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

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey **Hydrographic**

Project Nos. **OPR-E349-BH, S-E906-BH & S-E603-BH**

Time Frame **January 2005 - December 2005**

LOCALITY

State/Territory **Maryland and Virginia**

General Locality **Chesapeake Bay**

2004

CHIEF OF PARTY
LT Charles J. Yoos III, NOAA

DATA ACQUISITION AND PROCESSING REPORT

NOAA S/V BAY HYDROGRAPHER

Chief of Party: Lieutenant Charles J Yoos, NOAA

Effective Dates

January 2005- December 2005

Applicable Surveys

S-E906-BH
F00505 – Sparrows Pt. to Locust Pt.
Baltimore Harbor, Maryland
Hydrographic Letter Instructions dated May 12, 2005

OPR-E349-BH
H11450 – Cedar Point to Little Cove Point
Chesapeake Bay, Maryland
Hydrographic Letter Instructions dated May, 2005

S-E603-BH
Homeland Security
Chesapeake Bay Route to Baltimore Harbor, Maryland & Virginia
Hydrographic Letter Instructions dated April 2, 2003

TABLE OF CONTENTS

A. EQUIPMENT

BAY HYDROGRAPHER was used for the acquisition and post-processing of all side scan-sonar (SSS) data, vertical-beam echo sounder (VBES) data, shallow-water multibeam (SWMB) data, sound speed profiles (SVP) and detached positions (DP's) unless otherwise noted in the Descriptive Report. BAY HYDROGRAPHER was used as the dive platform for all diver investigations conducted during these projects. No unusual vessel configurations or problems were encountered on these projects. Vessel configuration and offset measurements are included in Appendix III of this report.

Three different types of sonar systems (VBES, SWMB, and SSS) were utilized for these projects unless otherwise noted in the Descriptive Report. The methods and systems used to meet full-coverage requirements for the projects were determined by the Hydrographer and are in accordance with guidance provided in the Hydrographic Survey Letter Instructions and the Field Procedures Manual. Other considerations included system performance limitations, complexity of bathymetry, water depth, and ability of the vessel to safely navigate a particular area. Bathymetric data was acquired using either VBES or SWMB systems. Side scan sonar was utilized for imagery and object detection. These sonar systems are described individually in the following sections of this report.

SOUNDING EQUIPMENT

Vertical-Beam Echo Sounder (VBES)

BAY HYDROGRAPHER is equipped with an Odom Echotrac MKIII Precision Survey Echo Sounder. The Odom Echotrac is a dual frequency digital recording vertical-beam echo sounder with the capability to record water column data either via analog paper trace or into digital files. BAY HYDROGRAPHER's current configuration is to record water column data to digital .bin files that can be viewed by a utility in the Pydro Post Acquisition Tools. Transducer frequencies utilized are 24 kHz and 100 kHz. Unless edited by the hydrographer, selected soundings were acquired in meters using high frequency. Vertical-beam echo sounder data were acquired in conjunction with SSS. In areas where 200% SSS revealed no point features requiring further investigation, VBES was determined adequate to define the natural depth contours of the area.

Shallow-Water Multibeam (SWMB)

BAY HYDROGRAPHER is equipped with Reson Seabat 8125 shallow water multibeam sonar. The system is installed on a retractable arm that deploys over the starboard side of the vessel. The Seabat 8125 is a 455 kHz system that measures relative water depths across a 120^o swath. The sonar utilizes 240 individual beams, each with a footprint of 1.0^o x 0.5^o. The sensor head is mounted vertically (0^0 mount) at a depth of 5.3ft below the water line. The SWBM system was used to develop significant contacts identified with SSS and to provide additional bathymetric data in critical areas such as along commercial pier faces and shipping terminals.

Multibeam operations were limited to speed-over-ground of 6.0 knots to ensure the required along-track coverage for object detection as stated in the NOS Specifications and Deliverables.

Line spacing for item investigations was set at two times the water depth, while main scheme SWMB sounding lines were generally run at three times the water depth. The Reson Seabat 8125 system also provides a low-resolution digital SSS record of the multibeam swath. This SSS imagery was used during processing of the multibeam depth data to aid in determining whether anomalous soundings are true features or noise.

Diver's Least-Depth Gauge (DLDG)

BAY HYDROGRAPHER maintains a MOD III Diver's Least-Depth Gauge (DLDG) in order to obtain least depths over significant contacts. Due to the nature of projects in 2005, the DLDG was not utilized for hydrographic purposes.

