

W00493

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

DESCRIPTIVE REPORT

Type of Survey: Habitat Mapping

Registry Number: W00493

LOCALITY

State(s): US Virgin Islands

General Locality: Caribbean Sea

Sub-locality: Vicinity of St. Croix and 8NM South of St Thomas

2019

CHIEF OF PARTY
Timothy Battista

LIBRARY & ARCHIVES

Date:

HYDROGRAPHIC TITLE SHEET

W00493

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): **US Virgin Islands**

General Locality: **Caribbean Sea**

Sub-Locality: **Vicinity of St. Croix and 8NM South of St Thomas**

Scale: **N/A**

Dates of Survey: **07/02/2019 to 07/12/2019**

Instructions Dated: **02/05/2020**

Project Number: **ESD-AHB-20**

Field Unit: **NOAA Ship *Nancy Foster***

Chief of Party: **Timothy Battista**

Soundings by: **Kongsberg Maritime EM 2040 (MBES)
Kongsberg Maritime EM 710 (MBES)**

Imagery by: **N/A**

Verification by: **Atlantic Hydrographic Branch**

Soundings Acquired in: **meters at Mean Lower Low Water**

Remarks:

Field Acquisition - NF-19-01

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 20N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

DESCRIPTIVE REPORT SUMMARY

A. Area Surveyed

This hydrographic survey was conducted without formal project instructions. The Survey Number W00493 was provided after data acquisition had been completed. The survey was referred to as NF-19-01 during field acquisition and was assigned by AHB to ESD-AHB-20 after acquisition.

Data were acquired within the following survey limits:

| Northwest Limit | Southeast Limit |
|-----------------|-----------------|
| 18° 12' 45" N | 17° 38' 48" N |
| 65° 12' 18" W | 64° 37' 57" W |

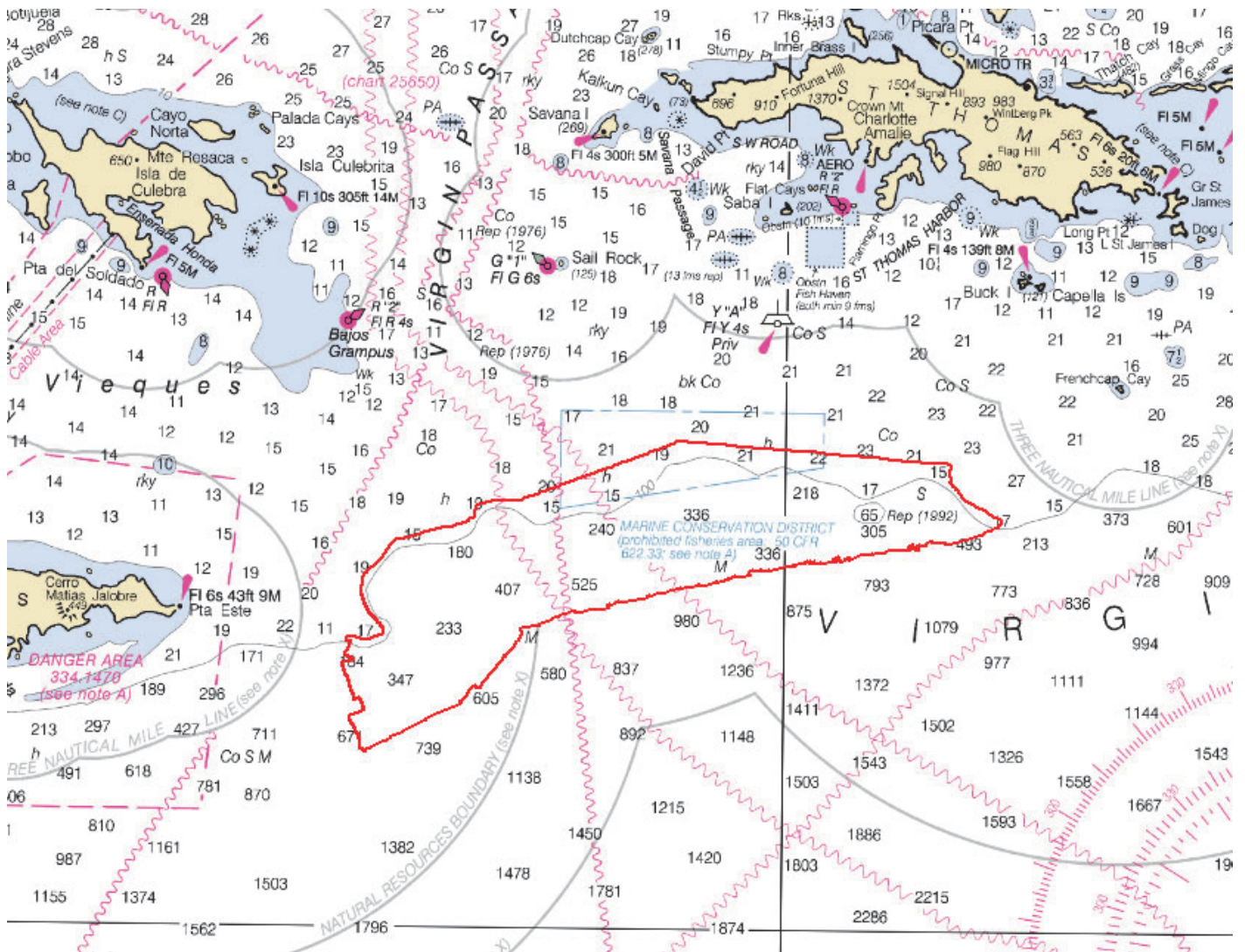


Figure 1: ESD-AHB-20 St. Thomas (STT) Survey Area



Figure 2: ESD-AHB-20 St. Croix (STX) Survey Area

B. Survey Purpose

The project is being conducted in support of the National Center for Coastal Ocean Science (NCCOS) to provide bathymetric data of critical benthic habitats in selected areas off of the coast of St. Thomas (STT) and St Croix (STX), USVI. Bathymetric and Acoustic Backscatter data from the project was collected with Kongsberg multibeam echosounders (MBES) and will be utilized by the Office of Coast Survey (OCS) to update the nautical charts in the surveyed area and the Marine Spatial Ecology Division to create benthic habitat charts.

