H13513

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	H13513

LOCALITY

State(s):	Maryland
General Locality:	Central Chesapeake Bay
Sub-locality:	Fairbank to Rich Neck

2023

CHIEF OF PARTY
Alex T. Bernier

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13513**

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):	**Maryland**
General Locality:	**Central Chesapeake Bay**
Sub-Locality:	**Fairbank to Rich Neck**
Scale:	**20000**
Dates of Survey:	**11/02/2022 to 04/24/2023**
Instructions Dated:	**08/23/2022**
Project Number:	**OPR-E347-KR-22**
Field Unit:	**Leidos**
Chief of Party:	**Alex T. Bernier**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Side Scan Sonar Multibeam Echo Sounder Backscatter**
Verification by:	**Atlantic 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 18N, 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 H13513

Project: OPR-E347-KR-22

Locality: Central Chesapeake Bay

Sublocality: Fairbank to Rich Neck

Scale: 1:20000

November 2022 - April 2023

Leidos

Chief of Party: Alex T. Bernier

A. Area Surveyed

H13513 was located in the Central Chesapeake Bay, Maryland with southern extents west of Tilghman Island and northern extents within the Eastern Bay west of Rich Neck (Figure 1). The survey was conducted in accordance with coverage requirements listed in the Project Instructions (PI) OPR-E347-KR-22.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
38° 51' 16.98" N 76° 23' 8.02" W	38° 41' 12.75" N 76° 16' 31.16" W

Table 1: Survey Limits

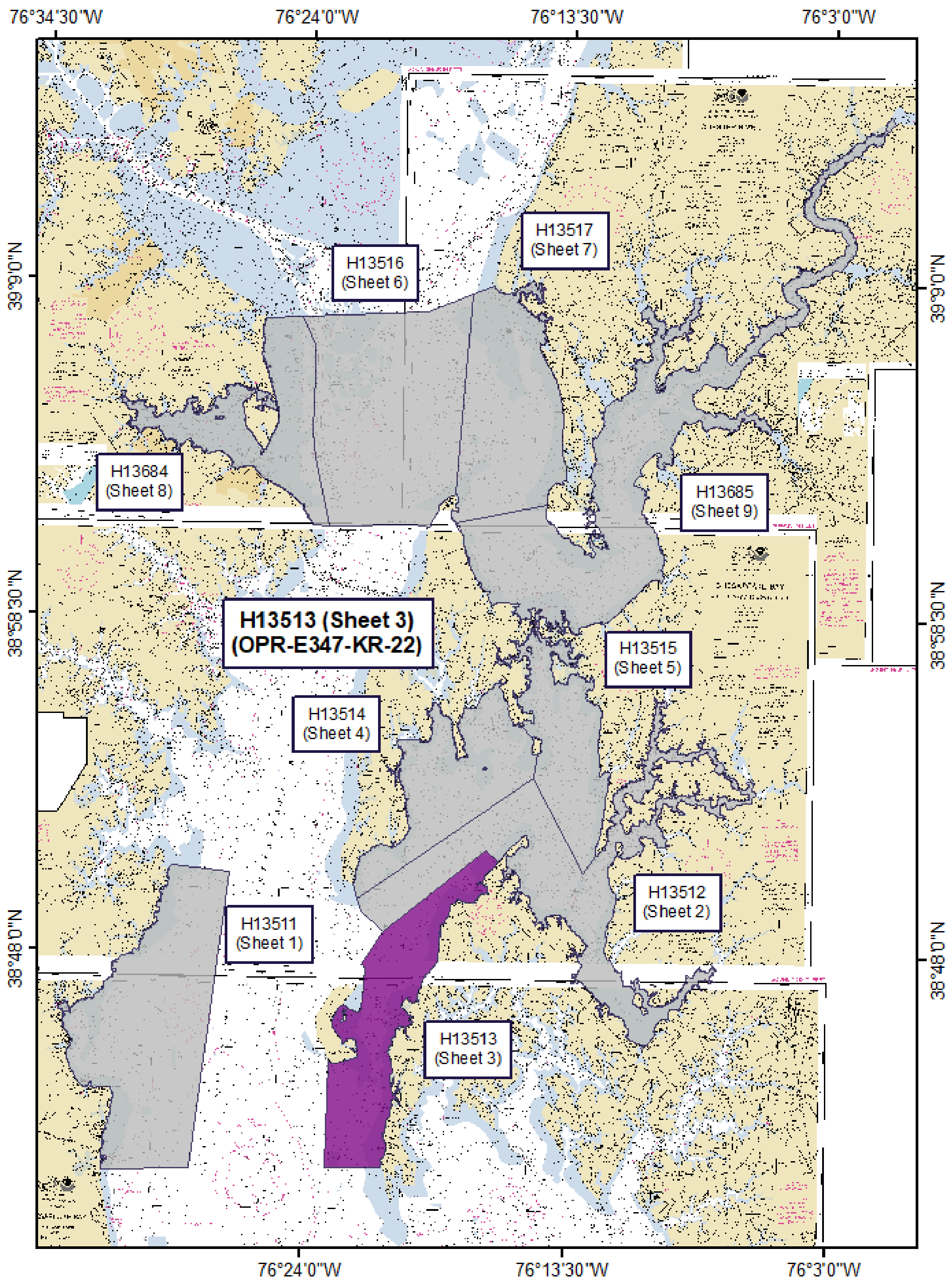

Figure 1: H13513 Survey Bounds

Survey limits were acquired in accordance with the requirements in the PI and the Hydrographic Survey Specifications and Deliverables (HSSD), March 2022.

A.2 Survey Purpose

The Chesapeake Bay is the largest estuary in North America and heavily trafficked by commercial and recreational vessels as tourism, fishing, and marine commerce are economically vital for the region. In addition to fishing and tourism traffic, commercial vessels transit through the project area to reach the Port of Baltimore, which is ranked as a top 15 port in container and tonnage, and a top 10 port for dry bulk.

The majority of the prior data in the project area spans from the 1880s to 1940s. The bathymetric data vintage coupled with numerous storms and hurricanes having potentially changed the seabed over the last century raises a need to survey the area. In addition, the Ever Forward container ship ran aground near the Craighill Channel in March 2022, and was removed after 35 days. 206,230 cubic yards of material was dredged and taken to Poplar Island. The data from this project will provide modern bathymetry for updating National Ocean Service nautical charting products improving the safety of maritime traffic and commerce as well as supporting the Seabed 2030 global mapping initiative. 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.

Leidos warrants only that the survey data acquired by Leidos and delivered to NOAA under Contract 1305M220DNCNJ0056 reflects the state of the sea floor in existence on the day and at the time the survey was conducted.

H13513 was surveyed in accordance with the following documents:
1. 1305M220DNCNJ0056 signed.pdf, received 23 August 2022
2. Hydrographic Survey Specifications and Deliverables (HSSD), March 2022
3. PRF.000, received 24 August 2022
4. CSF.000, received 24 August 2022
5. OPR-E347-KR-22 Project Brief, held 07 September 2022

A.4 Survey Coverage

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

Water Depth	Coverage Required
Sheets 1, 3, 4, 5, 7, 8, and 9	Complete Coverage (Refer to HSSD Section 5.2.2.3)
Inshore limit to 8 meters water depth	Sidescan may be acquired at an altitude of 6-20% of the range scale.

