18 March 2010

MEMORANDUM

To: Hon. Vinai K. Thummalapally, U.S. Ambassador to Belize
Hugo Gorziglia, Director, International Hydrographic Bureau
Dr. Edas Muñoz, Director, Gulf of Honduras Project
CAPT John Lowell, NOAA, Director, Office of Coast Survey

From: LCDR Chris van Westendorp, NOAA, Staff, Atlantic Hydrographic Branch

Cc: Kathryn Ries, Deputy Director, Office of Coast Survey
Eric Villalobos, USSOUTHCOM Naval Oceanography Program Regional Coordinator
Elliot Arroyo-Suarez, NAVOCEANO Navigation Products Division Technical Lead
Paul Bradley, Regional Geographic Manager RT6, United Kingdom Hydrographic Office
Mark Aspden, National Geospatial Intelligence Agency / UKHO
Mr. J.A. Diffily, Deputy Chief of Mission, U.S. Embassy (Belmopan, Belize)
Ms. Brianne Watts, Political and Economic Officer, U.S. Embassy (Belmopan, Belize)
Major John Flowers, Belize Ports Commissioner
Michael Jenkins, Chief Hydrographer, Belize Ports Authority
Jeffrey Ferguson, Chief, Hydrographic Surveys Division
LCDR Rick Brennan, NOAA, Chief, Atlantic Hydrographic Branch

Subj: Trip Report for Gulf of Honduras Project Phase 2 Hydrographic Training Mission to Belize

Background:

1. The Gulf of Honduras (GoH) project is a tri-national, internationally funded initiative of the Governments of Belize, Honduras and Guatemala to protect the Gulf of Honduras from ship and land-based sources of pollution. Sponsored in part by the International Hydrographic Organization's (IHO) MesoAmerican-Caribbean Sea Hydrographic Commission (MACHC), this training mission falls under Component 3 of the GoH project (Enhancing navigational safety in shipping lanes).
2. Belize officially established its hydrographic survey program in 2008-2009 with receipt of the following hydrographic survey capacity building measures via the GoH project and MACHC:
    a. Hydrographic survey equipment
        - Procured through the GoH Project Coordinating Unit, located in Puerto Cortes, Honduras
        - Equipment Listing:
            1. Panasonic Toughbook CF-52 Laptop Computer with Quatech 4-port Serial (DB9) card
            2. Reson Navisound 210 (Single Beam Echosounder)
            3. Imagenex Yellowfin (Side Scan Sonar)
            4. Kongsberg MRU-Z (Motion Reference Unit)
            5. HemisphereGPS Crescent VS-100 (Dual-antenna GPS Receiver)

6. Reson SVP-15 (Sound Velocity Probe)
7. Valeport 740 (Tide Gage – pressure sensor)

b. Basic training in hydrography and nautical charting
   - Provided by NOAA representatives both in the United States and Belize

c. Development of interregional (GoH) and international hydrographic partnerships
   - Via NOAA training and vendor networks as well as MACHC communications and meetings

3. At the 10th MACHC Conference held in Barbados (November 2009), the three GoH countries requested a second phase of hydrographic survey training be provided by the MACHC to build upon knowledge and experience gained during the 2009 training sessions. Travel funding for the trainers is/was provided by the IHO Capacity Building Committee through the MACHC.

Trip Objectives:

1. Continue international partnership with Belize Ports Authority (BPA) in support of hydrographic survey program
2. Provide BPA personnel with advanced evaluation and setup of hydrographic survey equipment
3. Provide advanced hydrographic survey training with the outcomes that BPA personnel are able to understand and/or conduct:
   a. Tide gage installation and data management
   b. Pre- and Intra-Survey planning
   c. Acquisition & processing of hydrographic survey data to IHO standards
   d. Troubleshooting and minor repair of hydrographic survey systems
   e. Generation & transmission of IHO standard survey products to the UK Hydrographic Office for nautical chart updates

Training Timeline:

Prior to the in-country training detailed in the table below, a representative trainee from the BPA attended the first two weeks of NOAA's annual Hydrotraining (8-19 February 2010) in Norfolk, Virginia. During this period, the trainee received intensive training in basic hydrographic survey principles, including (but not limited to):

- Introduction to Hydrography
- Nautical Chart Products
- Navigation and Orientation
- Geodesy
- Positioning and GPS
- Data Types
- Hardware and Software Systems
- Field Survey Planning
- Inertial Navigation
- HYPACK Software
- Sound Velocity
- Acoustics and Sonars
- Side Scan Sonar
  - Theory
  - Acquisition
  - Contact Selection
- Multibeam Sonar
- Horizontal Control
- Ellipsoidal Reference System
- Tide Theory and Application

Date	On-the-Water (OTW)?	In-Country Training Accomplished with BPA Personnel
2/24	Arrival day – No training	
2/25	No	Tides training (NOAA Contractor)
2/26	No	Tides training (NOAA Contractor)
2/27	No	Tides training (NOAA Contractor)
2/28	Sunday – No training	
3/1	No	Troubleshooting and regulating electrical power and survey equipment
3/2	Yes – 7 hours	HYPACK and survey equipment operation; survey operational safety and coordination; line planning and acquisition
3/3	No	Recovery from computer virus infection of survey laptop – no training
3/4	Yes – 4 hours	Regulating electrical power; HYPACK and equipment operation; line planning and acquisition; Valeport gage operation
3/5	Yes – 5 hours	Hydrographer attention cycle; Line planning; Survey logs & documentation; HYPACK operations; Line driving; Sound velocity
3/6	No	HYPACK processing of single beam echosounder data
3/7	Sunday – No training	
3/8	Holiday (Baron Bliss Day) – No training	
3/9	No	HYPACK processing of single beam & side scan sonar data; Tide and sound velocity corrector download/integration; Documentation
3/10	No	HYPACK single beam echosounder data processing; Windows functionality
3/11	No	HYPACK side scan sonar data processing
3/12	No	HYPACK side scan contact selection and mosaicing; bathymetric plot and preliminary product generation; System startup and shutdown; Development and holiday line planning
3/13	No	Report of Survey; Documentation

