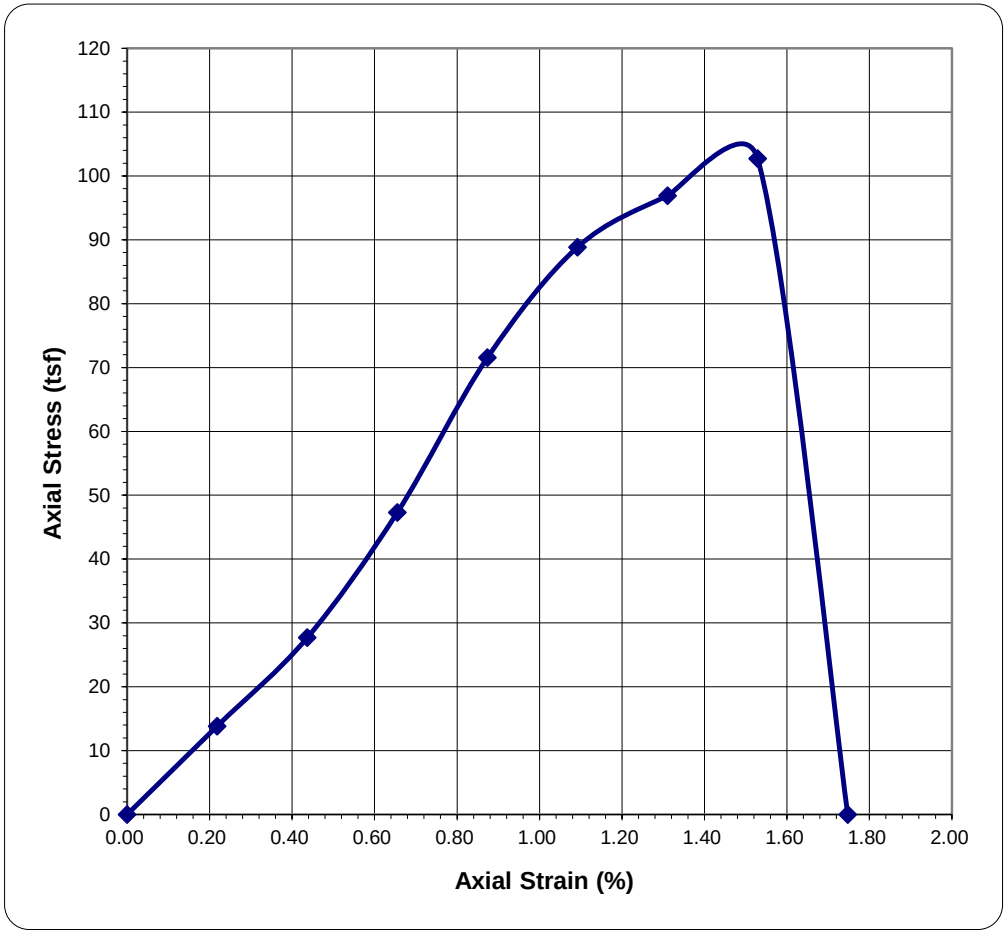
Project Name: NYSERDA - PORT IVORY
Project No.: 317660.0000
Boring No.: PTIV-1
Sample No: RC-4
Depth (ft): 56.6-57.3

Average Sample Diameter (in.):	1.993
Cross Sectional Area (sq. in.)	3.120
Average Sample Height (in.):	4.579
Sample Mass (g):	501.18
Unit Weight (PCF)	133.7

Sample Description:
RED-BROWN
WEATHERED SANDSTONE/
SILTSTONE

Test Data

Strain Dial (in.)	Load (lb)	Strain (%)	Stress (tsf)
0.000	0	0.00	0
0.010	600	0.22	14
0.020	1200	0.44	28
0.030	2050	0.66	47
0.040	3100	0.87	72
0.050	3850	1.09	89
0.060	4200	1.31	97
0.070	4450	1.53	103
0.080	0	1.75	0



TRC Engineers, Inc.
Soil Mechanics Laboratory

Unconfined Compression Strength Test of Rock Core

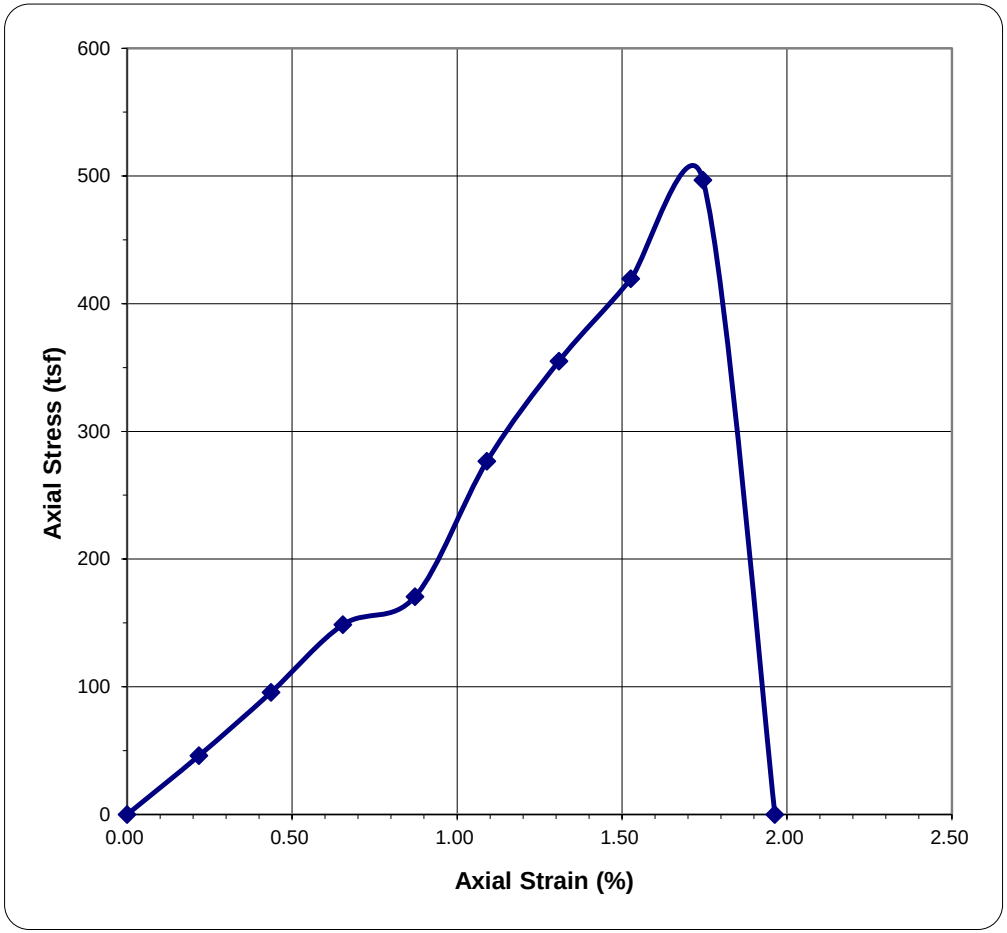
Project Name: NYSERDA - PORT IVORY
Project No.: 317660.0000
Boring No.: PTIV-2
Sample No: RC-1
Depth (ft): 55.0-56.0

Average Sample Diameter (in.):	1.994
Cross Sectional Area (sq. in.)	3.123
Average Sample Height (in.):	4.584
Sample Mass (g):	605.5
Unit Weight (PCF)	161.2

Sample Description:
RED-BROWN
MUDSTONE

Test Data

Strain Dial (in.)	Load (lb)	Strain (%)	Stress (tsf)
0.000	0	0.00	0
0.010	2000	0.22	46
0.020	4150	0.44	96
0.030	6450	0.65	149
0.040	7400	0.87	171
0.050	12000	1.09	277
0.060	15400	1.31	355
0.070	18200	1.53	420
0.080	21550	1.75	497
0.090	0	1.96	0