Lead Line

A lead line comparison to the Odom Echotrac VBES and RESON 8125 was performed August 16, 2005 (DN 228) at Calvert Marina, Solomons, MD. BAY HYDROGRAPHER does not maintain traditional lead lines. In lieu of this equipment, a lead was attached to a metal measuring tape and measurements were corrected to account for the weight assembly. The vessel was port side to the bulkhead at the time of the comparison. Due to typical shoaling along bulkheads and the fact the VBES transducer is located on the vessel's starboard side, lead line readings were taken on the starboard side only. The water was calm, enabling the leadsman to make multiple rapid readings and providing a steady fathometer reading. Copies of the lead line calibration reports are included in Appendix IV of this report. Lead lines were not used to acquire depths over rocks and other features over the course of this survey.

IMAGING EQUIPMENT

Side Scan Sonar (SSS)

BAY HYDROGRAPHER is equipped with a Klein System 5500 (S/N 101) High-Speed, High Resolution Side Scan Sonar (HSHRSSS) System. This integrated system includes the Model 5250 HSHRSSS towfish and the T5100 Transceiver Processing Unit (TPU). The Klein 5250 operates at a frequency of 455 kHz and has a 40^0 vertical beam angle. The towfish contains transducers, sonar processing and control electronics, attitude and heading sensors, the down-link de-multiplexer (for control signals), and the uplink multiplexer (for sonar and auxiliary sensor data). The T5100 TPU contains electronics to de-multiplex the sonar signal from the towfish and multiplex the control signals transmitted to the towfish via a coaxial tow cable. The T5100 also contains a network card for transmission of the sonar data to the **ISIS** acquisition computer.

The Klein System 5500 is unique in that each transducer simultaneously forms five dynamically focused beams per side (channel), allowing increased resolution along track (20-75 cm) and across track (7.5 cm). The Klein System 5500 multibeam transducer technology also enables higher tow speeds of up to 10 knots.

The Klein towfish is deployed on a 100 meter armored cable via an Oceans Engineering electric winch. The tow cable is fed from the winch drum to a stern mounted hydraulic A-frame and through a snatch block with a metered sheave. At the winch, the tow cable connects to a deck cable through a slip ring assembly mounted coaxially on the winch. Cable out is controlled remotely at the acquisition station (or locally at the winch) and is monitored using a DYNAPAR cable counter. This sensor computes cable out by the number of revolutions of the block's sheave. The DYNAPAR cable counter provides a serial message to the **HYPACK** and **ISIS** acquisition computers. The cable-out value was checked prior to each SSS deployment and recalibrated if necessary. Throughout the 2005 field season, the DYNAPAR cable counter experienced operating difficulty. BAY HYDROGRAPHER crewmembers used a metric tape and electrical tape to mark 5 meter increments on the side scan cable. When the DYNAPAR did not function correctly, the correct cable out was read directly from the cable and entered manually in **HYPACK**. The data was then carried to **ISIS** via the so-called Delph string.

Line spacing for SSS operations is determined as a function of the most suitable range scale. Typically when acquiring 100% SSS coverage, 80 meter line spacing is used while operating at a 50 m SSS range scale, 120 meter line spacing is used with a 75 m range scale, and 160 m line spacing is used with a 100 meter range scale. For 200% coverage SSS coverage, the line spacing for each range scale is half the line spacing for 100% coverage. A sonar altitude of eight to twenty percent of the range scale was maintained during data acquisition whenever possible without endangering either vessel or equipment safety. SSS altitude for towed operations was maintained by a combination of adjusting both the amount of deployed tow cable and vessel speed.

Imagery was monitored in real time using the side scan sonar waterfall display window in the **ISIS** acquisition software. Vessel speed was adjusted during SSS acquisition to insure that along-track coverage for object detection, as required by the NOS Specifications and Deliverables, was met. Confidence checks were performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image and by verifying aids to navigation or other known features on the side scan record.

POSITIONING EQUIPMENT

Trimble DSM212L DGPS Receiver

BAY HYDROGRAPHER is equipped with a Trimble DSM212L to measure and calculate differential GPS (DGPS) position. The DSM212L is an integrated 12-channel GPS receiver and dual-channel differential beacon receiver. The beacon receiver can simultaneously monitor two U.S. Coast Guard (USCG) DGPS beacon stations. The Trimble DSM212L was configured in manual mode to allow reception of only one beacon station during data acquisition. Correctors for these projects were received from either the Annapolis, MD or Cape Henry, VA radio beacons, depending upon proximity and beacon status.

