H13718

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13718

LOCALITY

State(s):	Alaska
General Locality:	Bristol Bay
Sub-locality:	Approach to Kulukak Bay

2023

CHIEF OF PARTY
Andrew Orthmann

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13718**

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):	**Alaska**
General Locality:	**Bristol Bay**
Sub-Locality:	**Approach to Kulukak Bay**
Scale:	**40000**
Dates of Survey:	**06/03/2023 to 09/11/2023**
Instructions Dated:	**01/30/2023**
Project Number:	**OPR-R340-KR-23**
Field Unit:	**Terrasond**
Chief of Party:	**Andrew Orthmann**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in WGS84 UTM 04N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

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Descriptive Report to Accompany Survey H13718

Project: OPR-R340-KR-23

Locality: Bristol Bay

Sublocality: Approach to Kulukak Bay

Scale: 1:40000

June 2023 - September 2023

Terrasond

Chief of Party: Andrew Orthmann

A. Area Surveyed

The survey area is located in Bristol Bay, Alaska.

Bristol Bay is located in southwestern Alaska. The area is ecologically rich and renowned for its wildlife and salmon fisheries. It is bound by the volcanic mountains of the Alaska Peninsula to the south, and tundra-covered landscapes to the north. The area is remote and disconnected from the road system, with area communities small and accessible only by air or water. The largest nearby community (and hub for the region) is Dillingham (population 2,203 in 2021).

An intricate network of rivers feed the bay, especially the Kvichak, Nushagak, Naknek, and Igushik. The rivers transport and deposit large amounts of sediment into the bay, resulting in seafloor variability with shifting sandbars and constantly changing depths. River current combined with the large daily tide range of the area (4-5 meters) causes very strong currents, especially at the approaches to the area rivers.

The area is unnavigable for much of the year due to sea and river ice. During the ice free period, approximately June through October, weather is frequently inclement, with sudden storms and dense fog common occurrences. The unpredictable weather pattern, coupled with the changeable seafloor and outdated charts of the area, pose significant navigational challenges for vessels.

Vessel traffic in the region is largely from fishing vessels (mostly smaller vessels of approximately 32' length) with a mix of larger fish tender vessels. Tug-and-tow barges also frequent the area, bringing fuel and supplies to the communities that border the bay, as well as communities further up the various rivers.

Field work for hydrographic data collection was carried out from June through September of 2023 under project OPR-R340-KR-23, with final processing and reporting occurring from October, 2023 through January, 2024. This area was surveyed concurrently with fourteen other areas in the Bristol Bay project in accordance with the Hydrographic Survey Project Instructions (dated January 30th, 2023), accompanying Scope of Work, and the NOAA Hydrographic Surveys Specifications and Deliverables (HSSD, 2022 edition).

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
58° 49' 37.43" N 159° 49' 50.74" W	58° 32' 24.85" N 159° 14' 8.14" W

Table 1: Survey Limits

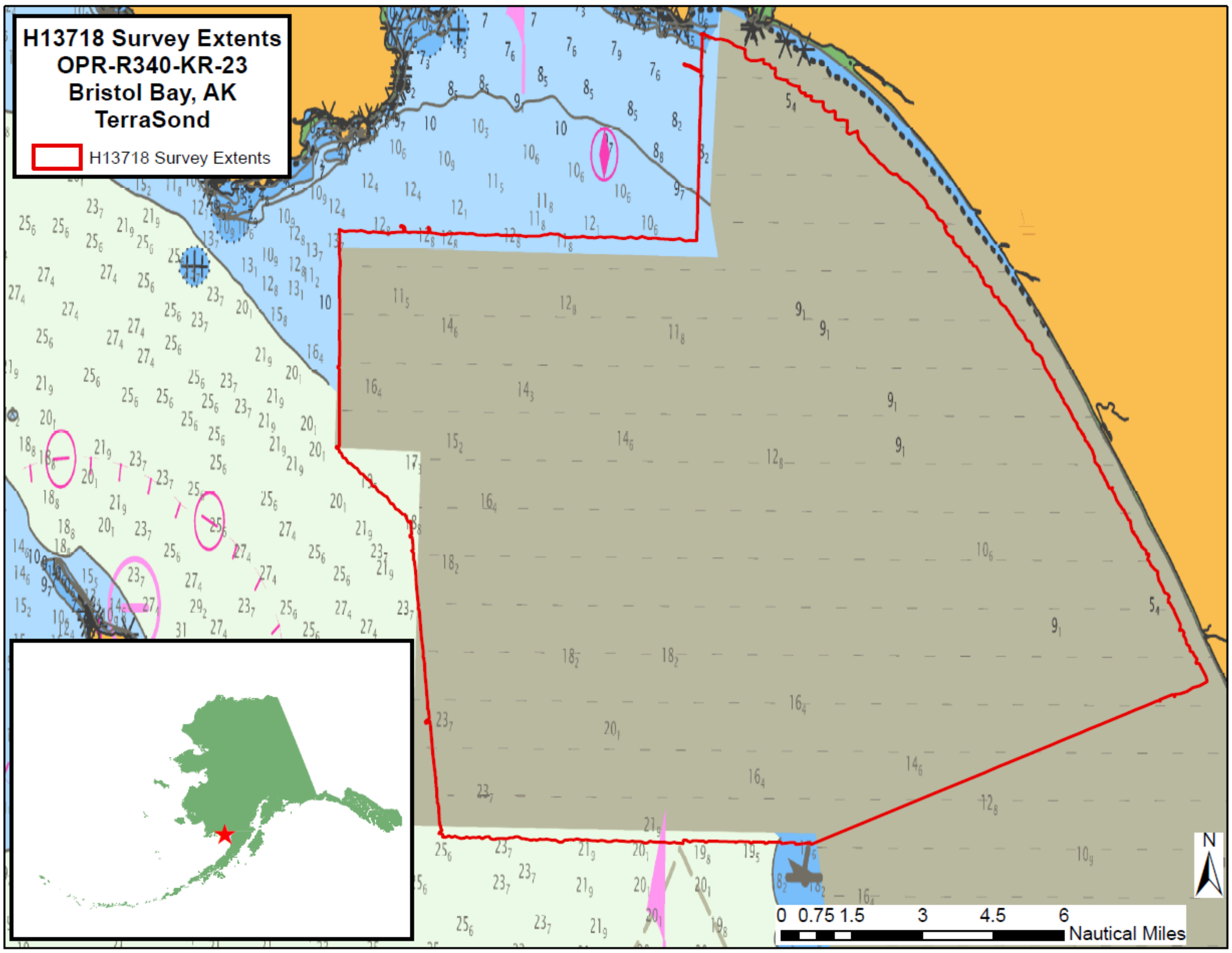


Figure 1: Overview of the survey extents.

Survey limits were acquired in accordance with the requirements in the Project Instructions and the HSSD.

A.2 Survey Purpose

The purpose of this survey is described as follows in the Project Instructions:

Bristol Bay is important to the US economy as the largest sockeye salmon fishery in the world, and second ranked fishing port in the United States. Known as “America’s Fish Basket”, the combined economic value of the commercial fishery, processing, visitor industry, and tourism is $1.1 Billion. It is home to 25 Alaska Native villages and communities who rely on the Alaska maritime infrastructure for goods and fuel.

The Bristol Bay project will provide contemporary surveys to update National Ocean Service (NOS) nautical charting products and services. Seventy percent of the project was last surveyed between 1945 and 1960, the rest has never been surveyed. Updated bathymetry and feature data will be used to create larger scale charts in the area, reducing the risk to navigation, and serve as the foundational dataset to support modeling, industry, and science.

The project will directly support the maritime services available to the remote coastal communities by providing the base data to update nautical products for nearby waters, including targeting navigational channels near the Port of Naknek, Ekuk, and Port Heiden. These products can improve the safety of subsistence fishing, marine transportation, and shipment of goods. It is noteworthy that Port Heiden has moved inland because of erosion.

The priority areas focus on collecting data for vessel lightering areas identified by the Western Alaska Tanker Lightering Best Practices Committee, as part of the Alaska Maritime Prevention & Response Network. These areas are used for Ship-to-Ship transfers of oil products, including fuel which is of key importance to local residents.

