MCCOI MARINE LTD.
Hydrographic Surveying & Marine Contracting

Vancouver BC, Pipeline Surveys

1. INTRODUCTION

1.1. About MCCOI

MCCOI Marine Ltd. is a survey company that specializes in hydrographic surveying, construction surveying and project management in the marine construction and dredging industry. The company was incorporated in 2012 and the principle C. Matthew Fawcus AScT, RSIS has been working in the survey and marine construction industry for over 20 years.

1.2. Survey Overview

Survey operations were conducted April 2 & 3 2016 aboard MOCCI Marine owned vessel Tomm 1 utilizing a Norbit iWBMS integrated multibeam sonar system with Applanix Wavemaster. The survey of the Iona pipeline was conducted on April 3 and the Belcarra pipeline was conducted on April 2. A 900m long section of the Iona pipeline was surveyed, from 20m to 111m water depth, and is located to the west of the Vancouver International Airport. The Belcarra pipeline was surveyed shore to shore between the towns of Belcarra and Deep Cove in water depths ranging from 3m to 50m.

1.3. Survey Locations

1.3.1. Iona Pipeline

The Iona pipeline is located at Sturgeon Bank between the mouth of the North Arm and Middle Arm of the Fraser River near Vancouver International Airport. It is owned and operated by the GVRD and is the main outfall pipe for treated sewer and storm water from the greater Vancouver area. Water depths for the pipeline range from 9 to 111 meters.

1. Location of Iona pipeline, West of Vancouver International Airport

1.3.2. Belcarra Pipeline

The Belcarra pipeline is a twin 200mm HDPE system that was installed in 2011 to supply additional fresh water to the town of Belcarra from the North Vancouver water supply. It is located in the southern end of the Indian Arm which is a body of water running north out of Vancouver Harbor. The pipeline runs from Cove Cliff in Deep Cove, and terminates south of Belcarra Bay in the town of Belcarra .The survey was run from a depth of 1m to 50m covering over 98% of the submerged pipeline.

2. Location of Belcarra pipeline, between towns of Belcarra and Deep Cove

2. SURVEY SYSTEM

2.1. Sonar and Inertial Navigation system.

The survey was conducted utilizing a Norbit iWBMS system. The small size and the tightly integrated Applanix Wavemaster of the iWBMS facilitates rapid mobilization on vessels of any size making it ideal for rapid deployments. In conjunction with the small size the wide swath angle (maximum 210°) allows for the flexibility to rapidly switch from a pipeline inspection survey to a beach or pier survey without the need to change the sonar mounting, meaning offsets and patch test values remain constant.

During this survey the WBMS was mounted on the starboard side of the TOMM 1 with a draft of 0.619m. The pole was secured at the top of the gunnel and close to the waterline. The inertial navigation system is tightly integrated with the sonar. The IMU is inside the forward fairing on the sonar and has a static

offset to the sonar reference point. The GNSS antennas are mounted on the cabin roof inline and above the keel of the vessel.

The system was provided RTK correctors utilizing a VRS service provided by CAN-NET. RTK correctors were provided directly to the Norbit topside unit via USB to serial connection.