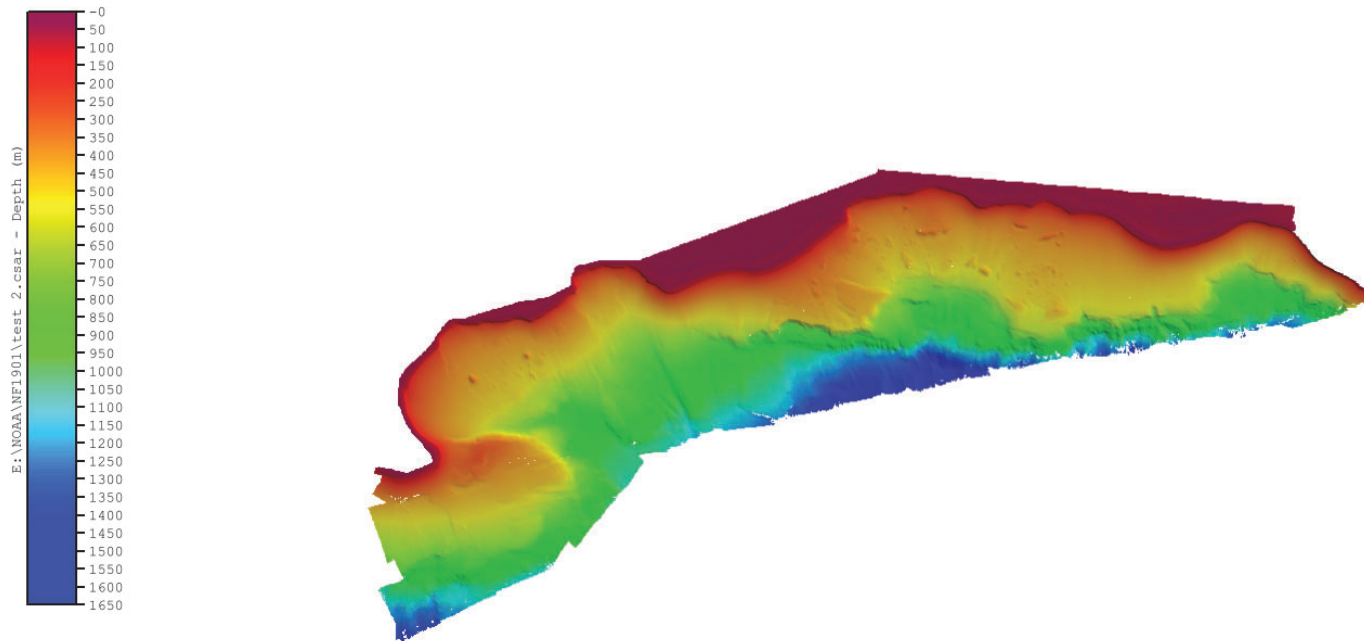


Figure 3: 16m CUBE Surface STT

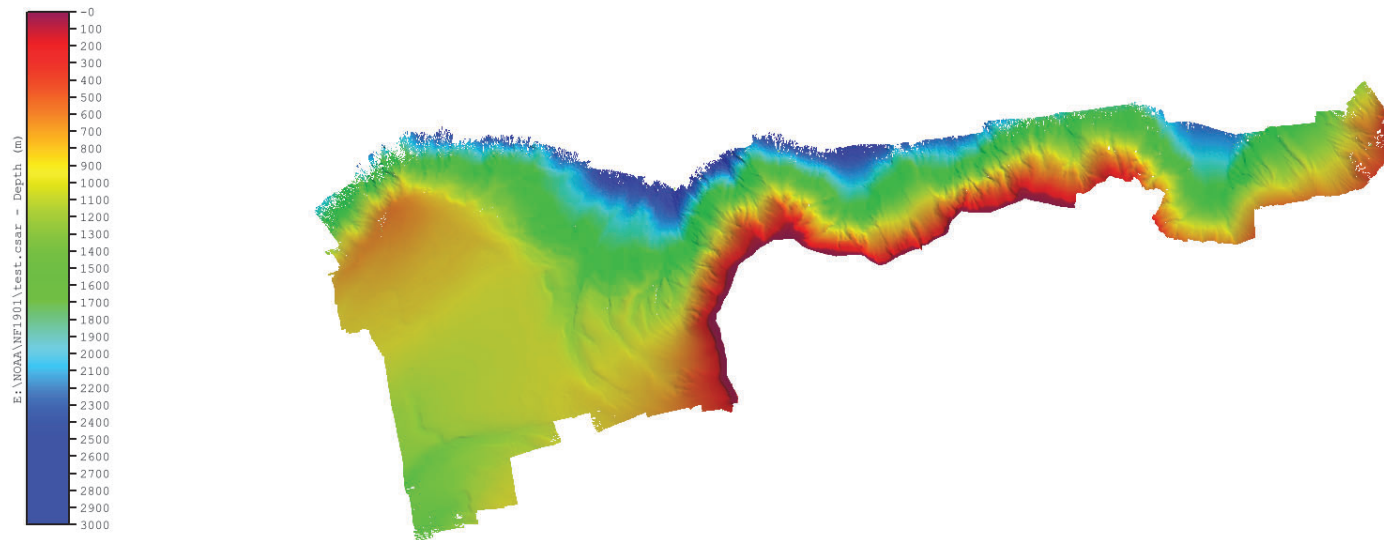


Figure 4: 16m CUBE Surface STX

C. Intended Use of Survey

The entire survey is adequate to supersede previous data.

D. Data Acquisition and Processing

No Data Acquisition and Processing Report (DAPR) is provided with this survey.

This survey was conducted from the NOAA Ship Nancy Foster and using the complete coverage MBES specification as defined in the Hydrographic Survey Specifications and Deliverables (HSSD). Prior to data collection at the Areas of Interest, static drafts were measured and confirmed with the SIS/HVF, a lead line comparison was performed dockside on DN182 and a patch test was performed on both MBES systems on DN183. While conducting the survey bathymetric coverage was monitored by creating CUBE surfaces with 1m, 2m, 4m, 8m, 16m and 32m resolutions as per the HSSD. Sounding densities generally meet the 95% of all nodes population criteria. The reef shelf from approximately 25m to 100m for both STX and STT areas was surveyed with an Kongsberg EM2040. An Kongsberg EM710 was used to cover from the reef shelf to the mapping extents or till the depth limit of the EM710 was met for complete MBES coverage of the areas of interest. Acoustic backscatter and water column data information was concurrently collected with the MBES data for additional habitat delineation..

The Nancy Foster is outfitted with an Applanix POS/MV 320 Version 5 GNSS inertial system. The POS/MV was used to measure attitude, heading, heave, and position for the MBES system. The POS/MV is comprised of an Inertial Motion Unit (IMU), two dual frequency GNSS antennas and a topside control unit. The POS/MV is augmented in real time with Fugro Marinestar Satellite service which improves the POS/MV positional accuracies to sub-DGPS standards. The POS/MV position, timing, heading and motion data were output to the Hypack and SIS acquisition systems using the POS/MV real-time ethernet option at 25 Hz. Additionally, using the ethernet logging controls, the POS/MV was configured to log TrueHeave™ and all of the raw observable groups needed to post process real-time navigation data. The POS/MV logged 13 megabyte files, which resulted in multiple files created per day.

In order to achieve further improved positional accuracy throughout the survey time period, an SBET (Smoothed Best Estimate of Trajectory) solution was derived during post-processing with POSpac MMS. This methodology employs Applanix's IN-Fusion SingleBase processing technique, the National Geodetic Survey's network of Continuously Operating Reference Stations (CORS), and final satellite ephemeris data. The tightly-coupled solution produces post-processed navigation, motion, and ellipsoidal height data with increased accuracy. For this survey only SBET navigation and attitude corrections were applied to the data, as a TCARI tidal solution was employed for vertical alignment. The SBET solution was not used for the STX survey area for the EM2040 data. Application of SBETs for these data introduced horizontal errors that were not an improvement to the real time solution. Additionally, the TrueHeave files were not applied to any of the Nancy Foster MBES data as it seemed to introduce error and not improve the solution either.

