

H13516

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

DESCRIPTIVE REPORT

Type of Survey: Basic Hydrographic Survey

Registry Number: H13516

LOCALITY

State(s): Maryland

General Locality: Central Chesapeake Bay

Sub-locality: 3 NM Northwest of Love Point

2023

CHIEF OF PARTY
Bridget W. Bernier

LIBRARY & ARCHIVES

Date:

HYDROGRAPHIC TITLE SHEET

H13516

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: **3 NM Northwest of Love Point**

Scale: **10000**

Dates of Survey: **09/21/2022 to 04/27/2023**

Instructions Dated: **08/23/2022**

Project Number: **OPR-E347-KR-22**

Field Unit: **Leidos**

Chief of Party: **Bridget W. 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 H13516

Project: OPR-E347-KR-22

Locality: Central Chesapeake Bay

Sublocality: 3 NM Northwest of Love Point

Scale: 1:10000

September 2022 - April 2023

Leidos

Chief of Party: Bridget W. Bernier

A. Area Surveyed

H13516 was located within the Central Chesapeake Bay, Maryland 3NM northwest of Love Point (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
39° 8' 41.07" N 76° 24' 25.36" W	39° 1' 11.16" N 76° 17' 28.65" W

Table 1: Survey Limits

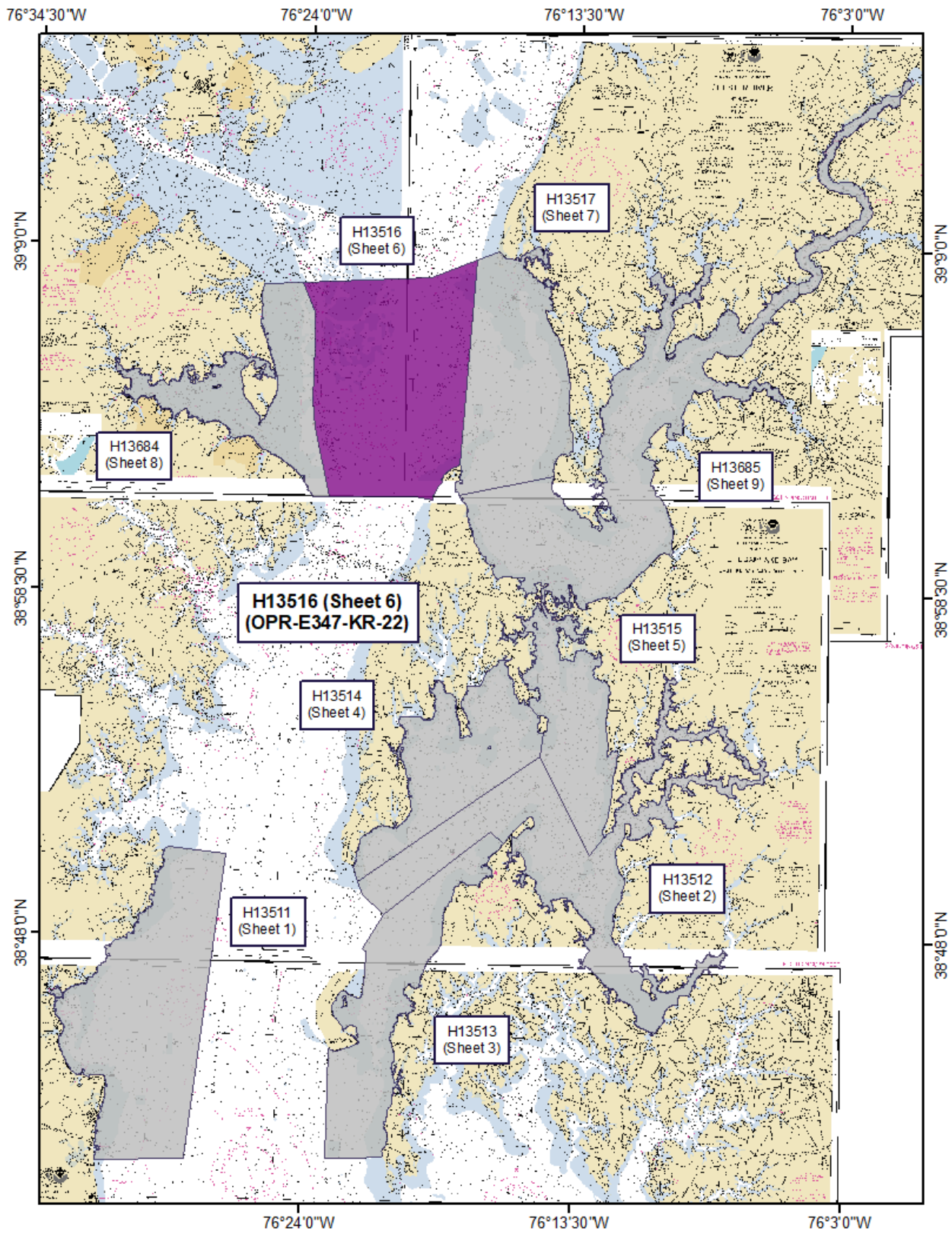


Figure 1: H13516 Survey Bounds

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.

H13516 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
Sheet 6	Object Detection Coverage (Refer to HSSD Section 5.2.2.2)
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

Survey coverage achieved was in accordance with the requirements in the PI and the HSSD (Figure 2). Leidos chose to achieve the coverage requirement using Object Detection Coverage, Option A and B (100% multibeam coverage and 200% side scan sonar coverage with concurrent multibeam). In many areas of H13516 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 to 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.

