H13365

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13365

LOCALITY

State(s):	Illinois Indiana
General Locality:	Chicago, IL
Sub-locality:	1 NM South of Chicago Harbor

2020

CHIEF OF PARTY
David J. Bernstein, CH, PLS, GISP

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13365**

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):	**Illinois Indiana**
General Locality:	**Chicago, IL**
Sub-Locality:	**1 NM South of Chicago Harbor**
Scale:	**10000**
Dates of Survey:	**05/30/2020 to 08/11/2020**
Instructions Dated:	**03/27/2020**
Project Number:	**OPR-Y395-KR-20**
Field Unit:	**Geodynamics LLC**
Chief of Party:	**David J. Bernstein, CH, PLS, GISP**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Low Water Datum 577.5 ft IGLD-1985 L Michigan,Huron**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in WGS84 UTM 16N, Low Water Datum 577.5 ft IGLD-1985 L Michigan,Huron. 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 H13365

Project: OPR-Y395-KR-20

Locality: Chicago, IL

Sublocality: 1 NM South of Chicago Harbor

Scale: 1:10000

May 2020 - August 2020

Geodynamics LLC

Chief of Party: David J. Bernstein, CH, PLS, GISP

A. Area Surveyed

Geodynamics LLC conducted a hydrographic survey in the assigned area of H13365 located 1 nautical mile (NM) south of Chicago Harbor, IL. Within H13365, all survey operations were conducted in accordance with the provided Statement of Work (SOW), Hydrographic Survey Project Instructions (PI), and the May 2020 National Ocean Service (NOS) Hydrographic Survey Specifications and Deliverables (HSSD). Any deviations from the aforementioned guidelines have been approved by the National Oceanographic and Atmospheric Administration (NOAA) Hydrographic Survey Division (HSD) Operations (OPS) branch and are documented in the survey correspondences.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
41° 53' 56.34" N 87° 37' 17.53" W	41° 44' 45.09" N 87° 26' 30.71" W

Table 1: Survey Limits

Data were acquired to the survey limits in accordance with the requirements listed in the PI and the HSSD.

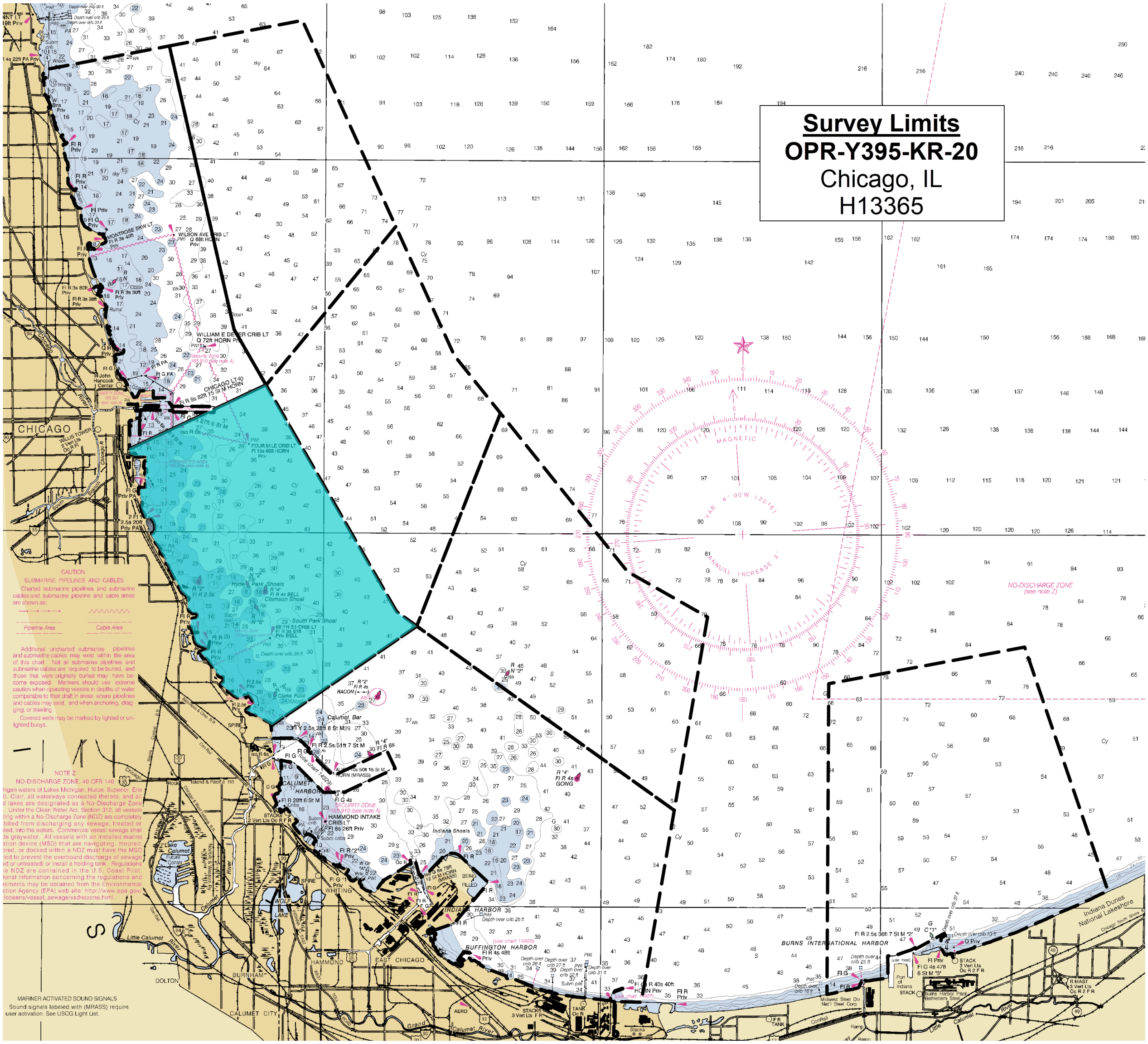


Figure 1: Overview of project survey limits, overlaid onto Chart 14905 with H13365 shown in blue

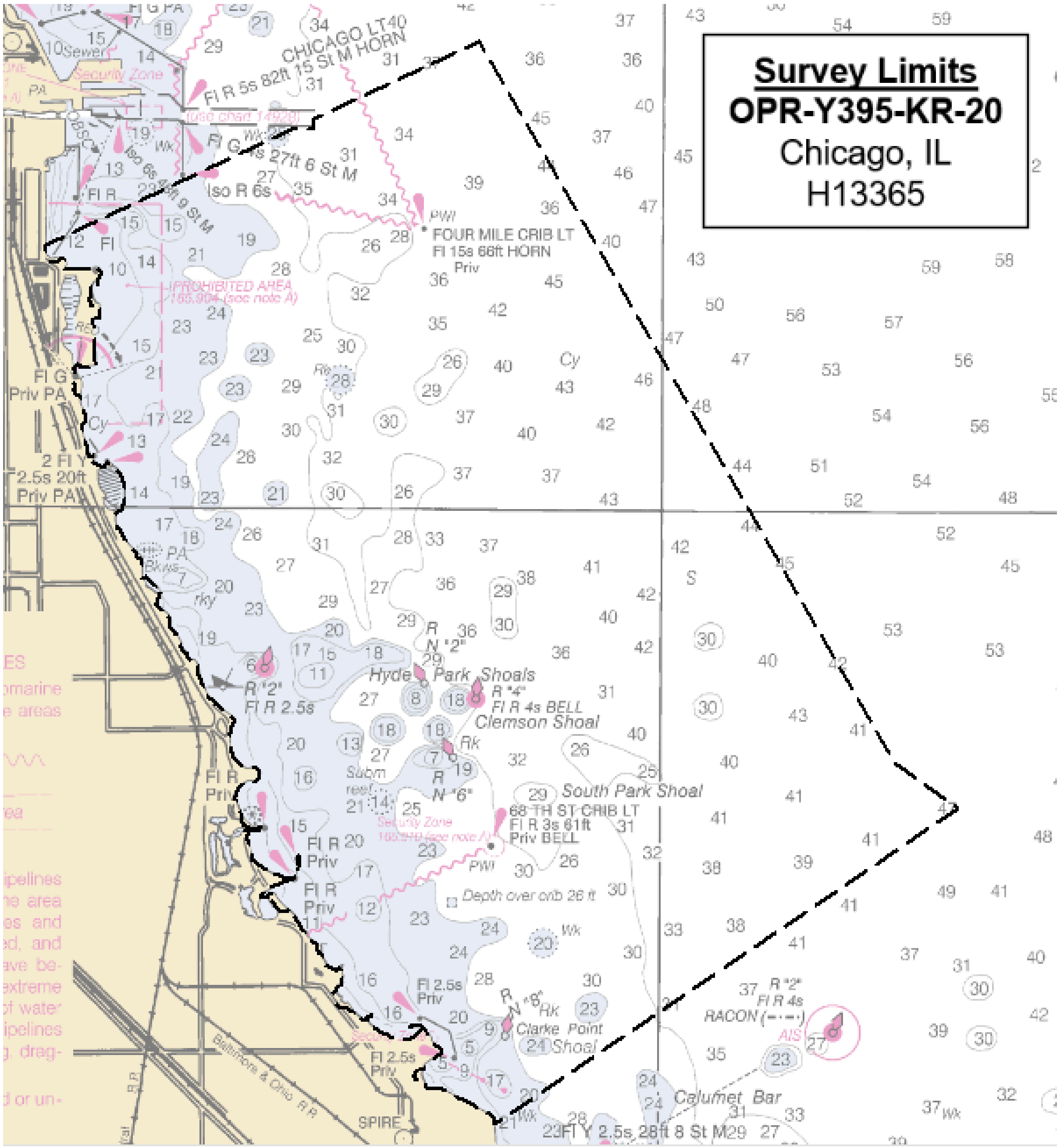


Figure 2: H13365 survey limits overlaid onto Chart 14905

A.2 Survey Purpose

This project is located in the most southern region of Lake Michigan, which includes the Chicago Harbor and much of the Indiana and Michigan shoreline. The Chicago Harbor, located in one of the largest cities in the country, is the northern entrance to the Mississippi River and has a tremendous amount of local barge traffic moving commodities throughout the year.

Much of the survey area within the project limits has not been surveyed since the late 1940s, and many throughout the Lake Michigan community, including tug and barge operators and recreational boaters, have been forced to predict the hazards and depths associated with the area near shore.

This survey provides critical data for the updating of NOS nautical charting products and contributes to increased maritime safety near the Michigan, Indiana, and Illinois shoreline. 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.

Survey quality in H13365 meets or exceeds requirements set forth in the HSSD. Survey quality was assessed through visual inspection, the analysis of crosslines, the utilization of QC Tools to assess uncertainty and density, and a junction analysis between overlapping data collected on this project. For more information on methods and results of the survey data quality assessments for this survey, refer to section B.2 of this report.

A.4 Survey Coverage

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

Water Depth	Coverage Required
All waters in survey area	Complete Coverage

Table 2: Survey Coverage

The entirety of H13365 was acquired with complete coverage in accordance with section 5.2.2.3 of the HSSD. See Figure 3 for an overview of coverage.

All efforts were made to acquire survey data to the sheet limits or to the Navigable Area Limit Line (NALL), as defined in section 1.3.2 of the HSSD. In all areas where the 3.5 meter depth contour or the sheet limits were not met, NALL was defined by the inshore limit of safe navigation for the survey vessel due to risks associated with maneuvering the vessel in shallow and/or hazardous areas. Example of such areas are shown in Figure 4 and the figures in section B.2.10.