All acquisition and processing workstations are located in the Dry Lab of the Nancy Foster, are networked as a workgroup, and are interfaced with the ship's backup system. Coastal Oceanographics Hypack 2018 was

used for vessel navigation. Kongsberg Seafloor Information System (SIS) software was used to acquire the EM2040 and EM710 bathymetric data in the .all and .wcd formats. Bathymetric survey data was converted and processed in Caris HIPS with modifications to the default Combined Uncertainty Bathymetric Estimator (CUBE) Parameters XML file. The default CUBE Parameters XML was replaced with the XML file issued to all NOAA hydrographic field units included with the Field Procedures Manual. This updated XML file uses the resolution dependent maximum propagation distance values required in the HSSD. Processing methodology followed the standard Caris HIPS CUBE workflow. These steps include data conversion using HSTB supplied HVF files for each MBES system, filtering, SBET application, tide correction (TCARI), Total Propagated Uncertainty (TPU) calculation, merging, and swath/subset editing. NOAA's QC Tools was used to generate a .HOB file of potential fliers. All potential fliers were then validated or flagged as rejected. Due to the steep terrain of the reef shelf break, some soundings identified as fliers are in fact soundings trying to resolve vertical surfaces.

Acoustic backscatter was collected with both Kongsberg systems for benthic habitat delineation and chart creation. The Marine Spatial Ecology Division is processing the backscatter with FMGT and data will be included with the final deliverables.

All sound speed profiles were concatenated and organized into one complete file for each survey area (NF1901_concat_STT.svp, NF1901_concat_STX.svp). Sound velocity casts were applied in real time to the MBES data with SIS software. Velocity casts were taken at approximately four-hour frequency intervals with the UCTD throughout the survey areas. Ray-tracing uncertainty analyses were performed periodically to ensure the four-hour sampling rate was sufficient to keep up with water column variability.



Figure 5: NOAA Ship Nancy Foster

| <i>Type</i> | <i>Manufacturer</i> | <i>Model</i> |
|--------------------------------|---------------------|---------------|
| Multibeam Echosounder | Kongsberg | EM710 |
| Multibeam Echosounder | Kongsberg | EM2040 |
| Primary Sound Speed Profiler | OceanScience | uCTD |
| Secondary Sound Speed Profiler | Sea-Bird | SBE-19 |
| Positioning & Attitude | Applanix | POS/MV 320 v5 |
| Positioning & Attitude | Trimble | BD982 |

Figure 6: Major Survey Components

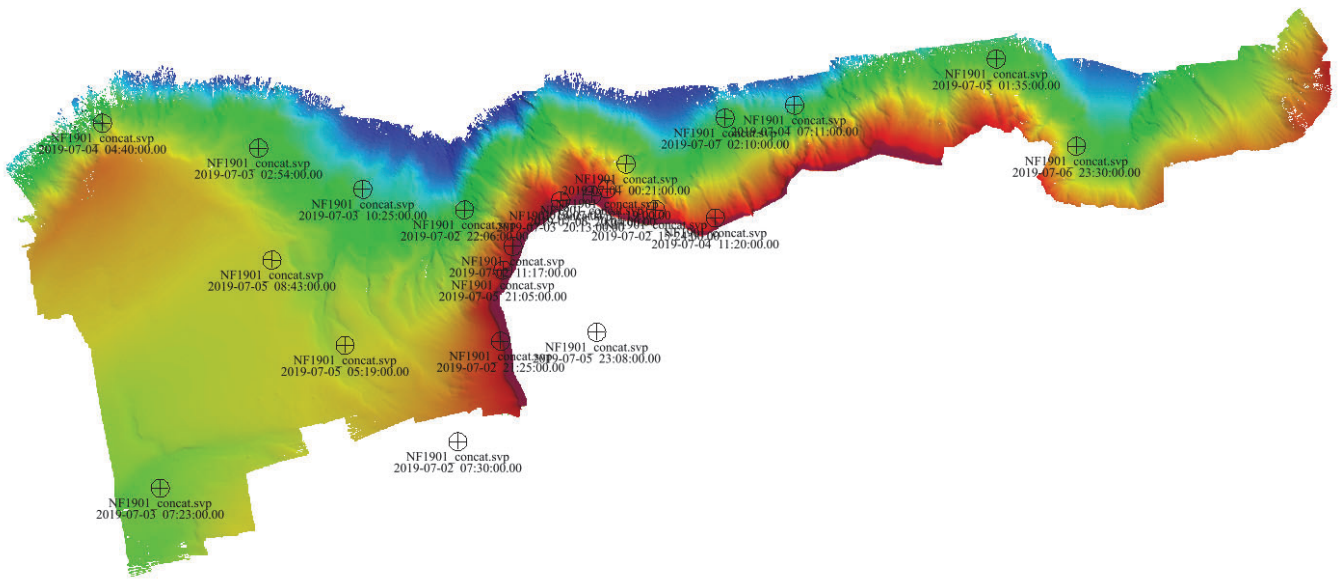


Figure 7: Spatial Distribution of Sound Speed Casts STX

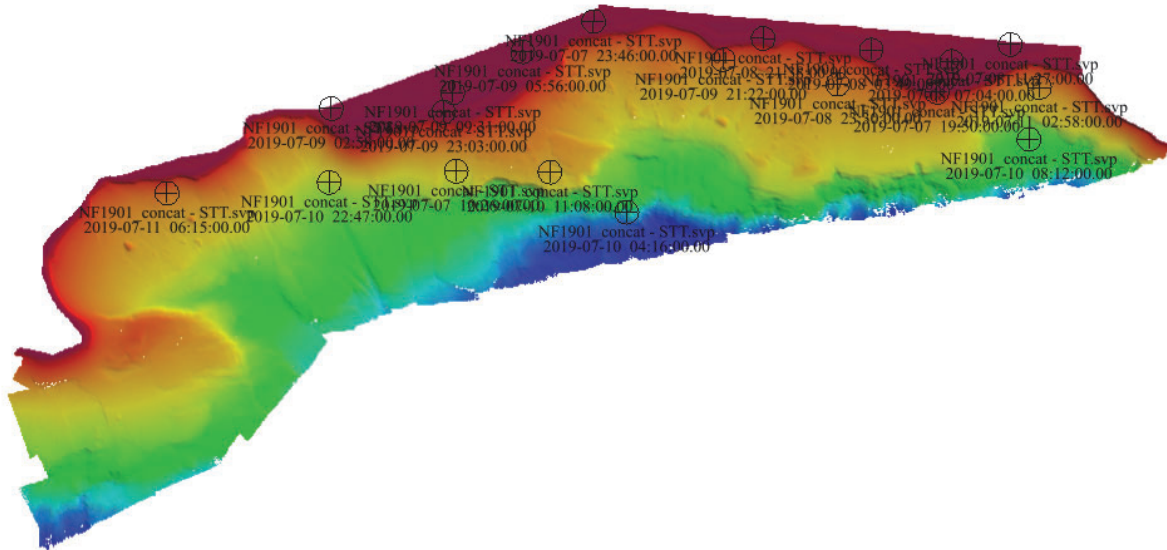


Figure 8: Spatial Distribution of Sound Speed Casts STT

E. Uncertainty

Results from the crossline analysis, final CUBE surface uncertainties, standard deviation comparison results between the two sonars and TVU QA results indicate internal consistency of the MBES data within IHO Order 1 and IHO 2 specifications for STT. The STX survey site met uncertainty standards for IHO 2 and fell short for IHO 1. This is due to the fact that the ratio of area of vertical reef shelf versus low slope areas within the STX surveyed area had a negative impact on the uncertainty standards results from QC Tools Grid QA analysis in addition to not having any crossline data to compare on the shelf.

