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National Oceanic and Atmospheric Administration

National Ocean Services

DATA ACQUISITION & PROCESSING REPORT

Type of Survey: Hydrographic

Project Number: OPR-C331-KR-13

Time Frame: Sept 2013 - June 2014

Locality

State: New York

General Locality: Vicinity of Southern Long Island

2013

Chief of Party

Ransom C White III

Library & Archives

DATE: 11/20/2014

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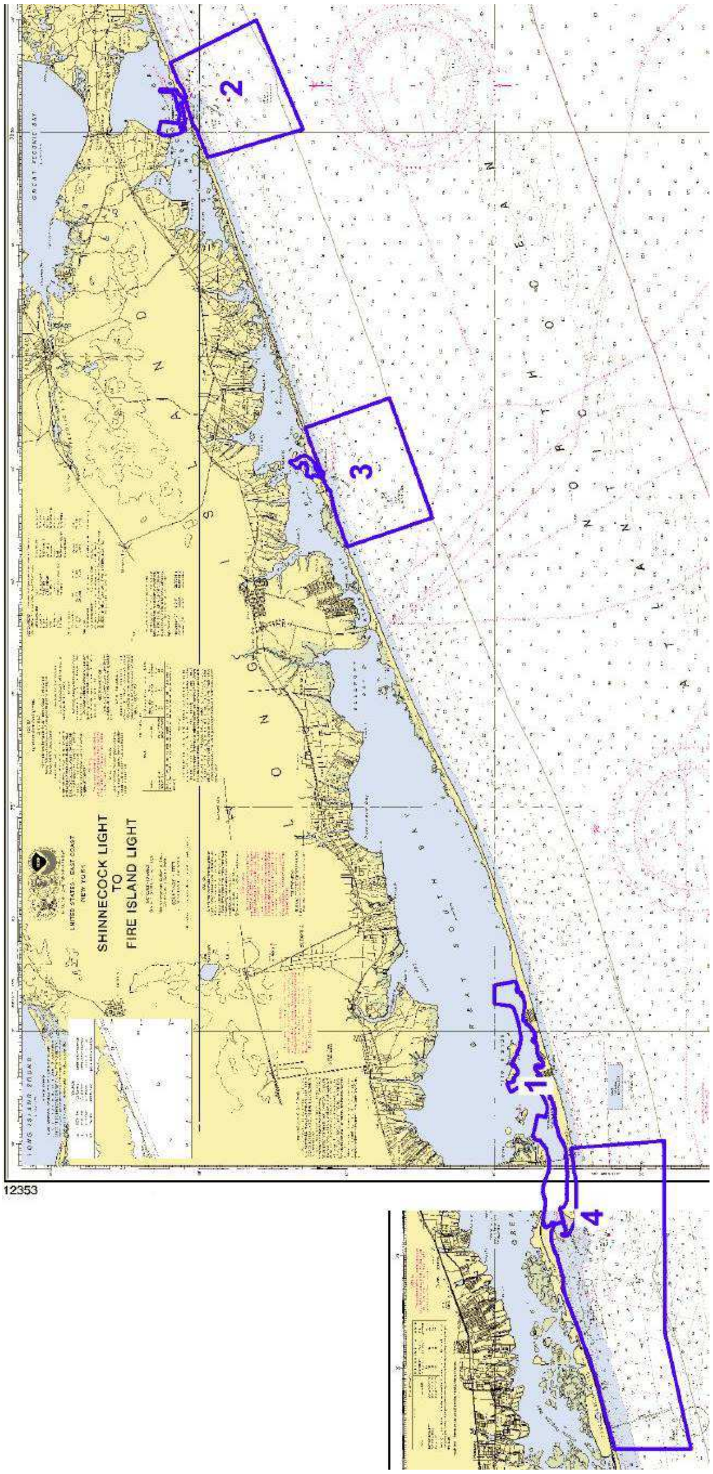

Figure 1: Survey Area OPR-C331-KR-13 (East up)

A. EQUIPMENT

A.1. Vessel – M/V Nooit Volmaakt

The vessel used throughout this survey was the M/V Nooit Volmaakt, a Hewes Craft 220 OceanPro with an aluminum hull and house, 24’3” in length and 8’5” beam. Detailed vessel information is available in *Appendix A.*

