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Data Acquisition & Processing Report

Type of Survey Hydrographic

Project No. OPR-P132-FA-07

Time frame August - October 2007

LOCALITY

State Alaska

General Locality Northwestern Prince William Sound, AK

2007

CHIEF OF PARTY
CDR Andrew Beaver

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DATE

APPENDICES

INTRODUCTION

This hydrographic project was completed as specified by Hydrographic Survey Project Instructions OPR-P132-FA-07, signed August 3, 2007. This Data Acquisition and Processing Report includes project level information common to sheet A (H11741), sheet B (H11742), and sheet K (H11637).

All sheets have the general locality of Northeastern Prince William Sound and are located in the state of Alaska.

Survey specific details will be listed in Descriptive Reports as needed. Unless otherwise noted, the acquisition and processing procedures used and deliverables produced are in accordance with the NOAA *Hydrographic Survey Specifications and Deliverables Manual (HSSDM) April 2007*, and the *Field Procedures Manual (FPM), March 2007*. Hydrographic Surveys Technical Directives (HTD) 2004-1, and 2007-3 through 2007-9 were followed during the course of this project.

A EQUIPMENT

Detailed descriptions of the equipment and systems, including hardware and software, used for bathymetric data acquisition, horizontal and vertical control operations, shoreline acquisition, and processing are listed below.

1.0 Hardware

The hardware listed in this section was used during project OPR-P132-FA-07.

1.1 Hardware Systems Inventory

Detailed hardware information, including installation dates and serial numbers, is included in Appendix I of this report. Manufacturer's product specifications are included in Appendix II.

1.2 Echo Sounding Equipment

1.2.1 Reson 8111ER Multibeam Echosounder (MBES)

FAIRWEATHER is equipped with a RESON SeaBat 8111 MBES with the Extended Range (ER) and snippet options. The 8111ER is a 100 kHz multibeam system with swath coverage of 150°. The swath is made up of 101 discrete beams with an along-track and across-track beamwidth of 1.5°. The typical operational depth range of the 8111ER on the FAIRWEATHER is 20 to 600 meters. No calibration information was provided by the manufacturer for the system.

The 8111ER is hull-mounted within a reinforced projection that extends 27 inches below the keel. It is located 39.5" starboard of the centerline at approximately frame 29. It has a specified depth range of 3 to 1200 meters.

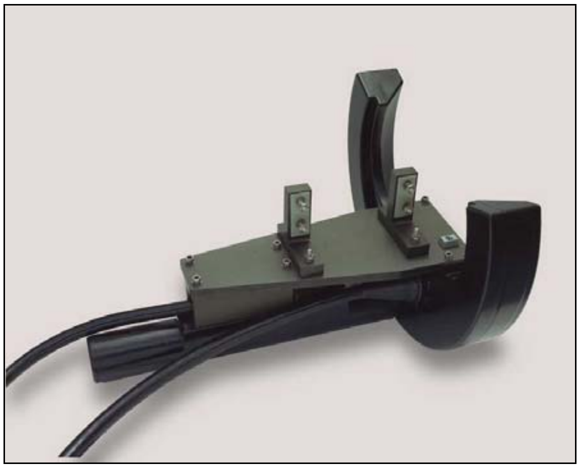

Figure 1: RESON SeaBat 8111ER MBES

Figure 2: RESON SeaBat 8111ER MBES on FAIRWEATHER

Figure 3: RESON SeaBat 8160

Figure 4: RESON SeaBat 8160 on FAIRWEATHER

1.2.2 RESON 8160 Multibeam Echosounder (MBES)

FAIRWEATHER is equipped with a RESON SeaBat 8160 MBES with the snippet option. The 8160 is a 50 kHz multibeam system with a swath coverage of greater than 4x water depth. Each swath is made up of 126 discrete beams with an along-track and across-track beamwidth of 1.5°. It has a specified depth range of 10 to 3000 meters. No calibration information was provided by the manufacture for the system.

The 8160 is hull-mounted within a reinforced projection that extends 13.6 inches below the keel. It is located 54 inches port of the centerline at approximately frame 29.

The RESON SeaBat 8160 MBES system was not used during this project.

1.2.3 RESON 8101ER Multibeam Echosounder (MBES)

Survey Launches 1010 and 1018 are each equipped with a RESON SeaBat 8101 MBES with the Extended Range and snippet option. The 8101ER is a 240 kHz multibeam system with a swath coverage of 150°. The swath is made up of 101 discrete beams with an along-track and across-track beamwidth of 1.5°. It has a specified depth range of up to 500 meters. The typical operational depth range of the 8101 on launches 1010 and 1018 in 2006 was 3 to 120 meters. Under optimal conditions with a hard bottom, high power and high gain, the depth range of the 8101 ER was observed to be as deep as 350 m producing a swath of ±45º from nadir. No calibration information was provided by the manufacturer for the system.

Each system is attached to a launch using a swing mount which is starboard of the keel and approximately centered fore and aft (see Figures 5 & 6).

Figure 5: Launch 1010 with 8101 extended

Figure 6: Launch 1010 with 8101 retracted

1.3 Manual Sounding Equipment – Lead Lines

Vessels 1010, 1018, 1706, and 2302 are each equipped with a lead line. Lead lines are mainly used for depth measurements near shore and for echosounder depth comparison.

Leadlines were created, measured and calibrated according to Section 1.5.3 of the FPM with the exception that the lines were calibrated to the meter instead of decimeter. Calibration was performed during March and April 2007. Calibration reports for the leadlines are included in Appendix V.

1.4 Positioning, Heading, and Attitude Equipment

1.4.1 TSS Positioning and Orientation System for Marine Vehicles (POS/MV)

FAIRWEATHER and her launches are each equipped with a TSS POS/MV 320 V4, configured with TrueHeave™ and Precise Timing. The POS/MV calculates position, heading, attitude, and vertical displacement (heave) of a vessel. It consists of a rack mounted version 2.12 POS Computer System (PCS), a strap down IMU-200 Inertial Measurement Unit (IMU), and two GPS antennas corresponding to GPS receivers in the PCS. The port side antenna is designated as the primary receiver, and the starboard side antenna is the secondary receiver. Differential correctors are supplied to the POS MV by a CSI wireless MBX-3S Automatic Differential GPS receiver. On May 6, 2007 (DN 126) FAIRWEATHER changed the POS MV firmware to version 3.41 and the controller software to version 3.4.0.0.

