H13502

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	H13502

LOCALITY

State(s):	Texas
General Locality:	Western Gulf of Mexico
Sub-locality:	Port Freeport

2021

CHIEF OF PARTY
Erin Markham

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Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13502**

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):	**Texas**
General Locality:	**Western Gulf of Mexico**
Sub-Locality:	**Port Freeport**
Scale:	**5000**
Dates of Survey:	**06/30/2021 to 08/04/2021**
Instructions Dated:	**05/13/2021**
Project Number:	**OPR-K380-KR-21**
Field Unit:	**Leidos**
Chief of Party:	**Erin Markham**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter Side Scan Sonar**
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 15N, 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 H13502

Project: OPR-K380-KR-21

Locality: Western Gulf of Mexico

Sublocality: Port Freeport

Scale: 1:5000

June 2021 - August 2021

Leidos

Chief of Party: Erin Markham

A. Area Surveyed

H13502 was located within the Port of Freeport, Texas. Southern limits extend approximately 10.5km offshore and northern limits extend approximately 5km up the Old Brazos River, encapsulating the Port of Freeport (Figure 1). The survey was conducted in accordance with coverage requirements listed in the Project Instructions.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
28° 57' 9.37" N 95° 20' 41.45" W	28° 51' 41.05" N 95° 12' 59.48" W

Table 1: Survey Limits

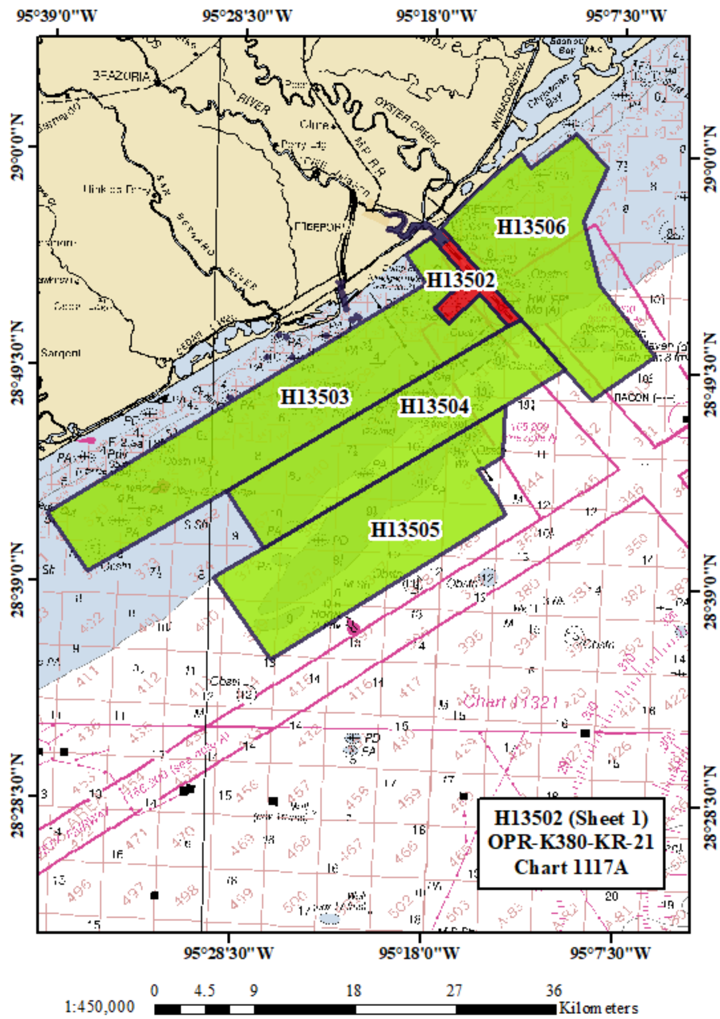

Figure 1: H13502 Survey Bounds

Survey limits were acquired in accordance with the requirements in the Project Instructions and the Hydrographic Survey Specifications and Deliverables (HSSD), April 2021.

A.2 Survey Purpose

This survey covers the general vicinity of the entrance channel to Port Freeport, Texas between the U.S. Coast Guard Station on the northwest of the entrance and Quintana Harbor to the southwest. The survey will wind 4.7 nautical miles south and west, around the Dow Chemical Plant Thumb to the Freeport Channel terminus. The surveyed area extends offshore 11 nautical miles to cover the approach channel, and 18 nautical miles southwest and 8 nautical miles northwest, outside safety fairway, where the AIS traffic deems intensity. Port Freeport, TX is undergoing channel expansion and deepening administered by the U.S Army

Corps of Engineers. Freeport will become the deepest port in Texas once the entrance and terminal channels reach the authorized 51-56 feet depth. With the physical position on the Intercoastal Waterway, direct rail and highway connections to major Texas hubs, and the deepened channels, Port Freeport is poised to exceed its current 28th ranking as the U.S. busiest port in tonnage transfer. Several powerful storms impacted the Port Freeport since the offshore vicinity was last surveyed in 2002 and the nearshore vicinity was last surveyed in the 1930s and 1960s. The Office of Coast Survey expects that modern hydrographic techniques will find significant changes to the seabed due to hurricane forces transforming the seafloor. 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.

H13502 was surveyed in accordance with the following documents:
1. 1305M221FNCNJ0270 signed.pdf, received 08 June 2021
2. Hydrographic Survey Specifications and Deliverables (HSSD), April 2021
3. OPR-K380-KR-21_PRF_FINAL_05032021.000, received 08 June 2021
4. OPR-K380-KR-21_CSF_FINAL_05032021.000, received 08 June 2021
5. OPR-K380-KR-21 Project Brief, held 24 June 2021
6. OPR-K380-KR-21 and OPR-K380-KR-21 feature guidance follow-up.pdf, 30 July 2021
7. 1305M221FNCNJ0270 - Modification P21001.pdf received 11 August 2021

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 Sheet 1	Object Detection Coverage (Refer to HSSD Section 5.2.2.2)

Table 2: Survey Coverage

Leidos chose to achieve the coverage requirement using Object Detection Coverage, Option B (200% side scan sonar coverage with concurrent multibeam). Survey coverage achieved was in accordance with the requirements in the Project Instructions and the HSSD (Figure 2 through Figure 4).

In many areas of H13502 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, moored vessels, or dredging equipment 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. During survey, attempts were made to acquire additional data where a moored vessel had been present, however many of these were stationary vessels that were present each day of survey within that area. Leidos coordinated survey effort with the Great Lakes Dredge & Dock Company yet moving of their equipment was not always possible.

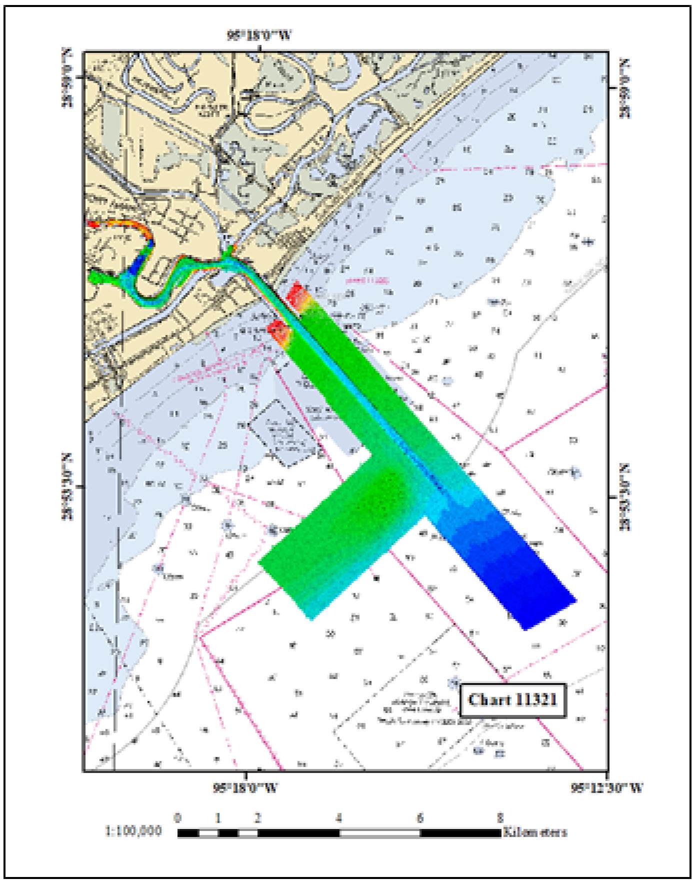

Figure 2: Final Bathymetry Coverage for H13502

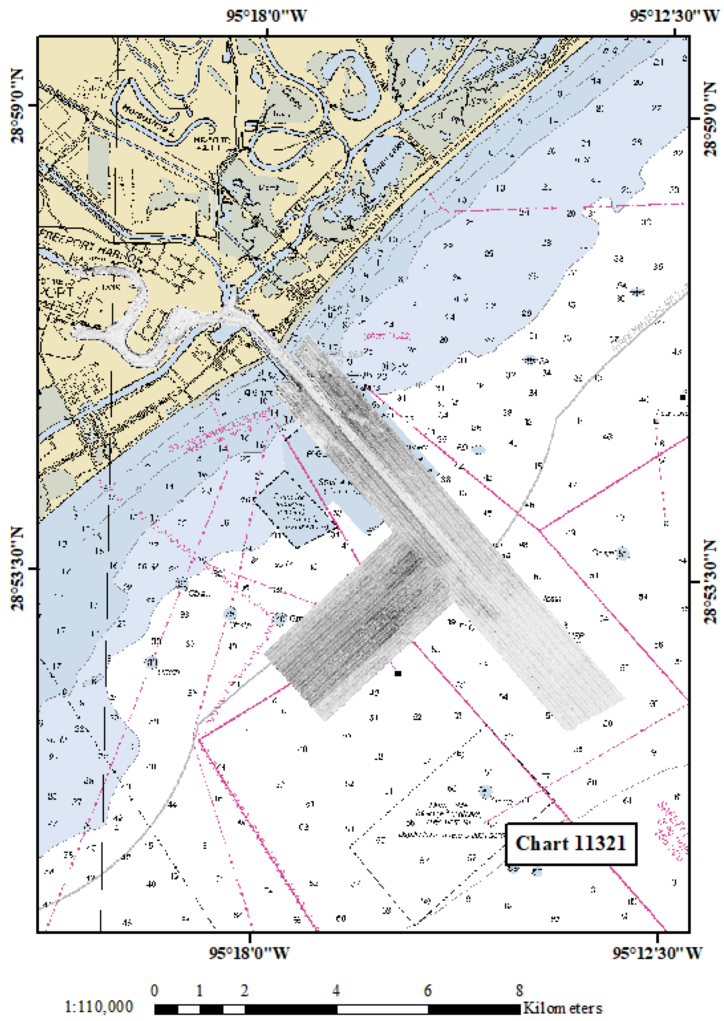

Figure 3: Final Side Scan Coverage for H13502 (First 100% coverage)

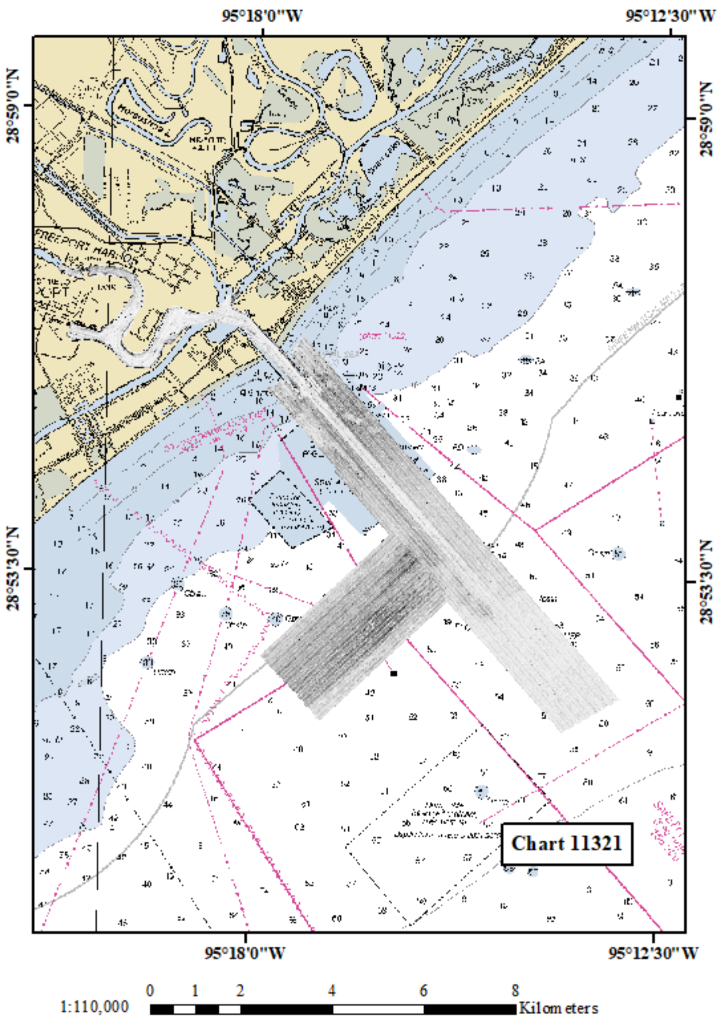

Figure 4: Final Side Scan Coverage for H13502 (Second 100% coverage)

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
	MBES Mainscheme	0	0
	Lidar Mainscheme	0	0
	SSS Mainscheme	0	0
	SBES/SSS Mainscheme	0	0
	MBES/SSS Mainscheme	433.02	433.02
	SBES/MBES Crosslines	19.56	19.56
	Lidar Crosslines	0	0
Number of Bottom Samples			0
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			7.63

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
06/30/2021	181

Survey Dates	Day of the Year
07/01/2021	182
07/02/2021	183
07/03/2021	184
07/04/2021	185
07/05/2021	186
07/06/2021	187
07/09/2021	190
07/10/2021	191
07/23/2021	204
07/24/2021	205
07/28/2021	209
07/29/2121	210
07/31/2021	212
08/03/2021	215
08/04/2021	216

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-K380-KR-21, delivered concurrently with H13502. 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 feet
Draft	3 feet

Table 5: Vessels Used

Figure 5: R/V Oyster Bay II

The R/V Oyster Bay II (Figure 5) 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 vessel 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	BaseX2	Sound Speed System

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 4.52 % of mainscheme acquisition. The resulting crossline to mainscheme percentage met the requirement to achieve approximately four percent of mainscheme mileage for an Object Detection coverage multibeam survey (Section 5.2.4.2 of the HSSD). H13502 requirements were for Object Detection coverage, Option B, based on the classifications defined in Section 5.2.2.2 of the HSSD.