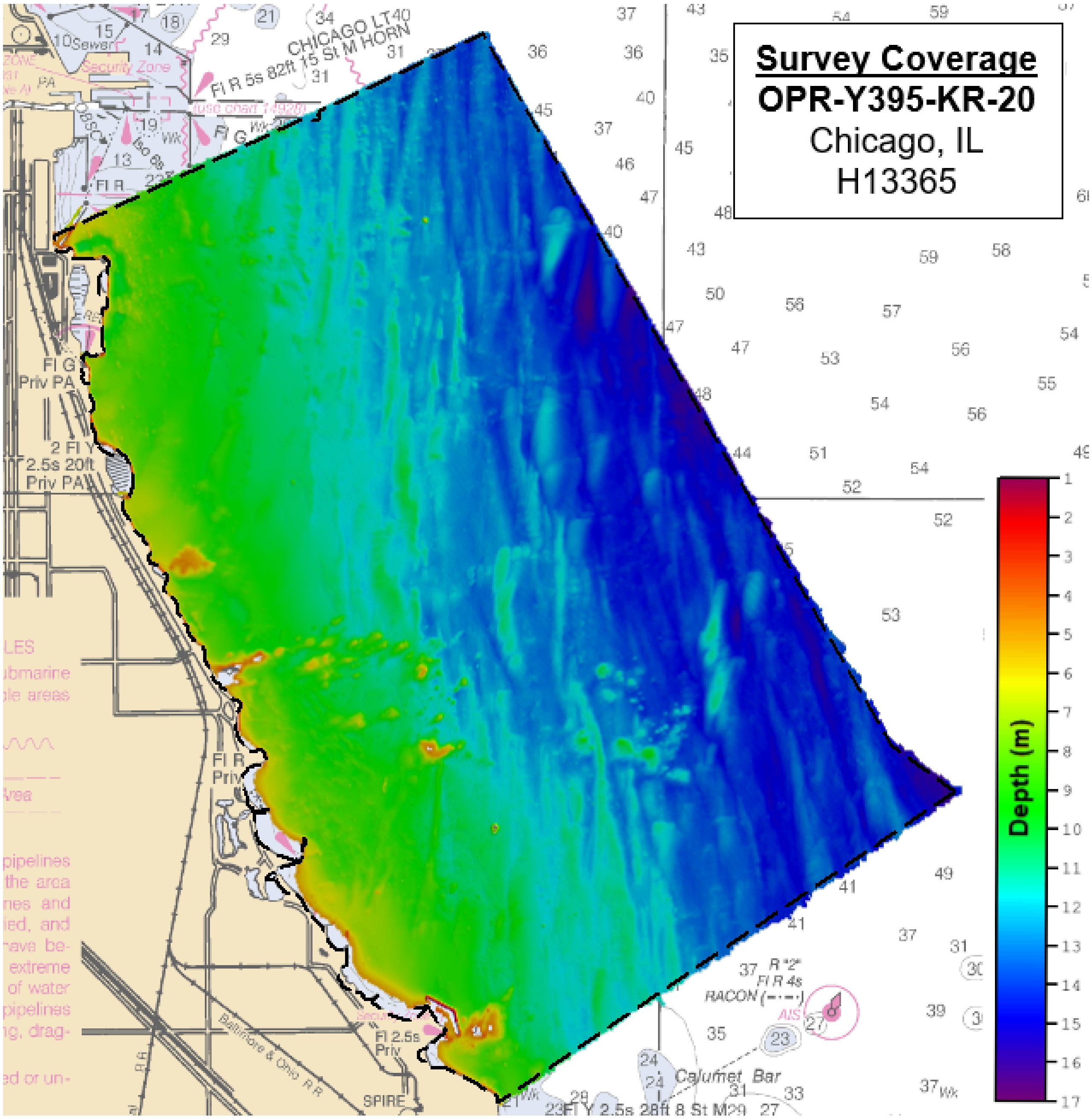


Figure 3: H13365 survey coverage overlaid onto Chart 14905

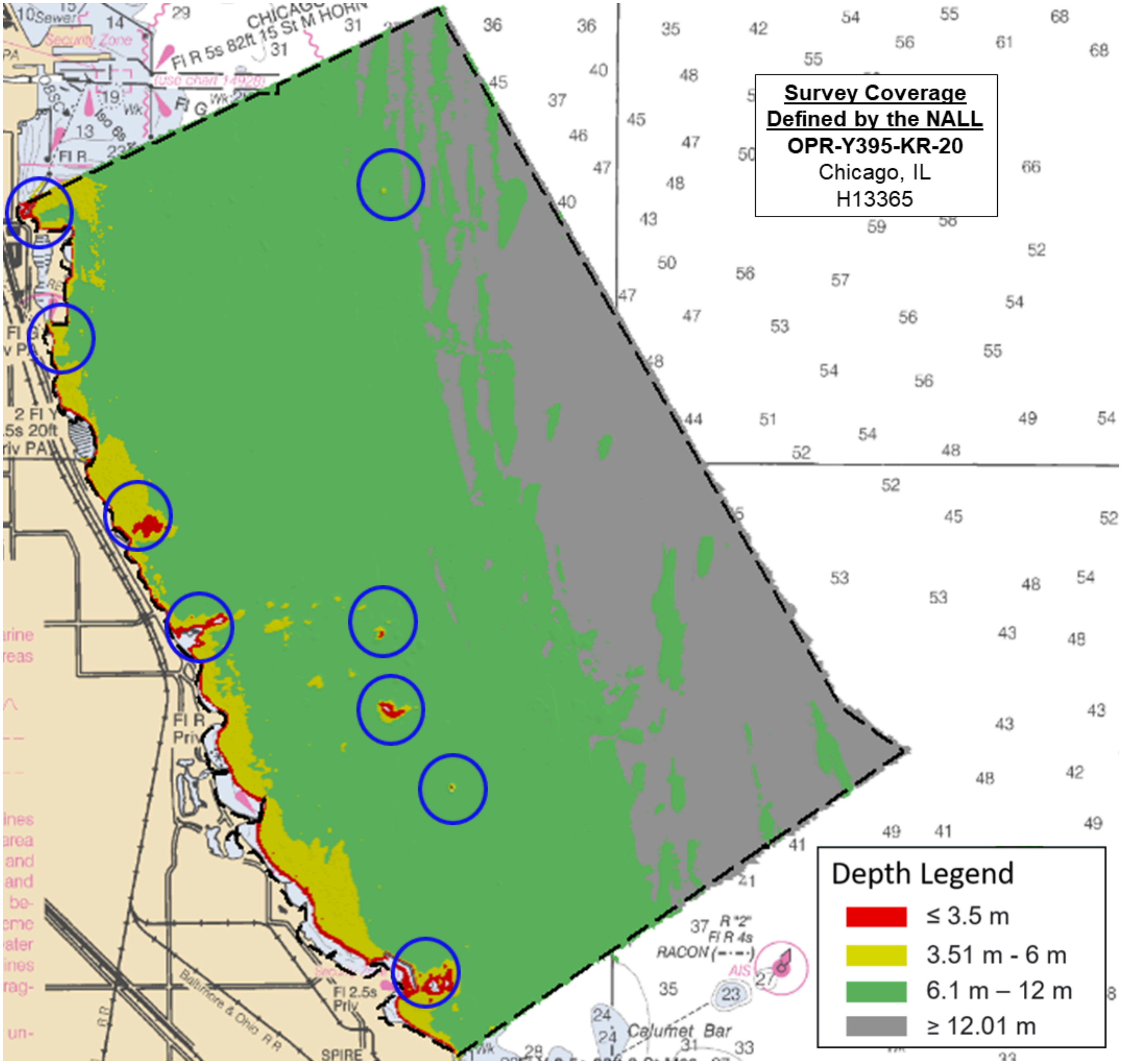


Figure 4: H13365 overview of areas where survey coverage was defined by the NALL

A.6 Survey Statistics

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

	HULL ID	*R/V Benthos*	*R/V Chinook*	*R/V Endeavor*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0	0.0	0.0
	MBES Mainscheme	41.55	7.32	1907.18	1956.05
	Lidar Mainscheme	0.0	0.0	0.0	0.0
	SSS Mainscheme	0.0	0.0	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0	0.0	0.0
	MBES/SSS Mainscheme	0.0	0.0	0.0	0.0
	SBES/MBES Crosslines	0.0	76.09	7.04	83.13
	Lidar Crosslines	0.0	0.0	0.0	0.0
Number of Bottom Samples					10
Number Maritime Boundary Points Investigated					0
Number of DPs					0
Number of Items Investigated by Dive Ops					0
Total SNM					37.4

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
05/30/2020	151

Survey Dates	Day of the Year
05/31/2020	152
06/01/2020	153
06/02/2020	154
06/03/2020	155
06/04/2020	156
06/05/2020	157
06/06/2020	158
06/07/2020	159
06/08/2020	160
06/09/2020	161
06/11/2020	163
06/12/2020	164
06/14/2020	166
06/15/2020	167
06/16/2020	168
06/17/2020	169
06/18/2020	170
06/19/2020	171
06/20/2020	172
06/21/2020	173
06/22/2020	174
06/23/2020	175
06/24/2020	176
06/25/2020	177
06/26/2020	178
06/28/2020	180
06/29/2020	181
06/30/2020	182
07/01/2020	183
07/02/2020	184
07/03/2020	185
07/21/2020	203

Survey Dates	Day of the Year
07/22/2020	204
07/23/2020	205
07/26/2020	208
07/29/2020	211
08/01/2020	214
08/08/2020	221
08/09/2020	222
08/10/2020	223
08/11/2020	224

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the OPR-Y395-KR-20 DAPR for a complete description of survey equipment and configurations, data acquisition procedures, data processing methods, quality control measures, and survey reporting methods. Additional information to supplement survey data and any deviations from the DAPR are discussed in the following sections.

B.1.1 Vessels

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

Hull ID	***R/V Benthos***	***R/V Chinook***	***R/V Endeavor***
LOA	9.14 meters	9.44 meters	13.41 meters
Draft	0.61 meters	0.61 meters	0.76 meters

Table 5: Vessels Used

B.1.2 Equipment

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

Manufacturer	Model	Type
Kongsberg Maritime	EM 2040C	MBES
R2Sonic	2024	MBES
Applanix	POS MV 320 v5	Positioning and Attitude System
AML Oceanographic	BaseX2	Sound Speed System
AML Oceanographic	SmartX	Sound Speed System
AML Oceanographic	MicroX SV	Sound Speed System

Table 6: Major Systems Used

R/V Benthos and R/V Chinook utilized a dual-head Kongsberg EM 2040C multibeam system, a POS MV 320 v5 positioning and attitude system, an AML MicroX surface sound speed system, and an AML BaseX2 sound speed profiling system. R/V Endeavor utilized a dual-head R2Sonic 2024 multibeam system, a POS MV 320 v5 positioning and attitude system, an AML MicroX surface sound speed system, and both an AML SmartX and BaseX2 sound speed profiling system.

B.2 Quality Control

B.2.1 Crosslines

Multibeam crosslines acquired for H13365 totaled 4.25% of mainscheme acquisition.

H13365 crosslines were collected and analyzed in accordance with section 5.2.4.2 of the HSSD and guidance from the HSD OPS Project Manager (see DR Appendix II). Crosslines were evaluated in CARIS HIPS with a detailed visual inspection followed by a thorough statistical analysis. To conduct the statistical analysis, a 1 m CUBE surface was generated with strictly mainscheme data and another, separate 1 m CUBE surface was generated with only crossline data. The mainscheme and crossline surfaces were analyzed using the Compare Grids tool in Pydro Explorer, which generated a difference surface and associated statistics. In addition to the direct statistics from the surface differencing, the tool assessed the difference surface statistics and computed the proportion of NOS total allowable vertical uncertainty (TVU) consumed by the mainscheme-to-crossline differences per surface node.

The statistical results of the difference comparison show 95% of nodes falling within +/-0.13 meters, with a mean difference of -0.03 meters (Figure 5). Additionally, 99.5+% of the difference surfaces nodes met or exceeded TVU specifications, as described in section 5.1.3 of the HSSD. The complete results and associated images from the Compare Grids tool were submitted within the Crossline Comparison folder of the Survey Separates II.