TRC Engineers, Inc.
Soil Mechanics Laboratory

Unconfined Compression Strength Test of Rock Core

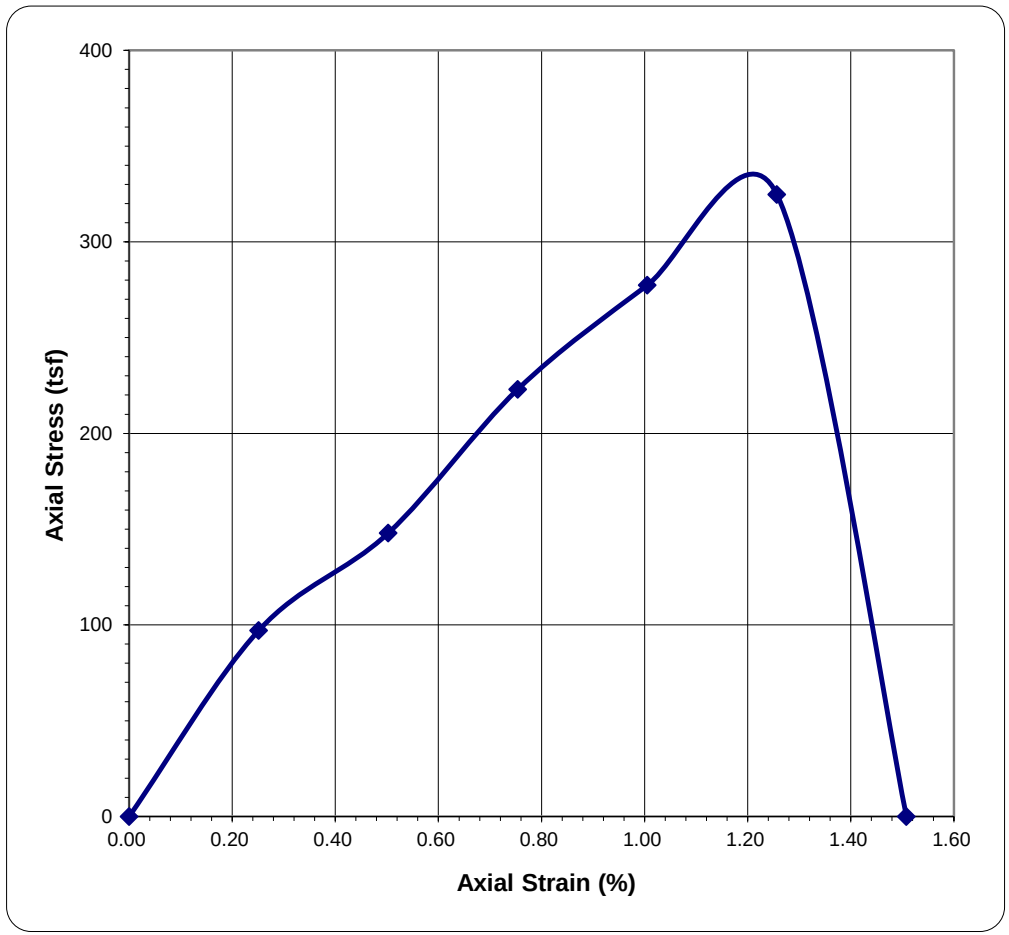
Project Name: NYSERDA - PORT IVORY
Project No.: 317660.0000
Boring No.: PTIV-2
Sample No: RC-2
Depth (ft): 57.5-58.0

Average Sample Diameter (in.):	1.992
Cross Sectional Area (sq. in.)	3.115
Average Sample Height (in.):	3.979
Sample Mass (g):	519.1
Unit Weight (PCF)	159.6

Sample Description:
RED-BROWN
WEATHERED MUDSTONE

Test Data

Strain Dial (in.)	Load (lb)	Strain (%)	Stress (tsf)
0.000	0	0.00	0
0.010	4200	0.25	97
0.020	6400	0.50	148
0.030	9650	0.75	223
0.040	12000	1.01	277
0.050	14050	1.26	325
0.060	0	1.51	0



TRC Engineers, Inc.
Soil Mechanics Laboratory

Unconfined Compression Strength Test of Rock Core

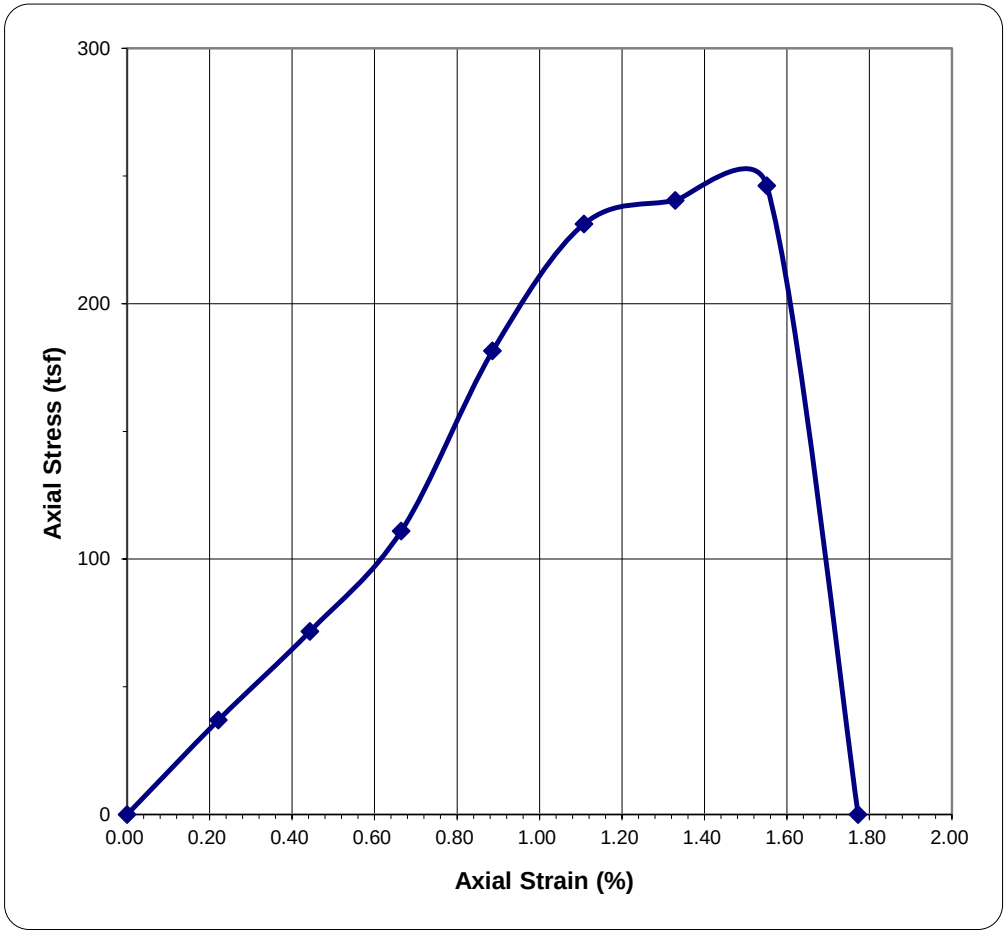
Project Name: NYSERDA - PORT IVORY
Project No.: 317660.0000
Boring No.: PTIV-3
Sample No: RC-2
Depth (ft): 73.0-73.5

Average Sample Diameter (in.):	1.991
Cross Sectional Area (sq. in.)	3.114
Average Sample Height (in.):	4.513
Sample Mass (g):	574.33
Unit Weight (PCF)	155.7

Sample Description: RED-BROWN *MUDSTONE/SILTSTONE*

Test Data

Strain Dial (in.)	Load (lb)	Strain (%)	Stress (tsf)
0.000	0	0.00	0
0.010	1600	0.22	37
0.020	3100	0.44	72
0.030	4800	0.66	111
0.040	7850	0.89	181
0.050	10000	1.11	231
0.060	10400	1.33	240
0.070	10650	1.55	246
0.080	0	1.77	0



Appendix B: Pre-FEED Drawings

NYSERDA 2018 PORTS ASSESSMENT

PORT IVORY PRE-FRONT END ENGINEERING DESIGN

LOCATION PLAN

SCALE: N.T.S.