In the survey area outside of the channel entrance, the mainscheme lines were spaced 40 meters apart and crosslines were generally spaced 1,000 meters apart based on line spacing and linear nautical miles of each survey area. Once inside the channel, line spacing varied depending on situational conditions and mainscheme lines were run to obtain 200% SSS coverage; crosslines were conducted at opportune times. 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. 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 50-centimeter H13502 mainscheme CUBE depths from the 50-centimeter H13502 CUBE depths.

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 TVU, which for the range of CUBE depths observed in the R/V Oyster Bay II crossline PFM comparison area (3.504 to 17.561) was calculated to be between 0.502 to 0.550 meters. Comparisons of the final crossline data versus final mainscheme data showed that 99.99% of comparisons were within 0.50 meters, less than the calculated allowable TVU ranges (Figure 6). The distribution is well spread about zero for all comparisons as presented in Figure 7.

Depth Difference Range (m)	All		Positive		Negative		Zero	
	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent	Count	Cumulative Percent
0.00-0.05	278417	70.01	153010	38.48	122213	30.73	3194	0.80
>0.05-0.10	97990	94.65	60131	53.60	37859	40.25		
>0.10-0.15	18530	99.31	11035	56.37	7495	42.14		
>0.15-0.20	2217	99.87	744	56.56	1473	42.51		
>0.20-0.25	206	99.92	104	56.59	102	42.53		
>0.25-0.30	97	99.95	91	56.61	6	42.53		
>0.30-0.35	70	99.96	62	56.62	8	42.54		
>0.35-0.40	41	99.97	40	56.63	1	42.54		
>0.40-0.45	34	99.98	34	56.64	0	42.54		
>0.45-0.50	17	99.99	17	56.65	0	42.54		
>0.50-0.55	6	99.99	6	56.65	0	42.54		
>0.55-0.838	45	100.00	45	56.65	0	42.54		
Totals	**397670**	**100.00%**	**225319**	**56.65%**	**169157**	**42.54%**	**3194**	**0.80%**
Reference Grid: h13502_50cm_CROSS_5deg_20211217_pfm_h13502_50cm_MAIN_20211216_pfm.dif								

Figure 6: Tabular Results Crossing Analysis

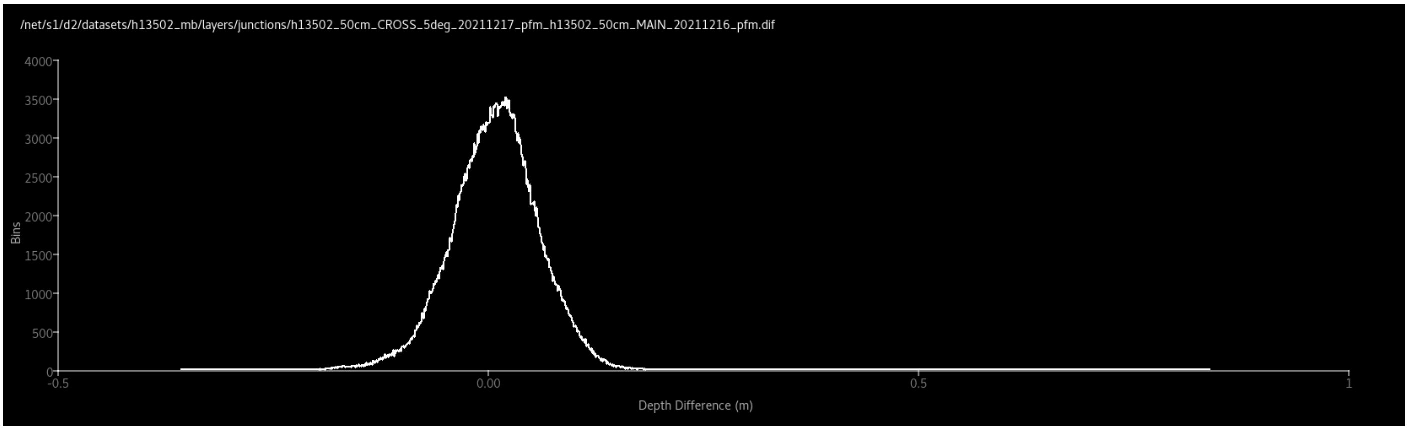

Figure 7: Plot of Crossing Analysis

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.09 meters	0.20 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
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, tending to be most affected by beam angle and sound speed, particularly in the vicinity of the Freeport Harbor Entrance Channel. 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).

Per HSSD Section 5.2.2.2, H13502 depth data fell within a single grid resolution at 50-centimeter.

The final H13502 50-centimeter PFM CUBE surface contained final vertical uncertainties that ranged from 0.210 meters to 1.617 meters. The IHO Order 1a maximum allowable vertical uncertainty was calculated to range between 0.500 to 0.556 meters, based on the minimum CUBE depth (1.652 meters) and maximum CUBE depth (18.765 meters). Results from the SABER Check PFM Uncertainty function identified that there were 7,916 nodes in the final H13502 50-centimeter PFM CUBE surface with final vertical uncertainties that exceeded IHO Order 1a allowable vertical uncertainty. The SABER Frequency Distribution Tool was also used to review the Hyp. Final Uncertainty surface within the final H13502 50-centimeter PFM grid. Results showed that 99.99 % of all nodes had final uncertainties less than or equal to maximum allowable vertical uncertainty of 0.556 meters.

There were unique factors associated with survey of H13502 that contributed to a high number of uncertainties in the final CUBE surface. The majority of the nodes which exceeded IHO Order 1a were a result of the active dredge operations (Figure 8) which caused steep slopes, pock-marks, sediment build-up piles, and depth differences resulting from the active dredge operations over multiple days.

Additionally, there were several areas where bathymetric variability was observed over the course of survey. For example, on slopes along the channel edges where sediment appears to have sloughed down (Figure 9).

In several cases along the Freeport Harbor Channel, as well as by dockage used for large tankers, changes in the seafloor were observed over time (Figure 10). This was due to the heavy vessel traffic and high propulsion and tonnage of ships coming through with tug assistance.

Remaining nodes exceeding uncertainties were associated with features, in areas of steep slopes and general bathymetric variability (Figure 11 and Figure 12). Refer to Section D.1.2 for discussion on some areas with shoaling where high uncertainties were observed.

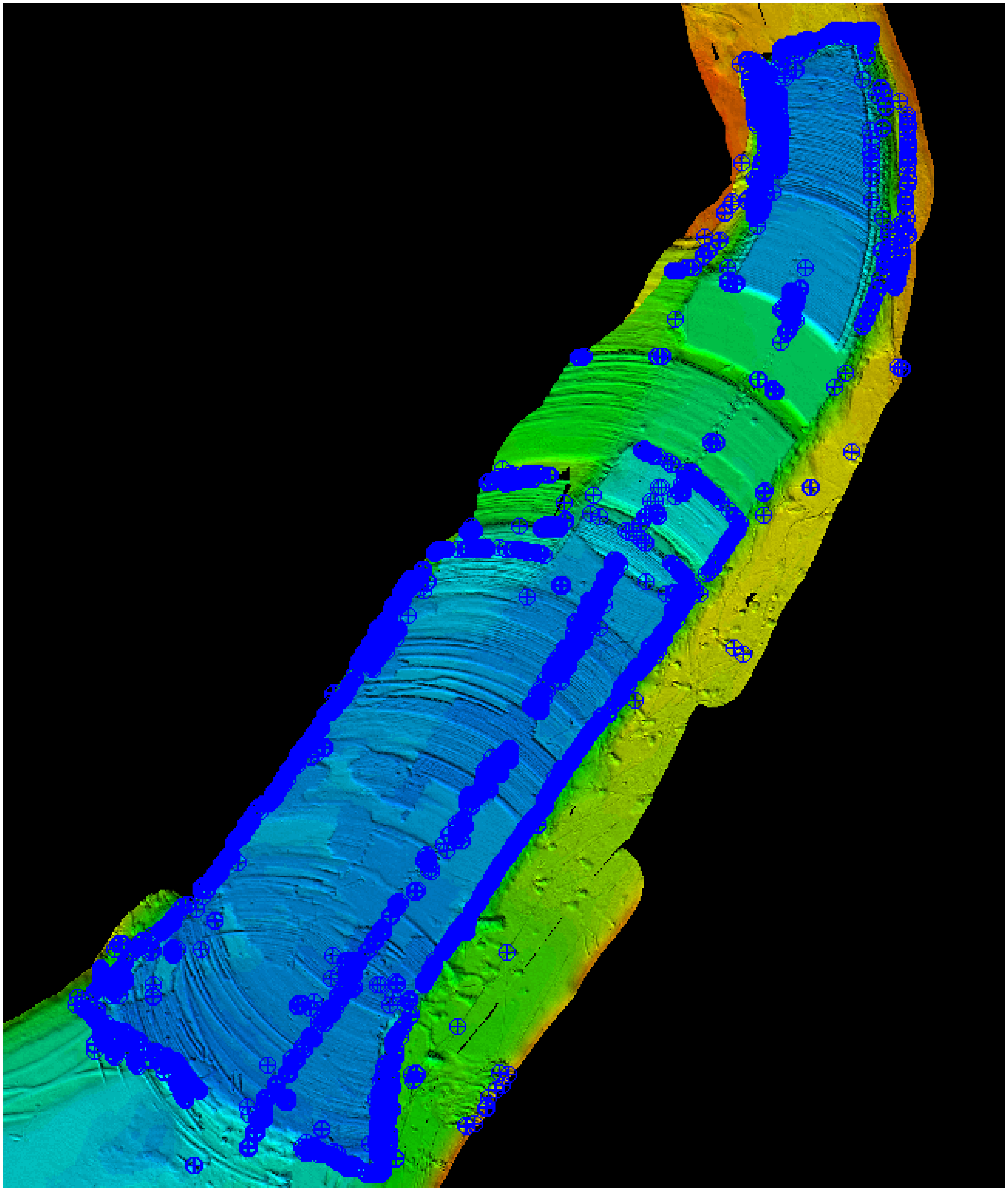

Figure 8: H13502 Dredge Area Uncertainty Exceeds (blue icons)

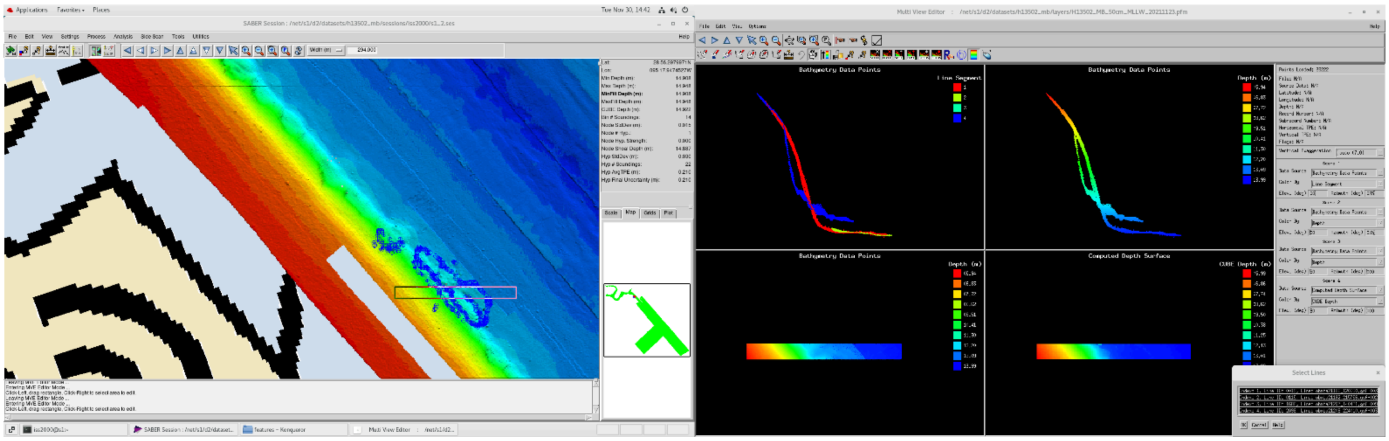

Figure 9: H13502 Uncertainty Exceeds (blue icons) due to Change in Slope Bathymetry as viewed in SABER (left) and MVE (right)

