2015 GEOTECHNICAL SITE INSPECTION REPORT
NUNAVUT WATER BOARD LICENCE No. 2AM-DOH1323
DORIS NORTH PROJECT
HOPE BAY, NUNAVUT

Submitted to:

Water Resources Regional Coordinator, Nunavut Region
Aboriginal Affairs and Northern Development Canada
Nunavut Regional Office

Submitted by:

Amec Foster Wheeler Environment & Infrastructure
a Division of Amec Foster Wheeler Americas Limited
Dartmouth, Nova Scotia

December 2015

TV154011

December 15, 2015

TV154011

Aboriginal Affairs and Northern Development Canada
Nunavut Regional Office
Building 918, P.O. Box 100
Iqaluit, NU X0A 0H0

Mr. David Abernethy
Water Resources Regional Coordinator, Nunavut Region

Re: Nunavut Water Board Licence No. 2AM-DOH1323
2015 Geotechnical Site Inspection Report
Doris North Project, Hope Bay, Nunavut

We are submitting this report that describes the results of a Geotechnical Inspection of the site features at the Doris North Project in the Kitikmeot Region, Nunavut.

Please contact the undersigned with any questions or comments.

Sincerely,

Amec Foster Wheeler Environment & Infrastructure,
a Division of Amec Foster Wheeler Americas Limited

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EXECUTIVE SUMMARY

Amec Foster Wheeler Environment & Infrastructure, a division of Amec Foster Wheeler America's Limited (Amec Foster Wheeler), has undertaken a Geotechnical Site Inspection at the Doris North Project in the Kitikmeot Region, Nunavut.

Based on the results of this site inspection, a series of recommendations have been made based on the current status of the site, which is Care and Maintenance, although production is expected to commence in late 2016 or early 2017. This report summarizes the results of the site inspection.

Three priority levels, High, Medium, or Low, are associated with each recommendation and are explained in the following table.

Priority Level	Definition	Timeframe for Implementation
High (H)	Refers to items/issues that should be implemented before the mine site enters production, or before the area is put back into use.	Should be implemented within 0 - 1 year.
Medium (M)	Refers to items/issues that do not necessarily pose an immediate threat to operations, stability or environmental or health and safety, however, if the item is not addressed in a timely manner, additional deterioration of the situation is anticipated. Delays in addressing the issue may lead to increased costs or an increased likelihood of potential issues in the future.	Should be implemented within 1 - 3 year.
Low (L)	Refers to items/issues that are generally flagged that can be dealt with standard care and maintenance undertaken at the Site.	No timeline.

The recommendations with associated priorities are summarized in the table on the following pages.

Summary of Recommendations for 2015 Geotechnical Inspection

Priority	Area	2015 Recommendations
L	Roberts Bay Jetty	The thermistors should be monitored in accordance with the recommended schedule. The recommendations with respect to staff inspections and repairs, and staff operational awareness, as well as settlement monitoring made by PND Engineers Canada Inc. (PND) should be implemented (PND 2013).
L	Shoreline Laydown Area	It is recommended that the area along the south edge of the main laydown pad be monitored to determine whether water regularly ponds against the main laydown pad. If so, accumulated water should be pumped out during freshet and after significant or prolonged rainfall events.
L	20 ML Roberts Bay Tank Farm Secondary Containment	Pieces of spalled rock should be removed from within the limits of the HDPE liner area. The pieces have sharp edges that can damage the liner, particularly if they are pushed into the liner under the weight of equipment moving within the containment area. Sections of exposed liner should be documented and inspected for damage. The gravel cover at wheel and track marks should be measured. Where the gravel is less than the design thickness, the gravel should be scraped back to expose the liner for inspection. The liner should be repaired if required by qualified personnel, and the cover gravel replaced. Appropriate snow clearing and water management practices should be maintained to prevent water from building up inside the containment berm that can cause potential erosion of the cover gravel and the raised tank pedestals. The construction of the sump should be checked to see if it were designed to allow water to enter from the sides. If so, the sump should be pumped out and monitored to see if water is entering from the sides. The concentration of sediment may be blinding the gravel cover in the immediate vicinity of the sump, and the gravel may need to be replaced with cleaner material at some time. Recommendations from inspections carried out by specialists examining the stability of the rock face and a rockfall protection system should be implemented Only essential traffic should be permitted inside the containment area.
H	5 ML Roberts Bay Tank Farm	Pieces of spalled rock should be removed from within the limits of the secondary containment area. The pieces have sharp edges that can damage the liner, particularly if they are pushed into the liner under the weight of equipment moving within the containment area.

