H13258

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	H13258

LOCALITY

State(s):	Michigan
General Locality:	Lake Huron; Lake Michigan
Sub-locality:	3 NM North of Hog Island

2019

CHIEF OF PARTY
David Neff, ACSM C.H.

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

H13258

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):	**Michigan**
General Locality:	**Lake Huron; Lake Michigan**
Sub-Locality:	**3 NM North of Hog Island**
Scale:	**20000**
Dates of Survey:	**06/05/2019 to 09/05/2019**
Instructions Dated:	**05/15/2019**
Project Number:	**OPR-X388-KR-19**
Field Unit:	**eTrac**
Chief of Party:	**David Neff, ACSM C.H.**
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:

All times are UTC. The purpose of this survey is to update existing NOS nautical charts. H13258 will cover approximately 41 square nautical miles of survey area, 3 nautical miles North of Hog Island, MI. SUB CONSULTANT: Geodynamics LLC, 310A Greenfield Dr., Newport, NC 98570

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 16N, IGLD LWD. All references to other horizontal or vertical datums in this report are applicable to

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Descriptive Report to Accompany Survey H13258

Project: OPR-X388-KR-19

Locality: Lake Huron; Lake Michigan

Sublocality: 3 NM North of Hog Island

Scale: 1:20000

June 2019 - September 2019

eTrac

Chief of Party: David Neff, ACSM C.H.

A. Area Surveyed

eTrac Inc. conducted hydrographic survey operations in the Straits of Mackinac which included the western Lake Michigan and the eastern Lake Huron regions. H13258 covers approximately 41 square nautical miles of survey area. 1074 linear nautical miles were acquired during the survey. H13258 is located 3 nautical miles North of Hog Island, MI.

Survey was conducted within these limits between June 05, 2019 (DN156) and August 23, 2019 (DN235)

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
45° 59' 25.5" N 85° 24' 59.16" W	45° 49' 58.08" N 85° 9' 3.24" W

Table 1: Survey Limits

All data were acquired in accordance with the requirements in the Project Instructions and specifications set forth in the Hydrographic Survey Specifications and Deliverables 2019 Edition (HSSD 2019).

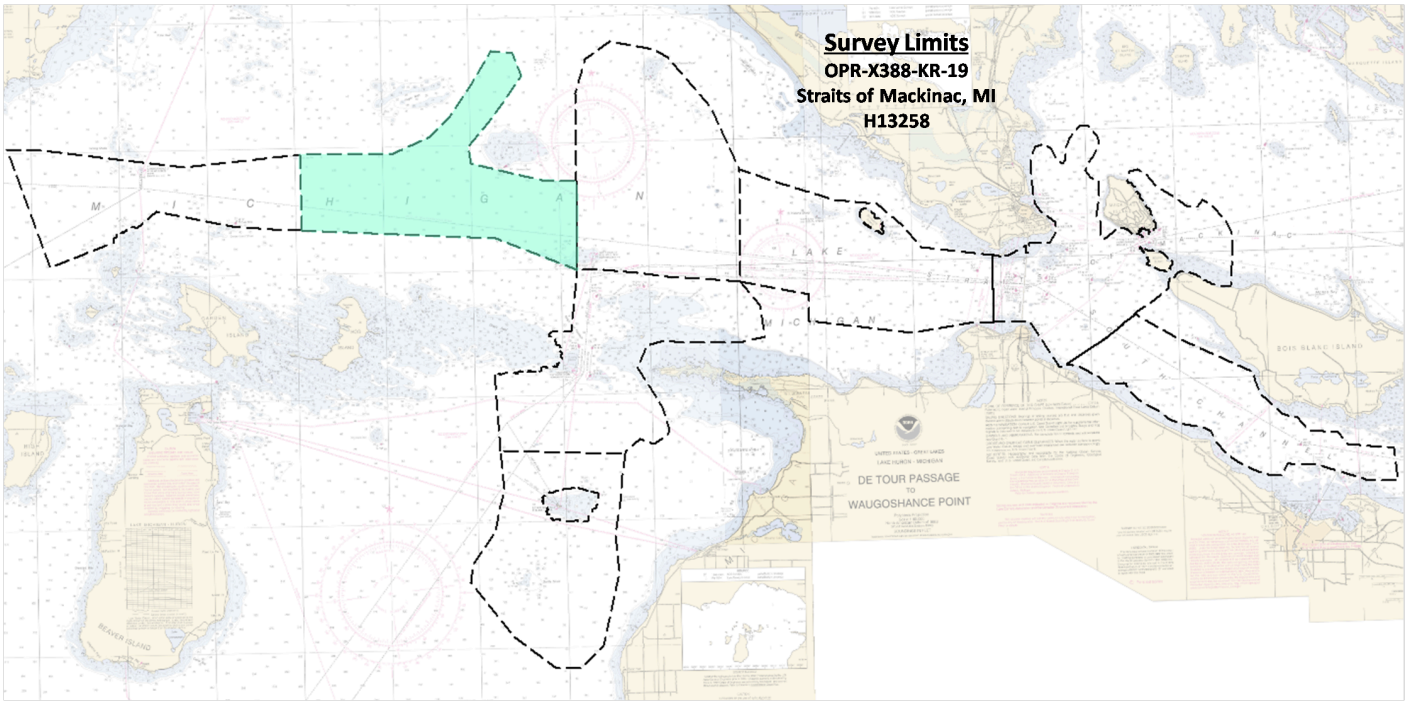

Figure 1: Survey Limits Overview (light blue area)

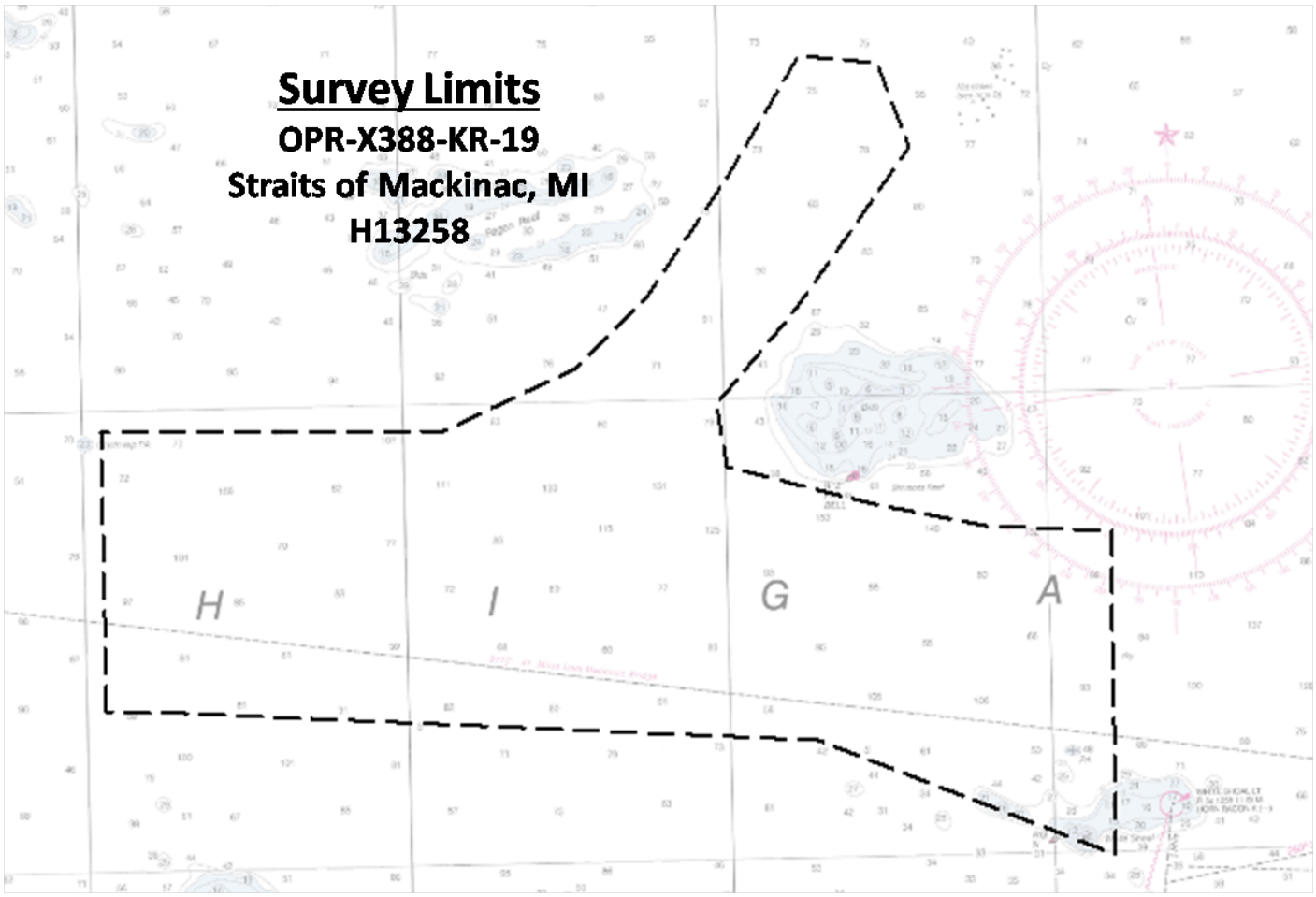

Figure 2: Survey Limits (black line)

Accounting for days spent acquiring bottom samples, field work ended 09/05/2019.

A.2 Survey Purpose

*The purpose of this survey is to update existing National Ocean Service (NOS) nautical charts.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

Survey H13258 is accurate to International Hydrographic Organization (IHO) Order 1a as required per the HSSD 2019.

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

Survey coverage was in accordance with the requirements listed above and in the HSSD.

Note: There was 1 coverage gap in H13258. The coverage gap was shallower than the Navigable Area Limit Line (NALL). As this gap was shallower than the NALL, it was not identified as a holiday. Additionally, it was determined to be unsafe to return to collect full coverage in the NALL as navigation clearance was uncertain.

