6-B: Addendum Hydrogeological Assessment and Modelling

REPORT

Hydrogeological Assessment and Modelling

Whale Tail Pit - Expansion Project

Submitted to:

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Distribution List

Agnico Eagle: 1 e-copy

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1.0 INTRODUCTION

Agnico Eagle Mines Limited: Meadowbank Division (Agnico Eagle) is proposing to develop the Whale Tail Pit, IVR Pit and Underground operations on the Amaruq property (Expansion Project), in continuation of mine operations and milling of the Meadowbank Mine. The Amaruq Exploration property is a 408 square kilometre (km^2) site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km north of the Meadowbank Mine in the Kivalliq region of Nunavut.

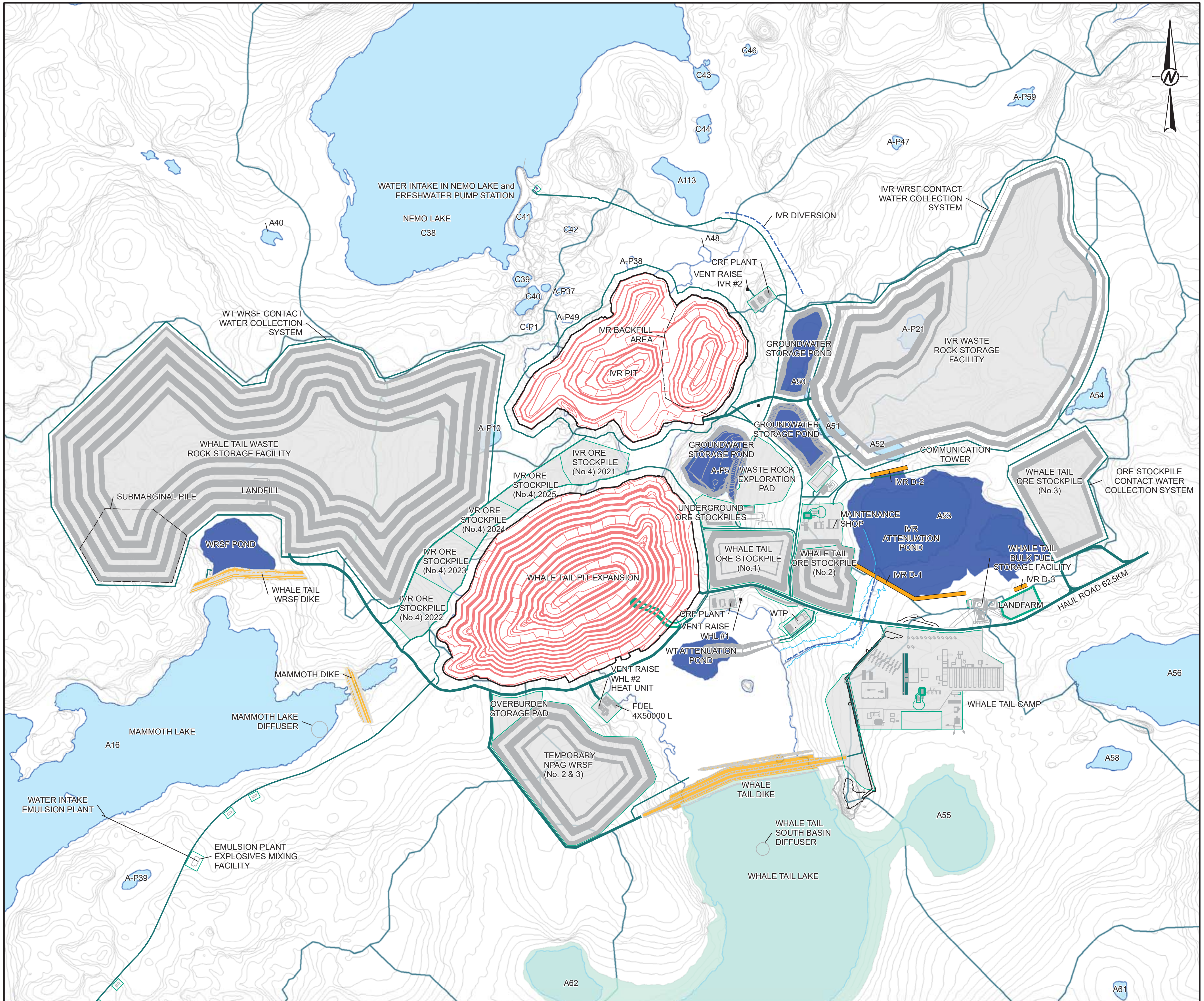
The Approved Project supports mining ore from one open pit, the Whale Tail Pit, processed over a three to four-year mine life. The Expansion Project proposes mining additional ore from the expanded Whale Tail Pit, the IVR Pit, and Underground operations. A detailed Project Description can be found in the Expansion Project's Final Environmental Impact Statement (FEIS) addendum (Volume 1). The Expansion Project layout is presented on Figure 1.

This report presents the results of hydrogeological modelling completed for the Expansion Project. Specifically, it addresses the approaches and assumptions adopted in the estimate of the potential groundwater inflow quantity and groundwater salinity (total dissolved solids [TDS] only) into mining areas during the dewatering, mining, filling and flooded phases of the Expansion Project. This information serves as input to the Expansion Project's design, water management plan and environmental impact assessments.

The hydrogeological assessment utilizes a previously developed numerical groundwater model for the Approved Project (Appendix 6B of the Approved Project FEIS). The model was updated based on data collected since the Approved Project model was built (between 2015 and 2018) and based on the mine plan for the Expansion Project.

This report is organized as follows:

- Section 2.0 provides a summary of hydrogeological data available since the Approved Project hydrogeological assessment
- Section 3.0 provides a description of the updated conceptual hydrogeological model based on the new data collected
- Section 4.0 provides a summary of the updated numerical groundwater model
- Section 5.0 provides a summary of the groundwater model predictions during mining and filling phases of the Expansion Project.
- Section 6.0 provides a summary of the model predictions for reflooded phase of the Expansion Project.



LEGEND

- WHALE TAIL WASTE ROCK STORAGE FACILITY
- WHALE TAIL LAKE (SOUTH BASIN) FLOODED LIMIT (WATER LEVEL 156.0m)
- NATURAL WATERSHED
- DIKE
- POND/SUMP
- ROAD
- WATERCOURSE
- WATERBODY

REFERENCE(S)

1. INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED FROM AMQ_2025Q4V7.DWG
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM PHOTOSAT

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

SITE LAYOUT

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-01
DESIGNED	JR
PREPARED	CDB
REVIEWED	JR
APPROVED	DF

PROJECT NO.	CONTROL	REV.	FIGURE
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PATH: Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Whale_Tail\99_PROJECTS\1896037\02_PRODUCTION\1300\MXD\1340\Report\1896037_1300_1340_1_2_1_SITE_LAYOUT.mxd PRINTED ON: 2018-11-01 AT 11:48:30 AM

2.0 DATA REVIEW

Since the completion of the hydrogeological assessment for the Approved Project, investigations have been carried out to collect additional site-specific hydrogeological data, as requested in the Project Certificate Terms and Conditions No. 15 for the Approved Project. A summary of the results of these investigations is presented below.

2.1 Hydrogeological Testing

Four investigations were undertaken between 2016 and 2017 to further characterize the hydraulic conductivity of the bedrock (Knight Piésold 2016; Golder 2016b, 2017b; SNC 2017). The investigations included the completion of 49 packer tests in unfrozen areas of bedrock (within the talik or below the regional permafrost).

Knight Piésold conducted 10 packer tests along a single drill hole as part of a 2016 geomechanical investigation (Knight Piésold, 2016). The tests were conducted over 30 m intervals along the drill hole to a maximum depth of approximately 330 m below ground surface (bgs). The first four tests were interpreted to be conducted in unfrozen rock; the remainder of the tests were inferred to be completed in frozen permafrost below the northern portion of Whale Tail Lake.

In 2016 and 2017, Golder conducted two investigations as follows:

- eight packer tests in 2016 along drill hole AMQ16-626 (into which a Westbay well was installed) from a depth of 186 to 466 m bgs.
- 33 packer tests in 2017 along five drill holes from a depth of 10 m bgs to a maximum depth of 735 m bgs; 10 of those tests were inferred to be in talik or unfrozen bedrock.

In 2017, SNC Lavalin conducted 43 packer tests along nine drill holes near the Whale Tail dike from a depth of 6 m bgs to a maximum depth of 48 m bgs; 27 of these tests were inferred to be completed in unfrozen bedrock.

Figure 2 presents a summary of the hydraulic conductivity measurements from the above investigations, in combination with the testing previously completed by Knight Piesold (2015) in support of the Approved Project. The larger dataset indicates that while the near surface bedrock is significantly more permeable than previously identified, the deeper bedrock is less permeable than assumed in the Approved Project. Overall, the bedrock hydraulic conductivity decreases with depth, with the hydraulic conductivity measurements ranging from less than 1×10^{-10} m/s at depth to 2×10^{-4} m/s near surface.

The highest hydraulic conductivity measured in the deeper bedrock corresponded to a hydraulic conductivity value of 3×10^{-7} m/s measured at the Westbay well location over a depth interval of 436 to 466 mbgs. Based on the geotechnical summary log, the higher hydraulic conductivity in this interval is likely attributed to an interval with localised multiple joint sets with carbonate infilling. The data collected thus far does not indicate the presence of enhanced permeability zone associated with a major structure or fault.

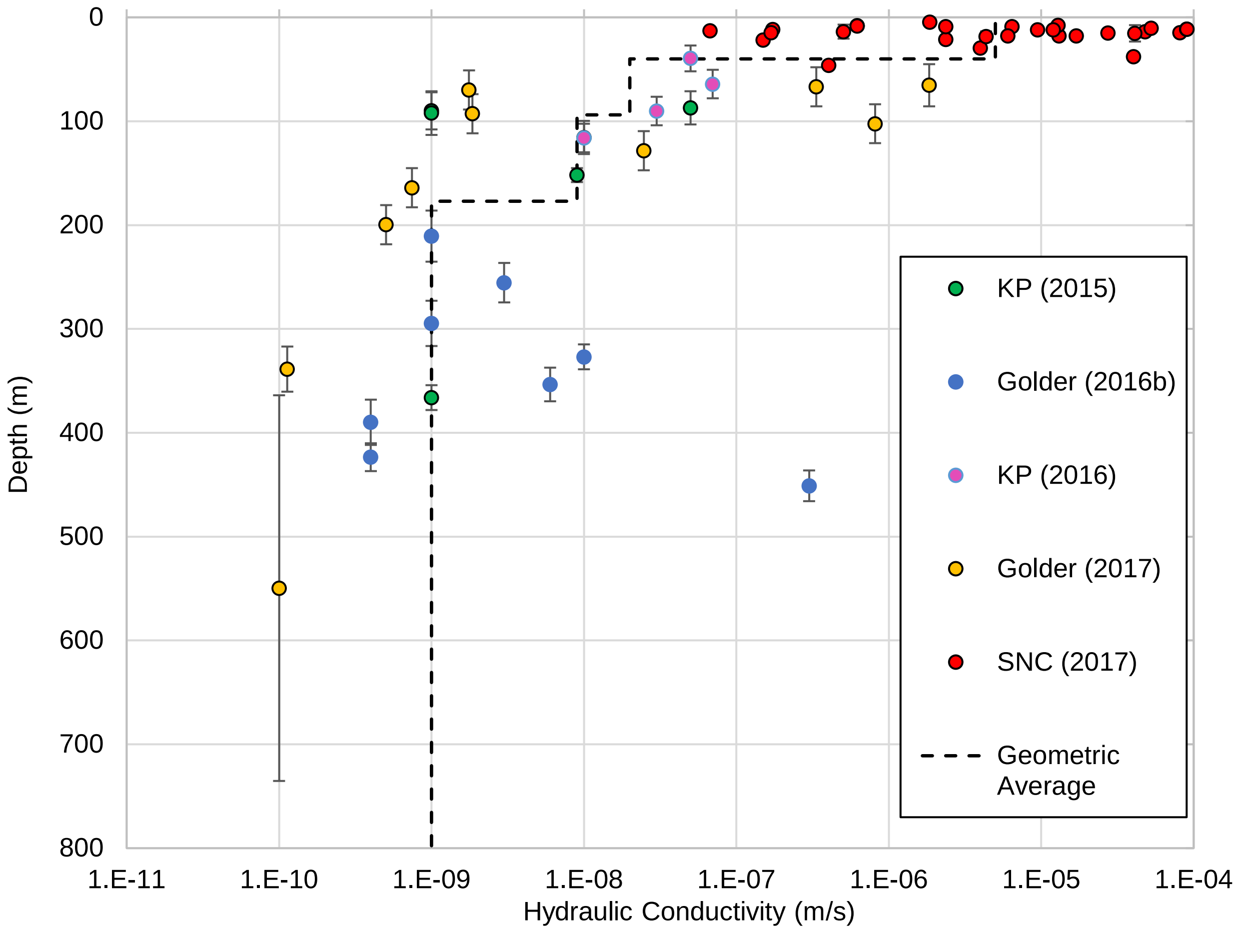


Figure 2: Summary of Hydraulic Conductivity Test Results – Expansion Project

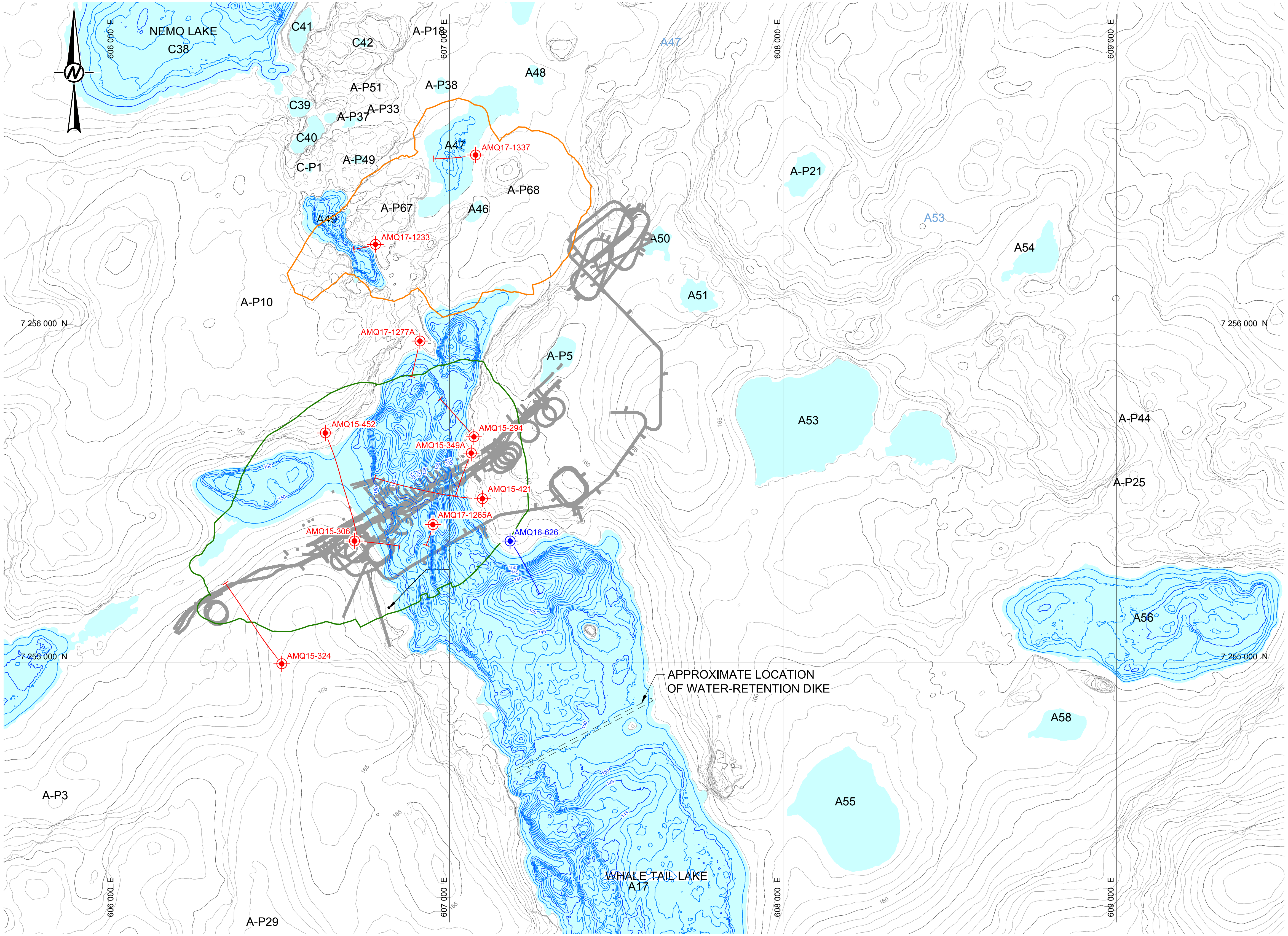
2.2 Permafrost Assessment

Since the completion of the Approved Project, thermal assessments have been completed that contribute to the understanding of the permafrost conditions near the Whale Tail Pit, IVR Pit and Underground. In 2017 a study was completed to evaluate the permafrost and talik characteristics near Whale Tail Lake and to provide input for planning of the 2017 field thermistor installation program in the northern portion of the lake (Golder 2017a). In 2018, a study was completed to support the hydrogeological modelling and to conservatively predict the evolution of permafrost due to the flooding of the Whale Tail Pit and IVR Pit (Golder 2018). A copy of the 2018 report is included in Appendix A of this report.

Based on the results of the above two studies (Golder 2017a; 2018), the following summarizes the updated understanding of permafrost conditions:

- Ten thermistors have been installed in the Expansion Project Area near Whale Tail Pit and IVR Pit. Data collected from these thermistors is presented in Golder 2018 (Appendix A). The location of the thermistors, which provide broad coverage of thermal data across the Expansion Project area are presented on Figure 3.
- The extrapolated mean annual ground temperatures from the thermistors ranged from -3.4°C to -9.9°C.

- The estimated depths of zero amplitude from the temperature profiles range from 18 m to 35 m, and the temperatures at the depths of zero amplitude are in the range of -3.1ºC to -8.4ºC.
- The geothermal gradient is in the range of 0.005ºC/m to 0.025ºC/m.
- The depth of permafrost in the Expansion Project area is estimated to be in the order of 425 m to 495 m for areas outside of Whale Tail Lake. In the area of Whale Tail Lake, data from thermistor AMQ17-1265A suggests that the talik near the central portion of the North Basin of Whale Tail lake extends about 112 m below the lake water level of 152.5 masl. Toward the South Basin, the closed talik below the North Basin is predicted by thermal modelling to transition to an open talik with direct connection to the sub-permafrost groundwater flow system.
- Whale Tail Pit is present in the North Basin in the area of the closed talik. The pit extends through this talik and into the underlying permafrost, with the base of the pit located in permafrost.
- The IVR Pit, which has a maximum depth of approximately 105 m, is located within the regional permafrost that extends to 425 m to 495 m bgs. The edge of this pit slightly intersects the north eastern edge of Whale Tail Lake; however, thermistors at two locations (AMQ17-1277A and AMQ15-294; Appendix A) do not indicate that an open talik is present in this area. These two thermistors are drilled at an angle from the shoreline and it is possible that thermistors have missed a shallow bulb of talik. If this shallow talik is present, groundwater in this localized area would drain towards the deeper portions of Whale Tail Lake during lake dewatering.
- Based on the measured salinity concentration of 0.3% to 0.4% from the groundwater samples collected at depths from 276 m to 392 m from a Westbay well system installed in borehole AMQ16-626 (Golder, 2016c), a freezing point depression of about 0.2 °C was calculated, which may reduce the frozen-solid portion of the permafrost at its base by approximately 20 m. This reflects the thickness of the basal cryopeg.
- With the formation of the Whale Tail Pit lake, permafrost near and beneath Whale Tail Pit is predicted to start melting. After approximately 11 years of filling, the base of the Whale Tail Pit Lake is predicted to be hydraulically connected to the deeper groundwater flow system, and after 50 years, the permafrost below a significant portion of the pit footprint is predicted to have nearly completely melted. The evolution of the permafrost is presented in Appendix A.
- The formation of the IVR Pit lake is also predicted to melt the underlying permafrost. Unlike Whale Tail Pit; however, IVR Pit is located within the regional permafrost and it is predicted that it will take approximately 1000 years to fully melt the permafrost below the pit footprint (Appendix A).



LEGEND

- EXISTING GROUND SURVEY
- EXISTING BATHYMETRY
- WATER BODY
- THERMISTOR
- WESTBAY SYSTEM
- PROPOSED WHALE TAIL PIT
- PROPOSED IVR PIT
- UNDERGROUND WORKS

NOTE(S)

1. ALL UNITS ARE IN METERS UNLESS NOTED OTHERWISE.
2. CONTOUR INTERVAL 1m MINOR AND 5m MAJOR.

REFERENCE

1. BASE PLAN AND BATHYMETRY DATA RECEIVED FROM AGNICO EAGLE MINES LTD. DATE RECEIVED NOVEMBER 25, 2016.
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   CAD FILE: 1665858-2100B-CM-0002.DWG
   CAD FILE: 61-000-142-001_R0BLOC.DWG
2. UNDERGROUND WORKS BASED ON
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   DXF FILE: AMQMY17UG_003_DEV_2019_SHIFTED.DXF
   DXF FILE: AMQMY17UG_003_DEV_2020_SHIFTED.DXF
   DXF FILE: AMQMY17UG_003_DEV_2021_SHIFTED.DXF
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CLIENT
AGNICO EAGLE
AGNICO EAGLE MINTES LIMITED
MEADOWBANK DIVISION

PROJECT
WHALE TAIL PIT - EXPENSION PROJECT

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-09
DESIGNED	AP
PREPARED	JK
REVIEWED	
APPROVED	

TITLE
LOCATION OF INSTALLED THERMISTORS

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1789310	2000/22010	A	3

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2.3 Groundwater Quality

Groundwater quality is inferred to reflect the thermal profile of the area, where the shallow groundwater in the shallow talik has low TDS, influenced by the lake above, while the deeper groundwater below the base of the permafrost has higher salinity.

As part of the Approved Project, three wells were installed to characterize groundwater; however, a representative sample of deep groundwater could not be collected (Knight Piésold 2015). Consequently, the shallow groundwater quality was inferred to be similar to the Meadowbank Mine based on similar geology and shallow talik ground conditions (Knight Piésold 2015), Data collected at the Meadowbank Mine was therefore used to develop a TDS profile for the Approved Project.

To obtain representative samples at greater depths, a Westbay well system was installed between March and April 2016. The borehole (AMQ16-626) was drilled to a depth of 499 m. The well was installed to measure hydraulic heads and hydraulic conductivity, and to collect groundwater samples from multiple depth intervals in the talik below Whale Tail Lake. The groundwater samples collected from the Westbay system at depths between 276 m and 392 m indicate that the TDS content in the groundwater was between 3,198 mg/L and 4,042 mg/L (Golder 2016c). This range is slightly higher than the groundwater TDS concentration measured at Meadowbank from shallower depths (less than 200 m vertical depth), which is expected based on the deeper level at which the Westbay well samples were collected.

These TDS concentrations are similar to those observed at other sites in the Canadian Shield at corresponding depths and in locations away from the influence of sea water (Frape and Fritz 1987; Lahermo and Lampen 1987). The groundwater quality results obtained from the Westbay well system provide reliable information on site-specific composition of groundwater to depths of 392 m and data from the Westbay well system and from other sites in the Canadian shield were used to help extrapolate the TDS concentrations to deeper depths.

The TDS profile developed for the Expansion Project is presented on Figure 4.