Priority	Area	2015 Recommendations
	Secondary Containment	Sections of exposed liner should be documented and inspected for damage. The gravel cover at wheel and track marks should be measured. Where the gravel is less than the design thickness, the gravel should be scraped back to expose the liner for inspection. The liner should be repaired if required by qualified personnel, and the cover gravel replaced. If an extension of the liner limits is required to meet the design capacity of the tank farm, it must be completed before the re-commissioning of the tank. Because a portion of the secondary containment facility bears on bedrock and a portion on engineered fill, regular inspections should include an assessment for differential settlement. The construction of the sump should be checked to see if it were designed to allow water to enter from the sides. If so, the sump should be pumped out and monitored to see if water is entering from the sides. The concentration of sediment may be blinding the gravel cover in the immediate vicinity of the sump, and the gravel may need to be replaced with cleaner material.
L	Roberts Bay Waste Management Area	Continue monitoring areas where rock was relocated from the tundra for signs of thermal settlement, and for ponded water along the edges of the thermal pad.
L	Quarry #1 Overburden Dump	The perimeter of the sedimentation control berm should be visually monitored to see that it is performing as designed, and that there is no sediment transport off of the overburden pile onto the tundra. The areas of subsidence are expected to require periodic ongoing maintenance with the placement of additional material. If this area is used for storage at some time in the future, increased maintenance requirements can be expected.
M	Airstrip	Areas where rock has been removed from the tundra should be monitored visually for deterioration. Even if the rock was carefully removed a thin layer of sand and gravel generally remains that will affect the vegetation and underlying thermal properties. This could depress the active layer and result in thawing and settlement. Although no standing water was observed on the airstrip at the time of the inspection, it is understood that there is a maintenance protocol in place whereby standing water is pumped out, and should be implemented whenever necessary.

Priority	Area	2015 Recommendations
		The tension cracks observed in the vicinity of the control tower and other nearby structures should be repaired. Generally these structures lie close to the edge of the pad and may experience some movement or damage if the cracks widen and are not repaired.
L	Former Wash Bay/Explosives Mixing Plant	If it is proposed to repurpose the building in the future, the tension cracks should be repaired. There is some potential for the cracking to propagate back into the pad and undermine the concrete building pad.
L	Upper Reagent Pad AN Storage	If it is proposed to use this area for secondary containment, the liner should be exposed to confirm that it is undamaged.
H	Sewage Treatment Plant Outfall	The original pipeline outlet should be monitored in the Spring for thermal settlement. The outlet should be switched to the bedrock outcrop as soon as possible in the Spring.
M	Landfarm / Rock Core Storage	Large pieces of stone / rock should be removed from the cells to avoid damage to the HDPE liner. Areas where stone has been (partly) scuffed off the liner should be replaced to provide a full cover thickness. The pothole at the base of the snow pond ramp should be repaired and a diffuser should be used to reduce the impact of the inflow into the pond. The area between the rock core storage and the Quarry #2 overburden dump should be kept free of standing water.
L	Quarry #2 and Crusher Area	Continue to manage the facility in accordance with the approved Quarry Management Plan.
M	Doris North Camp Pads (Pad X, Y, C, E/P, F, G, J/H, Q and Helipad)	Thermal pads are designed with the intent that no permanent heated facilities will be located on top of them. The heat can reduce the insulation properties of the pad and lead to permafrost degradation, and subsequent settlement below the structures. There are several heated structures on-site that should be monitored for settlement. The vertical rock face should be inspected periodically, particularly after periods of freeze thaw, and loose rock should be scaled. Alternatively, netting and rock bolts could be installed, or barricades installed to prevent access to the base of the wall.
M	ML Doris North Camp Tank Farm - Pad R	Long term stabilization measures have been designed for the rock faces to prevent damage to the tanks and the HDPE liner. These should be implemented as the site moves out of Care and Maintenance.
L	Power Generation Station - Pad B	The monitoring of the settlement points should continue regularly. A review of the foundation system should be undertaken to determine where the footings lie in proximity to the slope and what they bear on. A structural assessment of the stacks should also be undertaken.