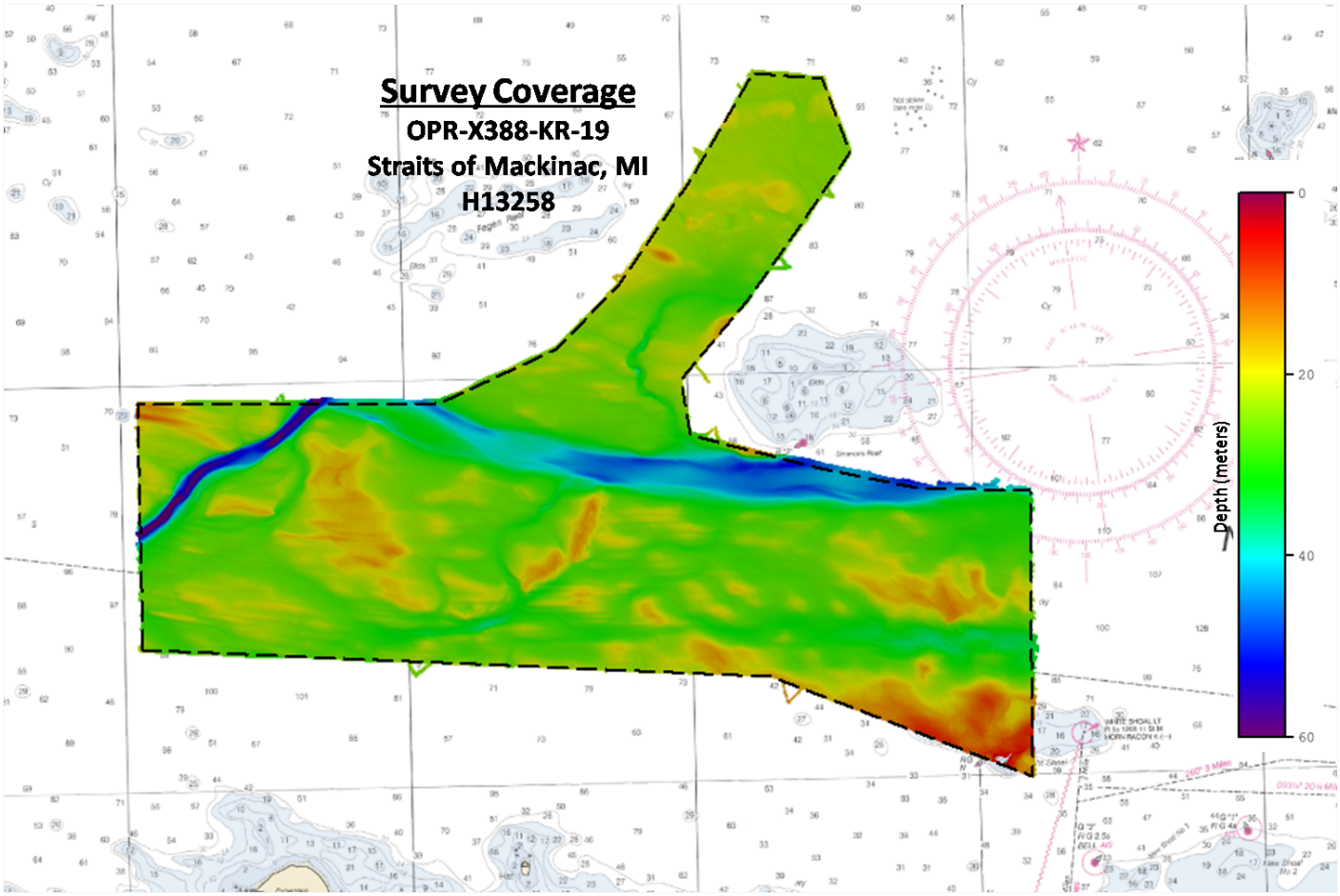

Figure 3: Survey Coverage

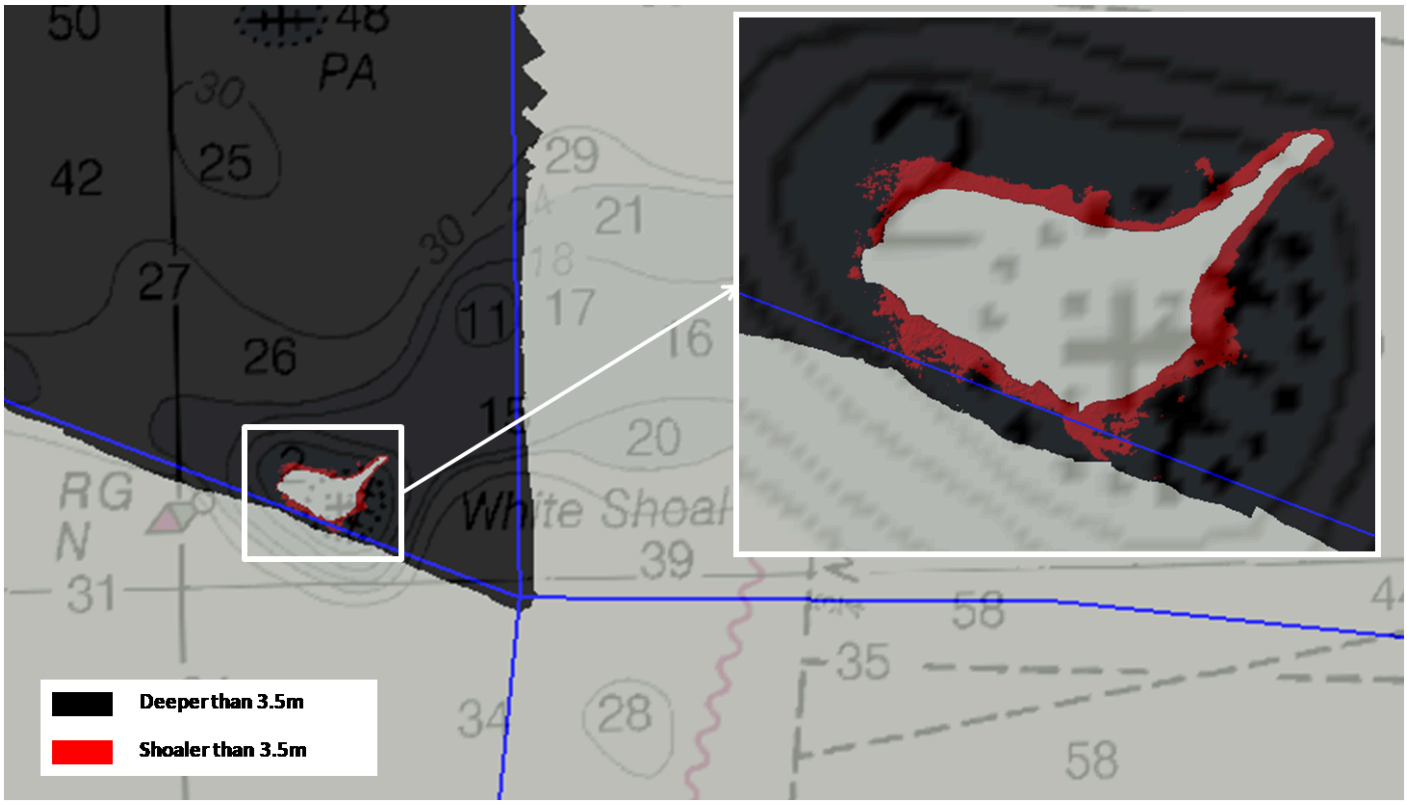

Figure 4: Survey Coverage Gap in area shallower than the NALL

A.6 Survey Statistics

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

	HULL ID	*R/V Benthos*	*R/V 505*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0	0.0
	MBES Mainscheme	532.3	493.4	1025.7
	Lidar Mainscheme	0.0	0.0	0.0
	SSS Mainscheme	0.0	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0	0.0
	MBES/SSS Mainscheme	0.0	0.0	0.0
	SBES/MBES Crosslines	25.8	22.5	48.2
	Lidar Crosslines	0.0	0.0	0.0
Number of Bottom Samples				21
Number Maritime Boundary Points Investigated				0
Number of DPs				0
Number of Items Investigated by Dive Ops				0
Total SNM				41.0

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
06/05/2019	156

Survey Dates	Day of the Year
06/16/2019	167
06/17/2019	168
06/18/2019	169
06/19/2019	170
06/20/2019	171
06/21/2019	172
06/22/2019	173
06/23/2019	174
06/24/2019	175
06/26/2019	177
06/27/2019	178
06/28/2019	179
08/23/2019	235

Table 4: Dates of Hydrography

Bottom samples for H13258 were acquired on DN 244 (09/01/2019), DN 245 (09/02/2019), and DN 248 (09/05/2019).

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures and data processing methods. Additional information to supplement sounding and survey data as well as 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 505*
LOA	10.0 meters	10.0 meters
Draft	0.6 meters	0.6 meters

Table 5: Vessels Used

The R/V Benthos is a 10 meter aluminum catamaran equipped with a custom over-the-side (port) multibeam hydraulic pole mount.

The R/V 505 is a 10 meter aluminum catamaran equipped with a Universal Sonar Mount (USM) starboard multibeam pole mount.

B.1.2 Equipment

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

Manufacturer	Model	Type
R2Sonic	2022	MBES
Kongsberg Maritime	EM 2040C	MBES
Applanix	POS MV 320 v5	Positioning and Attitude System
AML Oceanographic	BaseX	Sound Speed System

Table 6: Major Systems Used

Note: R/V Benthos utilized a dualhead Kongsberg 2040C multibeam echosounder system, an AML Base.X2 for the sound speed system and a POSMV 320 V5 for the positioning system. R/V 505 utilized a dualhead R2Sonic 2022 multibeam echosounder system, an AML Base.X2 for the sound speed system and a POSMV 320 V5 for the positioning system.

B.2 Quality Control

B.2.1 Crosslines

Multibeam/single beam echo sounder/side scan sonar crosslines acquired for this survey totaled 4.71% of mainscheme acquisition.

A beam-to-beam statistical analysis was performed using the Cross Check tool in Qimera. A 1 meter Combined Uncertainty and Bathymetric Estimator (CUBE) weighted dynamic surface was created incorporating only the mainscheme lines and excluded crosslines. The Cross Check tool was used to perform the beam-by-beam comparison of the crossline data to the mainscheme surface. Comparisons showed excellent agreement, well above 95% of the allowable TVU.

Note: This surface was created for QC only and is not submitted as a surface deliverable.

The beam-to-beam crossline comparison report generated through the Qimera Cross Check tool is included in Separates II.

Below is a histogram of the crossline comparison statistics showing IHO Order 1a compliance per beam.

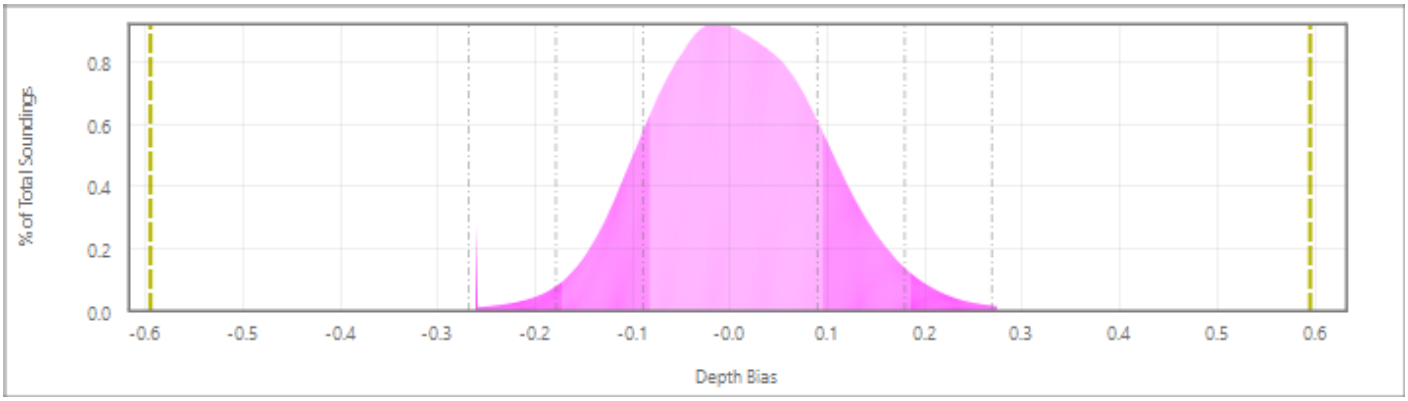

Figure 5: H13258 Crossline Comparison

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	meters	7.6 centimeters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Surface
R/V 505	2 meters/second	N/A	2 meters/second
R/V Benthos	2 meters/second	N/A	2 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Standard deviation and uncertainty layers of the Dynamic Surface were utilized during data processing to search for features, water column noise, and systematic errors.