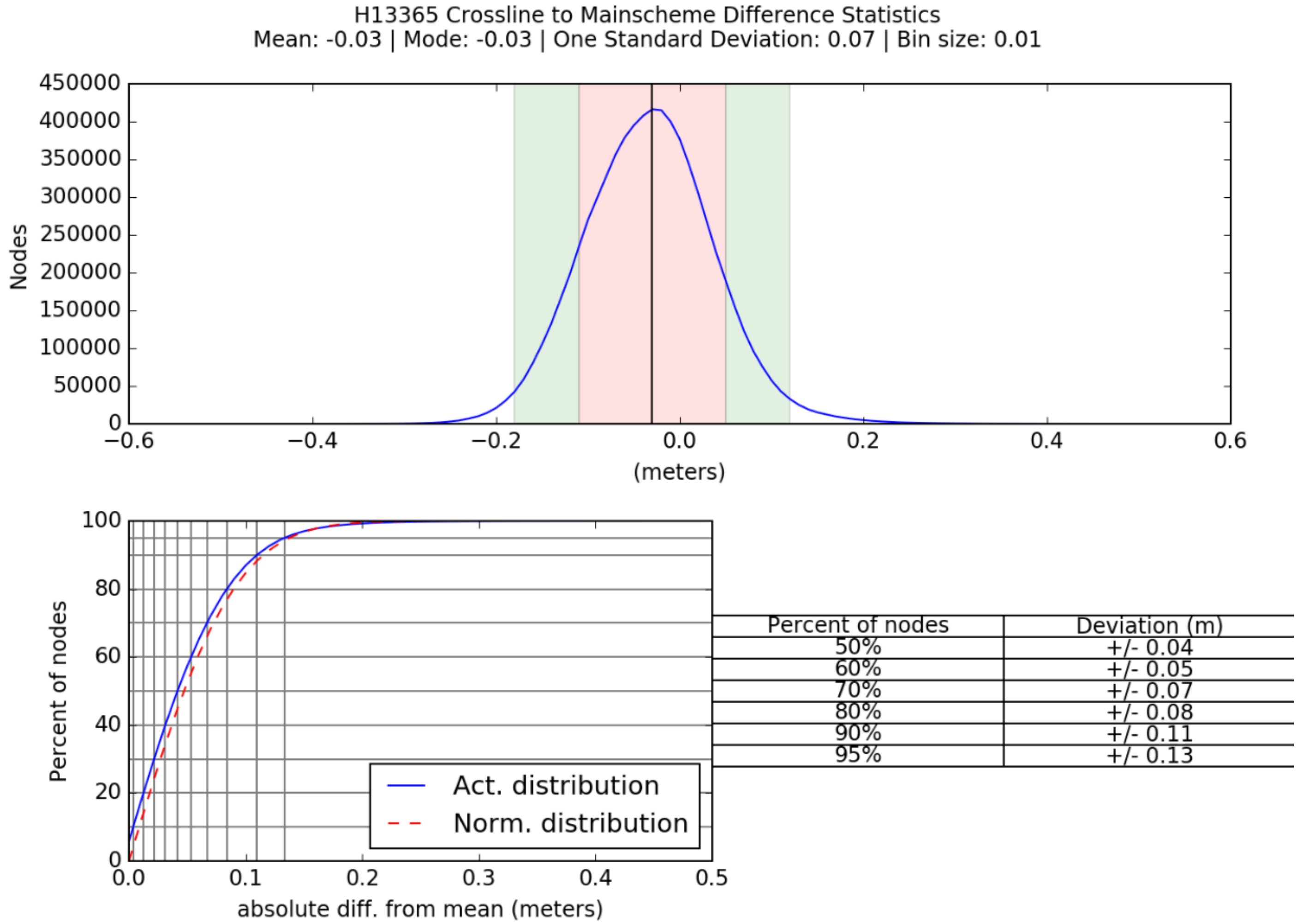


Figure 5: H13365 crossline to mainscheme difference statistics

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.045 meters	0.0 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Surface
R/V Benthos	2.00 meters/second	N/A	0.05 meters/second
R/V Chinook	2.00 meters/second	N/A	0.05 meters/second
R/V Endeavor	2.00 meters/second	N/A	0.05 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

The finalized CUBE surface was analyzed using the HydrOffice QC Tools Grid QA tool to assure 95% of the surface grid nodes meet TVU specifications. The results of the Grid QA tool determined that the finalized CUBE surface met or exceeded the TVU specifications, as shown in Figure 6.

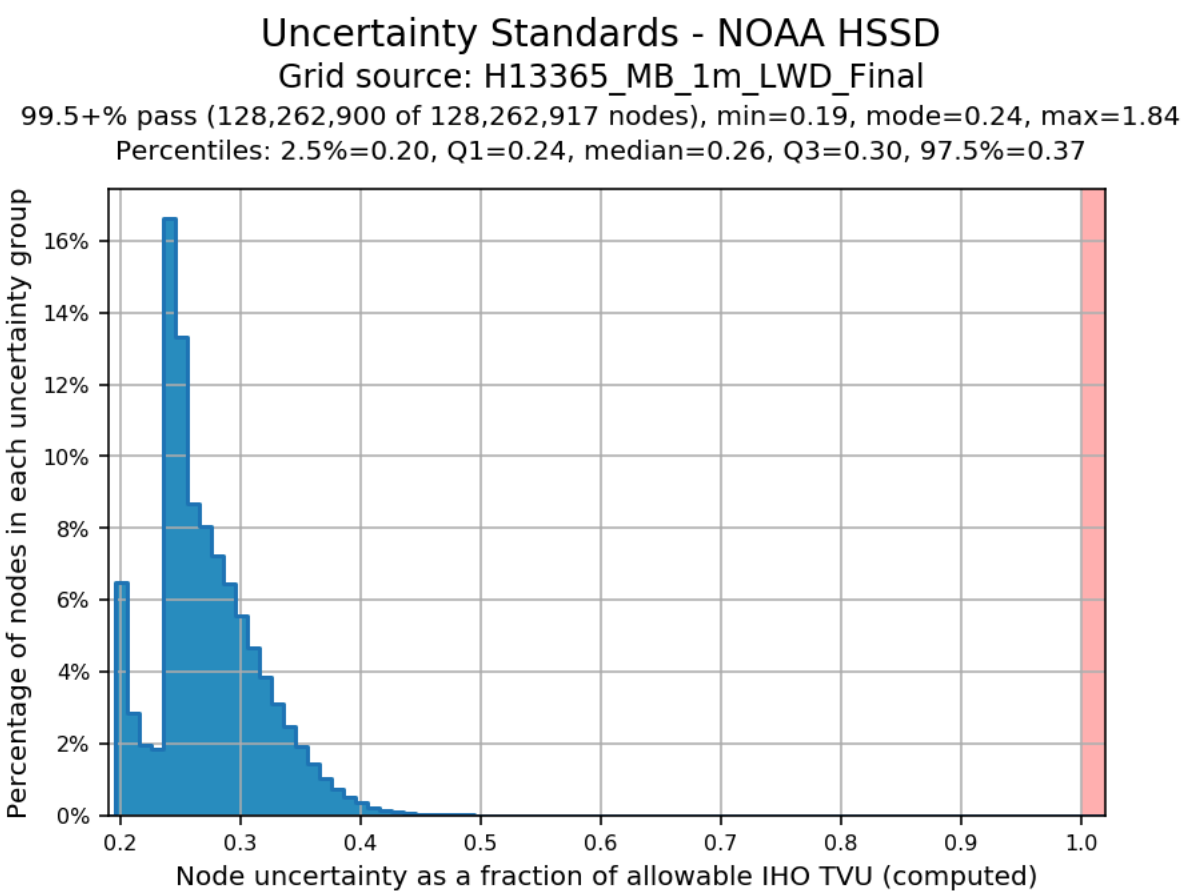


Figure 6: Finalized 1 m CUBE surface TVU statistics for H13365

B.2.3 Junctions

H13365 junctions with three adjacent surveys from this project: H13363, H13364, and H13366 (Figure 7). Data overlap between H13365 and each adjacent survey were attained. To conduct the junction analyses, similar to section B.2.1 of this report, the Pydro Compare Grids tool was utilized. The inputs for this tool were the CUBE surfaces for each individual survey at matching resolutions. The statistical results of the junction analyses are displayed below in Figures 8, 9, and 10. In all junctions, 99.5+% of the difference surfaces nodes met or exceeded TVU specifications, as described in section 5.1.3 of the HSSD.

In addition to the statistical results of the junction analyses, the resultant difference surfaces were visually inspected and CARIS Subset Editor was used to examine overlapping data for consistency, agreement between surveys, and confirming data met TVU specifications.