DRAWING INDEX

DWG NO.	DRAWING TITLE	REV.
A093893-G-01	COVER SHEET AND DRAWING INDEX	A
A093893-G-02	EXISTING SITE AND DEMOLITION PLAN	A
A093893-S-01	PROPOSED SITE PLAN	A
A093893-S-02	EXISTING SLOPE AND PROPOSED WHARF AND DREDGE SECTIONS	A
A093893-S-03	TYPICAL EXISTING AND PROPOSED EAST AND WEST SHORELINE SECTIONS	A

REV	DATE	DESCRIPTION	BY	CHK
A	01-25-2019	PORT IVORY PRE-FEED DRAWING SET	PNCN	NLKP

OWNER

CLIENT

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

CONSULTANT

BTMI | COWI
BRIDGE TUNNEL MARINE
276 5th Avenue, Suite 1006 New York, NY 10001
Tel.: 646.545.2125 Fax: 646.553.1620
Website: www.cowi-na.com

PROJECT TITLE

NYSERDA 2018 PORTS ASSESSMENT

PORT IVORY PRE-FRONT END ENGINEERING DESIGN

DRAWING TITLE

COVER SHEET AND DRAWING INDEX

ENGINEER'S STAMP

FOR PLANNING PURPOSES ONLY

SCALE	DESIGNED	APPROVED
N/A	NLKP	BRCO
DRAWN	CHECKED	DATE
PNCN	NLKP	01-25-2019

JOB NO.	DRAWING NO.	REV.
A093893	G-01	A

PLOTTED BY: PENNY CONRAD PLOT DATE: 1/24/2019 4:03:04 PM
FILE LOCATION: O:\A093800\A093893\CAD\PORT IVORY\A093893-PI-G01.DWG

EXISTING SITE AND DEMOLITION PLAN

1:2000

LEGEND:

- MHHW OR MLLW
- MAJOR CONTOUR LINES
- MINOR CONTOUR LINES
- PORT IVORY FACILITY
- PROPOSED DEMOLITION (PAVEMENT AND PIER)

GENERAL NOTES:

1. ELEVATION DATA IS BASED ON A COASTAL NATIONAL ELEVATION DATABASE (CONED) PROJECT; HORIZONTAL DATUM IS UTM 18N COORDINATE SYSTEM NAD 83; THE PROJECT VERTICAL DATUM IS THE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).

TIDAL DATUM	NAVD 88
FEMA BFE	3.96 m (13.00 FT.)
MEAN HIGHER HIGH WATER (MHHW)	0.77 m (2.51 FT.)
MEAN HIGH WATER (MHW)	0.66 m (2.19 FT.)
NAVD '88	0.00m (0.00 FT.)
MEAN SEA LEVEL (MSL)	-0.07 m (-0.23 FT.)
MEAN LOW WATER (MLW)	-0.85 m (-2.79 FT.)
MEAN LOWER LOW WATER (MLLW)	-0.91 m (-3.00 FT.)

NOTES:
' AS PER AT NOAA STATION 8519483, BERGEN POINT WEST REACH, NY

GRAPHIC SCALES

CHECK GRAPHIC SCALES BEFORE USING

0 1:2000 100

ENGINEER'S STAMP

FOR PLANNING PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY	CHK
A	01-25-2015	PORT IVORY PRE-FEED DRAWING SET	PNCN	NLKP

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NEW YORK STATE OF OPPORTUNITY. NYSERDA

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PROJECT TITLE

NYSERDA 2018 PORTS ASSESSMENT

PORT IVORY PRE-FRONT END ENGINEERING DESIGN

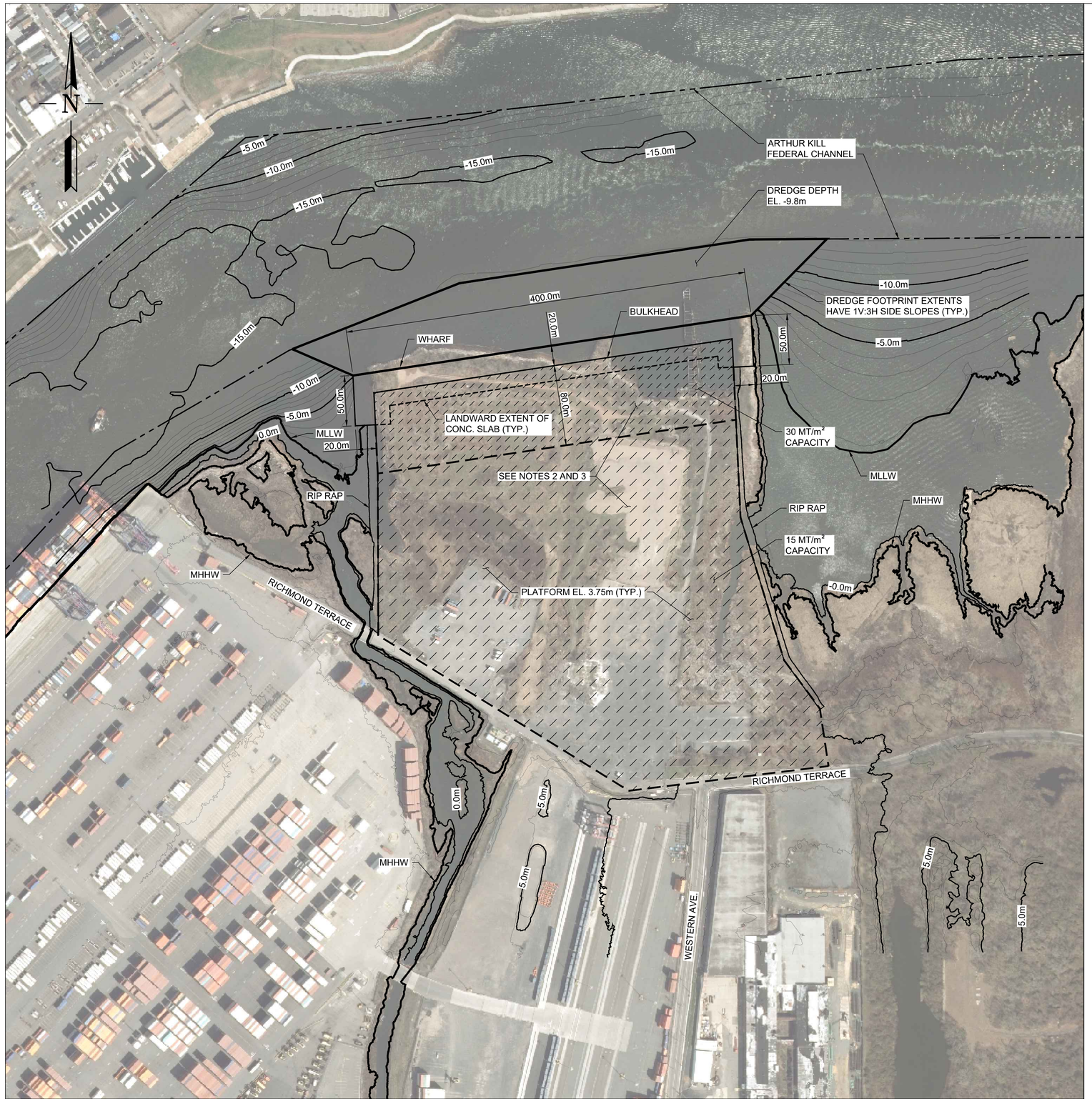
DRAWING TITLE

EXISTING SITE AND DEMOLITION PLAN

SCALE	DESIGNED	APPROVED
1:2000	NLKP	BRCO
DRAWN	CHECKED	DATE
PNCN	NLKP	01-25-2019
JOB NO.	DRAWING NO.	REV.
A093893	G-02	A

PLOTTED BY: PENNY CONRAD PLOT DATE: 1/24/2019 12:27:27 PM

FILE LOCATION: \\COWI.NET\PROJECT\A\A093893\CAD\PORT IVORY\A093893-PI-G02.DWG



PROPOSED SITE PLAN

1:2000

LEGEND:

- MHHW OR MLLW
- MAJOR CONTOUR LINES
- MINOR CONTOUR LINES
- PORT IVORY FACILITY
- EXTENT OF CONC. DECK
- 15 MT/m² CAPACITY
- 30 MT/m² CAPACITY

GENERAL NOTES:

1. ELEVATION DATA IS BASED ON A COASTAL NATIONAL ELEVATION DATABASE (CONED) PROJECT; HORIZONTAL DATUM IS UTM 18N COORDINATE SYSTEM NAD 83; THE PROJECT VERTICAL DATUM IS THE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).
2. BEARING CAPACITY IMPROVEMENTS FOR 15 MT/m² CAPACITY AREA TO INCLUDE RIGID INCLUSIONS AT 1.7m (6 FT.) SPACING IN BOTH DIRECTIONS. BEARING CAPACITY IMPROVEMENTS FOR 30 MT/m² CAPACITY AREA TO INCLUDE 1.2m (4 FT.) SPACING IN BOTH DIRECTIONS. SEE DRAWINGS S-02 AND S-03 FOR DETAILS.
3. PROPOSED SURFACE TREATMENT IN ALL AREAS OUTSIDE OF CONCRETE SLAB IS CRUSHED STONE. SEE DRAWINGS S-02 AND S-03 FOR DETAILS.