For all multibeam systems aboard FAIRWEATHER and her launches, timing between the sonar swath, position, heading and attitude information was synchronized by utilizing the TSS POS/MV 320 v.4's. A timing string was sent from the POS/MV to the RESON topside unit and to the ISIS computer recording the incoming data. Vessel wiring diagrams are included in Appendix III.

POS/MV controller software was used to monitor position accuracy and quality during data acquisition. This ensured that positioning accuracy requirements were met, as outlined in the *HSSDM*. The POS/MV controller software provides clear visual indications whenever accuracy thresholds are exceeded.

Due to a suspected hardware problem on the POS/MV PCS unit in launch 1018, it was swapped with the ship's POS/MV PCS on the evening of September 22, 2007. POS/MV PCS serial number 2411 was removed from the ship and installed on Launch 1018, while POS/MV PCS serial number 2560 was removed from Launch 1018 and installed on the ship. No further data acquisition was done by NOAA Ship FAIRWEATHER after the malfunctioning hardware was installed. The POS/MV PCS serial number 2560 was later confirmed to be malfunctioning and was repaired by Applanix.

1.4.2 POS/MV GAMS Calibration

GAMS (GPS Azimuth Measurement Sub-system) calibrations were performed on each of the three POS/MV units. The GAMS calibration procedure was conducted in accordance with instructions in chapter 4 of the *POSMV V4 Installation and Operation Guide,* 2005. Results are included in the individual vessel reports and spreadsheets, with calibration details located in Appendix III-5.

Figure 7: POS/MV antennas on 1018

Figure 8: POS/MV antennas on 1010

1.4.3 CCSI Wireless MBX-3S DGPS Receiver

FAIRWEATHER is equipped with commercial grade CSI Wireless MBX-3S DGPS Receivers that are used in conjunction with TSS POS/MV to provide vessel positioning during data acquisition. The DGPS receivers are configured in manual mode to allow reception of only one U.S. Coast Guard (USCG) differential GPS beacon station. Vessel wiring diagrams are in Appendix III.

Differential GPS (DGPS) was the sole method of positioning. Differential corrections from the U.S. Coast Guard beacons at Cape Hinchinbrook (292 kHz) and Potato Point (298 kHz) were used.

1.4.4 Trimble Backpack

FAIRWEATHER uses two GPS Pathfinder® Pro XRS receivers in conjunction with a field computer to acquire detached and generic positions during shoreline verification in the field. Data can also be collected with a handheld TSCe data collector. FAIRWEATHER's field computers consist of three Panasonic CF-18 Tuffbooks and one CF-29 Tuffbook. The receivers have integrated beacon/satellite differential antennas which allow access to digital real-time sub-meter accuracy solutions. Data quality assurance testing was conducted by FAIRWEATHER personnel in April 2007. The Trimble backpack GPS unit testing was combined with the Ashtech testing and the results are located in the Positioning Equipment Confidence Check file in Appendix V.

Figure 9: Trimble Backpack Unit

1.4.5 Impulse LR Hand-held Laser

The Impulse Laser Rangefinder and TruPulse 200 Laser Rangefinder are used in conjunction with the Trimble Backpack GPS unit to acquire distances and heights during shoreline verification. These data are entered directly into the TerraSync shoreline acquisition software and annotated on the detached position forms. The Impulse LR and TruPulse 200 Laser Rangefinder do not function properly in low light or in choppy seas when a feature is not distinguishable from surroundings.

Figure 10: IMPULSE LR laser

Figure 11: TruPulse 200 Laser Rangefinder

Data quality assurance testing was conducted on the Impulse LR on February 27, 2006 by FAIRWEATHER personnel. Comparison testing among the Laser Rangefinder, the TruPulse 200 Laser Rangefinder and the Trimble Backpack units was performed on March 3, 2006. Vertical and horizontal readings were taken with the laser level and compared to measurements taken with a fifteen meter steel tape and a graduated metric staff. Three marks were placed on the staff with SOLAS reflective tape in order to get a good fix. The laser level was set up on a bipod at 10, 20, 50 and 100 meter intervals from the staff. Three horizontal and three vertical readings were taken at each interval. The results of the testing are located in Appendix V.

The laser levels were tested less extensively in 2007 but their accuracy was verified by using them to obtain an offset to BM NO 37 at the USCG ISC Ketchikan facility in the horizontal positioning equipment check of the Trimble backpack units and the Ashtech Z-Xtreme receiver.

1.5 Sound Velocity Equipment

1.5.1 SBE 19*plus* SEACAT Profiler

FAIRWEATHER is equipped with three SBE 19*plus* SEACAT sound velocity profilers used to acquire conductivity, temperature, and depth (CTD) data in the water column to determine the speed of sound through water. Two of the SBE 19*plus* profilers have pressure sensors rated to 1000 meters. The third has a pressure sensor rated to 3,500 meters.

The SBE 19*plus* SEACAT sound velocity profilers were calibrated by the manufacturer and current calibration files were returned with the units. Calibration files for 2007 are located in Appendix V.

Periodic quality assurance checks include comparison casts between CTD instruments. Data quality assurance (DQA) checks include comparison casts between two instruments as per section 1.5.2.2 of the *FPM* for each survey. Results of the comparison casts are located in the *SV_Maintenance and Testing_2007.xls* file in Appendix VI. Any DQA checks subsequent to this DAPR will be included in Separate II of the survey's descriptive report.

To ensure that the CTDs continue to function properly a stringent maintenance schedule will be followed using guidelines from the manufacturer's recommendations. This will include a thorough rinsing of the instrument with distilled water after each cast. On a regular basis each CTD will be flushed with a Triton X-100 solution. On a regular basis the CTD was flushed with a 500-1000 ppm bleach solution followed by flushing with a Triton X-100 solution.