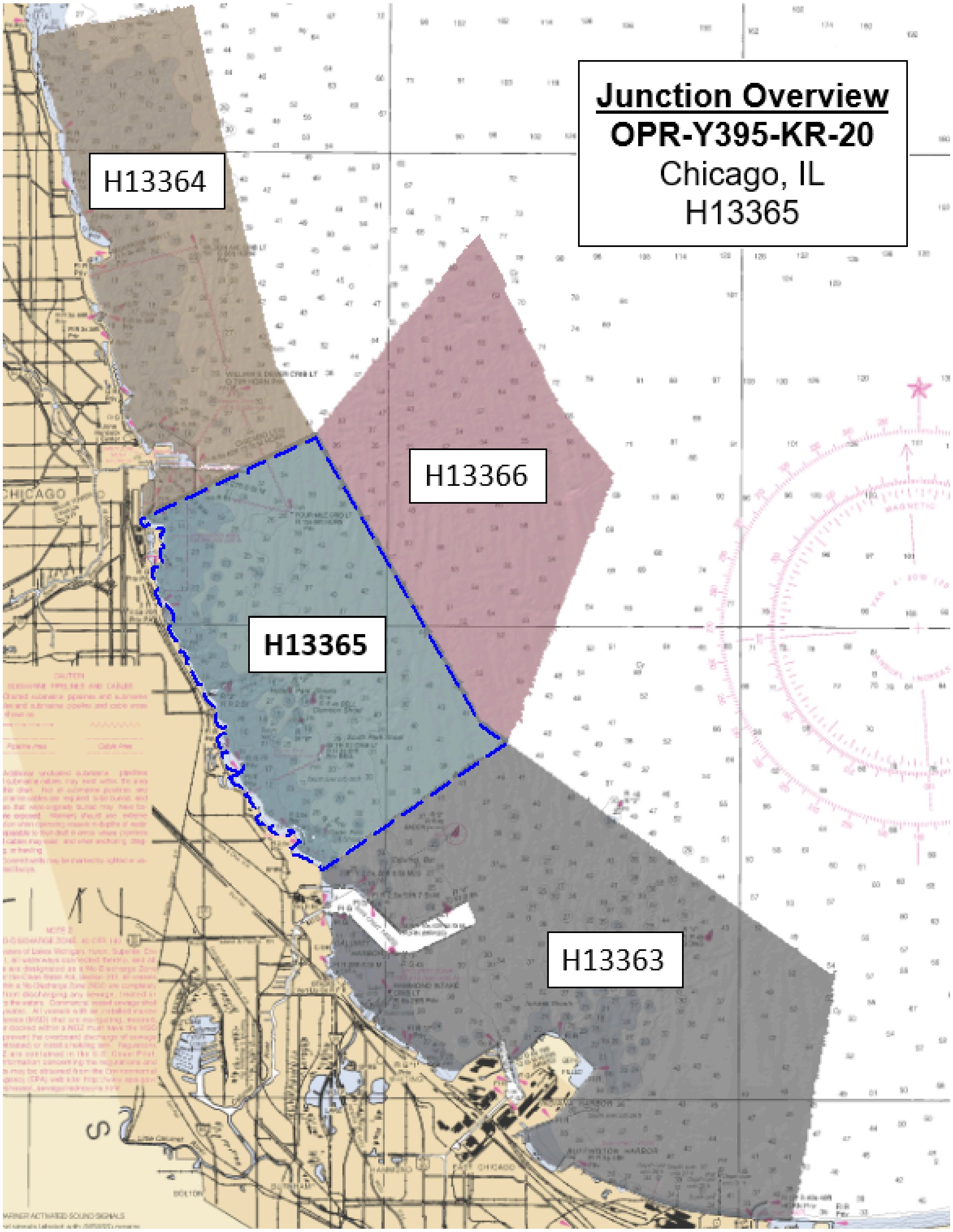
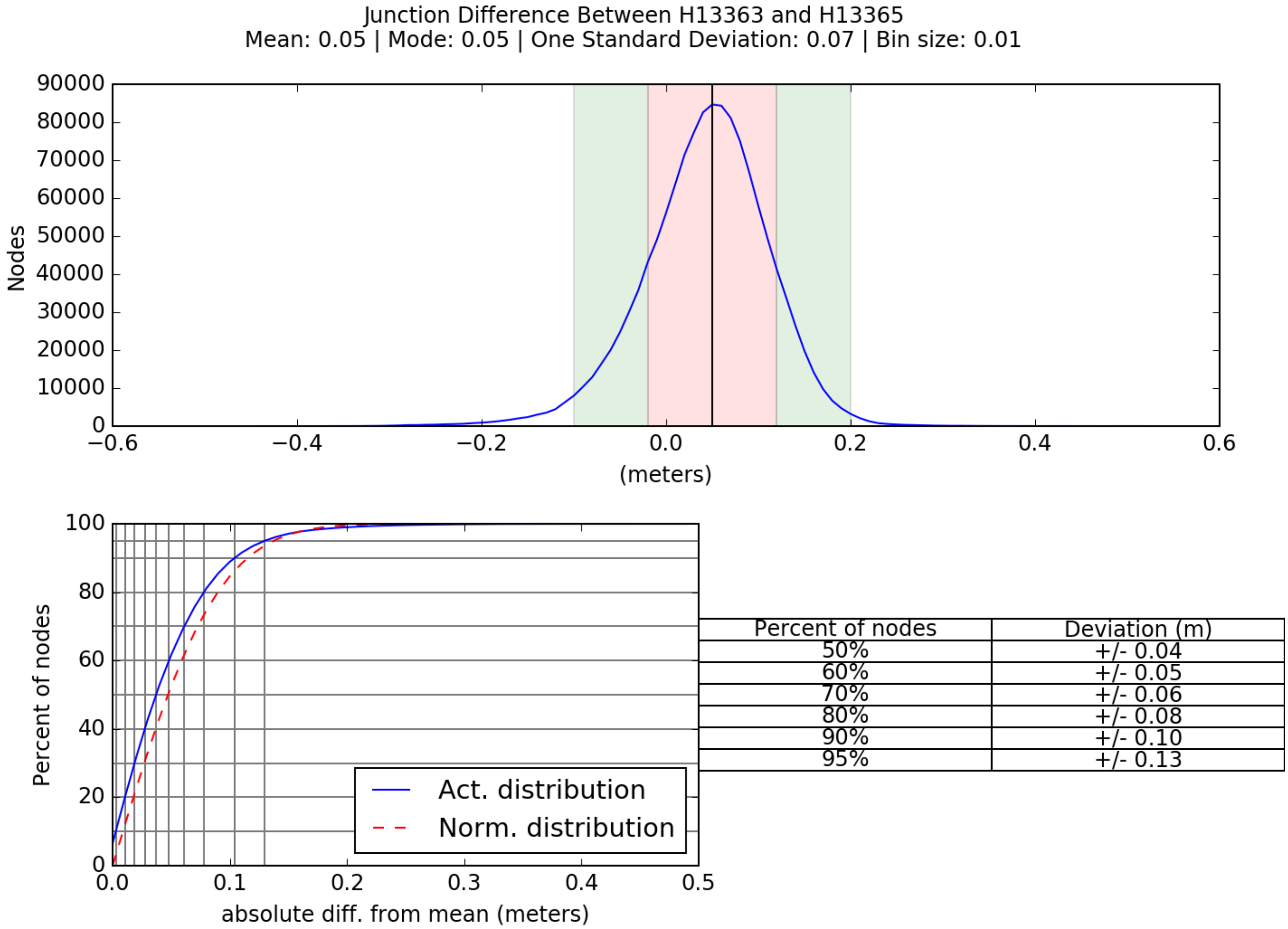
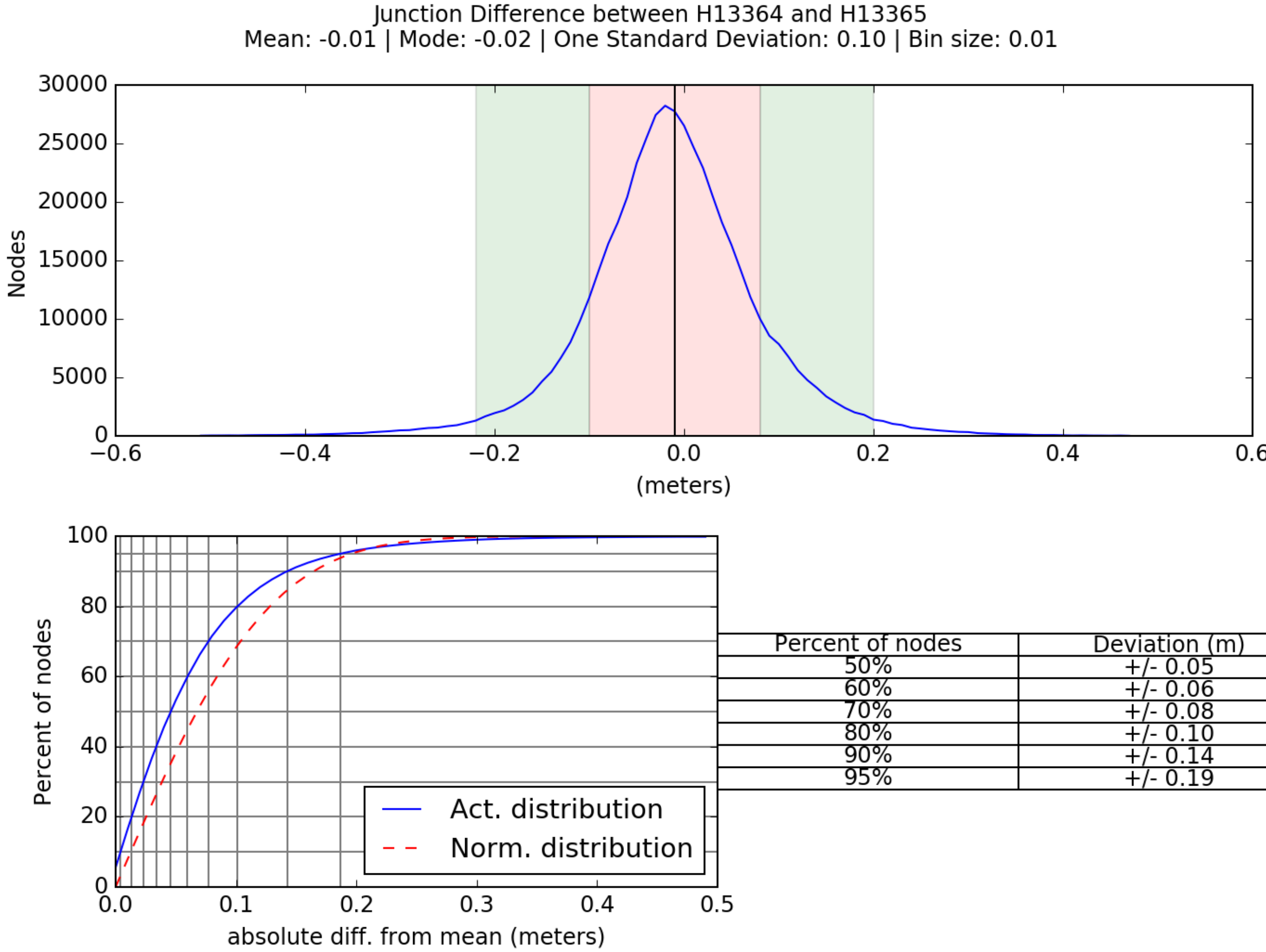


Figure 7: H13365 junction overview



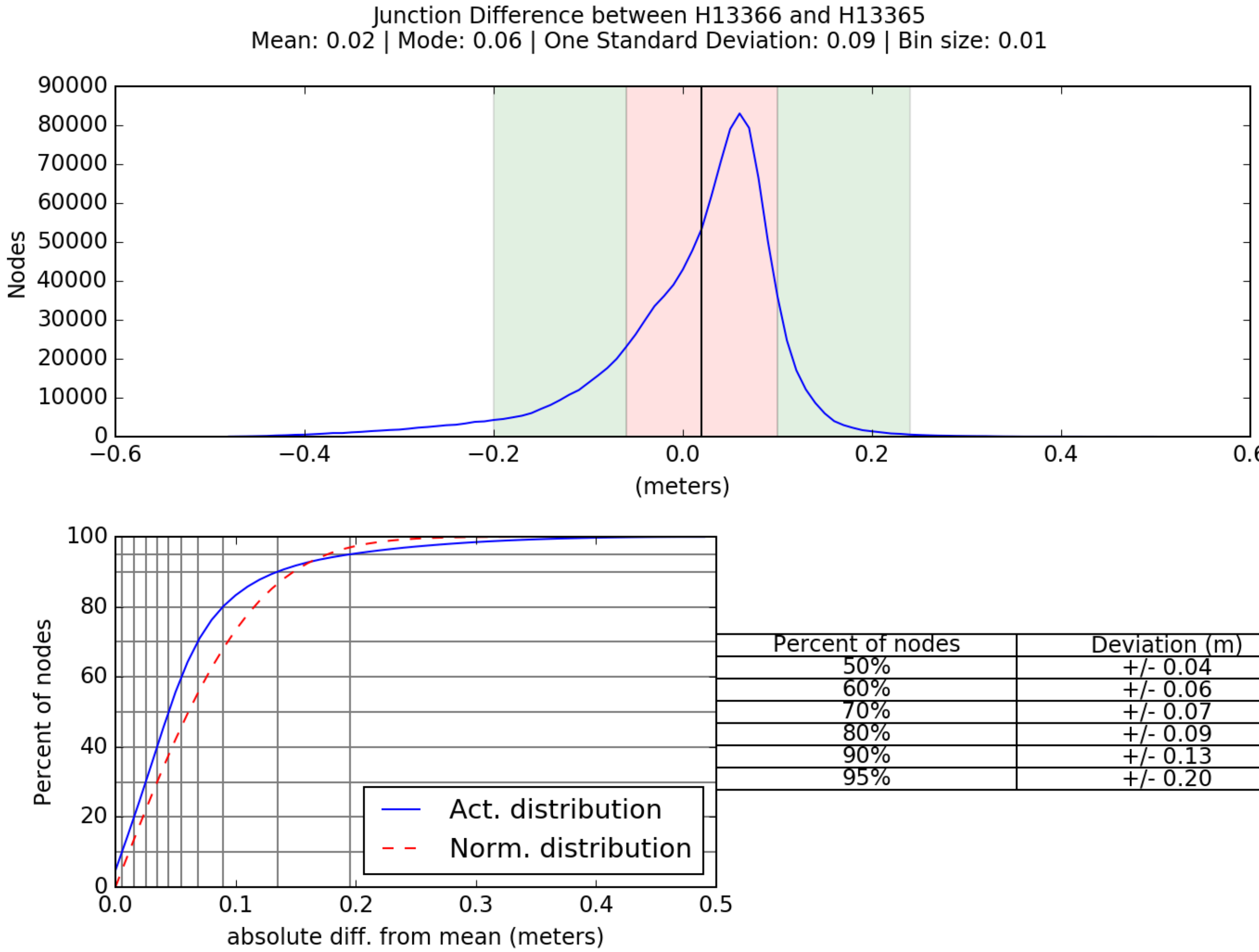
Percent of nodes	Deviation (m)
50%	+/- 0.04
60%	+/- 0.05
70%	+/- 0.06
80%	+/- 0.08
90%	+/- 0.10
95%	+/- 0.13

Figure 8: Junction analysis between H13363 and H13365



Percent of nodes	Deviation (m)
50%	+/- 0.05
60%	+/- 0.06
70%	+/- 0.08
80%	+/- 0.10
90%	+/- 0.14
95%	+/- 0.19

Figure 9: Junction analysis between H13364 and H13365



Percent of nodes	Deviation (m)
50%	+/- 0.04
60%	+/- 0.06
70%	+/- 0.07
80%	+/- 0.09
90%	+/- 0.13
95%	+/- 0.20

Figure 10: Junction analysis between H13366 and H13365

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 quality control section of the DAPR.

B.2.5 Equipment Effectiveness

POS MV Equipment Issues

The POS MV equipment on the R/V Endeavor had issues with IMU cable failures (primary and backup) leading to system configuration changes, as detailed in the DAPR. Additionally, the R/V Endeavor POS MV had momentary network communication dropouts. During these instances, a communication gap between the POS MV and QPS Qinsy resulted in a loss of data, causing small gaps in bathymetric data. These gaps were recovered immediately and did not result in holidays. Consequently, network communication problems also created data gaps within raw POS files, requiring the generation of multiple SBET files per raw POS file. To correct this problem, USB-logged raw POS files were also utilized for post-processing after DN166.