Table 2: Survey Coverage

Leidos chose to achieve the coverage requirement using Complete Coverage, Option B (100% side scan sonar coverage with concurrent multibeam). Survey coverage achieved was in accordance with the requirements in the PI and the HSSD (Figure 2).

In many areas of H13513 the inshore limit of the Navigable Area Limit Line (NALL) was reached seaward of the assigned survey bounds. Leidos surveyed to the NALL as defined by HSSD Section 1.3.2; within the surveyed bounds. However, due to safety concerns for personnel and survey equipment, some areas were not fully covered with multibeam echo sounder (MBES) data to exactly the 3.5-meter depth contour. This was due limited vessel maneuverability around the shoal depth areas, at these discrete locations. In these areas the side scan sonar (SSS) swath extended shoreward of the MBES swath, and indicated that the seafloor continued to rise abruptly and in a manner that the vessel could not navigate over for further MBES coverage; while also indicating in the SSS data that there were no significant objects that would require individual cartographic representation.

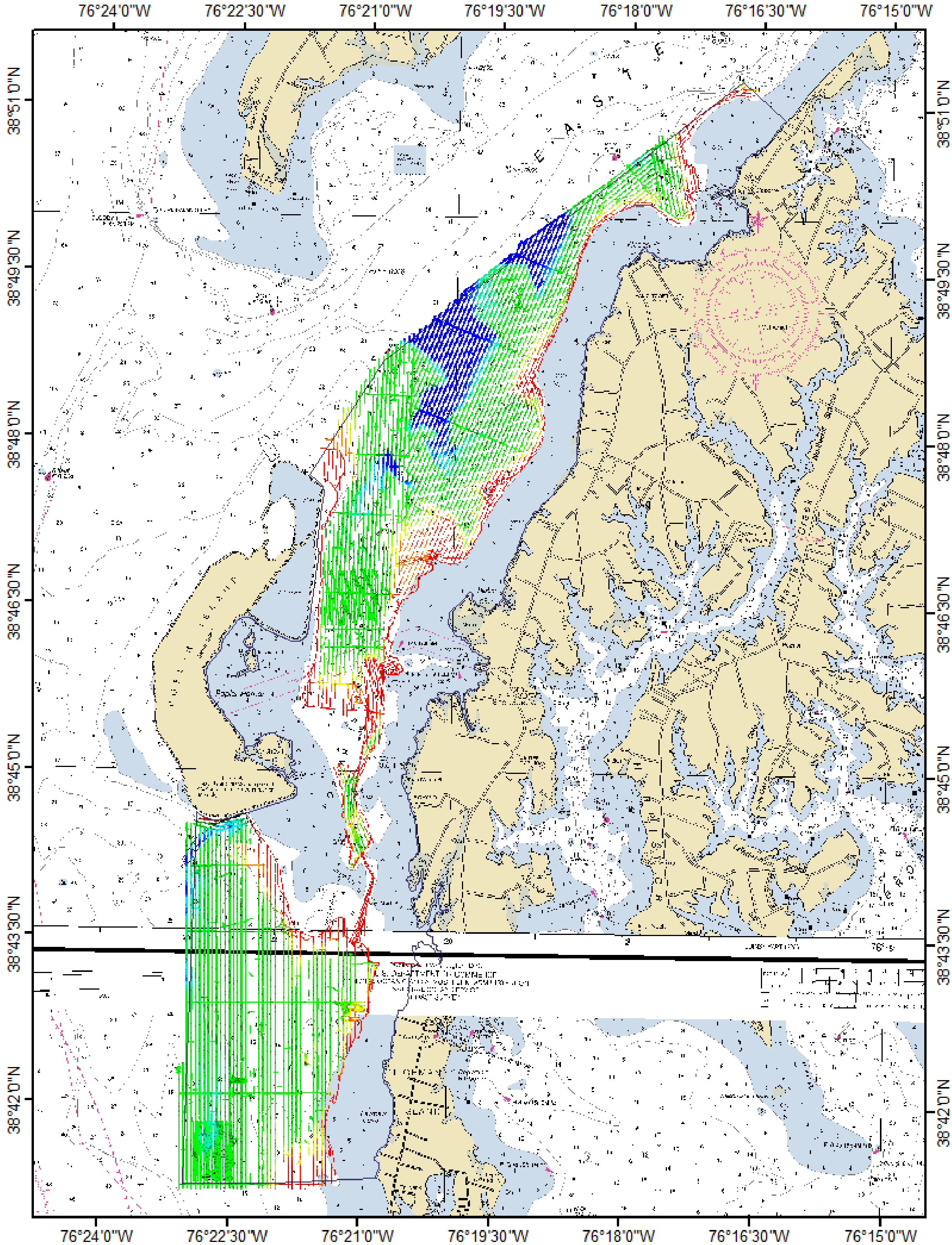

Figure 2: Final Bathymetry Coverage for H13513

A.6 Survey Statistics

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

	HULL ID	*R/V Oyster Bay II*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0
	MBES Mainscheme	0.0	0.0
	Lidar Mainscheme	0.0	0.0
	SSS Mainscheme	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0
	MBES/SSS Mainscheme	369.08	369.08
	SBES/MBES Crosslines	15.14	15.14
	Lidar Crosslines	0.0	0.0
Number of Bottom Samples			4
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			11.0

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
11/02/2022	306
11/05/2022	309
11/06/2022	310
11/09/2022	313
11/12/2022	316
11/14/2022	318
11/15/2022	319
11/16/2022	320
12/13/2022	347
12/30/2022	364
12/31/2022	365
03/30/2023	89
04/06/2023	96
04/09/2023	99
04/24/2023	114

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Leidos used their ISS-2000 software on a Windows platform to acquire these survey data. Survey planning and data analysis were conducted using the Leidos SABER software on Linux platforms. Side scan sonar (SSS) data were collected on a Windows platform using Klein's SonarPro software. Subsequent processing and review of the SSS data, including the generation of coverage mosaics, were accomplished using SABER.

A detailed description of the systems and vessel used to acquire and process these data is included in the Data Acquisition and Processing Report (DAPR) for OPR-E347-KR-22, delivered previously with H13511. There were no variations from the equipment configuration described in the DAPR.

B.1.1 Vessels

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

Hull ID	***R/V Oyster Bay II***
LOA	30.0 feet
Draft	3.0 feet

Table 5: Vessels Used

Figure 3: R/V Oyster Bay II

The R/V Oyster Bay II (Figure 3) was used to collect multibeam echo sounder (MBES) (RESON SeaBat T50), side scan sonar (SSS) (Klein 4900), and sound speed data during twelve hours per day survey operations.

A detailed description of the vessels used is included in the DAPR.

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
Klein Marine Systems	System 4900	SSS
Applanix	POS MV 320 v5	Positioning and Attitude System
AML Oceanographic	BaseX	Sound Speed System
Teledyne RESON	SeaBat T50-R	MBES Backscatter

Table 6: Major Systems Used

A detailed description of the equipment installed is included in the DAPR.

