H13372

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13372

LOCALITY

State(s):	Alaska
General Locality:	Norton Sound
Sub-locality:	Stuart Island

2020

CHIEF OF PARTY
Thomas Morino

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13372**

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:	**Norton Sound**
Sub-Locality:	**Stuart Island**
Scale:	**40000**
Dates of Survey:	**08/01/2020 to 09/16/2020**
Instructions Dated:	**04/14/2020**
Project Number:	**OPR-R385-KR-20**
Field Unit:	**Terrasond**
Chief of Party:	**Thomas Morino**
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 NAD83 UTM 3N, 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 H13372

Project: OPR-R385-KR-20

Locality: Norton Sound

Sublocality: Stuart Island

Scale: 1:40000

August 2020 - September 2020

Terrasond

Chief of Party: Thomas Morino

A. Area Surveyed

The survey area is located in Norton Sound, Alaska, approximately 100 nautical miles southeast of Nome. The area is off the road system and relatively remote. The small communities of the region are accessible only by air or sea.

Navigation through the area is limited to the summer and fall seasons due to the presence of sea ice for the majority of the year. The reliable ice free season is normally June through October, with ice likely to be encountered in May and November. Navigation is normally not possible for most vessels from December through April.

The closest communities to the survey area are Stebbins (pop. 571 in 2018), St. Michael (pop. 415 in 2018), and Unalkaleet (pop. 697 in 2018). Nome (pop. 3,866 in 2018) is the hub community for the region, with daily flights to Anchorage (weather permitting).

Transient traffic consists mostly of barges that bring supplies to the nearby communities. Local vessel traffic is mostly skiffs engaged in subsistence activities or travel between communities.

The area is relatively shallow (17.7 m to the inshore limit) and has a gradual slope towards shore. The seafloor of the area is largely featureless but has occasional linear ice scours. The nearby shoreline is rocky in nature, and rocks become more common on the seafloor as the coast is approached.

Bathymetric data collection was carried out from August through September of 2020 under project OPR-R385-KR-20, with final processing and reporting carried out from October 2020 through January 2021. Work was completed concurrently with five other sheets in SE Norton Sound, and done in accordance with the Hydrographic Survey Project Instructions (April 2020) and the NOS Hydrographic Surveys Specifications and Deliverables (HSSD), March 2019 edition.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
63° 47' 11.99" N 163° 6' 0.4" W	63° 28' 37.52" N 162° 13' 35.74" W

Table 1: Survey Limits

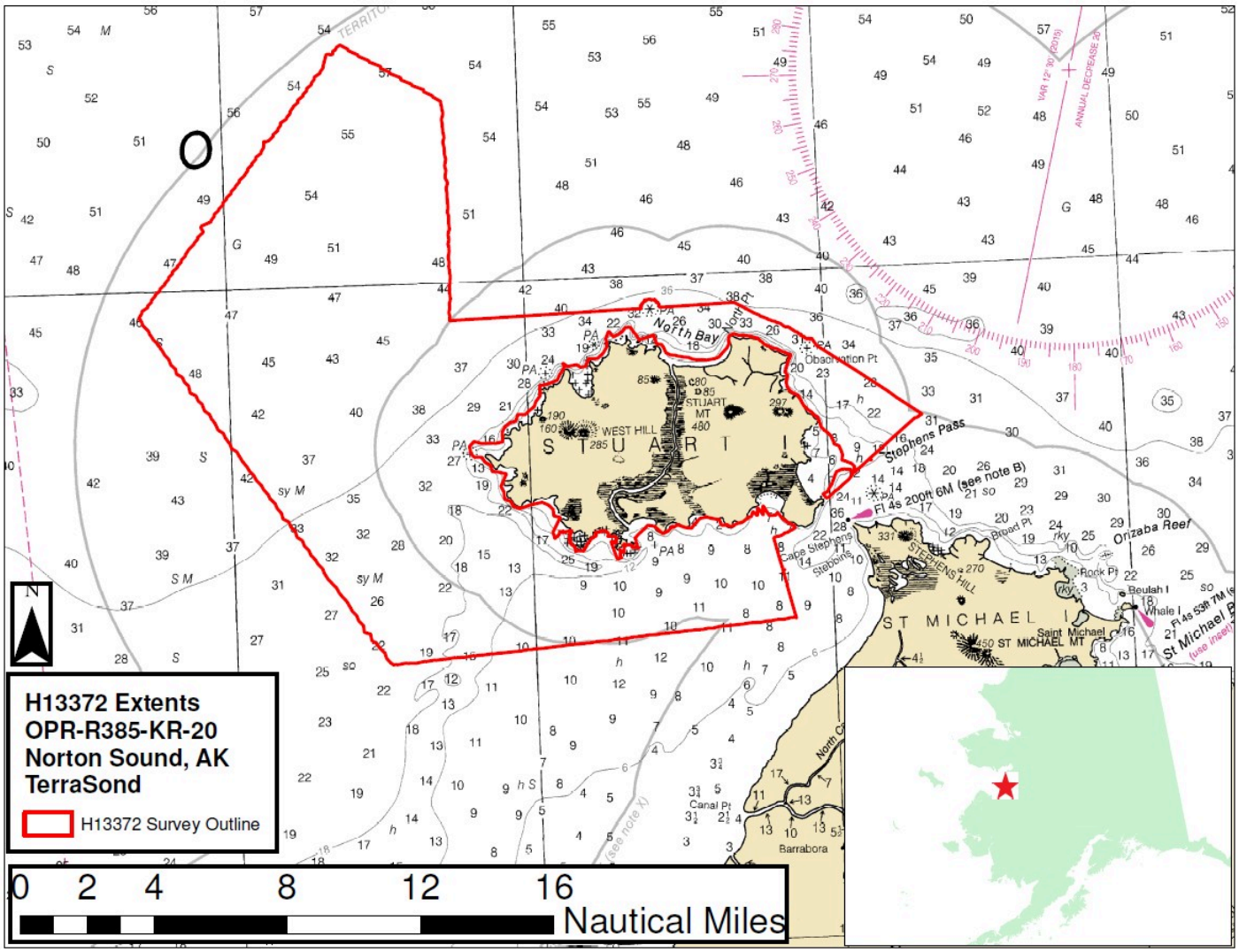

Figure 1: Image showing overview of survey extents.

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 document:

This project will provide contemporary data to update National Ocean Service (NOS) nautical charting products and services and increase maritime safety and commerce in the region. The Hydrographic Health Model and Automatic Identification Systems (AIS) traffic patterns identify this area as a hotspot where vessels are transiting in close proximity to the seafloor. This area was also identified as a high priority survey area by external stakeholders who identified the area extending from east of St. Michael Island to southwest of Egg Island as an area of refuge used by vessels transiting the Bering Sea. In addition, Stephens Pass between St. Michael and Stuart Islands was also identified as a travel lane for local shallow draft fishing traffic.

The survey area includes the remote coastal communities of Stebbins (Yup'ik name: Tapraq) and St. Michael, both located on Saint Michael Island. These villages rely on coastal shipping as a primary source of income, supplies, and fuel. This survey will improve the safety of the maritime traffic and services available to these communities by improving the quality of existing bathymetric data in the area, which currently predates the 1890s. Tide gauges will also be installed to provide tide data in an area currently underserved with tide observations. This will help improve tide predictions and fulfill further objectives of the Alaska Water Level Watch program. Survey data from this project is intended to supersede all prior survey data in the common area.

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	Complete 8840 LNM. 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.
All waters in Sheets 2 and 3	240 m Set Line Spacing (Reference HSSD Section 5.2.2.4 Option A). Note: All significant shoals or features found in waters less than 20m deep shall be developed to complete coverage standards. Note: The requirement to verify or disprove all charted depths falling between sounding lines and shallower than adjacent surveyed soundings is waived.