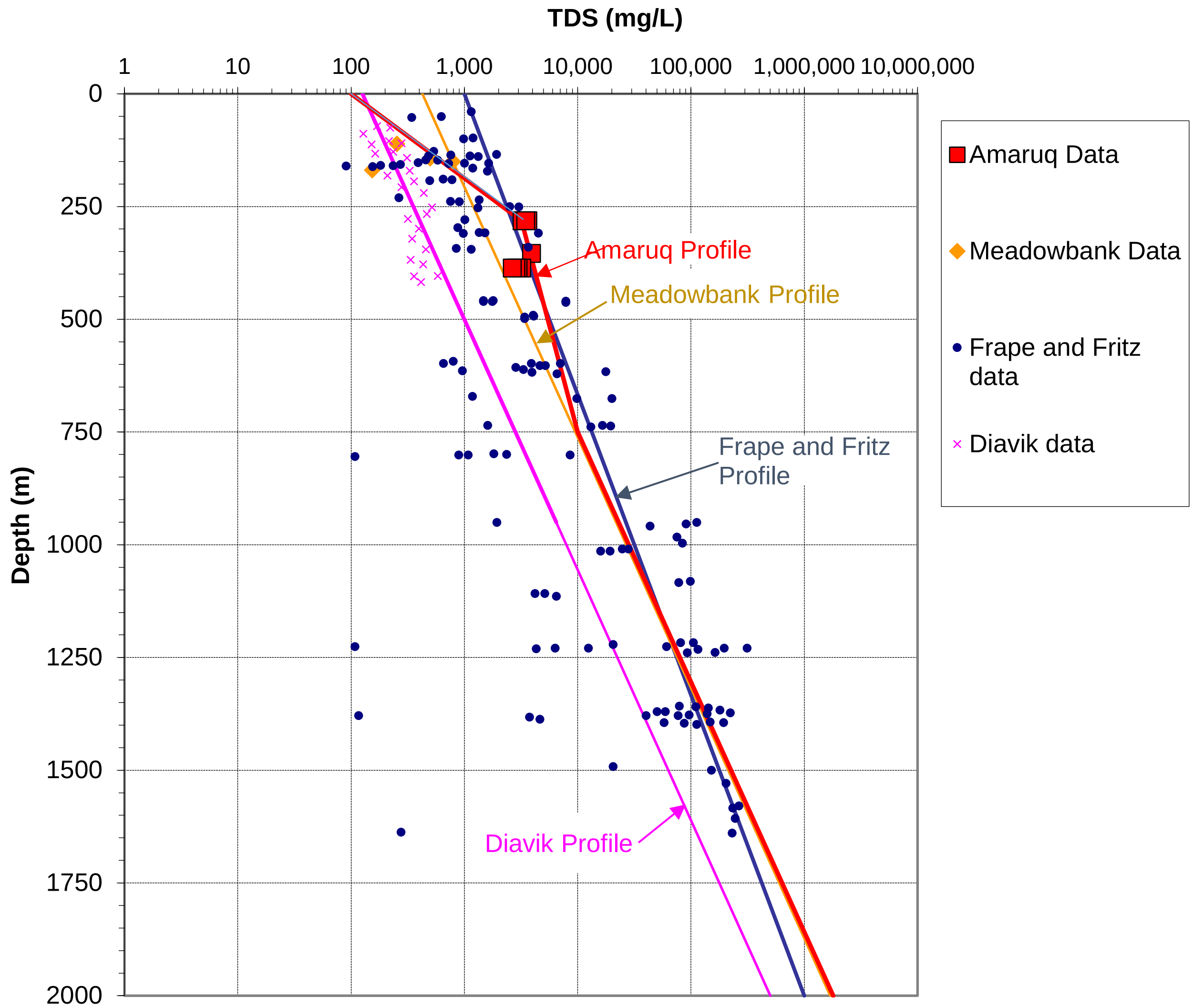
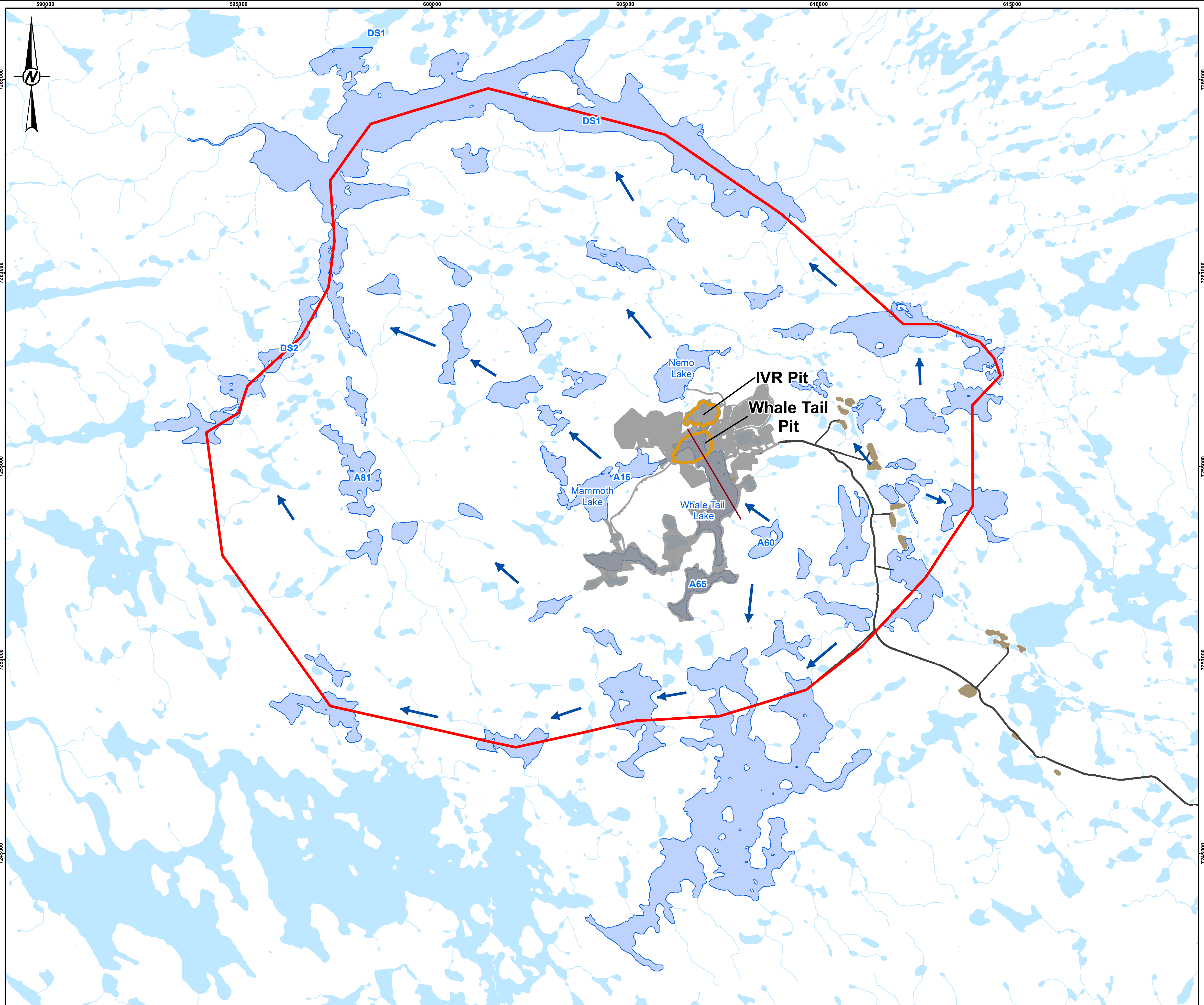


Figure 4: TDS Concentration vs Depth Profile – Expansion Project

3.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

This section of the report presents the updated conceptual model for the Expansion Project, that incorporates the baseline data collected for the Approved Project and the new hydrogeological data described in Section 2.0. The study area for the hydrogeological assessment is consistent with that developed for the Approved Project and is presented on Figure 5.

A conceptual hydrogeological model is a pictorial and descriptive representation of the groundwater regime that organizes and simplifies the site conditions, so they can be readily modelled. The conceptual model must retain sufficient complexity so that the analytical or numerical models developed from it adequately reproduce or simulate the actual components of the groundwater flow system to the degree necessary to satisfy the objectives of the modelling study.



LEGEND

- HYDROGEOLOGY BASELINE STUDY AREA
- LAKES WITH TALIK
- WATERBODY (NO TALIK OR OUTSIDE STUDY AREA)
- WATERCOURSE

WHALE TAIL

- BORROW SOURCE
- INFRASTRUCTURE
- HAUL ROAD
- GROUNDWATER FLOW DIRECTION
- CONCEPTUAL SECTION LOCATION
- PIT BOUNDARY

0 2 4

1:100,000 KILOMETRES

REFERENCE(S)
1. INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED, DRAWING AMQ_2025Q4V7.DWG.
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. INSET MAP DATA OBTAINED FROM ESRI
DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT
WHALE TAIL PIT - EXPANSION PROJECT

TITLE
HYDROGEOLOGY BASELINE STUDY AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-09
DESIGNED	AP
PREPARED	CDB
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
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3.1 Hydrostratigraphy

The conceptual model for the Expansion Project is comprised of three hydrostratigraphic units: overburden, weathered rock and competent rock. Structures such as fault zones may be present, but current data does not indicate that the permeability of structures intersected to date are higher than the surrounding competent bedrock.

Overburden and weathered bedrock are limited to the near surface; whereas, most of the rock domain consists of relatively competent bedrock. Hydraulic conductivity testing of the overburden has not been conducted. The hydraulic conductivity of the shallow overburden beneath Whale Tail Lake was estimated to be 2 x 10^{-6} m/s (Cumberland 2005) based on testing in the Meadowbank area. The hydraulic conductivity of the competent rock decreases with depth and permafrost is essentially impermeable. The hydraulic properties of the bedrock, based on the test data presented in Section 2.1, are summarized in Table 1 and Figure 6. These values are herein referred to as the "Base Case Scenario" and represent reasonable estimates of hydraulic conductivity based on the measured data and are generally equivalent to or up to three times greater than the geometric average of the test data.

Based on the results of the sensitivity analysis on this Base Case Scenario (Section 5.2) and in consideration of the distribution of measured hydraulic conductivity and density of testing, a higher estimate of hydraulic conductivity was also developed for the purposes of assessing potential effects of the Expansion Project (Section 5.3). This scenario is herein referred to as the "Environmental Assessment (EA) Scenario".

Table 1: Hydraulic Conductivity of the Hydrostratigraphic Units – Base Case and EA Scenario

Hydrostratigraphic Unit	Depth Interval (m)	Hydraulic Conductivity (m/s)	
		Base Case	EA Scenario
Overburden	0 to 6	2×10^{-6}	2×10^{-6}
Weathered bedrock	6 to 40	1×10^{-5}	1×10^{-5}
Competent bedrock	40 to 100	7×10^{-8}	1×10^{-7}
Competent bedrock	100 to 200	9×10^{-9}	3×10^{-8}
Competent bedrock	>200	1×10^{-9}	4×10^{-9}

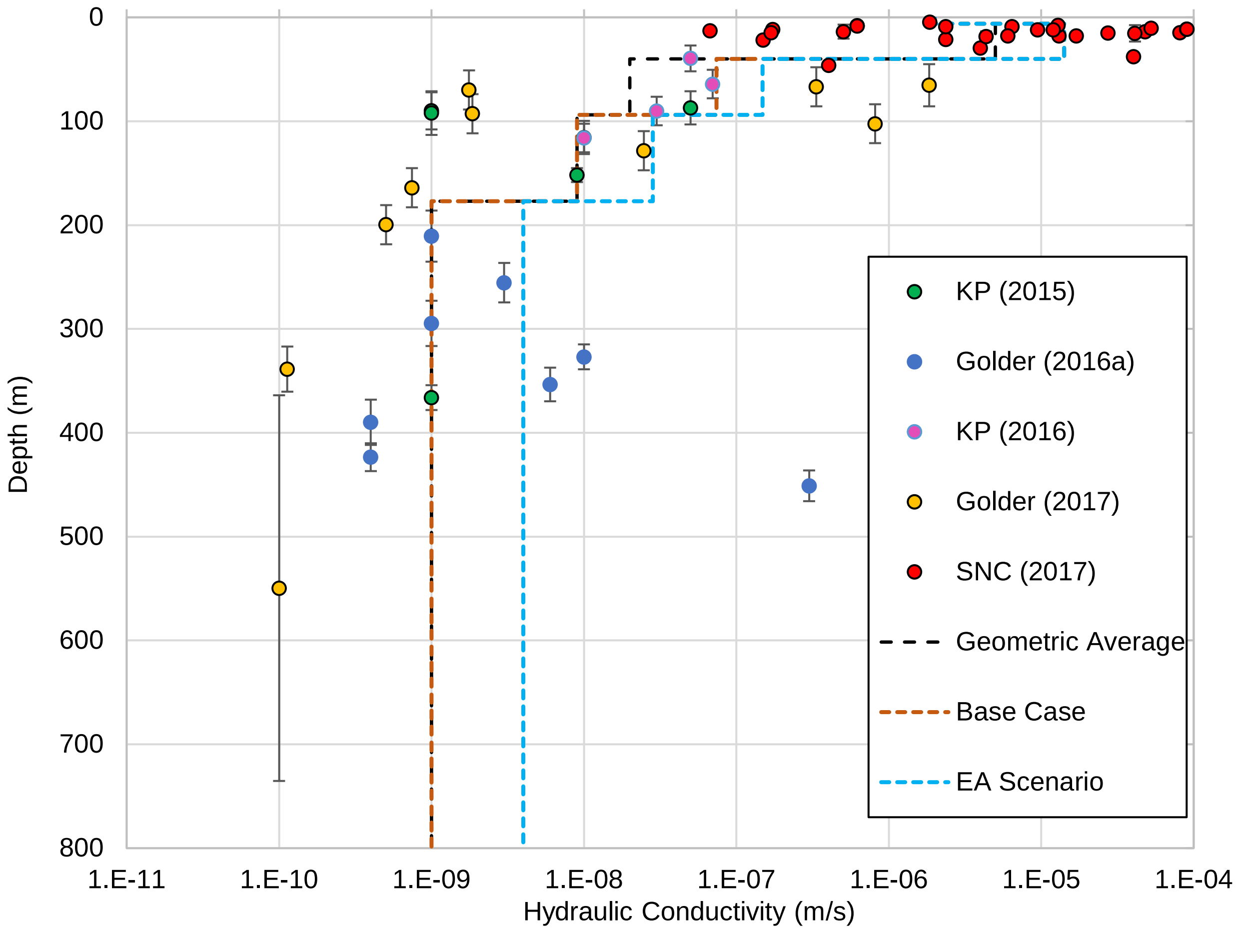


Figure 6: Hydraulic Conductivity Values – Base Case and EA Scenario

3.2 Groundwater Flow Regime

Two groundwater flow regimes occur at the Expansion Project: a deep groundwater flow regime beneath permafrost and a shallow groundwater flow system located in the active (seasonally thawed) layer near the ground surface. Except for areas of open taliks beneath lakes, the two groundwater regimes are isolated from one another by thick permafrost. The depth of the active layer is estimated to range between approximately 1 to 4 m. Permafrost thickness in Expansion Project area is expected to be approximately 425 to 495 m. Below Whale Tail Lake, the closed talik is present beneath the northern portion of the lake and an open talik is present beneath the southern portion of the lake.

Groundwater flow within the deep groundwater flow regime is limited to the sub-permafrost zone. This deep groundwater flow regime is connected to ground surface by open taliks underlying larger lakes. The elevations of these lakes are the primary control of groundwater flow directions in the deep groundwater flow regime, with density gradients providing a potential secondary control. The elevations of these lakes in the baseline study area indicate that Whale Tail Lake is likely a groundwater discharge zone at the south end of the Lake, with flow from Lake A60 to Whale Tail Lake, and a groundwater recharge zone at the north end of the Lake, with flow from Whale Tail Lake to Lake DS1 (Figure 5).

The TDS concentrations near the Expansion Project are similar to those observed at other sites in the Canadian Shield at corresponding depths and locations away from the influence of sea water. Consistent with other sites in the Canadian Shield, concentrations of TDS in groundwater are inferred to increase with depth, primarily in response to upward diffusion of deep-seated brines. The adopted TDS profile for the Expansion Project is presented in Figure 4 of Section 2.3.

3.3 Groundwater Flow – Mining

While portions of both Whale Tail Pit and the Underground are located within unfrozen rock, the IVR Pit is fully contained within permafrost. Groundwater inflow is therefore only expected during operations in the Whale Tail Pit and Underground.

Mining of the Whale Tail Pit occurs within the closed talik underlying Whale Tail Lake, whereas the Underground starts in permafrost and then extends below the permafrost into the deeper bedrock flow system. The Underground workings are not directly connected to either Whale Tail Pit or IVR Pit.

The conceptual hydrogeological model for groundwater flow conditions near the Whale Tail Pit and Underground during mining is presented on **Figure 7**. The location of the conceptual cross-section is shown in Figure 5.

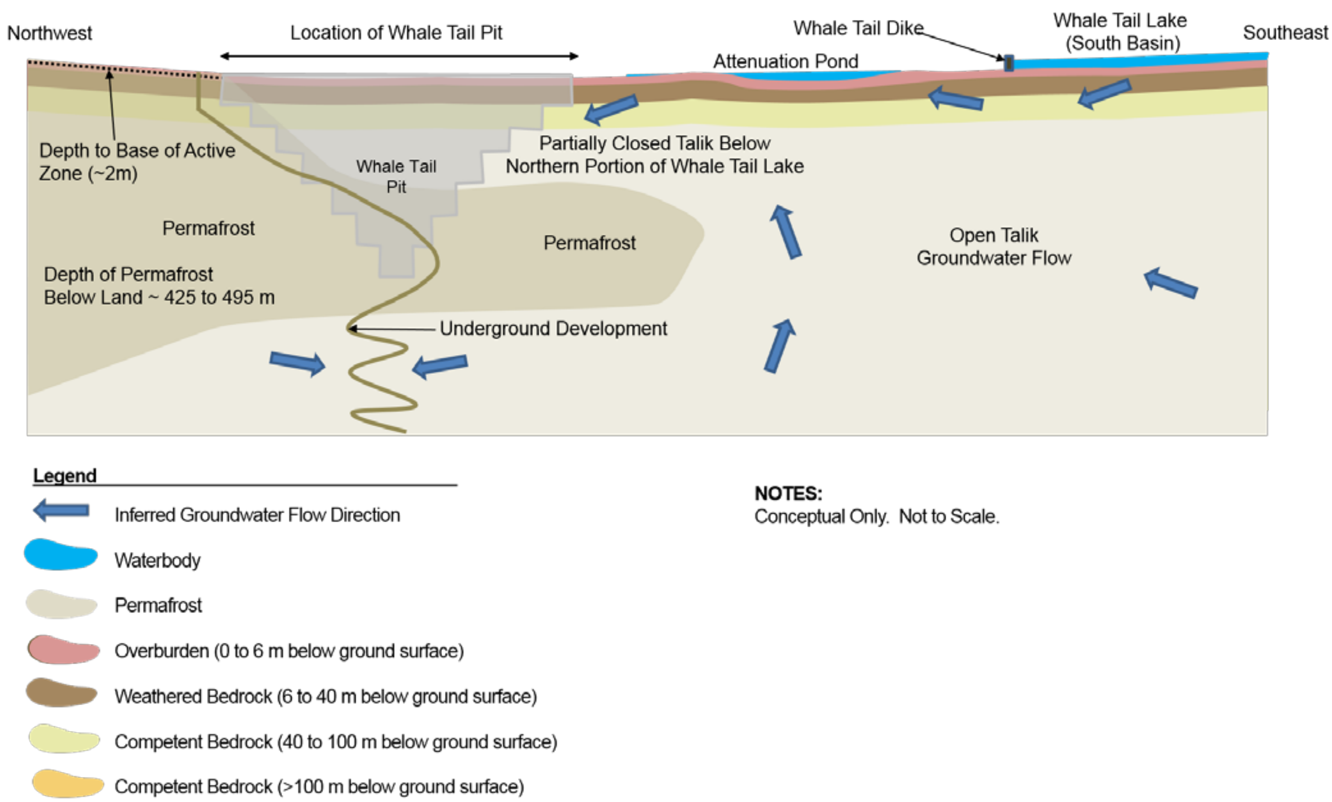


Figure 7: Conceptual Model of Deep Groundwater Flow Regime during Mining - Cross-Section View

Based on the thermal modelling (Golder 2017a), a closed talik is present to an approximate depth of 112 m below lake level (152.5 m) in the vicinity of Whale Tail Pit. The pit extends through this closed talik and into the underlying permafrost, with a maximum pit depth of 281.5 m below lake level (-129 masl). The permafrost extends deeper then the pit bottom, and overall is estimated to be present between 112.5 and 343 m below lake level.

The Underground development begins in permafrost and transitions to unfrozen bedrock in the sub-permafrost as it is deepened. The maximum depth of the underground is 658 m below current lake level, with the deepest Underground workings at an elevation -505 masl.

During mining, the Whale Tail Pit and Underground will act as a sink for groundwater flow, with seepage faces developing along the portions of the pit walls and Underground located in unfrozen rock in the sub-permafrost. In response to the deepening of the mine workings, groundwater will be induced to flow through bedrock to the Whale Tail Pit and the Underground. Mine inflow will originate primarily from Whale Tail Lake (South Basin), the Whale Tail Attenuation Pond, and deep bedrock underlying the permafrost. During mining, upward migration of brackish groundwater, with higher TDS concentrations from beneath the mine, will occur. The quality of mine inflow will be a result of the mixing of groundwater from each of these sources.

3.4 Groundwater Flow – Closure

Similar to operations, only Whale Tail Pit and the Underground are present in areas of talik and unfrozen rock during Closure (period of time following mining when the pits and underground are flooded). IVR Pit is located within the permafrost and groundwater inflow to the IVR Pit during closure will be negligible.

The conceptual hydrogeological model for groundwater flow conditions near the Whale Tail Pit and Underground near the end of closure is presented in Figure 8.

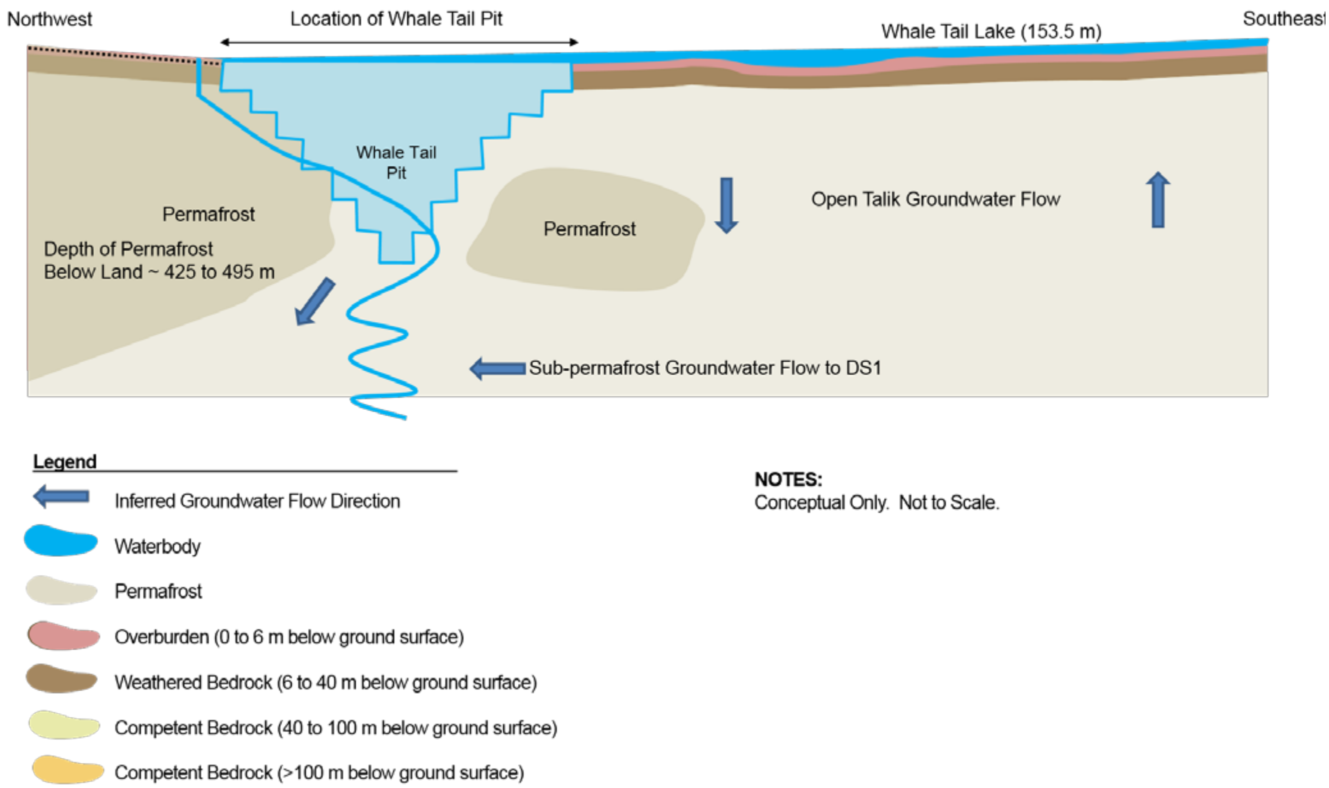


Figure 8: Conceptual Model of Deep Groundwater Flow Regime at the end of Closure - Cross-Section View

Mine closure will be initiated in 2025, and it is estimated that the Whale Tail Pit, IVR Pit, the Underground and the dewatered North Basin of Whale Tail Lake surrounding the Whale Tail Pit will be back-flooded over a period of approximately 16 years. The refilling process will dissipate the large hydraulic head differences established during mine operations near the mine workings and the rate of groundwater inflow to the mining areas will decrease as the water level in the Whale Tail Pit, IVR Pit t and Underground rises. The final reflooded elevation of Whale Tail Lake (153.5 masl) is slightly higher than the pre-development elevation of 152.5 masl.

As the Whale Tail Pit is reflooded it is expected that the permafrost present below the pit walls and base will begin to melt. The base of the pit is estimated to become hydraulically connected to the deeper groundwater flow system approximately 11 years into closure (Appendix A). IVR Pit is not expected to be connected to the deeper groundwater flow system within the closure period as the thickness of permafrost below the pit is significantly greater due to the pit being located within the regional permafrost.

3.5 Conceptual Model – Flooded Mine Development (Long-term Post-Closure)

Following flooding of the pits, the Underground, and the previously dewatered portion of Whale Tail Lake, natural drainage patterns will be re-established by breaching the Whale Tail Dike, Mammoth Dike, and Whale Tail Waste Rock Storage Facility (WRSF) Dike. When the groundwater level returns to near pre-mining conditions, the regional hydraulic gradients in the Expansion Project area are expected to return to conditions similar to what was present prior to mining but with the final elevation of Whale Tail Lake at 153.5 masl, which is slightly higher than the pre-development elevation of 152.5 masl. This one metre increase in lake level is expected to have negligible affect on hydraulic gradients in the deep groundwater flow system that connects lakes with open taliks, and on lake base flow within the study area, as the change in water level is small in consideration of the long travel distance to nearby lakes (generally over 1000 m). Any seepage in the active layer in the area of the land connection between the pit lake and Mammoth Lake, should there be any, would have the same water quality as that of the flooded Whale Tail Pit which would overflow to Mammoth in freshet. It would not be expected to have a measurable effect on water quality.

The flooded mine development is expected to provide recharge to the regional groundwater system. Based on the 2018 thermal study (Appendix A), the permafrost at the base of the Whale Tail Pit will continue to melt and eventually an open talik will be present below the full footprint of the pit (Figure 9). Open talik was also predicted to form below the IVR Pit, although at significantly slower rate (i.e., over approximately 1000 years).

