Trip Report:
Gulf of Honduras Project
Phase 3 Hydrographic
Training Mission to Belize

14 March 2011

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MEMORANDUM

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

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Jeffrey Ferguson, Chief, Hydrographic Surveys Division
CDR Rick Brennan, NOAA, Chief, Atlantic Hydrographic Branch

Subj: Trip Report for Gulf of Honduras Project Phase 3 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. From 2008-2010 Belize developed its first hydrographic survey program through the Belize Ports Authority (BPA), with assistance from the GoH project and MACHC through the following hydrographic survey capacity building measures:
    a. Hydrographic survey equipment
        - Procured through the GoH Project Coordinating Unit, located in Puerto Cortes, Honduras (2008)
        - 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. Primary and Secondary training in hydrography with some background in nautical charting
   - Provided by NOAA representatives both in the United States and Belize (2009 and 2010)

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

3. At the 11th MACHC Conference held in Suriname (November 2010), the three GoH countries jointly requested a third and final phase of hydrographic survey training be provided by the MACHC to build upon and solidify knowledge and experience gained during the 2009-2010 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 supervision and evaluation of hydrographic survey operations and equipment
3. Provide refresher / continuing 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
4. Generate & transmit IHO standard survey products to the UK Hydrographic Office for nautical chart updates

Accomplishment & Action Summary

Upon completion of Phase 3 Training, BPA Hydrographers:

- Completed acquisition and processing of a 200% Side Scan Sonar survey with accompanying single beam echosounder bathymetry in the Port of Belize Pier basin
- Generated accompanying products for this survey, including XYZ files, smooth sheet plots, side scan mosaics, and geo-tiff images
- Began UKHO / IHO compliant Report of Survey (to be delivered Spring/Summer 2011)
- Began formalizing acquisition plans for remaining critical survey areas
- Commenced formulating plans and necessary budget items for a sustainable national hydrographic program, such as:
  - Vessel design, procurement, repair, and maintenance with accompanying hydrographic equipment
  - Fuel, employee salaries/time, and resources

- Continued training and equipment calibration/repair visits from hydrographic programs and vendors
- Positive communication up and down the chain of command to provide accomplishments and products that correlate with customer/government needs while justifying resource requests and investments

- Will provide a summary of accomplishments, lessons learned, and in-kind investments to MACHC/CBC (to be delivered Summer 2011)

Training Timeline:

Date	Training Location(s)	Training Accomplished
2/20	Arrival day – No training	
2/21	Office	Requirements for sustainability of hydro programs; interpreting tide station data
2/22	Office / PBL Pier	Tide gage installation; personal computer protection measures
2/23	PBL Pier	Tide gage installation and testing
2/24	PBL Pier	Tide gage testing
2/25	On-the-water (4 hours)	System set-up, start-up, acquisition, shut-down, break-down
2/26	On-the-water (3 hours)	System start-up/shut-down, acquisition/planning, 100% SSS & VBES acquired
2/27	Sunday – No training	
2/28	On-the-water (6-8 hours)	Acquisition/planning, 200% SSS & VBES acquired; troubleshooting
3/1	Office	Data processing (SSS targeting/mosaicing); requirements for sustainability of hydro programs
3/2	Office	Data processing (SSS target/mosaic, VBES cleaning/ correction, sounding selection); Development/holiday line plan
3/3	On-the-water (6 hours) / PBL Pier	Acquisition/planning; holidays & developments acquired; tide gage download and testing
3/4	Office	Data processing (Tide correction to bathymetry); requirements and plans for sustainability of hydro programs
3/5	Office	Data processing (sounding selection, development verification, quality control checks); reporting
3/6	Departure day – No training	

Narrative / Observations:

1. **Dates and Location of Training** – In-country training was conducted with BPA personnel from 21 February to 5 March 2011, yielding 12 total training days. The training took place in Belize City at the new BPA Port Operations Base / Office, the survey vessel mooring at Old Belize, and areas in and around the Port of Belize Limited (PBL) pier.