IHO Order 1a uncertainty specification was met by 100% of the nodes.

The final Bathymetric Attributed Grid (BAG) surface's uncertainty was generated through the NOAA QC Tools and an image of the results is located below.

For H13258 the following percentages represent the results of the TPU calculation:

Complete Coverage MBES (Finalized 1m CUBE weighted Dynamic Surface in NOAA QC Tools) = 99.5+% of nodes are within the allowable TVU.

Complete Coverage MBES (Finalized 2m CUBE weighted Dynamic Surface in NOAA QC Tools) = 99.5+% of nodes are within the allowable TVU.

Complete Coverage MBES (Finalized 4m CUBE weighted Dynamic Surface in NOAA QC Tools) = 99.5+% of nodes are within the allowable TVU.

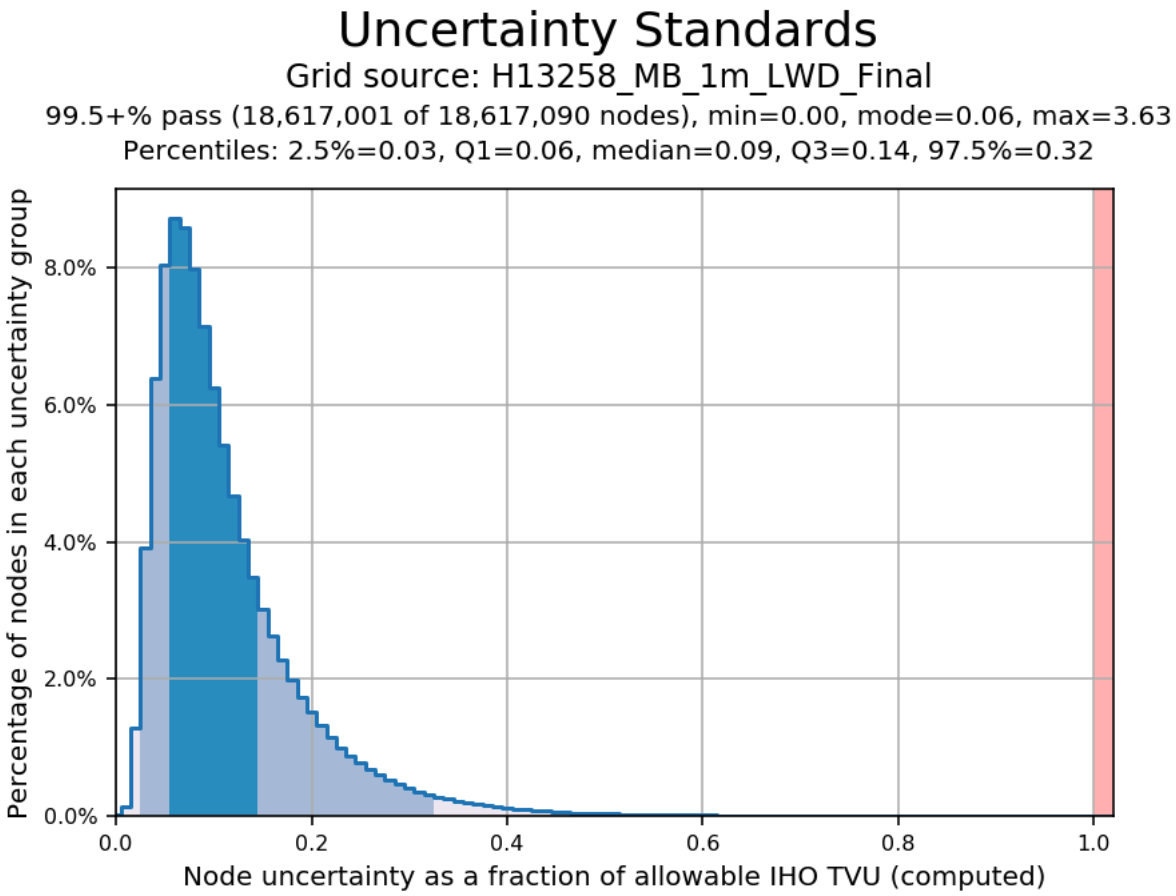

Figure 6: H13258 Finalized 1m Complete Coverage MBES TVU Statistics

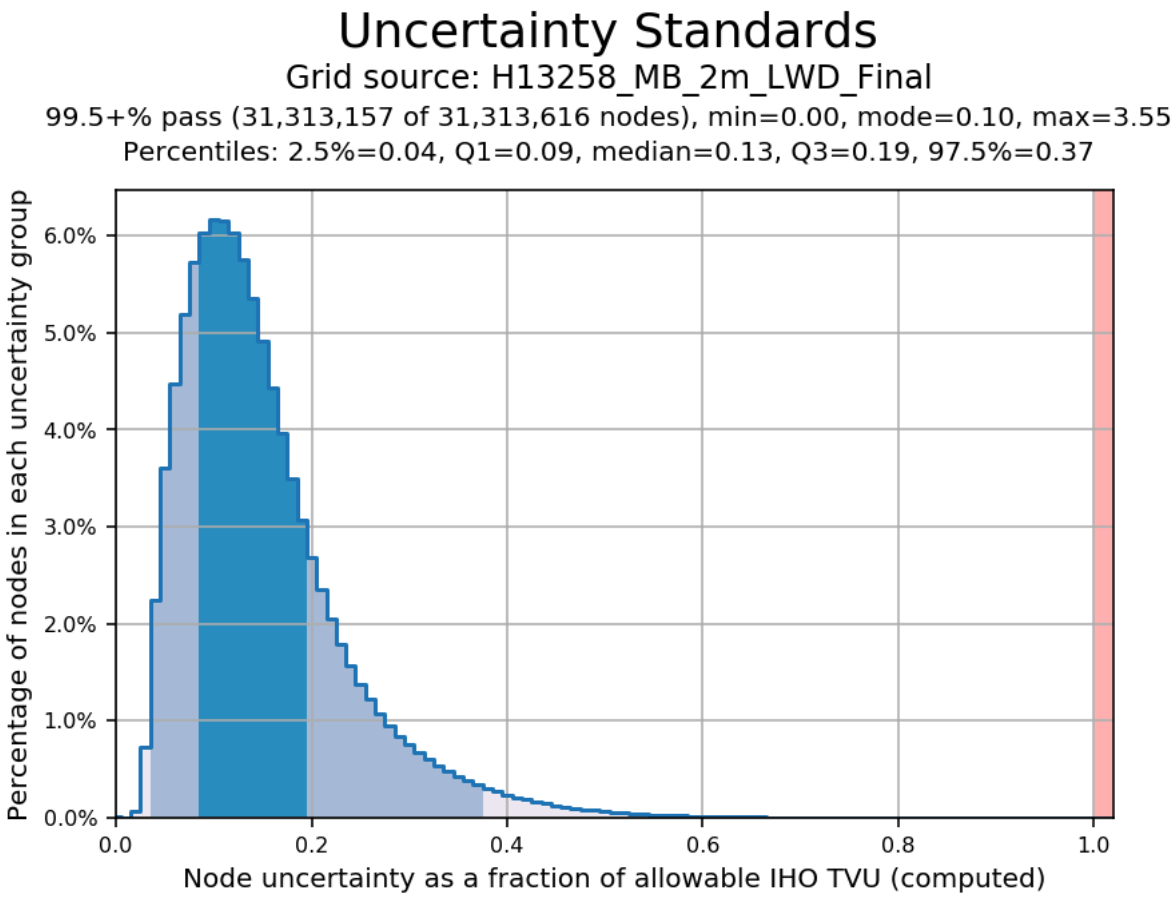

Figure 7: H13258 Finalized 2m Complete Coverage MBES TPU Statistics

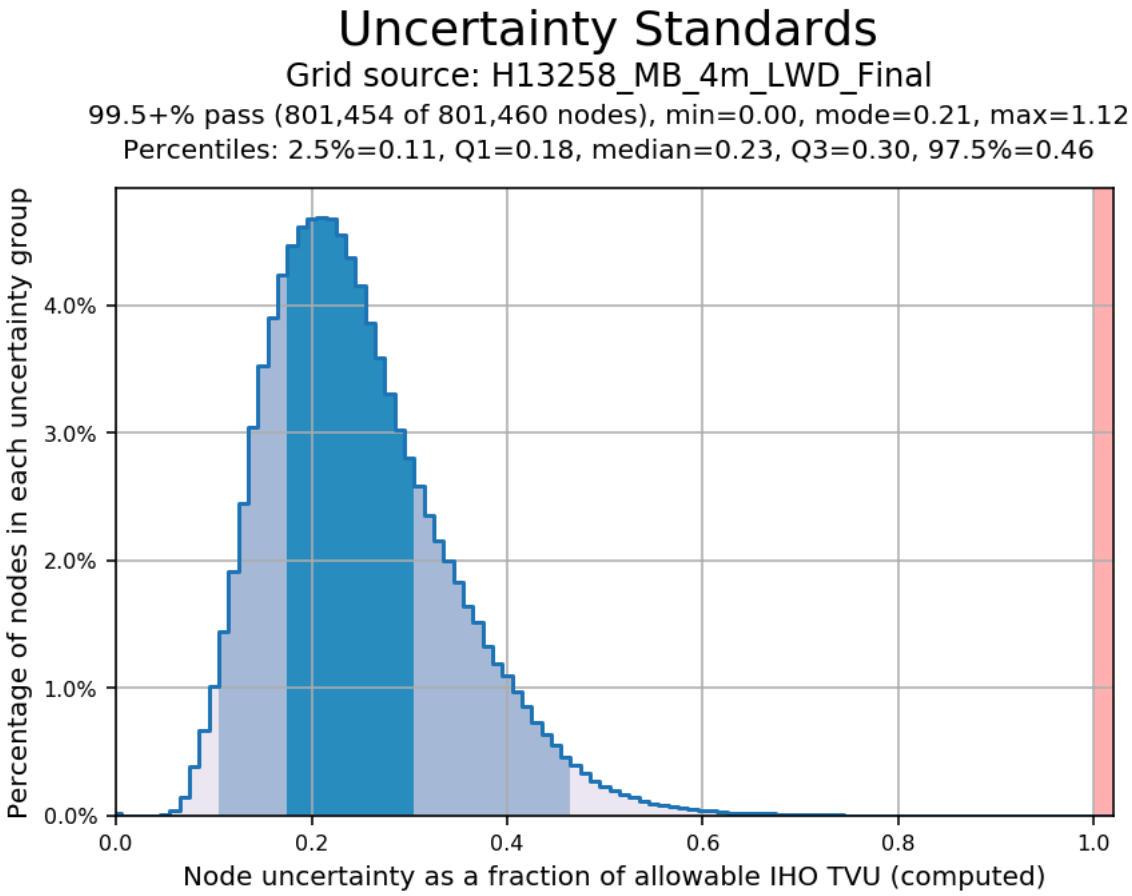

Figure 8: H13258 Finalized 4m Complete Coverage MBES TPU Statistics

The Qimera-exported BAG uncertainty values originate solely from the standard deviation of the soundings that contributed to each CUBE hypothesis, scaled to the 95% CL, and do not use total propagated vertical uncertainty estimates in this calculation. This is not in compliance with NOS HSSD 5.2.1.2.4, where the uncertainty value for the grid node shall be the greater of 1) standard deviation of the soundings contributing to the depth solution, or 2) the a priori computed uncertainty estimate. Furthermore, it is also not in compliance with NOS HSSD 2019 5.1.3, which requires the uncertainty estimates for depth values to support Total Propagated Uncertainty (TPU) estimates. The uncertainty values in the submitted BAGs do not adequately provide enough information to verify if the survey meets uncertainty requirements outlined in NOS HSSD 2019 5.1.3.

During the Survey Acceptance Review process, multiple depth fliers greater than allowable TVU were discovered present in the 1m surface. The depth fliers were removed (rejected) and new surfaces were created in the office using CARIS 10.4.24. The newly created surfaces meet or exceed quality requirements in accordance with NOS HSSD 2019.

B.2.3 Junctions

Depth differences between junctioning surveys were evaluated using the JunctionTrac program, developed in-house by eTrac Inc. For each junction, each CUBE weighted dynamic surface's nodes were exported to an ASCII CSV file where the fields were (Easting, Northing, Depth) for each node. A 1 meter difference surface between the junctioning datasets was also created and exported to an ASCII CSV file where the fields were (Easting, Northing, Diff) for each node. The three ASCII CSV files were then loaded into the JunctionTrac program and junction statistics were computed. A file was also created in this process to locate any nodes from the difference surface that exceed the allowable TVU, which was imported into Qimera and any identified points from JunctionTrac were analyzed. Note: the difference surfaces were created for comparison efforts only and are not submitted as surface deliverables.

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13259	1:20000	2019	eTrac Inc.	W
H13254	1:20000	2019	eTrac Inc.	E

Table 9: Junctioning Surveys

H13259

The junction comparison was performed using all overlapping data between H13258 and H13259. Below is a histogram of junction comparison statistics showing the difference between the junctioning surfaces and allowable TVU as well as difference statistics. 99.8975% of nodes were within allowable TVU.

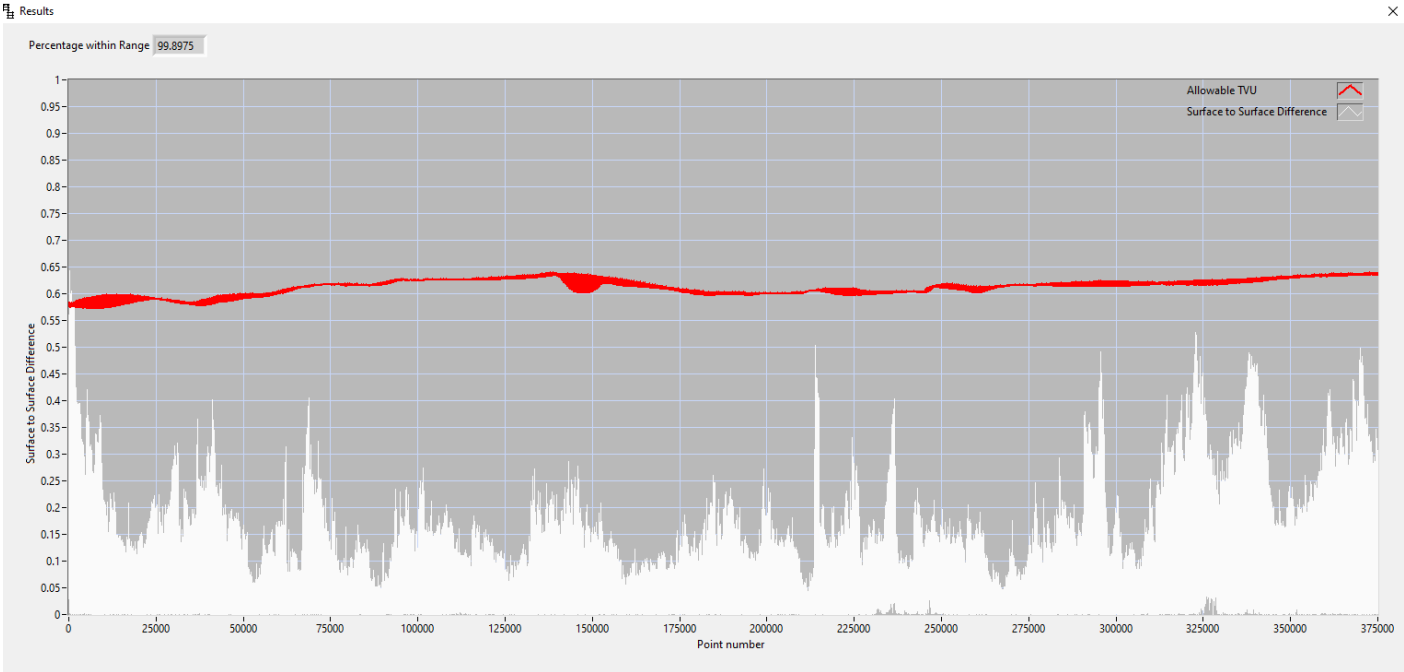

Figure 9: H13258 - H13259 Junction Comparison

Criteria	Number of Nodes	Resulting %
DIFF < 10cm	682507	83.18%
10cm < DIFF < 20cm	100486	12.25%
20cm < DIFF < 30cm	24304	2.96%
DIFF > 30cm	13236	1.61%
Total	820533	100.00%

Figure 10: H13258 - H13259 Difference Statistics

H13254

Note: The junction comparison between H13254 and H13258 will be submitted with the H13254 DR.

B.2.4 Sonar QC Checks

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

B.2.5 Equipment Effectiveness

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

B.2.6 Factors Affecting Soundings

There were no other factors that affected corrections to soundings.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: SVP casts were generally taken every 2 hours. Occasionally casts would exceed a 2 hour frequency, however would never exceed a 4 hour frequency.

On R/V Benthos casts were applied in both QPS QINSy and Kongsberg SIS acquisition software at the time of the cast. On R/V 505 casts were applied in QPS QINSy acquisition software at the time of the cast. Surface SVP measured at 1Hz was compared to surface speed from the current profile in realtime. If the surface velocity comparison was in excess of 2m/s at any time during survey operations, a new cast was taken.

B.2.8 Coverage Equipment and Methods

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

B.2.9 Data Density Evaluation

In order to determine if the density of the data met the specified 5 soundings per node, data density was evaluated using DensityTrac in the AmiTrac program, developed in-house by eTrac Inc. Each finalized CUBE weighted dynamic surface's nodes were exported to a BBH file. The BBH file was then loaded into the DensityTrac program and density statistics were computed.

For H13258 the following percentages represent the results of the density query:

Complete Coverage MBES (Finalized 1m CUBE weighted Dynamic Surface) = 99.3885% of nodes are composed from at least 5 soundings.

Complete Coverage MBES (Finalized 2m CUBE weighted Dynamic Surface) = 99.9715% of nodes are composed from at least 5 soundings.

Complete Coverage MBES (Finalized 4m CUBE weighted Dynamic Surface) = 99.932% of nodes are composed from at least 5 soundings.