A total of 13.92 nautical miles of crosslines, or 5.7% of all survey lines were ran for analysis of STT survey accuracy. A total of 25.21 nautical miles of crosslines, or 12.42% of all survey lines were ran for analysis of STX survey accuracy. Crosslines were run in a direction of less than 45 degrees to main scheme lines across most of the surveyed area, providing a good representation for analysis for IHO compliance. For water depths less than 100m, IHO Order 1 was used, and for water depths greater than 100m IHO Order 2 was used. Crossline analysis was performed using the Caris HIPS QC Line Report tool. This tool compares crossline data to a gridded surface and reports results by beam number and IHO compliance by the percentage of soundings that fall within the selected criteria (IHO 1, IHO 2).

The STT crosslines were compared to a 4m CUBE surface encompassing mainscheme data for depths less than 100m for IHO Order 1. The STT crosslines were compared to a 16m CUBE surface encompassing mainscheme data for depths more than 100m for IHO Order 2. STX crosslines were only acquired in the deeper waters and were not collected on the shelf area due to the navigation restrictions imposed by the Commanding Officer (too close to shore for the angle of lines needed to be collected). The STX crosslines that were collected in deeper water with the EM710 were compared to a 16m CUBE surface encompassing mainscheme data for depths more than 100m for IHO Order 2.

Survey specific uncertainty parameters were used for computing TPU within HIPS. The TCARI methodology for tidal correction creates an uncertainty model by propagating water level uncertainties, datum uncertainties, and TCARI grid vertical uncertainties. This error budget overwrites previously-defined error sources in CARIS, and is applied as part of the TPU processing. During surface finalization in HIPS, the "greater of the two" option was selected, where the calculated uncertainty from TPU is compared to the standard deviation of the soundings influencing the node, and where the greater value is assigned as the final uncertainty of the node. The uncertainty of the finalized surface increased for nodes where the standard deviation of the node was greater than the TPU.

Uncertainty evaluation was reviewed using NOAA's Pydro's Grid QA tool to evaluate compliance against the HSSD resolution and density requirements for Complete Coverage. The Grid QA was completed on representative finalized BAG surfaces from from each sonar used for the survey at STX and STT. Results of this process includes statistics and graphs for uncertainty standards, depth distribution and data density. In addition crossline analysis was performed for IHO level 1 and 2 for STT and IHO level 2 for STX. Selected graphs are presented below from both evaluations. Grid QA Uncertainty Standards results for STT on the 2 meter finalized surface pass at 95% of grid nodes meet the maximum allowable TVU, Data Density results of 96% of grid nodes are populated with at least 5 soundings. Line QC crossline analysis shows the the 2m surface compared to the crossline exceed the RMS 95% requirement for IHO 1 compliance and is shown in the below graph.

In addition an independent comparison between the EM2040 and EM710 was performed by collecting data simultaneously over a flat bottom at approximately 50m water depth. The two lines of data were processed the same as the rest of the data for STT and STX including TCARI application and results were favorable considering that the system operate at different frequencies and beam widths. Results indicate favorable agreement horizontally and vertically as shown in the difference surface and computed statistics of a standard deviation of 0.19m and a mean of -0.17m.

All of the results for both the Grid QA and Line QC reports can be found in the Digital Data folder included with this report.

| Options | |
|-------------------------|---------|
| Gyro Source | VESSEL |
| Heave Source | VESSEL |
| Navigation Source | VESSEL |
| Pitch Source | VESSEL |
| Roll Source | VESSEL |
| Sonar Source | VESSEL |
| Tide Source | STATIC |
| Measured Sound Velocity | 4 m/s |
| Surface Sound Velocity | 0.2 m/s |
| Sweep Maximum Heave | 0 m |
| Sweep Maximum Pitch | 0 deg |
| Sweep Maximum Roll | 0 deg |
| Measured Tide | 0.01 m |
| Tide Zoning | 0.2 m |