GRAPHIC SCALES

CHECK GRAPHIC SCALES BEFORE USING

0 1:2000 100

REV	DATE	DESCRIPTION	BY	CHK
A	01-25-2019	PORT IVORY PRE-FEED DRAWING SET	PNCN	NLKP

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PROJECT TITLE

NYSERDA 2018 PORTS ASSESSMENT

PORT IVORY PRE-FRONT END ENGINEERING DESIGN

DRAWING TITLE

PROPOSED SITE PLAN

ENGINEER'S STAMP

FOR PLANNING PURPOSES ONLY

SCALE	DESIGNED	APPROVED
1:2000	NLKP	BRCO
DRAWN	CHECKED	DATE
PNCN	NLKP	01-25-2019
JOB NO.	DRAWING NO.	REV.
A093893	S-01	A

PLOTTED BY: PENNY CONRAD PLOT DATE: 1/24/2019 12:55:07 PM

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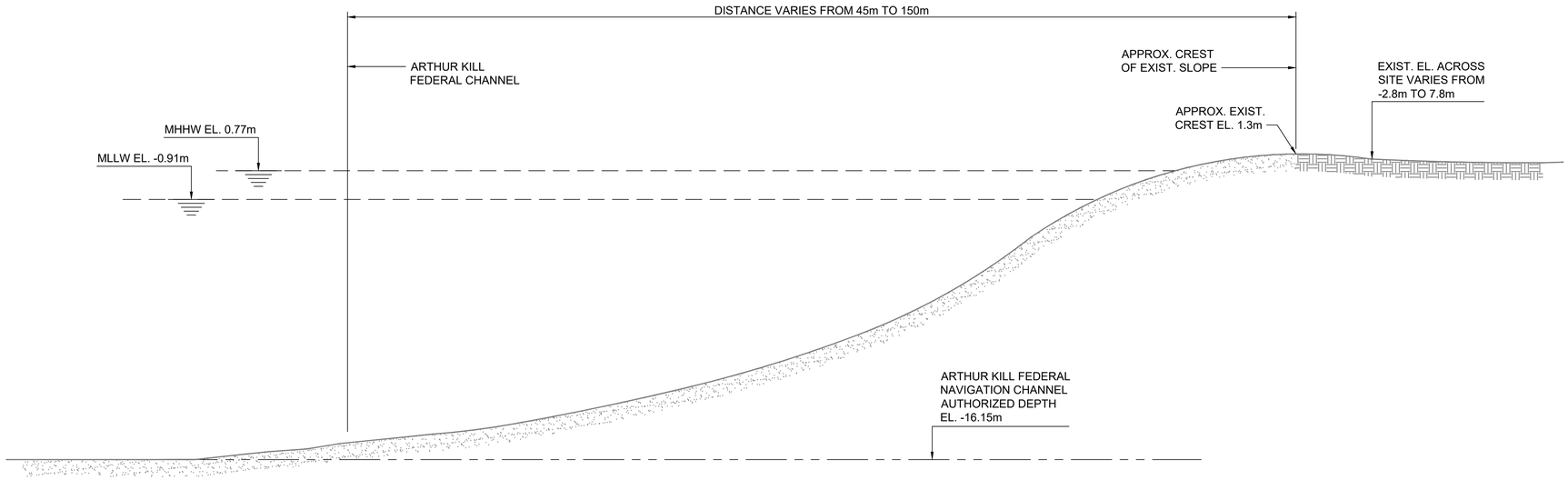
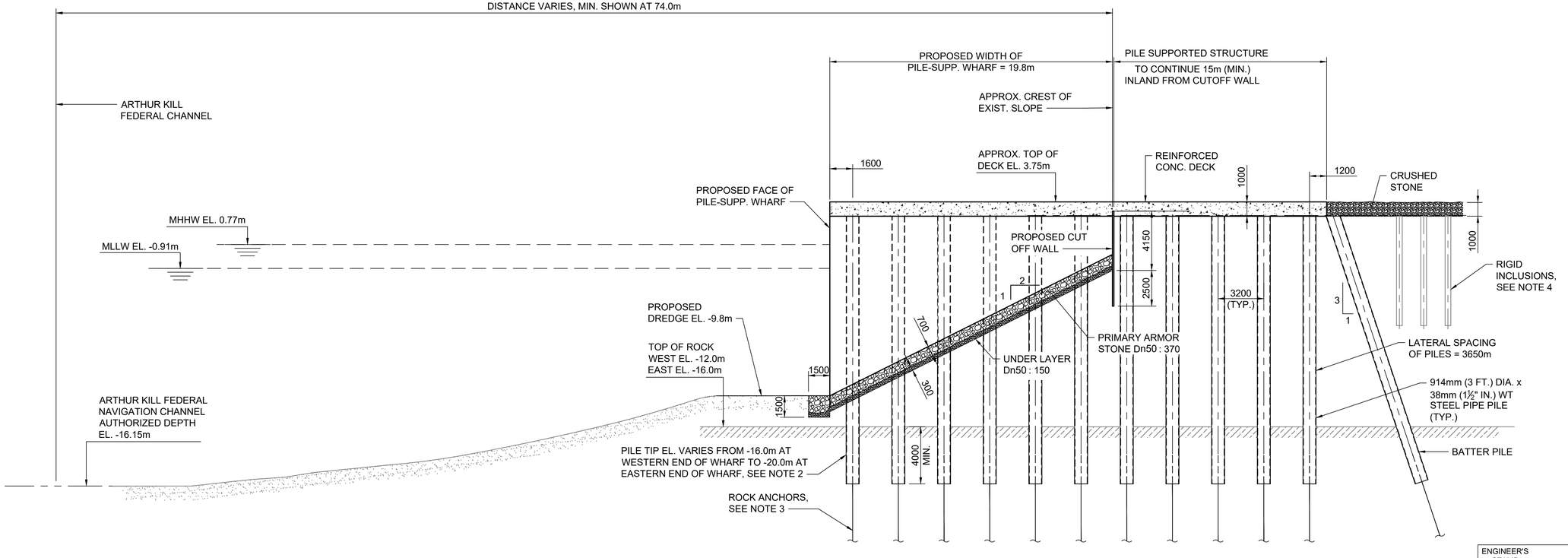


TYPICAL EXISTING CONDITIONS – NORTH SHORELINE

1:150



TYPICAL PROPOSED WHARF SECTION

1:150

NOTES:

1. ELEVATION DATA IS BASED ON COASTAL NATIONAL ELEVATION DATABASE (CONED) PROJECT. ALL ELEVATIONS REFERENCE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).
2. ALL PILES TO BE DRIVEN A MINIMUM OF 4m INTO ROCK UNLESS REFUSAL OCCURS EARLIER.
3. ROCK ANCHORS APPROXIMATED FOR PRE-FEED. ASSUMED TO BE APPROXIMATELY 6m OF BONDED LENGTH INTO ROCK.
4. DEPTH OF RIGID INCLUSIONS VARY DEPENDING ON LOCATION OF GREY SAND/RED CLAY. SEE DRAWING S-03 FOR DETAILS.
5. MATERIAL FOR STEEL PIPE PILES AND CUT OFF WALL SHALL BE ASTM A572 GR 50; STEEL SHEET PILES OR COMBINED WALLS WITH LARGER MOMENT OF INERTIA THAN THE SPECIFIED MAY BE ADOPTED.