Table 2: Survey Coverage

Coverage requirements were met. The following notes are provided for additional clarification.

Project-Wide LNM:

9,242 LNM were acquired project-wide, exceeding the requirement by 402 LNM. The excess of approximately 4% was collected to compensate for inefficiencies incidental to the execution of data collection such as crossline mileage that exceeded requirements, data acquired on run-ins or run-outs, and excess overlap, if any. LNM quantities do not include transit or calibration data, or mileage that does not meet HSSD specifications.

Inshore Limit / NALL:

The inshore limit for this survey was the NALL. The NALL was generally the safe limit of navigation or the 3.5 m depth limit, whichever was reached first. In addition, a shoaler inshore depth limit of 2 m was assigned along the south side of Stuart Island. The survey vessels were successful in achieving 3.5 m along most of the coast, as well as 2 m on most of the south side of Stuart Island. In areas where the depth limit was not achieved, the limit of safe navigation served as the NALL.

Complete Coverage:

A small amount of the survey area received Complete MBES coverage during search for assigned features. Some assigned features off both the north and south sides of Stuart Island were not initially found during limited shoreline verification and a search was therefore commenced with Complete MBES within the PRF-

assigned search radius (normally 500 m) associated with each feature. These survey areas of Complete MBES extended from the search radius boundary in to the NALL.

In addition, shoals observed while completing Set Spaced lines were developed further to Complete MBES standards. These developments occurred off the north and northwest parts of Stuart Island. These are indicated in the MBES data set as Complete Coverage areas that are not associated with assigned features.

Set Line Spacing Requirements:

240 m Set Line spacing was initially required under the Work Instructions. However, after approximately 1 week of survey in the sheet and completing most of the area, it became apparent that an incorrect line plan based on 320 m spacing had been executed. The NOAA COR was contacted immediately and informed. Given the gentle slopes of the survey area it was decided that, in conjunction with additional crossline LNM, 320 m line spacing would suffice for much of the area. NOAA issued new coverage and line spacing requirements on 8/18/20 (JD231) which were as follows (refer to included figure for areas):

1. For the Lightering area marked 1 on the map and shapefile, acquire 320 m set line spacing and 15% crosslines.

2. For the area to the SW of Stuart Island marked 2 on the map and shapefile, acquire 320m SLS with 15% crosslines

3. For the area to the E of Stuart Island marked 3 on the map and shapefile, acquire 240m SLS with 15% crosslines

4. For Areas in H13372 that have not yet been surveyed, and are not specified above, the 240m SLS requirement as specified in the Project Instructions remains unchanged

5. For areas not addressed in items 1-4 in H13372, 320m SLS is sufficient

These modified requirements were met for all areas: Areas 1-2 received the required coverage. Area 3 also received required coverage but was too shallow to receive significant survey. Areas outside of 1-3 received as mix of spacing -- 320 m spacing if surveyed prior to discovery of the issue, and 240 m if completed after.

Refer to the included project correspondence for additional detail.

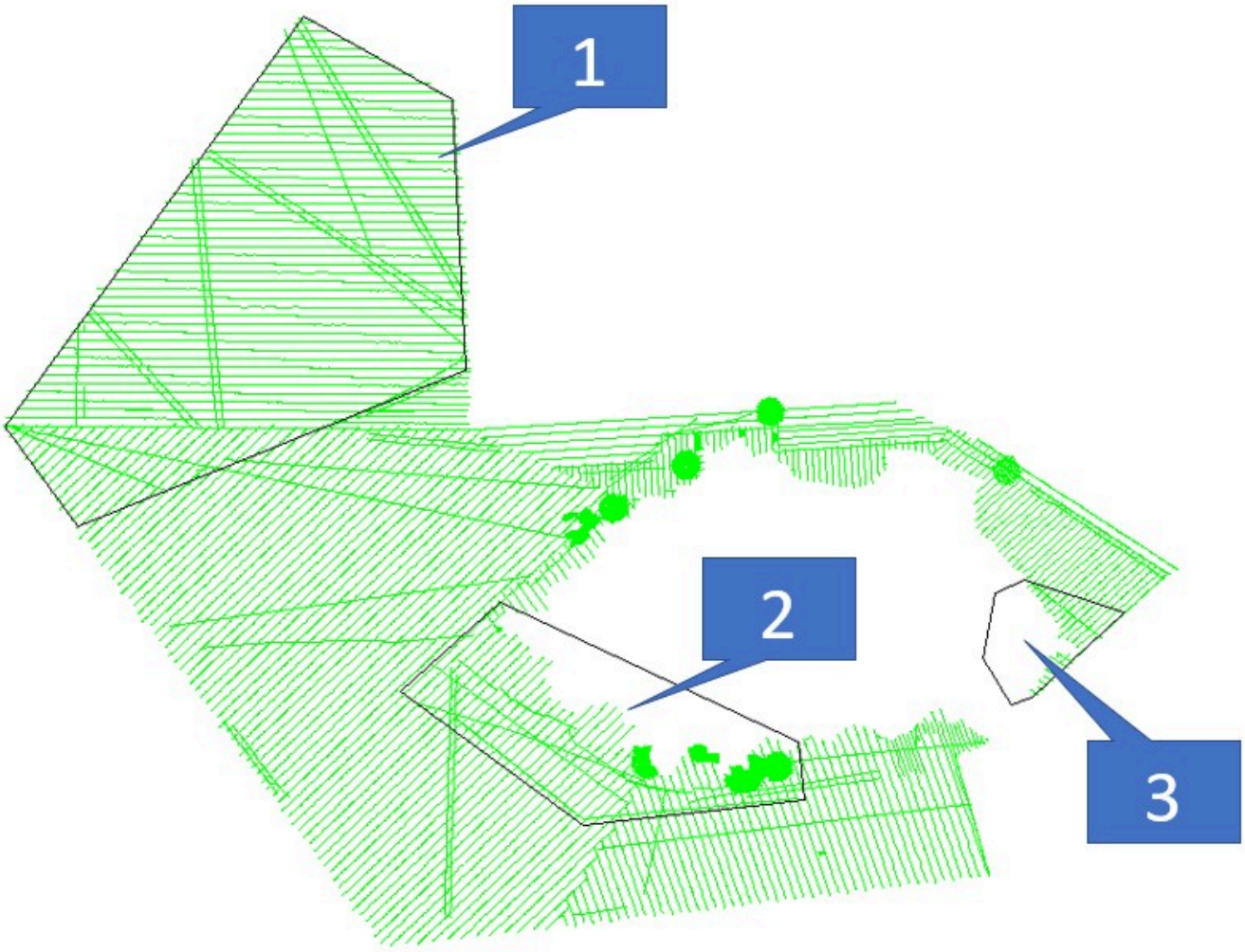

Figure 2: Figure showing areas itemized above for changes to line spacing and crossline requirements.

