2023 Summary Report of Seafloor Mapping: Portland Harbor Berths

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Maine Coastal Mapping Initiative, January 2024

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For an overview of the Maine Coastal Mapping Initiative (MCMI) information products, including maps, data, imagery, and reports visit: https://www.maine.gov/dmr/mcp/planning/mcmi/index.htm.

Acknowledgements

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Maine Department of Marine Resources
Bureau of Marine Science
Maine Coastal Mapping Initiative

SUMMARY REPORT

Type of Survey:	Navigable Area
Registry Number:	N/A

LOCALITY

State(s):	Maine
General Locality:	Gulf of Maine
Sub-Localities:	Portland Harbor, Casco Bay

2024

CHIEF OF PARTY
Peyton Benson, Lead Hydrographer, State of Maine

LIBRARY & ARCHIVES

Date:

MAINE DEPARTMENT OF MARINE RESOURCES MAINE COASTAL MAPPING INITIATIVE	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	N/A

INSTRUCTIONS: The hydrographic sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State(s):	**Maine**
General Locality:	**Gulf of Maine**
Sub-Locality:	**Portland Harbor, Casco Bay**
Scale:	
Dates of Survey:	**November 13, 2023**
Instructions Dated:	
Project Number:	
Field Unit:	***Amy Gale***
Chief of Party:	**Peyton Benson, Lead Hydrographer, State of Maine**
Soundings by:	**Kongsberg EM 2040C (MBES)**
Imagery by:	**Kongsberg EM 2040C (MBES Backscatter)**
Verification by:	
Soundings in:	**meters at Mean Lower Low Water**

Remarks:

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ABSTRACT

On November 13, 2023, the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic survey using a multibeam echosounder in state marine waters of Portland Harbor, Maine. The surveying efforts were conducted to support endeavors to enhance coastal resiliency through identification and characterization of seafloor habitat to provide information necessary to managing the marine environment and economy. The survey also coincides with state and federal efforts to update coastal data sets and increase high resolution bathymetric coverage for Maine's coastal and marine waters. This report serves as a comprehensive summary of the survey efforts conducted by MCMI for this small investigative project. In total, MCMI completed full-coverage surveys of 5 berths in Portland Harbor. Data products were created with 25cm, 50cm, and 1m grid resolutions and sounding uncertainty (95% confidence interval) fell within +/-10 cm across the dataset.

1.0 Area Surveyed

The survey area is located entirely within the bounds of Portland Harbor, Casco Bay, Maine and consists of 5 berthing areas designated as regions of interest by the Portland Harbor Pilots. These berths are referenced from West to East throughout this report as Winslow's Pier, Merrill's Wharf, Bridge Berth, Tug Berth, and Ocean Gateway, respectively. All navigable waters within each of the target berthing areas were ensonified by this survey effort. Survey limits are listed in Table 1.

These data were not collected in direct accordance with the *NOS Hydrographic Surveys Specifications and Deliverables* and the *Field Procedures Manual* requirements; however, both documents were referenced during acquisition for guidance.

Table 1 – Survey Limits

2023 Portland Harbor Berths Survey Limits

Southwest Limit	Northeast Limit
43.6393823° N 70.2843875° W	43.6605136° N 70.2394229° W

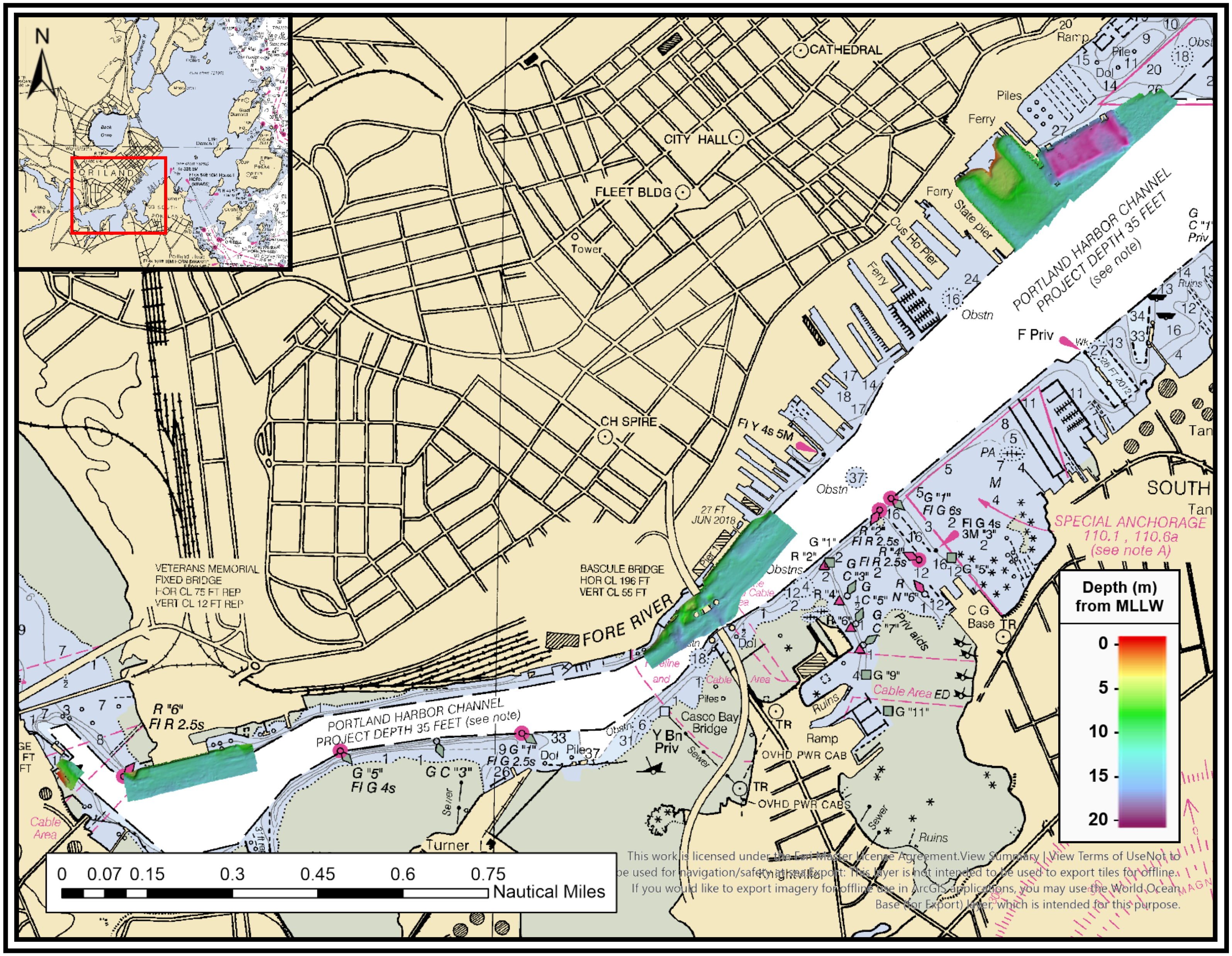

Figure 1 – General locality of Portland Berths survey, plotted atop NOAA chart 13292.

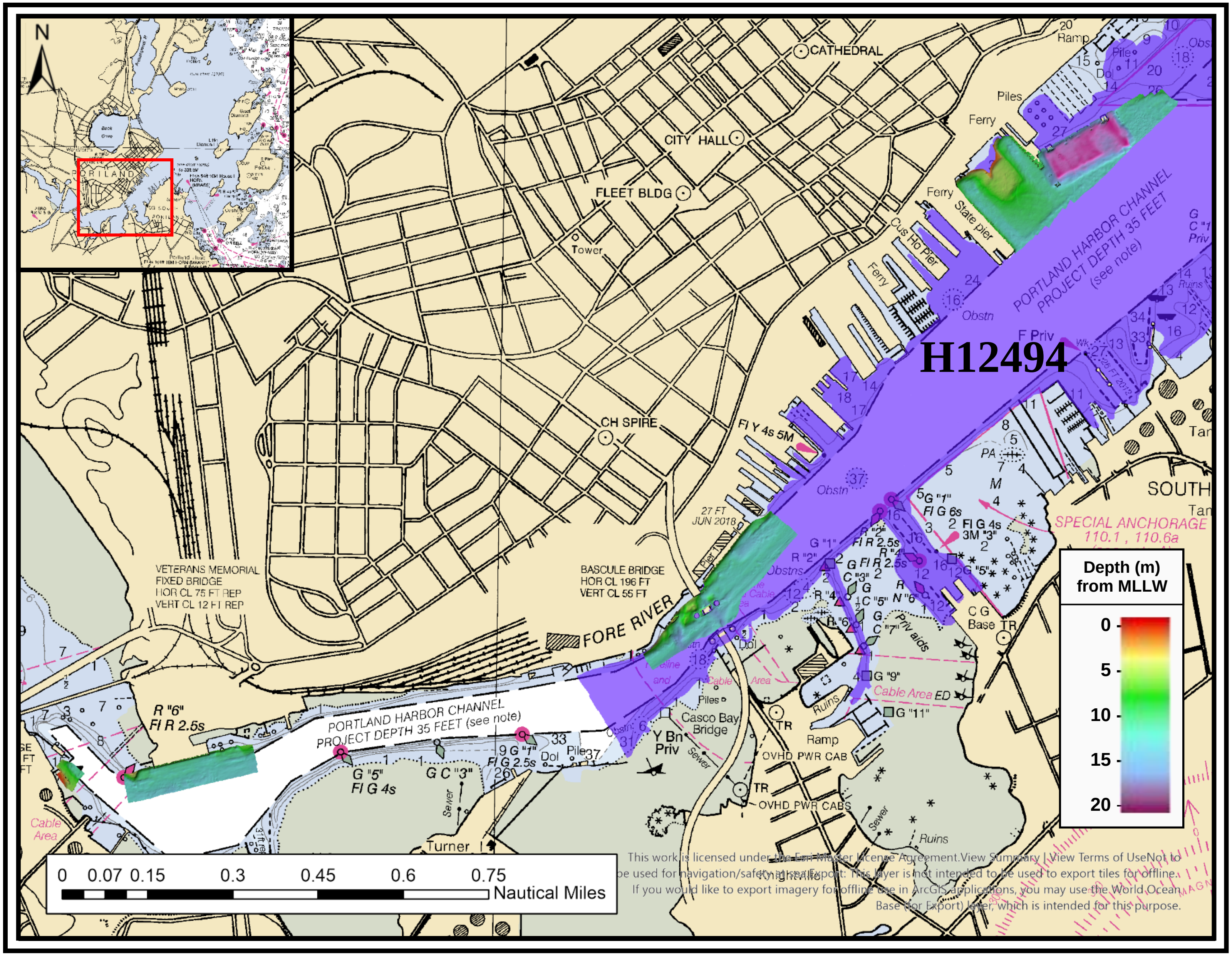

Figure 2 – General locality of Portland Berths survey coverage relative to existing datasets