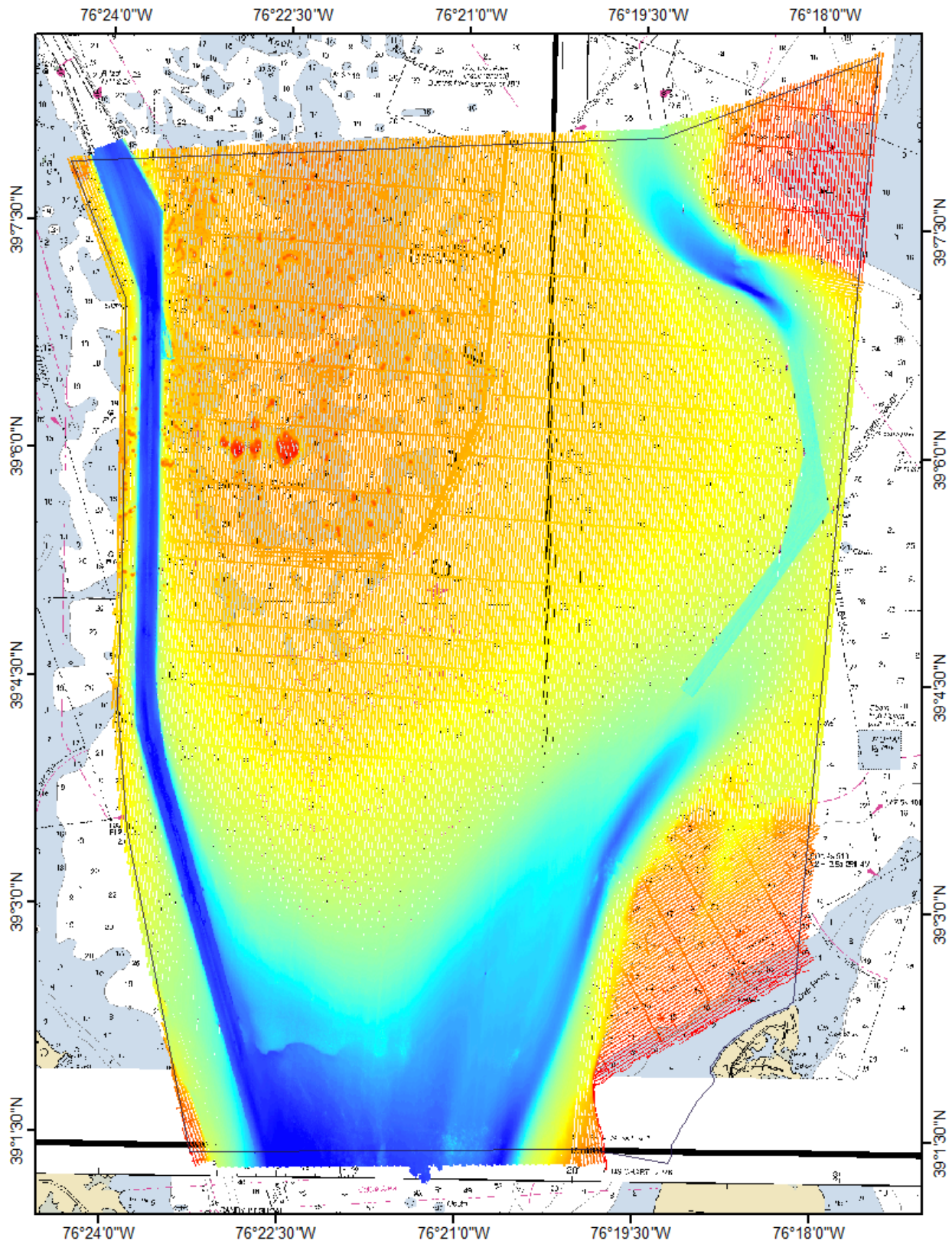


Figure 2: Final Bathymetry Coverage for H13516

A.6 Survey Statistics

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

	HULL ID	<i>R/V Sea Innovator I</i>	<i>R/V Oyster Bay II</i>	<i>Total</i>
LNM	SBES Mainscheme	0.0	0.0	0.0
	MBES Mainscheme	0.0	0.0	0.0
	Lidar Mainscheme	0.0	0.0	0.0
	SSS Mainscheme	0.0	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0	0.0
	MBES/SSS Mainscheme	1089.82	533.48	1623.3
	SBES/MBES Crosslines	56.79	26.91	83.7
	Lidar Crosslines	0.0	0.0	0.0
Number of Bottom Samples				5
Number Maritime Boundary Points Investigated				0
Number of DPs				0
Number of Items Investigated by Dive Ops				0
Total SNM				31.0

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
09/21/2022	264
10/04/2022	277
10/05/2022	278
10/06/2022	279
10/07/2022	280
10/08/2022	281
10/09/2022	282
10/10/2022	283
10/11/2022	284
10/12/2022	285
10/13/2022	286
10/14/2022	287
10/16/2022	289
10/21/2022	294
10/22/2022	295
10/24/2022	297
10/25/2022	298
11/02/2022	306
11/03/2022	307
03/05/2023	64
03/06/2023	65
03/12/2023	71
03/13/2023	72
03/16/2023	75
03/20/2023	79
03/21/2023	80
03/22/2023	81
04/27/2023	117

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	<i>R/V Sea Innovator 1</i>	<i>R/V Oyster Bay II</i>
LOA	135.0 feet	30.0 feet
Draft	9.0 feet	3.0 feet

Table 5: Vessels Used



Figure 3: R/V Sea Innovator 1



Figure 4: R/V Oyster Bay II

The R/V Sea Innovator I (Figure 3) was used to collect multibeam echo sounder (MBES) (RESON SeaBat T50), side scan sonar (SSS) (Klein 4000), and sound speed data during twenty four hours per day survey operations. The R/V Oyster Bay II (Figure 4) 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 4000	SSS
Klein Marine Systems	System 4900	SSS
Applanix	POS MV 320 v5	Positioning and Attitude System
AML Oceanographic	MVP30	Conductivity, Temperature, and Depth Sensor
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 5.15% of mainscheme acquisition. The resulting crossline to mainscheme percentage met the requirement to achieve approximately four percent of mainscheme mileage for a object detection coverage multibeam survey (Section 5.2.4.2 of the HSSD).

The mainscheme lines were spaced 40 meters apart, and crosslines were generally spaced 750 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 50-centimeter resolution for all data. One grid contained the full valid swath ($\pm 65^\circ$ from nadir, Class 2) of mainscheme multibeam and the other included only the near nadir swath ($\pm 5^\circ$ from nadir, Class 1) crossline data. The difference grid was created by subtracting the 50-centimeter H13516 mainscheme CUBE depths from the 50-centimeter H13516 crossline CUBE depths. Additional comparisons were conducted of each vessel's mainscheme to crossline depth data. These results are summarized in Figure 5.

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]. For all the crossline to mainscheme analysis conducted for H13516, 100% of the comparisons were within TVU. Results for all crossing analysis are summarized in Figure 5.

As multiple vessels were used to survey H13516 repeatability analysis was performed between the data collected by both vessels where coincident. Of the vessel to vessel analysis, 99.99% of the comparisons were within TVU. Results are summarized in Figure 6; comparisons which exceeded the maximum allowable TVU were associated with features.