A.2. Sounding Equipment

The M/V Nooit Volmaakt was equipped with a moon pool mounted multi-beam system (MBES) and a bow mounted Edge Tech 4600 side scan sonar (SSS) system. During the course of surveying the four sheets, we used two different multibeam systems. We first used an R2 Sonic 2024MBES system from 9/30/2013 to 2/12/2014 followed by a Reson 7125 between 5/7/2014 and 6/23/2014. The systems were changed during our winter stand-down. Both the R2 Sonic 2024 and the Reson 7125 systems were roll-stabilized and operated at 400 kHz with a max swath angle of 140° (system max is 160°). Both of these MBES systems 400 kHz settings operate with 256 beams with a 0.5º across track beamwidth and an along-track beamwidth of 1º. The Reson 7125 also operated at 512 beams when coverage required so.

The 540 KHz Edgetech SSS system slant range was set to 50 meters in water depths between 2 and 20 meters and 75 meters in water depths greater than 20 meters. It should be noted that the 2 – 4m water depth contour was not consistent enough to create a separate line plan. In water depths where the SSS altitude was less than 8% of the range scale, the effective range was limited; however, even in 2m water depths a 50 meter range was still found to resolve features larger than 1m cubed at the outer edge of the swath. The Edge Tech system achieves a 15mm range resolution at 540 kHz with an along track beam width of 0.5° (*Appendix E & F*). These slant ranges were tested and decided upon using actual data examples and test lines run during vessel mobilization.

A.3. Positioning and Orientation Equipment

The M/V Nooit Volmaakt was equipped with a POS/MV IMU and two associated GPS antennae as well as a secondary satellite based augmentation system (SBAS) DGPS antenna. While using DGPS corrections the POS/MV had a heading accuracy of 0.02º. Heave, surge and sway measurements were accurate to 5 cm or 5% of amplitude. The dynamic roll and pitch accuracy was 0.02º with a resolution of 0.001º (*Appendix H)*. Position was determined in real time using the DGPS receiver associated with the POS/MV. Coast Guard corrections were received by a Hemisphere MBX-4 DGPS beacon receiver. More information on the MBX-4 beacon receiver can be found in *Appendix G*.

Real-time QC displays in QINSy and POSView were monitored throughout the survey to ensure that the positional accuracies specified in the NOS Hydrographic Surveys Specifications and Deliverables, April 2012 (HSSD 2012) were achieved. Position comparisons between the Coast Guard DGPS corrected position and the SBAS DPGS position were performed regularly and showed no significant offset. More information can be found in the associated descriptive report (DR) for each sheet in Section B.2 Quality Control.

A.4. Software

A.4.a Acquisition Software

Two computers were online aboard the M/V Nooit Volmaakt, one for acquisition using EdgeTech-Discover and Reson Sea Bat/R2Sonic-Sonic Control, the other as a navigation computer using QINSy and POSView. The multibeam sounding data and multibeam navigation data were collected and stored using QINSy. The side scan sonar and side scan navigation data were collected and stored using Edge Tech Discover as well as a redundant collection in QINSy. Multibeam and backscatter data were stored in the native QINSy .db format, and exported to .xtf for CARIS (Computer Aided Resource Information System) processing. The positions recorded in the .XTF files are reduced to the IMU. The .XTF files also included the raw MBES, IMU attitude records, vessel heading and the UTC time. All motion was applied during post processing in CARIS. Roll stabilization was utilized during acquisition to avoid a "scalloped" swath however the QINSy multibeam data-packets required the roll corrections to be applied during post processing as well. Navigation and PPS data were exported from the POS/MV to the Edge Tech top-side. Side scan data was stored in the native Discover .JSF format with file names and sequence numbers identical to the QINSy file names for each line.

Two log files were maintained daily aboard the M/V Nooit Volmaakt, the SVP/Sonar Acquisition log and the Navigation log. The SVP/Sonar Acquisition log, maintained by the sonar operator, contains the Edge Tech file name, sound velocity at the MBES and SSS head and times of SSS data acquisition. This log also contains daily SVS and SSS confidence checks, notes concerning sonar behavior, significant contact/feature identification, sound velocity probe deployment operations and weekly svp comparison casts. Please refer to Section B.2.7 Sound Speed Methods in the DR. The Navigation log maintained by the navigator was used to record information such as the line number/name, start and stop times for each line that was run, navigation information concerning time and location of the current vessel and status updates about the daily operations and weather. The Navigation log also included two daily waterline measurements and weekly bar check results.