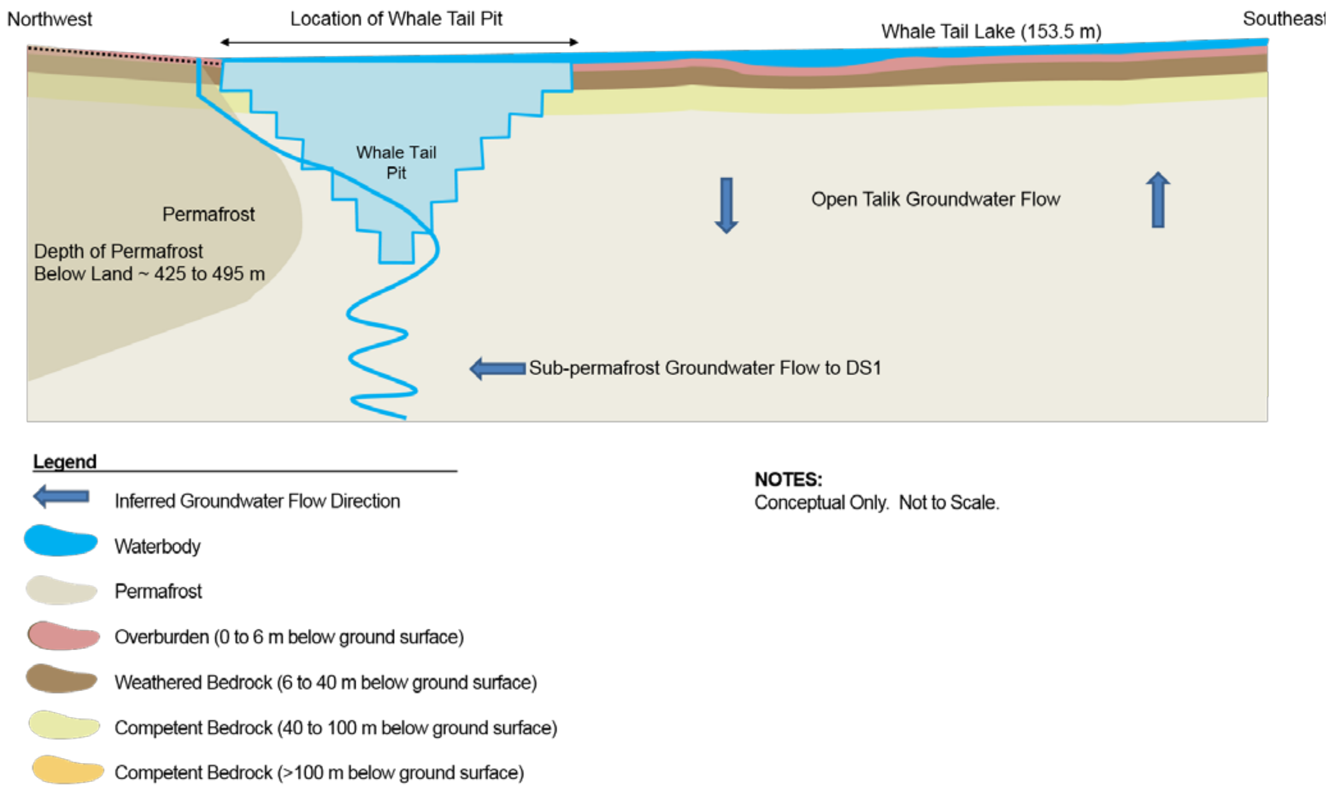


Figure 9: Conceptual Model of Deep Groundwater Flow Regime for the Flooded Mine Development - Cross-Section View

In saline environments, groundwater flow conditions can be affected by density differences in the water. During mining and filling of the pit lakes, when the magnitude of the hydraulic head gradients near the pit are higher, density-driven flow is relatively negligible. Following reflooding, when flow is primarily controlled by the regional gradients formed by the lake elevations within the study area, which are smaller, density-driven flow can be more significant.

The potential influence of density-driven flow on groundwater flow conditions for the flooded mine development was evaluated by assessing the ratio between the density-related driving force component and the pressure-related driving force component, or driving-force ratio (DFR) (Davies, 1989):

$$DFR = \frac{\Delta\rho|\nabla E|}{\rho_f|\nabla H_f|}$$

Where:

$\Delta\rho$ is the density difference, ∇E is the magnitude of gradient of elevation, ∇H_f is the magnitude of equivalent freshwater-head gradient and ρ_f is the density of water calculated based on the maximum TDS concentration in groundwater.

A DFR of 0.5 is considered an approximate threshold at which density-related gravity effects may become significant; values less than 0.5 indicate that density-related effects are not significant (Davies 1989). Based on the regional topographic and hydraulic gradient and the TDS vs depth profile adopted in this study (Section 2.3), a DFR of approximately 0.38 was estimated for post-closure. Therefore, density-dependent transport of solutes was not considered in the assessment of groundwater conditions for long-term post-closure, as the buoyancy effects were considered negligible in relation to the regional hydraulic head gradient.

4.0 3-D NUMERICAL HYDROGEOLOGICAL MODEL

To complete the hydrogeological assessment for the Expansion Project, the numerical hydrogeological model developed for the Approved Project was updated to reflect new data, the updated conceptual model, and the Expansion Project mine plan. The following section of the report documents the development and construction of the numerical model. The primary focus of this discussion is on model set-up for mining and reflooding phases. Additional changes were made to the model to represent the fully flooded mine, and these changes are described in Section 6.

4.1 Model Selection

The numerical code used for the development of a hydrogeological model should be capable of simulating key characteristics and features included in the site conceptual model. Consistent with the Approved Project, FEFLOW, a finite-element code from DHI-WASY (DHI-WASY 2017) was chosen for the development of the updated groundwater model. This code is capable of simulating transient, saturated-unsaturated groundwater flow, and density-coupled solute transport in heterogeneous and anisotropic porous media under a variety of hydrogeological boundaries and stresses. FEFLOW is particularly well suited for development of the site model because it allows for simultaneous predictions of groundwater flow and solute transport.

4.2 Model Extent and Mesh Configuration

The extent of the numerical model is based on the understanding of groundwater flow conditions near the Expansion Project, with lateral model boundaries set sufficiently far from the location of the open pits to allow adequate representation of pre-development conditions and potential seepage pathways during operations. The extent of the model is consistent with the Hydrogeology Baseline Study Area (Figure 5).

Figure 10 presents the model mesh. Horizontally, the model extends approximately 21 km in an east-west direction and 17 km in a north-south direction and is roughly centered on the Expansion Project area. The planar area of the model domain is approximately 242 km^2.

The mesh consists of approximately one million triangular elements with an approximate size of 25 m in the area around Whale Tail Lake where stronger hydraulic gradients are expected to develop during mine operations. Elements expand to a size of approximately 350 m along the model perimeter. Overall, the mesh spacing is considered to be of appropriate detail for simulation of hydrogeological conditions in the Expansion Project area.

Vertically, the model domain is discretized into 30 layers. The top of Layer 1 was set equal to 148 masl, or the average elevation of the bottom of Whale Tail Lake. The bottom of Layer 30 was set to a constant elevation of -1,500 masl, which is approximately 1000 m below the ultimate depth of the deepest planned Underground mine level at -505 masl.

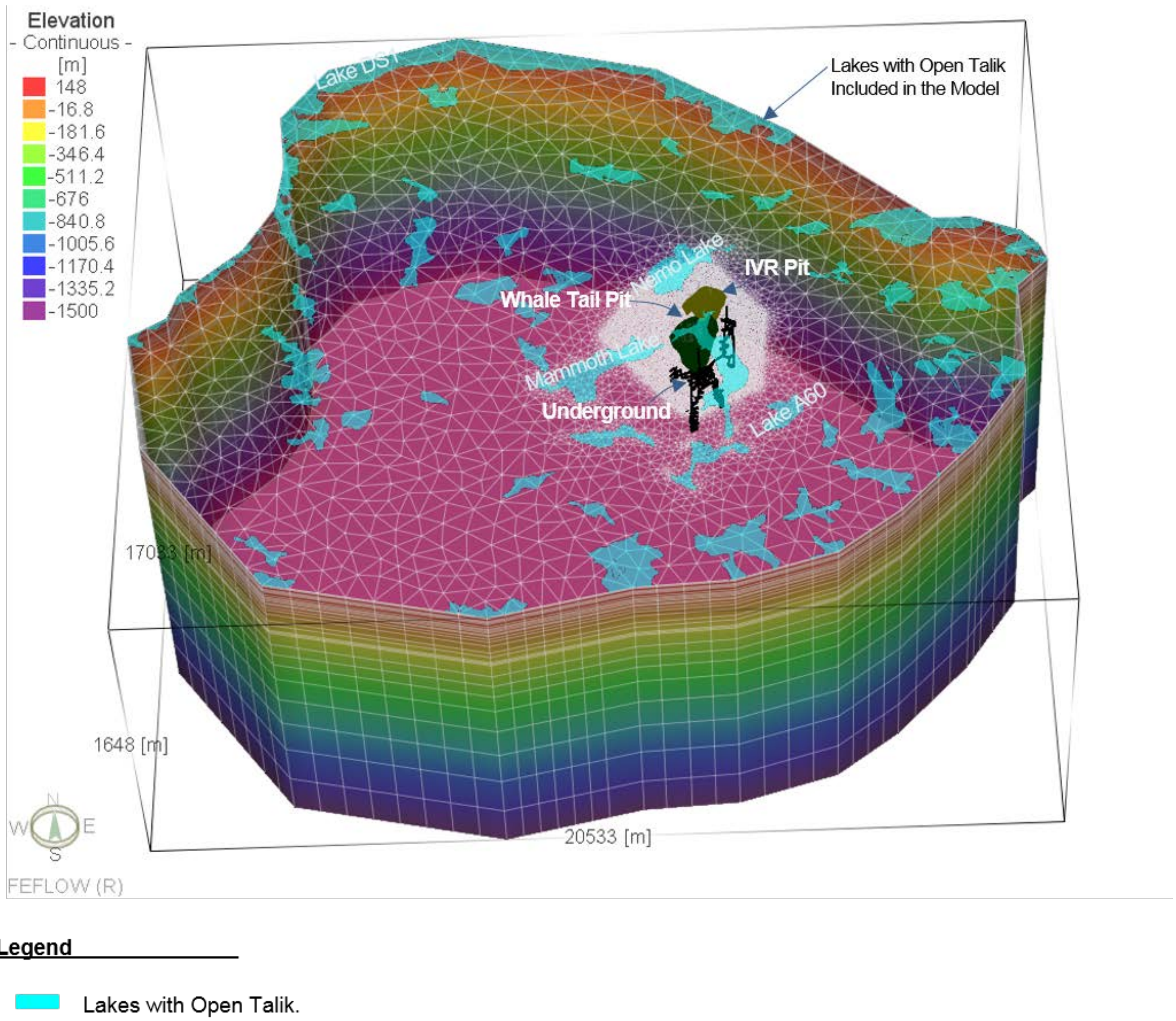


Figure 10: Hydrogeological Model Finite Element Mesh

4.3 Hydrostratigraphy and Model Parameters

Table 2 presents a summary of the hydrogeological properties assigned to each hydrostratigraphic unit for the Base Case Scenario. The Base Case Scenario reflects the most likely estimate of hydrogeological parameters based on hydraulic conductivity testing. Where in-situ values were not available, values were derived from testing near open pits at the Meadowbank Mine, from other nearby mining sites, and from typical values published in literature.

Table 2 also presents hydraulic parameters derived for the EA Scenario. These parameters are designed to be reasonable, yet conservatively high estimate of hydraulic conductivity, suitable for the prediction of potential effects of the Expansion Project on groundwater inflow quantity and quality. Figure 11 presents the assigned hydraulic conductivity values for the EA Scenario.

Table 2: Hydrogeological Parameters Used in Model

Unit	Depth Interval (m)	Hydraulic Conductivity (m/s)		Specific Storage (1/m) [b]	Specific Yield (-) [b]	Effective Porosity (-) [b]	Longitudinal Dispersivity (m) [c]	Transverse Dispersivity (m)[c]	Effective Diffusion Coefficient (m^2/s)
		Base Case [a]	EA Scenario						
Overburden	0 to 6	2×10^{-6}	2×10^{-6}	1×10^{-4}	0.2	0.2	10	1	2×10^{-10}
Weathered bedrock	6 to 40	1×10^{-5}	1×10^{-5}	2×10^{-4}	0.03	0.03	10	1	2×10^{-10}
Competent bedrock	40 to 100	7×10^{-8}	1×10^{-7}	1×10^{-5}	0.0006	0.001	10	1	2×10^{-10}
	100 to 200	9×10^{-9}	3×10^{-8}	1×10^{-5}	0.0006	0.001	10	1	2×10^{-10}
	>200	1×10^{-9}	4×10^{-9}	1×10^{-5}	0.0006	0.001	10	1	2×10^{-10}

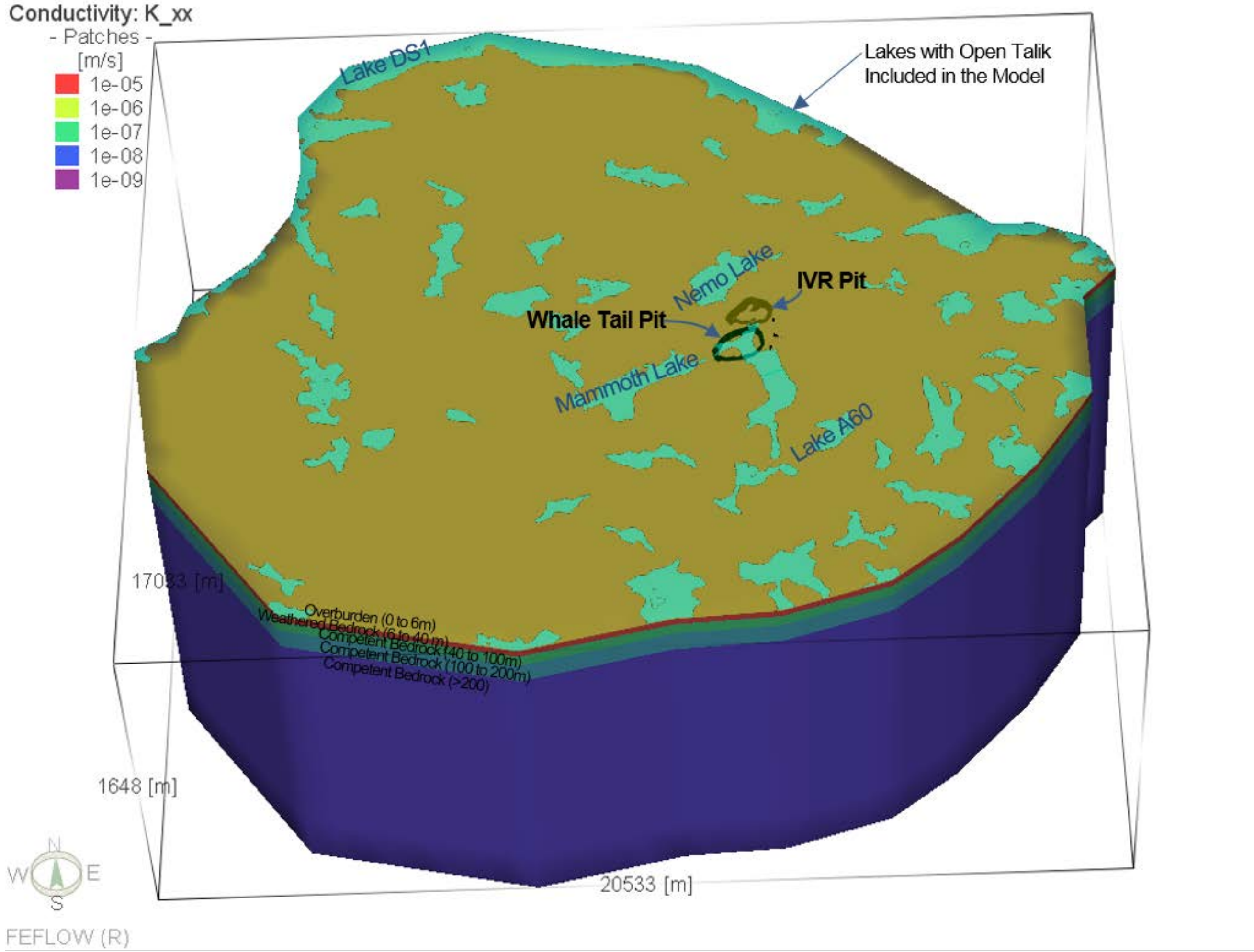
[a] Derived from hydraulic testing results as presented in Golder (2016b, 2017b), Knight Piesold (2015, 2016) and SNC (2017). Ratio of vertical to horizontal hydraulic conductivity assumed to 1:1.

[b] Parameter values within ranges documented in literature (Maidment 1992; Stober and Bucher 2007).

[c] Values are consistent with literature values (Schulze-Makuch 2005).

m = metre; m/s = metres per second; m^2/s = squared metres per second.

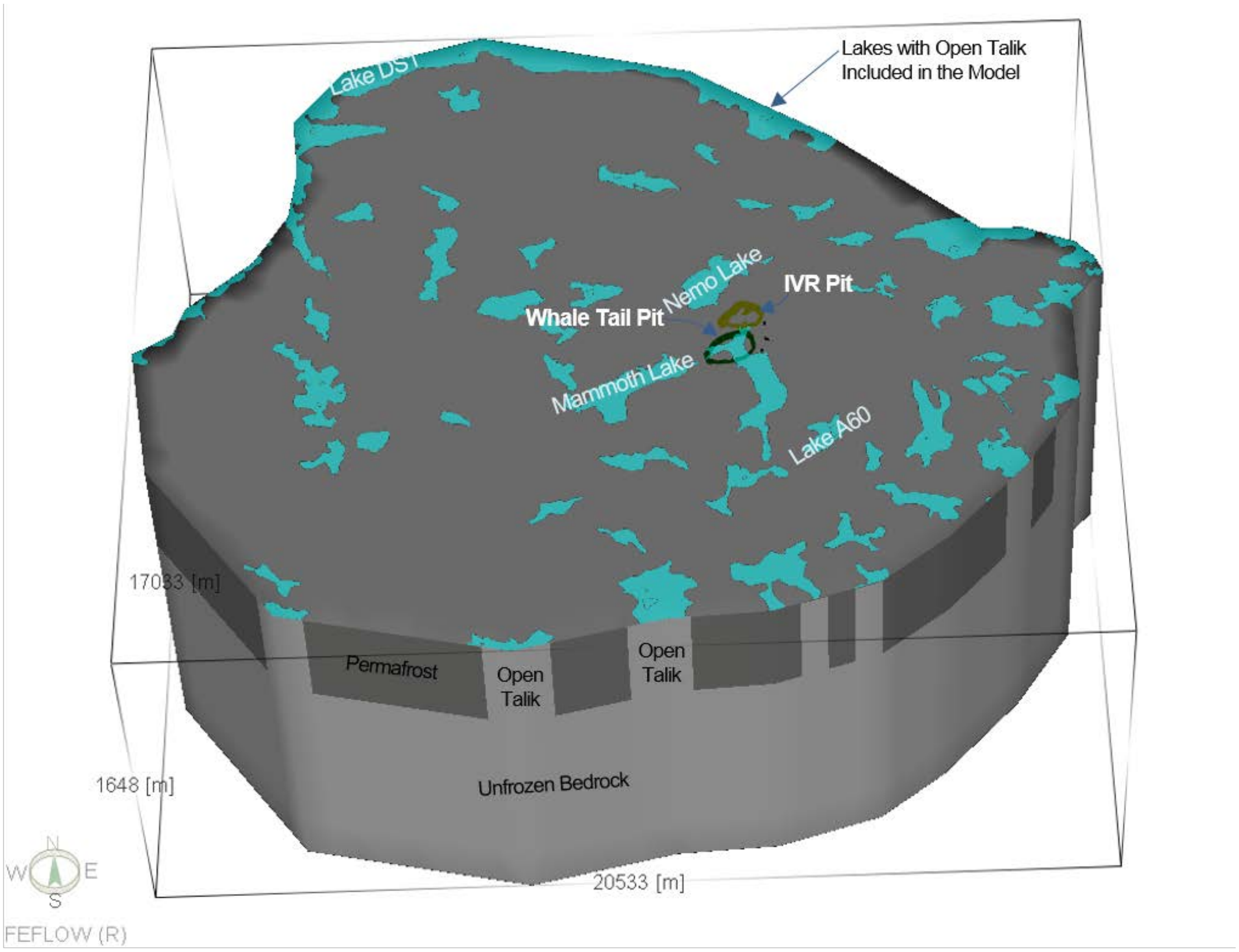
Mesh elements representing permafrost within the model domain were assumed to be effectively impermeable Figure 12). Outside of the Whale Tail Pit area, this low permeability was represented in the model by deactivating the model elements. Beneath Whale Tail Pit, where permafrost may melt during closure following the formation of the Pit Lake, the permafrost was represented by assigning a hydraulic conductivity approximately three orders of magnitude lower than the surrounding bedrock. The hydraulic conductivity was then modified 11 years into closure back to the unfrozen bedrock hydraulic conductivity to represent the connection of the base of the pit to the deeper groundwater flow systems. Modifications to the permafrost to represent the reflooded mine development are presented in Section 6.



Legend

Lakes with Open Talik

Figure 11: Hydraulic Conductivity Assigned to Numerical Model – EA Scenario



Legend

- Lakes with Underlying Open Talik (Specified Head Boundary)
- Inactive Element for Flow (Permafrost)
- Active Element for Flow (Talic or Unfrozen Bedrock)

Figure 12: Deactivated Elements within the Model to represent Permafrost and Locations of Simulated Lakes with Open Taliks

4.4 Mine Schedule

The November 2017 mine schedule for the Expansion Project was incorporated into the numerical model for the Whale Tail Pit and Underground. The IVR Pit is located within the regional permafrost; therefore, groundwater inflow during IVR mining and reflooding phases will be negligible and was not simulated.

Dewatering of the North Basin of Whale Tail Lake is expected to be initiated in February/March 2019 and be finished by June 2019. Mining within the talik below the dewatered North Basin is expected to start in August 2019 and to be finished at the end of 2024. Flooding of the Whale Tail Pit and was modelled to commence in 2026 and be completed by 2036. Flooding of the North Basin of Whale Tail Lake was modelled to continue until 2041.

4.5 Model Boundary Conditions

Model boundary conditions provide a link between the model domain and the surrounding hydrologic and hydrogeological systems. Two types of flow boundary conditions were used in the model; specified head and no-flow (zero-flux) boundaries.

4.5.1 Flow Boundary Conditions

Specified-head boundaries were assigned to the model to represent lakes that are assumed to have open taliks connected to the deep groundwater flow regime. These boundaries are consistent with the Approved Project and were set to the measured average lake elevation, where available (Golder 2016a), or to the topographic elevation of the surrounding ground if such data were not available. It was assumed that the surface water/groundwater interaction at all lakes was not impeded by lower-permeability lakebed sediments that may exist on the bottom of the lakes.

Specified-head boundaries were assigned to the model to represent the Whale Tail Attenuation Pond which was conservatively assumed to be unlined and in direct connection with the bedrock (no overburden), with a water level elevation of 143.5 m.

Time-variable specified-head boundaries were assigned to Layer 1 of the model to represent the dewatering and back-flooding of the North Basin of Whale Tail Lake. In the dewatering period, the water level was varied from the original water elevation of Whale Tail Lake (152.5 masl) to the average elevation of the bottom of the lake (148 masl), which varies from approximately 138 masl to 152.5 masl. At the end of mining and after the reflooding of the open pit, these boundaries were modified to represent the reflooding of the dewatered lake basin.

Mine workings (i.e., the Whale Tail Pit and the Underground) were simulated in the model using specified-head boundaries. The boundaries were assigned to nodes within the perimeter of the mine envelope and activated according to the mining schedule. Elements within the mine envelope were progressively deactivated over time as the pit was deepened below a model layer. During mining, the head boundaries were assigned to the nodal elevation/pit or underground wall elevation and were constrained to only allow water to flow from bedrock into the mine (i.e., boundaries acted as a seepage face). During reflooding, the boundaries were adjusted to represent the flooding of the pit and underground and were set to the flooded elevation within the mine workings once the flooded level rose above the elevation of the node.

No-flow boundaries were used to represent inferred groundwater flow divides, flow lines and permafrost along the perimeter of the model. A no-flow boundary was also applied along the bottom of the model at a depth of 1.6 km below ground surface (an elevation of -1,500 masl). Groundwater flow at greater depths is expected to be negligible.

4.5.2 Transport Boundary Conditions and Initial Conditions

Three types of boundary conditions were used to simulate transport of TDS in groundwater: specified-concentration boundaries, zero-flux boundaries, and exit (Cauchy type) boundaries.