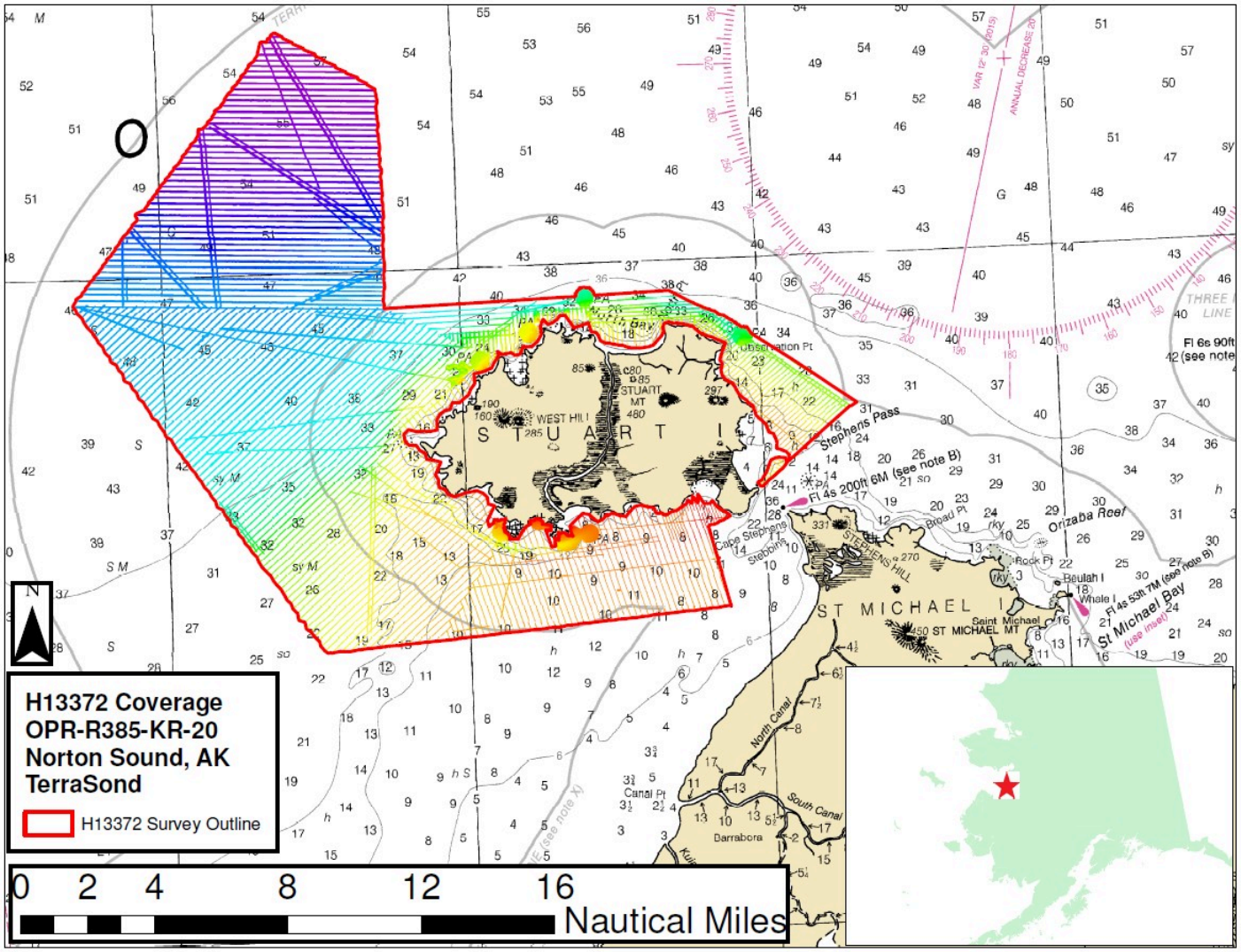

Figure 3: Image showing overview of survey coverage.

A.6 Survey Statistics

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

	HULL ID	*ASV-CW5*	*Qualifier 105*	*Total*
LNM	**SBES Mainscheme**	0	0	0
	MBES Mainscheme	960.9	341.3	1302.2
	Lidar Mainscheme	0	0	0
	SSS Mainscheme	0	0	0
	SBES/SSS Mainscheme	0	0	0
	MBES/SSS Mainscheme	0	0	0
	SBES/MBES Crosslines	123.3	63.5	186.8
	Lidar Crosslines	0	0	0
Number of Bottom Samples				8
Number Maritime Boundary Points Investigated				0
Number of DPs				195
Number of Items Investigated by Dive Ops				0
Total SNM				170.6

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
08/01/2020	214

Survey Dates	Day of the Year
08/02/2020	215
08/03/2020	216
08/04/2020	217
08/05/2020	218
08/06/2020	219
08/07/2020	220
08/15/2020	228
08/23/2020	236
08/24/2020	237
08/25/2020	238
08/26/2020	239
08/27/2020	240
09/03/2020	247
09/04/2020	248
09/05/2020	249
09/06/2020	250
09/07/2020	251
09/14/2020	258
09/15/2020	259
09/16/2020	260

Table 4: Dates of Hydrography

This survey was one of six completed under project OPR-R385-KR-20, with project-wide on-site hydrographic operations running from July 5 through September 17, 2020. Dates listed are for this survey only. Note: Bathymetry was not collected on 9/6 but it is listed here due to bottom samples obtained that day.

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	*Qualifier 105*	*ASV-CW5*
LOA	32 meters	5.5 meters
Draft	1.8 meters	0.5 meters

Table 5: Vessels Used

Figure 4: ASV-CW5 (foreground), and Qualifier 105 (background).

The Qualifier 105 (Q105) is a 32 m aluminum-hull vessel owned and operated by Support Vessels of Alaska. The Q105 acquired multibeam data and provided housing and facilities for on-site data processing. The vessel was also used to collect bottom samples, deploy/recover tide buoys, conduct sound speed casts, conduct feature investigations via skiff/UAS, and deploy/recover the ASV-CW5 vessel.

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 unmanned but monitored mode, collecting multibeam data in close proximity to the Q105.

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
Teledyne Oceanscience	rapidCAST	Sound Speed System
Valeport	SWiFT SVP	Sound Speed System

Table 6: Major Systems Used

The survey vessels were outfit for MBES data collection with similar survey equipment. Both vessels utilized Reson Seabat T-50 MBES systems, except the Q105 was configured with a dual-head setup while the ASV-CW5 used a single-head system. Both vessels used Applanix POSMVs for attitude and position measurements (Oceanmaster on the Q105, Wavemaster II on the ASV). Sound speed profiles were collected using Valeport rapidProSV and SWIFT sensors (deployed using a Teledyne Oceanscience RapidCast system) from the Q105 only.

B.2 Quality Control

B.2.1 Crosslines

Crossline LNM totaled 14.3% of mainscheme. Note: Crossline LNM quantity was higher than the standard HSSD requirement of 8% largely due to the request from HSD to acquire 15% crosslines in some areas, as discussed earlier.

Effort was made to ensure crosslines 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 both vessels (where depth permitted) to ensure there was ample overlap for inter-vessel comparisons, with each vessel crossing the other's mainscheme lines. Since the two 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.

1640-ASV-CW5-217-C4-XL -- 100.0% pass
1677-ASV-CW5-217-C4NS08320_-_0001 -- 100.0% pass
3736-ASV-CW5-248-C1_X09 -- 100.0% pass
3998-ASV-CW5-258-C4XL22_-_0001 -- 100.0% pass
4001-ASV-CW5-258-C4XL14_-_0001 -- 100.0% pass
4004-ASV-CW5-258-C4XL19_-_0001 -- 100.0% pass
4005-ASV-CW5-258-C4XL10 -- 100.0% pass
4104-ASV-CW5-258-C1579701711_00101_0_1579701711_00101S_-_0001 -- 100.0% pass
4006-ASV-CW5-258-C4XL11 -- 100.0% pass
4002-ASV-CW5-258-C4XL13_-_0001 -- 100.0% pass
3997-ASV-CW5-258-C4XL23_-_0001 -- 100.0% pass
3415-ASV-CW5-240-C4_XL_01_-_0001 -- 100.0% pass
3999-ASV-CW5-258-C4XL20_-_0001 -- 100.0% pass
1617-ASV-CW5-217-C4-XL_-_0001 -- 100.0% pass
4000-ASV-CW5-258-C4XL16_-_0001 -- 100.0% pass
1638-ASV-CW5-217-C4-XL -- 100.0% pass
0433-Q105-218-C2_Q105_218_XL -- 100.0% pass
4105-ASV-CW5-258-C1579701711_00101_0_1579701711_00101S_-_0001 -- 100.0% pass
3993-ASV-CW5-258-C4XL28_-_0001 -- 100.0% pass
4106-ASV-CW5-258-C1579701711_00101_0_1579701711_00101S_-_0001 -- 100.0% pass
2899-ASV-CW5-236-C6XL01 -- 100.0% pass
4003-ASV-CW5-258-C4XL17_-_0001 -- 100.0% pass
3996-ASV-CW5-258-C4XL25_-_0001 -- 100.0% pass
4007-ASV-CW5-258-C4XL44 -- 100.0% pass
3733-ASV-CW5-248-C1_X04 -- 100.0% pass
4107-ASV-CW5-259-C4XL45 -- 100.0% pass
1618-ASV-CW5-217-C4-XL_-_0001 -- 100.0% pass
0464-Q105-219-C2XL02 -- 100.0% pass