Priority	Area	2015 Recommendations
H	Waste Rock Pile – Pad I	Once production resumes and if Pad I is used to store more waste rock, it will need to be managed in accordance with the Waste Rock Management Plan. The stability of the waste rock pile along the south edge should be assessed, or the waste rock be removed from the edge of the pad. This area should be barricaded off until an assessment confirms that the pile is stable.
H	Pollution Control and Sedimentation Ponds	Pollution Control Pond The stability of the south edge of the Pollution Control Pond and the waste rock stockpile should be assessed. Continue to regularly regular monitor the temperature at the downstream side of the pond. Sedimentation Control Pond It should be confirmed that the cuts in the HDPE liner lie above the elevation of the overflow pipelines. The overlap between the two sections of liner at the north end of the berm that separates the two ponds should be sealed.
M	Sumps #1 and #2	A previous recommendation to backfill a low area around Sump #1 should be implemented to prevent standing water and further degradation of the permafrost.
H	Doris Primary Vent Raise Pad	The rock wall is in close proximity to the vent raise. Previous recommendations with respect to the installation of appropriate barricades and signage should be implemented to keep people and equipment at a safe distance from the wall. The sump and cut-off trench should be completed to divert surface runoff from the bedrock away from the raise.
H	Doris North Dam	If not already implemented, a regular program should be carried out for the depressions across the upstream and downstream faces. As previously recommended, sampling and testing of the seepage water along the toe should be carried out to characterize the seepage water to eliminate seepage from under the dam as a source. A regular maintenance program of the thermosyphons should be developed and implemented.
M	All-Weather Roads (Doris Site)	Former roadside turnout areas should be monitored for signs of thermal settlement. Areas where water regularly ponds against the road's toe should be documented and checked during freshet and after significant precipitation. Standing water should be pumped from these areas. It has been recommended that a buttress be constructed along the toe of the Secondary Road where there was a previous instability, although this has not been implemented. With construction activities, and as the

Priority	Area	2015 Recommendations
		mine goes into production, this road is expected to see increased traffic. It is recommended that a toe berm should be constructed. Until it is in place, the slope should be monitored for signs of movement.
M	Doris Creek Bridge	The thermistors should continue to monitor permafrost conditions at the bridge abutments. The gabions should be monitored to see if there is ongoing deformation.
M	Doris-Windy All-Weather Road	Former roadside turnout areas should be visually monitored for signs of thermal settlement.

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1.0 INTRODUCTION AND PROJECT BACKGROUND

Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler) was retained by Aboriginal Affairs and Northern Development Canada (AANDC) to carry out a geotechnical inspection at the Doris North Project (Doris North). The inspection was carried out under Standing Offer Agreement 46-0000-1035, Call-up No. 1.

The Doris North Project is a gold mine located in the Kitikmeot Region of Nunavut, approximately 125 km southwest of Cambridge bay, as shown on the key plan on Figure 1.1.

The mine is owned by TMAC Resources Inc. (TMAC). TMAC is applying to amend its Project Certificate and type A water licence to allow increased production rates, an increased mine size, changes to the management of tailings, changing the discharge from the tailings impoundment area to the marine environment (instead of an approved creek), and other associated Project changes. The mine is situated on Inuit Owned Land administered by the Kitikmeot Inuit Association, with the exception of the Roberts Bay Jetty that is administered under a Crown Land lease.

The purpose of this call-up is to provide technical support for AANDC's review of TMAC's Nunavut Water Board (NWB) water licence amendment application, which includes a geotechnical site inspection of the Project area by Amec Foster Wheeler.

Section 2 of this report provides a description of the project and scope of work. Section 3 describes travel to site and general site conditions for the inspection. Section 4 provides a brief description of the site infrastructure, and site observations, and recommendations. Section 5 provides a table summary of the geotechnical recommendations.

TITLE:
Key Site Plan

PROJECT:
2015 Annual Geotechnical Inspection

CLIENT
Aboriginal Affairs and Northern Development Canada / Government of Canada, Nunavut Region

LOCATION
Doris North Mine Hope Bay, Nunavut

DATE:
October 2015

DATUM & PROJECTION:
NAD83 UTM Zone 13

PROJECT NO:
TV154011

DWN BY:	CHK'D BY:	FIGURE NO:
EJM	JD	Figure 1.1

LEGEND:

