NOAA FORM 76-35A

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

# DATA ACQUISITION AND PROCESSING REPORT

*Project No.* **OPR-E346-BH**

## LOCALITY

*State/Territory* **Maryland**

*General Locality* **Upper Chesapeake Bay**

## 2001

CHIEF OF PARTY
**Lawrence T. Krepp, LT, NOAA**

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**NOAA SURVEY VESSEL BAY HYDROGRAPHER**
OPR-E346-BH
Chesapeake Bay, Maryland
Hydrographic Letter Instructions dated December 11, 2000
Chief of Party: Lieutenant Lawrence T. Krepp, NOAA

# A. EQUIPMENT

Data were acquired by the NOAA S/V BAY HYDROGRAPHER (vessel number 1107). BAY HYDROGRAPHER was used for the acquisition and post-processing of side scan-sonar data, vertical-beam echosounder (VBES) data, shallow-water multibeam data (SWMB), and sound velocity profiles. BAY HYDROGRAPHER was used to acquire detached positions (DP's), and to collect bottom samples. No unusual vessel configurations or problems were encountered on this project. Vessel descriptions and offset measurements are included in **Appendix III** of this report. Any unusual vessel configurations or problems will be addressed in survey-specific *Descriptive Reports* and *Homeland Security Reports*.

Six different categories of echo sounder systems were utilized for project OPR-E346-BH. The individual system(s) chosen for use in a given area were decided at the discretion of the Hydrographer using the guidance stated in the Hydrographic Letter Instructions and Field Procedures Manual, and depended upon the limitations of each system, the bottom topography, the water-depth, and the ability of the platform vessel to safely navigate the area. These systems are described in the following section.

The methods and systems used to meet full-coverage requirements for this project 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 vessels to safely navigate a particular area.

## SOUNDING EQUIPMENT

### Vertical-Beam Echo Sounder (VBES)

BAY HYDROGRAPHER is equipped with an Knudsen Engineering Limited 320m Marine Echosounder which replaced an Odom Hydrographic Systems, Inc. Echotrac DF3200 MKII Precision Survey Echo Sounder on May 15, 2001. The Knudsen Echosounder is a dual frequency digital recording vertical-beam echo sounder with an analog paper record. Standard frequencies are 24 kHz to 100 kHz. Transmit pulse width is variable either automatically (actual value dependent on frequency and depth) or manually by keypad entry. The Odom Echotrac is a dual-frequency digital-recording echosounder with an analog paper record. The high frequency transducer operates at a frequency of 100 kHz with a circular beam footprint of 7.5° at the –6 dB point. The low frequency operates at a frequency of 24 kHz with a rectangular beam of 27° (fore-aft direction) by 47° (athwartship direction) at the –6 dB point. The low frequency transducer is not currently operational on the BAY

HYDROGRPAHER, therefore high frequency data collected in meters was used for this survey. If SWMB data were acquired, VBES data were archived, but not processed.

**Shallow-Water Multibeam (SWMB**)

## General Operations

These systems are used to develop significant contacts and corresponding least depths as defined by side scan-sonar. SWMB data are 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 8101 sonar processor. Adjustable parameters used to control the Reson from the **Isis** software include range scale, power, gain, and pulse width. These parameters were adjusted as necessary to ensure best data quality. Additionally, vessel speed was adjusted as necessary, and in accordance with the NOS Specifications and Deliverables and Standing Project Instructions, to ensure the required along-track coverage for object detection.

Line spacing for item investigations was established by multiplying two times the water depth over an item investigation. Mainscheme SWMB sounding lines were generally run parallel to the contours of the chart. Coverage was determined in real-time using coverage tools in ISIS software as well as Digital Terrain Model (DTM) generation in HIPS.

## Reson Seabat 8125 Ultra High Resolution Multibeam Echosounder

BAY HYDROGRAPHER is equipped with a starboard side-mounted Reson Seabat 8125 sonar-head. The 8125 multibeam replaced the Reson Seabat 9001 on April 2, 2002. The Seabat 8125 is a 455 kHz Ultra High Resolution Multibeam Echosounder system. The system measures relative water depths that illuminate a $120^o$ across track by $1^o$ along track swath. The swath consists of 240 individual $0.5^o$ x $1.0^o$ beams at nadir and $1.0^o$ by $1.0^o$ beams at the outer edges. The Seabat 8125 measures a swath width of 3.5 times the water depth in depths ranging from 0 to 60 meters, with a bottom detection range resolution of 2.5cm. The sensor head was mounted vertically ($0^0$ mount) at a depth of approximate 5.5ft below the water line on the end of a aluminum, retractable pole mounted on the starboard fantail. A Digibar model WG2100 is mounted horizontally on the forward side of the 8125 sonar head. The Digibar 2100 measures sound velocity in water and provides a continuous real-time output. The Digibar samples the sound velocity by transmitting and receiving a signal across a fixed distance to a reflecting plate. The Digibar 2100 is required for use in the 8125 Processor to aid in projector beam steering computations.