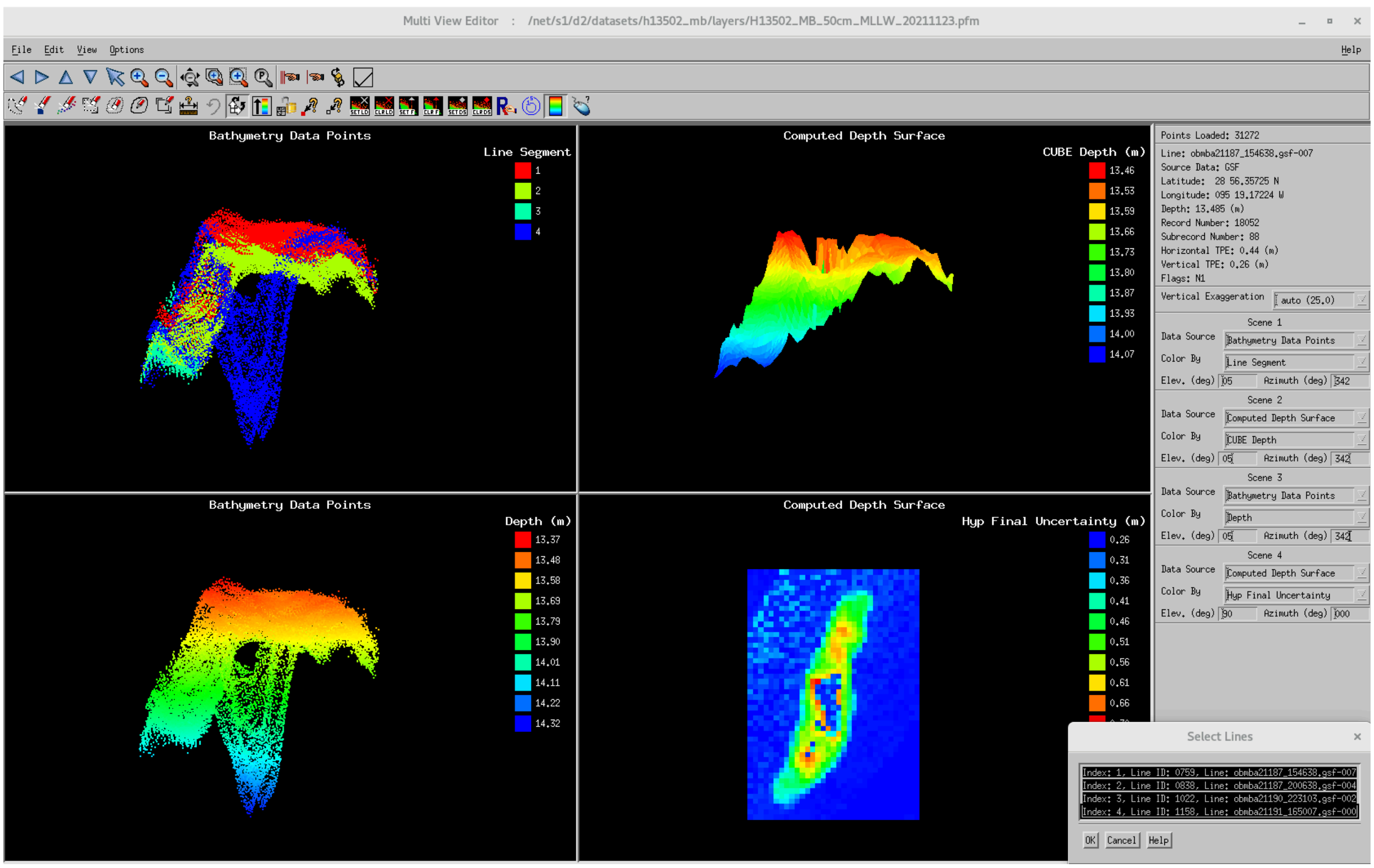

Figure 10: H13502 Uncertainty Exceeds due to Changes in Bathymetry over Time

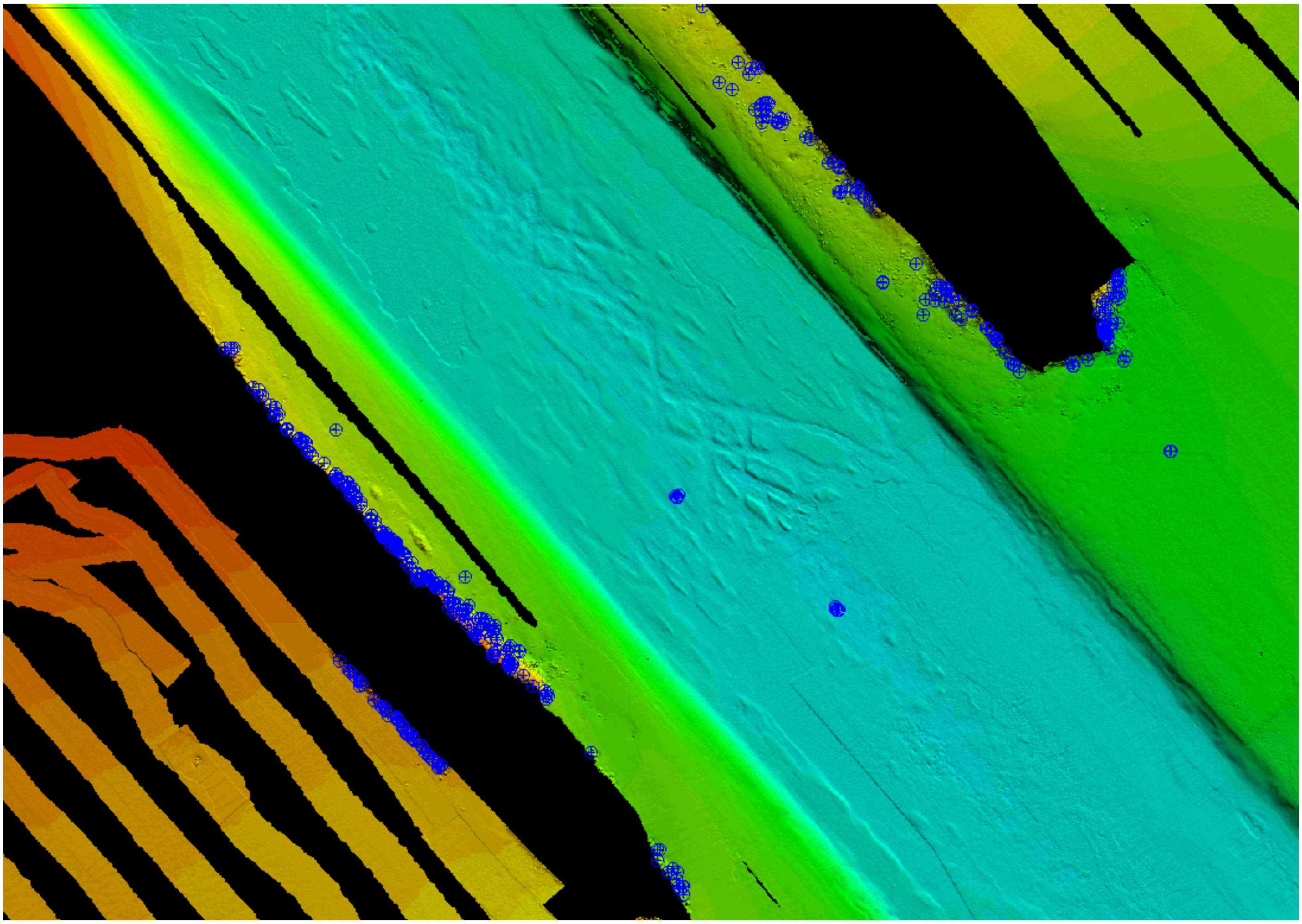

Figure 11: H13502 Uncertainty Exceeds (blue icons) Along Edge of Breakwater

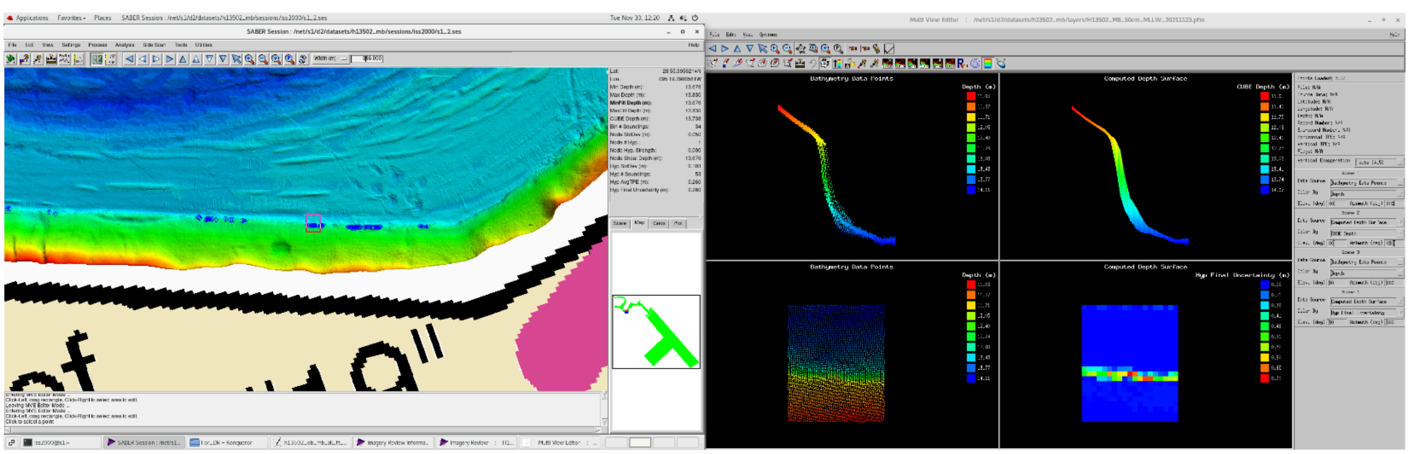

Figure 12: H13502 Uncertainty Exceeds (blue icons) on Slope as viewed in SABER (left) and MVE (right)

B.2.3 Junctions

Per the Project Instructions, junction analysis was assigned for OPR-K380-KR-21. Analysis of sheet H13502 to the three adjacent sheets H13503, H13504, and H13506 will be discussed within those Descriptive Reports as final analysis and processing efforts for those sheets remain on-going.

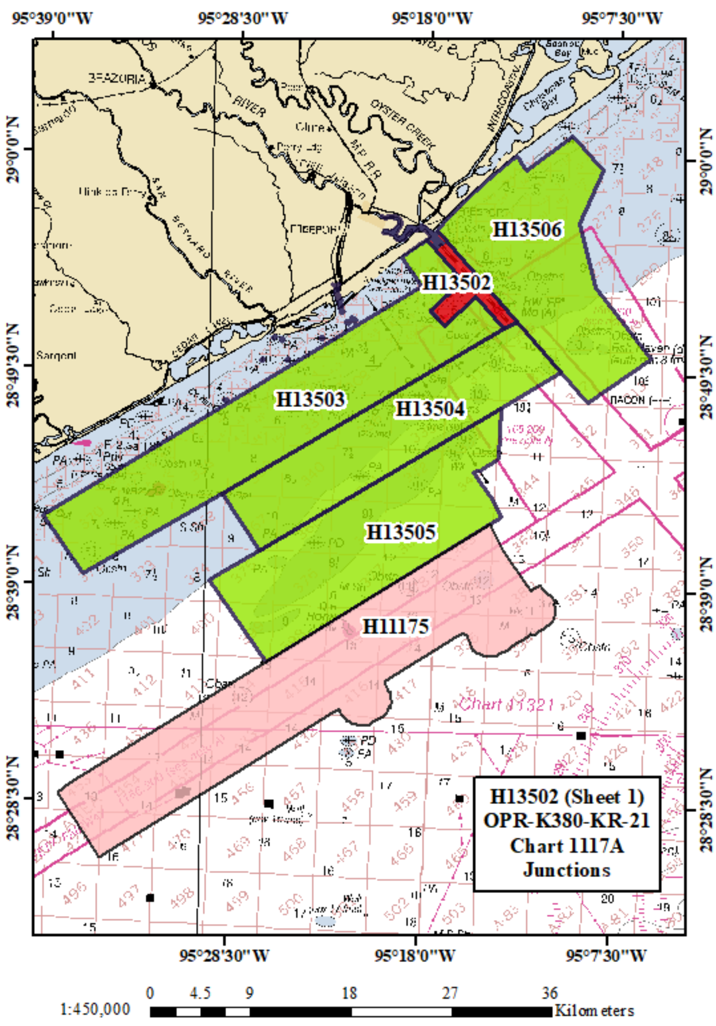

Figure 13: General Locality of H13502 with Junctioning Surveys

There are no contemporary surveys that junction with this survey.

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

<u>Corrections to Soundings</u>

There were serval factors which affected soundings during survey on H13502; these included vessel traffic, weather events, and particulate in the water column. The H13502 survey limits were coincident to the Port of Freeport and approaches as well as the Intracoastal Waterway, there was significant commercial and recreational vessel traffic present during survey operations. During and after weather events, there was often a significant amount of debris observed floating down the river, ranging from tree logs to trash and general debris. At times there also appeared to be a high level of particulate matter in the water column. All of these factors culminated in acoustic interference observed during real-time data collection. Additionally, there was typically a significant change observed in the sound speed cast profile between the river and areas located outside of the breakwaters that often resulted in an increased calculated TPU in the outer beams of MBES. In cases where uncertainties in the outer beams exceeded IHO Order 1a, they were invalidated prior to contributing to the CUBE surface (Refer to DAPR Section C.6.1).