The lightering areas, together with the Automatic Identification Systems (AIS) traffic patterns, regional requests, and hydrographic health modeling were used to identify 2300 square nautical miles of priority project area. Data from this project will supersede all prior survey data providing modern hydrographic survey data for this area and updating the local charting products.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

A.4 Survey Coverage

The following table lists the coverage requirements for this survey as assigned in the project instructions:

Water Depth	Coverage Required
All waters in survey area (Any lines of data provided including opportunity data)	Complete a minimum of 15,606 LNM. Unlogged transit mileage, system calibration mileage and data which do not meet HSSD specifications shall not count towards the completion of the LNM requirement. Notify the COR/Project Manager upon nearing completion of LNM requirement. The final survey area shall be squared off and ensure the full investigation of any features within the surveyed extent. Set Line Spacing system of MBES (HSSD Section 5.2.2.4 Option A).
Sheet H13718	Sounding lines shall be acquired with spacing adequate to collect data at an interval of at least 240 meters.
All Shoreline Sheets SDB Checklines	Within each shoreline sheet, acquire four geographically dispersed sounding lines that extend to the inshore limit of safe navigation. The field unit will chose the location for the safe and efficient acquisition of shoal depths.

Table 2: Survey Coverage

Coverage requirements were met. Additional clarification on specific requirements are provided below.

LNM Requirements: A minimum of 15,606 LNM of MBES data was required project-wide. 15,997 was actually acquired. The excess of 391 was collected to compensate for inefficiencies incidental to data collection such as crossline mileage that exceeded requirements, data acquired on run-ins or run-outs (including in shallow water in order to scout between lines), and excess overlap (if any). LNM quantities do not include transit or calibration data, or data that does not meet HSSD requirements.

Splits: Splits were generally not acquired on charted soundings that were shoaler than surrounding survey data. It was observed during survey operations that there was a project-wide trend of nearly all charted soundings being shoaler than survey data, and excessive effort and LNM would be required to perform splits on the charted soundings. This was brought to the attention of the NOAA COR and an exception was approved to de-prioritize bathymetric splits over shoal charted soundings and use hydrographer's discretion when choosing these splits. Splits were still acquired where necessary to develop shoals. Correspondence is included with the survey deliverables.

NALL: The inshore depth contour definition of the NALL was specified to be 4.5 m for this survey. 4.5 m (or shoaler) was successfully achieved fully along the coast. Note that shoreline trace lines that run roughly parallel to the shore was completed early in the project to scout the nearshore area depths in this relatively uncharted area. With the shoreline trace in place, mainscheme lines that were roughly perpendicular to the shore could be collected more safely and efficiently. However, mainscheme lines were terminated when 4.5 m depth was achieved, which did not always coincide with the shoreline trace lines. This left gaps in some areas between the shoreline trace, which were shoaler than 4.5 m in many places, and the mainscheme lines. However, the trace is included with the deliverables as it is good data in uncharted water that adds value to the dataset.

SDB Checklines: SDB (Satellite Derived Bathymetry) checklines, to be used for SDB calibrations, were acquired at geographically dispersed locations chosen by the field crew. These were also run co-incident with NASA ICESat-2 data provided by NOAA when practical per NOAA's request for overlap (see included correspondence), but personnel and vessel safety took precedence in location decisions. For the checklines, the ASV-CW5 vessel collected data as shallow as possible, until it was deemed unsafe to continue closer to shore. These checklines were normally acquired at mid- to high- tide in order to achieve as shoal of a tide-corrected depth as possible. All checkline data is incorporated in the final surface submitted with the survey deliverables.

Four checklines were acquired for this sheet. Their location relative to the survey area and the least depth achieved on each line is shown in the image below.

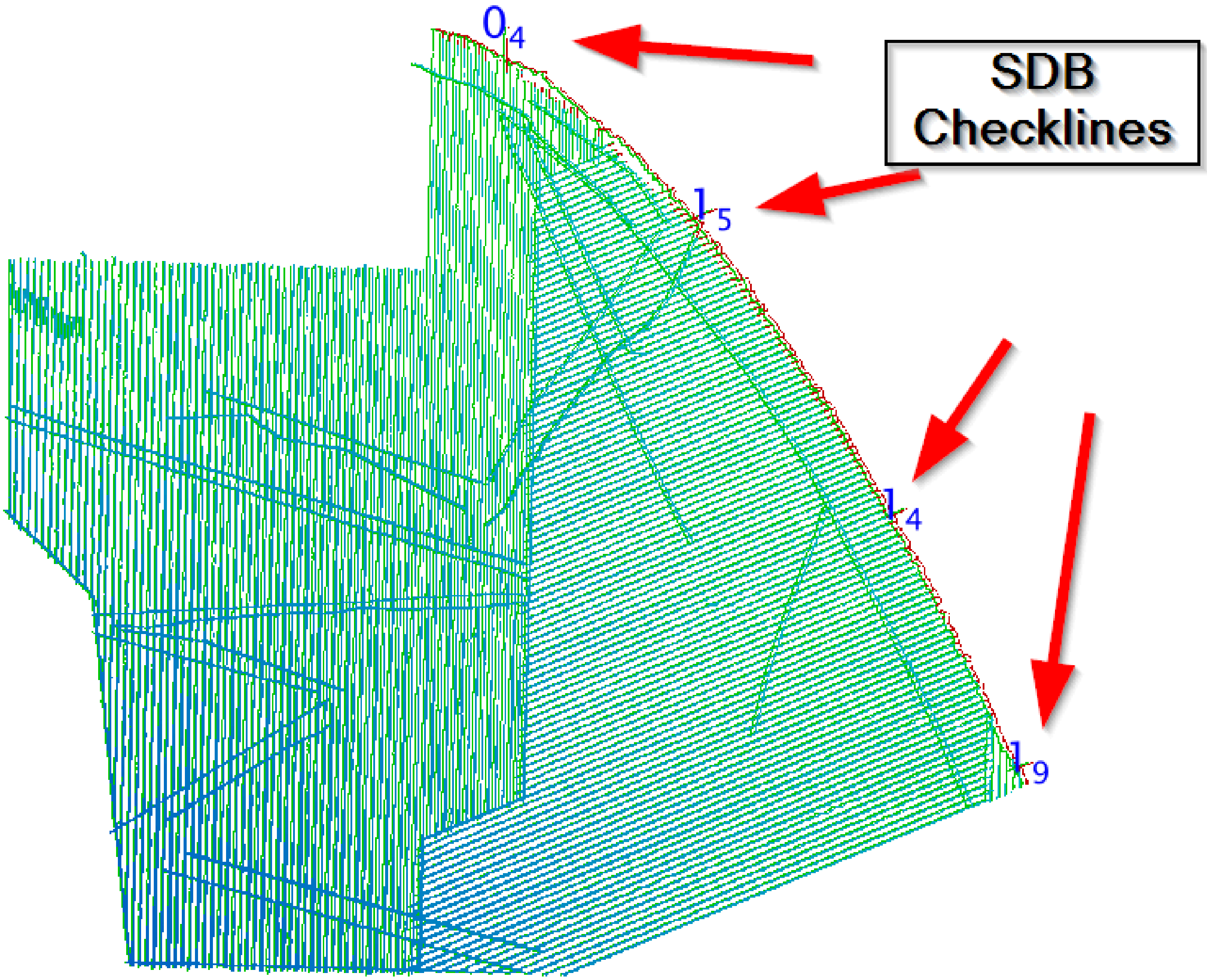


Figure 2: Image showing the relative location of SDB checklines.
The least depth achieved on each checkline is shown in meters.