3759-ASV-CW5-249-C6NESW00000_-_0001 -- 100.0% pass
1639-ASV-CW5-217-C4-XL -- 100.0% pass
1513-ASV-CW5-215-C3_XL_ASV_-_0001 -- 100.0% pass
3995-ASV-CW5-258-C4XL29_-_0001 -- 100.0% pass
3737-ASV-CW5-248-C1_X09_-_0001 -- 100.0% pass
0778-Q105-248-C1_XL10 -- 99.9% pass
1711-ASV-CW5-219-C2XL_ASV_219 -- 99.9% pass
3734-ASV-CW5-248-C1_X05 -- 99.9% pass
0466-Q105-219-C2XL03 -- 99.9% pass
0775-Q105-248-C1_XL03 -- 99.9% pass
3992-ASV-CW5-258-C4XL29_-_0001 -- 99.9% pass
4113-ASV-CW5-259-C_North_Inv_XL_3_-_0001 -- 99.9% pass
3735-ASV-CW5-248-C1_XL08 -- 99.9% pass
3988-ASV-CW5-258-C4XL100_-_0001 -- 99.9% pass
3732-ASV-CW5-248-C1_XL01 -- 99.9% pass
0818-Q105-251-C1XL101 -- 99.9% pass
2991-ASV-CW5-237-C5_XL_-_0001 -- 99.8% pass
1570-ASV-CW5-216-Southwest_Stuart_Island_Channel_-_0001 -- 99.8% pass
0819-Q105-251-C1XL102 -- 99.8% pass
0776-Q105-248-C1_XL06 -- 99.7% pass
0777-Q105-248-C1_X07 -- 99.7% pass
0754-Q105-247-C1_XL -- 99.7% pass
1697-ASV-CW5-218-C2-XL_-_0001 -- 99.6% pass
3710-ASV-CW5-247-XL -- 99.6% pass
1704-ASV-CW5-219-C2-XL -- 99.6% pass
0441-Q105-219-C2XL_01 -- 99.5% pass
1684-ASV-CW5-218-C3-XL -- 99.4% pass
4114-ASV-CW5-259-C_North_Inv_XL_1_-_0001 -- 99.4% pass
0444-Q105-219-C2XL_Q105_219 -- 99.3% pass
3417-ASV-CW5-240-C4_XL_02 -- 99.3% pass
3987-ASV-CW5-258-C4XL46 -- 99.2% pass
1707-ASV-CW5-219-C5-XL_-_0001 -- 99.2% pass
3039-ASV-CW5-237-C5_XL -- 99.1% pass
4026-ASV-CW5-258-C4_Investigations_-_0001 -- 99.0% pass
0774-Q105-248-C1_XL02 -- 98.9% pass
0467-Q105-220-C5XL_01 -- 98.9% pass
3994-ASV-CW5-258-C4XL27_-_0001 -- 98.6% pass
4115-ASV-CW5-259-C_North_Inv_XL_1_-_0001 -- 98.5% pass
1512-ASV-CW5-215-C3_XL_ASV -- 98.2% pass
1728-ASV-CW5-219-C2-XL -- 98.2% pass
4172-ASV-CW5-259-C6_XL_1_-_0001 -- 97.8% pass
1538-ASV-CW5-215-C3_XL_ASV -- 97.7% pass
2899-ASV-CW5-236-C6XL02 -- 97.6% pass
0417-Q105-215-C3_XL_Q105 -- 97.5% pass
3991-ASV-CW5-258-C4XL30_-_0001 -- 95.3% pass
4260-ASV-CW5-260-C_XL_-_0001 -- 84.6% pass

4259-ASV-CW5-260-C_XL_-_0001 -- 82.8% pass
4242-ASV-CW5-260-C_XL_-_0001 -- 81.6% pass
4258-ASV-CW5-260-C_XL_-_0001 -- 72.3% pass

Results: Agreement between them mainscheme surface and crossline soundings is excellent.

Of 77 crosslines, 73 passed with at least 95% of crossline soundings comparing to the mainscheme surface within IHO Order 1a.

Four (4) of 77 initially failed at 72.3% to 84.6%. These were investigated and no error exceeding IHO Order 1a was observed. Instead, the cause was determined to be due to crossline soundings on rocks and fine bottom features not captured adequately in the relatively course 4 m resolution mainscheme surface, and therefore being counted as a failure. These four crosslines were then compared instead to a finer resolution (1 m) surface made from the mainscheme data and found to pass at 99.9%. These are therefore considered to also pass QC.

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	0.135 meters	0 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Surface
Qualifier 105	N/A	1.275 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, as well as analyzed in Pydro QC Tools V3.2.13 Grid QA v6.

Uncertainty of the final grid cells range from 0.288 to 0.698 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 and rocky seafloor where many soundings of different depths contribute to the value of the relatively large (4 m) grid cell, resulting in a higher standard deviation for the grid cell. All final grid cells are within specifications.

B.2.3 Junctions

During field operations, effort was made to ensure sufficient overlap was achieved between lines run in adjacent survey sheets in order to complete junction analysis.

The "Gridded Surface Comparison V19.4" 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.