## Reson Seabat 9001 Multibeam Echosounder

The Seabat 9001 is a 455 kHz multibeam system that measures relative water depths across a $90^o$ swath, with the profile width being twice the water depth below the sonar head, consisting of 60 individual $1.5^o$ x $1.5^o$ beams. The sensor head was mounted vertically ($0^0$ mount) at a depth of approximate 6ft below the water line on the end of a pole secured to the stern. The stern mounted sensor head required the

BAY HYDROGRAPHER to orient the sensor's projector aft, creating an azimuthally offset of $180^0$.

## SIDE SCAN SONAR EQUIPMENT

### General Operations

Line spacing for side scan sonar (SSS) operations is determined by the required range scale. Typically, to acquire two hundred percent coverage, 40 meter line spacing is used at the 50 m range scale, 60 meter line spacing is used at the 75 m range scale, and 80 m line spacing is used at the 100 meter range scale. SSS altitude of eight to twenty percent of the range scale was maintained during data acquisition. Nearly all SSS operations were conducted using the 100-meter range scale. For the purpose of the 2002 Home Land Security projects for the U.S. Navy's Naval Oceanographic Office (NAVO), 75 m range scale was used. SSS altitude for towed operations is adjusted by the amount of deployed tow cable, and to a lesser degree by 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 to ensure 100% along-track coverage for each SSS type used.

### Klein 5500 High Speed, High Resolution Side Scan Sonar (SSS)

BAY HYDROGRAPHER used the Klein System 5500 (S/N 101) as the primary data acquisition sonar on this project. This integrated system includes the Model 5250 High Speed, High Resolution (HSHRSSS) towfish and the T5100 Transceiver Processing Unit (TPU). The Klein 5250 towfish is configured with a $40^0$ beam depression at 455 kHz frequency. The HSHRSSS contains the 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 demultiplex the sonar signal from the HSHRSSS and multiplex the control signals transmitted to the HSHRSSS via the 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 tranducer technology also enables higher tow speeds of up to 15 knots. Two hundred percent side scan-sonar coverage was completed for this survey. Side scan-sonar coverage was checked using SIPS generated mosaics imported into MapInfo to ensure proper overlap between adjoining lines . 200 percent requirement was fulfilled with a holiday line file determined from coverage gaps of the swath and mosaic plots. Confidence checks were performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image, and by passing aids to navigation. Features were identified in post processing using **CARIS SIPS**.

### EG&G 272 Side Scan Sonar (SSS)

BAY HYDROGRAPHER also used the EG&G Model 272 Towfish, Model 260 Recorder Sonar and EdgeTech Analog Control Interface (ACI) Power Supply Module. This system incorporates a patented time varied gain (TVG) circuit, which

compensates for the known signal losses versus range. The ACI acts as an interface between the **ISIS** sonar processor and the 272-T tow fish, converting the analog imagery signal from the tow fish to a digital signal. The ACI also controls the tow fish pulse width, trigger and data sampling rate. A power converter is mounted external to the **ISIS** computer which takes the 12 vdc power of the host computer and converts it to 800 vdc to supply the power to the tow fish. User-operable controls for the ACI include SSS range scale and two types of receiver gain: master gain and fine gain. Master gain adjusts port and starboard channels simultaneously and ranges from G1 (3db) to G4 (12db). Fine gain allows the operator to change individual port and starboard gains in 1.5db increments. Adjusting the master gain settings will affect the recorded SSS imagery data. Side scan sonar operations using the EG&G 272 were limited to a speed-over-ground of 5 knots for 100 m.r.s; while all other vessel speeds were determined by ping rate vs. vessel speed to assure 3 pings on a 1X1X1 meter object. Confidence checks were performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image, and by passing aids to navigation.