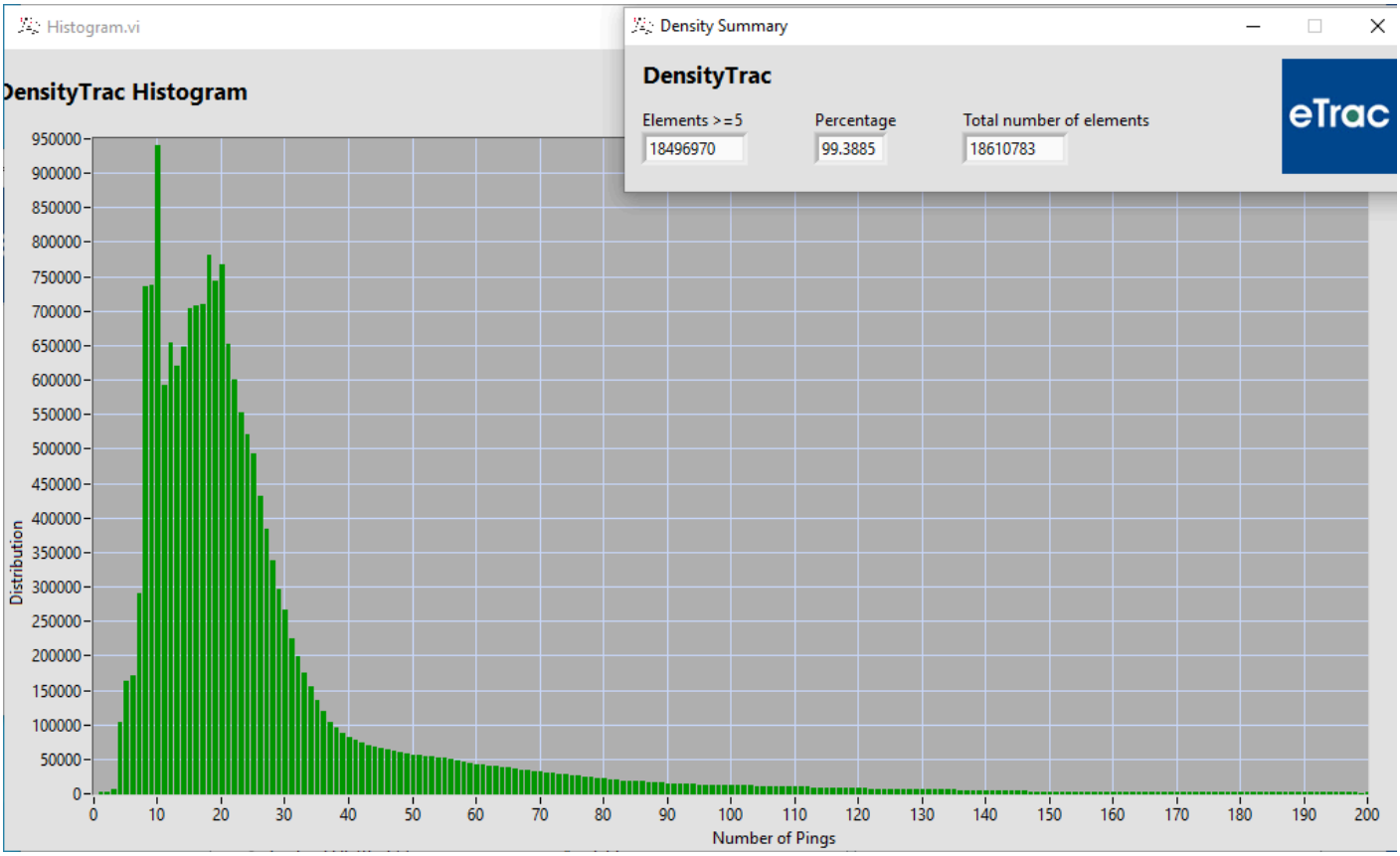

Figure 11: H13258 Finalized 1m Complete Coverage MBES Density Distribution

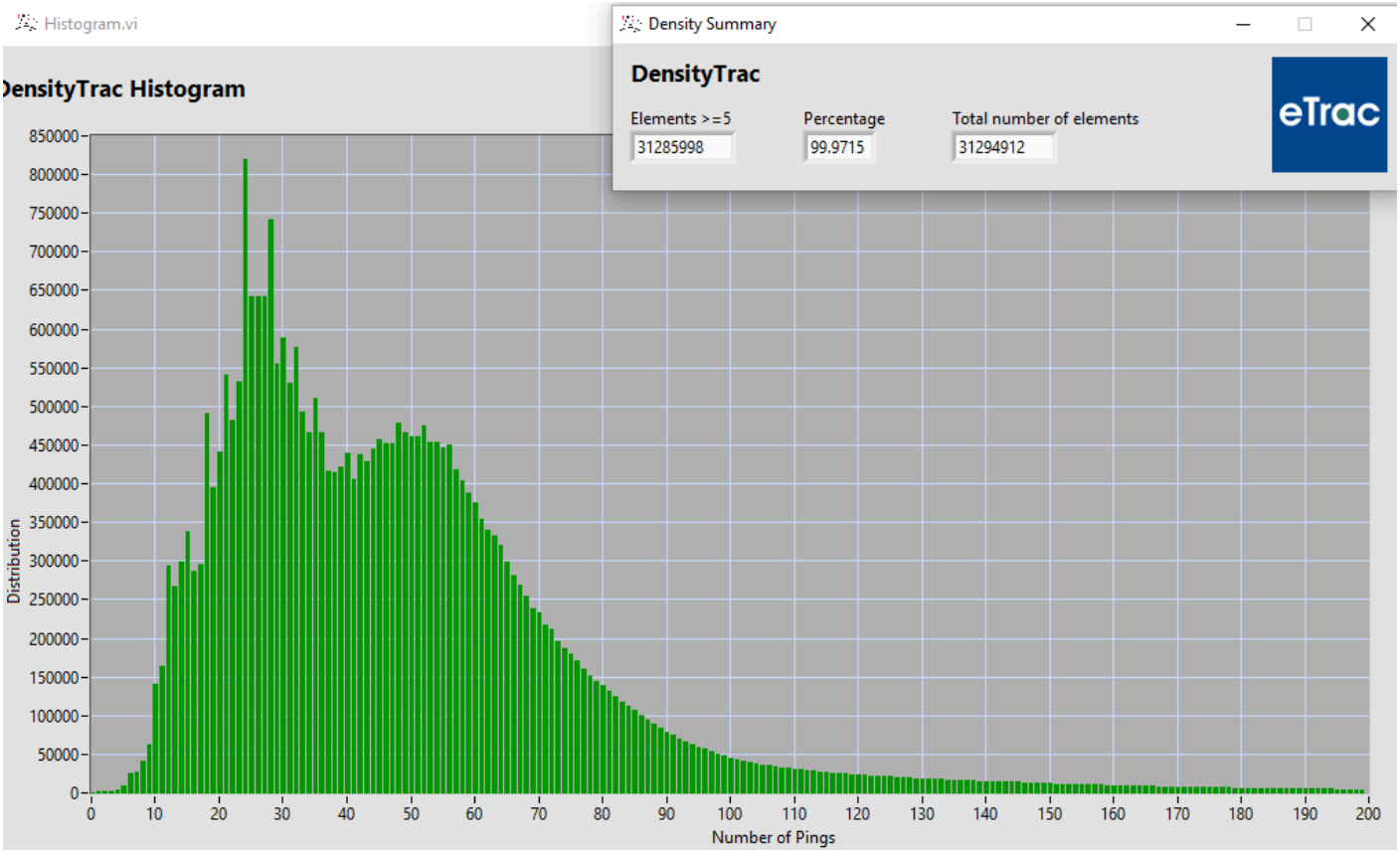

Figure 12: H13258 Finalized 2m Complete Coverage MBES Density Distribution

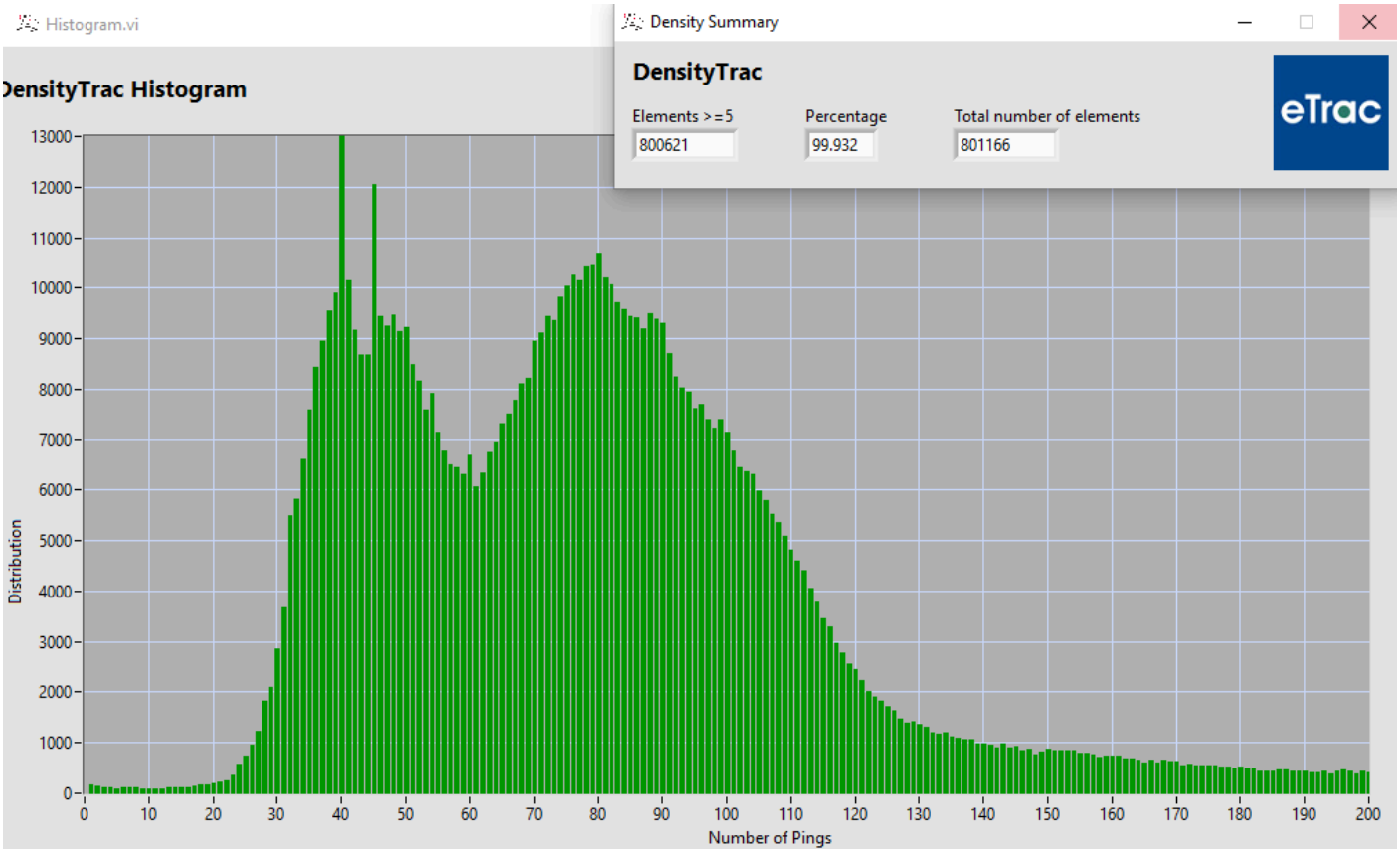

Figure 13: H13258 Finalized 4m Complete Coverage MBES Density Distribution

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

Backscatter data were collected throughout the survey and are retained in the raw ALL and DB files. Every effort was made in the field to collect quality backscatter data while maintaining the primary mandate of high quality bathymetric data. While no processing or analysis of backscatter was required, eTrac Inc. verified coverage and general quality of the backscatter data collected. A beam intensity window was monitored in Qinsy during acquisition to ensure backscatter data collection. Raw backscatter data were viewed in QPS FMGeocoder to further confirm collection criteria had been met. Shown below is an example of the unprocessed backscatter mosaic from H13258 DN170.

