1998

July-August

FINAL FIELD REPORT

Central and Arctic Region

CCGS *NAHIDIK*

SURVEYS OF:

- Melville Sound, NWT
- Bathurst Inlet, NWT

K. A. Lyngberg, CLS
Hydrographer-in-Charge
email: lyngbergk@pac.dfo-mpo.gc.ca

CANADIAN HYDROGRAPHIC SERVICE
DEPARTMENT OF FISHERIES AND OCEANS
INSTITUTE OF OCEAN SCIENCES
SIDNEY B.C.

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Table of Contents

CHS STAFF

Knut Lyngberg	Hydrographer-in-Charge (Pacific Region)	July 23 – Aug 30
Glenn Rodger	Hydrographer (Atlantic Region)	July 28 – Aug 30
Dan Dexel	Hydrographer (C&A Region)	July 28 – Aug 29
Peter Smith	Hydrographer (Co-op Student, Nfld.)	July 28 – Aug 30
Denny Sinnott	Hydrographer (Pacific Region)	July 25 – July 30
Bob Langford	Systems Manager (C&A Region)	July 30 – Aug 13
Alan Thomson	Electronics Technologist (Pacific Region)	July 23 – Aug 30
Larry Toomer	Coxswain/Mechanic (C&A Region)	July 28 – Aug 30

CCGS *NAHIDIK* CREW

Larry Green	Commanding Officer	July 22 - Sept 15
Terry Weller	Chief Officer	July 14 - Sept 15
Pat McGarrity	2nd Officer	July 22 - Sept 15
Mike Trotter	Chief Engineer	July 14 - Sept 16
Jeff Joly	1st Engineer	July 16 - Sept 16
Peter Steward	2nd Engineer	July 22 - Sept 16
Sherman Rine	Bosun	July 15 - Sept 16
Bev MacDonald	Cook	July 15 - Sept 16
Jack Roberts	Seaman	July 15 - Sept 16
Wesley Mack	Seaman	July 15 - Sept 16
Steven Solmundson	Seaman	July 15 - Sept 16
Kathy Logan	Steward	July 15 - Sept 16

LIST OF MAJOR CRAFT AND EQUIPMENT

1. CCGS *Nahidik:*

   53.35 m HomeTrade II ship, twin screw, geared diesel, draft 1.98m
   Gross Tonnage 856T

2. Survey Launch:

   CSL *Bold* 7.6m modified Bertram design, Volvo Penta

3. Aircraft and Helicopters:

   Huisson Aviation Ltd Helicopters 206B with floats (Polar Continental Shelf Project) 25.8 hrs
   Coast Guard Helicopter Messerschmit Bolkow
   (CCGS *Sir Wilfrid Laurier*) 1.5 hours
   Jet- B fuel deployed from Cambridge Bay to Umingmaktok and Bathurst 8 drums arranged through (Polar Continental Shelf Project)

4. Positioning Systems:

   Reference Stations:
   MSAT localized corrections calculated and uploaded from Ottawa (NRCan) received using Global Survey model 1550 receivers and high gain antennae.

   Portable back pack position logger
   NovAtel 3151R 12 Channel GPS receiver
   501 antenna
   Global Surveyor 1550 receiver and high gain antennae (moved from ship)
   Psion computer Geo'cord software for logging
   All contained within a "Dry Box"

   Back up Reference Stations:
   2 units each consisting of a NovAtel 3151R 12 Channel GPS receiver with a model 501 antenna mounted in a choke ring, a DataRadio UHF T-modem with a 4.5 dB gain Larsen antenna tuned for 430Mhz, 4 / 55Amp/hr GelCel batteries, and 4 / 30W solar panels.

   Monitor Station Reference Stations:
   1 unit consisting of a NovAtel 2151R 10 Channel GPS receiver with a model 501 antenna mounted in a choke ring, a DataRadio UHF T-modem with a 4.5 dB gain Larsen antenna tuned for 430Mhz, 4 / 55Amp/hr GelCel batteries, and 4 / 30W solar panels

iomega zip 100 drive
PC/104 Serial Data Logger

UHF Repeaters:
2 / IOS designed Store and Forward repeaters with 4.5 dB gain Larsen antennae, powered by one 12V 55Ahr Gel Cell battery backed up by one 30W solar panel.

Remote GPS Systems:
3 / Novatel 3151R and 1/ 2151 GPS receiver. One of the 3151R's used in the *Bold* was equipped with the METS software option. The 2151 10-channel unit is a spare. 3 / Novatel 501 GPS antennae and 3 / 3dB gain UHF antennae and accompanying T-Modems.

5. Echo Sounding Equipment:

CCGS *Nahidik*:	Knudsen 320M (200& 150 kHz) digital sounder
Launch *Bold*:	Knudsen 320M (200kHz & 38 kHz)
Spare Sounder:	Knudsen 320M (200kHz single frequency C & A)
Velocimeter:	Applied MicroSystems SVP-16
Side Scan Sonar:	Imagenex Model 858 (330kHz)

6. Data Loggers:

CCGS *Nahidik:*	One 133Mhz Pentium PC with 64Mb RAM, 1.2Gb Hard Drive, 256Kb cache, SIIG I/O Expansion Card, Mach 64 ATI SVGA Video Card, Iomega Zip Drive, 24 Vdc Power Supply, and 2 / 640x480 10" Flat Panel LCD Displays
Launch *Bold*:	Same as the *Nahidik.* Wireless pointing device

7. Processing Systems:
Dec Alpha Unix with external disc drives and tape backup.
One Pentium Computer with writable CD ROM drive, external Zip drive and printer
One 486 Computer
Two 386 laptop Computers

8. Communications:

VHF:

The *Nahidik* is equipped with a 25W Raytheon Ray78 and each launch carries a 25W Icom M80 marine VHF radio. The *Nahidik* handhelds were used for shore party work, and 2 Icom M5 VHF handhelds.

Satellite:

The *Nahidik* is equipped with an ABB Nera Saturn Mm, an Inmarsat-M system with voice, fax, and distress capabilities.

A Mitsubishi St111 Land Mobile MSAT terminal with the AU200A domed antenna.

9. Tidal Equipment:
   Three REVLIS Low Powered Tide Gauges (LPTG) with diaphrams.
   Two Ottboro tide gauges.

10. Horizontal/Vertical Control Equipment:
    One Wild N-2 level
    One Psion GPS data logging system (3151R with NMETS)

11. Software:
    GEOsurv Geo'corder vers 1.64 GIS software
    GEOsurv CHS Novatel data logger vers 1.4a
    GEOsurv FLYKIN & SEMIKIN for windows - Data Processing for Static, Kinematic & On-the-Fly GPS Data
    Universal Systems Ltd Hydrographic Information Processing System (HIPS)
    Universal Systems Ltd CARIS
    HYPACK vers 8.1