All issues were remedied as quickly as possible through equipment replacements and adjustments to survey methodology. Additional information can be found in the DAPR.

B.2.6 Factors Affecting Soundings

Sound Speed

The spatio-temporal variability in temperature of the water column created complex sound speed conditions throughout the survey. These complexities often created challenges for the field team and resulted in occasional refraction artifacts in the survey data and resultant surfaces, as shown in Figure 11.

The hydrographer made considerable efforts to reduce the impact of sound speed issues during acquisition. These efforts included increasing the frequency of casts, closely monitoring real-time swath “smiling” or “frowning”, utilizing alerts for surface-to-profile sound speed deviation, observing the real-time standard deviation map display, and utilizing Sound Speed Manager to track spatial changes in surface sound speed along with profile location. Additional efforts in post-processing to minimize refraction artifacts included outer beam filtering, manual outer beam editing, and strategic application of sound speed profiles.

The convex or concave trend in the across-track sonar data, as a result of refraction, is most prevalent on the outer beams and is noticeable in the surface as a striped line-to-line artifact.

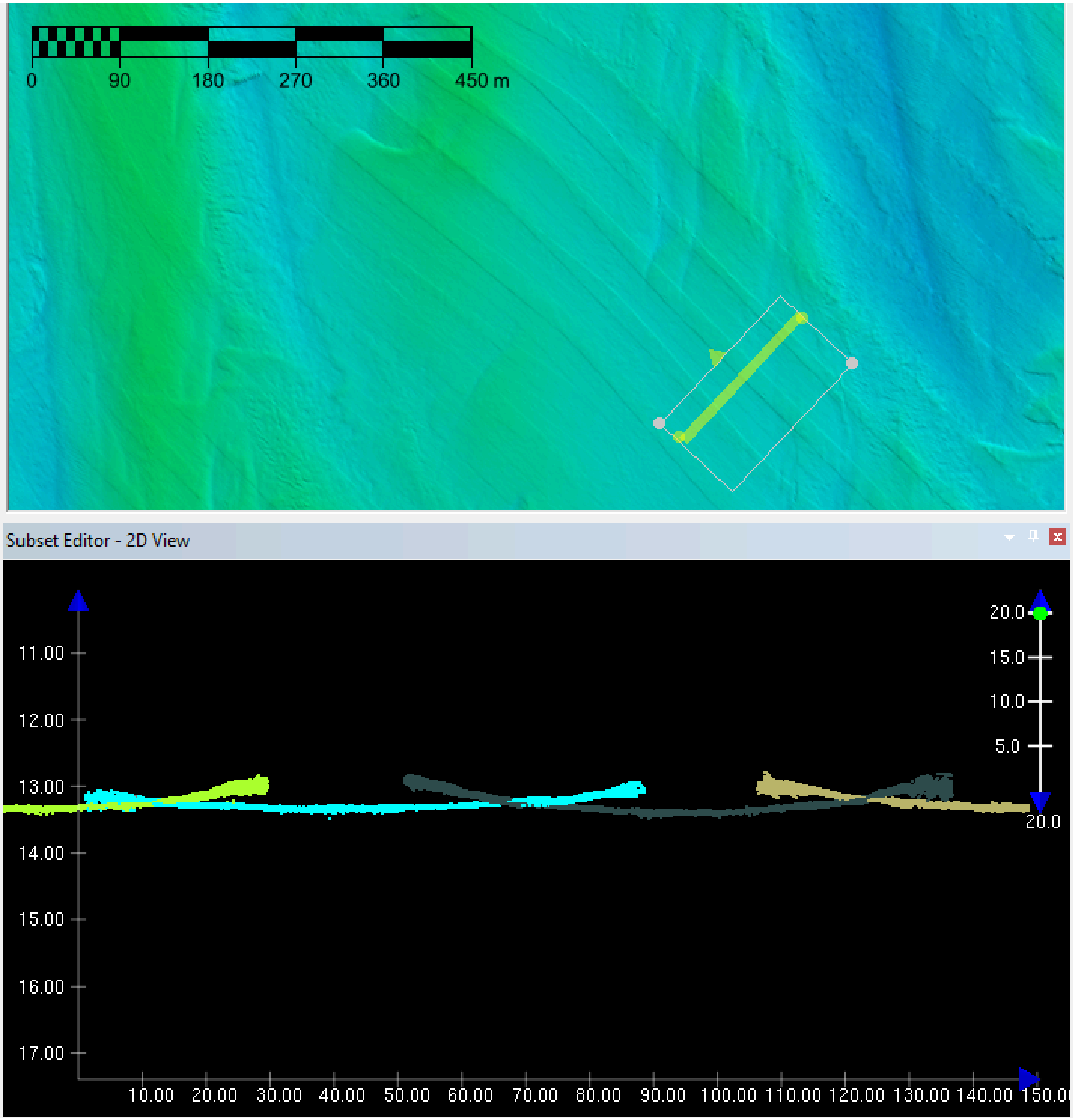


Figure 11: H13365 surface artifacts as a result of refraction in the sounding data

Trimble RTX

Trimble RTX post-processing methods produced SBET solutions that improved the real-time positioning and attitude data, as described in section C.1. However, variability in the ellipsoid (altitude) solution can result in artifacts that resemble static offset data or line-to-line offset data. To help identify and assess this variability, the SMRMSG error data associated with the SBET along with surface Depth and Standard Deviation layers were inspected. Although portions of the surface did display some slight vertical variations, the post-processed positioning and attitude data were well within the allowable error budget as outlined in section 5.2.3.5 of the HSSD. An example of a deviation in the quality of the GNSS position corrections can be seen below in Figure 12.

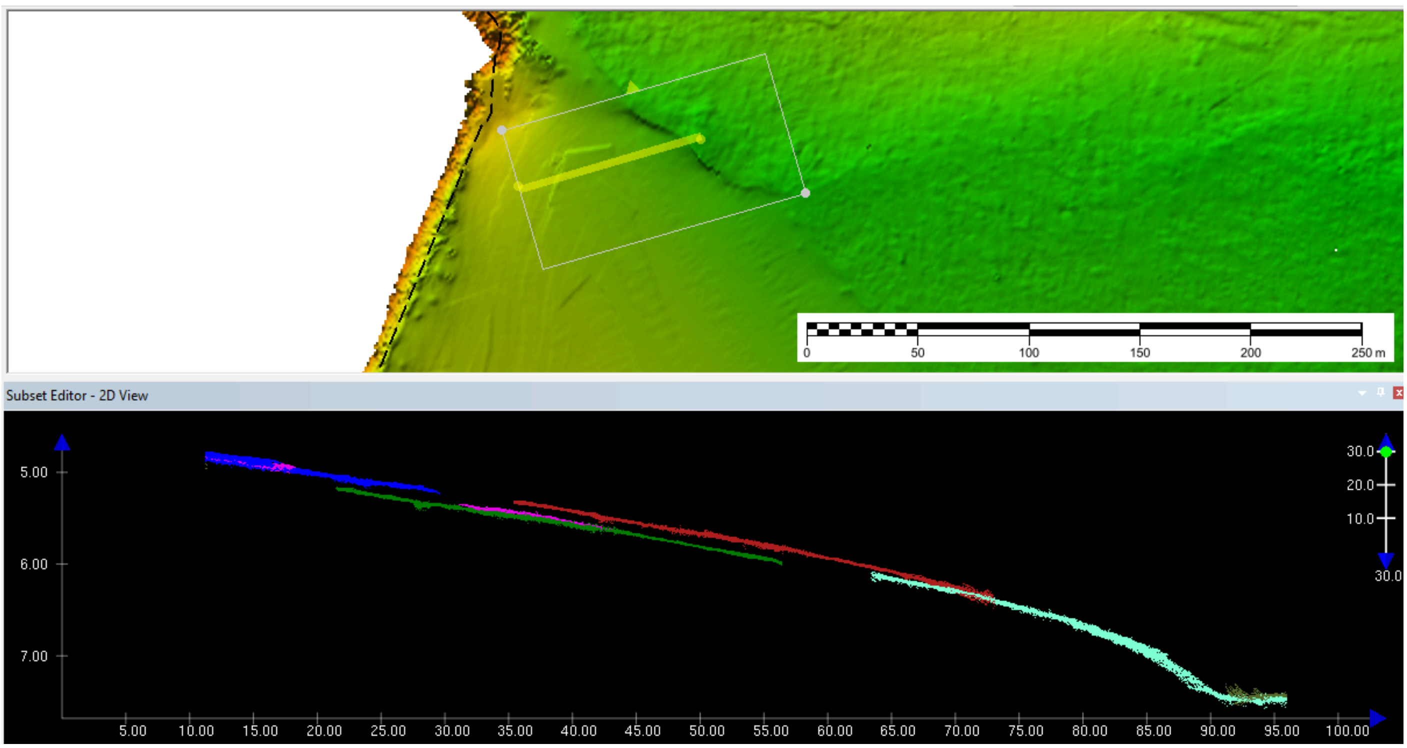


Figure 12: An example of a deviation in the quality of the GNSS position corrections in H13365

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: Sound speed casts were acquired at least once every four hours. Casts were often conducted more frequently (~every two hours) than this time interval because of the dynamic water properties in the survey area.

Surface sound speed was compared in real-time to the current sound speed profile. When the comparison differed by more than 2 m/s, a new sound speed profile was acquired. Additionally, QPS Qinsy and

Kongsberg SIS provided a real-time visual assessment of data quality (standard deviation grids, bathymetric grids, swath views), aiding the hydrographer in determining when a new cast was required.

For more detailed information on sound speed methods, please refer to the DAPR.

B.2.8 Coverage Equipment and Methods

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

B.2.9 Density

The finalized CUBE surface was analyzed using HydrOffice QC Tools Grid QA tool to assure data met the required density specifications. The 1 m complete coverage surface had 99.5+% of surface nodes containing at least five or more soundings, exceeding the specifications required by section 5.2.2.3 of the HSSD.

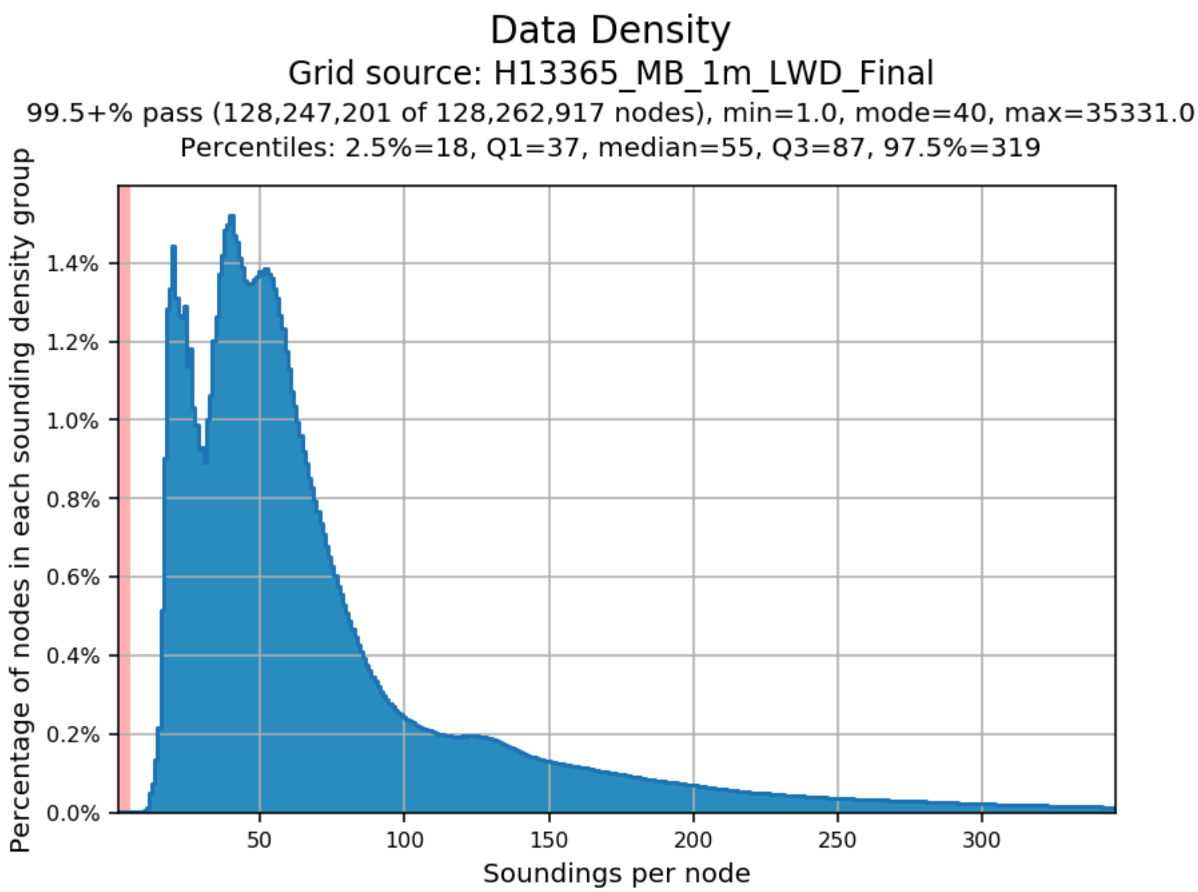


Figure 13: Finalized 1 m CUBE surface density statistics for H13365

B.2.10 Holidays

All CUBE surfaces were analyzed using HydrOffice QC Tools Holiday Finder to determine if the surface contained holidays, as described in section 5.2.2.3 of the HSSD. The tool scanned the CUBE surfaces to identify any holidays and generated an S-57 file to represent the locations of holidays.

