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

Data Acquisition & Processing Report

Type of Survey:	Basic Hydrographic Survey
Project Number:	S-K949-MIST-18
Time Frame:	October - October 2018

LOCALITY

State(s):	Texas
General Locality:	Western Gulf of Mexico

2018

CHIEF OF PARTY
Erin Diurba

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Date:

Table of Contents

List of Figures

Data Acquisition and Processing Report

MBES MIST
Chief of Party: Erin Diurba
Year: 2018
Version: 1
Publish Date: 2020-04-30

A. System Equipment and Software

A.1 Survey Vessels

A.1.1 Research Vessel Manta

Vessel Name	Research Vessel Manta	
Hull Number	R8301	
Description	Catamaran	
Dimensions	*LOA*	83'
	Beam	30'
	Max Draft	3.5'
Most Recent Full Static Survey	*Date*	2017-03-28
	Performed By	Terrasond

Figure 1: Research Vessel Manta

A.2 Echo Sounding Equipment

A.2.1 Multibeam Echosounders

A.2.1.1 Teledyne Reson Seabat T20P

Multibeam sonar

<table>
<tr><td>Manufacturer</td><td colspan="6">Teledyne Reson</td></tr>
<tr><td>Model</td><td colspan="6">Seabat T20P</td></tr>
<tr><td rowspan="6">Inventory</td><td rowspan="6">8301</td><td>Component</td><td>Receiver</td><td>Transducer</td><td>Topside Box</td></tr>
<tr><td>Model Number</td><td>T20P</td><td>T20P</td><td>Seabat</td></tr>
<tr><td>Serial Number</td><td>2313068</td><td>2413031</td><td>84143413019</td></tr>
<tr><td>Frequency</td><td>n/a</td><td>200-400kHz</td><td>n/a</td></tr>
<tr><td>Calibration</td><td>2018-10-11</td><td>2018-10-11</td><td>2018-10-11</td></tr>
<tr><td>Accuracy Check</td><td>2018-10-11</td><td>2018-10-11</td><td>2018-10-11</td></tr>
</table>

Figure 2: Teledyne Reson Seabat T20P

Figure 3: T20P Sonar installed on survey arm being lowered into place.

A.2.2 Single Beam Echosounders

No single beam echosounders were utilized for data acquisition.

A.2.3 Side Scan Sonars

No side scan sonars were utilized for data acquisition.

A.2.4 Phase Measuring Bathymetric Sonars

No phase measuring bathymetric sonars were utilized for data acquisition.

A.2.5 Other Echosounders

No additional echosounders were utilized for data acquisition.

A.3 Manual Sounding Equipment

A.3.1 Diver Depth Gauges

No diver depth gauges were utilized for data acquisition.

A.3.2 Lead Lines

No lead lines were utilized for data acquisition.

A.3.3 Sounding Poles

No sounding poles were utilized for data acquisition.

A.3.4 Other Manual Sounding Equipment

No additional manual sounding equipment was utilized for data acquisition.

A.4 Horizontal and Vertical Control Equipment

A.4.1 Base Station Equipment

No base station equipment was utilized for data acquisition.

A.4.2 Rover Equipment

No rover equipment was utilized for data acquisition.

A.4.3 Water Level Gauges

No water level gauges were utilized for data acquisition.

A.4.4 Levels

No levels were utilized for data acquisition.

A.4.5 Other Horizontal and Vertical Control Equipment

No other equipment were utilized for data acquisition.

A.5 Positioning and Attitude Equipment

A.5.1 Positioning and Attitude Systems

A.5.1.1 Applanix POS MV V5

The POS MV V5 is a GNSS-aided inertial navigation system, which provides a blended position solution derived from both an Inertial Motion Unit (IMU) and an integrated GNSS receiver. The IMU and GPS receiver are complementary sensors, and data from one are used to filter and constrain errors from the other. This inter-dependence results in higher position accuracy and fewer errors. Position accuracy is displayed in real time by the POS MV software and is monitored to ensure that positioning accuracy requirements as outlined in the NOS Hydrographic Surveys Specifications and Deliverables (HSSD) were not exceeded. In addition to position, the POS MV also provides accurate navigation and attitude data to correct for the effects of heave, pitch, roll and heading. When using differential correctors, the POS MV generates attitude data in three axes (roll, pitch and heading) to an accuracy of 0.02° or better. Heave measurements supplied by the POS MV maintain an accuracy of 5 cm or 5% of the measured vertical displacement (whichever is greater) for movements that have a period of up to 20 seconds.