The DSM212L was configured using Trimble **TSIPTalker** version 2.0 software. The configuration was checked if problems were encountered throughout the project period. Parameters included number of visible satellites ($\geq$4 SV's), positional dilution of precision (PDOP < 8), maximum pseudo range corrector age ($\leq$30 sec), and satellite elevation mask ($\geq$8°).

The DSM212L was not used for survey positioning. The Trimble feeds a GGA data string to the KLEIN TPU as required for the calculation of number of beams to be used by the side scan sonar. However, this GGA string is only used for this purpose, never for survey positioning. The Trimble is also configured to provide DGPS beacon data to the POS/MV (see below) in the form of an RTCM message.

Applanix POS/MV Position and Orientation System

All survey positioning data were acquired using an Applanix POS/MV v 4 (S/N 2084) (Position and Orientation System for Marine Vessels). The POS/MV is a GPS-aided inertial positioning system that functions as an aided strap down inertial navigation system, providing a composite position solution derived from both an Inertial Measurement Unit (IMU) and dual-frequency GPS receivers. The IMU and GPS receivers are complementary sensors; data from one are used to filter and constrain errors from the other resulting in high position accuracy. The POS/MV v.4 uses an algorithm known as "tightly coupled data." Instead of processing the GPS data and inertial motion data for positioning and then filtering the two, the version 4 uses the raw ranges to satellites and raw accelerations from the IMU to calculate a "tighter" solution.

Position accuracy and quality were monitored in real time using the POS/MV Controller software to ensure positioning accuracy requirements in the NOS Hydrographic Surveys Specifications and Deliverables were met. The POS/MV Controller software provides clear visual indications whenever accuracy thresholds are exceeded. However, because of the "tightly coupled" solution, the POS/MV can deliver DGPS quality positioning for up to 4 or 5 minutes after losing a differential beacon signal. The unit gives no indication that it is not receiving differential correctors until the positioning drops below the DGPS accuracy level. Therefore it is not possible to monitor the NOS Hydrographic Specification that (3.2.1): "The age of pseudo-range correctors used in position computation will not exceed 20 seconds . . ." At all times, the POS/MV position user accuracy parameter was set to 2.0 meters, and data were recollected if the accuracy exceeded 2.0 meters.

HEADING AND ATTITUDE EQUIPMENT

Applanix POS/MV Position and Orientation System

POS/MV Heading Computation

The POS Computer System (PCS) blends data from both the IMU and the two GPS receivers to compute highly accurate vessel heading. The IMU determines accurate heading during aggressive maneuvers and is not subject to short-period noise. However, IMU accuracy characteristically degrades over time. The GPS receivers compute a vector between two fixed antennas and provide azimuth data using the GPS Azimuth Measurement Subsystem (GAMS). GPS heading data is accurate over time, but is affected by short-period noise. The POS/MV combines both heading measurement systems into a blended solution with accuracies greater than either system could achieve alone. Heading accuracy in the POS/MV Controller software was set to 0.080°.

POS/MV Heave, Pitch, and Roll Computation

The POS version 4 has two types of heave outputs: real-time heave and TrueHeave. Real-time heave is computed by performing a double integration on the IMU sensed vertical accelerations. A heave filter must be used for real-time heave to counteract minor noise that will eventually become significant due to the nature of mathematical integration. BAY HYDROGRAPHER's filter settings for 2005 were set to a heave bandwidth of 10 s and a dampening ratio of 0.707 (critically damped). TrueHeave is a software option that is based on a two-way filter that analyzes both past and present vertical motion data to provide a more accurate heave solution. Because TrueHeave uses both future and past heave data to provide the best solution, the TrueHeave solution is only available three minutes after the data have been collected. The TrueHeave data are acquired in a separate raw file and applied in post processing. Due to the size of these files, TrueHeave is only collected during SWMB operations.

Both roll and pitch measurements are computed by the IMU after sensor alignment and leveling. The IMU mathematically simulates a gimbaled gyro platform and applies the sensed angular accelerations to this model to determine roll and pitch. Attitude accuracy parameters were set to 0.050° in the POS/MV Controller software.