1.5.2 SBE 45 Micro Thermosalinograph (TSG)

FAIRWEATHER is equipped with one SBE 45 MicroTSG. The SBE 45 uses continuously pumped sea water to measure conductivity and temperature near the ship's hull mounted transducers. The intake is located 9 feet below the DWL (13 ft) between frames 11 and 12.

The conductivity and temperature information is converted to sound velocity and output to the RESON 8160's and 8111's processing units. The 8160 requires sound velocity information for beam forming and pitch stabilization while the 8111 only requires it for pitch stabilization. The 8160 cannot be used to acquire data without real time sound velocity information.

The unit was calibrated prior to the 2007 field season. The current calibration report is included in Appendix V.

The SBE 45 MicroTSG is normally used in conjunction with the RESON SeaBat 8160 MBES system. Both systems were not used during this project.

1.5.3 Moving Vessel Profiler 200

A Brooke Ocean Technology, Ltd. (BOT) Moving Vessel Profiler 200 (MVP200) is mounted in the aft starboard corner of the fantail (see Figure 12). The MVP200 system is a self contained sound velocity profiling system capable of measuring water column profiles to 200m depth from a vessel moving up to 12 knots. The system is configured with a Single Sensor Free Fall Fish (SSFFF) outfitted with an Applied Microsystems Ltd. Sound Velocity and Pressure Smart Sensor. Deeper profiles can be obtained by reducing the vessel speed. When the vessel is holding station, the system is capable of recording casts over 600m in depth.

The MVP system consists of a winch, cable, fish (the towed unit with the sound velocity sensor), support assembly, and controlling hardware and software. During ship acquisition, the fish is deployed using the on-deck controller and towed with enough cable out to keep the fish 3-5 m below the water surface. A "messenger" (a short cable-thickening sleeve) is set to allow the system to keep the appropriate amount of cable out and is reset as needed when the ship acquisition speed is altered.

During SVP acquisition, the controlling computer application, BOT MVP version 2.26 is used to control the MVP system and to acquire SVP data. MVP allows for three acquisition modes: 1) automatic continuous multiple cast freefall casting while at speed, 2) single cast freefall casting while at speed, and 3) single cast winch speed casting while stationary. The user limits the depth to which the fish will fall by setting 1) the depth-off-bottom and 2) the maximum depth. Either single, individually initiated casts can be performed at the discretion of the Hydrographer or the auto deploy function can be enabled and set with varying intervals (every 2 minutes, for example) for deployment.

Periodic quality assurance checks include comparison casts between the MVP and one of the SBE 19*plus* SEACATs. Data quality assurance (DQA) checks include comparison casts among the instruments as per section 1.5.2.2 of the *FPM* for each survey. A record of the DQA tests performed aboard the ship is kept and is included in Appendix VI.

Figure 12: FAIRWEATHER's MVP200 sound velocity system

1.6 Vertical Control Equipment

1.6.1 Water Level Gauges

Three Sutron 8210 tide gauges are provided to FAIRWEATHER by the Center for Operational Oceanographic Products and Services (CO-OPS). These gauges are equipped with Paros Scientific Sensors (SDI-12) for pressure measurements. The tide gauges are checked annually by CO-OPS Field Operations Division personnel to ensure that their accuracy standards are being met.

CO-OPS does not provide calibration or quality assurance documentation to the FAIRWEATHER. FAIRWEATHER personnel are responsible for installation and removal of the water level gauges. CO-OPS is responsible for delivering final approved vertical correctors to the field unit or processing branch for application to the hydrographic data set. As FAIRWEATHER received new gauges, data quality assurance checks were conducted to ensure full functionality prior to deployment.

1.6.2 Leveling Equipment

FAIRWEATHER is equipped with four universal automatic levels (two Zeiss NI2 333 and two Leica NA2 100) and graduated metric staffs to assist in leveling tide gauges.

A Kukkamaki procedure is performed prior to leveling in order to verify the collimation error. Procedures were followed as described in the *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations,* October 1987. Kukkamaki results for 2007 are located in the Tides folder in Appendix V.

1.7 Horizontal Control Equipment

FAIRWEATHER is equipped with one Ashtech Z-Xtreme dual-frequency GPS receiver used for the positioning of tidal benchmarks, aids to navigation and portable DGPS reference stations (Fly-Away). The Ashtech Z-Xtreme 12 channel, L1/L2 receiver is connected to 4 Ashtech Geodetic GPS antennas.

The antennas can be equipped with an optional ground plane and mounted on fixed height Seco GPS tripods.

Data quality assurance testing of the Horizontal Control equipment was performed on 14 March 2007 (DN073) by FAIRWEATHER personnel. The Ashtech Z-Xtreme GPS receiver (SN ZE1200339016) was set up over Benchmark No. 37 in Ketchikan, AK using a Seco fixed height tripod. Data was collected for 2 hours 30 minutes and submitted to OPUS which returned an ultra rapid solution position the same day. The OPUS position was less than a centimeter off the published NGS Control Point for BM No. 37. The OPUS solution and a map of the results of the test (HSRR_Comparison.pdf) are located in Appendix V. Accuracy standards have been met according to NOAA Technical Memorandum NOS NGS-58.

Horizontal control equipment serial numbers and installation dates are located in the hardware section of Appendix I, System Tracking.

2.0 Software

2.1 Software Systems Inventory

An extensive software inventory with documentation, of the software systems used by the NOAA ship FAIRWEATHER, is maintained as a *Survey Software* spreadsheet and included in Appendix I. This spreadsheet includes specifics such as software applications, versions, and hot fixes, in addition to dates loaded on specific computers within the survey department.

2.2 Data Acquisition Software

2.2.1 Isis Sonar/ BathyPro/ DelphMap/ DelphNav

The FAIRWEATHER uses the Triton Imaging Inc. software packages Isis Sonar and Sonar Suite to acquire multibeam echo sounder and backscatter data on all of its multibeam platforms. Sonar Suite has two software packages, DelphNav and DelphMap, which work together along with Isis Sonar to produce real time data planning, acquisition, and execution.