As beams with uncertainties which exceeded IHO Order 1a were invalidated prior to calculating the CUBE surface these issues had no significant impact to the final sounding data. In some instances, a CUBE artifact remained in the final grid surface due to bathymetric variability. Refer to Section B.2.2 and D.2.9 for additional information.

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 sound speed profile (SSP) data, refer to the DAPR for additional details. SSP data were obtained at intervals frequent enough to meet depth accuracy requirements. Section 5.2.3.3 of the HSSD requires that if the sound speed measured at the sonar head differs by more than two meters/second from the commensurate profile data, then another cast shall be acquired.

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.

The SSP files delivered with the H13502 data and are broken out into sub-folders, which correspond to the purpose of each cast. Also, all individual SSP files for H13502 have been concatenated into two separate files based on the purpose of the cast, provided in CARIS format files (.svp), and delivered under (H13502/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 complete coverage requirement using 200% side scan sonar coverage with concurrent multibeam bathymetry. To achieve this coverage, the SSS was set to 50-meter range scale, and main scheme survey lines were spaced at 40-meter to ensure 200% SSS coverage. There were areas where the SSS was set to 75-meter range scale to increase achievable coverage in areas that the survey vessel was not able to reach due to moored or docked vessels.

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. 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 of the H13502 50-centimeter PFM showed that all holidays as defined for complete coverage surveys in Section 5.2.2.3 of the HSSD were fully covered with 100% SSS coverage .

The final H13502 CUBE PFM grid was 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 from the PFM grid to ensure that the requirements for complete coverage surveys, as specified in HSSD Section 5.2.2.3 were met. Within the final 50-centimeter PFM grid 99.57% of all nodes contained five or more soundings.

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. Multibeam files associated with calibration were delivered with the OPR-K380-KR-21 DAPR, concurrently with the H13502 delivery.

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 Project Instructions using Object Detection Coverage, Option B (200% 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. As mentioned in Section A.4, there were areas where 200% SSS coverage may not extend to the SOW due to limitations from positioning of dredge equipment or NALL (Figure 14 and Figure 15). Refer to Section D.1.3 for information regarding an assigned charted feature that fell outside of the SOW and was relocated over the course of survey.

Both coverage mosaics are determined to be complete and sufficient to meet the requirements contained within the Project Instructions and HSSD. Each 100 percent coverage mosaic is delivered as a single georeferenced raster file (datum of NAD83) in floating point GeoTIFF format, as specified in Sections 8.2.1 and 8.3.3 in the HSSD.

Multibeam Echo Sounder Seafloor Backscatter: Leidos collected MBES backscatter data with all GSF data acquired, in accordance with HSSD Section 6.2. The MBES settings used were checked to ensure acceptable quality standards were met and to mitigate acoustic saturation of the backscatter data. 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. Evaluation of backscatter data and processing were not required for OPR-K380-KR-21 and therefore no additional processing was performed by Leidos, and no additional products were produced.

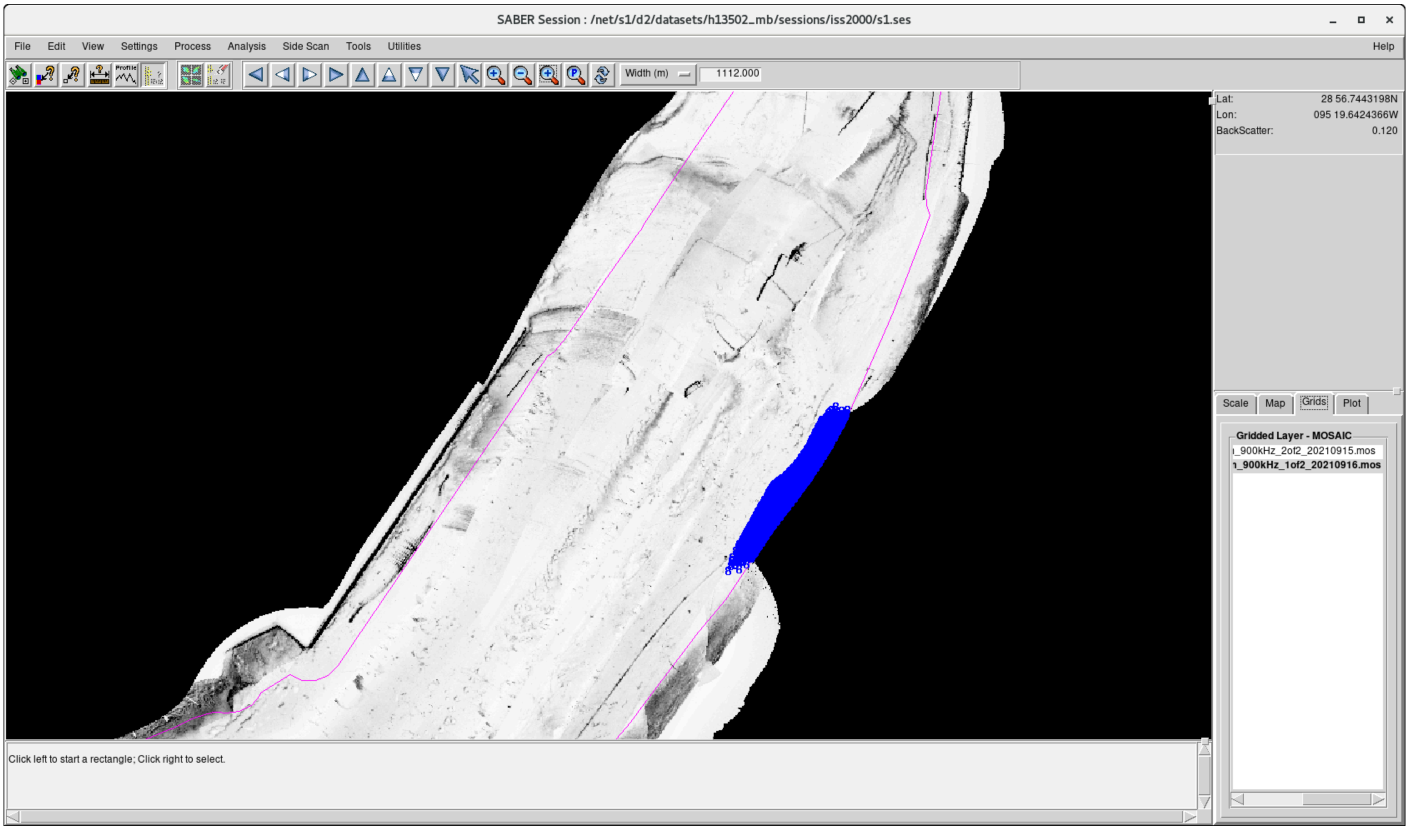

Figure 14: First 100% Mosaic Gaps in coverage to SOW due to Presence of Dredge Equipment (Gaps in Blue)

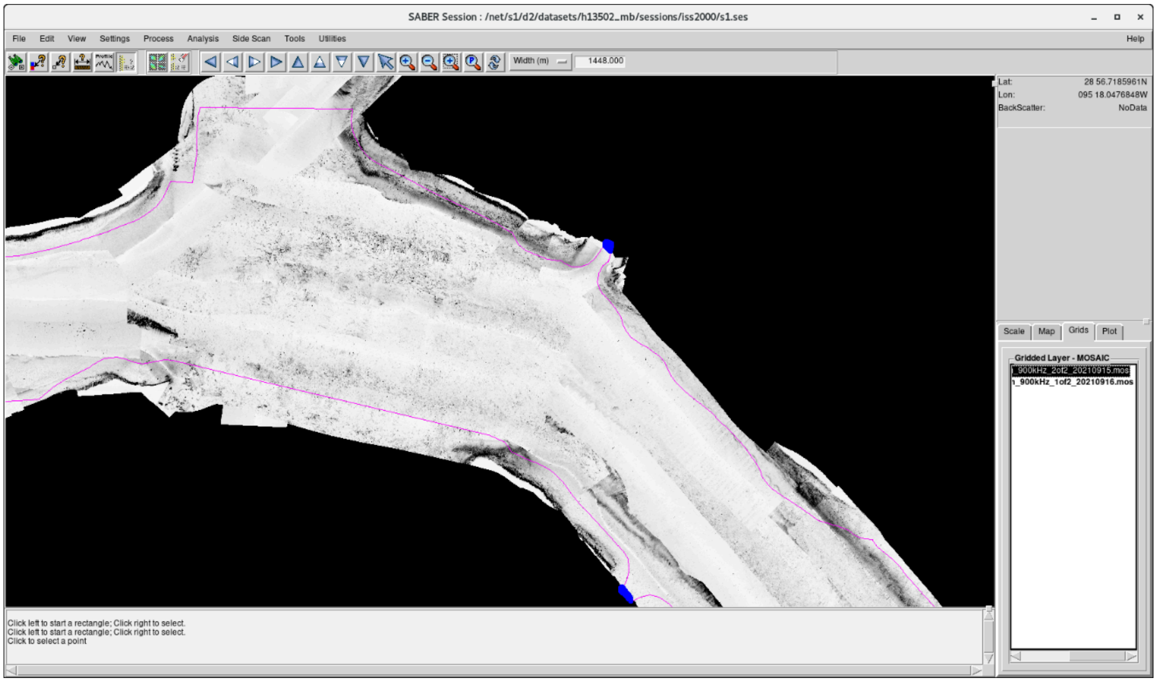

Figure 15: First 100% Mosaic Gaps in Coverage to SOW due to NALL Limitations (Gaps in Blue)

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	5.4.1.5.5

Table 9: Primary bathymetric data processing software

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

Manufacturer	Name	Version
Leidos	SABER	5.4.1.5.5

Table 10: Primary imagery data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2021.

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
H13502_MB_50cm_MLLW_Final	BAG	1 meters	1.652 meters - 18.765 meters	N/A	Object Detection coverage, Option B
H13502_SSSAB_1m_900kHz_1of2	SSS Mosaic (.tif)	1 meters	0 meters - 0 meters	N/A	First 100% SSS
H13502_SSSAB_1m_900kHz_2of2	SSS Mosaic (.tif)	1 meters	0 meters - 0 meters	N/A	Second 100% SSS (Disproval)

Table 11: Submitted Surfaces

Object Detection coverage Section 5.2.2.2 of the HSSD requires 50-centimeter node resolution for depths ranging from 0 meters to 20 meters. Leidos generated the CUBE PFM grid for H13502 at 50-centimeter resolution.

SABER populates the CUBE depth with either the node’s chosen hypothesis or the depth of a feature or designated sounding set by the hydrographer, which overrides the chosen hypothesis. The range of CUBE depths of the H13502 50-centimeter PFM grid were from 1.652 meters (5.420 feet; 0.260 meters Total Vertical Uncertainty [TVU]) to 18.765 meters (61.565 feet; 0.384 meters TVU).

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

C. Vertical and Horizontal Control

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	O PR-K380-KR-21_NAD83_VDatum_MLLW.cov

Table 12: 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 of 1983 (NAD 83).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 15.

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. H13502 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 H13502 depth data generally showed mixed agreement with charted depths compared to the ENCs listed in Section D.1.1. Note that there were several areas where slight discrepancies were observed between charted dredge area depths and observed depths on H13502. However, dredge operations were being conducted during H13502 survey and were expected to continue following completion of H13502 survey. See below for further detail on dredge operations discussed in the Local Notice to Mariners (LNM).

Charting recommendations for new features and updates to charted features, are documented in the H13502 S-57 FFF. Additional charted objects are discussed in later sections.

United States Coast Guard (USCG) District 8 LNM publications were reviewed for changes subsequent to the date of the Project Instructions and before the end of survey . The LNM reviewed were from week 23/21 (09 June 2021) until week 03/22 (19 January 2022). Refer to Figure 16 and the H13502 FFF for further information on the ATONs.

Active construction and dredging operations were ongoing at the Port of Freeport during and after H13502 survey. Refer to Figure 17 and Section D.2.9 for further information.