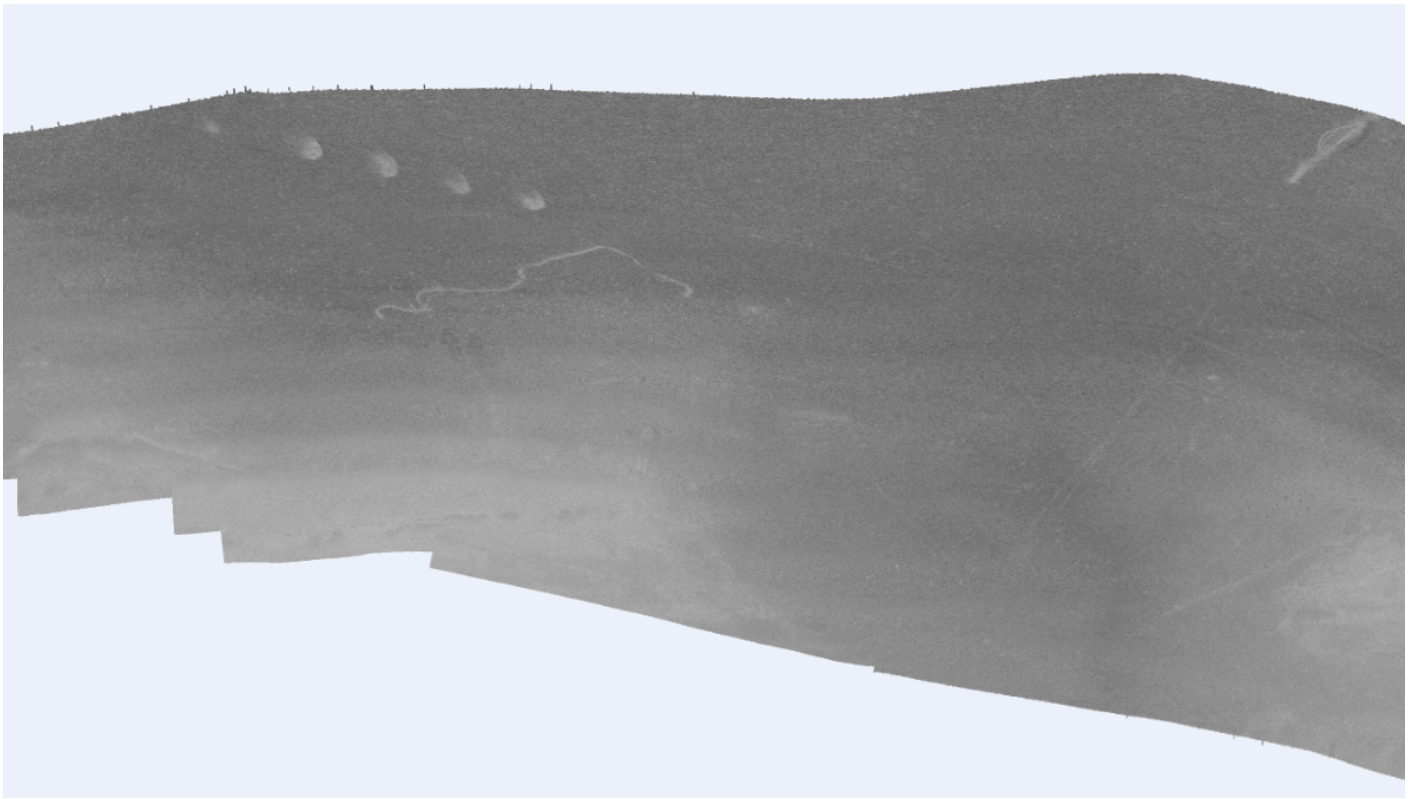

Figure 14: Raw Backscatter from R/V Benthos (DN170)

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
QPS	Qimera	1.7.6

Table 10: Primary bathymetric data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2019.

Feature Object Catalog, NOAA Profile Version 2019 was used only in CARIS. Qimera was used as the primary processing software, which included feature management.

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
H13258_MB_1m_LWD_Final	BAG	1 meters	1.44 meters - 20.0 meters	NOAA_1m	Complete MBES
H13258_MB_2m_LWD_Final	BAG	2 meters	18.0 meters - 40.0 meters	NOAA_2m	Complete MBES
H13258_MB_4m_LWD_Final	BAG	4 meters	36.0 meters - 73.52 meters	NOAA_4m	Complete MBES

Table 11: Submitted Surfaces

A 1m, 2m and 4m surface are provided meeting complete coverage MBES with backscatter specifications for H13258.

Parent surfaces of the 1m, 2m, and 4m surfaces are also provided in the Surfaces_Mosaics Folder in this delivery drive package.