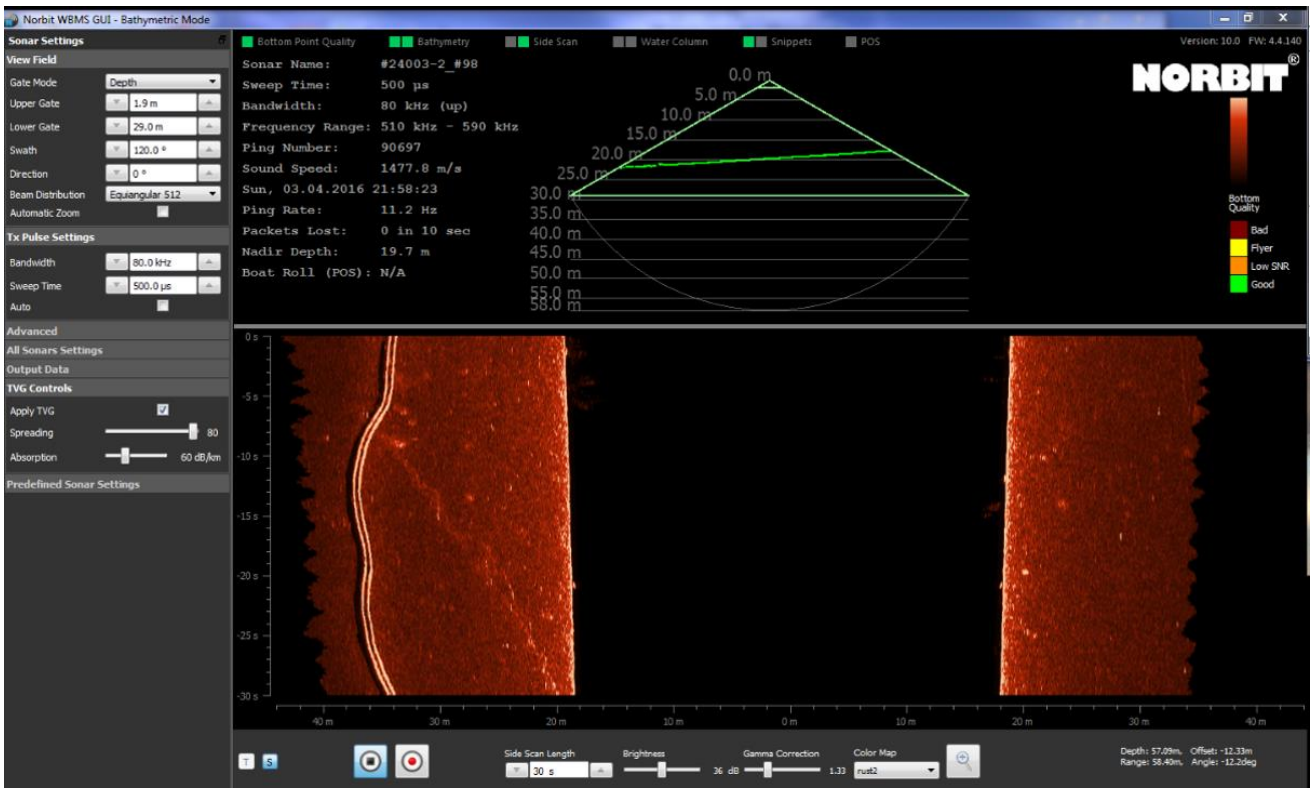
2.2. Survey Software and Firmware

Hypack 2016 was utilized for data acquisition and processing. This survey utilized the recently released version 10 of the Norbit sonar firmware. The Applanix POSMv was utilizing firmware 8.15.

3. DATA ACQUISITION

For the two pipelines surveyed a general bathymetry survey, utilizing the Norbit's wide swath capabilities, was first conducted. This allowed for the fast location of the pipeline and allowed for any potential threats to the pipeline, not directly in the pipeline corridor, to be identified.

After the area surrounding the pipelines was surveyed a higher resolution inspection survey was conducted directly over the pipeline. During this, the high frequency options (550 &700kHz) in conjunction



3. Parallel 20cm diameter pipeline clearly visible in the high resolution sidescan at 550kHz

with inspect mode were used to provide the very highest resolution facilitating through and accurate results.

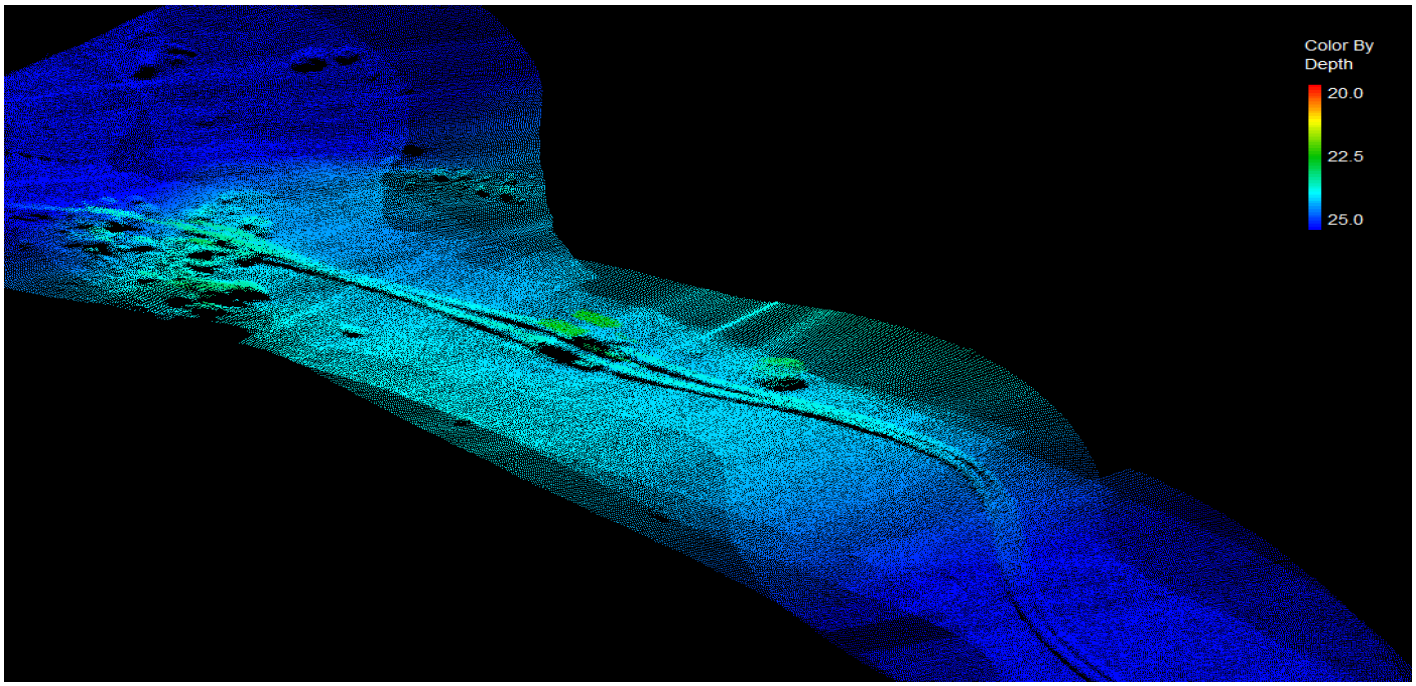
During inspection high resolution sidescan of the WBMS was able to clearly show the small pipeline (20cm in diameter) facilitating rapid identification and inspection