SOFTWARE

All VBES data were acquired using Coastal Oceanographic's **HYPACK MAX** software, and processed with the **CARIS HIPS** Single Beam Editor. Detached positions (DPs) were also acquired with **HYPACK MAX** in the format of target ("*.tgt") file and converted in **PYDRO** using the "Insert **HYPACK** DP" tool. **HYPACK MAX** was also used for vessel navigation and line tracking during all data acquisition.

Shallow-water multibeam and side scan data, along with position and attitude data, were acquired using **TRITON-ELICS' ISIS** software and logged in the Extended Triton Format (*.XTF). SWMB and SSS data were processed using **CARIS HIPS** and **SIPS** software.

All Detached Positions, SWMB and VBES soundings, and side scan and SWMB features were analyzed during post-processing using **PYDRO**. **PYDRO** is an extension package created by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP) using the Python 20 programming language to interface with the **CARIS HDCS** data directly.

Soundings and features were exported from **PYDRO** by saving the Preliminary Smooth Sheet (PSS) and drawing into **MAPINFO** using the **HYDRO_MI** "Draw PSS" function. **MAPINFO** was used for final data analysis and for creating final plots. The **HYDRO_MI** application created by HSTP was used for drawing features, tracks, depths, and Preliminary Smooth Sheets.

Raw sound speed data were processed using **VELOCWIN** supplied by HSTP. **VELOCWIN** uses raw salinity, temperature, and pressure measurements to create a sound speed profile using Wilson's Equation for the speed of sound.

A complete list of software and versions is included in Appendix I.

B. DATA PROCESSING AND QUALITY CONTROL

SHALLOW WATER MULTIBEAM DATA

Shallow-water multibeam data were monitored in real-time using the 2-D and 3-D data display windows in **ISIS** and the on-screen display for the Reson Seabat 8125 sonar processor. Adjustable user parameters are range scale, power, gain, pulse width, swath width and bottom slope type. These parameters were adjusted as necessary to insure the best data quality. Additionally, vessel speed was adjusted as necessary, in accordance with the NOS Specifications and Deliverables and Standing Project Instructions, to ensure the required along-track coverage for object detection.

Following acquisition, shallow-water multibeam data were converted from raw .XTF files to **CARIS**' Hydrographic Data Cleaning System (HDCS) format using **CARIS'** convert utility. After conversion, the multibeam data were corrected with tide and sound speed corrections and then merged with vessel position and orientation. The resulting spatially referenced data were then analyzed using **CARIS** HIPS subset editor. "Flyers" and other data that did not represent a measurement of the sea floor were flagged as rejected.

After review in subset editor the data were used to create a BASE surface using the Total Propagated Error (TPE) method. Different attributes of this surface, such as depth, density, standard deviation, etc., were used to look for additional problems, such as data blowouts, tide busts, etc. The processing model has a feedback loop here: when problem are discovered in the surface, the data is further analyzed in subset editor, the surface is regenerated and analyzed for further problems.

VERTICAL BEAM ECHO SOUNDER DATA

VBES data was acquired using **HYPACK MAX** software. **CARIS HIPS** tools generic data parser and **HYPACK** converter were utilized for converting raw-data into readable digital format for **HIPS** Single Beam Editor. In addition, **HYPACK** created .bin files that digitally record the full water column data, in lieu of paper records; .bin files are viewed in PYDRO Post Acquisition Tools when necessary. All selected VBES soundings were combined with SWMB soundings, excessed using **PYDRO** and plotted in **MAPINFO** to compare the two types of bathymetric data with each other as well as with charted depths.

Often, VBES data were also acquired concurrently with BAY HYDROGRAPHER's SWMB data. The VBES data were compared to nadir beams of multibeam in real-time during data acquisition to confirm multibeam data quality. However, in some instances, especially in Baltimore Harbor, the high frequency VBES interfered with Multibeam data. In these cases, the VBES was secured in order to acquire the best possible multibeam data.

To produce the reduced, shoal-biased data set represented in the final field sheet, all non-rejected soundings that passed all other quality-assurance checks were imported into **PYDRO** using the "Insert **CARIS** Line Bathy" tool. Depths were inserted into **PYDRO** using a 15 meter bathymetry grid resolution and an over-plot removal character size of 1.5 millimeters at the scale of the survey.

Data processing flow diagrams are included in Appendix II of this report.