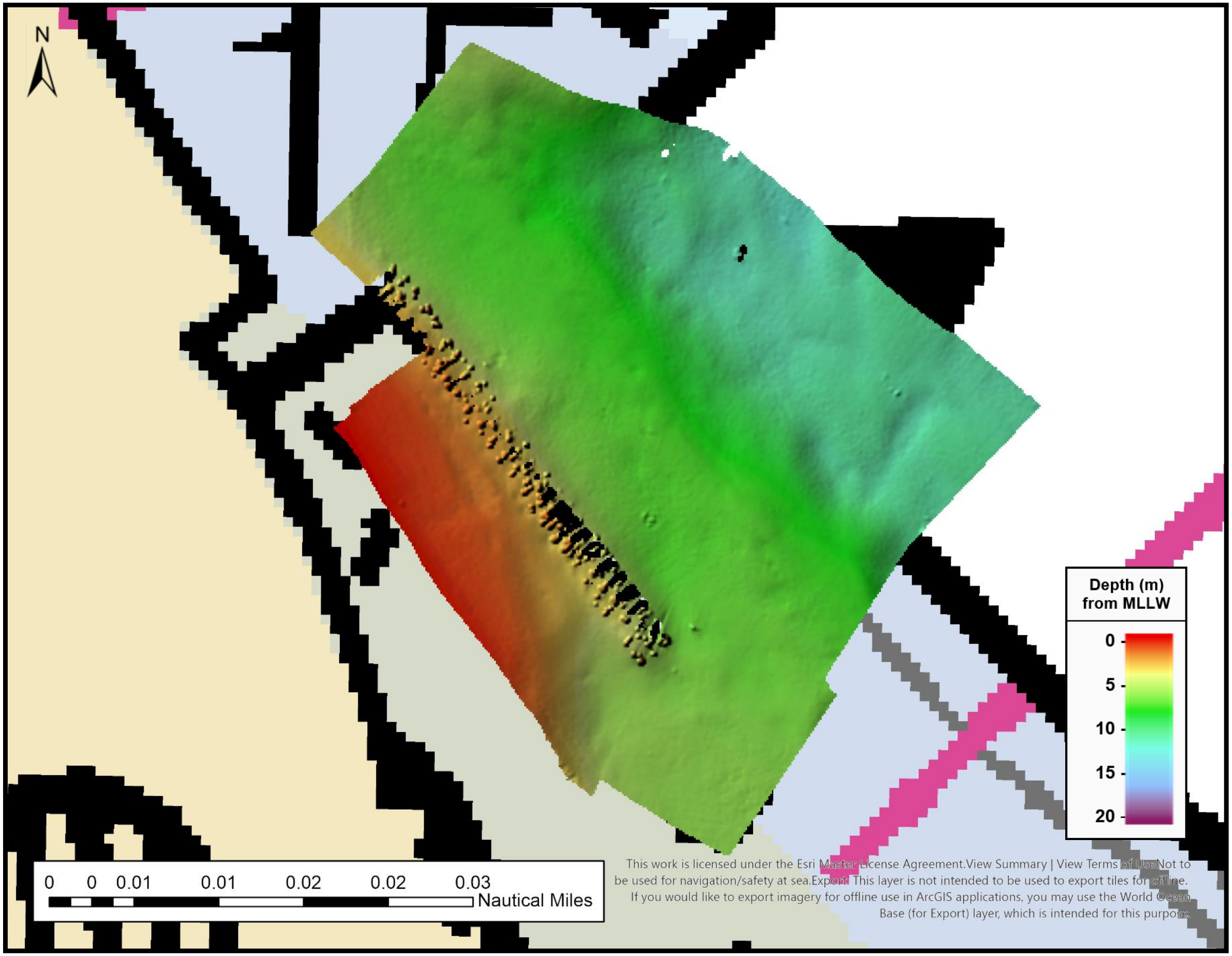

Figure 3 – 25cm resolution shaded relief surface of Winslow's Pier

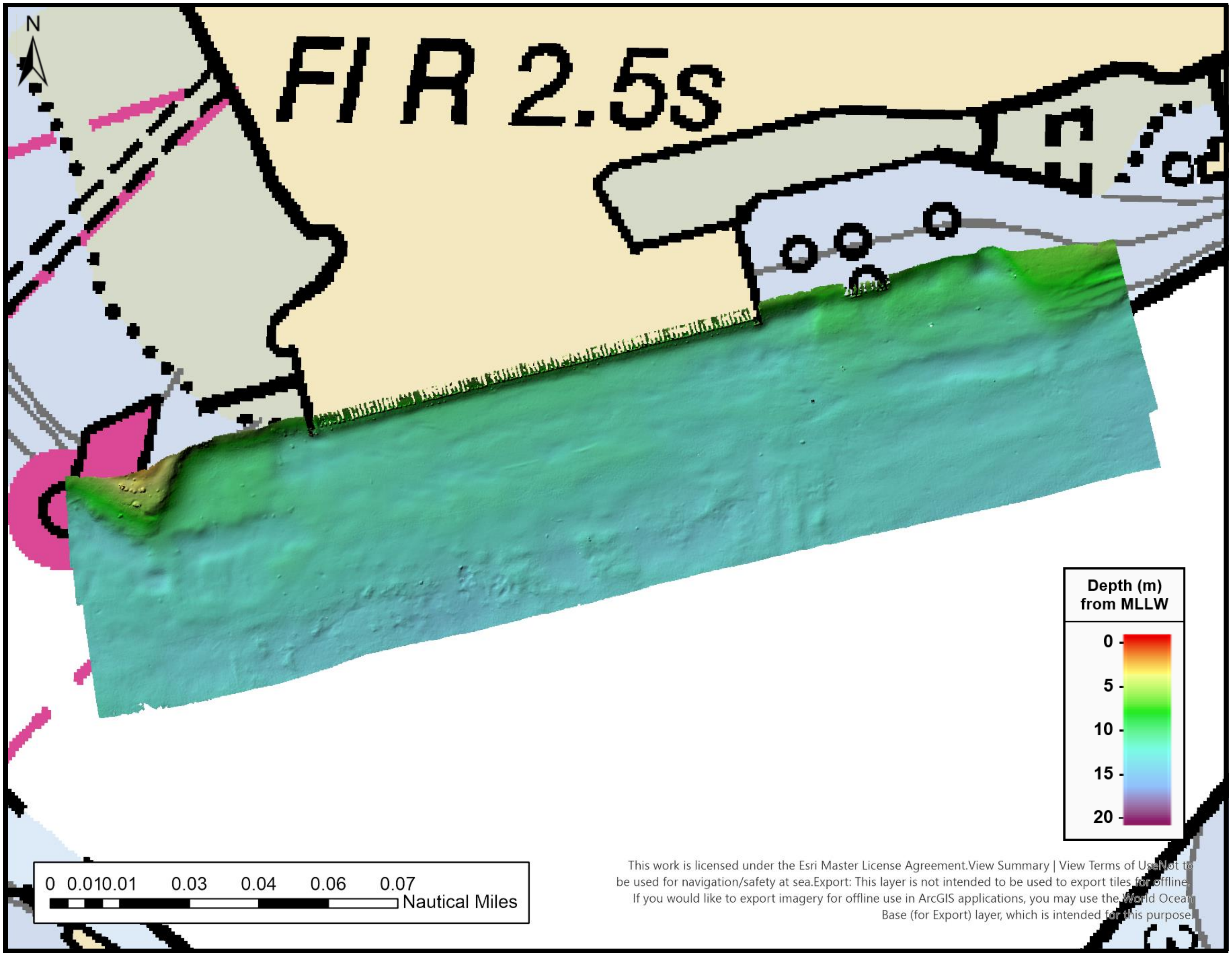

Figure 4 – 25cm resolution shaded relief surface of Merrill's Wharf

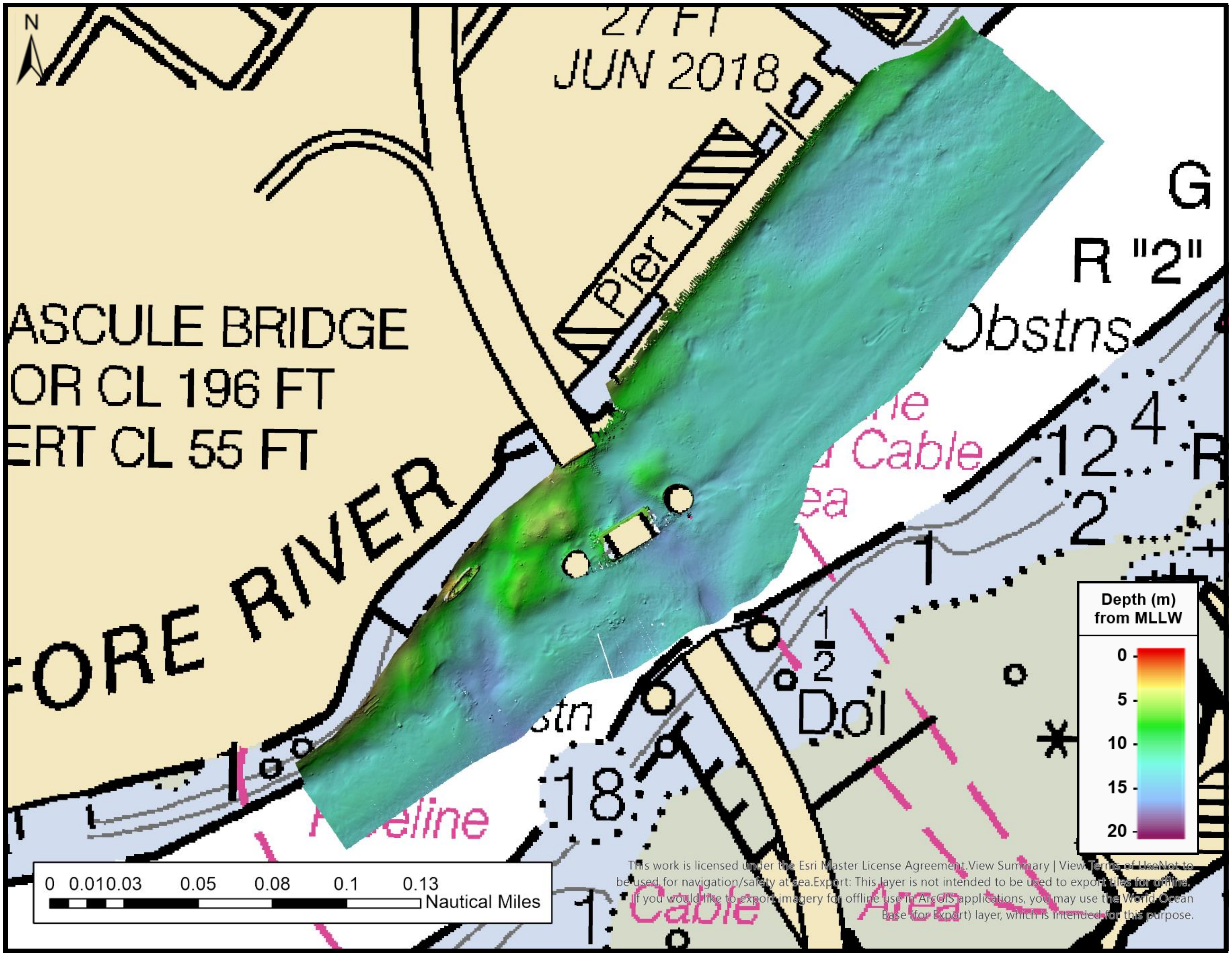

Figure 5 – 25cm resolution shaded relief surface of Bridge Berth

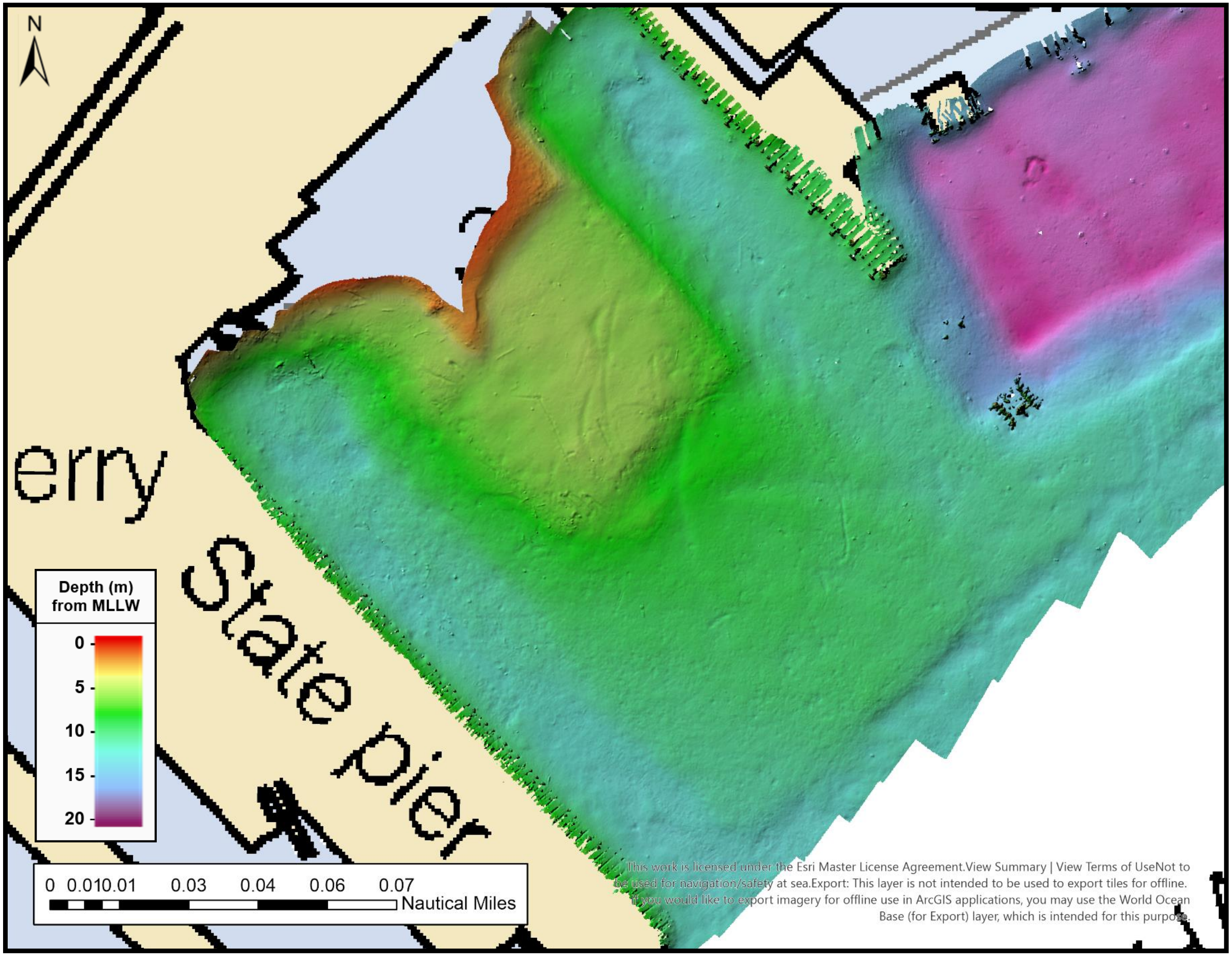

Figure 6 – 25cm resolution shaded relief surface of Tug Berth

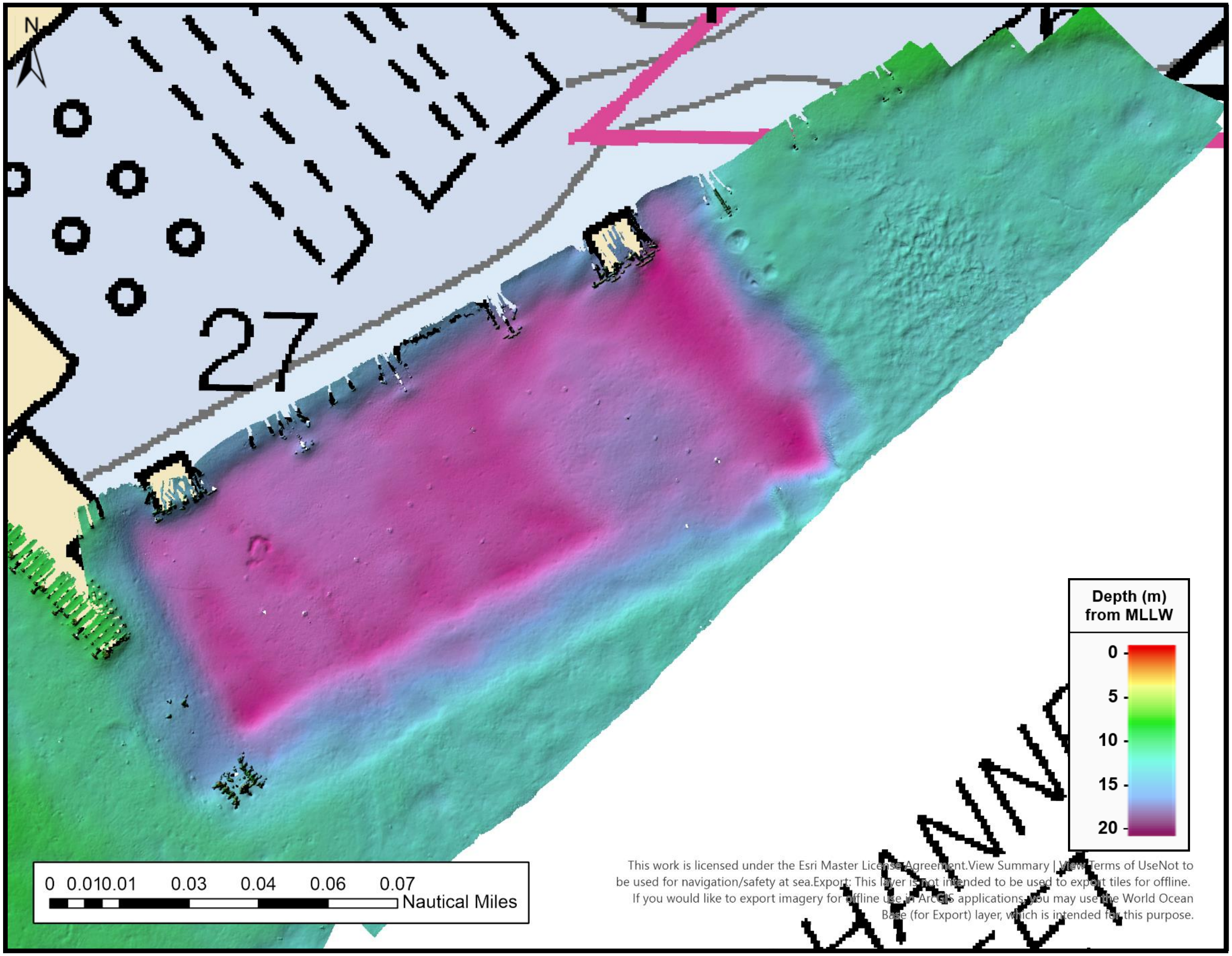

Figure 7 – 25cm resolution shaded relief surface of Ocean Gateway

1.1 Survey Purpose

This survey was conducted by the Maine Department of Marine Resources' Maine Coastal Mapping Initiative (MCMI) as an investigative survey effort to deepen understanding of benthic topography in areas of interest designated by the Portland Harbor Pilots. This project also coincides with state and federal efforts to update coastal datasets for Maine's coastal waters and provides new data in the areas covered by National Oceanic and Atmospheric Administration (NOAA) nautical charts 13288, 13290, 13292, and 13296 in Casco Bay. These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and are shared with the NOAA Office of Coast Survey for review.

1.2 Survey Quality

The entire survey should be adequate to supersede previous data.

1.3 Survey Coverage

Survey coverage was collected in accordance with the NOAA Hydrographic Survey Specifications and Deliverables manual for complete coverage multibeam survey (NOAA, 2022). Select few small holidays (gaps in MBES coverage) exist within the surveyed area, but none were found to exist atop potentially significant features. Analyses of bathymetric data show that the least depths were achieved over all features, and that holidays have not compromised data integrity.

2.0 Data Acquisition

The following sub-sections contain a summary of the systems, software, and general operations used for acquisition and preliminary processing for the Portland Berth Survey conducted in November, 2023.

2.1 Survey Vessel

All data were collected aboard the Fishing Vessel (F/V) Amy Gale (length = 10.95 m, beam = 3.81 m, draft = 0.93 m) (Figures 8 and 9), a former lobster boat converted to a survey vessel and contracted to the MCMI. The vessel was captained by Caleb Hodgdon of Hodgdon Vessel Services. The survey vessel is equipped with a Kongsberg EM2040C multibeam echosounder, an MRU-5 motion reference unit, dual GNSS antennas, one Fugro 3610 RTK receiver and AD-341 antenna, an AML Micro-X surface sound speed probe, and a Valeport SWiFT sound velocity profiler. The multibeam transducer is affixed to the bottom of a bow-mounted pole, which also contains the MRU, surface sound speed probe, and GNSS/RTK antennas. The pole can be raised for transit to and from survey sites, and lowered to a known, fixed position during data collection. The main cabin of the vessel served as the data collection center and was outfitted with four main display monitors for real-time visualization of data during acquisition.

Figure 8 – F/V Amy Gale shown with pole-mounted systems in acquisition mode.

2.2 Acquisition Systems

The real-time acquisition systems used aboard the F/V Amy Gale during the reported survey are outlined in Table 2. Data acquisition was performed using the Quality Positioning Services (QPS) Qinsy (Quality Integrated Navigation System v.9.5.4) acquisition software. The modules within Qinsy integrated all systems and were used for real-time navigation, survey line planning, date time tagging, data logging, and visualization.