A.4.b Processing Software

All multibeam soundings were processed using CARIS HIPS (Hydrographic Information Processing System) v8.1.0. Side scan sonar data was processed and reviewed in SonarWiz v5.06.0034. The Edge Tech SSS Discover native format (.JSF) files were converted into Sonar Wiz .CSF files for processing, viewing and contact picking. The .CSF files were then exported as position and bottom-tracked corrected .XTF files for conversion through CARIS SIPS. These .XTF files were converted into HDCS format and delivered with this task order as the SSS data digital deliverables along with the CARIS HIPS vessel file used to convert them into CARIS SIPS; EdgeTech_4600_Zeroed.HVF.

B. QUALITY CONTROL

B.1. Processing Routine

B.1.a. MBES

The processing routine involved several steps beginning with file conversion from QINSy acquisition files to CARIS processing files, followed by several CARIS processing functions. Roll was corrected in real time, however the datagrams stored in QINSy still required the roll data to be applied. The RESON V2 and the R2Sonic allow the user to use different protocols to output datagrams. The one we used allows the user to export “un-scalloped” roll corrected data with no actual roll values applied. This allows the user to account for any possible latency in post processing instead of having it “hardwired” into the raw datagram. Please refer to Figure 2: MBES Processing Workflow, located at the end of this section.

In order for the QINSy XTF files to be used by CARIS, they were converted to HDCS format using the CARIS conversion wizard. As needed for the conversion, vessel offsets were accounted for in the CARIS HVF, along with the patch test calibration values, TPU values, delta draft and waterline measurements. Also prior to conversion, lines were separated by type (e.g. main-scheme/crosslines and patch test lines) and stored in separate projects for final digital delivery. Main-scheme and crosslines were placed in a project named by the correlating sheet registry number. Patch test lines, squat and settlement lines and bar checks were all stored under the project “Test_Lines” and were not separated by sheet registry number.

Once converted, the standard CARIS procedures were followed. The preliminary tide data were loaded into each line as well as the delayed heave acquired from the POS/MV. The lines were then SVP corrected and merged by CARIS HIPS. The TPU was then computed for each sounding. The attitude, navigation and bathymetry data for each individual line were examined for noise to ensure the completeness and correctness of the data set. One issue did arise when checking the navigation editor in CARIS.

Once the navigation had been analyzed, CARIS still flagged the navigation as having not been analyzed. Dialogue was opened with CARIS’s support team and no resolution was met. As a result, if lines are queried in CARIS the navigation query would read “No”.

Data were then swath edited using CARIS swath editor because large “flier” soundings are easily and quickly removed using this tool. Once the largest sounding outliers were removed, the TPU values were used to create a working Combined Uncertainty Bathymetry Estimator (CUBE) surface.

After each individual line was examined and cleaned in CARIS HIPS, the HDCS files were then used to build final CUBE surfaces in CARIS. All CUBE surfaces were created using the *CubeParams_NOAA.xml* file and final resolution specs. The following depth thresholds were used on this project.

- Depth Threshold: 0 to 20 meter resolution = 0.5 m
- Depth Threshold: 18 to 40 meter resolution = 2 m

The sounding data were then 200% subset edited (edited twice, once along track and once across track) using 20-50 meter x 50-200 meter slices in the along and across-track direction. During subset editing rejected soundings were checked for validity and sound velocity/positional errors. Any issues were noted and either accounted for or corrected.

Deviations from these procedures, if any, are detailed in the appropriate Descriptive Report (DR) in section B. Data Acquisition and Processing. See *Appendix J.1* for a full MBES processing outline.