GRAPHIC SCALES
CHECK GRAPHIC SCALES BEFORE USING

0 1:150 7.5

REV	DATE	DESCRIPTION	BY	CHK
A	01-25-2019	PORT IVORY PRE-FEED DRAWING SET	PNCN	NLKP

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PROJECT TITLE
NYSERDA 2018 PORTS ASSESSMENT

PORT IVORY PRE-FRONT END ENGINEERING DESIGN

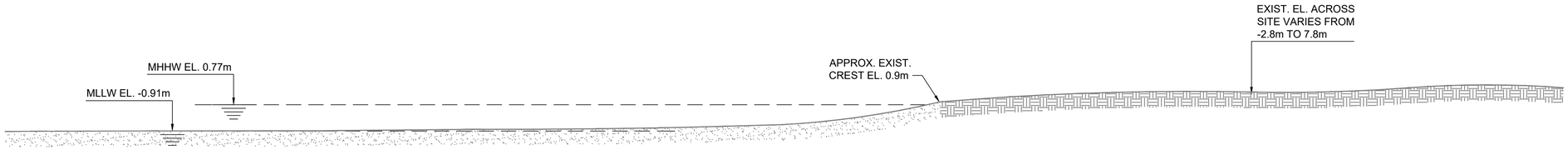
DRAWING TITLE
EXISTING SLOPE AND PROPOSED WHARF AND DREDGE SECTIONS

ENGINEER'S STAMP

FOR PLANNING PURPOSES ONLY

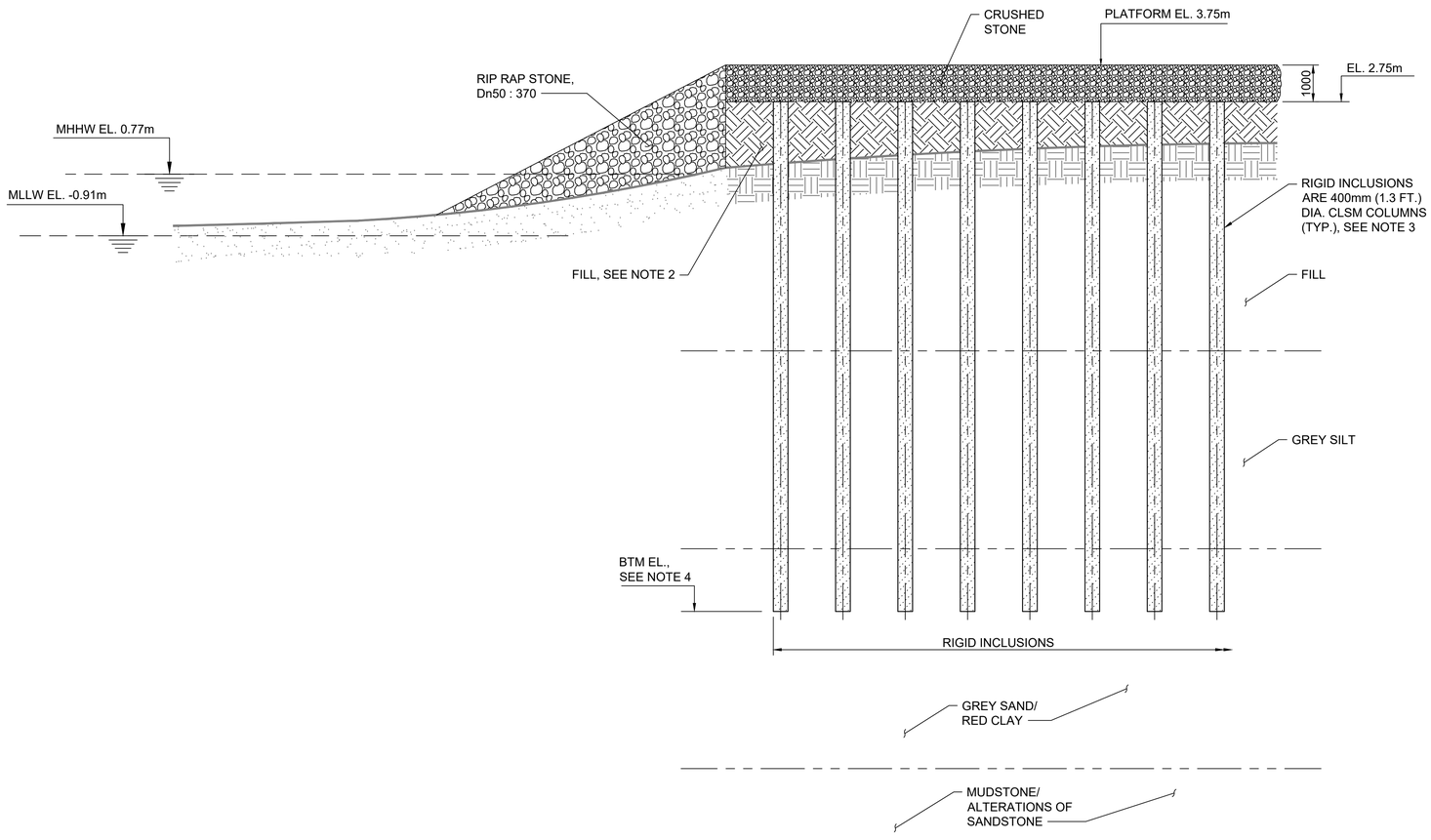
SCALE	DESIGNED	APPROVED
1:150	NLKP	BRCO
DRAWN	CHECKED	DATE
PNCN	NLKP	01-25-2019

JOB NO.	DRAWING NO.	REV.
A093893	S-02	A



TYPICAL EXISTING CONDITIONS EAST AND WEST SHORELINE

1:150



TYPICAL PROPOSED EAST AND WEST SHORELINE

1:75

NOTES:

1. ELEVATION DATA IS BASED ON COASTAL NATIONAL ELEVATION DATABASE (CONED) PROJECT. ALL ELEVATIONS REFERENCE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).
2. FILL IS OBTAINED FROM A COMBINATION OF CUT MATERIAL AND NEW FILL MATERIAL; NEW FILL MATERIAL SHALL BE BANK RUN GRAVEL.
3. 15 MT/m² CAPACITY AREA TO INCLUDE RIGID INCLUSIONS AT 1.7m (6 FT.) IN BOTH DIRECTIONS. 30 MT/m² CAPACITY AREA TO INCLUDE RIGID INCLUSIONS AT 1.2m (4 FT.) SPACING IN BOTH DIRECTIONS.
4. DEPTH OF RIGID INCLUSIONS VARIES DEPENDING ON DEPTH OF GREY SAND/RED CLAY LAYERS.

GRAPHIC SCALES

CHECK GRAPHIC SCALES BEFORE USING

0 1:75 3.5

0 1:150 7.5

REV	DATE	DESCRIPTION	BY	CHK
A	01-25-2019	PORT IVORY PRE-FEED DRAWING SET	PNCN	NLKP

OWNER

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NEW YORK STATE OF OPPORTUNITY. | NYSERDA

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PROJECT TITLE

NYSERDA 2018 PORTS ASSESSMENT

PORT IVORY PRE-FRONT END ENGINEERING DESIGN

DRAWING TITLE

TYPICAL EXISTING AND PROPOSED
EAST AND WEST SHORELINE SECTIONS

ENGINEER'S STAMP

FOR PLANNING PURPOSES ONLY

SCALE	DESIGNED	APPROVED
AS NOTED	NLKP	BRCO
DRAWN	CHECKED	DATE
PNCN	NLKP	01-25-2019
JOB NO.	DRAWING NO.	REV.
A093893	S-03	A

Appendix C: Opinion of Probable Cost Backup

NYSERDA 2018 PORTS STUDY					
PRE-FRONT END ENGINEERING DESIGN REPORT					
PORT IVORY					
OPINION OF PROBABLE COSTS					
PROJECT NO:	A093893.2				
PROJECT NAME:	NYSERDA 2018 PORTS STUDY				
CLIENT:	NYSERDA				
SITE LOCATION:	STATEN ISLAND, NY				
PREPARED BY:	NLKP				
DATE:	18-Jan-2019				
CHECKED BY:	JOBA				
WORK ITEM DESCRIPTION		**QUANTITY**	**UNITS**	**UNIT PRICE**	**TOTAL**