The original IMU cable (S/N 5-02501) was irreparably damaged during the first survey day. A new cable (S/N 5-02345) was obtained and used for the remainder of the survey.

Manufacturer	Applanix					
Model	POS MV V5					
Inventory	*3801*	*Component*	IMU	Topside Box	IMU Cable 1	IMU Cable 2
		Model Number	IMU82	POS-MV V5-1	N/A	N/A
		Serial Number	4850	5872	5-02501	5-02345
		Calibration	2018-10-01	2018-10-11	2018-10-11	2018-10-11

Figure 4: POS MV V5 with IMU 82

A.5.2 DGPS

DGPS equipment was not utilized for data acquisition.

A.5.3 GPS

GPS equipment was not utilized for data acquisition.

A.5.4 Laser Rangefinders

Laser rangefinders were not utilized for data acquisition.

A.5.5 Other Positioning and Attitude Equipment

No additional positioning and attitude equipment was utilized for data acquisition.

A.6 Sound Speed Equipment

A.6.1 Moving Vessel Profilers

No moving vessel profilers were utilized for data acquisition.

A.6.2 CTD Profilers

A.6.2.1 SonTek Castaway CTD

The CastAway-CTD is a small, rugged CTD designed for profiling to depths of up to 100m. The system achieves a 5 Hz response time, fine spatial resolution, and high accuracy, with sound speed measurements

accurate within ±0.15 m/s. It uses a six electrode flow through conductivity cell with zero external field coupled with a rapid response thermistor to attain high measurement accuracies. The instrument is simple to deploy, does not require a pump and is hydrodynamically designed to free fall rate of 1 m/s.
Each CastAway-CTD cast is referenced with both time and location using its built-in GPS receiver. Latitude and longitude are acquired both before and after each profile. Plots of conductivity, temperature, salinity and sound speed versus depth can be viewed immediately on the CastAway's integrated color LCD screen. Raw data is downloaded via Bluetooth to the launch acquisition computer for analysis and to export into CARIS during data processing.

Manufacturer	SonTek	
Model	Castaway CTD	
Inventory	*Component*	CTD
	Model Number	Castaway
	Serial Number	CC1228004
	Calibration	2018-06-27

Figure 5: SonTek Castaway CTD

A.6.3 Sound Speed Sensors

A.6.3.1 AML Oceanographic Micro X

The AML MicroX instrument with an SVXchange sensor-head provided surface sound speed data to the Seabat T20P for beam forming and steering. The unit is mounted on top of the T20P bracket behind the survey pole connection. The unit is configured to output an AML datagram to Reson's Sonar UI.

<table>
<tr><td>Manufacturer</td><td colspan="3">AML Oceanographic</td></tr>
<tr><td>Model</td><td colspan="3">Micro X</td></tr>
<tr><td rowspan="4">Inventory</td><td rowspan="4">3801</td><td>Component</td><td>Sound Velocity Profiler</td></tr>
<tr><td>Model Number</td><td>Micro X</td></tr>
<tr><td>Serial Number</td><td>CC1228004</td></tr>
<tr><td>Calibration</td><td>2018-06-27</td></tr>
</table>

Figure 6: AML MicroX

A.6.4 TSG Sensors

No surface sound speed sensors were utilized for data acquisition.

A.6.5 Other Sound Speed Equipment

No surface sound speed sensors were utilized for data acquisition.