CHRONOLOGY OF EVENTS

July 23	Hydrographer Lyngberg and Electronics Technologist Thomson arrive at Cambridge Bay.
July 24	Unpacking of electronic equipment. Installation of hydrographic electronics commences. Fuel caches deployed at Umingmaktok and Bathurst.
July 25	Helicopter flies to Roberts Bay, reconnaissance. Hydrographer Denny Sinnott arrives in Cambridge Bay.
July 26	Installed tide gauges in Roberts Bay and in Bay Chimo.
July 27	Deployed tide gauge in southern Bathurst Inlet. Established monitor control point at south end of Bathurst Inlet using rapid static method, post processed GPS data using SemiKin software.
July 28	Hydrographers Rodger, Dexel, Smith and Coxswain Toomer arrive in Cambridge Bay.
July 29	Survey launch serviced by Toomer. Check on all tide gauges. Check of MSAT corrections done on control point in Cambridge Bay.
July 30	Deployed backup reference station on control station 71-A-59 near Cape Flinders.
July 31	Deployed MSAT monitor station on station 71-A-59A (Entry Islands). CSI inspection of ship completed. Ship departs Cambridge Bay.
Aug 1	CCGS *Nahidik* arrives in work area. Velocimeter casts and checks on MSAT GPS monitor station. Sounding Dease Strait to Patsy Klengenburg Island commences.
Aug 2	Sounding Dease Strait to Patsy Klengenburg Island.
Aug 3	Sounding Dease Strait to Patsy Klengenburg Island. Port main engine failure, running on starboard main engine only at a slower speed and with less manoeuvering capabilities.
Aug 4	Launch and Ship sounding, Dease Strait – Patsy Klengenburg Island
Aug 5	Weathered out of Dease Strait – Patsy Klengenburg Island area, re-located to west of Cape Croker area to fill in unsounded area from 1997.
Aug 6	Returned to Dease Strait – Patsy Klengenburg Island area checklines and interlines. MSAT corrections working well. Recovered backup reference station on Cape Flinders.
Aug 7	Moved to Cape Croker. Monitor station established on existing geodetic control point (Crok). Ship sounding only due to poorweather.
Aug 8	Sounding dense sounding pattern north of Cape Croker.
Aug 9	Sounding continues north of Cape Croker. Ship at anchor collecting current information.
Aug 10	Launch Sounding miscellaneous shoals Cape Croker to Roberts Bay found during QC check of 1997 data. Survey moves to Roberts Bay.
Aug 11	Survey launch *Bold's* alternator fails, promptly replaced. Launch sounding Roberts Bay. Rock positioned in Roberts Bay using portable backpack Tidal information downloaded at Roberts Bay.

Aug 12	Completed sounding at south end of Roberts Bay. Depart for Umingmaktok to collect tidal information and to meet Adlair Ltd Beaver aircraft for System Manager/Processor Bob Langford.
Aug 13	Bob Langford departs survey. Provision re-supply. Coastline verification. Departed Umingmaktok.
Aug 14	Survey returns to Dease Strait-Patsy Klengenburg Island interlines and shoal examinations.
Aug 15	Additional interlines and shoal examinations done at Dease Strait – Patsy Klengenburg Island. Depart for south Bathurst Inlet. Cleanup Red Islands to Amamok Creek.
Aug 16	Cleanup Red Islands to Amamok Creek.
Aug 17	Moved to south end of Bathurst Inlet to extended 1997 Bathurst Inlet survey.
Aug 18	Extending southern end of 1997 Bathurst Inlet survey.
Aug 19	Winds 40 knots, weather day.
Aug 20-21	Sounding south end of Bathurst Inlet.
Aug 22	Side Scan Sonar lines south end of Quadyuk Island to Red Islands. Bottom Samples Quadyuk Island to Red Island.
Aug 23	Cape Croker Side Scan Sonar lines.
Aug 24	Roberts Bay Side Scan lines. Recovered tide gauge
Aug 25	Additional lines Dease Strait to Patsy Klengenburg Island. Bottom Samples Roberts Bay to Breakwater Islands.
Aug 26	Sounding additional lines in South Bathurst Inlet.
Aug 27	Recovered monitor station at southern Bathurst Inlet. Recovered tide gauges at Quadyuk Island and Umingmaktok.
Aug 28	Investigating reported shoals and charted PA by Marcet Island on chart 7780. Depart for Cambridge Bay. Packing.
Aug 29	Packing. Arrive Cambridge Bay. Transferred equipment to CCGS *Sir Wilfrid Laurier.*
Aug 30	Depart Cambridge Bay to Yellowknife.
Aug 31	Depart Yellowknife for Victoria.

SUMMARY

This was the second and final season of a CHS hydrographic survey in Bathurst Inlet and Melville Sound, NWT. In 1997, the CHS operating from the CCGS *Nahidik* sounded most of the planned corridors running into Roberts Bay and into the proposed port facility in southern Bathurst Inlet. In 1998, the corridors from Dease Strait into these proposed port locations were completed.

The 1998 hydrographic program began by linking the 1997 data to the 1994 Dease Strait corridor. The survey then moved to Cape Croker where a 1:10,000 survey was done adding more detail to the 1997 survey in this same critical area. Next, the survey located to the south end of Roberts Bay and a more detailed 1:10,000 survey was done at the proposed port site at the south end of Roberts Bay. Finally the survey moved to the south end of Bathurst Inlet where the 1997 sounding limit was extended to the south end of Bathurst Inlet, thereby, providing ample manoeuvering information for large vessels.

SURVEY AREA

Melville Sound (68-08N, 107-52W) extends 60 miles along the south side of Kent Peninsula. Sounding from 1997 through Melville Sound indicated mostly deep bathymetry with the area north of Cape Croker containing numerous hazards.

Bathurst Inlet, entered between Cape Barrow (68-01N, 110-06W) and Cape Flinders, penetrates the mainland in a southerly direction for 120 miles. It has irregular shores and is fronted by and encumbered with numerous islands and islets.

PLANNING AND PREPARATIONS

As this was the continuation of an ongoing survey, there was little planning to do. Most hydrographic equipment was transported by truck to the Coast Guard Base in Hay River. From Hay River, arrangements were made by CCG's Tom Maher to transport the hydrographic equipment along with Coast Guard equipment by two chartered aircraft to Cambridge Bay. The remainder of the equipment, mostly computers, was air freighted directly to Cambridge Bay from Victoria B.C.

K. Lyngberg, for a week in June, joined a survey in progress along the BC coast to become familiar with the new data acquisition software (HYPACK) and processing software (HIPS). CHS's K. Czotter and S. Oraas handled communication between the PC's and the UNIX at the Institute of Ocean Sciences at Sidney B.C.

OPERATIONS

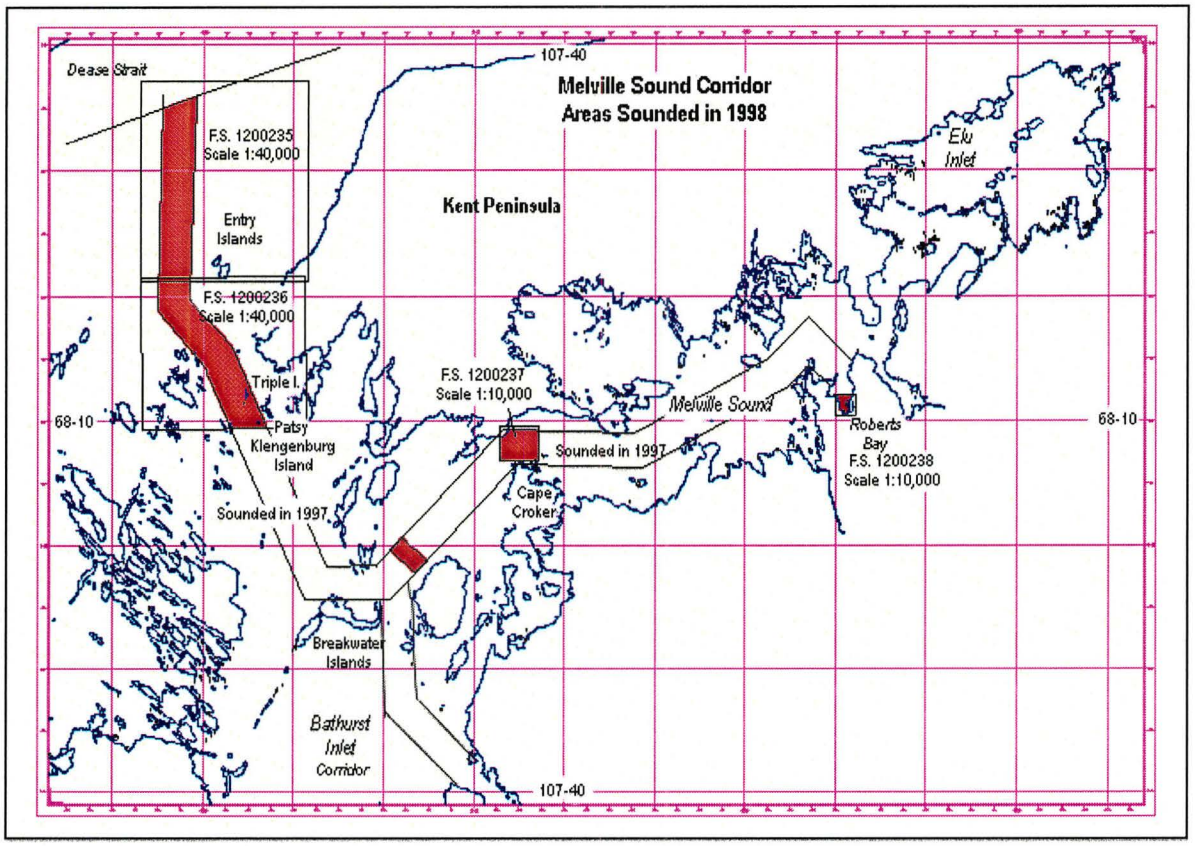
K. Lyngberg, A. Thomson and a Polar Shelf helicopter arrived in Cambridge Bay July 23rd. An additional hydrographer, D. Sinnott, arrived 2 days later. Helicopter fuel caches