The **ISIS** computer records digital side scan data along with other data such as cable out, position, depth, and heading data in the **ISIS** XTF file format. Additionally, **ISIS** forwards range scale data and sonar altitude data to the **HYPACK** acquisition computer via a serial connection.

*Side Scan Sonar Towed Operations*

BAY HYDROGRAPHER's SSS is deployed using a hydraulic winch spooled with armored cable. The tow cable is led from the winch through the stern A-frame over a snatch block with a metered sheave. The tow cable at the winch is connected 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 on an 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, and if necessary, adjusted, for every SSS deployment. DYNAPAR cable counter was periodically calibrated throughout the project.

## POSITIONING EQUIPMENT

BAY HYDROGRAPHER is equipped with a Trimble DSM212L to measure and calculate position. The DSM212L is an integrated 12-channel GPS receiver and dual-channel DGPS beacon receiver. The beacon receiver can simultaneously monitor two independent U.S. Coast Guard (USCG) DGPS beacons. Correctors for this project were received from Cape Henlopen, DE and Annapolis, MD radiobeacons for the entire survey. N0TE: There are three modes: Auto-Range, which locks onto the beacon nearest the vessel; Auto-Power, which locks onto the beacon with the greatest signal strength; and Manual, which allows the user to select the desired beacon. BAY HYDROGRAPHER used Manual mode in order to maintain control over the source of differential correctors. Additionally, the DSM212L can accept differential correctors (RTCM messages) from an external source such as a user-established DGPS reference station. The following parameters were monitored in real-time through Trimble **TSIPTalker** software in order to ensure position data quality: number of visible satellites (≥4 SV's), positional

dilution of precision (PDOP < 8), maximum pseudo range corrector age (≤30 sec), and satellite elevation mask (≥8°).

Position quality was monitored real time in the **HYPACK** data acquisition software. The primary positional quality monitored was HDOP. Where HDOP exceeded 4.0, the data were examined during post-processing, and if necessary, positions interpolated or rejected. The **HYPACK** nmea.dll configuration includes a 1000-ms update rate and a non-differential alarm in the acquisition window to alert the operator when the signal is lost.

BAY HYDROGRAPHER is additionally equipped with a Starlink DNAV-212 Integrated GPS and beacon receiver. The DNAV-212 outputs standard GPS data and can be used with any system or software designed to interface using standard GPS NMEA messages. Correctors for this project were received from Cape Henlopen, DE and Annapolis, MD. The DNAV-212 differential receiver data provided many quality indicators of beacon reception; the two most important being Signal to Noise Ratio for current beacon in dB (SNR) and amount of impulse noise which the receiver has removed in the last 10 seconds (Sferics). SNR shows how big the received signal is in respect to the normal background noise. BAY HYDROGRAPHER monitored the SNR level to maintain at or above 10dB. Sferics values indicate how much electrical activity is interfering with beacon reception. High numbers indicate more interference. BAY HYDROGRAPHER experienced no unusual SNR of Sferics, which affected the quality of data. Additionally, the DNAV-212 can accept differential correctors (RTCM messages) from an external source such as a user-established DGPS reference station. No unusual interference occurred during the course of this survey.

### Diver Least-Depth Gauge

A Diver Least-Depth Gauge (DLDG) attached to BAY HYDROGRAPHER is used to determine least depths over selected rocks and features. The DLDG S/N 68334 was last calibrated January 4, 2002. A copy of the calibration report is included in Appendix IV. The DLDG measures pressure, and is combined with a CTD profile using VelocWin software in order to determine depth. These depths were processed in Caris HIPS Single Beam Editor and compared to process depths in PYDRO along with the corresponding detached position (DP) position.

### Lead Line

BAY HYDROGRAPHER personnel calibrated lead lines in February 2000. No corrections to Echotrac MKII and Reson 9001 sonar systems resulted. 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.

## HEADING AND ATTITUDE EQUIPMENT

### Sperry SR 50 Gyrocompass

BAY HYDROGRAPHER is equipped with a Sperry SR 50 gyrocompass that serves as its primary heading sensor for survey operations and vessel navigation. This gyro has a heading accuracy of +/- 1.8°. Heading data are output as a serial

message from a synchronous repeater to the **HYPACK** and **ISIS** acquisition computers with a 1-Hz update rate.

**TSS DMS-05 Motion Sensor**

BAY HYDROGRAPHER (VN 1107) utilizes a TSS DMS-05 dynamic motion sensor to collect heave, roll and pitch data. Heave correctors were collected during data acquisition and applied to VBES data only in **CARIS HIPS**. Heave, roll, and pitch correctors were collected during data acquisition and applied to SWMB data in **CARIS HIPS**.