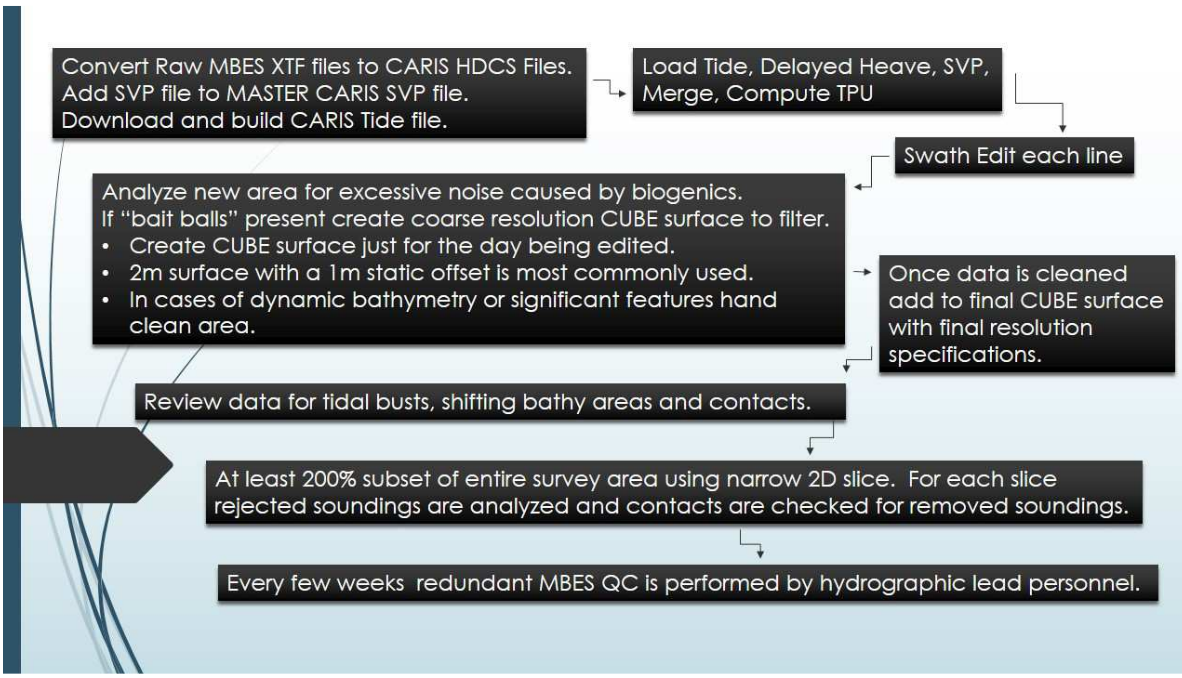

Figure 2: MBES Processing Workflow (begins with upper left box)

Vertical confidence checks were completed using cross-lines and weekly bar checks. Each bar check was conclusive and within the allowable Total Vertical Uncertainty (HSSD 5.1.3) showing maximum offsets of 5cm. All bar check results are reported in the Navigation/Acquisition logs and the CARIS processed bar check data are included in the digital deliverables. Bar check results can also be found in Separates I for each sheet’s individual DR in section B.2.1 Crosslines. The results were both observed and recorded onboard the vessel and double checked by querying the soundings in CARIS’s subset editor.

B.1.b. Side Scan Sonar (SSS)

Side Scan Sonar data were processed nightly after the day’s acquisition. Each line was bottom tracked using SonarWiz’s bottom tracking tool, then analyzed and corrected manually in areas with biogenic, vessel wake or suspended material water column interference. The data were then reviewed line by line to create, measure and log contacts. These contacts were then compared to multibeam data by plotting the contact positions in CARIS and reviewing the soundings in subset editor. Once the contact or feature had been found in the MB data, the positions were exported as a working S-57 file. The working S-57 file was once again reviewed and cross-referenced with both the SSS and MBES data for positional accuracy and validity. Once all contacts were verified to exist in both or just one of the data sets (MB and SSS) they were added to the master S-57 feature file. The working S-57 contains depths that were based on preliminary tides, however, a Final Feature File was generated and attributed using verified tides. Mosaics were created with no water column included and nadir set to "transparent". The mosaics were geo-referenced as is corroborated by the matching alignment of geological features in both SSS and MBES data. See *Appendix J.2* for the full SSS processing and targeting procedures. Please refer to Figure 3: SSS Processing & Targeting Workflow, located below.

Side Scan Sonar coverage was analyzed using SonarWiz's coverage report utility. This utility creates a geo referenced raster image of the SSS coverage, color coded by coverage amount: 100%, 200%, 300%, etc. The signal/noise ratio across the swath was monitored real time during acquisition by conducting daily confidence checks using seabed features and again during processing. Any areas with inadequate swath coverage were accounted for in each sheet's DR, in section A.4 Survey Coverage.