were deployed by Adlair Ltd. from Cambridge Bay to Umingmaktok and Bathurst Inlet (4 drums each location). Backup fuel arrangements to use fuel at "Windy Camp" were made with BHP (Greg MacMaster). Installation of survey electronics commenced immediately upon arrival on board the CCGS *Nahidik*. Tide gauge sites were established at Roberts Bay, Umingmaktok and on Quadyuk Island in southern Bathurst Inlet. A DGPS reference station was deployed on a DND control monument (71-A-59) at Cape Flinders on Kent Peninsula and a monitor station was deployed on another DND control monument (71-A-59A) on Entry Islands. The remainder of the hydrographers and one coxswain arrived in Cambridge Bay on July 28th.

CCGS *Nahidik* passed the CSI inspection on July 31st and then departed Cambridge Bay arriving in the work area (Dease Strait – Patsy Klengenburg Island) on August 1st. Two velocity profiles were taken and the MSAT DGPS corrections at the monitor station on Entry Islands were examined and checked to be within under 5 metres of the published control position. The ship and survey launch then commenced sounding a corridor from Dease Strait to Patsy Klengenburg Island. On Aug 5th weather conditions forced the survey to move and additional hydrography was done to fill sounding gaps left from the 1997 survey west of Cape Croker. The survey then returned to the Dease Strait – Patsy Klengenburg Island area and continued sounding. On Aug 7th the survey moved to Cape Croker and commenced a dense 25 metre line spacing sounding pattern in an east-west direction. A narrow but safe passage for shipping in this area is well defined. Twenty-four hours of current readings, all of which were less than 1 knot, were taken at Cape Croker. On Aug 10th the survey moved to the south end of Roberts Bay. This area was sounded at a scale of 1:10,000. The survey then returned to Dease Strait – Patsy Klengenburg Island where additional interlines and shoal examinations were completed.

On August 15th, the survey located to southern Bathurst Inlet. Two days were spent examining shoals found during the QC of the 1997 data between Red Islands and Amagok Creek. In addition, numerous off shore rocks were positioned with a DGPS backpack using Geo'corder software. After these rock positions and shoal examinations were completed the southern limit of the 1997 Bathurst Inlet survey was extended.

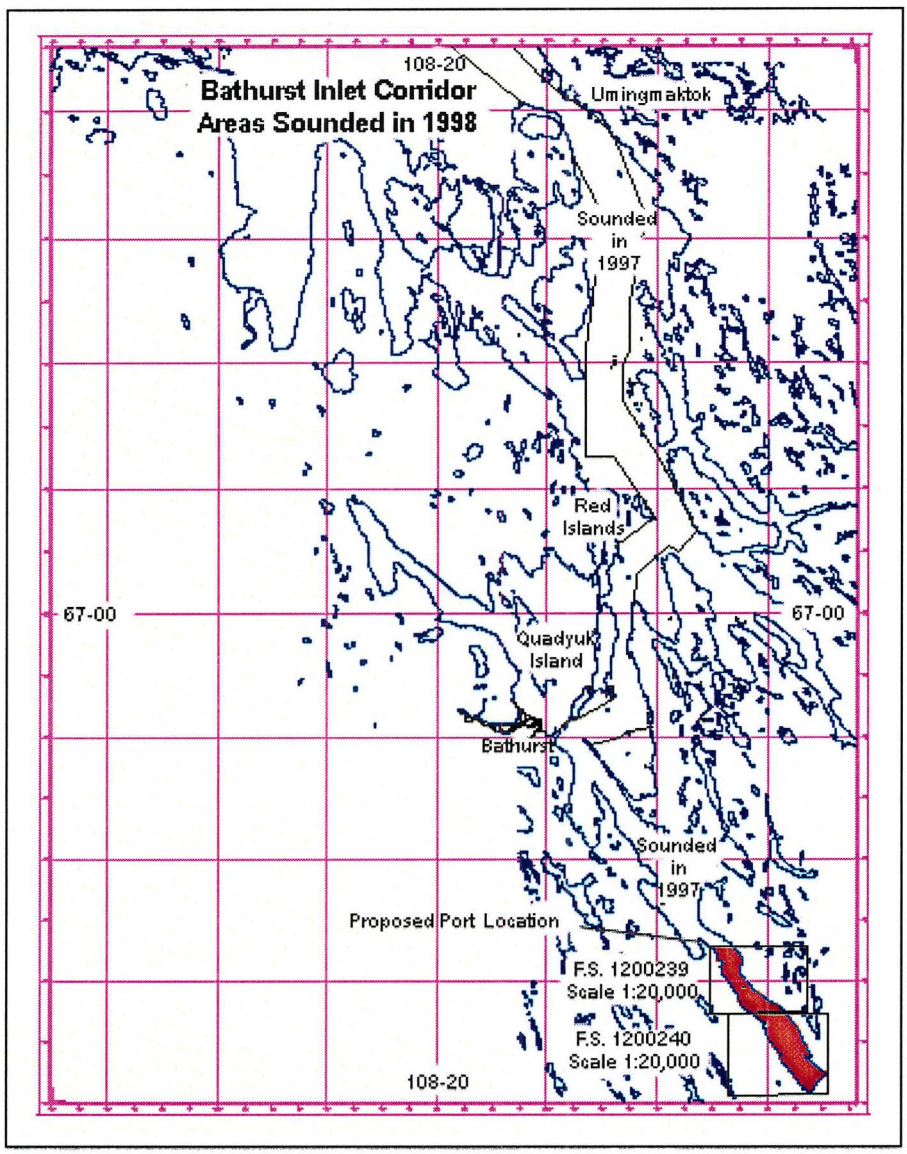
Various tasks were accomplished during the final week of August. Sounding on the southern extension of Bathurst Inlet was completed. Numerous bottom samples were taken throughout the area. Side Scan Sonar lines were run at the following locations: Quadyuk Island to Red Islands, north of Cape Croker, at Roberts Bay, and at the proposed port site in southern Bathurst Inlet. Tide gauges at Roberts Bay, Umingmaktok, and South Quadyuk Island were recovered. Additional interlines were run at Entry Island to Patsy Klengenburg Island. A few reported shoals on chart 7780 near Marcet Island were investigated and a one day survey was done in this area. Data collection ended on August 28th. The ship then proceeded to Cambridge Bay where most of the hydrographic equipment including launch *Bold* were loaded on to CCGS *Sir Wilfrid Laurier* for shipment back to Victoria. Computer equipment was flown directly to Victoria from Cambridge Bay. All hydrographers departed Cambridge Bay on August 30th.