Triton Imaging BathyPro is an add-on package for Isis Sonar which processes XTF data real-time to produce DTMs supported by DelphMap. Triton Imaging DelphNav is an add-on package to DelphMap used for line planning and vessel navigation. Triton Imaging DelphMap is a stand-alone GIS program which combines georeferenced bathymetric digital terrain models and reference files such as raster charts and vector shoreline files to display real-time bathymetric bottom coverage.

2.2.2 TerraSync/ Pathfinder Office

For GPS positioning and shoreline verification FAIRWEATHER uses two Trimble Navigation Limited software programs: TerraSync 2.41 and GPS Pathfinder 3.1.

GPS Pathfinder is run on a Microsoft Windows operating system and is used to manage and process Trimble GPS data, transfer files to and from GPS receivers and handheld data collectors, and export processed data.

Trimble TerraSync 2.41 supports a data dictionaries built with S57 objects and attributes and georeferenced TIFF images. The georeferenced TIFF images are used for reference and navigation purposes as well as for immediate S-57 attribution of positions in the field. TerraSync is installed and configured for data collection on all of the Tuffbook field computers, the TuffTab, and the TSCe handheld computer.

GPS precision masks in TerraSync using the following parameters:

- Horizontal Dilution of Precision (HDOP) ≤ 2.5
- Signal-to-Noise Ratio (SNR) ≥ 4
- Elevation Mask ≥ ~8°-15° (varies by location)

Differential GPS correction is applied in real-time, using the unit's integrated beacon as the first choice corrector, and specifying "wait for real-time" as the secondary option. Positions are filtered so that only those with a minimum of 4 satellites (3D position), and HDOP ≤ 2.5, and Positional Dilution of Precision (PDOP) ≤ 6 will be recorded.

2.3 Data Processing Software

2.3.1 NOAA Hydrographic Systems and Technology Programs (HSTP) Software

Sound velocity data is processed with Velocwin, in-house software produced and maintained by NOAA's Hydrographic Systems and Technology Programs (HSTP) division. Velocwin creates and archives water column profiles, performs quality assurance, and processes pressure based depth data. Velocwin creates a standard file format across NOAA's hydrographic fleet for sound velocity profiles applied to shallow water multibeam and single beam data.

Pydro, another NOAA program produced and maintained by HSTP, is used to process features such as detached positions (DP), generic positions (GP), and Automated Wreck and Obstruction Information System (AWOIS) contacts. PYDRO also converts and attributes features according to S-57 standards for insertion into CARIS Notebook.

2.3.2 CARIS

CARIS HIPS™ (Hydrographic Information Processing System) is used to process all shallow water multibeam data including data conversion, filtering, sound velocity, tide correcting, merging and cleaning. CARIS HIPS also calculates the Total Propagated Error (TPE) used to produce Bathymetry Associated with Statistical Error (BASE) surfaces which assist the Hydrographer in data cleaning and analysis.

CARIS Notebook™ is used to compile and display source shoreline, shoreline updates and S-57 features imported from Pydro. The .hob files created in Notebook are the current shoreline deliverables.

2.3.3 Fledermaus™

Fledermaus ™, an Interactive Visualization Systems 3D™ (IVS 3D) program, is used for data visualizations and creation of data quality control products, public relations material and reference surface comparisons.

As an additional data quality assurance check, Fledermaus ™ may be used to examine the CARIS surfaces prior to submission. The combined BASE surface will be exported to XYZ from CARIS. This file is then converted to a Fledermaus .sd file via the Avggrid and Dmagic programs.

2.3.4 MapInfo™

MapInfo™ is used to review tables and workspaces associated with assigned projects received from Hydrographic Survey Division (HSD). MapInfo may also be used to produce scaled plots produced for public relation purposes. HydroMI, an HSTP produced MapBasic program, is used through MapInfo to convert tide and tidal zoning files into a format that is useable in CARIS HIPS, and obtain latitude/longitude coordinates for pre-survey planning.

3.0 Vessels

3.1 Vessel Inventory

The NOAA Ship FAIRWEATHER (S220) and her survey launches 1010 and 1018 are equipped to acquire multibeam echosounder (MBES) and sound velocity profile (SVP) data. Launch 1018 is also the primary vessel for dive operations. The AMBAR (2302) and Monarch (1706) are used during shoreline verification, bottom samples, and horizontal and vertical control operations. All vessels were used in support of tide gauge operations. See Appendix I for the complete vessel inventory.

3.2 Noise Analysis

The FAIRWEATHER sonar system RESON 8111ER underwent noise analysis testing on October 11, 2004. The results are used during acquisition to enhance data quality and are included in Appendix III-S220-7. Standard operating procedures utilizing the RESON 8111ER aboard the FAIRWEATHER have survey speeds set to minimize noise based on the noise analysis.

4.0 Data Acquisition

4.1 Horizontal Control

A complete description of horizontal control for the project can be found in the *OPR-P132-FA-07 Horizontal and Vertical Control Report (HVCR)*, submitted under separate cover.

The horizontal datum for this project is the North American Datum of 1983 (NAD83).

Multibeam and shoreline data were differentially corrected in real time using correctors provided by Coast Guard beacons at Cape Hinchinbrook (292 kHz) or Potato Point (298 kHz). If loss of the differential beacon resulted in any data being recorded with C/A GPS positions it will be noted in the descriptive report for the survey.

Specific DGPS quality control checks were not performed during this project. Based on correspondence between personnel from the Hydrographic Systems and Technology Program and FAIRWEATHER, system checks were deemed unnecessary. Refer to correspondence included in Appendix VII.

4.2 Multibeam Echosounder Acquisition and Monitoring Procedures

Methods of acquisition took into consideration system performance limitations, the bottom topography, water depth, and the ability of the vessel to safely navigate the area.