2. **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 (estimates

between 80,000 and 100,000 people). 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.

3. **New Port Operations Base** – The BPA has been experiencing some positive changes over the past 2-3 months, moving into a brand new operations building. Sitting on land that adjoins a new Belize National Coast Guard (BNCG) facility, it provides an ideal location for all BPA activities, including hydrography. Unfortunately no pier or mooring facilities have been built on the site thus far, but plans are to either enter into an agreement with the BNCG to use the mooring currently under construction or build a separate pier exclusively for the BPA.

New BPA Port Operations Base – Approximately one mile north of previous operations station at Old Belize marina.

New BNCG Facility (left) – Land adjoins BPA Port Operations Base. A new jetty and pier structure from the new Coast Guard facility is under construction (right) and may be available for BPA use in the future.

4. **Previous Training Sessions** – As stated in the Background section of this report, BPA personnel received both basic and advanced hydrographic survey training from 2009-2010. Although no official hydrographic products were produced during these sessions, and despite facing several challenges during the training periods, the BPA hydrographic team had the ability to begin collecting hydrographic survey data and adequately process it to IHO standards for nautical chart updates.

5. **R/V SEA KING Update** – After the 2009 training session, R/V SEA KING was designated as BPA's hydrographic survey vessel, complete with an enclosed and air conditioned cabin, mounted single beam echosounder, and electric generator. Several issues became evident during and following the 2010 training session; some new issues also appeared during this 3rd phase of training. This section addresses various components that impact vessel readiness for hydrographic survey.

    a. **Electric Generator** – In addition to suffering from numerous mechanical problems, the vessel's original generator (from 2009-2010) did not meet the power requirements for all electrical systems (including survey equipment) to operate simultaneously. Following several attempts to salvage the old generator, a new generator was purchased following the 2010 training session. While this generator is not marine-grade (designed to be mounted inside a vessel's engine compartment), it does meet power requirements for survey.

New Generator used aboard R/V SEA KING

    b. **Vessel Integrity / Maintenance** – Several engine breakdowns prevented SEA KING from conducting any hydrographic survey acquisition following the 2010 training session, but the vessel remained in the water throughout this period. SEA KING was subsequently lifted from its mooring at Old Belize during a hurricane storm surge and deposited further into the marina on top of a pier; the vessel appeared to be spared from any major damage from this event. Upon my arrival in Belize, the decision was made to attempt hydrographic survey with only one of the two engines rather than continue to wait for parts and repairs on the second engine. On-the-water hydrographic survey days resulted in few mechanical difficulties while operating on the one engine, although the vessel showed several signs of relative neglect, such as the state of the cabin door (see image below). Presumably, numerous stresses from the aforementioned hurricane, combined with a relative lack of vessel maintenance over the past year, greatly reduced SEA

KING's seaworthiness and resulted in the vessel sinking at the end of the Phase 3 training. Fortunately no topside survey equipment was onboard during the sinking, so damage is limited to the engine compartment and vessel electrical system. It should be noted that the issues leading to the sinking are being addressed now, including patching the hull, replacing/repairing shaft seals, and repairing the existing engines.

Cabin Door shows serious signs of neglect and should be replaced with a more marine-grade door.

Sinking at the Pier – R/V SEA KING at Old Belize on the last day of Phase 3 Training.

c. **Safety** – Following the 2010 training session, BPA effected several safety-related improvements to R/V SEA KING, including the addition of hand rails around the main deck, coxswain stand, and coxswain stand steps. Additionally, a small enclosure was added to the coxswain stand to try and protect the coxswain survey monitor display. Some safety issues still exist and/or became evident during the Phase 3 training session:
    i. The size and design of the new electric generator (approximately 1000 lbs) forces BPA personnel to place it on the boat's afterdeck, rather than inside the covered engine compartment. Additionally, since the survey vessel is located in a somewhat unsecured area at Old Belize, the generator must be loaded onboard and removed from the vessel each survey day. This procedure requires at least five personnel and presents significant injury risk to all involved (trip / burn / accessibility hazard).