ATON	Start LNM	End LNM	LNM Note
Freeport Harbor Outbound Range Front Light	39/18: 27 September 2018	Presently active (03/22): 19 January 2022	MSLD SIG
Freeport Harbor Outbound Range Rear Light	39/18: 27 September 2018	Presently active (03/22): 19 January 2022	MSLD SIG
Freeport Entrance Lighted Buoy 6	46/18: 15 November 2018	33/21: 18 August 2021	RELOCATED
Freeport Harbor Junction Light FH	35/20: 27 August 2020	44/21: 03 November 2021	STRUCT DEST/TRLB
Freeport Harbor Junction Light FH	45/21: 10 November 2021	-	REBUILT / REMAINS
Freeport Harbor Entrance Light 12	08/21: 25 February 2021	44/21: 03 November 2021	STRUCT DEST/TRLB
Freeport Harbor Entrance Light 12	45/21: 10 November 2021	-	REBUILT / REMAINS
Freeport Harbor Light 20	10/21: 11 March 2021	31/21: 04 August 2021	DISCONTINUED FOR DREDGING
Freeport Harbor Light 20	28/21: 14 July 2021	-	RELOCATE
Freeport Harbor Light 22	09/21: 04 March 2021	31/21: 04 August 2021	DISCONTINUED FOR DREDGING
Freeport Harbor Light 22	28/21: 14 July 2021	-	RELOCATE
Dow Barge Canal Security Zone Marker 1	28/21: 14 July 2021	-	RELOCATE
Dow Barge Canal Security Zone Marker 2	28/21: 14 July 2021	-	RELOCATE
Freeport Jetty Inbound Range Front Light and Passing Light	31/21: 04 August 2021	-	LT EXT
Freeport Jetty Inbound Range Front Light and Passing Light	-	32/21: 11 August 2021	RELIGHTED
Freeport Entrance Light 7	37/21: 15 September 2021	Presently active (03/22): 19 January 2022	STRUCT DEST
Freeport Entrance Light 8	37/21: 15 September 2021	-	STRUCT DMGD
Freeport Entrance Light 8	-	38/21: 22 September 2021	WATCHING PROPERLY
Freeport Harbor Light 21	44/21: 03 November 2021	-	LT EXT
Freeport Harbor Light 21	-	45/21: 10 November 2021	REBUILT / RECOVERED
Freeport Entrance Lighted Buoy FP	40/21: 06 October 2021	-	SINKING / BUOY DMGD
Freeport Entrance Lighted Buoy FP	42/21: 20 October 2021	-	MISSING
Freeport Entrance Lighted Buoy FP	44/21: 03 November 2021	-	WATCHING PROPERLY
Freeport Entrance Lighted Buoy FP	44/21: 03 November 2021	Presently active (03/22): 19 January 2022	RELOCATED
Brazos Harbor Security Zone Marker 1	03/22: 19 January 2022	-	STRUCT DEST
Brazos Harbor Security Zone Marker 2	03/22: 19 January 2022	-	STRUCT DEST

Figure 16: ATONs Referenced in LNM 23/21 through 03/22

Construction / Dredging Location	Start LNM	End LNM	LNM Note	Leidos Note
Freeport Harbor Channel – Upper Turning Basin	37/20: 15 September 2020	52/21: 29 December 2021	References pile driving and concrete deck construction of the Port of Freeport Berth 8, directly north of Berth 7, of the Upper Turning Basin, Port Freeport, TX	Active construction was ongoing at the time of survey. Refer to Section D.2.9 for additional information
Freeport Channel	20/21: 20 May 2021	33/21: 18 August 2021	References USACE Project No.: W912HY20C0034 / Freeport Channel Improvement Project for Reach 3 – Lower Stauffer to take place from 26 January 2021 through 20 August 2021	Dredging operations were active at the time of survey and remained ongoing at the close of our survey operations. Refer to Section D.2.9 for additional information.
Freeport Entrance Channel, Jetty Channel	41/21: 13 October 2021	Presently active (03/22): 19 January 2022	References dredging operations in the vicinity of Freeport Harbor Entrance Channel and Jetty Channel; expected to continue until March 5, 2022. An update was entered in LNM 48/21 (01 December 2021).	N/A – after the close of survey operations
Freeport Harbor	43/21: 27 October 2021	49/21: 08 December 2021	References diver directed dredging and bank stabilization operations in the vicinity of Dow Chemical Plant A (Dow Thumb) to take place until approximately December 12, 2021	N/A – after the close of survey operations
Freeport	50/21: 15 December 2021	02/22: 12 January 2022	References dredging operations near Enterprise Seaway at Old Quintana, Freeport, TX	N/A – after the close of survey operations

Figure 17: Active Construction and Dredging Referenced in LNM 23/21 through 03/22

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
US5FPOCA	1:10000	8	12/02/2021	12/02/2021
US5FPOCB	1:10000	8	12/16/2021	09/30/2021
US5FPOCC	1:10000	4	09/13/2021	09/13/2021
US5FPODA	1:10000	1	06/15/2020	06/15/2020
US5FPOBB	1:10000	1	04/05/2021	06/15/2021
US5FPOBC	1:10000	3	09/27/2021	09/27/2021
US4TX41M	1:80000	21	12/21/2021	09/27/2021

Table 13: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

Figure 18 details the Leidos submitted Anti-DTON and DTON reports for H13502. DTON reports were submitted per HSSD as S-57 format to the Atlantic Hydrographic Branch (AHB). Copies of the email correspondence for Leidos' submissions of DTON Reports, as well as the DTON recommendation files, are referenced in Appendix II of this DR and included within Project Correspondence. Per the CSF there were three features within H13502 with investigation requirements that indicated that if they were not present to conduct disproval and submit an Anti-DTON expeditiously, Leidos submitted these through the H13502_AntiDtoN_1-4 file.

Refer to Figure 19 through Figure 22 and Section D.1.4 for significant shoals or hazardous features within the area covered by this survey.

Steep shoaling and sediment buildup was observed inside of the Seaway Teppco restricted area adjacent to the inner sea wall (Feature 120) and away from the primary docking area. CUBE adequately represents the portion covered by MBES (Figure 19) and side scan imagery shows consistent sediment buildup along the majority of the seawall stretch (Figure 20). There is a section of eroded coastline in this area between a break in the sea wall and the start of revetment mats that indicates the prone nature of this basin to erosion (Figure 21). Due to the location and adequate representation of the shoaling and sediment buildup, no MBES feature overrides were set and associated SSS contacts are retained within the Side Scan Contact S-57 file. Similar shoaling and buildup was observed off of the sea wall at Dow Chemical Plant A-22 Dock (Figure 22).

Within the dredging operations area (Reach 3), some sediment buildup was observed near the active construction of the sea wall at Port of Freeport (Figure 23). The passes observed on Julian Day (JD) 204 showed piles of sediment at depths contrasting those which were observed on JD 191, leading to an area of high uncertainty. As this was part of an active construction area and the bottom was still being dredged during the time of survey, no feature overrides were set.

DTON Report Name	Date Submitted to AHB	AHB Submitted to NDB and MCD	NDB Registration	Feature Number(s)
H13502 AntiDtoN 1-4.000	2021-08-02	2021-08-02	DD-34744	N/A
H13502 DTON 01 02.000	2022-01-05	2022-01-06	DD-35649	10, 202

Figure 18: DTON Reports

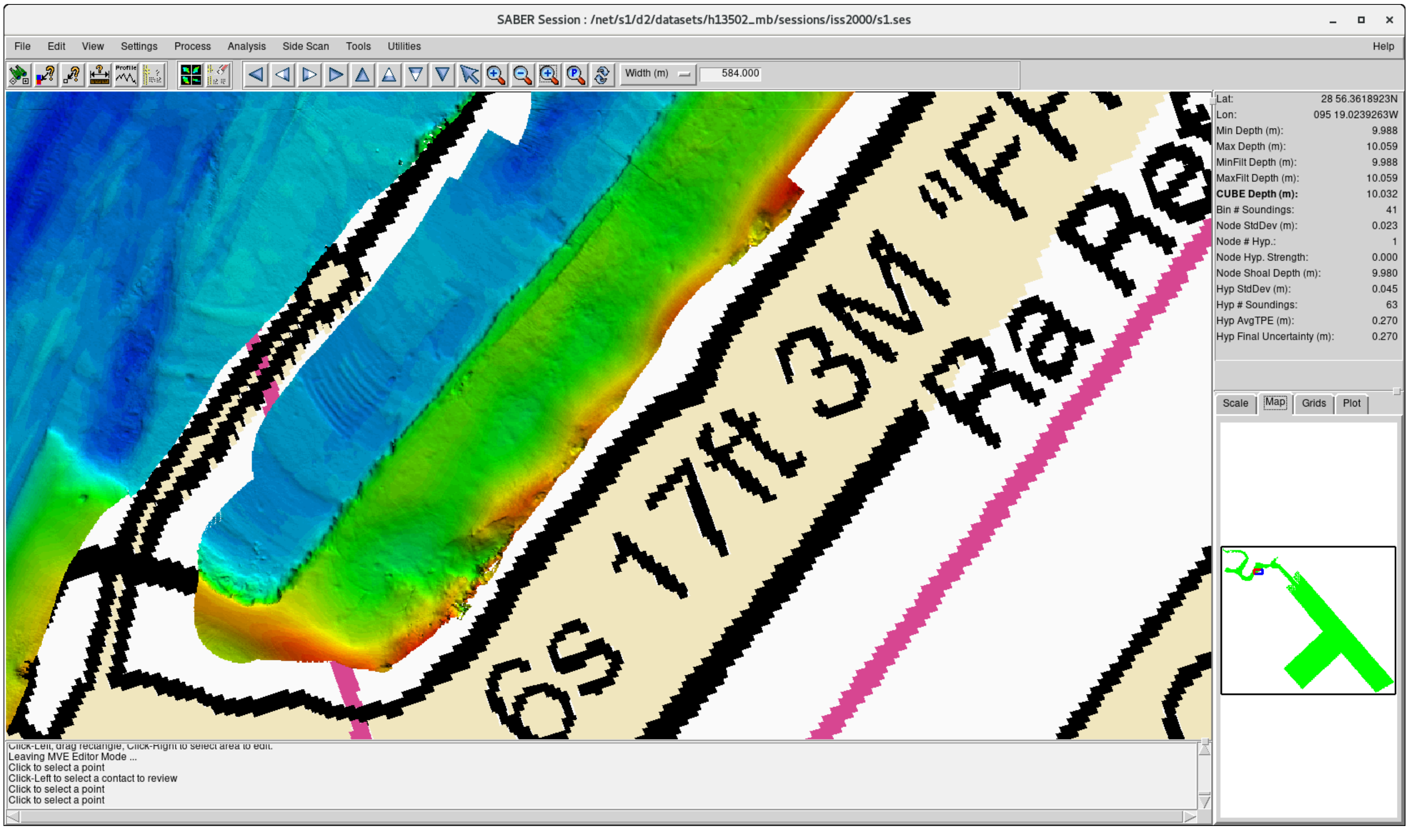

Figure 19: Shoaling Along the Inner Sea Wall of Seaway Restricted Area (MBES)

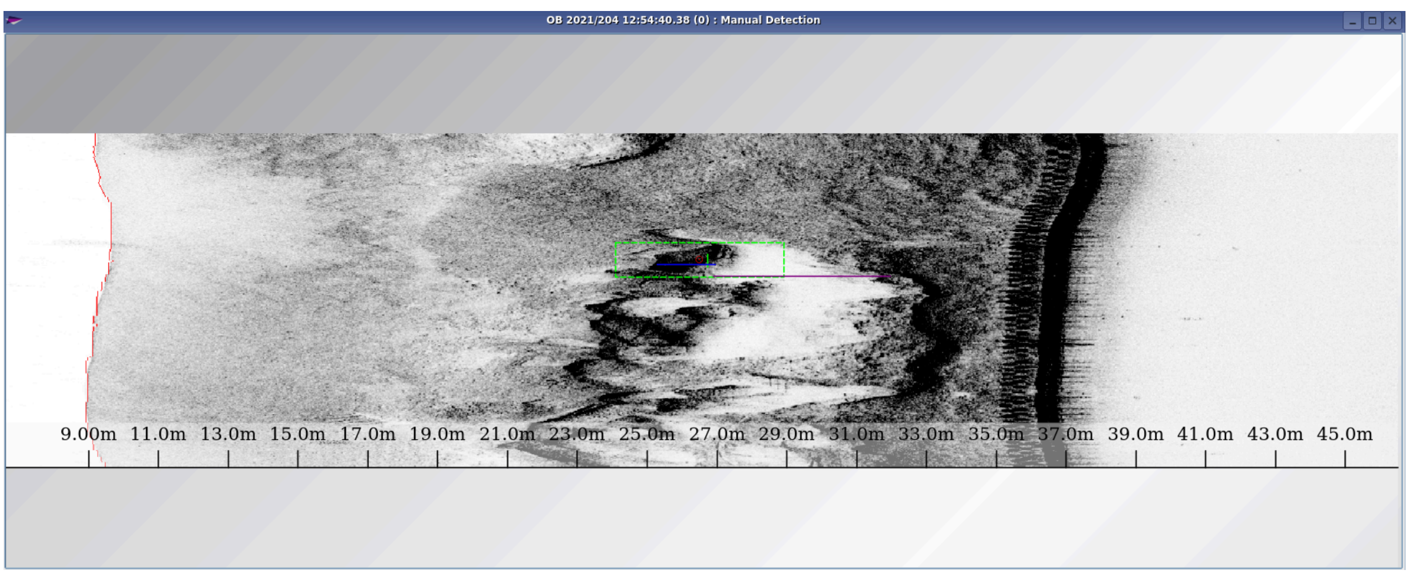

Figure 20: Shoaling Along the Inner Sea Wall of Seaway Restricted Area (SSS)

Figure 21: Photo of Eroded Coastline Along the Inner Sea Wall of Seaway Restricted Area