A.7 Computer Software

Manufacturer	*Software Name*	*Version*	*Use*
Teledyne CARIS	HIPS and SIPS	10.4.2	Processing
Teledyne CARIS	BASE Editor	4.4	Processing
Applanix Corporation	MV-POS View	9.29	Acquisition and Processing
Applanix Corporation	POSPac MMS	8.3	Processing
NOAA, Hydrographic Systems and Technology	Pydro Explorer	18.1	Processing
Xylem	HYPACK Survey	2018	Acquisition
Xylem	HYSWEEP	2018	Acquisition

A.8 Bottom Sampling Equipment

A.8.1 Bottom Samplers

No bottom sampling equipment was utilized for data acquisition.

B. System Alignment and Accuracy

B.1 Vessel Offsets and Layback

B.1.1 Vessel Offsets

For the Manta installation, vessel offset values are stored in the CARIS HVF. The IMU is the Reference Point (RP) for hull R3801. The offset values for the RP to the Primary GNSS receiver was entered into POS View prior to mainscheme surveying.

B.1.1.1 Vessel Offset Correctors

<table>
<tr><td>Vessel</td><td colspan="5">3801</td></tr>
<tr><td>Echosounder</td><td colspan="5">Tekhnicraft Design Ltd 83' Research Catamaran</td></tr>
<tr><td>Date</td><td colspan="5">2018-10-11</td></tr>
<tr><td rowspan="9">Offsets</td><td rowspan="4">MRU to Transducer</td><td></td><td>Measurement</td><td>Uncertainty</td></tr>
<tr><td>x</td><td>0.000 meters</td><td>0.050 meters</td></tr>
<tr><td>y</td><td>0.207 meters</td><td>0.050 meters</td></tr>
<tr><td>z</td><td>0.251 meters</td><td>0.050 meters</td></tr>
<tr><td rowspan="3">Nav to Transducer</td><td>x</td><td>-1.235 meters</td><td>0.050 meters</td></tr>
<tr><td>y</td><td>1.101 meters</td><td>0.050 meters</td></tr>
<tr><td>z</td><td>7.246 meters</td><td>0.050 meters</td></tr>
<tr><td>Transducer Roll</td><td>Roll</td><td>0.00 degrees</td><td></td></tr>
</table>

B.1.2 Layback

n/a

Layback corrections were not applied.

B.2 Static and Dynamic Draft

B.2.1 Static Draft

Static draft corrector values are set at zero for an ERS survey. All the vertical uncertainty values from the vessels motion and water level come from the SBET RMS file. The waterline values were manually measured with a steel tape and entered in the CARIS HVF. This waterline value in CARIS is the only location that waterline values are entered so the hvf applied designator should be set to “Yes”.

B.2.1.1 Static Draft Correctors

<table>
<tr><td colspan="2">Vessel</td><td>3801</td></tr>
<tr><td colspan="2">Date</td><td>2018-10-11</td></tr>
<tr><td colspan="2">Loading</td><td>0 meters</td></tr>
<tr><td rowspan="2">Static Draft</td><td>Measurement</td><td>-1.042 meters</td></tr>
<tr><td>Uncertainty</td><td>0.1 meters</td></tr>
</table>

B.2.2 Dynamic Draft

Dynamic draft values were are not required for an ERS survey.

B.2.2.1 Dynamic Draft Correctors

Dynamic draft correctors were not applied.

B.3 System Alignment

B.3.1 System Alignment Methods and Procedures

n/a

B.3.1.1 System Alignment Correctors

System alignment correctors were not applied.

C. Data Acquisition and Processing

C.1 Bathymetry

C.1.1 Multibeam Echosounder

Data Acquisition Methods and Procedures

Multibeam data from the T20P sonar on the Manta were monitored in real-time with the User Interface (UI) from Teledyne. Data were displayed in 2D next to the backscatter display window. Mainscheme data were acquired using planned lines. A monitor was set up near the coxswain to display the real-time coverage map in Hysweep and to help them steer the lines.