The DMS-05 measures linear accelerometers and angular rates then combines aiding sources such as heading input from GPS track or compass to compute attitude values from those measurements. Various attitudes termed accelerometers send out signals, which are converted to roll and pitch information. At the same time, array of angular rate sensor information is applied to the input of the integrator. Using a standard 3_ per second input rate applied for 10 seconds output from the integrator provides a 30_ angle of turn in each plane of rotation. Therefore, integrator output supplies the angles of roll, pitch and yaw through which the array was rotated. This takes care of short-term variations when turning from line to line during surveying. Additional small levels of offset which, when integrated, give rise to drift in attitude measurement. Linear accelerometers do not suffer from drift and can be used to differentiate the two independent measurements in estimating the magnitude of offset for each of the angular rate sensors. Inherent in the integrator is a negative feedback loop serving to remove the effect of rate sensor bias. Centripetal acceleration is determined by combining incoming GPS velocity aiding signals with rate-of-turn information supplied by the angular rate sensors. Heading information is used by the DMS-05 to provide yaw-axis reference for the array of linear accelerometers. Intrinsic bias values for each sensing component and the value of 0.25_/minute caused by the earth's rotation are calculated for. The Earth's rotation value changes due to vessel heading and vessel latitude. With all corrections applied, the output from the sensing array maintains the specified 0.05_r.m.s. accuracy required by NOS Hydrographic Survey Specifications & Deliverables.
Data are passed to the **HYPACK** acquisition computer as a serial message string with a
25-Hz update rate. The DMS-05 has the capability to measure attitude to 5% of the translation in question assuming an installation at the vessel's center of motion. This accuracy is degraded if the sensor is mounted further from the vessel's center of motion. Bay Hydrographer has it's DMS-05 unit mounted within two meters of the assumed center of motion (reference point, or UP), which keeps the attitude measurements within the desired 5% envelope. The following are the accuracy and resolution specifications for the DMS-05:

| Type of Motion | Accuracy | Resolution | Range |
|---|---|---|---|
| Heave | 5 cm or 5% | 1 cm | +/- 10 m |
| Roll | +/- 0.05° | 0.01° | +/- 30° |
| Pitch | +/- 0.05° | 0.01° | +/- 30° |

**SOFTWARE**

All VBES data were acquired using Coastal Oceanographic's **HYPACK MAX** version 005b in the "RAW" format, and processed with the **CARIS HIPS** Single Beam Editor and **MAPINFO** 5.0,6.0,6.5. Detached positions (DPs) were acquired with **HYPACK MAX** in the format of target ("*.tgt") and converted in **PYDRO** using the "Insert/Convert **HYPACK** DP" tool. **HYPACK MAX** was also used for vessel navigation and line tracking during acquisition of both SWMB and VBES data.

Shallow-water multibeam (SWMB) echo sounder data, along with position and attitude data from the TSS DMS-05, were acquired using **TRITON-ELICS' ISIS** software version 4.54 through version 5.84 and logged in the Extended Triton Format (XTF). SWMB data were processed using **CARIS** Hydrographic Information Processing System (**HIPS/SIPS)** version 5.1a and 5.2 which runs on **CARIS GIS** software version 4.3.3/4.4a The data processed in Caris and Pydro was stored in a SAG Electronics Intel III Raid 5 microprocessor and then was replaced with a Infortrend External Raid 5 that runs off a Caliber Intel 4 CPU.

As of August 22, 2002 Bay Hydrographer's data is processed and stored on two mirrored Network Appliance DS14 Disk storage drives that run on two NetApp F820c CPU's.

All Detached Positions, SWMB and VBES soundings, and side scan and SWMB features were analyzed during post-processing using **PYDRO** version 1.0 through 2.9.1. **PYDRO** is an extension package created by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP) using the Python 20/22 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 MAPINFO** application by HSTP was used for drawing features, tracks, depths, and Preliminary Smooth Sheets.