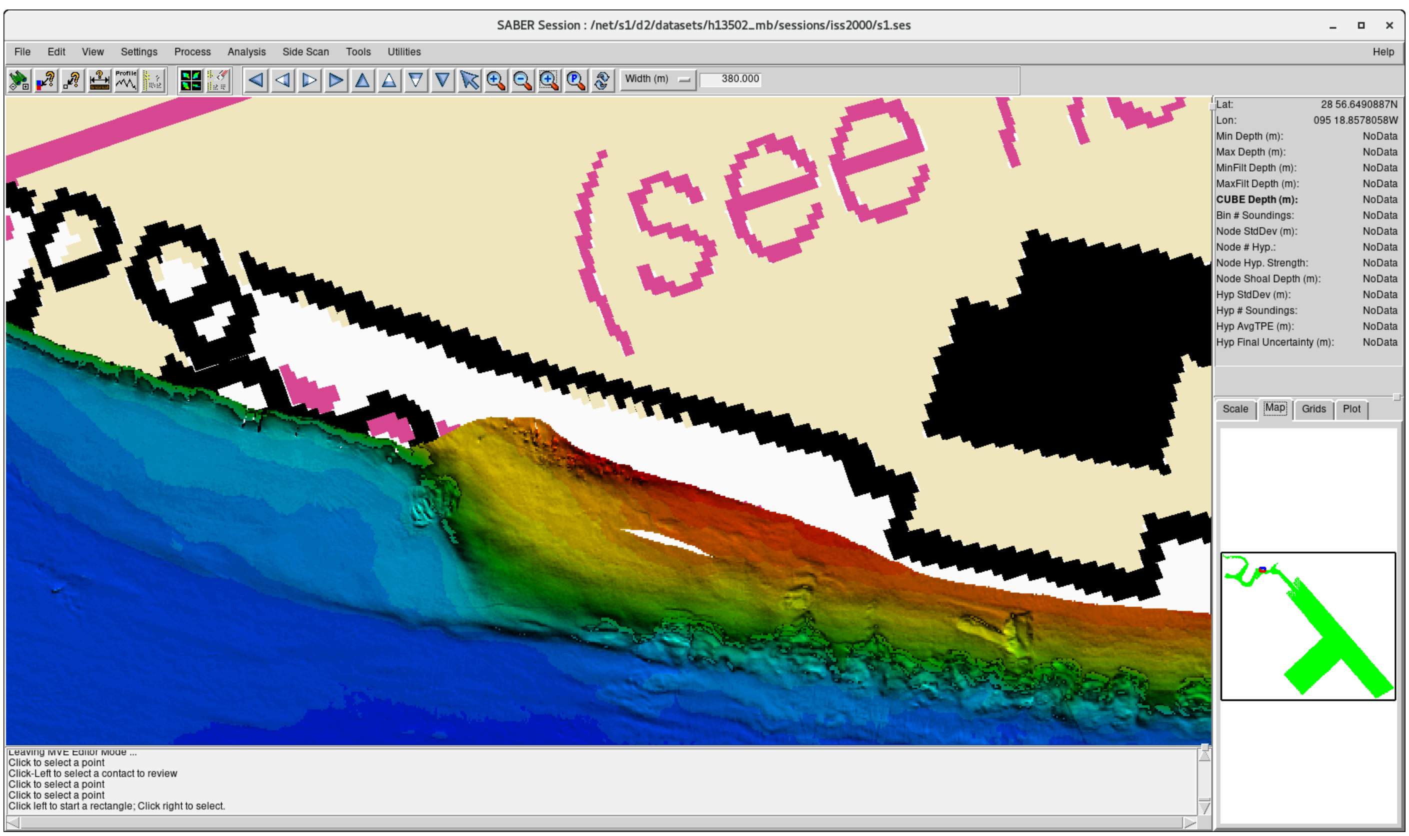

Figure 22: Shoaling Along the Sea Wall of Dow Chemical Plant A-22 Dock (MBES)

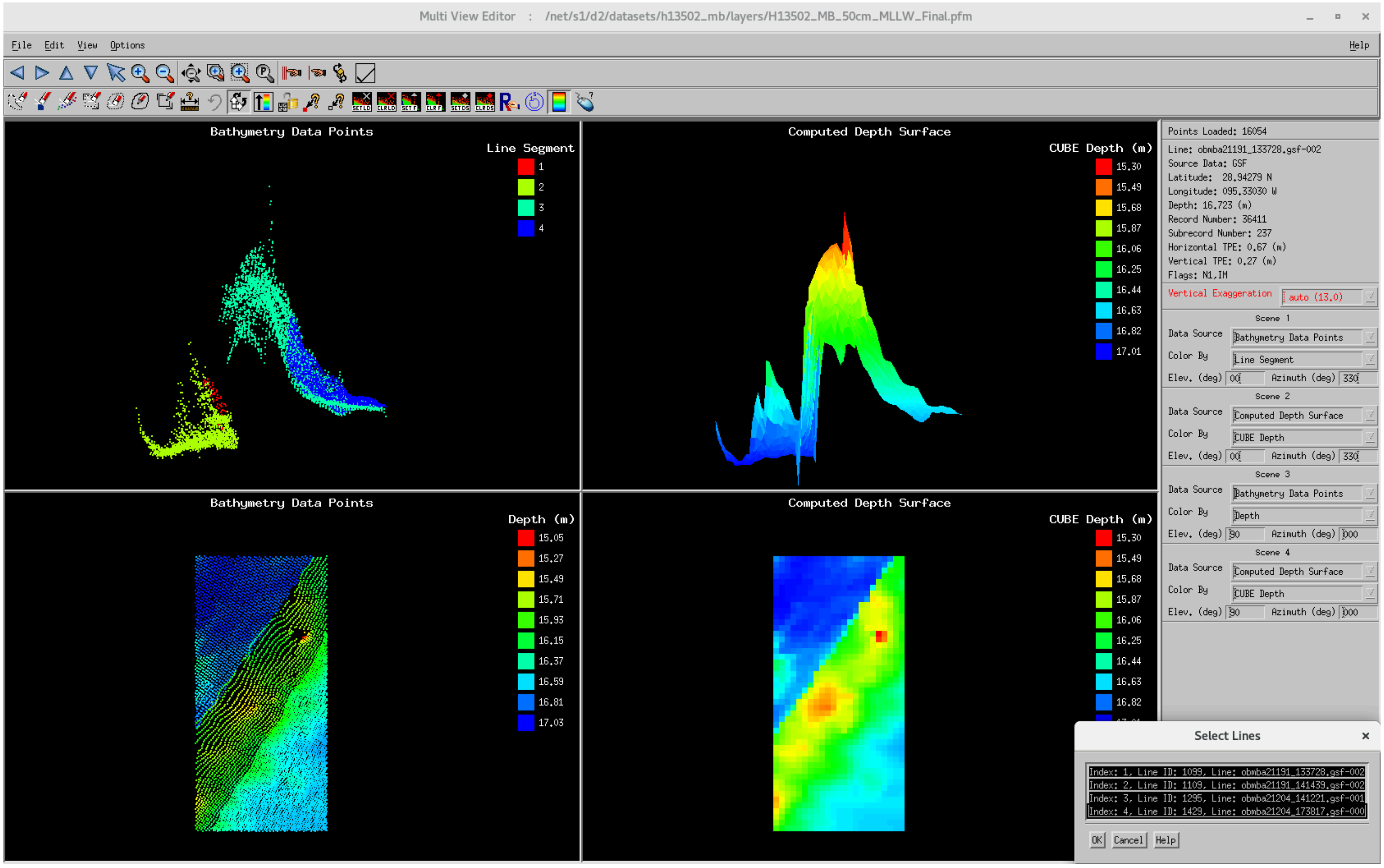

Figure 23: Sediment Buildup within Dredge Area near Active Construction as Viewed in MVE

D.1.3 Charted Features

There were numerous assigned charted features in the final CSF (OPR-K380-KR-21_CSF.000) within the SOW of H13502. Per HSSD Section 8.1.4, charted features are not addressed in this section, refer to the H13502 S-57 FFF (H13502_FFF.000) for all the details and recommendations regarding these features .

There was one charted special purpose beacon that was assigned in the CSF but fell outside of the SOW boundary ("Dow Barge Canal Security Zone Marker 1"). The charted beacon position fell within the transit area to and from the Surfside Marina where R/V Oyster Bay II was docking, which allowed coverage to be extended outside of the survey limit bounds to complete a disproval. The Local Notice to Mariners (LNM) dated 28/21 (14 July 2021) noted the relocation of this beacon to a position outside of the SOW; therefore a full disproval was not conducted. Refer to the S-57 FFF for further information regarding this feature.

D.1.4 Uncharted Features

See the H13502 S-57 FFF for all the details and recommendations regarding new uncharted features investigated.

During the course of H13502 survey operations, a small number of fishing markers and crab pot floats (Figure 24) were observed within the survey limits. There was also a significant amount of both floating and submerged dredge equipment associated with ongoing dredge operations. This ranged from a white and orange informational buoy noting the submerged dredge pipe (Figure 25) to several floating barrels and pipes (Figure 26) to a submerged dredge pipe. During acquisition these objects were ensonified by either or both MBES and SSS. For OPR-K380-KR-21, unique to H13502 was the presence of several spud barges (Figure 27) throughout the river. In some cases the barges appeared to be associated with dredging and construction, as discussed in Section D.2.9; and in others, they appeared to be associated with commercial activity in the river. SSS data often captured returns on the spuds (Figure 28) and several contacts were set on spuds throughout the course of survey and data analysis and review. Due to the temporary nature of all discussed objects above, there are no features associated with temporary objects within the H13502 S-57 FFF. When a temporary object or surface float was identified and correlated to objects in the MBES data, the MBES data were invalidated and no longer contributed to a CUBE surface as these were not true skin of the earth. SSS contacts were classified as non-significant and are retained within the H13502_SSS_Contacts.000 file.

There were numerous instances within the H13502 survey bounds where rocks and objects were positioned in close proximity to breakwaters, rip rap, and within the charted dump site area measured over 1-meter proud of the seafloor but were adequately represented by CUBE and therefore did not have a feature override set per HSSD 5.2.1.2.3. Figure 29 demonstrates on example of this a rock observed off the Surfside Breakwater is represented by CUBE to within the allowable TVU (0.506 m). Non-significant contacts were retained on all objects that were not correlated to a feature.

Figure 24: Photo of Temporary Crab Pot in Old Brazos River

Figure 25: Photo of Informational Buoy for Temporary Submerged Dredge Pipe

Figure 26: Photo of Floating Dredge Equipment

Figure 27: Photo of Spud Barge

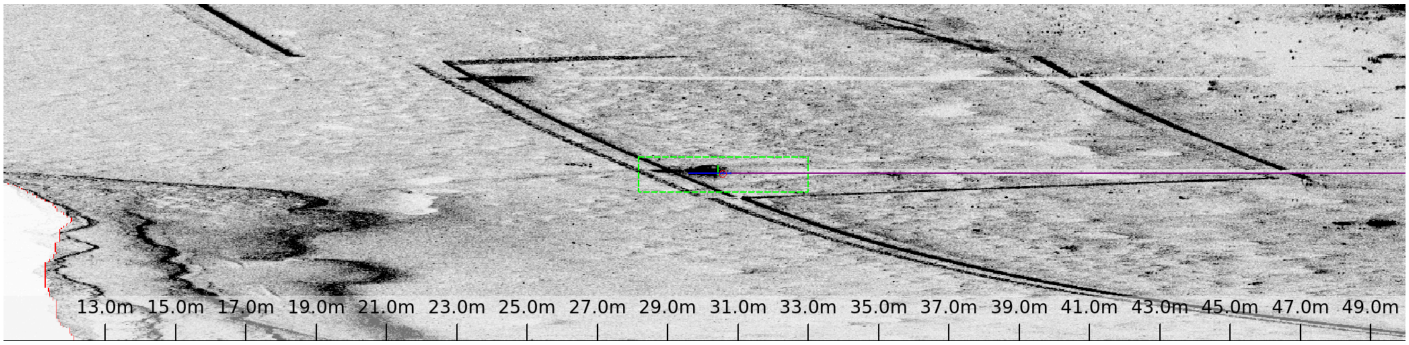

Figure 28: SSS Imagery of Return on Spud Barge

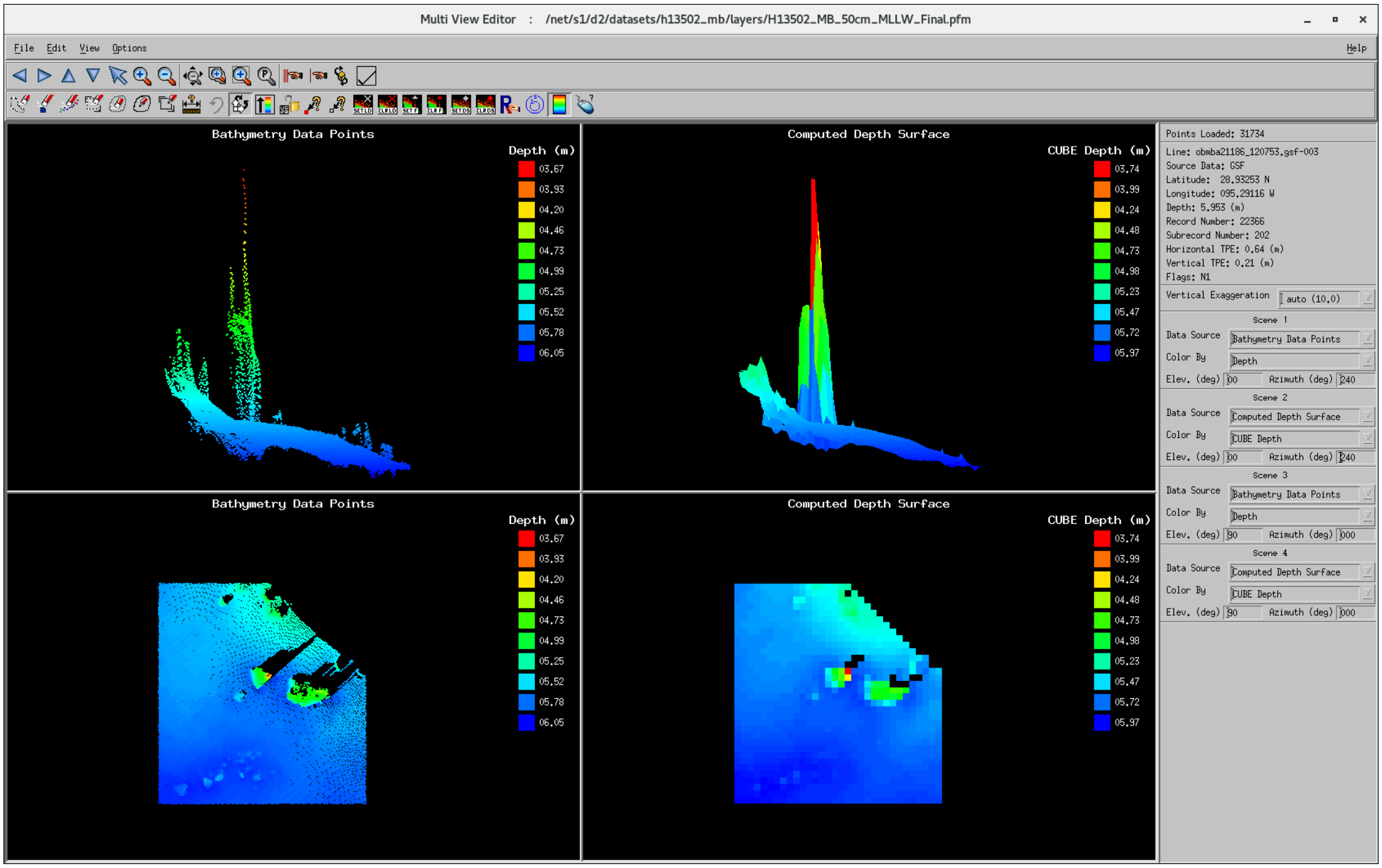

Figure 29: MVE view of Rock off Breakwater with Adequate CUBE representation

D.1.5 Channels

There were no assigned channels within the H13502 SOW from the final CSF. However, the survey area was coincident to Freeport Harbor Channel (ENC US4TX41M, US5FPOCB, US5FPOCC, and US5FPOBC) as well as a portion of the Intracoastal Waterway (ENC US5FPOCB, US4TX41M). H13502 CUBE depths were in general agreement with the charted depth range for both. Refer to Section D.1.1 for further detail.