4. RESULTS

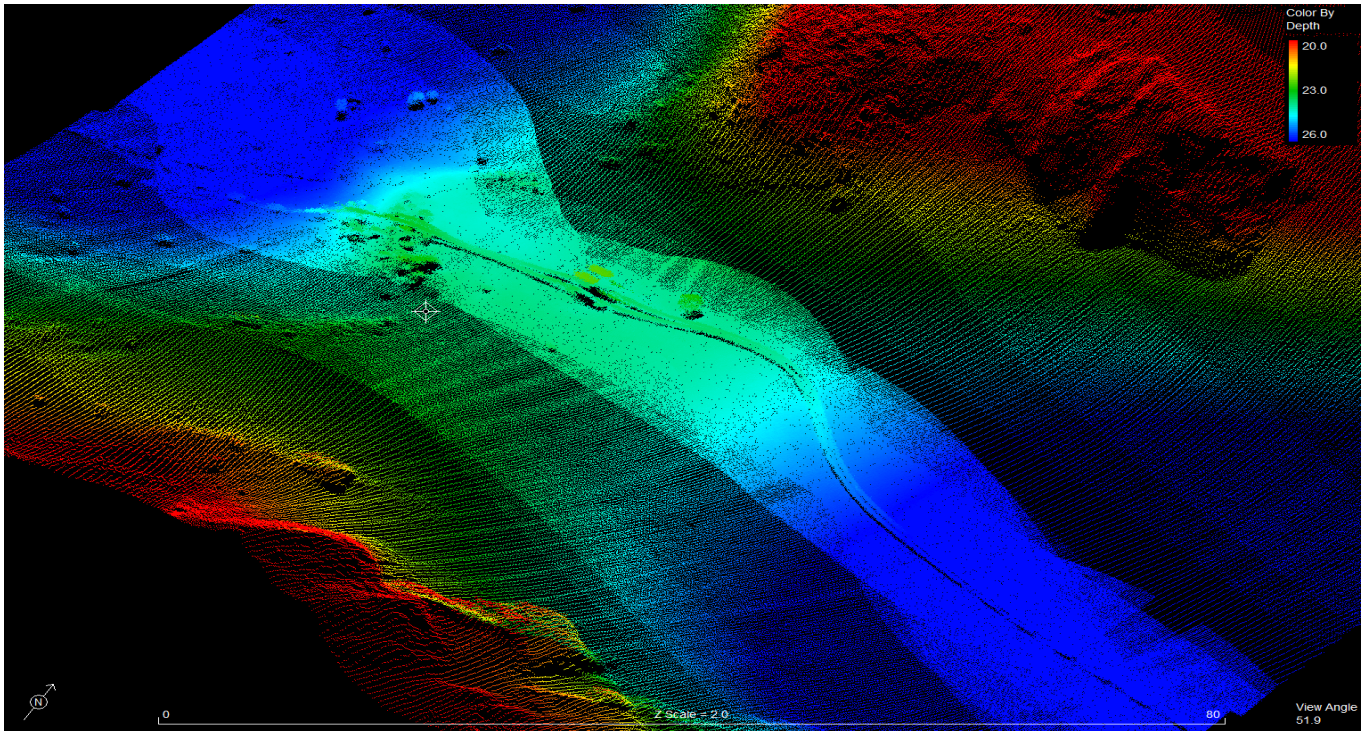
The following sections outline any issues that were found during the course of the survey. All images presented in the following section were generates using Hypack 2016.

4.1. Belcarra Pipeline

Inspect mode on the WBMS was utilized directly over the pipeline creating a detailed scan. This allows the system to be utilized in normal bathymetry mode, with wide swath, to locate the pipeline and switch to high resolution inspect mode for the critical part of the survey.