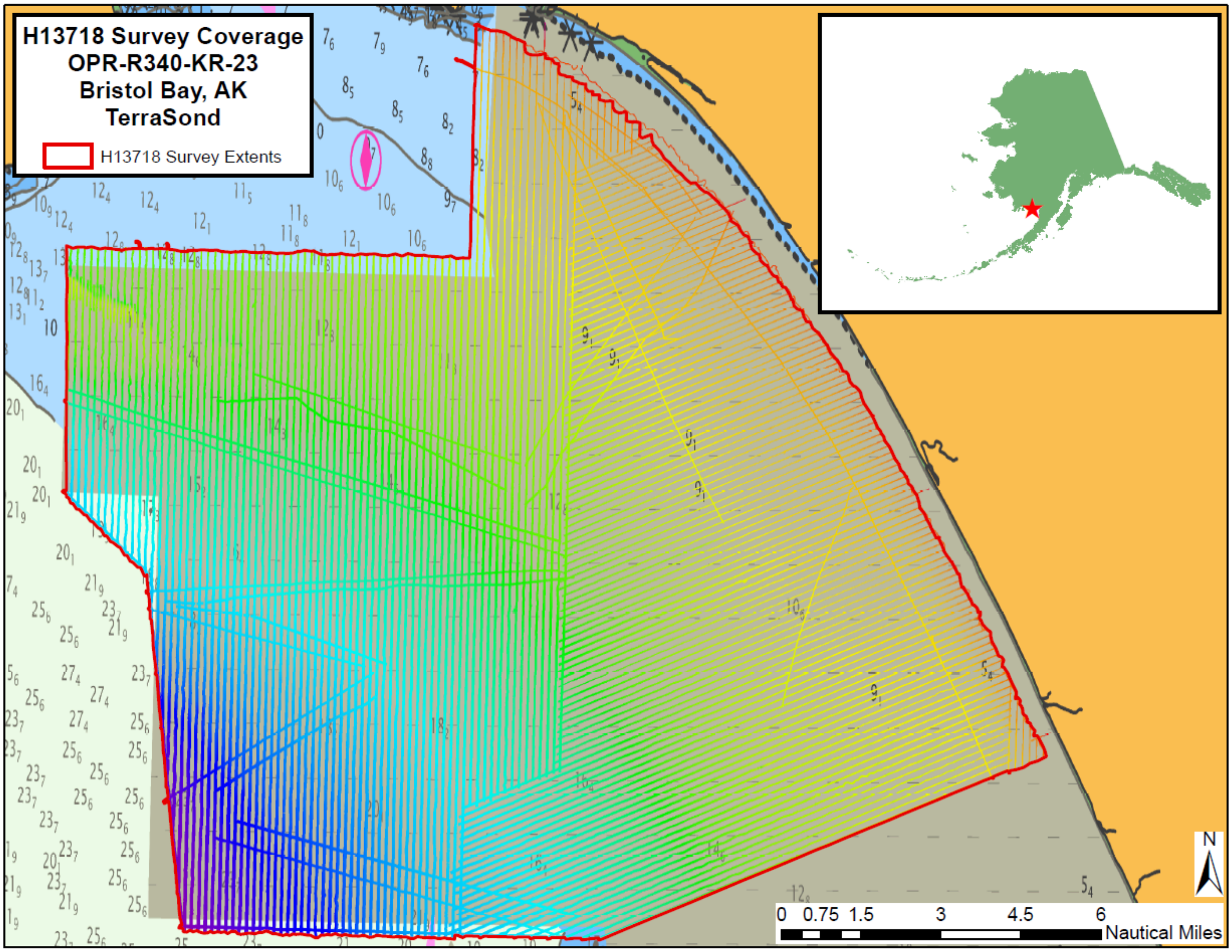


Figure 3: Overview of the survey coverage.

A.6 Survey Statistics

The following table lists the mainscheme and crossline acquisition mileage for this survey:

	HULL ID	*Arctic Seal*	*ASV-CW5*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0	0.0
	MBES Mainscheme	905.1	711.0	1616.1
	Lidar Mainscheme	0.0	0.0	0.0
	SSS Mainscheme	0.0	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0	0.0
	MBES/SSS Mainscheme	0.0	0.0	0.0
	SBES/MBES Crosslines	84.4	60.0	144.4
	Lidar Crosslines	0.0	0.0	0.0
Number of Bottom Samples				11
Number Maritime Boundary Points Investigated				3
Number of DPs				0
Number of Items Investigated by Dive Ops				0
Total SNM				199.5

Table 3: Hydrographic Survey Statistics

The following table lists the specific dates of data acquisition for this survey:

Survey Dates	Day of the Year
06/03/2023	154

Survey Dates	Day of the Year
06/04/2023	155
06/27/2023	178
06/28/2023	179
07/02/2023	183
07/03/2023	184
07/07/2023	188
07/08/2023	189
07/09/2023	190
07/10/2023	191
07/16/2023	197
07/17/2023	198
07/18/2023	199
07/19/2023	200
09/10/2023	253
09/11/2023	254

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures and data processing methods. Additional information to supplement sounding and survey data, and any deviations from the DAPR are discussed in the following sections.

B.1.1 Vessels

The following vessels were used for data acquisition during this survey:

Hull ID	***Arctic Seal***	***ASV-CW5***
LOA	39.6 meters	5.5 meters
Draft	2.0 meters	0.6 meters

Table 5: Vessels Used

Figure 4: The Arctic Seal in the Bristol Bay survey area.

Figure 5: The ASV-CW5 in the Bristol Bay survey area.

The Arctic Seal is a 40 m steel-hull, landing craft style vessel owned and operated by Support Vessels of Alaska. The Arctic Seal acquired multibeam data and provided housing and facilities for on-site data processing. The vessel was also used to collect bottom samples, conduct sound speed casts, and deploy/recover the ASV-CW5 (uncrewed) launch and LC-25 (crewed) launch.

The ASV-CW5 (ASV) is a 5.5 m aluminum-hull Autonomous Surface Vessel (ASV), C-Worker 5 model, owned and operated by L3-Harris ASV. The ASV was operated in an uncrewed but monitored mode, collecting multibeam data in close proximity to the Arctic Seal, as well as in areas too shallow for the larger vessel.

B.1.2 Equipment

The following major systems were used for data acquisition during this survey:

Manufacturer	Model	Type
Teledyne RESON	SeaBat T50-R	MBES
Teledyne RESON	SeaBat T50-R	MBES Backscatter
Applanix	POS MV 320 v5	Positioning and Attitude System
Valeport	SWiFT SVP	Sound Speed System
AML Oceanographic	MicroX SV	Sound Speed System

Table 6: Major Systems Used

The survey vessels were configured for MBES data collection with nearly identical survey equipment and software. Both vessels utilized Reson Seabat T50-R MBES systems, with surface sound speed measurements provided by AML Oceanographic Micro-X sensors. Both vessels used Applanix POSMVs (integrated into the T50-R MBES systems) with submersible IP-68 rated IMUs for attitude and position measurements. Sound speed profiles were collected using a Valeport SWiFT sensor, deployed while underway using a C-MAX Vigo winch, on the Arctic Seal. QPS QINSy software, running on Microsoft Windows 10-based PCs, was used for multibeam data logging and vessel navigation.

B.2 Quality Control

B.2.1 Crosslines

The percentage of crossline to mainscheme miles is 8.9%.

Effort was made to ensure crosslines (XLs) had good temporal and geographic distribution, were angled to enable nadir-to-nadir comparisons, and that the required minimum percent of mainscheme LNM was achieved.

Crosslines were conducted with all vessels to ensure there was ample overlap for inter-vessel comparisons, with each vessel crossing the other's mainscheme lines. Since the Arctic Seal and ASV-CW5 vessels worked in close proximity and normally ran parallel lines, crosslines were collected in sets whenever both vessels were in simultaneous operation. The collection of crosslines in sets, while spreading sets out across the survey area for good distribution, led to incidental collection of additional crossline LNM beyond the required 8% of mainscheme.

Crosslines were often collected while transiting across the survey area to reach a different survey priority such as bottom sample locations or infills, leading to crosslines that were diagonal to the direction of mainscheme lines.

The crossline analysis was conducted using CARIS HIPS “Line QC Report” process. Each crossline (with all associated file segments) was selected and run separately through the process, which calculated the depth difference between each accepted crossline sounding and a "QC" BASE (CUBE-type) surface’s depth layer created from the mainscheme data. The QC surface was created with the same parameters and resolution used for the final surface, with the important distinction that the QC surface did not include crosslines so as to not bias the results. Differences in depth were grouped by beam number and statistics were computed, including the percentage of soundings with differences from the QC surface falling within IHO Order 1a.