Narrative / Observations:

1. **Dates and Location of Training** – In-country training was conducted with BPA personnel from 24 February to 13 March 2010, lasting 3 days longer than originally planned and yielding 14 total training days. The training took place in Belize City at the BPA Operations office and areas in and around the Port of Belize Limited (PBL) pier. As mentioned previously, preliminary hydrographic survey training was provided for one BPA member (Robbie Barrow) in Norfolk, Virginia from 8-19 February 2010.

2. **Economic Climate** – Maritime commerce provides a critical artery for Belize's economy. Belize's ports provide the vast majority of its import and export trade (of which the United States is the primary commercial origin and destination, respectively). Tourism, another key link in the country's economy, is strongly supported by the cruise ship industry, which brings thousands of visitors to Belize City every week. Major exports of Belize include lumber, sugar, seafood, and citrus products. Major imports include food, consumer goods, machinery, mineral fuels and lubricants. The country's heavy reliance on maritime commerce further underlines the importance of continuing to build hydrographic capacity through this project.

3. **Belize Ports Authority and Scope of Responsibility** – The BPA currently employs approximately 30-40 personnel and holds responsibility for the safety, inspection, and licensing of marine vessels and vessel operators in all Belizean ports. BPA headquarters is located in Belize City, the country's largest port and most populous city (approximately 100,000 people). The recently opened and occupied BPA Operations office is located at the Old Belize marina, just south of downtown Belize City. The coastline of Belize spans approximately 200 miles and is largely protected by the MesoAmerican Barrier Reef System, the largest barrier reef system in the Western Hemisphere (second largest worldwide to Australia's Great Barrier Reef), which is frequently subject to negative shipping impacts.

4. **R/V SEA KING** – One of the major hindrances during the 2009 training period stemmed from the fact that BPA's designated survey vessel (R/V SEA KING) was not ready for sea due to much-needed engine overhaul and power/cabin modifications. SEA KING became available for survey during the spring & summer of 2009 and has been used for preliminary and/or reconnaissance hydrographic surveys since then. While the vessel's two engines are diesel, its generator is a separate gasoline-powered 50Hz/120V Onan. Modifications to the vessel's original design included an improved cabin superstructure complete with air conditioning, providing shelter for survey personnel and hydrographic survey equipment preservation.

BPA Hydrographic Survey Vessel – R/V SEA KING at Old Belize

5. **Vessel Safety Issues** – The following safety hazards were identified on SEA KING during Phase 2 training:
    a. SEA KING has very few hand railings, most importantly around the exterior of the vessel and coxswain stand. It is highly recommended that hand railings be installed inside and around the vessel to provide critical safety support for crewmembers. Additionally, it is recommended that a windowed shelter be constructed around the coxswain stand to protect the coxswain/captain and provide shading for increased visibility of the survey display.

Safety Railings: The lack of hand railings onboard SEA KING present a serious safety hazard to crew members, particularly the coxswain/captain, who has no lateral or aft railing support while standing at a high point in the vessel's reference frame.

b. As SEA KING uses diesel (propulsion engines) as well as gasoline (electric generator), BPA personnel are concerned about fume mixing and the potential for fire due to unseen leaks and engine compartment overheating. This concern is compounded by the fact that there is no working internal ventilation system in the engine compartment. BPA personnel address this issue by removing at least one compartment cover during at-sea operations to promote natural air ventilation. This presents a significant safety hazard to crewmembers due to risks of tripping, falling, burns, or more serious injuries. Therefore, it is recommended that a forced air ventilation system be procured and installed in the SEA KING engine compartment.

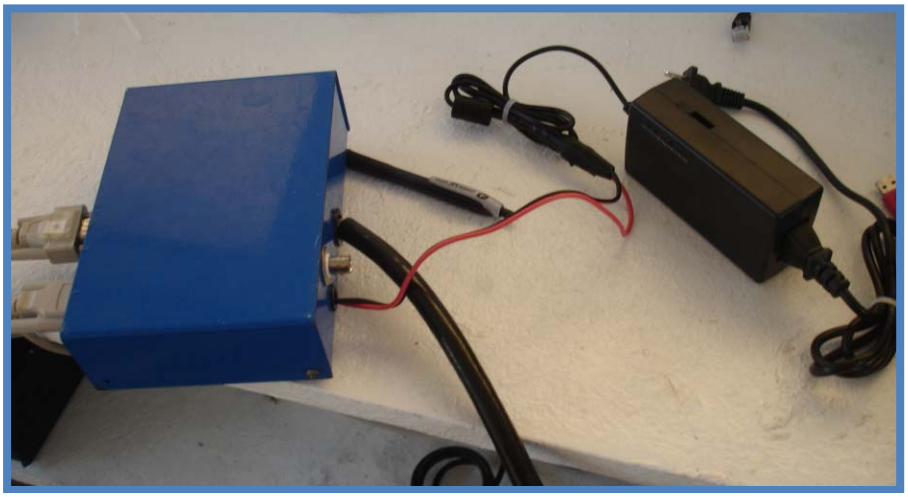
Compartment Covers are removed from the engine compartment during at-sea operations in order to provide natural air ventilation for the propulsion engines and generator; this poses a significant safety hazard.

c. The side scan sonar is towed from an aft centerline towpoint on the vessel. In order to maintain positive control of the towfish and rapidly adjust cable out with changes in towfish altitude, one BPA crewmember must maintain a continuous watch on the towcable and haul in / let out cable by hand as necessary. This poses a safety issue to the cable watch, particularly with regard to a trip hazard from the deck-lain towcable and a finger snag hazard from the towpoint block/pulley. It is recommended that an electric winch with 100m of cable be procured and installed on the vessel for towed side scan sonar operations.