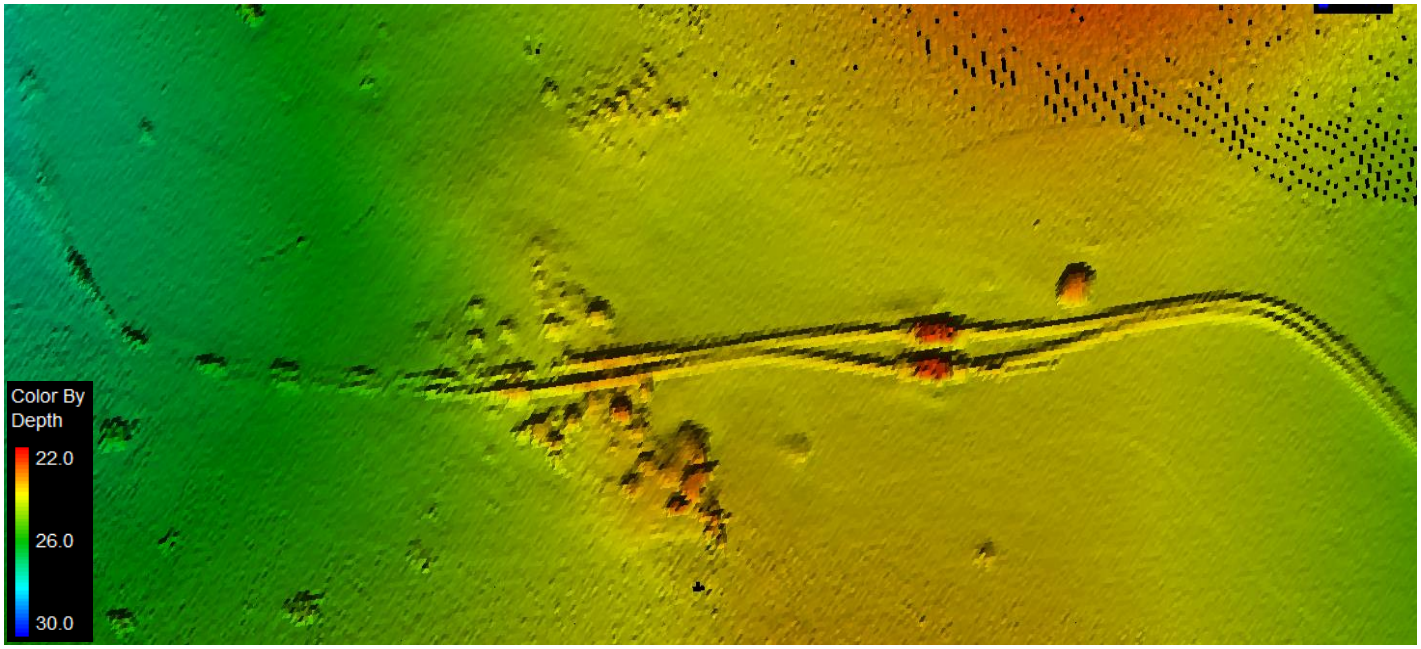


4. Inspect mode bathymetry utilized directly over the pipeline demonstrating attainable high resolution

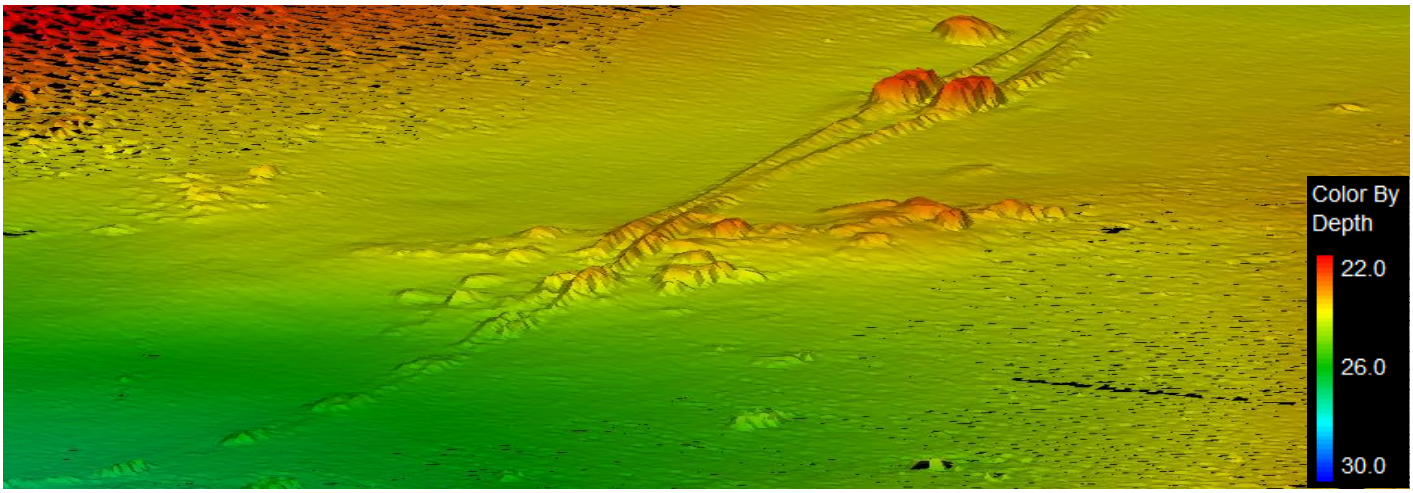


5.Point cloud of lower resolution general bathymetry integrated with high resolution pipeline inspection

The high resolution data along the pipeline corridore allows for the generation of a high resolution grid to be generated along the piipeline at all water depths. This is shown in the following images taken along the Belcarra pipeline. In downstream processing the higher resolution data can be gridded at a fine resolution while the general bathymetry can be grided at a coarser resolution. These two data sets can be merged to create a seamless product.