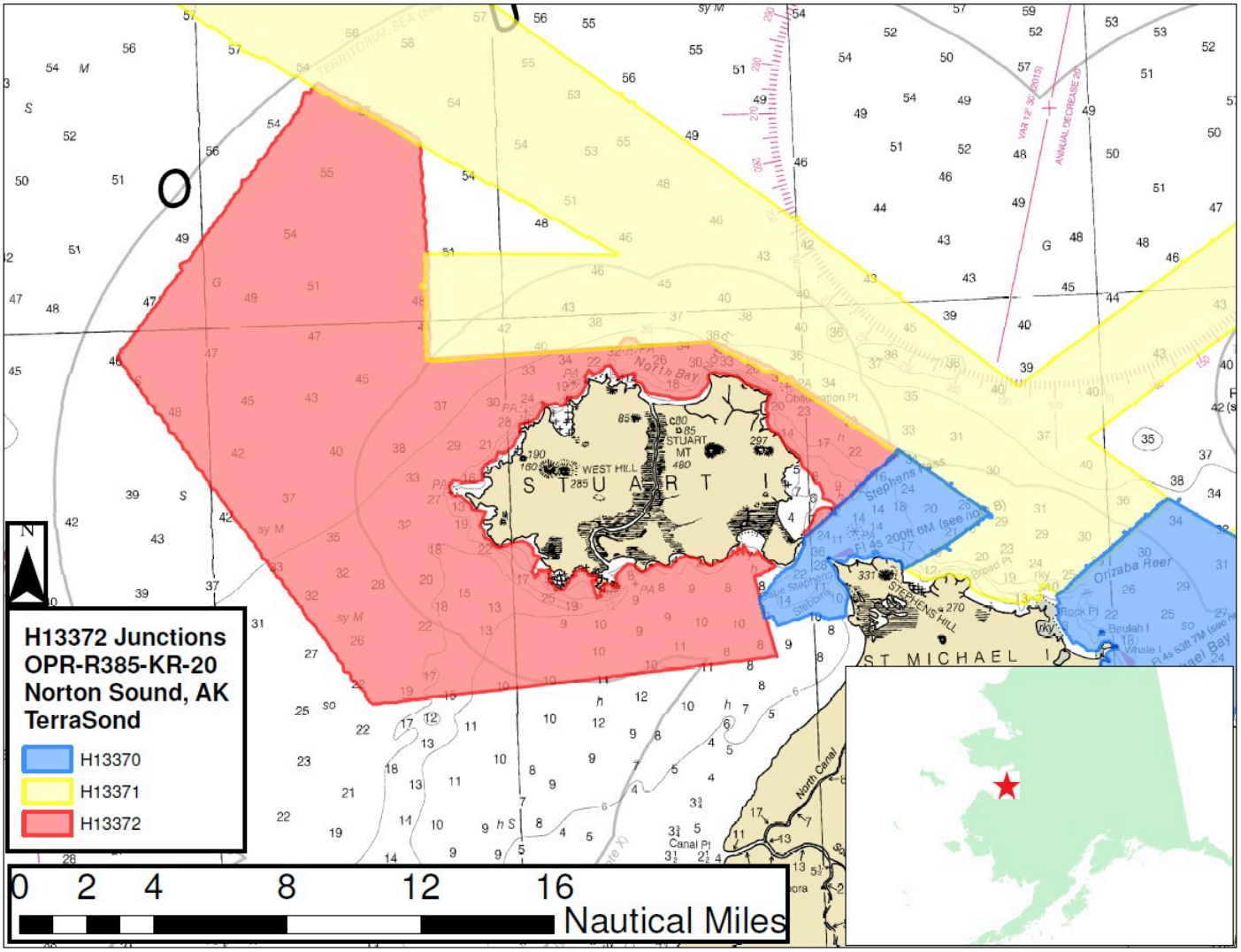

Figure 5: Graphic showing survey Junctions.

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13371	1:40000	2020	TerraSond	NE
H13370	1:20000	2020	TerraSond	SE

Table 9: Junctioning Surveys

H13371

Final 4 m resolution surfaces from the two surveys were used for the comparison.

Agreement between the two surveys is excellent. The mean difference is 0.01 m with a standard deviation of 0.07 m. Greater than 99.5% of grid cells agree within the allowable TVU for the depth. The few differences exceeding allowable TVU were investigated and found to be due to slightly differing gridded results over the same seafloor in areas showing variable bottom from the relatively large (4 m) grid size. Data is within specifications.

H13370

H13370 is a Complete MBES survey. The final 4 m resolution surface from this survey was compared to the final 1 m resolution surface from H13370.

Agreement between the two surveys is excellent. The mean difference is 0.01 m with a standard deviation of 0.07 m. Greater than 99.5% of grid cells agree within the allowable TVU for the depth. The few differences exceeding allowable TVU were investigated and found to be due to slightly differing gridded results over the same seafloor in areas showing variable bottom, where the 1 m surface from H13370 was better capturing finer features such as rocks than the courser 4 m H13372 surface. Data is within specifications.

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the quality control section of the DAPR.

B.2.5 Equipment Effectiveness

There were no conditions or deficiencies that affected equipment operational effectiveness.

B.2.6 Factors Affecting Soundings

There were no other factors that affected corrections to soundings.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: 2 hours

Sound speed profiles or "casts" were acquired aboard the Q105 while underway with a Teledyne Oceanscience RapidCAST system, which utilized a Valeport SWIFT sound speed profiler. The ASV was not equipped with a sound speed profiler.

Surface sound speed at the 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 favored to ensure that changes across the full water column were measured. The cast data was used to correct the sounding data for both vessels, 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.2.9 GPS Vertical Busts

Although vertical agreement is very good in general, vertical busts attributable to GPS positioning error between crosslines or overlapping mainscheme are apparent sporadically in the data set. These normally result in less than 0.20 m of vertical separation. Any that approached or exceeded IHO Order 1a were investigated and addressed in processing, either through interpolation of GPS Height data or application of alternate PPK SBETs. All crosslines pass within IHO Order 1a, and final surfaces are within allowable TVU for the depth.

B.2.10 Sound Speed Error

Overall error due to sound speed is relatively minimal. However, a general downward or upward cupping of the bathymetric profiles in an across-track direction indicative of sound speed error, resulting in along-

track linear artifact in the final surface, is present periodically in the dataset. Where this occurs, effect on soundings can approach 0.30 m on the outer beams. This was addressed in the field by a relatively frequent SVP cast interval. In processing, lines showing the largest amount of error, especially crosslines which could span larger distances between casts, received additional beam filtering to reject more of the outer portion of the swaths. Regardless, the final surface is within specifications.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

Deviations from the Corrections to Echo Soundings section of the DAPR are itemized below. Note that in all cases final data is within specifications.

Sound Speed Correction Exceptions:

The following line files were SVP-corrected using nearest in distance in time 3 hours instead of the standard 2 hours:

1603-ASV-CW5-216-C4NS11520_-_0002
1604-ASV-CW5-216-C4NS11200_-_0001
1605-ASV-CW5-216-C4NS11200_-_0001
3431-ASV-CW5-240-C_investigation_-_0001
3432-ASV-CW5-240-C_investigation_-_0001
3433-ASV-CW5-240-C_investigation_-_0001
3434-ASV-CW5-240-C_investigation_-_0001
3435-ASV-CW5-240-C_investigation_-_0001
3436-ASV-CW5-240-C_investigation_-_0001
3437-ASV-CW5-240-C_investigation_-_0001
3438-ASV-CW5-240-C_investigation_-_0001
3759-ASV-CW5-249-C6NESW00000_-_0001
3987-ASV-CW5-258-C4XL46_-_0001
3987-ASV-CW5-258-C4XL46_-_0002
4172-ASV-CW5-259-C6_XL_1_-_0001

Delayed Heave Exceptions:

Delayed Heave was unavailable for application to a small number of line files collected with the ASV on JD215. Real-time heave was used instead. In addition, during GPS Tide computation in CARIS HIPS, real-time heave was selected to use in the computation instead of Delayed Heave. Since heave is captured in the GPS altitude records used for vertical corrections, there is no negative effect on final soundings. The affected line files are listed below.

1492-ASV-CW5-215-C3NESW00320_-_0001

1492-ASV-CW5-215-C3NESW00320_-_0002
1492-ASV-CW5-215-C3NESW00320_-_0003
1492-ASV-CW5-215-C3NESW00320_-_0004
1493-ASV-CW5-215-C3NESW00960_-_0001
1494-ASV-CW5-215-C3NESW00960_-_0001
1494-ASV-CW5-215-C3NESW00960_-_0002
1494-ASV-CW5-215-C3NESW00960_-_0003
1495-ASV-CW5-215-C3NESW01600_-_0001
1495-ASV-CW5-215-C3NESW01600_-_0002
1495-ASV-CW5-215-C3NESW01600_-_0003
1496-ASV-CW5-215-C3NESW02240_-_0001
1496-ASV-CW5-215-C3NESW02240_-_0002
1496-ASV-CW5-215-C3NESW02240_-_0003
1497-ASV-CW5-215-C3NESW02880_-_0001
1497-ASV-CW5-215-C3NESW02880_-_0002
1497-ASV-CW5-215-C3NESW02880_-_0003

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 V2020.3.

Features in the FFF were encoded in CARIS HIPS with mandatory S-57 attributes and required NOAA Extended Attributes (V2020.3). Refer to the DAPR for detail requiring feature investigations and compilation of the FFF.