Melville Sound Corridor (summary of 1997 and 1998 data)

A 5 km wide corridor linking Roberts Bay with the Dease Strait Corridor was completed.

Mariners navigating from the Dease Strait corridor to west of Patsy Klengenburg Island will generally find depths greater than 100 metres with the exception of a 40 metre ridge that traverses the corridor in an east west direction at the north end. The most significant hazard in the Dease Strait to Patsy Klengenburg Island portion of the corridor is a 3.2 metre shoal located south-west of Triple Islands at 68-11-30.375 N, 108-51024.121 W. From Patsy Klengenburg Island and southward the depths deepen to over 200 metres until reaching north of Breakwater Islands. Heading eastward and north of Breakwater Islands the depths rise from 200 metres to less than 50 metres. A 12.9 metre shoal at 67-56-45.169 N, 108-22-55.523 W lies midway between Breakwater Island and Cockburn Islands. From Breakwater Island to Cape Croker the depths once again deepen. North of Cape Croker the bottom quickly shallows and numerous hazards, most notably a 6.9 metre shoal in mid channel (68-08-11.285 N, 107-50-11.374 W), are located in this area. However, a safe but narrow channel is evident north of the 6.9 metre shoal. From Cape Croker the soundings deepen once again and remain deep until reaching the south end of Roberts Bay. For course notes by Capt. L. Green see Appendix C.



Bathurst Inlet Corridor (summary of 1997 and 1998 data)

In 1998 the Bathurst Inlet corridor was extended to the southern limit of Bathurst Inlet, thereby, providing ample maneuvering information south of the proposed port location.

From Breakwater Islands the corridor into southern Bathurst Inlet heads southward, east of Breakwater Islands. A 0.8 metre high small islet (67-53-46.008 N, 108-18-53.895 W) lies 0.7 nm east of the Breakwater Islands. Approximately 6.4 nm south of Breakwater Island the corridor alters to a south easterly direction. Depths from Breakwater Islands to Red Islands remain deep. Rounding Red Islands the mariner must steer well south of Red Island staying clear of a 3.6 metre shoal located at 67-07-22.167 N, 107-38-48.357 W. There are a number of shoals under 5 metres near the 3.6 metre shoal. In the vicinity of

Red Islands to Wignick Island the mariner must negotiate a number of turns. Depths in this portion of the corridor generally range from 20-70 metres. From Wignick Island to the proposed port facility depths are greater than 170 metres in mid channel. Vessels progressing past the proposed port site will encounter depths generally greater than 70 metres. However, approximately 10.2 nm past the proposed port site a long shallow ridge under 5 metres in depth extends from middle of the inlet in a south easterly direction until attaches to a point of land on the eastern coastline of Bathurst Inlet. For course notes by Capt. L. Green see Appendix C.

Data Processing

Universal Systems Ltd Hydrographic Information Processing System (HIPS) was used to process all collected bathymetric data. Processing data with this software was inefficient; consequently, an additional hydrographer was assigned to data processing. CHS should avoid using HIPS until significant software improvements are made. For HIPS critique by Bob Langford see Appendix A.

Coastline

Coastline delineation was subcontracted to Terra Surveys Ltd of Sidney B.C. Data were collected from July 17 – July 25. The video data were digitized for shoreline, foreshore character, and approximate low-water line where low-water line was determined from seabed colouration change. In some areas deemed "non-critical navigation", video coverage was reduced from total coverage to wider spaced PUG lines. These PUG lines were used to reposition the photogrammetric base mapping. Coastline deliverables were submitted to the CHS in January 1999.

Electronics

Although there were numerous problems with some electronics all repairs were quickly dealt with and very little down time was attributable to electronic failures. For more detail see Appendix B written by Electronics Technologist Al Thomson.

Positioning

Originally, the plan was to operate much the same way as in 1997 which was to deploy DGPS reference stations with UHF differential radio links at the various working areas. However, in September 1997, hydrographer K.L. Czotter was involved in a successful beta trail of the Global Surveyor™ differential GPS service while doing a survey of Adams Lake BC. This service provided through TMI communications and Geographic Data BC, BC Ministry of Environment, Lands and Parks the BC Government utilizes the MSAT (TMI communications) satellite in providing real-time DGPS corrections to users. Inquires were made to see if the same technology in the Arctic. Eventually through NRCAN arrangements were made to provide local area corrections for Bathurst Inlet and Melville Sound. Prior to sailing from Cambridge Bay NRCAN sent two model 1550

receivers (Global Surveyor™) along with 2 special high gain quadrifilar antennae required in higher latitudes. From Ottawa corrections were determined and uploaded to the MSAT satellite and then received on the ship and survey launch. This system enabled the survey to move from one location to another without deploying reference stations on existing geodetic control. All corrections were determined by NRCAN (Mark Casey and Ken MacLeod) and whenever the survey moved into new areas, local area solutions were quickly computed, uploaded and received at the survey site. Examination of the monitor stations data reveal that static corrected positions at the monitor sites were under 5 metres of the listed positions. In conclusion, the Global Surveyor™ service worked extremely well for the duration of the survey and this service will have positive ramifications for future hydrographic surveys throughout Canada and perhaps for shipping that require precise navigation outside the CCG Marine Radio Beacon (MRB) areas.

Helicopter support

Helicopter support was arranged though Polar Continental Shelf Project in Ottawa. Additional arrangements were made Polar Continental Shelf project to deploy of fuel caches at Umingmaktok and Bathurst Inlet and to pick up Bob Langford at Umingmaktok on August 13th. Backup fuel arrangements were made to use fuel at "Windy Camp" with BHP.

From Cambridge Bay a Huisson Helicopters Bell 206 on floats was used to deploy tide gauges in Roberts Bay, at Umingmaktok, and on the east side of Quadyuk Island in southern Bathurst Inlet. A control station for monitoring DGPS corrections was established in southern Bathurst Inlet using the rapid static method for determining positions. Extensive control established by Sub-Arctic Surveys Ltd was found in Roberts Bay and through BHP, positions for these stations were obtained. Other helicopter use included the deployment of a backup reference station on an existing DND control station at Cape Flinders and a monitor station deployed on a DND control monument on Entry Islands. On August 12th, additional helicopter support was acquired from the *Sir Wilfrid Laurier* and the monitor station was moved.

CCGS *Nahidik*

One mechanical problem occurred with the *Nahidik*. On Aug 3rd the *Nahidik* lost control of its port main engine when the over speed trip mechanism cracked. As result, the ship operated at reduced speed and reduced maneuverablity until a replacement part arrived on August 7th.

CCGS *Nahidik*, built by Allied Shipyard in North Vancouver in 1974, is powered by two loud General Motors diesel engines that are capable of developing 4300 HP of power. Optimal sounding speed for the vessel is between 8-10 knots. The vessel's twin propeller, and shallow hull design make it a highly manoeuvrable vessel capable of navigating in shallow waters. In addition the ship's broad beam provides excellent

stability in the Arctic Ocean as well as good storage for two hydrographic launches on the bow and a boston whaler storage on the stern. One launch was stored on board during the 1998 season. *Nahidik* returned to Hay River NWT at the end of the season.