In the 1 m complete coverage CUBE surface, all holidays identified were inshore or within the NALL (see examples in Figures 14, 15, and 16).

Another method of holiday evaluation was to visually pan the CUBE surfaces to identify holidays. The hydrographer would often alter the surface display (color ranges, symbology, shading) to help identify coverage gaps. The results reflected the same outcome as the tool.

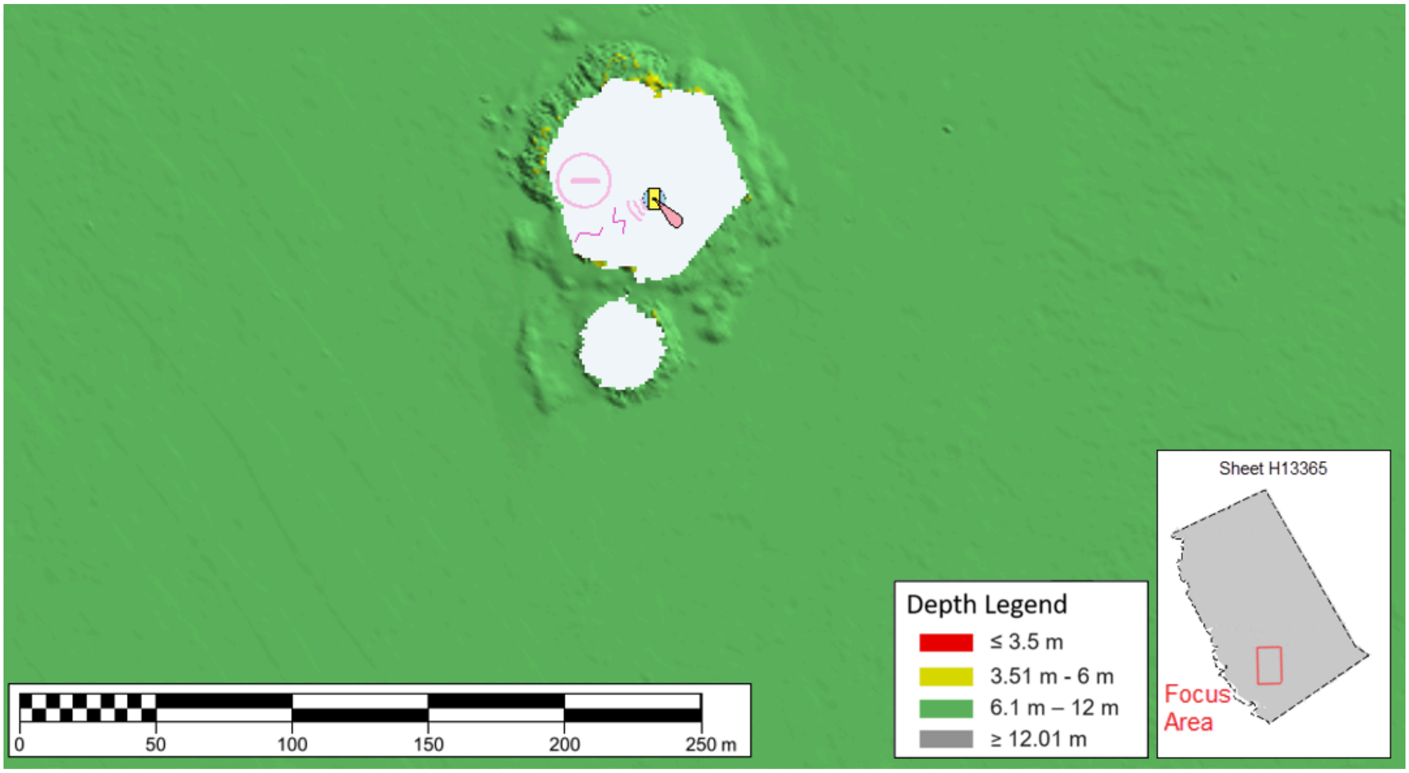


Figure 14: Example of an area where holidays were identified within the NALL, due to the presence of an obstruction

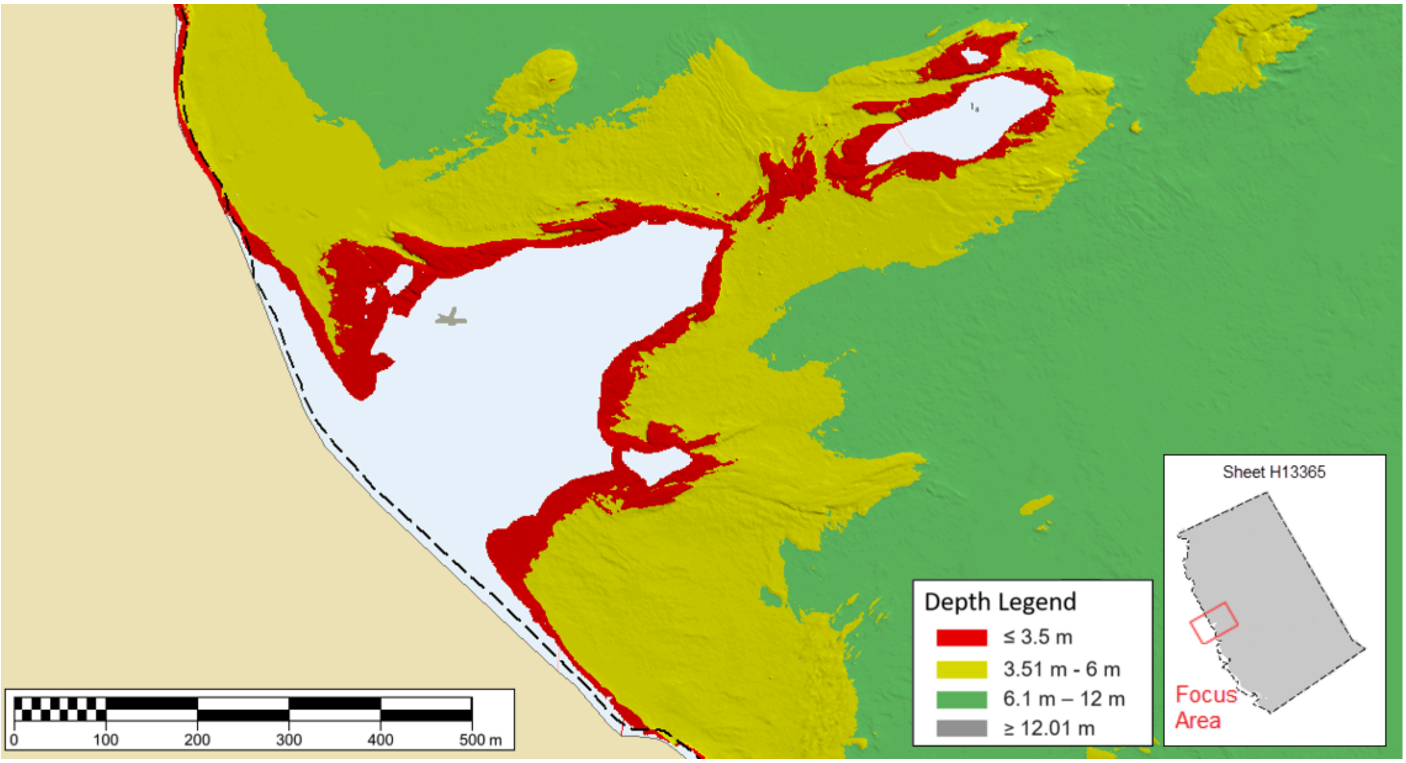


Figure 15: Example of an area where holidays were identified within the NALL, due to the presence of a shoal

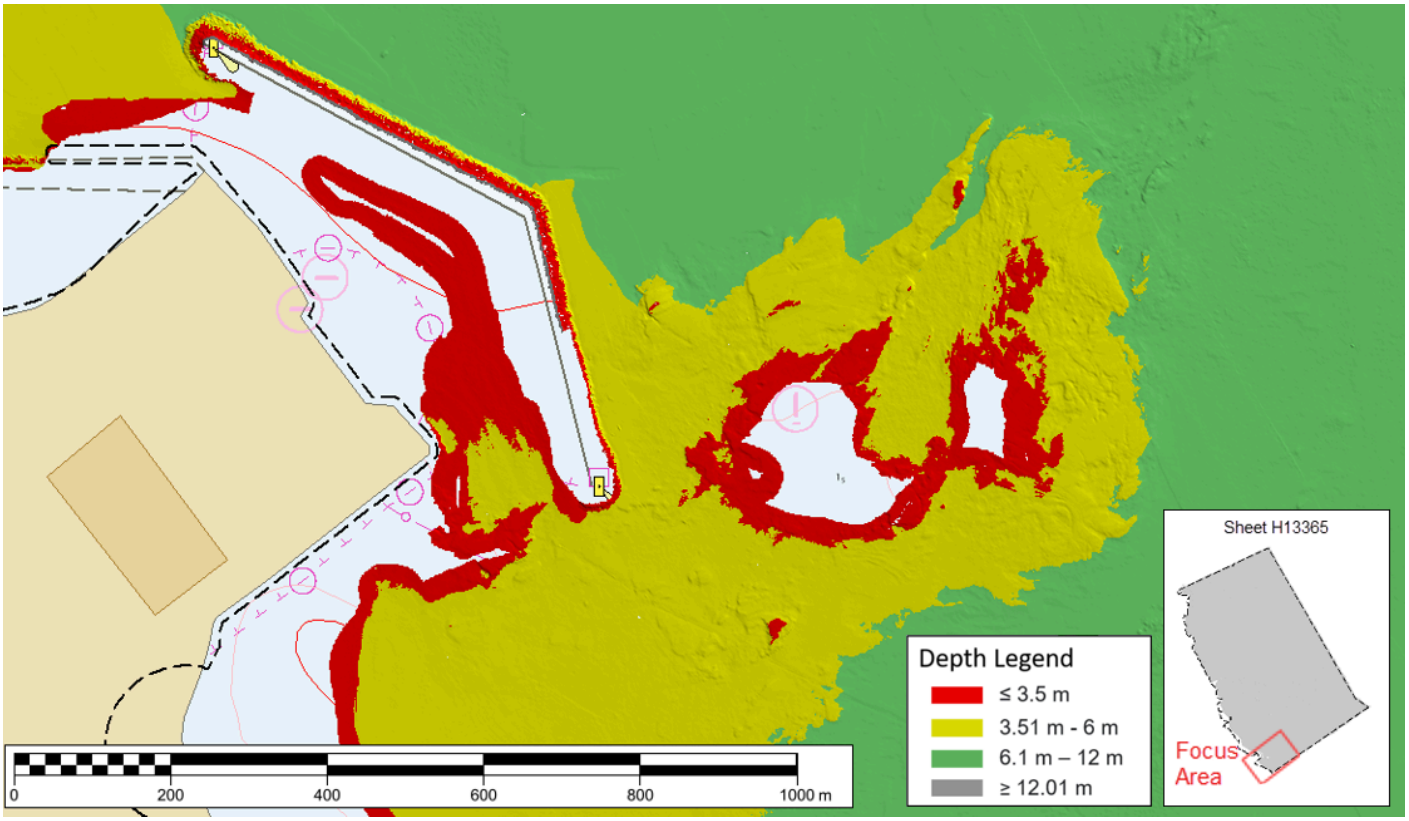


Figure 16: Example of an area where holidays were identified within the NALL, due to the presence of a shoal and breakwater

B.2.11 Flier Finder

In addition to visual inspection, all CUBE surfaces were analyzed using HydrOffice QC Tools Flier Finder tool to assure data does not contain fliers (anomalous data as defined by QC Tools flier finding algorithms #2-6). While the Flier Finder tool flags surface fliers meeting a set criteria, it will also flag real surface features that meet the same criteria. Spurious soundings flagged by Flier Finder were cleaned until only the remaining flagged fliers were deemed valid aspects of the surface. This was especially prevalent around hard structures along the shoreline.