MOBILIZATION AND DE-MOBILIZATION					
-	Mobilization and Demobilization	1	Lump Sum	$1,687,000.00	$1,687,000.00
-					

DEMOLITION, CLEARING AND GRUBBING					
_	Clearing and Grubbing	95620	Square Meter	$1.91	$183,000.00
_	Demolition - Pavement	33580	Square Meter	$46.40	$1,558,000.00
_	Demolition - Piles	1600	Square Meter	$4.02	$6,439.15
_					
MARINE STRUCTURES					
_	30T/m² Pile Supported Wharf	16010	Square Meter	$8,060.27	$129,045,000.00
_	Rip Rap Revetment	650	Linear Meter	$4,681.54	$3,043,000.00
_					
EARTHWORK & GROUND IMPROVEMENT					
_	Upland Excavation above MHW	81230	Cubic Meter	$16.55	$1,344,000.00
_	Upland Fill above MHW	115330	Cubic Meter	$24.28	$2,800,000.00
_	Rigid Inclusions	95620	Square Meter	$733.04	$70,093,000.00
_					
SURFACE TREATMENT					
_	Gravel 30T/m² & 15 T/m² Staging Area	137240	Square Meter	$132.33	$18,161,000.00
_					
DREDGING					
_	Berth Dredging	142860	Cubic Meter	$111.19	$15,884,000.00

SUBTOTAL					**$261,649,439.15**
			CONTINGENCY:	30%	$78,494,831.74
				TOTAL	**$340,145,000.00**
NOTE: COWI HAS NO CONTROL OVER THE COST OF LABOR, MATERIALS, EQUIPMENT, OR SERVICES FURNISHED BY OTHERS, OR OVER THE CONTRACTOR'S METHODS OF DETERMINING PRICES, OR OVER COMPETITIVE BIDDING OR MARKET CONDITIONS. COWI'S OPINIONS OF PROBABLE PROJECT COST AND CONSTRUCTION COST PROVIDED FOR HEREIN, ARE MADE ON THE BASIS OF COWI'S BEST JUDGEMENT AS EXPERIENCED AND QUALIFIED PROFESSIONAL ENGINEERS, FAMILIAR WITH THE CONSTRUCTION INDUSTRY; BUT COWI CANNOT AND DOES NOT GUARANTEE THAT PROPOSALS, BIDS OR ACTUAL PROJECT OR CONSTRUCTION COSTS WILL NOT VARY FROM OPINIONS OF PROBABLE COST PREPARED BY COWI.					

PROJECT NO.:		A093893.2				
DATE:		18-Jan-2019				
REFERENCES:						
THIS OPINION OF PROBABLE COST IS BASED UPON THE FOLLOWING DRAWINGS						
	PREPARED BY	**DRAWING NAME**	**DRAWING NO.**	**REV.**	**DATE**	**COPY ATTACHED?**
	COWI	COVER SHEET AND DRAWING INDEX	G-01	A	01-24-19	YES
	COWI	EXISTING SITE PLAN	G-02	A	01-24-19	YES
	COWI	PROPOSED SITE PLAN	S-01	A	01-24-19	YES
	COWI	EXISTING SLOPE AND PROPOSED WHARF AND DREDGE SECTIONS	S-02	A	01-24-19	YES
	COWI	TYPICAL EXISTING AND PROPOSED EAST AND WEST SHORELINE SECTIONS	S-03	A	01-24-19	YES

PROJECT NO.:			A093893.2						
DATE:			18-Jan-2019						
ASSUMPTIONS:									
1	CURRENCY IN U.S. DOLLARS								
2	COSTS ARE BASED ON FY 2018$								
3	OPC IS BASED ON MATERIAL PRICING AND AVAILABILITY AS OF THE DATE OF THE OPC. MATERIAL PRICING AND AVAILABILITY AT TIME OF CONSTRUCTION MAY VARY.								
4	RESOURCES USED FOR PRICING:								
	a	PREVAILING WAGE RATES FOR ALBANY COUNTY, NY							
	b	R.S. MEANS HEAVY CONSTRUCTION COST DATA							
5	EXCLUDED ITEMS:								
	a	SALES AND USE TAXES							
	b	UTILITIES							
	c	CONTAMINATED MATERIALS HANDLING AND DISPOSAL							
	d	ELECTRICAL WORK							
	e	MECHANICAL WORK							
	f	ITEMS NOT SPECIFICALLY LISTED IN "REFERENCES" SECTION OF THIS OPC.							

	g	ENGINEERING AND CONSTRUCTION OVERSIGHT				
	h	CONSTRUCTION MANAGEMENT FEES				
	i	PERMIT ACQUISITION AND PERMIT FEES				
	j	ARCHITECTURAL FINISHES				
	k	FENDERING AND MOORING APPURTENANCES				
6	ACCESS FOR WORK IS FROM WATERBORNE AND UPLAND-BASED EQUIPMENT WITH UPLAND STAGING ON SITE OR ADJACENT TO THE WORK AREA.					
7	IT IS ASSUMED THAT THERE WILL BE UNRESTRICTED ACCESS FOR THE WORK WITH NO DISRUPTIONS.					

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
MOBILIZATION AND DE-MOBILIZATION						
Mobilization and Demobilization						
Quantity:	1	Lump Sum				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL MATERIALS					0.00	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
COORDINATION	120.0	MH	100.00	12000.00		PROJECT MANAGER
PREP OFF SITE	10.0	SHIFT	17304.46	173044.61		
MOBILIZATION	10.0	SHIFT	17304.46	173044.61		
SET-UP ON SITE	5.0	SHIFT	17304.46	86522.31		

BREAK-DOWN ON SITE	10.00	SHIFT	17304.46	173044.61		
DEMOBILIZATION	10.00	SHIFT	17304.46	173044.61		
TOTAL LABOR & EQUIPMENT					790700.75	
SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
MARINE TOWING	1	LS	500000.00	500000.00		
TOTAL SUBCONTRACTORS					500000.00	
SUBTOTAL PROJECT					1290700.75	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		103256.06	
OVERHEAD		10%	PERCENT		139395.68	
PROFIT		10%	PERCENT		153335.25	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$1,686,687.74**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
DEMOLITION, CLEARING AND GRUBBING						
Clearing and Grubbing						
Quantity:	95620	Square Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL MATERIALS					0.00	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL LABOR & EQUIPMENT					0.00	

SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
CLEARING AND GRUBBING	9.6	HECTARE	14639.45	139982.42		RS MEANS BARE TOTAL, LINE NO. 311110100200, MEDIUM TREES TO 300 mm, CUT AND CHIP.
TOTAL SUBCONTRACTORS					139982.42	
SUBTOTAL PROJECT					139982.42	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		11198.59	
OVERHEAD		10%	PERCENT		15118.10	
PROFIT		10%	PERCENT		16629.91	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$182,929.03**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
DEMOLITION, CLEARING AND GRUBBING						
Demolition - Pavement						
Quantity:	33580	Square Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL MATERIALS					0.00	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL LABOR & EQUIPMENT					0.00	

SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
PAVEMENT DEMOLITION	33,580	SM	10.18	341844.40		RS MEANS BARE TOTAL, LINE NO. 024113175050, 100-150 mm THICK
DEBRIS HAULING	6,296	LCM	9.60	60444.00		CYCLE HAULING (WAIT, LOAD, TRAVEL, UNLOAD OR DUMP & RETURN) TIME PER CYCLE, EXCAVATED BORROW, LOOSE CUBIC METERS, 30 MIN LOAD/WAIT/UNLOAD, 15.28 m^3 TRUCK, CYCLE 16.1 km, 32 kmh, EXCLUDES LOADING EQUIPMENT. RS MEANS BARE TOTAL, LINE NO. 312323204638. ASSUMES 50% VOIDS.
DEBRIS DISPOSAL	9,749	MT	81.00	789706.24		SELECTIVE DEMOLITION, DUMP CHARGES, TYPICAL URBAN CITY, BUILDING CONSTRUCTION MATERIALS, INCLUDES TIPPING FEES ONLY. RSMEANS BARE TOTAL, LINE NO. 024119200100.
TOTAL SUBCONTRACTORS					1191994.64	