Nahidik would make a more effective hydrographic/science working platform if the following improvements could be considered:

- Significantly increase dedicated work space. This would require a re-design and expansion of the bridge area.
- Install a retractable ram. This would improve sounding quality during adverse sea conditions. The 200kHz transducer is located in an area on the hull that is highly susceptible to aeration and for the most part is useless. The 150 kHz transducer is less susceptible to aeration; however, when winds increase to over 20 knots the ability to collect quality data becomes a problem.
- Install an A-Frame on the stern for towing side scan sonar.
- Install a system of davits for raising and lowering survey launches.
- Improve sound proofing throughout the ship. A sound study by Health and Welfare Canada in 1990 show that the noise levels exceed the regulatory limit.
- Remove all asbestos.

The CCGS *Nahidik* is the most cost effective Coast Guard Vessel that operates in the Arctic Archipelago during the summer navigational season. Lobbying Coast Guard to allocate funding for improvements to this versatile vessel would be prudent if continued hydrographic or science use is envisioned for the future.

Nahidik in southern Bathurst Inlet

Survey Launch *Bold*

The Bertram hydrographic survey launch, *Bold*, was winterized at the end of the 1997 field season and stored on the deck the *Nahidik*. Mechanic/Coxswain Larry Toomer serviced this launch at the beginning of 1998 field season. On August 11th the 24 volt alternator was replaced. The propellers were replaced three times due to groundings. *Bold* was loaded on board the *Sir Wilfrid Laurier* for transport to Victoria at the end of the field season.

Survey Results

The results of the 1998 hydrographic survey have been compiled on the following 7 field sheets:

- Field Sheet 1200235 (Dease Strait to Entry Islands) Scale 1:40,000
- Field Sheet 1200236 (Entry Islands to Patsy Klengenburg Island) Scale 1:40,000
- Field Sheet 1200237 (Cape Croker (1:10,000))
- Field Sheet 1200238 (Roberts Bay –South Portion) Scale 1:10,000
- Field Sheet 1200239 (Southern Bathurst Inlet (1)) Scale 1:20,000
- Field Sheet 1200240 (Southern Bathurst Inlet (2)) Scale 1:20,000
- Field Sheet 1200265 (Marcet Island) Scale 1:40,000

Other field work included:

- Coastline verification.
- Investigation of a number of shoals found during QC on 1997 field sheets.
- Collection of 24 hours of current information north of Cape Croker.
- Side Scan Sonar lines at critical locations along the corridor and at proposed port sites.
- Thirty-five days of continuous tidal data at Roberts Bay, Umingmaktok, and east of Quadyuk Island.
- 64 bottom samples throughout the survey areas.

Recommendations

Hydrographic

- Make appropriate changes to HIPS software for improved efficiency.
- Static calibration checks of the MSAT corrections show that the positions are under 5 metres. Future bathymetric surveys can eliminate the CHS's requirement for establishing reference stations. However, establishing monitor stations for QC at existing control points should be maintained whenever practical.
- Purchase a portable data logging/sounder that could quickly attached to a small open boat.

- Purchase heave compensators.

Cartographic

- Produce new charts of Bathurst Inlet and Melville Sound for the 1999 navigational season with large scale insets for Cape Croker, Roberts Bay, and Red Islands to Wignick Island.
- Ensure the safe channel area north of Cape Croker is well defined on the Cape Croker Inset. Perhaps emphasize a recommended track in this area.

Shipping

- No radio beacons that provide corrections for GPS currently exist in the Arctic. Therefore, any future shipping requiring precise navigation should investigate making use of the same MSAT technology for receiving differiential corrections that was used during the 1998 survey.

CONCLUSIONS

Once again excellent cooperation of the officers and crew of the CCGS *Nahidik*, Kit Resources Ltd, BHP, NRCAN and the NWT government contributed to another successful hydrographic survey season in Bathurst Inlet and Melville Sound. As a result, a 5 km wide corridor extending from Dease Strait into Roberts Bay and into Southern Bathurst Inlet has been completed. Navigational hazards have been well defined and a safe navigational route has been accurately been determined.

STATISTICS

Project name	Number		
Survey of Bathurst Inlet and Melville Sound NWT	7780-98 7781-98		
	July-Aug		Totals
No. of Personnel (person days (PD)			
Hydrographers (3 hydrographers for duration of survey 1 additional hydrographer for initial setup)	4/33		109
Systems Manager	1/14		14
Technologists	1/38		38
Students	1/33		33
Coxswain	1./33		33
No. of Vehicles			
Launches	1		1
Ship	1		1
Polar Shelf helicopter C-GJWL	25.8hrs		25.8hrs
Coast Guard Messerschmit Bolkow	1.5hrs		1.5hrs
Beaver (Cambridge Bay –Umingmaktok – Cambridge Bay) Adlair Ltd			
Deployment of 8 fuel drums to Umingmaktok and Bathurst from Cambridge Bay. Adlair Ltd.			
Work record			
Total days in field	38		38
Total days actual field work	38		38
Launch days lost (weather)	2.5		2.5
Ship days lost (weather)	1.0		1.0
Days lost due to traveling	3		3
Sounding			
Launch sounding days	25.5		25.5
Launch sounding lines (km)	2199		2199
Shoal examinations (launch and Ship)	59		59
Ship sounding days	27		27
Ship sounding lines (km)	2556		2556
Side Scan Sonar lines (km)	30		30
Horizontal control			
Stations recovered	8		8
New stations (monitor)	1		1
Stations marked			
Observations -rapid static GPS	2		2
Reference stations established	1		1
Navigational aids positioned	*N/A*		*N/A*
Fixed aids; checked with DGPS			
Floating aids			

Project name	Number		
Survey of Bathurst Inlet and Melville Sound	7780-98 7781-98		
	July-August		Totals
Vertical control			
Bench marks recovered (CHS)	5		5
Bench marks recovered (GSC)			
Bench marks established			
Water level gauges established	3		3
Shoreline			
High-water line delineation (km)	5		5
Low-water line delineation (km)			
Rocks/features positioned	17		17
Heights/depths taken	15		15
Quality control			
DGPS integrity monitoring sites	4		4
Sound speed profiles SVP-16	Daily		28
Bar checks	6		6
Miscellaneous			
Bottom Samples	64		64
Navigational aids positioned			
Buoys positioned			

APPENDIX A

Appendix A

HIPS Single Beam Processing Critique
Bathurst Inlet Survey
August 1998

By

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Using U.S.L.'s HIPS processing package is a major change in direction in the data processing of the digital survey data for Central & Arctic Region.

Central and Arctic Region's in-house processing software was written to interactively edit / verify the "selected soundings" by graphically displaying the selected soundings on top of the raw data. Using U.S.L.'s HIPS processing software we now interactively edit the raw position and depth data. This new procedure will change the time required to verify and process the digital data; it should improve the quality. It may now take longer to edit the raw position and depth data than it did to collect it; especially when the quality of the digital data is poor.

One comment I have heard is "*What was the scale of the survey? So do not worry about the small positional jumps.*" The next statement I have heard is "*We are no longer scale dependent*" meaning that all data has to be looked at with an eye to remove all discrepancies. Management will have to make a decision and define the criteria for future processing.

The processor loads all the edited sounding data into the CARED structure and then suppresses the depth data. The HIPS software has the capability to load in sounding data with the constraint of shoalest sounding within a user defined bounding box. With the multi-beam depth data this may simplify subsequent processing in the CARED structure, but with single beam data it should not be necessary.

Future field survey parties should be setup with a second processing station, which could be a PC with a large display screen. The large screen is required because the HIPS processing windows are not scalable and if the display is not large enough, you cannot get to the bottom of the HIPS editing windows. The second processing station would allow for a second and/or a part-time processor, as a single processor could have difficulty keeping up to date with the processing.