SIDE SCAN SONAR DATA

Side scan sonar data were acquired with the Klein 5500 Towfish using **ISIS**. Side scan sonar data were converted from .XTF and post-processed using **CARIS SIPS**.

Post-processing of side scan data consisted of first examining and editing fish height, heading (gyro), and vessel navigation records. Fish navigation was then recalculated using the **CARIS SIPS "**Recompute Towfish Navigation" sub-program. During "Recompute Towfish Navigation", tow point measurements (A-frame and cable out), fish height, and depth are used to calculate horizontal layback. Once fish navigation was re-calculated, side scan imagery data was slant-range corrected. The slant-range corrected side scan imagery was scanned, and check-scanned, for any significant contacts. Contacts in less than or equal to 20meters of water were determined significant if their computed target height (based on shadow lengths obtained using SIPS) were at least 1meter. In depths greater than 20 meters contacts with computed target heights rising above the bottom at least 10 percent of the depth were considered significant. Significant contacts were saved in a **CARIS** contact file, and contact snapshot (.tif) images were created to aid in analysis and contact classification in **PYDRO**.

All contacts were imported into **PYDRO** using the “Insert **CARIS** Line Features” tool. Contacts were arranged by day and line and could be selected in the data “Tree” window. Information concerning a specific contact was displayed in **PYDRO**’s “Editor Notebook Window” including contact position, AWOIS item positions, surrounding depths, contact cross references, and charting recommendations. Each contact was reviewed, and information flags were set accordingly. If there were multiple contacts for a single feature, then the one providing the best SSS image of the feature was chosen as “Primary”. Any items that were to be addressed in the Item Investigation section of the Descriptive Report were flagged as “Chart”. Items which had the “Chart” flag set could also be further designated for inclusion in the Danger To Navigation Report by choosing the “DTON” flag. “Snapshots” of contacts were displayed in **PYDRO**’s “Image Notebook Editor”. Contacts appearing significant were further investigated with SWMB. Final positioning and least depth determinations of significant items were accomplished using multibeam and/or diver investigation.

Side scan-sonar coverage was verified using **CARIS SIPS** generated side scan mosaics imported into **MAPINFO** for analysis. Any deficiencies in the side scan sonar data were filled by completing a holiday line plan to meet the 200% requirement. Confidence checks were performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image and by correlating sonar contacts to known features such as aids to navigation. These checks were performed in real time during data acquisition each day.

PRELIMINARY SMOOTH SHEET

Once all sounding data and features were reviewed and analyzed using **PYDRO**, the data was saved into a Preliminary Smooth Sheet (PSS). The PSS is a working file, that does not actually contain data, but contains links to the data with specific path information as well as ancillary data flag information which is not supported in the **HDCS** file structure. The PSS was then imported into **MAPINFO** via the **HYDRO_MI** “Draw PSS” function. Final field analysis of the PSS was performed in **MAPINFO**.

C. CORRECTIONS TO ECHO SOUNDINGS

SOUND SPEED CORRECTION

Sound speed profiles were acquired with a SeaBird Electronics SeaCat SBE19 Conductivity, Temperature, and Depth (CTD) profiler (S/N 1913768-2039). Raw conductivity, temperature, and pressure data were processed using the program **VELOCWIN** that generates sound speed profiles for **CARIS**. Sound speed correctors were applied to SWMB and VBES soundings in **CARIS HIPS** during post processing. CTD calibration reports and dates are included in Appendix IV of this report.

The speed of sound through water was determined by a minimum of one cast every four hours of SWMB acquisition, and one cast every week for VBES acquisition, in accordance with the Standing Project Instructions and NOS Specifications and Deliverables for Hydrographic Surveys. Additional casts were conducted when changing survey areas or if it was felt that conditions, such as a change in weather, tide, or current, would warrant additional sound speed profiles.

In order to correctly form its beams, the RESON 8125 requires a surface sound speed. BAY HYDROGRAPHER uses an ODOM Digibar to provide surface sound speed to the multibeam. Three Digibar units were used over the course of 2005, the calibrations for each can be found in Appendix 4 of this report.

VESSEL OFFSETS AND DYNAMIC DRAFT CORRECTORS

A separate HIPS Vessel File (HVF) was created for each type of survey required. Sometimes the HVFs are redundant, e.g. the HVF for 100% and 200% side scan coverage have the exact same offsets, but they are kept different to facilitate ease of processing. The following table lists each Vessel Configuration File.