Side Scan Towpoint: The side scan tow cable must be hand tended, introducing safety hazards to the cable watchperson.

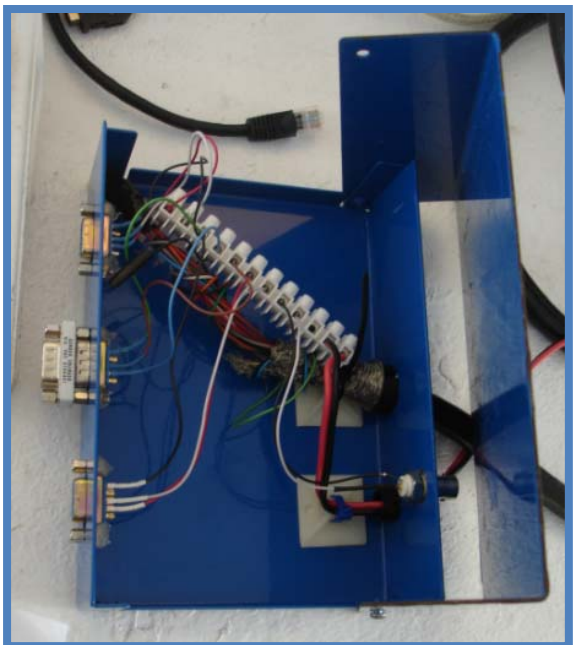
6. **State of Survey Equipment & Installation** – During the 2009 training, numerous data cable and power terminations were procured and manufactured to ensure all equipment operated properly for sustained hydrographic survey operations. All connections established in 2009 remained the same for the 2010 training. The following details specific equipment issues:

    a. **Kongsberg MRU Z** – The MRU-Z was delivered to the BPA in 2009 without a manufacturer-recommended junction box for proper power supply and data delivery. Following the 2009 training period, the GoH Project Office coordinated with the BPA and contracted equipment provider (Reson) to deliver and properly integrate such a junction box into the BPA hydrographic survey system.
        i. The junction box recommended in the Kongsberg MRU-Z manual is a Kongsberg manufactured part and includes a 1A fast fuse for protection of the MRU from power surges. It also requires 24 VDC power.
        ii. The junction box provided to BPA personnel appears to be homemade and contains no apparent fuse protection. Additionally, power provided to the BPA junction box was from a 24VAC (vice DC) transformer.
        iii. Although BPA personnel reported that the MRU worked properly with AC power, three (3) separate AC transformer power supplies failed during the Phase 2 training period when connected to the junction box. This issue was remedied by adapting a 24VDC power supply (designed for laptop computers) to connect to the junction box.



DC Power Adaptation: To provide proper power to the Kongsberg MRU-Z, a 24VDC laptop power supply was spliced with existing junction box power supply wires.

        iv. As it is currently configured the MRU appears to operate properly, but it is highly recommended that the manufacturer-recommended junction box be procured and replace the current junction box. This will ensure that the MRU has proper power surge protection.



BPA Junction Box for Kongsberg MRU-Z: The current junction box contains no 1A fast fuse per the manufacturer's specifications. This fuse would prevent power surges from damaging sensitive electronics inside the MRU casing.

v. The MRU is now held stable with respect to the vessel reference frame in a proper mount.

b. **Panasonic Toughbook CF-52 Laptop** – Upon initial inspection of the BPA's acquisition/processing computer, several issues became apparent with the Microsoft Windows XP operating system, such as irregular system boot, user logon, system speed, and hardware settings (e.g. inoperable serial COM ports). To correct these issues, an attempt was made to download and install Windows Updates via the laptop's wireless internet connection, resulting in a catastrophic system crash. The crash, along with several other failed correction procedures, resulted from a computer virus attack. It is presumed that the virus was unintentionally downloaded sometime during the past year and laid relatively dormant until Windows attempted to run an update. The entirety of 3 March was spent with a local Microsoft Certified computer repair person who took the following actions:

i. The laptop hard drive was removed and swept for virus, malware, and spyware with an external computer; approximately 450 infected files were detected and either repaired or deleted. The hard drive contained replicants of two or three separate TrojanHorse viruses which were removed.

ii. Critical documents and survey-related files were cleaned, copied, and preserved for re-installation on the laptop.

iii. The newly cleaned hard drive was placed back into the laptop, formatted, and Microsoft Windows XP Professional re-installed.

iv. Avira and Symantec antivirus software were installed and updated; a full system scan was completed with no detections
v. System drivers were downloaded from vendor websites and re-installed
    - **Note:** Driver for the CD/DVD drive could not be found/downloaded. The BPA requires the original purchase date of the laptop be provided to Panasonic for download access to the complete laptop driver list. A request has been placed with the GoH Project Office for this information.
vi. All survey software was re-installed, including an updated version of HYPACK (2009a).
vii. A complete system retest was completed on 4 March verifying 100% system operability.