When at least 95% of the sounding differences exceed IHO Order 1a, the crossline was considered to “pass,” but when less than 95% of the soundings compare within IHO Order 1, the crossline was considered to “fail.” A 5% (or less) failure rate was considered acceptable since this approach compares soundings to a surface (instead of a surface to a surface), allowing for the possibility that noisy crossline soundings that don't adversely affect the final surface could be counted as a QC failure in this process.

Lines selected as crosslines and their percentage (%) of soundings passing IHO Order 1a, sorted from highest passing to lowest, are listed below. Note that within the CARIS HIPS projects provided with the survey deliverables, lines used as crosslines have their "Line Class" attribute set to "Check", while all others have this attribute set to "Track".

0024-154-ASV-CW5-E-Shoreline -- 100.0% pass
0025-155-ASV-CW5-E-Shoreline -- 100.0% pass
2751-253-ASV-CW5-E-XL102 -- 100.0% pass
2752-253-ASV-CW5-E-XL103 -- 100.0% pass
2754-253-ASV-CW5-E-XL104 -- 100.0% pass
2770-254-ASV-CW5-E-XL-108 -- 100.0% pass
2771-254-ASV-CW5-E-XL-109 -- 100.0% pass
2773-254-ASV-CW5-E-XL-110 -- 100.0% pass
2775-254-ASV-CW5-E-XL-112 -- 100.0% pass
0056-154-ArcticSeal-E_Shore_XL -- 100.0% pass
0057-154-ArcticSeal-E_Shore_XL -- 100.0% pass
0058-155-ArcticSeal-E_Shore_XL -- 100.0% pass
0683-191-ArcticSeal-E-SouthBorder-XL -- 100.0% pass
1893-253-ArcticSeal-E-XL50 -- 100.0% pass
1894-253-ArcticSeal-E-XL51 -- 100.0% pass
1895-253-ArcticSeal-E-XL52 -- 100.0% pass
1896-253-ArcticSeal-E-XL53 -- 100.0% pass
1897-253-ArcticSeal-E-XL54 -- 100.0% pass
1904-253-ArcticSeal-E-XL55 -- 100.0% pass
1907-254-ArcticSeal-E-XL58 -- 100.0% pass
1908-254-ArcticSeal-E-XL59 -- 100.0% pass
2768-254-ASV-CW5-E-XL-107 -- 100.0% pass
2756-253-ASV-CW5-E-XL105 -- 100.0% pass
2767-253-ASV-CW5-E-XL-106 -- 100.0% pass
1906-254-ArcticSeal-E-XL57 -- 100.0% pass
2774-254-ASV-CW5-E-XL-111 -- 99.8% pass

1905-254-ArcticSeal-E-XL56 -- 99.6% pass

Results: Agreement between them mainscheme surface and crossline soundings is excellent. At least 95% of all crossline soundings compare to the mainscheme surface within IHO Order 1a for all crosslines. Refer to Separate II: Digital Data for the detailed Crossline QC reports.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via ERTDM	0.18 meters	0.0 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
Arctic Seal	0 meters/second	2.4 meters/second	0 meters/second	0.025 meters/second
ASV-CW5	0 meters/second	2.4 meters/second	0 meters/second	0.025 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

The uncertainty layer of the final surface was examined in CARIS HIPS software, as well as analyzed in Pydro QC Tools V3.10.9 Grid QA v6.

Uncertainty of the final grid cells range from 0 to 1.26 m. Greater than 99.5% of grid cells have TVU falling within the allowable range by depth. The larger values were observed to be in areas of highly variable seafloor where many soundings of different depths contribute to the value a grid cell and result in a overall higher standard deviation for the final depth of the cell. This was most prevalent around abrupt shoals, sandwaves, and areas exhibiting bottom change. Despite the higher uncertainty computed for some grid cells, depths for all final grid cells are within specifications.

B.2.3 Junctions

During field operations, effort was made to ensure sufficient overlap was achieved between this survey and any overlapping surveys for junction analysis. This included extending survey lines into overlapping sheets, and in some cases running survey lines along junction boundaries.

The "Gridded Surface Comparison V22.1" utility within Pydro was used to compare survey junctions. The utility differences the surfaces from the two surveys and generates statistics that include the percentage of grid cells that compare to within allowable TVU for the depth. 4 m resolution surfaces were used for all comparisons.

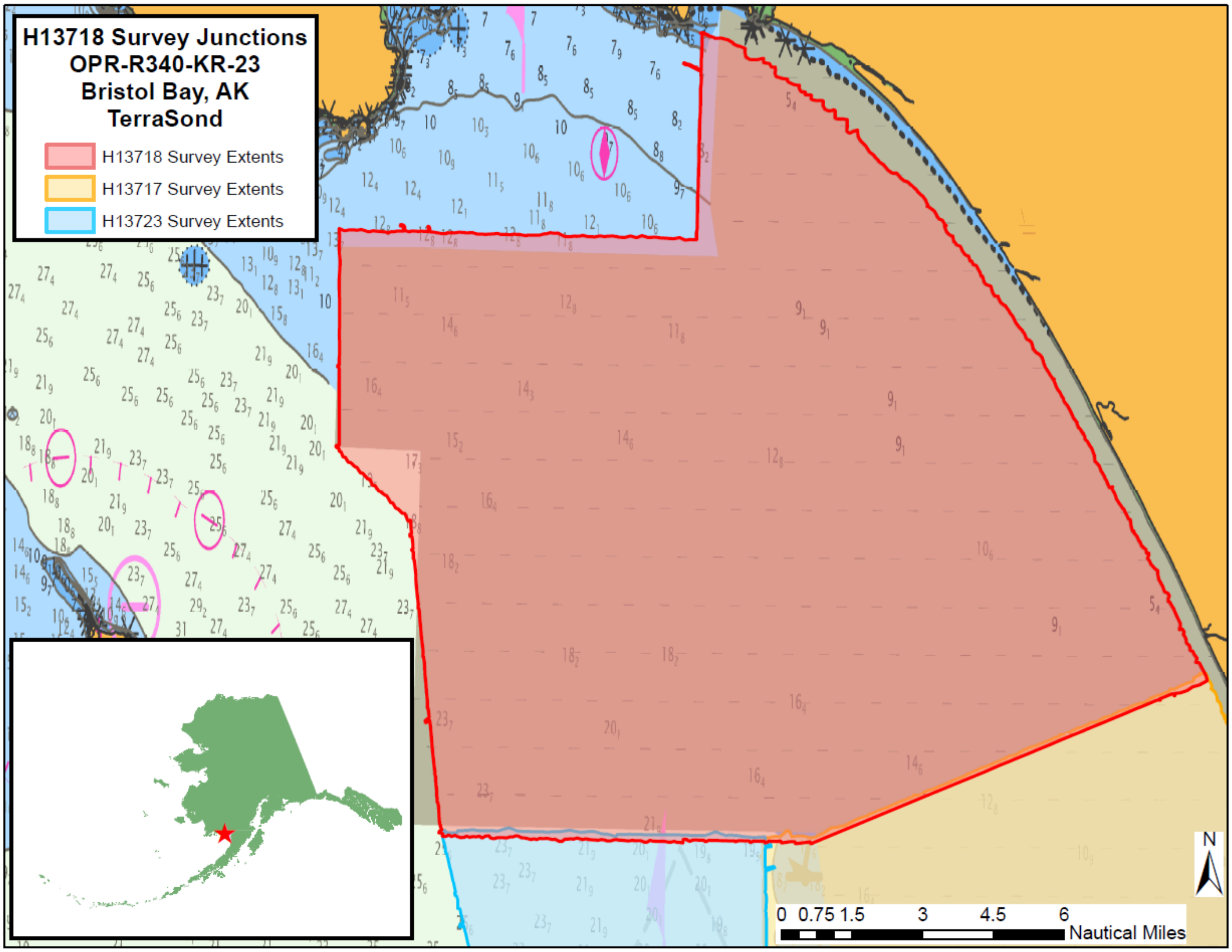


Figure 6: Overview of survey Junctions.