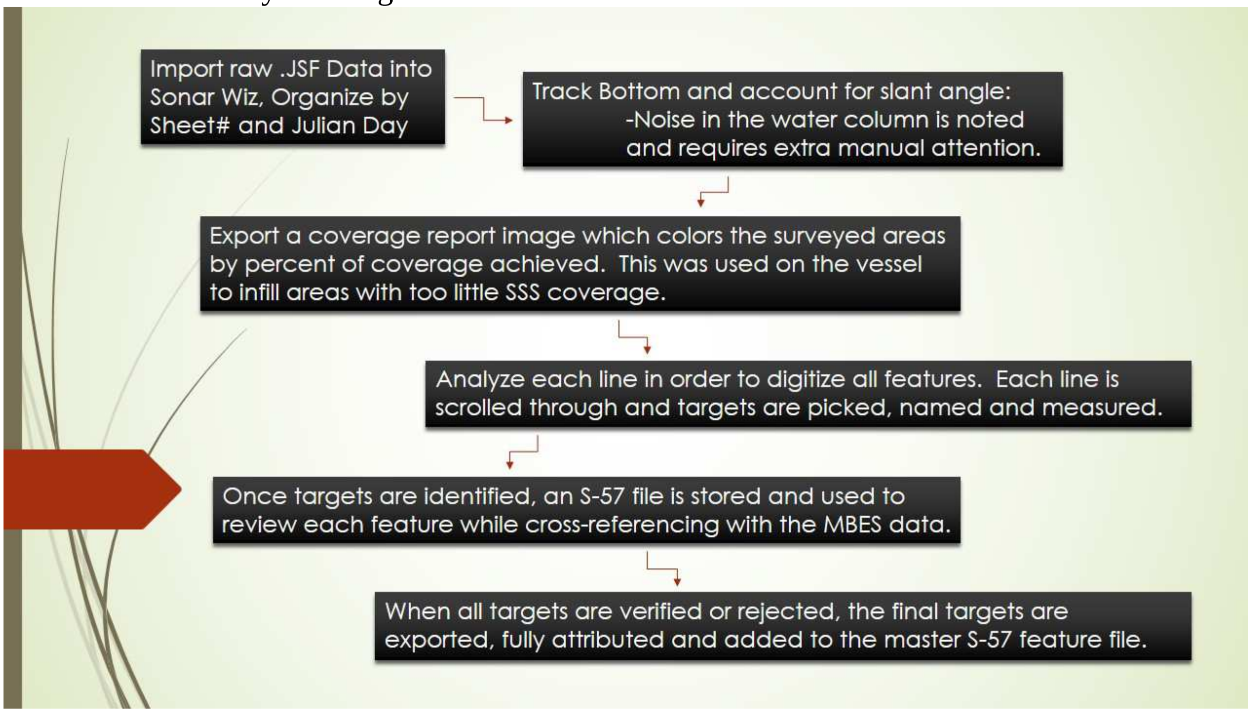

Figure 3: SSS Processing & Targeting Workflow (begins with upper left box)

B.2. Uncertainty Values

Uncertainty was generally lowest near the sonar nadir beams and increased toward the outer range of each swath. This was expected and primarily a result of sound velocity and the expected amount of ray bending.

Some survey areas provided for higher uncertainty values than others. Higher uncertainty was apparent in areas of steep or rapidly changing bottom topography, areas of variable sound velocity through the water column and areas where outer beams were included to contribute to the CUBE surface. In areas of rapid shoaling, it is evident that tidal surging was unaccounted for and was felt by the vessel, resulting in tidal busts up to 0.2m in areas. Also, shifting sand bedforms due to currents and dredging in areas caused data discrepancies between separate days of acquisition. Care was taken to acquire data in these areas within the smallest possible time period to avoid these types of alignment issues. Despite high uncertainty in these areas, data correlation was acceptable for nautical charting purposes based on HSSD 2012 Section 5.3.2 Coverage and Resolution.

Error estimates for all survey sensors were entered in the CARIS HVF for the M/V Nooit Volmaakt. These error estimates were used in CARIS to calculate the Total Propagated Uncertainty (TPU) at the 95% confidence interval for the horizontal and vertical components for each individual sounding. The values that were input in the CARIS HVF file for the survey sensors are the specified manufacturer accuracy values which were downloaded from the CARIS website **http://www.caris.com/tpu** in September 2013 and are shown in Table 1.