SUBTOTAL PROJECT					1191994.64	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		95359.57	
OVERHEAD		10%	PERCENT		128735.42	
PROFIT		10%	PERCENT		141608.96	
SALES TAX		0%	PERCENT		0.00	
CONTINGENCY		0%	PERCENT		0.00	
TOTAL OPC					**$1,557,698.60**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
DEMOLITION, CLEARING AND GRUBBING						
Demolition - Piles						
Quantity:	1600	Square Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
TOTAL MATERIALS					0.00	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
TOTAL LABOR & EQUIPMENT					0.00	

SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
DEMO DERELICT PILES	1600.0	SM	2.37	3790.32		50% OF UNIT COST FOR PIER DEMOLITION, AS PER WEEKS MARINE & SIMPSON & BROWN BIDS
TOTAL SUBCONTRACTORS					3790.32	
SUBTOTAL PROJECT					3790.32	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		303.23	
OVERHEAD		10%	PERCENT		409.35	
PROFIT		10%	PERCENT		450.29	
SALES TAX		0%	PERCENT		0.00	
CONTINGENCY		30%	PERCENT		1485.96	

TOTAL OPC					**$6,439.15**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
MARINE STRUCTURES						
30T/m² Pile Supported Wharf						
Quantity:	16010	Square Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
STEEL PIPE PILES	17928224.4	KG	2.20	39524922.02		914 DIA. X 25 mm WT
PIPE PILE COATING	26679.4	SM	43.06	1148698.16		EXPOSED PILE LENGTH + 3.05m
CONCRETE SLAB	16008.0	CM	196.19	3140649.54		1.0 m THICK
CONCRETE SLAB REINFORCEMENT	1899431.3	KG	2.20	4187524.32		118 KG/CM ASSUMED
CONCRETE FORMWORK	16997.6	SMCA	53.82	914802.33		
STEEL SHEET PILES	598099.8	KG	2.20	1318582.78		AZ44-700N ASSUMED
BULKHEAD COATING	4105.71	SM	43.06	176773.81		OUTER FACE, COMPLETE HEIGHT

REVETMENT ARMOR STONE	19426.4	MT	110.23	2141395.45		DUMPED, 25% VOIDS ASSUMED, D50=370 mm TOP LAYER, D50=150 mm UNDERLAYER
MARINE FENDER UNITS	8.0	EA	25000.00	200000.00		
MOORING BOLLARDS	8.0	EA	2500.00	20000.00		
TOTAL MATERIALS					52773348.42	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
SET AND DRIVE PIPE PILES	277.5	SHIFT	14584.46	4047187.94		ASSUME 2.75 PER SHIFT
SET AND DRIVE PIPE PILES	305.0	SHIFT	17304.46	5277860.61		ASSUME 2.5 PER SHIFT
PLACE REBAR	161.0	SHIFT	14861.40	2392685.39		ASSUME 100 SM PER SHIFT
FORM AND POUR CONCRETE	321.0	SHIFT	14861.40	4770509.38		ASSUME 50 CM PER SHIFT
SET & DRIVE SSP BULKHEAD	42.0	SHIFT	14584.46	612547.36		ASSUME 10 LM PER SHIFT
PLACE REVETMENT ARMOR STONE	54.0	SHIFT	16104.46	869640.90		ASSUME 7.5 LM PER SHIFT
ERECT FENDER UNITS	3.0	SHIFT	16104.4	48313.38		

			6			
ERECT BOLLARDS	1.0	SHIFT	16104.46	16104.46		
TOTAL LABOR & EQUIPMENT					18034849.42	
SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
INSTALL ROCK ANCHORS	1397	EA	20000.00	27940000.00		
				0.00		
TOTAL SUBCONTRACTORS					27940000.00	
SUBTOTAL PROJECT					98748197.84	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		7899855.83	
OVERHEAD		10%	PERCENT		10664805.37	
PROFIT		10%	PERCEN		11731285.90	

			T			
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$129,044,144.94**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
MARINE STRUCTURES						
Rip Rap Revetment						
Quantity:	650	Linear Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
REVETMENT RIP RAP STONE	14838.6	MT	110.23	1635676.51		INCLUDES RIP RAP ON EAST AND WEST SHORELINES (INCLUDING RIP BENEATH WHARF RETURNS). SAME STONE AS UNDER WHARF REVETMENT - DUMPED, 25% VOIDS ASSUMED, D50=370 mm TOP LAYER, D50=150 mm UNDERLAYER
TOTAL MATERIALS					1635676.51	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**

PLACE REVETMENT RIP RAP STONE	43.0	SHIFT	16104.46	692491.82		ASSUME 15 LM PER SHIFT
TOTAL LABOR & EQUIPMENT					692491.82	
SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
TOTAL SUBCONTRACTORS					0.00	
SUBTOTAL PROJECT					2328168.33	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		186253.47	
OVERHEAD		10%	PERCENT		251442.18	
PROFIT		10%	PERCENT		276586.40	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$3,042,450.38**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
EARTHWORK & GROUND IMPROVEMENT						
Upland Excavation above MHW						
Quantity:	81230	Cubic Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL MATERIALS					0.00	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
SOIL EXCAVATION	81230.0	BCM	12.66	1028371.80		RS MEANS BARE TOTAL, LINE NO. 312316462400, DOZER, 90 m HAUL, ASSUME ALL CUT IS USED AS BACKFILL

TOTAL LABOR & EQUIPMENT					1028371.80	
SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL SUBCONTRACTORS					0.00	
SUBTOTAL PROJECT					1028371.80	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		82269.74	
OVERHEAD		10%	PERCENT		111064.15	
PROFIT		10%	PERCENT		122170.57	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$1,343,876.27**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
EARTHWORK & GROUND IMPROVEMENT						
Upland Fill above MHW						
Quantity:	115330	Cubic Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
NEW FILL MATERIAL	34100.0	CM	26.78	913198.00		RS MEANS BARE MATERIAL, LINE NO. 321123231532, GRAVEL, BANK RUN
NEW FILL HAULING	40920.0	LCM	18.43	754155.60		RS MEANS BARE TOTAL, LINE NO. 312323201070, 9.17 CM TRUCK, CYCLE 64.4 KM, 15 MIN WAIT; LCM QUANTITY ASSUMED TO BE 20% GREATER
TOTAL MATERIALS					1667353.60	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**

BACKFILL SOILS	115330.0	LCM	4.12	475159.60		RS MEANS BARE TOTAL, LINE NO. 312323142400, DOZER, 90 m HAUL, ASSUME CUT & NEW FILL MATERIAL IS USED
TOTAL LABOR & EQUIPMENT					475159.60	
SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL SUBCONTRACTORS					0.00	
SUBTOTAL PROJECT					2142513.20	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		171401.06	
OVERHEAD		10%	PERCENT		231391.43	
PROFIT		10%	PERCENT		254530.57	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$2,799,836.25**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
EARTHWORK & GROUND IMPROVEMENT						
Rigid Inclusions						
Quantity:	95620	Square Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL MATERIALS					0.00	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
TOTAL LABOR & EQUIPMENT					0.00	

SUBCONTRACTORS & UNIT PRICES	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
RIGID INCLUSIONS	1	LS	53636721.85	53,636,721.85		BASED ON BUDGETARY ESTIMATES FROM HAYWARD BAKER
TOTAL SUBCONTRACTORS					53636721.85	
SUBTOTAL PROJECT					53636721.85	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		4290937.75	
OVERHEAD		10%	PERCENT		5792765.96	
PROFIT		10%	PERCENT		6372042.56	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$70,092,468.11**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
SURFACE TREATMENT						
Gravel 30T/m² & 15 T/m² Staging Area						
Quantity:	137240	Square Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
GRAVEL FOR SURFACE TREATMENT	263804.9	MT	49.60	13085763.26		1922 KG/CM ASSUMED
TOTAL MATERIALS					13085763.26	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
PLACE GRAVEL FILL (LOOSE)	164688.0	LCM	2.76	454538.88		RS MEANS BARE TOTAL, LINE NO. 312323142200. ASSUME LOOSE VOLUME IS 20% GREATER THAN IN-PLACE VOLUME.