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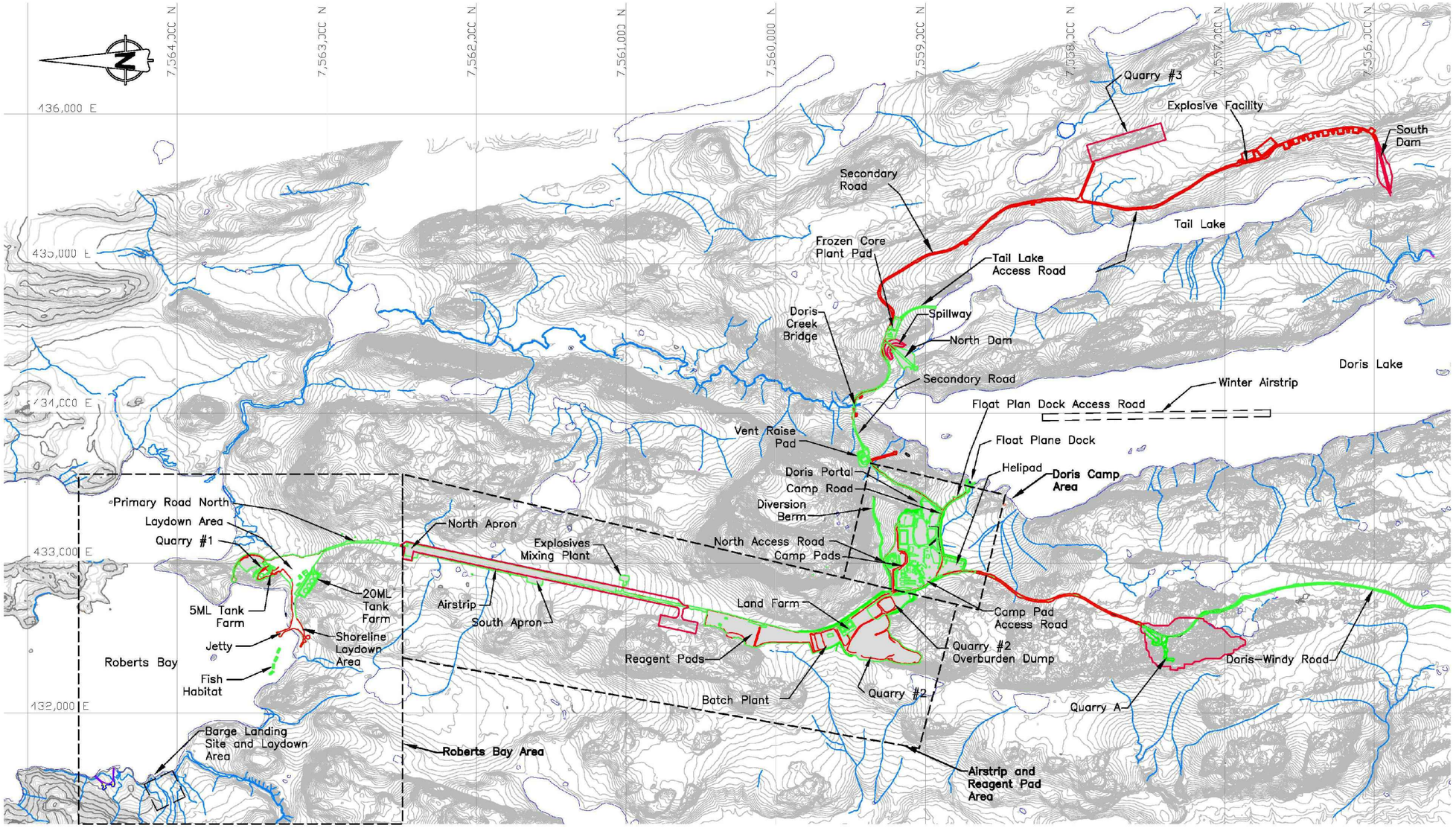

LEGEND

- Asbuilt
- Licenced but not yet constructed

0 200 400 600 800 1000 Metres

srk consulting

SRK JOB NO.: 1CT022.001

FILE NAME: 1CT022.001__GT-2014.dwg

TMAC RESOURCES

HOPE BAY MINING LTD.