B.2 Quality Control

B.2.1 Crosslines

Multibeam echo sounder crosslines acquired for this survey totaled 4.10% of mainscheme acquisition. The resulting crossline to mainscheme percentage met the requirement to achieve approximately four percent of mainscheme mileage for a complete coverage multibeam survey (Section 5.2.4.2 of the HSSD). H13513 requirements were for Complete Coverage, Option B, based on the classifications defined in Section 5.2.2.3 of the HSSD.

The mainscheme lines were spaced 70 meters apart, and crosslines were generally spaced 1500 meters apart. In the field, hydrographers conducted daily comparisons of mainscheme to near nadir crossline data to ensure that no systematic errors were introduced and to identify potential problems with the survey systems. After the application of all correctors and completion of final processing in the office, separate CUBE PFM grids were built at 1-meter resolution for all data. One grid contained the full valid swath (±65° from nadir, Class 2) of mainscheme multibeam and the other included only the near nadir swath (±5° from nadir, Class 1) crossline data. The difference grid was created by subtracting the 1-meter H13513 mainscheme CUBE depths from the 1-meter H13513 crossline CUBE depths. These results are summarized in Figure 4.

The SABER Frequency Distribution Tool was used to analyze the difference grid created from the mainscheme and crossline PFM grids and the results of the analysis were compiled into the following section.

Section 5.2.4.2 of the HSSD states that the depth difference values are to be within the maximum allowable Total Vertical Uncertainty [TVU]. The mainscheme to crossline analysis conducted showed that 100.00% of the comparisons were within TVU. Results for the crossing analysis are summarized in Figure 4.

Results for analysis conducted are presented in Figure 4 to Figure 6.

Crossing Analysis	Minimum and Maximum CUBE Depth (meters) of Crossline Grid	IHO Order 1A Maximum Allowable Uncertainty (meters) for the Range of Depths	Percentage of Depth Differences Within IHO Order 1A Maximum Allowable Uncertainty
R/V Oyster Bay II MBES 1m Crossline (Class 1) to R/V Oyster Bay II MBES 1m Mainscheme	2.268 – 9.250	0.501 – 0.514	100.00%

Figure 4: Summary of Crossing Analysis

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	4896	24.87	2138	10.86	2518	12.79	240	1.22
>0.01-0.02	3844	44.39	1534	18.65	2310	24.52		
>0.02-0.03	3586	62.61	1318	25.35	2268	36.04		
>0.03-0.04	2807	76.87	858	29.70	1949	45.94		
>0.04-0.05	2022	87.14	479	32.14	1543	53.78		
>0.05-0.06	1204	93.25	235	33.33	969	58.70		
>0.06-0.07	797	97.30	104	33.86	693	62.22		
>0.07-0.08	324	98.95	31	34.02	293	63.71		
>0.08-0.09	162	99.77	11	34.07	151	64.48		
>0.09-0.1	36	99.95	1	34.08	35	64.66		
>0.1-0.11	5	99.98	2	34.09	3	64.67		
>0.11-0.115	4	100.00	0	34.09	4	64.69		
Total	**19687**	**100.00%**	**6711**	**34.09%**	**12736**	**64.69%**	**240**	**1.22%**
Reference Grid: H13513_MB_1m_cross_5degree_pfm_CUBE_vs_H13513_MB_1m_main_pfm_CUBE.dif								

Figure 5: Tabular Results Crossing Analysis, Crosslines vs. Mainscheme Lines

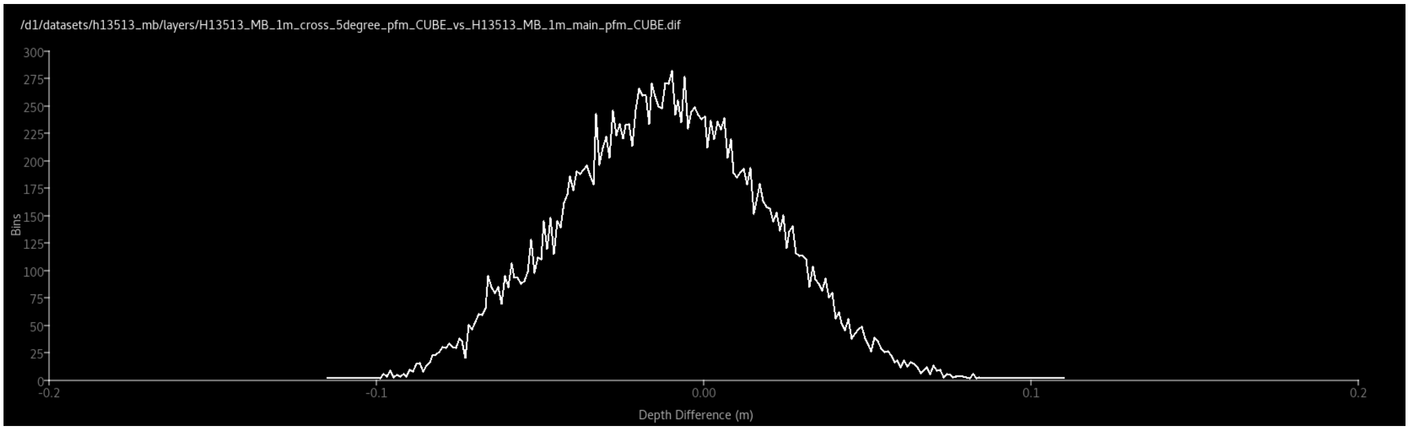

Figure 6: Plot of Crossing Analysis Crosslines vs. Mainscheme Lines

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.092 meters	0.2 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
R/V Oyster Bay II	1 meters/second	1 meters/second	1 meters/second	1 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

For specific details on the use and application of the SABER Total Propagated Uncertainty (TPU) model, refer to the DAPR. Once the TPU model was applied to the GSF bathymetry data, each beam was attributed with the horizontal uncertainty and the vertical uncertainty at the 95% confidence level. The vertical and horizontal uncertainty values, estimated by the TPU model for individual multibeam soundings, varied little across the dataset, tending to be most affected by beam angle. Individual soundings that had vertical and horizontal uncertainty values above IHO S-44 6th Edition, Order 1a were flagged as invalid during the uncertainty attribution.

As discussed in the DAPR, SABER generates two vertical uncertainty surfaces: the Hypothesis Standard Deviation (Hyp. StdDev) and the Hypothesis Average Total Propagated Uncertainty (Hyp. AvgTPU). A third vertical uncertainty surface is generated from the larger value of these two uncertainties at each node and is referred to as the Hypothesis Final Uncertainty (Hyp. Final Uncertainty).

The final H13513 1-meter PFM CUBE surface contained final vertical uncertainties that ranged from 0.200 meters to 0.553 meters. The IHO Order 1a maximum allowable vertical uncertainty was calculated to range between 0.500 to 0.516 meters, based on the minimum CUBE depth (1.363 meters) and maximum CUBE depth (9.806 meters). Results from the SABER Check PFM Uncertainty function identified three nodes in the final H13513 1-meter PFM CUBE surface with final vertical uncertainties that exceeded IHO Order 1a allowable vertical uncertainty. These nodes were associated with features and natural steep slopes in the seafloor. The SABER Frequency Distribution Tool was also used to review the Hyp. Final Uncertainty surface within the final H13513 1-meter CUBE PFM grid. Results showed that 99.44% of all nodes had final uncertainties less than or equal to 0.210 meters.