The HIPS software was written to run in windows mode. The drop-down and pop-up menus are useful. These menus and the methodology behind them still need refinements. The possibility of having tear off menus would be helpful. Tear-off menus are menu

windows that can be moved off to one side and left open for easy access. A good location for these tear-off menus would be in the navigation and depth editing windows, instead of the continual right button, left button action.

On the Bathurst Inlet Survey we had a field sheet that crossed UTM Zone boundaries and that started some headaches as described below!

1. In the Single Beam Depth Editor when the soundings crossed the UTM Zone boundary the program automatically switched central meridians in its position calculations. The distance along line would jump from 1200 metres to 250000 metres along line. Although not investigated, this bug may exist in the Multi Beam processing software also.

2. When processing any sounding data that crosses the boundary between UTM zones, the geographical position of the south west corner of the first line loaded is used to define the Central Meridian for all subsequent UTM positions. When we loaded in a data set where the first line was in Zone 12 and the rest of the data was in Zone 13, all data positions were calculated in Zone 12. Loading the same data set, but loading a line that was completely in Zone 13 and then loading the remaining data all positions were calculated in Zone 13.

We have already defined the Central Meridian and / or UTM Zone for the Generic Parser, so why does the software not check for these environment variables before computing its own Central Meridian.

Within U.S.L.'s Generic Parser the sounding velocity should be set using an environment variable that can be set for the season or project instead of having to manually configure the Generic Parser for each data set conversion.

The HIPS directory structure should be re-configured so that all project related files are in one directory structure, not spread through several directories.

There is presently a limit to the number of processed data files that the software can read into the HDCS_DATA convertor. Once past this limit the software will not allow you to select these files to be imported into the CARED document. A temporary fix is to move "project directories" that are not being currently worked on out of the HDCS_DATA directory structure.

Modify the editing software to allow the use of a polygon (lasso command) to identify data points that are to be rejected, accepted or queried. Both the Navigation Editor and Single Beam Depth Editor currently support only a rectangular box to identify data points.

HDCS -

1. The HDCS menu requires modifications to allow for batch changes of "Line Attributes" instead of doing them one at a time. These batch data loads are still at the discretion of the processor and how he wants to define the data.

Navigation Editing -

1. The Navigation Editor could be more user friendly, if environment variables could be used to define the start-up parameters.

2. When you start the editor the display box should include the beginning of the line, not being centered in the display window.

Single Beam Depth Editing -

1. The Single Beam Depth Editor does not remember the previous configuration, whereas the Navigation Editor once configured keeps these settings for the rest of the session. Every time you go into the Single Beam Depth Editor window you must reset all the settings to your preferences.

2. The depths should be plotted with reference to time, not the distance along line. When the vessel is stationary (tied up at a wharf etc.) and logging, the depths can actually be plotted on top of each other. Having the Depths displayed with reference to time would give a better representation of the sounding graph.

3. The colour of the Minute Marks should be changed so that it is easier to identify the selected depths that fall on the minute marks.

4. When you have finished editing the line there should be an option to allow you to save the data and close the window in one action.

5. When you have logged dual frequency soundings the High Frequency soundings should not be automatically tagged as "selected". If the software defines the selected soundings it should ignore zero depths.
   Currently, if the high frequency depths are all zero, the Generic Data Parser makes the high frequency depths the selected depths and then filters them out in the depth filter. The processor then has to select all the low frequency depths so that they can be added into the CARED structure.

6. The display of the three colour boxes identifying the high frequency, low frequency and selected depths in the depth edit window should be moved to outside the editing window as their present location can conflict with the displayed depth.

7. It would be preferable to type in the exaggeration to be used in the display; not being forced to use an exaggeration of 1, 2, 4, 8, ... etc.

8. Having a vertical scroll bar to allow the processor to move the window display up and down. This is handy where the bottom changes rapidly and you do not want to keep changing the exaggeration and time scale of window.
9. Being able to set the depth interval to be displayed on the screen; for example every two metres or five metres. Now when you change from one section of data to the next, the depth lines displayed may go from every 2 metres to every 5 metres and there is no discernible change in displayed depth range.

APPENDIX B

Appendix B

Electronic Support for Bathurst Inlet 1998 Hydrographic Survey.

CHS Pacific, Alan Thomson, Electronics Technologist,
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Preparation

1. Dialogue with Amin Kassam (BC Active Control System), and Mark Casey of NRCAN Active Control Network wide area corrections via MSAT using Global Surveyor helped get units delivered with appropriate antennae.
2. Grouping equipment according to where it is used and labelling the major contents of each box on the outside helped locate items aboard Nahidik.
3. Air shipping the Dangerous goods (aerosol contact cleaners to bear spray) required individual documentation, MSDS showing UN number and class label and packaging required. This was done and no delays in shipping resulted.
4. Tested 4 solar panels and their regulators.
5. Toshiba UPS battery pack ran for 22 minutes at 600 Watts.

Logistics

1. IOS shipper Don Tillie arranged trucking from IOS to Hay River (contact was Tom Maher), CCG charter NWT Air flight to Cambridge Bay worked well. From Cambridge Bay Airport our cargo got to the Nahidik with a truck rented from Fred Ross at Cambridge Bay.
2. A Huisson Helicopters Bell 206 on floats C-GJWL piloted by Riele deployed tide gauges.
3. The Cambridge Bay airport manager would not let me load and unload the helicopter without a flashing light, even with the helicopter at the very edge of the airport.

People

1. A happy and co-operative crew from all parts of Canada consisted of: 12 Coast Guard employees and 6 CHS employees.
2. CHS people: two from Central and Arctic region (one for 2 weeks), one from BIO Atlantic Region, one co-op student from College of North Atlantic in Newfoundland and two from CHS at IOS Pacific region.
3. Jim Vosbourgh of Terra Surveys, operating from Cambridge Bay, reported no ice in our survey area July 23.
4. Gordon Worthing's documentation and support was excellent, including ZIPing my computers backup from the network to restore configuration files etc I needed but were deleted by C&A processor.
5. Thanks to C. & A. staff (Dave Tobio and Rudy Cutillo) surveying in Hudson's Bay for helping with ISAH memory board problems and rebuilding software.
6. In Bathurst Inlet, as the Nahidik sailed southward we crossed the realm of King Neptune.

At the mercy of the sea and those who respect her, five shipmates submitted to a memorable yet safe arctic crossing ceremony, which left 2 hydrographers needing hats.

Platforms

CCGS Nahidik

1. Readily passed the CSI safety inspection on schedule.
2. Capable of sounding in less than 2 meters of water !
3. Nahidik vibrates significantly at speeds of more than 10 knots and while turning at end of line. We put packing foam under equipment sensitive to vibration.
4. Antenna mounting locations are limited, as the mast has no spreader arm space available.
5. Only the 150 kHz transducer was effective, physically better positioned.
6. The 200 kHz transducer we had installed was again unusable once the vessel is moving in a sea state more than light chop. The Nahidik has 5 other 200 kHz sounders operating which interferes with the Knudsen 200 kHz survey sounder.
7.

CSL Bold

1. One of the 24.Volt batteries was not healthy but survived if charged while longer testing.
2. At 650 rpm the 24 volt alternator is on the edge of providing enough power to keep the Imagenex powered. We increased the rpm when the 24 volts dropped off.
3. The 120 Vac power bar (for heater and battery charger) gave two of us shocks when connecting and disconnecting ship power. Salt water corrosion and leakage or tracking to the case was the reason. Replaced it with a good quality power bar and …no more shocks.
4. The 24 volts would not charge on August 11 so we replaced the self-regulated alternator (needed to transfer shaft spacer, key, and sheeve).