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

Raw backscatter data were collected and stored within the .ALL files from vessels utilizing Kongsberg MBES systems. For R/V Endeavor, which utilized a dual-head R2 Sonic 2024, the raw backscatter data were stored within the QPS Qinsy .db files and submitted as GSF files exported from QPS Qimera. The submitted GSF files for the R/V Endeavor contain backscatter data and raw bathymetry. These files were not used for bathymetric data processing.

Although no processing or analysis of backscatter was required, backscatter data were processed for quality assurance purposes in QPS FMGT. Additionally, mosaics were created to assure the coverage and quality of the backscatter (Figure 17). Hydrographers in the field monitored backscatter intensities in real-time and made efforts to collect quality backscatter without hindering bathymetric data quality. Refer to the DAPR for more information on backscatter data acquisition and processing procedures.

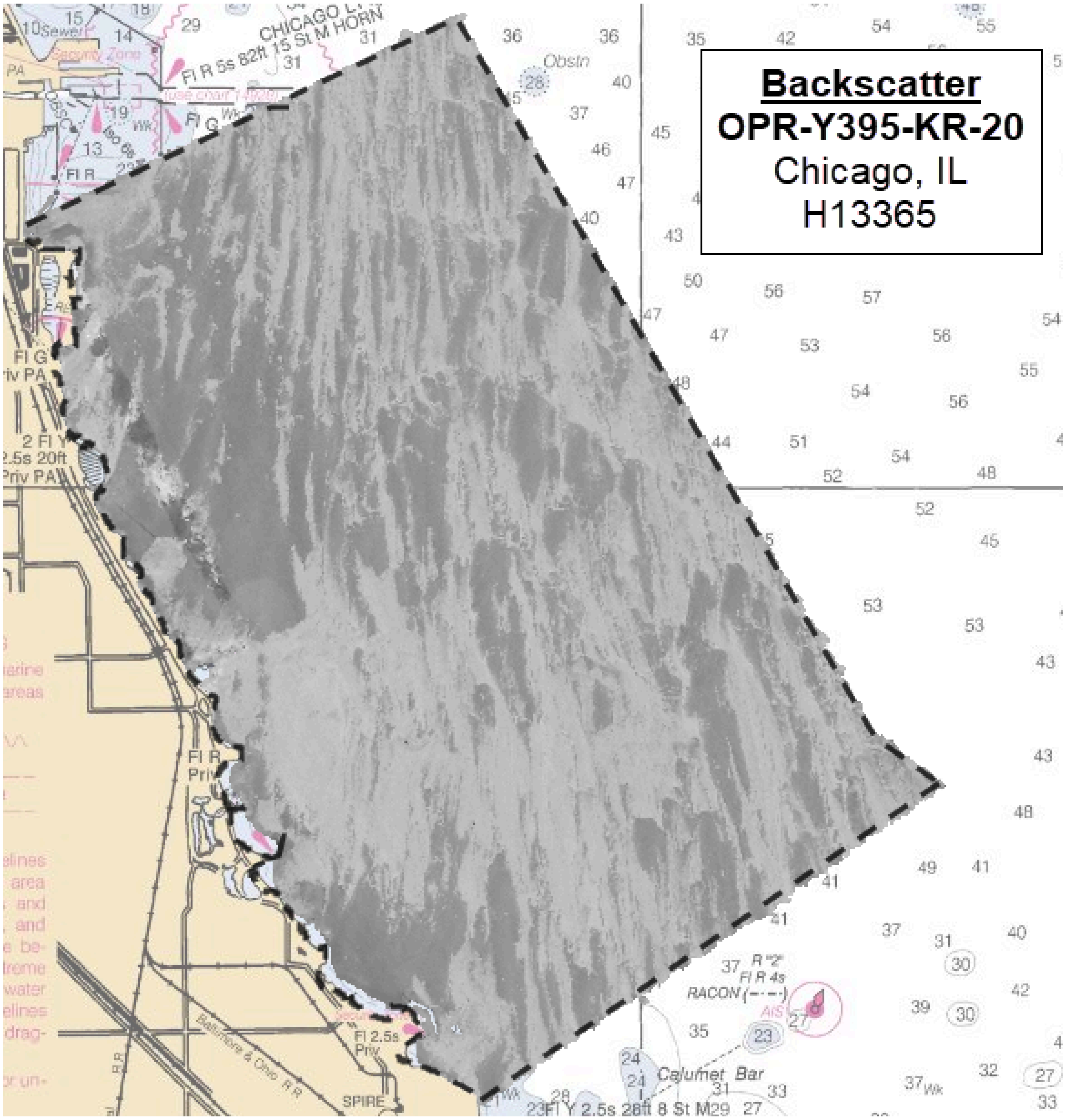


Figure 17: H13365 backscatter mosaic

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
CARIS	HIPS	10.4.22

Table 9: Primary bathymetric data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2020.

Due to a known bug in CARIS HIPS 10, the “Line Report” function in CARIS HIPS (also referred to as Detailed Line Query), which produces a .txt file documenting all correctors utilized for individual lines within a CARIS project, was not properly functioning for many Nav/Att files. The Line Report was reporting ***Not Loaded*** for Nav/Att files, although the post-processed SBET position and navigation corrections have been applied. Correspondence with CARIS is located in DR Appendix II Supplemental Survey Records Correspondence. Please note this does not affect the data and the SBET application is still reflected in the Logviewer window within CARIS. Additionally, a custom Python script was developed to help verify that each line of MBES data corrected with SBET data had the corresponding SBET file in the appropriate folder due to the HIPS line query not functioning correctly. The script read through each HIPS Process.log file and reported the last SBET applied to the data, then generated a report that was cross-referenced to the SBET directories to assure the proper files were included in the deliverable.

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
H13365_MB_1m_LWD_Final	CARIS Raster Surface (CUBE)	1 meters	-1.32 meters - 16.02 meters	NOAA_1m	Complete MBES
H13365_MB_1m_LWD	CARIS Raster Surface (CUBE)	1 meters	-1.32 meters - 16.02 meters	NOAA_1m	Complete MBES

Table 10: Submitted Surfaces

All surfaces submitted are in compliance with the complete coverage MBES requirements per section 5.2.2.3 of the HSSD.

A H13365_MB_1m_LWD_Final.csar object detection grid was also submitted by the field unit as part of sheet H13365 MBES deliverable requirements.

B.5.3 Designated Soundings

H13365 contains 16 designated soundings in accordance with section 5.2.1.2.3 of the HSSD. These designated soundings were created to facilitate feature management and best represent the least depths over features in the Final Feature File (FFF). In the finalized CUBE surfaces, the CARIS HIPS Apply Designated Soundings function ensured designated sounding depths are retained in the finalized surfaces.

C. Vertical and Horizontal Control

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

C.1 Vertical Control

The vertical datum for this project is Low Water Datum 577.5 ft IGLD-1985 L Michigan,Huron.

ERS Datum Transformation

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

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	OPR-Y395-KR-20_100m_ITRF2014-LWD_IGLD85_geoid12b.csar

Table 11: ERS method and SEP file

Real-time positional data were corrected with G2+ Global Navigation Satellite System (GNSS) satellite corrections provided by the Fugro Marinestar Satellite-Based Augmentation System (SBAS). To improve the accuracy of the real-time data, real-time position and attitude data were post-processed using Applanix POSPac Mobile Mapping Solution (MMS) software. Trimble CenterPoint RTX correction methods were used to create Smoothed Best Estimate of Trajectory (SBET) files, which were applied to the survey data in CARIS HIPS. The provided separation model was then utilized to bring the data from ellipsoid heights to chart datum.

C.2 Horizontal Control

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

The projection used for this project is Universal Transverse Mercator (UTM) Zone 16.

The following PPK methods were used for horizontal control:

- RTX

Real-time position and attitude data were post-processed using the Applanix POSPac MMS software. Post-processed corrections were implemented with Trimble's CenterPoint RTX service to create SBET files.

RTK

Real-time position and attitude data were corrected with G2+ GNSS satellite corrections provided by the Fugro Marinestar SBAS.

C.3 Additional Horizontal or Vertical Control Issues

C.3.1 POS MV Data

No raw POS data were recorded for lines 0410-0415 on DN156, line 0742 on DN159, and lines 0951, 0956, 0964, 0965 on DN161 for the R/V Endeavor because of data logging / network issues. Therefore, these lines do not contain post-processed attitude and navigation corrections (SBET/SMRMSG). However, since Marinestar G2+ SBAS corrections were utilized, the real-time attitude and navigation data and respective accuracies were more than sufficient, as the real-time data exceeded specifications outlined in section 3.2 and section 5.1.3 of the HSSD. Section B.2.5 of this report elaborates on some of the POS MV equipment issues on the R/V Endeavor.

D. Results and Recommendations

D.1 Chart Comparison

A comparison was performed in CARIS between H13365 and the ENCs listed in Table 12 of section D.1.1. Soundings and contour layers were generated from the 1 m CUBE surface and overlaid onto the ENCs to visually assess differences between the surveyed depths and charted depths. Depth comparisons can be seen in Figure 18. In addition to a detailed visual inspection in CARIS, all charted depths were downloaded from NOAA's ENC Direct to GIS application as a shapefile and differenced with the nearest surveyed depth from H13365 in ESRI ArcPro. A statistical analysis of the difference comparison is shown in Figure 19. The surveyed depths from H13365 generally agree with the charted depths from the ENCs within the survey area, with a mean difference of 0.83 m.