BPA Personnel loading new electric generator onboard R/V SEA KING.

ii. Side scan sonar towing is still done by hand with a deck-lain cable. Also, the new hand rails now block access to the towpoint from inside the vessel (trip, snag hazard).

Generator Placement & Hand SSS Towing present safety hazards to BPA hydrographic personnel.

iii. Engine compartment hatches continue to be left open during vessel operation to provide natural air cooling of the engines (fall / trip hazard).

Engine Compartment Hatches are left open during vessel operation.

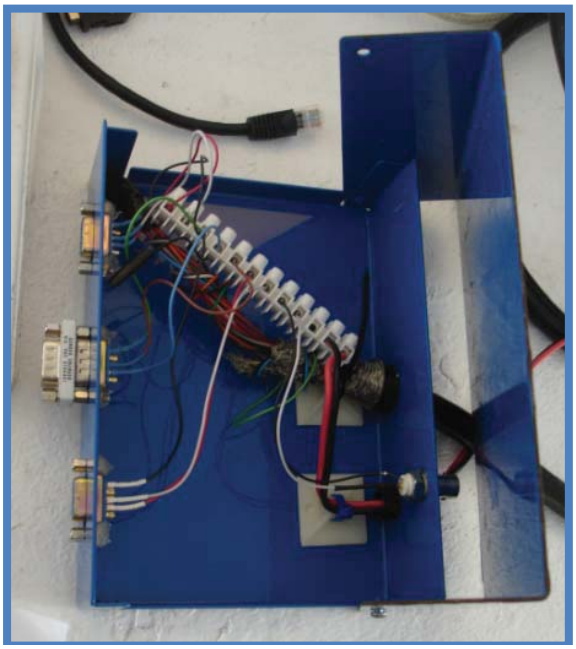
iv. No handrails are installed inside the cabin and only one of three available cabin chairs can be secured to the deck (fall / trip hazard).
v. The anchor locker on the bow has no cover (fall hazard), which resulted in injury to a BPA hydrographer during vessel mooring.
vi. In the event a fuel transfer from the engine compartment to the generator is required to continue survey operations, BPA personnel lack appropriate equipment, resulting in fuel spills on the main deck and in the engine compartment (slip, fall, fire hazard).

6. **State of Survey Equipment** – 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 and 2011 training sessions. The following details specific equipment issues:

    a. **Kongsberg MRU Z** – The MRU-Z junction box remains the same from last year, with no 1A fast fuse protection (per MRU-Z manual). Due to a series of miscommunications between Kongsberg Seatex, BPA, and the GoH Project trainers and office, the MRU was delayed in being returned to Belize from calibration. However, it arrived during the first week of the Phase 3 training period and was installed and successfully operated from the first day of on-the-water acquisition (25 February). Issues encountered and/or corrected include:
        i. One of the reasons for the calibration (aside from the manufacturer's recommendation of once per year) was an apparent lack and/or incorrect heave signal from the sensor. Upon investigation by Seatex personnel, it was determined that the MRU mount, and thus the MRU, were installed incorrectly (upside down) in 2009/2010. The mount onboard SEA KING

was re-installed correctly during the Phase 3 training session and appears to now provide correct heave output values.

ii. When examining data output in the vendor supplied MRU software, it appears that while the Heave and Pitch signals are correct, the Roll signal is out by approximately 180 degrees. While this error may be due to incorrect interpretation of the Roll signal by the PC and/or software (also seen in Hypack), it is not necessarily a critical problem for current hydrographic goals. Single beam bathymetry does not necessarily require a Roll signal to meet IHO Order 1 standards, particularly in shallow water, but this issue will need to be addressed with Kongsberg Seatex if the BPA intends to use the system with a multibeam echosounder.



