



CSR GeoSurveys Limited

PAB Vardy's Island – Navigation Improvements 2020 Hydrographic & Geophysical Survey Port aux Basques, Newfoundland

Submitted To:



Lorna Campbell, P.Eng.
Civil Engineer
CBCL Limited
164 Charlotte Street, Suite A
PO Box 567, Sydney, NS, B1P 6H4
Telephone: 902-539-1330

Prepared By:

CSR GeoSurveys Ltd.
341 Myra Road, Porters Lake, Nova Scotia,
Canada, B3E 1G2
Telephone: (902) 827-4200
Fax: (902) 827-2002

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TABLE OF CONTENTS

Table of Contents	i
List of Figures	ii
List of Tables	iii
List of Appendices	iii
List of Enclosures	iii
Report Citation.....	iv
Statement of Quality	iv
Executive Summary	v
1.0 Introduction.....	1
1.1 Survey Objective.....	2
1.2 Report Overview.....	4
2.0 Geologic Setting.....	6
3.0 Survey Operations.....	10
3.1 Survey Equipment.....	11
3.1.1 Positioning.....	12
3.1.2 Multibeam Sonar.....	13
3.1.3 Sub-bottom Profilers.....	14
3.2 Equipment Calibration	15
3.2.1 Multibeam Echosounder Calibration	16
3.2.2 Water Levels	16
3.2.3 Sub-bottom Profilers.....	16
3.3 Survey Reference	17
3.4 Survey Coverage.....	19
4.0 Data Processing & Mapping	22
4.1 Bathymetry.....	22
4.2 Sub-bottom Geology.....	23
5.0 Results.....	24
5.1 Seabed Morphology and Features.....	24
5.2 Geology.....	32
5.2.1 Surficial Geology.....	32
5.2.2 Sub-bottom Geology	32
6.0 Summary	41
7.0 Recommendations.....	43
8.0 References.....	43

LIST OF FIGURES

Figure 1.1 – Port aux Basques location map.....	1
Figure 1.1.1 – Proposed survey boundary provided by CBCL.....	3
Figure 2.1 – Onshore bedrock geology map.....	7
Figure 2.2 – Onshore surficial geology map.....	8
Figure 2.3 – Lithological units within the Port aux Basques Gneiss.....	9
Figure 3.1 – Survey Boat SeaQuest mobilized at dock.	10
Figure 3.2 – Survey Boat SeaQuest within Port aux Basques Harbour.....	10
Figure 3.3 – Multibeam transducer on SeaQuest over-the-side mount.	11
Figure 3.1.1 – Trimble RTK-GPS base station set up on CSR1945 BS1f.	12
Figure 3.1.2 – Multibeam sonar data collection.	13
Figure 3.1.3 – Boomer data collection.....	14
Figure 3.1.4 – Boomer system on deck after retrieval.....	15
Figure 3.3.1 –CHS benchmark 90F9004.	18
Figure 3.3.2 – Trimble RTK-GPS base station set up on CSR1945 BS1f.	18
Figure 3.3.3 – Trimble rover setup over 82G2332.	19
Figure 3.4.1 - Location of multibeam survey tracklines.....	20
Figure 3.4.2 – Location of sub-bottom profiler (Boomer) tracklines.	21
Figure 5.1.1 - Shaded relief multibeam bathymetry image of Port aux Basques survey area referenced to chart datum.....	26
Figure 5.1.2 - Spatial distribution of dredged and dredge spoil areas over multibeam shaded relief.....	27
Figure 5.1.3 - Multibeam shaded relief of dredged areas offshore Vardy's Island.....	28
Figure 5.1.4 - Multibeam shaded relief of dredged areas and dredge spoil near Baldwin Rocks.....	29
Figure 5.1.5 - Location of seabed features mapped from multibeam sonar data.....	30
Figure 5.1.6 - Multibeam shaded relief image of submarine pipes.	31
Figure 5.2.1 – Spatial distribution of the surficial bedrock geology with seismic section figure locations over the multibeam shaded relief.....	35
Figure 5.2.2 - Single channel seismic (Boomer) section (top) and interpreted sub-bottom sequences (bottom) showing irregular acoustic basement reflector overlain by post glacial sediments.....	36
Figure 5.2.3 - Single channel seismic (Boomer) section (left) and interpreted sub-bottom sequences (right) showing two fine grained sequences.	37
Figure 5.2.4 - Single channel seismic (Boomer) section (top) and interpreted sub-bottom	

sequences (bottom) showing interpreted bedrock overlain by till and post glacial sediments.....	38
Figure 5.2.5 - Single channel seismic (Boomer) section (top) and interpreted sub-bottom sequences (bottom) showing interpreted acoustic basement reflector and overlying coarse gravel/till.	39
Figure 5.2.6 – Quaternary sediment thickness with locations of bedrock at or near the seabed.....	40

LIST OF TABLES

Table 1.2.1 – Abbreviation & Acronym Definitions	4
Table 3.2.1 – Patch Test Summary	16
Table 3.3.1 – Project Benchmarks	19

LIST OF APPENDICES

Appendix I – Daily Field Log
Appendix II – Vessel Offsets
Appendix III – Sound Velocity Profiles
Appendix IV – Survey Control
Appendix V – Deliverables
Appendix VI – Enclosures (not to scale)

LIST OF ENCLOSURES

Enclosure 1 – Sounding Chart (North)
Enclosure 2 – Sounding Chart (South)
Enclosure 3 – Bathymetric Contour Chart (North)
Enclosure 4 – Bathymetric Contour Chart (South)
Enclosure 5 – Surficial Bedrock Geology & Acoustic Basement Isopach Map (North)
Enclosure 6 – Surficial Bedrock Geology & Acoustic Basement Isopach Map (South)
Enclosure 7 – Sub-bottom Trackline and Probe Location Map (North)
Enclosure 8 – Sub-bottom Trackline and Probe Location Map (South)

REPORT CITATION

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STATEMENT OF QUALITY

CSR GeoSurveys Ltd. warrants that its service with respect to this study was performed with a degree of skill and care equal to or greater than that ordinarily exercised under similar conditions by reputable members of our profession practicing in the same or similar locality. No other warranty, expressed or implied, is made or intended. Geophysical surveying is a remote sensing method that may not detect all surface or subsurface features of interest or concern.

CSR Project Team

Daniel Campbell, EIT
Patrick Campbell, P.Geo.
Archan Dabadi, P.Geo.
Mitch Grace, M.Sc.
Colin Toole
Mark White

Client Representative

Lorna Campbell, P.Eng.

EXECUTIVE SUMMARY

Port aux Basques is located on the southwestern tip of Newfoundland. The Marine Atlantic ferry terminal in Port aux Basque is the primary entry point onto the island of Newfoundland. CSR GeoSurveys Ltd. was contracted by CBCL to conduct a hydrographic and marine geophysical survey in preparation for Marine Atlantic's Port aux Basques Vardy's Island Navigation Improvements. The surveys were conducted between January 22nd and January 28th 2020. The hydrographic survey included the collection of full bottom coverage utilizing multibeam sonar. Sub-bottom profile data were acquired simultaneously during the multibeam survey utilizing a single channel seismic reflection system (Boomer).

The hydrographic survey was conducted using ellipsoidal referenced survey techniques. CHS benchmark 90F9004 was used for establishing CSR's project survey control on the eastern side of the former fish plant dock off Pleasant Street. An RTK-GPS base station was set up each day which broadcasted RTK corrections to the rover GPS onboard SeaQuest. The RTK-GPS ellipsoid elevations were converted to CHS Chart Datum based on the CanEast 2015 v1 model. Water level heights were checked using RTK-GPS and compared with data from CHS tide station 625 at Port aux Basque and CSR tide gauge installed during the survey.

The processed multibeam data was exported from Caris as a 1 m horizontal resolution CUBE surface. Sounding and Bathymetry Charts compiled from this surface included the minimum/shoalest value within 5 m x 10 m cells and 1 m contour intervals respectively. The bathymetry over the area surveyed ranged from 0.5 m to 51 m. Shoal areas comprised of bedrock occurred throughout the area surveyed. Port aux Basques Harbour is characterized by a narrow northwest-southeast channel from the approaches to the Marine Atlantic Terminal. The narrowest sections of the channel reach a maximum depth of approximately 25 m west of Middle Baldwin Rock and 27 m west of Vardy's Island. The channel widens between Sheaves Cove and Pikes Island breakwater where it reaches a maximum depth of approximately 29 m. The inner harbour, oriented northeast-southwest, reaches a maximum depth of approximately 18 m north of Vardy's Island.

Seabed features related to previous dredging activities were observed offshore of Vardy's Island and Baldwin Rocks. Two possible dredged areas occur west of Middle and East Baldwin Rocks while areas of dredge spoil were observed southeast of East Baldwin Rock within water depths of 20 m to 35 m and east of Pikes Island Breakwater. A number of linear seabed features were observed including an intake pipeline that makes landfall at Pleasant Point as well as an abandoned pipe.

The surficial bedrock geology was mapped from the multibeam sonar data and single channel seismic records. The seabed over the remaining areas surveyed comprised undifferentiated Quaternary sediment. The surficial bedrock geology was divided into three units based on the morphology of the seabed. The three surficial bedrock geology units include; 1) bedrock outcrop or bedrock at the seabed, 2) bedrock / boulders with local sediment veneer, 3) bedrock with local sediment veneer generally <0.2 m.

The sub-bottom geology within the survey area was mapped from the single channel seismic (Boomer) records based on acoustic characteristics and seismic impedance. All sub-surface measurements were calculated based on a sound velocity of 1600 m/s. Based on the data acquired, CSR identified three main sub-bottom geological sequences.

Sub-Bottom Sequence 1 (SB1) consisted of post glacial sediments. This sequence was divided into two sub-units; SB1a and SB1b. Sequence SB1a, interpreted as fine-grained sands, silts and clays ranged in thickness from <0.2 m to approximately 7 m. SB1a was observed throughout the area surveyed with the exception of where bedrock outcrops. SB1b, interpreted as primarily fine-grained sands, was observed in the deep channel between Vardy's Island and the Marine Atlantic dock with a maximum thickness of approximately 14 m. SB1b also occurred within the channel west of East Baldwin Rock.

Sub-Bottom Sequence 2 (SB2) was interpreted as Glacial Till and or proglacial sediments. Based on the acoustic signature this unit was interpreted as an unsorted heterogeneous sediment matrix, composed of varying grain sizes ranging from silts/clays to cobbles and boulders deposited by glacial activity. The thickness of SB2 ranged from approximately 1 m to >10 m. A significant occurrence of SB2 was observed between Sheaves Cove and Pikes Island Breakwater. The acoustic basement reflector was not observed over this area due to limited penetration of the seismic energy as a result of the coarse nature of the overlying glacial till.

Sub-Bottom Sequence 3 (SB3) represents acoustic basement interpreted as bedrock although in some areas it may also represent the top of a boulder rich glacial till. Acoustic basement is characterized by a strong reflector where it was well defined. The reflector was often rough and irregular in nature possibly due to fracturing of the bedrock. The acoustic basement reflector was visible throughout the majority of the area surveyed and occurred at surface where bedrock outcropped.

Isopach contours representing the thickness of Quaternary sediment over acoustic basement were generated from the interpreted sub-bottom geology. The Quaternary sediments include sub-bottom sequences SB1 and SB2. The thickness of Quaternary sediments over the area surveyed ranged from <0.2 m to approximately 21 m. The majority of the area surveyed had sediment thicknesses <2 m with the exception of the deepest sections of the northwest-southeast Port aux Basques channel.

1.0 INTRODUCTION

Port aux Basques (PAB) is located on the southwestern tip of Newfoundland, see Figure 1.1. It is home to a deep water harbour facilitating year-round shipping operations. The harbour has been utilized for shipping since 1898 and has grown and evolved to include ten deep water docks of various lengths and water depth. The harbour has an approximate water depth of 10 metres, harbour channel width of 55 metres, and an inner harbour turning radius of 270 metres.

Marine Atlantic Inc. was established in 1986 to oversee the provision of ferry services in Atlantic Canada including the crossing between Port aux Basque and North Sydney. The Marine Atlantic ferry terminal in Port aux Basque is the primary entry point onto the island of Newfoundland.

CSR GeoSurveys Ltd. (CSR) was contracted by CBCL to conduct a hydrographic and marine geophysical survey in preparation for Marine Atlantic's PAB Vardy's Island Navigation Improvements. The surveys were conducted between January 22nd and January 28th 2020 within Port aux Basques Harbour and approaches. This report documents the results of the surveys conducted by CSR.

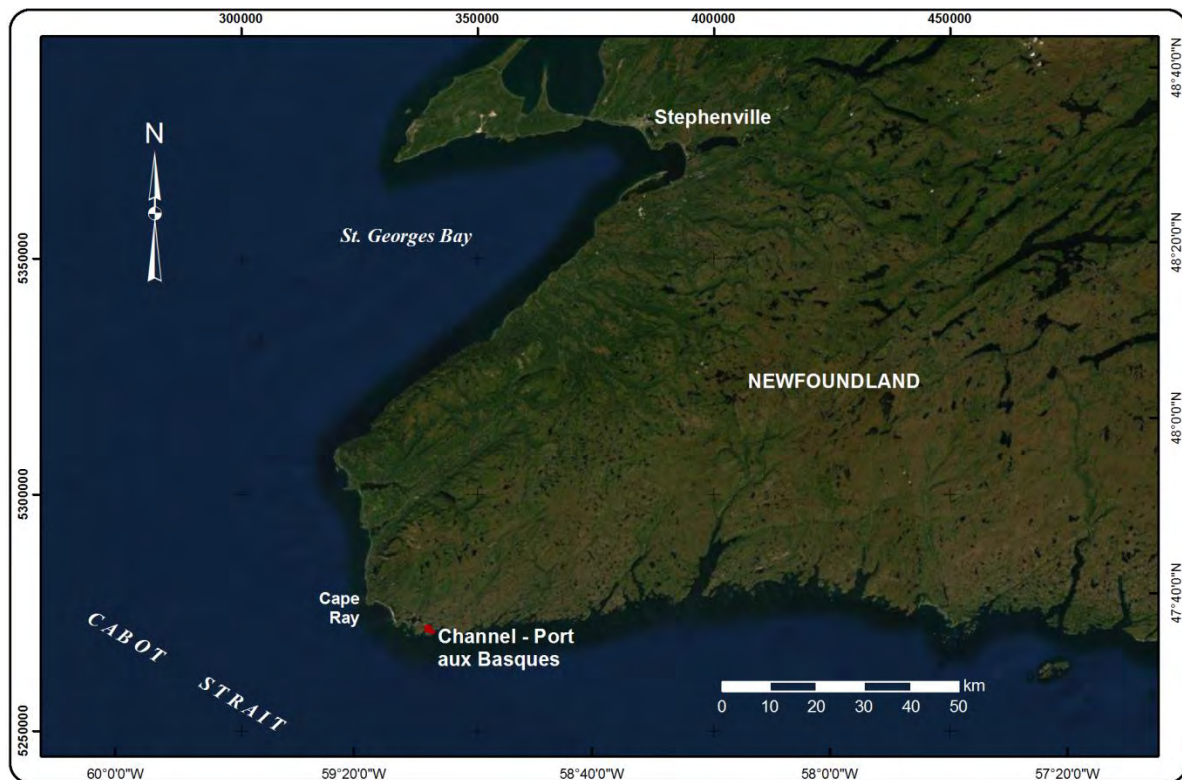


Figure 1.1 – Port aux Basques location map.

1.1 SURVEY OBJECTIVE

The specific objectives of the project were to conduct a hydrographic survey of the area, determine the nature and thickness of sediment over bedrock, and delineate the bedrock surface. The intended area to survey was provided by CBCL as outlined on Figure 1.1.1.

The hydrographic survey included the collection of full bottom coverage utilizing multibeam sonar within the Port aux Basques Harbour and approaches to meet CHS requirements. Sub-bottom profile data were acquired simultaneously during the multibeam survey.

The objectives of the survey were accomplished by the collection, processing, interpretation and subsequent reporting of the hydrographic and geophysical data. The following data were collected during the survey:

- RTK-GPS was recorded to provide real-time horizontal and vertical geo-referencing for all data sets acquired during the survey.
- Hydrographic survey using a multibeam sonar and associated ancillary equipment.
- High-resolution single channel seismic reflection sub-bottom profiler data were acquired to map the sub-surface geology and delineate the top of bedrock.

All data were processed and mapped upon completion of the survey. The project deliverables include this report documenting the survey methodology, equipment, data processing, and results as well as the following charts.

- 1) Sounding
- 2) Bathymetry Contour
- 3) Isopach Map of unconsolidated quaternary sediment.

All CSR maps were referenced to NAD 83 UTM Zone 21 coordinates and CHS vertical datum.

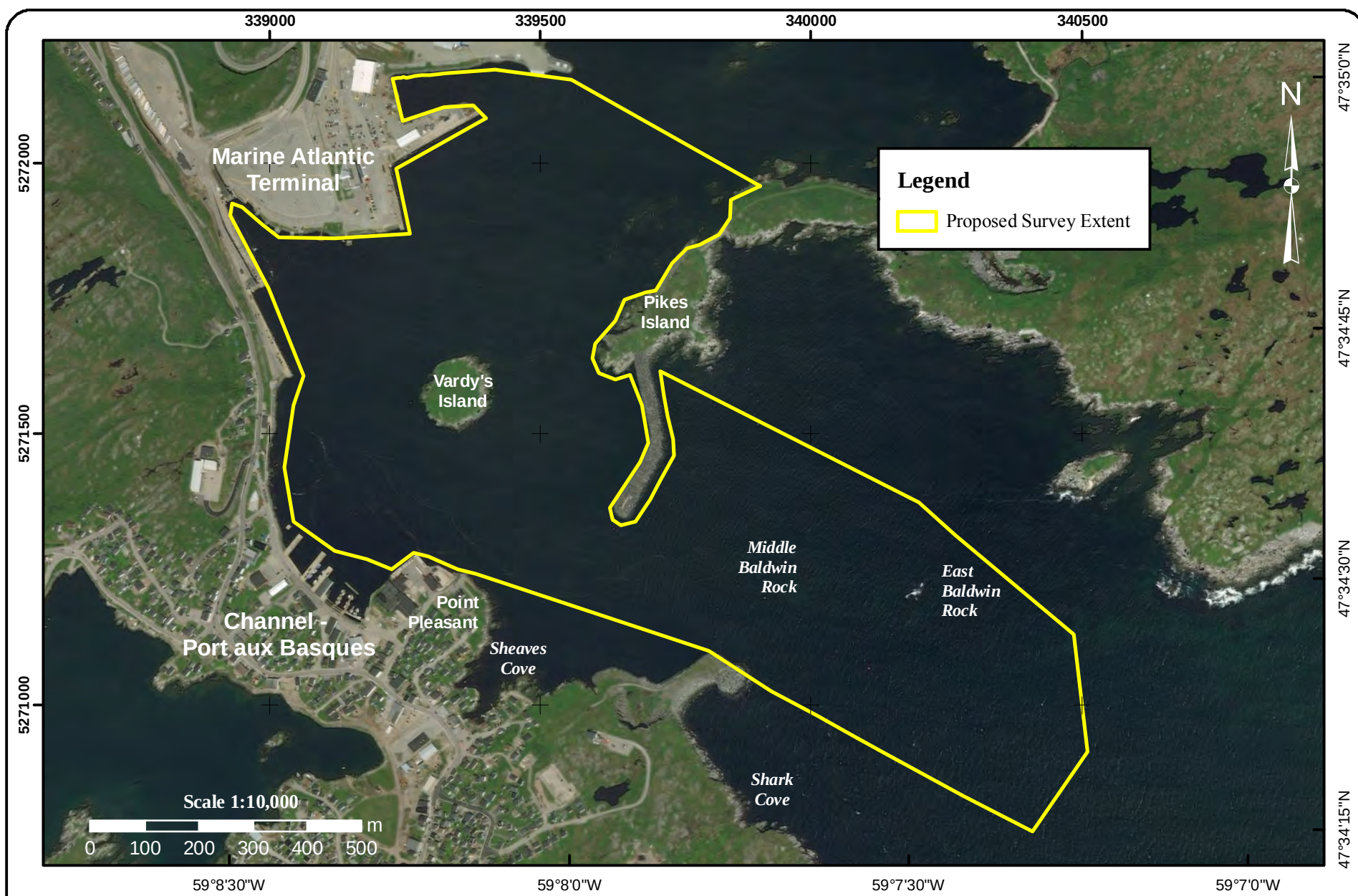


Figure 1.1.1 – Proposed survey boundary provided by CBCL.



1.2 REPORT OVERVIEW

This section presents a general overview of the report structure while Table 1.2.1 defines the abbreviations and acronyms used throughout the report.

Section 2 of the report provides information on the Port aux Basques geologic setting. Section 3 includes a discussion of the survey operations including survey equipment and survey coverage. Section 4 documents data processing and interpretation methodologies. The results of the processing, interpretation and geological mapping are documented in Section 5.

Table 1.2.1 – Abbreviation & Acronym Definitions

Acronym	Definition
cm	centimetre
CD	CHS Chart Datum
CSR	CSR GeoSurveys Ltd.
CSRS	Canadian Spatial Reference System
db	decibel
DGPS	Differential Global Positioning System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRS80	Geodetic Reference System of 1980
Hz	Hertz
LLWLT	Low Low Water Large Tide
kHz	Kilohertz
km	kilometre
m	Metre
NAD83	North American Datum of 1983
NRCan	Natural Resources Canada
QC	Quality Control
PAB	Port aux Basques
RMS	Root Mean Square
RTK	Real Time Kinematic
SBP	Sub-Bottom Profiler

Acronym	Definition
SGY	Society of Exploration Geophysicists Data Format
SVP	Sound Velocity Profiler
TVG	Time Varied Gain
UI	User Interface
UTM	Universal Transverse Mercator

2.0 GEOLOGIC SETTING

Regional geological mapping of Port aux Basques has been conducted by the Geological Survey of Canada (1996), and Newfoundland & Labrador Department of Natural Resources (2009). Figures 2.1 and 2.2 include the bedrock and surficial geology of the Port aux Basques onshore area. The marine bedrock and quaternary geology is not well documented within Port aux Basques Harbour.

The onshore bedrock geology includes the Port aux Basques Gneiss, comprising three Cambrian-Ordovician paragneiss and schist assemblages. Spanning the southern shore of Newfoundland from Cape Ray and Harbour le Cou, the Port aux Basque Gneiss covers an approximate area of 700 km², bounded to the west by the Cape Ray Fault and by the Bay le Moine Fault Zone to the east.

Geologic mapping of the Port aux Basque Gneiss has led to its subdivision into three lithologically distinct units separated by high strain zones (Schofield et al., 1998). From west to east these lithologic units include the Grand Bay Complex, Port aux Basques Complex, and the Harbour le Cou Group (Figure 2.3). The mainland surrounding the Port aux Basques Harbour is entirely composed of rock belonging to the Port aux Basque Complex. These rocks are composed of massive quartz-rich psammites with kyanite or sillimanite bearing pelites which have been subjected to partial melting and multiple deformation events (Schofield et al., 1998). These are intercalated with sheets of orthoamphibolite and metabasite, and intruded by narrow syntectonic bands of Upper Ordovician Port aux Basques Granite (Schofield et al., 1998).

Surficial geological mapping by the Newfoundland Department of Natural resources revealed no quaternary sediment or overburden accumulations within the Port aux Basques onshore area. Bedrock is at surface throughout the area, concealed by varying degrees of vegetation on the southwestern side of the harbour, and largely exposed to the northeastern side of the harbour.

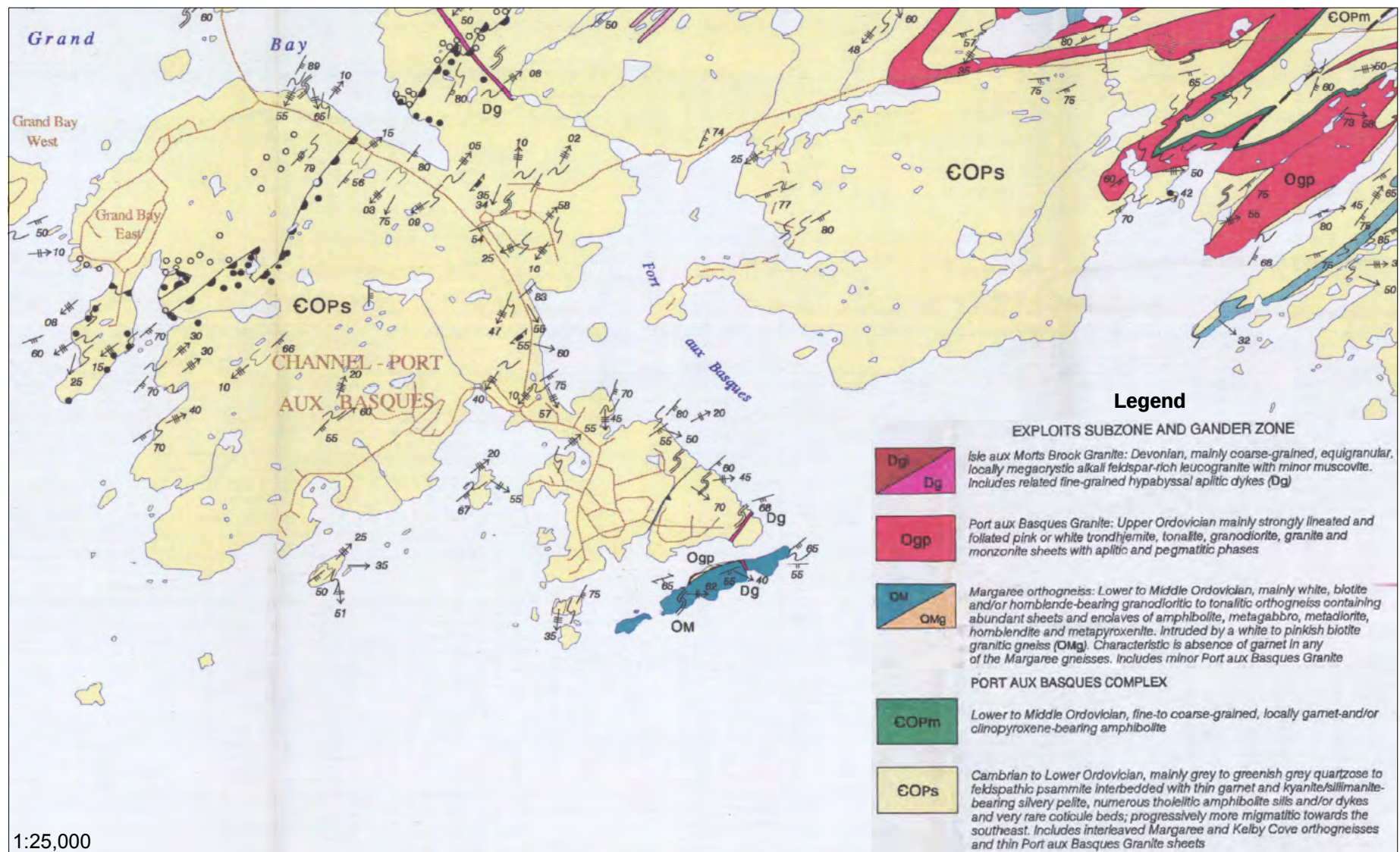


Figure 2.1 - Onshore Bedrock Geology of the Port Aux Basques area (van Staal et al., 1996).