Results for analysis conducted are presented in Figure 7 to Figure 14.

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 Sea Innovator I and R/V Oyster Bay II MBES 50cm: Crossline (Class 1) to Mainscheme	2.790 – 19.580	0.501 – 0.561	100.00%
R/V Sea Innovator I MBES 50cm: Crossline (Class 1) Mainscheme	6.100 – 19.580	0.501 – 0.552	100.00%
R/V Oyster Bay II MBES 50cm: Crossline (Class 1) to Mainscheme	2.790 – 17.970	0.501 – 0.552	100.00%

Figure 5: Summary of Crossing Analysis

Repeatability Analysis	Minimum and Maximum CUBE Depth (meters) of Comparison	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 Sea Innovator I MBES 50cm to R/V Oyster Bay II MBES 50cm	3.010 – 19.700	0.502 – 0.562	99.99%

Figure 6: Summary of Vessel Comparison Repeatability Analysis

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	208045	23.12	61252	6.81	76883	8.54	69910	7.77
>0.01-0.02	130841	37.66	51075	12.48	79766	17.41		
>0.02-0.03	118156	50.79	40200	16.95	77956	26.07		
>0.03-0.04	103488	62.29	31055	20.40	72433	34.12		
>0.04-0.05	88389	72.11	22718	22.92	65671	41.41		
>0.05-0.06	72043	80.11	16173	24.72	55870	47.62		
>0.06-0.07	55680	86.30	11264	25.97	44416	52.56		
>0.07-0.08	41144	90.87	8124	26.88	33020	56.23		
>0.08-0.09	29791	94.18	6297	27.57	23494	58.84		
>0.09-0.1	19685	96.37	4096	28.03	15589	60.57		
>0.1-0.11	12281	97.73	2548	28.31	9733	61.65		
>0.11-0.12	7785	98.60	1663	28.50	6122	62.33		
>0.12-0.13	5078	99.16	1255	28.64	3823	62.76		
>0.13-0.14	3068	99.50	822	28.73	2246	63.01		
>0.14-0.15	1573	99.68	525	28.79	1048	63.12		
>0.15-0.16	923	99.78	367	28.83	556	63.18		
>0.16-0.17	559	99.84	273	28.86	286	63.22		
>0.17-0.18	338	99.88	157	28.88	181	63.24		
>0.18-0.19	205	99.90	102	28.89	103	63.25		
>0.19-0.2	118	99.92	71	28.89	47	63.25		
>0.2-0.3	358	99.96	116	28.91	242	63.28		
>0.3-0.4	377	99.99	16	28.91	361	63.32		
>0.4-0.47	16	100.00	3	28.91	13	63.32		
Total	899941	100.00%	260172	28.91%	569859	63.32%	69910	7.77%

Reference Grid: H13516_MB_50cm_Cross_H13516_MB_50cm_Main.dif

Figure 7: Tabular Results Crossing Analysis, Crosslines vs. Mainscheme Lines

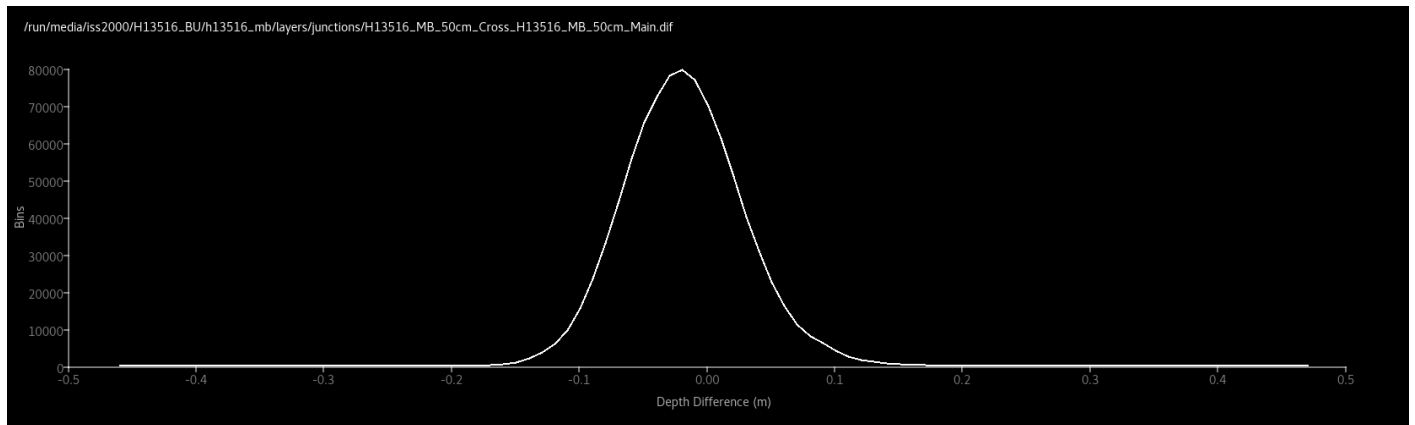


Figure 8: Plot of Crossing Analysis Crosslines vs. Mainscheme Lines

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	110347	15.67	48517	6.89	56480	8.02	5350	0.76
>0.01-0.02	91399	28.65	37899	12.27	53500	15.62		
>0.02-0.03	94201	42.02	34039	17.10	60162	24.16		
>0.03-0.04	85558	54.17	26860	20.92	58698	32.50		
>0.04-0.05	83334	66.01	22038	24.05	61296	41.20		
>0.05-0.06	64435	75.16	14773	26.15	49662	48.25		
>0.06-0.07	52250	82.58	10077	27.58	42173	54.24		
>0.07-0.08	36078	87.70	6574	28.51	29504	58.43		
>0.08-0.09	30532	92.04	5834	29.34	24698	61.94		
>0.09-0.1	21365	95.07	4189	29.93	17176	64.38		
>0.1-0.11	14040	97.06	2711	30.32	11329	65.98		
>0.11-0.12	8924	98.33	1614	30.55	7310	67.02		
>0.12-0.13	5563	99.12	1199	30.72	4364	67.64		
>0.13-0.14	3241	99.58	769	30.83	2472	67.99		
>0.14-0.15	1561	99.80	398	30.88	1163	68.16		
>0.15-0.16	720	99.90	187	30.91	533	68.23		
>0.16-0.17	292	99.95	68	30.92	224	68.27		
>0.17-0.18	181	99.97	36	30.93	145	68.29		
>0.18-0.19	88	99.98	18	30.93	70	68.30		
>0.19-0.2	47	99.99	12	30.93	35	68.30		
>0.2-0.3	57	99.99	26	30.93	31	68.31		
>0.3-0.4	9	99.99	7	30.93	2	68.31		
>0.4-0.465	3	100.00	3	30.93	0	68.31		
Total	704224	100.00%	217847	30.93%	481027	68.31%	5350	0.76%