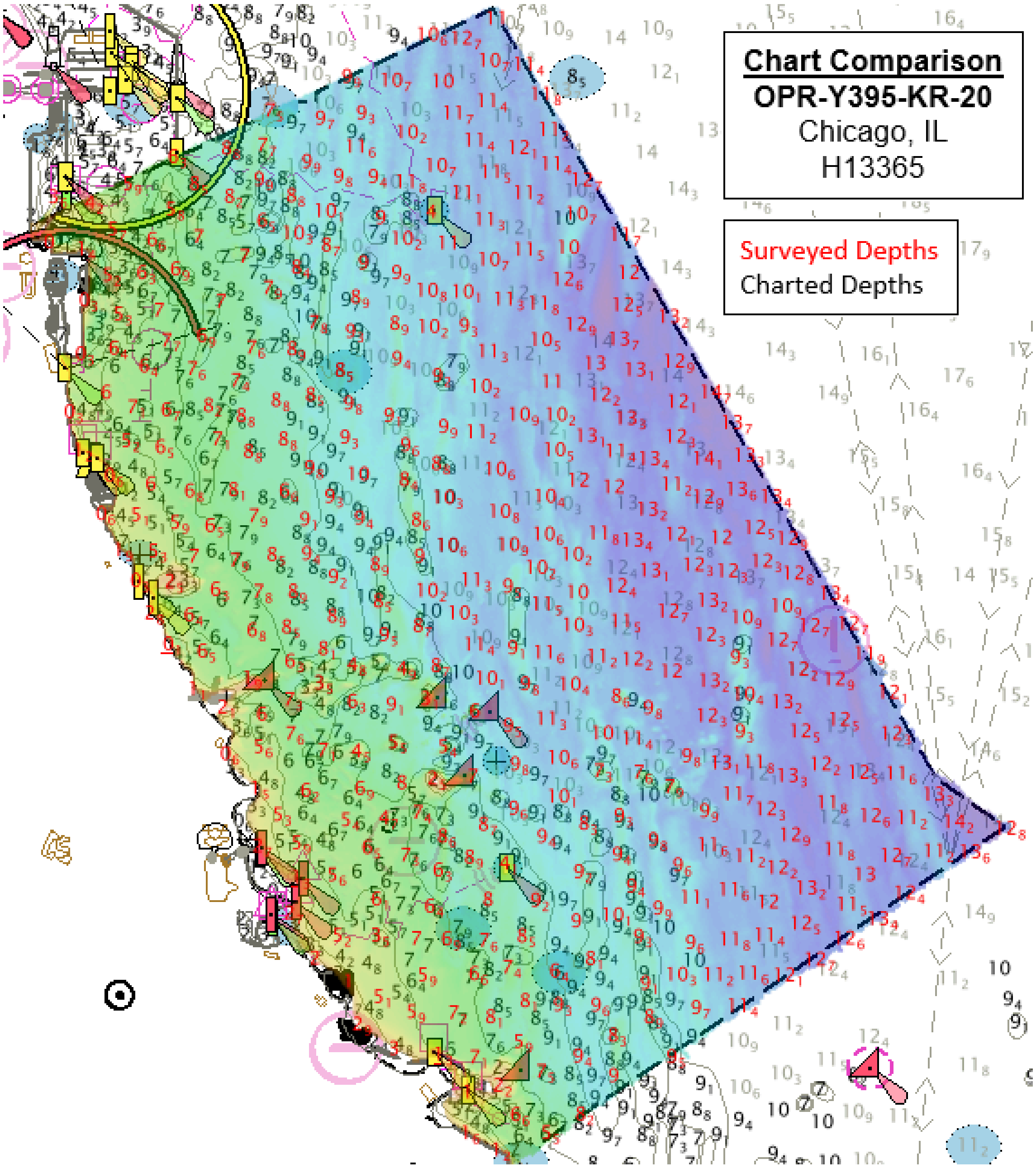


Figure 18: H13365 overview of the surveyed depths overlaid onto ENC US4IL10M

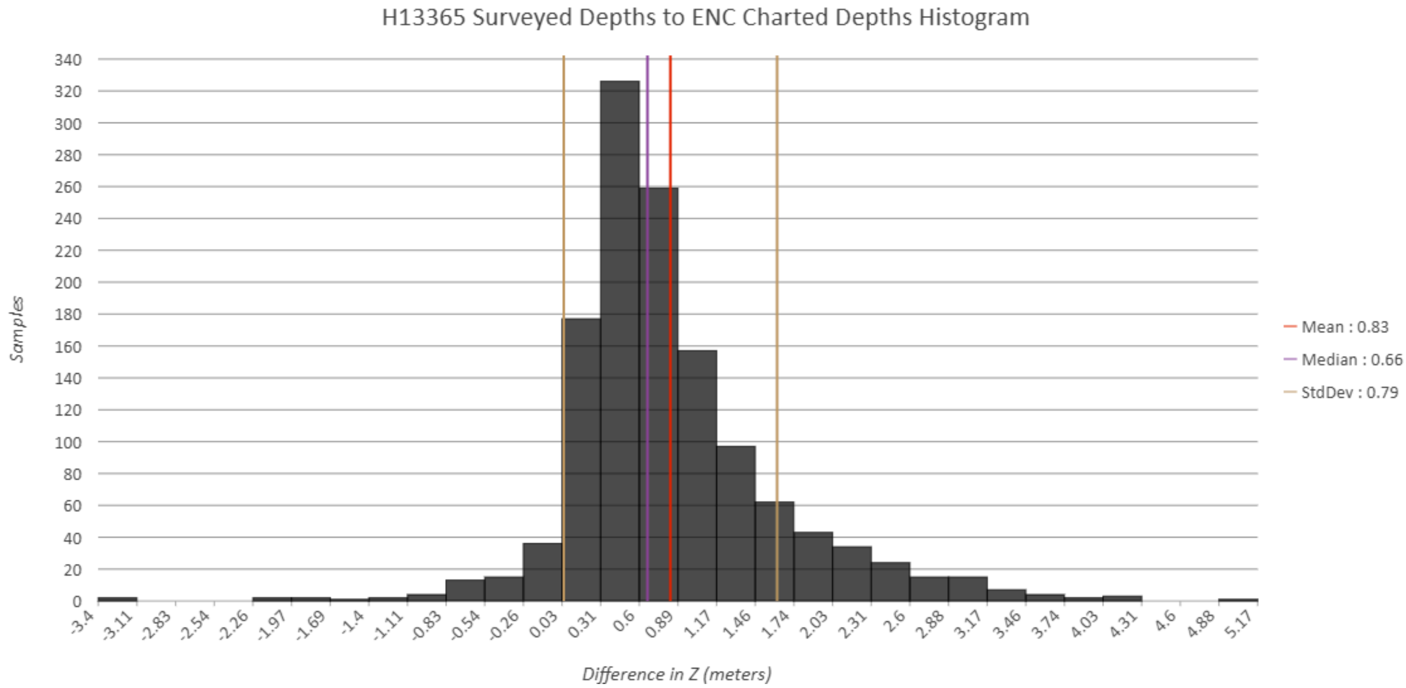


Figure 19: H13365 statistical analysis of surveyed depths to charted depths

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
US4IL10M	1:60000	10	10/01/2018	11/18/2020
US5IL11M	1:15000	15	10/01/2018	09/22/2020
US6IL1AM	1:10000	3	10/09/2019	09/18/2020

Table 12: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey.

D.1.3 Charted Features

There were 120 assigned charted features within H13365 and are detailed in the FFF in accordance with section 7.3 of the HSSD. There were 17 assigned features with Special Feature Type as ‘Unverified Charted

Feature’ that were investigated during survey operations, 15 of these assigned features were disproved, all of which are detailed as such in the FFF.

D.1.4 Uncharted Features

There were 59 new features found within H13365 and are detailed in the FFF in accordance with section 7.3 of the HSSD.

D.1.5 Channels

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

D.2 Additional Results

D.2.1 Aids to Navigation

A charted light and beacon (FOID 10821 and 10645 respectively) were mispositioned based on field observations and the multibeam data. The associated daymark (FOID 10661) was not observed to be on station during survey operations.

A charted light, fog signal, and beacon (FOID 08944, 08890, and 08900 respectively) associated with a charted crib were also mispositioned based on field observations and the multibeam data.

All mispositioned aids to navigation were not deemed to be dangerous. All Aids to Navigation within the survey area are detailed in the FFF in accordance with section 7.3 of the HSSD.

There were five uncharted orange and white buoys located in H13365 outside of the Eugene Water Treatment Plant. These buoys were determined to be private and temporary in nature, and therefore not included in the FFF.

There was one assigned buoy (FOID 10609) with a description as 'Not Addressed' due to having a periodic date outside the time of survey operations.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

10 bottom samples were acquired in accordance with section 7.2.3 of the HSSD and are described completely in the FFF. Backscatter data were used to modify bottom sample locations from what was originally assigned in the Project Reference File (PRF). See DR Appendix II Supplemental Survey Records Correspondence for the correspondence with the HSD OPS Project Manager regarding the modification of the bottom sample locations.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

There were 24 submerged pipelines that were visible as exposed or unburied within the multibeam data. The exposed pipelines are detailed in the FFF and were reported in accordance with section 1.7 of the HSSD and guidance from the Project Manager (see DR Appendix II Supplemental Survey Records Correspondence).

There were two assigned submerged pipelines (FOID 07367 and FOID 11092) not visible in the MBES data as elevated or exposed.

There were five assigned charted submerged cables within H13365. In the southeast area of H13365, the multibeam data revealed potential exposed submerged cables that could be associated with the nearby charted cable, as shown below in Figure 20. No other cables associated with the charted submerged cables were identified as visible within the multibeam data. The assigned submerged cables were not included in the FFF in accordance with the Investigation Requirements listed in the Composite Source File (CSF).

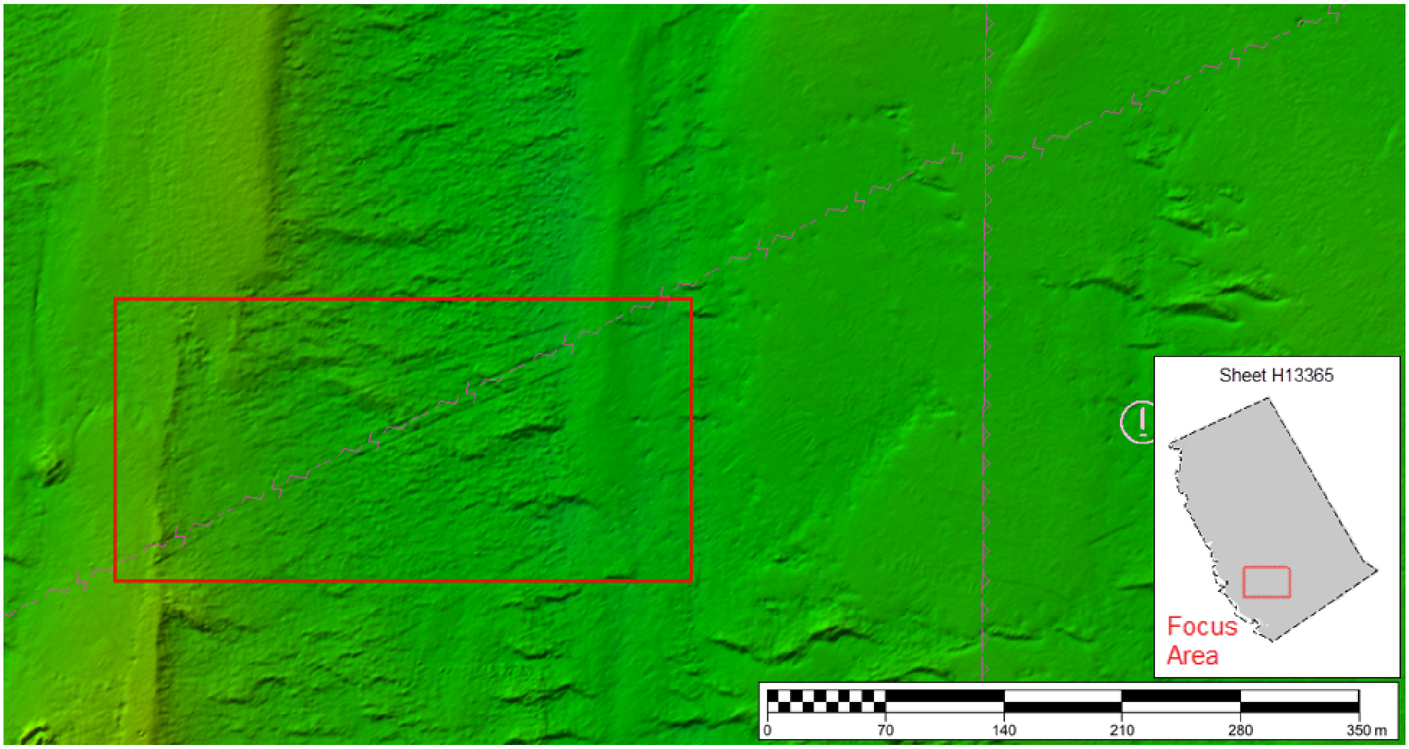


Figure 20: Potential submerged cables in H13365

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.8 Abnormal Seafloor or Environmental Conditions

No abnormal seafloor or environmental conditions exist for this survey.

D.2.9 Construction and Dredging

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

D.2.10 New Survey Recommendations

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

D.2.11 ENC Scale Recommendations

No new ENC scales are recommended for this area.

E. Approval Sheet

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

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

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys Specifications and Deliverables, Field Procedures Manual, Letter Instructions, and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

Report Name	Report Date Sent
Data Acquisition and Processing Report	2020-11-23
Horizontal and Vertical Control Report	2020-11-23
Coast Pilot Report	2020-11-02

Approver Name	Approver Title	Approval Date	Signature
David J. Bernstein, CH, PLS, GISP	Chief of Party	12/14/2020	David J. Bernstein Digitally signed by David J. Bernstein Date: 2020.12.14 13:46:58 -05'00'

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