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

Data Acquisition & Processing Report

Type of Survey:	Natural Disaster Response
Project Number:	S-G948-NRT1-18
Time Frame:	September - September 2018

LOCALITY

State(s):	South Carolina
General Locality:	Murrels Inlet

2018

CHIEF OF PARTY
Alex Ligon

LIBRARY & ARCHIVES

Date:

Table of Contents

List of Figures

Data Acquisition and Processing Report

Navigation Response Team 1
Chief of Party: Alex Ligon
Year: 2018
Version: 1.1
Publish Date: 2019-02-11

A. System Equipment and Software

A.1 Survey Vessels

A.1.1 USCG Georgetown Subordinate Station Sector Charleston

Vessel Name	USCG Georgetown Subordinate Station Sector Charleston	
Hull Number	262173	
Description	Trailerable Aid to Navigation Boats, TANBs, are the small boats utilized by USCG Aid to Navigation Team. They are the most common option as a Vessel of Opportunity for the Navigation Response Branch's Mobile Integrated Survey Team in Disaster Response scenarios.	
Dimensions	*LOA*	29 feet 7 inches
	Beam	8 feet
	Max Draft	2 feet 4 inches
Most Recent Partial Static Survey	*Date*	2018-09-17
	Performed By	PS Michael Annis, PST Joshua Bergeron, PST Alex Ligon
Most Recent Partial Offset Verification	*Date*	2018-09-17
	Method	The MIST used a steel tape measure with units in feet and meters to verify the static offsets of: the Trimble Primary GPS antenna to the Secondary GPS antenna; the Odom CV100 Singlebeam Echosounder to the Primary GPS antenna; and the phase center of the Edgetech Side Scan Sonar to the Primary GPS antenna.

Figure 1: Image of TANB taken from www.metalsharkboats.com

A.2 Echo Sounding Equipment

A.2.1 Multibeam Echosounders

No multibeam echosounders were utilized for data acquisition.

A.2.2 Single Beam Echosounders

A.2.2.1 Teledyne Odom Hydrographic CVM Single Beam Echosounder

Pole mounted Single Beam Echosounder system with an 8 degree beam angle operated at 200 kHz.

<table>
<tr><td>Manufacturer</td><td colspan="4">Teledyne Odom Hydrographic</td></tr>
<tr><td>Model</td><td colspan="4">CVM Single Beam Echosounder</td></tr>
<tr><td rowspan="6">Inventory</td><td rowspan="6">26173</td><td>Component</td><td>Transducer</td><td>Topside Processing Unit</td></tr>
<tr><td>Model Number</td><td>N/A</td><td>CVM</td></tr>
<tr><td>Serial Number</td><td>TR7715</td><td>003175</td></tr>
<tr><td>Frequency</td><td>200</td><td>N/A</td></tr>
<tr><td>Calibration</td><td>2018-09-17</td><td>2018-09-17</td></tr>
<tr><td>Accuracy Check</td><td>2018-09-17</td><td>2018-09-17</td></tr>
</table>

Figure 2: Transducer pole and head.

Figure 3: Teledyne Odom CVM Topside Processing Unit

A.2.3 Side Scan Sonars

A.2.3.1 Edgetech 4125

The 4125 Side Scan Sonar uses Edgetech's Full Spectrum CHIRP Technology which provides high resolution imagery. It can be operated at both 400 and 900 kHz to collect imagery and detect obstructions on the sea floor.

<table>
<tr><td>Manufacturer</td><td colspan="2">Edgetech</td></tr>
<tr><td>Model</td><td colspan="2">4125</td></tr>
<tr><td>Inventory</td><td>26713</td><td>
<table>
<tr><td>Component</td><td>Towfish</td><td>Topside Processor</td></tr>
<tr><td>Model Number</td><td>4125</td><td>4125P</td></tr>
<tr><td>Serial Number</td><td>N/A</td><td>40412</td></tr>
<tr><td>Frequency</td><td>400 & 900</td><td>N/A</td></tr>
<tr><td>Calibration</td><td>2018-09-17</td><td>2019-09-17</td></tr>
<tr><td>Accuracy Check</td><td>2018-09-17</td><td>2019-09-17</td></tr>
</table>
</td></tr>
</table>

Figure 4: Edgetech 4125 towfish

Figure 5: Edgetech 4125 Topside Processor

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

Positioning and attitude system was not utilized for data acquisition.