Raw sound velocity data were processed using **VELOCWIN** 6.01/7.01/7.03 supplied by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP). **VELOCWIN** 6.01/7.01/7.03 uses raw salinity, temperature, and pressure measurements to create a sound velocity profile.
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 9001 and 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 ensure 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 XTF to HDCS using the **CARIS** xtfToHDCS Conversion Wizard program, and initially reviewed with the HDCS program SwathEdit. All soundings were reviewed, ping-by-ping, and obvious depth fliers were identified and manually flagged as "rejected". Vessel positioning and attitude data from each system were similarly displayed and manually cleaned. Fliers or gaps in positioning and attitude data were rejected and interpolated for small periods in time and outright rejected for larger periods in time in which the characteristic of the curve was ambiguous. All soundings beyond a maximum angle of $60^{o}$ off-nadir were rejected in accordance with the Draft Standing Project Instructions to reduce the noise and specular refraction errors possible in these outer beams. Additionally, when it was felt that the quality of the data was reduced due to environmental conditions such as sea conditions or extreme variance in sound velocity, data were filtered to a lesser swath width to ensure data quality. Specific data quality factors are discussed in the Descriptive Report for each survey.

After review and cleaning in SwathEdit, depth, position and attitude data were merged, using the HDCS program HDCSLineMerge, with sound velocity, tide, vessel offset, and dynamic draft correctors to compute the corrected depth and position of each sounding. All soundings were then again reviewed, spatially referenced, in HDCS Subset Mode. Data were compared with adjacent lines and crosslines, for systematic errors such as tide or sound velocity errors. Questionable soundings were also compared with adjacent or overlapping data for confirmation or further rejection. Depth fliers and noisy data, which were not rejected in SwathEdit, were rejected in Subset Mode.

Sun-illuminated Digital Terrain Model images (DTMs) were created in order to demonstrate coverage and to further check for systematic errors such as tide, sound velocity, or attitude and/or timing errors. DTMs created for quality-assurance purposes were dependant upon depth. A 5-meter grid was used for the Reson Seabat 9001/8125 in depths from 0 to approximately 25 meters.

## VERTICAL-BEAM ECHOSOUNDER DATA

VBES raw-data was obtained with **HYPACK**. **CARIS HIPS** tools generic data parser and **HYPACK** converter were utilized for converting raw-data into readable digital format for HDCS Single Beam Editor. DTMs of SBE VBES soundings were created using **CARIS HIPS** maker to further inspect for fliers and to look for systematic errors such as tide or sound velocity errors. All selected SBE soundings were combined with SWMB soundings and excessed using **PYDRO** at a character size of 3.0 millimeters, and plotted in **MAPINFO** at a character size of approximately 2.0 millimeters.

To produce the final reduced data set represented by the final field sheet, all non-rejected soundings having passed all other quality-assurance checks were imported into **PYDRO** using the "Insert **CARIS** Line Bathy tool". Depths were inserted into **PYDRO** using a 2.5 mm grid size at the scale of the survey and an over-plot

removal (excessing) character size of 3 meters, ensuring that the largest spacing between selected soundings would not exceed 7 millimeters at the survey scale.

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

### Side Scan Sonar Data

Side scan sonar data was obtained with Klein 5250 Towfish using **ISIS** v4.54/5.29/5.84 and with EG&G Model 272 Towfish using **ISIS** v4.71/5.29. Side scan sonar data were converted from **XTF** (**ISIS** raw format) to **HDCS** using the **CARIS xtfToHDCS** program. Side scan data were post-processed using **CARIS SSMOS** and **SSEDIT** (sub-programs of **HIPS/SIPS**).

Post-processing **HDCS** side scan data includes examining and editing fish height, vessel heading (gyro), and vessel navigation records. Fish navigation is recalculated using the **CARIS SSEDIT** Recompute SSS Navigation sub-program. During Recompute SSS Navigation, tow point measurements (A-frame and cable out), fish height, and depth are used to calculate horizontal layback.

After fish navigation is re-calculated, side scan imagery data are slant-range corrected using **CARIS SSEDIT**. The slant-range corrected side scan imagery data are closely examined for any targets. Targets-of-interest are evaluated as potential contacts based on apparent shadow length and appearance; particularly targets which do not appear to be natural in origin. Contacts are selected and saved to a **CARIS** contact file for each line of **HDCS** data. Contact selection includes measuring apparent height, selecting contact position, and creating a contact snapshot (*.tif) image.

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. The available flags were "Resolved", "Rejected", "Primary Hit", "Significant", "Chart", and "DTON". "Resolved" was chosen after the contact had been reviewed by the Sheet OIC. If the contact was significant, then the "Significant" flag was chosen. If there were multiple contacts for a single feature, then the one providing the best SSS image of the feature was chosen as the "Primary Hit". 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 by multibeam. Final positioning and least depth determination of significant items was accomplished using multibeam and/or diver investigation.