B.2.3 Junctions

Per the PI, junction analysis was performed between H13513 and the surveys listed in the table below and illustrated in Figure 7.

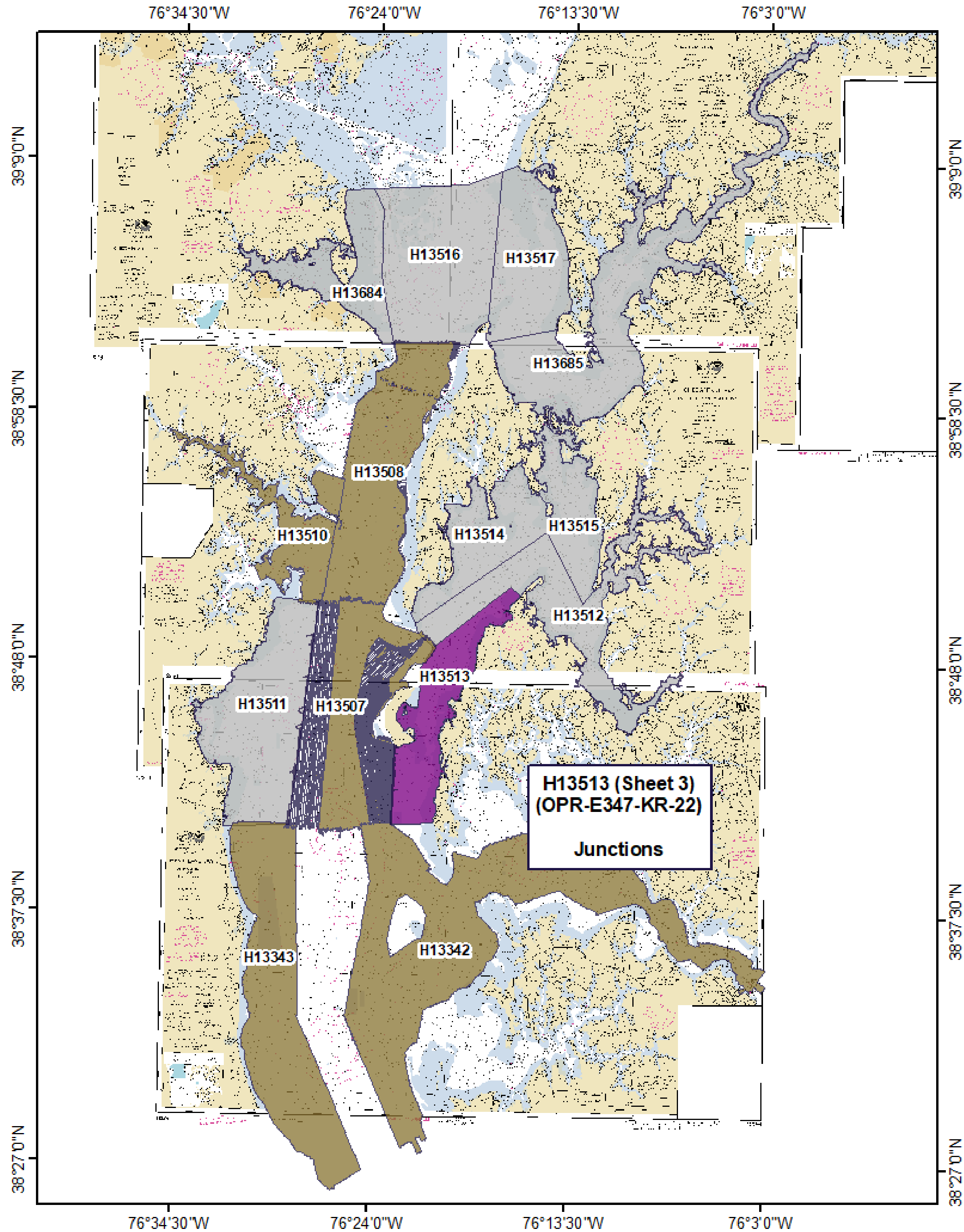

Figure 7: General Locality of H13513 with Junctioning Surveys

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13512	1:20000	2023	Leidos	N
H13507	1:20000	2021	NOAA Ship Thomas Jefferson	W
H13442	1:20000	2020	Leidos	S

Table 9: Junctioning Surveys

H13512

Junctioning survey H13512 was conducted in 2022 - 2023 and junctions to the north of H13513. For this analysis the H13512 50-centimeter CUBE depth surface was compared to the H13513 1-meter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 7,900 by 200 meters along the northern edge of H13513. Observed depths within the common area were 2.328 to 10.028 meters, which resulted in a calculated allowable TVU range of 0.501 to 0.517 meters.

The difference grid was generated by subtracting the H13512 data from the H13513 data. Positive values indicate that H13513 depth data were deeper than H13512 depth data. Throughout the common area, H13513 CUBE depths were deeper 26.58% of the time and were shoaler 72.35% of the time (Figure 8). There were two comparisons which exceeded TVU, the difference are attributed to an observed feature. The distribution is centered on zero with a negative skew as presented in Figure 9.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	82629	22.40	38832	10.53	39821	10.79	3976	1.08
>0.01-0.02	59323	38.48	22799	16.71	36524	20.70		
>0.02-0.03	50010	52.04	14729	20.70	35281	30.26		
>0.03-0.04	37976	62.33	8667	23.05	29309	38.20		
>0.04-0.05	33301	71.36	7439	25.07	25862	45.21		
>0.05-0.06	24386	77.97	3700	26.07	20686	50.82		
>0.06-0.07	20589	83.55	1271	26.41	19318	56.06		
>0.07-0.08	17949	88.42	394	26.52	17555	60.82		
>0.08-0.09	17354	93.12	173	26.57	17181	65.48		
>0.09-0.1	11312	96.19	32	26.58	11280	68.53		
>0.1-0.11	6072	97.83	3	26.58	6069	70.18		
>0.11-0.12	3534	98.79	1	26.58	3533	71.14		
>0.12-0.13	2094	99.36	0	26.58	2094	71.70		
>0.13-0.14	1073	99.65	0	26.58	1073	71.99		
>0.14-0.15	531	99.79	0	26.58	531	72.14		
>0.15-0.16	355	99.89	0	26.58	355	72.23		
>0.16-0.17	191	99.94	0	26.58	191	72.29		
>0.17-0.18	86	99.96	0	26.58	86	72.31		
>0.18-0.19	62	99.98	1	26.58	61	72.33		
>0.19-0.2	34	99.99	0	26.58	34	72.34		
>0.2-0.21	26	99.99	0	26.58	26	72.34		
>0.21-0.701	2	100.00	0	26.58	2	72.35		
Total	**368898**	**100.00%**	**98041**	**26.58%**	**266881**	**72.35%**	**3976**	**1.08%**
Reference Grid: H13513_MB_1m_MLLW_All_pfm_vs_H13512_MB_50cm_MLLW_Final_bag.dif								