All multibeam data were acquired in Triton Elic's extended transfer format (XTF) and monitored in real-time using the 2-D and 3-D data display windows and the on-screen displays for the RESON SeaBat 8101ER and 8111ER. Adjustable parameters that were used to control the RESON from the ISIS software include range scale, power, gain, and pulse width. Vessel speed was also adjusted as needed to eliminate noise from the data. These parameters were adjusted as necessary to ensure best data quality. Additionally, vessel speed was adjusted as necessary to ensure the required along-track coverage for object detection in accordance with the *HSSDM*. Survey personnel follow standard operating procedures documented aboard the FAIRWEATHER while setting and utilizing the RESON systems and Isis for acquisition of data.

Mainscheme multibeam sounding lines using the RESON SeaBat 8111ER were generally run parallel to the contours at a line spacing approximately three to four times the water depth. For discrete item developments, line spacing was reduced to 2 times water depth to ensure least-depth determination by multibeam near-nadir beams. Triton Elic's DelphMap Real Time Bathy was used in lieu of planned line files. The Real Time Bathy displayed the acquired multibeam swath during acquisition and was monitored to ensure overlap and full bottom coverage. If coverage was not adequate, additional lines were run while still in the area.

4.3 Shoreline Verification

FAIRWEATHER personnel conducted field shoreline verification at times near predicted low water, in accordance with the Standing Project Instructions, the FPM (March 2007), and HTD 2007-7. Standard operating procedures on the use of Trimble TerraSync and GPS Pathfinder for shoreline verification were followed by survey personnel.

CARIS Notebook 3.0 was used to review the project level composite source (.000) file supplied by HSD and described in HTD 2007-7 Appendix 1. The composite source file for OPR-P132-FA-07 contained features from a sole source: Geographic Cell (GC), or Digital Data (DD), shoreline compiled by the Remote Sensing Division (RSD). The file was opened in Notebook and copied to a .hob file using the same name. The project level composite source .hob file was edited by the survey manager to include only features within the survey limits and renamed according to survey number, HXXXXX_Composite_Source.hob. A copy was made of the unedited survey level composite source .hob file and named HXXXXX_Original_Composite_Source.hob. All modifications to source shoreline features addressed during field verification were made in the HXXXXX_Composite_Source.hob, with the original composite source .hob file remaining unedited. These HOB files are submitted as shoreline deliverables.

A Mean High Water (MHW) Buffer line was created in MapInfo to represent a preliminary Navigable Area Limit Line (NALL). Charts 16700 (1:200,000), 16708 (1:79,291) and 16709 (1:80,000) were the largest scale charts for the survey area. The buffer line was offset 64 meters (0.8 mm at scale of 1:80,000) from the GC MHW line. The MHW Buffer line was then imported into Notebook as a reference .hob file to be added to the boat sheet for use during shoreline verification. *Note: The NALL for a survey is the farthest offshore of 1) the 4-meter depth contour or 2) the MHW buffer line, a guideline specified in HTD2007-7.*

Charted features offshore of the MHW buffer line were digitized in Notebook into the composite source .hob file using the correct S57 object class and attribution for each feature. The SORIND and SORDAT S57 attribute fields were propagated with the chart number and edition date from which the features were digitized.

AWOIS were imported into Notebook as individual .hob files. AWOIS items are primarily inserted into Pydro where all updates and reporting will be completed; however, they were added to Notebook for inclusion on the shoreline boat sheets and for assistance in survey planning.

After all source, reference, and investigation features were added to the Notebook shoreline session, boat sheets were produced and geo-referenced images (tif/tfw) were created for use in Trimble TerraSync during shoreline verification.

During shoreline verification, the boat coxswain followed either the 4 meter depth contour or the MHW Buffer Line, whichever was most seaward of the two, to define the NALL. If deemed navigationally significant by the chief of party, items inshore of the NALL were investigated or verified. The estimated NALL was logged as a line file in Trimble Terrasync.

Detached positions (DPs) and generic positions (GPs) acquired during shoreline verification indicate new features, revisions to source features, or source features not found in the field. They were recorded in the shoreline acquisition software TerraSync using a Trimble Backpack and on DP forms, and then initial processing was done in GPS Pathfinder.

Scanned copies of the DP forms are included in the digital Separates folder to be included with Survey Data. In addition, annotations describing shoreline were recorded on hard copy plots of the digital shoreline, referred to as boat sheets which are also submitted with the individual survey as Separates.

The term “Verified” was used when the existence of a source feature is confirmed in close proximity to its provided position on the boat sheet, dependent on the largest scale chart in the survey area. All source rocks seaward of the NALL were verified with a DP to update the height and/or position.

4.4 Shoreline Data Processing

During shoreline verification, DPs and GPs were acquired with TerraSync 2.41. Data were imported into GPS Pathfinder 3.1 and were reviewed for quality. New or Updated point and line features were exported to a Microsoft Access Database file (.mdb) and NALL buffer lines were exported to ESRI shape files (.shp).

Features included in the database file were imported into Pydro as DPs or GPs (depending on how they were designated in the field). Once the features were in Pydro, short descriptive comments taken from the boat sheet or DP forms along with investigation or survey methods were listed under the Remarks tab in Pydro. Features were flagged as Primary, unless there were multiple DPs or GPs taken on the same feature. In that case, the most important DP was marked Primary and any associated DPs/GPs were flagged Secondary. All features were S57 attributed.

Significant features that deserved special attention or additional discussion, were flagged Report in Pydro and included in the Pydro feature report. Along with the hydrographer notes and investigation methods provided in the Remarks tab, the Hydrographer included recommendations to the cartographer in the Recommendations tab when warranted. All features were flagged according to section 4.4.4 of the FPM. All features flagged as “report” in Pydro were included in the Shoreline Feature Report.

Photos labeled and associated with a DP/GP number were included in the Pydro PSS session and stored in a folder with the PSS file.

HDCS_DATA lines associated with DPs were tide corrected in CARIS HIPS. GPs do not have heights associated with them and required no additional processing.

All primary and accepted DPs and GPs were exported from Pydro as an .xml to CARIS Notebook 3.0. Two separate stand alone .hob files were created from the Pydro .xml files. The files are named H#####_Updates.hob and H#####_Disprovals.hob.