BPA Junction Box for Kongsberg MRU-Z: *[picture from Phase 2 training]* 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.

b. **Panasonic Toughbook CF-52 Laptop** – A computer virus attack adversely impacted the Phase 2 training session, causing significant damage to the laptop's operating system and some BPA hydrographic files. Following a thorough cleaning of the hard drive and restoration of most of the software and drivers, a local computer technician installed two antivirus programs to prevent further computer virus issues. Computer issues encountered during the Phase 3 training session follow:

i. Of the two antivirus programs, only one (Symantec) appears to have automatically updated itself successfully. The second program (Avira) had its last antivirus signature update at the end of March 2010. Fortunately, the

Symantec program showed evidence of preventing several separate virus attacks over the course of the last year. To verify the laptop was properly cleaned of viruses, I installed a full version (3 year license) of Avira and ran several full scans with current virus signature updates. During this process, 97 infected files were found by both Avira and Symantec. Without going into great detail, it appears the programs are performing as expected and have prevented a second virus outbreak on the computer. No adverse effects were witnessed during the training session to suggest the damage of any software or files.

ii. In order to recover from the 2010 virus attack, the computer technician installed new Windows XP Professional operating system software. Unfortunately, since the software was not from a validated license, it appeared that Windows updates could not be installed on the laptop. During this training session, I enabled automatic updates and the operating system successfully updated itself without requiring software validation.

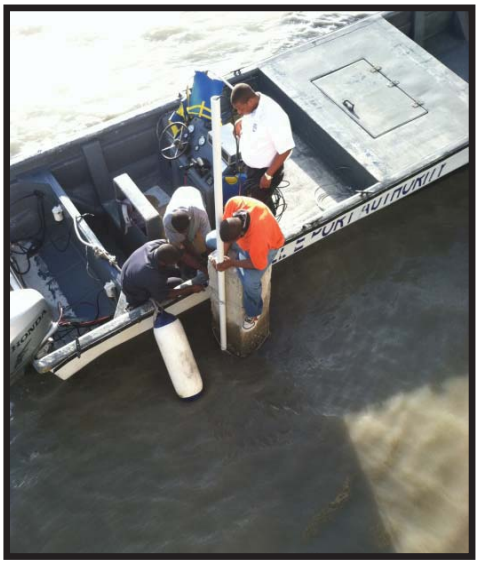
iii. Following the 2010 recovery, the driver for the laptop's CD/DVD drive could not be found. Following the Phase 2 training session, the driver was located on the Panasonic website but attempts to install it proved unsuccessful.

c. **Tide Gages** – Following Phase 2 training, a Memorandum of Agreement (MOA) was generated between the BPA, Caribbean Community Climate Change Center (CCCCC), and Belize National Meteorological Service (BNMS) to jointly monitor and maintain the Aquatrak tide station at PBL. A website developed by the Texas A&M University Corpus Christi Division of Natural Resources (TAMUCC DNR) provides near real-time data from the PBL tide station as well as the accompanying meteorological components. Additionally, the Valeport 740 tide gage provided to BPA through the GoH Project remained in operation at the Old Belize marina, collecting data until November 2010.

i. Prior to Phase 3 training, BPA personnel verified with BNMS that the PBL tide station was operational but did not view or analyze the data stream. Upon commencement of training, the PBL gage data was downloaded with assistance from James Rizzo (TAMUCC DNR tide trainer from 2010) and analyzed for the resultant tide signal and accuracy. Analysis and a subsequent visit to the PBL tide gage revealed significant problems with the tide station that should be addressed by BPA, BNMS, and CCCCC jointly under the 2010 MOA. Further investigation suggests that BNMS personnel who co-signed the 2010 MOA have since retired and passed down little/no information on the tide gage or MOA to their respective reliefs.