Figure 8: Tabular Results Junction Analysis H13513 vs. H13512

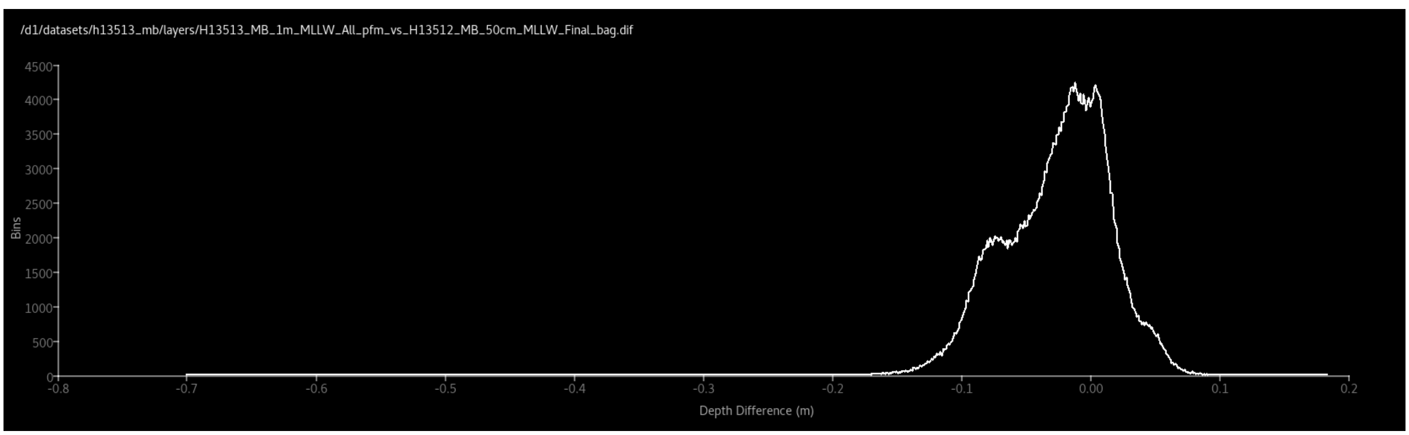

Figure 9: Plot of Junction Analysis H13513 vs. H13512

H13507

Junctioning survey H13507 was conducted in 2021 and junctions to the west of H13513. For this analysis the NOAA provided H13507 BAG (H13507_MB_VR_MLLW.bag) depth surface was compared to the H13513 1-meter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 8,000 by 500 meters along the western edge of H13513. Observed depths within the common area were 2.373 to 9.936 meters, which resulted in a calculated allowable TVU range of 0.501 to 0.516 meters.

The difference grid was generated by subtracting the H13507 data from the H13513 data. Positive values indicate that H13513 depth data were deeper than H13507 depth data. Throughout the common area, H13513 CUBE depths were deeper 17.95% of the time and were shoaler 81.84% of the time (Figure 10). The distribution is centered on zero as presented in Figure 11. Differences exceeding the calculated allowable TVU range are attributed to the difference in node resolution as the H13507 was a variable resolution source grid stored at a course single node resolution (70-meter) within the NOAA provided BAG file.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.1	456028	57.52	97668	11.87	356560	45.45	1800	0.21
>0.1-0.2	273286	84.09	35132	15.31	238154	68.57		
>0.2-0.3	80616	93.39	11191	16.6	69425	76.58		
>0.3-0.4	23992	96.16	3281	16.98	20711	78.97		
>0.4-0.5	10613	97.38	2082	17.22	8531	79.95		
>0.5-0.6	5355	98.00	1487	17.39	3868	80.40		
>0.6-0.7	2740	98.31	1014	17.51	1726	80.60		
>0.7-0.8	2318	98.58	977	17.62	1341	80.75		
>0.8-0.9	2486	98.87	1251	17.77	1235	80.89		
>0.9-1.0	1631	99.06	431	17.82	1200	81.03		
>1.0-2	7416	99.91	1001	17.93	6415	81.77		
>2.0-3	394	99.96	161	17.95	233	81.8		
>3.0-3.334	382	100.00	0	17.95	382	81.84		
Total	**867257**	**100.00%**	**155676**	**17.95%**	**709781**	**81.84%**	**1800**	**0.21%**
Reference Grid: H13513_MB_1m_MLLW_All_pfm_vs_H13507_MB_VR_MLLW_bag.dif								

Figure 10: Tabular Results Junction Analysis H13513 vs. H13507

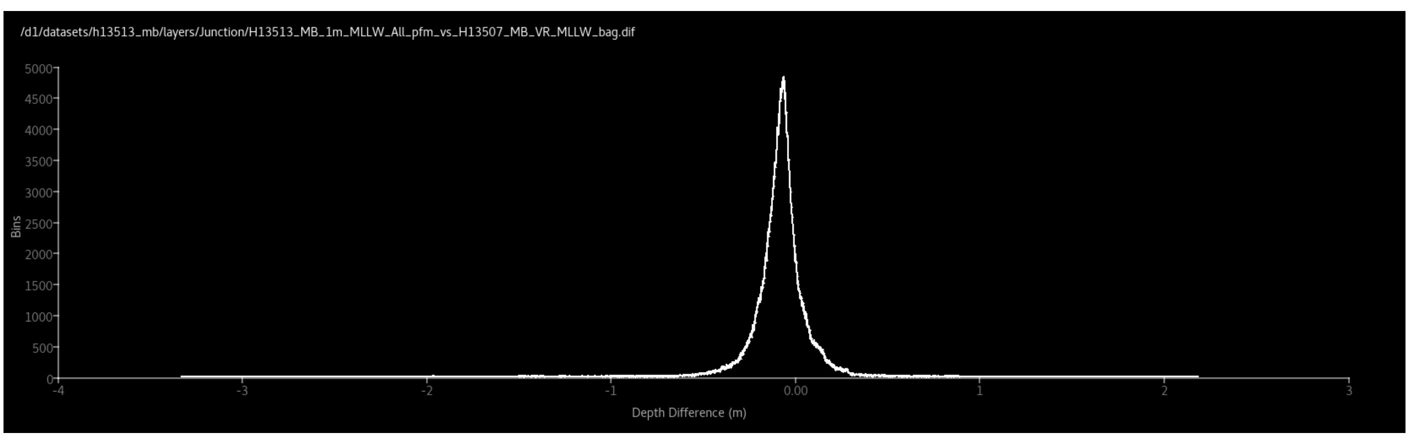

Figure 11: Plot of Junction Analysis H13513 vs. H13507

H13442

Junctioning survey H13342 was conducted in 2020 and junctions to the south of H13513. For this analysis the H13342 CUBE depth surface was compared to the H13513 1-meter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 160 by 125 meters. Observed depths within the common area were 4.962 to 5.278 meters, which resulted in a calculated allowable TVU range of 0.504 to 0.505 meters.