Reference Grid: h13516_mb_SI_Cross_pfm_h13516_mb_SI_Main_pfm.dif

Figure 9: Tabular Results Crossing Analysis, R/V Sea Innovator I Crosslines vs. Mainscheme Lines

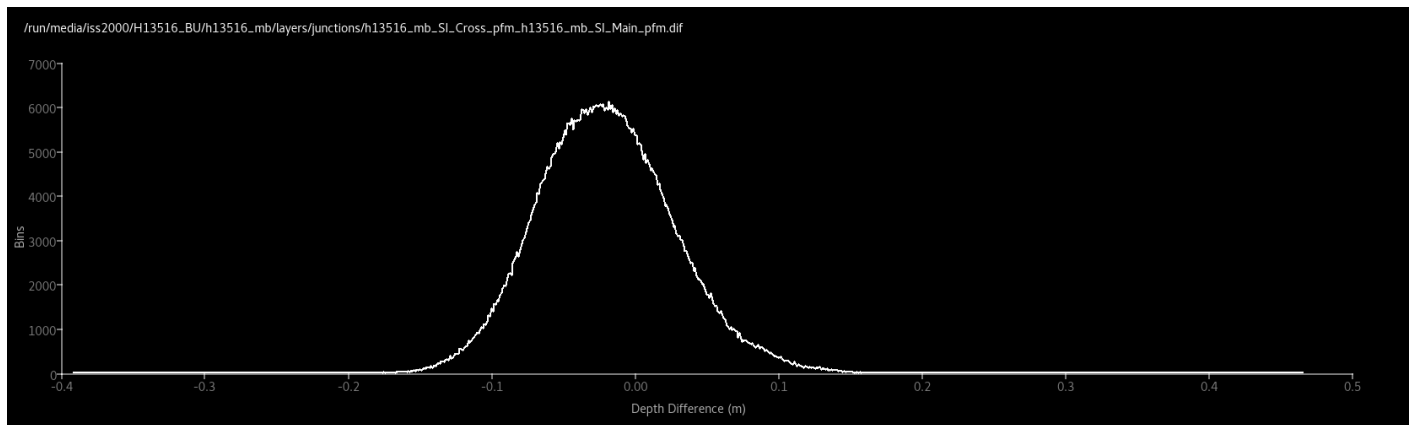


Figure 10: Plot of Crossing Analysis R/V Sea Innovator I Crosslines vs. Mainscheme Lines

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	36076	20.62	15836	9.05	18601	10.63	1639	0.94
>0.01-0.02	29979	37.76	11951	15.88	18028	20.94		
>0.02-0.03	29605	54.68	10346	21.80	19259	31.95		
>0.03-0.04	24742	68.82	7924	26.33	16818	41.56		
>0.04-0.05	20304	80.43	5722	29.60	14582	49.89		
>0.05-0.06	13331	88.05	3229	31.44	10102	55.67		
>0.06-0.07	8659	93.00	1914	32.54	6745	59.52		
>0.07-0.08	5084	95.90	1039	33.13	4045	61.84		
>0.08-0.09	3542	97.93	725	33.55	2817	63.45		
>0.09-0.1	2006	99.08	446	33.80	1560	64.34		
>0.1-0.11	781	99.52	153	33.89	628	64.70		
>0.11-0.12	314	99.70	74	33.93	240	64.83		
>0.12-0.13	165	99.80	64	33.97	101	64.89		
>0.13-0.14	112	99.86	40	33.99	72	64.93		
>0.14-0.15	70	99.90	30	34.01	40	64.96		
>0.15-0.16	50	99.93	21	34.02	29	64.97		
>0.16-0.17	26	99.94	12	34.03	14	64.98		
>0.17-0.18	22	99.96	15	34.03	7	64.98		
>0.18-0.19	15	99.96	8	34.04	7	64.99		
>0.19-0.2	10	99.97	4	34.04	6	64.99		
>0.2-0.3	39	99.99	7	34.04	32	65.01		
>0.3-0.4	10	100.00	0	34.04	10	65.02		
>0.4-0.458	5	100.00	0	34.04	5	65.02		
Total	174946	100.00%	59560	34.04%	113747	65.02%	1639	0.94%
Reference Grid: H13516_MB_50cm_OBII_Cross_pfm_H13516_MB_50cm_OBII_Main_pfm.dif								

Figure 11: Tabular Results Crossing Analysis, R/V Oyster Bay II Crosslines vs. Mainscheme Lines

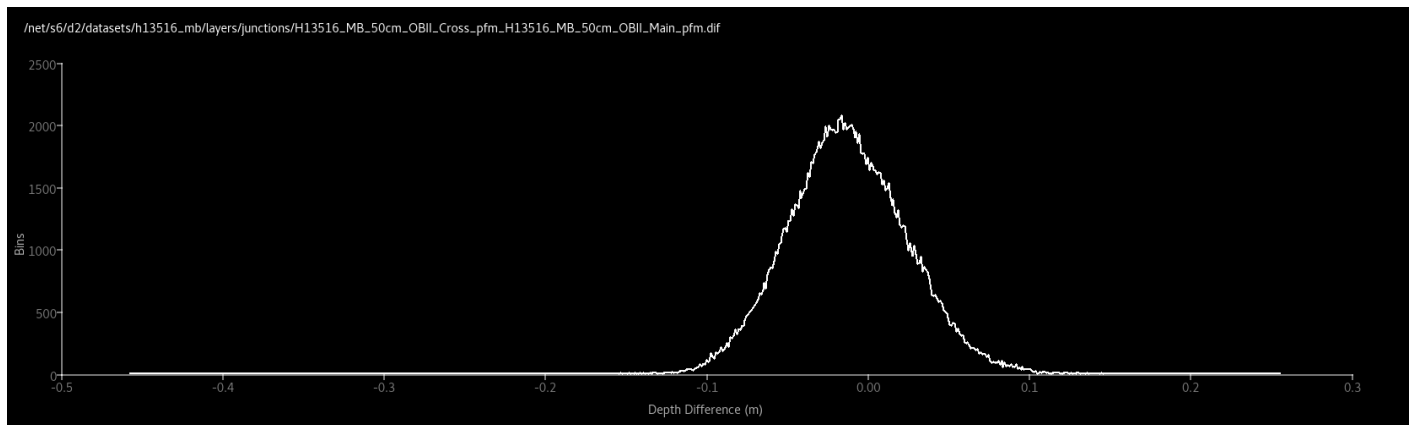


Figure 12: Plot of Crossing Analysis R/V Oyster Bay II Crosslines vs. Mainscheme Lines