Side scan sonar coverage was determined by using mosaics generated in **SIPS** and imported into **MAPINFO**. Any deficiencies in the side scan sonar data were found, and a holiday line file was created from the mosaics, and swath plots to complete the 200 percent 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 passing aids to navigation. These features were identified during processing in **CARIS SIPS**.

## 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. There are five files which make up a PSS; an .fsl file (Field Sheet Layer) for bathymetry, a .xml file (Extended Markup Layer) for features, a .charts file (contains a list of raster charts for display in the Chart Window), a .treestate file (contains configuration information about the Data Tree Window), and a .txt file (which contains the text entered into the Notes Window).

## C. CORRECTIONS TO ECHO SOUNDINGS

## SOUND VELOCITY

Sound velocity profiles were acquired with SeaBird Electronics SeaCat SBE19 Conductivity, Temperature, and Depth (CTD) profilers (S/N'S 1251, 287, 2039). Raw conductivity, temperature, and pressure data were processed using the program **VELOCWIN** version 6.01/7.01, which generates sound velocity profiles for **CARIS**. Sound velocity correctors were applied to SWMB soundings in **CARIS** and to VBES soundings in **CARIS** Single Beam Editor during post processing only. 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 Draft Standing Project Instructions and NOS Specifications and Deliverables for Hydrographic Surveys. Casts were conducted more frequently when changing survey areas, or when it was felt that conditions, such as a change in weather, tide, or current, would warrant additional sound velocity profiles.

## VESSEL OFFSETS AND DYNAMIC DRAFT CORRECTORS

The following table shows when the vessel offsets and dynamic draft correctors used for this survey were last determined:

| Vessel No. | Date of Static Draft and Transducer Offset Measurements | Method of Settlement and Squat Measurement | Date of Settlement and Squat Measurement | Location of Settlement and Squat Measurement |
|---|---|---|---|---|
| 1107 | February 1998<br>April 2002 | OTF* | March 2000 | Annapolis, MD |

*OTF: "On-the-fly" GPS techniques

Sensor offset and dynamic draft values were applied to VBES and to SWMB data in **CARIS** during post-processing. These values are stored in **CARIS** Vessel Configuration Files (VCFs). Vessel offset diagrams and dynamic draft tables are included in Appendix III of this report. The VCFs themselves are included with the digital **HDCS** data.

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

Heave, pitch, roll, and navigation latency biases for BAY HYDROGRPAHER were determined during Patch Tests conducted off Delaware Bay, DE, July 26, 2000. SWMB vessel offsets, dynamic draft correctors, and system bias values are contained in **CARIS** Vessel Configuration Files (VCFs are BH00/BH02 for SSS and SWMB operations and BH_SB for single beam operations) and were created using the program "**VCFEDIT**" in **CARIS**. These offsets and biases are applied to the sounding data during processing in **CARIS**. The VCFs and Patch Test data are included with the digital HDCS data.

## WATER LEVEL CORRECTORS

Soundings were reduced to Mean Lower-Low Water (MLLW) using unverified observed tide data for station Tolchester, MD (857-3364) obtained from the Center for Operational Oceanographic Products and Services (CO-OPS) web site http://co-ops.nos.noaa.gov/hydro.html, emailed transmissions through TIDEBOT, or through regular communications with CO-OPS Requirements and Development Division (RDD). These data were used in creating CARIS HIPS Tide tables. Final tide correctors applied to soundings have been fully adjusted for the tidal zoning scheme supplied with the Hydrographic Survey Letter Instructions. Refer to individual Descriptive Reports for further information regarding water level correctors' specific to each survey.

BAY HYDROGRAPHER personnel installed no tide gauges during the course of this survey in the vicinity of OPR-E346-BH-00.

## D. APPROVAL

As Chief of Party, I have ensured that standard field surveying and processing procedures were utilized during this project in accordance with the Hydrographic Manual, Fourth Edition; Hydrographic Survey Guidelines; Field Procedures Manual, and the NOS Hydrographic Surveys Specifications and Deliverables, as updated for 2000.

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

Submitted: _____

Brian M. Kidd
Physical Scientist, NOAA
BAY HYDROGRAPHER

Approved and Forwarded: _____

Lawrence T. Krepp
Lieutenant, NOAA
Officer in Charge