c. **Tide Gages** – As reported during the 2009 training period, the BPA's water level sensor (Valeport 740) was installed / leveled to a nearby benchmark network at the PBL pier and water level data collection commenced. The installation made use of existing tide gage infrastructure at the end of the pier that was originally part of a sea level monitoring project from approximately 1999-2000 (discussed in Section 13). The following details current tide monitoring events and capabilities resulting from the Phase 2 training period:
    i. Unfortunately, due to intra-country miscommunication and events beyond the control of the BPA, the Valeport gage was removed at the end of November 2009 by personnel from Belize's National Meteorological Service (BNMS) for installation of an Aquatrak water level gage. The Aquatrak gage is part of a project sponsored by the Caribbean Community Climate Change Centre (CCCCC).
    ii. Observations by James Rizzo (NOAA Tide Contractor) led to the impetus for meetings with the BNMS and CCCCC to discuss the current state of the PBL gage and potential future improvements and collaborations between BNMS, BPA, and CCCCC.
    iii. Following the meeting at BNMS, Mr. Albert Jones (Electronics Technician, BNMS) and Mr. Rudolph Williams (Hydrologist, BNMS), the primary points of contact for the PBL Aquatrak gage, expressed great interest in generating a cooperative agreement between BPA, BNMS, and CCCCC. The agreement would accomplish any or all of the following:
        1. Enable BPA personnel to take the lead on monitoring and maintaining the PBL Aquatrak gage in return for using its data as a primary tide station for hydrographic surveys
        2. Ensure BNMS holds primary responsibility for the PBL gage and its data through the CCCCC
        3. Request CCCCC provide necessary resources for proper training of BPA personnel on maintaining CCCCC equipment (including the PBL tide gage)
        4. Utilize the established data-basing capabilities of Mr. Rizzo's organization (Texas A&M University Corpus Christi Division of Nearshore Research, TAMUCC DNR) for collection and

dissemination of tide/meteorological data products on a long or short term basis

iv. Mr. Jones subsequently provided information to Mr. Rizzo via the NOAA trainer for data collection from the PBL station suite of instruments.

v. As of the writing of this report, PBL water level data appears inaccurate and the PBL gage requires inspection, maintenance, and/or repair.

vi. ***Detailed information on the Tide Training portion of the Phase 2 training period can be found in Mr. Rizzo's assessment, submitted separately from this report.***

vii. The BPA's Valeport 740 gage has been installed in a temporary mount configuration at the new BPA Port Operations Office. However, its data cannot be used for hydrographic survey until either:
    1. The primary station at PBL pier is made fully operational, or
    2. The gage is more permanently mounted and leveled to a benchmark network (which would need to be installed at Old Belize)

d. **R/V SEA KING Electrical Power** – Since conclusion of the 2009 training period, the BPA had been operating all survey equipment aboard SEA KING without any form of electrical surge or battery backup protection, plugging all equipment directly into vessel outlets and exposing the equipment to raw generator power.

i. To address this issue and prevent any potential future electrical damage to the survey equipment, the BPA purchased a Minuteman MBK 550E Uninterruptible Power Supply (UPS), which provides battery backup protection for sensitive instruments (i.e. GPS, side scan sonar, echosounder, MRU) and surge protection for all powered equipment.

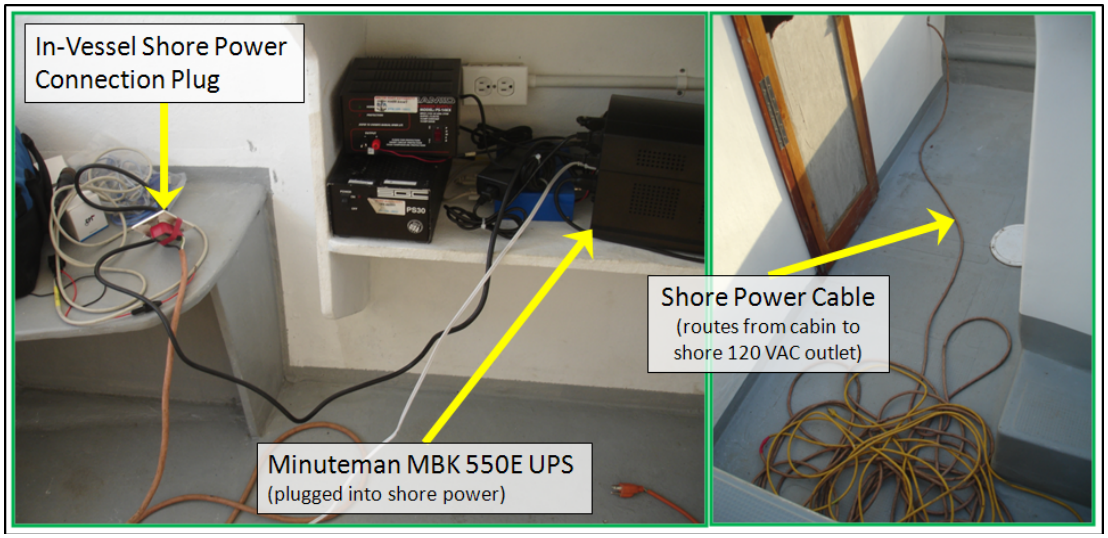
ii. Upon installation of the UPS into the electrical system, generator power was discovered to be highly unstable, with periodic voltage fluctuations from 60-145 VAC. An electrician and BPA engineer were consulted on how to correct this issue, at which point it was determined that:
    1. The generator's voltage regulator and/or load auto-sensing circuit was faulty
    2. The generator most likely does not meet minimum power requirements in order for all survey equipment and the air conditioning system to operate simultaneously

iii. All survey data acquired during the training period required a BPA engineer to remain onboard the vessel to provide near continuous manual adjustment of the generator and ensure power supplied to the UPS and survey equipment fell within allowable tolerances.

iv. In order for BPA to reliably conduct hydrographic survey, the electrical generator onboard SEA KING will either need a major repair/overhaul or replacement with a higher quality/rated marine-grade (not commercial or residential) generator.

v. During the Phase 2 training period, a temporary shore power solution for the vessel's hydrographic survey equipment was produced with available materials. The shore power supply consisted of splicing several extension cords together and plugging one end into an electrical outlet inside the

Operations Office. It is recommended that a more permanent shore power solution be integrated onboard SEA KING so that the vessel's existing electrical outlets can be used with or without generator power.