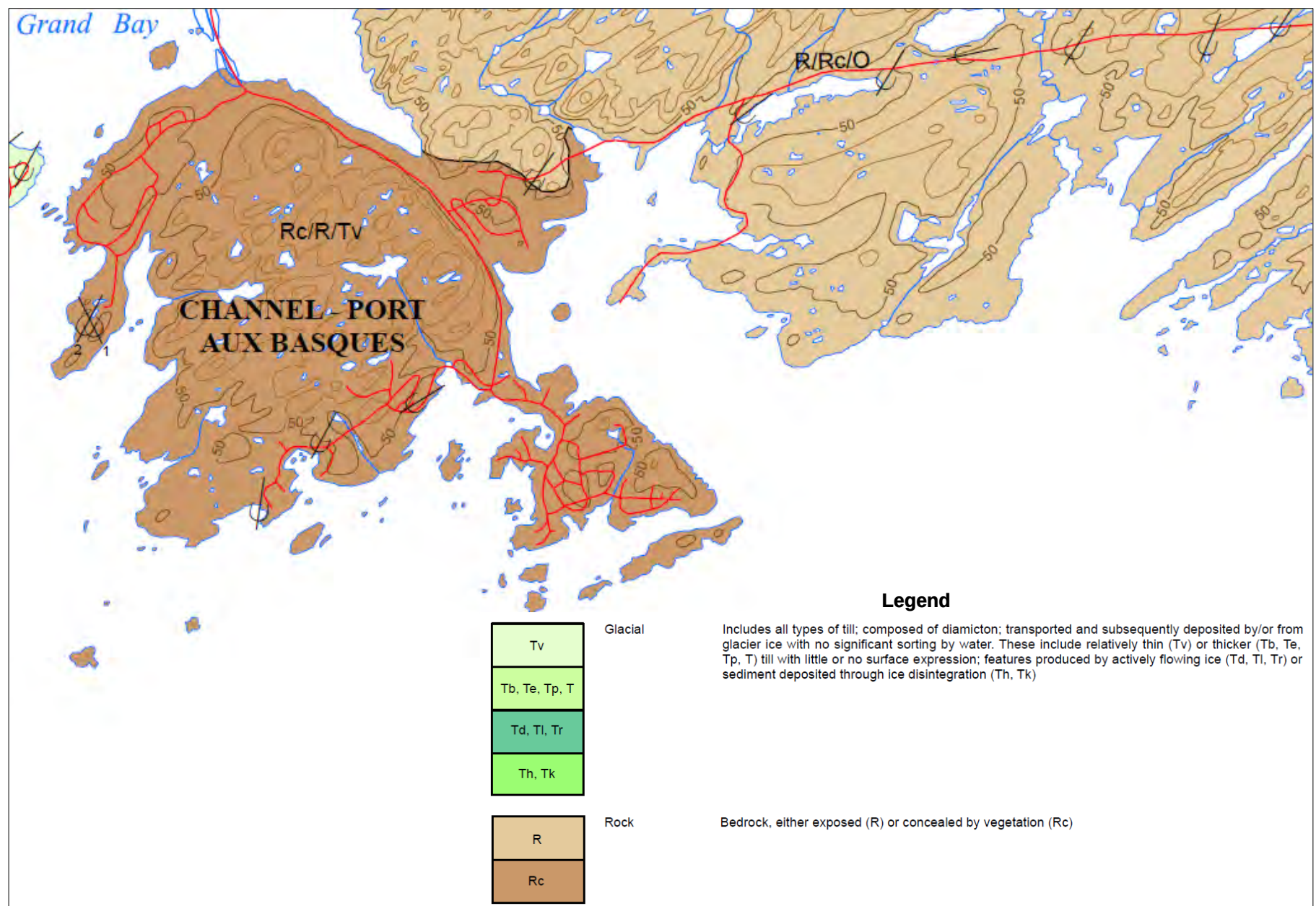


Figure 2.2 - Onshore Surficial Geology of the Port Aux Basques area (Kirby et al., 2009).



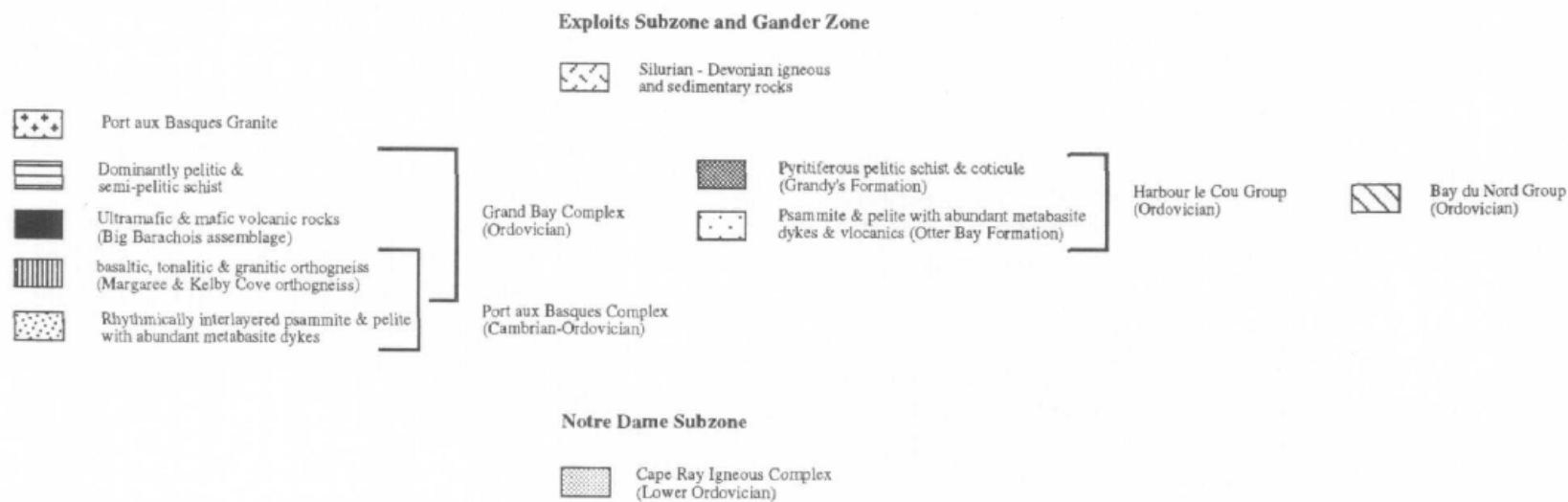
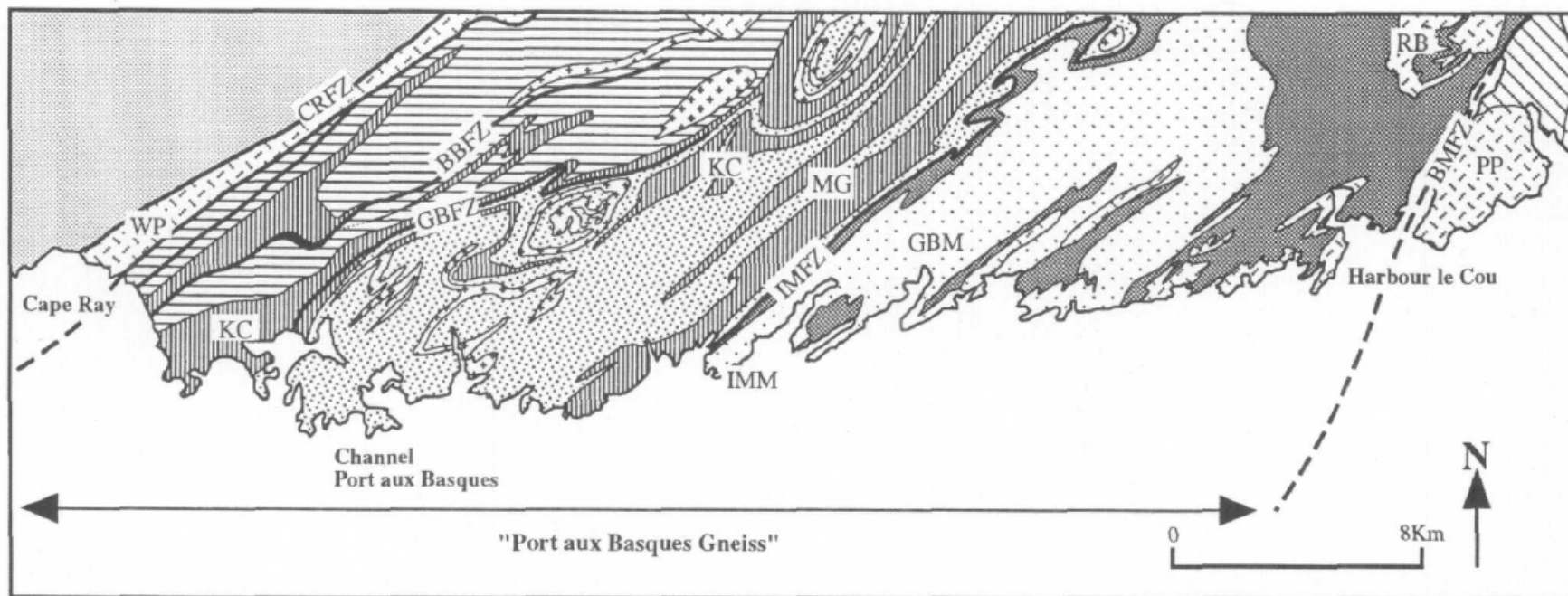


Figure 2.3 - Stratigraphic divisions of the Port Aux Basques Gneiss (Schofield et al., 1998).

3.0 SURVEY OPERATIONS

The hydrographic and geophysical surveys were conducted onboard CSR's survey boat *SeaQuest* (RF-246 Rosborough). The Rosborough boat is an ideal platform for conducting surveys in nearshore waters. *SeaQuest* has an enclosed wheel house and cuddy for housing echo sounding and navigation equipment, an open back deck with storage area for generators, and A-frame for towing geophysical equipment, see figures 3.1 and 3.2. *SeaQuest* also includes an over-the-side mounted high frequency multibeam transducer, shown in Figure 3.3.



Figure 3.1 – Survey Boat SeaQuest mobilized at dock.



Figure 3.2 – Survey Boat SeaQuest within Port aux Basques Harbour.



Figure 3.3 – Multibeam transducer on SeaQuest over-the-side mount.

The survey was conducted during daylight hours. CSR personnel for the survey included:

Colin Toole	Party Chief/Surveyor
Mitch Grace, M.Sc.	Geophysicist
Cole Gilbert	Electronic Technologist
Dillon Rowe	Boat Operator

Appendix I include CSR survey daily progress reports while equipment offsets and vessel layout diagrams can be found in Appendix II.

3.1 SURVEY EQUIPMENT

This section describes the positioning and hydrographic equipment utilized during the survey.

SURVEY NAVIGATION

HYPACK Survey Navigation Software

Trimble RTK-GPS

Hemisphere VS-330 GNSS Receiver & Heading System

Hemisphere R-100 DPGS Receiver

HYDROGRAPHIC

HYSWEEP Navigation Workstation

RESON T20-P Multibeam Echosounder

SBG Ekinox D Internal Measurement Unit

Odom DigiBar-Pro Velocimeter
AML Oceanographic SVP

SUB-BOTTOM

EG&G 240 Low Frequency (400-14,000 Hz) Shallow Seismic System (Boomer)
Applied Acoustics CSP-300 Power Supply
Ministreamer with GeoSpectrum M5 Hydrophones
SonarWiz SBP Acquisition & Processing Software
Klein Chirp Sub-bottom Profiler

3.1.1 Positioning

The navigation system incorporated a Trimble RTK-GPS receiving horizontal and vertical corrections via a Trimble base station set up over survey control in Port aux Basques, see Figure 3.1.1. Additional project survey control information can be found within Section 3.3. The horizontal accuracy of the Trimble 5700/5800 RTK-GPS system is $\pm 10 \text{ mm} + 1 \text{ ppm RMS}$ and the vertical accuracy is $\pm 20 \text{ mm} + 1 \text{ ppm RMS}$.

Vessel heading was acquired with an SBG Ekinox2-D with dual GNSS antenna configuration along a 2 m baseline. The dual GNSS antenna configuration calculates heading to an accuracy of 0.08° and was aided internally. The systems were interfaced to Hypack Survey Acquisition Software. In operational survey mode, the system supported a helmsman display with survey line indicator to assure survey lines were followed as accurately as possible. In addition to the planned survey grid lines, the survey screen also displayed bathymetric contours, coastline, and navigational hazards. During survey operations, all navigation information was logged in Hypack to ensure simultaneous geo-referencing of all datasets. A Hemisphere VS-330 GNSS Receiver & Heading System and Hemisphere R-100 DPGS Receiver were available as back-up to the RTK-GPS system.



Figure 3.1.1 – Trimble RTK-GPS base station set up on CSR1945 BS1f.

3.1.2 Multibeam Sonar

Multibeam bathymetry data were collected using a Teledyne-Reson SeaBat T20-P Multibeam Echosounder. The T20-P system transmits on a frequency of 200 - 400 kHz and has a maximum swath width of 140°. The system has a maximum range of 575 m and a ping rate of 50 Hz. During this survey the system was operated at a frequency of 400 kHz with a transducer configuration of 1° along-track and across-track beam width, 512 beams, and 100° to 140° swath coverage (dependent on water depth and seafloor topography).



Figure 3.1.2 – Multibeam sonar data collection.

The multibeam system required input from ancillary sensors including vessel motion, position, heading, and sound velocity. An AML Oceanographic SVP provided continuous real-time sound velocity data at the location of the multibeam transducer. The transducer depth was measured and the draft offset was applied during post-processing. Horizontal offsets from the RTK-GPS antenna to the transducer were also applied during post processing in order to calculate exact positions of the bathymetric data. Sound velocity profiles through the water column were collected at a minimum of twice daily during the bathymetric survey using an Odom Digibar SVP, see Appendix III. The SVP data was applied during processing to correct for speed of sound variations within the water column.

An SBG Ekinox2-D Inertial Navigation System was mounted in the cabin during the survey. Vessel motion (heave, pitch, and roll) was recorded continuously during the bathymetric survey at a rate of 50 Hz. The SBG Ekinox2-D provided high accuracy attitude motion within 0.03°. This data, including sensor offset values, were applied to the bathymetry data during post processing.

The data were acquired with HySweep in HSX format and with Reson's Seabat UI in S7K format during the survey.

3.1.3 Sub-bottom Profilers

Seismic Reflection

Seismic reflection data were collected using a single channel seismic (Boomer) system, see Figure 3.1.3. This system provided low frequency energy in the range of 400-10,000 Hz and included four main components (boomer plate, power supply, hydrophone, and acquisition computer). The energy source for the system was the Applied Acoustics CSP-300 which has output settings ranging from 50-350 joules. The CSP supplied power to the boomer plate which was towed in conjunction with a low frequency hydrophone streamer. The boomer plate was responsible for transmitting the sound energy through the water column and seabed sediments. The hydrophone streamer received the reflected sound energy and transmitted the signal to the topside recording computer.

The raw acoustic signal was recorded on a topside computer running SonarWiz acquisition software. RTK-GPS positions were integrated with the data in real-time and recorded by SonarWiz in SGY format. Acoustic frequency filters applied to the data in real time using SonarWiz were not recorded to the raw data. The frequency filters essentially “cleaned” the data allowing for better visualization and interpretation of the sub-surface sediments.

During this survey the energy source was operated at an output level of 250 joules with a firing rate of ¼ second. The record length was synced to the firing rate within SonarWiz. The maximum penetration achieved was approximately 20 m within post glacial and glacial sediments.

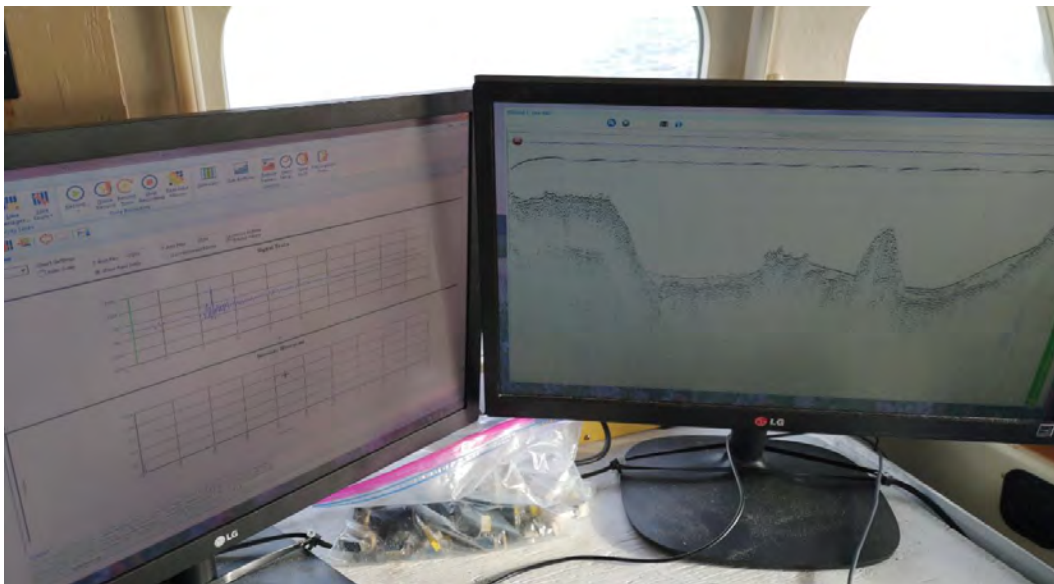


Figure 3.1.3 – Boomer data collection.



Figure 3.1.4 – Boomer system on deck after retrieval.

Chirp Sub-bottom Profiler

CSR provided a Klein 3000 chirp sub-bottom profiler for high resolution imaging of the sub-surface. The Klein 3000 chirp SBP integrates with the Klein 3000 sidescan sonar system. It mounts directly to the Klein 3000 towfish and uses the existing physical connections and electrical communications. This option takes advantage of the existing Klein 3000 hardware by using the same tow cable, transceiver processor unit (TPU), workstation and towing systems. The chirp sub-bottom profiler consisted of a subsea assembly used to contain the transmit projectors, receive hydrophone and SBP electronics. These components were enclosed in a fiberglass shroud with an integrated support structure to allow for combined transducer/electronics mounting and towing. The amplifier modulates both amplitude and phase of the transmit waveform for pulse lengths up to 40 msec.

Specifications

Chirp Frequency: 2-8 kHz

Beam Angle: 20° along track; 40° cross track @ 5 kHz

Resolution: 12.5 cm or better

Power: 1 kW

Source Level: 204 db @ 1 m

The chirp profiler data was recorded on a topside computer running SonarPro acquisition software. RTK positioning information was integrated with the data in real-time and recorded by SonarPro in XTF format.

The chirp profiler system was tested but did not provide sufficient penetration of the quaternary sediments and therefore was not utilized during the survey.

3.2 EQUIPMENT CALIBRATION

During mobilization all navigation, hydrographic, and geophysical equipment were dry and wet-tested at dockside prior to commencing the survey.

3.2.1 Multibeam Echosounder Calibration

The SBG GNSS antennas were installed on the survey vessel, aligned with the main axis of the boat. The antennas were installed above the multibeam transducer with a 2 m baseline separation.

The motion sensor mount angle offsets were calculated according to the manufacturer's system calibration procedure. Calibration lines were surveyed during calm conditions within the survey area.

Prior to collecting bathymetry data each day, the multibeam system was calibrated using a procedure known as a patch test. The patch test was designed to precisely determine the static configuration of the sonar head (pitch, roll, and yaw) and the latency between the reception of the RTK-GPS or DGPS position and its integration by the acquisition system. The procedure for performing a patch test requires the survey vessel to collect data over a series of predetermined lines. The location and orientation of the test lines were selected based on seabed characteristics ideal for patch test value computations. For the variables of pitch, yaw and latency, a seabed slope or feature is required. The roll variable is best computed along lines collected over a flat seabed. The steep channel slope and flat seabed southwest of Vardy's Island within Port aux Basques Harbour were selected to perform the patch test. The average calibration values determined are listed in Table 3.2.1.

Table 3.2.1 – Patch Test Summary

Dates	Component	Average Value
January 23 rd to January 28 th 2020	Latency	0 seconds
	Pitch	-2.88°
	Roll	1.07°
	Yaw	2.0°

Sound velocity measurements were continuously recorded at the transducer head to aid in beam forming. Sound velocity casts of the full water column were collected at least twice per day and applied to the bathymetry data during post-processing.

3.2.2 Water Levels

Water level values (tides) were calculated for the multibeam survey in real-time using RTK-GPS. Ellipsoid heights were measured at the RTK-GPS antenna on the survey vessel. A vertical offset from the RTK-GPS antenna to the waterline was applied in real time using Hypack Survey Navigation Software. The ellipsoid to chart datum conversion for the water level height was calculated using separation values provided to CSR by CHS. Water level heights were checked using RTK-GPS and compared with data from CHS tide station 665 at Port aux Basques and the tide gauge installed by CSR.

3.2.3 Sub-bottom Profilers

Prior to collecting sub-bottom data, the chirp profiler and boomer seismic systems were configured and tested dock side. The transmit and receive (hydrophone) components of

each system were placed in the water at the dock. Once in the water, the systems were powered to test the operation of the power source in conjunction with the receive components. The resulting data were recorded and reviewed on the acquisition computers. When required system noise was mitigated through additional grounding of the system components and adjustments to the placement and orientation of the cables.

After confirmation that the sub-bottom systems were operating correctly at the dock, test lines were surveyed in the area. During testing, frequency filters were manipulated to highlight the interpretable data and filter noise. Time varied gain (TVG) was also adjusted for optimal data collection.

3.3 SURVEY REFERENCE

During the survey, the horizontal and vertical positioning of the vessel was calculated using Real-Time Kinematic (RTK) corrections. The Trimble RTK-GPS system on the boat received corrections from a Trimble base station set up over survey control established at Port aux Basques.

The primary point used to establish project survey control was CHS benchmark 90F9004, which is set vertically in the northwest corner of the concrete deck of the most eastern dolphin at the Marine Atlantic terminal in Port aux Basques, see Figure 3.3.1. This dolphin also includes the host structure for the permanent CHS tide station 665. CHS benchmark 90F9004 was used for establishing CSR's project survey control (CSR1945 BS1f) on the eastern side of the former fish plant dock off Pleasant Street, see Figure 3.3.2, and a temporary benchmark to be used as a daily check located on the northern corner of the former fish plant dock (CSR1945CHK2f). An RTK-GPS base station was set up over the primary control point, CHS benchmark 90F9004, and a rover GPS receiving corrections from the base was used to survey the two CSR control points. Rover observations over each point were collected as an average of 1000 measurements taken at 1 second intervals. Upon establishing the project survey control, a back check was performed on CHS benchmark 90F9004. Daily checks were performed each morning on CSR's temporary benchmark CSR1945CHK2f. A check was also performed on benchmark 82G2332 prior to commencing marine survey operations, see Figure 3.3.3. Table 3.3.1 includes a summary of the survey control while Appendix IV comprises additional survey control information.

Ellipsoid elevations were converted to Chart Datum (CD) elevations by applying the NAD83-CD separation values provided by CHS for the survey area, ranging from 10.42 m to 10.51 m. Vertical quality control checks were performed each day during the survey. Primary checks on the RTK-GPS system were performed using CSR's field check point CSR1945 CHK2f. Water level checks were completed by comparing the elevation of the water level at the dock with CHS observed water levels at Station #665. This ensured elevation values calculated by the RTK-GPS matched the observed tide values recorded by the CHS tide station. CHS water level monitoring program provided real time water levels online. These real time water levels referenced to CD provided a quality control check on the elevations calculated by the RTK-GPS. The geodetic parameters for the survey were as follows.

Horizontal Datum: North American Datum 1983 (CSRS)
Ellipsoid: GRS80

Projection: Universal Transverse Mercator (UTM)
Zone: 21 N
Central Meridian: 57° W
Scale Factor at CM: 0.9996
False Easting: 500,000 metres
False Northing: 0 metres

Units: Metres

Vertical Datum: Chart Datum

All maps and digital files provided are referenced to the North American Datum 1983 (CSRS) and Universal Transverse Mercator projection.



Figure 3.3.1 –CHS benchmark 90F9004.



Figure 3.3.2 – Trimble RTK-GPS base station set up on CSR1945 BS1f.



Figure 3.3.3 – Trimble rover setup over 82G2332.

Table 3.3.1 – Project Benchmarks

Benchmark ID	Northing (m)	Easting (m)	Ellipsoid Elevation (m)	CD Elevation (m)	Notes
90F9004	5271852.628	339144.811	-6.968	3.506	NRCan HP3D and CHS Benchmark
82G2332	5271140.464	338923.655	4.036	14.556	NRCan HP3D, CD elevation calculated using separation
CSR1945 BS1f	5271262.387	339278.076	-7.728	2.772	CSR base station point, CD elevation calculated using separation
CSR1945 CHK2f	5271270.551	339271.424	-7.793	2.717	CSR check point, CD elevation calculated using separation

3.4 SURVEY COVERAGE

The hydrographic survey included the collection of full bottom coverage utilizing multibeam sonar within the Port aux Basques survey extent provided by CBCL which covered the majority of the Port aux Basque Harbour and approaches. These areas were also surveyed with the sub-bottom profiler (Boomer).

Figures 3.4.1 and 3.4.2 include the multibeam and sub-bottom profiler (Boomer) trackline locations surveyed within Port aux Basques. A total of 152 lines of multibeam were surveyed over the area totaling 78 survey line kilometres while a total of 77 lines of Boomer were surveyed over the area totaling 45 survey line kilometres.

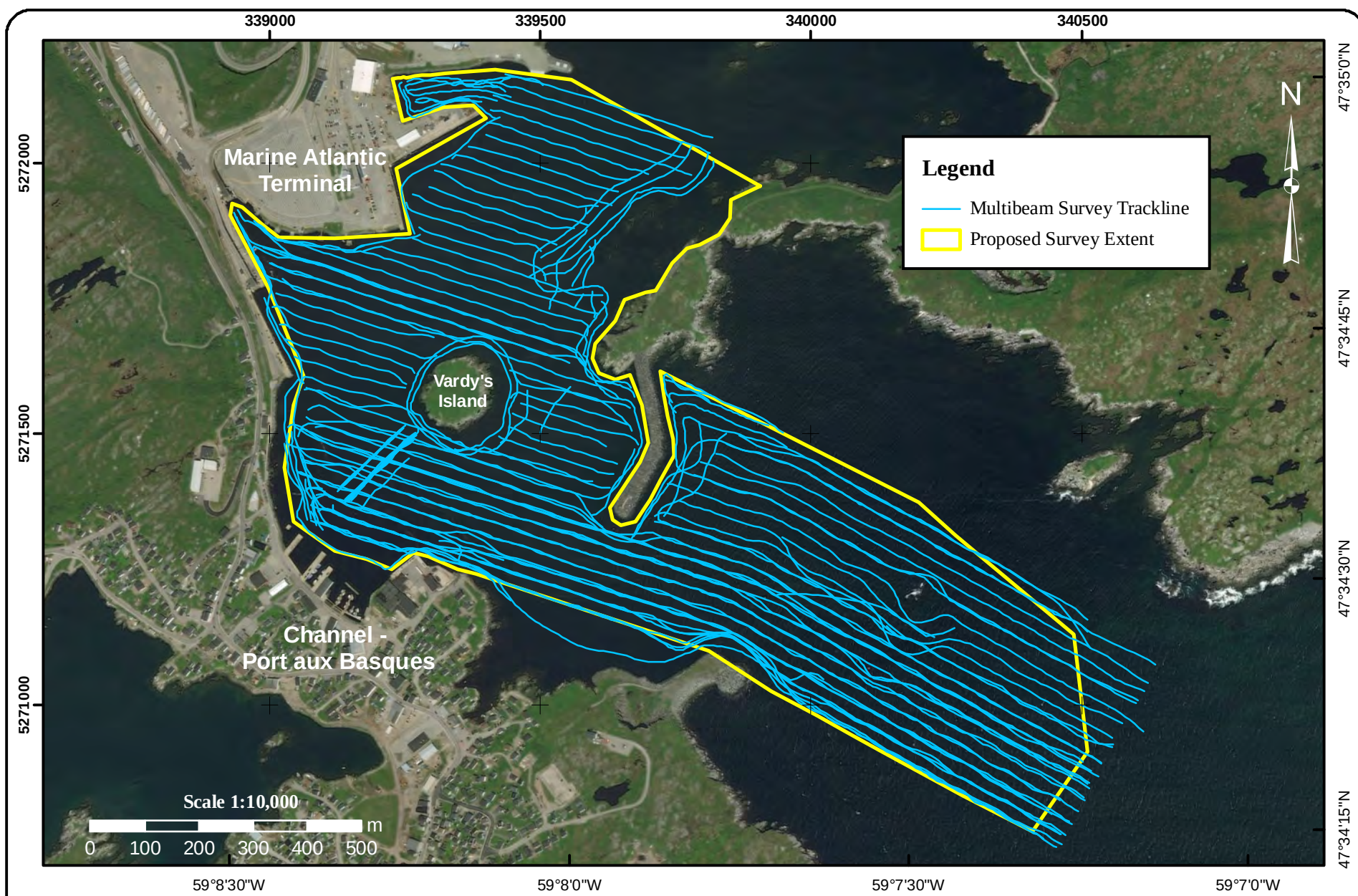


Figure 3.4.1 - Location of multibeam survey tracklines.