The difference grid was generated by subtracting the H13342 data from the H13513 data. Positive values indicate that H13513 depth data were deeper than H13342 depth data. Throughout the common area, H13513 CUBE depths were deeper 60.76% of the time and were shoaler 35.33% of the time (Figure 12). The distribution is centered on zero as presented in Figure 13.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	1833	59.69	1019	33.18	694	22.60	120	3.91
>0.01-0.02	789	85.38	488	49.07	301	32.40		
>0.02-0.03	227	92.77	146	53.83	81	35.04		
>0.03-0.04	39	94.04	30	54.80	9	35.33		
>0.04-0.05	11	94.40	11	55.16	0	35.33		
>0.05-0.06	89	97.3	89	58.06	0	35.33		
>0.06-0.07	78	99.84	78	60.60	0	35.33		
>0.07-0.074	5	100.00	5	60.76	0	35.33		
Total	**3071**	**100.00%**	**1866**	**60.76%**	**1085**	**35.33%**	**120**	**3.91%**
Reference Grid: H13513_MB_1m_MLLW_All_pfm_vs_H13342_MB_1m_MLLW_Final_bag.dif								

Figure 12: Tabular Results Junction Analysis H13513 vs. H13342

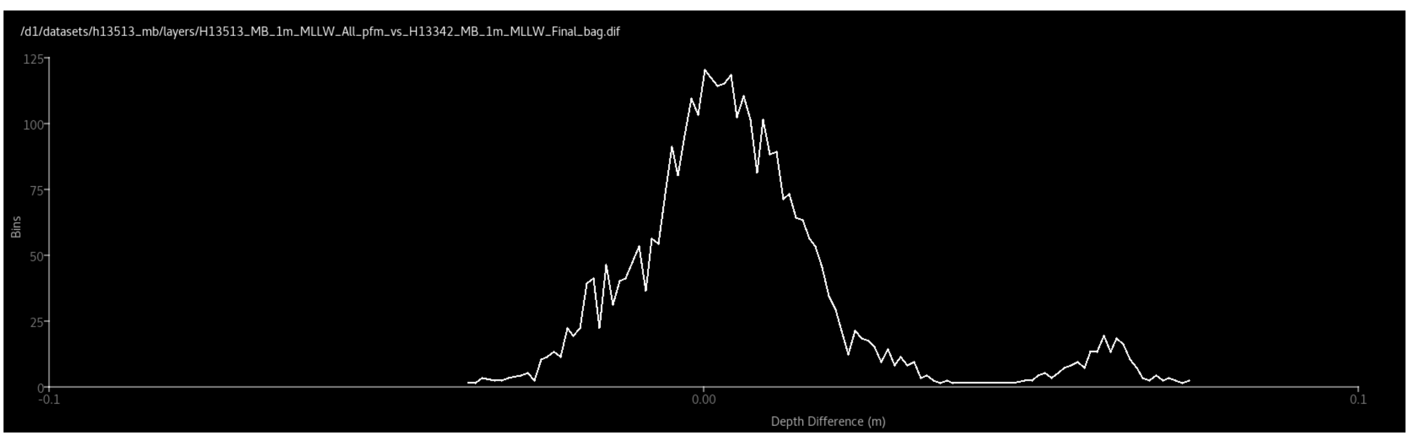

Figure 13: Plot of Junction Analysis H13513 vs. H13342

B.2.4 Sonar QC Checks

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

B.2.5 Equipment Effectiveness

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

B.2.6 Factors Affecting Soundings

Factors Affecting Soundings

Dense biological interference were observed during discrete areas and during various days of survey which required numerous holiday reruns. Additionally, throughout survey acquisition both commercial and recreational fishing activity was heavy causing deviations in the survey acquisition lines requiring numerous holiday reruns. The end result was that there were no significant impacts to the final sounding data.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: On the R/V Oyster Bay II, the AML BaseX2 was the primary system used to collect SSP data; refer to the DAPR for additional details. SSP data were obtained at intervals frequent enough to meet depth accuracy requirements.

All sound speed profiles applied for online bathymetry data collection were acquired within 500 meters of the bounds of the survey area as specified in Section 5.2.3.3 of the HSSD.

Confidence checks of the sound speed profile casts were routinely conducted by comparing at least two consecutive casts taken with different SSP sensors.

All individual SSP files are delivered with the H13513 data and are broken out into sub-folders, which correspond to the purpose of each cast. Also, all individual SSP files for H13513 have been concatenated into two separate files based on the purpose of the cast, provided in CARIS format files (.svp), and delivered under (H13513/Processed/SVP/CARIS_SSP) on the delivery drive. In accordance with HSSD Section 8.3.6, SSP files were also converted to NCEI format, as detailed in the DAPR, and provided as a separate delivery to NCEI. Refer to the DAPR for additional details.

B.2.8 Coverage Equipment and Methods

All equipment and survey methods are detailed in the DAPR.

B.2.9 Multibeam Coverage Analysis

Leidos chose to achieve the coverage requirement using 100% or 200% SSS coverage with concurrent MBES. To achieve this coverage, the SSS was set to 50-meter range scale, and main scheme survey lines were typically collected 70-meters apart to ensure 100% SSS or 200% SSS coverage was achieved.

The SABER Gapchecker program was used to flag MBES data gaps within the CUBE surface. Additionally, the entire surface was visually scanned for holidays at various points during the data processing effort. Additional survey lines were run to fill any holidays that were detected as defined for complete coverage surveys in Section 5.2.2.3 of the HSSD and email correspondence dated 02/22/2023 (refer to Project Correspondence for additional details). MBES data and SSS imagery were reviewed and bathymetric splits were acquired if deemed necessary per hydrographer’s discretion, as noted in Section 5.2.2.1 of the HSSD.

A final review of the CUBE Depth surface for H13513 showed that there were no holidays as defined for complete coverage surveys in Section 5.2.2.3 of the HSSD or NOAA provided guidance (02/22/2023). Any three by three node gaps were along the outer swath data beyond side scan nadir coverage.

The final CUBE PFM grids were examined for the number of soundings contributing to the chosen CUBE hypotheses for each node by running SABER’s Frequency Distribution Tool on the Hypothesis Number of Soundings (Hyp. # Soundings) surface. The Hyp. # Soundings surface reports the number of soundings that were used to compute the chosen hypothesis. Analysis was conducted on the Hyp. # Soundings surface of the PFM grid to ensure that the requirements for Complete Coverage surveys (HSSD Section 5.2.2.3) were met. Within the final 1-meter CUBE PFM grid 99.44% of all nodes contained five or more soundings.

As noted in Section A.4, the assigned survey bounds were achieved across H13513 except where the inshore limit of the NALL was reached or the shoreline bathymetry made it unsafe for equipment and crew to continue into shoaler depths.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

All data reduction procedures conform to those detailed in the DAPR.

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Side Scan Sonar (SSS) Coverage Analysis: For all details regarding SSS data processing, see the DAPR. Leidos chose to adhere to the coverage requirements in the PI using Complete Coverage, Option B (100% side scan sonar coverage with concurrent multibeam). Leidos generated two separate coverage mosaics at 1-meter cell size resolution as specified in Section 8.2.1 of the HSSD (See section B.2.9 for additional information). The first 100% and second 100% coverage mosaics were independently reviewed using tools in SABER to verify data quality and swath coverage. The SABER Gapchecker routine was used to flag data gaps within each of the 100% SSS coverage mosaics. Additionally, the entirety of each SSS surface was visually scanned for holidays at various points during the data processing effort. Additional survey lines were run to fill any holidays that were detected. All coverage mosaics are determined to be complete and sufficient to meet the requirements contained within the PI and HSSD. Each 100 percent coverage mosaic is delivered as a single georeferenced raster file (datum of NAD-83) in floating point GeoTIFF format, as specified in Sections 8.2.1 and 8.3.3 in the HSSD.