Shore Power manufactured for R/V SEA KING during Phase 2 training

e. **Reson Navisound 210** – The Reson Navisound 210 echosounder operated properly throughout the training period and appears to provide hydrographic survey quality data within IHO standards. BPA personnel will need to incorporate a calibration/check procedure with a bar, lead line, or second separate IHO-grade echosounder into their survey routine in order to verify its accuracy.

f. **Imagenex Yellowfin Side Scan Sonar** – The side scan sonar appeared to operate properly throughout the training period, with the following issues identified:

   i. Upon arrival, side scan sonar data were not being received by either HYPACK or the Imagenex Yellowfin proprietary software. Investigation revealed that network settings for the laptop's ethernet connection had been changed to allow for internet access. Network settings were reset for side scan sonar operation, correcting the problem. BPA personnel also received training on network connections.

   ii. The towfish does not provide an altimeter reading for towfish height above the bottom. In lieu of using an altimeter, the HYPACK Side Scan acquisition program has a digital altimeter which interprets the side scan data grams and estimates towfish altitude based on user-controlled settings. The altitude can also be manually edited during post-acquisition processing. Training on acquisition and post-acquisition altitude measurement was provided to BPA personnel.

   iii. Side scan sonar settings for imagery quality were normally best when controlled manually by the hydrographer, rather than through any automated settings. Also, the relationship between best towfish operating frequency versus range scale must be learned through practice and experience.

g. **HemisphereGPS Crescent VS-100** – The GPS operated properly throughout the Phase 2 training period. However, the receiver unit is currently mounted inside the cabin in a relatively unstable manner. The unit should be held inside the vendor-provided mounting brackets with four (4) mounting screws, whereas it is currently held in place with only two (2) screws. This mounting method may result in unreliable GPS positioning and/or heading/pitch measurement. It is recommended that the GPS be mounted with four (4) screws per the VS-100 operating manual.

GPS Receiver Unit: The Crescent VS-100 GPS receiver is currently held in place in its mounting brackets with only two (2) screws rather than four (4) screws as stated in the operating manual.

h. **Reson SVP-15** – The Reson SVP-15 sound velocimeter operated properly throughout the training period.

7. **General Equipment Maintenance** – It was a welcome sight to see the great pride that BPA personnel take in their suite of hydrographic survey equipment. Following each day of survey, personnel give the side scan sonar towfish and sound velocimeter a fresh water washdown. They also maintain a high level of awareness with respect to cable and electronics preservation, minimizing trip hazards and other potential causes of accidental damage and injuries. If the equipment is not to be used for an extended period of time, personnel lock the equipment either in the Operations Office or onboard the vessel in designated boxes and storage areas. It is recommended that the BPA purchase Pelican-type cases for the side scan sonar, GPS, and single beam echosounder components to provide an added level of storage and shipping protection for these sensitive electronic systems.

8. **Loss of Planned Boat Time** – As may be seen in Section 6 of this report, on-the-water training was limited by a few primary issues:
   a. Irregular generator power (approximately 2 total survey days lost)
   b. Incorrect MRU installation (approximately 1 survey day lost)

c. Computer virus recovery (approximately 1.5 survey days lost)

It should also be noted that unlike the 2009 training period where a premium was placed on on-the-water training, the intent of the Phase 2 training was to take a small survey area through all phases of planning, acquisition, processing, and product generation. This process therefore required less time in the vessel and more time in the office.

9. **Classroom Training** – As all of the BPA trainees had been exposed to basic hydrographic classroom training either from NOAA training in Norfolk, Virginia, or the 2009 in-country training period, less emphasis was placed on basic hydrographic principles and more emphasis on data processing. Classroom (office) training followed the outline:

    a. Advanced (Holiday and Feature Development) Line Planning
    b. Tide data processing
    c. Sound Velocity data processing
    d. Single Beam Echosounder data processing
    e. Side Scan Sonar data processing, targeting, and mosaicing
    f. XYZ plot generation
    g. Other bathymetric products
    h. Report of Survey

    As was the case in 2009, HYPACK training modules led the trainees through each part of the planning-acquisition-processing data pipeline. BPA survey personnel also received general Windows training, although they did exhibit noted improvement in overall survey system and Windows computer operations when compared with skill levels observed in 2009.