Figure 9: Compute HIPS TPU Options

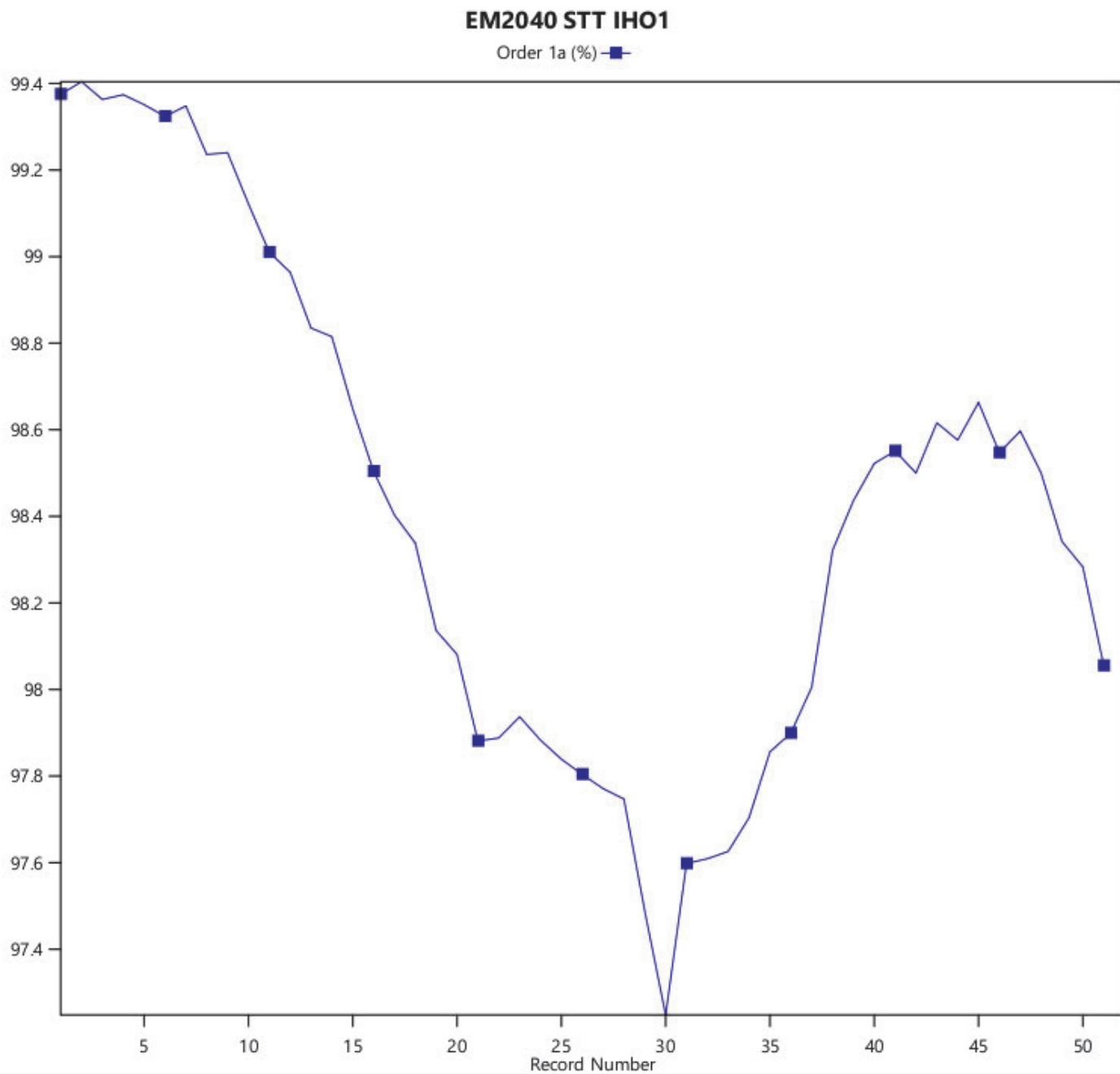


Figure 10: EM2040 STT IHO 1 Compliance

Uncertainty Standards

Grid source: W00493_STT_EM2040_MB_2m_MLLW_Final

95% pass (5,821,397 of 6,111,988 nodes), min=0.23, mode=0.70, max=4.20

Percentiles: 2.5%=0.52, Q1=0.66, median=0.70, Q3=0.76, 97.5%=1.20

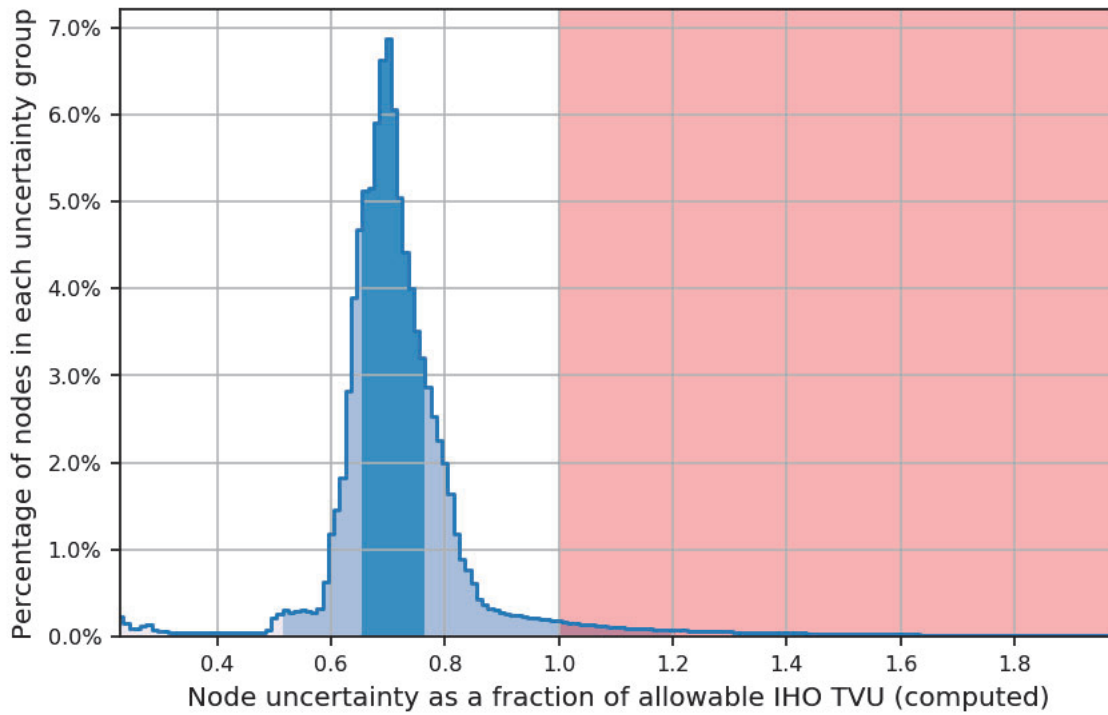


Figure 11: STT Uncertainty Standards 2m 2040 Finalized Surface

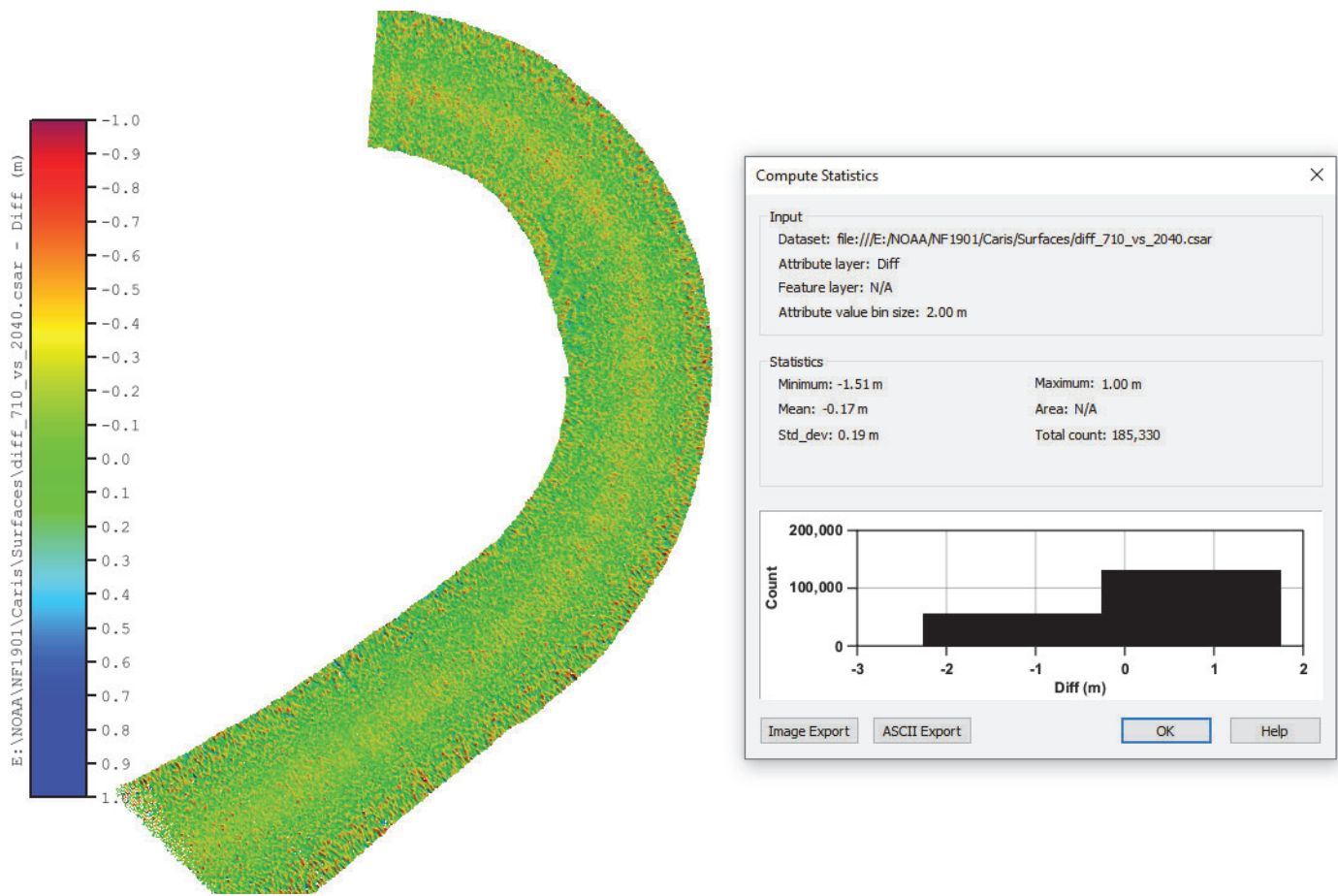


Figure 12: 2040 vs 710 Difference Surface and Statistics

F. Results and Recommendations

The following are the largest scale ENC's, which cover the survey area:

| ENC | Scale | Edition | Update Application Date | Issue Date | Preliminary? |
|----------|----------|---------|-------------------------|------------|--------------|
| US3PR10M | 1:326856 | 23 | 01/02/2020 | 01/02/2020 | NO |
| US4PR11M | 1:100000 | 19 | 01/02/2020 | 01/02/2020 | NO |
| US5PR12M | 1:10000 | 16 | 05/29/2019 | 05/29/2019 | NO |
| US5PR13M | 1:20000 | 15 | 05/29/2019 | 05/29/2019 | NO |