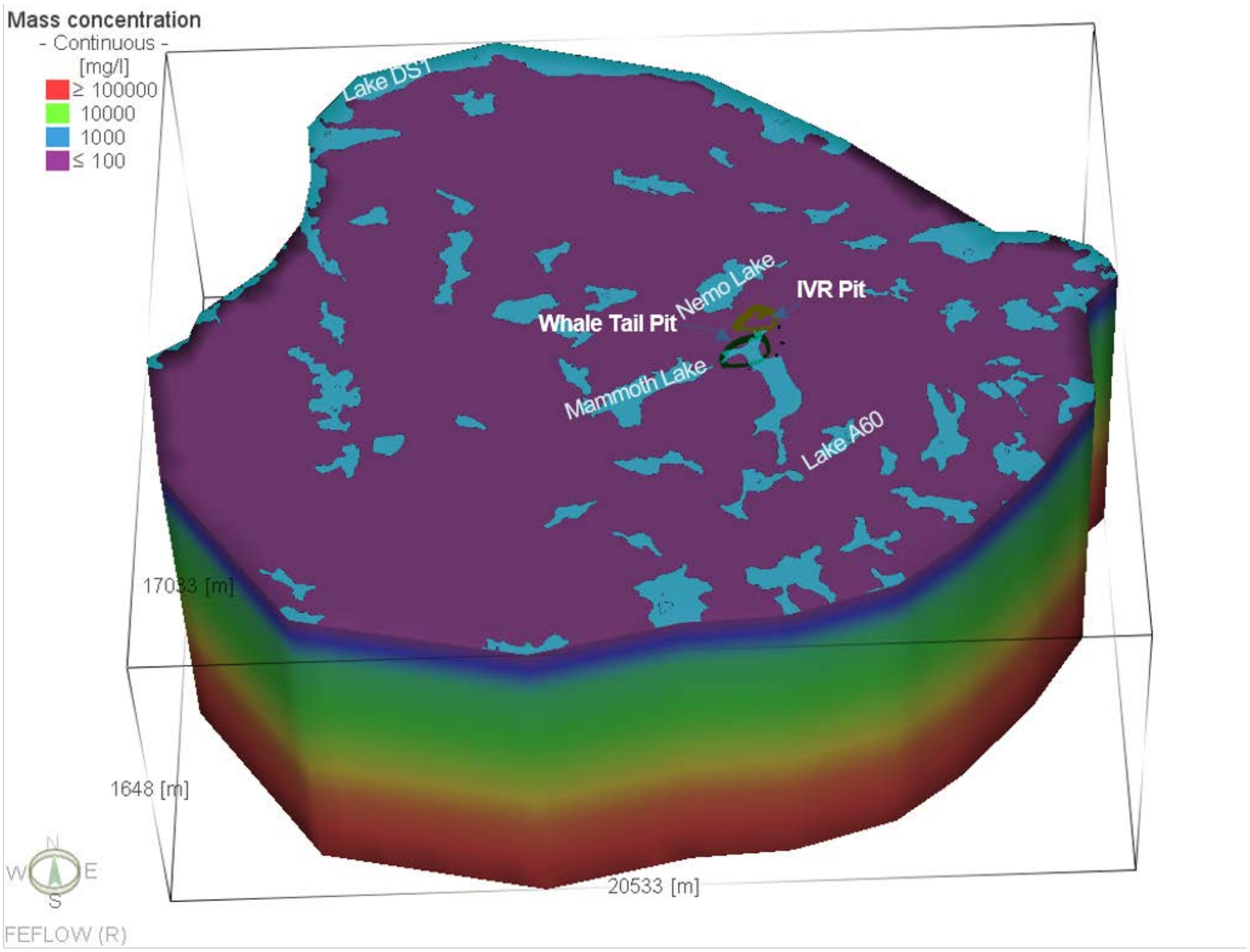
Specified-concentration boundaries were assigned to the bottom of all lakes assumed to have open taliks, to the Whale Tail Attenuation Pond, and to the portion of Whale Tail Lake that is not dewatered. The specified-concentration boundaries were assigned a concentration of zero milligrams per litre (mg/L); therefore, the model only accounts for the TDS contribution from groundwater in the predicted flow to the mining areas. Although TDS will also be contributed from the Whale Tail Attenuation Pond and from nearby lakes, the mass loading from these features during mining and reflooding phases will be accounted for outside of the numerical hydrogeological model as part of the Site Wide Water Quality Model. Discussion of these boundary conditions for the fully flooded mine development is provided in Section 5.0.

The Whale Tail Attenuation Pond is located between the Whale Tail dike and Whale Tail Pit and could act as both a recharge and discharge boundary. For predicted flow into the model domain (i.e., flow from the pond to bedrock) the specified concentration of 0 mg/L was applied; however, the boundary was constrained such that if groundwater was predicted to discharge to the pond, the boundary switched to an Exit (Cauchy type) boundary, which simulates the free movement of TDS out of the surrounding groundwater flow system and into the pond.

Exit (Cauchy type) boundaries were also assigned to the nodes representing the unfrozen pit walls and the Underground workings. These boundaries simulate the movement of TDS mass out of the surrounding groundwater system and into the mine workings.

Zero-flux boundaries were applied along the bottom of Layer 30, approximately 1.6 km below the ground surface. Mass flux from beneath this depth was considered to have negligible effect on model predictions.

Figure 13 presents the initial TDS concentrations in groundwater in each model layer, which were assigned based on the Whale Tail TDS depth profile presented on Section 2.3.



Legend

Lakes with Talik (Specified Concentration Boundary)

Figure 13: Initial TDS Concentrations Assigned to Numerical Model

4.6 Summary of Assumptions and Limitations of the Numerical Model Code and Approach

An overall summary of the assumptions and limitations of the numerical modelling is provided in Table 3, including those associated with the underlying modelling codes.

Table 3: Assumption and Limitations of the Groundwater Model

Groundwater flow in the bedrock was simulated as "equivalent porous media." Flow in bedrock is assumed to be laminar, steady, and governed by Darcy's Law.
Horizontal mesh discretization of approximately 25 m, and vertical mesh discretization between 6 and 20 m, were used to provide sufficient spatial resolution for simulation of groundwater flow and transport near the open pit.
Values assigned to model input parameters were based on hydrogeological investigations conducted by Knight Piésold (2015, 2016), Golder (2016b, 2017b) and SNC (2017), values published for nearby pits at the Meadowbank project, other nearby mining projects, or published in the literature where site-specific data were not available.
Surface waterbodies were simulated using specified-head boundaries. It was assumed that the permeability of sediments beneath these waterbodies is similar to the underlying geologic strata. Thus, no restriction of flow between the surface water and underlying hydrostratigraphic units was simulated.
Groundwater flow deeper than approximately 1.5 km below ground surface was assumed to be negligible and to have negligible influence on model predictions.

m = metres; km = kilometres.

5.0 MODEL PREDICTIONS - PRE-DEVELOPMENT, DEWATERING, MINING, AND FILLING PHASES

The following section of the report provides groundwater model predictions for pre-development, dewatering, mining and reflooding phases of the Expansion Project. Predictions for mining and reflooding phases are limited to the Whale Tail Pit and Underground, where groundwater flow to these mining areas are expected.

The IVR Pit is in an area of regional permafrost; therefore, during mining and reflooding groundwater inflows to the pit were assumed to be negligible. Following reflooding and the formation of the IVR Pit lake, the permafrost is predicted to melt and connect the IVR Pit lake to the deep bedrock flow system. Based on the results of the thermal assessment (Appendix A), it is expected to take approximately 1000 years for the regional permafrost to fully melt below the IVR Pit lake and connect the lake to the deep groundwater flow regime system.

This section is subdivided as follows:

- Section 5.1 presents model predictions for the Base Case Scenario. These predictions represent the best estimate of groundwater inflow and groundwater salinity (TDS) based on the measured data.
- Section 5.2 presents the sensitivity analysis conducted to evaluate the potential effects of the uncertainty in the assigned hydraulic conductivity parameters on the Base Case model predictions. The sensitivity analysis was used to guide the development of a more conservative model scenario for the purposes of evaluating potential effects of the Expansion Project on groundwater flow;
- Section 5.3 presents model predictions for the EA Scenario. Hydraulic conductivity values adopted in the EA Scenario consider the available field measurements of hydraulic conductivity and the results of the sensitivity analysis. The EA Scenario is designed to be a reasonable, yet more conservative, assessment of potential groundwater inflow quantity and quantity such that the potential effects of the Expansion Project on

groundwater flow can be assessed. Results from the EA Scenario are used in the Site-Wide Water Balance and Water Quality model for the Expansion Project.

5.1 Base Case Scenario

5.1.1 Pre-Development

Pre-mining hydrogeological conditions for the Base Case are consistent with the conceptual groundwater flow model (Section 3.0), Groundwater flow is controlled by the relative elevations of lakes with open taliks in the study area and groundwater is predicted to flow from Lake A60 to Whale Tail Lake and from Whale Tail Lake to DS1. Whale Tail Pit is in the portion of Whale Tail Lake that is predicted to recharge the sub-permafrost groundwater flow system and then flow towards Lake DS1.

5.1.2 Dewatering and Mining

Table 4 presents a summary of the predicted groundwater flow rates and groundwater TDS concentration to the mine development areas for the Base Case Scenario during dewatering and mining. The predictions presented in Table 4 are conceptually shown on Figure 14 and include: predicted groundwater inflow to Whale Tail Pit, predicted groundwater inflow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom). Groundwater inflow to the IVR Pit during mining is not included as the pit is in permafrost (groundwater inflow will be negligible). Some interception of surface water runoff and direct precipitation by the IVR Pit is excepted, but this is not a flow component derived from the groundwater modelling. It is addressed in the Water Balance and Water Quality Model for the Expansion Project.

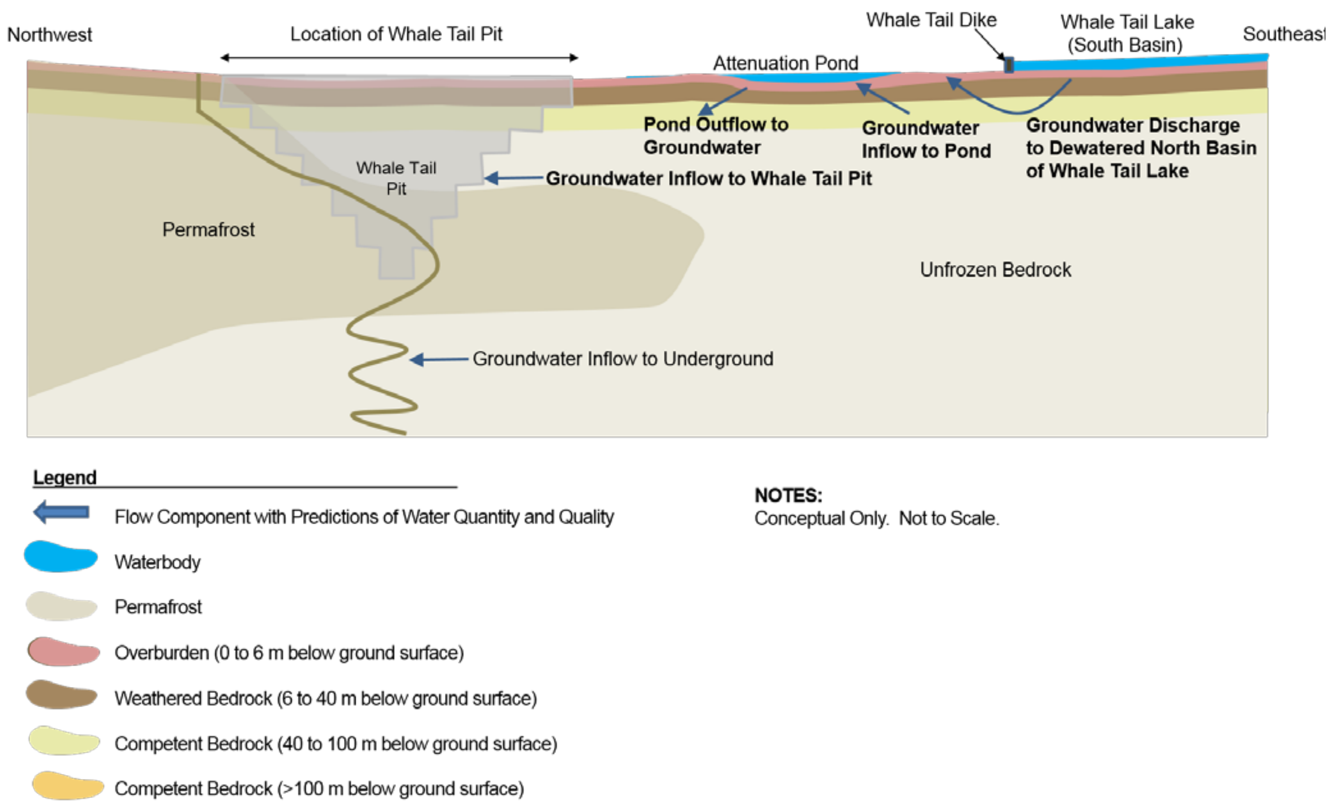


Figure 14: Conceptual Schematic showing Areas with Provided Predictions of Groundwater Inflow

Whale Tail Pit

In the last quarter of 2019, following dewatering of the North Basin of Whale Tale Lake, mining is expected to intersect the closed talik, and groundwater inflow to the pit is predicted to be 1,140 m^3/day (Table 4). Groundwater inflow to the Whale Tail Pit was predicted to increase to 1,350 m^3/day near the end of mining. The overall inflow to the pit does not increase significantly as the pit deepens because the flow of water is primary through the permeable weathered bedrock and the lower portion of the pit is in permafrost.

Groundwater inflow predictions during mining conservatively assumes that no freeze-back will occur in the pit walls. This assumption was adopted for Whale Tail Pit to be conservative and because during the first few years of mining, the pit will be both widened and deepened, resulting in the continual exposure of unfrozen bedrock. During the later years of mining; however, the pit development will be entirely within the permafrost and significant freeze back in the pit walls is considered possible and has been observed at Meadowbank. Although not simulated, if freeze back does occur as is the case at Meadowbank, actual groundwater inflow to the pit could be substantively lower than the predicted values in Table 4.

TDS concentration in the groundwater inflow to the pit was predicted to decrease during mining from approximately 120 mg/L (2019) to 10 mg/L (2023 to 2025). The relatively low TDS concentration and decrease in TDS over time reflects the minimal upwelling of higher salinity waters at depth due to the presence of the permafrost at the base of the pit and the high contribution of lake water and Whale Tail Attenuation Pond water. As previously discussed, the predicted TDS concentrations in this model only account for TDS loading from groundwater. TDS loading from the Whale Tail Attenuation Pond and South Basin of Whale Tail Lake is accounted for in the water quality model.

Underground

For the Underground, groundwater inflow was predicted to increase from 30 m^3/day in 2020, which is the first year the Underground development will be within unfrozen bedrock, up to 200 m^3/day in 2023 and 2024, which is when the Underground reaches its maximum depth of -505 masl. TDS concentration in the groundwater inflow to the Underground was predicted to increase from 3,880 mg/L in 2020 to 7,780 mg/L near the end of mining. The predicted increase in TDS concentration is the result of the interception of higher salinity groundwater as the mine is deepened, and the upwelling of higher TDS water from beneath the Underground.

Predictions of groundwater inflow do not include potential inputs from direct precipitation within the footprint of the open pit and/or surface water runoff from the surrounding areas. Dewatering rates for the Whale Tail Pit and Underground may therefore be higher than the groundwater inflow rates presented in this report. The site-wide water balance accounts for these contributions and potential flow of water through the active layer (which is hydraulically driven by snow melt and precipitation).

Table 4: Predicted Groundwater Inflow and Groundwater Salinity during Dewatering and Mining – Base Case Scenario

Phase	Time Period	Whale Tail Pit		Underground		Whale Tail Attenuation Pond			North Basin of Whale Tail Lake (within the diked area) [3]	
		Groundwater Inflow (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L)	Surface Water Outflow (m^3/day)	Groundwater Discharge to Surface (m^3/day)	Inflow TDS Concentration (mg/L)
Lake Dewatering	March-July 2019	-	-	-	-	-	-	-	1340	80
Mining	August-December 2019[1]	1140	120	NA	NA	350	100	170	650	70
	2020	1190	50	30	3880	120	160	860	720	30
	2021	1330	30	30	4090	90	150	1040	730	20
	2022	1350	20	120	5660	90	130	1080	720	10
	2023	1350	10	200	6890	90	110	1080	720	10
	2024	1350	10	200	7410	90	80	1080	720	10
	2025	1340	10	150	7780	90	70	1080	720	10

Notes:
IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance. 1Mining prior to Q4 2019 is within permafrost and groundwater inflow will be negligible.
2TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
[3]Exlcudes the area of the attenuation pond and pit. Primary reflects the by-pass of water around the dike and to the dewatered lake bed surface.
NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre.

5.1.3 Reflooding of Pits and Underground

Table 5 and Table 6 present a summary of the predicted groundwater flow rates and groundwater salinity (TDS) to the mine development areas for the Base Case Scenario during reflooding. The predictions presented in Table 5 and Table 6 include: predicted groundwater inflow to Whale Tail Pit lake, predicted groundwater flow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom surface). Groundwater inflow to the IVR Pit during reflooding was not included as the pit is in permafrost (groundwater inflow will be negligible).

The predictions presented for the reflooding period utilize a conceptual filling schedule for the Whale Tail Pit and the Underground, based on initial water balance predictions. Fine tuning of the flooding sequence was conducted after the conceptual filing schedule was developed: however, these adjustments will not have a significant impact on the predicted flow rates and salinity for a given elevation range.

For the prediction of pit-reflooding, the Whale Tail Pit walls were assumed to be frozen at the start of closure / end of mining, which restricts the inflow of groundwater to the pit lake until the pit lake water level rises and thaws the pit walls. This is considered reasonable as during the later years of mining, the pit development is limited to within the permafrost below Whale Tail Lake. If the pit walls do not remain frozen or melts seasonally, higher inflows than what is predicted could occur resulting in a shorter pit-filling period.

Considering the assumption of freeze-back in the Whale Tail Pit walls, groundwater inflow to the Whale Tail Pit was not predicted to occur until 2030, when the pit lake level rises above the top of permafrost elevation near the pit (approximately 40 masl) and begins to melt the freezing in the pit walls. The groundwater inflow to the pit lake was predicted to increase from 10 m^3/day in 2030 to approximately 1170 m^3/day in 2036 as the pit walls progressively become unfrozen and connected to the permeable weathered bedrock. As the pit lake water level continues to rise and steep hydraulic gradients near the pit walls dissipate, the groundwater inflows were predicted to decrease, and the pit lake eventually becomes a groundwater recharge boundary (i.e., the pit lake starts to recharge the regional sub-permafrost groundwater flow system).

The refilling of the Underground is expected to occur over a very short period (i.e. the bottom 500 m will be refilled in the first year). The water level in the Underground is therefore almost immediately higher then the hydraulic heads in bedrock near the Underground, resulting in a small but generally consistent flux of groundwater from the Underground to bedrock. At the end of the reflooding period (2041) the Underground remains a source of groundwater recharge.

Table 5: Predicted Groundwater Inflow and Groundwater Salinity during Reflooding – Base Case Scenario – Whale Tail Pit, Whale Tail Attenuation Pond and North Basin of Whale Tail Lake

Phase	Approximate Time Period	Water Level in Pit (masl)		Whale Tail Pit		Whale Tail Attenuation Pond			Dewatered North Basin of Whale Tail Lake (within the diked area)	
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L)[2]	Surface Water Outflow (m^3/day)	Net Groundwater Discharge to Surface[1] (m^3/day)	Inflow TDS Concentration[2] (mg/L)
Flooding	2026	-130	-76	NA	NA	150	35	<5	340	<10
	2027	-76	-39	NA	NA	170	30	<5	340	<10
	2028	-39	3	NA	NA	180	25	<5	340	<10
	2029	3	26	NA	NA	180	20	<5	340	<10
	2030	26	43	10	25	190	20	<5	340	<10
	2031	43	61	60	25	180	20	10	340	<10
	2032	61	73	100	25	170	20	30	340	<10
	2033	73	87	120	20	160	20	45	340	<10
	2034	87	101	130	20	160	20	50	340	<10
	2035	101	111	720	<10	130	30	500	330	<10
	2036	111	124	1170	<10	90	35	940	300	<10
	2037	124	133	920	<10	90	30	740	300	<10
	2038	133	142	360	<10	120	20	315	320	<10
	2039	142	149	-40	NA	70	30	140	370	<10
	2040	149	153.5	-10	NA	0	NA	10	160	<10
	2041	153.5	153.5	0	NA	0	NA	5	-10	NA

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.

[1]Positive values indicate flow to the pit lake or pond, and negative values indicate flow to bedrock.

[2]TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources is accounted for in the Site Wide Water Quality model.

NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre.

Table 6: Predicted Groundwater Inflow and Groundwater Salinity during Reflooding – Base Case Scenario – Underground

Phase	Approximate Time Period	Water Level in Underground (masl)		Underground	
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration[2] (mg/L)
Flooding	2026	-505	-76	-30	NA
	2027	-76	-39	<-5	NA
	2028	-39	3	<-5	NA
	2029	3	26	<-5	NA
	2030	26	43	<-5	NA
	2031	43	61	-5	NA
	2032	61	73	-5	NA
	2033	73	87	-10	NA
	2034	87	101	-10	NA
	2035	101	111	-10	NA
	2036	111	124	-10	NA
	2037	124	133	-15	NA
	2038	133	142	-30	NA
	2039	142	149	-15	NA
	2040	149	152.5	-15	NA
	2041	153	152.5	-10	NA

Notes:
IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
[1]Positive values indicate flow to Underground and negative values indicate flow to bedrock.
[2]TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre.

5.2 Sensitivity Analysis

Section 5.1 presented model predictions for the Base Case Scenario. These predictions represent the best estimate of groundwater inflow and groundwater salinity based on the measured data.

Due to the inherent uncertainty in the subsurface conditions and parameters controlling groundwater flow, uncertainty exists in the model predictions such that the actual inflow could be higher or lower than the Base Case values. This uncertainty in groundwater inflow during operations was evaluated using a sensitivity analysis. As part of this analysis, selected model parameters were systematically varied from the Base Case values, and the results were used to identify the parameters to which predicted groundwater inflow was most sensitive.

Three model input parameters were included in the sensitivity analysis. These included:

- **Weathered Bedrock Hydraulic Conductivity (6 m to 40 m depth)** – Hydraulic conductivity of weathered bedrock was increased and decreased by a factor of two from Base Case Values
- **Competent Bedrock (40 m to 200 m depth) Hydraulic Conductivity** – Hydraulic conductivity of the shallow competent bedrock was increased and decreased by a factor of three from Base Case Values
- **Competent Bedrock (below 200 m depth) Hydraulic Conductivity** – Hydraulic conductivity of deep competent bedrock was increased and decreased by a factor of three from Base Case Values

The sensitivity analysis was used to guide the development of a more conservative model scenario for the purposes of evaluating potential effects of the Expansion Project on groundwater flow;

During the sensitivity analysis, six simulations were completed (one adjustment for each parameter considered). Table 7 presents the predicted average groundwater inflow and TDS concentrations in the open pit and underground at the end of mining compared to the values predicted in the Base Case.

Table 7: Hydrogeological Model - Results of Sensitivity Analysis

Sensitivity Scenario		Predicted Groundwater Inflow at the End of Mining				Predicted TDS Concentration at the End of Mining			
		Whale Tail Pit		Underground		Whale Tail Pit		Underground	
		m^3/day	% Change	m^3/day	% Change	mg/L	% Change	mg/L	% Change
Base Case		1350	NA	200	NA	10	NA	7410	NA
Weathered Bedrock	K x 2	2630	+95%	200	0%	5	-50%	7410	0%
	K / 2	700	-48%	190	-5%	20	+100%	7410	0%
Competent Bedrock (40 to 200 m depth)	K x 3	1410	+4%	200	0%	12	+20%	7410	0%
	K / 3	1330	-1%	200	0%	9	-10%	7410	0%
Competent Bedrock (below 200 m depth)	K x 3	1350	0%	410	+105%	10	0%	9075	+22%
	K / 3	1350	0%	100	-50%	10	0%	7017	-5%

Note: K = Hydraulic Conductivity. Kx2 and Kx3 = Hydraulic conductivity a factor of 2 or factor 3 higher than Base Case values respectively. K/2 or K/3 = Hydraulic conductivity a factor of 2 or factor of 3 lower than Base Case values respectively. % change calculated relative to Base Case Values.

Results of the sensitivity analysis indicate that the quantity and salinity of groundwater inflow predicted for the Whale Tail Pit was most sensitive to the hydraulic conductivity assigned to the weathered bedrock. Pit inflow quantity and quality was relatively insensitive to the hydraulic conductivity of the deeper competent bedrock.

Results of the sensitivity analysis indicate that the quantity and salinity of groundwater inflow predicted for the Underground was most sensitive to the hydraulic conductivity assigned to the deep competent bedrock (below 200 m). The unfrozen weathered bedrock is not encountered in the Underground mine (that portion of the bedrock is frozen); therefore, hydraulic conductivity of this shallow bedrock does not affect groundwater inflow predictions to the Underground.

The weathered bedrock has the highest number of packer tests (28 in unfrozen rock); therefore, there is a reasonable degree of confidence in the bulk properties of this unit. However, given the sensitivity of predictions to this value, conservatism was adopted in selecting the hydraulic conductivity for both the Base Case and EA Scenario, and a value of three times the geometric mean (1×10^{-5} m/s) was assigned to both predictive scenarios. For other bedrock units, where less data are available, the hydraulic conductivity of the bedrock was increased in the EA Scenario by a factor of 1.5 to 4.

5.3 Environmental Assessment Scenario

The Base Case predictions discussed in the preceding section provides the most likely predictions of groundwater inflow quantity and quality for the Expansion Project based on the available hydraulic conductivity data (Section 2.1). Considering the number of tests available, however, and in consideration of the sensitivity analysis, an EA Scenario was developed to provide a reasonable yet conservative estimate of groundwater inflow such that there is a high level of confidence that the potential effects of the Expansion Project on groundwater inflow quantity and salinity have not been underestimated. Results from the EA Scenario are used in the Site-Wide Water Balance and Water Quality Models for the Expansion Project. Hydraulic conductivity values adopted in the EA Scenario relative to the Base Case are presented in Section 4.3.

5.3.1 Pre-Development

Pre-mining hydrogeological conditions for the EA Scenario are consistent with the Base Case (Section 5.1.1). Groundwater flow is controlled by the relative lake elevations with open taliks in the study area and groundwater is predicted to flow from Lake A60 to Whale Tail Lake and from Whale Tail Lake to DS1 (Figure 15). Whale Tail Pit is in the portion of Whale Tail Lake predicted to be recharging the sub-permafrost groundwater flow system and flowing towards Lake DS1.