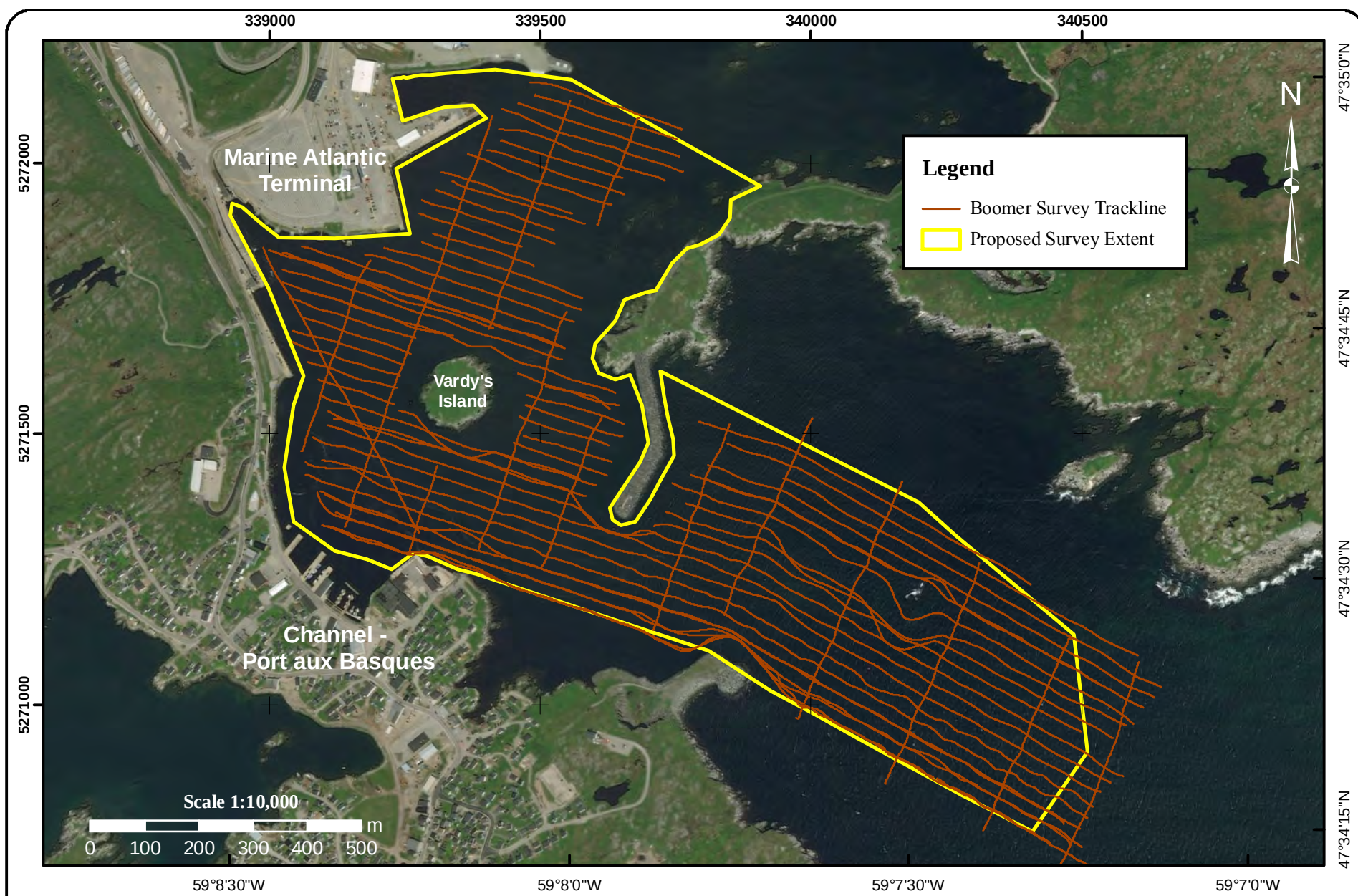


Figure 3.4.2 – Location of sub-bottom profiler (Boomer) tracklines.

4.0 DATA PROCESSING & MAPPING

Post survey data processing, interpretation, mapping and reporting were conducted at CSR's office in Porters Lake, Nova Scotia.

4.1 BATHYMETRY

Bathymetric data processing was accomplished using three software packages including, Caris HIPS and SIPS processing software, Surfer surface modeling software, and Hypack multibeam processing software.

The raw multibeam sonar data collected during the survey were post processed with hydrographic information processing software Caris. Caris is a comprehensive software package that allows for the integration of bathymetric data including raw sonar information, sound velocity, tide corrections and vessel offset information. The following steps were conducted to post process the raw multibeam sounding data.

- All survey control, RTK, and water level measurements were checked.
- Vessel configuration file was generated.
- Sound velocity profile files were created from each sound velocity cast performed during the survey.
- Raw data were imported into Caris HIPS, where horizontal and vertical offsets were applied based on the vessel configuration file.
- All patch test data acquired during the survey were reviewed independently by two multibeam processors. The mean pitch / roll / yaw values from these redundancy checks were used during final processing of the data.
- Vessel motion was applied.
- Tide files for each survey day were generated using water level values obtained from RTK elevations. The soundings were converted to CHS Chart Datum based on the CanEast 2015 v1 (chart datum height relative to NAD 83) model obtained from CHS. A vertical separation file provided by CHS was used to generate tide corrections using RTK fixes for the ellipsoidal height. RTK referenced tide data was checked against observed tide data obtained from CHS Port aux Basques Station #665 and CSR's tide gauge deployed during the survey.
- Both sound velocity and tide corrections were applied to the data during processing.
- The multibeam data was extensively examined and cleaned for erroneous soundings and artifacts using Caris.

- The processed data was exported as a 1 m horizontal resolution CUBE surface in ASCII XYZ format. The processed data were examined within Hypack's multibeam editing software as a final QC.

The processed multibeam XYZ file was imported into Surfer and grid cells of 1 metre by 1 metre were established based on a kriging interpolation algorithm. Contours displayed on the Enclosures were generated at 1 metre intervals based on the grid data. The soundings displayed on the Enclosures represent the minimum/shoalest value within 5 m x 10 m cell. The soundings represent results at the time of the survey and can only be considered as indicating the conditions at that time.

4.2 SUB-BOTTOM GEOLOGY

The seismic reflection (Boomer) data were recorded in raw uncorrected SEG Y format. The data were post-processed with CODA Survey Engine. During processing layback and cross-track offsets from the RTK-GPS antenna were applied and the gains were optimized.

When an acoustic signal from a seismic source encounters an interface between two units with different acoustic impedances, some of the energy will reflect back to the hydrophone. A reflection within the seismic record that has incurred more than once is called a multiple. Multiples from the seabed (water/sediment) and geological units (sediment/rock) are common in marine reflection data. These multiples can be difficult to suppress or remove in single channel seismic data. The following methods were used within Coda to remove or suppress acoustic noise / interference.

- Acoustic interference within the water column was removed with a Zap filter.
- Low-cut and high-cut filters were used to suppress/remove noise within the seismic section.
- Multiple tracking tools provided a visual tool for the interpreter during mapping.

Sub-bottom data were interpreted using established seismo-stratigraphic techniques. Seismo-stratigraphic analysis involves the identification of seismic sequences, based on variations in acoustic character, and correlation of bounding reflectors throughout the survey area. Identification of probable sediment types is based on the geometry and internal characteristics of each sequence. The data were utilized in the interpretation and mapping of the sub-bottom geological sequences and shallow gas accumulations. All sub-surface measurements were calculated based on a sound velocity of 1600 m/s.

Upon completion of the sub-bottom interpretation, the acoustic basement reflector representing the interpreted top of bedrock below seabed was exported from Coda in XYZ format. The Z value in the file represented the thickness of Quaternary sediment over acoustic basement. The XYZ file was imported into Surfer where a 5 m x 5 m grid was generated based on a kriging interpolation algorithm. Isopach contours of the Quaternary sediments at 1 m intervals displayed on the Enclosures were generated from the grid file. Areas between survey lines and where no visible reflectors were observed are interpolated.

5.0 RESULTS

This section documents the results of the hydrographic and geophysical survey conducted at Port aux Basques. The multibeam survey obtained 100% coverage over the proposed survey area except in those areas not navigable due to rocks and shoals while sub-bottom profiler data was acquired along 25 m spaced survey lines.

The multibeam and sub-bottom datasets have been mapped and interpreted and the results presented within the accompanying Figures and Enclosures. The information derived from the data included bathymetry, surficial geology, sub-bottom geology and seabed features. Enclosures 1 through 8 include maps at a scale of 1:1500. Appendix V includes a list of the digital CAD and ArcGIS files delivered to CBCL during this project. Page size versions of the Enclosures (not to scale) can be found in Appendix VI.

5.1 SEABED MORPHOLOGY AND FEATURES

The soundings and bathymetry contours generated for this study are referenced to Chart Datum. The survey was conducted using ellipsoidal referenced survey techniques. The RTK-GPS ellipsoid elevations were converted to CHS Chart Datum based on the CanEast 2015 v1 (chart datum height relative to NAD 83) model obtained from CHS.

The Sounding Charts, Enclosures 1 and 2, include the minimum/shoalest value within 5 m x 10 m cells. Bathymetry contours at 1 m intervals are presented on Enclosures 3 and 4 while Figure 5.1.1 displays a shaded relief seabed image of the area surveyed. The bathymetry over the area surveyed ranged from 0.5 m to 51 m. Shoal areas comprised of bedrock occur throughout the area surveyed. The area is characterized by a narrow northwest-southeast channel from the approaches to Port aux Basque to the Marine Atlantic Terminal. The narrowest sections of the channel reach a maximum depth of approximately 25 m west of Middle Baldwin Rock and 27 m west of Vardy's Island. The channel widens between Sheaves Cove and Pikes Island breakwater where it reaches a maximum depth of approximately 29 m. The inner harbour, oriented northeast-southwest, reaches a maximum depth of approximately 23 m northwest and 18 m north of Vardy's Island.

Seabed features related to previous dredging activities were observed offshore of Vardy's Island and Baldwin Rocks, see Figure 5.1.2. The areas west and north of Vardy's Island have consistent water depths of approximately 9 m while the dredged area east of the island ranges from 7 to 10 m, see Figure 5.1.3. Two possible dredged areas occur west of Middle and East Baldwin Rocks with water depths of 9 to 10 m, see Figure 5.1.4. Areas of dredge spoil southeast of East Baldwin Rock occur within water depths that ranged from 20 m to 35 m, see Figures 5.1.2 and 5.1.4. Additional dredge or rock spoil were observed east of Pike's Island breakwater within water depths 12 to 18 m, see Figure 5.1.2.

A number of linear seabed features were observed including an intake pipeline that makes landfall at Pleasant Point. The locations of these seabed features are displayed on Figure 5.1.5 while the pipeline and abandoned pipe are illustrated on Figure 5.1.6. The

submarine cable from Pikes Island to Vardy's Island noted on the CHS chart was not observed within the multibeam data acquired.

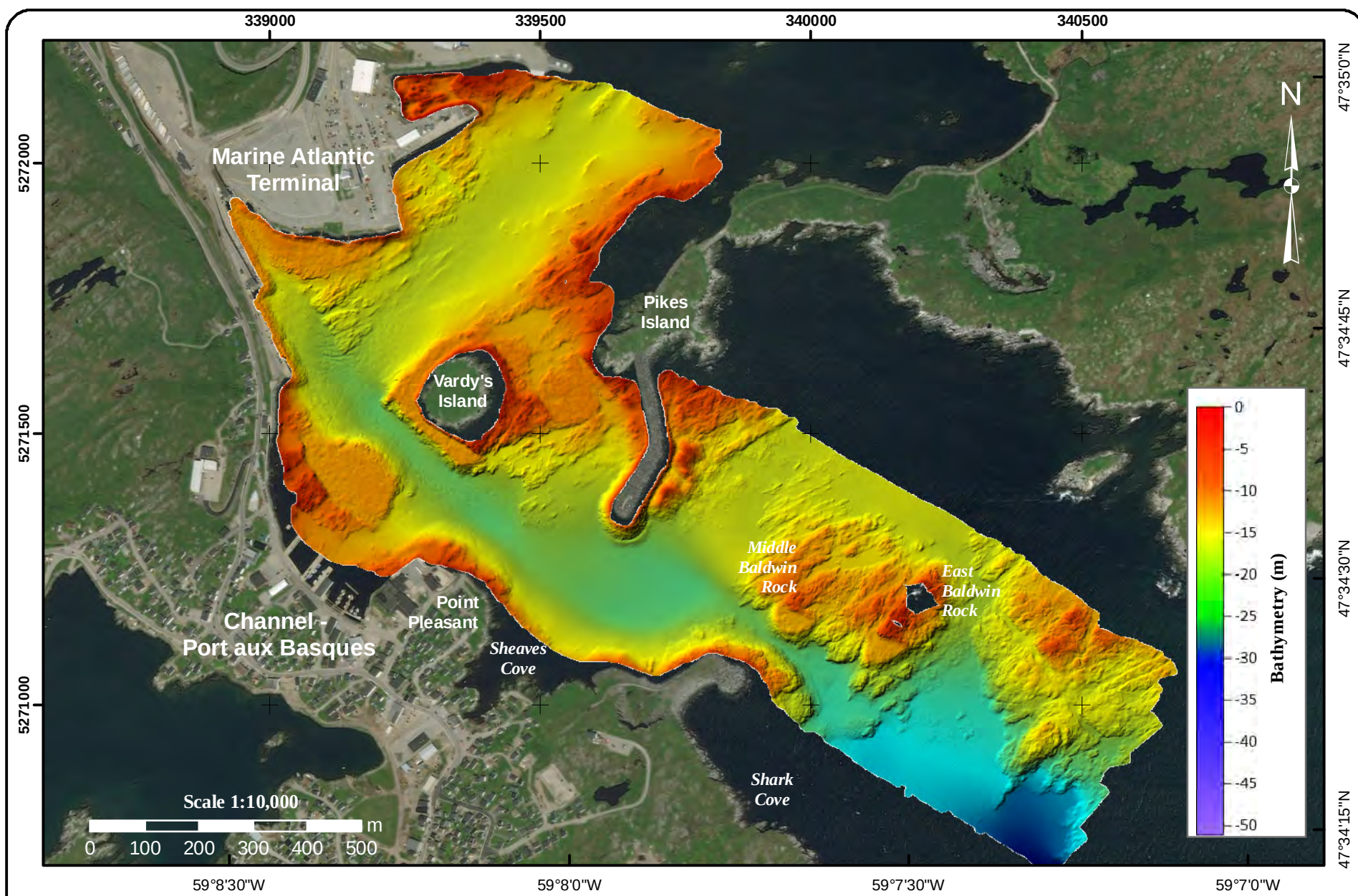


Figure 5.1.1 – Shaded relief multibeam bathymetry image of Port aux Basques survey area referenced to chart datum.

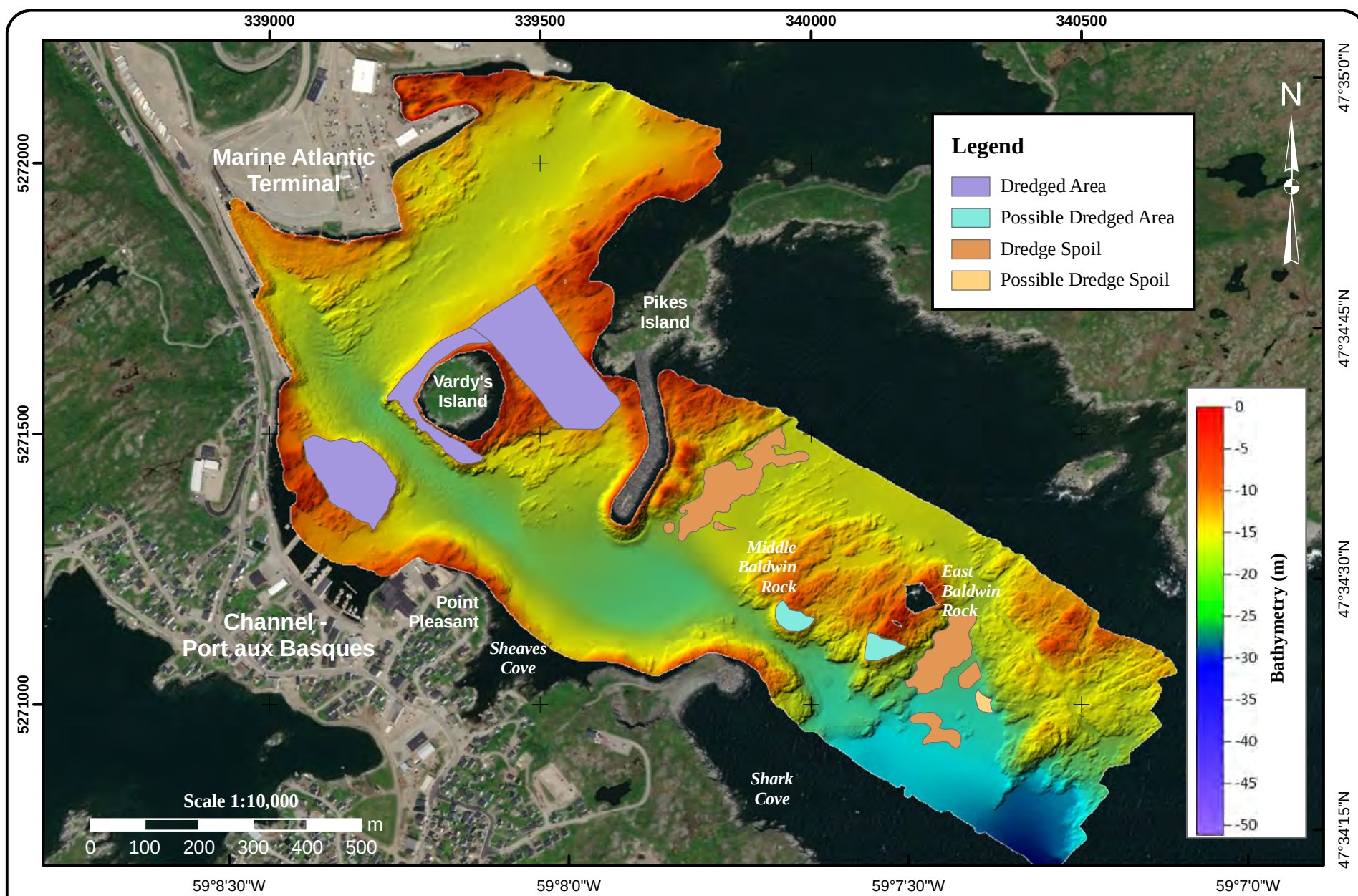


Figure 5.1.2 - Spatial distribution of dredged and dredge spoil areas over multibeam shaded relief.

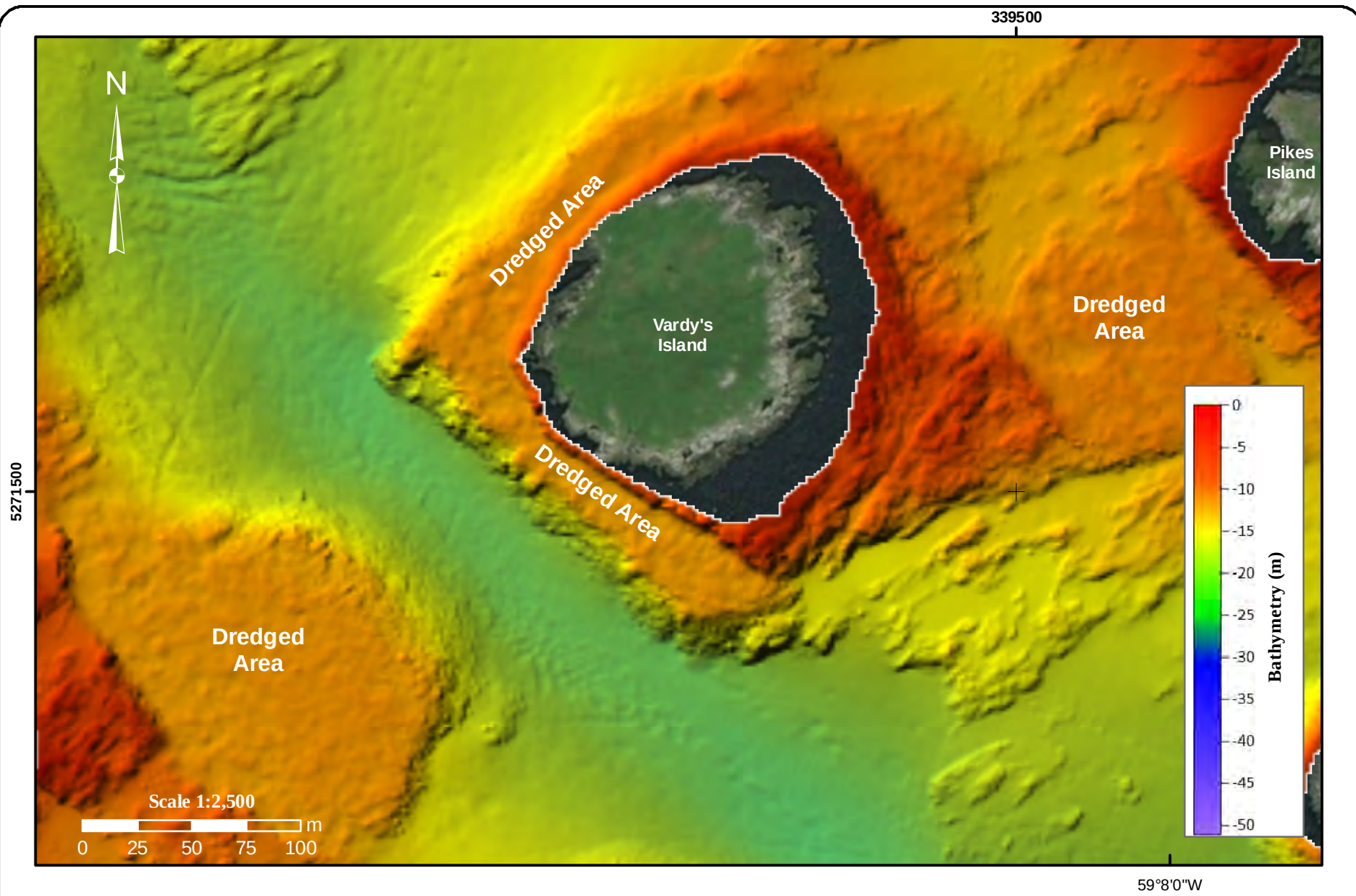


Figure 5.1.3 - Multibeam shaded relief of dredged areas offshore Vardy's Island.

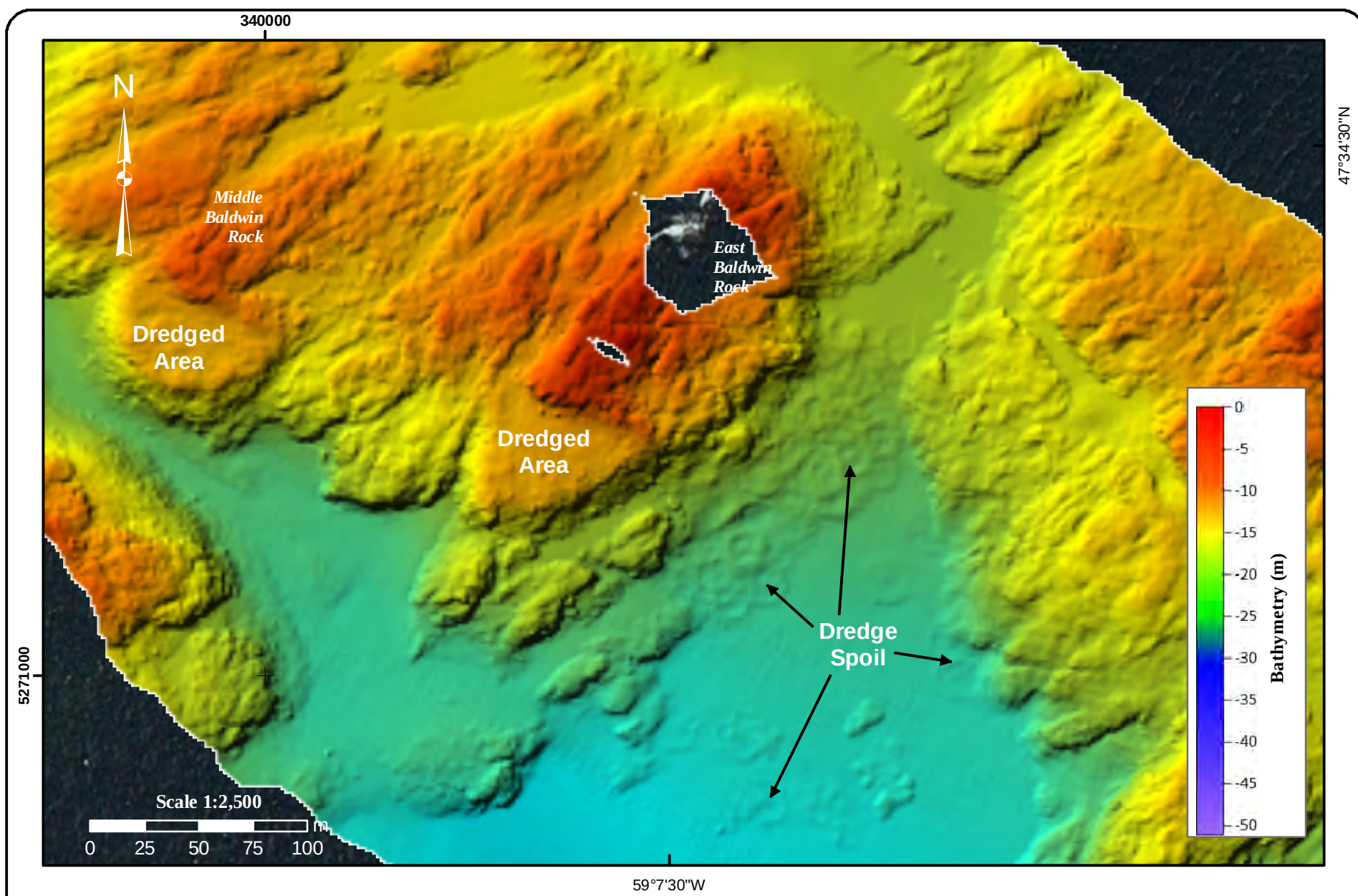


Figure 5.1.4 - Multibeam shaded relief of dredged areas and dredge spoil near Baldwin Rocks.

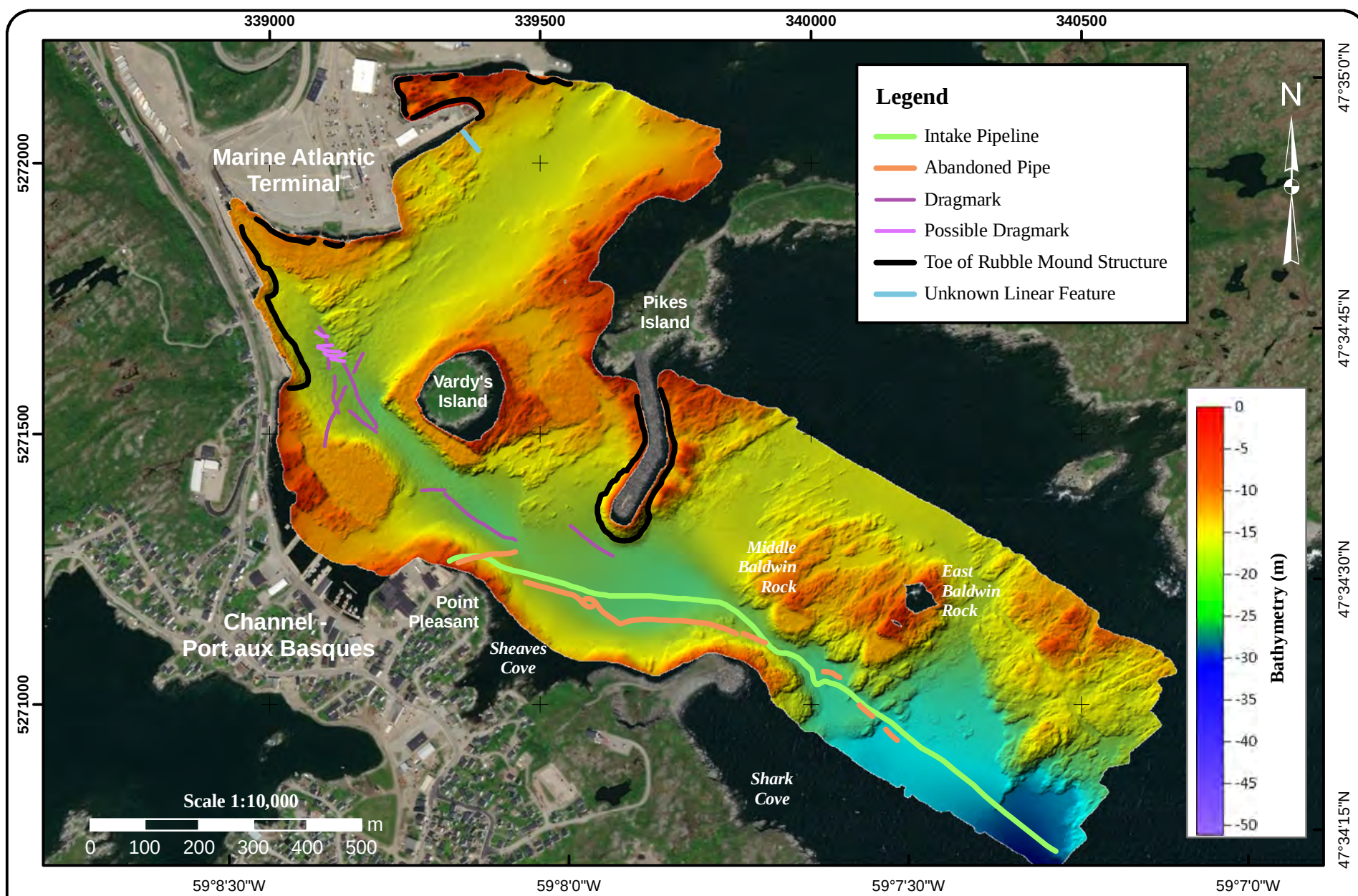


Figure 5.1.5 - Location of seabed features mapped from multibeam sonar data.