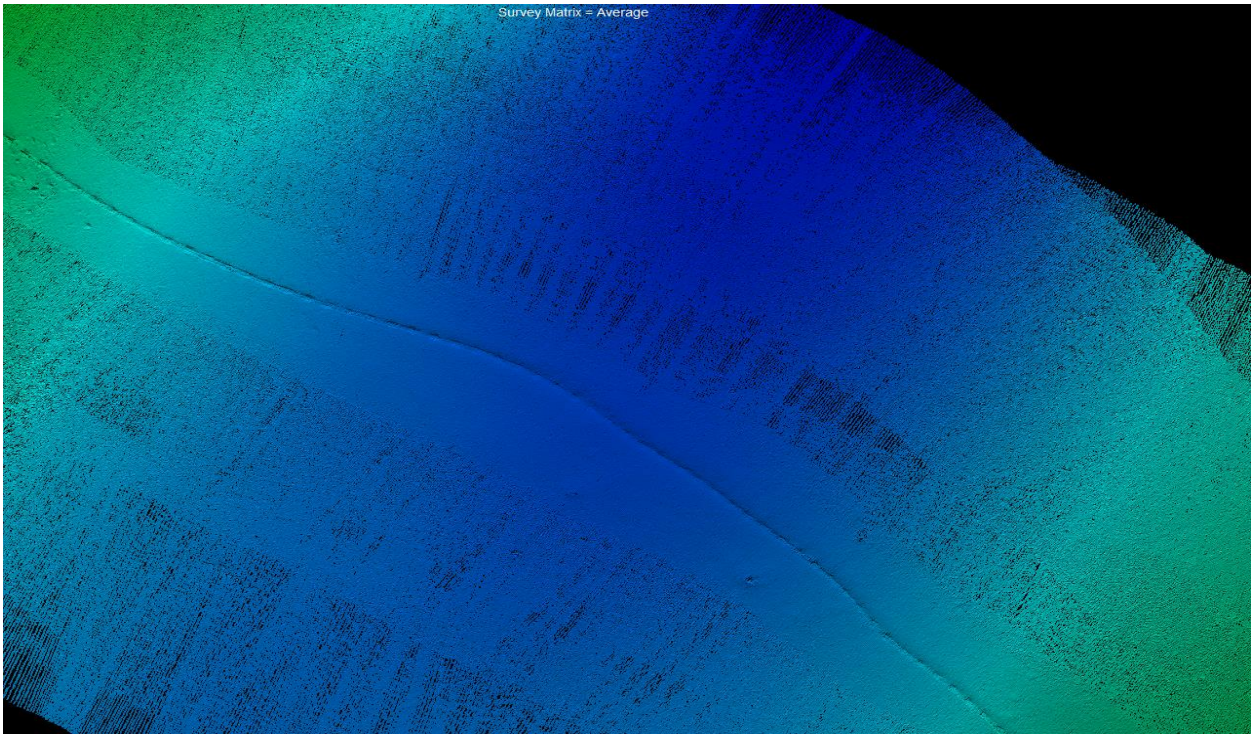


6. 20cm surface with high resolution pipeline inspection integrated with low resolution general bathymetry outside of the pipeline corridor.



7.20cm surface with combined high resolution inspection and general bathymetry data

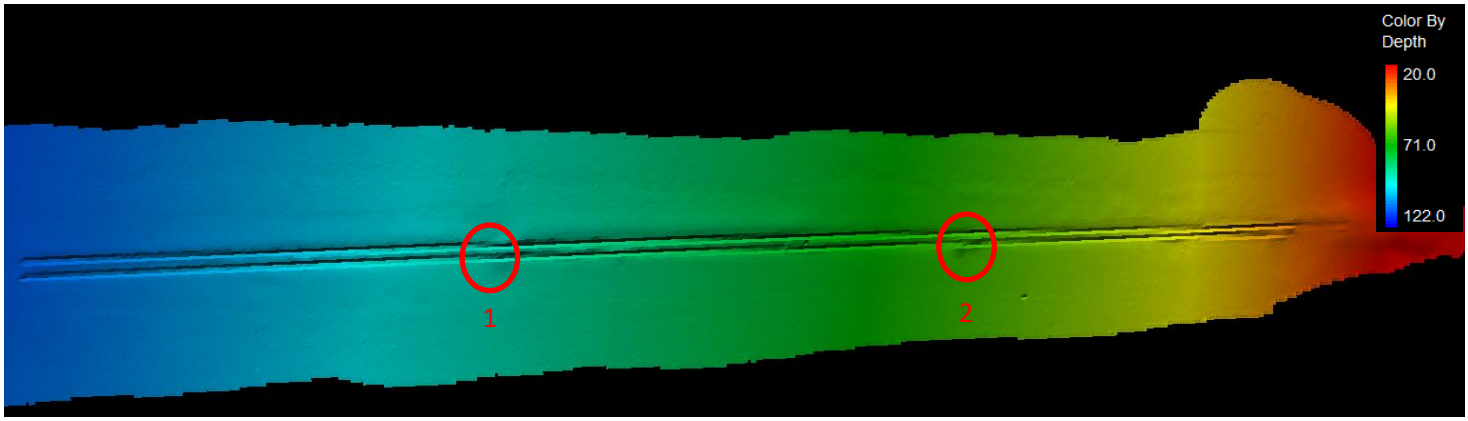
When a few passes are made over the pipeline utilizing inspection mode, a high resolution surface is still passable even in 50m water depth. This greatly increases the ability to conduct a thorough inspection throughout the iWBMS depth range.