D.2 Additional Results

D.2.1 Aids to Navigation

There were several assigned features designated as aids to navigation (ATON) within the SOW of H13502 from the final CSF. All ATONs within the survey limits were observed on station and serving their intended purpose with the exception of two Beacons, Brazos Harbor Security Sone Marker 1 and Brazos Harbor Security Zone Marker 2. These were not present during survey and were not documented in a LNM as having been moved; per HSSD Section 1.6.2.2 Leidos submitted information for each of the missing beacons through the USCG ATON Discrepancy Report. LNM 03/22 (19 January 2022) subsequently noted the markers as STRUCT DEST. Refer to Section D.1 for discussion on any Aids to Navigation addressed in the LNM during and after completion of H13502 survey.

Per the investigation requirements from the CSF, all ATONs that were on station and serving intended purpose are included in the H13502 FFF with description of retain. Additional buoys that were not assigned in the final CSF and were observed during survey are also documented within the H13502 FFF.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

No Bottom Samples were assigned for this survey.

D.2.4 Overhead Features

There were three overhead features within this survey area; a bridge (assigned), tide gate (for info only), and power line (assigned), all within the upper northwestern limits of the survey area. All three features were visually confirmed to exist as charted; the tide gate (Feature 43, Figure 30) and bridge (Feature 42, Figure 31) were both also observed in MBES and SSS data. Per the CSF investigation requirements, none were included in the S-57 FFF. Leidos recommends retaining as charted (ENC US5FPODA). Note that on ENC US4TX41M, the tide gate is charted as a BRIDGE (fixed bridge) instead of GATCON. Leidos recommends updating the feature acronym.

No overhead clearance reports were submitted for this survey, nor were they required.

Figure 30: Tide Gate with Overhead Cable

Figure 31: Pine Street Bridge

D.2.5 Submarine Features

Within the final CSF there were two assigned submarine features for investigation. Neither were observed in MBES or SSS data to be exposed and were therefore included in the H13502 FFF with the descrp field set to ‘Retain’ per the CSF investigation requirements. There were several linear objects identified that were not considered submarine features. Non-significant side scan contacts were retained within the H13502 Side Scan Sonar Contact S-57 file (H13502_SSS_Contacts.000).

One exposed uncharted pipeline (Feature 13) was identified within the bounds of H13502 and within the State of Texas Coastal Zone Management Area (CZMA). In accordance with HSSD Section 1.7 and Project Instructions dated 06 July 2021, the pipeline was submitted in the form of a Non-Dangerous Pipeline Report to NOAA (.000) and as a .KMZ file to the General Land Office of Texas (GLO).

D.2.6 Platforms

No offshore platforms were assigned from the CSF within this survey area. One uncharted Tide Station (Freeport Harbor Tide Station 8772471; Feature 189) was observed; information was provided to AHB regarding the uncharted tide gauge. AHB noted that this would be forwarded to MCD through the OCS ASSIST portal via email correspondence 06 January 2022, see Project Correspondence. Final charting recommendations are addressed in the S-57 FFF.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist within this survey area.

D.2.8 Abnormal Seafloor or Environmental Conditions

The majority of abnormal seafloor or environmental conditions, as defined in Section 8.1.4 of the HSSD, that exist within this survey area are discussed in Sections B.2.6, D.1.2, and D.2.9.

Additionally, it was observed in the upper channel stretches, primarily the Stauffer Turning Basin that some objects and debris had shifted in position from days of initial survey and passes captured on later dates. In all cases, these objects were considered to be non-significant due to their height and/or controlling shoaler depths nearby. Figure 32 shows a MBES return on two circular objects from survey on JD 191. Figure 33 shows a MBES return on the same two circular objects from survey on JD 204, indicating that one of the two objects had moved. Figure 34 shows the MBES returns from all survey data. Additional instances of similar non-significant debris shifting were observed within H13502 data. As noted in Section B.2.6, the channel was often subject to high flow and currents during and immediately following weather events.

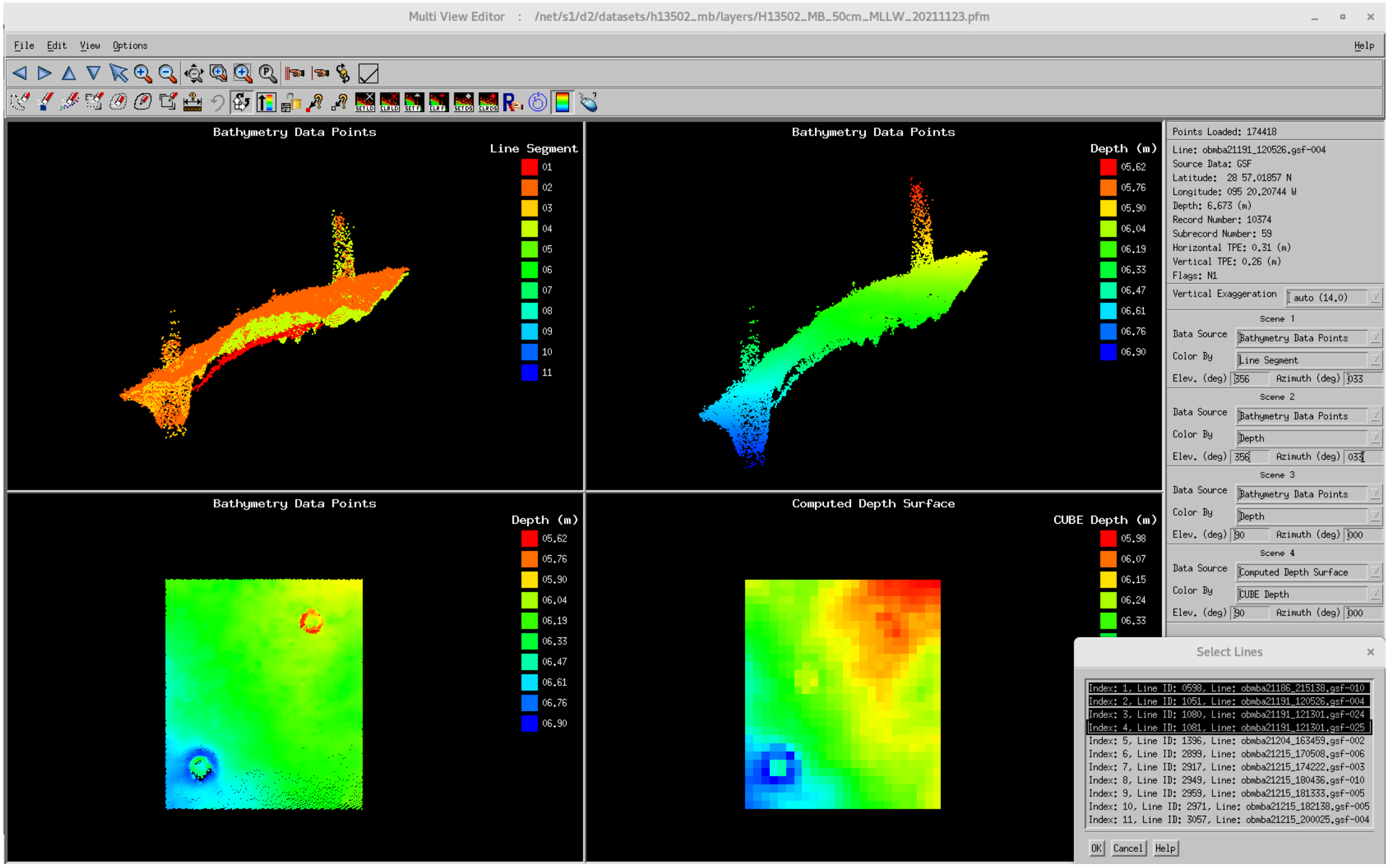

Figure 32: Circular Objects seen on Julian Day (JD 191)