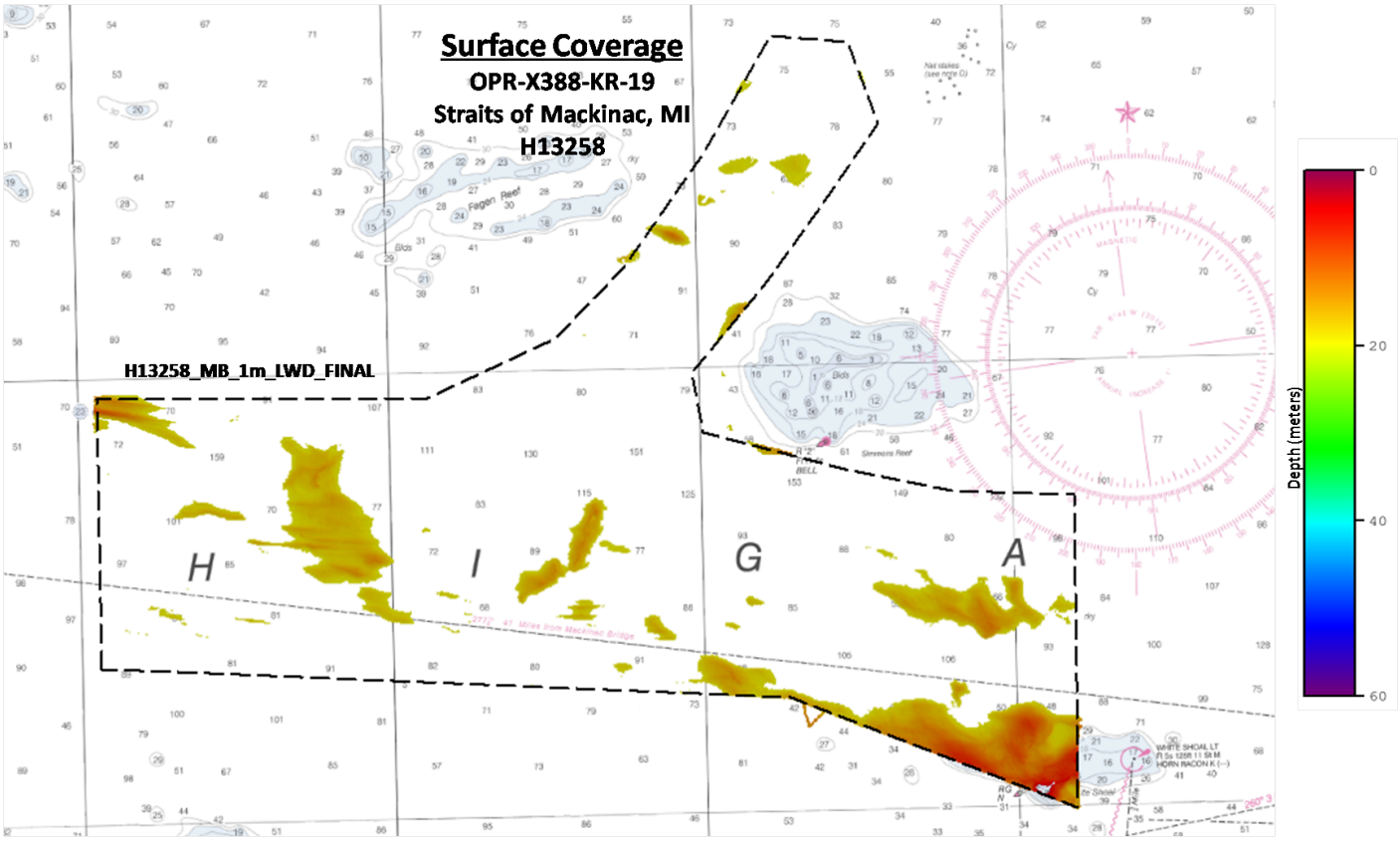

Figure 15: H13258 Delivered 1m CUBE weighted Dynamic Surface Coverage Graphic

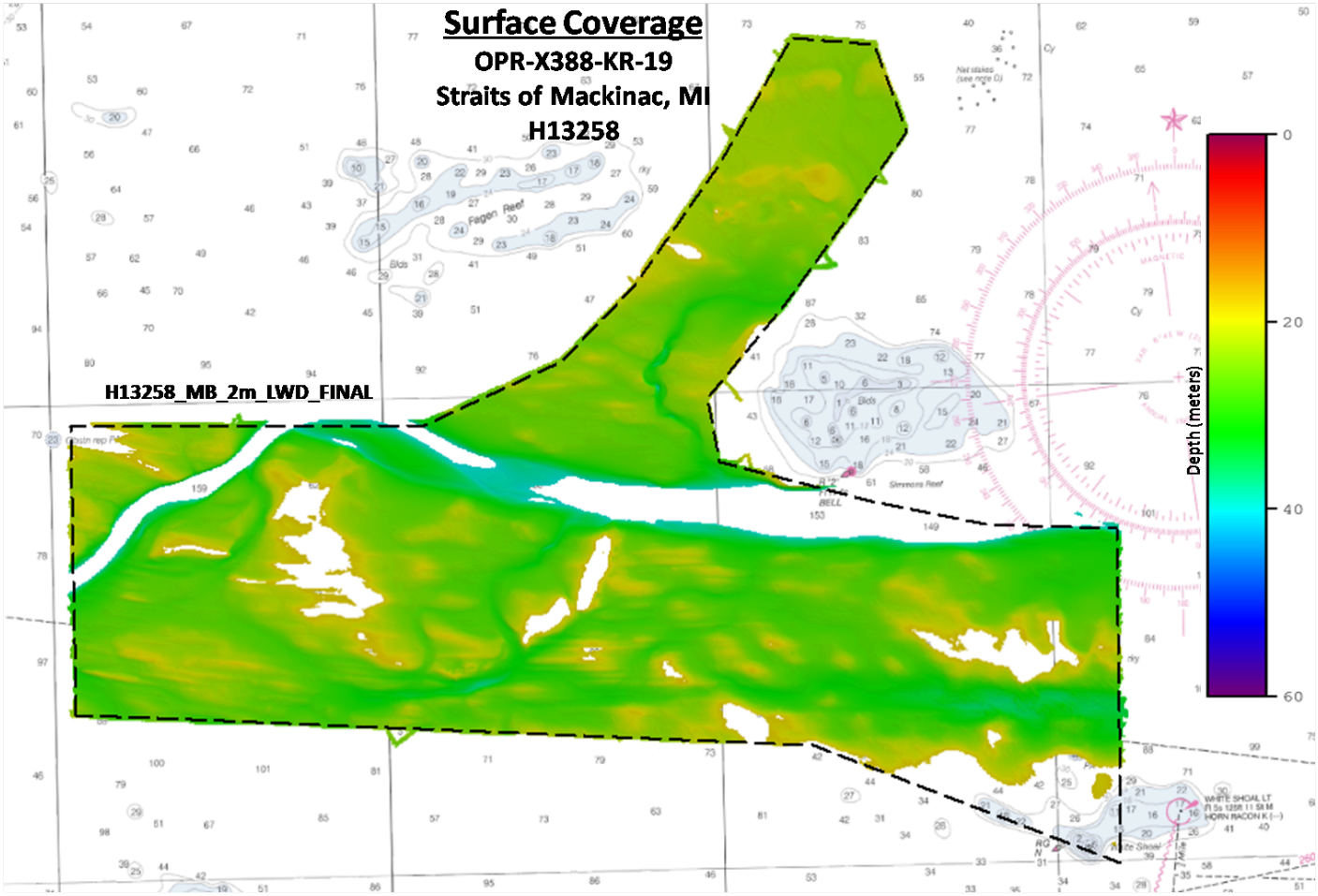

Figure 16: H13258 Delivered 2m CUBE weighted Dynamic Surface Coverage Graphic

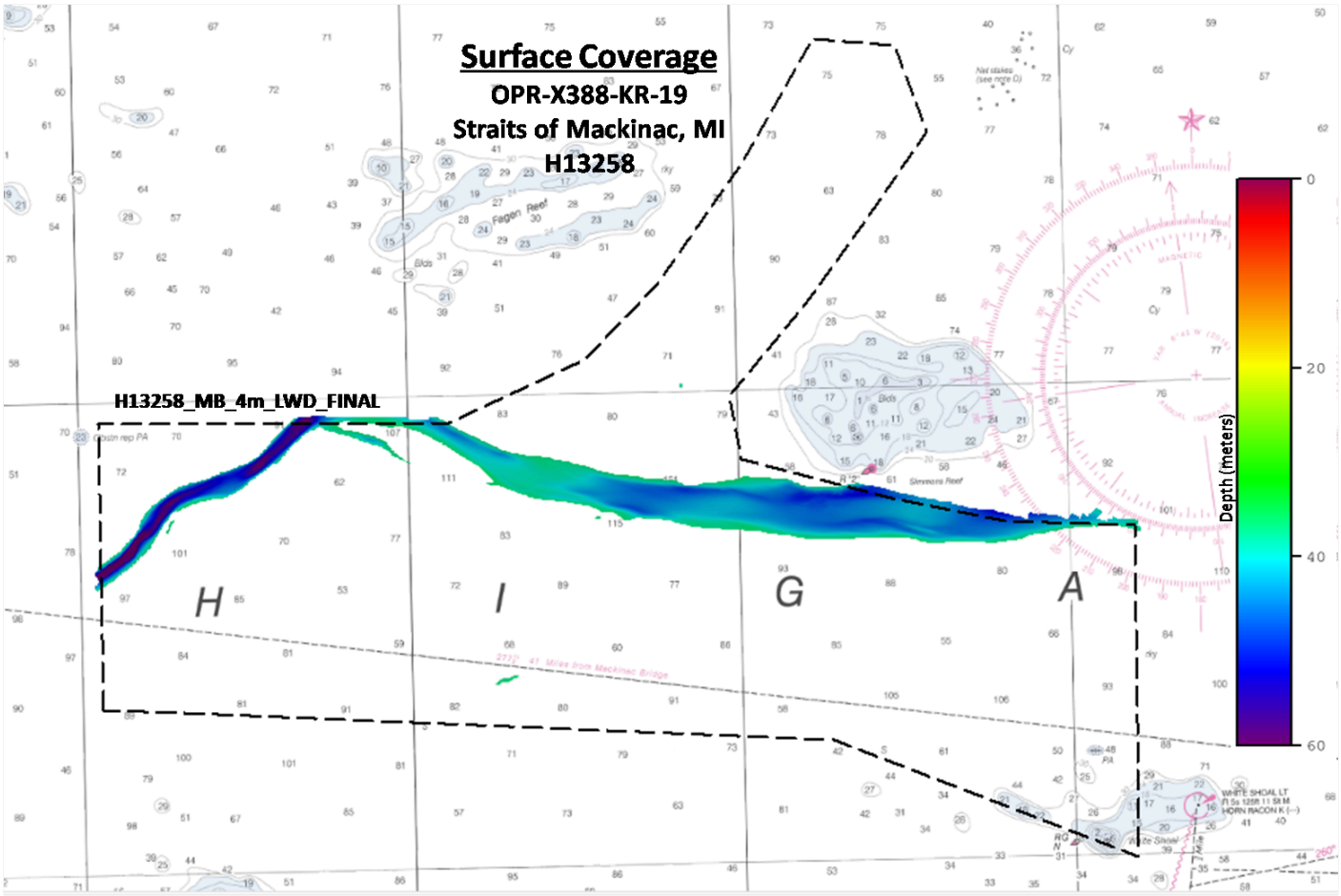

Figure 17: H13258 Delivered 4m CUBE weighted Dynamic Surface Coverage Graphic

C. Vertical and Horizontal Control

Additional information discussing the vertical or 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	Mackinaw_ITRF_to_LWD.bin

Table 12: ERS method and SEP file

In order to reference soundings to Low Water Datum, a VDatum separation model was applied to the QINSy DB files via a separation file in the acquisition software.

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 16.

The following PPK methods were used for horizontal control:

- RTX

Applanix PosPac MMS was utilized to post process realtime positioning data utilizing Trimble's PP-RTX implementation of Trimble CenterPoint RTX to create a Smoothed Best Estimate of Trajectory (SBET).

RTK

GNSS satellite corrections were received on each vessel using the G2+ carrier signal from the Marinestar Global Correction System maintained by Fugro.

D. Results and Recommendations

D.1 Chart Comparison

A chart comparison was conducted for H13258 using Qimera and Caris HIPS and SIPS. Contours and soundings were compared against the largest scale ENC US4MI52M to accomplish the chart comparison. The methods and results of the comparison are detailed below.

Contour Comparison Method: Using the 2 meter CUBE weighted Dynamic Surface, the 12, 18, 24 and 30 foot contours were generated in Qimera and displayed against the charted contour. Additionally, the 2 meter CUBE weighted Dynamic Surface was viewed by a custom color band range based on the contour intervals (6ft, 12ft, 18ft, 24ft, 30ft). The results of the comparison are described below, followed by 1-2 images of example areas.