Table 1: Uncertainty values for computation in CARIS

Standard Deviations	System	TPU Values	System	TPU Values	System	TPU Values
Motion	Gyro (deg)	0.02	Heave%Amplitude	0.05	Heave (m)	0.05
	Roll (deg)	0.02	Pitch (deg)	0.02	PitchStablized (deg)	0
Position	Navigation	1				
Timing	Transducer (sec)	0.01	Navigation (sec)	0.01	Gyro (sec)	0.01
	Heave (sec)	0.01	Pitch (sec)	0.01	Roll (sec)	0.01
Tide	Measured (m)	Sheet DR	Zoning (m)	Sheet DR		
SVP	Measured (m/s)	1.5	Surface (m/s)	0.2		
Offsets (m)	X	0.03	Y	0.03	Z	0.03
MRUAlignment (deg)	Gyro	0.5	Pitch	0.5	Roll	0.5
Vessel	Speed (m/s)	0.14	Loading (m)	0.01	Draft (m)	0.02
	DeltaDraft (m)	0.01				

Preliminary tidal uncertainty values were obtained from the *Statement of Work OPR-C331-KR-13 Vicinity of Southern Long Island Instructions*, section *1.3.3. Tide Component Error Estimation*. Final tidal uncertainty values were supplied by JOA Surveys who were subcontracted by Williamson & Associates to install, manage, remove and prepare the tide gauges, zoning and data for final submission. Final tide notes can be found in appendix IV in each survey sheet's associated DR. Discussions on the individual tidal uncertainty values used for each survey sheet can be found in section B.2.2 of each survey sheet's associated DR. The sound speed values were determined using the average spatial and temporal patterns of daily SV casts along with the correlation of comparison casts and daily SVS confidence checks. The recommended values outlined in chapter 4 of the *Field Procedures Manual April 2013* were then considered before settling on the final sound speed TPU values.

B.3. Designated Soundings

While examining the data in subset mode, soundings were designated wherever the CUBE surface did not adequately depict shoal areas of the least depth soundings of a prominent feature. Designations were made on significant features of 30m depth or less. Soundings were designated when they met or exceeded the criteria for designation set forth in the HSSD 2012 Section 5.2.1.2 General Requirement, to ensure they were carried through to the finalized CUBE surfaces.

C. CORRECTIONS TO SOUNDINGS

The offsets for GPS and MBES on the vessel were applied in the CARIS HIPS Vessel File (.HVF) during processing. The HVF also includes the patch test calibration values, total propagated uncertainty (TPU) values, dynamic & static draft and waterline measurements. The physical offsets for the GPS and MBES on the vessel were as follows (See *Appendix A* for vessel survey diagrams):

Table 2: M/V Nooit Volmaakt's GPS and Transducer Offsets (Meters)

M/V Nooit Volmaakt: 9/30/2013 – 2/12/2014	x ("+" stdb)	y ("+" bow)	z ("+" down)
POS IMU	0	0	0
Primary GPS	-0.765	0.991	-1.875
SSS	0	5.538	0.799
MBES	0	0.028	1.053

M/V Nooit Volmaakt: 5/7/2014 – 6/23/2014	x ("+" stdb)	y ("+" bow)	z ("+" down)
POS IMU	0	0	0
Primary GPS	-0.765	1.024	-1.875
SSS	0	5.571	0.799
MBES	0	0.15	0.791

C.1. Sound Velocity Profiles

Sound velocity casts were taken approximately every 2-4 hours, or when the sound velocity at the MBES head shifted by more than 2-4 m/s. Two calibrated Seabird CTDs were kept aboard the Nooit Volmaakt. The CTD used for daily operations was a SBE 19+, while a SBE 19 was used for comparisons and as a secondary probe should the SBE19+ fail. For each cast, the probes were held at the surface for 1-2 minutes to allow time for the unit to turn on and reach temperature and pressure equilibrium. The probes were then lowered and raised at an approximate rate of 1 m/s. The SBE 19+ and the SBE 19 were both set to sample at 1Hz. Only the downcast was used for post processing. The Sea Bird probes were rinsed out with freshwater to minimize salt-corrosion and in some cases to rinse out sediment. Comparison casts were completed every week between each probe and confidence checks were completed between the casting probe and the surface sensor daily in compliance with the HSSD 2012. Results for the comparison casts can be found in *Separate I – Sounding System Comparison Check* in the Descriptive Report for each individual sheet.