2014 Geotechnical Inspection

Overall Site Layout (Sheet 1)

DATE:	APPROVED:	FIGURE:
Nov. 2014	EMR	2

TITLE: 2014 Site Features

PROJECT: 2015 Annual Geotechnical Inspection

CLIENT: Aboriginal Affairs and Northern Development Canada / Government of Canada, Nunavut Region

LOCATION: Doris North Mine Hope Bay, Nunavut

DATE: August 2015

DATUM & PROJECTION: NAD83 UTM Zone 13

PROJECT NO: TV154011

DWN BY:	CHK'D BY:	FIGURE NO:
EJM	JD	Figure 1.2

LEGEND:

NOTES:
1. RASTER IMAGE CONTAINED IN DRAWING, WAS REPORTED BY SRK CONSULTING FOR TMAC RESOURCES, 2014 GEOTECHNICAL INSPECTION, NOVEMBER 2014.

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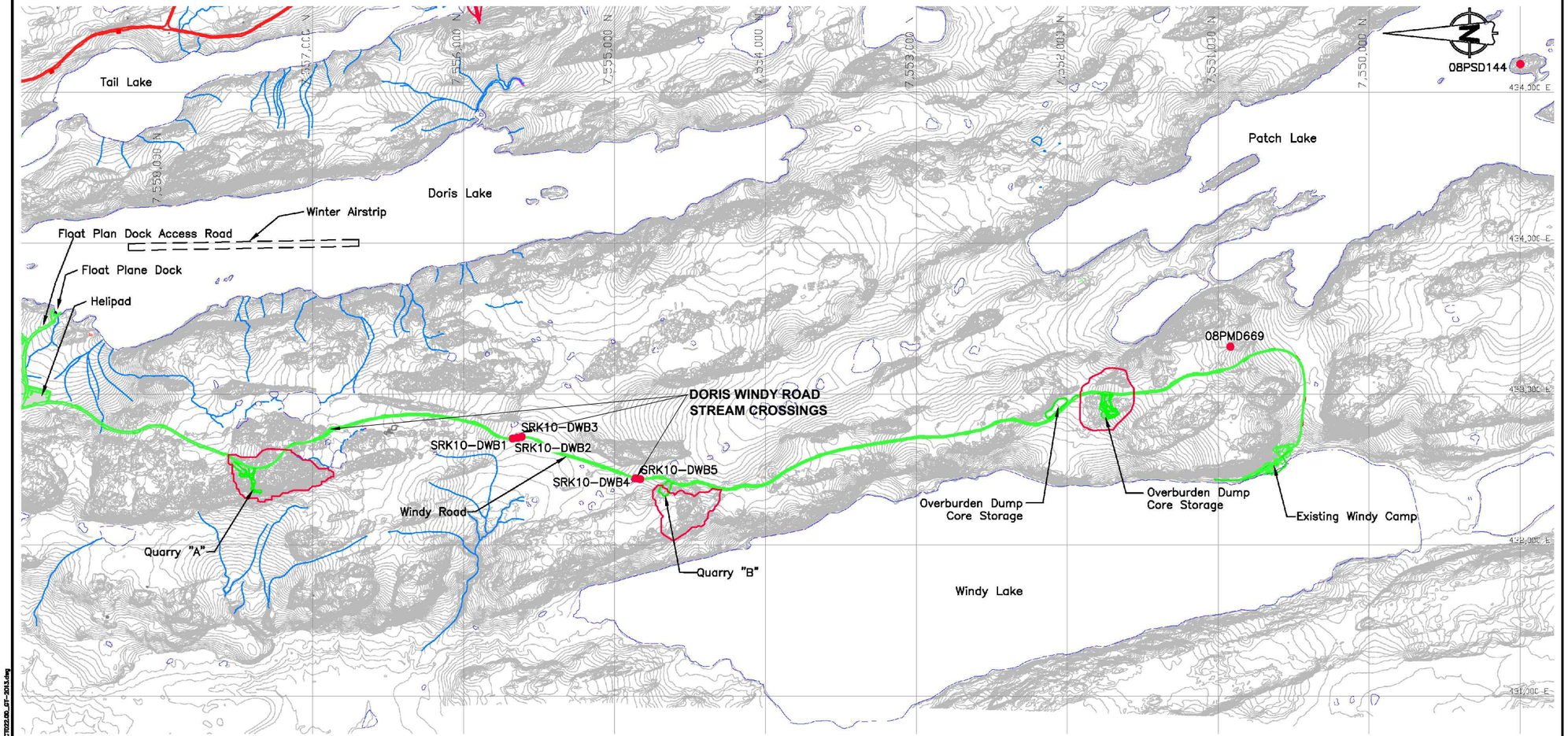

LEGEND

- Active Thermistor Installation
- Inactive Thermistor Installation
- Status Unknown
- Westbay Wells
- Proposed Thermistor Location
- Asbuilt
- Licensed but not yet Constructed

0 200 400 600 800 1000 Metres

srk consulting

SRK JOB NO.: 1CT022.000

FILE NAME: 1CT022.00_GT-2013.dwg

TMAC RESOURCES

HOPE BAY MINING LTD.