Sounding Comparison Method: Using the same 2 meter CUBE weighted Dynamic surface, soundings were generated in Caris HIPS and SIPS. Soundings were displayed against the charted soundings and a visual comparison was made. The results of the comparison are described below, followed by 1-2 images of example areas.

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	Preliminary?
US4MI52M	1:80000	15	02/26/2019	02/26/2019	NO

Table 13: Largest Scale ENCs

US4MI52M

Contour Comparison Results:
In general, the depths in the area of White Shoal are deeper than charted.
On White Shoal the 6 foot contour was not found in the charted location, however a new 6 foot contour was not surveyed due to the NALL.

The 12 foot contour in the northern central end of White shoal no longer exists. The 12 foot contour in the southern central end of White Shoal has receded inward approximately 300 feet from the charted contour.

The 18 foot contour in the central area of White Shoal has receded inward and southwest approximately 400 to 700 feet from the charted contour. The 18 foot contour in the western end of White Shoal no longer exists.

The 24 foot contour in the central area of White Shoal receded inward approximately 300 to 500 feet from the charted contour. The 24 foot contour in the western end of White Shoal receded inward approximately 200 to 500 feet from the charted contour.

The 30 foot contour of White Shoal has receded inward approximately 100 to 400 feet from the charted contour; and has formed two separate shoals bound by the 30 foot contour. The small 30 foot contour north of White Shoal has receded inward from the charted contour and changed in diameter from 1,010 feet to 520 feet.

Sounding Comparison Results:
In areas where shoals have formed and where a feature was detected, soundings differ from the charted depths. In general for H13258, the soundings are in moderate agreement with the chart. Soundings are generally within 1 to 9 feet from the chart, although there are some soundings that differ greater than 10 feet from the chart. Depth differences are not biased in any particular direction to support a systematic error.

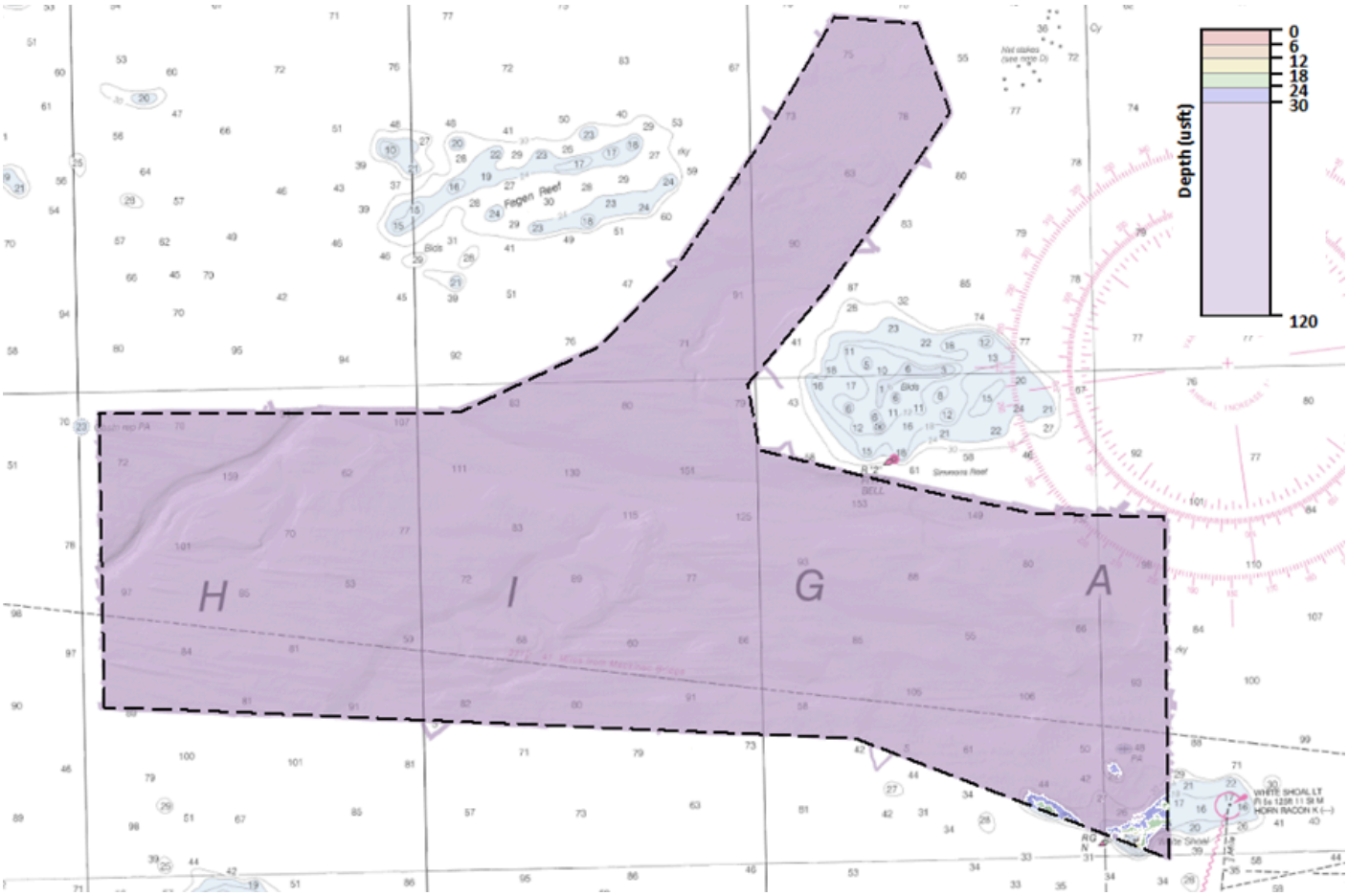

Figure 18: H13258 Contour Comparison (ENC US4MI52M)