Coast Lining Backpack

1. Consisted of: a nylon backpack, and inside was a dry box containing a Novatel 3151R, 7Amp-hr gel-cell with external charging cable.
2. Operator I/O was a Psion Workabout connected to the 3151R-console port.
3. Differential Corrections were supplied by a Global Surveyor 1550 taped to the top of the dry box.
4. Two pipes taped and tie-wrapped to the sides of the pack supported the Novatel 501 GPS antenna and Global Surveyor quadrifilar MSAT antenna.

Tides

Three REVLIS Low Power Tide Gauges with diaphragm sensors ran for 35 days without any battery replacements and downloaded tides to notebook or Psion properly at each opportunity. The LPTGs were deployed at Roberts Bay, Baychimo and Quadyuk Island.

Re-terminated one LPTG to Psion cable at the PT-10-S end, one broken wire, and improved strain relieving.

Currents

The ducted current meter sensor was suspended below the hull of the Nahidik and logged manually every 15 minutes for over 24 hours while at anchor. This equipment worked well.

Communications

1. I installed the C&A supplied Mitsubushi MSAT phone in the processors cabin. The antenna cable is only about 8 meters long, so I installed the motorised antenna on the Nahidik's funnel mounted on foam to isolate large vibrations. When the Nahidik was turning at end of line and the mast passed between this antenna and the satellite, calls were interrupted.
2. UHF corrections from the Nahidik to the Bold were good (about 98% at 17 kms, 90% at 23 kms and 60% at 28 kms).

Underwater

Side Scan Sonar - Imagenex

1. The system was not operational as received. The SCSI disc storage unit would not select either drive. I located and repaired a crushed ribbon cable used for SCSI addressing of drives. The Imagenex Processor could now enable, write and read to the SyQuest disc.
2. The CHS Imagenex Side Scan Sonar performed well on the Bold. A 600-Watt inverter running off the launch 24-volt system powered the Imagenex.
3. GPS input to the 858 must be GLL. I installed a second Novatel GPS receiver (2151R in reference station with differential Corrections) to supply $GPGLL
4. Snatch block borrowed from PGC is very appropriate; has a good diameter; swivels well and the polypropylene lining helps protect the cable.
5. The Klein cable grabber works holds well but can be tricky to unload under tension.
6. The yellow depressor works but an even steeper towing angle would be better.
7. The 4-lay braided fingers worked well for attaching the depressor to the cable.

Sound Velocity Probe - AML

1. I installed 6 alkaline D cells in the C&A owned Applied Microsystems SVP-16 freshly calibrated at AML. I also purchased an operators manual and set of 3 Electro plugs (shorting, dummy and data).
2. A few casts with the Pacific region Odom Digibar produced +/- 0.3m/s differences between C&A SVP-16 and Odom to the Odom's maximum depth of 28 meters using slow deployment for better temperature tracking for the Odom.

Single Beam Sonar - Knudsen

1. Called Knudsen (Gord Snow) for step by step instructions to change output string needed for Hypack (PKEL:01010200) in sounder with a MPM-tag file earlier than v2.46. (our 150/200 kHz 320M has mpm.tag v1.27).
2. Paper drive clutch adjustment was needed on both ship and launch. The problem seems to be that a small change in adjustment makes too much change in drive torque.
3. Printer power cable molex connector wires broke on 2 of three sounders. Re-terminated.

Positioning

1. Our T-Modem's comm. port speed varies with RF link baud rate, ie 4800, 9600)
2. Used an elevation mask of 8 degrees, Differential Mode RTCM6.
3. PC3 locks up on POST, replaced with PC1.
4. Watch the Novatel data output quality field =2 for valid differential corrections.

Global Surveyor

1. NRCAN sent two model 1550 receivers with 2 high gain quadrifilar antennae.
2. Terrace position becomes Bathurst Inlet Local Area Solution for CCGS Nahidik.
3. Williams Lake position becomes Hudson's Bay for CCGS Griffon CHS C&A survey.
4. Mark Casey of NRCAN obtained the DIP switch settings needed to configure the Global Surveyor 1550 from 9600 baud to 4800 baud which allowed us to rapidly switch between differential corrections sources a) UHF/reference station and b) MSAT.
5. UHF Repeater R1 was used on the Nahidik to re-broadcast corrections to the launch. I made a Y-cable to split the Global surveyor into 1) Novatel 3151R and 2) UHF repeater.

PC-104 Monitor Station

This procedure worked:

1) Power monitor station's main switch off then on.
2) Wait for Novatel GPS receiver's "valid position" LED to light (approx. 2 minutes).
3) Switch PC-104 power on and start timing on wristwatch.
4) Insert blank zip cartridge.
5) Wait for 10 minutes, 26seconds for Zip's right LED to flash, this indicates it is writing data.

Data logging

1. Used 3 keyboard and pointing device extension cables and round to DB adapters.
2. PC3's power-on-self-test stops at "Memory test: 640k" with no mouse or keyboard response and was replaced with PC1.
3. The industrial pointing device on the Bold was replaced with a Logitech Trackman Live wireless mouse from C&A. While its range is short, Hydrographers liked it better and one set of AAA cells ran for 32 days.

Hypack

1. Decreased position update "frequency" from 100 to 1000 ms between samples. This seemed to reduce or eliminate pauses in screen updates and mouse control (too fast a data rate from Novatel 3151R).
2. Set depth update "frequency" to 100.ms so the latest depth from the Knudsen 320M is read when "At ping rate" is selected. This may reduce interpolation between aged pings.

If data visible in "Test" mode but not in "Survey" mode

Processing

1) Thin-wire Ethernet coax and BNC's connected the Alpha workstation and 2 PCs.
2) DEC Alpha has an external disk drive with 2 hard disks and one exabyte. The 4GB Seagate Barracuda hard disk with CARIS and HIPS (791MB used) had intermittent access to several files, block errors etc. Removed cover, re-seated SCSI and power connectors, mounted the enclosure on medium density foam under the box and on its side between the desk pedestal it was bungie-corded to. Micro DB50 to Centronics SCSI cable looked good. No further trouble was reported while on Nahidik but it took disassembly, a few UNIX "df "commands and power on/off cycles to get it to run back at IOS.

Tools

The most frequently used tool was the notebook computer for configuring and testing GPS, depth sounders

Recommendations

1. **Need for a launch cabin air system.** The"Bold" (all enclosed cabin launches) should have a fresh air exchange system. Presently, to get fresh air on the Bold, the hydrographer is forced to work with the door or hatch open to allow fresh breathing air, reduce humidity and cool the cabin in warm, sunny weather.

   Problems with the launch door open:

   a) An objectionable amount of diesel exhaust emissions enter the cabin.

   b) A lot of fine salt spray enters and dries on the electronics and reduces reliability (e.g.: power bar shocks).

   c) An open door lets in more noise from the engine and exhaust, which interferes with cox'n to hydrographer dialogue and radio communications.

   Proposed solution:

   a) A forward air intake is needed to avoid engine exhaust.

   b) This intake should be baffled to separate water from air.

   c) A fan is needed in the air supply path for a positive pressure against engine/battery emissions and when launch operation is slow or with the wind.

   d) Combining fresh air supply with the cabin "bus heater" plenum would allow temperature adjustment, reduce humidity and window condensation in wet weather.

   e) A rear cabin exhaust outlet would give a cross-flow for good distribution.

2. Heave is the largest noise in our data now. HIC, processors and myself all recommend CHS purchase 2 Seatex MRU-H or MRU-6 heave sensors, as capital funds permit. These are directly connectable to C&A or PAC region Knudsen sounders and will reduce processing time and improve data quality. Perhaps we could share the heave sensors cost nationally and deploy the sensors to the survey with the largest sea-state.