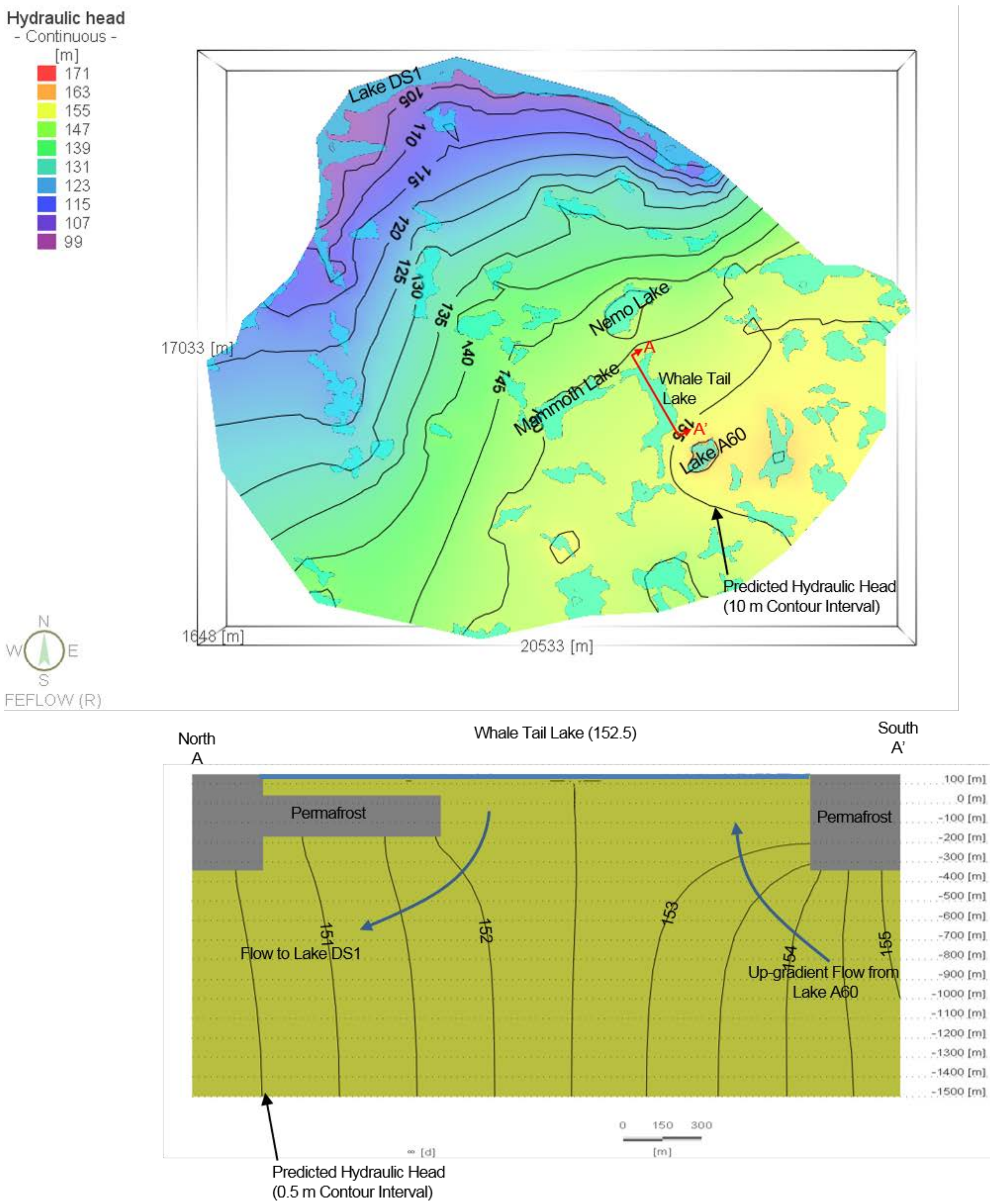


Figure 15: Predicted Hydraulic Heads - Pre-mining Conditions – EA Scenario

5.3.2 Dewatering and Mining

Table 8 and Table 9 present a summary of the predicted groundwater flow rates and groundwater TDS concentrations to the mine development areas for the EA Scenario during dewatering and mining. Figure 16 presents a summary of the predicted hydrogeological conditions at the end of mining in 2026 prior to reflooding the pit and Whale Tail Lake (North Basin). The predictions presented in Table 8 are conceptually shown on Figure 14 and include: predicted groundwater inflow to Whale Tail Pit, predicted groundwater inflow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Basin of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom surface). Groundwater inflow to the IVR Pit during operations is not included as the pit is in permafrost (groundwater inflow will be negligible). Some interception of surface water runoff and direct precipitation by the IVR Pit is excepted, but this is not a flow component derived from the groundwater modelling and will instead be addressed in the Site Wide Water Balance Model.

Whale Tail Open Pit

The predicted quantity and TDS of groundwater inflow into the open pit during mining for the EA Scenario is similar to the Base Case and assumes no freeze-back in the pit walls. For the EA Scenario, the groundwater inflow to the open pit was predicted to increase from 1,140 m^3/day in 2019 to 1,360 m^3/day in 2025 and the TDS concentration was predicted to decrease from 120 mg/L in 2019 to 10 mg/L in 2025. Groundwater inflow is controlled by the shallow bedrock hydraulic conductivity, which was not modified between the Base Case and EA Scenario due to the high number of tests in this unit and the conservatism used in the Base Case Scenario.

Underground

For the EA Scenario, groundwater inflow to the Underground was predicted to increase from 70 m^3/day in 2020 to 430 m^3/day in 2025 and the predicted TDS concentration was predicted to increase from 4,200 mg/L in 2020 to 11,200 mg/l in 2025. These groundwater inflow rates are approximately 2 to 3 times higher than the Base Case values for the same period of mining. Predicted TDS concentrations for the EA Scenario are 44% higher than the Base Case at the end of mining and reflect more upwelling of deeper more saline groundwater beneath the Underground.

Contribution to the inflow to the Whale Tail Pit and the Underground from the Whale Tail Attenuation Pond and the South Basin of Whale Tail Lake was evaluated for the EA Scenario to support the Site-wide Water Quality Model. TDS concentrations from these sources are accounted for in the Site-wide Water Quality model through a feedback loop. The quantity contributions predicted by the hydrogeological model are presented in Table 8 and 9. In 2020, approximately 62% of groundwater inflow to the pit is originating from the Whale Tail Attenuation Pond. The pond represents the major contributor to groundwater inflow to the pit due to its connection to the pit through the permeable shallow bedrock. The contribution from the pond was predicted to increase to 81% at the end of mining. The contribution from the South Basin of Whale Tail Lake is also predicted to increase from 3% in 2021 to 15% at the end of mining in 2025. In the Underground, the source of groundwater inflow is attributed only to water from deep bedrock flow system.

Table 8: Predicted Groundwater Inflow and Groundwater Quality during Dewatering and Mining - EA Scenario – Whale Tail Pit and Underground

Phase	Time Period	Whale Tail Pit				Underground			
		Groundwater Inflow (m^3/day)[3]	Inflow TDS Concentration (mg/L) [2]	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)	Net Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L) [2]	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)
Lake Dewatering	March-July 2019	NA	NA	NA	NA	NA	NA	NA	NA
Mining	August-December 2019[1]	1140	120	1%	<1%	NA	NA	NA	NA
	2020	1200	50	62%	<1%	70	4200	<1%	<1%
	2021	1340	30	79%	3%	80	4770	<1%	<1%
	2022	1370	20	80%	9%	300	6460	<1%	<1%
	2023	1370	20	81%	12%	510	8270	<1%	<1%
	2024	1360	10	81%	14%	510	9810	<1%	<1%
	2025	1360	10	81%	15%	430	11200	<1%	<1%

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.

[1]Mining prior to Q4 2019 is within permafrost and groundwater inflow will be negligible.

[2]TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.

NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Table 9: Predicted Groundwater Inflow and Groundwater Salinity during Dewatering and Mining - EA Scenario – Whale Tail Attenuation Pond and Whale Tail Lake (North Basin)

Phase	Time Period	Whale Tail Attenuation Pond				North Basin of Whale Tail Lake (within the diked area)[1]		
		Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)	Pond Outflow (m^3/day)	Net Groundwater Inflow (m^3/day)[3]	TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)
Dewatering	Match-August 2019	NA	NA	NA	NA	1350	80	1%
Mining	August-December 2019	350	100	0%	180	650	70	39%
	2020	120	160	0%	860	720	30	86%
	2021	90	150	5%	1050	730	20	98%
	2022	90	130	22%	1090	720	10	99%
	2023	90	110	47%	1090	720	10	99%
	2024	90	90	70%	1090	720	10	>99%
	2025	90	70	89%	1090	720	10	>99%

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.

[1] Predictions of groundwater inflow to North Basin of Whale Tail lake represents the discharge of groundwater to the lake basin during dewatering and mining. This excludes discharges to the pit and Whale Tail Attenuation Pond, which are within the North Basin of Whale Tail Lake.

[2]TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources are accounted for in the Site Wide Water Quality model.

NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

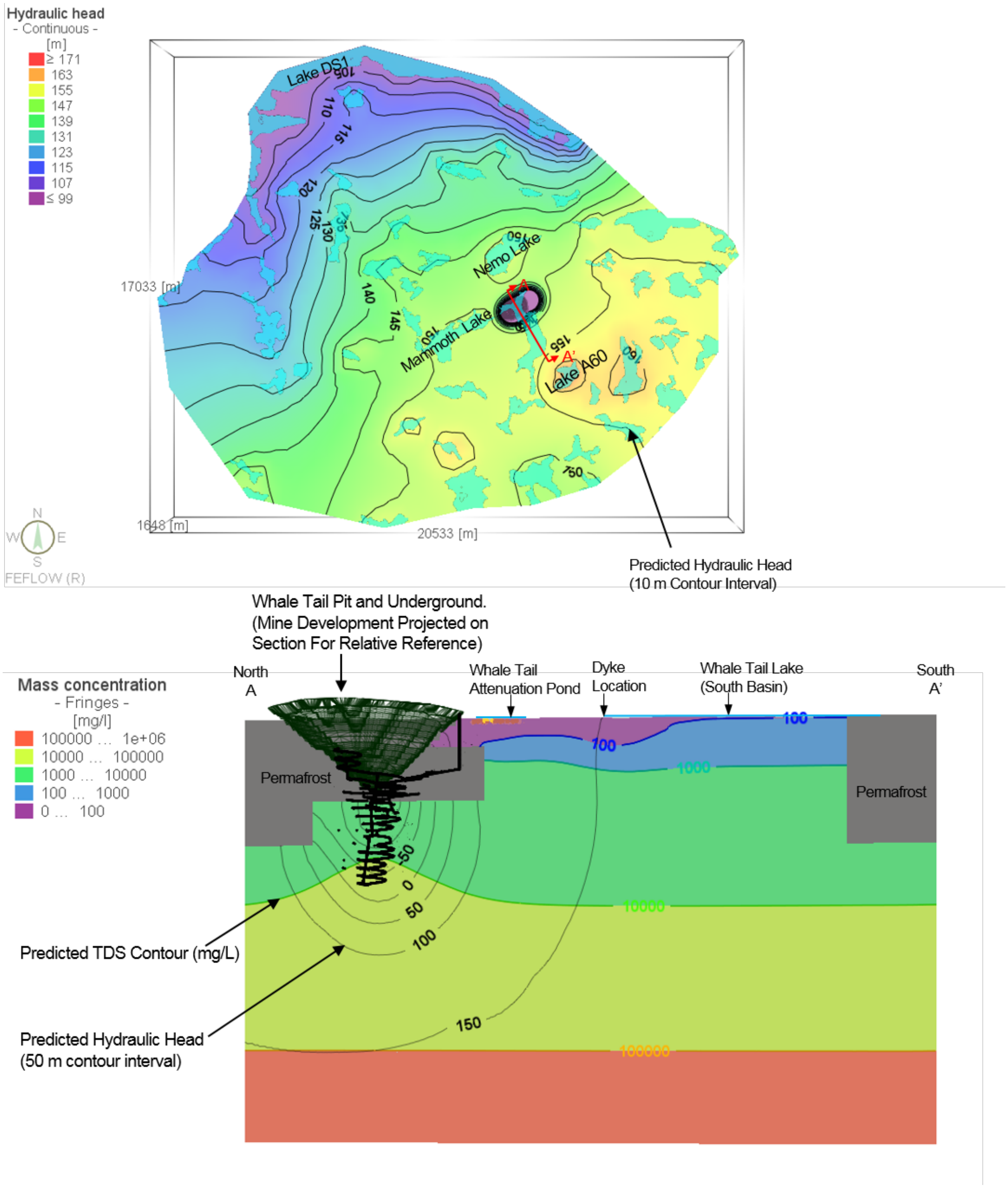


Figure 16: Predicted Hydraulic Heads and TDS Concentrations - End of Mining – EA Scenario

5.3.3 Reflooding of Pits and Underground

Table 10 and Table 11 presents a summary of the predicted groundwater inflow rates and groundwater TDS concentration to the mine development areas for the EA Scenario during reflooding. The predictions presented in Table 10 and Table 11 include: predicted groundwater inflow to Whale Tail Pit Lake, predicted groundwater flow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom surface). Groundwater inflow to the IVR Pit during refilling was not included as the pit is in permafrost (groundwater inflow will be negligible).

The predictions presented for the reflooding phase utilize a conceptual filling schedule for the Whale Tail Pit and the Underground, based on initial water balance predictions. Fine tuning of the flooding sequence was conducted after the conceptual filing schedule was developed; however, these adjustments will not have a significant impact on the predicted flow rates and salinity for a given elevation range.

Similar to the Base Case, the pit walls were assumed to be frozen at the start of closure / end of mining, which restricted the inflow of groundwater to the pit lake until the pit lake rises and thaws the pit walls. Predicted hydrogeological conditions at the end of refilling and flooding of the Whale Tail Lake (North Basin) are presented on Figure 17.

Considering the assumption of freeze-back in the pit walls, groundwater inflow to the Whale Tail Pit was not predicted to occur until 2030, when the pit lake level rises above the top of permafrost elevation near the pit (approximately 40 masl). When the water elevation in the pit lake rises above the permafrost, the freeze back is assumed to dissipate below the lake level and groundwater inflow to the pit was predicted to resume. The groundwater inflow to the pit lake was predicted to increase from 20 m^3/day in 2030 to approximately 1,180 m^3/day in 2036 as the pit walls progressively become unfrozen and connected to the permeable weathered bedrock. As the pit lake rises further in elevation, the groundwater inflows decrease and eventually the pit lake switches to a groundwater recharge boundary (i.e., the pit lake starts to recharge the sub-permafrost groundwater flow system).

At the start of reflooding, a small flux of groundwater inflow is predicted to discharge to the Underground, which likely reflects the higher hydraulic conductivity of the bedrock in the EA Scenario relative to the Base Case. Over time, as hydraulic gradients near the Underground dissipate, the Underground switches to a groundwater recharge boundary. At the end of the filling period (2041) the Underground remains a source of groundwater recharge to the sub-permafrost groundwater regime.

Table 10: Predicted Groundwater Inflow and Groundwater Salinity during Reflooding - EA Scenario – Whale Tail Pit, Whale Tail Attenuation Pond, North Basin of Whale Tail Lake

Phase	Approximate Time Period	Water Level in Pit (masl)		Whale Tail Pit				Whale Tail Attenuation Pond				North Basin of Whale Tail Lake (within the diked area)		
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	Inflow TDS Concentration [2] (mg/L)	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)	Pond Outflow (m^3/day)	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)
Flooding	2026	-130	-76	NA	NA	NA	NA	150	35	0%	<5	340	<10	>99%
	2027	-76	-39	NA	NA	NA	NA	170	30	2%	<5	340	<10	>99%
	2028	-39	3	NA	NA	NA	NA	180	25	11%	<5	340	<10	>99%
	2029	3	26	NA	NA	NA	NA	180	20	28%	<5	340	<10	>99%
	2030	26	43	20	25	46%	41%	185	20	46%	<5	340	<10	>99%
	2031	43	61	100	25	46%	41%	170	20	64%	25	340	<10	>99%
	2032	61	73	140	20	42%	49%	160	20	76%	55	340	<10	>99%
	2033	73	87	180	20	44%	51%	150	20	84%	80	340	<10	>99%
	2034	87	101	180	20	48%	47%	150	20	89%	90	335	<10	>99%
	2035	101	111	750	<10	69%	31%	120	25	92%	530	330	<10	>99%
	2036	111	124	1180	<10	81%	19%	85	30	95%	950	300	<10	>99%
	2037	124	133	920	<10	82%	18%	90	20	96%	740	300	<10	>99%
	2038	133	142	350	<10	82%	18%	115	15	97%	320	320	<10	>99%
	2039	142	149	-40	NA	NA	NA	70	20	97%	140	370	<10	>99%
	2040	149	153.5	-10	NA	NA	NA	0	NA	NA	10	160	<10	>99%
	2041	153.5	153.5	0	NA	NA	NA	0	NA	NA	5	-10	NA	NA

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.

[1]Positive values indicate flow to the pit/pond and negative values indicate flow to bedrock.

[2]TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.

NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Table 11: Predicted Groundwater Inflow and Groundwater Salinity during Refilling - EA Scenario – Underground

Phase	Time Period	Water Level in Underground (masl)		Underground			
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	Inflow TDS Concentration[2] (mg/L)	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)
Flooding	2026	-505	-76	35	11200	<1%	<1%
	2027	-76	-39	50	13600	<1%	<1%
	2028	-39	3	35	14300	<1%	<1%
	2029	3	26	25	15100	<1%	<1%
	2030	26	43	20	15500	<1%	<1%
	2031	43	61	15	15800	<1%	<1%
	2032	61	73	10	16200	<1%	<1%
	2033	73	87	5	16200	<1%	<1%
	2034	87	101	-5	NA	NA	NA
	2035	101	111	-10	NA	NA	NA
	2036	111	124	-15	NA	NA	NA
	2037	124	133	-20	NA	NA	NA
	2038	133	142	-40	NA	NA	NA
	2039	142	149	-30	NA	NA	NA
	2040	149	152.5	-30	NA	NA	NA
	2041	153	152.5	-25	NA	NA	NA

Notes:
IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
[1]Positive values indicate flow to the underground and negative values indicate flow to bedrock.
[2]TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

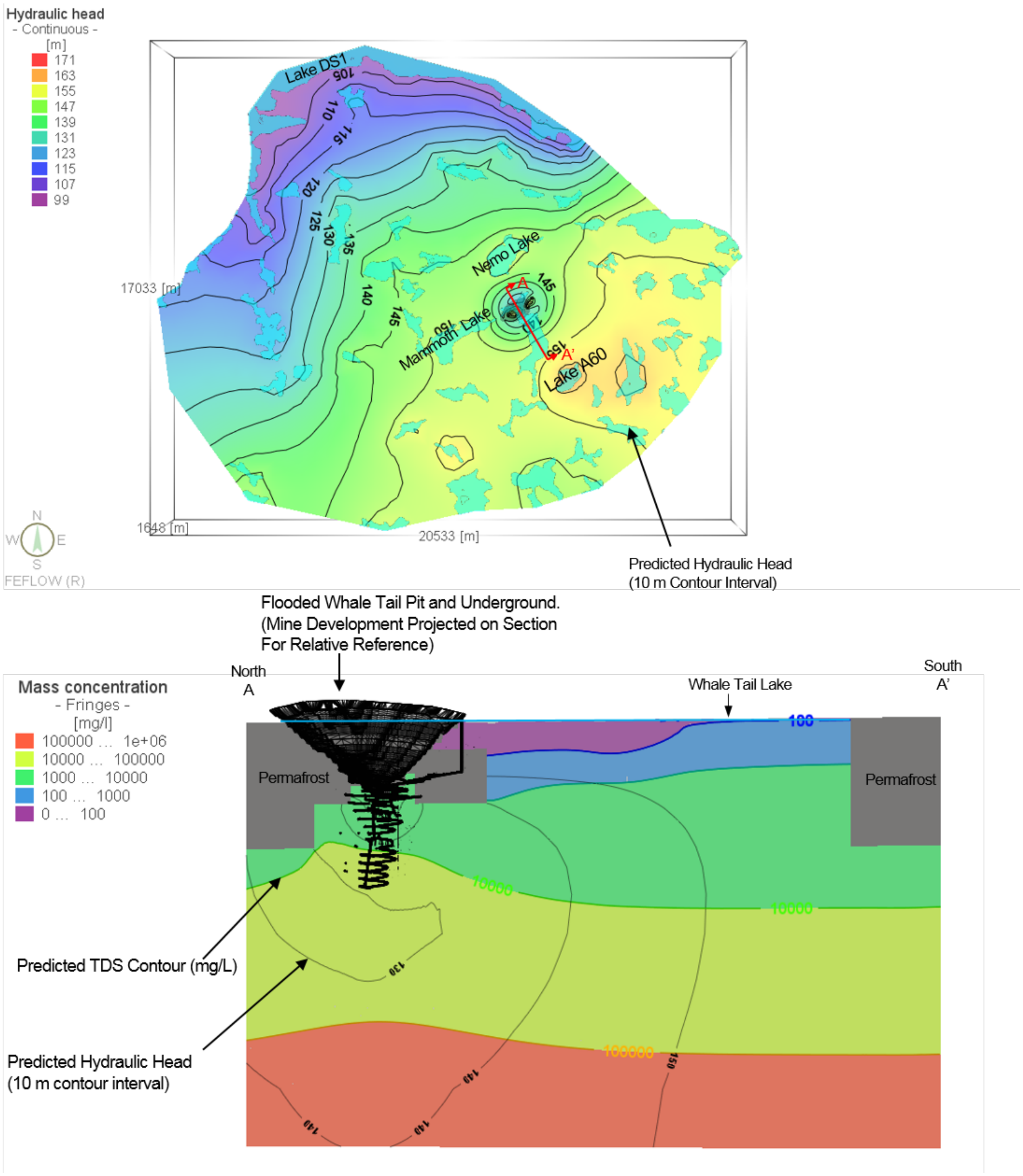


Figure 17: Predicted Hydraulic Heads and TDS - End of Filling - EA Scenario

6.0 MODEL PREDICTIONS – FULLY FLOODED MINE

The following section of the report provides groundwater model predictions following flooding of the mine development and North Basin of Whale Tail Lake to support the hydrodynamic modelling of the Whale Tail and IVR Pit lakes and the evaluation of long-term pit lake water quality.

The model predictions were provided for the EA Scenario, and utilizes the same model developed for mining and flooding, with some modifications to reflect the reflooded and long-term post-closure conditions. The changes to the model, adopted initial conditions, and a summary of the predictions are presented in Section 6.1 for the Whale Tail Pit lake and in Section 6.2 for the IVR Pit lake.

As discussed in Section 3.5, density-dependent transport of solutes was not considered for the assessment of groundwater conditions as the buoyancy effects were considered negligible in relation to the regional hydraulic head gradient.

Although the two pit lakes are connected following filling, the groundwater flow conditions surrounding the pit lakes are initially very different. The Whale Tail Pit lake is predicted by thermal analysis to be connected to the deep sub-permafrost groundwater 11 years into filling and for the permafrost below the pit lake to fully degrade over 50 years. The IVR Pit lake is predicted to be within permafrost during mining and flooding and for the permafrost below the pit lake to fully degrade over 1000 years.

6.1 Whale Tail Pit

6.1.1 Modifications to Model to Support Post-Closure Assessment

The following section describes the changes made to the EA Scenario model to predict conditions for the flooded Whale Tail Pit.

- Initial conditions for the model simulation were derived from the predicted conditions at the end of flooding for the EA Scenario.
- Specified-concentration and specified-head boundaries were assigned to the nodes representing the flooded Whale Tail Lake (153.5 m). A TDS concentration of 11 mg/l was assigned to the lake water quality, based on assumptions adopted in the Site-Wide Water Quality Model and Hydrodynamic Model.
- Specified-concentration and specified-head boundaries were assigned along the pit walls to represent the pit lake. The TDS concentration assigned to the boundary is 34 mg/L at all elevations of the pit lake based on the initial results of Site-Wide Water Quality Model for the Whale Tail Pit lake. Boundary constraints were used to automatically turn off the specified-concentration boundaries at locations where groundwater inflow to the pit lake was predicted, allowing the free exit of TDS mass from the model.
- During mining and flooding, the underground workings were represented using specified head boundaries to predict flow into and out of the Underground in response to dewatering and subsequent reflooding. For the fully flooded simulation of Whale Tail Pit, the underground was represented in the model using elements of high hydraulic conductivity (at least two orders of magnitude higher than the surrounding bedrock). This approach was adopted to simulate the potential preferential pathway the underground creates between shallow flow system under Whale Tail Lake and the deeper sub permafrost groundwater flow system.

- Initial permafrost conditions under the Whale Tail Pit lake were assumed to be equivalent to those assigned at the end of pit reflooding. Results of the thermal assessment (Appendix A) were used to incorporate the development of an open talik below the footprint of Whale Tail Pit. Based on the thermal study, the permafrost layer immediately beneath the Whale Tail Pit lake would be nearly fully melted in 50 years. The permafrost in the model near the pit was initially assigned a very low hydraulic conductivity of $1x10^{-12}$ m/s (approximately three orders of magnitude lower than the surrounding bedrock) and modified back to the unfrozen bedrock hydraulic conductivity at 50 years based on the results of the thermal assessment. The regional permafrost outside of the pit area was assumed to be essentially impermeable, and consistent with the model for mining and reflooding, the model elements in this area were deactivated. The permafrost conditions over time simulated in the model are presented in Figure 18.