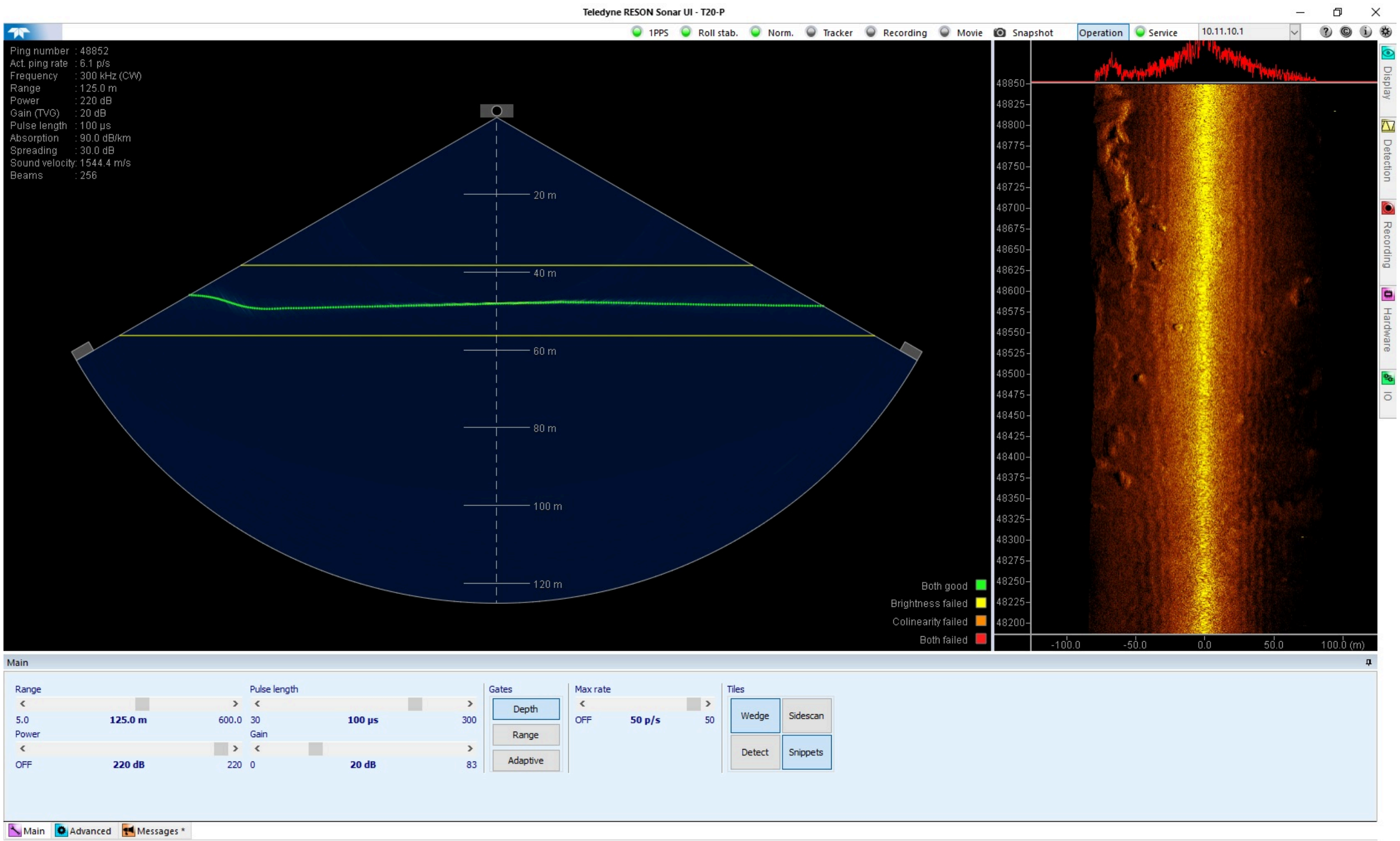

Figure 7: Teledyne RESON Sonar UI display

<u>Data Processing Methods and Procedures</u>

Following acquisition, multibeam sonar data were processed using the automated Pydro Explorer application, Charlene, to perform the processing steps in CARIS. The standard data processing steps are as follows:

1. Convert raw Hypack (.HSX) files to the HDCS data format
2. Load delayed heave
3. Load and apply sound velocity correctors
4. Compute GPS tide to transform data from the ellipsoid to the tidal datum using a separation model
5. Merge data to apply position attitude, and dynamic draft correctors to bathymetry and compute the corrected depth of each sounding
6. Compute Total Propagated Uncertainty (TPU)
7. Add data to a CUBE surface encompassing the entire survey
8. Complete data quality control check and analysis

C.1.2 Single Beam Echosounder

Single beam echosounder bathymetry was not acquired.