Table 2 – Major systems used aboard F/V Amy Gale

Sub-system	Components
Multibeam Sonar	Kongsberg EM2040C and processing unit
Position, Attitude, and Heading	Seapath 330 processing unit and HMI unit, dual GPS/GLONASS antennas, MRU-5 motion reference unit (subsea bottle), Fugro 3610 Receiver and AD-341 antenna
Acquisition Software and Workstation	Qinsy software v.9.5.4 and 64-bit Windows 10 PC console
Surface Sound Velocity (SV) Probe	AML Micro X with SV Xchange
Sound Velocity Profiler (SVP)	Valeport SWiFT

* See Appendix A for a diagram overview of survey systems aboard the Amy Gale.

2.3 Vessel Configuration Parameters

In 2017, the MCMI contracted Doucet Survey, Inc. to perform high-definition (precision ±5mm) 3D laser scanning of the Amy Gale and all external MBES system components (e.g. MRU, GPS antennas, and EM2040C) (Figure 9). The purpose of the laser scan survey was to refine and or verify the precision of hand-made vessel reference frame measurements for future surveys. All points were referenced to the center point of the base of the MRU (mounted inside the pole and directly atop the EM2040C transducer) (Figures 8 and 9), which served as the origin (e.g. 0,0,0), where ‘x’ was positive forward, ‘y’ was positive starboard, and ‘z’ was positive down. The laser scan survey results only differed from hand-made measurements by ≤ 3mm for all nodes of interest. Reference measurements for each component were entered into the Seapath 330 Navigation Engine (Table 3) and converted so all outgoing datagrams would be relative to the location of the EM2040C transducer (e.g. EM2040C was used as the monitoring point for all outgoing datagrams being received by Qinsy during acquisition). Additional configuration and interfacing of all systems were established during the creation of a template database in the Qinsy console.

These offset values were not changed for the reported survey. See included data package for a diagram of survey systems aboard the Amy Gale, specific settings as entered in the Seapath 330 Navigation Engine, for the template database, and the computation settings used during data acquisition while online in Qinsy. Configuration settings of the EM2040C were assigned in the EM Controller module of Qinsy.

Table 3 – 2017 equipment reference frame measurements for Seapath 330

Equipment	**x (m)**	**y (m)**	**z (m)**
MRU	0.000	0.000	0.00
Antenna 1 (port)	0.158	-1.245	-3.000
Antenna 2 (starboard)	0.158	1.252	-3.035
EM2040C	0.036	0.000	0.133

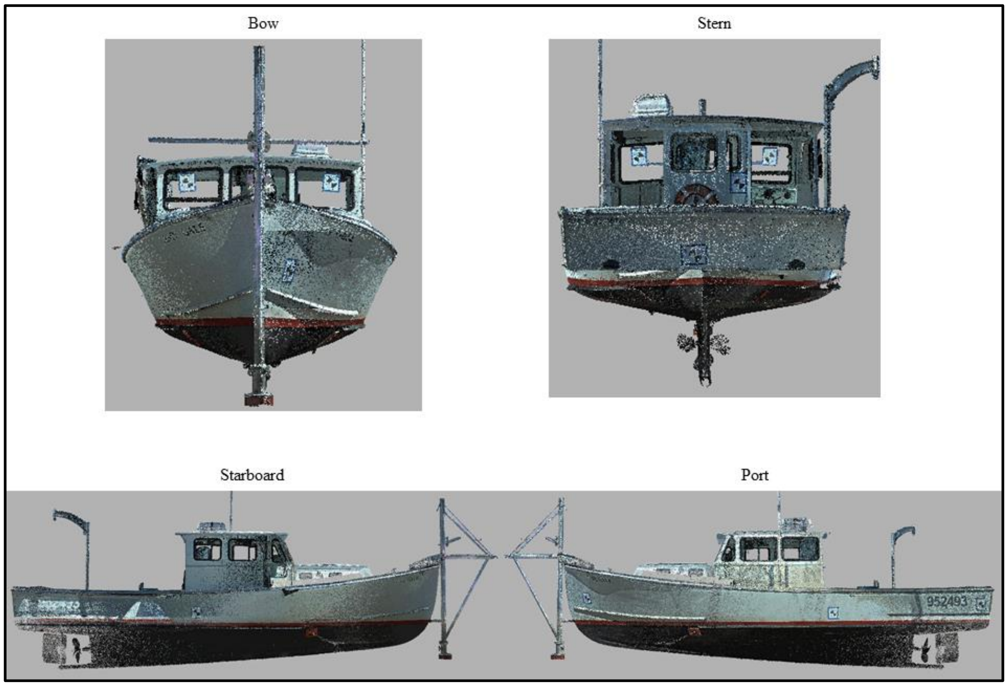

Figure 9 – Amy Gale RGB color images generated from 3D laser scan survey (GPS antennas and external cabling not included in survey) data (.pts file converted to .las for visualization)

2.4 Survey Operations

Prior to the survey the sonar pole-mount was lowered into survey position and its bracing rods were fastened securely to the hull of the vessel via heavy-duty ratchet straps. Electric power was provided by a 2000-watt Honda *eu2000i* generator which delivers clean power to a CyberPower PR2200LCD uninterruptible power supply (UPS) that then distributes pure sine wave electricity to survey systems. Immediately following power-up, all interfacing instruments were given time to stabilize (e.g. approximately 30-45 minutes for Seapath to acquire accurate positioning). Once all systems have completed initialization, the Qinsy project is brought online to begin data collection. Prior to the start of the first transect, a sound velocity cast is taken to correct for refraction of the sonar swath. This cast data is inspected for data anomalies and compared to the surface probe for agreement, then it is applied to the project, which informs the sonar of the profile. Survey transects then begin in an along-channel orientation. For this project, 200% coverage was targeted, meaning 50% of the sonar swath will be overlapping data collected on the previous transect. Regular sound speed casts were collected throughout the survey day when necessitated by changing tide, location, or upon disagreement with the surface probe measurement (exceeding +/-2.0 m/s difference). Data were gridded at 0.25 to 2 meters for real-time visualization, depending on expected water depth range. Any areas in which data anomalies occurred were resurveyed with future transects to ensure clean data products and higher certainty in the soundings collected. Raw sonar files were logged in the Qinsy Controller module in .db format and saved directly onto the hydrographic workstation computer. All data were backed up following survey on an external hard drive.

2.5 Survey Planning

Line planning and coverage requirements were designed to meet requirements for NOAA hydrographic standards and in accordance with IHO S-44 6th Edition Order 1a Survey (International Hydrographic Organization, 2020 & NOAA, 2022). Throughout the survey area, parallel lines were planned prior to the survey and primarily run in an along-channel orientation, but variation was necessary for highly dynamic areas such as atop features or around navigational obstructions. Lines were spaced at constant intervals to obtain a minimum of 50% overlap between full swaths, so that a 200% coverage could be achieved. Soundings from beam angles outside ±60 degrees from the nadir were blocked from visualization during acquisition, thus increasing the true minimum full-swath overlap. This online blocking filter was recommended by QPS field engineers with the intent of eliminating noisy outer beams from the final product, thereby increasing the overall contribution of higher quality soundings. All data were acquired at approximately 6.5-7 knots, although some areas required slower speeds to ensure safe navigation of the vessel around obstructions or in restrictive spaces. Throughout the survey area, shoal soundings to at least 5m MLLW were achieved in all navigable areas.

2.6 Calibrations

Patch tests are regularly conducted aboard the F/V Amy Gale whenever a system is added or removed to the survey configuration, or if a system is installed/reinstalled. This is done to correct for alignment offsets of the transducer and to ensure accurate sounding data is collected in a given survey. For each patch test, a series of lines are run to determine the latency, pitch, roll, and heading offsets for the multibeam echosounder following standard protocol (NOAA Office of Coast Survey, 2021). The patch test data for this survey was processed in Qimera v2.5.3 with the patch test tool. After offsets were determined, the values were entered into the Qinsy template database for acquisition. The offset values for the Portland Berth Survey can be seen in Table 4. Full built-in self-tests (BISTs) are also performed at semi-regular intervals throughout the year to ensure no significant deviations in background noise are present at the chosen survey frequency of 300 kHz.

Table 4 – Patch test calibration offsets for EM2040C

Parameter	**Offsets 11/13/23**
Roll (degrees)	0.000
Pitch (degrees)	0.511
Heading (degrees)	1.091

3.0 Quality Control

The following sub-sections outline the efforts taken by MCMI to ensure high quality data were collected throughout this survey.

3.1 Crosslines

No crosslines were conducted for this investigative survey effort.

3.2 Junctions

The location of this survey is situated such that a significant portion of the dataset overlaps with existing surveys in the region. Following evaluation of existing datasets in the region, NOAA survey H12494 was identified for junction comparison within the bounds of the survey area (Table 5). Areas of overlap were evaluated for sounding agreement by performing surface difference tests in Fledermaus v8.5.3, where the newly acquired surface is subtracted from the existing surface. A summary of the surface difference test results is shown in Table 6. The extent of overlap between the newly collected 2023 surface and the existing survey area is illustrated in Figure 10. Detailed junction surfaces can be seen in Figures 11 and 12. The surfaces used for and created within these tests are submitted with the data package accompanying this report.

Table 5 – Portland Harbor Berth survey junction

Registry Number	Resolution (m)	Year	Field Unit	Relative Location
H12494	1	2012	NOAA SeaArk Launch S3002	E

Table 6 – Summary of surface difference test results for overlapping (junction) surveys

Junction Surface ID	New Surface ID	Mean (m)	Median (m)	Std. Dev. (m)
H12494_MB_1m_MLLW_combined	W00649_4m_MLLW	0.09	0.10	0.52

Notable differences between overlapping surveys are likely attributable to poor agreement in areas which contained pilings and walls. In the NOAA H12494 surface, pilings were removed from the final surface, but they remained in the MCMI final surface. Other differences could be due to the changing topography of the survey area due to the high volume of large vessel traffic throughout the region, as well as due to the dynamic and high-energy currents that affect the survey area. These factors, coupled with the temporal distance between surveys, likely accounts for the majority of differences seen between the two surfaces. Overall, however, both surfaces strongly agreed across all soundings, with average agreement falling within a 10 cm difference and 95% of soundings falling within ± 52 cm.

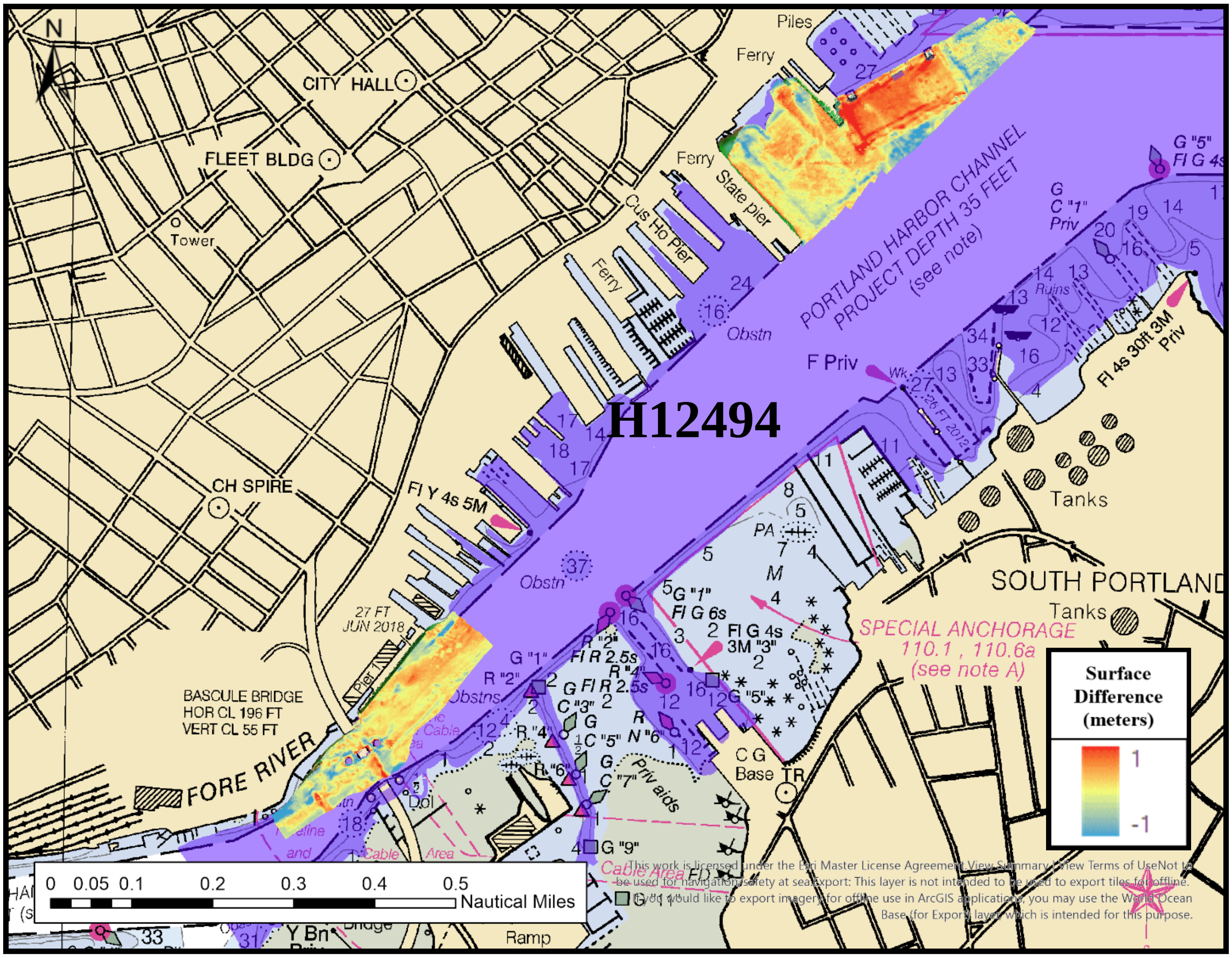

Figure 10 – Overview of resulting junction surfaces atop Portland Harbor Berths survey

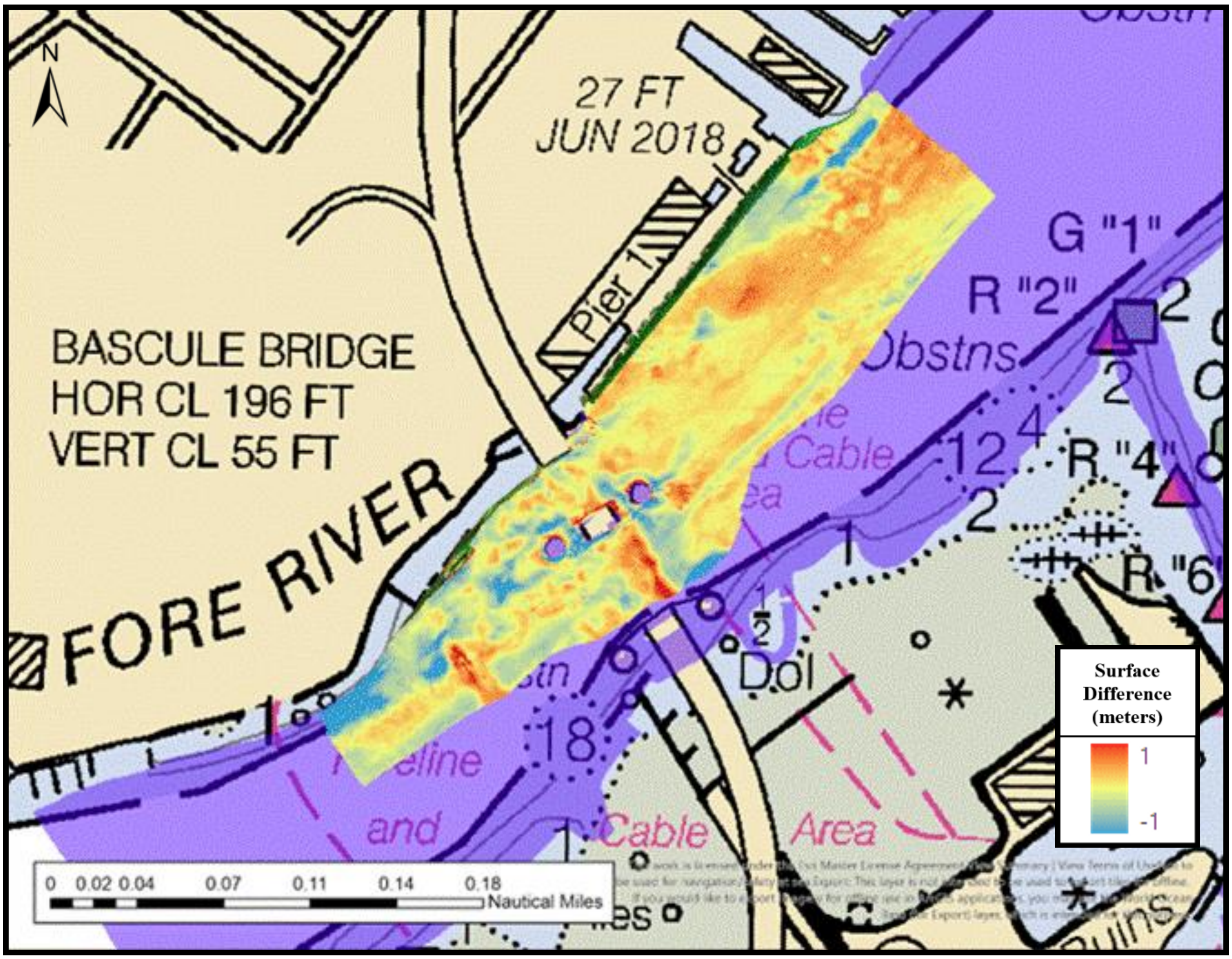

Figure 11 – Junction surface created from surface differencing in Fledermaus with focus area depicting the Bridge Berth