8. 20cm surface, in 50m water depth, showing high resolution data over the pipeline and general bathymetry in the outlying area

4.2. Iona Pipeline

900m of the Iona pipeline were surveyed. The water depths for the pipeline ranged from 20m to 111m. The same survey technique was utilized on the Iona pipeline survey as was used on the Belcarra survey. Utilizing a 120° swath angle, the bathymetry surrounding the pipeline was surveyed. Once the exact location of the pipeline was identified, the WBMS mode was switched to inspect.



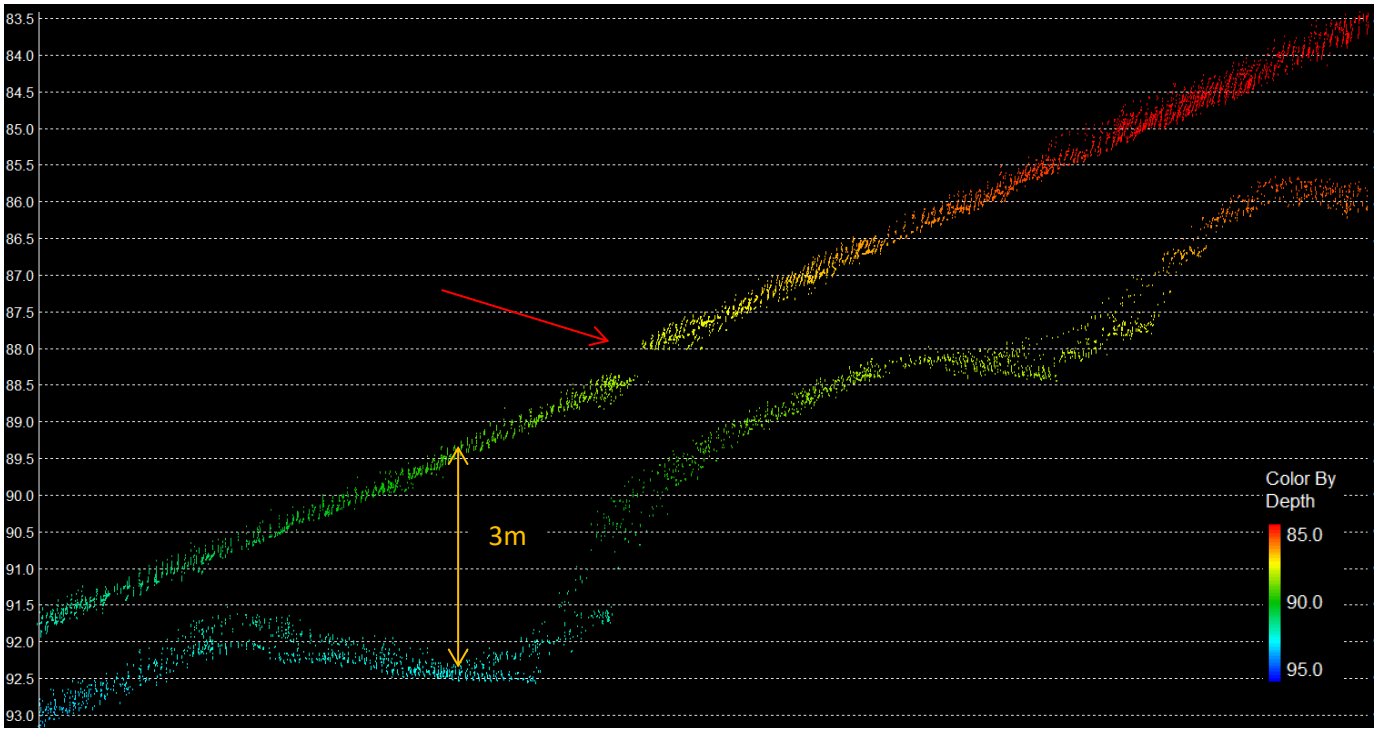
9. Full extent of the Iona pipeline. 900m from exposure to termination. Potential problem areas identified are circled in red.