3. Gordon Worthing could develop a procedure to quickly verify that valid data is being written from the PC-104 to the Zip drive before we leave the monitor station. (Presently we need to wait multiples of 10 minutes and the only indication is a brief LED blink).
   E.g.: connect a notebook parallel port to the Zip drive?

4. All CHS packing crates must have handles for lowering equipment through hatches into a ship's hold.

5. Install current meters at the beginning of a survey and recover at the end of a survey just as the tide gauges handled.

6. Investigate operating our Dataradio T-Modem UHF differential corrections at 9600 baud for quick switching over to Global Surveyors which are shipped at 9600 baud.

7. Add one or two general-purpose 12-volt receptacles (or inline connectors) to all of our launch positioning trays, reference stations, monitor stations and backpack. This would speed up changing assignments of the Global Surveyor and no need for tools or powering down the ship's positioning.

8. Approach B.C. Wide Area Solution people about legality of re-broadcasting Global Surveyor corrections from the ship to the launch or shore monitor station. Manual's licence agreement doesn't really cover a ship with a launch on the same survey.

9. HYPACK should allow line numbers to remain visible in the screen to help determine port or starboard turns at end of line and reference current position to "Targets" in adjacent lines. The version of HYPACK we used would only show survey line numbers at the ends of the lines. Zooming out to get an end of line on the screen, from mid-line makes the font too small to read.

10. Bob Langford (C&A) recommends Obis Form chairs for working aboard ship. He found that the Nahidik's chairs are not appropriate for 11 or more hours of processing every day.

11. Spare alternators should have the correct sheeve, key, and shaft spacer/collar installed, as this transfer is tricky without a press.

12. To improve sounding production on CCGS Nahidik, install either a ram and gate valve or an over-the-side retractable transducer mounting.

13. ADT could compare our SVP-16 to the newer SV-Plus this winter. If any significant errors show up then have it calibrated at AML.

14. ADT should convert our SVP-16 from 20 mA current loop to RS232 to eliminate the converter box and its power source.

15. ADT test each of the gel-cell chargers as one of them is slow to recharge deeply discharged batteries where no solar panels were installed.

16. ADT should a) finish the logging program for the ducted current meter so logging can occur without attending so continuously. b) Add a program to remove the errors due to boat motion at anchor by removing position changes logged from DGPS.

17. ADT follow up on the latest version software for the Knudsen 320M for 150 & 200 kHz I requested so this sounders menu and operation is like our upgraded 38 & 200 kHz.

APPENDIX C

Dease Strait to Roberts Bay, (Nav. Notes by Capt. Green)

Wpt 1	68°35' N 109°05' W		
		→ Co. 180(T), 15.5 nm.	Index line@2.6 nm (to port) on SW tip Entry Island
Wpt 2	68°19.5 N 109°05' W		
		→ Co. 152° (T), 15.2 nm	Index line @1.15 nm (to port) on P. Klengenberg Is.
Wpt 3	68°06' N 108°45.9' W		(*shoaling Triple Islds to P.Klengenberg Is P&S)
		→ Co. 156° (T), 8.74 nm	
Wpt 4	67°58' N 108°36.5' W		
		→ Co. 109° (T), 3.76 nm	
Wpt 5	67°56.8' N 108°27' W		
		→ Co. 068° (T), 4.25 nm	Index line @ 0.7 nm (to port) on S tip Cockburn Islds
Wpt 6	67°56.8' N 108°16.5' W		(*shoals S of Cockburn & N of Breakwater Islds)
		→ Co. 042° (T), 13.9 nm	Caution: 6.9 m shoal to SE at end of course line
Wpt 7	68°08.7' N 107°51.1' W		
		→ Co. 090° (T), 2.75 nm	Index line @ 2.0 nm (to stbd.) N. Tip C. Croker
Wpt 8	68°08.7' N 107°44.1' W		Caution: 6.9m shoal to south of course line
		→ Co. 104° (T), 4.81 nm	
Wpt 9	68°07.5' N 107° 31.6' W		
		→ Co. 066° (T), 15.9 nm	Index line 0.73 nm (to port) S tip Hurd Islds
Wpt 10	68°13.9' N 106°52.5' W		
		→ Co. 045° (T), 5.09 nm	
Wpt 11	68°17.5' N 106°42.8'W		
		→ Co. 163° (T), 4.82 nm	
Wpt 12	68°13.9' N 106°38.9' W		
		→ Co. 174° (T), 1.01 nm	
Wpt 13	68°12.9' N 106°38.6' W		

Dease Strait to South Bathurst Inlet (Nav. Notes by Capt. Green)

Wpt 1	68°35' N 109°05' W		
		→ Co. 180(T), 15.5 nm.	Index line@2.6 nm (to port) on SW tip Entry Island
Wpt 2	68°19.5 N 109°05' W		
		→ Co. 152° (T), 15.2 nm	Index line @1.15 nm (to port) on P. Klengenberg Is.
Wpt 3	68°06' N 108°45.9' W		(*shoaling Triple Islds to P.Klengenberg Is P&S)
		→ Co. 156° (T), 8.74 nm	
Wpt 4	67°58' N 108°36.5' W		
		→ Co. 109° (T), 3.76 nm	
Wpt 5	67°56.8' N 108°27' W		
		→ Co. 066° (T), 2.46 nm	
Wpt 14	67°57.78' N 108°21.0' W		
		→ Co. 150° (T), 2.28 nm	
Wpt 15	67°55.8' N 108°18' W		
		→ Co. 180° (T), 7.83 nm	Index line@ 1.0 nm (to stbd.) on Breakwater Islds
Wpt 16	67°47.97' N 108°18' W		Caution: small islet east of Breakwater Islds
		→ Co. 134° (T), 11.1 nm	Index line 0.6 nm (to port) on Is NW of Bay Chimo hbr
Wpt 17	67°40.2' N 107° 57.04' W		
		→ Co. 155° (T), 9.05 nm	Index line 1.2 nm (to port) on Shoe Is
Wpt 18	67°32' N 107°47' W		
		→ Co. 187° (T), 11.5 nm	Index line 1.1 nm (to stbd) on E. edge of Kanuyak Is.
Wpt 19	67°20.61' N 107°50.5'W		Caution shoaling to port @ end of course line
		→ Co. 159° (T), 14.9 nm	Caution shoaling to P&S
Wpt 20	67°06.73' N 107°36.4' W		
		→ Co. 228° (T), 5.26 nm	Caution: shoaling to P&S
Wpt 21	67°03.2' N 107°46.4' W		
		→ Co. 179° (T), 7.5 nm	Caution: shoaling to P&S
Wpt 22	66°55.7 N 107°46.2' W		
		→ Co. 176° (T), 1.9 nm	Caution: shoaling to P&S
Wpt 23	66°53.8' N 107°45.9' W		
		→ Co. 188° (T), 2.93 nm	Caution: shoaling to P&S
Wpt 24	66°50.9' N 107°47' W		

→ Co. 280° (T), 2.07 nm Caution: shoaling to P&S

Wpt 25 66°51.25' N
107°52.2' W

→ Co. 251° (T), 1.08 nm Caution: shoaling off N. tip of islds,NW side Tinney C

Wpt 26 66°50.9' N
107°54.8' W

→ Co. 214° (T), 0.844 nm

Wpt 27 66°50.2' N
107°56.0' W

→ Co. 148° (T), 14.0 nm

Wpt 28 66°38.34' N
107°37.24' W

→ Co. 157° (T), 4.62 nm

Wpt 29 66°34.1' N
107°32.6' W

→ Co. 128° (T), 1.31 nm

Wpt 30 66°33.3' N
107°30.0' W