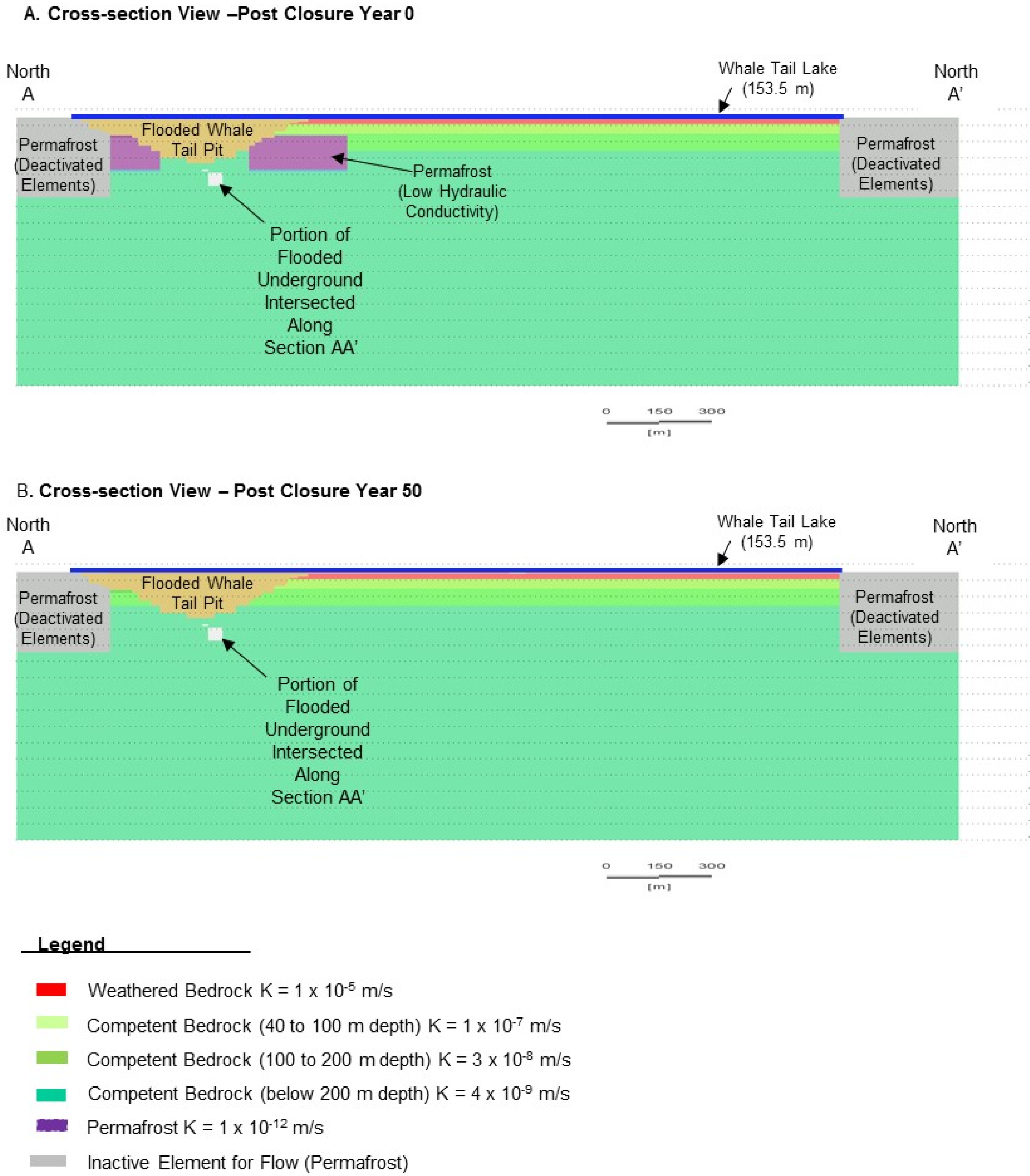


Figure 18: Permafrost Conditions Simulated Near Whale Tail Pit - Reflooded Mine Development

6.1.2 Prediction Results for Fully Flooded Whale Tail Pit

Table 12 and Figure 19 present predicted outflow from the Whale Tail Pit lake following full reflooding of the pit. The pit lake was predicted to recharge the regional sub-permafrost groundwater system from the first year after full flooding and over the sub-sequent 300 years. Over time, as the groundwater flow system near the flooded mine workings re-equilibrates and the shallow bedrock re-saturates and/or re-pressurizes, the amount of recharge to the sub-permafrost flow system decreases from 4.1 m^3/day in Year 1 to 1.5 m^3/day after 200 years. The long-term predicted pit lake discharge to the sub-permafrost groundwater flow system is predicted to be 1.5 m^3/day. No significant groundwater inflows to the pit lake were predicted.

Table 12: Predicted Whale Tail Pit Lake outflow following Flooding of the Mine Development

Time (Years after Reflooding)	Pit Lake Outflow to Groundwater (m^3/day)
1	4.1
50	3.1
100	2.3
200	1.5
300	1.5

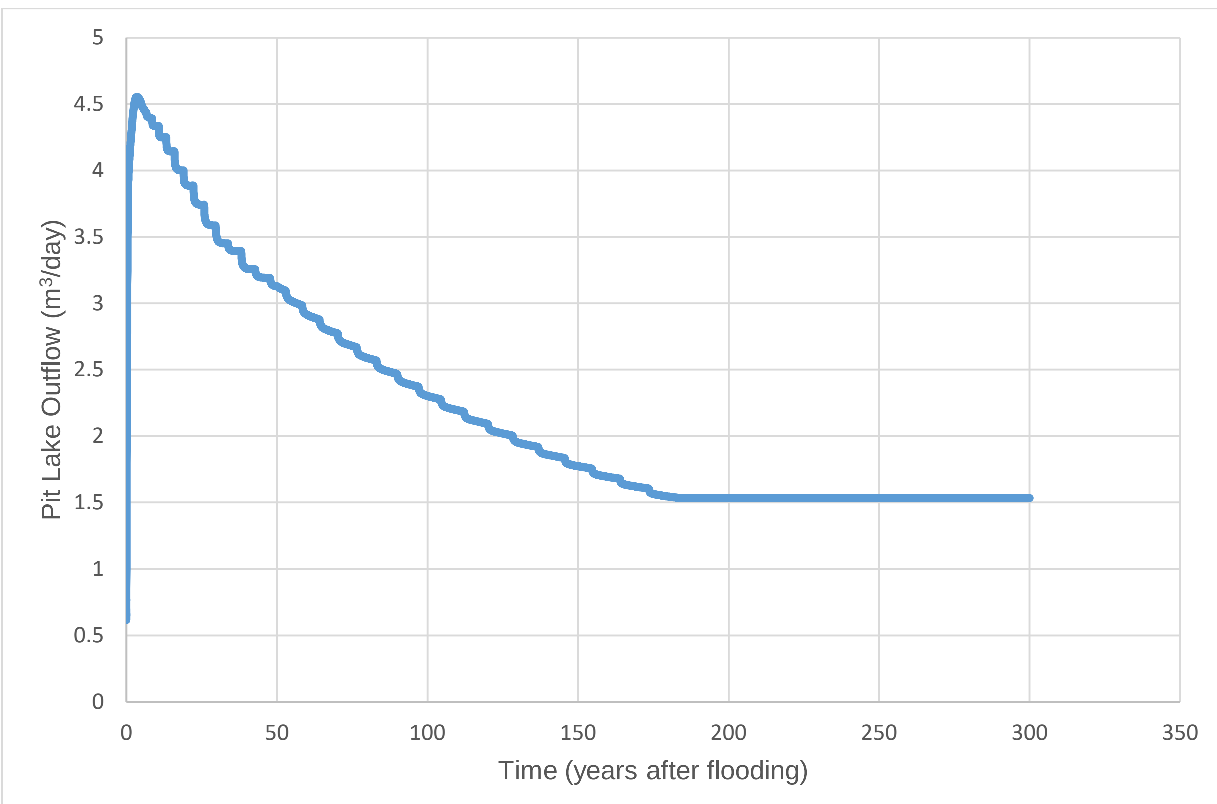


Figure 19: Predicted Pit Lake Outflow –EA Scenario – Flooded Mine Development

6.2 IVR Pit

The IVR Pit is in an area of regional permafrost: therefore, during mining and flooding groundwater inflows to the pit were assumed to be negligible. Following flooding and the formation of the IVR Pit lake, the permafrost is expected to melt and connect the IVR Pit lake to the sub-permafrost groundwater flow system. Based on the results of the thermal assessment (Appendix A), it is expected to take approximately 1000 years for the regional permafrost to fully melt below the IVR Pit lake and connect the lake to the deep groundwater flow system.

In consideration of the long timeline associated with the evolution of the permafrost, the fully flooded analysis of the IVR Pit was limited to a prediction of the long-term steady-state groundwater flow environment that would develop near the pit lake following the full melting of permafrost below the pit footprint. The hydrogeological model for the EA Scenario described in the previous section (Section 6.1) was used to simulate groundwater conditions over the long-term for the IVR Pit lake with the following modifications:

- The IVR Pit shell was simulated in the model. Specified head boundaries at 153.5 masl were assigned to the nodes representing the open pit to represent the fully-flooded open pit. Solute transport was not simulated for the IVR Pit as it is expected that the pit will act as a groundwater recharge boundary. This was verified by the model predictions.
- The inactive elements representing permafrost beneath the IVR Pit lake were reactivated to represent the formation of an open talik below the pit lake. Those elements were assigned hydrogeological properties of unfrozen bedrock.

Model results confirmed the assumption that the IVR Pit lake would act as recharge boundary to the regional groundwater system once the permafrost layer beneath the lake melts. The long-term predicted discharge from the IVR Pit lake to the sub-permafrost groundwater flow system was approximately 0.7 m^3/day.

6.3 Predicted Groundwater Inflow / Lake Outflow

Budget analyses were performed to estimate the changes to pre-mining groundwater inflows and outflows to lakes with open taliks beneath them within the hydrogeology baseline study area. This assessment was conducted to evaluate if the Expansion Project could potentially affect long-term baseflow (groundwater discharge) to the lakes within the study area following flooding of the mine development. The assessment considers conditions after the permafrost below both pit lakes has fully degraded, and long-term steady-state conditions are established.

Table 13 presents a summary of lakes within the hydrogeology baseline study area that had a predicted change (greater than 1 cubic metre per day [m^3/day]) in groundwater inflow and outflow relative to pre-development conditions during mining. Following reflooding, near to pre-mining hydraulic gradients and groundwater flow directions will be re-established once the open pits and the dewatered portion of Whale Tail Lake are flooded. Consistent with pre-development conditions, groundwater from Whale Tail Lake and the Whale Tail Pit lake was predicted to discharge to Lake DS1, along with water from the IVR Pit lake. Groundwater inflow to the southern portion of Whale Tail Lake will occur from Lake A60 to the southeast.

Hydraulic gradients following reflooding and establishment of long-term steady state conditions were used to estimate groundwater travel times from the Whale Tail Lake and the open pit lakes to DS1. Based on the shortest travel time, water from Whale Tail Lake or the flooded open pits was predicted to take over 1000 years to reach Lake DS1.

Table 13: Predicted Groundwater Inflows and Outflows from Lakes at End of Mining and Following Reflooding (Long-term Steady-State Condition)

Lake	Pre-Development	End of Mining		Reflooded (Long-term Post-closure)	
	(m^3/day)	(m^3/day)	(% change from Pre-Development)	(m^3/day)	(% change from Pre-Development)
A16	2.7	1.9	-20	2.7	0
A60	4.3	3.1	-28	4.3	0
A81	-5.2	-3.1	-40	-5.2	0
DS1	-49.4	-32.5	-34	-49.4	0
DS2	-2.6	-1.1	-57	-2.6	0
Nemo	6.5	4.6	-29	6.5	0

Note: Positive number denotes that the lake is a source of groundwater recharge. Negative number denotes that the lakes is a groundwater discharge zone.

m^3/day = cubic metres per day; % = percent.

7.0 SUMMARY AND CONCLUSIONS

To complete the hydrogeological assessment for the Expansion Project, the numerical hydrogeological model developed for the Approved Project was updated to reflect new data, the updated conceptual model, and the Expansion Project mine plan. The developed model was used to provide predictions of groundwater inflow quantity and salinity (TDS) for Whale Tail Pit and Underground over the life of the Expansion Project and for the IVR Pit, for long-term.

Thermistor data indicates the IVR Pit is in an area of regional permafrost; therefore, during mining and refilling, groundwater inflows to the pit were assumed to be negligible. Following refilling and the formation of the IVR Pit lake, the permafrost would be expected to melt and connect the IVR Pit lake to the sub-permafrost groundwater flow system. Based on the results of the thermal assessment (Appendix A), it is expected to take approximately 1000 years for the regional permafrost to fully melt below the IVR Pit lake and connect the lake to the sub-permafrost groundwater flow system.

Predictions of groundwater inflow quantity and TDS were provided for two scenarios:

- Base Case – Most likely estimate of hydrogeological parameters based on hydraulic testing. These predictions represent the best estimate of groundwater inflow and groundwater salinity based on the measured data.
- EA Scenario – Hydraulic conductivity values adopted in the EA Scenario consider the available field measurements of hydraulic conductivity and the results of the sensitivity analysis. The EA Scenario is designed to be a reasonable, yet more conservative, assessment of potential groundwater inflow quantity and quantity such that the potential effects of the Expansion Project on groundwater flow can be assessed. Results from the EA Scenario are used in the Water Balance and Water Quality model for the Expansion Project.

7.1 Pre-Development Conditions

Pre-mining hydrogeological conditions for the Base Case and EA Scenario were consistent with the conceptual groundwater flow system. Groundwater flow is controlled by the relative lake elevations in the study area and groundwater is predicted to flow from Lake A60 northwest to Whale Tail Lake and from Whale Tail Lake further northwest to DS1. Whale Tail Pit is in the portion of Whale Tail Lake predicted to be recharging the sub-permafrost groundwater flow system and flowing towards Lake DS1.

7.2 Mining

For the Base Case Scenario, groundwater inflow to the Whale Tail Pit is predicted to increase from an average of 1,140 m^3/day in 2019 to 1,350 m^3/day in 2025 and the TDS concentration of the inflow is predicted to decrease from 120 mg/L in 2019 to 10 mg/L in 2025[1]. The groundwater inflow to the Underground is predicted to increase from 30 m^3/day in 2020 to 200 m^3/day in 2023 and 2024, and the predicted TDS concentration is predicted to increase from 3,880 mg/L in 2020 to 7,780 mg/L near the end of mining.

For the EA Scenario, groundwater inflow to the Whale Tail Pit is predicted to increase from an average of 1,140 m^3/day in 2019 to 1,360 m^3/day in 2025 and the TDS concentration in the inflow is predicted to decrease from 120 mg/L in Q4 of 2019 to 10 mg/L in 2025[1]. The groundwater inflow to the Underground is predicted to increase from 70 m^3/day in 2020 to 430 m^3/day in 2025, and the predicted TDS concentration is predicted to increase from 4,200 mg/L in 2020 to 11,200 mg/l in 2025.

The groundwater inflow to the Whale Tail Pit is similar for both scenarios as a conservatively high estimate of hydraulic conductivity in the shallow weathered bedrock is adopted for both scenarios. For the deeper bedrock, less data were available, and a higher hydraulic conductivity is assumed in the EA Scenario relative to the Base Case. The predicted groundwater inflows and predicted TDS concentration to the Underground are therefore higher in the EA Scenario. The higher TDS is associated with increased predicted upwelling of deeper more saline groundwater beneath the Underground.

7.3 Flooding

Following mining, reflooding of Whale Tail Pit and Underground will begin dissipating the steep hydraulic gradients that developed during mining around the mine workings. By the end of refilling, both the Whale Tail Pit Lake and the Underground are predicted to be sources of groundwater recharge.

Groundwater flow to the Whale Tail Pit is expected to be affected by freeze back in the pit walls; therefore, groundwater inflows to the pit lake are expected to slowly increase as the pit lake rises and the walls thaw. For the Base Case, the groundwater inflow to the pit lake is predicted to increase from 10 m^3/day in 2030 to approximately 1170 m^3/day in 2036 as the pit walls progressively thaw and connect to the permeable weathered bedrock. Similar flow rates are predicted for the EA Scenario, where groundwater inflow to the pit lake is predicted to increase from 20 m^3/day in 2030 to approximately 1,180 m^3/day in 2036 as the pit walls progressively thaw and connect to the permeable weathered bedrock. As the pit lake water level rises further in elevation, the groundwater inflows for both scenarios decrease and eventually the pit lake becomes a groundwater recharge boundary (i.e., the pit lake starts to recharge the regional groundwater flow system).

[1] TDS predictions only account for TDS loading from groundwater and not loading from the Attenuation Pond and South Whale Tail lake. Loading from these sources was accounted for in the Site Wide Water Quality model.

The reflooding of the Underground is expected to occur over a very short period (i.e. the bottom 500 m will be reflooded in the first year). The water level in the Underground is therefore almost immediately higher than the hydraulic heads in bedrock near the Underground, resulting in a small but generally consistent flux of groundwater from the Underground to bedrock in both the Base Case and EA Scenario. At the end of the flooding phase (2041), the Underground is predicted to remain a source of groundwater recharge.

7.4 Fully Flooded Mine

Although the Whale Tail Pit Lake and IVR Pit are connected following full flooding, the groundwater flow conditions surrounding the pit lakes are initially very different. The Whale Tail Pit lake is predicted by thermal analysis to be connected to the deep sub-permafrost groundwater flow system during refilling, and for the permafrost below the pit lake to fully degrade over 50 years. The IVR Pit lake is predicted to be within permafrost during refilling and for the permafrost below the pit lake to fully degrade over 1000 years. The long-term groundwater recharge from the Whale Tail and IVR Pit lakes is predicted to be minimal; 1.5 m^3/day and 0.7 m^3/day, respectively.

Flow budget analyses was performed to estimate the changes to pre-mining groundwater inflows and outflows to lakes with open taliks beneath them within the hydrogeology baseline study area. This assessment was conducted to evaluate if the Expansion Project could potentially affect long-term baseflow (groundwater discharge) to the lakes within the study area after reflooding. The assessment considers conditions after the permafrost below both pit lakes has fully degraded, and long-term steady-state conditions are established.

The flow budget analysis indicates that small changes in lake baseflow may occur during mining (between less than 1 m^3/day to 29 m^3/day) but that following full reflooding of the Pit lake, the predicted groundwater flow to and flow the lakes would return to near pre-development flow rates.

7.5 Uncertainty

Sensitivity analysis conducted as part of the numerical modelling indicates that quantity and salinity (TDS) of groundwater inflow predicted for the Whale Tail Pit is sensitive to the hydraulic conductivity assigned to the shallow weathered bedrock but relatively insensitive to the hydraulic conductivity of the deeper competent bedrock.

Results of the sensitivity analysis indicate that the quantity and salinity of groundwater inflow predicted for the Underground is sensitive to the hydraulic conductivity assigned to the deep competent bedrock (below 200 m). The shallow weathered bedrock is in the frozen part of the Underground mine; therefore, hydraulic conductivity of this shallow bedrock does not affect groundwater inflow predictions to the Underground.

Results of the sensitivity analysis were incorporated in the parameters adopted in the EA Scenario, such that the EA Scenario predictions provide a reasonable yet conservative estimate of groundwater inflow. There is a high level of confidence that the potential effects of the Expansion Project on groundwater inflow quantity and salinity have not been underestimated.

Although direct thermistor measurements are not available for the inferred open talik area in the South Basin of Whale Tail Lake, 1-D analytical and 2-D thermal analysis predict an open talik would be present. The assumption of an open talik below the South Basin is conservative with respect to the prediction of potential groundwater inflow to the dewatered open pit, as it allows for higher inflows and the potential inflow of deeper saline groundwater into the open pit. If an open talik is not present, groundwater inflows could be less than predicted and of lower TDS.

Long-term post-closure predictions of groundwater flow to the Whale Tail North Basin area of the Pit Lake would not be expected to be affected by the assumption of an open or closed talik, as the permafrost will eventually degrade below the pit foot print and connect the shallow talik to the deeper sub-permafrost flow system. Long-term predicted post-closure flows from the pit lakes to the groundwater flow system are less than 2 m^3/day, which is negligible relative to the surface water exchange into the Pit lake when basins are reconnected post-closure. These predictions are reasonable considering the low hydraulic conductivity of the competent bedrock and the small hydraulic gradients that are present between the regional lakes and Whale Tail Lake. This indicates that the long-term lake level in the Pit lake will not be affected by the permafrost degradation, regardless of the current presence or absence of an open talik beneath the lake.

Signature Page

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PERMIT TO PRACTICE
GOLDER ASSOCIATES LTD.
Signature
Date Nov 16, 2018
PERMIT NUMBER: P 049
NT/NU Association of Professional Engineers and Geoscientists

AP/JL/DC/VJB/jr

https://golderassociates.sharepoint.com/sites/19830g/2000_phase2expansion/22000_hydrogeology/hydrogeology modelling report/rev0/1789310-213-rpt-hydrogeomodelling_rev0.docx

8.0 REFERENCES

DHI WASY. 2018. FEFLOW v.7.1 Finite Element Subsurface Flow and Transport Simulation System. DHI-WASY Institute for Water Resources Planning and System Research Ltd., Berlin, Germany.

Knight Piésold Consulting. 2015. Whale Tail Pit Permafrost and Hydrogeological Characterization. Prepared for Agnico Eagle Mines: Meadowbank Division.

Knight Piésold Consulting. 2016. Whale Tail Pit 2016 Geomechanical Site Investigation Summary. Prepared for Agnico Eagle Mines: Meadowbank Division.

Frape SK, Fritz P. 1987. Geochemical trends for groundwaters from the Canadian Shield; in saline water and gases in crystalline rocks. Editors: Fritz, P. and Frape, S.K. Geological Association of Canada Special Paper 33.

Golder Associates Ltd. 2016a. Agnico Eagle Mines: Meadowbank Division – Whale Tail Pit Project 2015 Hydrology Baseline Report. Dated January 2016.

Golder Associates Ltd. 2016b. Westbay System Installation Summary – Whale Tail Pit Project, Nunavut. Dated July 7, 2016 (Reference 1649355-003-TM-Rev0-4000).

Golder Associates Ltd. 2016c. Groundwater Quality Investigation, Amaruq, Nunavut. Dated 15 November 2016. (Reference 006-1649355_Doc080).

Golder Associates Ltd. 2017a. Whale Tail Lake Thermal Assessment, Whale Tail Pit Project, Nunavut dated 22 February 2017.

Golder Associates Ltd. 2017b. Hydrogeological and Permafrost Field Investigations, Amaruq Project 2017 Factual Report. Dated 31 July 2017. (Reference 1649355-008-R-Rev0-5000).

Golder Associates Ltd. 2018 in progress. Whale Tail Pit Expansion Project - Pit Lake Thermal Assessment in support of hydrogeological post-closure analysis.

Laherro P.W. and Lampen P.H., 1987. Brackish and saline groundwaters in Finland. Saline Waters and Gases in Vrystelline Rocks (P. Fritz and S.K. Frape, eds.. GAC Special Paper 33, 103-109.

Maidment, D.R. 1992. Handbook of Hydrology. McGraw-Hill, New York, USA.

Schulze-Makuch, D. 2005. Longitudinal dispersivity data and implications for scaling behaviour. GROUND WATER May/Jun 2005; 43, 3; ProQuest Science Journals p. 443.

SNC Lavalin. 2017. Preliminary Studies for the Water Management and Geotechnical Infrastructures at Amaruq. Dated 25 May 2017.

Stober, I., and K. Bucher. 2007. Hydraulic properties of the crystalline basement. Hydrogeol J. 15:213-224.

APPENDIX A

2018 Thermal Analysis in Support of Post-closure Hydrogeological Predictions

TECHNICAL MEMORANDUM

DATE 16 November 2018 **Project No.** 1789310-206-TM-Rev0

TO Jamie Quesnel
Agnico Eagle Mines Limited

CC Michel Groleau, Valérie Bertrand

FROM Fernando Junqueira and Serge Ouellet **EMAIL** Fernando_Junqueira@golder.com; Serge_Ouellet@golder.com

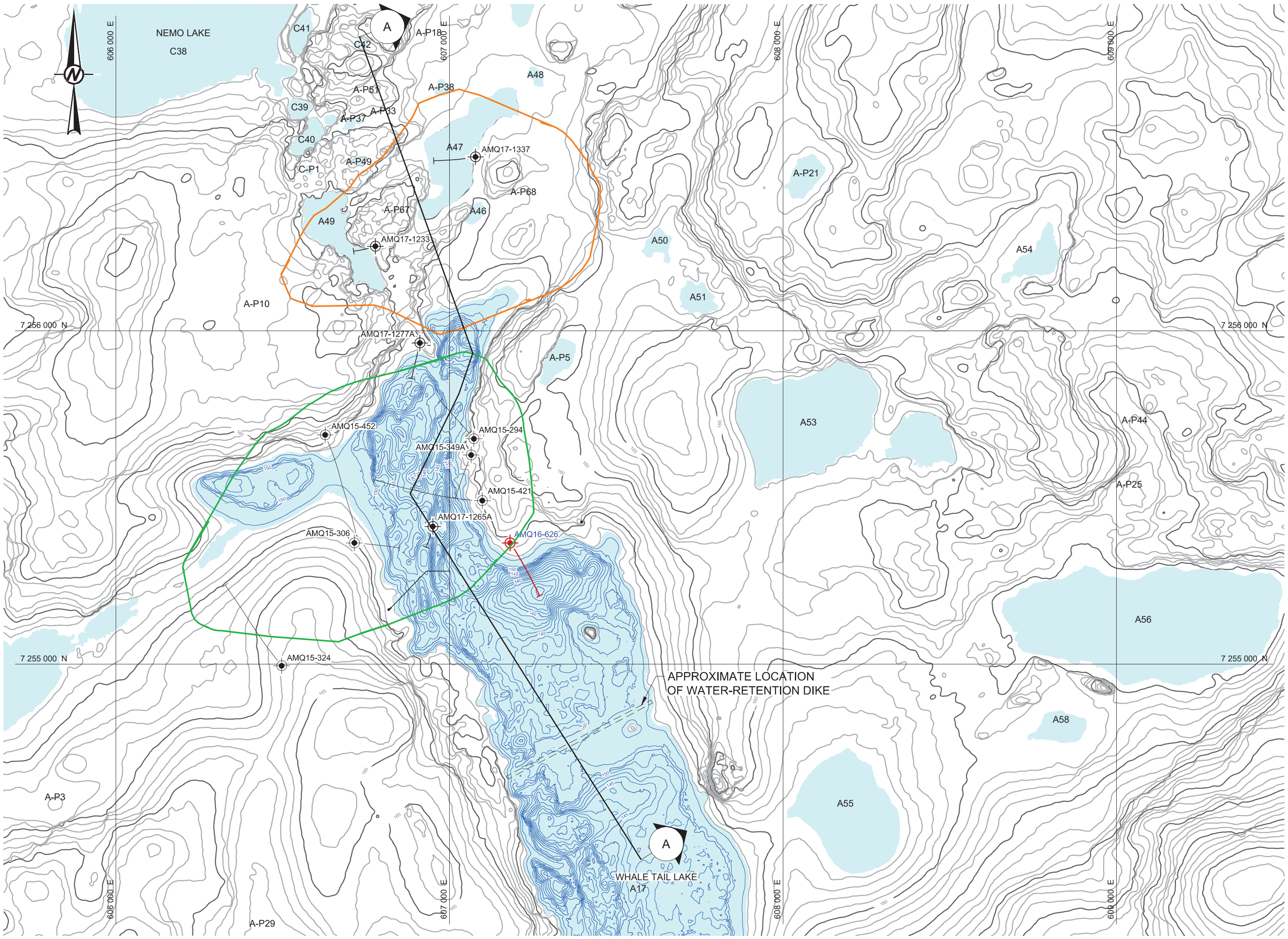
PIT LAKE THERMAL ASSESSMENT IN SUPPORT OF HYDROGEOLOGICAL POST-CLOSURE ANALYSIS WHALE TAIL PIT EXPANSION PROJECT

1.0 INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) is currently evaluating the potential development for mining the Whale Tail Pit Project (Project), a satellite deposit located on the Amaruq exploration property in Nunavut. The Amaruq property is a 408 km^2 site located in Inuit Owned Land approximately 150 km north of the hamlet of Baker Lake and approximately 50 km northwest of Agnico Eagle's operating Meadowbank Mine.