2013 Geotechnical Inspection

Overall Site Layout
(Sheet 2)

DATE:	APPROVED:	FIGURE:
March 2014	EMR	3

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TITLE:
2014 Site Features

PROJECT:
2015 Annual Geotechnical Inspection

CLIENT
Aboriginal Affairs and Northern Development Canada / Government of Canada, Nunavut Region

LOCATION
Doris North Mine Hope Bay, Nunavut

DATE:
August 2015

DATUM & PROJECTION:
NAD83 UTM Zone 13

PROJECT NO:
TV154011

DWN BY:	CHK'D BY:	FIGURE NO:
EJM	JD	Figure 1.3

LEGEND:

NOTES:
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2.0 PROJECT DESCRIPTION

2.1 General Site Description

The general features are shown on Figure 1.2 and 1.3. The site features for the Doris North Camp and Roberts Bay are further delineated in Figures 2.1 and 2.2.

The Doris North Project is a narrow, linear site, extending from the shoreline at Roberts Bay, south to Tail Lake. The Roberts Bay area is linked to the Doris North Camp that lies approximately 4 km to the south, by the Primary Road. Approximately 2.5 km easterly of the Doris North Camp along the Secondary Road lies the north end of the tailings impoundment area (TIA).

Facilities at Roberts Bay include a jetty, offloading / laydown areas, a waste management area, tank farms and an overburden dump. Along the Primary Road between Roberts Bay and the Doris North Camp, are the site airstrip, storage / laydown pads, cement batch plant, a land farm, quarry, and a second overburden dump.

The Doris North Camp consists of living quarters and support structures, mining support facilities and storage areas, a tank farm, a power generating station, a mill complex (under construction), waste rock and raw ore stockpiles, sedimentation and pollution control ponds, the underground portal and a helipad. A vent raise is located east of the camp along the Secondary Road.

The TIA presently consists of a frozen core dam at the north end of Tail Lake, called the North Dam. It will retain the reclaim pond once mining operations begin. Future construction will include the South Dam at the south end of Tail Lake, off which tailings will be discharged. An Interim Dyke is also planned half way between the North and South Dam that will decant tailings water into the reclaim pond.

2.2 Description of Permafrost and Geophysical Conditions

The site is situated in an area of Arctic tundra with continuous permafrost. The local topography ranges from sea level at Roberts Bay to an elevation of 158 m at the summit of Doris Mountain approximately three kilometers (km) inland.

Bedrock outcrops form north to northwest ridges, while tundra covers most of the flat valleys. The general overburden consists of ice-rich (10% to 30% by volume on average, but occasionally as high as 50%) marine clay. Vegetation consists of primary lichen, moss, dwarf willows, and birches.

The climate is classified as Arctic, semi-arid. Snow accumulation and freeze-up of lakes begins in mid to late September and remains into mid-June, with areas in the higher elevation persisting through July. Temperatures in January are often below -30°C while the mean annual precipitation is less than 200 mm.

2.3 Scope of Work

The mine has never operated and has been managed under Care and Maintenance since 2012. It is presently being prepared for production which is expected to begin in late 2016 or early 2017.

In 2006, Miramar Hope Bay Ltd. (MHBL), the previous Owner, was issued a Nunavut Impact Review Board (NIRB) Project Certificate pursuant to s. 12.5.5 of the *Nunavut Land Claims Agreement*. In 2013, a NWB type A water licence was issued that allows use of water and disposal of waste associated with mining and milling operations.

TMAC acquired the Doris North Project in 2013. TMAC is applying to amend its Project Certificate and type A water licence to allow increased production rates, an increased mine size, changes to the management of tailings, changing the discharge from the tailings impoundment area to the marine environment (instead of an approved creek), and other associated Project changes.