VCF NAME	SURVEY SYSTEM
BH_S5501_KLEIN5000_SSS100	Side scan configuration for 100% Side Scan Lines
BH_S5501_KLEIN5000_SSS200	Side scan configuration for 200% Side Scan Lines
BH_S5501_RESON8125	Multibeam configuration file
BH_S5501_SB	Standard VBES configuration
BH_S5501_DP	Used for detached positions only, referenced to waterline

Vessel offsets were measured on September 14 and 15, 2004 by Kendall Facher of the National Geodetic Survey. A Leica TC2002 Total Precision Station was used to measure offsets to GPS antennae, sonar transducers, the POS IMU, and various vessel benchmarks. A report from this survey is included in Appendix 3. Vessel waterline was measured on March 10, 2005 by taking the top off the vessel's moon pool and using a steel ruler to directly measure to the waterline. A value of 3.4 cm below the reference point was found. All offsets are included in the HIPS Vessel file reports included in Appendix 3.

Settlement and squat correctors for BAY HYDROGRAPHER were determined on February 26, 1998 using on the fly GPS for relative measurements. An Ashtech M12 receiver was set up on a mark on the pier at NOAA's Atlantic Marine Center, Norfolk, VA and a second was set up on BAY HYDROGRAPHER. Both receivers logged data for two continuous hours as the vessel ran a series of reciprocal courses at varying speeds. The data was then processed to yield a relative vertical change versus time and speed table. These values were confirmed in May 2000, using rod level techniques. On May 19, 2005, Settlement and squat data were run using kinematic GPS techniques with the POS/MV. These data are pending processing at the Hydrographic Systems and Technologies Program (HSTP).

Sensor offsets and dynamic draft values are stored in the **CARIS** HVFs and were applied to VBES, SWMB and SSS data in **CARIS** during post-processing. The Reference Point (RP) used in all HVFs is the small divot in the moon pool in BAY HYDROGRAPHER's middle hold. Vessel offset diagrams are included in Appendix III of this report. The HIPS Vessel Files have been submitted with the digital processed data.

HEAVE, PITCH, ROLL AND HEADING, INCLUDING BIASES AND NAVIGATION TIMING ERRORS

BAY HYDROGRAPHER is configured for the so-called Precise Timing setup for SWMB operations. In this method of minimizing timing errors, a UTC serial time stamp is output from the POS/MV and received by the ISIS PC and the RESON processing unit. All data (navigation, heave, pitch, roll, and bathymetry) are time stamped according to this string at acquisition, as opposed to upon arrival at ISIS. Because these data are time stamped at acquisition and the time stamp is honored in post-processing, the timing errors between navigation, heave, pitch, and roll are minimized. For more detailed information on this setup, see the Field Procedures Manual.

Three patch tests were conducted throughout the year to address the removal and replacement of the RESON 8125 SWMB head on March 22, June 6, and July 7 of 2005. These patch tests are designed to find any roll, pitch, and yaw, and remaining time offset between the MB reference frame and the navigation reference frame. Results of the patch tests are included in the Hips Vessel Files (HVF) reported in Appendix 3. All HVFs are digitally submitted with project data.

As per the Specifications and Deliverables, pitch and roll are not applied to VBES soundings.

WATER LEVEL CORRECTION

Soundings were reduced to Mean Lower-Low Water (MLLW) using verified observed tide data (unless otherwise noted in the DR) from each tide station applicable for a specific survey sheet. All tide data was obtained from the Center for Operational Oceanographic Products and Services

(CO-OPS) web site http://co-ops.nos.noaa.gov. These data were used to create a CARIS HIPS Tide file (.tid). Final tide correctors applied to soundings have been adjusted for the tidal zoning scheme supplied with the Hydrographic Survey Letter Instructions. Refer to individual Descriptive Reports for further information regarding water levels specific to each survey.

BAY HYDROGRAPHER personnel installed no tide gauges in conjunction with the survey projects referenced in this report.

D. APPROVAL

As Chief of Party, I have ensured that standard field surveying and processing procedures were utilized in accordance with the Hydrographic Manual, Fourth Edition; Hydrographic Survey Guidelines; Field Procedures Manual, and the NOS Hydrographic Surveys Specifications and Deliverables (March 2003).

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

LT Charles Yoos