PBL Tide Gage on 22 February 2011 – The Aquatrak system appears to have sustained significant damage from storm and/or shipping activity at the pier head. The lower mounting clamp and lower sections of the outer (well) and inner (sounding tube) PVC piping have been removed.

ii. Unfortunately, although the Valeport gage operated for several months at Old Belize, it was never leveled to a benchmark network, so its relative vertical position was never monitored or recorded. That being said, the gage did collect a significant amount of data to show BPA personnel a tide pattern for the area. With the PBL Aquatrak out of commission and in order to have tide data to apply to bathymetry collected during the training period, BPA personnel installed the Valeport at PBL on a concrete piling separate from the pier. Using their previous tides training experience from 2009-2010, they successfully mounted the sensor to a PVC pipe, mounted the pipe to the piling, and properly leveled the sensor to a benchmark at PBL.



Mounting the Valeport 740 Tide Gage – Fixed to a 1-inch PVC pipe, the sensor was mounted inside a protective 3-inch PVC pipe well (left). BPA personnel strapped the well to a concrete piling near the PBL pier (right) and manually measured the distance between the sensor and top of the well to provide a leveling point to the benchmark.

iii. Following gage installation, Valeport 740 water level data showed a realistic tidal period. However, the water level ranges as well as the measured physical position of the sensor in the water column compared with corresponding data readouts appeared inaccurate. With assistance from Valeport Technical Support, several troubleshooting steps were run on the sensor both in and out of the water and revealed a problem with its transducer and/or the cable. Despite these issues, BPA personnel applied the data for tide correction of training period bathymetry based on two major points of justification:
    1. The training period and its objectives were time sensitive.
    2. Water level data approximated expected tide cycle values closely enough to maintain the survey within IHO Order 1 standards (see data results in 12).

d. **Minuteman MBK 550E Uninterruptible Power Supply (UPS) and Shore Power** – During Phase 2 training, a UPS was purchased and integrated into the BPA hydrographic survey system for surge protection and battery backup of critical survey instruments. Throughout the Phase 3 training period, the UPS provided adequate surge protection, but the battery light indicated a fault, most likely due to battery failure. The survey equipment therefore has no battery backup in the event of a loss of power. R/V SEA KING also still has no shore power capability short of connecting an extension cord to the UPS when the vessel is moored.

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 still 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 (SSS)** – The SSS appeared to operate properly throughout the training period, and BPA personnel have a solid understanding of its basic and advanced operating capabilities and procedures. In a few instances during survey acquisition, the SSS displayed intermittent connectivity issues, but these were corrected by removing the towfish from the water, examining and tightening topside and wet end connections.

g. **HemisphereGPS Crescent VS-100** – The GPS operated properly throughout the Phase 3 training period. However, the receiver unit is still mounted inside the cabin in a relatively unstable manner (issue identified in 2010). 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: *[picture from Phase 2 training]* The Crescent VS-100 GPS should be secured using four (4) screws, vice two, as stated in the operating manual.

h. **Reson SVP-15** – The Reson SVP-15 sound velocimeter operated properly throughout the training period, although it required a full 12-hour charge prior to operation.

7. **BPA State of Hydrographic Readiness** – Although BPA personnel received several sessions of basic and advanced hydrographic training in 2009 and 2010, they demonstrated only basic levels of knowledge at the beginning of Phase 3 training. Fortunately, the collective group of training participants "ramped up" fairly rapidly once given a refresher in most all training topics. However, the degradation of their knowledge from 2010 until now can only be attributed to a lack of survey experience. Similarly, the state of the survey vessel indicates a general lack of attention to hydrographic operations. Upon completion of Phase 3 training, the hydrographic team was ready to continue practicing survey and begin generating products for the UKHO and other Belize marine stakeholders. Their success depends solely on the active support of all levels of management with regards to survey time and resources.

8. **General Equipment Maintenance** – While BPA hydrographic survey equipment is well-maintained, it clearly had not been used much since the Phase 2 training period. Additionally, the equipment is still stored and transported in the original cardboard shipping boxes and plastic bags. It is again highly recommended that the BPA purchase Pelican-type cases for all survey components to provide an added level of storage and shipping protection for these sensitive electronic systems.