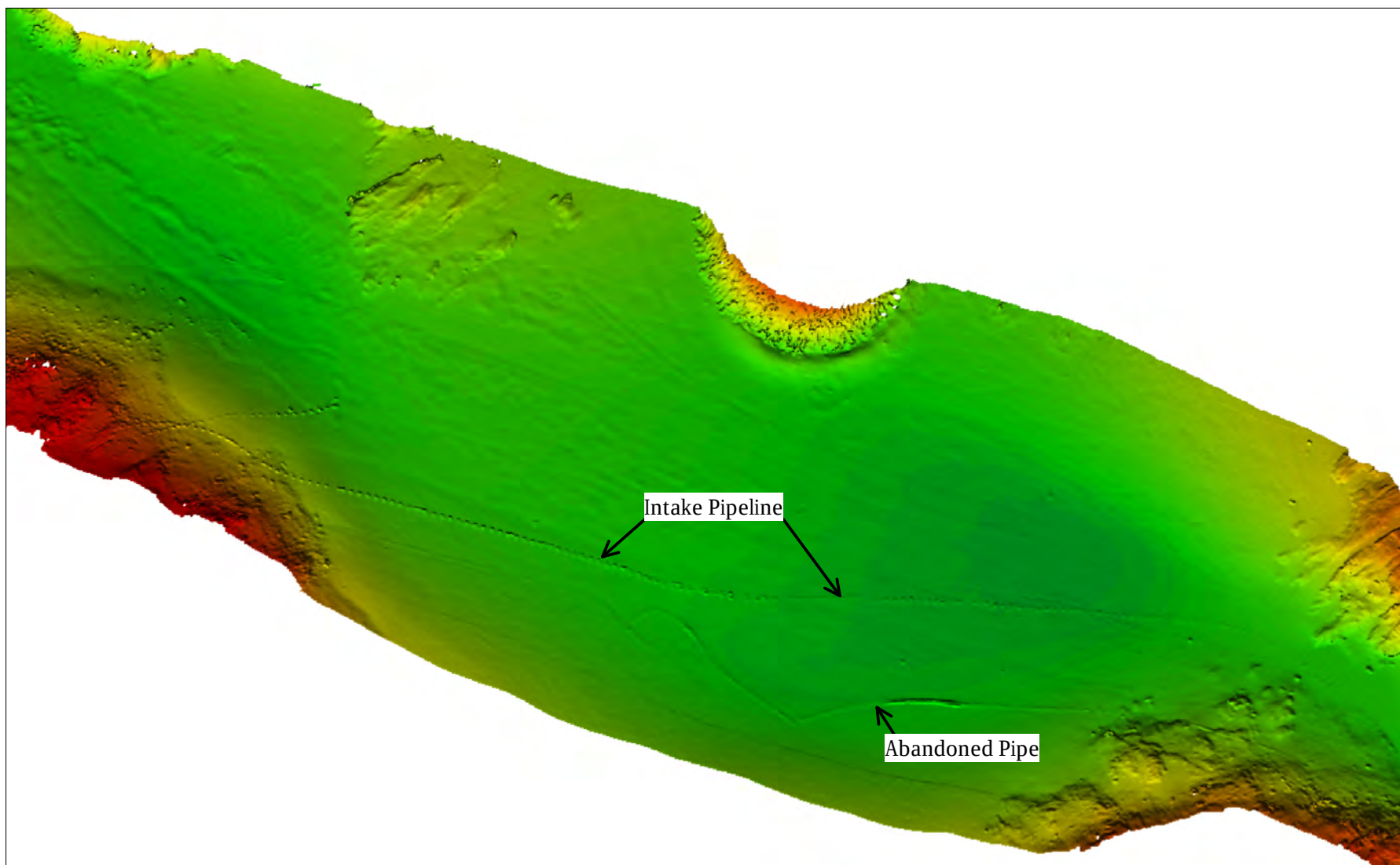


Figure 5.1.6 - Multibeam shaded relief image of submarine pipes.

5.2 GEOLOGY

5.2.1 Surficial Geology

The surficial bedrock geology was mapped from the multibeam sonar data and single channel seismic records. The surficial bedrock represents 42% of the area surveyed. The seabed over the remaining areas surveyed is comprised of undifferentiated Quaternary sediment interpreted as silt and/or sand with gravel, cobbles, and boulders. Enclosures 5 and 6 as well as Figure 5.2.1 display the spatial distribution of bedrock at or near surface within the area surveyed.

The surficial bedrock geology was divided into three units based on the morphology of the seabed. The majority (80%) of the surficial bedrock geology within the area surveyed includes outcropping bedrock exposed at the seabed.

Undifferentiated sediment within the surficial bedrock areas were mapped from the multibeam sonar data. Based on information recorded during diver surveys completed by CBCL the sediment is composed of silt and/or sand with gravel and local cobbles. The thickness of the sediment was determined from the single channel seismic records and manual diver probe data provided by CBCL. Enclosures 7 and 8 include the locations of the sub-bottom survey tracklines and manual diver probes. Where sediment occurs over the bedrock areas it was difficult to determine the thickness due to its coarse nature and the acoustic signature of the bedrock surface reflector. As a result the minimum sediment thickness interpreted from the sub-bottom data was between 0.2 to 0.4 m while the manual diver probes ranged from 0 to 1.1 m.

Areas of bedrock outcrop (bedrock at the seabed) are characterized by rough seabed morphology with numerous linear trends representing bedding and fracture planes. Spatially, the unit occurs within the outer and inner harbour as well as southeast of Vardy's Island. Discontinuous patches of undifferentiated sediment deposited within bedrock depressions occur locally throughout the unit. All of the sediment patches observed from the multibeam data within this unit were mapped.

Areas interpreted as bedrock / boulders with local sediment veneer are characterized by a blocky to rough seabed morphology especially within the areas adjacent to the previously dredged locations north and west of Vardy's Island as well as southeast of Pyke's Island breakwater. The morphology of this unit along the Port aux Basque shoreline is relatively smoother indicating the presence of a sediment veneer.

Areas of bedrock with local sediment veneer have a relatively smooth morphology compared to areas where bedrock outcrops. These areas occur over the previously dredged locations east, west and north of Vardy's Island. The sediment veneer is generally < 0.2 m. Only those areas of undifferentiated sediment with a known sediment thickness were mapped and included on Enclosures 5 and 6 as well as Figure 5.2.1.

5.2.2 Sub-bottom Geology

The sub-bottom geology within the survey area was mapped from the single channel

seismic (Boomer) records based on acoustic characteristics and seismic impedance. Although the main objective was to determine the thickness of sediment over bedrock three significant reflectors (R1, R2, and R3) were observed within the seismic data. R1 represents the interpreted top of a sub-bottom post glacial sequence, R2 represents the interpreted top of glacial till, and R3 represents acoustic basement. Based on the data acquired, CSR identified three main sub-bottom geological units. These units are described below and illustrated on Figures 5.2.2 through 5.2.5. Figure 5.2.1 includes the location of the seismic sections displayed on Figures 5.2.2 through 5.2.5.

Sub-Bottom Sequence 1 – Post Glacial Sediments

Sub-Bottom Sequence 1 (SB1) consists of post glacial sediments. This sequence was divided into two sub-units; SB1a and SB1b.

Based on the acoustic transparency and occasionally laminar character of SB1a, these sediments are interpreted to be primarily fine-grained sands, silts and clays that have been deposited in occasionally laminated sequences, see Figure 5.2.2. SB1a is bounded at the top by the seabed and at the bottom by SB1b, SB2 or Acoustic Basement. SB1a ranges in thickness from <0.1 m to a maximum thickness of approximately 7 m. SB1a was observed throughout the area surveyed with the exception of where bedrock outcrops.

The acoustic transparency and occasionally laminar character of SB1b was interpreted as primarily fine-grained sands that have been deposited in occasionally laminated sequences. This sequence is interpreted as a separate depositional unit than the overlying SB1a post glacial sediments based on the presence of a strong smooth reflector separating the two units, see Figure 5.2.3. SB1b is bounded at the top by R1 where the unit is overlain by the fine grained post-glacial sediments of SB1a and below by the Acoustic Basement reflector R3. SB1b was observed in the deep channel between Vardy's Island and the Marine Atlantic dock. SB1b also occurs within the channel west of East Baldwin Rock. SB1b reaches a maximum thickness of approximately 14 m in the channel west of Vardy's Island.

Sub-Bottom Sequence 2 – Glacial Till

Sub-Bottom Sequence 2 (SB2) is interpreted as Glacial Till and or proglacial sediments. Based on the acoustic signature this unit was interpreted as an unsorted heterogeneous sediment matrix, composed of varying grain sizes ranging from silts/clays to cobbles and boulders deposited by glacial activity. The heterogeneous nature of the unit resulted in chaotic reflections in the seismic records, see Figures 5.2.4 and 5.2.5. No laminations were observed within SB2, thus suggesting a possible basal till origin.

SB2 is bounded at the bottom by Acoustic Basement reflector R3 and at the top by R1 where the unit is overlain by fine grained post-glacial sediments of SB1a. The thickness of SB2 ranged from approximately 1 m to >10 m. A significant occurrence of SB2 was observed between Sheaves Cove and Pikes Island Breakwater, see Figure 5.2.5. The seismic signature of SB2 over this area was characterised by a strong chaotic reflector (R2) with numerous internal reflections and diffractions. The acoustic basement reflector was not observed below this unit due to limited penetration of the seismic energy as a

result of the coarse nature of the overlying glacial till. This area is designated on Enclosures 5 and 6 as an area of no visible acoustic basement reflector. The overlying Quaternary sediment in this area was generally >10 m.

Sub-Bottom Sequence 3 – Acoustic Basement (Interpreted Bedrock)

Sub-Bottom Sequence 3 (SB3) represents acoustic basement interpreted as bedrock although in some areas it may also represent the top of a boulder rich glacial till. The bedrock within Port aux Basque Harbour is probably equivalent to the onshore Port aux Basque Gneiss, see Section 2.

Acoustic basement is characterized by a strong reflector where it was well defined. The reflector was often rough and irregular in nature owing to the rough, possibly fractured surface of the underlying bedrock. The acoustic basement reflector was visible throughout the majority of the area surveyed and occurred at surface where bedrock outcrops. The acoustic basement reflector was faint or not visible over a small area north-northwest of Vardy's Island where an interpreted deposit of glacial till was observed (Figure 5.2.4) and the region between Sheaves Cove and Pikes Island breakwater, see Figure 5.2.5.

Isopach Contours

Enclosures 5 and 6 as well as Figure 5.2.6 include Isopach contours representing the thickness of Quaternary sediment over acoustic basement and the spatial distribution of bedrock at or near surface. The Quaternary sediments include sub-bottom sequences SB1 and SB2.

The thickness of the quaternary sediments over the area surveyed ranged from <0.1 m to approximately 21 m. The majority of the area surveyed has sediment thicknesses <2 m with the exception of the deepest sections of the northwest-southeast Port aux Basques channel, see Figure 5.2.6.

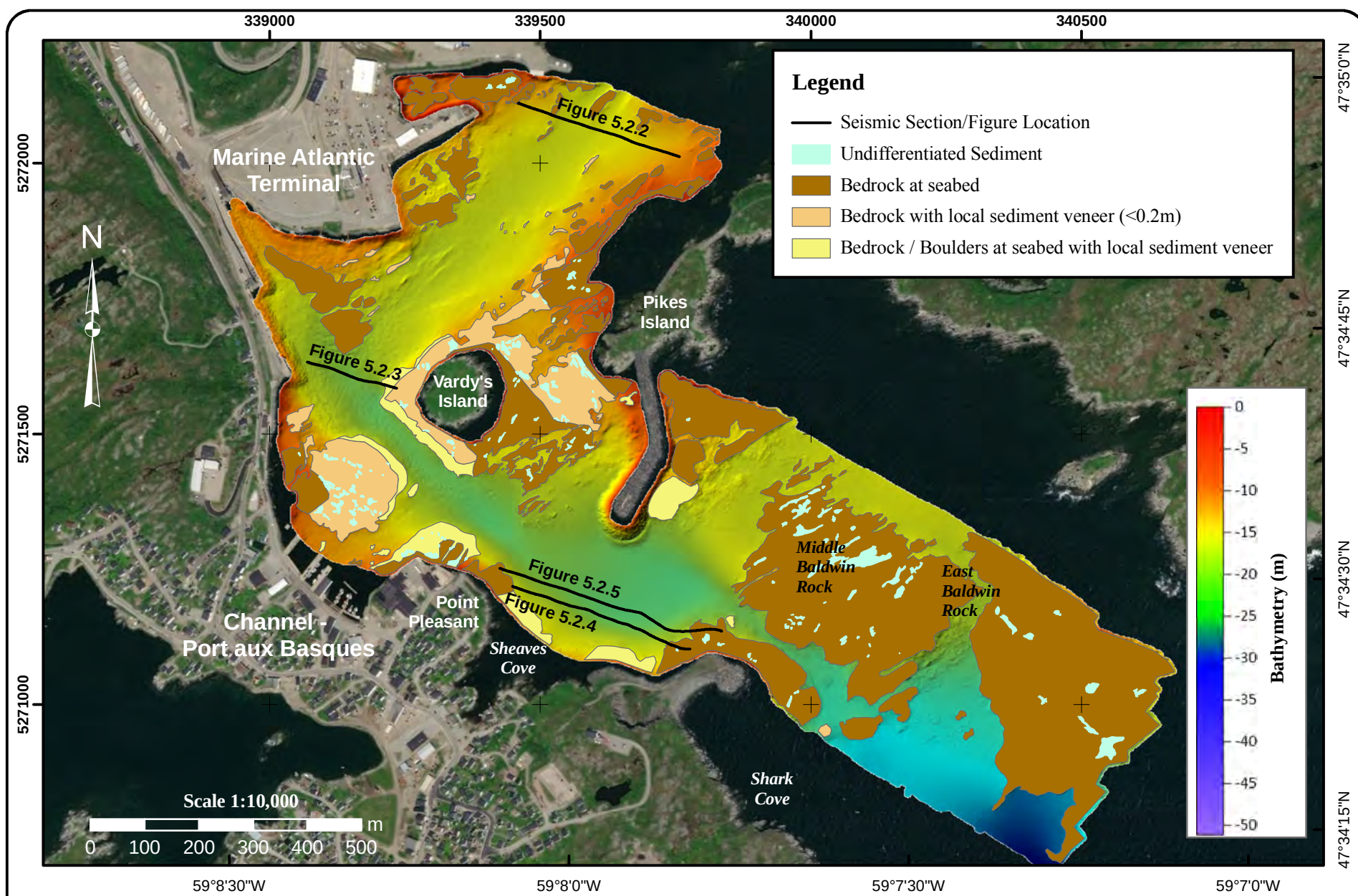


Figure 5.2.1 – Spatial distribution of the surficial bedrock geology with seismic section figure locations over the multibeam shaded relief.

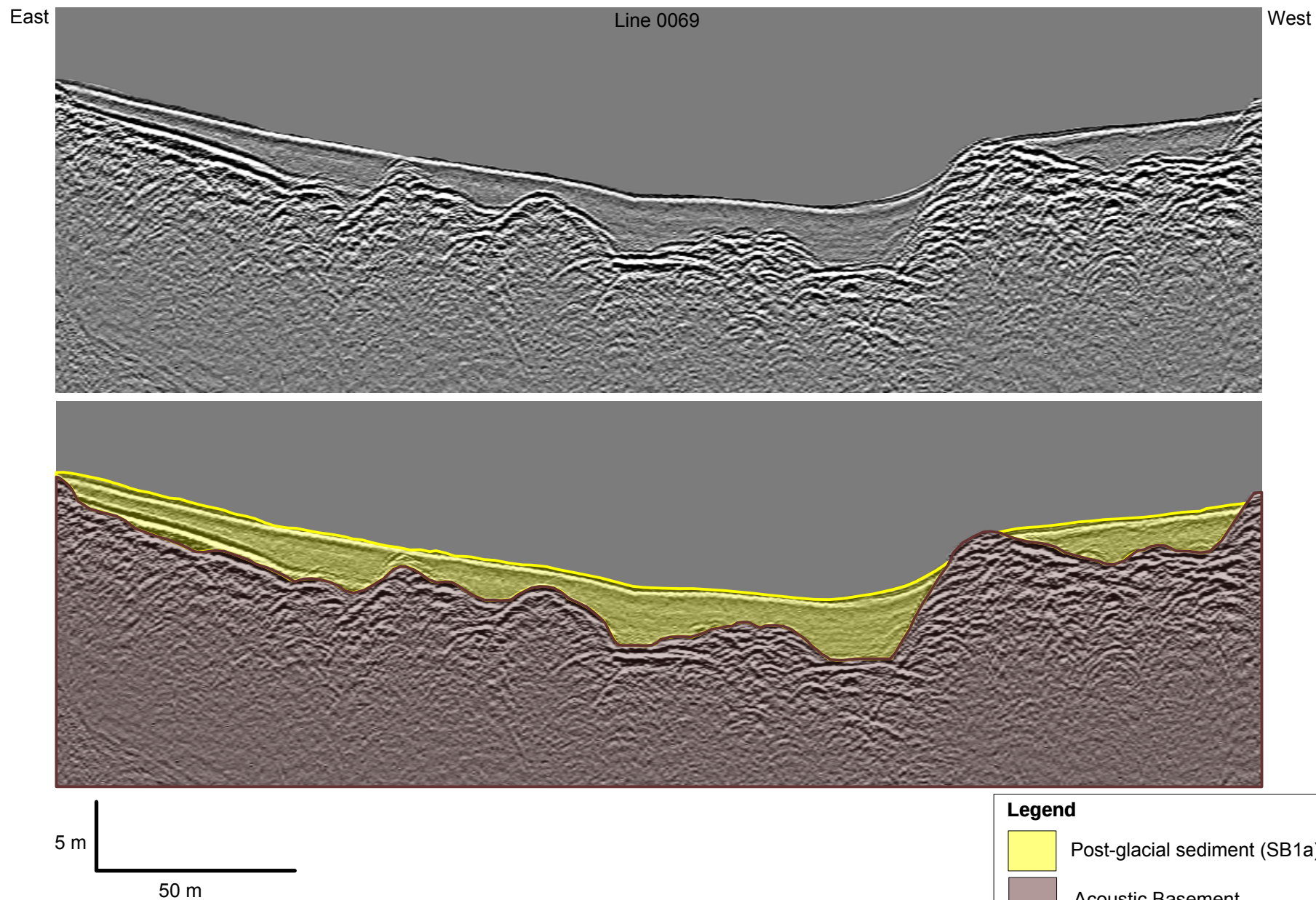


Figure 5.2.2 - Single channel seismic (Boomer) section (top) and interpreted sub-bottom sequences (bottom) showing irregular acoustic basement reflector overlain by post glacial sediments.



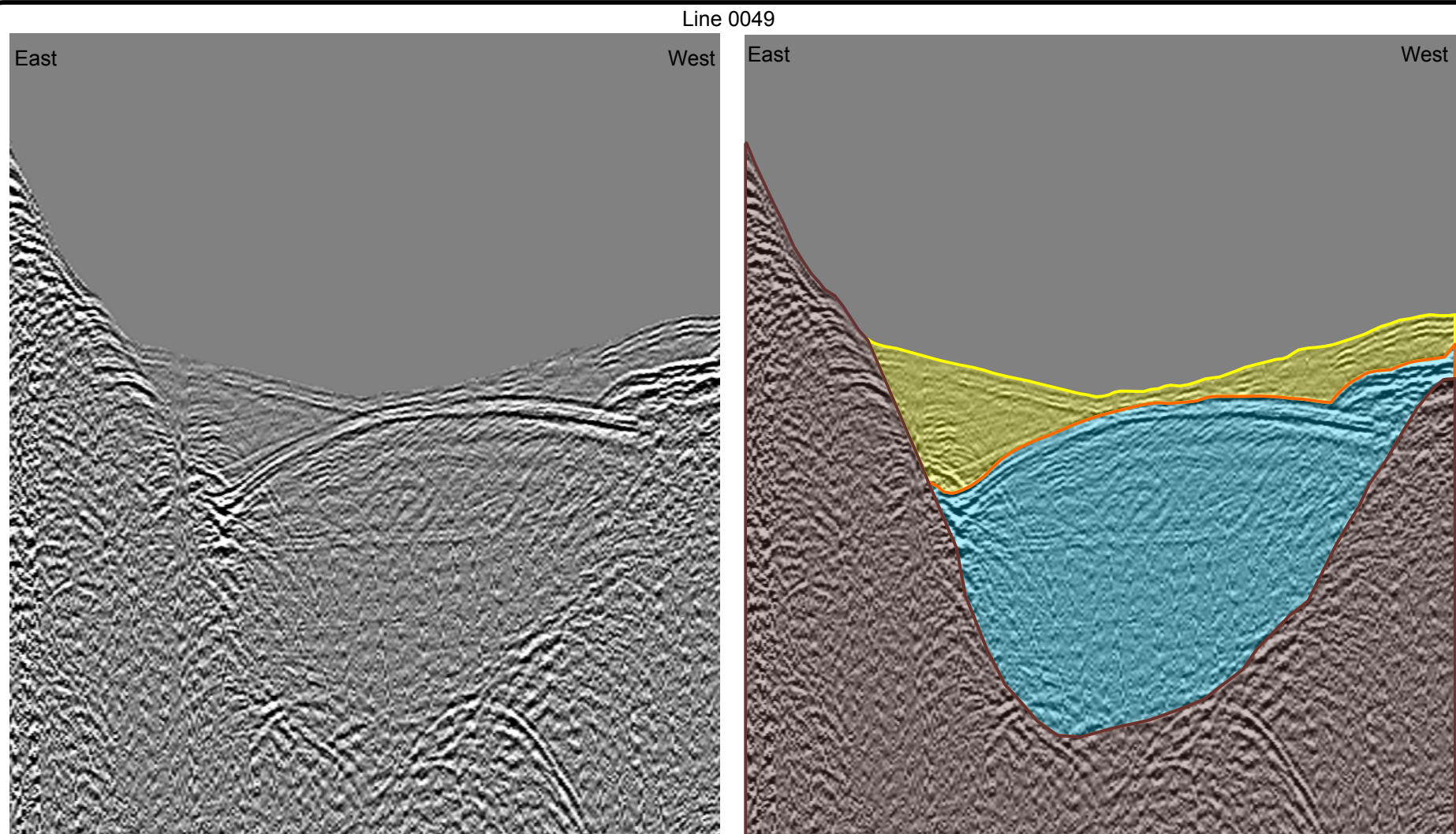


Figure 5.2.3 - Single channel seismic (Boomer) section (left) and interpreted sub-bottom sequences (right) showing two fine grained sequences.

Legend

-  Post-glacial sediment (SB1a)
-  Post-glacial sediment (SB1b)
-  Acoustic Basement



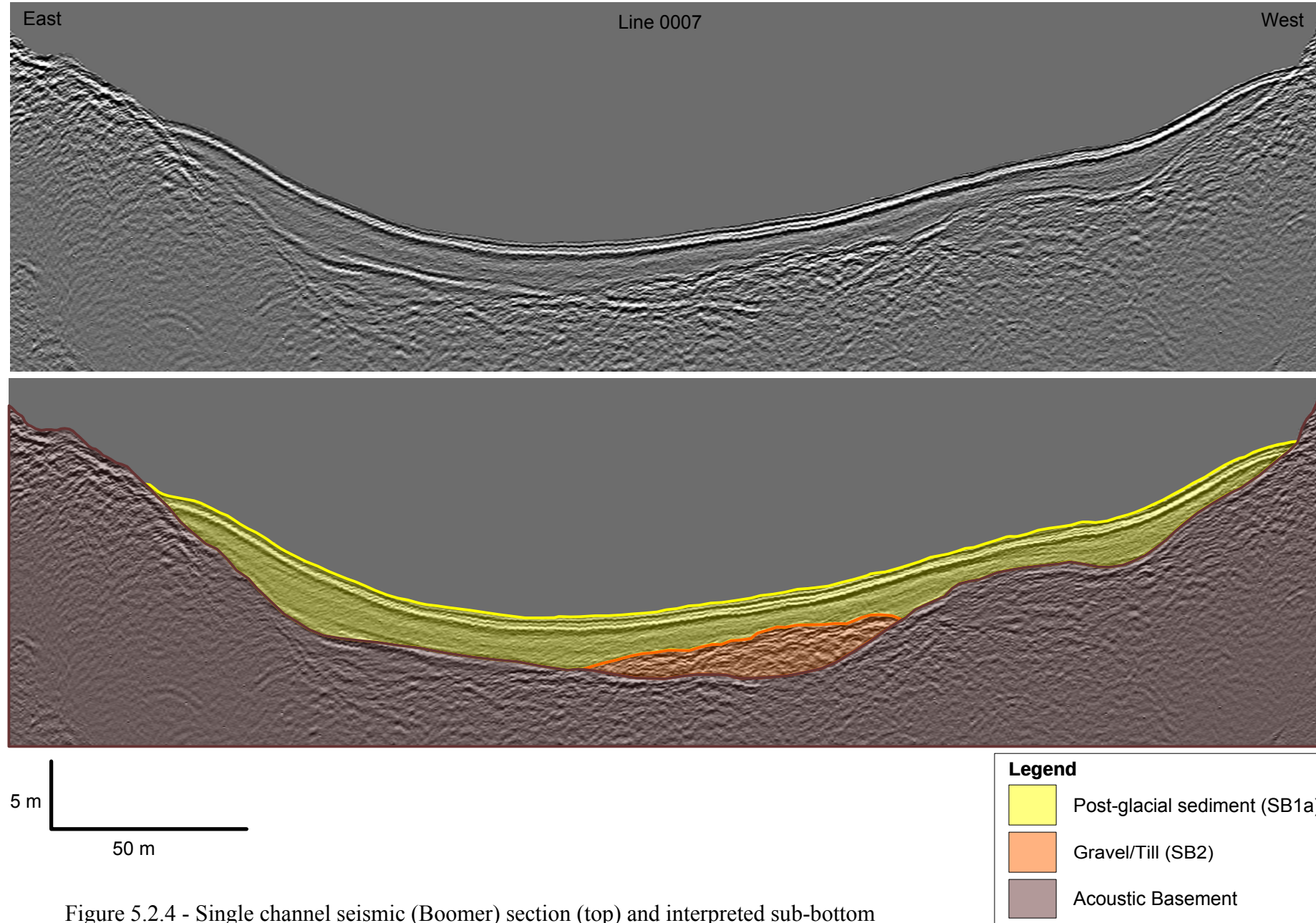
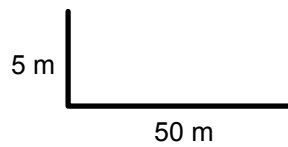
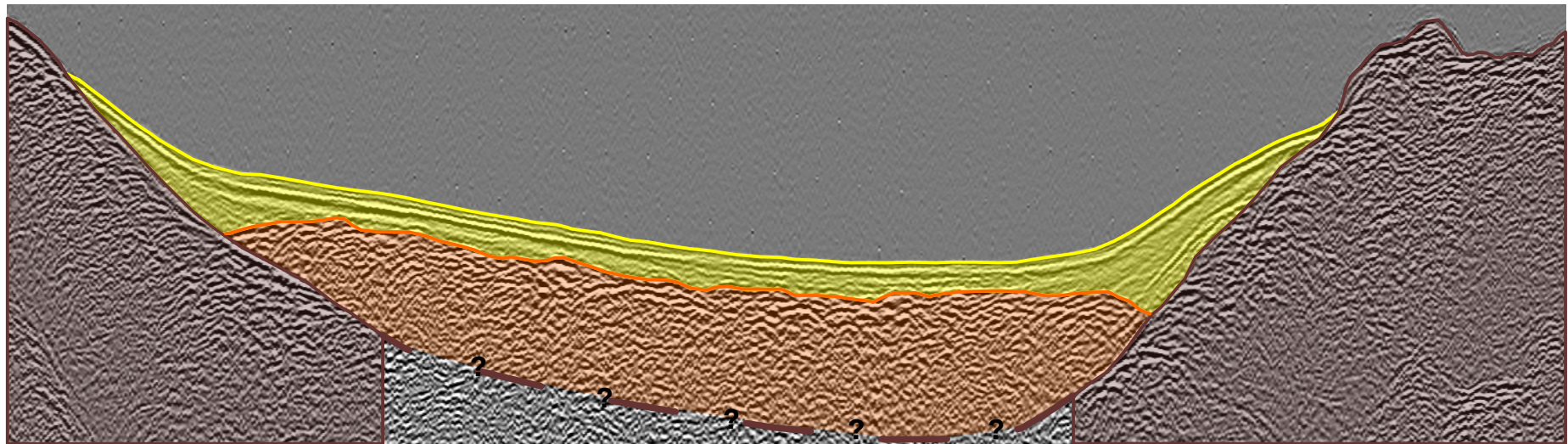
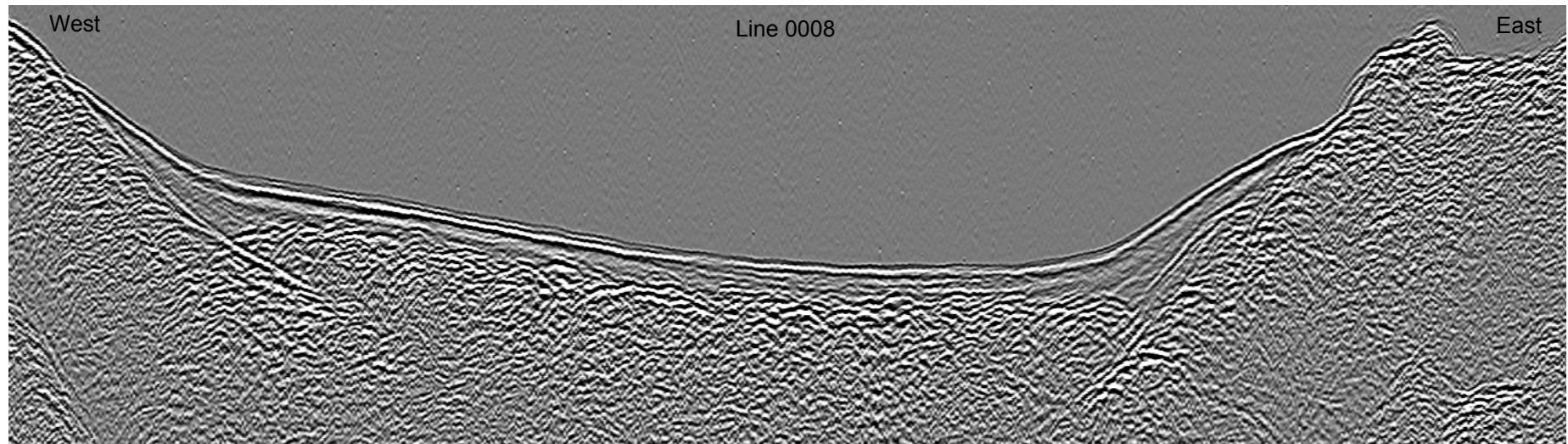


Figure 5.2.4 - Single channel seismic (Boomer) section (top) and interpreted sub-bottom sequences (bottom) showing interpreted bedrock overlain by till and post glacial sediments.