C.2. Squat and Settlement

The squat and settlement test for the M/V Nooit Volmaakt was conducted on 9/28/2013 (JD270) just south of Robert Moses Inlet found on sheet H12600. The purpose of conducting this test offshore was to achieve depths equal to or greater than 7 times vessel draft. The results showed improved alignment between lines after applying the dynamic draft values.

The squat and settlement test was performed by first establishing a 1000 meter line up a shallow slope. Three reference areas were then logged at 250m, 500m and 750m along track with the engines out of gear coasting at around 1 knot. These reference areas were run again using the same methodology after the following full line acquisition was completed. This isolated anomalies in tide or other vertical variables besides squat and settlement.

The full line was then run 5 times while heading East at incrementing vessel speeds (3, 4, 5, 6, and 7 knots, which was the maximum survey speed). This data was then compared at each reference point by sampling soundings in the subset editor in CARIS. Median depth and average speed were computed for each line at each reference point. The difference in median depth was computed and correlated with the appropriate average speeds to plot overall Squat and Settlement (*Appendix B*)

All measurements were corrected for tide, pitch and roll, and then reduced to the vessel's common reference point (CRP) in the CARIS vessel configuration file, HVF. Procedures were taken from Settlement and Squat Procedures Using the Multibeam Echo Sounder Method (*Appendix J.4*). The squat and settlement results can be viewed in Figure 4 and Table 3.

The results of the squat and settlement test for the Nooit Volmaakt using the R2Sonic 2024 are shown below which matches well with Squat and Settlement tests performed previously with this vessel.

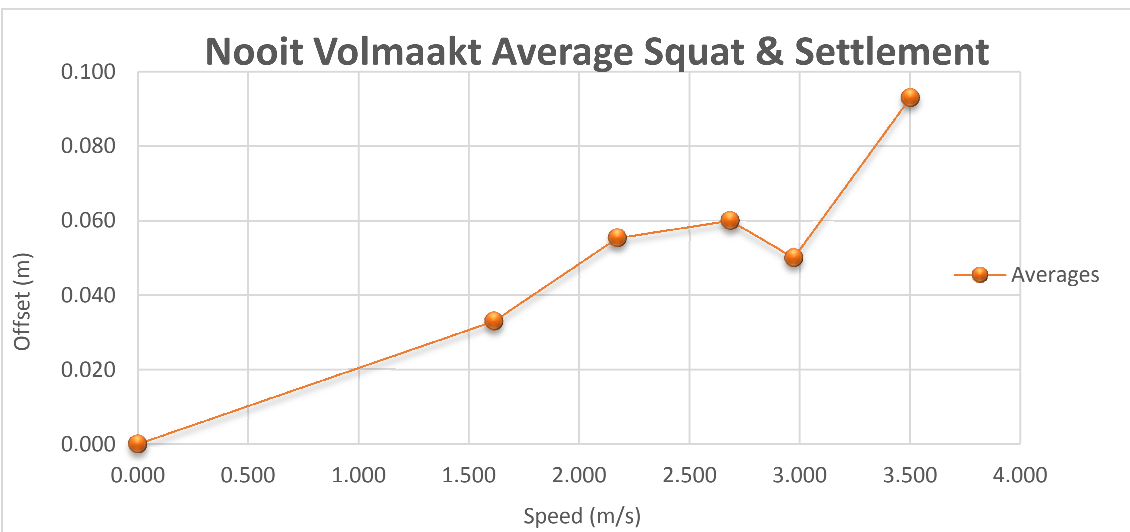

Figure 4 - M/V Nooit Volmaakt Settlement Curve

Table 3

M/V Nooit Volmaakt CALCULATED SETTLEMENT	
Offset (m)	Speed (m/s)
0.000	0.000
0.033	1.614
0.055	2.174
0.060	2.685
0.050	2.973
0.093	3.502

C.3. Static Draft

Static draft was measured immediately prior to and following daily survey operations. Measurements were acquired from the waterline to the deck through a moon pool centered on the vessel and then referenced to the IMU (also the common reference point). Measurements were logged in the vessel Navigation Log by the Navigator. Two measurements were taken and averaged for each log entry. Over the span of the entire survey the average draft for the M/V Nooit Volmaakt was 0.14m with a standard deviation of 0.01m.