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.1	6107491	71.01	1059528	12.32	4764303	55.39	283660	3.30
>0.1-0.2	2201108	96.60	163555	14.22	2037553	79.08		
>0.2-0.3	186727	98.77	60773	14.93	125954	80.55		
>0.3-0.4	82391	99.73	45386	15.45	37005	80.98		
>0.4-0.5	20986	99.97	12310	15.60	8676	81.08		
>0.5-0.6	1605	99.99	1164	15.61	441	81.08		
>0.6-0.7	252	99.99	122	15.61	130	81.08		
>0.7-0.8	109	99.99	57	15.61	52	81.09		
>0.8-0.9	85	99.99	40	15.61	45	81.09		
>0.9-1	50	99.99	30	15.61	20	81.09		
>1-2	133	99.99	64	15.61	69	81.09		
>2-3	6	99.99	2	15.61	4	81.09		
>3-3.65	2	100.00	0	15.61	2	81.09		
Total	8600945	100.00%	1343031	15.61%	6974254	81.09%	283660	3.30%

Reference Grid: H13516_MB_50cm_OBII_H13516_MB_50cm_SI.dif

Figure 13: Tabular Results Vessel Comparison Analysis, R/V Sea Innovator I vs. R/V Oyster Bay II

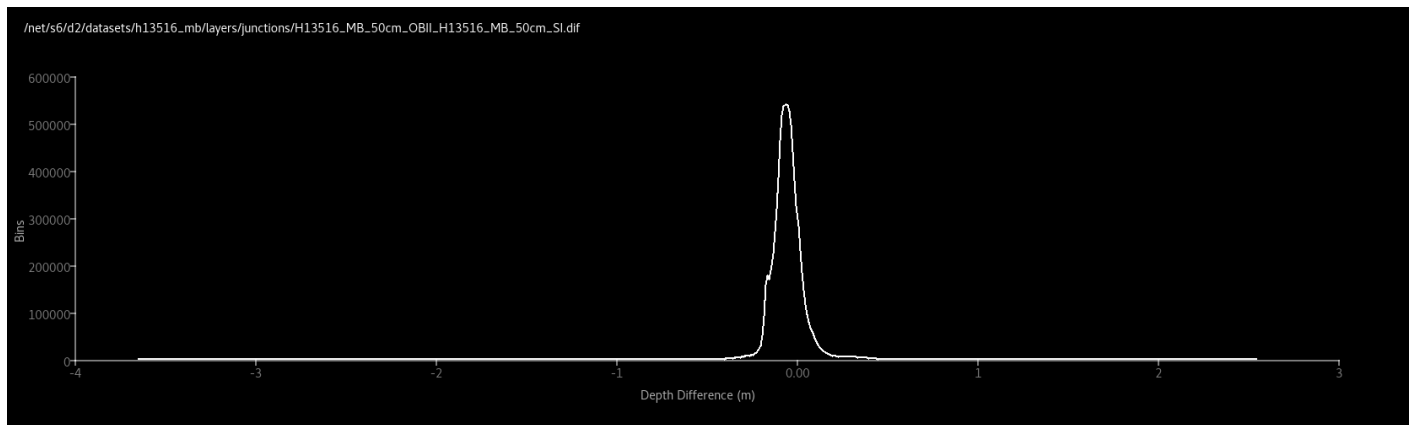


Figure 14: Plot of Vessel Comparison Analysis R/V Sea Innovator I vs. R/V Oyster Bay II

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 Sea Innovator I	1.0 meters/second	1.0 meters/second	1.0 meters/second	1.0 meters/second
R/V Oyster Bay II	1.0 meters/second	1.0 meters/second	1.0 meters/second	1.0 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 H13516 50-centimeter PFM CUBE surface contained final vertical uncertainties that ranged from 0.200 meters to 1.699 meters. The IHO Order 1a maximum allowable vertical uncertainty was calculated to range between 0.501 to 0.561 meters, based on the minimum CUBE depth (1.538 meters) and maximum CUBE depth (19.664 meters). Results from the SABER Check PFM Uncertainty function identified that there were 12,607 nodes in the final H13516 50-centimeter PFM CUBE surface with final vertical uncertainties that exceeded IHO Order 1a allowable vertical uncertainty. Nodes which exceeded IHO Order 1a were associated with objects found within the survey area, along steep slopes or areas containing reduced MBES data. The SABER Frequency Distribution Tool was also used to review the Hyp. Final Uncertainty surface within the final H13516 50-centimeter CUBE PFM grid. Results showed that 98.52% of all nodes had final uncertainties less than or equal to 0.220 meters.

B.2.3 Junctions

Per the PI, junction analysis was performed between H13516 and the surveys listed in the table below and illustrated in Figure 15; results are discussed below. The analysis between H13516 and H13517 was provided within the H13517 Descriptive Report.