C.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not acquired.

C.1.4 Gridding and Surface Generation

C.1.4.1 Surface Generation Overview

MBES data are gridded using CARIS HIPS Combined Uncertainty and Bathymetric Estimator (CUBE) algorithm and is processed as described in FPM Section 4.2.1.1, using methods described above in Section C.1.1. The CUBE surface is also created using a grid resolution determined by coverage type and depth, as required by the Project Instructions and specified in the HSSD, Section 5.2.2. The "Depth" layer is reviewed for holidays (gaps in coverage) or erroneous soundings. Any erroneous soundings, known as fliers, are flagged as rejected and removed from the surface so the surface more accurately represents the seafloor. Any least depth on a feature that is not accurately reflected in the surface is flagged as “designated” in order to force the surface to reflect that shoaler depth in accordance with HSSD Section 5.2.1.2.3.

C.1.4.2 Depth Derivation

See above.

C.1.4.3 Surface Computation Algorithm

See above.

C.2 Imagery

C.2.1 Multibeam Backscatter Data

Data Acquisition Methods and Procedures

The ping rate was automatically adjusted in accordance with the depth ranges specified by the operator. The deeper the water depth the fewer pings are transmitted per second. For example, in 70m of water, we had a ping rate of 5.1 pings/second even though the T20P sonar has a maximum ping rate of 50 pings per second.

Data Processing Methods and Procedures

The T20P backscatter data was recorded within the Hypack HSX files and in proprietary 7k files. Pydro was used to convert the 7k files to 7ks files for that a surface mosaic could be developed in CARIS. The survey team doesn't have access to the appropriate software for more intensive backsatter processing so the raw data should also passed along to the client.

C.2.2 Side Scan Sonar

Side scan sonar imagery was not acquired.

C.2.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not acquired.

C.3 Horizontal and Vertical Control

C.3.1 Horizontal Control

C.3.1.1 GNSS Base Station Data

GNSS base station data was not acquired.

C.3.1.2 DGPS Data

DGPS data was not acquired.

C.3.2 Vertical Control

C.3.2.1 Water Level Data

Water level data was not acquired.

C.3.2.2 Optical Level Data

Optical level data was not acquired.

C.4 Vessel Positioning

Data Acquisition Methods and Procedures

Attitude and Heave data were measured with the sensors described in Section A.5, and applied in postprocessing during SVP Correct and Merge in CARIS HIPS. The MIST kit utilizes a heave filter integration method known as “TrueHeave” as described in Section 3.4.1.2 of the 2014 Field Procedures Manual. This filter almost completely eliminates the need for steadying up on lines before logging can begin. TrueHeave data were logged throughout the day via the POS MV's USB logging feature. Data are logged to the removable media in approximately 12-Megabyte (MB) files. Each file has a unique identifier for the year, Julian day number, and the vessel number (ex. 2017_214_S3007.000). The multple POS files that are created from logging in this way are each distunguished by the numbering found in the file type (e.g, 000, 001, 002, etc.). After regular CARIS data conversion, the TrueHeave file was separately loaded into HIPS, replacing the unfiltered heave values recorded in the raw data. TrueHeave is actually applied to the data, if the checkbox is marked, during the sound velocity correction process. It is standard procedure to begin logging the POS MV Applanix .000 file at least 5 minutes before starting bathymetric data acquisition and letting it run for at least 5 minutes afterward. Although the filter that produces the true heave values by looking at a long series of data to create a baseline needs only 3 minutes before and after the acquisition of bathymetric data, SBET processing which uses the same .000 file, requires logging for 5 minutes before and after bathymetric acquisition. Timing and attitude biases were determined in accordance with Section 1.5 of the Field Procedures Manual, and are described in Section B of this report.