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13717	1:40000	2023	TerraSond	SE
H13723	1:80000	2023	TerraSond	S

Table 9: Junctioning Surveys

H13717

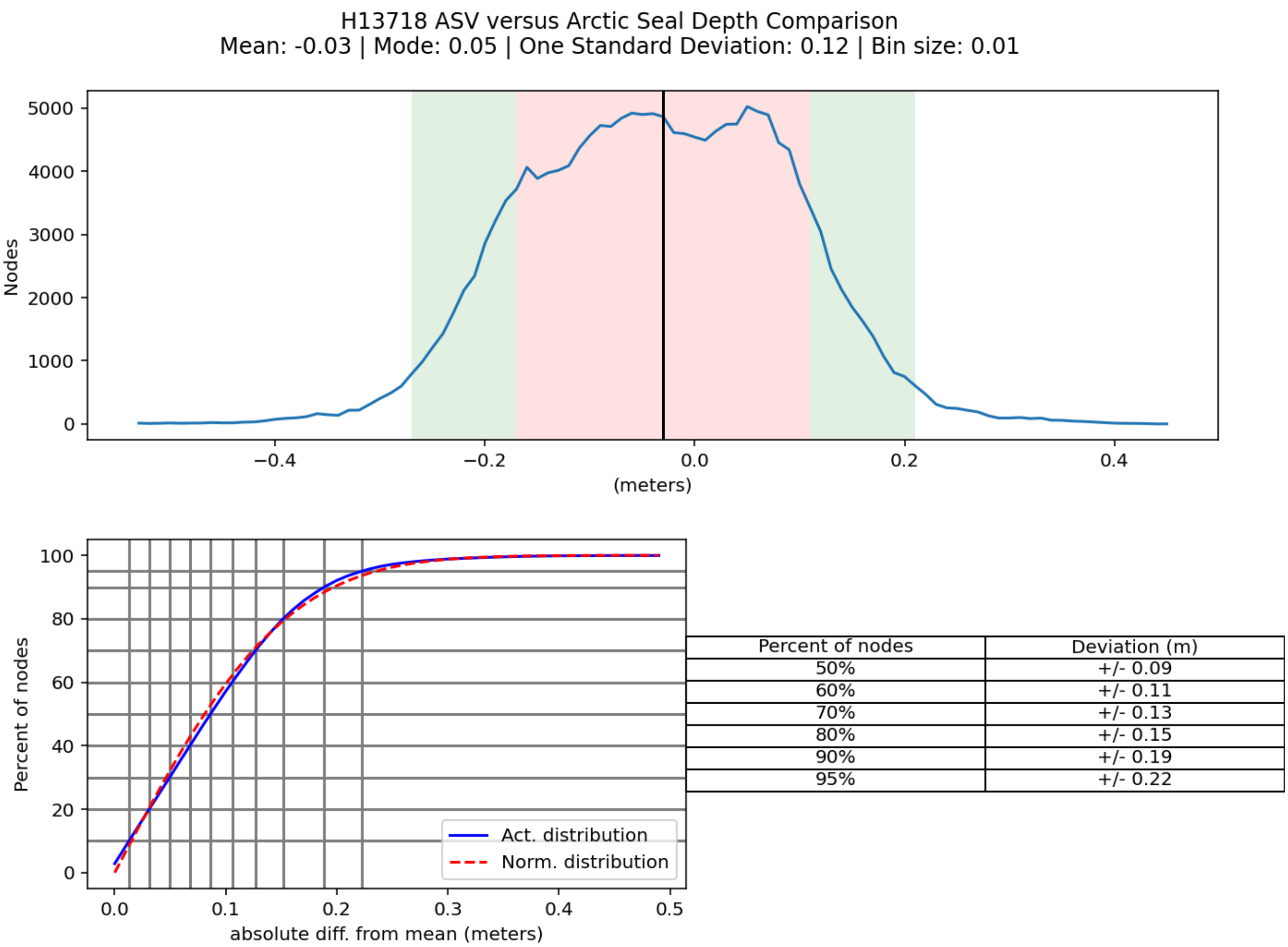
Agreement between the two surveys is excellent. The mean difference is 0.03 m with a standard deviation of 0.09 m. 100% of grid cells agree within allowable TVU by depth.

H13723

Agreement between the two surveys is excellent. The mean difference is 0.05 m with a standard deviation of 0.12 m. 100% of grid cells agree within allowable TVU by depth.

B.2.4 Sonar QC Checks

In addition to the crossline checks which included inter-vessel comparisons, as an additional area-specific QC check, the depth data acquired by each vessel was gridded separately at 4 m resolution and differenced from each other. The results are excellent, with the two vessels comparing within 0.03 m on average, with a standard deviation of 0.12 m. 100% of the grid cells agree within the allowable TVU by depth. The results are shown below.



Percent of nodes	Deviation (m)
50%	+/- 0.09
60%	+/- 0.11
70%	+/- 0.13
80%	+/- 0.15
90%	+/- 0.19
95%	+/- 0.22

Figure 7: The results of the difference between ASV and Arctic Seal depth data for this survey.

B.2.5 Equipment Effectiveness

Along Track Gaps

On both survey vessels, during rough weather conditions air bubbles would occasionally be forced under the multibeam sonar head and result in temporary loss of bottom tracking or "blowouts", sometimes resulting in along-track gaps. Note that data acquired early in the project (prior to JD168) on the Arctic Seal was most affected. On JD168 a 0.6 m extension was installed on the Arctic Seal's MBES pole to position the sonar deeper in the water column. This significantly improved data quality for the remainder of the project, though in adverse conditions air could still be forced under the sonar.

In addition, intermittent sonar issues on the Arctic Seal late in project (approximately JD192 onwards), due to a possible sonar receiver issue, occasionally resulted in dropped pings. Too many consecutive dropped pings could result in an along-track gap.

Along-track gaps, either from weather or sonar issues, were examined and normally only rerun when the along-track gap exceeded three nodes (12 m horizontal distance) for mainscheme lines in depths of 20 m or less. These were not rerun where they occurred on crosslines since there was ample crossline LNM for QC purposes. Final data is within specifications.

Arctic Seal MBES Arm Issues

The Arctic Seal's hydraulic MBES arm experienced movement that had the potential to adversely affect survey data. From approximately JD178 onwards the arm experienced intermittent hydraulic pressure drops which resulted in arm movement and therefore shifts in the sonar and IMU orientation relative to the POSMV reference frame. This was more prevalent in adverse weather when the vessel was experiencing above average roll conditions. A hinged joint in the MBES arm also experienced issues from JD178 until JD181.

Co-location of the IMU and sonar mitigated most of the effects since mount movements were captured in the motion record and largely compensated for. However, some residual error remained as a result of shifts in the reference frame, which shows up periodically as a small roll bias in Arctic Seal data, apparent at crossline intersections. To reduce the effect, small roll corrections were systematically applied in the HVF at obvious change points, and all Arctic Seal MBES data was filtered with a 55 degree nadir filter to remove outer beams most subject to the error. Following these corrections, final data is within allowable TVU.

More information on the issue and mitigation is available in the DAPR.

GNSS Vertical Busts

Although vertical agreement between overlapping lines is generally very good, normally within 0.10 m or better, vertical busts attributable to GNSS positioning error are apparent sporadically in the data set. Any that approached or exceeded allowable TVU for their depth were investigated and addressed in processing. Final data is within specifications.

B.2.6 Factors Affecting Soundings

Sound Speed Error

Sound speed error, which is characterized by a general upward or downward across-track cupping of sounding data that increases in magnitude towards the outer beams, is evident sporadically in the dataset.

Profiles were taken frequently, approximately every two hours and whenever changing areas, but some residual error remains. In processing, beam filters were applied to reject outer beams greater than 65 degrees from nadir in order to reject soundings most subject to sound speed error.

The effect on the final surfaces is relatively minor. Final data is within specifications.