A.5.2 DGPS

A.5.2.1 Trimble SPS361

Differential GPS receiver unit that allows dual antennae input for accurate heading alignment.

<table>
<tr><td>Manufacturer</td><td colspan="5">Trimble</td></tr>
<tr><td>Model</td><td colspan="5">SPS361</td></tr>
<tr><td rowspan="4">Inventory</td><td rowspan="4">26173</td><td>Component</td><td>DGPS Receiver</td><td>Antenna</td><td>Anenna</td></tr>
<tr><td>Model Number</td><td>SPS361</td><td>GA530</td><td>GA530</td></tr>
<tr><td>Serial Number</td><td>5331K63803</td><td>14794</td><td>14783</td></tr>
<tr><td>Calibration</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

Figure 6: GPS receiver and antennae.

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 YSI Castaway

The YSI Castaway measures conductivity, temperature of seawater versus pressure, in depths up to 100 meters. GPS enabled for positioning, data is uploaded via Bluetooth to the acquisition computer.

<table>
<tr><td>Manufacturer</td><td>YSI</td></tr>
<tr><td>Model</td><td>Castaway</td></tr>
<tr><td>Inventory</td><td><table>
<tr><td>Component</td><td>CTD Sensor</td></tr>
<tr><td>Model Number</td><td>Castaway</td></tr>
<tr><td>Serial Number</td><td>CC1433012</td></tr>
<tr><td>Calibration</td><td>2018-09-20</td></tr>
</table></td></tr>
</table>

Figure 7: YSI Castawy CTD.

A.6.3 Sound Speed Sensors

No sound speed profilers were utilized for data acquisition.

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*
Xylem	HYPACK 2018	18.1.11.0	Bathymetric Data Acquisition
Edgetech	Discover	1.0 Beta	Side Scan Sonar Data Acquisition
Teledyne	CARIS HIPS & SIPS	10.4.6	Bathymetry and Side Scan Sonar imagery data processing and quality assurance.
NOAA	PydroGIS	18.4 (r9125)	Bathymetry and Side Scan Sonar imagery data processing and quality assurance.

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

The Single Beam and Side Scan Sonar MIST set up places the reference point of the sonars at the phase center of the Primary GPS Antenna, and applying a waterline value in the Z orientation to the SBES. Vessel offsets were measured and recorded in meters by the team members with a steel tape.

Figure 8: MIST Setup on TANB during Hurricane Florence Response.

B.1.1.1 Vessel Offset Correctors

Vessel	26173			
Echosounder	Metal Shark Odom CV100 Single Beam Echosounder & Edgetech 4125 Side Scan Sonar			
Date	2018-09-17			
Offsets	*MRU to Transducer*		*Measurement*	*Uncertainty*
		x	-2.150 meters	0.010 meters
		y	-5.820 meters	0.010 meters
		z	0.000 meters	0.000 meters
		x2	0.000 meters	0.000 meters
		y2	0.000 meters	0.000 meters
		z2	0.000 meters	0.000 meters
	Nav to Transducer	*x*	0.000 meters	0.000 meters
		y	0.000 meters	0.000 meters
		z	0.000 meters	0.000 meters
		x2	0.000 meters	0.000 meters
		y2	0.000 meters	0.000 meters
		z2	0.000 meters	0.000 meters
	Transducer Roll	*Roll*	0.00 degrees	

B.1.2 Layback

SSS layback was not calculated for this survey as the towfish was pole mounted. The tow point was calculated by measuring, with a steel tape measure, the offsets in the X and Y direction from the phase center of the SSS to the phase center of the Primary GPS antenna.

Layback correctors were not applied.

B.2 Static and Dynamic Draft

B.2.1 Static Draft

Using a steel tape measure, the field unit took a measurement along the fixed pole mounted to the transom of the vessel, from the Odom Single Beam Echosounder transducer head to the waterline. Measurements taken from the vessel's partial static offset survey in the X and Y axis were applied to this waterline measurement, then added to the Caris Hips Vessel File.

B.2.1.1 Static Draft Correctors

Vessel		26173
Date		2018-09-17
Loading		0.010 meters
Static Draft	*Measurement*	-0.800 meters
	Uncertainty	0.010 meters

B.2.2 Dynamic Draft

Due to time constraints and lack of efficient equipment, no dynamic draft measurements were collected.

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

No system alignment calibrations, i.e patch test, were run for this configuration. The configuration installed during this survey did not use any systems that are affected by alignment variables.