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
H13372_MB_4m_MLLW_Final	CARIS Raster Surface (CUBE)	4 meters	0 meters - 80 meters	NOAA_4m	MBES Set Line Spacing
H13372_MB_1m_InvestigationsDevelopments_MLLW_Final	CARIS Raster Surface (CUBE)	1 meters	0 meters - 20 meters	NOAA_1m	Complete MBES
H13372_MBAB_1m_400kHz_1of6	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing
H13372_MBAB_1m_400kHz_2of6	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing
H13372_MBAB_1m_400kHz_3of6	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing
H13372_MBAB_1m_400kHz_4of6	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing
H13372_MBAB_1m_400kHz_5of6	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing
H13372_MBAB_1m_400kHz_6of6	MB Backscatter Mosaic	1 meters	0 meters - 80 meters	N/A	MBES Set Line Spacing

Table 10: Submitted Surfaces

The final depth information for this survey was submitted as a CARIS BASE surface (CSAR format), 4 m resolution, which best represented the seafloor at the time of the 2020 survey. The surface was created from fully processed data with all final corrections applied using NOAA CUBE parameters and resolutions by depth range, in conformance with the 2019 HSSD. The surface was finalized, and designated soundings were applied where applicable. Horizontal projection was selected as UTM Zone 3 North, NAD83.

Note: A finalized 1 m resolution surface is also included (see filename and parameters above). It is included only to show that Complete MBES coverage was achieved in item and shoal investigation areas. It excludes most of the survey area and is a best-fit rectangle encompassing areas with Complete MBES, including some

of the Set Spaced data, all of which were in the vicinity of Stuart Island. It should be used for reference only; the 4 m surface is the final deliverable.

Non-finalized versions of the CSAR surfaces are also included which does not have a depth cutoff applied. These do not have the "_Final" designation in the filename.

An S-57 (.000) Final Feature File (FFF) was submitted with the survey deliverables as well. The FFF contains data not readily represented by the final surface, including bottom samples and shoreline verification results. Each object is encoded with mandatory S-57 attributes and NOAA Extended Attributes (V2020.3).

Georeferenced multibeam backscatter mosaics (Geotif format in NAD83 UTM Zone 3N, 1 m resolution) were also produced and are provided with the survey deliverables. These were provided as six separate images. Note that backscatter processing and mosaic generation was not a requirement and the mosaics are provided as-is. The mosaics may have flaws or holidays which could be addressed through further processing. However, they are of sufficient quality to show the relative changes in seafloor type across the survey area.

In addition to the surfaces listed above, orthomosaics and DEM images of shoreline areas are also provided in the "Surfaces_Mosaics" directory as products of limited shoreline investigation: Assigned features near and inshore of the NALL were investigated in the field with Unmanned Aerial Systems (UAS) and processed with Structure from Motion (SfM) methodology. This resulted in Orthomosaics and Digital Elevation Model (DEM) Geotif images (projected in NAD83 UTM Zone 3N) that were used in conjunction with MBES data to address assigned features, digitize new features, and assign heights as necessary to compile the FFF. The images are compatible with CARIS HIPS 10.4, and DEMs open as CSAR surfaces that include Z values relative to MLLW. Refer to the DAPR for additional information.

Section B.5.2 includes language that could be interpreted to indicate that the 1-meter surface was submitted as a reference only and was not intended as a deliverable. However, the 1-meter surface is an intended deliverable for areas that required complete coverage. The 1-meter surface was reviewed and found to meet specs within areas where complete coverage was required (significant shoals/features). Despite this, a new surface was created in review to rename it in accordance with specified naming conventions - H13372_MB_1m_MLLW_Final - and to ensure only complete coverage data were included in the gridded surface.

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-R385-KR-20_ERTDM_NAD83-MLLW_04162020.csar

Table 11: ERS method and SEP file

All soundings were reduced to MLLW using the ERTDM NAD83 to MLLW separation model grid file provided by NOAA using ERS methodology.

Tide gauges and ERTDM validation sites (GPS buoys) were installed as part of the overall project but were not used for reduction of soundings. Gauge data and validation results have been separately provided to NOAA CO-OPS. Reports (with accompanying data packages) that have been submitted directly to CO-OPS are itemized in Section E of this report.

Discrete tide zones were generated using project gauge data but were not used for sounding reduction. Zones were used for an ERZT comparison to the provided ERTDM grid, with the two methods having an overall agreement of 0.02 m with a standard deviation of 0.12 m. Zones are provided in the Water Levels directory. Additional detail is available with the project HVCR.

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD 83).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 3.

The following PPK methods were used for horizontal control:

- Smart Base
- RTX

Post-processing of all navigation data was done in Applanix POSPac MMS (v8.4) software. Initial processing was done in the field using Trimble PP-RTX methodology. Following completion of operations and availability of precise ephemeris data, navigation data was reprocessed in POSPac using Applanix SmartBase (ASB) methodology to achieve better overall results than the initial PP-RTX method, and applied to all survey data. ASB processing was possible because the project area was fully encompassed by a network formed by three or more CORS base stations. ASB processing was further facilitated by the

presence of the nearby stations at St. Michael (AT01) and Unalakleet (AB17). ASB processing replaced all initial PP-RTX positions. However, when troubleshooting GPS busts it was found that in a few isolated cases PPRTX achieved better positioning results. All final positions are therefore PPK, with the vast majority utilizing ASB and a select few cases (itemized earlier in this report) using PPRTX.

The following CORS Stations were used for horizontal control:

HVCR Site ID	Base Station ID
StMichael AK2018	AT01
Bethel WAAS	BET1
BaldHead Ak2006	AC31
Buckland AK2007	AC07
Unalakleet AK2008	AB17
Razorback AK2007	AB09
Mekoryuk AK2008	AB04
Savoonga AK2007	AB04

Table 12: CORS Base Stations

WAAS

The Wide Area Augmentation System (WAAS) was used for real-time horizontal control during data acquisition. All real-time positions were replaced in final processing with post-processed kinematic (PPK) positions generated in Applanix POSPac software, as described previously.

D. Results and Recommendations

D.1 Chart Comparison

The chart comparison was performed by examining the best-scale Electronic Navigational Charts (ENCs) that intersect the survey area. The latest edition(s) available at the time of report compilation were used.

The chart comparison was accomplished by overlaying the finalized BASE surface(s) with shoal-biased soundings and the final feature file (FFF) on the charts in CARIS HIPS. The general agreement between charted soundings and survey soundings was then examined and a more detailed comparison was undertaken for any shoals or other dangerous features.

In areas where a large scale chart overlapped with a small scale chart, only the larger scale chart was examined. When comparing to survey data, chart scale was taken into account so that 1 mm at chart scale was considered to be the valid radius for charted soundings and features.

Results are shown in the following sections. It is recommended that in all cases of disagreement this survey should supersede charted data.

USCG Notice to Mariners (NM) and USCG Local Notice to Mariners (LNM) for District 17 from week 27/2020 through 38/2020 were checked. No items were found that affected the survey area.

ENC metadata and non-specific geographic area objects on the ENCs that overlap the survey area were not investigated.

Charted soundings are in generally good agreement, with most soundings agreeing to 1 m or better.

No significant changes including shoaling or deepening trends were observed.