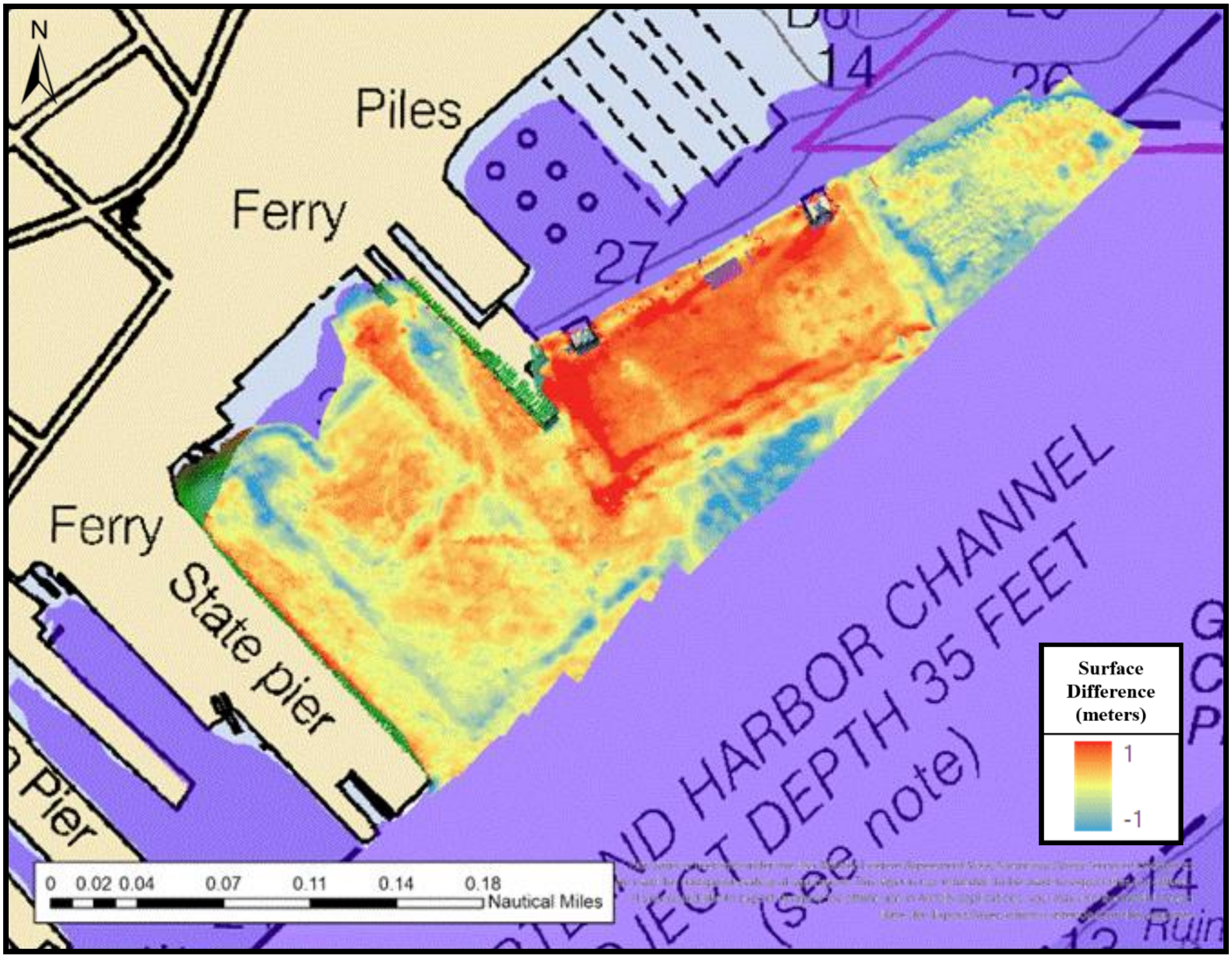

Figure 12 – Junction surface created from surface differencing in Fledermaus with focus area depicting the Tug Berth and the Ocean Gateway

3.3 A-Priori Uncertainties

A-priori uncertainties for all systems are entered into Qinsy prior to data collection and can be extracted from the provided .db files or can be found in the provided template database. All a-priori uncertainties are entered in accordance with manufacturer provided specifications. Realtime positional uncertainty values cannot be integrated into raw data files due to Qinsy not receiving quality indicators from the Seapath datagram. To account for this, the standard deviation accuracy of vertical and horizontal uncertainties for positioning systems are always assumed (0.10 m vertical and 0.10 m horizontal). The Seapath display is monitored at all times, and if the quality exceeds these values, data collection stops immediately until they return to an acceptable range. In practice, vertical and horizontal positioning uncertainty is nearly always lower than the assumed uncertainty, but the static entered values are used to generate the positioning variables for this dataset to ensure the highest confidence in calculated values.

3.4 TVU/THU and CUBE

Total vertical uncertainty (TVU), total horizontal uncertainty (THU), and combined uncertainty and bathymetric estimator (CUBE) surfaces were generated at the highest deliverable resolution of 25cm for this survey. These surfaces were generated in Qimera v2.5.3 via a point-by-point calculation method which meets NOAA standards for TPU calculation outlined in the draft of the 2023 NOAA HSSD (NOAA, 2023). All uncertainty surfaces are provided in the data package accompanying this report.

HydrOffice QC Tools v.3.10.10 Grid QA feature was used to analyze the highest resolution surface for compliance with NOAA allowable uncertainty standards for TVU. Statistical analysis indicates that 99.5%+ of all soundings were below allowable tolerances as set by the NOAA HSSD (NOAA, 2022), with 97.5% of all soundings falling under 35% of the maximum allowable TVU for the depths of the survey area (Figure 13). Detailed results from the analysis are shown in Figure 13 below.

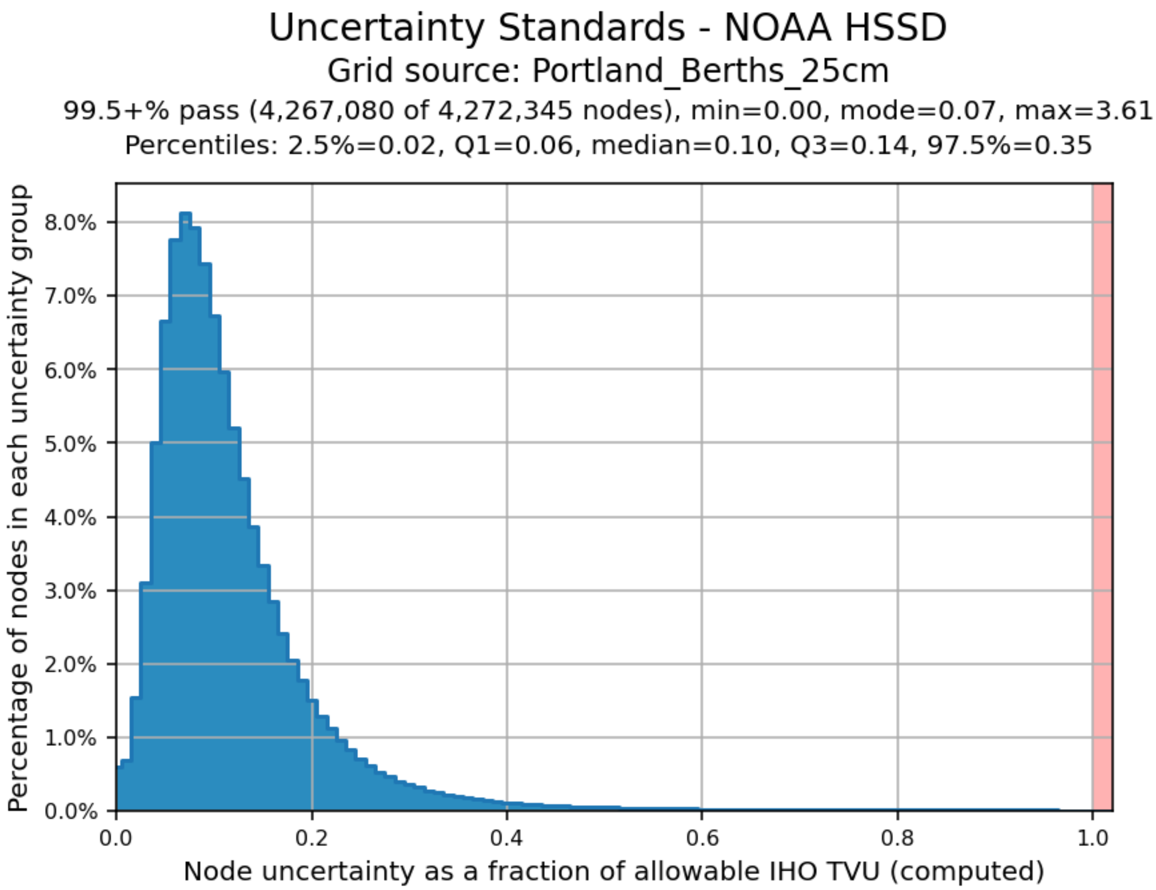

Figure 13 – Histogram results from HydrOffice QC Tools analysis of Portland Berths Survey.

No tool currently exists in the HydrOffice suite to analyze THU versus the allowable value from the HSSD. In lieu of this, the surface statistics tool in Qimera used to generate both TVU and THU was used to analyze these data. Qimera results indicates that 99.5%+ of soundings are below the tolerable allowances for THU, with 95% of all values falling under 20% of the of the maximum allowable THU. Text outputs of these statistics for both TVU and THU surfaces are included in the data package accompanying this report.

The CUBE (combined uncertainty and bathymetric estimator) developed by Brian Calder in 2004 at the University of New Hampshire (UNH) is a widely accepted industry standard for generating bathymetric surfaces and calculating corrected uncertainty values for all points in a 3D point cloud/bathymetric grid. Qimera software includes this tool in their processing toolbox and MCMI employs the use of this feature to create final bathymetric products. The output of this tool accounts for all inputs of uncertainty and through implementation of several procedural algorithms, creates a best-estimate surface with refined values, which differ from the raw TVU and THU. The CUBE surface generated for this survey indicates a mean uncertainty value of 6 cm with 95% confidence in all soundings to 9 cm. Text output containing the statistics of this computation are also attached in the data package accompanying this report. Additionally, the CUBE uncertainty surface is the layer of uncertainty used in the .BAG files provided in the data package.

3.5 Equipment Effectiveness

Sonar

Depth sounding and backscatter data were acquired with a Kongsberg EM 2040C multibeam echosounder. Acquisition frequency for this survey was set to 300 kHz, with high-density beam forming and 400 beams per ping. Although the EM 2040C has a capable swath width of 130° at the selected frequency, the returns from beams outside a 120° swath have been blocked from acquisition and all data products. The removal of the outer beams has been done to ensure greater confidence in collected soundings and is following the recommendations provided to MCMI by Quality Positioning Services (QPS) engineers in previous years.

Data quality and sonar performance were monitored continuously throughout data acquisition. Any instances in which data artifacts presented themselves during survey had the location ensonified at least once more on subsequent lines. Sonar behavior was characteristic of normal performance throughout the survey.

Other Systems

All systems performed normally throughout the duration of the survey.

3.6 Sound Speed Methods

Sound velocity profiles were conducted regularly throughout the survey with a Valeport SWiFT SVP. Sound velocity casts were taken at intervals sufficient to adequately characterize the survey area at the time of acquisition. Throughout this survey, 6 sound velocity profiles were collected and applied in real-time to the sonar and the active Qinsy project. Casts were spaced such that each distinct survey area was represented appropriately by the water column data recorded.

Surface sound velocity measurements were continuously taken by an AML Micro-X SV sensor affixed near the face of the sonar head. A live display of recorded values can be seen in the Qinsy online display, and this reading was continuously monitored by the sonar operator. Sound velocity cast values were compared to the real-time reading from the AML probe and readings suggested strong agreements between the sensors throughout the duration of the survey.

All sound velocity cast data is included in the data package accompanying this report. All surface sound velocity readings are embedded in the raw data files also included in the associated data package.

4.0 Data Post-Processing

The following is a summary of the procedures used for post-processing and analysis of survey data using Qimera (v2.5.3) and Fledermaus (v8.5.1) software.

4.1 Horizontal Datum

The horizontal datum for these data is WGS84 projected in UTM zone 19N (EPSG 32619).

4.2 Vertical Datum and Water Level Corrections

The vertical datum for these data is mean lower-low water (MLLW) level in meters. A tidal zoning file ("Maine_Tide_Zoning_modified.zdf") containing time and range corrections for verified tide station data was provided by NOAA Office of Coast Survey (OCS) to MCMI in May 2020. This file was used to apply time corrections, tide height offsets, and tide scale (range) for collected data in each zone. For this survey, all data fell within a single tide zone with Zone ID ME25.

Given the proximity of the collected data to the tide station, there is no applied time correction, offset, or adjustment to tide scale (1.00).

4.3 Processing Workflow

The general post-processing workflow in Qimera was as follows:

1. Create project
2. Import raw sonar files (.db files created during acquisition in Qinsy)
3. Apply sound velocity profiles via real-time scheduling
4. Add tide zoning file and associated tide data before integrating into raw files
5. Reprocess all data to be referenced to MLLW
6. Create dynamic surface with NOAA CUBE settings enabled for given grid resolution
7. Clean data via filtering tools and manual point removal
8. Run statistical analyses and create derivative surfaces (TVU/THU)
9. Export final surfaces to .BAG files
10. Export all processed data in .GSF format for backscatter processing

4.4 Final Surfaces

The following surfaces are included in the data package associated with this report. Each .BAG file contains the CUBE-processed sounding surface layer and CUBE uncertainty layer.

Table 7 – Bathymetric surfaces created from Portland Berth Survey

Surface Name	Resolution (m)	Depth Range (m)
Portland_Berths_25cm_MLLW	0.25	1 – 19
Portland_Berths_50cm_MLLW	0.50	1 – 19
Portland_Berths_1m_MLLW	1.00	1 – 19

4.5 Backscatter

Backscatter data was logged in raw .db files during acquisition. The .db files also hold the navigation record and bottom detections for all lines of surveys. Processed sonar files containing multibeam backscatter data (snippets, beam average, and beam time-series) were exported from Qimera in .GSF format. QPS Fledermaus Geocoder Toolbox (FMGT v7.10.3) was used to import, process, and mosaic time-series backscatter data. Default backscatter processing settings were used to create the mosaic, except the Angle Varied Gain (AVG) filter and AVG window size, which were set to "Adaptive" and "100", respectively. Backscatter mosaics of the data were gridded at 25 cm, 50 cm, and 1 m resolutions. Mosaics were exported in floating-point GeoTIFF format. The mosaics included in the associated data package are shown in Table 8.