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

Multibeam echosounder bathymetry was not acquired.

C.1.2 Single Beam Echosounder

Data Acquisition Methods and Procedures

Single Beam data from the Odom CV100 installed on USCG 262173 were monitored in realtime using the acquisition software, HYPACK 2018. Data were displayed in the HYPACK Survey, Map, Data Display and Odom CV100 Bottom Display windows. Mainscheme data were acquired using either planned lines based on 200% SSS coverage, or by steering based on safe water away from extending shoals or anthropogenic features.

Data Processing Methods and Procedures

Following acquisition, SB sonar data were manually processed using CARIS HIPS and SIPS.

1. Convert raw Odom CV100 SB data (.RAW & .BIN) to the HDCS data format
2. Clean spurious data, removing false heights and depths
3. Import Tide from a zone tide file (.zdf) or TCARI file (.tc) to correct the data vertically to MLLW
4. Load and apply sound velocity corrections
5. Merge data to apply correctors
6. Compute Total Propagated Uncertainty (TPU)
7. Create Swath & CUBE grids
8. Data quality control and analysis.

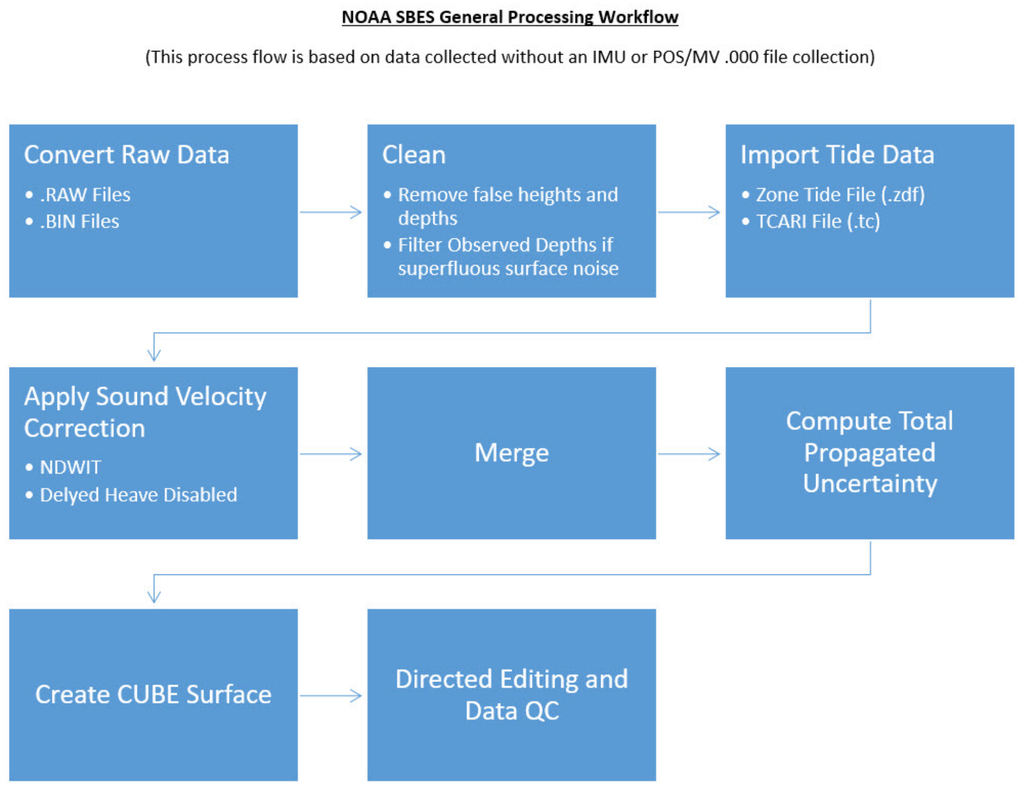

Figure 9: SBES processing work flow.

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

Surfaces are generated in CARIS using the CUBE gridding method. Resolution is determined by the Project Instructions and the HSSD.

C.1.4.2 Depth Derivation

Final depths are derived after preliminary tide data has been applied and data has undergone full cleaning and QC. Pydro QC Tools 2 is used to run programs such as Flier Finder and Surface QC.

C.1.4.3 Surface Computation Algorithm

Gridding parameters and surface computation algorithms used are consistent with HSSD specs and guidance from HSD.