Data Processing Methods and Procedures

Positioning and attitude data (POS files) were post processed via Applanix POSPac MMS software, providing a RTX solution. A Smoothed Best Estimate of Trajectory (SBET) is created using Applanix's proprietary RTX application. The resulting SBET file consists of GPS position and attitude data corrected and integrated with inertial measurements and reference station correctors. These SBET navigation and attitude files are applied to all lines in CARIS and supersede initial positioning and attitude data.

C.5 Sound Speed

C.5.1 Sound Speed Profiles

Data Acquisition Methods and Procedures

The MIST kit uses the SonTek CastAway CTD to acquire sound speed data. Sound speed casts were taken at a minimum of every four hours. More casts were taken when the SIS software notified the team that the salinity was no longer within designated tolerances. SIS monitors changes in the surface sound speed vs. the value obtained with the last cast in real-time. The user is then warned for the need of a new cast by highlighting both the “SV Profile” and “SV Used numerical displays in yellow with a difference greater than 3 m/s and red for a difference greater than 5 m/s.

Casts were taken while the vessel was at rest. A 15 meter deployment line, included with the CastAway CTD, was tied off to a point on the aft deck. Using the LCD interface on the CastAway, a starting GPS location was recorded and then the device was lowered just beneath the water surface for approximately 10 seconds to allow the sensor to stabilize to the water conditions. After waiting for the sensor to stabilize, the CTD would be allowed to free fall through the water column. When the CTD reached the bottom, or when the the deployment line was completely paid out, the CTD was retrieved to the surface at a rate of about 1 m/s. Once the CTD was brought back on deck, the data collection process was terminated and the final GPS location was recorded. The data were then downloaded via a bluetooth connection to the survey computer.

Data Processing Methods and Procedures

After the CastAway GPS location is recorded and the device is in range of the USB Bluetooth adapter inserted in the acquisition computer, the cast data is automatically downloaded into the CastAway CTD software. The data can then be exported to an ASCII format for import into Pydro's Sound Speed Manager application. Sound Speed Manager can then transmit this sound velocity data directly into SIS, and can convert the sound velocity files into a CARIS usable format. All sound velocity profiles for CARIS are concatenated into a vessel-wide or sheet-wides files in order of ascending time/date. These concatenated file(s) are then applied to all HDCS data acquired with the option “Nearest in distance within time (4 Hours)” selected under the “Profile Selection Method”.

C.5.2 Surface Sound Speed

Data Acquisition Methods and Procedures

The multibeam system utilized aboard the Manta requires a sound velocity probe to be interfaced with the sonar acquisition unit for use in projector steering computations. Surface sound velocity probes are on at all times during acquisition and the unit is configured to output an AML datagram to the UI interface, which is installed on the acquisition computer. An AML Micro X provided surface sound speed data to the T20P processing unit for beam steering and beam forming. The surface sound speed measurement unit is mounted on the T20P bracket at the base of the survey pole.

Data Processing Methods and Procedures

EMPTY

C.6 Uncertainty

C.6.1 Total Propagated Uncertainty Computation Methods

There are two places in CARIS where the user directly defines uncertainty values for use in CARIS to calculate TPU values, in the HVF and the direct input of SV and tide values during the TPU computation. TPU values for all motion, navigation position and timing values are taken directly from Appendix IV (Uncertainty values for use in CARIS with vessels equipped WITH an attitude sensor) of the FPM. All timing values were set to 0.01 seconds as outlined for setups with Ethernet connections and precise timing. All offset values were chosen to be 0.05 meters based on the accuracy provided by professional surveys. All MRU alignment values are derived from the patch test. The gyro value is taken directly from the standard deviation of the yaw values. The pitch/roll value is combined as one in the HVF and is computed as the square root of pitch standard deviation squared plus roll standard deviation squared.

C.6.2 Uncertainty Components

A Priori Uncertainty

Vessel		3801
Motion Sensor	*Gyro*	0.02 degrees
	Heave	5.00% 0.02 meters
	Roll	0.02 degrees
	Pitch	0.02 degrees
Navigation Sensor		1.00 meters

Real-Time Uncertainty

Real-time uncertainty was not applied.

C.7 Shoreline and Feature Data

Shoreline and feature data was not acquired.