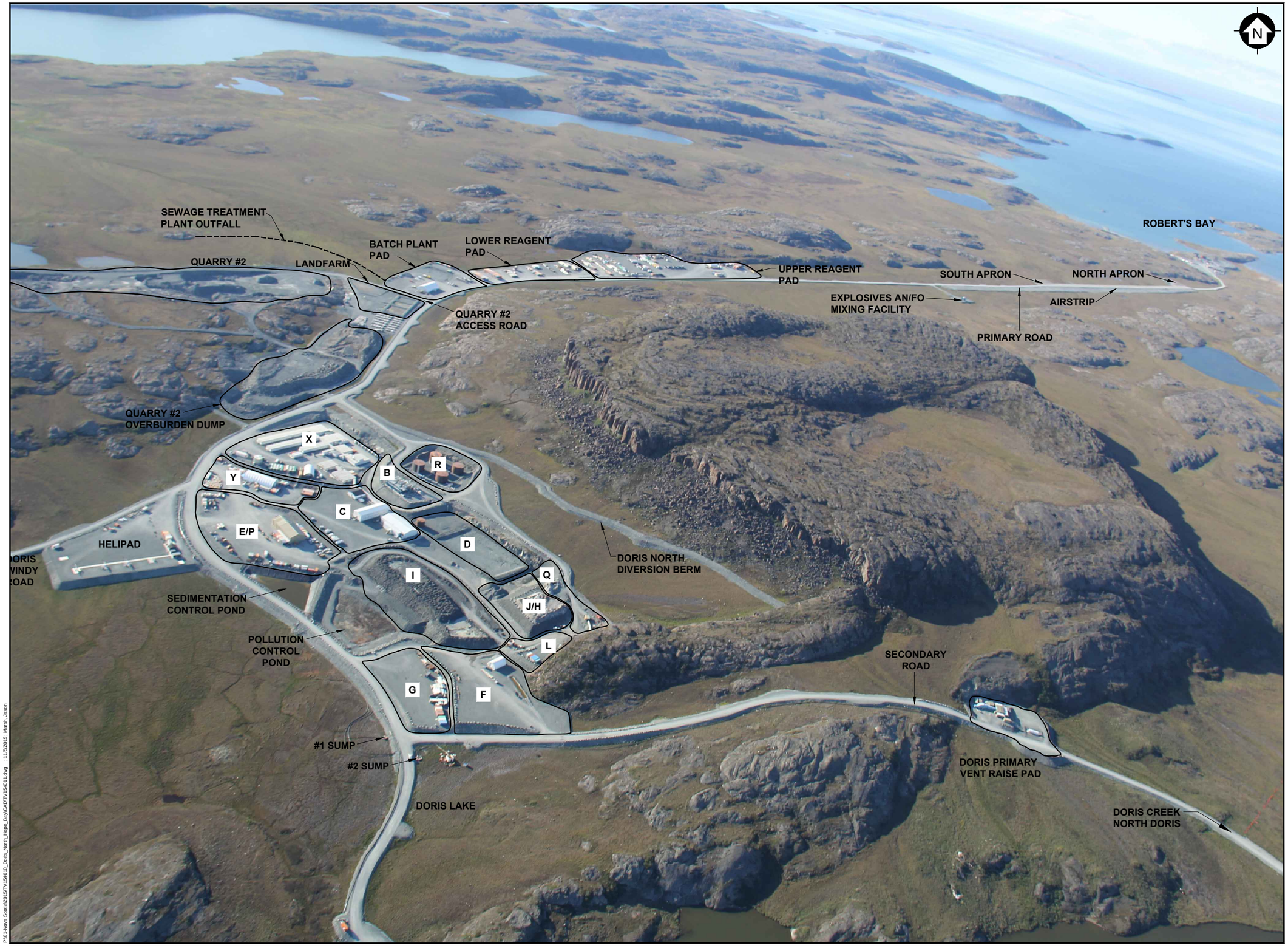
The Doris North Project is subject to both NIRB Project Certificate and NWB water licence amendment review processes. The purpose of this call-up is to provide technical support for AANDC's review of the NWB water licence amendment application, by the completion of a geotechnical site inspection of the Project area.

2.4 Methodology

This inspection was carried out in the company of:

- Mr. David Abernethy, Regional Coordinator, Water Resources Division, AANDC; and
- Mr. John Roberts of TMAC Resources Inc.

Travel to and from site was by a regularly scheduled TMAC charter flight. It arrived on-site at approximately noon on August 25th and left site on the morning of August 28th, 2015.