Legend

- Post-glacial sediment (SB1a)
- Gravel/Till (SB2)
- Acoustic Basement

Figure 5.2.5 - Single channel seismic (Boomer) section (top) and interpreted sub-bottom sequences (bottom) showing interpreted acoustic basement reflector and overlying coarse gravel/till.



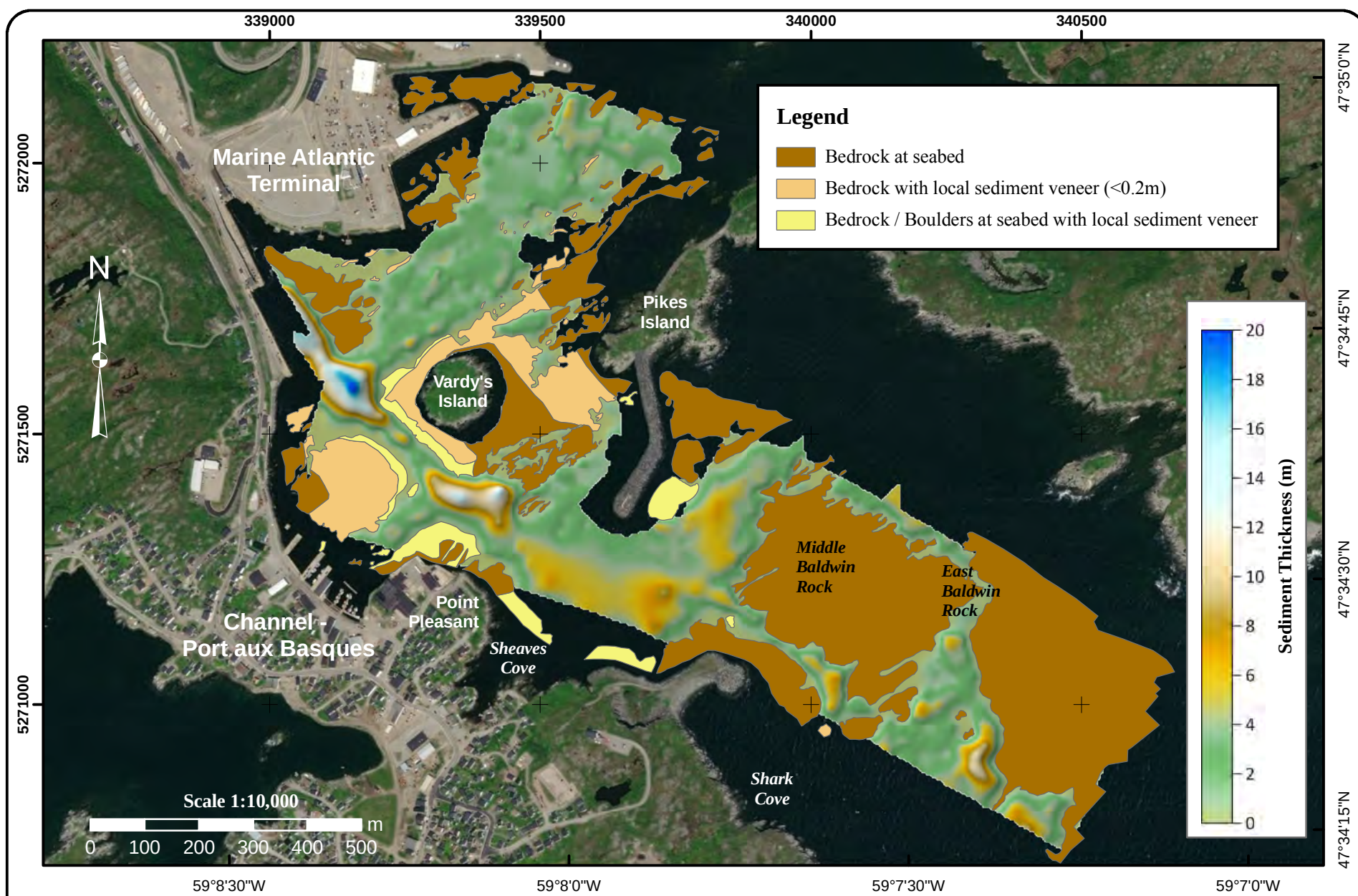


Figure 5.2.6 – Quaternary sediment thickness with locations of bedrock at or near the seabed.

6.0 SUMMARY

Port aux Basques is located on the southwestern tip of Newfoundland. The Marine Atlantic ferry terminal in Port aux Basque is the primary entry point onto the island of Newfoundland. CSR GeoSurveys Ltd. was contracted by CBCL to conduct a hydrographic and marine geophysical survey in preparation for Marine Atlantic's Port aux Basques Vardy's Island Navigation Improvements. The surveys were conducted between January 22nd and January 28th 2020 within Port aux Basques Harbour and approaches. The hydrographic survey included the collection of full bottom coverage utilizing multibeam sonar to meet CHS requirements. Sub-bottom profile data were acquired simultaneously during the multibeam survey utilizing a single channel seismic reflection system (Boomer).

The hydrographic survey was conducted using ellipsoidal referenced survey techniques. CHS benchmark 90F9004 was used for establishing CSR's project survey control (CSR1945BS1f) on the eastern side of the former fish plant dock off Pleasant Street. An RTK-GPS base station was set up each day over CSR1945BS1f which broadcasted RTK corrections to the rover GPS onboard SeaQuest. The RTK-GPS ellipsoid elevations were converted to CHS Chart Datum based on the CanEast 2015 v1 model obtained from CHS. Water level heights were checked using RTK-GPS and compared with data from CHS tide station 625 at Port aux Basque and CSR tide gauge installed during the survey.

The processed multibeam data was exported from Caris as a 1 m horizontal resolution CUBE surface. Sounding and Bathymetry Charts compiled from this surface included the minimum/shoalest value within 5 m x 10 m cells and 1 m contour intervals respectively.

The bathymetry over the area surveyed ranged from 0.5 m to 51 m. Shoal areas comprised of bedrock occur throughout the area surveyed. Port aux Basques Harbour is characterized by a narrow northwest-southeast channel from the approaches to the Marine Atlantic Terminal. The narrowest sections of the channel reach a maximum depth of approximately 25 m west of Middle Baldwin Rock and 27 m west of Vardy's Island. The channel widens between Sheaves Cove and Pikes Island breakwater where it reaches a maximum depth of approximately 29 m. The inner harbour, oriented northeast-southwest, reaches a maximum depth of approximately 18 m north of Vardy's Island.

Seabed features related to previous dredging activities were observed offshore of Vardy's Island and Baldwin Rocks. The areas west and north of Vardy's Island have consistent water depths of approximately 9 m while the dredged area east of the island ranged from 7 to 10 m. Two possible dredged areas occur west of Middle and East Baldwin Rocks while areas of dredge spoil were observed southeast of East Baldwin Rock and east of Pikes Island Breakwater.

A number of linear seabed features were observed including an intake pipeline that makes landfall at Pleasant Point as well as an abandoned pipe.

The surficial bedrock geology was mapped from the multibeam sonar data and single

channel seismic records. The surficial bedrock represents 42% of the area surveyed. The seabed over the remaining areas surveyed is comprised of undifferentiated Quaternary sediment interpreted as silt and/or sand with gravel, cobbles, and boulders. The surficial bedrock geology was divided into three units based on the morphology of the seabed. The majority (80%) of the surficial bedrock geology within the area surveyed includes bedrock at the seabed. Undifferentiated sediment within the surficial bedrock areas were also mapped from the multibeam sonar data. Based on information recorded during diver surveys the sediment is composed of silt and/or sand with gravel and local cobbles. The thickness of the sediment was determined from the single channel seismic records and manual diver probe data provided by CBCL. The three surficial bedrock geology units include; 1) bedrock outcrop or bedrock at the seabed, 2) bedrock / boulders with local sediment veneer, 3) bedrock with local sediment veneer generally <0.2 m.

The sub-bottom geology within the survey area was mapped from the single channel seismic (Boomer) records based on acoustic characteristics and seismic impedance. All sub-surface measurements were calculated based on a sound velocity of 1600 m/s. Based on the data acquired, CSR identified three main sub-bottom geological sequences.

Sub-Bottom Sequence 1 (SB1) consisted of post glacial sediments. This sequence was divided into two sub-units; SB1a and SB1b. Sequence SB1a was interpreted as fine-grained sands, silts and clays with occasional laminations. SB1a ranged in thickness from <0.1 m to approximately 7 m. SB1a was observed throughout the area surveyed with the exception of where bedrock outcrops. SB1b was interpreted as primarily fine-grained sands. This sequence was interpreted as a separate depositional unit than the overlying SB1a unit. SB1b was observed in the deep channel between Vardy's Island and the Marine Atlantic dock with a maximum thickness of approximately 14 m. SB1b also occurred within the channel west of East Baldwin Rock.

Sub-Bottom Sequence 2 (SB2) was interpreted as Glacial Till and or proglacial sediments. Based on the acoustic signature this unit was interpreted as an unsorted heterogeneous sediment matrix, composed of varying grain sizes ranging from silts/clays to cobbles and boulders deposited by glacial activity. SB2 is bounded at the bottom by Acoustic Basement and at the top by post-glacial sediments (SB1a). The thickness of SB2 ranged from approximately 1 m to >10 m. A significant occurrence of SB2 was observed between Sheaves Cove and Pikes Island Breakwater. The acoustic basement reflector was not observed over this area due to limited penetration of the seismic energy as a result of the coarse nature of the overlying glacial till. The thickness of SB2 in this area was generally >10 m.

Sub-Bottom Sequence 3 (SB3) represents acoustic basement interpreted as bedrock although in some areas it may also represent the top of a boulder rich glacial till. Acoustic basement is characterized by a strong reflector where it was well defined. The reflector was often rough and irregular in nature possibly due to fractured bedrock. The acoustic basement reflector was visible throughout the majority of the area surveyed and occurred at surface where bedrock outcropped. The acoustic basement reflector was faint or not visible over a small area north-northwest of Vardy's Island and the region between

Sheaves Cove and Pikes Island breakwater.

Isopach contours representing the thickness of Quaternary sediment over acoustic basement were generated from the interpreted sub-bottom geology. The Quaternary sediments include sub-bottom sequences SB1 and SB2. The thickness of Quaternary sediments over the area surveyed ranged from <0.1 m to approximately 21 m. The majority of the area surveyed had sediment thicknesses <2 m with the exception of the deepest sections of the northwest-southeast Port aux Basques channel.

7.0 RECOMMENDATIONS

- If required, Isopach contours of the fine grained post glacial sediments (SB1a and SB1b) over the area surveyed could be generated from the sub-bottom data acquired.
- An Elevation map of the acoustic basement reflector representing the top of bedrock referenced to Chart Datum could be generated. The volume of bedrock that occurs above the proposed dredge datum could then be calculated.
- If marine boreholes are drilled in the future then this information should be correlated with our sub-bottom geological interpretation and if necessary revised.

8.0 REFERENCES

Kirby, F.T., Ricketts, R.J., and Vanderveer, D.G. 2009. Surficial Geology of the Port aux Basques map sheet (NTS 11O/11). Geological Survey, Department of Natural Resources, Government of Newfoundland and Labrador, Map 2009-88, Open File 011O/11/0404.

Schofield, D.I., Van Staal, C.R., and Winchester, J.A. 1998. Tectonic setting and regional significance of the "Port aux Basques Gneiss", SW Newfoundland. *Journal of the Geological Society*, Vol. 155, 323-334.

Van Staal, C.R., Hall, L., Schofield, D., and Valverde, P. 1996. Geology, Port aux Basques, Newfoundland (part of NTS 11-O/11). Geological Survey of Canada, Open File 3165, scale 1:25,000.

APPENDIX I
DAILY PROGRESS REPORTS



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	20-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	1

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:00	na	na	-4	Sunny
12:00	na	na	-3	Sunny
17:00	na	na	-2	Snowy

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	
	Colin Toole	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	7
Travel	5
Onsite Mob/Demob	0
Survey Operations	0
Standby	0
TOTAL	12

HSE METRICS

Classification	Cases
Occupational Illness	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
Survey equipment preparations HSE & Survey plan review Survey kick-off meeting; safety meeting CG, MG, DR travelled to North Sydney	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	0
Sub-bottom Survey	0
PLANNED ACTIVITES FOR THE NEXT 24 HOURS	
CG, MG, DR to take ferry to Port aux Basques CT to travel to North Sydney, take late ferry to PAB	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss travel conditions & towing boat	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	21-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	2

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:00	na	na	-3	Overcast
12:00	na	na	-1	Overcast
17:00	na	na	-1	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	
	Colin Toole	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	12
Onsite Mob/Demob	0
Survey Operations	0
Standby	0
TOTAL	12

HSE METRICS

Classification	Cases
Occupational Illness	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
CG, MG, DR took ferry to Port aux Basques Reconned ramp and dockage; spoke with Nikita at Harbour Authority CT travelled to North Sydney, took late ferry to PAB	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	0
Sub-bottom Survey	0
PLANNED ACTIVITES FOR THE NEXT 24 HOURS	
Marine Atlantic orientation at 9 am Set up BS at HPN benchmark on MA dolphin; establish control network Prep survey gear on boat Clear boat ramp Launch boat and test gear Install TG	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss boat ramp ice and launching boat	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	22-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	3

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	10 SW	0.3	-8	Overcast
12:00	10 SW	0.3	-5	Overcast
17:30	10 SW	0.3	-4	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	
	Colin Toole	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	11
Survey Operations	0
Standby	0
TOTAL	11

HSE METRICS

Classification	Cases
Occupational Illness	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
CT arrive at 7 am on ferry Meeting with crew at house DR working on shovelling/de-icing ramp CT, CG, MG attended Marine Atlantic orientation at 930 am Set up RTK GPS BS on HPN benchmark on MA dolphin CT, MG worked on control network CG, DR worked on mobbing chirp and multibeam on boat at house MA sent backhoe to clear ramp of snow and ice Installed tide gauge Tide too low to launch boat in evening; waiting for high tide early tomorrow morning	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	0
Sub-bottom Survey	0
PLANNED ACTIVITIES FOR THE NEXT 24 HOURS	
Set up RTK GPS BS on CSR control; check in to HPN Launch boat and test gear in harbour Start multibeam and sub-bottom survey Retrieve RTK GPS BS Data download and review	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss marine terminal protocols, PPE required	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	23-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	4

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	10 SW	0.3	-4	Overcast
12:00	15 SW	0.5	-2	Overcast
17:30	20 SW	0.8	0	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	
	Colin Toole	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	0
Survey Operations	12
Standby	0
TOTAL	12

HSE METRICS

Classification	Cases
Occupational Illness	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
Launched boat Set up RTK GPS base station on CSR control in town; checked in at MA Terminal Testing multibeam and sub-bottom systems in the harbour Started MB and SB surveys Waited at dock for ferry to depart 1230-130 SVP cast and patch test Data download and review	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	15
Sub-bottom Survey	10
PLANNED ACTIVITIES FOR THE NEXT 24 HOURS	
Set up RTK GPS base station on CSR control; check in to HPN Continue with MB and SB surveys CT to depart on ferry	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss deploying/retrieving chirp	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	24-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	5

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	15 NW	0.3	-1	Sunny
12:00	20 NW	0.3	-2	Sunny
17:30	15 NW	0.3	-4	Sunny

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	
	Colin Toole	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	0
Survey Operations	12
Standby	0
TOTAL	12

HSE METRICS

Classification	Cases
Occupational Illness	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
Set up RTK GPS base station on CSR control Continued with MB and SB surveys Waited at dock for ferry to depart 1115-1200 SVP cast and patch test Data download and review CT leaving on late ferry	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	30
Sub-bottom Survey	30
PLANNED ACTIVITIES FOR THE NEXT 24 HOURS	
Set up RTK GPS base station on CSR control Continue with MB and SB surveys	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss shallow water hazards, safe operating procedures around shoals	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	25-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	6

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	10 NNW	0.0	-11	Sunny
12:00	10 WNW	0.1	-3	Sunny
17:30	13 NW	0.1	-3	Sunny

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	0
Survey Operations	12
Standby	0
TOTAL	12

HSE METRICS

Classification	Cases
Occupational Illness	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
Set up RTK GPS base station on CSR control Continued with MB and SB surveys Waited at dock for ferry to depart 1115-1200 SVP cast and patch test Data download and review	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	60
Sub-bottom Survey	60
PLANNED ACTIVITIES FOR THE NEXT 24 HOURS	
Set up RTK GPS base station on CSR control Continue with MB and SB surveys Forecast: Wind/heavy rain warning in effect	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss shallow water hazards, safe operating procedures around shoals	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	26-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	7

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	10 ENE	0.5	-6	Overcast
12:00	13 SE	1.0	-1	Overcast
17:30	18 E	1.5	-3	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	0
Survey Operations	9
Standby	3
TOTAL	12

HSE METRICS

Classification	Cases
Occupational Illness	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
Set up RTK GPS base station on CSR control Continued with MB and SB surveys Waited at dock for ferry to depart 0800-0830 Waited at dock for ferry to depart 1015-1100 SVP cast and patch test Pull SeaQuest for impending heavy wind/rain Standby due to high winds Data download and review	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	75
Sub-bottom Survey	75
PLANNED ACTIVITES FOR THE NEXT 24 HOURS	
Set up RTK GPS base station on CSR control Launch SeaQuest Continue with MB and SB surveys	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss shallow water hazards, safe operating procedures around shoals	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	27-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	8

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	11 W	1.5	2	Overcast
12:30	21 SE	1.5	0	Overcast
17:30	14 W	1.5	0	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	0
Survey Operations	8
Standby	4
TOTAL	12

HSE METRICS

Classification	Cases
Near Miss	1
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	2
Emergency/Safety Drill	

SURVEY SUMMARY	
Set up RTK GPS base station on CSR control Launched SeaQuest Continued with MB and SB surveys Near miss due to entering exclusion zone that we were not made aware of SVP cast and patch test Standby due to storm surge outside breakwater Data download and review	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	90
Sub-bottom Survey	90
PLANNED ACTIVITES FOR THE NEXT 24 HOURS	
Set up RTK GPS base station on CSR control Complete MB and SB surveys outside breakwater if conditions allow for safe operations Pull SeaQuest Demob survey equipment CG, MG, DR depart on 11:45pm ferry	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss shallow water hazards, safe operating procedures around shoals Toolbox to discuss exclusion zone information and safe operating procedures around construction activities	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	28-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	9

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	20 ENE	1.5	-1	Overcast
12:30	14 ENE	2.0	-1	Overcast
17:30	9 ENE	2.0	-1	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	0
Survey Operations	7
Standby	5
TOTAL	12

HSE METRICS

Classification	Cases
Near Miss	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	2
Emergency/Safety Drill	

SURVEY SUMMARY	
Set up RTK GPS base station on CSR control MB survey inside harbour breakwater SVP cast and patch test Weather standby Data download and review	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	95
Sub-bottom Survey	95
PLANNED ACTIVITIES FOR THE NEXT 24 HOURS	
Set up RTK GPS base station on CSR control Complete MB and SB surveys Pull SeaQuest Demob survey equipment CG, MG, DR depart on 11:45pm ferry	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss shallow water hazards, safe operating procedures around shoals Toolbox to discuss exclusion zone information and safe operating procedures around construction activities	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	29-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	10

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	2 NNW	0.5	-3	Overcast
12:30	10 NW	0.5	-3	Overcast
17:30	18 NW	0.3	-6	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	0
Travel	0
Onsite Mob/Demob	6
Survey Operations	6
Standby	0
TOTAL	12

HSE METRICS

Classification	Cases
Near Miss	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	2
Emergency/Safety Drill	

SURVEY SUMMARY	
Set up RTK GPS base station on CSR control Completed MB & SB survey SVP cast and patch test Pulled SeaQuest Demob survey equipment Data download and review CG, MG, DR depart on 11:45pm ferry	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	100
Sub-bottom Survey	100
PLANNED ACTIVITES FOR THE NEXT 24 HOURS	
CG, MG, DR travel day Demob survey equipment	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss shallow water hazards, safe operating procedures around shoals Toolbox to discuss exclusion zone information and safe operating procedures around construction activities	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Signed: _____

Name: Cole Gilbert

Name: _____

CSR Party Chief

Client Representative



CSR GeoSurveys Ltd.
Engineering and Environmental Geophysics

DAILY PROGRESS REPORT

Date:	30-Jan-20	Party Chief:	Cole Gilbert
Client Name:	CBCL	Party Chief Email:	cgilbert@csr-marine.com
CSR Job Number:	1945	Party Chief Mobile:	902 229 7486
Vessel:	SeaQuest	CSR Office Phone:	902 827 4200
Survey Location:	Port aux Basques	Daily Report #	11

Hydrographic and Geophysical Survey

WEATHER CONDITIONS

Time	Wind Speed(Kts)/Direction	Wave Ht (m)	Temperature (°C)	Observation
7:30	na	na	-6	Snowy
12:30	na	na	-5	Snowy
17:30	na	na	-3	Overcast

PERSONNEL

Client Representative (s)	CSR	Subcontractors
Lorna Campbell	Cole Gilbert	na
	Mitch Grace	
	Dillon Rowe	

SURVEY EQUIPMENT

Navigation & Ancillary	Geophysical/Hydrographic	Geotechnical/Sampling
Trimble 5700 RTK	Multibeam Echosounder	na
SBG INS	Chirp SBP	
R110	Boomer SBP	
VS330		

DAILY TIME ALLOCATION

Classification	Hours
Survey Preparation	5
Travel	7
Onsite Mob/Demob	0
Survey Operations	0
Standby	0
TOTAL	12

HSE METRICS

Classification	Cases
Near Miss	
Lost Time Injury	
First Aid Case	
Environmental Incident	
Equipment Damage/Loss	
Toolbox Talk	1
Emergency/Safety Drill	

SURVEY SUMMARY	
CG, MG, DR travel day Demob equipment Data backup	
SURVEY PROGRESS	
Survey Task	Percent Complete
Multibeam Survey	100
Sub-bottom Survey	100
PLANNED ACTIVITES FOR THE NEXT 24 HOURS	
MEETINGS HELD AND ITEMS DISCUSSED	
Toolbox to discuss weather conditions and driving from North Sydney to office	
CHANGE ORDERS / DECISIONS	
na	

Signed: _____

Name: Cole Gilbert

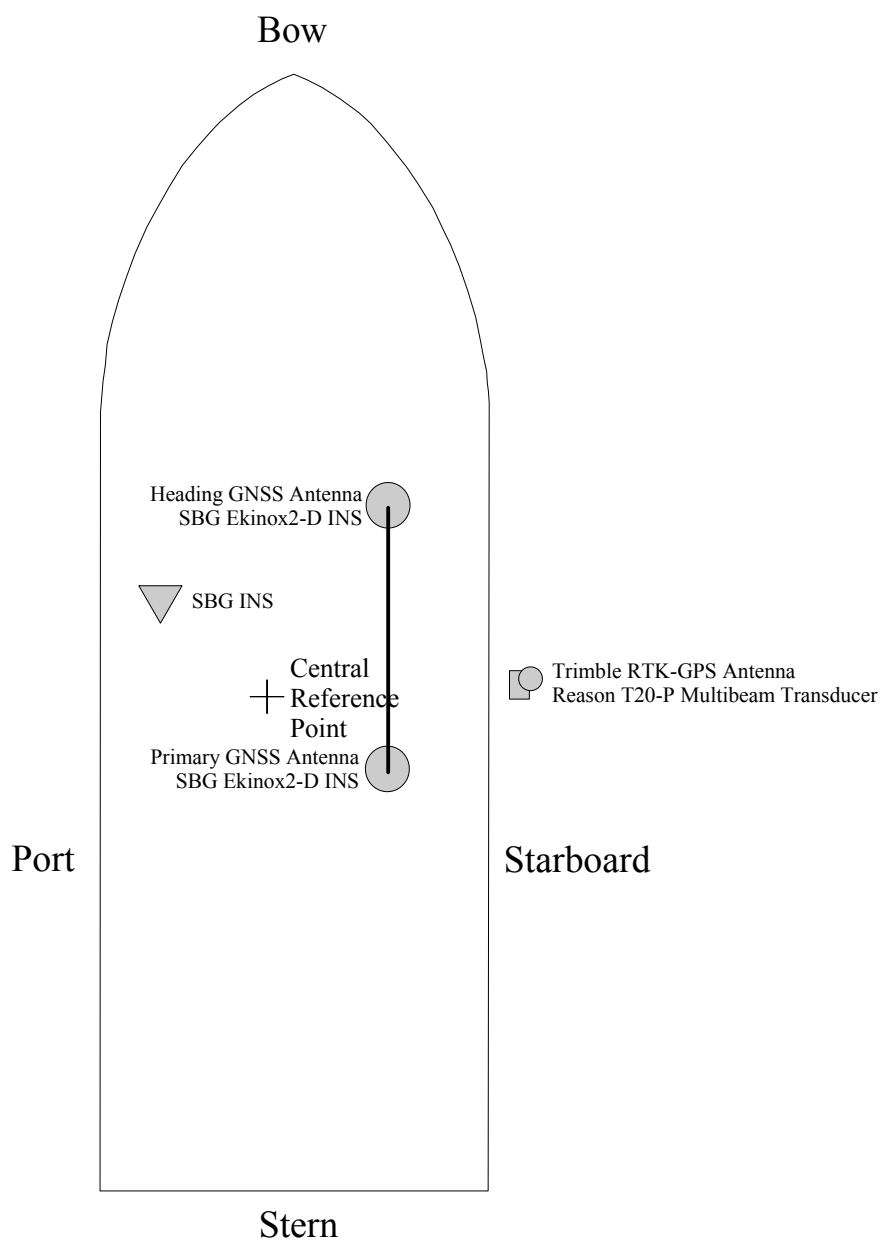
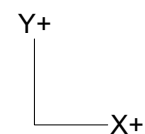
Signed: _____

Name: _____

APPENDIX II

VESSEL OFFSETS

SeaQuest Survey Equipment Offsets



Multibeam System Offsets (m)			
System	X	Y	Z
SBG Ekinox2-D INS	-0.470	0.800	0.230
Reson T20-P Multibeam Transducer	1.670	0.155	-0.700
Trimble RTK-GPS Antenna	1.765	0.050	1.994

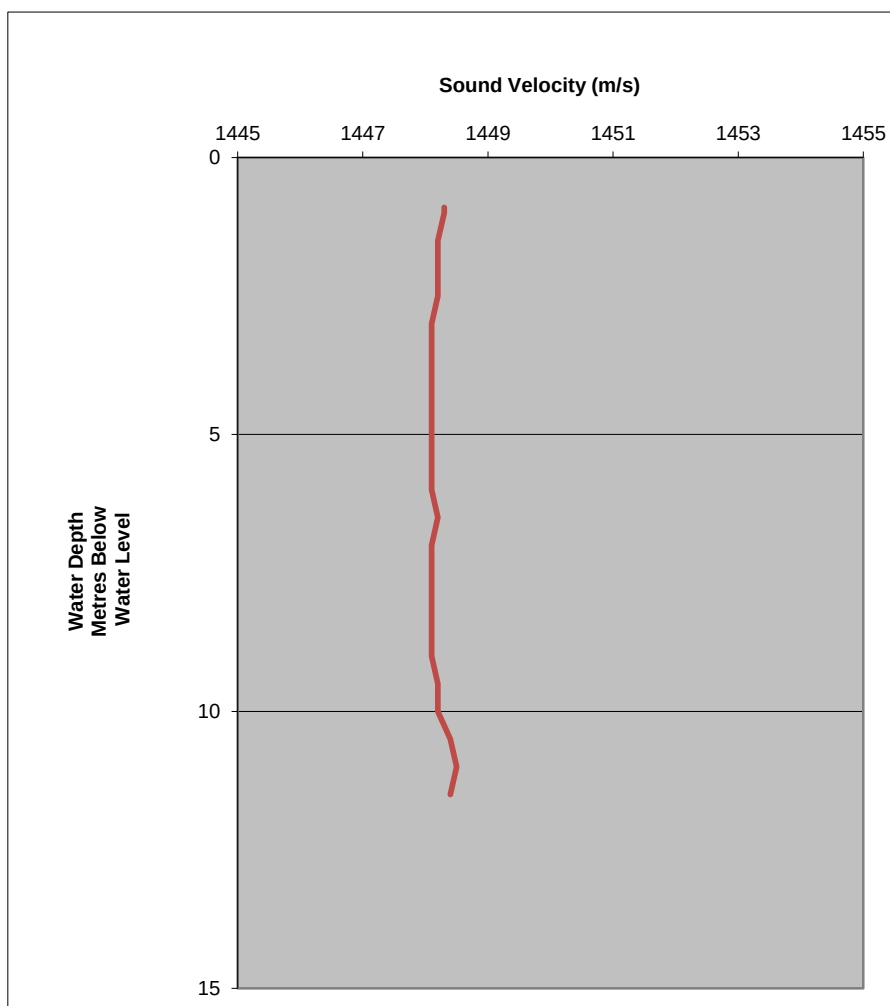
SeaQuest plan view and offsets to Central Reference Point.