In support of post-closure hydrogeological modelling for the Whale Tail Pit, IVR Pit and Underground mine (Expansion Project), this technical memorandum presents a summary of the permafrost conditions based on the available thermistor data to October 2017, and thermal modelling results of predicted thermal conditions under the Whale Tail and IVR pit lakes post-closure. The two-dimensional (2D) thermal analysis was conducted to evaluate thawing progress of the permafrost below the Whale Tail and IVR pits following the formation of the IVR/Whale Tail Pit Lake during closure and post-closure. The locations of Whale Tail and IVR pits are presented on Figure 1.

This thermal assessment included a review of the original Whale Tail Lake talik estimation based on available thermistor data at the time of the FEIS (Agnico Eagle 2016); the previous assessment completed by Golder (2017a); and ground thermal conditions in the Whale Tail Lake area based on thermistor data to the end of October 2017, with modelling being initiated in December 2017, when this study commenced. The model predicts thermal changes during and after flooding the Whale Tail and IVR pits.



LEGEND

- EXISTING GROUND SURVEY
- EXISTING BATHYMETRY
- WATER BODY
- THERMISTOR
- WESTBAY SYSTEM
- PROPOSED WHALE TAIL PIT
- PROPOSED IVR PIT

NOTE(S)

1. ALL UNITS ARE IN METERS UNLESS NOTED OTHERWISE.
2. CONTOUR INTERVAL 1m MINOR AND 5m MAJOR.

REFERENCE

BASE PLAN AND BATHYMETRY DATA RECEIVED FROM AGNICO EAGLE MINES LTD. DATE RECEIVED NOVEMBER 25, 2016.
CAD FILE: COURBESZM_AMARUQ_GLOBAL_UTM14_20150929.DWG
CAD FILE: 1665858-2100B-CM-0002.DWG
CAD FILE: 61-000-142-001_R0BLOC.DWG

0 250 500
1:12,500 METRES

CLIENT	AGNICO EAGLE AGNICO EAGLE MINES LIMITED	PROJECT	WHALE TALE PIT PROJECT POST CLOSURE PIT LAKE THERMAL ANALYSIS NUNAVUT
CONSULTANT	GOLDER	TITLE	**SITE PLAN AND SECTION LOCATION**
YYYY-MM-DD	2018-11-16		
DESIGNED	CM		
PREPARED	MSH		
REVIEWED	FJ		
APPROVED	SO		

PROJECT NO.	PHASE/TASK/DOC#	REV.	FIGURE
1789310	2000/22030/206	0	1

2.0 BACKGROUND

The Project is located in the zone of continuous permafrost. The Project area is mostly within permafrost, except under the lake where water is too deep to freeze to the bottom during winter. Taliks (areas of unfrozen ground) are expected beneath a water body where the water depth is greater than the ice thickness. Closed talik formations consist of a depression in the permafrost table below relatively shallower and smaller lakes. Open talik formations that penetrate through the permafrost and connect the lake waterbody with the sub-permafrost hydrogeological regime are to be expected for relatively deeper and larger lakes.

A previous site investigation on permafrost conditions in the Project area was completed by Knight Piésold (Knight Piésold 2015) between June and October of 2015. It included the installation of six thermistors in the vicinity of the proposed development of Whale Tail Lake to collect ground temperature data.

A further review on site thermistor data was carried out by Golder, with a summary of the thermal conditions presented in Golder (2017a). Four additional thermistors were installed within the vicinity of Whale Tail Lake in 2017 by Golder.

Based on site investigation data, soils in the project area are typically medium to coarse grained glacial till and colluvium with high coarse fragment content overlying bedrock at shallow depths. The six thermistor boreholes drilled in 2015 indicated soil thicknesses varying from 6.1 to 12.4 m. Review of existing data indicates the soil thicknesses varying from about 1 m to 12 m in the proposed waste rock storage facility area located northwest of the proposed pits. Underlying the soil, bedrock in the area generally consists of a stratigraphic sequence of greywacke and komatiite ultramafic rocks.

A mean annual air temperature for the site is of -11.3 °C, based on climate data provided by Agnico Eagle (Golder 2016a, Agnico Eagle 2016). Climate normal for Baker Lake between 1981 and 2000 shows a mean annual air temperature of -11.2 °C (Golder 2017b). Table 1 presents a summary of average air temperature at the site and at the Baker Lake climate station. The mean monthly temperatures of the two sets of data are similar. Mean monthly temperatures from Meadowbank site from 1997 to 2003 is included in the table for comparison (Golder 2003). The Meadowbank data gives a similar annual average air temperature of -11.1 °C.

Table 1: Mean Monthly Air Temperatures

Month	Whale Tail Project (Golder 2016a, Agnico Eagle 2016)	Meadowbank Project (1997 - 2003) (Golder 2003)	Baker Lake Climate Normal (1981 to 2000)
Unit		**°C**	
January	-31.3	-31.6	-31.2
February	-31.1	-31.7	-31.0
March	-26.3	-25.5	-26.2
April	-17.0	-17.2	-17.0
May	-6.4	-5.6	-6.3
June	4.9	3.8	4.8
July	11.6	12.4	11.6
August	9.8	9.9	9.8
September	3.1	3.3	3.1
October	-6.5	-7.6	-6.4
November	-19.3	-18.0	-19.3
December	-26.8	-25.6	-26.5
Average	**-11.3**	**-11.1**	**-11.2**

3.0 SITE PERMAFROST CONDITIONS

The following sections present a summary of site-specific permafrost conditions based on the available thermistor data reviewed by Golder (2017a, 2018b).

3.1 Thermistor Installation

The locations of the existing thermistors are shown in Figure 1; Table 2 presents a summary of thermistor locations and installation data obtained to date.

Table 2: Thermistor Location and Installation Summary

Borehole	Collar Coordinates					Drilled Length (m)	Thermistor	Date of First Reading	Status[c]
	Northing	Easting	Elevation	Inclination (deg)	Azimuth (deg)		Depth Below Ground Surface (m)		
AMQ15-294	607,073.2	7,255,676.1	155.9	-45.18	322.7	220.5	144.4	September 2015	Functioning
AMQ15-306	606,714.8	7,255,363.8	154.9	-45.41	96.3	201.0	141.5	September 2015	Functioning[b]
AMQ15-324	606,496.8	7,254,995.2	161.8	-55.46	325.5	505.0	317.4	September 2015	Functioning
AMQ15-349A	607,064.9	7,255,627.5	155.3	-45.32	204.4	202.5	140.6	September 2015	Not functioning
AMQ15-421	607,098.3	7,255,490.8	155.1	-51.31	273.9	501.0	388.3	September 2015	Not functioning
AMQ15-452	606,627.2	7,255,687.9	156.2	-49.98	159.5	501.0	382.3	September 2015	Functioning
AMQ17-1265A	606,950.1	7,255,413.6	152.5	-80.0	196.0	425.0	349.6[a]	August 2017	Functioning
AMQ17-1233	606,777.7	7,256,253.8	161.9	-59.06	252.7	156.0	132.4	August 2017	Functioning
AMQ17-1337	607,078.4	7,256,522.0	155.2	-59.62	260.4	250.0	218.0	May 2017	Functioning
AMQ17-1277A	606,911.1	7,255,963.6	153.2	-60.17	193.1	250.0	217.4	May 2017	Functioning

Notes:

a) Depth below lake water (ice) level.

b) Only the top node is functioning.

c) Based on information provided by Agnico Eagle in April 2018

3.2 Thermistor Data Summary

Table 3 presents a summary of the permafrost information estimated from the ten thermistors on site. The parameters were estimated using average values from September 2015 to October 2017. Thermistor data used for modelling was assessed for stabilization, recorded temperatures used were stabilized or near to stabilization in October 2017.

Ground temperature plots for the thermistor data is presented in Attachment 1.

Based on the thermistor data, the findings on the permafrost characteristics in the project area remain similar to those presented in Golder (2017a, 2018b), and are summarized below:

- The depth of permafrost in the project site is estimated to be in the order of 427 m to 495 m for areas outside of Whale Tail Lake.
- The thermistor AMQ17-1265A installed within the Whale Tail Lake suggests the talik depth at this location is about 112 m below the lake water level of El.152.5 masl.
- The extrapolated mean annual ground surface temperatures estimated from thermistors range from -3.4 °C to -9.9 °C.
- The estimated depths of zero amplitude from the temperature profiles range from 18 m to 35 m.
- The temperatures at the depths of zero amplitude are in the range of -3.1 °C to -8.4 °C.
- The geothermal gradient is in the range of 0.005 °C/m to 0.025 °C/m.
- Based on the measured salinity concentration of 0.3% to 0.4% from the groundwater samples collected in 2016 at depths from 276 m to 392 m from a Westbay well system installed in borehole AMQ16-626, a freezing point depression of about 0.2 °C was calculated. This is estimated to reduce the frozen ground depth by approximately 20 m corresponding to the thickness of the basal cryopeg. No additional groundwater quality data was obtained since 2016 and therefore, no additional estimation of freezing point depression are provided for this assessment; these are assumed to remain unchanged since the last assessment (Golder 2016b).

Table 3: Summary of Permafrost Conditions from Site Thermistors

Hole ID	Approx. Collar Distance to Lake (m)	Thermistor Location	Zero Annual Amplitude		Mean Annual Ground Temperature (°C)[a]	Geothermal Gradient (°C/m)	Estimated Permafrost Depth (metres below ground or lake surface)
			Approximate Depth (m)	Approximate Temperature (°C)			
AMQ15-294	31	Beneath Whale Tail Lake	19	-3.0	-3.5	Insufficient depth	Insufficient depth
AMQ15-306	55	Beneath Whale Tail Lake	20	-7.4	-8.1	Insufficient depth	Insufficient depth
AMQ15-324	370	On land	35	-8.4	-9.9	0.025[b]	427
AMQ15-349A	40	Beneath Whale Tail Lake	18	-5.2	-5.2	Insufficient depth	Insufficient depth
AMQ15-421	40	Beneath Whale Tail Lake	24	-3.6	-3.9	0.005[c]	445
AMQ15-452	50	Beneath Whale Tail Lake	23	-3.6	-3.4	0.011[d]	468
AMQ17-1265A	0 (within Whale Tail Lake)	Beneath Whale Tail Lake	N/A	N/A	N/A	0.016[e]	343 (including 112 m lake talik)
AMQ17-1233	21	Beneath A49 Lake	Insufficient depth	Insufficient depth	Insufficient depth	Insufficient depth	Insufficient depth
AMQ17-1337	12	Beneath A47 Lake	Insufficient depth	Insufficient depth	-9.5	0.019[f]	495
AMQ17-1277A	29	Beneath Whale Tail Lake	Insufficient depth	Insufficient depth	Insufficient depth	Insufficient depth	Insufficient depth

Notes:

a) Estimated by projecting best fit line to surface.
b) Based on thermistor data from 105.1 to 282.1 m depth.
c) Based on thermistor data below 271.8 m depth.
d) Based on thermistor data below 248.4 m depth.
e) Based on thermistor data below 290.5 m depth.
f) Based on thermistor data below 166.2 m depth.

4.0 PIT LAKE THERMAL MODEL

Two-dimensional thermal modelling was carried out using the finite element program, TEMP/W, of GeoStudio 2007 (Ver. 7.23), developed by GEO-SLOPE International Ltd. This section presents the model scenarios, input parameters, and assumptions.

Golder previously conducted thermal modelling to evaluate the permafrost and talik conditions in the Whale Tail Lake and project area (Golder 2017a), conducted thermal modelling for the cover of the Whale Tail waste rock storage facility (Golder 2017b, 2018a), and completed a thermal assessment of the Approved Project which includes mining of Whale Tail Pit (Golder 2018b) only. A number of model parameters used in these assessments were adopted for this pit lake thermal modelling.

For the purpose of providing input to the pit hydrogeological modelling, section A shown in Figure 1 was selected for thermal modelling of the post-closure pit lakes. The modelling included the following steps.

- Evaluate the current condition of permafrost regime under Whale Tail Lake through review of the existing thermistor data at the time of the analysis and the 2017 Whale Tail Lake thermal assessment results (Golder 2017a).
- Estimate the ground thermal conditions at the time the Whale Tail and IVR pits are mined out, for use as the model initial condition.
- Run a transient thermal model with the pits being flooded based on the proposed flooding schedule, to estimate changes in the permafrost regime during flooding at closure.
- Run a subsequent transient model to evaluate long-term changes in the permafrost regime, after the water-retaining dike is breached and the Whale Tail Lake (South Basin) and the fully flooded Whale Tail and IVR pit lakes are merged.
- Run a steady-state thermal model for the pit lakes to estimate the ultimate permafrost regime.
- The thermal modelling did not consider any of the underground structures of the Whale Tail Pit. The flooding of the underground structures is expected to accelerate thawing of the permafrost in areas surrounding the underground workings in the short-term but would have limited effects on the overall site permafrost regime in the long-term.

4.1 Material Properties

Consistent with Golder (2017a, 2018b), for the purposes of this thermal assessment, each model assumed uniform thickness of 12 m of till overlying bedrock both on land and under the lake, except the pit lake. No lake bed sediment or weathered bedrock materials were included in the models. It is expected that the material properties of the bedrock will have a more significant effect on the thermal conditions than the soil due to the relatively small thickness of the soil compared to the bedrock. Material properties and depths used in the thermal models are summarized in Table 4. The material thermal properties were referenced from typical values presented in Andersland and Ladanyi (2004) and are consistent with Golder (2017a and b).

Table 4: Material Thermal Properties Used in the Models

Material	Assumed Volumetric Water Content	Thermal Conductivity (W/m-°C)		Volumetric Heat Capacity (MJ/m³-°C)		Assumed Depth Below Ground surface (m)
		Frozen	Unfrozen	Frozen	Unfrozen	
Till	30%	1.8	1.5	2.0	2.5	0 to 12
Bedrock	1%	3.0	3.0	2.0	2.0	>12

The thermal models were solved considering groundwater with a phase change temperature of 0 °C. The addition of salinity in the groundwater would result in a freezing point depression and could lower the phase change temperature to below 0 °C if salinity is high enough. The estimated freezing point depression of -0.2 °C is considered to have minor impact to the evolution of the thermal regime around the pit lake in the long-term.

4.2 Boundary Conditions

4.2.1 Ground Surface Temperature

A monthly ground surface temperature function was estimated through numerical modelling using daily climate data from Baker Lake, and review of existing thermistor data from the Whale Tail site (Golder 2017b). Ground surface temperatures are often observed to be warmer than the air temperatures in permafrost regions. Figure 2 shows the ground surface temperature function used in the model, as well as the Baker Lake normal air temperatures from 1981 to 2010. The ground surface temperature function with a mean annual ground temperature of -7.3 °C used in the model remains consistent with Golder (2017b and 2018b) and is considered to be reasonable for use in the transient models.

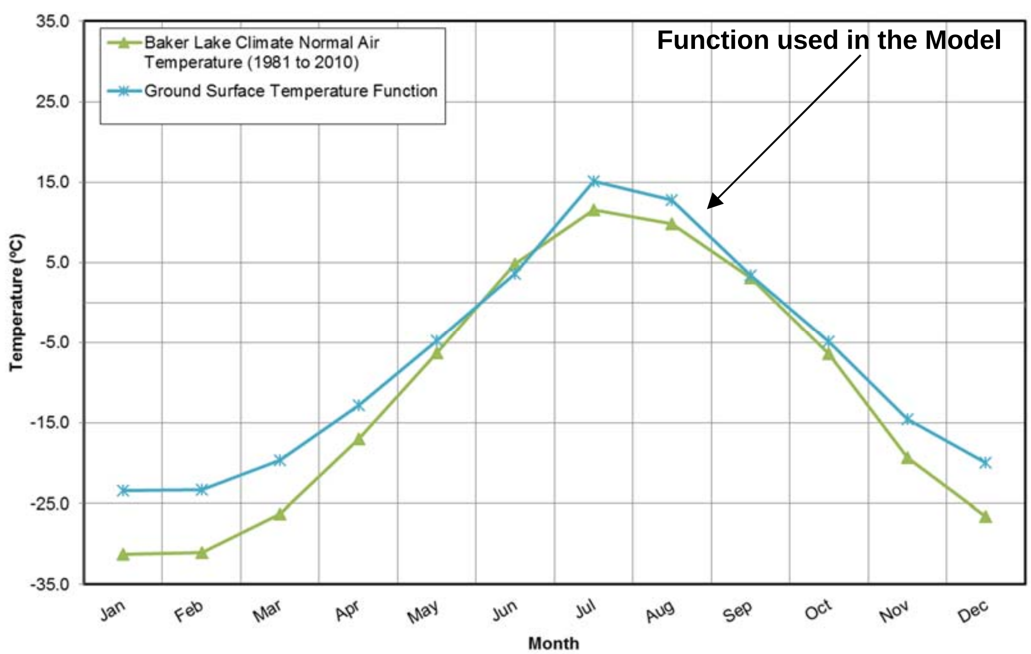


Figure 2: Monthly Air and Ground Surface Temperature Functions

4.2.2 Geothermal Gradient

A geothermal heat flux of 0.048 J/sec was applied to the models as the lower boundary condition based on the assumed bedrock thermal conductivity of 3.0 W/m-°C and a geothermal gradient of 0.016°C/m (Golder 2017a, 2018b). This thermal gradient is consistent with the one estimated during the Meadowbank Project baseline study (Golder 2003).

4.2.3 Pit Lake Bottom Temperature

Water temperature at the bottom of the pit lakes is a key boundary condition to the model. Differently from ground temperature, lake bottom temperature tends to be constant and will have strong influence on the process of permafrost melting under the lake.

Typically, a mean annual lake bottom temperature is related to water depth in a permafrost region: the deeper the lake, the higher the mean annual lake bottom temperature. Deep pit lake temperatures tend to stabilize near +4°C at which the maximum water density typically occurs for fresh water and low salinity water. An assessment of the variation of the pit lake temperature was not carried out at this stage. A review of measured pit lake bottom temperatures from Pieters and Lawrence (2014) and Crusius et al. (2002) indicates the following:

- +3.5°C at about 110 m depth for Zone 2 Pit Lake at Colomac Mine located 250 km north of Yellowknife, NWT
- +5°C at about 90 m depth for Faro Pit Lake at Faro Mine near Faro, Yukon
- +4.5°C at about 60 m depth for Grum Pit Lake at Faro Mine near Faro, Yukon
- +4.2°C at about 50 m depth for Vangorda Pit Lake at Faro Mine near Faro, Yukon

For the purpose of the modelling, the Whale Tail and IVR pit lakes were assumed to have a constant mean annual bottom temperature of +4°C in all models based on the above review. Due to the depth of the proposed pit lakes, meromictic conditions are expected to develop. When meromictic conditions are present, mixing of the surface and deep water is inhibited (stratification) which results in a stable bottom temperature.

For the relatively shallow lake area near the proposed water-retaining dike (Whale Tail Dike), a constant temperature of +2°C was assumed for the lake bottom.

4.3 Model Scenario and Assumptions

This thermal model was designed to provide reasonable assumptions for the closure and post-closure hydrogeological assessment. Pit flooding was adopted according to a preliminary pit refilling schedule provided by the site-wide water balance study (Figure 3). This schedule underwent some modifications during the fine tuning of the site-wide water balance, however, for the time scale of analysis being adopted and evaluated in the thermal analysis, these changes are not considered to significantly affect predictions on the evolution of the permafrost and talik conditions during post-closure for the purposes of the hydrogeological assessment.

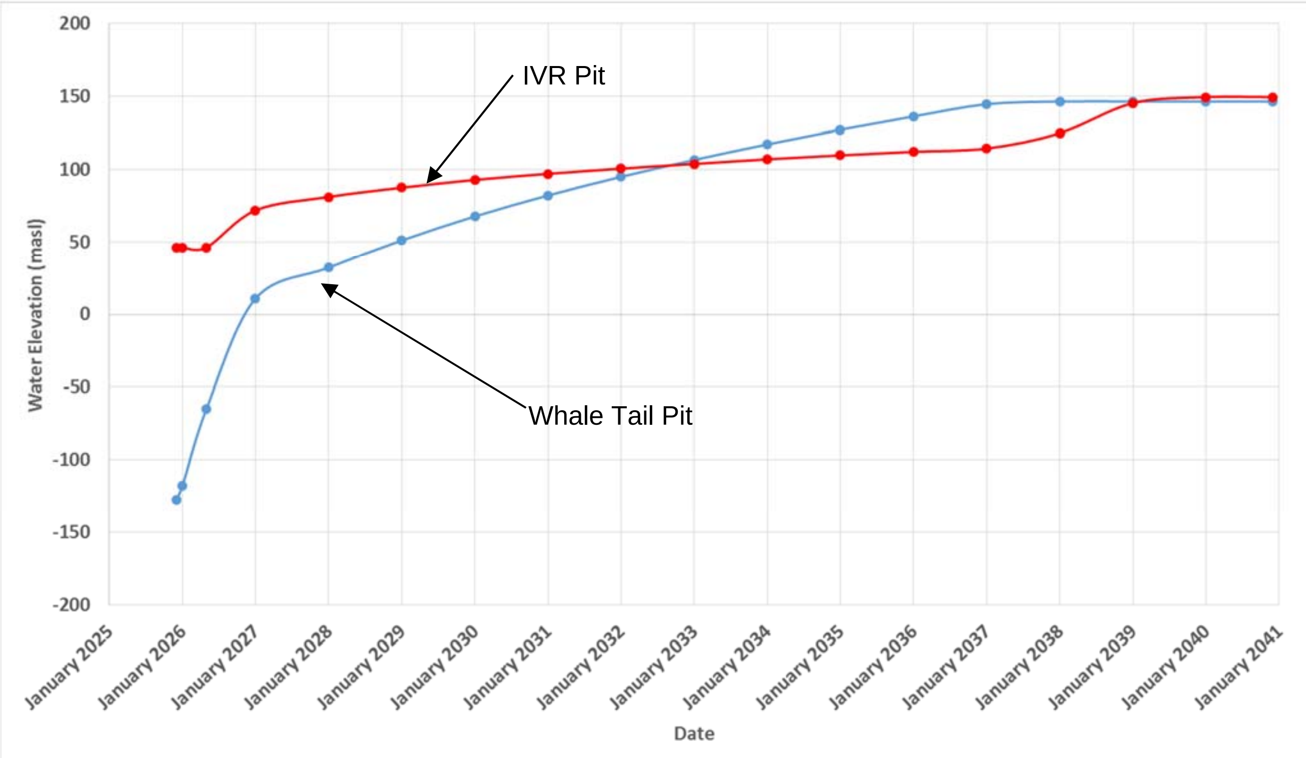


Figure 3: Whale Tail and IVR Pit Proposed Flooding Schedule

The modelling scenario was developed to simulate the proposed Whale Tail Pit flooding elevations from years 1 to 15 as presented in Table 5.

Table 5: Thermal Model Pit Lake Flooding Elevations

Year	Whale Tail Pit Lake Elevation (masl)	IVR Pit Lake Elevation (masl)
0	-127.6	46.3
1	-64.9	46.3
2	10.8	71.8
5	67.7	92.8
8	106.5	103.8
11	136.1	112
13	146.3	124.7
15	146.3	149.3

For post-closure conditions, the pit lake is assumed to maintain the baseline elevation of 152.5 masl.

The modelling was completed up to 10,000 years from start of flooding for the section through the centreline of the ultimate Whale Tail and IVR Pit configuration. The model used the ground surface temperature function and a daily time step without consideration to climate change up to 300 years and used a yearly timestep with a constant average ground surface temperature of -7.3 °C (based on ground surface temperature function shown on Figure 2) for years 300 to 10,000 to reduce the total number of time steps required to complete the model.

This hypothetical scenario assumed climatic conditions in 10,000 years remain similar to current site conditions (no global warming). Climate change impacts are typically considered for a post-closure period of up to 100 years as the current standard practice. A climate change scenario for the duration of 300 to 10,000 years cannot be defined with a minimal degree of certainty and would not bring any benefit to the model quality.