AWOIS investigation items were inserted into Pydro for processing. If the investigation items were noted by the Hydrographer but not positioned, the original feature was flagged Primary and included with the H#####_Updates.hob. If the investigation item was positioned in the field, the DP/GP was marked Primary and included in the H#####_Updates.hob, the original investigation item was marked as Secondary. Any investigation items disproved were included in the H#####_Disprovals.hob, with either the original item flagged as Primary or the DP/GP position taken during the field investigation flagged as Primary.

In CARIS Notebook, all field notes from the boat sheet or DP form regarding verified or modified source shoreline feature were entered in the feature’s Remarks field in the HXXXXX_Composite_Source.hob layer. Notes for shoreline investigation files and new DP/GP features were added to the “remarks” field in Pydro.

New HW/MLLW features and any updates to the source shoreline, such as ledges or reefs, were digitized with S57 attribution into the H#####_Composite_Source.hob. Updates to a source shoreline feature primarily include a change in height, position or S57 classification. Notebook’s editing tools were used to modify source feature extents or positions. The PICREP S57 attribute field or Marker notes were used to associate field pictures with new or modified features.

Depth values for rocks that were DP’d for height were added to the source rock’s VALSOU (value of sounding) S-57 attribute field following tide correction. If approved tides were not available prior to a survey’s submission, VALSOU depths will need to be updated by the processing branch following the application of smooth tides. This is done by tide correcting the accompanying DP in HIPS/Pydro and manually copying the tide corrected value to the source feature in the composite source hob file.

The SORIND and SORDAT S57 attribute fields for new features or modified source features were updated to reflect the information for their associated survey number and date. All unmodified source features retain their original SORIND and SORDAT values.

Source features accompanied by a full disproval investigation were deleted from the Composite Source HOB file. All disproved source features seaward of the NALL were discussed in the survey's descriptive report.

The CARIS Notebook files along with CARIS HIPS BASE surface(s) were viewed to compare soundings and features simultaneously. Standard operating procedures, for processing shoreline features in Pydro and CARIS Notebook, were followed by survey personnel as documented.

Final Shoreline Deliverables include the Pydro PSS, the Pydro Shoreline Feature Report, and up to four Notebook HOB files:

HXXXXX_Original_Composite_Source
HXXXXX_Composite_Source
HXXXXX_Updates (Pydro Data Import, if applicable)
HXXXXX_Disprovals (Pydro Data Import, if applicable)

5.0 Bottom Sample Acquisition

Bottom samples were conducted according to section 7.1 of the *HSSDM*. Bottom samples results are found in the Pydro PSS and the Notebook HOB deliverable layer, HXXXXX_Updates.

B QUALITY CONTROL

The FAIRWEATHER has numerous standard operating procedures (SOPs) that are followed by personnel throughout the survey to ensure consistent high quality data and products.

1.0 Uncertainty Modeling

Error values for the multibeam and positioning systems on FAIRWEATHER and her survey launches were compiled from manufacturer specification sheets for each sensor (Heave, Pitch, Roll, Position, and Heading) and from values set forth in Chapter 4 Appendix of the FPM.

Estimates for the error in measuring vessel offsets, multibeam system biases (timing, pitch, roll and yaw) and dynamic draft are the standard deviations of the set of values reached for each of these corrections resulting from several people processing the data.

In the specific case of MRU Alignment error; values were set after an email exchange between Rainier, Fairweather, HSTP and CO-OPS (see TPE_MRU Alignment.txt email messages in Appendix VII). The error value for MRU alignment deviated from that set in Chapter 4 Appendix of the FPM due to the directive's value for MRU alignment error being set too high (possibly due to a misinterpretation of what the alignment error represented). This error should represent the standard deviation of measurement of the error derived from multiple people processing the patch test. Based on this, the MRU alignment errors were significantly lower than the 1 degree value set in Chapter 4 Appendix of the FPM.

An estimate of the total error due to tides was not included in the Letter Instructions for the project, but a value of 0.09 meters (two sigma - 95% confidence level) was given by CO-OPS in the above noted email exchange. Using this value as a reference, tidal errors were set at 0.01 m for the gauge and 0.1 meters for zoning. The 0.01 meter estimate for the gauge is a conservative estimate that can be recalculated based on the sigma values in the final approved water levels. The 0.1 meter estimate for zoning is also a conservative one sigma value based on the total two sigma tide error of 0.09 meters.

The final uncertainty values for FAIRWEATHER and her launches, tides, and sound velocity, along with information on how the values were derived, are shown in the FA_TPE_Values.xls spreadsheet located in Appendix IV. Uncertainty values relating to vessels and survey systems were entered into the HIPS Vessel File (HVF) for each platform. Uncertainty values for tide and sound velocity were entered during the CARIS Compute TPE process.

2.0 Data Processing

2.1 Multibeam Echosounder Data Processing

Bathymetry processing followed section 4.2 of the *FPM* unless otherwise noted.

Raw XTF multibeam data were converted to Caris HDCS format using FAIRWEATHER documented settings. True heave, sound velocity and water level data were then applied to all lines and the lines merged. Once lines were merged Total Propagated Error (TPE) was computed.

Vessel heading, attitude, and navigation data were reviewed in HIPS navigation editor and attitude editor. Where necessary, fliers or gaps in heading, attitude, or navigation data were manually rejected or interpolated for small periods of time.

BASE surfaces were created using the Combined Uncertainty and Bathymetric Estimator (CUBE) algorithm and parameters contained in the Cubeparams.xml file. This file contains settings for “Deep” or “Shallow” surveys. As stated in HTD 2007-2, the “Deep” setting corresponds to NOAA “Complete” multibeam coverage and “Shallow” to NOAA “Object Detection” coverage. As the Letter Instructions for project OPR-P132-FA-07 require “complete” multibeam coverage, all BASE surfaces were created using the “Deep” configuration of CUBE parameters.

Multibeam data were reviewed and edited in HIPS swath editor and in subset mode as necessary.
The BASE surface was used for directed data editing in subset editor, to demonstrate coverage, and to check for errors resulting from tide, sound velocity, attitude and timing.