APPENDIX III
SOUND VELOCITY PROFILES

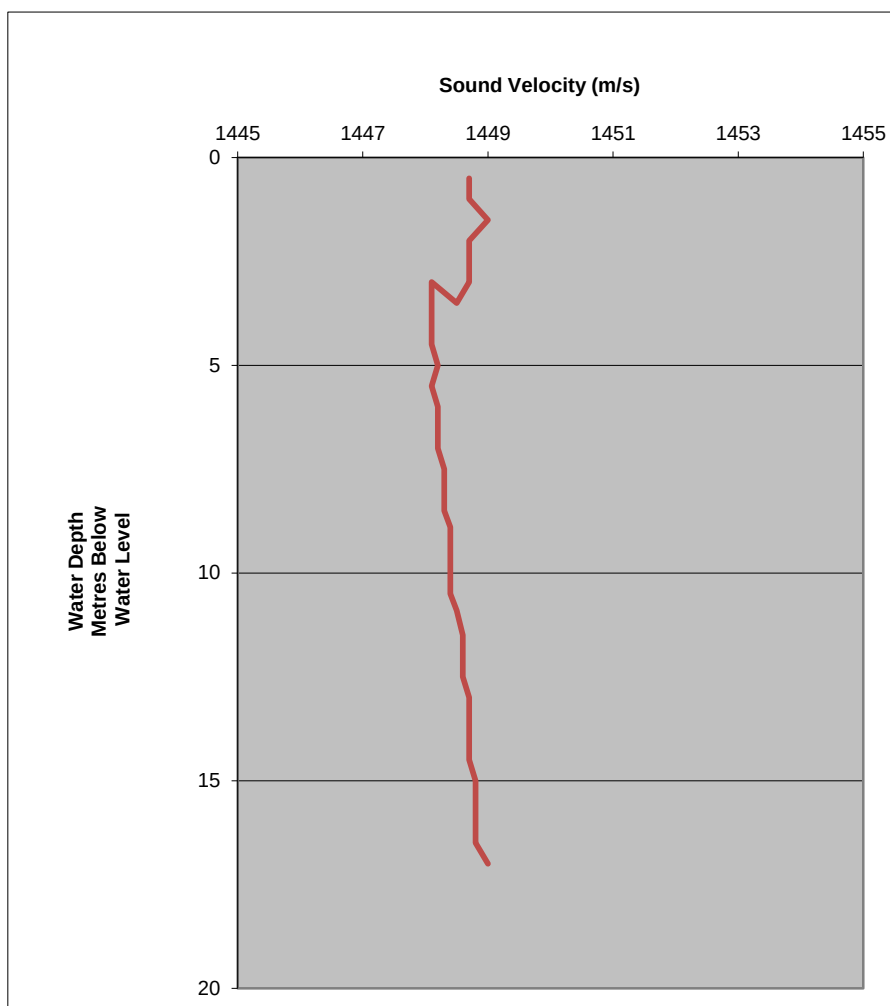


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-01
Date:	23-Jan-20
Time:	13:55:00



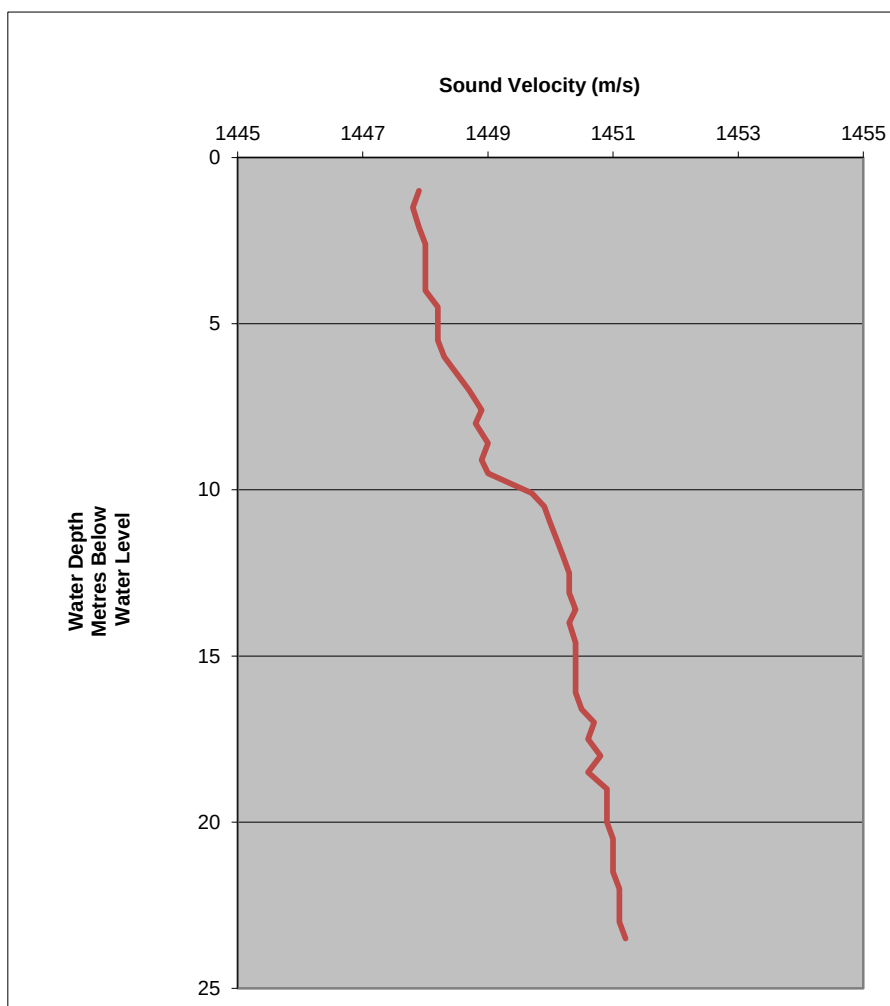


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-02
Date:	23-Jan-20
Time:	16:21:00



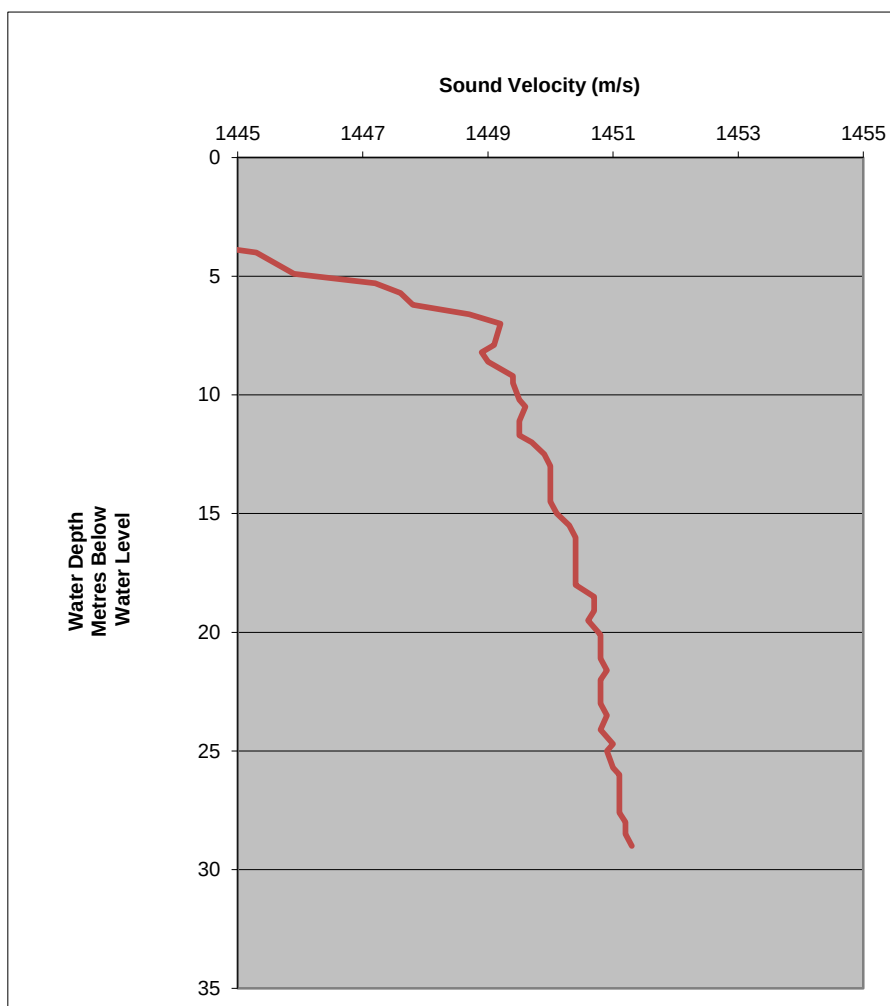


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-03
Date:	24-Jan-20
Time:	17:33:00



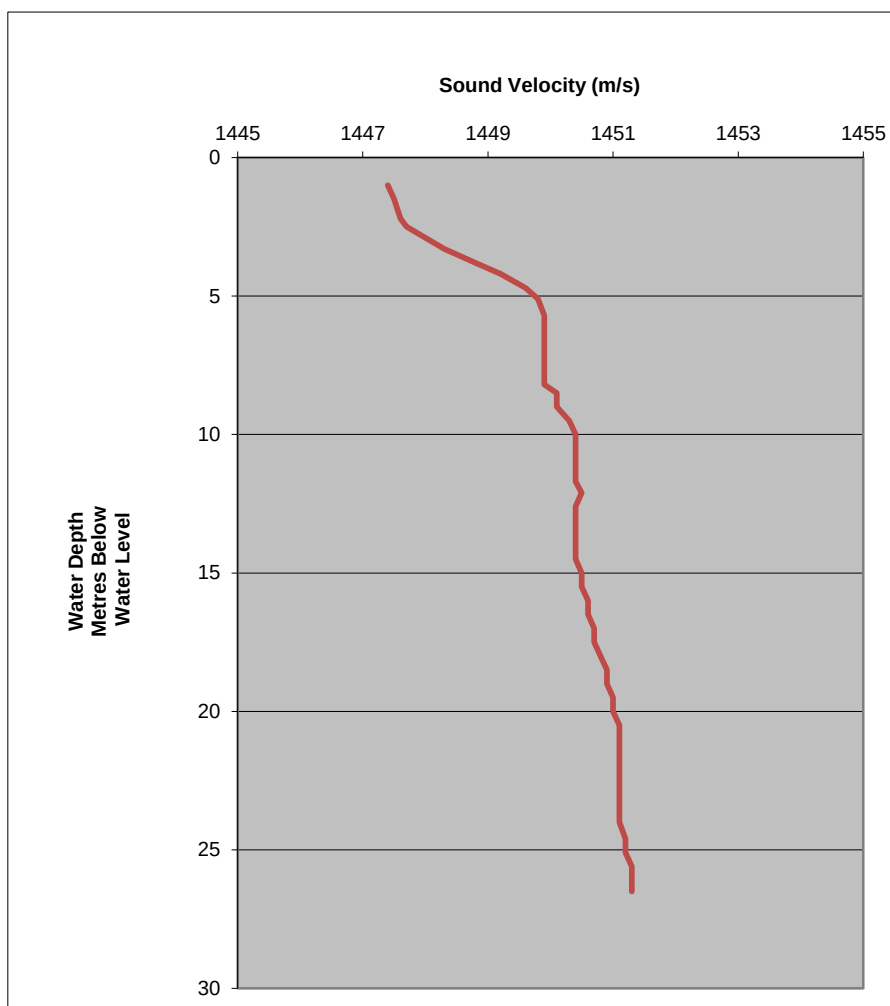


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-04
Date:	25-Jan-20
Time:	11:33:00



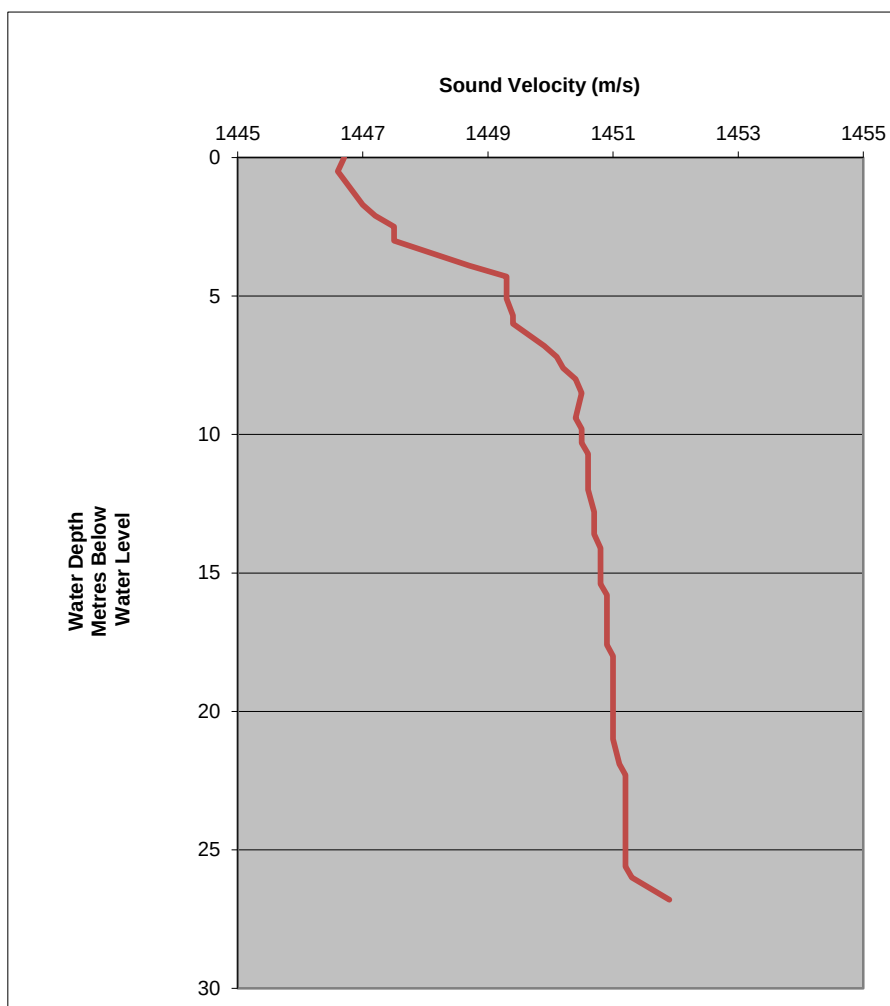


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-05
Date:	25-Jan-20
Time:	16:30:00



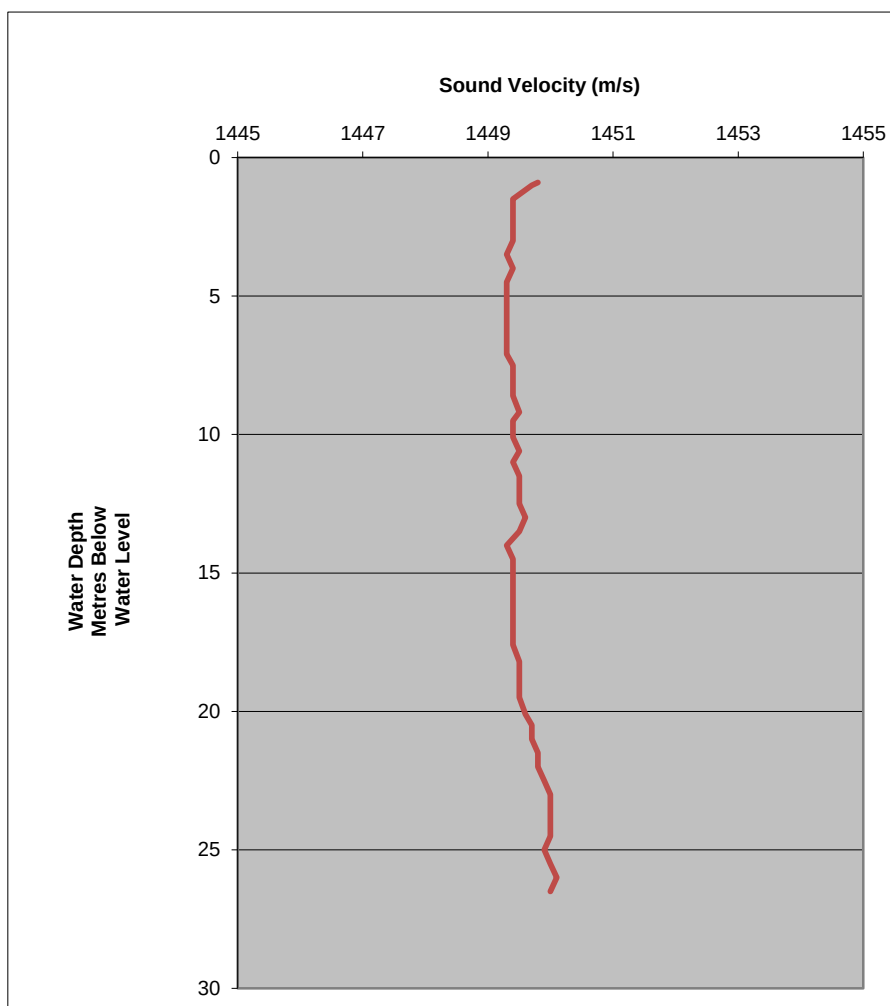


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-05b
Date:	25-Jan-20
Time:	16:30:00



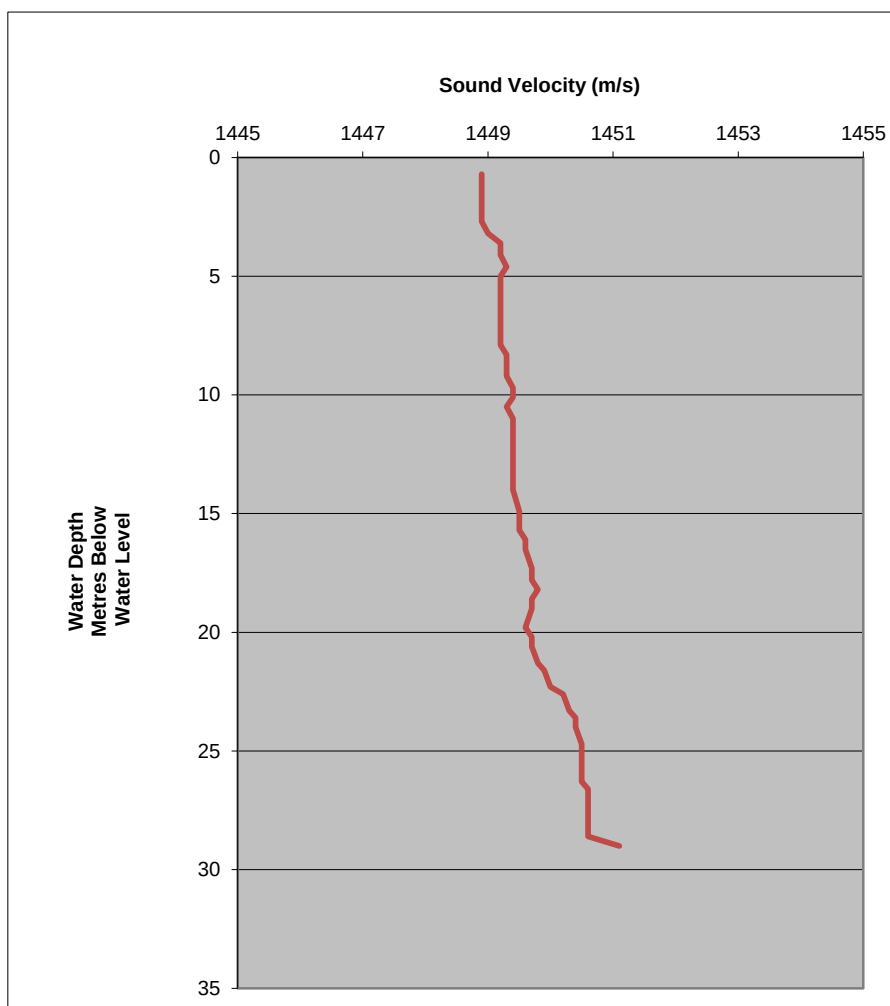


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-06
Date:	26-Jan-20
Time:	10:59:00



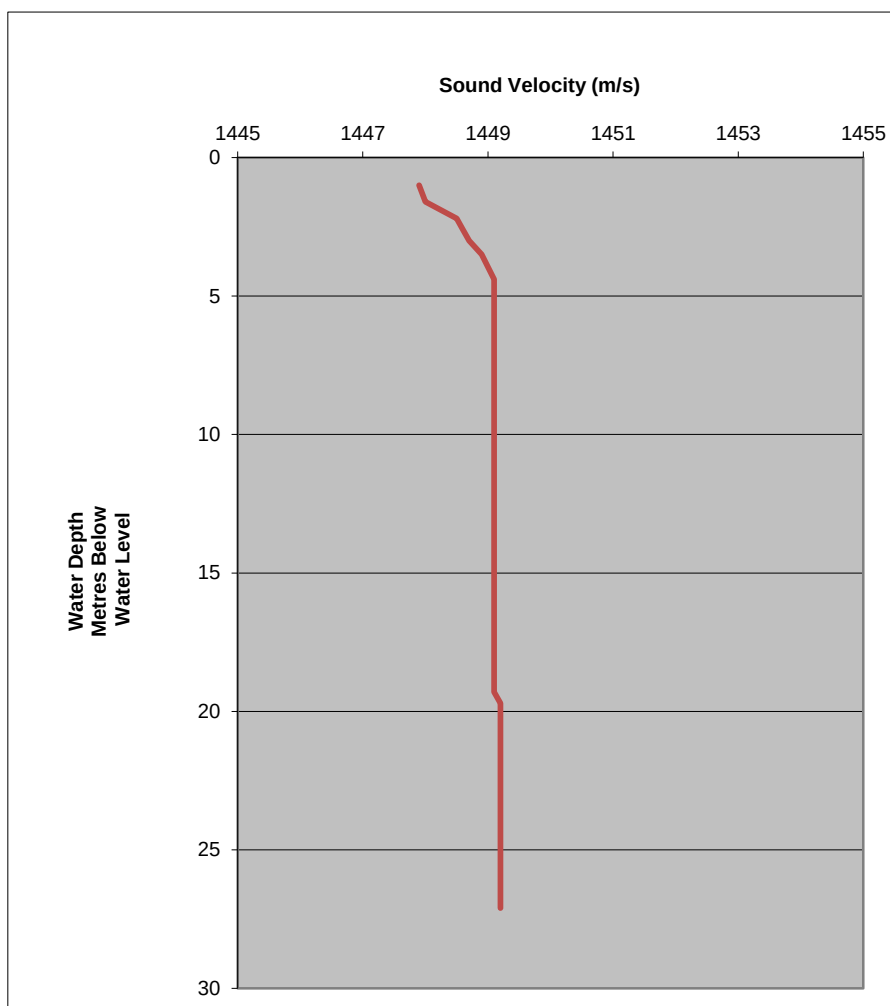


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-06b
Date:	26-Jan-20
Time:	10:59:00



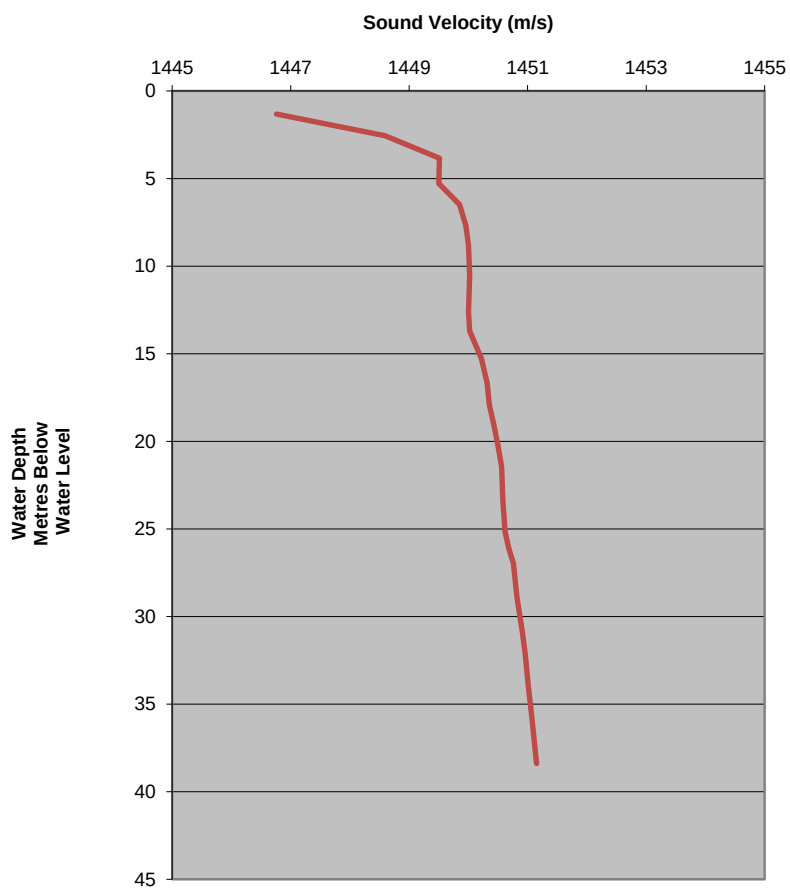


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-07
Date:	28-Jan-20
Time:	13:34:00