Bottom Change

The seafloor in the area is dynamic due to the large amount of sediment deposition from the many rivers draining into the area. The sediment is then readily transported by the strong tidal currents that flood the area daily. Sandwaves are present in the survey area, and data acquired distant in time, for example crosslines late in the job that cross mainscheme acquired earlier in the project, frequently show evidence of bottom change. Note that in most cases of bottom change data was not edited to "choose" a bottom.

Up to 0.4 m of vertical change was observed over the course of this survey due to bottom change in some areas. An example is shown below.

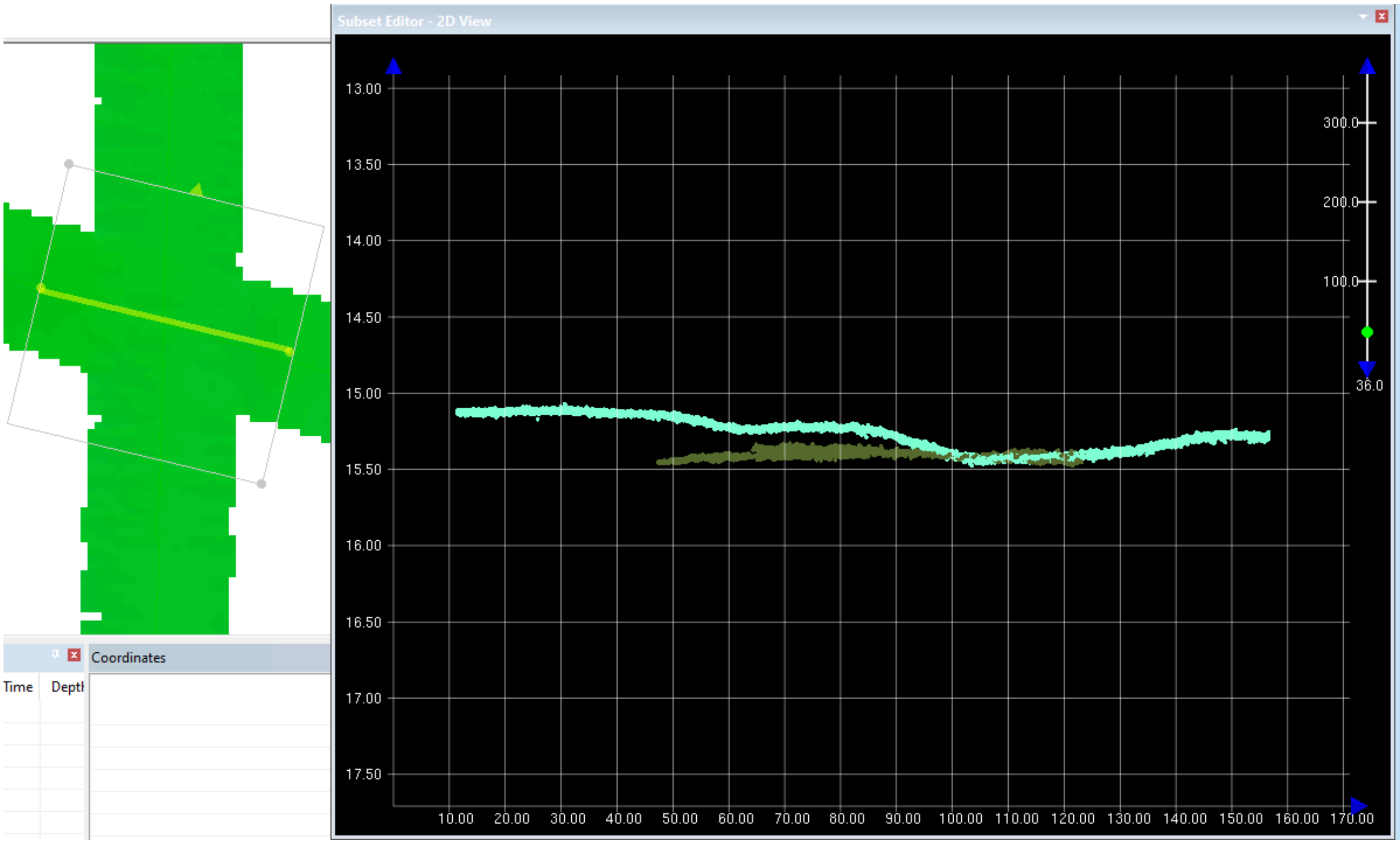


Figure 8: Example of bottom change on this survey viewed in CARIS HIPS subset. Cyan line (2767) was run on JD253, 70 days after the green line (0840) run on JD183. This results in about 0.4 m of vertical change. Both lines are from the ASV.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: 2 hours

Sound speed profiles or "casts" were normally acquired aboard the Arctic Seal while underway with a C-MAX Vigo profiling winch, which utilized a Valeport SWiFT sound speed profiler. Note that the ASV-CW5 was not equipped to collect sound speed profiles -- Arctic Seal sound speed profiles were used to correct all ASV sounding data, which was possible because the vessels always worked in close proximity to each other (usually within 2 kilometers).

Surface sound speed at the Arctic Seal sonar head was monitored continuously and a new cast was collected when the surface speed varied from the previous profile's speed at the same depth by greater than 2 m/s, leading to a cast interval of approximately 2 hours.

Casts were taken as deep as possible. On survey lines with significant differences in depth, the deeper portion of the line was normally favored to ensure that changes across the full water column were measured.

The cast data was used to correct the sounding data using the "nearest in distance within time" (set to 2 hours) within CARIS HIPS.

B.2.8 Coverage Equipment and Methods

All equipment and survey methods were used as detailed in the DAPR.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

Deviations from the Correction to Echo Soundings section of the DAPR are itemized below. Despite the deviations, final data is within specifications.

GNSS Processing Exceptions

The following lines utilized Applanix Smart Base (ASB) processing instead of PPRTX to address GNSS vertical busts:

ASV, JD184, line 0869
ASV, JD200, line 1074

The following lines had altitudes loaded using CARIS Generic Data Parser (GDP) to address GNSS vertical busts that could not be repaired with other methods. GDP altitudes were smoothed, removing heave from the altitude data, therefore these lines were subsequently georeferenced with "GPS dynamic heave" set to "NONE".

Arctic Seal, JD155, lines 0061 through 0067
Arctic Seal, JD184, lines 0600 through 0604

Delayed Heave Exceptions

These lines did not have Delayed Heave available. Realtime heave was used instead.

Arctic Seal, JD155, lines 0061 through 0067
Arctic Seal, JD184, lines 0600 through 0604
ASV, JD200, line 1072 (segment 2 only)

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

All equipment and survey methods were used as detailed in the DAPR.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following Feature Object Catalog was used: NOAA Extended Attribute Files V2023_1.

The most current version of NOAA's Extended Attribute Files available at the start of survey operations was utilized for this project.

B.5.2 Surfaces

The following surfaces and/or BAGs were submitted to the Processing Branch:

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H13718_MB_4m_MLLW_Final	CARIS Raster Surface (CUBE)	4 meters	0.431 meters - 27.264 meters	NOAA_4m	MBES Set Line Spacing
H13718_MBAB_2m_400kHz_1of1	MB Backscatter Mosaic	2 meters	0.431 meters - 27.264 meters	N/A	MBES Set Line Spacing

Table 10: Submitted Surfaces

The final depth information for this survey was submitted as a 4 m resolution CARIS BASE surface (CSAR format) which best represents the seafloor at the time of the 2023 survey. The surface was created from fully processed data with all final corrections applied.

The surface was created using NOAA CUBE parameters and resolutions in conformance with the 2022 HSSD. The surface was finalized with a 0 to 80 m depth limit, "standard deviation" selected as the final uncertainty source, and designated soundings applied (if present). Horizontal projection was selected as WGS84 / UTM zone 4N.

A non-finalized version of the CSAR surface is also included with the survey deliverables for reference. This does not have the "_Final" designation in the filename.

The Multibeam Acoustic Backscatter (MBAB) surface(s), produced with QPS Fledermaus Geocoder Toolbox (FMGT), is also provided. MBAB data for both vessels, acquired using 400 kHz, is combined in the mosaic.