Table 1 lists the general resolution and depth ranges used by FAIRWEATHER. These values may be adjusted by sheet managers for individual surveys based on bathymetry and conditions in the survey area. A detailed listing of the actual resolutions and depth ranges used during the processing of each survey, along with the corresponding fieldsheet(s), will be provided in the descriptive report of each survey.

FAIRWEATHER			
Depth Ranges			Resolutions
Lo (m)	Hi (m)	Overlap (m)	Res. (m)
0	40		2
30	70	10	5
50	120	20	10
100	200	20	20
180	350+	20	35

Table 1: Resolutions and Depth Ranges

In areas of navigational significance where the BASE surface did not depict the desired depth for the given area, a designated sounding was selected. Designated soundings were selected as outlined in chapter 5 of the *HSSDM*.

3.0 DATA REVIEW

Specific procedures were used on FAIRWEATHER to ensure quality control of data throughout acquisition, processing, and submission. These procedures are documented and followed by the Hydrographer. A detailed in Quality Control Check is preformed by the survey manager. A detailed Review is conducted by qualified survey personnel (FOO, CST, SST, or PS) other than the survey manager as an outside review of the survey data and deliverables. The Data and Analog Submission checklists are used to ensure that all data and deliverables are complete and included upon submission. Documentation of these tasks are completed for every survey but only the final processing log, *HXXXXX_Data_Log,* is submitted with the individual survey data.

C Corrections to Echo Soundings

1.0 Vessel HVFs

CARIS HIPS Vessel Files (HVF) were created by FAIRWEATHER personnel and used to define a vessel's offsets and equipment uncertainty. The HVF is used for converting and processing data collected by each survey platform. For each survey platform, an *HVF Report*, listing specific HVF entries, was produced in the CARIS Vessel Editor and is included in Appendix III. The HVFs used for the current project are included with the digital separates submitted with the individual survey data.

2.0 Vessel Offsets

Sensor offsets were measured with respect to each vessel's reference point. The reference point for FAIRWEATHER and survey launches 1010 and 1018 is the IMU. Specific offset values were input into the POS/MV and the CARIS HIPS Vessel File (HVF).

A ship survey was completed for the FAIRWEATHER by Westlake Consultants, Inc on September 23, 2003 and a POS/MV component spatial relationship survey of the FAIRWEATHER was conducted by NGS in February, 2007. The results of both of these surveys were used to determine the offsets for ship. The reports from each survey are located in documents in Appendix III-S220-2, and the final values for FAIRWEATHER's offsets and explanations of how they were calculated are located in the S220_Offsets & Measurements spreadsheet in the same folder.

Permanent control points were established on launches 1010 and 1018 in July of 2004. Sensor offsets were measured by Fairweather personnel according to documented procedures. Total stations were utilized for positioning the permanent control points. The total station specifications are located in Appendix II-7. A steel tape was used to verify and update specific vessel offsets in April 2007 and the results are located in the respective vessel's *Minimum Physical Measurements_2007* spreadsheets in Appendix III. The final offsets for survey launches 1010 and 1018 were derived from a combination of values from the original full survey and the values updated in the verification surveys. The measurements, derivations, descriptions of methodology used, diagrams, and coordinate system references are included in the respective vessel's *Offsets & Measurements* spreadsheet in Appendix III.

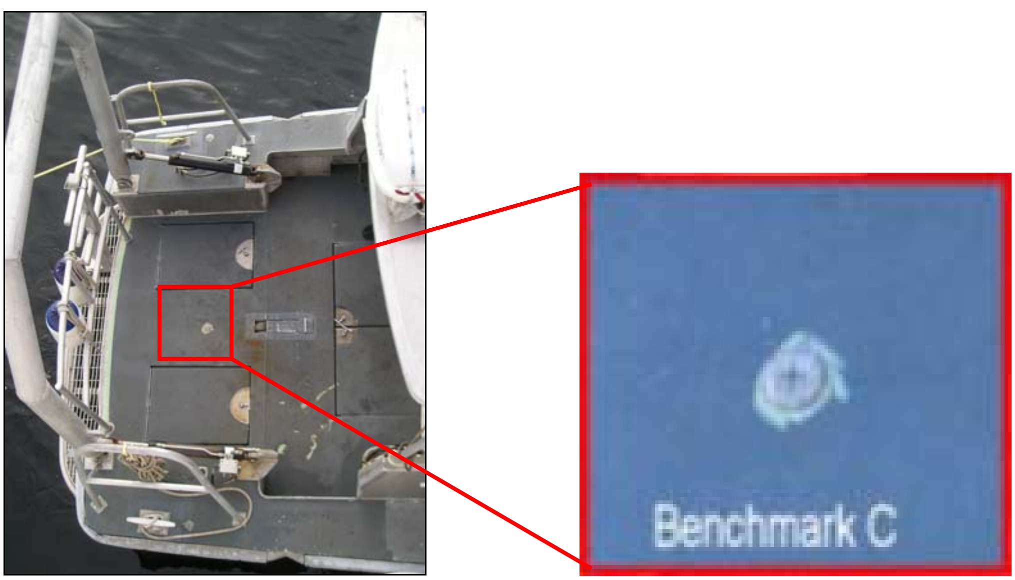

Figure 7: Permanent Control Point "Benchmark C" on launch 1018

3.0 Static and Dynamic Draft

Static draft (*Waterline Height* in the HVF) for launch 1010 and 1018 was calculated based on steel tape measurements of the distance from benchmarks on the port and starboard quarter of the vessel to the waterline. Although static draft tubes have been installed in launch 1010 and 1018 the tubes have not yet been calibrated, nor have procedures for the determination of loading been developed.

The bow and stern draft marks were used to perform a linear interpolation of the static draft at the FAIRWEATHER's IMU. The static draft was measured multiple times with the vessel under different loading conditions: with and without launches on board and with different amounts of fuel. The final value for the static draft was an average of the most likely loading conditions during survey operations.

The values and calculations for static draft are listed in each vessel's Offsets Measurement spreadsheet located in Appendix III.