The Norbit iWBMS was able preform the full inspection of the Iona pipeline without any issues, from its exposure on the sea floor (20m water depth) to its termination (111m water depth). The parallel pipelines remained clearly identifiable.

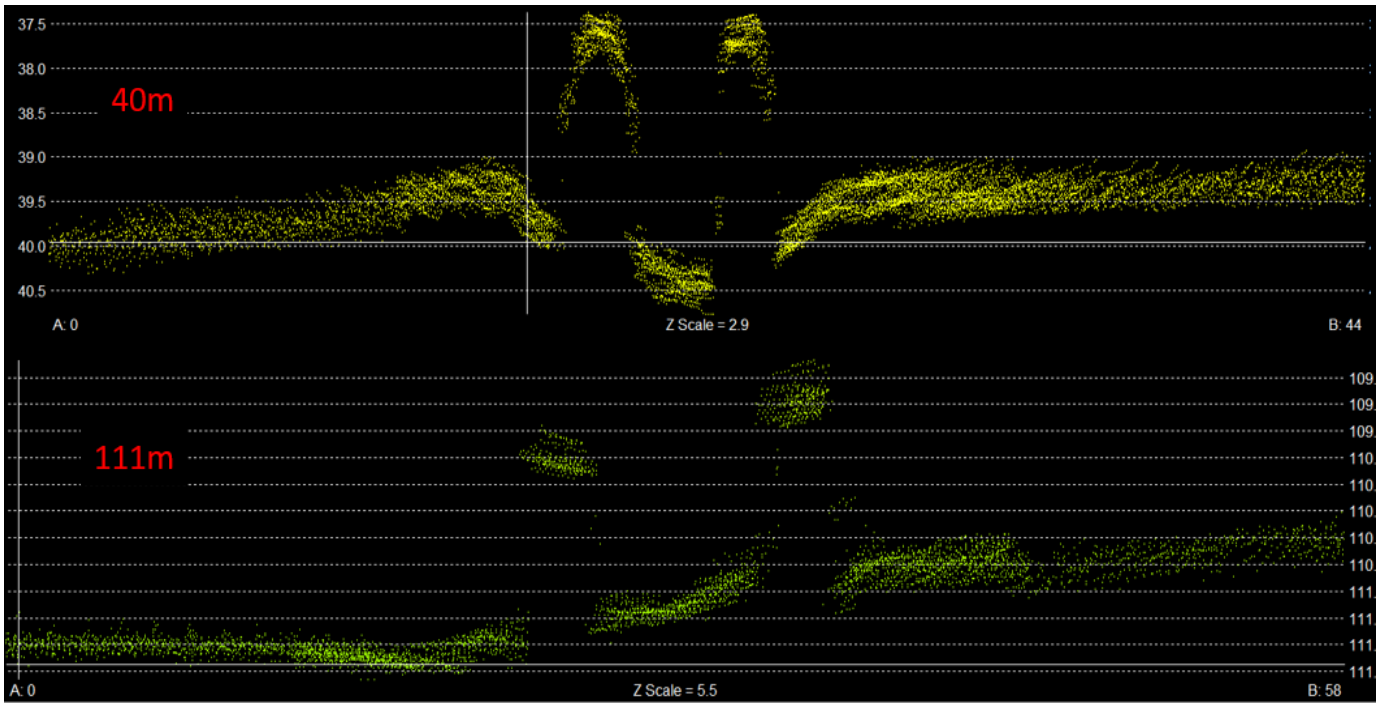
4.2.1. Iona Pipeline Findings

The survey identified two possible areas of concern on the southern pipe. Evidence suggest that there may be damage to the pipe that is resulting in localized scour underneath the pipe. These areas of concern were reported to responsible parties for further investigation.

At approximately 90m water depth (area 1 circled in figure 8) a large scour area is present and is up to 3m deep. There is also indication in the bathymetry that the pipe may be separated at this site allowing all contents to flow out of the break.