Table 8 – Backscatter mosaics created from Portland Berth Survey

Mosaic Name	**Pixel Size (m)**
Portland_Berths_25cm_BS	0.25
Portland_Berths_50cm_BS	0.50
Portland_Berths_1m_BS	1.00

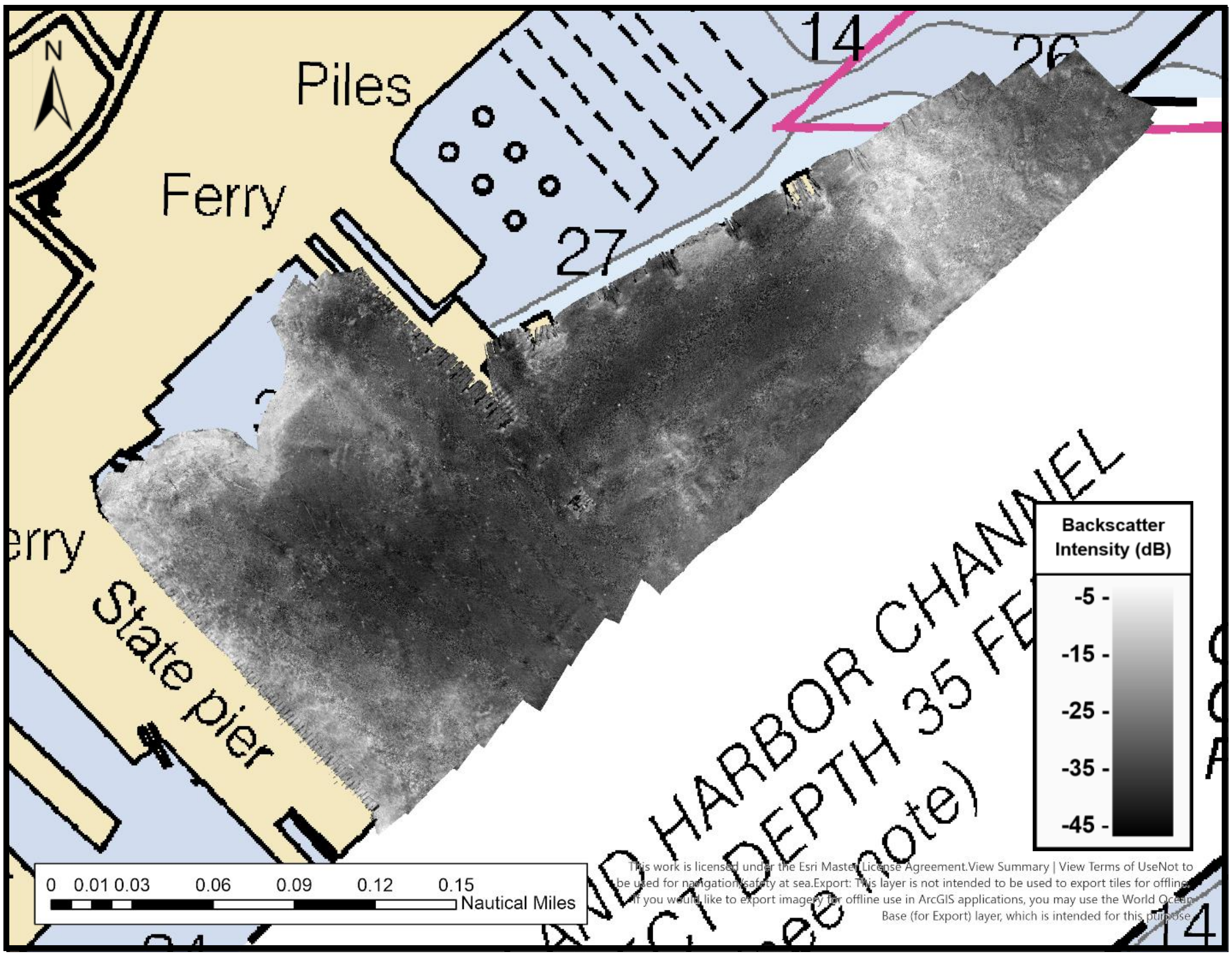

Figure 14 – 25cm resolution backscatter mosaic of Ocean Gateway terminal and Tug Berth

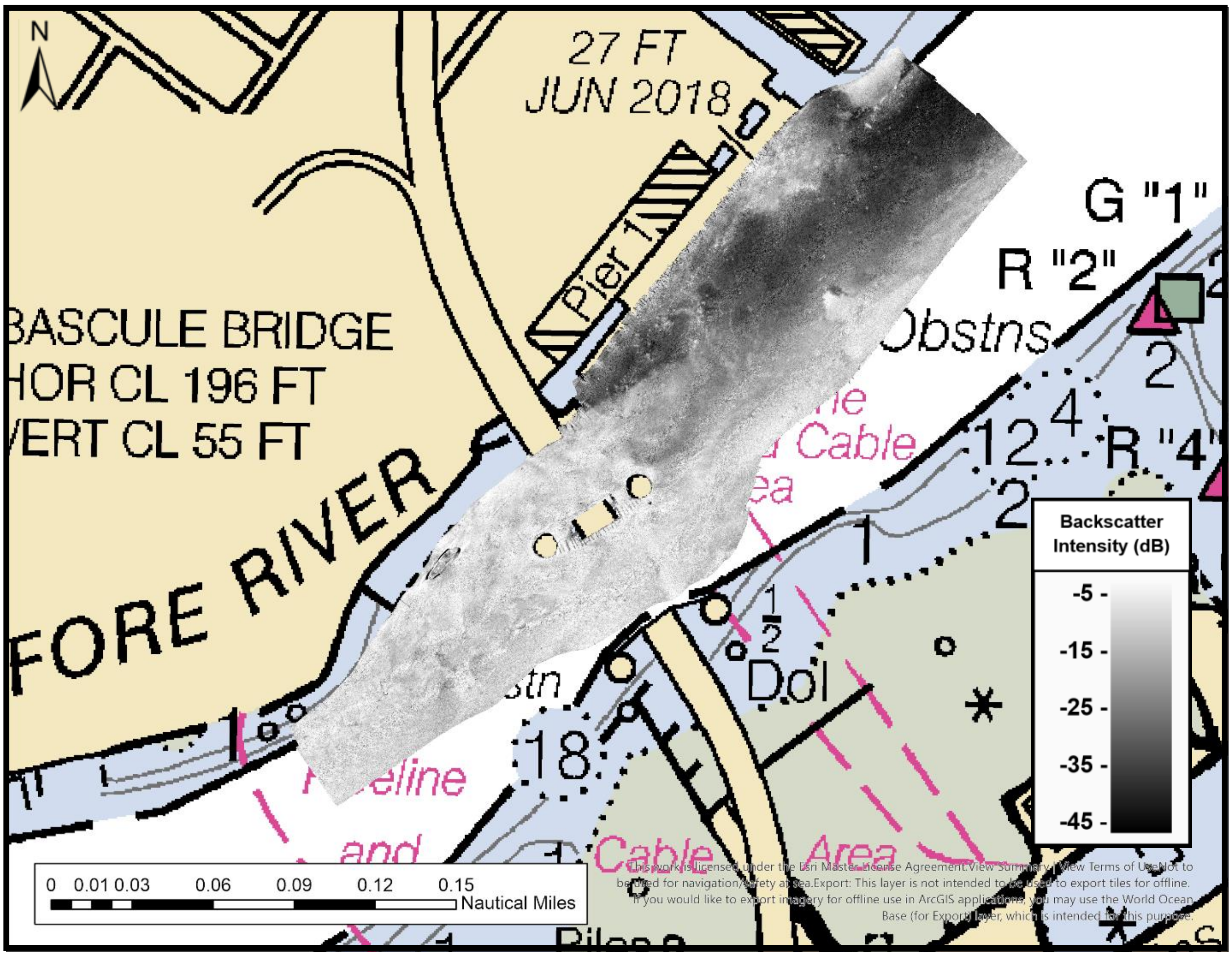

Figure 15 – 25cm resolution backscatter mosaic of Bridge Berth

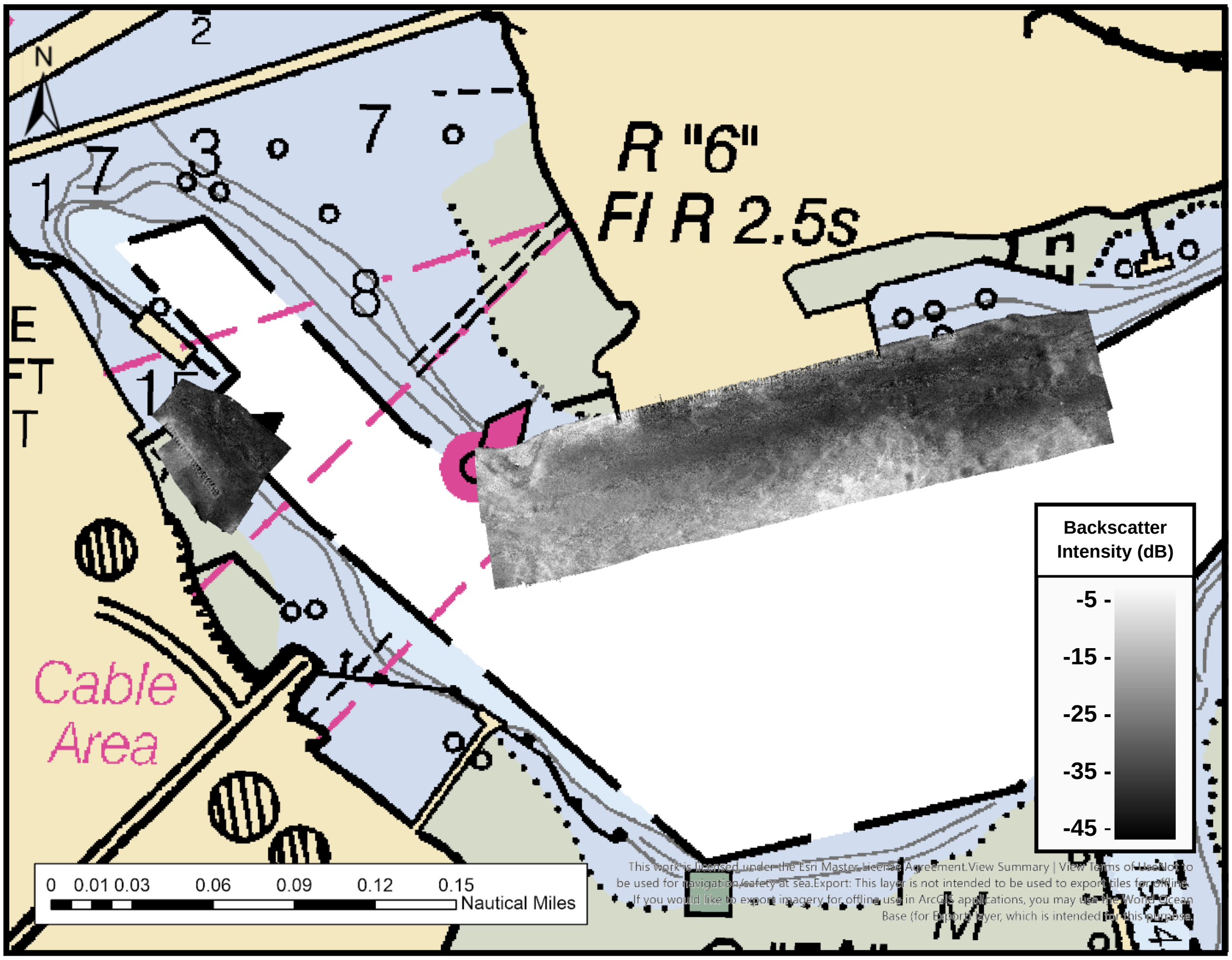

Figure 16 – 25cm resolution backscatter mosaic of Merrill's Wharf and Winslow's Pier

4.6 Spot Soundings

Spot sounding files were generated in Qinsy v9.5.4 Survey Manager for this survey for simplified visualization of depth sounding data. The spot sounding files depicts a numerical value atop the depth sounding grid which reports the average depth value (meters) for each 32m cell. Values that appear outside of the shaded surface contain a sufficient density of data to generate an average value, but these can be ignored when interpreting these datasets. It is a current limitation of the Qinsy spot sounding tool that these values cannot be removed from the resulting product, but it is suggested that only values which appear atop a visual grid be used for informative purposes. Figures 17 through 21 can be referenced for an overview of this visualization for each berth.

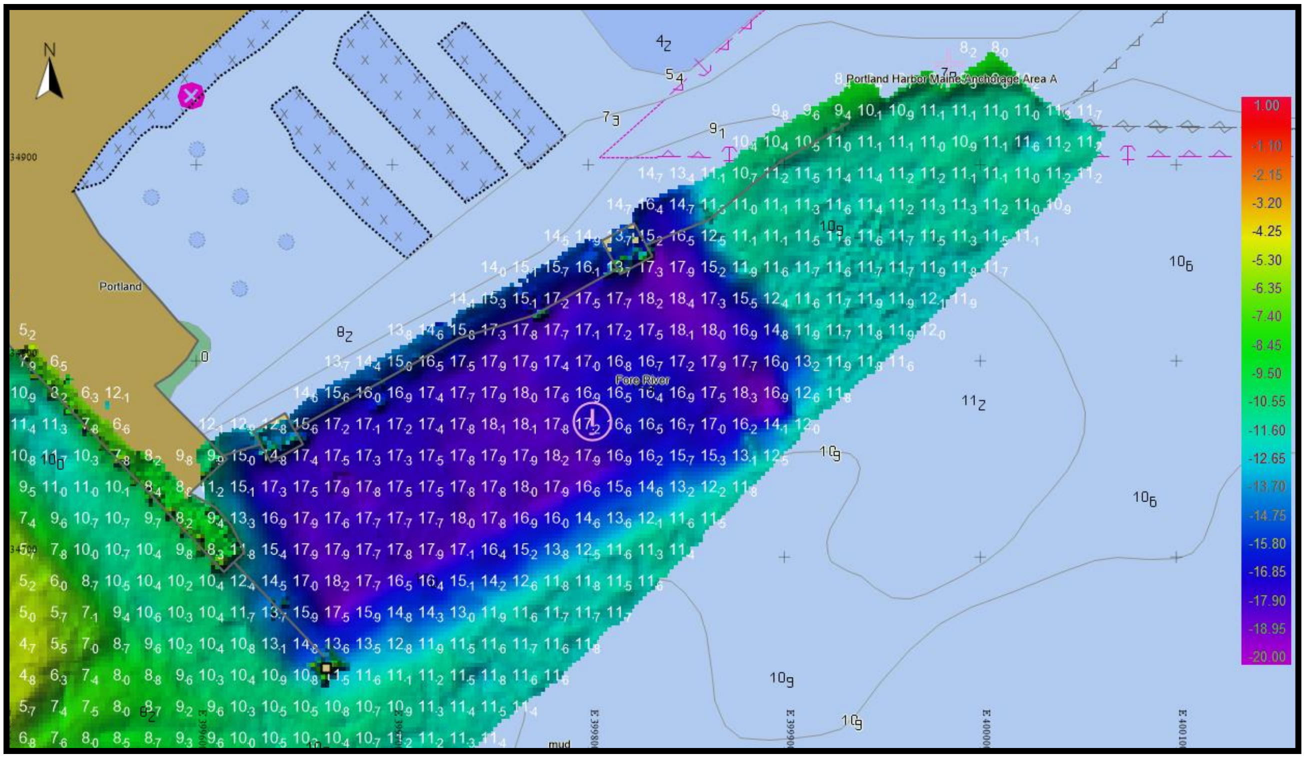

Figure 17 – Spot soundings shown atop 25cm grid surface at Ocean Gateway terminal