The following surfaces and/or BAGs were submitted to the Processing Branch:

| Surface Name | Surface Type | Resolution | Depth Range | Surface Parameter | Purpose |
|-------------------------------------|--------------|------------|---------------------|-------------------|---------------|
| W00493_STX_EM2040_MB_1m_MLLW_Final | BAG | 1 m | 10.48 m - 275.19 m | NOAA_1m | Complete MBES |
| W00493_STX_EM2040_MB_2m_MLLW_Final | BAG | 2 m | 10.56 m - 275.19 m | NOAA_2m | Complete MBES |
| W00493_STX_EM2040_MB_4m_MLLW_Final | BAG | 4 m | 10.85 m - 275.19 m | NOAA_4m | Complete MBES |
| W00493_STX_EM2040_MB_8m_MLLW_Final | BAG | 8 m | 10.97 m - 275.19 m | NOAA_8m | Complete MBES |
| W00493_STX_EM2040_MB_16m_MLLW_Final | BAG | 16 m | 11.58 m - 264.65 m | NOAA_16m | Complete MBES |
| W00493_STX_EM710_MB_8m_MLLW_Final | BAG | 8 m | 63.18 m - 2910.06 m | NOAA_8m | Complete MBES |
| W00493_STX_EM710_MB_16m_MLLW_Final | BAG | 16 m | 63.82 m - 2899.88 m | NOAA_16m | Complete MBES |
| W00493_STX_EM710_MB_32m_MLLW_Final | BAG | 32 feet | 64.23 m - 2892.22 m | NOAA_32m | Complete MBES |
| W00493_STT_EM2040_MB_2m_MLLW_Final | BAG | 2 m | 27.69 m - 294.01 m | NOAA_2m | Complete MBES |
| W00493_STT_EM2040_MB_4m_MLLW_Final | BAG | 4 m | 27.90 m - 294.01 m | NOAA_4m | Complete MBES |
| W00493_STT_EM2040_MB_8m_MLLW_Final | BAG | 8 m | 27.98 m - 294.01 m | NOAA_8m | Complete MBES |
| W00493_STT_EM2040_MB_16m_MLLW_Final | BAG | 16 m | 28.06 m - 291.93 m | NOAA_16m | Complete MBES |
| W00493_STT_EM710_MB_8m_MLLW_Final | BAG | 8 m | 43.95 m - 1634.71 m | NOAA_8m | Complete MBES |
| W00493_STT_EM710_MB_16m_MLLW_Final | BAG | 16 m | 41.47 m - 1634.50 m | NOAA_16m | Complete MBES |
| W00493_STT_EM710_MB_32m_MLLW_Final | BAG | 32 m | 44.97 m - 1634.47 m | NOAA_32m | Complete MBES |

The chart comparison for STT were performed by comparing a shoal biased sounding layer generated in CARIS to the largest scale chart, for STX three charts were compared because of overlapping effect of different scaled charts. A 900 and 200 meter shoal sounding surface of the entire survey area was generated from the finalized 16m CUBE depth surface for both STT and STX. The chart comparison was conducted by visually reviewing the shoal biased sounding selections comparing to the charted soundings.

Surveyed soundings generally compare well with the ENC charts, considering the water depths and steep terrain along the reef shelf within the STT and STX survey areas. Due to the generally steep slopes throughout the surveys and especially area along the reef shelf, minor location differences in the charted soundings and surface soundings can have large depth differences which is evident in some areas. Examples of the comparison results captured in the following images.

Finalized surfaces were exported from Caris in the BAG format. The Caris CUBE surface are also included in the digital data deliverable. The CUBE surface and BAGs use the same naming nomenclature, survey number, site, sonar model, sounding type and resolution in meters. The resolutions selected were in accordance with the HSSD for Complete Coverage specifications for single resolution surfaces. Depth thresholding was not utilized for this surveys deliverable due the varieties of resolutions at all depths required for benthic habitat analysis and delineation.