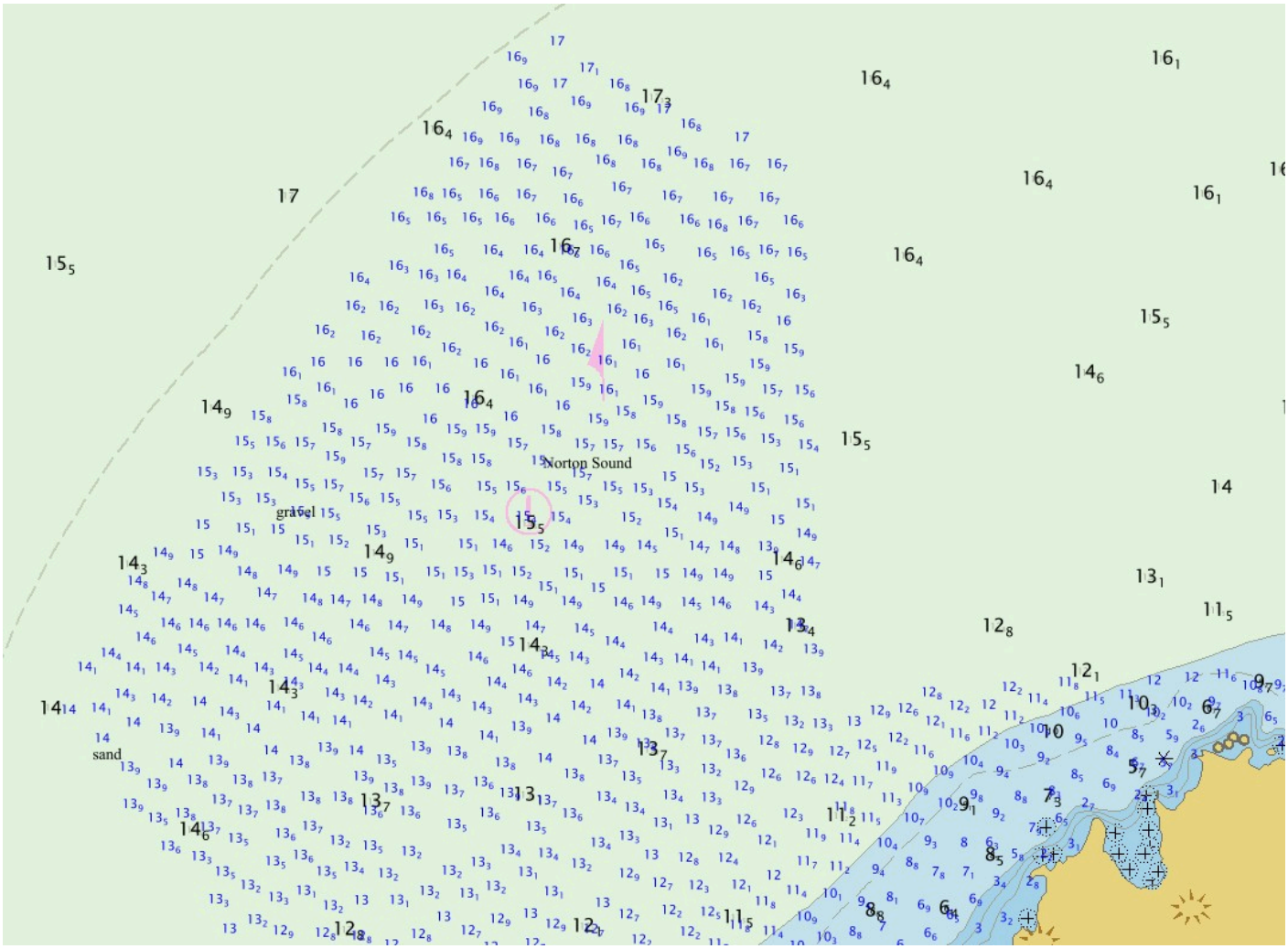

Figure 6: Soundings from this survey (blue) overlaid on soundings from chart US3AK83M (black), showing generally good agreement. Area NW of Stuart Island.

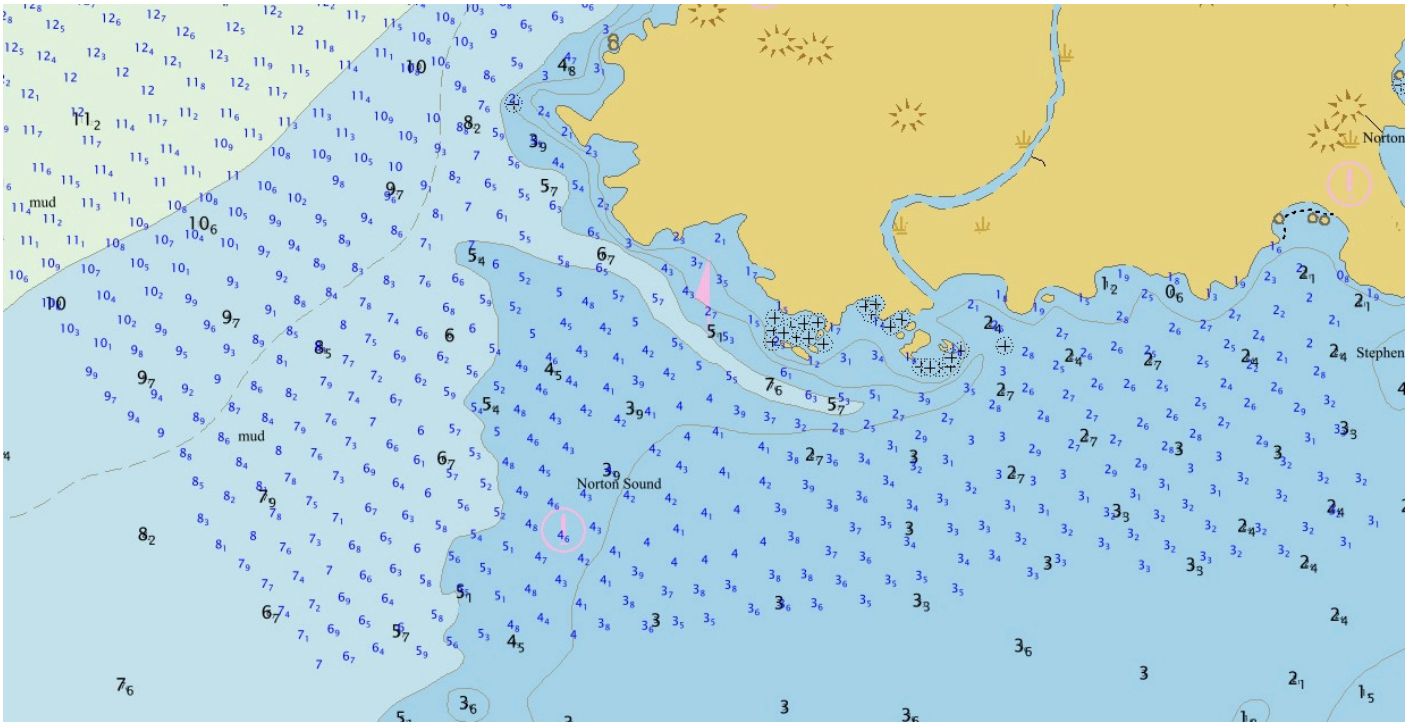

Figure 7: Soundings from this survey (blue) overlaid on soundings from chart US3AK83M (black), showing generally good agreement. Area south of Stuart Island.