10. **Primary Lessons Learned** – The Phase 2 training period provided a great deal of quality training time, despite relatively limited on-the-water training. The following details some of the primary lessons learned during both on-the-water and in-office training:
    a. **Planning & Coverage**
        i. The hydrographer should check all hardware devices, offsets, and serial communications prior to beginning survey. Serial communications may be checked in either Windows Hyperterminal or HYPACK WCOM32.
        ii. If unsure of the extent of a particular survey area prior to commencing acquisition, use HYPACK targets when in the field to outline the area and then Line Editor to develop an appropriate line plan within the targets.
        iii. When developing a line plan, use both the chart and reconnaissance bathymetry (if available), to determine appropriate range scale, towfish altitude (a function of water depth and range scale), and desired side scan operating frequency. Line plans may need to be altered in the field based on system performance and surveyed water depths.
        iv. Use side scan mosaics from separate 100% and 200% lines to determine holiday line plans for each coverage area
        v. Use side scan contacts to generate star-pattern echosounder development line plans. If two targets appear to be the same feature but have horizontal separation, ensure the line plan covers at least the area between them.

vi. 200% side scan sonar, concurrent single beam bathymetry, and single beam crosslines provide adequate coverage for an IHO specification survey.

b. **Survey Safety**

i. Prior to commencement of each survey day, all personnel (including non-survey personnel) should participate in a pre-operations safety briefing led by the designated Lead Hydrographer on the vessel. The briefing should include but not be limited to:

1. Area to be surveyed and survey equipment to be used (i.e. echosounder only, echosounder with side scan sonar, etc)
2. Vessel chain of command and proper communications
3. Assessment of environment (i.e. traffic, bottom depth, weather, etc)
4. Proper deployment and recovery of the side scan towfish
5. Responsibilities during normal operations
6. Responsibilities during emergency situations (i.e. fire, snagged towfish, flooding, man overboard, etc)
7. Other issues/concerns

ii. When deploying and recovering the towfish, no other operations (i.e. survey) should occur; 100% of the crew's attention should be focused on towfish and personnel safety. The vessel should make way toward safe water, and positive communications between all crewmembers should be maintained.

iii. From towfish deployment to recovery, the vessel should always be making forward way. Exceptions may be during emergencies, at which point personnel should understand responsibilities and priorities.

iv. When the towfish is deployed, attention should be given to the angle of the towcable during turns.

v. When the towfish is recovered, measures should be taken to discharge any static electricity on the towfish prior to any personnel skin contact. This may include securing the towfish power, wearing safety gloves, and using a metal rod to ground the towfish to the deck.

c. **Acquisition**

i. Prior to commencing any data acquisition, ensure all desktop windows are visible and configured to the hydrographer's liking. The repeated Survey Map display for the coxswain/captain should use larger fonts for legibility. All program windows should be separated from each other to enable simultaneous monitoring (i.e. side scan waterfall, side scan signal, echosounder depth output, acquisition log, side scan controls, etc).

ii. Selection and logging of planned survey lines may be accomplished either with the mouse cursor and HYPACK menus or via the numerous HYPACK hotkeys. Hotkeys are generally easier to use when acquiring data in a dynamic marine environment.

iii. While there are numerous duties of a hydrographer during acquisition, primary focus should be on the safety of personnel and any equipment deployed over the side of the vessel, i.e. the side scan sonar towfish.

Therefore, a typical hydrographer routine during side scan sonar acquisition should follow something like:

1. Check towfish altitude and adjust cable out as necessary to maintain towfish within survey parameters (update layback in HYPACK)
2. Monitor HYPACK Map and Data Display for proper vessel positioning on the survey line and resulting sonar coverage
3. Check towfish altitude and adjust cable out as necessary
4. Check echosounder display for water depth trends
5. Check towfish altitude and adjust cable out as necessary
6. Check side scan sonar waterfall display for contacts of interest and/or proper bottom detection settings
7. Check towfish altitude and adjust cable out as necessary
8. Update acquisition log with hydrographer observations for each line
9. Check towfish altitude and adjust cable out as necessary

iv. While different people think and process information in different ways, the vessel coxswain/captain should use all available display information during survey acquisition to maintain the vessel on the selected survey line.

v. Don't be afraid to tweak settings (i.e. range scale, frequency, gain, pulse rate, etc) on the echosounder and side scan sonar in order to clean and/or clarify incoming data. This process should preferably occur prior to data acquisition but may be necessary during acquisition due to changing conditions (bottom type, seas, weather, etc). At the same time, do not try to over-clean your data stream and eliminate good raw data which can be corrected during post-processing. Ensure any changes you make to the system are documented properly in the acquisition log; update the line plan if necessary.

vi. Having a clean towfish altitude trace during acquisition prevents extensive post-processing work.

d. **HYPACK Single Beam Echosounder Processing**

i. Tide correction files should be generated manually in HYPACK from reviewing downloaded tide files from whichever gage(s) are used for the given survey. Generally, entry of high and low tide values/times with spline interpolation in between will provide sufficient tide correction for bathymetric soundings, but full entry of all 6-minute tide readings will ensure that the survey meets IHO specifications.

ii. Sound velocity profiles may be imported directly from raw SVP-15 data files using the HYPACK Sound Velocity conversion program.

iii. Filters should not be used unless it is understood what impact they will have on the data and permission is granted by the Chief Hydrographer.

iv. When cleaning single beam data, ensure that real data are not confused with noise/fliers and accidentally cleaned. This applies to both echosoundings and horizontal (GPS) positions.

v. Just as important as the acquisition log, ensure the processing log is filled out as data processing occurs.

vi. Use XYZ files, smooth sheets, and other 2D/3D products generated from them (TINs/geo-tiffs) to further identify features and bathymetric noise that may require cleaning. These products may also be used for displaying overall survey results.

e. **HYPACK Side Scan Sonar Processing**
   i. Follow the HYPACK process of side scan review and processing. Do not conduct target search/analysis or mosaic generation without reviewing and editing towfish altitude for all lines first.
   ii. When selecting side scan targets for development and/or review, document as thoroughly as possible to prevent confusion and simplify reporting.
   iii. Ensure to update the processing log as side scan processing occurs.
   iv. Don't be afraid to make assessments on targets (i.e. two targets from different lines are the same target). This will help the Chief Hydrographer make better decisions on contact development and survey time management.