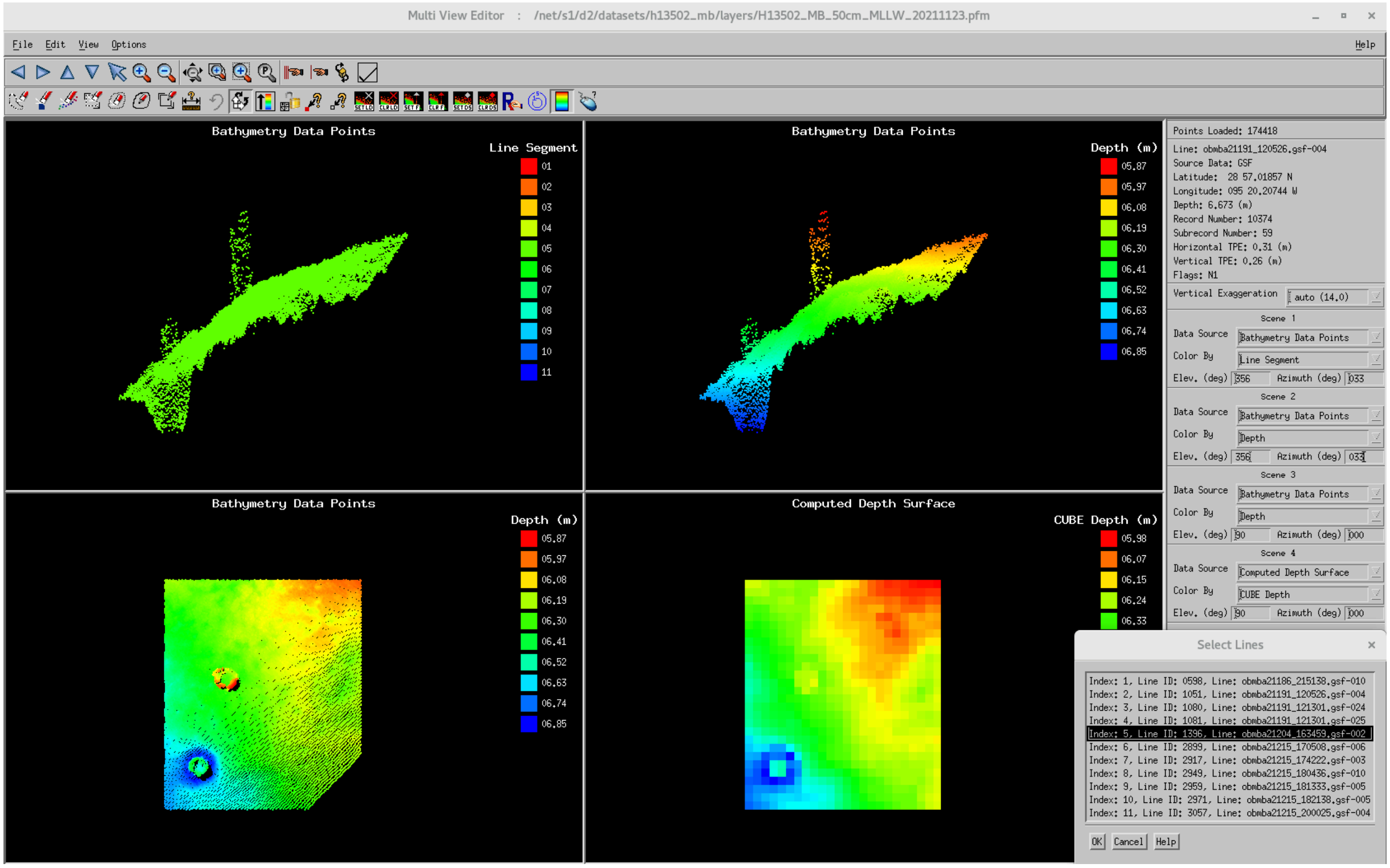

Figure 33: Circular Objects seen on JD 204

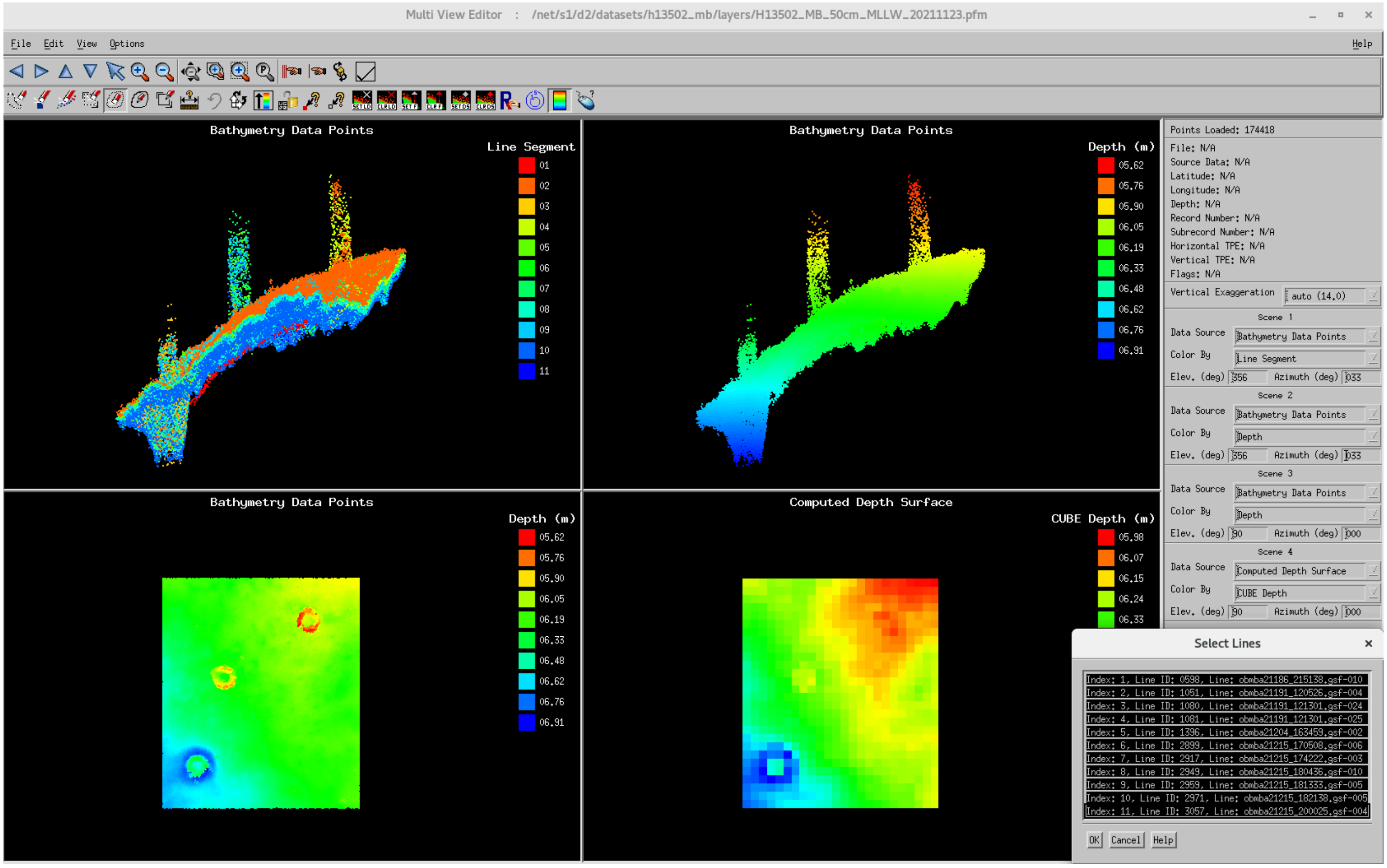

Figure 34: Multiple Returns on Circular Objects from All Survey Data

D.2.9 Construction and Dredging

Construction and dredging operations were observed during H13502 survey. From the LNM the Great Lakes Dredge & Dock Company performed dredge operations prior to the start of H13502 and after survey was completed. LNM 20/21 (20 May 2021) was the notice for dredge operations beginning and LNM 33/21 (18 August 2021) for when dredge operations concluded. H13502 MBES data shows the impact of the dredging activity (Figure 36 and Figure 37). During data analysis in these areas of active dredging the older data were invalidated for CUBE to provide the true seafloor. As discussed in earlier sections with the difference in depth data between days of active dredging to data collection resulted in nodes which exceeded the allowable uncertainty. As discussed in Sections A.4 and B.4, dredge vessels and equipment were present in MBES and SSS data. Following the completion of H13502 and review of LNM additional dredging operations were scheduled to start in the Freeport Entrance Channel and Jetty Channel, at Dow Chemical, and at Enterprise Seaway. Refer to Section D.1 for additional information.

Active construction was ongoing at Port of Freeport to build Berth 8. The reference to Pile Driving and Deck operations can be found in the LNM beginning 37/20 (15 September 2020) and continuing through 52/21 (29 December 2021). In the H13502 FFF, refer to Feature 113 for information on two charted seawalls (ENC US5FPOCA) that were under construction during H13502.

Figure 35: Overview of Primary Dredge Area

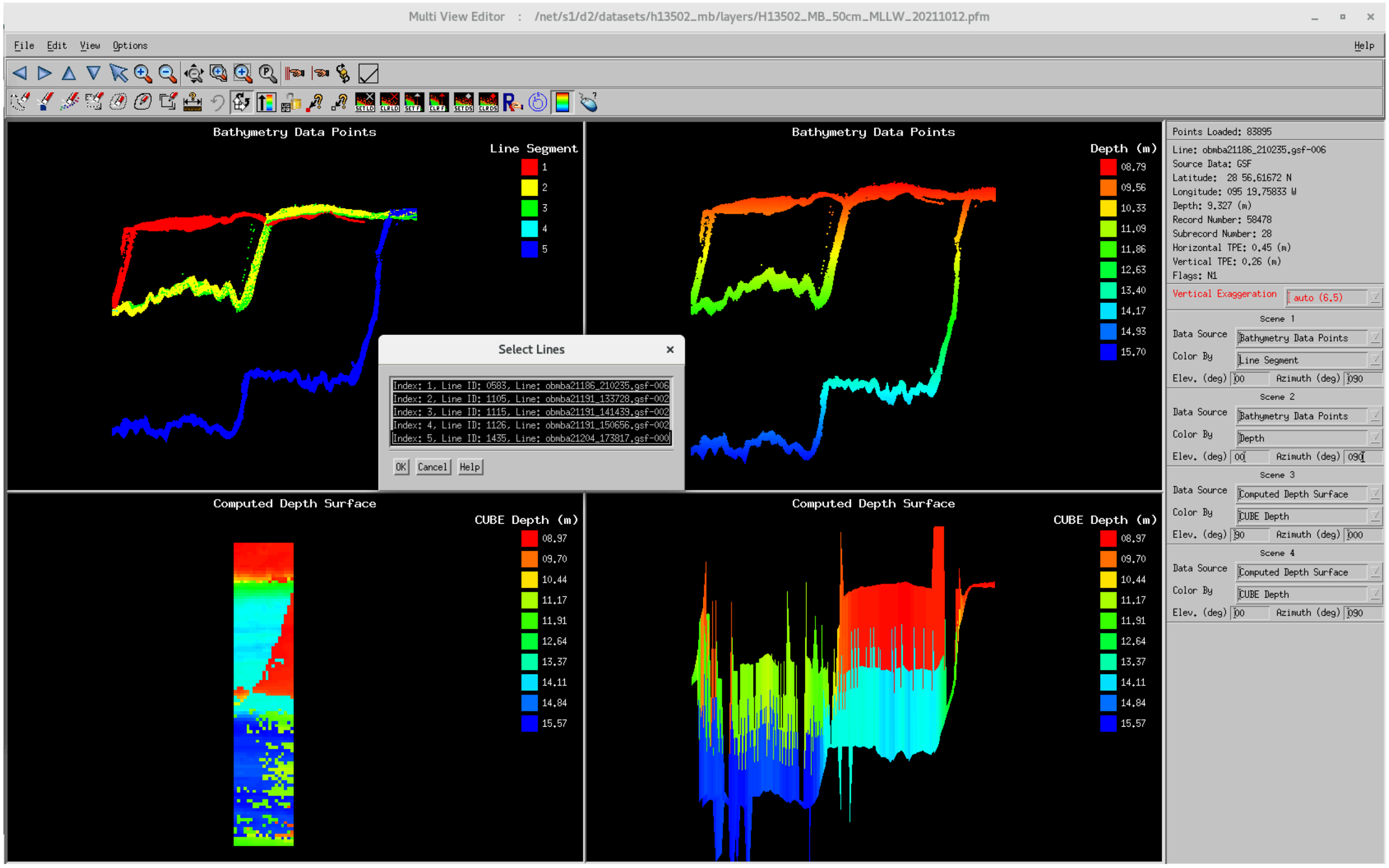

Figure 36: Dredge Variability between JD 186, 191, and 204

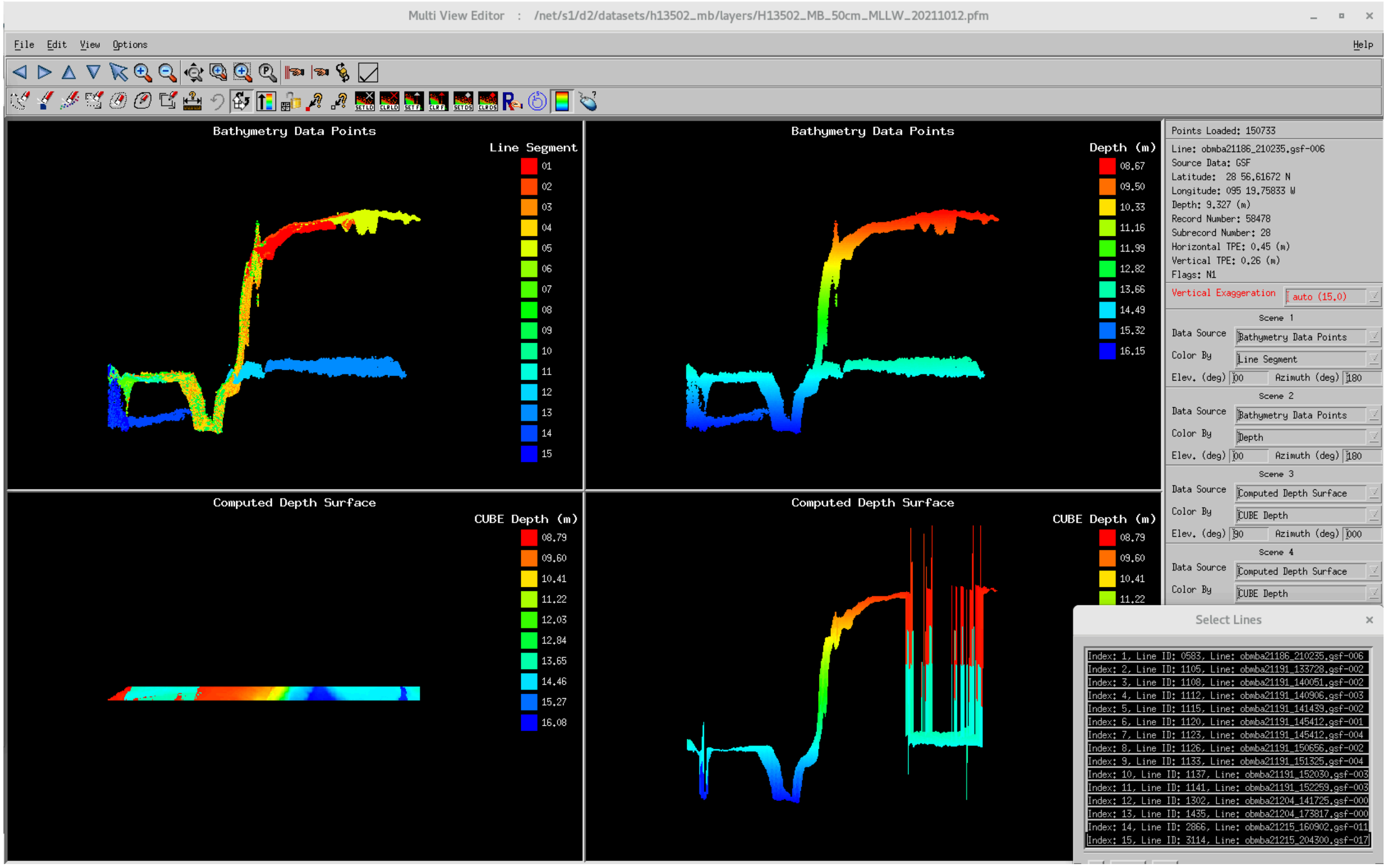

Figure 37: Dredge Variability between JD 186, 191, 204, and 215

Figure 38: Active Construction at Port of Freeport, Photo 1

Figure 39: Active Construction at Port of Freeport, Photo 2

D.2.10 New Survey Recommendations

An additional USACE post-dredging and channel survey is recommended for the Port Freeport and channels areas (portions of H13502), as active dredging operations remained on going within these areas throughout and beyond completion of the OPR-K380-KR-21 survey acquisition.

Note that along the stretch of rip rap (Feature 112) between the USCG Basin and the Intracoastal Waterway, there were some private uncharted docks observed to extend over rip rap. These docks have a minimal footprint in the water and were not discernable in SSS data.

D.2.11 ENC Scale Recommendations

No new ENC recommendations are made for the area surrounding this survey area.

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