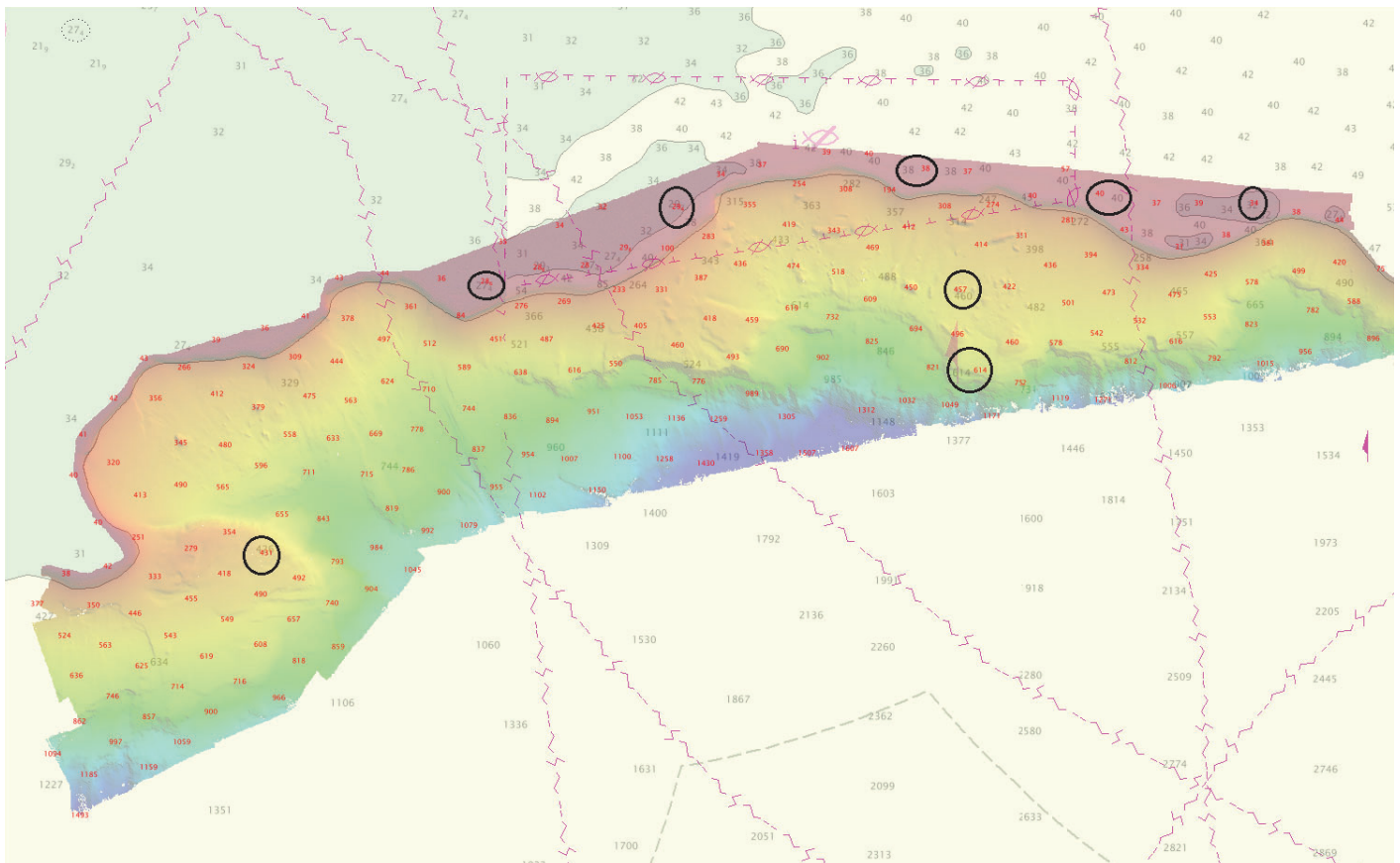


Figure 13: STT vs Chart US4PR10M - US4PR11M

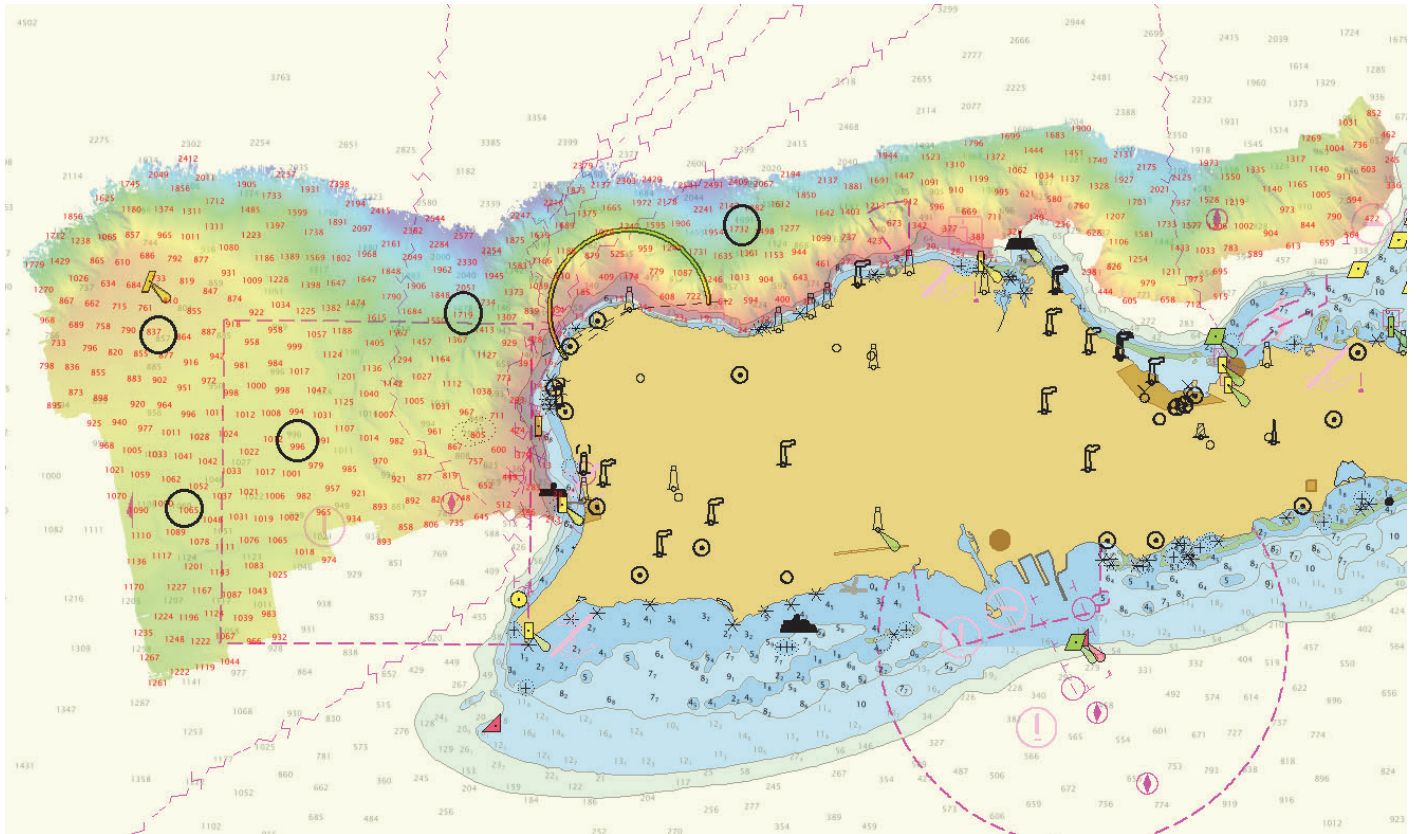


Figure 14: STX vs Chart US4PR11M

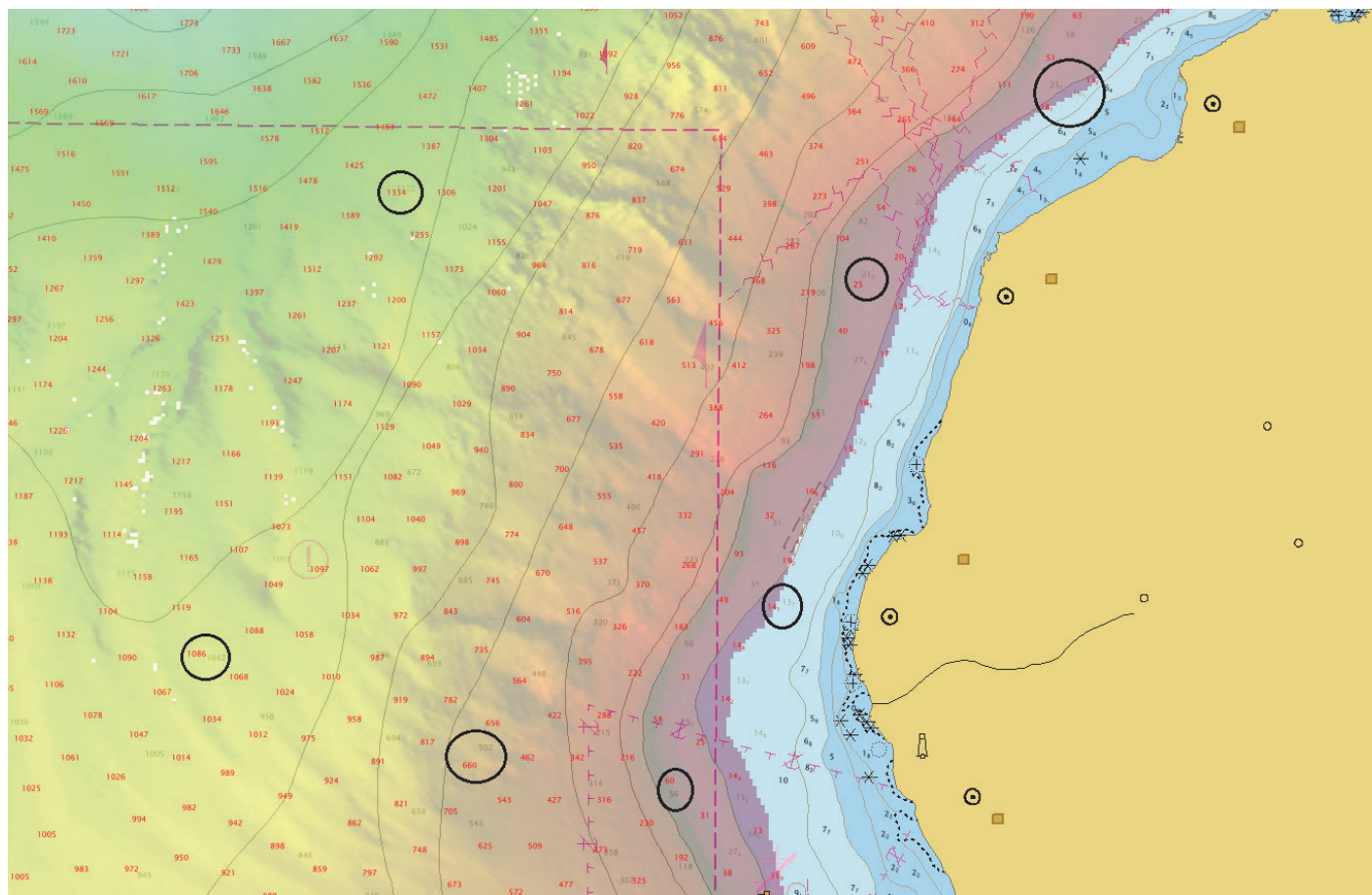


Figure 15: STX vs Chart US4PR13M

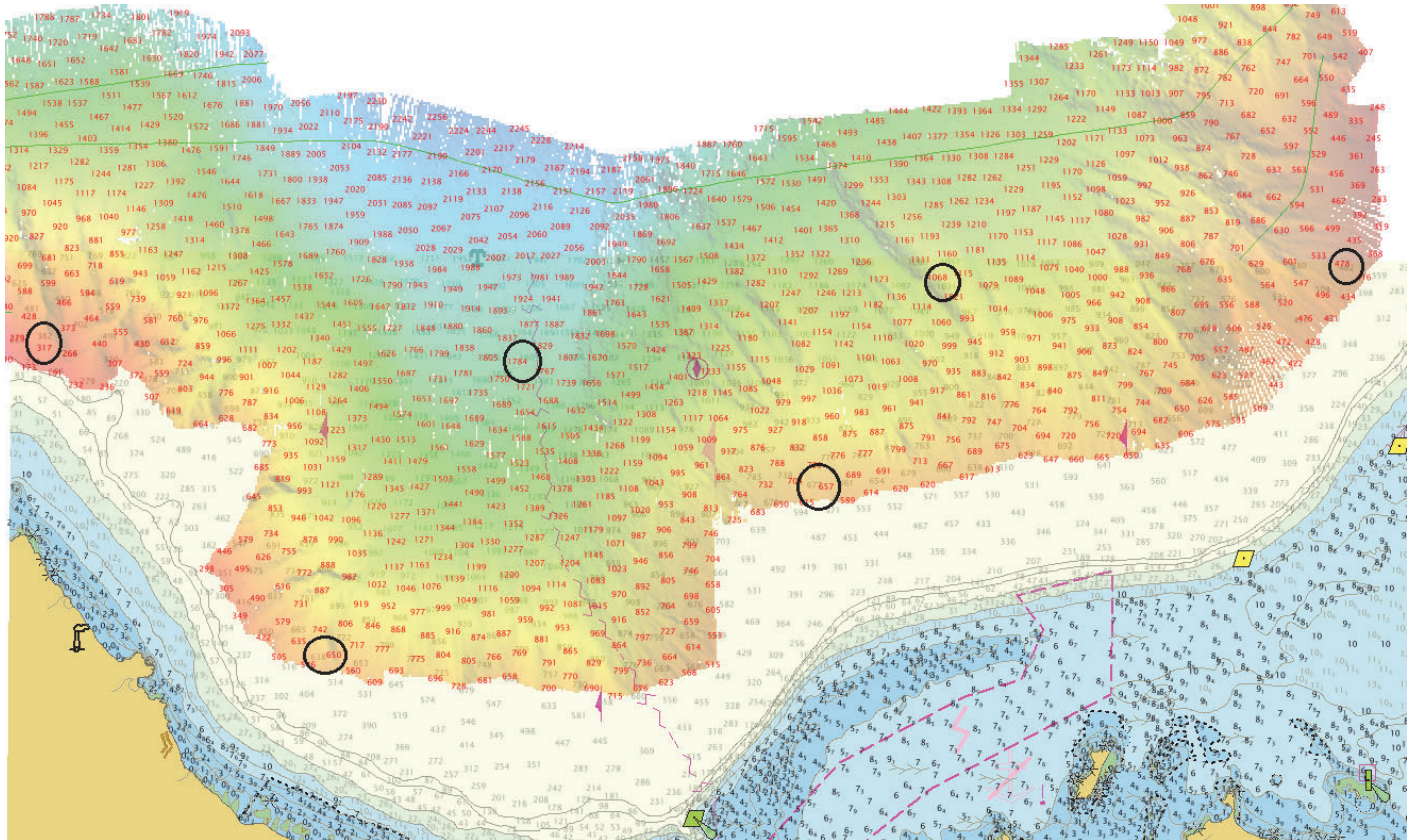


Figure 16: STX vs Chart US4PR12M

G. Vertical and Horizontal Control

The vertical datum for this project is Mean Lower Low Water. The vertical control method used was TCARI.

The following National Water Level Observation Network (NWLON) stations served as datum control for this survey:

| Station Name | Station ID |
|---------------------------------|------------|
| Christiansted, St. Croix | 9751364 |
| Lameshur Bay, St. John | 9751381 |
| Lime Tree Bay, St. Croix | 9751401 |
| Charlotte Amalie, St. Thomas | 9751639 |
| Culebra,PR | 9752235 |
| Esperanza, PR | 9752695 |

The vertical datum for this project is MLLW 83-01 NTDE. Tidal data was applied with a finalized TCARI grid (NF-19-01.tc) supplied by CO-OPS with verified tides values obtained from the assigned NWLON tide gauges.

The horizontal datum for this project is North American Datum of 1983 (NAD 83).

The projection used for this survey is Projected UTM Zone 20 North. There were no HorCon or VertCon operations performed for this survey.

H. Additional Results


There are no additional results for this survey.

I. Approval

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 Survey Summary 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, Standing and 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 Survey Summary Report.

| Approver Name | Title | Date | Signature |
|---------------|---------------|------------|--|
| Mike Stecher | Sheet Manager | 02/26/2020 |  Digitally signed by Michael Stecher DN: cn=Michael Stecher, o=Solmar Hydro Inc, ou, email=mike@solmarhydro.com, c=US Date: 2020.03.02 10:34:23 -08'00' |