C. Vertical and Horizontal Control

Additional information discussing the vertical or horizontal control for this survey can be found in the accompanying HVCR.

C.1 Vertical Control

The vertical datum for this project is Mean Lower Low Water.

ERS Datum Transformation

The following ellipsoid-to-chart vertical datum transformation was used:

Method	Ellipsoid to Chart Datum Separation File
ERS via ERTDM	OPR-R340-KR-23_AK_ERTDM_2023_WGS84(G2139)-MLLW_.csar

Table 11: ERS method and SEP file

All soundings were reduced to MLLW using the ERTDM WGS84 to MLLW separation model grid file provided by NOAA using ERS methodology. The uncertainty stated for the model in the Project Instructions is 0.18 m.

Note all altitudes are relative to the WGS84 datum, therefore the WGS84 to MLLW ERTDM model was utilized to reduce soundings to MLLW.

C.2 Horizontal Control

The horizontal datum for this project is World Geodetic System (WGS) 1984.

The projection used for this project is Universal Transverse Mercator (UTM) Zone 4.

The following PPK methods were used for horizontal control:

- Smart Base

Applanix Smart Base (ASB) was used when necessary to address GNSS vertical busts. Any lines that used ASB were itemized earlier in this report.

PPP

Post-processing of all navigation data for final positions was done in Applanix POSPac MMS (v8.9) software. Trimble PP-RTX was used as the primary processing methodology within POSPac, with any exceptions noted previously.

RTK

Real-time positions were primarily RTK. Hemisphere SmartLink antennas on each vessel were set to receive the subscription-based Atlas H-10 service, which output RTCM corrections to each vessel's POSMV, allowing them to operate in RTK mode. This assisted with real-time positioning. However, all real-time positions were replaced in post-processing with PPK corrections, as described previously.

WAAS

The Wide Area Augmentation System (WAAS) was used incidentally for real-time positions as a backup when there were issues receiving RTK corrections. However, all real-time positions were replaced in postprocessing with PPK corrections, as described previously.

C.3 Additional Horizontal or Vertical Control Issues

C.3.1 HSSD Section 2.2 (NAD83)

A waiver to HSSD Section 2.2 was was granted for this project. All products are submitted with horizontal positions as WGS84 instead of NAD83(2011). This was done to provide a consistent dataset from raw data, which was acquired in WGS84, through final processed data. See project correspondence for the waiver and additional discussion.

D. Results and Recommendations

D.1 Chart Comparison

An overview of this survey overlaid on affected charts is shown below. Most of the area was uncharted at the time of this survey.

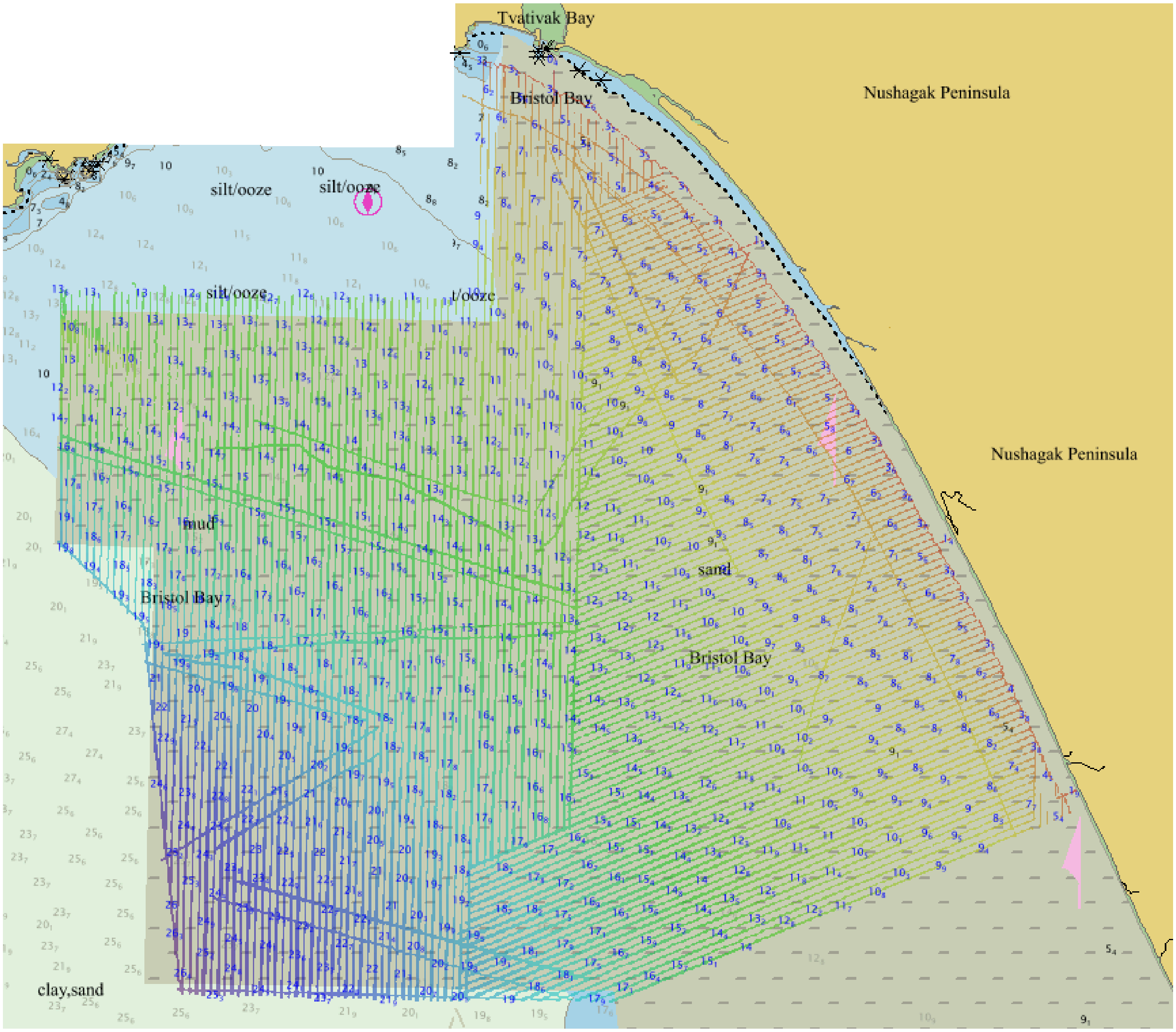


Figure 9: This survey overlaid on affected ENCs. Soundings from this survey are blue. All soundings in meters.

D.1.1 Electronic Navigational Charts

The following are the largest scale ENCs, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date
US4AK3XU	1:90000	1	12/12/2023	12/12/2023
US4AK3XT	1:90000	1	12/12/2023	12/12/2023
US4AK3YU	1:90000	1	12/12/2023	12/12/2023

Table 12: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey. No Danger to Navigation Reports were submitted for this survey.

D.1.3 Charted Features

No charted features exist for this survey.

D.1.4 Uncharted Features

No uncharted features exist for this survey.

D.1.5 Channels

No channels exist within the survey limits.

D.2 Additional Results

D.2.1 Aids to Navigation

No Aids to navigation (ATONs) exist for this survey.

D.2.2 Maritime Boundary Points

Three MBPs were assigned for this survey.

The MBPs were investigated with a skiff on July 18th, 2023 (UTC) when the tide was at or near 0 m MLLW. The assigned locations were investigated by approaching as close as safely possible. The western two MBPs were observed to be exposed at MLLW and were confirmed to be at their assigned location by range and bearing. Photographs were taken. They could not be approached closer due to insufficient tide.

The eastern MBP was similarly investigated during the same skiff deployment, but could not be found. The site could not be visited again for additional investigation due to safety issues as the area was usually awash with swells when in the area.

Refer to the FFF for results.

Figure 10: The western-most MBP.

D.2.3 Bottom Samples

The Project Instructions required one bottom sample per 20 SNM of surveyed area. 11 were therefore acquired in this area. Bottom sample locations were chosen in regards to the acquired survey data backscatter. Samples were examined, photographed, and then discarded overboard.