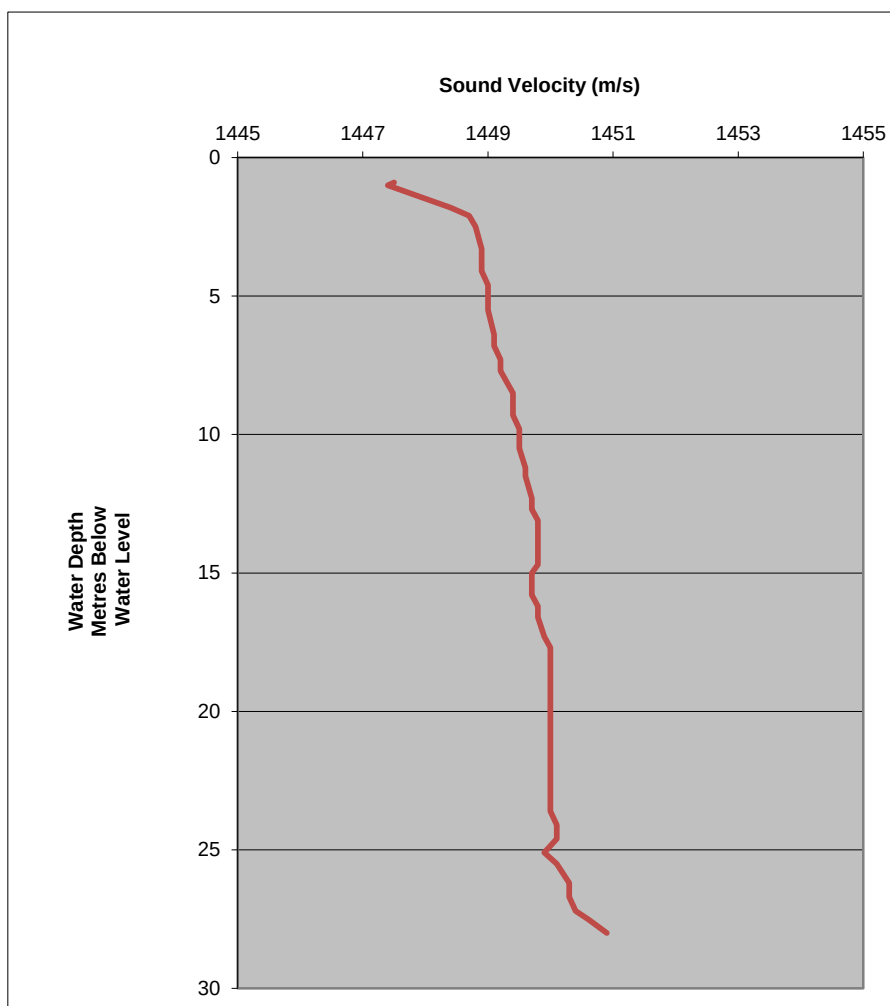


Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-08
Date:	29-Jan-20
Time:	





Instrument Type/Serial No:	Odom Digibar SVP / 3107
Client:	CBCL
Project Number:	1945
Project Location:	Port aux Basque
Vessel:	SeaQuest
Name:	SVP-09
Date:	29-Jan-20
Time:	10:35:00



APPENDIX IV
SURVEY CONTROL



Station Report - 90F9004

Station 1 of 1

Site Identification

Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
0665	Newfoundland	011011	90F9004		HP3D

Station Coordinates

Coordinates	Geoid	Reference Frame	Epoch
geo	CGG2013a	NAD83(CSRs)	2010.0

Latitude	Longitude	h (metres)
N47° 34' 48.478501" ± 0.0024m	W59° 08' 20.800322" ± 0.0020m	-6.968 ± 0.0134m
Vφ (mm/y)	Vλ (mm/y)	Vh (mm/y)
-1.44 ± 0.00	1.32 ± 0.00	-2.16 ± 0.00
N (metres)	H (metres)	Published date and project ID
-8.875 ± 0.017	1.907	2004-01-01 M04711

Vertical Data

Use the value of H from the coordinates above.



Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Brass/bronze tablet or cap	1998	Canadian hydrographic service - f & o	Good	None

Location

Accessible by passenger car or light truck and a walk of less than 50 m.

Port Aux Basques

Marked by a bronze tablet set in pier.



Station Report - 90F9004

Station 1 of 1

Site Identification

Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
0665	Newfoundland	011011	90F9004		HP3D

Station Coordinates

Coordinates	Geoid	Reference Frame	Epoch
plan	CGG2013a	NAD83(CSRs)	2010.0

Zone: UTM21

Easting (metres)	Northing (metres)	h (metres)
339144.811 ± 0.0050	5271852.628 ± 0.0080	-6.968 ± 0.0100
Scale	Combined	Convergence
0.999918	0.999919	1° 34' 46.11"
N (metres)	H (metres)	Published date and project ID
-8.875 ± 0.017	1.907	2004-01-01 M04711

Vertical Data

Use the value of H from the coordinates above.



Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Brass/bronze tablet or cap	1998	Canadian hydrographic service - f & o	Good	None

Location

Accessible by passenger car or light truck and a walk of less than 50 m.

Port Aux Basques

Marked by a bronze tablet set in pier.



Station Report - 82G2332

Station 1 of 1

Site Identification

Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
82G2332	Newfoundland	011011	82G2332		GPS

Station Coordinates

Coordinates	Geoid	Reference Frame	Epoch
geo	CGG2013a	NAD83(CSRs)	2010.0

Latitude	Longitude	h (metres)
N47° 34' 25.228498" ± 0.0025m	W59° 08' 30.439799" ± 0.0020m	4.036 ± 0.0145m
Vφ (mm/y)	Vλ (mm/y)	Vh (mm/y)
-1.44 ± 0.00	1.32 ± 0.00	-2.16 ± 0.00
N (metres)	H (metres)	Published date and project ID
-8.919 ± 0.018	12.955	2001-01-01 M01707

Vertical Data

Use the value of H from the coordinates above.



Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Permanent agency marker	1992	Nfld dept of forest resources and lands (survey directorate,	Good	None

Location

Accessible by passenger car or light truck and a walk of less than 50 m.

Port Aux Basques

Large bedrock hill on the north side of main street in town, just east of junction with brook st., regional st. And main st., just northwest of post office and federal building, 6.37 m northwest of chain link fence running along rock cut, about 5 m above road level.



Station Report - 82G2332

Station 1 of 1

Site Identification

Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
82G2332	Newfoundland	011011	82G2332		GPS

Station Coordinates

Coordinates	Geoid	Reference Frame	Epoch
plan	CGG2013a	NAD83(CSRs)	2010.0

Zone: UTM21

Easting (metres)	Northing (metres)	h (metres)
338923.655 ± 0.0054	5271140.464 ± 0.0086	4.036 ± 0.0108
Scale	Combined	Convergence
0.999919	0.999918	1° 34' 52.65"
N (metres)	H (metres)	Published date and project ID
-8.919 ± 0.018	12.955	2001-01-01 M01707

Vertical Data

Use the value of H from the coordinates above.



Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Permanent agency marker	1992	Nfld dept of forest resources and lands (survey directorate,	Good	None

Location

Accessible by passenger car or light truck and a walk of less than 50 m.

Port Aux Basques

Large bedrock hill on the north side of main street in town, just east of junction with brook st., regional st. And main st., just northwest of post office and federal building, 6.37 m northwest of chain link fence running along rock cut, about 5 m above road level.

Benchmarks for PORT AUX BASQUES (#665)

Benchmark Number: 8-1984 Unique Number: 84F9500

Benchmark Number:8-1984

Unique Number:84F9500

Station Number:665

Station Name:PORT AUX BASQUES

Holding Benchmark	Datum Name	Elevation (metres)	Status
NO	CD	3.888	

Description:

A CHS bronze tablet stamped BM 8-1984 and set vertically in a rock outcrop along the shore of Ring Bolt Cove in Port Aux Basques. BM is 0.30 m W of HS 1-1964, 3 m SSE of concrete road leading to govt wharf. CONTROL

Benchmark Number: 87F9164 Unique Number: no id

Benchmark Number:87F9164

Unique Number:no id

Station Number:665

Station Name:PORT AUX BASQUES

Holding Benchmark	Datum Name	Elevation (metres)	Status
NO	CD	4.693	

Description:

A CHS bronze tablet stamped 87F 9164 set vertically in a rock outcrop. The tablet is 10.6 m W of the central line of Norman Ave, 3.6 m E from the N corner of the house, 8.9 m from the S corner of the bait depot and 15.2 m from SE corner of the same bait d

Benchmark Number: 9-1984 Unique Number: no id

Benchmark Number:9-1984

Unique Number:no id

Station Number:665

Station Name:PORT AUX BASQUES

Holding Benchmark	Datum Name	Elevation (metres)	Status
NO	CD	3.575	

Description:

A CHS bronze tablet stamped 9-1984 set vertically in the concrete apron of the DFO building at the Port-aux-Basques-Channel govt wharf. The tablet is located on the E end of the building 0.4 m E of the buildings brick facing, 1.15 m NW of the NE corner of

Benchmark Number: 90F9004 Unique Number: no id

Benchmark Number: 90F9004

Unique Number: no id

Station Number:665

Station Name: PORT AUX BASQUES

Holding Benchmark	Datum Name	Elevation (metres)	Status
NO	CD	3.506	

Description:

A CHS bronze tablet stamped 90F9004 set vertically in the concrete deck of the most E dolphin at the Marine Atlantic terminal in Port Aux Basques. This dolphin is the host structure for the permanent water level network station. The tablet is in the NW co

Benchmark Number: no id Unique Number: 90F9003

Benchmark Number:no id

Unique Number:90F9003

Station Number:665

Station Name:PORT AUX BASQUES

Latitude:47.580191 ° N

Longitude:-59.1397 ° W

Established:1990

Benchmark Condition:Good

Setting:VERTICAL

Type:Bronze Tablet

Agency:CHS

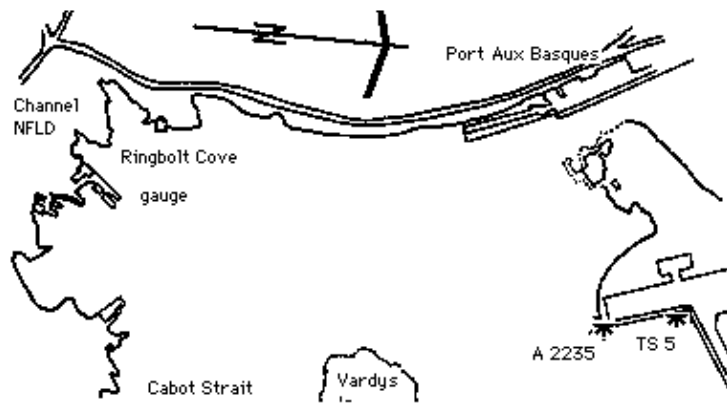
Last Inspected:2009

Holding Benchmark	Datum Name	Elevation (metres)	Status
NO	CD	3.545	

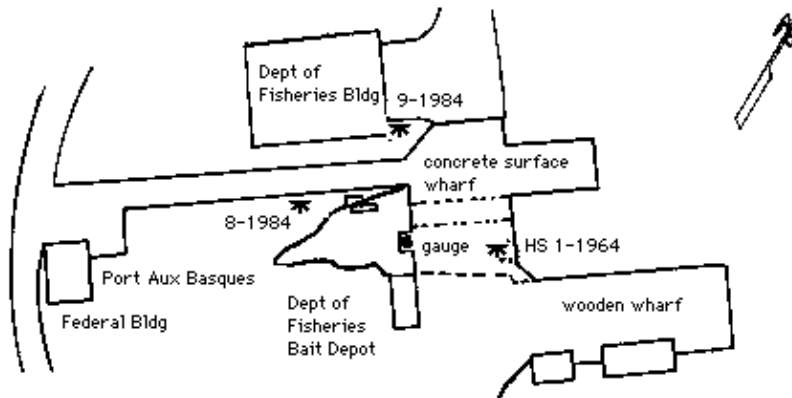
Description:

A CHS bronze tablet stamped 90F9003 set vertically in the concrete deck of a dolphin at the Marine Atlantic terminal in Port Aux Basques. The dolphin with 90F9003 is the W'ly of two which are not shore based, these two dolphins have metal access walkways.

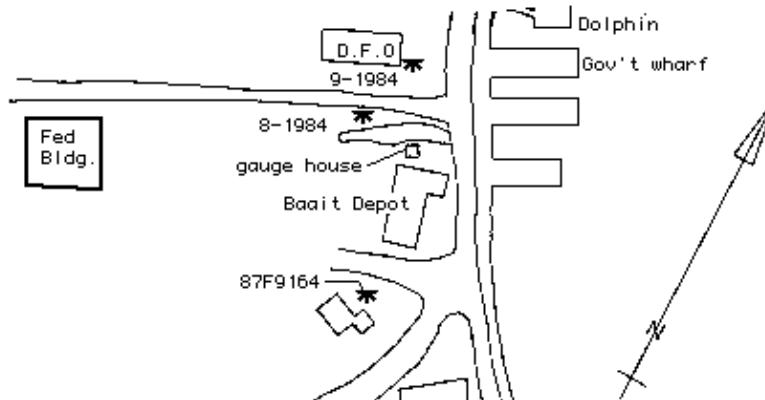
Sketch Status: ACTIVE



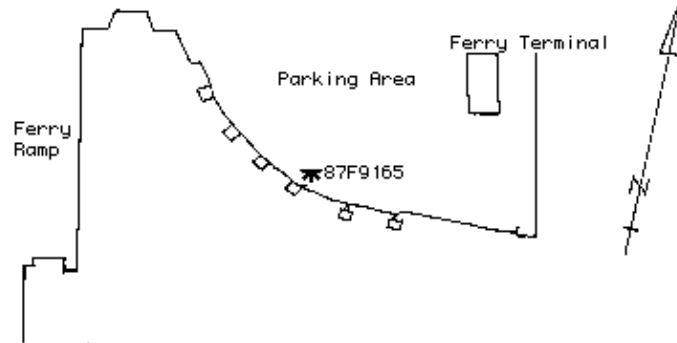
Sketch Status: ACTIVE



Sketch Status: ACTIVE

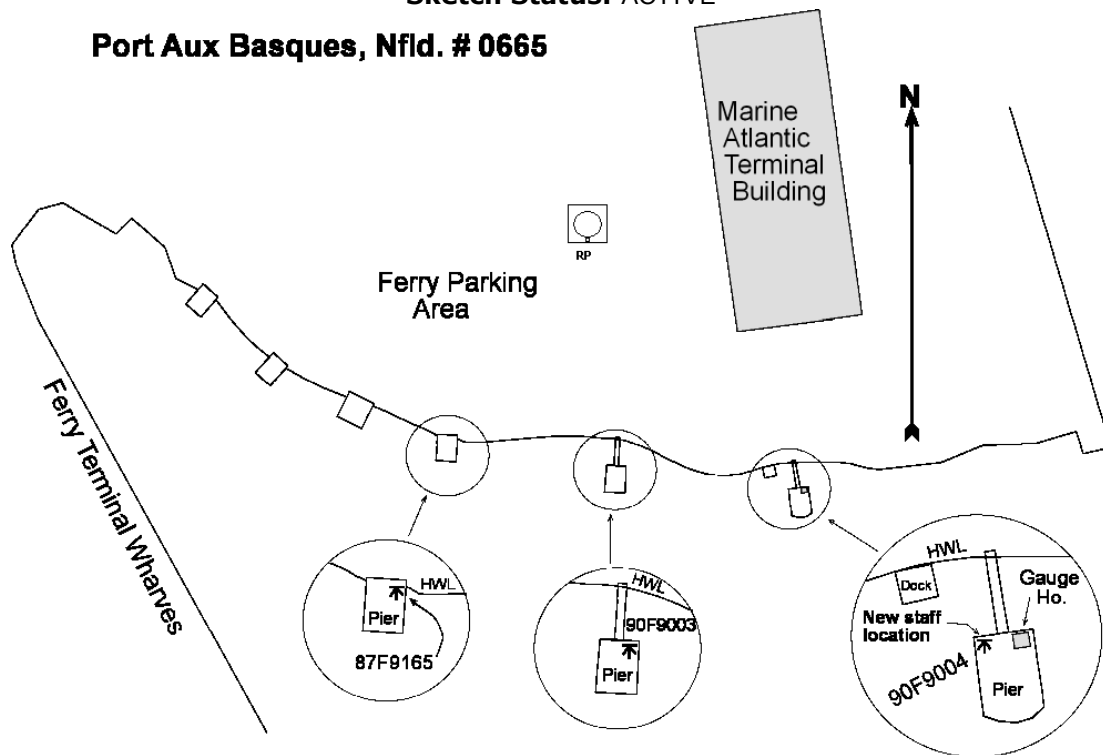


Sketch Status: ACTIVE



Sketch Status: ACTIVE

Port Aux Basques, Nfld. # 0665



Sketch Status: HISTORICAL

APPENDIX V
DIGITAL DELIVERABLES

DATA FILE DESCRIPTIONS**SURVEY REFERENCE**

Horizontal Datum: North American Datum 1983 (CSRS)
Projection: Universal Transverse Mercator (UTM), Zone 21 N
Central Meridian: 57° W
Scale Factor at CM: 0.9996
False Easting: 500,000 metres
False Northing: 0 metres
Units: Metres
Vertical Datum: Chart Datum

AUTOCAD DRAWINGS

File Name	1945_SC_20201106.dwg
Description	Processed multibeam soundings referenced to Chart datum of Port aux Basques Harbour and Approaches. The Soundings on the drawings represent the minimum/shoalest value within 5 m x 10 m cell selected from the Caris CUBE surface. This Autocad drawing includes Enclosures 1 and 2.
File Type	Autocad Civil 3D 2019

File Name	1945_BC_20201106.dwg
Description	Bathymetric contours at 1 m intervals referenced to Chart datum of Port aux Basques Harbour and Approaches. This Autocad drawing includes Enclosures 3 and 4.
File Type	Autocad Civil 3D 2019

File Name	1945_AB_20201106.dwg
Description	Quaternary sediment isopach contours at 1 m intervals and spatial distribution of bedrock at or near the seabed surface of Port aux Basques Harbour and Approaches. The Isopach contours represent the thickness of unconsolidated sediment over Acoustic Basement (interpreted bedrock). This drawing also includes locations of linear seabed features. This Autocad drawing includes Enclosures 5 and 6.
File Type	Autocad Civil 3D 2019

File Name	1945_TK_20201106.dwg
Description	Includes the location of the sub-bottom profiler survey tracklines and diver manual probes. This Autocad drawing includes Enclosures 7 and 8
File Type	Autocad Civil 3D 2019

PROCESSED ASCII BATHYMETRY

File Name	1945_Soundings_10mx5m_20200303.xyz	
Description	Processed multibeam soundings referenced to Chart datum of Port aux Basques Harbour and Approaches in Ascii XYZ format. This file represents the minimum/shoalest value within 5 m x 10 m cell selected from the Caris CUBE surface. These soundings are displayed on Enclosures 1 and 2.	
Feature Type	Point	
Fields	Field Name	Description
	Easting	UTM Zone 21 Easting
	Northing	UTM Zone 21 Northing
	DepthCD	Chart Datum Seabed Elevation in metres

File Name	PAB_1945_MB_1m_CLIPPED_20200305.xyz	
Description	Processed multibeam soundings referenced to Chart datum of Port aux Basques Harbour and Approaches in Ascii XYZ format. This file represents the 1 m Caris CUBE surface.	
Feature Type	Point	
Fields	Field Name	Description
	Easting	UTM Zone 21 Easting
	Northing	UTM Zone 21 Northing
	DepthCD	Chart Datum Seabed Elevation in metres

ARCGIS FILES***Multibeam Surface***

GIS Layer Name	CSR1945_PaB_MBE_Surface_20200303.tif
Description	This GIS layer includes the multibeam colour shaded relief image.
Feature Type	Geotiff

Bathymetry

GIS Layer Name	CSR1945_BathymetryContours_1m_NAD83_UTM21_20200306.shp			
Description	This GIS layer includes Bathymetry Contours at 1 m intervals referenced to Chart Datum			
Feature Type	Polyline			
Attribute Fields	Attribute Field Name	Description	Field Type	Value
	Bathy_CD	Water Depth Contour in metres	Integer	1 to 51 m

Geology

GIS Layer Name	CSR1945_BedrockBoundary_NAD83_UTM21_20200305.shp			
Description	This GIS layer includes spatial distribution of bedrock at or near the seabed surface.			
Feature Type	Polygon			
Attribute Fields	Attribute Field Name	Description	Field Type	Value
	Feature	Description of polygon area.	Text	Bedrock, local sediment veneer Probable Rock Fill
	Notes	Additional information of the area.	Text	

GIS Layer Name	CSR1945_IsopachContours_1m_NAD83_UTM21_20200310.shp			
Description	This GIS layer includes Isopach Contours at 1 m intervals of the thickness of Quaternary sediments over Acoustic Basement (interpreted bedrock surface)			
Feature Type	Polyline			
Attribute Fields	Attribute Field Name	Description	Field Type	Value
	Sed_Thck	Sediment Thickness in metres	Integer	1 to 20 m

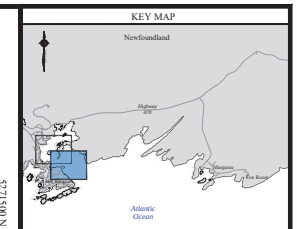
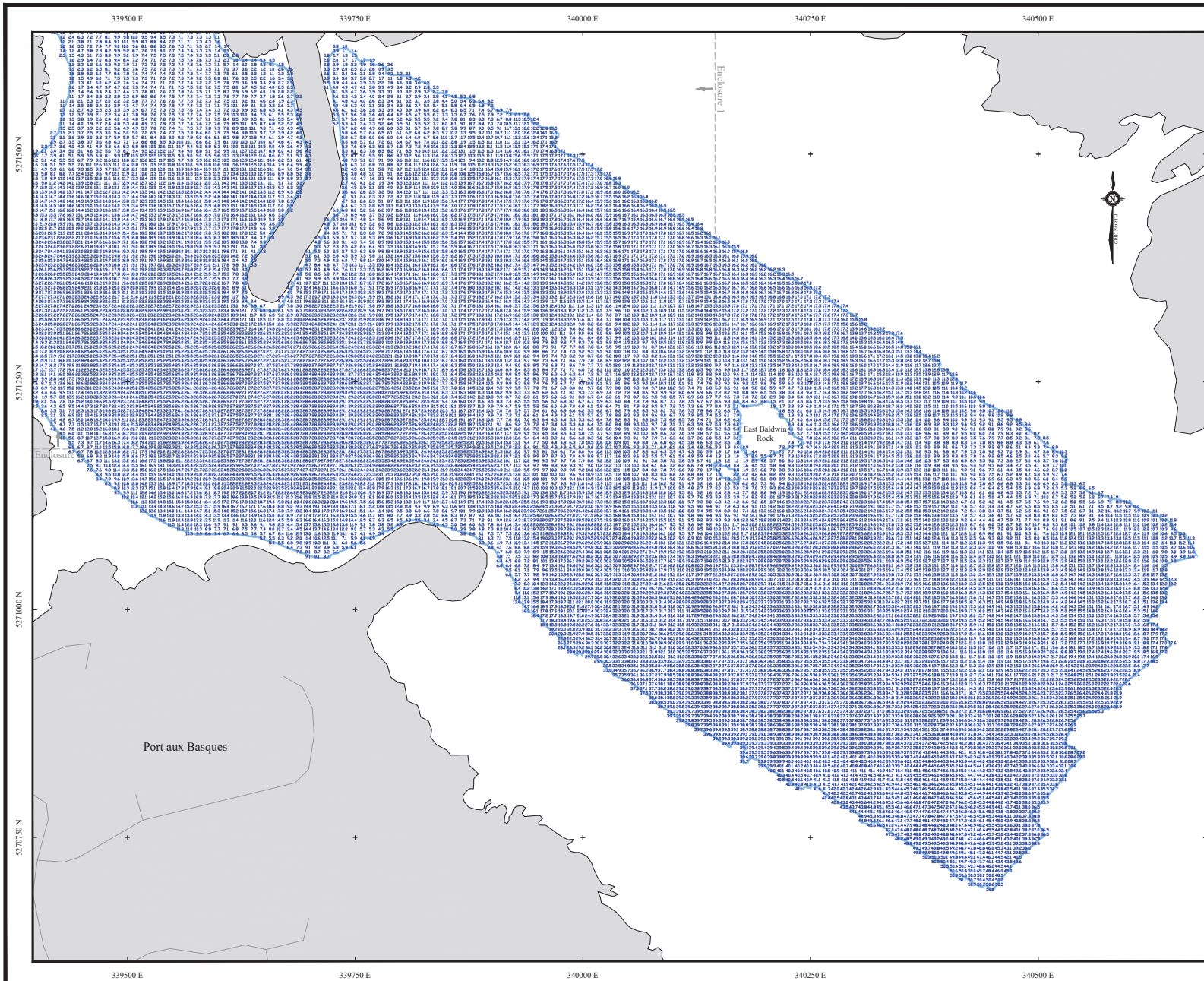
Seabed Features

GIS Layer Name	CSR1945_Dredge_Feature_Boundaries_NAD83_UTM21_20200305.shp			
Description	This GIS layer includes spatial distribution of dredge related features.			
Feature Type	Polygon			
Attribute Fields	Attribute Field Name	Description	Field Type	Value
	Feature	Description of polygon area.	Text	Dredged Area Possible Dredged Area Dredge Spoil Possible Dredge Spoil

GIS Layer Name	CSR1945_LinearFeatures_NAD83_UTM21_20200305.shp			
Description	This GIS layer includes the locations of seabed linear features.			
Feature Type	Polyline			
Attribute Fields	Attribute Field Name	Description	Field Type	Value
	Feature	Description of linear features.	Text	Intake Pipe Abandoned Pipe Dragmark

				Possible Dragmark Toe of Rubble Mound Structure Unknown Linear Feature
	Notes	Additional information of the features.	Text	

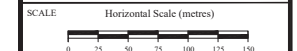
APPENDIX VI
ENCLOSURES (NOT TO SCALE)



- LEGEND**
- Shoal soundings within 5 m or 10 m (see notes)
 - Midbottom data contour
 - Adjacent exclusive boundary
 - UTM Gridline

GEOIDETIC PARAMETERS

Horizontal Datum: NAD 83 CHRS
Vertical Datum: Chart Datum
Projection: UTM Zone 21
Units: Metres



NOTES

CHRS conducted the hydrographic and geophysical survey from January 20 to January 31, 2020.

HYDROGRAPHIC SURVEY EQUIPMENT

Vessel: *Chaloupe* (R/Surveyor 200)
Vessel Operator: *Chaloupe*
Surveyor: *Chaloupe*
Positioning: *Chaloupe*
Bathymetry: *Chaloupe*
Geophysics: *Chaloupe*
Data Acquisition: *Chaloupe*
Data Processing: *Chaloupe*
Data Storage: *Chaloupe*
Data Archiving: *Chaloupe*
Data Distribution: *Chaloupe*
Data Maintenance: *Chaloupe*
Data Archiving: *Chaloupe*
Data Distribution: *Chaloupe*
Data Maintenance: *Chaloupe*

BATHYMETRY

Bathymetric data were recorded continuously along survey lines using a R/V T200 bathymetric echosounder with 120 m of cable (120 m). The depth of the water at the time of the survey was recorded with an IHO (International Hydrographic Organization) SVP. Sound velocity through the water column was acquired with an IHO SVP. The survey was conducted using CHRS digitalized survey techniques. Observed water levels were obtained for CHRS Port aux Basques Station (0001) and also acquired with a CHRS tide gauge deployed during the survey and verified for Chart datum.

The bathymetric data were post processed using CHRS HYPERBOL software and exported as a 1 m x 1 m CHRS surface file. The exported data set was imported into PAB and post-processed as a 1 m x 1 m CHRS surface file. Each cell is represented on the chart by the shallowest (deepest) sounding value within the cell. The cell content is the shallowest (deepest) value of the cell and the shallowest (deepest) value was rounded to the nearest value of 1 metre.