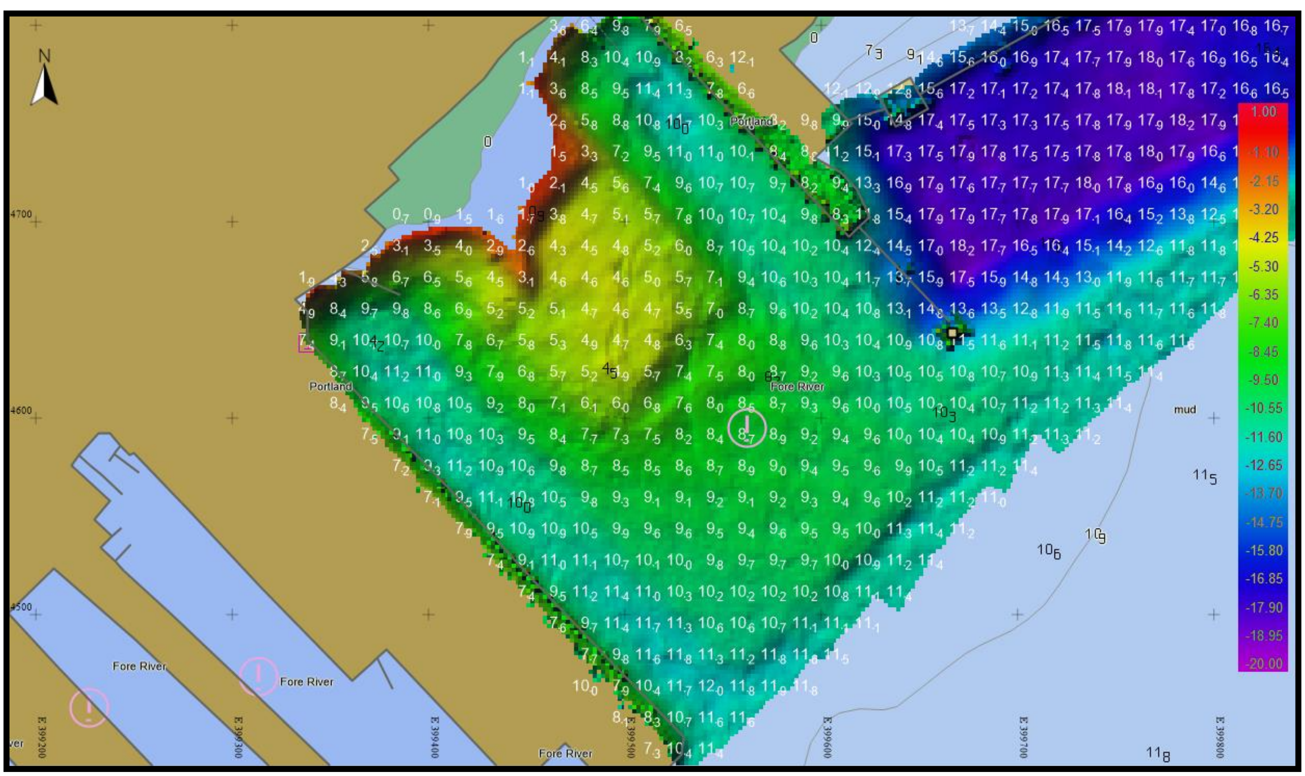

Figure 18 – Spot soundings shown atop 25cm grid surface at Tug Berth

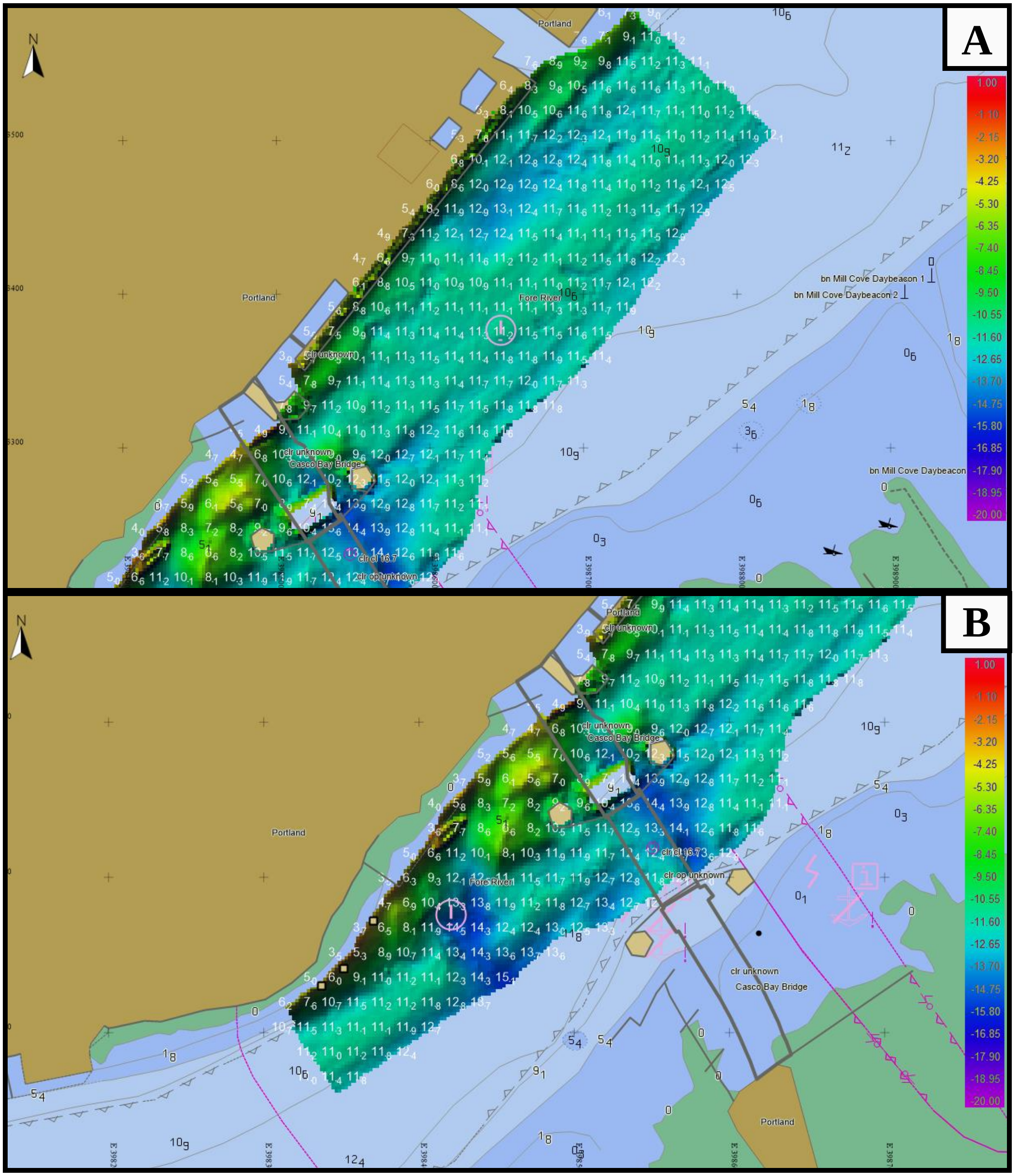

Figure 19 – Spot soundings shown atop 25cm grid surface at A) Bridge Berth North and B) Bridge Berth South

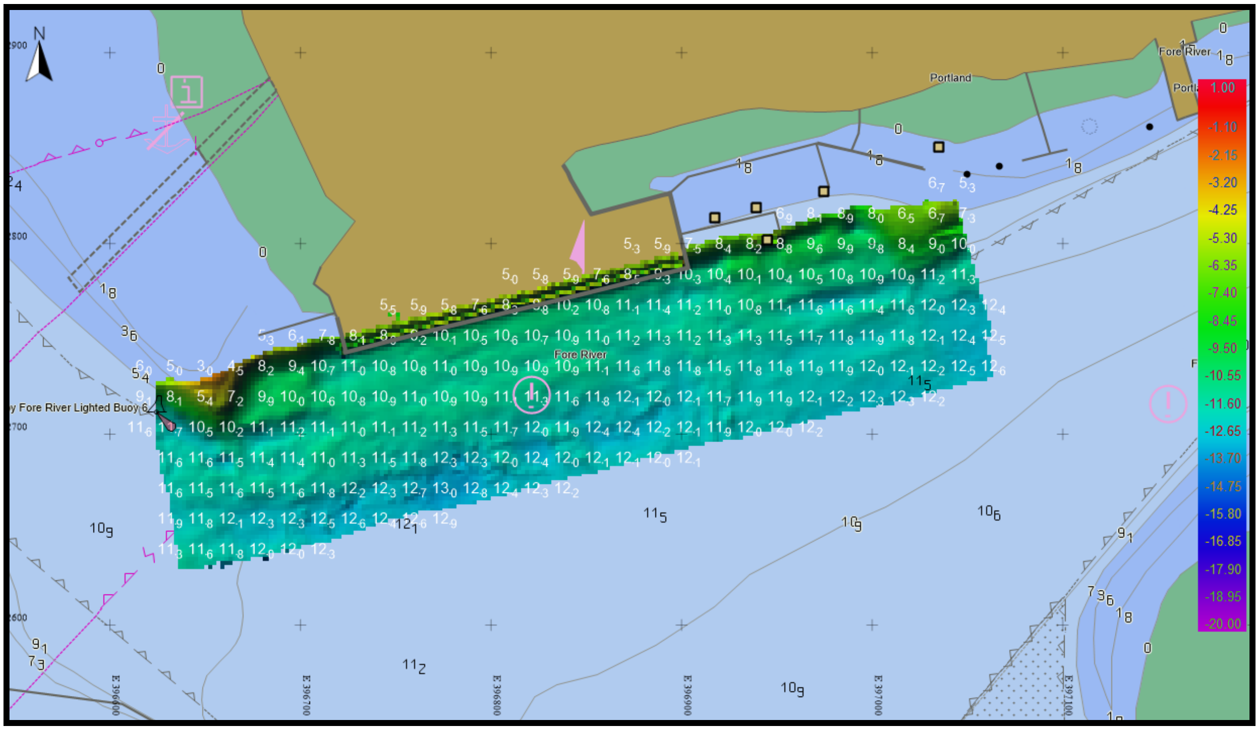

Figure 20 – Spot soundings shown atop 25cm grid surface at Merrill's Wharf

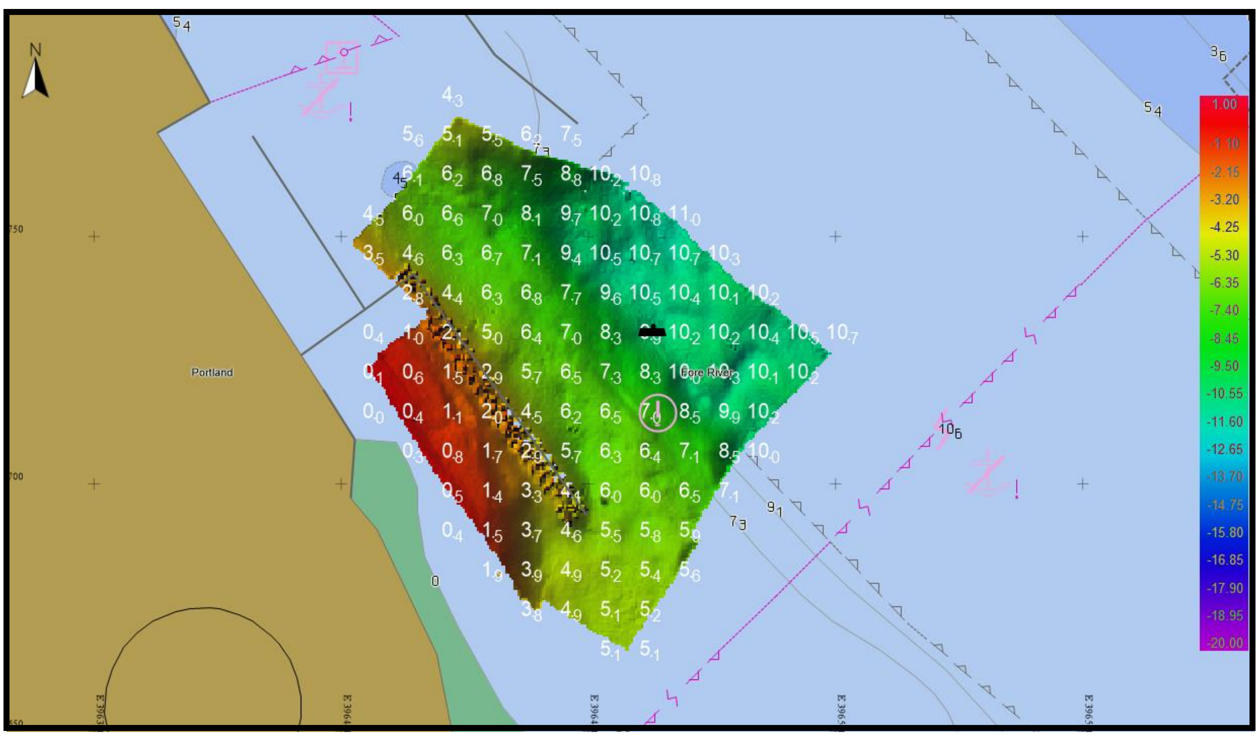

Figure 21 – Spot soundings shown atop 25cm grid at Winslow's Pier

4.7 Contours

A contour surface with depth intervals of 6 ft was created for a simplified depth visualization of the survey area. Figures 22 – 24 can be referenced for contour examination in each of the berths surveyed.

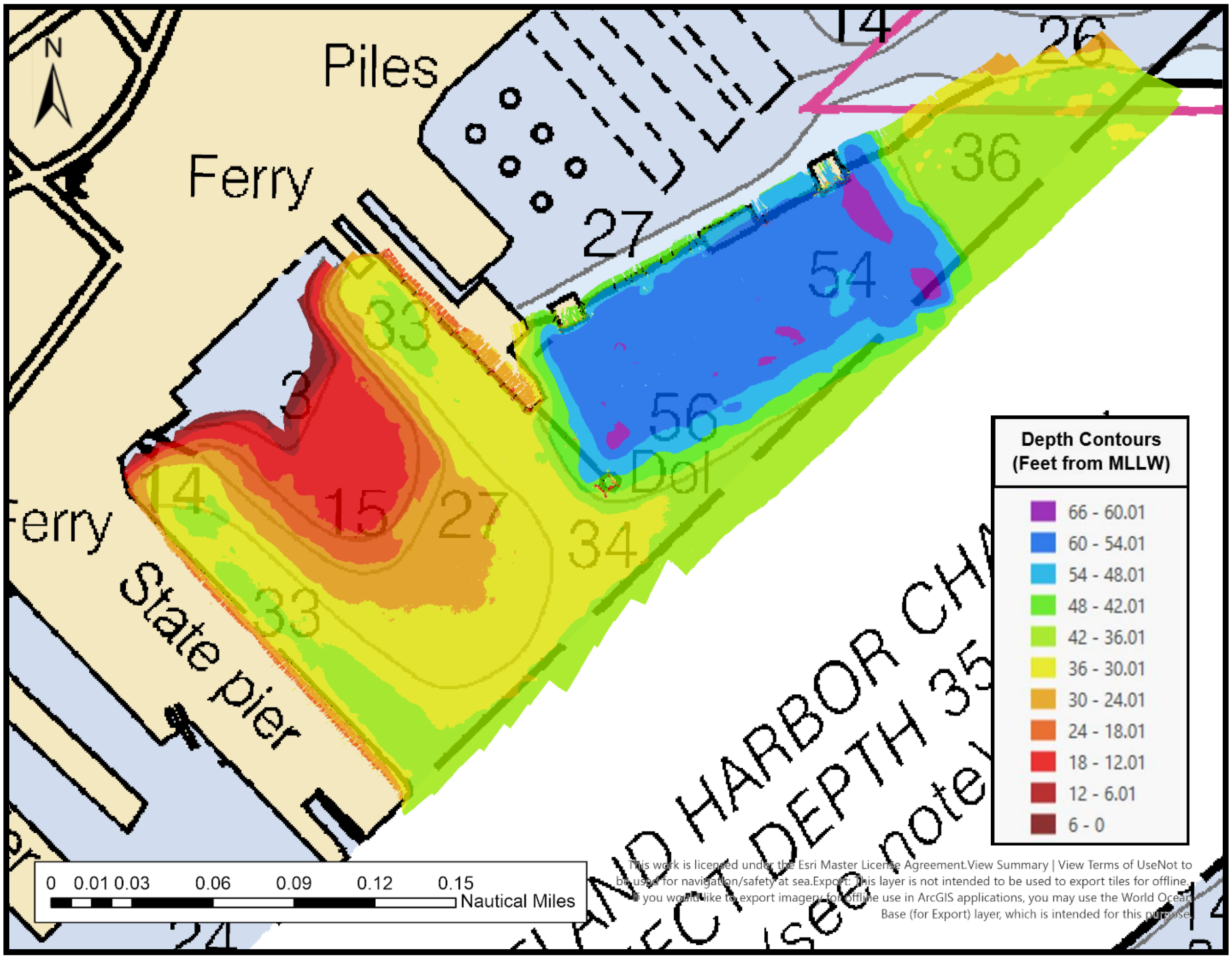

Figure 22 – Contour surface of Tug Berth and Ocean Gateway depicted atop NOAA chart 13292