C.4. Tides

All sounding data were initially adjusted to mean lower-low water (MLLW) using predicted tidal data from the Sandy Hook and Newport tide stations (station IDs: 8351680 and 8452660, respectively). Predicted tides were used for preliminary processing only. Verified tide values were obtained from JOA Surveys after tide gauge removal for final processing and statistics. Subordinate tide gauges were used for all assigned sheets except for sheet H12603. Verified tide values for sheet H12603 were obtained from CO-OPs for stations 8351680 and 8452660.

Information on the installed tide gauges can be found in the associated Horizontal and Vertical Control Report. More information can be found for each sheet's tide gauges in the associated Descriptive Reports Appendix IV.

Tidal zoning was deemed acceptable by examining cross and main scheme line agreement on either side and across the tidal zone boundaries. Daily QC and compilation of tidal busts were logged and used to fine tune the final tidal zoning. The tidal busts observed were concentrated in and around sand bars near inlets and inshore areas which received restricted tidal flow. These seabed features, when mixed with currents, resulted in tidal surge that was challenging to account for using remote tide station data. These busts were clearly surge related as the surge could often be felt on the vessel, especially near the inlets. Final tide zoning was supplied by JOA surveys and was reviewed before the data submittal using the uncertainty and standard deviation values and cross-line analysis. No tidal bust resulted in an offset large enough to throw the data out of the 95% confidence interval as was seen in the surface QC report and cross-line analysis.

C.5. Vessel Attitude

The M/V Nooit Volmaakt heading and dynamic motion were measured by the POS/MV. The system calculated heading and motion using three fiber optic gyroscopes in conjunction with three accelerometers. The POS/MV inertial motion unit (IMU) was located centrally in the vessel directly above the MBES transducer and at the vessels center of gravity (COG). The operational accuracy specifications for this system can be found in *Appendix H.*

The average sea state offshore during the high majority of survey days was a 1m swell. Depending on the direction of the swell some attitude artifacting resulted, mostly in deeper areas of the survey. These lines were not rejected because no latency was found to exist and QC showed the lines to be within spec using cross line analysis. The attitude artifacts were concluded to be the result of a small survey vessel in large enough seas to challenge the accuracy of the IMU.

C.6. Calibrations

The R2 Sonic mounted on the M/V Nooit Volmaakt was calibrated inshore of Fire Island Inlet on 9/19/2013. The Reson 7125 mounted during the month of May was calibrated in the same area on 5/7/2014 and 5/8/2014. After the initial MB Calibrations for the M/V Nooit Volmaakt, daily calibration checks were performed to determine the accuracy of the pitch and roll offsets due to the occasional grounding in near shoreline areas and mid channel bars.

The M/V Nooit Volmaakt required re-calibration each time the vessel was grounded on sand bars inshore. Recalibration occurred on 10/03, 10/06, 10/15, 10/18, 11/05 and 11/11/2013. Each resulted in differing angular offsets; those occurring 11/11/2013 were the most drastic, having 3°of pitch shift. These calibration results were deemed acceptable through data analysis after each re-calibration was performed. Patch test lines were acquired immediately after grounding and offset values were applied to the data during processing within 12 hours after acquisition.

All calibration lines and the HIPS vessel file (HVF) are included in the digital data deliverables. Please see *Appendix C* for the calibration report and procedures.

The Seabird CTDs used aboard the Nooit Volmaakt (SBE-19 and SBE-19+) were each calibrated at the Sea Bird headquarters between July and August 2013. The SBE-19+ was recalibrated on April 1st, 2014. The sound speed sensor used at the multibeam head between 9/30/2013 and 12/22/2013 was a Valeport mini SVS calibrated on 2/05/2013. A Reson SVP70 was used between 5/7/2014 and 6/23/2014 and was calibrated on 05/14/2013. Please see *Appendix I* for the calibration reports for all sound speed sensors.

D – APPROVAL SHEET

REGISTRY NUMBERS H12600, H12601, H12602 & H12603

This report and the accompanying digital data are respectfully submitted.

Field operations contributing to the accomplishment of projects H12600, H12601, H12602 & H12603 were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and smooth sheet have been closely reviewed and are considered complete and adequate as per the Statement of Work.

WILLIAMSON AND ASSOCIATES, INC.

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Ransom C White III
Chief of Party

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Curtis Clement
Project Manager
Williamson & Associates, Inc.

November 20, 2014