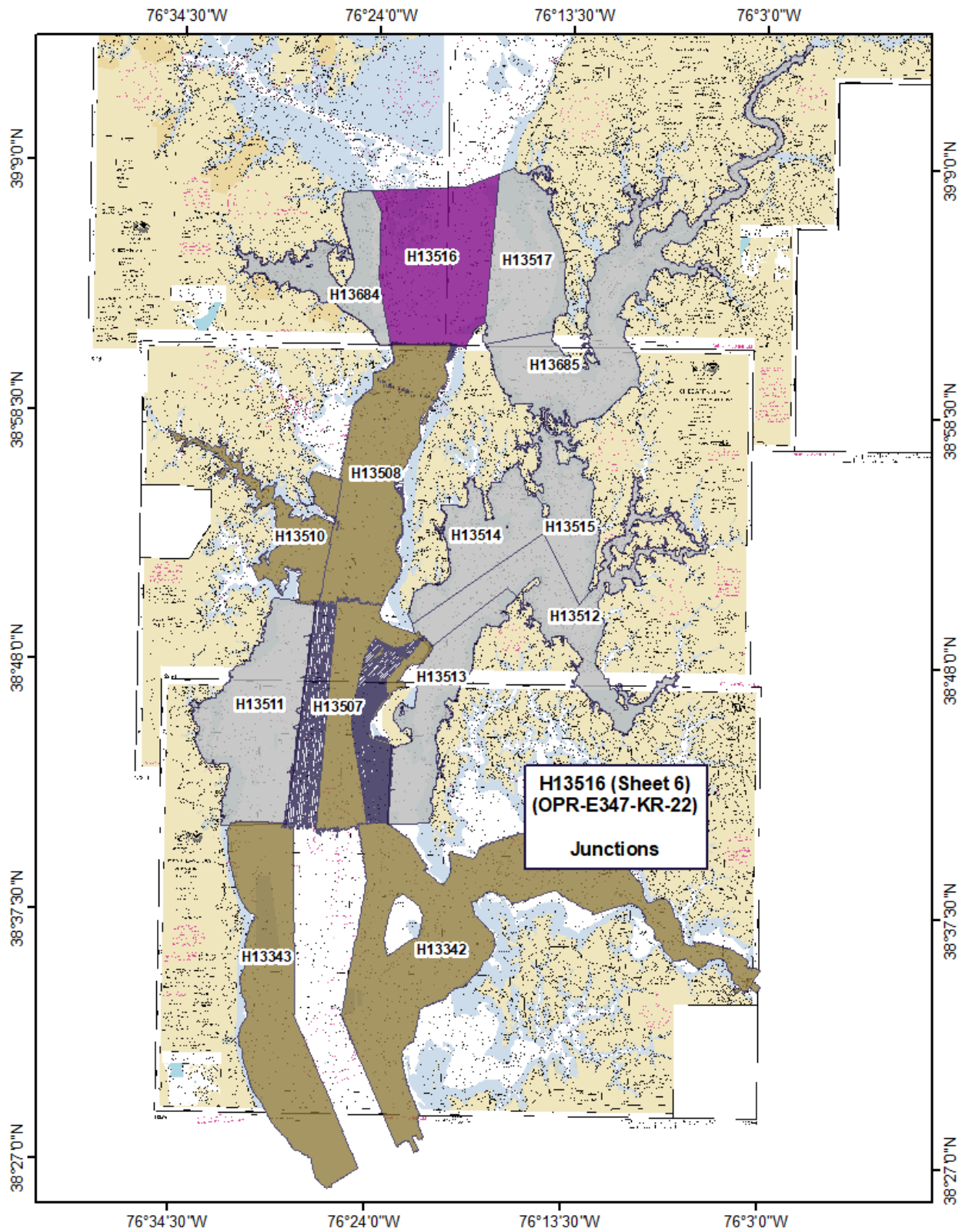


Figure 15: General Locality of H13516 with Junctioning Surveys

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13684	1:10000	2023	Leidos	W
H13508	1:5000	2021	NOAA Ship Thomas Jefferson	S

Table 9: Junctioning Surveys

H13684

Junctioning survey H13684 was conducted in 2022-2023 and junctions to the west of H13516. For this analysis the H13684 1-meter CUBE depth surface was compared to the H13516 50-centimeter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 12,400 by 480 meters meters along the western edge of H13516. Observed depths within the common area were 2.877 to 10.489 meters, which resulted in a calculated allowable TVU range of 0.501 to 0.518 meters.

The difference grid was generated by subtracting the H13684 data from the H13516 data. Positive values indicate that H13516 depth data were deeper than H13684 depth data. Throughout the common area, H13516 CUBE depths were deeper 96.01% of the time and were shoaler 3.77% of the time (Figure 16). The distribution is centered on zero as presented in Figure 17. Differences exceeding the calculated allowable TVU range are attributed to the bottom topography gridded at different node resolutions.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-0.01	84046	4.56	52324	2.84	27689	1.50	4033	0.22
>0.01-0.02	83628	9.09	69426	6.60	14202	2.27		
>0.02-0.03	116142	15.38	107063	12.40	9079	2.76		
>0.03-0.04	140631	23.01	135141	19.73	5490	3.06		
>0.04-0.05	171154	32.28	167165	28.79	3989	3.28		
>0.05-0.06	154184	40.64	151704	37.01	2480	3.41		
>0.06-0.07	142125	48.34	140509	44.62	1616	3.50		
>0.07-0.08	110557	54.33	109464	50.56	1093	3.56		
>0.08-0.09	100571	59.79	99679	55.96	892	3.61		
>0.09-0.1	84307	64.35	83655	60.49	652	3.64		
>0.1-0.11	77503	68.56	76992	64.67	511	3.67		
>0.11-0.12	75189	72.63	74800	68.72	389	3.69		
>0.12-0.13	72376	76.55	72050	72.63	326	3.71		
>0.13-0.14	69461	80.32	69244	76.38	217	3.72		
>0.14-0.15	67277	83.96	67100	80.02	177	3.73		
>0.15-0.16	63268	87.39	63136	83.44	132	3.74		
>0.16-0.17	53958	90.32	53827	86.36	131	3.74		
>0.17-0.18	49503	93.00	49386	89.03	117	3.75		
>0.18-0.19	37479	95.03	37375	91.06	104	3.76		
>0.19-0.2	28453	96.57	28365	92.60	88	3.76		
>0.2-0.3	65140	99.98	64948	95.99	192	3.77		
>0.3-0.4	439	99.99	418	96.01	21	3.77		
>0.4-0.5	6	99.99	1	96.01	5	3.77		
>0.5-0.567	6	100.00	3	96.01	3	3.77		
Total	1845005	100.00%	1771384	96.01%	69588	3.77%	4033	0.22%
Reference Grid: H13516_MB_50cm_MLLW_Final_pfm_H13684_1m_MLLW_Final_bag.dif								