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TITLE:
Site Layout Aerial

PROJECT:
2015 Annual Geotechnical Inspection

CLIENT
Aboriginal Affairs and Northern Development Canada / Government of Canada, Nunavut Region

LOCATION
Doris North Mine Hope Bay, Nunavut

DATE:
August 2015

DATUM & PROJECTION:
NAD83 UTM Zone 13

PROJECT NO:
TV154011

DWN BY:	CHK'D BY:	FIGURE NO:
EJM	JD	Figure 2.1

LEGEND:

Area Boundary

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TITLE:
Site Layout Aerial

PROJECT:
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CLIENT
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DATUM & PROJECTION:
NAD83 UTM Zone 13

PROJECT NO:
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DWN BY:	CHK'D BY:	FIGURE NO:
EJM	JD	Figure 2.2

LEGEND:

Area Boundary

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3.0 SUMMARY OF OBSERVATIONS

3.1 General

As mentioned previously, the Doris North site lies in a region of continuous permafrost. The most significant issue with respect to geotechnical engineering is the impact on the permafrost from mine site activities. The thermal equilibrium of permafrost is disrupted when the vegetation, snow cover or the active permafrost layer is compacted. The permafrost table is depressed by the melting of ice within the soil. This process causes settlement of the ground surface (thermal settlement) on which surface water will collect, resulting (in summer) in a wetter, thicker active permafrost layer with less bearing strength.

The general approach for construction is to place a thermal gravel or rock fill pad under a structure. The fill is generally a good conductor of heat, and if the layer is too thin, it could cause additional thawing. The fill pad must be thick enough so that it contains the annual freeze-thaw fluctuation entirely within the fill and the compacted active layer.

Consequently, signs that may indicate permafrost degradation include standing water around the construction pads, obvious settlement, and cracking of the pads, sediment transport onto the tundra or fill placement that will affect vegetation and compact the active zone.

The following sections provide a brief description of each component that was inspected, observations made during the inspection, and recommendations for further work or maintenance, and photographs.

3.2 Old Beach Laydown Area

General Description

The Old Beach Laydown Area is located west and north of the Roberts Bay Jetty, on the west side of Roberts Bay. It is the original barge landing and laydown area used to supply the site during the early construction phase of the Project, before the construction of the jetty in 2007.

During the 2007 to 2012 construction seasons, it was used by the previous licensee, Hope Bay Mining Ltd., to store construction explosives in self-contained storage magazines. The magazines were removed in 2013 and the site has not been used since. It could potentially be used in the future, if required, to offload heavy items that exceed the design capacity of the jetty.

The Old Beach Laydown Area is a sand beach. There has been no surface improvement (e.g. thermal pads) at the site, and no infrastructure has been constructed.

Inspection

This area was not inspected during the 2015 geotechnical inspection. Aerial photos show the site is covered with wheel tracks, although no signs of thermal settlement was observed in the previous inspections.

Recommendations
No action is required.

3.3 Roberts Bay Jetty

The Roberts Bay Jetty is a docking facility used to offload lighter barges that carry supplies and fuel from larger ships moored offshore. It was constructed in 2007 to replace the Old Beach Laydown Area for general resupply operations for the Project. (Photos 3.3-1 to 3.3-4)

Foundation conditions beneath the jetty consist of weak marine sediments. Submarine permafrost is present for the first approximately 55 m from the shoreline, transitioning to unfrozen soils. The unfrozen soils have little strength and significant consolidation settlement was expected. The design for rock fill placement for the jetty included a double layer of geogrid on top of the foundation soils. Nevertheless, the front section of the jetty slumped during construction, and the jetty design was subsequently revised to a shorter structure.

Monitoring carried out within the first year after construction showed approximately 0.5 m of settlement. Since then, the jetty has generally been levelled and raised as required before each annual sealift; however, no further settlement monitoring has been carried out. The jetty was damaged in 2013 by a severe storm that required significant reconstruction. Because of the reconstruction, PND Engineers Canada Inc. (PND) became the Engineers-of-Record (EoR) for the jetty.

Two thermistor strings are installed through the jetty and into the submarine permafrost to monitor the conditions of the thermal gradient.

Observations
The Roberts Bay Jetty appeared in good condition. There were no areas of settlement observed across the jetty surface. The side slopes were uniform with no signs of deformation at the toe or settlement along the crest.

The data from the thermistor SRK-JT1-09 did not suggest a significant change in conditions.

Recommendations
The thermistors should be monitored in accordance with the recommended schedule.

The recommendations with respect to staff inspections and repairs, and staff operational awareness, as well as settlement monitoring made by PND should be implemented (PND 2013).