f. **Valeport 740 Tide Gage Operation**
   i. Inspect the gage during each visit for mount stability and sensor obstructions.
   ii. During each download session, check battery voltage and monitor long term voltage trends to anticipate when battery replacement will be required and minimize sensor downtime.
   iii. When downloading data, it is highly recommended that data files from previous days be moved to separate day folders on the laptop to prevent overwrite and data loss during the Valeport's automated download process.
   iv. Following data download and gage initialization, ensure that the Switch Plug (vice any of the blank caps) is replaced on the DATA port of the Valeport box; verify the LED flashes following plug replacement. Otherwise, water level data collection will not (has not) commence(d).

g. **Reson SVP-15 Operation**
   i. A proper sound velocity cast consists of a full set of readings from the surface to the bottom, vice one reading at the surface or bottom.
   ii. Ensure the sound velocimeter is properly charged and initialized prior to commencing a sound velocity cast
   iii. Ensure the sound velocimeter is deployed over the windward side of the vessel while dead-in-the-water.

h. **Troubleshooting** – Reiterating a lesson learned from 2009, when conducting troubleshooting, follow the NOAA Hydrotraining methodology:
   i. Check power
   ii. Check physical connections
   iii. Check power
   iv. Check equipment status lights/indicators
   v. Check power
   vi. Check software settings
   vii. Check power

11. **Assessment of BPA Post-Training Capability** – Using training objectives discussed during the 10th MACHC Conference (Barbados), and detailed at the beginning of this report, BPA personnel have received instruction and basic experience in the following:
    a. Tide gage installation and data management
    b. Pre- and Intra-Survey planning
    c. Acquisition & processing of hydrographic survey data to IHO standards
    d. Troubleshooting and minor repair of hydrographic survey systems
    e. Generation & transmission of IHO standard survey products to the UK Hydrographic Office for nautical chart updates

    Additionally, BPA personnel have a working level of knowledge with respect to employing quality assurance methods throughout the entire field hydrographic survey process.

12. **Future Work** – While training has been received and some experience gained with the following items, future work that may require either remote or in-country assistance includes:
    a. Generation of a completed Report of Survey, including survey results and applicable amplifying information and appendices
    b. Finding and developing navigationally significant side scan targets of interest
    c. Developing a robust tide gage and benchmark network to provide adequate water level coverage for the entire Belizean coastline
    d. Long-term data archiving and security
    e. Generation of a billing schedule for hydrographic survey activities
    f. Inclusion of error model / budget in final survey results

13. **CCCCC Meeting** – A half day was taken on 10 March to travel to Belmopan and visit the Caribbean Community Climate Change Centre (CCCCC). Unfortunately, the lead managers for CCCCC were not in-country (particularly Dr. Kenrick Leslie, Executive Director). Instead, a meeting was held with two other CCCCC employees, Dr. Mark Bynoe (Environmental / Resource Economist) and a sea level researcher at CCCCC.
    a. Discussion topics focused around function of the CCCCC and its role with the PBL gage, even though Dr. Leslie is the main point of contact for that gage.
    b. The original tide / meteorological station at PBL (infrastructure discovered and used during the 2009 training) was established through the Caribbean Planning for Adaptation to Climate Change project (CPACC) in the late 1990s. It has been re-established by the Belizean government and is part of the Mainstreaming Adaptation to Climate Change in the Caribbean project (MACC). Each of these projects receives funding support and oversight from the CCCCC.
    c. A meeting is scheduled for the end of March that will involve the National Focal Points for participating Caribbean Community (CARICOM) nations of the current projects (i.e. MACC). This meeting will be used to discuss the regional tide/meteorological station framework with respect to leveraging data from and providing continuous maintenance of existing CARICOM stations.
    d. The proposal described in Section 6.c.iii of this report was discussed and both CCCCC members agreed that the agreement sounds mutually beneficial for all parties involved (CCCCC, BPA, and BNMS). However, final approval for CCCCC involvement will need to come from Dr. Leslie.

e. Upon inquiring if an outside contractor (such as TAMUCC DNR) could attend the meeting to discuss supporting a CARICOM regional database, it was suggested that the BPA may want to send a representative first to evaluate whether or not a contractor would be needed or desired. Currently, CCCCC plans to build and maintain a record clearinghouse and database for the CARICOM station network.
    i. If Mr. Rizzo were allowed to attend and/or become involved, it would be as an advisor to the Belize National Focal Point through the BPA
f. Michael Jenkins (BPA Chief Hydrographer) is scheduled to meet with Dr. Leslie regarding the above issues.