All samples returned sand as their primary constituent. The image below shows their relative location within the survey area. Refer to the FFF for results.

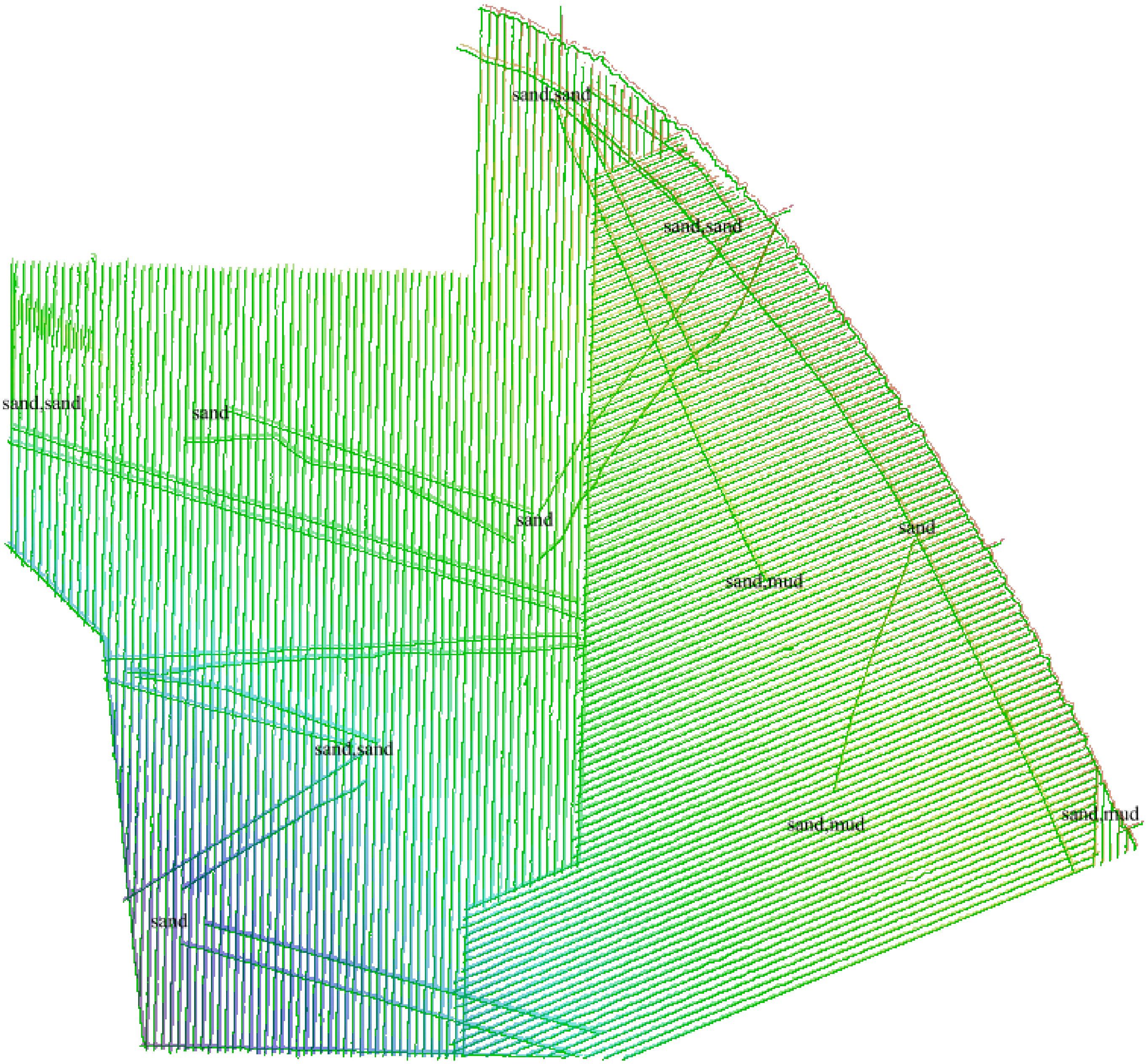


Figure 11: An overview of bottom sample results.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

No submarine features exist for this survey.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.8 Abnormal Seafloor or Environmental Conditions

Any abnormal seafloor or environmental conditions were discussed previously in this report.

D.2.9 Construction and Dredging

No present or planned construction or dredging exist within the survey limits.

D.2.10 New Survey Recommendations

No new surveys or further investigations are recommended for this area.

D.2.11 ENC Scale Recommendations

No new ENC scales are recommended for this area.

E. Approval Sheet

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

All field sheets, this Descriptive Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch.

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys Specifications and Deliverables, Hydrographic Survey Project Instructions, and Statement of Work. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies, if any, noted in the Descriptive Report.

Report Name	Report Date Sent
Final Progress Report	2023-10-23
Survey Outline Submittal	2023-10-23
MMO Logsheets and Training Observer Logs	2023-10-23
NCEI Sound Speed Data Submittal	2023-12-01
Coast Pilot Review Report	2024-01-08

Approver Name	Approver Title	Approval Date	Signature
Andrew Orthmann	Charting Program Manager	01/17/2024	Andrew Orthmann Digitally signed by Andrew Orthmann Date: 2024.01.17 18:17:35 -09'00'

F. Table of Acronyms

Acronym	Definition
AHB	Atlantic Hydrographic Branch
AST	Assistant Survey Technician
ATON	Aid to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BAG	Bathymetric Attributed Grid
BASE	Bathymetry Associated with Statistical Error
CO	Commanding Officer
CO-OPS	Center for Operational Products and Services
CORS	Continuously Operating Reference Station
CTD	Conductivity Temperature Depth
CEF	Chart Evaluation File
CSF	Composite Source File
CST	Chief Survey Technician
CUBE	Combined Uncertainty and Bathymetry Estimator
DAPR	Data Acquisition and Processing Report
DGPS	Differential Global Positioning System
DP	Detached Position
DR	Descriptive Report
DTON	Danger to Navigation
ENC	Electronic Navigational Chart
ERS	Ellipsoidal Referenced Survey
ERTDM	Ellipsoidally Referenced Tidal Datum Model
ERZT	Ellipsoidally Referenced Zoned Tides
FFF	Final Feature File
FOO	Field Operations Officer
FPM	Field Procedures Manual
GAMS	GPS Azimuth Measurement Subsystem
GC	Geographic Cell
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSD	Hydrographic Surveys Division

Acronym	Definition
HSSD	Hydrographic Survey Specifications and Deliverables
HSTB	Hydrographic Systems Technology Branch
HSX	Hypack Hysweep File Format
HTD	Hydrographic Surveys Technical Directive
HVCR	Horizontal and Vertical Control Report
HVF	HIPS Vessel File
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
ITRF	International Terrestrial Reference Frame
LNM	Linear Nautical Miles
MBAB	Multibeam Echosounder Acoustic Backscatter
MCD	Marine Chart Division
MHW	Mean High Water
MLLW	Mean Lower Low Water
NAD 83	North American Datum of 1983
NALL	Navigable Area Limit Line
NTM	Notice to Mariners
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRT	Navigation Response Team
NSD	Navigation Services Division
OCS	Office of Coast Survey
OMAO	Office of Marine and Aviation Operations (NOAA)
OPS	Operations Branch
MBES	Multibeam Echosounder
NWLON	National Water Level Observation Network
PDBS	Phase Differencing Bathymetric Sonar
PHB	Pacific Hydrographic Branch
POS/MV	Position and Orientation System for Marine Vessels
PPK	Post Processed Kinematic
PPP	Precise Point Positioning
PPS	Pulse per second

Acronym	Definition
PRF	Project Reference File
PS	Physical Scientist
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
RTX	Real Time Extended
SBES	Singlebeam Echosounder
SBET	Smooth Best Estimate and Trajectory
SNM	Square Nautical Miles
SSS	Side Scan Sonar
SSSAB	Side Scan Sonar Acoustic Backscatter
ST	Survey Technician
SVP	Sound Velocity Profiler
TCARI	Tidal Constituent And Residual Interpolation
TPU	Total Propagated Uncertainty
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDF	Zone Definition File