C.2 Imagery

C.2.1 Multibeam Backscatter Data

Multibeam backscatter imagery was not acquired.

C.2.2 Side Scan Sonar

Data Acquisition Methods and Procedures

The Edgetech 4125 SSS towfish is deployed from a port side mounted Universal Sonar Mount (hydro) Foil Z pole. Line spacing for side scan sonar (SSS) operations is determined by range scale. The range scales of the Edgetech 4125's high and low frequencies can be set independently. Confidence checks are performed daily by observing changes in linear bottom features extending to the outer edges of the digital side scan image, features on the bottom in survey area, and by passing aids to navigation. Daily rub tests are also conducted.

Data Processing Methods and Procedures

Following acquisition, side scan sonar data were processed either using CARIS HIPS & SIPS manually, or by using the automated Pydro Explorer application, Charlene, to perform the same steps. The standard data processing steps are as follows:

1. Convert raw Edgetech .JSF or .HSX data to the HDCS data format
2. Check Attitude and Navigation for spikes
3. Recompute towfish navigation to compute the position of the towfish in relation to the vessel
4. Review each line for contacts, proper towfish altitude tracking, gain, intensity and beam pattern corrections
5. Create mosaics and evaluate for coverage gaps

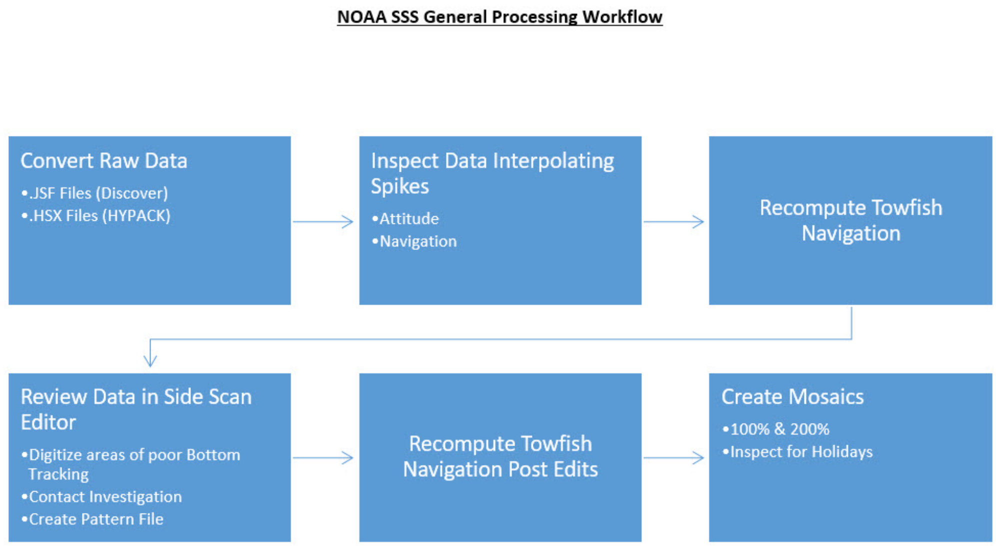

Figure 10: SSS processing work flow.

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

Data Acquisition Methods and Procedures

Water level data were not collected by the field unit.

Data Processing Methods and Procedures

Water level data were provided to the field unit by HSD as part of the Project Instructions in the form of Discrete Tide Zoning Files (.zdf) and TCARI Tide Models (.tc). Zone Tide Files were loaded in Caris HIPS & SIPS using the Load Tide tool and applied during the Merge process. TCARI Tide Files were applied using a combination of Pydro GIS and Caris HIPS & SIPS. Following is the work flow for the TCARI method:

1: Download preliminary water level data for each assigned Tide Station using Pydro Fetch Tides
2: In Pydro GIS, load TCARI data
3: Load water level data
4: Load TCARI Tide in HIPS PVDLs
5: Check output from Pydro GIS to ensure tide files were applied

C.3.2.2 Optical Level Data

Optical level data was not acquired.

C.4 Vessel Positioning

Position and attitude data was not acquired.

C.5 Sound Speed

C.5.1 Sound Speed Profiles

Sound speed profile was not acquired.

C.5.2 Surface Sound Speed

Surface sound speed was not acquired.

C.6 Uncertainty

C.6.1 Total Propagated Uncertainty Computation Methods

Although no IMU was installed on board the V.O.O.P., TPU values were applied to the HVF for CUBE Surface 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 Field Procedures Manual. All timing values were set to 0.005 seconds as outlined for setups with Ethernet connections and precise timing.