C.8 Bottom Sample Data

Bottom sample data was not acquired.

D. Data Quality Management

D.1 Bathymetric Data Integrity and Quality Management

D.1.1 Directed Editing

The CUBE surface child layers: uncertainty, standard deviation, and node standard deviation were primarily used to help focus directed editing to soundings that were negatively affecting the BASE surface. Another method to check the quality of sounding data prior to submission is the Pydro QCTools “Flier Finder”. This software scans the CUBE surface for potential anomalous grid data. Lowering the flier height value will increase the sensitivity of the flier finder, resulting in more nodes being flagged. Fliers are then exported as .000 S-57 files that can be imported into CARIS HIPS and SIPS to aid in further cleaning. If desired, the user can set a new tolerance ("Flier height") and rerun Flier finder.

D.1.2 Designated Sounding Selection

Since the calculated depth for each grid node of a BASE surface is influenced by multiple soundings, the least depth of a feature may not always be accurately represented in the gridded data. Poor sounding density, noisy data, strong filters, and improper data cleaning, can all exacerbate this issue. Therefore, prior to creating a finalized BASE surface, the hydrographer must systematically review significant feature least depths to ensure they are accurately portrayed by the BASE surface. Additional data (including local knowledge, diver investigations, or sidescan sonar) should be reviewed in concert with the depth soundings. If the hydrographer finds that a specific least depth sounding should be represented in the weighted mean depth calculation for the associated BASE surface grid node, that sounding should be flagged "Designated". A designated sounding is required to be the shoalest sounding of a feature that sits at least 1m above the seafloor and the gridded surface is shown to exceed the allowable TVU at that depth (see Figure 5.1 in section 5.2.1.2.3 of the HSSD). The designated sounding must also be at least 2mm away, at survey scale, from any other shoaler sounding.

D.1.3 Holiday Identification

This survey was a 100% multibeam data object detection survey. The survey line spacing was based on a the water depth and a sonar coverage angle of 120 degrees. Due to the rough sea state, some of the lines did not acquire the desired overlap and created a holiday. The data were processed, cleaned, and then run through Pydro QC tools holiday finder. The holiday shape file was exported and put up on the coxswain monitor for completion.

D.1.4 Uncertainty Assessment

The primary bathymetric data review and quality control tool is the CARIS CUBE surfaces. The CUBE algorithm generates a surface consisting of multiple hypotheses that represent the possible depths at any given position. The CUBE surface is a grid of estimation nodes where depth values are computed based on the horizontal and vertical uncertainty of each contributing sounding. Any individual sounding's uncertainty, or Total Propagated Uncertainty (TPU), is derived from the assumed uncertainty in the echosounder measurement itself, as well as the contributing correctors from sound speed, water levels, position, and attitude. TPU values for tide and sound velocity must be entered for each vessel during TPU computation, unless using TCARI, where uncertainty is added directly to survey lines by Pydro.

D.1.5 Surface Difference Review

D.1.5.1 Crossline to Mainscheme

Cross lines were not collected for this survey.

D.1.5.2 Junctions

In some areas there were surveys completed by other contractors. However, their surveys were not provided to us and there was not a requirement in place to complete a junction survey assessment.

D.1.5.3 Platform to Platform

n/a

D.2 Imagery data Integrity and Quality Management

Imagery data integrity and quality management were not conducted for this survey.

E. Approval Sheet

As Chief of Party, I acknowledge that all of the information contained in this report is complete and accurate to the best of my knowledge.

n/a

n/a

Approver Name	Approver Title	Date	Signature
Michael Bloom	Team Lead	04/30/2020	BLOOM.MICHAEL.GRAHAM.1029463049 Digitally signed by BLOOM.MICHAEL.GRAHAM.1029463049 Date: 2020.04.30 11:51:28 -04'00'

List of Appendices:

Mandatory Report	***File***
Vessel Wiring Diagram	MIST_WiringDiagram.jpg
Sound Speed Sensor Calibration	N/A
Vessel Offset	N/A
Position and Attitude Sensor Calibration	N/A
Echosounder Confidence Check	N/A
Echosounder Acceptance Trial Results	N/A