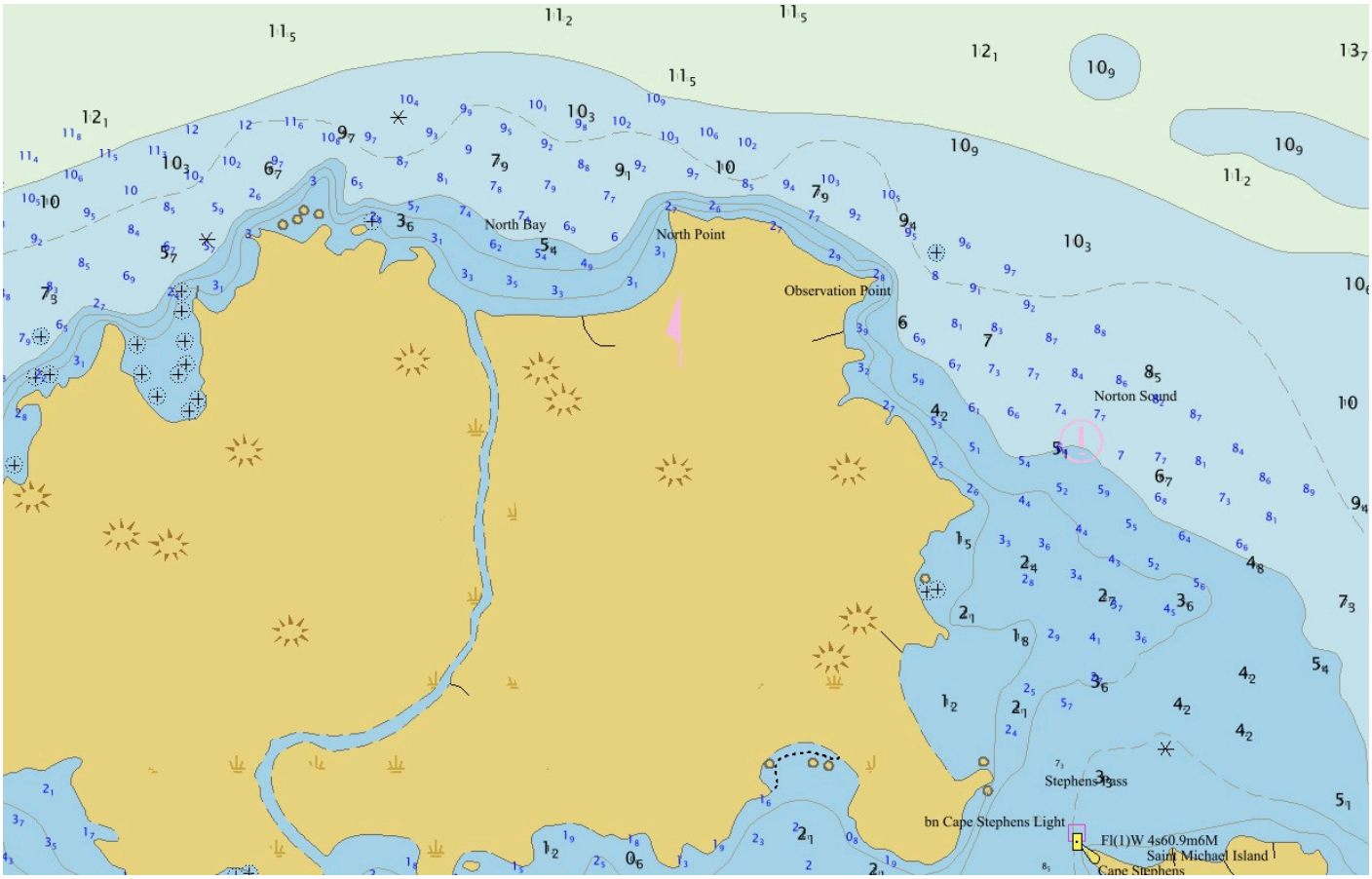

Figure 8: Soundings from this survey (blue) overlaid on soundings from chart US3AK83M (black), showing generally good agreement. Area north and east of Stuart Island.

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
US3AK83M	1:300000	9	07/18/2018	09/30/2019

Table 13: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

No DTONs were submitted for this survey.

The following rocks are charted in dangerous locations outside the NALL Each was investigated and received Complete MBES at the feature location as well as a 500 m search radius around the feature as defined in the PRF. No sign of these rocks or other significant shoaling within the search areas was found. Each is therefore disproved and recommended for removal.

1. Charted rock (always under water), PA, at 63-37-12.828 N, 162-38-44.340 W
2. Charted rock (covers and uncovers), PA, at 63-38-00.204 N, 162-35-25.152 W
3. Charted rock (covers and uncovers), PA, at 63-39-00.432 N, 162-31-33.384 W
4. Charted rock (always under water), PA, at 63-37-38.280 N, 162-21-05.616 W
5. Charted rock (always under water), PA, at 63-31-56.064 N, 162-31-50.124 W

In addition, numerous features near or inside the NALL were were assigned for investigation in the CSF. All were addressed with limit shoreline verification, as well as Complete MBES coverage where applicable in areas of search radii that extended outside the NALL. Refer to the FFF for all investigation results, including recommendations and new features.

D.1.3 Charted Features

Five (5) rocks charted as PA were addressed previously in this report. All five were disproved with Complete MBES.

A PA charted rock at 63-34-51.816 N, 162-44-01.176 W, off the western most point of Stuart Island, was found during limited shoreline verification to be a collection of rocks and a foul area about 300 m NE of the currently charted location.

Refer to the FFF for additional information and recommendations for all feature investigations.

No other charted features labeled PA, ED, PD, or Rep. existed.

D.1.4 Uncharted Features

Numerous uncharted features as well as changes to charted features in the nearshore area were found during feature investigations and are recommended for charting. Refer to the FFF for results and recommendations.

D.1.5 Channels

No channels exist for this survey. There are no designated anchorages, precautionary areas, safety fairways, traffic separation schemes, pilot boarding areas, or channel and range lines within the survey limits.

D.2 Additional Results

D.2.1 Aids to Navigation

No Aids to navigation (ATONs) exist for this survey. An ATON at Cape Stephens was investigated under junctioning survey H13370.

D.2.2 Maritime Boundary Points

Maritime Boundary Points existed but were not assigned for investigation.

D.2.3 Bottom Samples

Nine bottom samples intersecting the survey area were assigned in the PRF.

Seven were successfully obtained at their assigned location. One could not be obtained despite three attempts at the assigned location (63-42-25.775 N, 162-49-17.486 W). Assigned sample at 63-32-13.956 N, 162-23-48.192 W was not accessible due to shallow water by the larger vessel, therefore a sample was obtained at more accessible location about 4.5 NM to the west instead.

Eight samples were obtained in total. All returned sticky mud (black, gray, or brown in color) as primary constituents.

Samples were photographed but not retained. Refer to the FFF submitted with the survey deliverables for 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

Ice scour features caused by wind-driven pack ice dragging on the seafloor are relatively common in the area. The linear features are ephemeral and not navigationally significant, usually resulting in no more than 1 m of vertical relief from the surrounding seafloor.

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 2019 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
9468151 Stebbins Install Report	2020-07-29
9999771 Norton Sound Buoy Install Report	2020-07-31
9999770 St Michael Install Report	2020-07-31
9469031 Koyuk Install Report	2020-09-10
9999776 Eastern Norton Sound Buoy Install Report	2020-10-14
9999771 Western Norton Sound Buoy Removal Report	2020-10-17
Final Summary Report for OPR-R385-KR-20 Norton Sound	2020-10-18
Survey Outlines for OPR-R385-KR-20	2020-10-20
9468151 Stebbins Removal Report	2020-10-21
9999776 Eastern Norton Sound Buoy Removal Report	2020-10-22
9469031 Koyuk Removal Report	2020-10-28
9999770 St Michael GNSS-R Analysis Report	2020-10-30
NCEI Sound Speed Profile Data Submission	2020-11-09
MMO Training and Observation Logs	2020-11-30
Coast Pilot Review Report for OPR-R385-KR-20	2020-12-04

Approver Name	Approver Title	Approval Date	Signature
Thomas Morino	Lead Hydrographer	01/12/2021	Thomas Morino Digitally signed by Thomas Morino Date: 2021.01.12 13:28:38 -09'00'
Andrew Orthmann, C.H.	Charting Program Manager	01/12/2021	Andrew Orthmann Digitally signed by Andrew Orthmann Date: 2021.01.12 13:29:03 -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