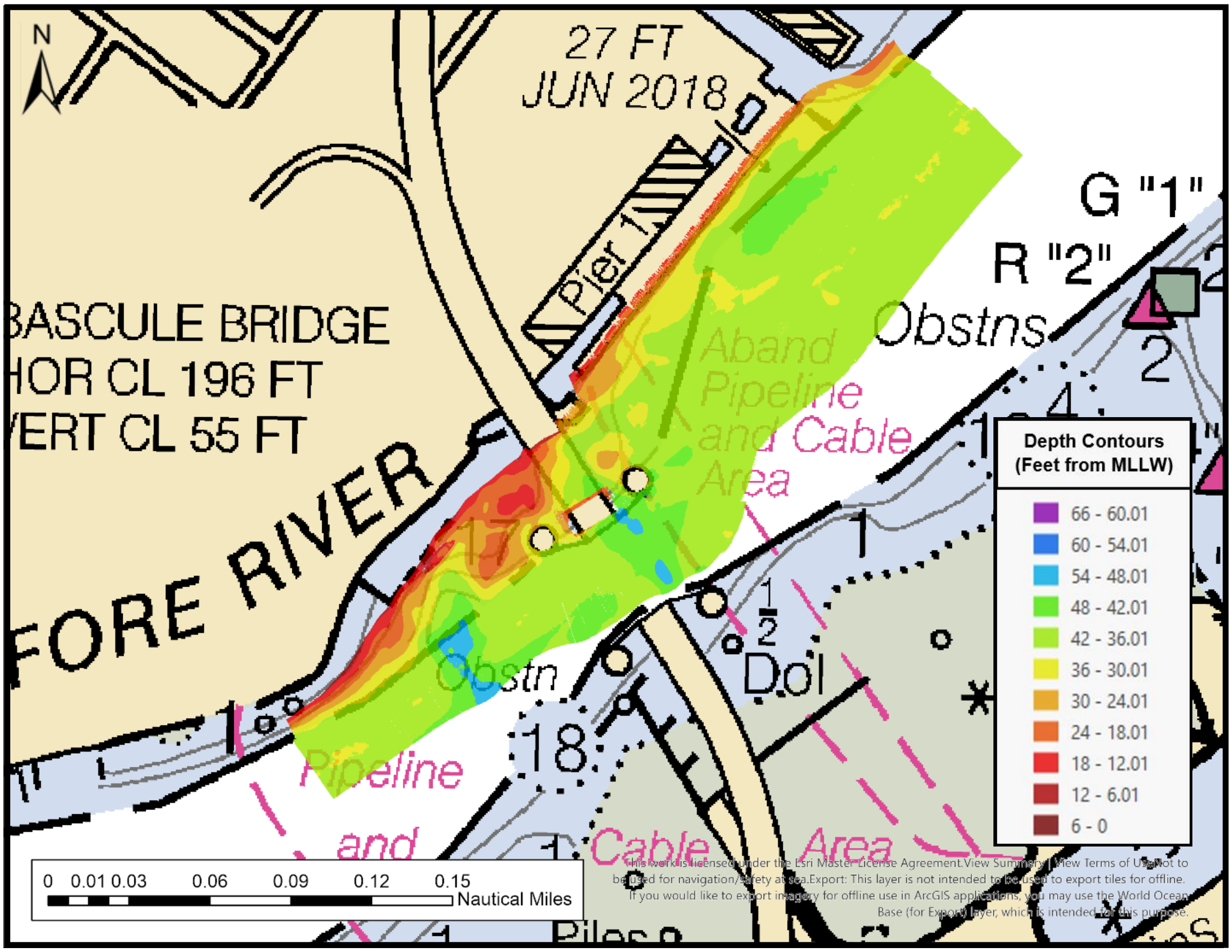

Figure 23 – Contour surface of Bridge Berth depicted atop NOAA chart 13292

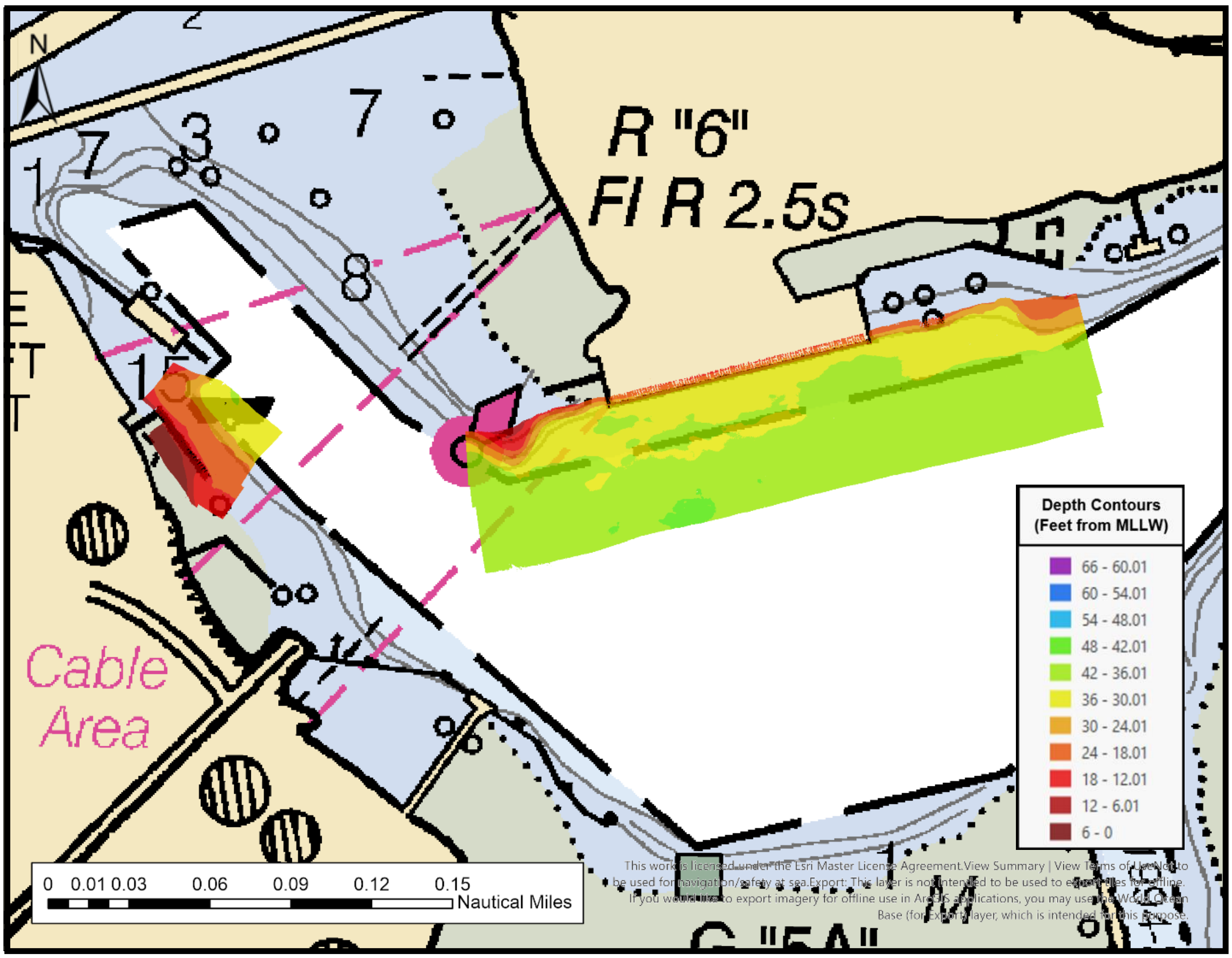

Figure 24 – Contour surface of Merrill's Wharf and Winslow's Pier depicted NOAA chart 13292

5.0 Discussion

The following subsections contain a summary of physical characteristics of the survey area, as well as details on obstructions and wrecks documented in the region.

5.1 Bathymetry and Characteristics of Seafloor

Due to the scope of this survey, seafloor characteristics are discussed separately for each berth.

5.1.1 Ocean Gateway

The Ocean Gateway berth can be divided into two distinct regions of depth and substrate characteristic, referred to here as the western and eastern regions, respectively. The western region is the deeper portion of the berth, with average values falling approximately 6 meters deeper than the eastern region. The western region is a dredged area with consistent depths between 17 and 18 meters, and navigable areas not shoaling less than 16 meters along the terminal causeway. The eastern region of the Ocean Gateway shoals to depths of 11 meters along the terminal causeway and remains a consistent depth across the breadth of the survey area. Substrate type appears to indicate a finer-grain, muddy bottom in the western region with a coarser substrate present in the eastern region. There were no objects of a significant height identified within the navigable area in either region which the hydrographer believes could impede transit of vessels whose drafts fall within 10 meters or less.

5.1.2 Tug Berth

The Tug Berth is a broad region bounded by piers to the southwest, northwest, and northeast. In the middle of the berth is a shallow formation which extends out to the edge of the survey extent. This region is significantly shallower than the depths immediately adjacent to the southwest and northeast piers, which would prohibit navigation of vessels with drafts of 10 meters or more. This region decreases in depth rapidly as it approaches the northwest pier, where it shoals to a tidally exposed area before joining the pier. The southwestern dredged region adjacent the southwest pier is an area of consistent depth and muddy substrate, with average depth values falling around 11 meters. Shoalest depths in navigable regions of this area fall to values of 9.1 meters immediately adjacent to the pier in the northwestern corner. In this southwestern dredged region, there is a notable debris field present, but no objects were found to extend upward more than 1 meter above the surrounding substrate. No objects were identified in this survey to be hazardous to vessels drafting 9 meters or less in this region. The northeast dredged region adjacent the northeast pier is similar in depth to the southwest dredged region, but appears to contain a finer grain muddy bottom, and does not contain the same magnitude of debris. Shoalest depths immediately adjacent to the pier were ensonified at 9.7 meters, near the center of the pier. Values shoal to a least depth of 8.3 meters next to the float which extends south from the northern corner of this region. No objects were identified in this survey to be hazardous to vessels drafting 8 meters or less in this region.

5.1.3 Bridge Berth

The Bridge Berth can be divided into two distinct regions, divided by the Casco Bay Bridge, and referenced here as the northern region and southern region, respectively. The northern region of the Bridge Berth has a more complex and less homogenous bottom than the Ocean Gateway and Tug Berths, with the substrate appearing to have more evidence of influence from local bottom currents and forming gently sloping SW-NE oriented features throughout. Substrate composition of this northern region indicates softer fine-grain substrate adjacent to the pier, with coarser sediment becoming more dominant moving eastward to the center of the harbor channel. Depths across the face of the pier vary to a degree of nearly 4 meters, with least depths found at 7.8 meters and deepest depths found at 12.0 meters. Consequently, navigation to all portions of the northern region would be hazardous to vessels with drafts exceeding 7 meters. The southern region of the Bridge Berth is much more variable than the northern region, with little evidence of recent dredging, and significant features with coarse grain sediment evident throughout. This portion of the dataset is punctuated most notably by a large wreck, documented in section 5.2 of this report and shown in Figures 25 – 30. Also evident in this region is a set of sunken pilings or an old float, with is found in the southwestern portion of this region. This approximately 12 meter long and 6 meter wide feature does not extend more than 1 meter above the surrounding substrate, but is readily apparent in both the point data and resulting bathymetric surfaces provided in the accompanying data package.

5.1.4 Merrill's Wharf

Merrill's Wharf is a relatively consistent region in both depth and substrate composition, with the exception being the shallow formation which extends out near the Fore River Lighted Buoy 6. This region is beyond the bounds of the wharf itself, so in-depth analysis will not be discussed in the scope of this report. Across the face of the wharf, depths were found at an average value of roughly 10 meters, but shoalest soundings across the wharf were found immediately adjacent to the pilings at 8 meters. Substrate type indicates a muddy fine-grain substrate throughout, with coarser grain sediment found toward the southern extent, approaching the main channel of the harbor. No objects were identified in this survey to be hazardous to vessels drafting less than 8 meters in this region.

5.1.5 Winslow's Pier

Winslow's Pier is a small, shallow pier, which was investigated as an additional effort due to the allowance of the survey window, in which the other areas of interest were completed ahead of schedule. This pier is especially shallow on the western side, with depths falling less than 1 meter at MLLW. Small craft with draft less than 1 meter may navigate in this area at certain points in the tide cycle, but all other vessels should exercise extreme caution even at high tide. The eastern side of the pier has slightly deeper average depths, with approximate soundings averaging 4 meters from MLLW. The shoalest sounding on this side of the pier was 2.9 meters. It is the hydrographer's recommendation that vessels with drafts of greater than 2.9 meters should not navigate in this area. Substrate throughout this region is indicative of very fine grain substrate that is largely consistent throughout the entire pier area.

5.2 Wrecks and Obstructions

An uncharted wreck with a least depth of 1.765m from MLLW was discovered during the course of this survey, west of the Casco Bay Bridge and just off the southern portion of the Bridge Berth. Center position of this wreck is located at 43.645114° N 70.259492° W. Dimensions of the wreck measure roughly 31m in length with a beam of 8m. Discussions with Portland Pilots indicate this could be the wreck of the steam tug *Falmouth*, which was scuttled during the construction of the "new" Casco Bay Bridge somewhere between 1993 and 1997. Existing NOAA survey H12494 did not ensonify this wreck due to the extent of coverage.

This feature is determined to be a danger to navigation and mariners should avoid the obstruction if transiting in the area. It is the recommendation of the hydrographer that the charts 13288, 13290, 13292, and 13296 be updated to include this feature.