The hydrographic survey was conducted at the time of the survey and can only be considered as indicating the conditions at the time.

BACKGROUND

These data were obtained from <https://open.canada.ca/data/en/open>. The coastline was digitized from the Open Data Portal and is not a nautical chart.

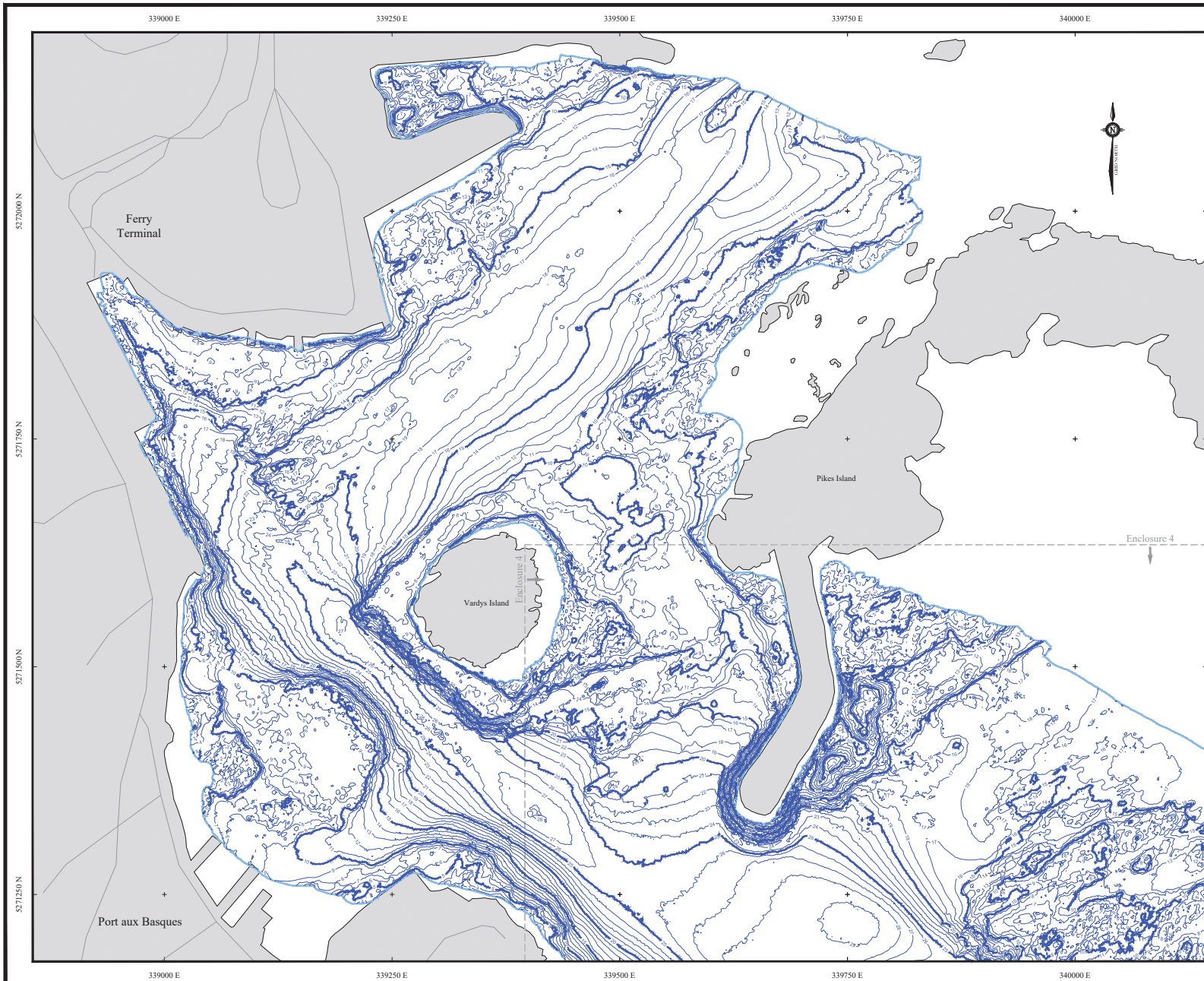
CSR GEOSURVEYS LTD.
341 MYRA ROAD, PORTER LAKES, NOVA SCOTIA
CANADA B0E 1G2
Tel: (902) 827-4200 Fax: (902) 827-2002
Email: info@csr-geosurveys.com

ENGINEERING & ENVIRONMENTAL GEOPHYSICS

PAB Vardy's Island - Navigation Improvements
Port aux Basques, Newfoundland
Bathymetric Sounding Chart (South)
Enclosure 2

REV	DATE	REVISION	BY	CHKD	APPD	STATUS
1	2020-03-20	Initial	AL	AL	AL	Final

PROJECTION: UTM Zone 21
FILE: PAB_V21_20201002.dwg



KEY MAP

LEGEND
— Bathymetric contour (1 m interval)
— Bathymetric contour (5 m interval)
— Bathymetric data contour
— Adjacent enclosure boundary
+ UTM traverse

GEODETIC PARAMETERS
Horizontal Datum: NAD 83 CHRS
Vertical Datum: Chart Datum
Projection: UTM Zone 21
Units: Metres

SCALE
Horizontal Scale (metres)
0 25 50 75 100 125 150

CLIENT

NOTES
CSR conducted the hydrographic and geophysical survey from January 20 to January 30, 2020.
HYDROGRAPHIC SURVEY EQUIPMENT
Vessel: "SeaQuest" (Boatwright 80' 240)
Survey Software: HYPACK
Hydrophone Reference: HYPACK
Positioning: Trimble 7800 RTK GPS, Realtime V530 GNSS
Motion Sensor: IMU (Class 2.5)
Heaving: IMU (Class 2.5), Sonotronics V530 GNSS
Bathymetric Echo-sounder: EK60, EK60 7° beam echosounder
Hydrophone: A&A Model 7107 and A&A HydroPro
Tide Gauge: Sola 125
Sonar Reflector: HYPACK, Zed Marine 400-10000 Hz, Applied Acoustics CSR-500, Power Supply Microcomputer with GeoPacMap MS Hydrophones

CAUTIONARY
Bathymetric data were recorded continuously along survey lines using a Realtime T200 bathymetric echosounder using 700 kHz beam echosounder at 200 Hz. The speed of sound in water at the time of the survey was recorded with an A&A Oceanographic SVP. Sound velocity through the water column was acquired with an Ocean Digital Pro. The survey was conducted using RTK GPS differential survey techniques. Observed water levels were obtained for CSR Port aux Basques Tide Station (0657) and also acquired with a CSR tide gauge deployed during the survey and verified for their datum.
The bathymetric data were post processed using CARS HYPACK software and exported as a 1 m x 1 m in CSR format. The exported data was then imported into HYPACK 7.0 and grid cells of 1 m x 1 m were established based on a kriging interpolation algorithm. Contours were generated at 1 metre intervals based on the gridded data.
The chart represents results at the time of the survey and can only be considered as indicating the conditions at that time.

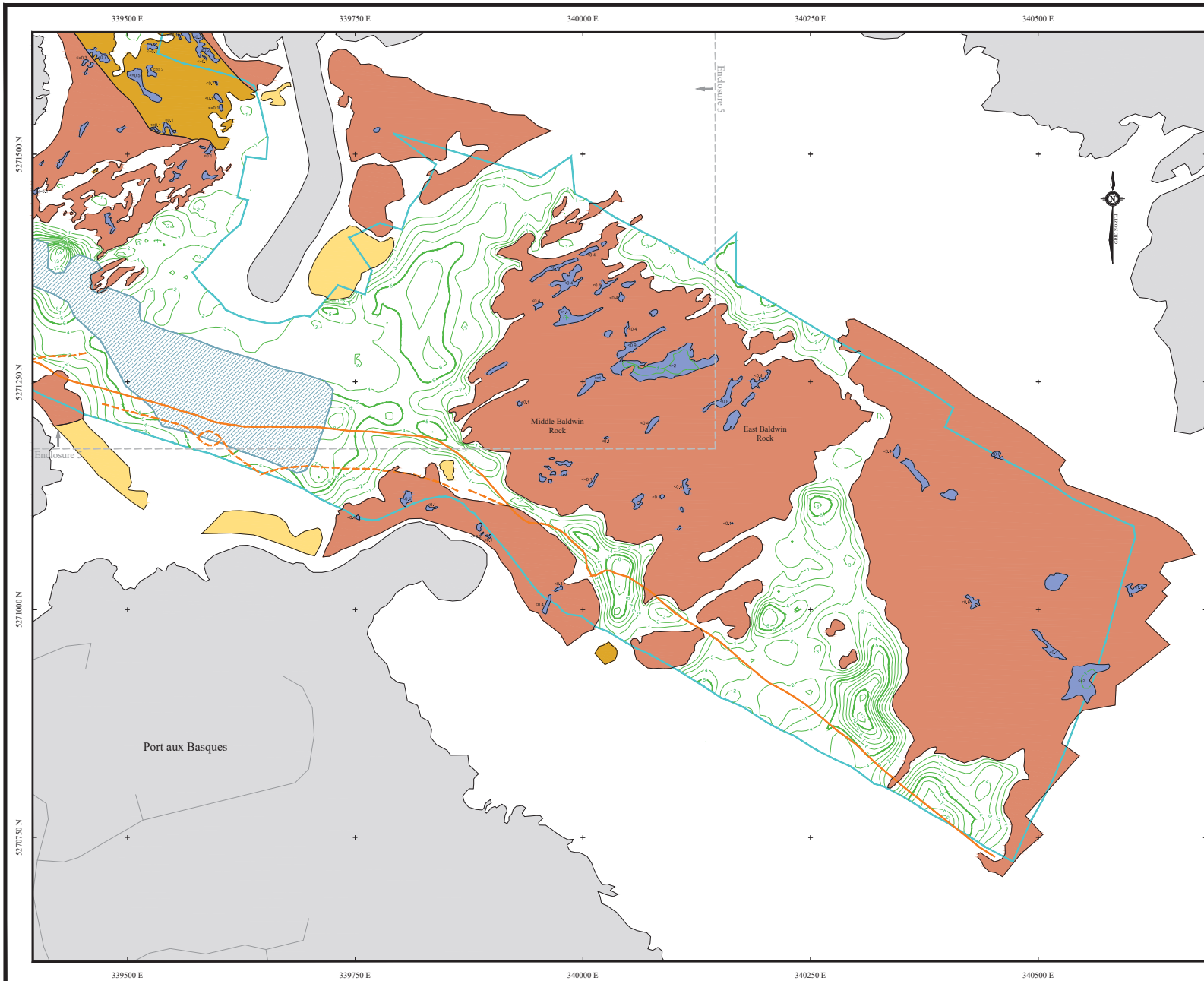
BACKGROUND
Roads were obtained from <https://maps.canada.ca/index-en.html>. The coastline was digitized from Google Earth Pro and a coastal topographic.

CSR GEOSURVEYS LTD.
341 MYRA ROAD, PORTERS LAKE, NOVA SCOTIA
CANADA B0E 1G2
Tel: (902) 827-4200 Fax: (902) 827-2002
Email: info@csr-ns.com

ENGINEERING & ENVIRONMENTAL GEOPHYSICS
PAB Vardy's Island – Navigation Improvements
Port aux Basques, Newfoundland
Bathymetric Contour Chart (North)
Enclosure 3

REV	DATE	REVISION	BY	APPROVED BY	COMPLETED	CHECKED BY
1	2020-01-30	ISSUED	AS	AS	AS	AS
2	2020-02-03	REVISED	AS	AS	AS	AS

CSR PROJECT # 15057
PROJECTION: UTM Zone 21
FILE: 1945-DE-2020-106.dwg



KEY MAP

LEGEND

- Sediment thickness isopach (2 m interval)
- Sediment thickness isopach (2 m interval)
- Sub-bottom data contour
- Pipeline tracks
- Abandoned Pipe
- Adjacent enclosure boundary
- UTM traverse
- Bathack at seabed (may include sediment patches)
- Bathack with local sediment contour (generally <10m)
- Bathack / Bathack at seabed with local sediment contour
- Unidentified sediment thickness (bathack where data is available)
- Area of no visible acoustic basement reflections

GEODETIC PARAMETERS

Horizontal Datum	NAD 83 CHRS	Projection	UTM Zone 21
Vertical Datum	Chart Datum	Units	Meters

SCALE

Horizontal Scale (metres)

CLIENT

NOTES

CSR conducted the hydrographic and geophysical survey from January 20 to January 30, 2020.

HYDROGRAPHIC SURVEY EQUIPMENT

Vessel	SeaQuest (Boothby 80' 240')
Survey Software	Hydroware
Hydrographic Software	Hydroware
Positioning	Trimble 7700 RTK GPS, Realtime V530 GNSS
Water Sensor	HOBO Ocean 2.5
Heading	HOBO Ocean 2.5, Sonotek V530 GNSS
Water Temperature	HOBO Ocean 2.5, V530 and Ocean Pro
Salinity	HOBO Ocean 2.5, V530 and Ocean Pro
Water Depth	HOBO Ocean 2.5, V530 and Ocean Pro
Water Reflection	HOBO Ocean 2.5, V530 and Ocean Pro

PROCESSING AND INTERPRETATION

Sub-bottom data were recorded along survey lines throughout the survey site using an EG&G 240 Benthos system.

The Benthos data were post-processed using Coda Survey 6.2 software. The acoustic basement (unprocessed top of bathack) was mapped using a sedimentary model velocity of 1500 m/s and the sediment thickness data acoustic basement was the result.

The expected data was imported into bathack 17 and grid cells of 5 m x 5 m were established based on a 100m interpolation algorithm. Sediment thickness isopach were generated at 1 metre intervals based on the gridded data.

The area of no visible acoustic basement reflections was caused by the increased penetration of the sediments, mostly due to the coarse nature of the underlying sediment.

Bathack bathack area and pipe locations were interpreted from multibeam water data along with areas of unidentified sediment within the bathack bathack area. Sediment thickness of these areas were determined from the sub-bottom data and manual diver probe where available. Probe position and sediment thickness were obtained from CHRS.

This chart represents results at the time of the survey and can only be considered as indicating the conditions at that time. Geophysical surveying is a science using methods that may not detect all surface or sub-surface features of interest or concern.

BACKGROUND

Work was obtained from <https://maps.google.com/maps/@52.715, -52.715, 15z>. The coastline was digitized from Google Earth Pro and is considered approximate.

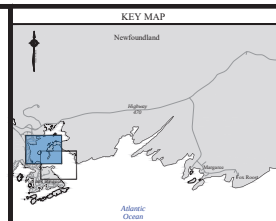
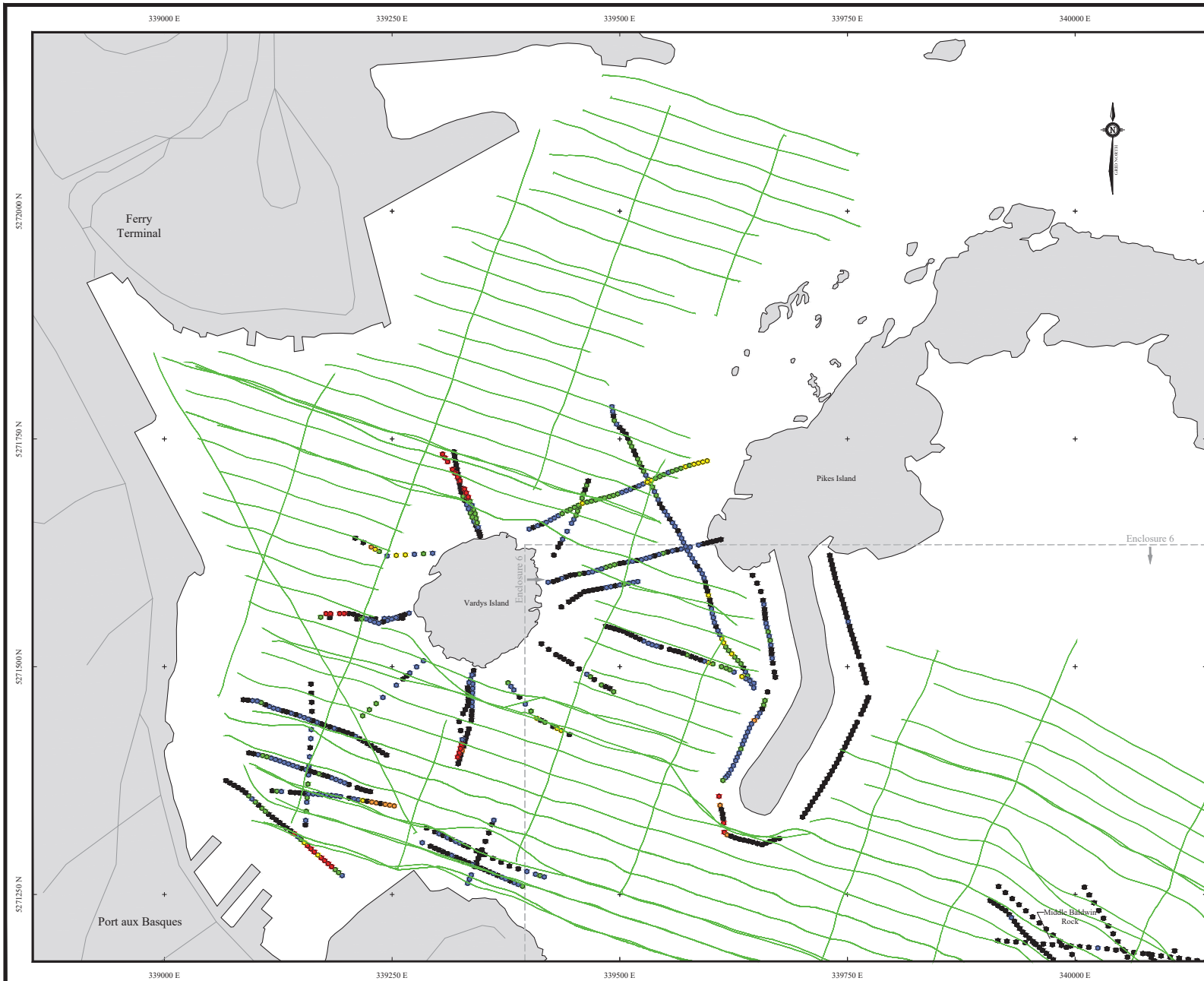
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341 MYRA ROAD, PORTERS LAKE, NOVA SCOTIA
CANADA B0E 1G2
Tel: (902) 827-4200 Fax: (902) 827-2002
Email: info@csr-surveys.com

ENGINEERING & ENVIRONMENTAL GEOPHYSICS

PAB Vardy's Island - Navigation Improvements
Surficial Bedrock Geology & Acoustic Basement Isopach Map (South)
Enclosure 6

DATE	REVISION	BY	CHKD	DATE
2020-10-20	001	AL	AL	2020-10-20
2020-10-20	002	AL	AL	2020-10-20
2020-10-20	003	AL	AL	2020-10-20

PRODUCTION: UTM Zone 21
FILE: 1945 AD 2020 196.dwg
CSR PROJECT # 1945

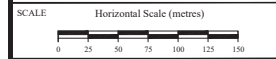


LEGEND

Sub-bottom trackline	Manual Drive Probe Location (colour-coded according to return depth)
Adjustment enclosure boundary	0 m to 0.25 m
UTM Gridline	0.25 m to 0.50 m
	0.50 m to 0.75 m
	0.75 m to 1.00 m
	> 1.00 m

GEODETIC PARAMETERS

Horizontal Datum	NAD 83 CHS	Projection	UTM Zone 21
Vertical Datum	Chart Datum	Units	Metres



NOTES

CSR conducted the hydrographic and geophysical survey from January 20 to January 30, 2020.

HYDROGRAPHIC SURVEY EQUIPMENT

Vessel	SeaQuest (Boothby 80' 240')
Survey Software	Hydroware
Hydrographic Software	Hydroware
Positioning	Trimble 7700 RTK GPS, Realtime V530 GNSS
Water Sensor	HOBO Ocean 2.0
Heading	HOBO Ocean 2.0, Sonotek V530 GNSS
Waterline Elevation	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Temperature	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Conductivity	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Salinity	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Density	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Pressure	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Depth	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Current	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Velocity	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Direction	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Turbidity	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Chlorophyll	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Dissolved Oxygen	HOBO Ocean 2.0, Sonotek V530 GNSS
Water pH	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Ammonia	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Nitrate	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Silica	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Phosphorus	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Nitrogen	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Suspended Solids	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Dissolved Solids	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Solids	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Organic Carbon	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Organic Nitrogen	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Organic Phosphorus	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Organic Solids	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Carbon	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Nitrogen	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Phosphorus	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Solids	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Carbon	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Nitrogen	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Phosphorus	HOBO Ocean 2.0, Sonotek V530 GNSS
Water Total Inorganic Solids	HOBO Ocean 2.0, Sonotek V530 GNSS

Sub-bottom data were recorded along survey lines throughout the survey site using an EG&G 240 Benthos system. The tracklines on this map represent the survey vessel's track during the collection of the sub-bottom data.

The position and sediment thickness of the manual drive probes displayed on this map were obtained from CHS.

BACKGROUND

Reefs were obtained from <https://map.earth.com/index-en.html>. The coastline was digitized from Google Earth Pro and is a generalized approximation.

CSR GEOSURVEYS LTD.
341 MYRA ROAD, PORTERS LAKE, NOVA SCOTIA
CANADA B0E 1G2
Tel: (902) 827-4200 Fax: (902) 827-2002
Email: info@csr-surveys.com

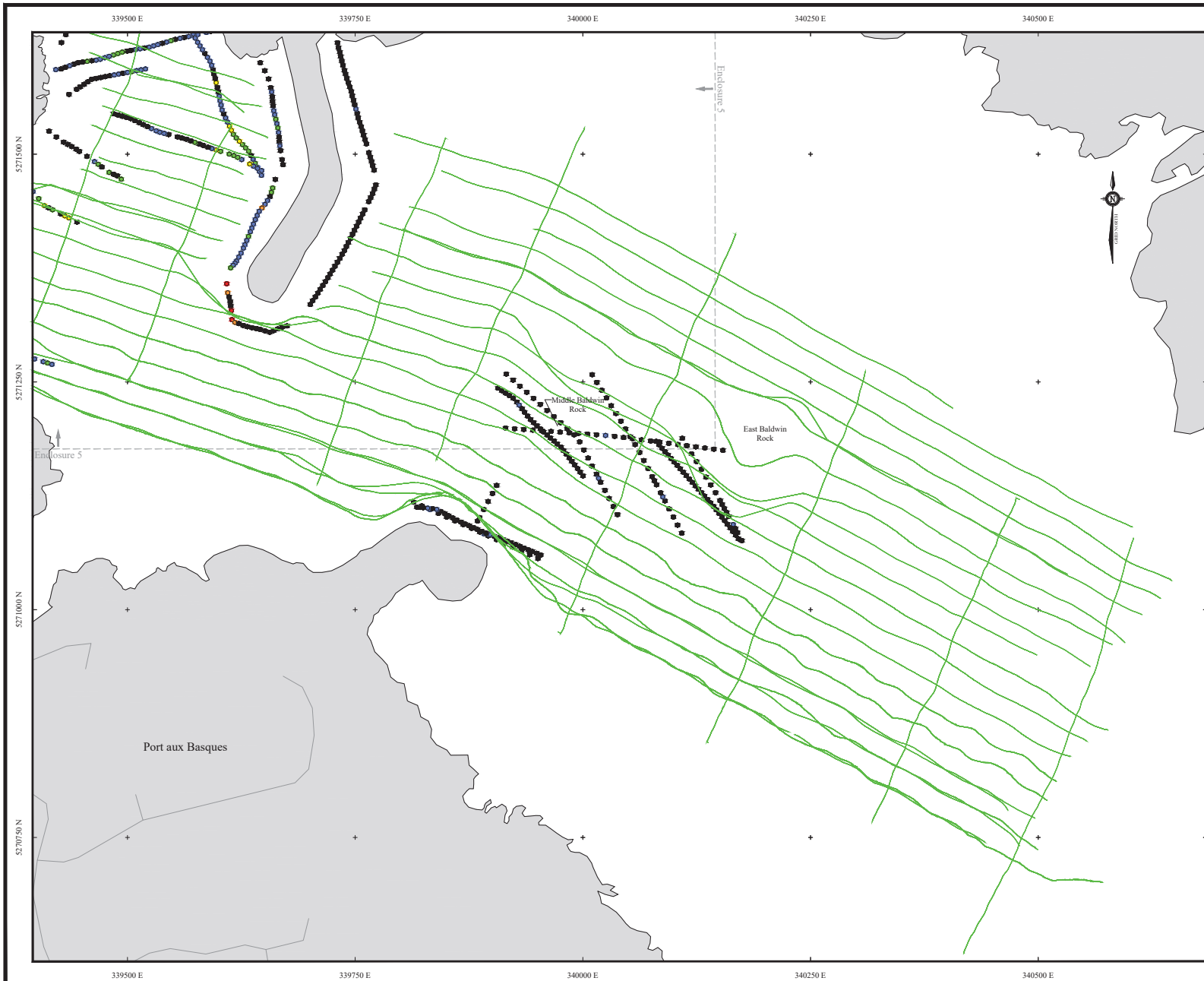
ENGINEERING & ENVIRONMENTAL GEOPHYSICS

PAB Vardys Island - Navigation Improvements
Port aux Basques, Newfoundland
Sub-bottom Trackline and Probe Location Map (North)

Enclosure 7

REV	DATE	REVISION	APPROVED BY	COMPLETED BY	CHECKED BY
1	2020-01-20	ISSUED	CSR	CSR	CSR
2	2020-01-20	REVISED	CSR	CSR	CSR
3	2020-01-20	REVISED	CSR	CSR	CSR
4	2020-01-20	REVISED	CSR	CSR	CSR
5	2020-01-20	REVISED	CSR	CSR	CSR
6	2020-01-20	REVISED	CSR	CSR	CSR
7	2020-01-20	REVISED	CSR	CSR	CSR
8	2020-01-20	REVISED	CSR	CSR	CSR
9	2020-01-20	REVISED	CSR	CSR	CSR
10	2020-01-20	REVISED	CSR	CSR	CSR

CSR PROJECT # 15047 PROJECTION: UTM Zone 21
FILE: 1945_15_2020_106.dwg



KEY MAP

LEGEND
Sub-bottom trackline
Manual Driver Probe Location (colored symbol according to water depth)
UTM coordinates
Enclosure boundary
UTM coordinates

GEODETIC PARAMETERS
Horizontal Datum: NAD 83 CHRS
Vertical Datum: Chart Datum
Projection: UTM Zone 21
Units: Metres

SCALE
Horizontal Scale (metres)
0 25 50 75 100 125 150

CLIENT

NOTES
CSR conducted the hydrographic and geophysical survey from January 20 to January 30, 2020.
HYDROGRAPHIC SURVEY EQUIPMENT
Vessel: SeaQuest (Boothby 80' 240)
Survey Software: HYPACK
Position Reference: GPS
Positioning: Trimble R100 RTK GPS, Realtime V530 GNSS
Motion Sensor: IMU (Coda Octopus)
Heading: IMU (Coda Octopus)
Water Depth: Echosounders: EK60 (1200 kHz) and EK60 (700 kHz)
Data Collection: EG&G Zodi Benthos (400-1000 Hz), Applied Acoustics CSF-500, Plover Supply/Motionmaster with GeoPacSystem M3 Hydrophones
Sub-bottom data were recorded along survey lines throughout the survey site using an EG&G 240 Benthos system. The tracklines on this map represent the survey vessel's track during the collection of the sub-bottom data.
The positions and sediment thickness of the manual driver probes displayed on this map were obtained from CSR.

BACKGROUND
Roads were obtained from <https://map.ontario.ca/index-en.html>. The coastline was digitized from Google Earth Pro and is a visual approximation.

CSR GEOSURVEYS LTD.
341 MYRA ROAD, PORTERS LAKE, NOVA SCOTIA
CANADA B9T 1G2
Tel: (902) 827-4200 Fax: (902) 827-2002
Email: info@csr-surveys.com

ENGINEERING & ENVIRONMENTAL GEOPHYSICS
PAB Vardy's Island - Navigation Improvements
Port aux Basques, Newfoundland
Sub-bottom Trackline and Probe Location Map (South)
Enclosure 8

REV	DATE	REVISION	APPROVED BY	DATE	CHECKED BY
1	2020-01-20	ISSUED	AL	2020-01-20	AL
2	2020-01-20	REVISED	AL	2020-01-20	AL

CSR PROJECT # 15047
PROJECTION: UTM Zone 21
FILE: 1945_PAB_2020106.dwg