14. **New BPA Leadership / Current BPA Goals** – A meeting was held with the BPA's new Ports Commissioner (Major John Flowers) and Mr. Jenkins to discuss primary concerns and goals of the BPA with respect to the hydrographic survey program and desires for cartographic changes in Belizean waters.
    a. Several groundings have occurred inside and outside the MesoAmerican Barrier Reef. Major Flowers believes this is due to (1) mariners not paying attention to current charted features, but also to (2) mariners having no obvious charted direction of where to go when entering and exiting Belizean waters. He therefore wishes for a "Recommended Traffic Scheme" be placed on the chart that passes through the outer reef areas and into/through inside reef waters.
        i. An outer reef traffic separation scheme is the most likely to be rapidly added to the chart, since water depths between outer reefs are typically very deep with respect to surface navigation.
        ii. The inside reef traffic separation scheme will probably require hydrographic surveys to support updated charted depths (shallower water).
        iii. Following completion of survey in critical areas, the hydrographic survey program will shift its focus to reef mapping. Critical areas include approach channels, pier basins, and anchorages.
    b. One of the frustrations Major Flowers faces is that the BPA has requirements for port businesses to maintain particular water depths at their pier faces. Prior to 2009, BPA had no verifiable method of enforcement, but now the hydrographic survey program can be used to enforce dredge requirements and legally support findings.
    c. Major Flowers understands that to conduct hydrographic survey outside of the reef, the hydrographic survey program will require a larger, more seaworthy vessel.
    d. Major Flowers is supportive of the hydrographic survey program. He has already taken steps to try and expand the capacity of the BPA by hiring more personnel. This action will hopefully result in expansion of the BPA budget and spill over into the hydrographic survey program with increased resources and personnel.

<u>Closing Thoughts</u>:

1. **Accomplishment of Objectives** – As is expected in hydrography, several obstacles were encountered during the Phase 2 training period. Despite these obstacles, BPA hydrographers received a great deal of quality training and successfully worked through numerous challenges. The BPA team completed 90% acquisition of a 200% side scan sonar survey in the Kings Pier basin with concurrent single beam bathymetry. Personnel

adequately processed and scrutinized all side scan and single beam data through various quality control measures. Post-processing line plans were created for a collection of side scan targets and coverage holidays. Several products were generated, including XYZ files, smooth sheet plots, side scan mosaics, and geo-tiff images. The Report of Survey has been started and should be ready for transmission to UKHO within weeks of survey completion.

2. **Equipment and Platform Recommendations** – As discussed in Sections 5, 6, and 7 of this report, several issues should be considered and addressed to ensure the success of BPA Hydrography. Issues include:

    a. Integration of vessel safety measures
        i. Hand railings & coxswain stand shelter
        ii. Engine compartment forced ventilation
        iii. Remote-controlled & metered towcable winch
    b. Survey equipment preservation
        i. New marine-grade generator
        ii. Vessel-integrated shore power connection
        iii. Manufacturer-recommended MRU junction box
        iv. GPS receiver mounting
        v. Pelican storage/shipping cases
        vi. Periodic computer antivirus updates/scans
    c. IHO Survey Requirements
        i. Integration / maintenance of operational and leveled tide gage(s)
        ii. Calibration of survey equipment
            1. Single beam echosounder – daily/weekly lead line / bar check / etc
            2. Sound velocimeter – annual vendor calibration/inspection
            3. Side scan sonar – bi-annual vendor calibration/inspection
            4. GPS – annual positioning test
            5. MRU – vendor-recommended calibration/inspection

3. **Management Support of Hydrographic Survey Program** – As is the case with nearly every organization, budgets are always tight, but the saying, "You must spend money to make money," also applies. Existing bureaucratic processes sometimes make procurement of materials and labor difficult, but I was led to believe and observed that BPA management is supportive of the hydrographic survey program. On a few occasions, particularly at the beginning of the Phase 2 training period, emergent expenses were immediately authorized to ensure a successful training session. In the brief time I was able to speak with Major Flowers (Ports Commissioner), he expressed great interest in the products provided by hydrographic survey as well as commitment to expanding BPA's hydrographic survey capacity. He is eager for the program to begin production in order to both update Belize's nautical charts and legally enforce various BPA regulations.

4. **Communications** – In order for any program to succeed, positive and open communications are mandatory. BPA has begun to communicate its hydrographic capability and resulting national economic and conservational benefits via Belizean media outlets on television and radio. Successful completion of hydrographic surveys and the

various products resulting from them will inevitably further public support for hydrography. I also recommend that the BPA provide continuous reporting of BPA's accomplishments and needs to the various players involved in this project (GoH Project Office, MACHC, Belize partners such as CCCCC and BNMS, etc.), as that will increase the opportunity for program longevity while accomplishing short term goals (i.e. follow-up training visits, procurement of improved/advanced technologies, etc.).

5. **Follow-up Work & Visits** – BPA Hydrography now possesses all tools and access to knowledge needed to successfully conduct an IHO survey. The key for program success will come from open positive communication and learning through practice and experience.
    a. BPA Chief Hydrographer Michael Jenkins and I will be working together via telephone and e-mail to finalize the Phase 2 training survey of the Kings Pier basin and complete the adjoining Report of Survey. Unfortunately, this survey will not have IHO standard tide correction, as the water level data from neither the PBL gage nor BPA's Valeport gage are usable. However, using predicted tides from the BNMS should provide enough of a correction for a "preliminary" product to the UKHO for evaluation and future reference.
    b. Future surveys must include observed water level corrections from a leveled tide gage (either the PBL Aquatrak gage or the BPA Valeport 740) in order to meet IHO specifications. Assistance will most likely be required from any of the CCCCC, BNMS, or NOAA via TAMUCC DNR in order to ensure proper tide station installation, datum correction, and maintenance.
    c. A visit to Belize may be warranted next year by a NOAA trainer (myself or another representative, perhaps cartographic) and/or a tide trainer (such as Mr. Rizzo of TAMUCC DNR). Evaluation of required visits and/or in-country work and training will occur over the next few months as the BPA Hydrography program progresses.

Gulf of Honduras Phase 2 Training Group (Belize Ports Authority). In front of R/V SEA KING at Old Belize / BPA Operations Office. From left to right: Darrell Ramclam, Robbie Barrow, Michael Jenkins, Chris van Westendorp (NOAA), Zachary Young, Michael Usher