Multibeam Echo Sounder Seafloor Backscatter: For all details regarding MBES backscatter acquisition and processing see the DAPR. Leidos generated a MBES backscatter at 2-meter cell resolution; per HSSD. The MBES backscatter mosaic was reviewed for data quality and coverage. The MBES backscatter data acquired were written to the GSF in real-time by ISS-2000 and are delivered in the final GSF files for this sheet under the Processed/Sonar_Data/H13513_MB directory. The MBES backscatter mosaic was determined to be complete and sufficient to meet the requirements contained within the PI and HSSD. The coverage mosaic is delivered as a single georeferenced raster file (datum of NAD-83) in floating point GeoTIFF format, as specified in Section 6.2.4.2 in the HSSD.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following software program was the primary program used for bathymetric data processing:

Manufacturer	Name	Version
Leidos	SABER	5.4.1.6.1

Table 10: Primary bathymetric data processing software

The following software program was the primary program used for imagery data processing:

Manufacturer	Name	Version
Leidos	SABER	5.4.1.6.1
QPS	FMGT	7.10.3

Table 11: Primary imagery data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2022.

The primary data processing software used for both bathymetry and imagery was SABER.

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
H13513_MB_1m_MLLW_Final	BAG	1 meters	1.363 meters - 9.806 meters	N/A	Complete coverage, Option B
H13513_SSSAB_1m_900kHz_1of1	SSS Mosaic	1 meters	-	N/A	100% SSS
H13513_SSSAB_1m_900kHz_2of2	SSS Mosaic	1 meters	-	N/A	200% SSS
H13513_MBAB_2m_OysterBayII_300kHz_1of1	MB Backscatter Mosaic	2 meters	-	N/A	Multibeam Backscatter Coverage

Table 12: Submitted Surfaces

Complete Coverage Section 5.2.2.2 of the HSSD requires 1-meter node resolution for depths ranging from zero meters to 20 meters. Leidos generated a CUBE PFM grid for H13513 at 1-meter resolution (Figure 2).

The final gridded bathymetry data are delivered in Bathymetric Attributed Grid (BAG) format. The BAG files were exported from the CUBE PFM grid as detailed in the DAPR.

C. Vertical and Horizontal Control

In accordance with HSSD Section 2.2, the horizontal datum for this project is NAD83. HSSD Section 2.2 states that the "only exception for the NAD83 datum requirement is that the S-57 Final Feature File (Section 7.3) will be in the WGS84 datum to comply with international S-57 specifications". As discussed in the DAPR Section C.7, for every feature flag in a MBES GSF file, SABER converts the position from the NAD83 datum to the WGS84 datum to generate the S-57 file and comply with HSSD and IHO requirements. Feature positions meet the precision stated in HSSD Section 7.4 for each respective datum. Depending on geographic reference there may be approximately a 1-meter difference comparing positions between NAD83 and WGS84 datums. Therefore, if the feature overrides from the BAG surface (NAD83) are compared to the Final Feature File S-57 positions (WGS84) it is anticipated that there could be positional differences exceeding those listed in Section 7.4 of the HSSD. Additional information discussing the vertical and horizontal control for this survey can be found in the DAPR.

C.1 Vertical Control

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

<u>ERS Datum Transformation</u>

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

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	OPR-E347-KR-22 _NAD83_VDatum_MLLW.cov

Table 13: ERS method and SEP file

Refer to the DAPR for details regarding the application of VDatum to the MBES data files. No final tide note was provided nor was it required from NOAA Center for Operational Oceanographic Products and Services (CO-OPS).

C.2 Horizontal Control

The horizontal datum for this project is North American Datum 1983 (2011).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 18.

PPP

The vessel kinematic data (POS/MV files) were post-processed in Applanix POSPac software using the Applanix PP-RTX solution to generate the Smoothed Best Estimate of Trajectory (SBET) solutions which were applied through SABER to the multibeam data. Refer to the DAPR for additional information and for details regarding all antenna and transducer offsets. Any soundings with total horizontal uncertainties exceeding the maximum allowable IHO S-44 6th Edition Order 1a specifications were flagged as invalid and therefore were not used in the CUBE depth calculations.

D. Results and Recommendations

D.1 Chart Comparison

Chart comparisons were conducted using a combination of SABER and CARIS' HIPS and SIPS. H13513 data met data accuracy standards and bottom coverage requirements. Leidos recommends updating the common areas of all charts using data from this survey. Review showed that the H13513 CUBE data were generally in agreement with charted depths compared to the ENCs listed in Section D.1.1. Depths were typically observed to be within ±1m; some greater variation was observed in shoaler areas.

Charting recommendations for new features and updates to charted features, are documented in the H13513 S-57 FFF. Additional charted objects are discussed in later sections.

United States Coast Guard (USCG) District 5 LNM publications were reviewed for changes subsequent to the date of the PI and before the end of survey. The LNM reviewed were from week 35/22 (30 August 2022) until week 27/23 (05 July 2023).

Leidos confirmed all ATONs encountered were on station and serving their intended purpose during survey operations.

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
US5MD17M	1:40000	19	12/03/2021	02/09/2023
US5MD18M	1:40000	17	01/28/2022	07/26/2023
US5MD1AM	1:40000	9	09/10/2021	06/27/2023
US5MD13M	1:40000	32	05/09/2023	07/14/2023
US5MD16M	1:40000	34	05/09/2023	05/09/2023

Table 14: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

Refer to Section D.1.4 for significant shoals or hazardous features within the area covered by this survey. Leidos submitted the following DTON reports to the Atlantic Hydrographic Branch (AHB) in S-57 format per HSSD:
-H13513_DTON_01.000, submitted to AHB 2022-11-14, NDB registration DD-37351
-H13513_DTON_02_06.000, submitted to AHB 2023-08-01

D.1.3 Charted Features

There were numerous assigned charted features in the final CSF within the SOW of H13513. Per HSSD Section 8.1.4, these charted features are not addressed in this section, refer to the H13513 S-57 FFF (H13513_FFF.000) for all the details and recommendations regarding these features.

D.1.4 Uncharted Features

See the H13513 S-57 FFF for all the details and recommendations regarding new uncharted features investigated. During the course of H13513 survey operations, fishing gear and temporary floats were observed throughout the survey area. When a temporary fishing surface float was identified and correlated to objects in the MBES data, as these data were not true seafloor the MBES data were invalidated to no longer contributed to a CUBE surface. In many cases, where it was not possible to confirm the fishing gear were not derelict or tied to a surface float, the object was retained in the MBES data. See Section B.2.5 for more information. Per the HSSD Section 7.3.6, temporary uncharted buoys (e.g. those associated with fishing activity) were not provided in the FFF. Associated contacts are provided within the SSS Contacts S57.