COMPACT GRAVEL FILL	137240.0	ECM	2.60	356824.00		RS MEANS BARE TOTAL, LINE NO. 312323237640, 300 mm LIFTS, 4 PASSES, VIBRATING ROLLER
TOTAL LABOR & EQUIPMENT					811362.88	
SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL SUBCONTRACTORS					0.00	
SUBTOTAL PROJECT					13897126.14	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		1111770.09	
OVERHEAD		10%	PERCENT		1500889.62	
PROFIT		10%	PERCENT		1650978.59	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$18,160,764.44**	

PROJECT NO.:	A093893.2					
DATE:	18-Jan-2019					
DREDGING						
Berth Dredging						
Quantity:	142860	Cubic Meter				
OPINION OF PROBABLE COSTS						
MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		
TOTAL MATERIALS					0.00	
LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
				0.00		

				0.00		
				0.00		
TOTAL LABOR & EQUIPMENT					0.00	
SUBCONTRACTORS & UNIT PRICES	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
BERTH DREDGING	142860.0	BCM	85.08	12154835.59		INCLUDES UPLAND DISPOSAL. BASED ON $111.18/CM ESTIMATE. THIS UNIT COST HAS BEEN REDUCED TO $85.08/CM IN ORDER TO REMOVE GENERAL CONDITIONS, OVERHEAD, AND PROFIT THAT WAS INCLUDED IN ESTIMATE. THIS WAS ORIGINALLY ESTIMATED TO BE $65-$162 / CM IN PHASE 1.
TOTAL SUBCONTRACTORS					12154835.59	
SUBTOTAL PROJECT					12154835.59	
ESCALATION		0%	PERCENT		0.00	
GENERAL CONDITIONS		8%	PERCENT		972386.85	
OVERHEAD		10%	PERCENT		1312722.24	

PROFIT		10%	PERCENT		1443994.47	
SALES TAX		0%	PERCENT		0.00	
TOTAL OPC					**$15,883,939 .15**	

PROJECT NO.:	A093893.2							
DATE:	18-Jan-2019							
LABOR AND EQUIPMENT RATE BREAKDOWN								
CREW 1 - MARINE CONSTRUCTION WITH PILE DRIVING - UPLAND ACCESS								
				FULL COST	A	B	A+B	
				W / BURDEN	DIRECT WAGES*	FRINGES		
	LABOR							
		DOCKBUILDER FOREMAN		170.87	64.36	50.67	115.03	
		DOCKBUILDER		150.84	53.63	50.67	104.30	
		DOCKBUILDER		150.84	53.63	50.67	104.30	
		DOCKBUILDER		150.84	53.63	50.67	104.30	
		DOCKBUILDER		150.84	53.63	50.67	104.30	
		DOCKBUILDER		150.84	53.63	50.67	104.30	
		OILER		115.27	41.22	38.28	79.50	
		OPERATOR - CRANE		182.71	80.77	31.85	112.62	
	EQUIPMENT							
		COMPRESSOR		50.00				

		CRANE		300.00				
		UTILITY TRUCK		50.00				
		PILE DRIVING HAMMER		150.00				
		MISC		50.00				
	TOTAL HOURLY RATE			1823.06				
	TOTAL SHIFT RATE			14584.46	BASED ON EIGHT HOUR SHIFT			

PROJECT NO.:	A093893.2						
DATE:	18-Jan-2019						
LABOR AND EQUIPMENT RATE BREAKDOWN							
CREW 2 - MARINE CONSTRUCTION - UPLAND ACCESS							
				FULL COST	A	B	A+B
				W / BURDEN	DIRECT WAGES*	FRINGES	
	LABOR						
		DOCKBUILDER FOREMAN		170.87	64.36	50.67	115.03
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		OPERATOR - EXCAVATOR		184.62	81.79	31.85	113.64
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		OILER		115.27	41.22	38.28	79.50
		OPERATOR - CRANE		182.71	80.77	31.85	112.62

	EQUIPMENT						
		COMPRESSOR		50.00			
		CRANE		300.00			
		UTILITY TRUCK		50.00			
		MISC		50.00			
	TOTAL HOURLY RATE			1857.67			
	TOTAL SHIFT RATE			14861.40	BASED ON EIGHT HOUR SHIFT		

PROJECT NO.:	A093893.2						
DATE:	18-Jan-2019						
LABOR AND EQUIPMENT RATE BREAKDOWN							
CREW 3 - SITE WORK - UPLAND							
				FULL COST	A	B	A+B
				W / BURDEN	DIRECT WAGES*	FRINGES	
	LABOR						
		LABORER FOREMAN		136.77	50.40	42.63	93.03
		LABORER		121.08	42.00	42.63	84.63
		LABORER		121.08	42.00	42.63	84.63
		LABORER		121.08	42.00	42.63	84.63
		OPERATOR - EXCAVATOR		184.62	81.79	31.85	113.64
	EQUIPMENT						
		EXCAVATOR		120.00			
		COMPACTOR		20.00			
		UTILITY TRUCK		25.00			

		MISC		50.00			
	TOTAL HOURLY RATE			899.62			
	TOTAL SHIFT RATE			7196.94	BASED ON EIGHT HOUR SHIFT		

PROJECT NO.:	A093893.2						
DATE:	18-Jan-2019						
LABOR AND EQUIPMENT RATE BREAKDOWN							
<u>CREW 4 - MARINE CONSTRUCTION - WATERBORNE PILE DRIVING</u>							
				FULL COST	A	B	A+B
				W / BURDEN	DIRECT WAGES*	FRINGES	
	LABOR						
		DOCKBUILDER FOREMAN		170.87	64.36	50.67	115.03
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30

		DOCKBUILDER		150.84	53.63	50.67	104.30
		OILER		115.27	41.22	38.28	79.50
		OPERATOR - CRANE		182.71	80.77	31.85	112.62
	EQUIPMENT						
		BARGE - MATERIAL		75.00			
		COMPRESSOR		50.00			
		CRANE - BARGE MOUNTED		300.00			
		FLOAT STAGE (4)		40.00			
		TUG BOAT		200.00			
		PILE DRIVING HAMMER		150.00			
		UTILITY TRUCK		75.00			
		MISC		50.00			
	TOTAL HOURLY RATE			2163.06			
	TOTAL SHIFT RATE			17304.46	BASED ON EIGHT HOUR SHIFT		

PROJECT NO.:	A093893.2						
DATE:	18-Jan-2019						
LABOR AND EQUIPMENT RATE BREAKDOWN							
CREW 5 - MARINE CONSTRUCTION - WATERBORNE							
				FULL COST	A	B	A+B
				W / BURDEN	DIRECT WAGES*	FRINGES	
	LABOR						
		DOCKBUILDER FOREMAN		170.87	64.36	50.67	115.03
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		DOCKBUILDER		150.84	53.63	50.67	104.30
		OILER		115.27	41.22	38.28	79.50
		OPERATOR - CRANE		182.71	80.77	31.85	112.62
	EQUIPMENT						

		BARGE - MATERIAL		75.00			
		COMPRESSOR		50.00			
		CRANE - BARGE MOUNTED		300.00			
		FLOAT STAGE (4)		40.00			
		TUG BOAT		200.00			
		UTILITY TRUCK		75.00			
		MISC		50.00			
	TOTAL HOURLY RATE			2013.06			
	TOTAL SHIFT RATE			16104.46	BASED ON EIGHT HOUR SHIFT		

PROJECT NO.:	A093893.2							
DATE:	18-Jan-2019							
LABOR AND EQUIPMENT RATE BREAKDOWN								
CREW 6 - DYNAMIC COMPACTION								
				FULL COST	A	B	A+B	
				W / BURDEN	DIRECT WAGES*	FRINGES		
	LABOR							
		LABORER		121.08	42.00	42.63	84.63	
		OPERATOR - CRANE		182.71	80.77	31.85	112.62	
	EQUIPMENT							
		CRANE		300.00				
		UTILITY TRUCK		25.00				
		DYNAMIC COMPACTION WEIGHT		150.00				
		MISC		50.00				

	TOTAL HOURLY RATE			828.79				
	TOTAL SHIFT RATE			6630.32	BASED ON EIGHT (8) HOUR SHIFT			

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