9. **UKHO ARCS Charts** – One of the bigger challenges for BPA hydrography throughout each of the three GoH Project training phases was and is the unfortunate lack of UKHO ARCS charts. Despite several attempts with UKHO assistance to update the ARCS license file and download applicable ARCS chart sets to the laptop, BPA is still using an outdated NOAA chart for its Belize City harbor and approaches survey planning, acquisition, and processing. Due to the laptop CD/DVD drive failure, HYPACK software is unable to load ARCS charts due to programming limitations. This issue must be remedied ASAP through whatever means necessary to ensure (1) proper survey planning, comparison, and reporting, and (2) safe navigation during hydrographic survey work. Potential solutions include purchase of an external CD/DVD drive and/or implementation of a HYPACK "hotfix" to

correct software limitations. Cooperation and communication between BPA personnel, the UKHO, and HYPACK will be critical to correcting this issue.

10. **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 2009/2010 in-country training periods, less emphasis was placed on basic hydrographic principles and more emphasis on data processing and product generation. BPA survey personnel also received additional general Windows training, although they showed continued improvement in overall survey system and Windows computer operations when compared with skill levels observed in 2009 and 2010.

11. **Primary Lessons Learned** – Despite equipment and vessel delays, the Phase 3 training period provided a great deal of quality training time for BPA personnel. Although many are the same as Phase 2 training results, the following details some of the primary lessons learned during both on-the-water and in-office training:
    a. **Planning & Coverage**
        i. 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.
        ii. Use side scan mosaics from separate 100% and 200% lines to determine holiday line plans for each coverage area. Don't forget to add holiday line data to the respective mosaics and verify coverage.
        iii. 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.

    b. **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. Do not start the HYPACK Survey or Side Scan Survey programs unless the echosounder and SSS are operating first. Signal troubleshooting of the SSS may be accomplished using the vendor-supplied Yellowfin program.
        iii. 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.
        iv. The hydrographer's survey routine remains the same as described during Phase 2 training. Primary attention should always be on the safe navigation of the vessel and location/altitude of the towfish (both via the HYPACK

bottom tracking algorithm and monitoring of the water column in the SSS waterfall display).

v. Changing towfish or echosounder settings during acquisition is encouraged if data appears either weak or excessively noisy. All changes to system settings should be documented in the acquisition log.

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

vii. If environmental conditions warrant it (unexpected change in bottom depth, refraction, environmental noise), the line plan can and should be changed in the field. Additionally, the towfish should be kept as far from the vessel as possible to prevent signal washout from boat wake.

viii. If weather and seas result in poor data collection, it is better to head in to port and wait for conditions to improve rather than collect bad data.

c. **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 maximum/minimum or spline interpolation 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. 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.

iii. 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.

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

v. Run HYPACK Statistics on the full bathymetric data set to conduct a quality control check between mainscheme and crosslines. These results should be included in the Report of Survey.

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. **Warning: TIN's do not reflect reality but rather can be used to display generalized preliminary products – not for navigation!**

vii. Use no greater than 4m resolution when creating XYZ data sets for the UKHO in HYPACK SORT. Preliminary products (i.e. sounding plots for stakeholders / not for navigation) may be generated using coarser resolutions.

viii. Final XYZ data sets should include development and holiday SBES data.

d. **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. Altitude editing is generally the hydrographers best guess if the bottom of the water column is not clear and/or distorted by noise.