C.6.2 Uncertainty Components

A Priori UncertaintyA priori uncertainty was not applied.

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

Depth, Standard Deviation, Hypothesis Strength and Hypothesis Count models derived from the surface are viewed with appropriate vertical exaggeration and a variety of sun illumination angles to highlight potential problem areas.

D.1.2 Designated Sounding Selection

In some instances, due to the nature of the weighting algorithm, a CUBE surface does not accurately represent the least depth of a navigationally significant feature (typically a fine item such as a tall, narrow coral head or a shipwreck's mast). In such cases, a sounding can be flagged as Designated to force the nearest CUBE surface grid node to honor the depth of the designated sounding.

Since the calculated depth at each grid node of a CUBE surface is influenced by multiple soundings, the least depth of a feature may not always be accurately represented in the gridded data. Prior to creating a finalized CUBE surface collection, the hydrographer must systematically review significant feature least depths to ensure they are accurately portrayed by the CUBE surface. If a specific least depth sounding is preferred over the weighted mean-depth calculation for the associated CUBE surface grid node, that sounding should be flagged Designated. The Designated flag can be applied in either HIPS or Pydro. If a sounding is made Designated in one software package, this flag will automatically carry through to the other application. Designated soundings shall be selected in accordance with section 5.2.1 and 5.2.2 of the HSSD.

A common area of confusion is the preferred spatial density of designated soundings. It is easy to lose ones sense of scale when viewing data in subset editor. Sand ripples can look like mountains and small rocks appear like house sized boulders. The hydrographer shall take a holistic view of the surrounding bathymetry to help determine the hydrographic significance of a feature before designating a sounding. When there are a group of features near each other (e.g. they would be shown as a single sounding or charted feature at the scale of the survey), only the shoalest sounding on the feature with the most representative shoal depth shall be selected.

As discussed in the Specifications and Deliverables section 5.2.1.2, the hydrographer should use discretion in designating soundings on features.

D.1.3 Holiday Identification

Holidays are defined as gaps in main scheme data or areas where accuracy requirements have not been met. Holidays may be caused by various events, such as vessel maneuvering, survey equipment problems, unexpected shoals, or rejection of poor quality data during post-processing. Holiday line plans are typically developed to address these data gaps as main scheme acquisition progresses, rather than at the end of main scheme operations. This practice will minimize transit time required to revisit each area of the survey with a holiday and the time required to acquire, process, and manage additional sound speed profiles. If the field unit uses a real- time coverage map during main scheme data acquisition, most holidays can be identified and addressed prior to ceasing operations that day, thus increasing survey efficiency. NRT1 makes every effort to identify potential holidays during acquisition. Upon initial office review of the data holidays are identified visually by examining the surface or by using the Pydro QC tools "Holiday Finder".

D.1.4 Uncertainty Assessment

MIST primary bathymetric data review and quality control tool are the CARIS CUBE surfaces as implemented in CARIS HIPS. 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 as follows:

Soundings with a low vertical uncertainty are given more influence than soundings with high vertical uncertainty
Soundings with a low horizontal uncertainty are given more influence than soundings with a high horizontal uncertainty.
Soundings close to the node are given a greater weight than soundings further away from the node.

As soundings are propagated to a node, a hypothesis representing a possible depth value is developed for the node. If a sounding's value is not significantly different from the previous sounding then the same or modified hypothesis is used. If the value does change significantly, a new hypothesis is created. A node can contain more than one hypothesis. As node-to-node hypotheses are combined into multiple surfaces through methodical processing, a final surface that is the best representation of the bathymetry is created.

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.

Tide values measured uncertainty value error ranges from 0.01m to 0.05 m dependent upon the accuracy of the tide gauges used and the duration of their deployment. NRT1 is using a value of 0.0 since the Tide Component Error Estimation section of the Hydrographic Survey Project Instructions now includes the estimated gauge measurement error in addition to the tidal datum computation error and tidal zoning error.

Tide values zoning is unique for each project area and typically provided in Appendix II of the Hydrographic Survey Project Instructions, Water Level Instructions. In section 1.3.1.1 of the Water Level Instructions, Tide Component Error Estimation, the tidal error contribution to the total survey error budget is provided at the 95% confidence level, and includes the estimated gauge measurement error, tidal datum computation error, and tidal zoning error. Since this tidal error value is given for two sigma, the value must be divided by 1.96 before it can be entered into CARIS (which expects a one sigma value). If TCARI grids are assigned to the project area, this value is set at 0.0 since TCARI automatically calculates the error associated with water level interpolation and incorporates it into the residual/harmonic solutions.