Figure 16: Tabular Results Junction Analysis H13516 vs. H13684

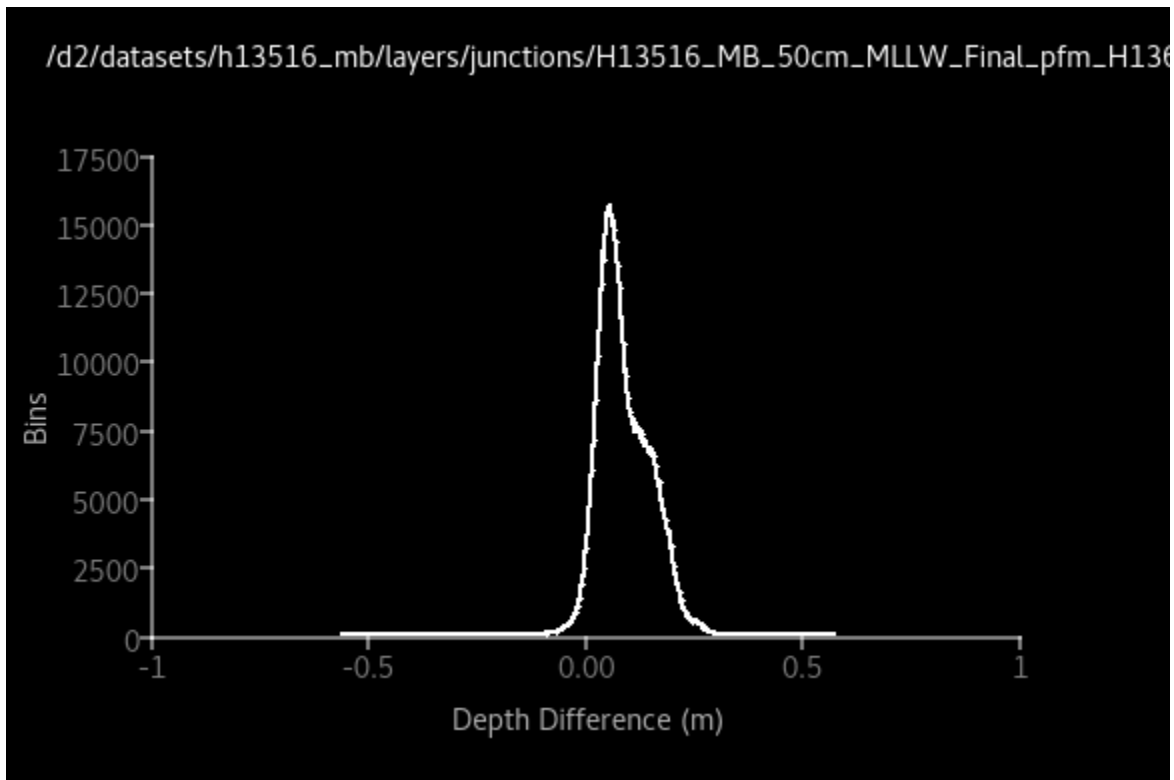


Figure 17: Plot of Junction Analysis H13516 vs. H13684

H13508

Junctioning survey H13508 was conducted in 2021 and junctions to the south of H13516. For this analysis the NOAA provided H13508 BAG (H13508_MB_VR_MLLW_1of1.bag) depth surface was compared to the H13516 50-centimeter CUBE depth surface. Junction analysis was conducted on the common area of these two sheets, with an overlapping area approximately 5,100 by 290 meters along the southern edge of H13516. Observed depths within the common area were 2.222 to 18.130 meters, which resulted in a calculated allowable TVU range of 0.501 to 0.553 meters.

The difference grid was generated by subtracting the H13508 data from the H13516 data. Positive values indicate that H13516 depth data were deeper than H13508 depth data. Throughout the common area, H13516 CUBE depths were deeper 49.02% of the time and were shallower 50.54% of the time (Figure 18). The distribution is centered on zero as presented in Figure 19. Differences exceeding the calculated allowable TVU range are attributed to the difference in node resolution as the H13508 was a variable resolution source grid stored at a coarse single node resolution (70-meter) within the NOAA provided BAG file. CUBE depths were in agreement between the two sheets.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0-1	6113694	99.84	2998766	48.97	3088346	50.44	26582	0.43
>1-2	8335	99.98	2648	49.02	5687	50.53		
>2-3	1301	99.99	442	49.02	859	50.54		
>3-4	1	99.99	0	49.02	1	50.54		
>4-5	1	99.99	0	49.02	1	50.54		
>5-5.109	1	100.00	0	49.02	1	50.54		
Total	6123333	100.00%	3001856	49.02%	3094895	50.54%	26582	0.43%