Dynamic Draft Settlement and Squat (DDSSM) tests were conducted for FAIRWEATHER and survey launches 1010 and 1018 in April 2007. The final DDSSM values are the average of results obtained from multiple individuals processing the DDSSM data. Detailed processing spreadsheets of DDSSM results for each vessel are located in the respective vessel's folder in Appendix III.

4.0 Patch Tests

Patch tests were conducted for the multibeam acquisition systems on FAIRWEATHER and survey launches 1010 and 1018 in April 2007. The results of the patch tests, along with the acquisition and processing logs, are included in the individual MBES Calibration Tables in Appendix III-3.

It was discovered during processing of the 2007 patch tests that the new POS/MV's for launches 1010 and 1018 were set to output GPS time instead of UTC time. This introduced a fourteen second error (the precise difference between GPS and UTC time) into the navigation time. To avoid time spent rerunning the patch tests, the tests were processed using a time correction value of fourteen seconds, which effectively canceled out the time error. An entry in the HIPS vessel files for launches 1010 and 1018 dated 2007-001 show the fourteen second correction in the "Time Correction(s)" column. The POS/MV units were subsequently changed to output UTC time and a second entry in the HIPS vessel files, removing the fourteen second navigation latency value, was entered on 2007-102. All data collected for the project took place after the POS/MV's were corrected to output UTC time.

Additional testing for adjustments were required throughout the field season on both Launch 1010 and 1018 due to the instability of the roll arm mounts. Launch 1010 was retested on Dn197 prior to this project and required additional roll adjustments on Dn252 during this project. Launch 1018 was tested and had roll values updated prior to starting acquisition on this project on Dn236.

5.0 Attitude

All attitude corrections were generated by the POS/MV using data from the IMU-200 Inertial Measurement Unit (IMU). IMU values for uncertainty of heave, pitch and roll are included in the manufacturer specification in Appendix II and are included in the FA_TPE_Values_2007.xls spreadsheet located in Appendix IV. IMU failures noted during this project were actually attributed to faulty POS/MV PCS units as documented in section 1.4.1above. IMU correctors applied to the data were not affected and no additional patch testing was required.

5.1 True Heave

FAIRWEATHER and her launches are equipped with the POS/MV TrueHeave™ (TH) option. True Heave™ is a 'delayed' heave corrector as opposed to 'real time' heave corrector and is fully described in Section 6 of the *POS/MV Version 4 Installation and Operation Manual*. Daily TH files were logged through the Ethernet Logging function in the POS/MV controller software. To ensure proper calculation of TH, files were logged for at least three minutes past the end of each day's survey operations.

In cases where TrueHeave™ could not be applied, real time heave correctors were used. Real time heave data were recorded in Triton Elic's Isis software, stored in the .xtf format and applied as the heave corrector for multibeam data. Data that does not have TrueHeave™ applied will be listed in the individual Descriptive Report for the survey.

6.0 Sound Velocity

Seacat SBE 19*plus* sound velocity profilers were used to collect sound velocity data for survey launches 1010 and 1018's Reson 8101 multibeam systems. The Brooke Ocean Technology Moving Vessel Profiler (MVP) was used to collect sound velocity data to correct data collected with FAIRWEATHER's Reson 8111 multibeam system.

Daily sound velocity profiles from the SBE 19*plus* were processed with Velocwin and concatenated into a single .svp file for the sheet. Individual .svp files and the concatenated file for the survey will be submitted with each survey.

Sound velocity profiles acquired using the Brooke Ocean Technology Moving Vessel Profiler 200 (MVP) are stored in files labeled .001, .001c, .001d, and .001e (collectively called BOT files) where the number increments by one with each subsequent cast. The .00#c file for each cast was opened with Velocwin and converted into CARIS .svp file format. The individual .svp profiles were concatenated into a single .svp file for the sheet. Individual sound velocity profile files taken by the MVP will not be submitted due to the large number of casts acquired; however, the daily concatenated files are submitted.

The concatenated sound velocity files were applied to multibeam data in CARIS HIPS during data processing. CARIS HIPS uses one of four different algorithms to automatically apply a sound velocity profile stored in the concatenated sound velocity file. They are: "previous in time," "nearest in time," "nearest in distance" and "nearest in distance within time." In general, "previous in time" was the method used for applying sound velocity information in HIPS, but the other methods may have been used in certain situations. The method of applying sound velocity is included in the processing logs that are submitted with each survey.

7.0 Water Level

The vertical datum for this project is Mean Lower-Low Water (MLLW). Predicted water level correctors from the primary tide stations at Cordova, AK (945-4050) and Valdez (945-4240) were downloaded from the CO-OPS website and used for water level corrections during the course of the project.

The files for the relevant days were collated into a tide station master file which was converted to CARIS .tid file format in MapInfo using HydroMI. Water level data in the .tid files were applied to data using the zone definition file (P132FA2007CORP.zdf) supplied by CO-OPS.

A complete description of vertical control for the project can be found in the *OPR-P132-FA-07 Horizontal and Vertical Control Report (HVCR)*, submitted under separate cover.

D Approval Sheet

The approval sheet is signed digitally and included with this report.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NOAA Marine and Aviation Operations
NOAA Ship FAIRWEATHER S-220
1010 Stedman Street
Ketchikan, AK 99901

June 9, 2007

MEMORANDUM FOR: CDR David Neander, NOAA
Chief, Pacific Hydrographic Branch

FROM: CDR Douglas D. Baird, NOAA
Commanding Officer

Digitally signed by Doug Baird
DN: cn=Doug Baird, o=NOAA Ship FAIRWEATHER, ou=NOAA, email=co.fairweather@noaa.gov, c=US
Reason: I am approving this document
Date: 2008.06.08 17:29:26 -08'00'

TITLE: Approval OPR-P132-FA-07 DAPR

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

This report is respectfully submitted to N/CS34, Pacific Hydrographic Branch.

In addition, the following individuals were responsible for oversight of acquisition and processing of this report:

Matthew Ringel
I agree to specified portions of this document
2008.06.08 23:10:32 Z

LT Matthew Ringel, NOAA
Field Operations Officer

Lynnette V. Morgan,
Chief Survey Technician

Attachment