Measured sound speed value error ranges from 0.5 to 4 m/s, dependent on temporal/spatial variability. FPM recommends a value of 4 m/s when 1 cast is taken every 4-hours.

Surface sound speed value is dependent on the manufacturer specifications of the unit utilized to measure surface SV values for refraction corrections to flat-faced transducers.

All other error estimates are read from the Hydrographic Vessel File (HVF) and Device Model file. The HVF contains all offsets and system biases for the survey vessel and its systems, as well as error estimates for latency, sensor offset measurements, attitude and navigation measurements, and draft measurements. The HVF specifies which type of sonar system the vessel is using, referencing the appropriate entry from the Device Model file.

D.1.5 Surface Difference Review

D.1.5.1 Crossline to Mainscheme

Crossline data are used to identify any systematic data problems by comparing it to main scheme data acquired at different times, water levels, and line azimuths. Ideally, crosslines should be acquired prior to main scheme data, in areas of gently sloping bottom, and when water levels are as close to survey datum (MLLW) as practicable. Two separate surfaces are created for main scheme and crosslines. These surfaces are then differenced in Caris HIPS and SIPS. The resulting difference surface is examined for statistical variations.

D.1.5.2 Junctions

Junctioning surveys are evaluated by differencing the overlapping surfaces and examined for statistical variations.

D.1.5.3 Platform to Platform

MIST rarely has the opportunity to compare data across platforms.

D.2 Imagery data Integrity and Quality Management

D.2.1 Coverage Assessment

The MIST performs 200% coverage SSS regularly. To achieve this coverage careful line planning, taking into account the water depth and range scale, is required. 10 meter overlap of SSS coverage is the goal in each percentage to ensure adequate coverage. Any SSS holidays are discovered by turning on a bright red background in Caris and overlaying each percentage's mosaic.

D.2.2 Contact Selection Methodology

Imagery data is reviewed twice using CARIS SIPS Side Scan Editor. The initial review process is referred to as “scanning” the data. The second review is performed by a different person and is called “check scanning.” The initial reviewer should identify any object that warrants further investigation, often referred to as a “significant contact”, and record these items into the digital data. The second review serves as a quality control, and should add any significant contacts that were overlooked during the initial check. SIPS provides several tools to assist in determining if a contact is significant. Two of the most frequently used are “Measure Shadow” and “Measure Distance.”

“Measure Shadow” can be used to determine the height of an object by measuring its acoustic shadow and calculating the object’s approximate elevation off the seafloor. This tool can only be used when viewing data in slant range corrected mode. “Measure Distance” is used to measure the distance between two points. This tool is helpful in determining the overall size of contacts, which may determine significance. For example, a very large item, even if it does not protrude significantly from the seafloor, may be listed in the AWOIS database and should therefore be investigated. The Measure Distance tool can be used when viewing both “raw” (i.e., not slant range corrected) and slant range corrected data.

All significant contacts are recorded in the digital data by creating a contact in SIPS. The general MIST practice for determining significance of an imagery contact is stated in the HSSD. The hydrographer must always consider the location of a contact when determining significance. For example, in a major channel where vessels transit with minimal under keel clearance, a contact less than one meter high could be significant.

When a contact is recorded in SIPS, the item is geo-coded and attributes are attached to it in the Side Scan Editor. Each contact should be attributed as thoroughly as possible. A contact file is created for each survey line and is stored in the line folder within the Project directory structure.

E. Approval Sheet

As acting Team Lead for this response to Hurricane Florence, I acknowledge that all the information contained in this report is complete accurate to the best of my knowledge.

Please see the Descriptive Report for further information regarding survey completion.

Approver Name	Approver Title	Date	Signature
Alex Ligon	Physical Science Technician	02/13/2019	

List of Appendices:

Mandatory Report	***File***
Vessel Wiring Diagram	N/A
Sound Speed Sensor Calibration	MIST_Castaway_Cal_Doc_2018.pdf
Vessel Offset	N/A
Position and Attitude Sensor Calibration	N/A
Echosounder Confidence Check	N/A
Echosounder Acceptance Trial Results	N/A