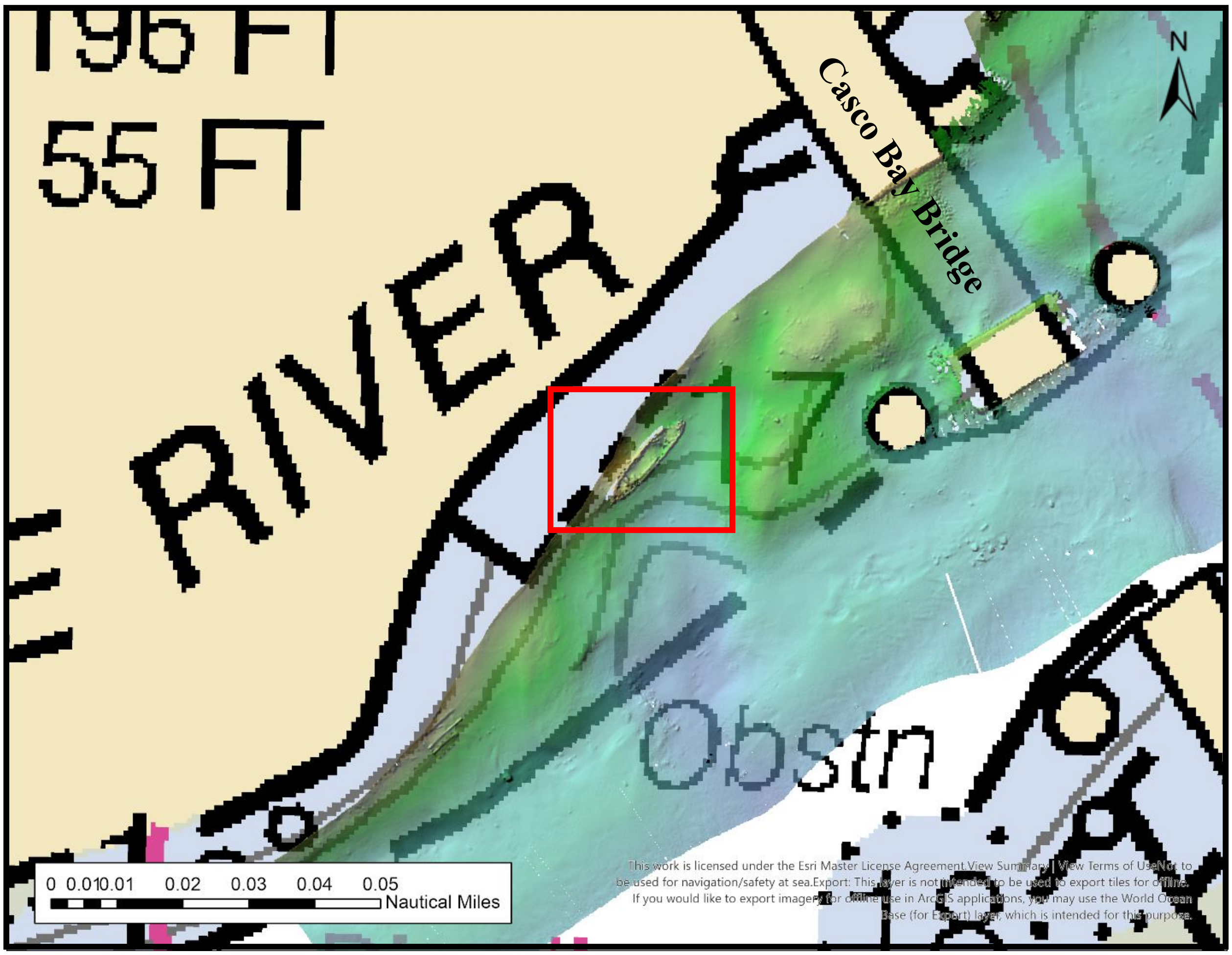

Figure 25 – Overview of wreck location atop chart 13292

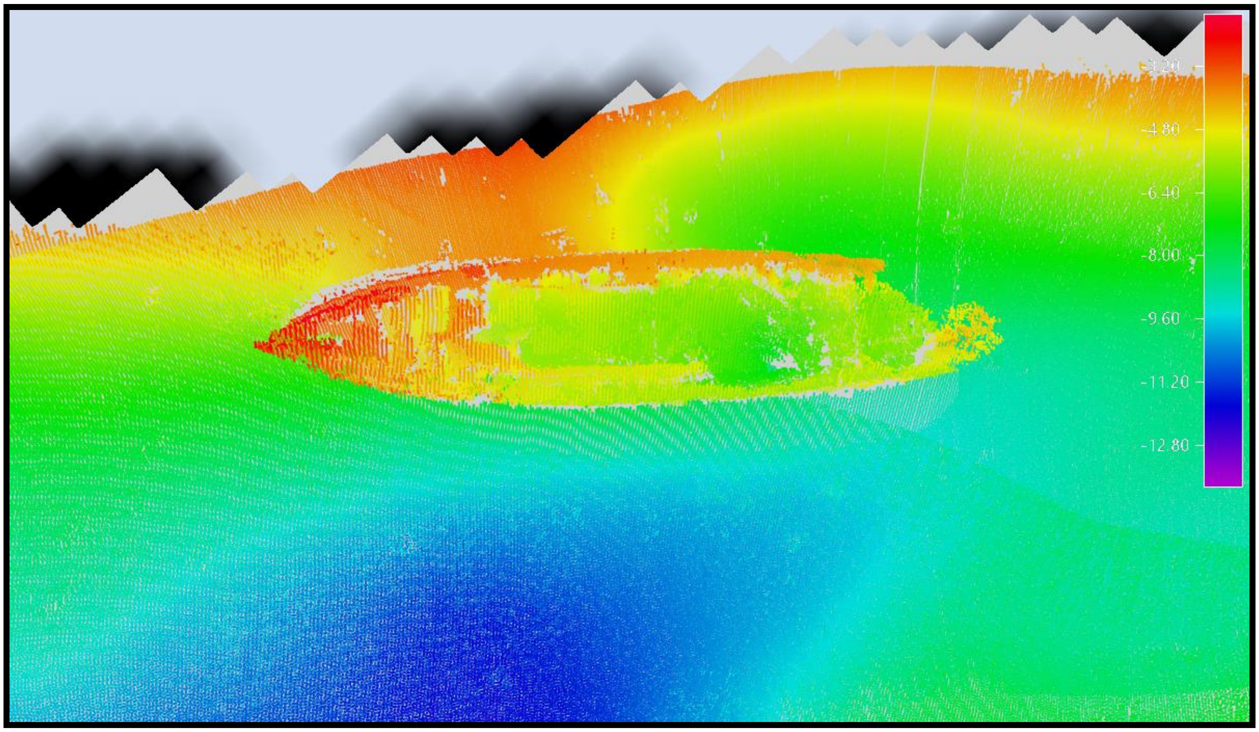

Figure 26 – Overview of point data of wreck

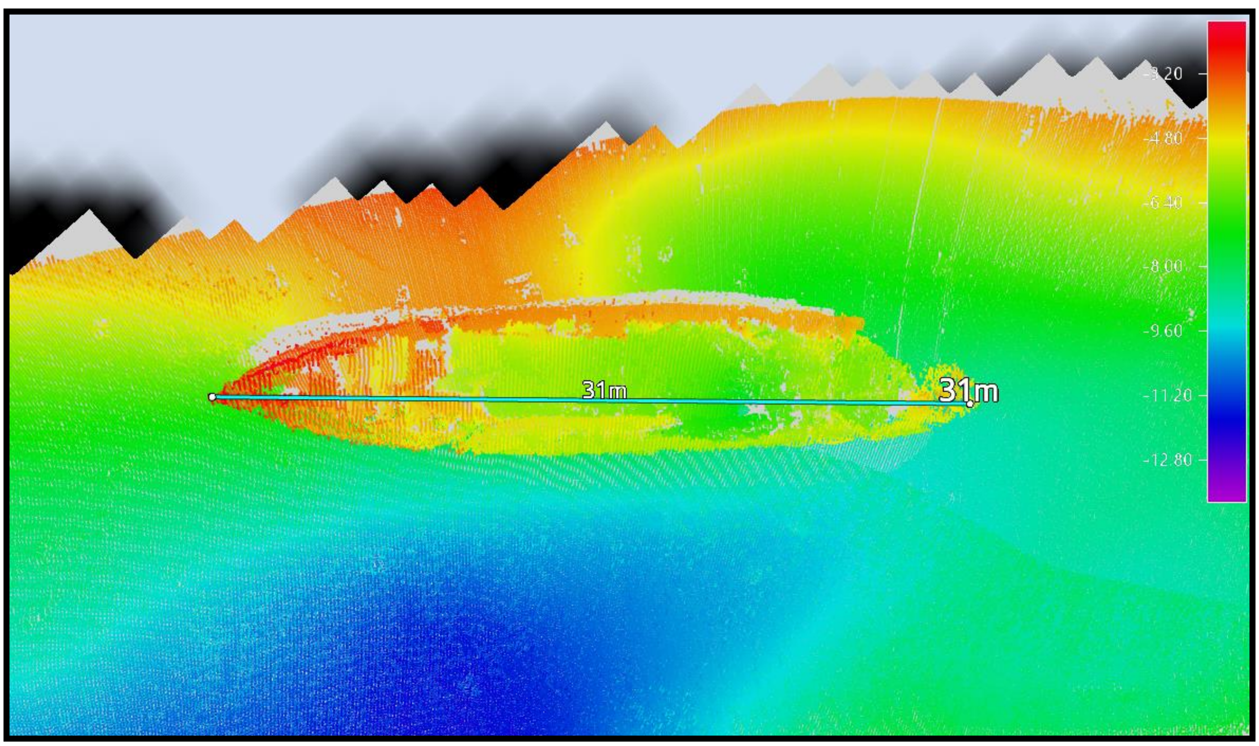

Figure 27 – Point data of wreck with approximate length measurement depicted

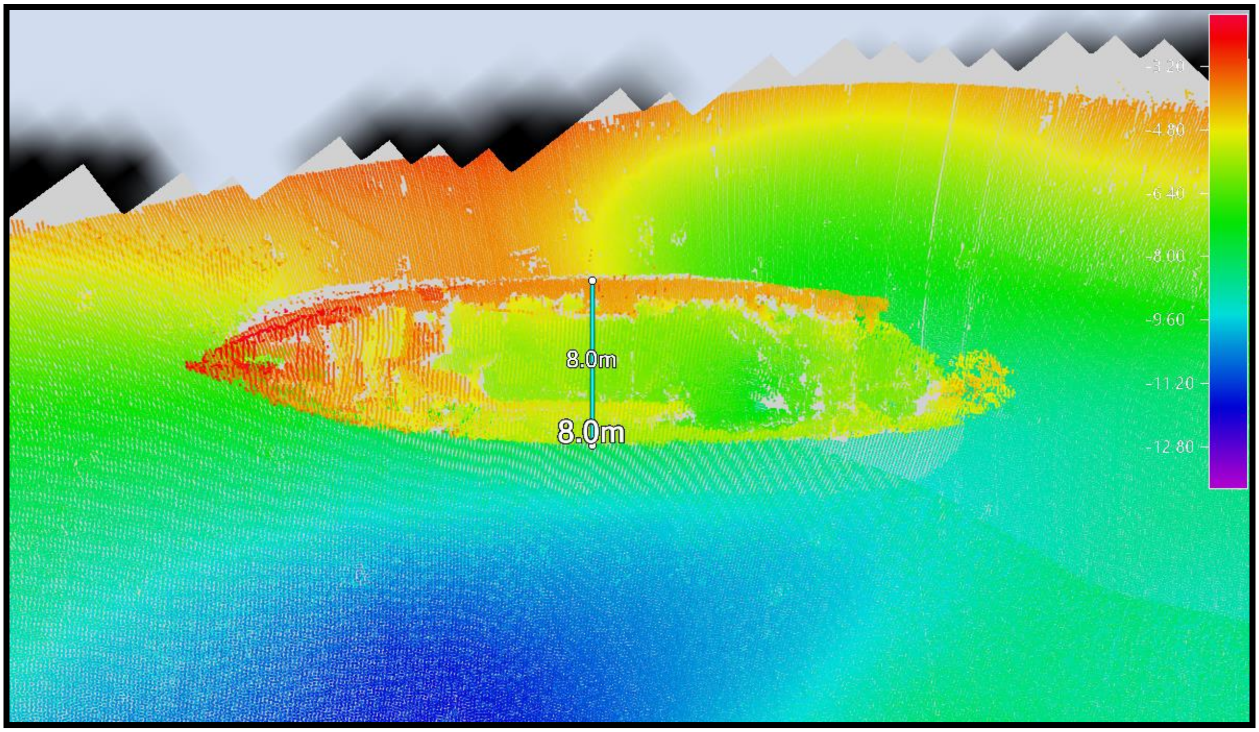

Figure 28 – Point data of wreck with approximate beam measurement

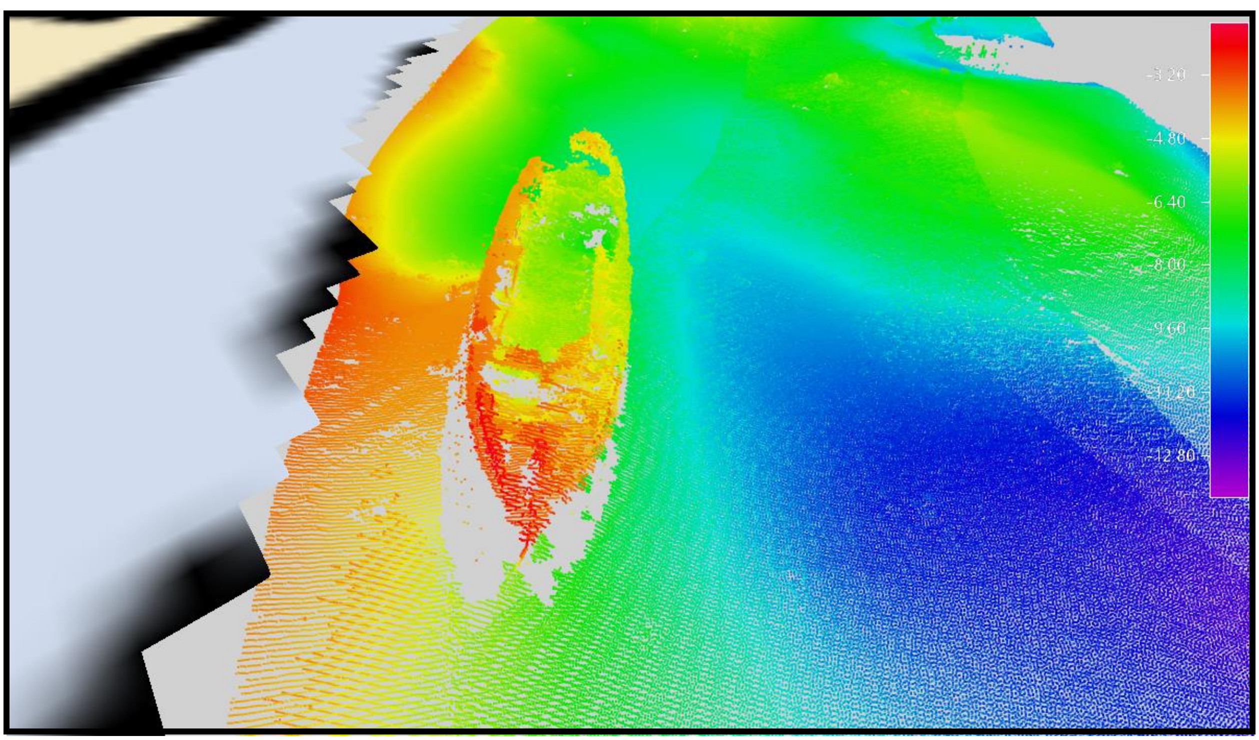

Figure 29 – Oblique angle view of point data looking at the bow of the wreck

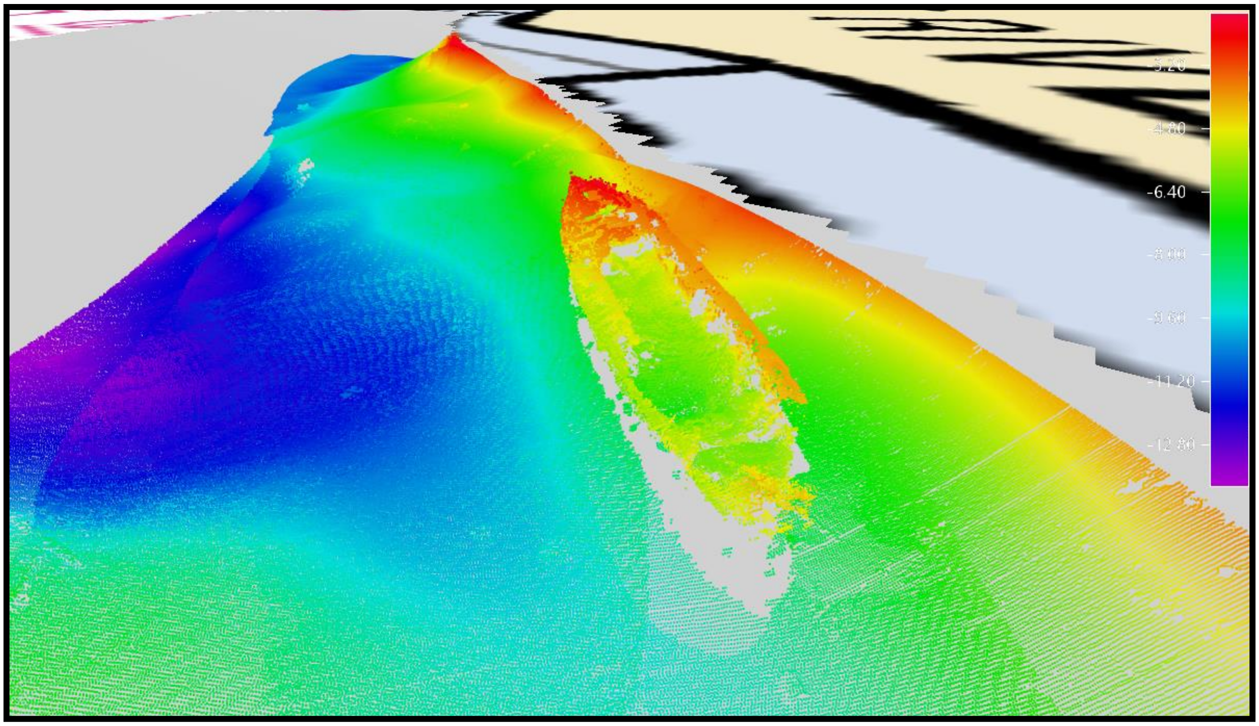

Figure 30 – Oblique angle view of point data looking at the stern of the wreck

6.0 Summary

On November 13, 2023, the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic survey using a Kongsberg EM 2040C multibeam echosounder in state marine waters of Portland Harbor, Maine. In total, MCMI completed full-coverage surveys of 5 berths in Portland Harbor. Bathymetry and backscatter data products were produced at 25cm, 50cm, and 1m grid resolutions for the extent of the survey area. Across the dataset, sounding uncertainty (95% confidence interval) fell within +/-10 cm and calculated TVU and THU values for all areas were within tolerances for IHO Order 1a and NOAA specifications at all depths, where 99.5%+ of all nodes fell within the allowable range.

One notable wreck which could pose a hazard to navigation was discovered over the course of this survey and it is the recommendation of MCMI that this feature be updated in future NOAA navigational products.

These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and were shared with the NOAA Office of Coast Survey for review. These data provided and this accompanying report are encouraged for use as an informational resource but are not intended for use as a navigational aid.

Please contact the Maine Coastal Mapping Initiative's Program Lead for additional information or data.

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Appendix A – 2023 MCMI Survey Systems Diagram for the F/V Amy Gale