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.

e. **Valeport 740 Tide Gage Operation**

i. When installing the gage, take a manual measurement of the sensor depth to the waterline and compare with Valeport 740 output in Tidelog. Also ensure all settings, including gain and offset information are correct in the Tidelog system setup.

ii. When connecting to the Valeport, it may be necessary to first wait for the system to finish recording (indicated by rapid flashing of the LED).

iii. When downloading data, move data files from previous days to separate day folders on the laptop to prevent overwriting previous files 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).

f. **Reson SVP-15 Operation**

i. At least one SVP cast is required for each week of single beam echosounder survey acquisition, but one cast or more per day is encouraged in order to analyze for environmental fluctuations.

ii. In order to download SV casts from the SVP-15, the serial connection cable must be found and/or a replacement purchased from Reson. If download is not possible, each cast must be manually entered into HYPACK Sound Velocity using the SVP-15 interface box for individual SV/depth readings.

g. **Troubleshooting** – When conducting troubleshooting, follow the methodology:

i. Check power
ii. Check physical connections
iii. Check power
iv. Check equipment status lights/indicators
v. Check power
vi. Check software settings/configurations
vii. Check power

12. **Data Results** – There was some concern that a lack of "good" tide data (particularly without 30 continuous days of readings to calculate preliminary datums) would prevent the Phase 3 training survey from meeting IHO Order 1 standards. BPA personnel applied observed maximum and minimum tide levels to acquired bathymetry with spline

interpolation (correction therefore is to lowest observed astronomical tide). Running the HYPACK Statistics difference utility on mainscheme versus crossline data revealed a mean difference of 0.074m +/- 0.164 at the 95% Confidence Interval. Since survey bathymetry was collected over three separate days during three separate tidal phases, this data set and difference appears to be acceptable and meet IHO Order 1 specifications for a shallow water survey.

13. **Report of Survey** – Work began on the Report of Survey for the training data set at the end of Phase 3 training. Unfortunately, many components of the intended deliverables package were lost during the 2010 virus crash. BPA personnel intend to submit the survey while properly documenting missing items in the Report of Survey.

14. **Assessment of BPA Post-Training Capability** – Upon completion of Phase 3 training, BPA personnel now have the knowledge and ability to plan, conduct, process, and submit deliverables for full IHO Order 1 hydrographic surveys. However, their knowledge and confidence must be supported through accumulation of experience and practice.

Closing Thoughts:

1. **Accomplishment of Objectives** – The BPA team has completed all necessary data acquisition and processing of a 200% SSS survey in the Kings Pier basin with concurrent single beam bathymetry. BPA personnel generated several products, 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. **Demonstrating Support** – BPA's hydrography personnel displayed an enormous amount of spirit, focus, and excitement to accomplishing their hydrographic goals during the training period. However, (1) the state of the vessel, (2) the hydrography team's lack of experience/knowledge despite previous training, and (3) varying availability of hydrographic personnel during the training period, leads one to question where hydrography lies in the overall list of priorities. Through several conversations with George Hanson and Major Flowers, I acknowledged that several coincident issues may have been in play to prevent BPA from developing its hydrographic program further over the last year. On the other hand, I also expressed that hydrography is not an inexpensive task, but the benefits from doing it far outweigh the costs. I sincerely hope that the support for hydrography expressed verbally by BPA management converts into sustained action; the BPA hydrographic team should be given the opportunity to practice and gain mastery in hydrographic survey. I also believe that an upper-level visit by the MACHC to Belize ministerial and BPA upper management/board levels will benefit the program by expressing the needs for, costs of, and rewards from having fiscally sustained national hydrography.

3. **Communications** – This training period was delayed for approximately three weeks due to a series of miscommunications. As has been stated before, any successful program requires positive and open communications both within and outside an organization. Although

limited over the past year due to several issues, I continue to recommend that the BPA provide continuous reporting of its hydrographic 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, procurement of improved/advanced technologies, etc.). Also, as BPA hydrography personnel begin to generate products that result in nautical chart updates, these accomplishments should be communicated to public media to generate popular and political support for the program.