Reference Grid: H13516_MB_50cm_MLLW_Final_pfm_H13508_MB_VR_MLLW_1of1_bag.dif

Figure 18: Tabular Results Junction Analysis H13516 vs. H13508

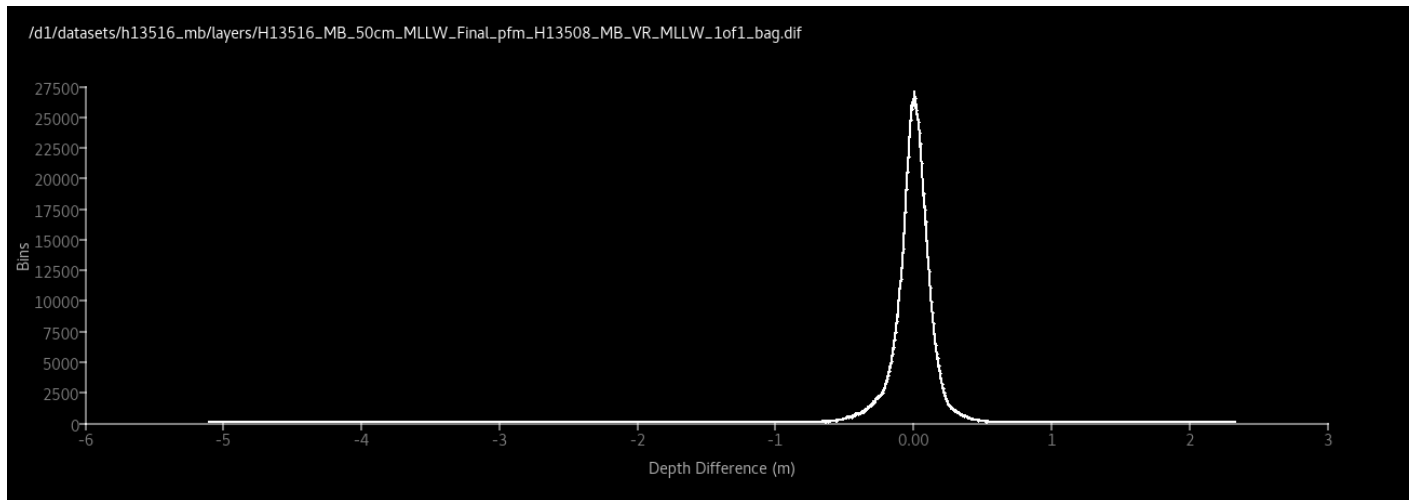


Figure 19: Plot of Junction Analysis H13516 vs. H13508

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 Sea Innovator I, the MVP30 was the primary system used to collect sound speed profile (SSP) data, and 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 H13516 data and are broken out into sub-folders, which correspond to the purpose of each cast. Also, all individual SSP files for H13516 have been concatenated into two separate files based on the purpose of the cast, provided in CARIS format files (.svp), and delivered under (H13516/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 200% SSS coverage with concurrent MBES or 100% MBES. To achieve this coverage, main scheme survey lines were spaced approximately 40-meters to ensure coverage was achieved. The SABER Gapchecker program was used to flag MBES data gaps

within the CUBE surface. 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 object detection coverage surveys in Section 5.2.2.2 of the HSSD and email correspondence dated 02-22-2023 (refer to Project Correspondence for additional details). Bathymetric data and side scan sonar 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 H13516 showed that there were no holidays as defined for object detection coverage surveys in Section 5.2.2.2 of the HSSD or NOAA provided guidance (02/22/2023).

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 Object Detection Coverage surveys (HSSD Section 5.2.2.2) were met. Within the final 50-centimeter CUBE PFM grid 99.29% of all nodes contained five or more soundings.

As noted in Section A.4, the assigned survey bounds were achieved across H13516 except where the inshore limit of the NALL was reached or the shoreline bathymetry made it unsafe of 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 as outlined in Section A.4. For H13516 the SSS range scale was set to 50-meters. 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 vessel; per HSSD. The MBES backscatter mosaics were 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/H13516_MB directory. All MBES backscatter mosaics are determined to be complete and sufficient to meet the requirements contained within the PI and HSSD. The coverage mosaics are 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
H13685_MB_50cm_MLLW_Final	BAG	0.5 meters	1.558 meters - 19.664 meters	N/A	Object Detection
H13516_SSSAB_1m_400kHz_900kHz_1of2	SSS Mosaic	1 meters	-	N/A	100% SSS
H13516_SSSAB_1m_400kHz_900kHz_2of2	SSS Mosaic	1 meters	-	N/A	200% SSS
H13516_MBAB_2m_SeaInnovatorI_400kHz_1of2	MB Backscatter Mosaic	2 meters	-	N/A	Multibeam Backscatter Coverage
H13516_MBAB_2m_OysterBayII_300kHz_2of2	MB Backscatter Mosaic	2 meters	-	N/A	Multibeam Backscatter Coverage

Table 12: Submitted Surfaces

Object Detection Coverage Section 5.2.2.2 of the HSSD requires 50-centimeter node resolution for depths ranging from zero meters to 20 meters. Leidos generated a CUBE PFM grid for H13516 at 50-centimeter resolution. A small number of CUBE nodes exceeded the 20 meter depth limit; Leidos confirmed that in these areas the requirements for coverage were met at 50-centimeter resolution.

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.

ERS Datum Transformation

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. H13516 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 H13516 CUBE data generally agreed well with charted depths compared to the ENC's listed in Section D.1.1. Charting recommendations for new features and updates to charted features, are documented in the H13516 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 24/23 (13 June 2023).

D.1.1 Electronic Navigational Charts

The following are the largest scale ENC's, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date
US5MD12M	1:40000	50	11/24/2021	06/27/2023
US5MD22M	1:25000	15	06/20/2023	01/07/2022

Table 14: Largest Scale ENC's

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:

-H13516_DT0N_01.000, submitted to AHB 2022-11-03, NDB registration DD-37292

-H13516_DT0N_02_07.000, submitted to AHB 2023-08-01, not forwarded by AHB at time of delivery

D.1.3 Charted Features

There were numerous assigned charted features in the final CSF (CSF.000) within the SOW of H13516. Per HSSD Section 8.1.4, these charted features are not addressed in this section, refer to the H13516 S-57 FFF (H13516_FFF.000) for all the details and recommendations regarding these features.

D.1.4 Uncharted Features

See the H13516 S-57 FFF for all the details and recommendations regarding new uncharted features investigated. During the course of H13516 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.

D.1.5 Channels

There were three channels coincident to H13516: Craighill Channel, Swan Point Channel, and Tolchester Channel. There were no discrepancies within the assigned dredge areas for these channels.

D.2 Additional Results

D.2.1 Aids to Navigation

While there were no assigned Aids to Navigation (ATON) within the SOW of H13516 from the final CSF; there were numerous USCG and privately maintained fixed and floating ATONs within H13516. Per HSSD Section 7.3.6 and the CSF, ATONs found on-station are not provided within the FFF. Associated contacts 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 H13516. Bottom characteristics were acquired at the assigned in the final PRF (PRF.000). 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 H13516/Processed/Multimedia.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

Refer to H13516 FFF for additional details regarding submarine features.

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

Bottom features within Craighill Channel, the slope of the channel was found to have migrated over the course of the survey. The changes in bottom topography created artifacts in the CUBE depth solution. Therefore; to reduce the artifact when there was sufficient data in a newer MBES pass the previous MBES data were invalidated. Smaller artifacts may be present where the two data passes meet. 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

No construction or dredging was observed during H13516 data acquisition. Artifacts from having conducted dredge operations to free the Ever Forward container ship ran around Craighill Channel were present in the H13516 data.

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.

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, or 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
OPR-E347-KR-22_20230719.zip (NCEI Sound Speed Data)	2023-07-19
H13514_DR.pdf	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
H13513_DR.pdf	2023-08-01

Approver Name	Approver Title	Approval Date	Signature
Bridget W. Bernier	Data Processing Manager	08/01/2023	Bridget Bernier: A01410D00000186FFAF186FFAF1CC60003D152 Digitally signed by Bridget Bernier: A01410D00000186FFAF1CC60003D152 Date: 2023.08.01 21:24:22 -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