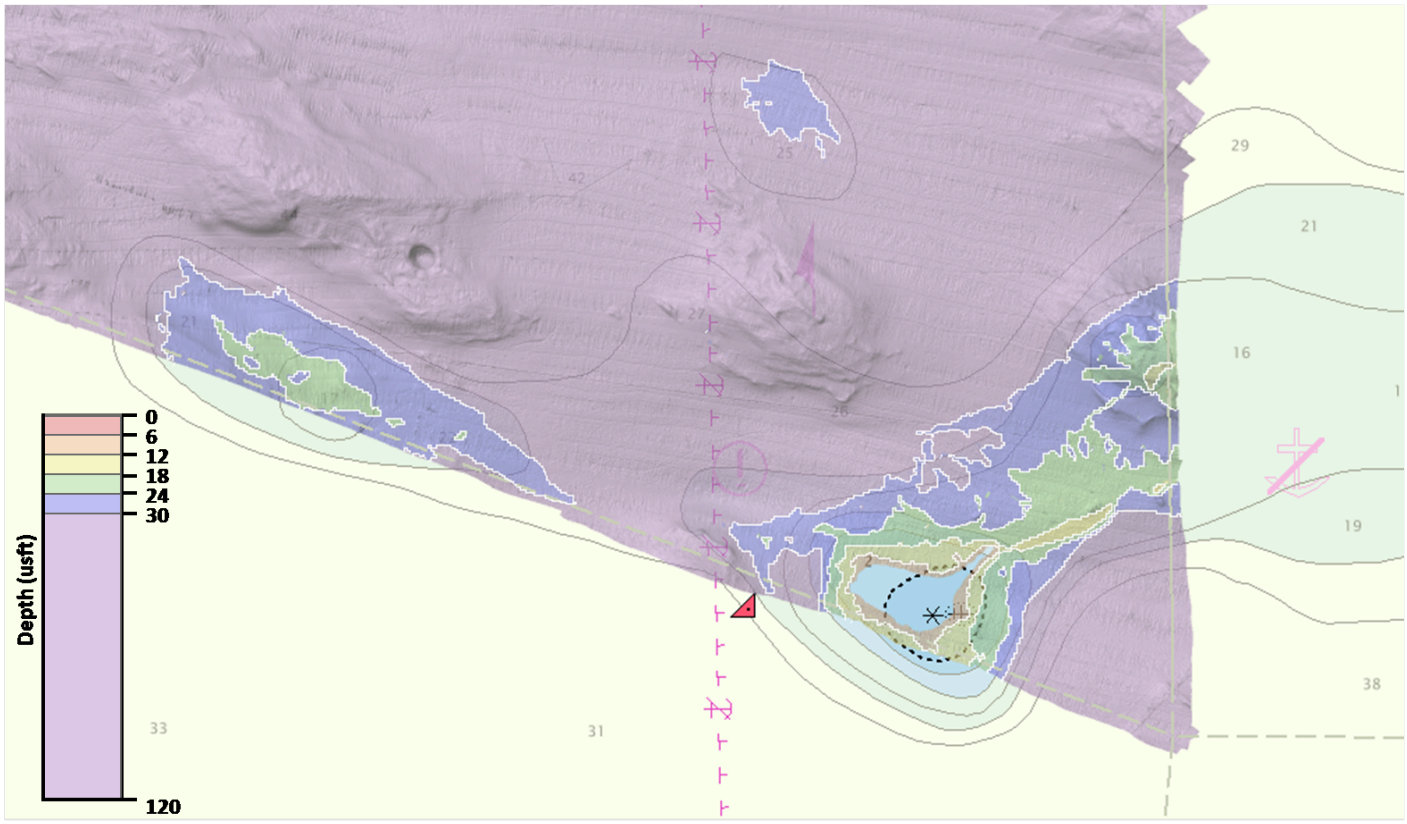

Figure 19: H13258 Contour Comparison (ENC US4MI52M) - Detailed View

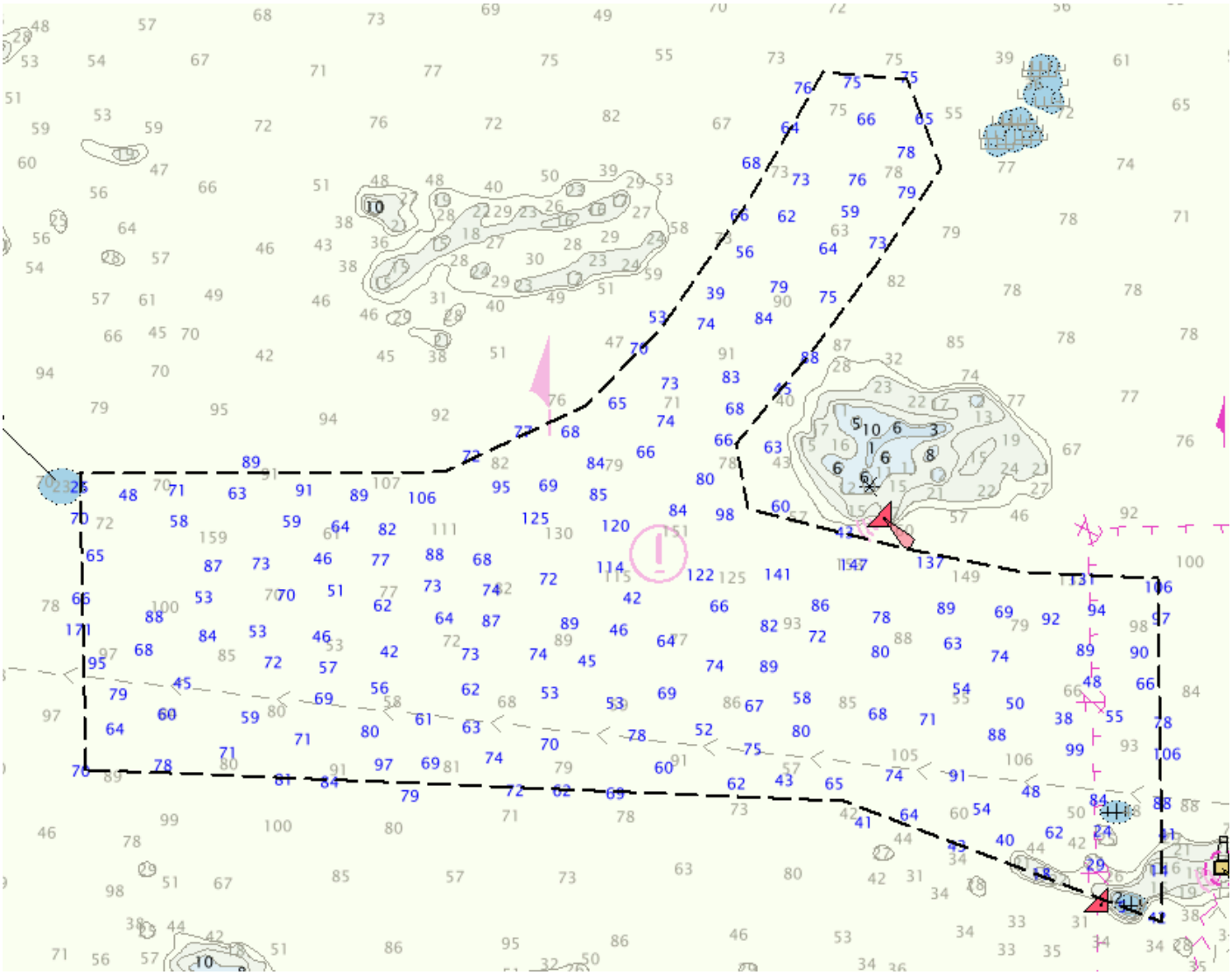

Figure 20: H13258 Sounding Comparison (ENC US4MI52M) (Soundings in US Survey feet)

D.1.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.1.3 Charted Features

There were 5 charted features assigned to H13258. The assigned features are retained in the Final Feature File (FFF). Each feature in the FFF has been given a unique identifier in the "userid" field of the .000 S-57

file (format 8XXX). Refer to the FFF for determinations and recommendations of each feature. Note: 2 charted features were not addressed due to survey coverage and safety limits.

D.1.4 Uncharted Features

There were 8 new features found in H13258 and added to the Final Feature File (FFF). Each feature was given a unique identifier in the "userid" field of the .000 S-57 file (format 8XXXX). Refer to the FFF for determinations and recommendation of each feature.

D.1.5 Shoal and Hazardous Features

DtoNs were found in H13258 and added to the Final Feature File (FFF). Each feature in the FFF has been given a unique identifier in the "userid" field of the .000 S-57 file (format 8XXXX). Refer to the FFF for determinations and recommendations of each feature.

D.1.6 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.1.7 Bottom Samples

21 bottom samples were obtained in accordance with section 7.1 of the HSSD 2019 in areas designated by the feature object class springs (SPRING) in the Project Reference File (PRF). Detailed information and images of the bottom samples listed above are located in the Final Feature FIle (FFF). Each bottom sample has been given a unique identifier in the "userid" field of the .000 S-57 file (format GX)

D.2 Additional Results

D.2.1 Shoreline

Shoreline was not assigned in the Hydrographic Survey Project Instructions or Statement of Work.

D.2.2 Aids to Navigation

There was 1 charted AtoN assigned in H13258. The feature was given a unique identifier in the "userid" field of the .000 S-57 file (format 8XXX). Refer to the FFF for determinations of the feature. Note: The AtoN was included in the number of charted features within section D.1.4.

D.2.3 Overhead Features

No overhead features exist for this survey.

D.2.4 Submarine Features

No submarine features exist for this survey.*

During the Survey Acceptance Review process, an uncharted submarine pipeline was observed spanning the entire length of the survey area, running in an ENE and WSW direction. Refer to the FFF for more details.

D.2.5 Platforms

No platforms exist for this survey.

D.2.6 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.7 Abnormal Seafloor and/or Environmental Conditions

No abnormal seafloor and/or environmental conditions exist for this survey.

D.2.8 Construction and Dredging

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

D.2.9 New Survey Recommendation

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

D.2.10 Inset Recommendation

No new insets 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.

Approver Name	Approver Title	Approval Date	Signature
David Neff, C.H.	Chief of Party	10/25/2019	David Neff Digitally signed by David Neff DN: C=US, E=david@etracinc.com, O=eTrac Inc., CN=David Neff Date: 2019.10.25 09:10:24-07'00'

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