4. **Follow-up Work & Visits** – BPA Hydrography now possesses all tools and knowledge needed to successfully conduct an IHO Order 1 survey. As discussed several times in this report, program success will rely on open positive communication and learning through practice and experience. As this is the final year of MACHC-funded GoH training, I will be unavailable for further training visits, but will work with BPA personnel as requested to assist with action items below:
    a. **BPA Action Items (Short Term)** – To succeed in the short term, BPA personnel must accomplish the following:
        i. Repair R/V SEA KING for hull integrity, engine operation, and electrical operation/connectivity following recent vessel sinking / engine breakdowns.
        ii. Collect at least 30 days of tide data and incorporate into Phase 3 training survey data with calculation of new lowest astronomical tide level.
        iii. Collaborate with Valeport Technical Support to test, repair, and/or replace existing Valeport 740 tide gage.
        iv. Collaborate with Kongsberg Seatex to correct apparent Roll artifact in MRU-Z
        v. Conduct calibration checks on echosounder (latency and bar/lead line) and GPS (horizontal position verification).
        vi. Repair and/or replace the existing UPS for survey battery backup capacity.
        vii. Coordinate/train with CCCCC and BNMS to repair, relocate, and/or replace existing Aquatrak tide gage at PBL pier to have a primary tide gage.
        viii. Send four (4) members of hydrographic survey team with survey laptop and data to EMPORNAC, Guatemala, for advanced HYPACK training.
        ix. Generate accomplishments report for MACHC and GoH Project detailing surveys completed, chart updates, in-kind monetary and resource contributions to hydrographic program and training, etc. (Due June 2011)
        x. Continue hydrographic survey operations per GoH Project goals; submit deliverables to UKHO as surveys are completed.

    b. **BPA Action Items (Long Term)** – In order to have a successful national hydrographic survey program, and assuming it maintains this program, BPA should:
        i. Transfer all vessel support activities to the Port Operations Base. This will require construction of a dedicated pier and/or agreement with the adjoining BNCG facility to use its pier. Additionally, pier services should be available, including water, power, and (if possible) fuel. A ramp near the pier area and/or crane services should be available to remove vessels from the water as weather and maintenance conditions require.

ii. Establish a well-documented and sustainable budget for planning 1 to 3 years out. This budget should at a minimum cover the following:
    1. Personnel time, salary, communications, and/or travel
    2. Fuel
    3. Periodic vessel and survey equipment maintenance
    4. Annual survey equipment calibration
    5. Shipping costs for survey submissions and equipment calibrations
    6. Periodic technology updates and upgrades (increased computing power, software and license updates, additional acquisition and/or processing computer workstations, etc)
    7. Periodic refresher training from vendors and/or partner nations and organizations (UK, USA, MACHC, etc)

iii. Procure one or more hydrography-designed vessels to increase survey efficiency and productivity (**Note:** While SEA KING's renovations made it ready for hydrographic survey, its base design prevents maximizing current survey system capabilities).

iv. Modify current hydrographic vessel (SEA KING) to have generator-free shore power capability, safe generator placement, and overall safer vessel conditions (handrails, secured chairs, improved tow point accessibility, remotely operated mechanical SSS towing capability, etc)

v. Provide continuous product advertisement to and solicit feedback from stakeholders and upper management / ministerial level leadership; improve products while justifying fiscal needs.

Overall, BPA management and its governing board should support the hydrographic survey program with funding and resources as necessary to succeed. Conversely, hydrographic team members should justify requests for support with continuous communication of accomplishments, lessons learned, and hydrographic products up the chain-of-command.

c. **Partner Action Items** – 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:
    i. HYPACK and UKHO partners provide continued software and other technical support as needed to correct various survey-related issues.
        1. ARCS chart import and display in HYPACK
        2. Automated or semi-automated HYPACK tide data import utility
        3. Bottom feature report generation from HYPACK target and development processing
    ii. NOAA trainer review/finalize BPA's first Report of Survey and deliverables prior to transmission to UKHO.
    iii. NOAA / NAVOCEANO personnel review and finalize MACHC/GoH accomplishment/contribution reports from GoH countries.