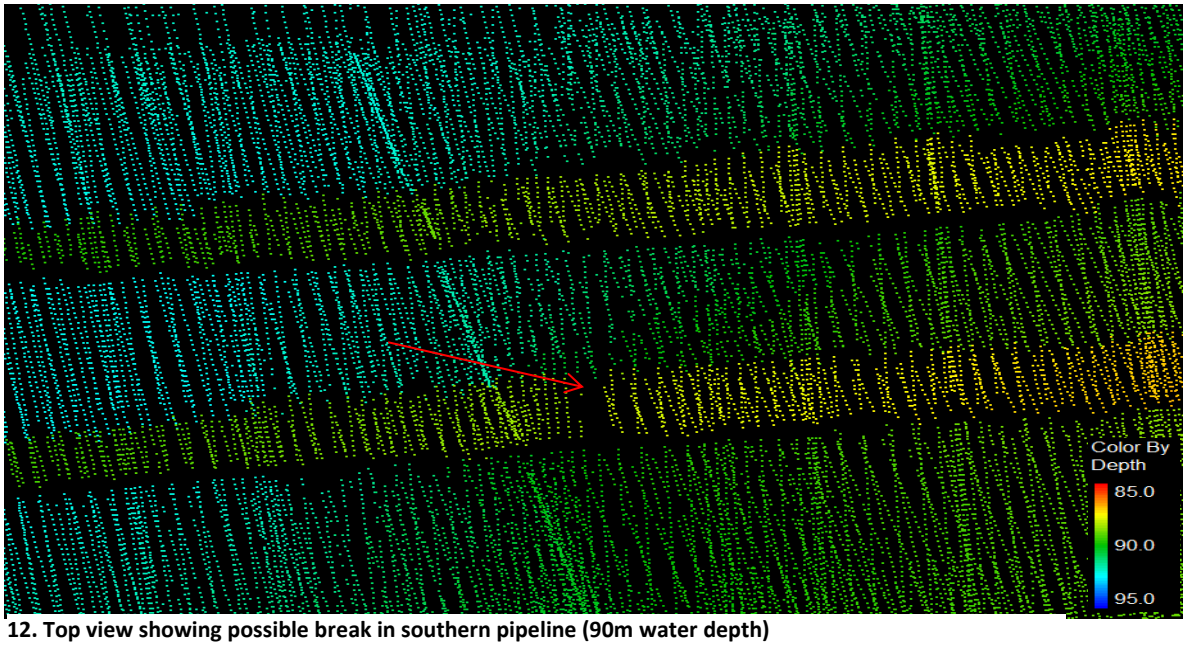


10. Cross sections of the pipelines at 40 and 111 meters. Pipe curvature is visible at 40m. At 111m pipe diameter is still measurable



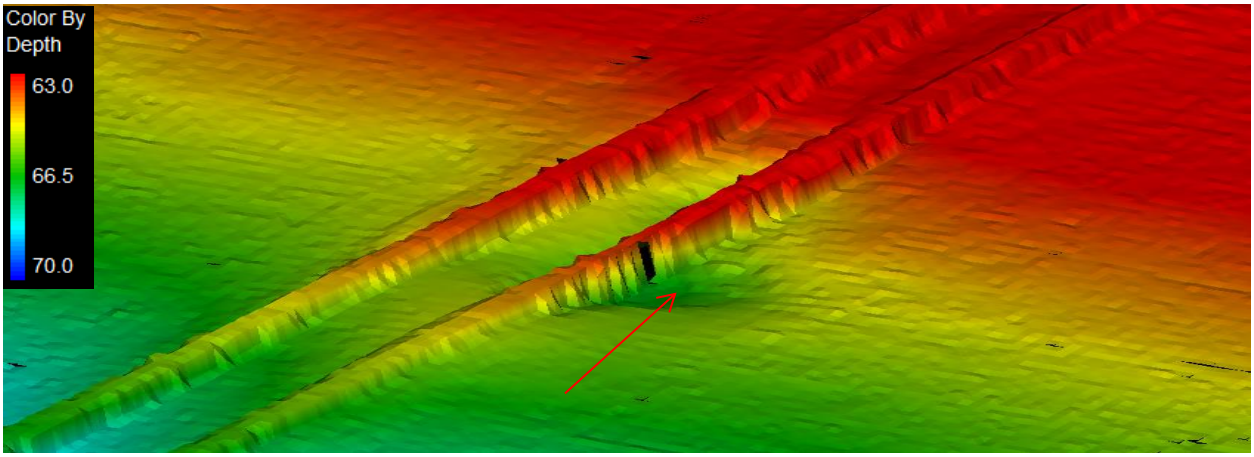
11. Cross section, in 90m water depth, of the southern pipe showing a potential break (red arrow) and possible resulting 3m deep scour.

The potential break also appears to be evident when viewed from above. The break is approximately 2m wide



12. Top view showing possible break in southern pipeline (90m water depth)

In approximately 60m of water depth (area 2 circled in figure 8) a scour hole was identified forming under the southern pipe. This is a possible indication of damage, as uncontained outfall material may be creating the highly localized scour.



13. 50cm surface showing a scour hole forming under southern pipe, indicated by red arrow, in 60m water depth. This may be the result of damage to the pipeline.

5. CONCLUSION

With its small compact form factor, tightly integrated INS system, and selectable frequencies (200, 400, 550 & 700 kHz) the Norbit proved to be the ideal system to conduct a short notice pipeline inspection. Unlike other systems on the market today the iWBMS successfully integrates the sonar, sound velocity probe and IMU into a single cable system that connects to a single compact topside box. This not only allows for easy transport in the single required case but also greatly simplifies setup as only a single offset is required (sonar reference point to primary antenna). This allows the iWBMS to be easily setup on any vessel of opportunity with minimal mobilization time required.

During the course of this survey the iWBMS was able to be successfully utilized to survey and inspect pipelines in 3 to 111 meters of water. Not only were the pipelines easily detected but potential problems were detected in deeper water depths of 60 and 90 meters. The Norbit iWBMS is perfectly equipped to carry out a wide variety of inspection duties and allows the surveyor increased flexibility in successfully completing the survey.