D.1.5 Channels

There were no assigned channels within the H13513 SOW from the final CSF. However, the survey area was coincident to Safety Fairway (FAIRWY) to the Knapps Narrows Channel (US5MD1AM). Under OPR-E350-KR-20 Leidos had transited through Knapps Narrows Channel and submitted a DTON (05-06-2021); as observed depths were shoaler than charted depths and the Channel was not safely navigable. During H13513, observed depths were shoaler than currently charted depths. The full FAIRWY was not surveyed in H13513 as NALL was reached, as depicted in Figure 14.

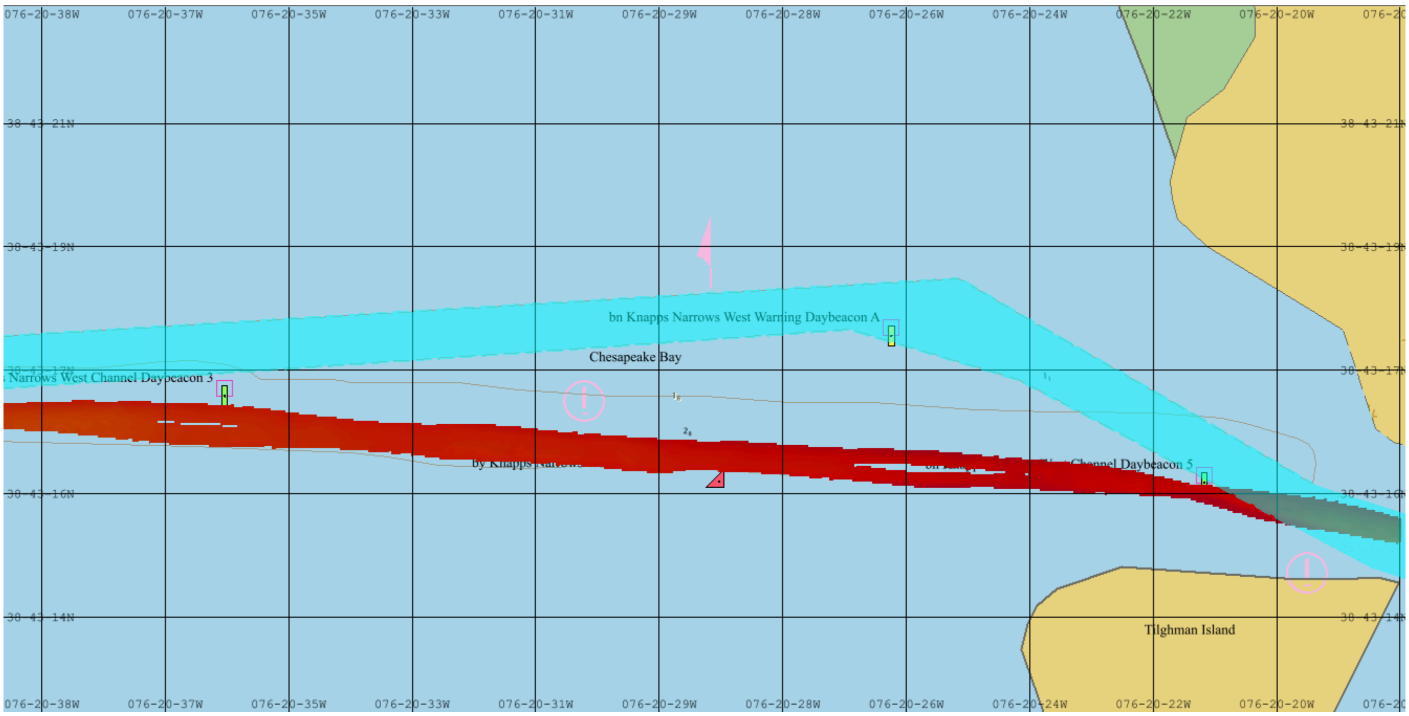

Figure 14: Achieved H13513 coverage in area of Knapps Narrows Channel

D.2 Additional Results

D.2.1 Aids to Navigation

While there were no assigned Aids to Navigation (ATON) within the SOW of H13513 from the final CSF; there were numerous USCG and privately maintained fixed and floating ATONs within H13513. Per HSSD Section 7.3.6 and the CSF, ATONs found on-station are not provided within the FFF.

Clam line buoys, shell fishing buoys, and speed limit buoys are examples of buoys that were observed to be temporary in nature and/or repositioned frequently; as mentioned in Section D.1.4, these buoys were not included in the FFF. Associated contacts for all ATONs and temporary buoys are provided within the SSS Contacts S-57.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

In accordance with both the PI and Section 7.2.3 of the HSSD, bottom characteristics were obtained for H13513. Bottom characteristics were acquired at the locations assigned in the final PRF. Leidos did not modify the bottom sample locations from the location proposed by NOAA in the PRF. Bottom characteristics are included in the S-57 FFF. In addition, images of the sediment obtained for each bottom sample are referenced in the S-57 FFF and are included on the delivery drive under the folder H13513/Processed/Multimedia.

D.2.4 Overhead Features

There were no overhead features within this survey area.

D.2.5 Submarine Features

There were no submarine features charted or identified within this survey area.

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

No other abnormal seafloor or environmental conditions, as defined in Section 8.1.4 of the HSSD, exist within this survey area other than those discussed in Section B.2.5 and D.1.2.

D.2.9 Construction and Dredging

While there were no active construction or dredging activities occurring during survey acquisition within the bounds of achieved H13513 coverage, there was evidence that construction/dredging operations had been occurring for the area of Poplar Island which is being filled. This area of Poplar Island which is being filled, exists west and inshore of the H13513 survey area. Within the bounds of H13513 survey area there were four assigned mooring facilities, located east of the area of Poplar Island that is being filled. Within these assigned mooring facilities, no mooring operations were observed during survey acquisition, and moorings were no longer observed to be present, however, there was evidence of disturbed sediment and mounding from previous anchoring, and dredge spoils from off vessels. Refer to the H135153 FFF and SSS Contacts S-57.

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 Hydrographic Survey Specifications and Deliverables, 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. Previously submitted deliverables for OPR-E347-KR-22 are provided in the table below.

Report Name	Report Date Sent
OPR-E347-KR-22 Final Project Summary Report.pdf	2023-05-31
OPR-E347-KR-22_ Marine_Species_Awareness_Training_Record.pdf	2023-06-21
OPR-E347-KR-22_Coast Pilot Review Report.pdf	2023-06-22
OPR-E347-KR-22_DAPR.pdf	2023-07-17
H13511_DR.pdf	2023-07-17
H13515_DR.pdf	2023-07-18
H13514_DR.pdf	2023-07-19
OPR-E347-KR-22_20230719.zip (NCEI Sound Speed Data)	2023-07-19
H13517_DR.pdf	2023-07-20
H13684_DR.pdf	2023-07-20
H13685_DR.pdf	2023-07-21
H13512_DR.pdf	2023-07-28

Approver Name	Approver Title	Approval Date	Signature
Alex T. Bernier	Lead Hydrographer	08/01/2023	Alex T. Bernier Digitally signed by Alex T. Bernier Date: 2023.08.01 21:00:35 -04'00'

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