Steady-state conditions were compared to the results of the 10,000 year model for two cases: 1) where the ground between the two pits is flooded and 2) where it is not flooded (this would require the pit lake to be of a lower elevation than 152.5, or for ground to be built up between the two pits, both of which are not planned to occur). The purpose of this scenario was to assess the thermal conditions in the on-land areas where there is no flooding between the two pit lakes (above el.152 m).

4.4 Thermal Conditions Prior to Flooding

Section A is located within Whale Tail Lake in the longitudinal direction. Modelling the entire section was not deemed appropriate to estimate the initial thermal conditions before pit flooding, as the lateral thermal impacts from surrounding colder ground cannot be accounted for in two dimensions. Instead, the initial thermal regime along section A was interpolated by modelling a steady-state condition of the northern terrace at the proposed IVR Pit, the ground temperature data from thermistor AMQ17-1265A, and previous thermal analysis of the Whale Tail Lake completed by Golder (2017a). Based on the ground temperature profile from AMQ17-1265A, the extent of permafrost is expected to occur from El. 40.8 masl to -191 masl at the southeast side of Whale Tail Pit on Section A. The assumed initial conditions are presented on Figure 2-1 of Attachment 2.

For the purpose of this assessment, the majority of the thermal regime prior to mining was assumed to be the same as when the mining is complete due to the short duration of mining. Some freeze-back during the pit mining is expected and was estimated to form a part of the initial thermal condition for the post-closure period.

5.0 SUMMARY OF MODEL RESULTS FOR THE POST-CLOSURE PERIOD

The model results are presented in Figures 2-1 to 2-7 of Attachment 2 including:

- The assumed initial thermal conditions prior to pit flooding.
- Thermal conditions during the pit flooding in closure.
- Zero-degree isolines at selected years of post-closure, up to year 10,000.
- Steady-state thermal conditions for the post-closure pit lakes with and without flooding between each pit lake.

The following findings are based on the model results:

- During pit flooding, the warm pit lake temperature melts mostly the upper portion of the permafrost under the pit, and talik zones starts to occur around the pit wall and floor. A through talik starts to form around year 11 as seen on Figure 2-4.
- The permafrost under the Whale Tail Pit Lake continues to thaw post-closure, and the open talik expands from the lake (south) toward the land (north) as seen on Figure 2-6. The majority of the permafrost under the pit lake is thawed 300 years after closure.
- The permafrost under the IVR Pit Lake continues to thaw post-closure, and the open talik expands from the lake side (south) toward the land (north). The majority of the permafrost under the pit lake is thawed in approximately 1,000 years after closure.
- The steady-state models indicate the pit lakes will thaw the permafrost in the long-term, and eventually reduce the permafrost depth under the adjacent ground northwest of the IVR Pit. A significantly longer time (in the order of 10,000 years) is likely required for the pit lakes to reach the steady-state thermal conditions.
- The potentially colder temperatures at the narrow area between the Whale Tail and IVR pit lakes may reduce the upper ground temperatures but are not expected to significantly change the thawing progress of the deep permafrost below this area.

All the findings listed above are based on climate conditions in 10,000 years remaining similar to current conditions. This assumption is recognized to be unrealistic, but currently there is no scientific method that is known to produce a reliable forecast for climate change in such a long-term. The reader is therefore advised to make use of the model results with appropriate caution and perspective.

6.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this technical memorandum.

We trust this document satisfies you current requirements. If you have any questions or require further assistance, please do not hesitate to contact the undersigned.

Golder Associates Ltd.

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JFC/SO/sg

https://golderassociates.sharepoint.com/sites/19830g/2000_phase2expansion/22000_hydrogeology/thermal analysis/memo/rev 0/1789310-206-tm-rev0-expansionprojectwhaletailpit_post-closurethermal.docx

Attachments: Study Limitations
Attachment 1: Thermistor Readings
Attachment 2: Thermal Model Results

PERMIT TO PRACTICE
GOLDER ASSOCIATES LTD.
Signature
Date Nov 16, 2018
PERMIT NUMBER: P 049
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REFERENCES

Agnico Eagle (Agnico Eagle Mines Limited). 2016. Meadowbank Mine – Amendment/Reconsideration of the Project Certificate (No.004/File No. 03MN107) and Amendment to the type A Water Licence (No. 2AM-MEA1525). Volume 8, Appendix 8-B.2. Submitted to the Nunavut Impact Review Board, 30 June 2016.

Andersland, O.B. and Ladanyi, B. 2004. Frozen Ground Engineering. 2nd edition, John Wiley & Sons, Inc.

Crusius J, Pieters R, Leung A, Whittle P, Pedersen T, Lawrence GA, McNee JJ. 2002. A Tale of Two Pit Lake: Initial Results of a Three-Year Study of the Main Zone and Waterline Pit Lakes Near Houston, BC. 2002 SME Annual Meeting, Feb. 25 – 27, Phoenix Arizona, USA.

Golder (Golder Associates Ltd.). 2003. Report on Permafrost Thermal Regime Baseline Studies, Meadowbank Project, Nunavut. Golder Project No. 03-1413-078. Prepared for Cumberland Resources Ltd. Submitted 18 December 2003.

Golder. 2016a. Water Management and Water Balance Related to Amaruq Exploration Portal/Ramp Program, Quarry and Advanced Underground Exploration and Bulk Sample, Amaruq Exploration Site, Nunavut. Golder Doc. No. 069-1665859 Ver 0. Prepared for Agnico Eagle Mines Ltd. Submitted 15 November 2016.

Golder. 2016b. Groundwater Quality Investigation, Amaruq, Nunavut. Golder Document No. 080-1649355. Prepared for Agnico Eagle Mines Ltd. Submitted 15 November 2016.

Golder. 2017a. Whale Tail Lake Thermal Assessment. Golder Reference No. 1665859-085-TM-Rev0-5100. Prepared for Agnico Eagle Mines Ltd. Submitted 22 February 2017.

Golder. 2017b. Commitment 39: Whale Tail Pit Project Waste Rock Storage Facility Cover Thermal Assessment. Golder Reference No. 1774579-124-TM-Rev0-2500. Prepared for Agnico Eagle Mines Limited. Submitted 10 July 2017.

Golder. 2018a. Whale Tail Pit Project Waste Rock Storage Facility Cover Thermal Assessment. Reference No. 1789310_177_TM_Rev0. Prepared for Agnico Eagle Mines Limited. June 2018.

Golder. 2018b. Whale Tail Pit Post-Closure Pit Lake Thermal Assessment. Reference No. 1789310-174-TM-Rev0. Prepared for Agnico Eagle Mines Limited. 30 July 2018.

Knight Piésold. 2015. Agnico Eagle Mines Ltd.: Meadowbank Division – Whale Tail Pit – Permafrost and Hydrogeological Characterization. Submitted 24 November 2015.

Pieters R, Lawrence GA. 2014. Physical Processes and Meromixis in Pit Lakes Subject to Ice Cover. Canadian Journal of Civil Engineering. 41(6):569-578.

STUDY LIMITATIONS

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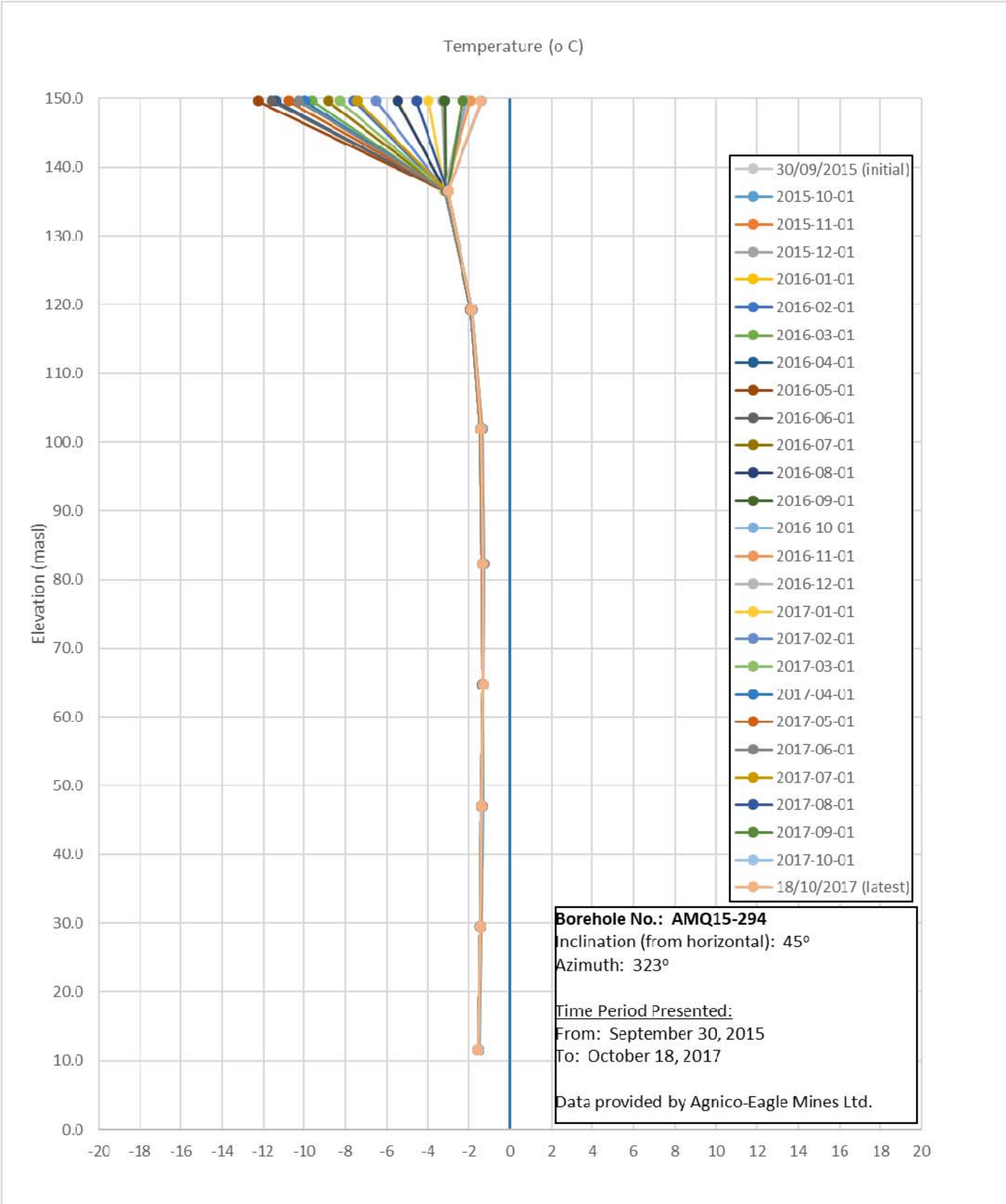
ATTACHMENT 1

Thermistor Readings



NOTE: Readings are shown once per month for clarity.

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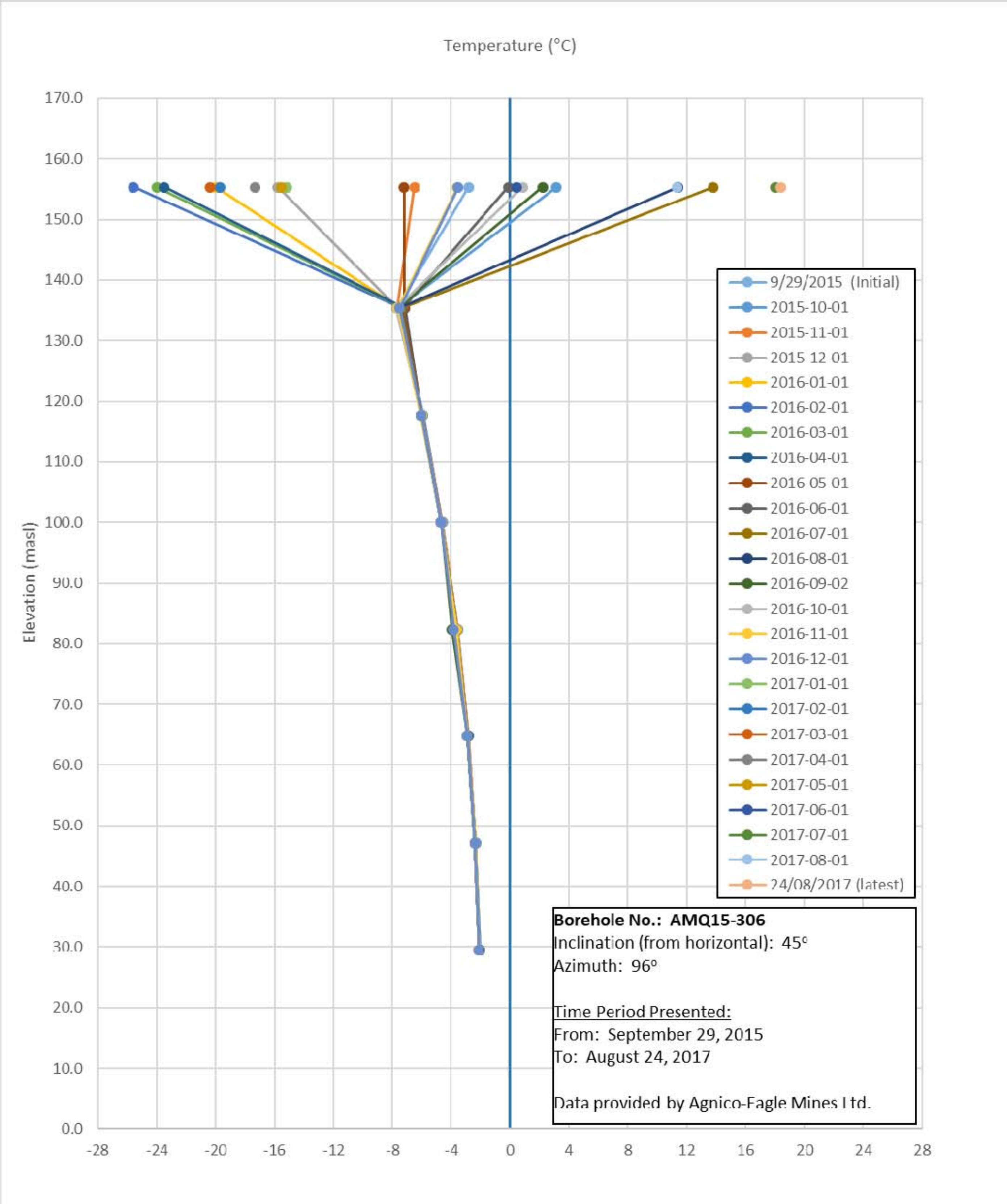

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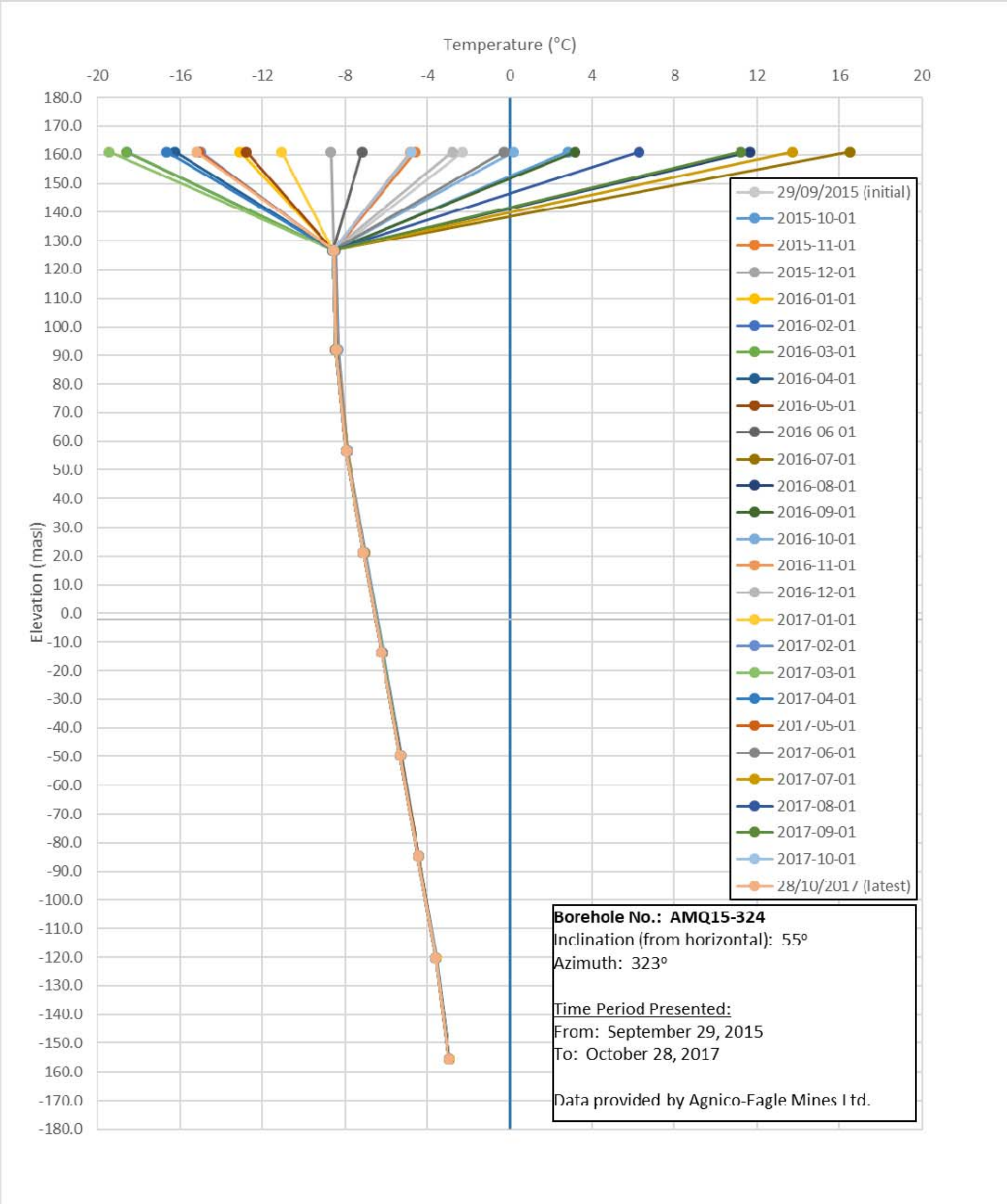

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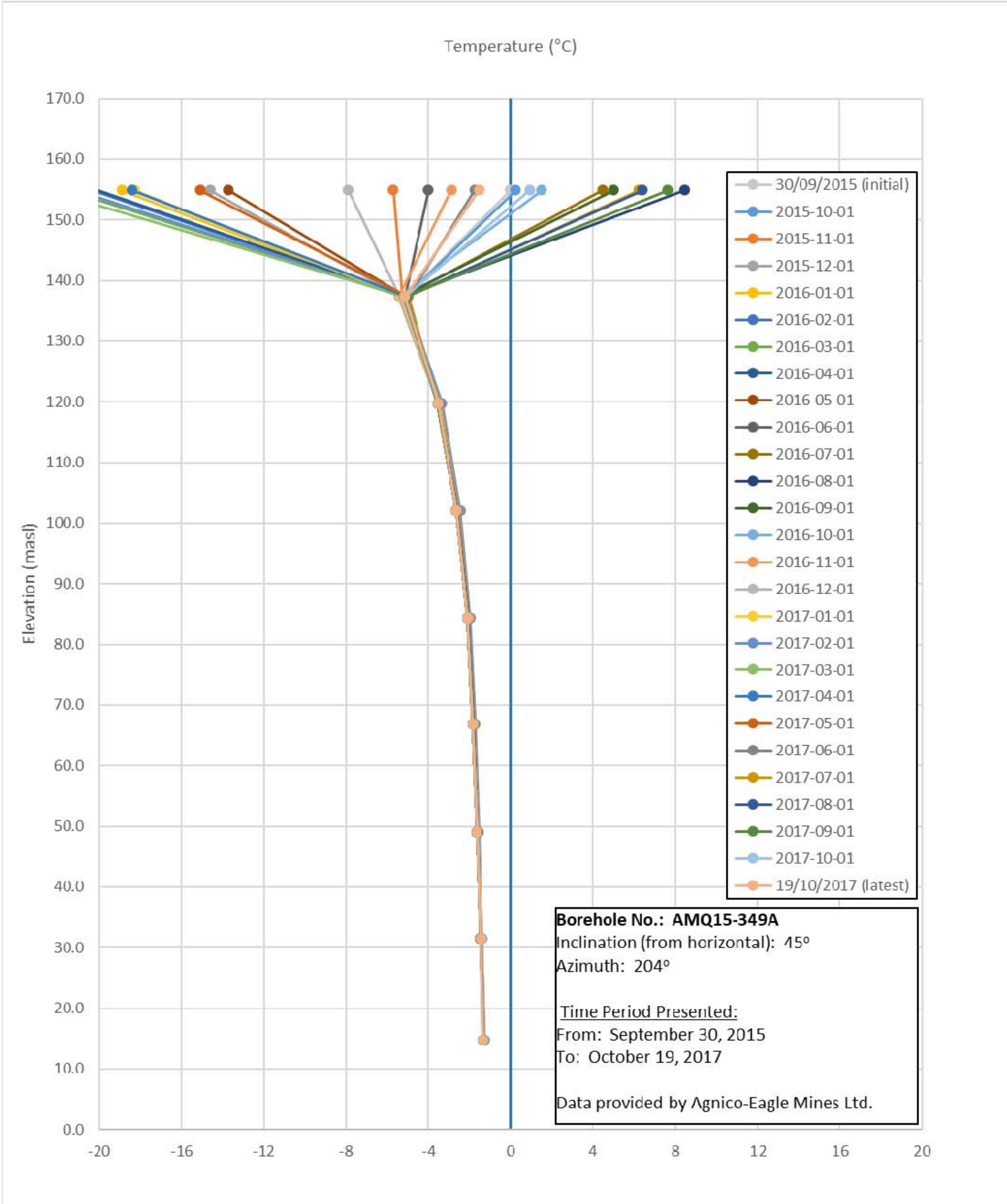

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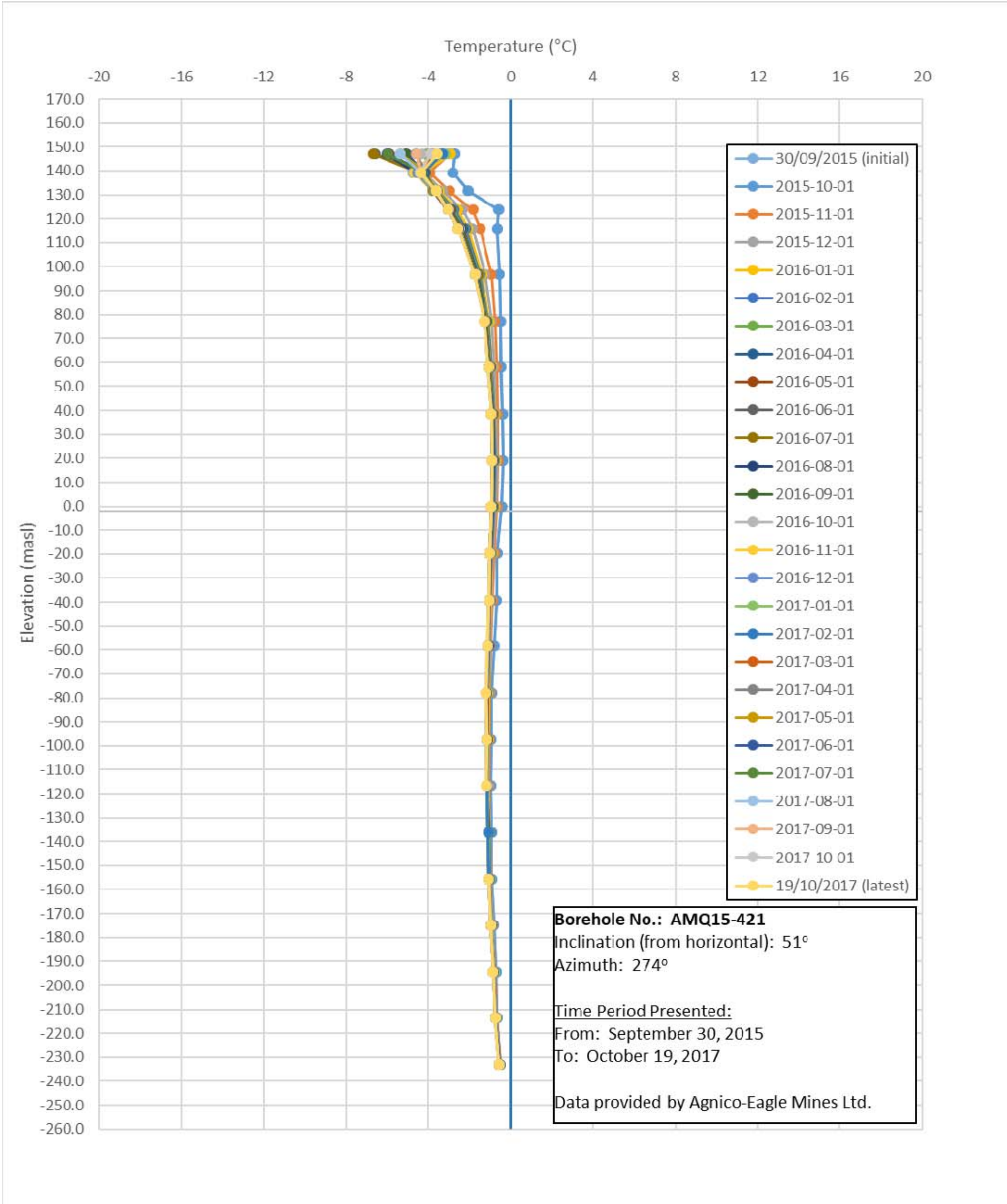

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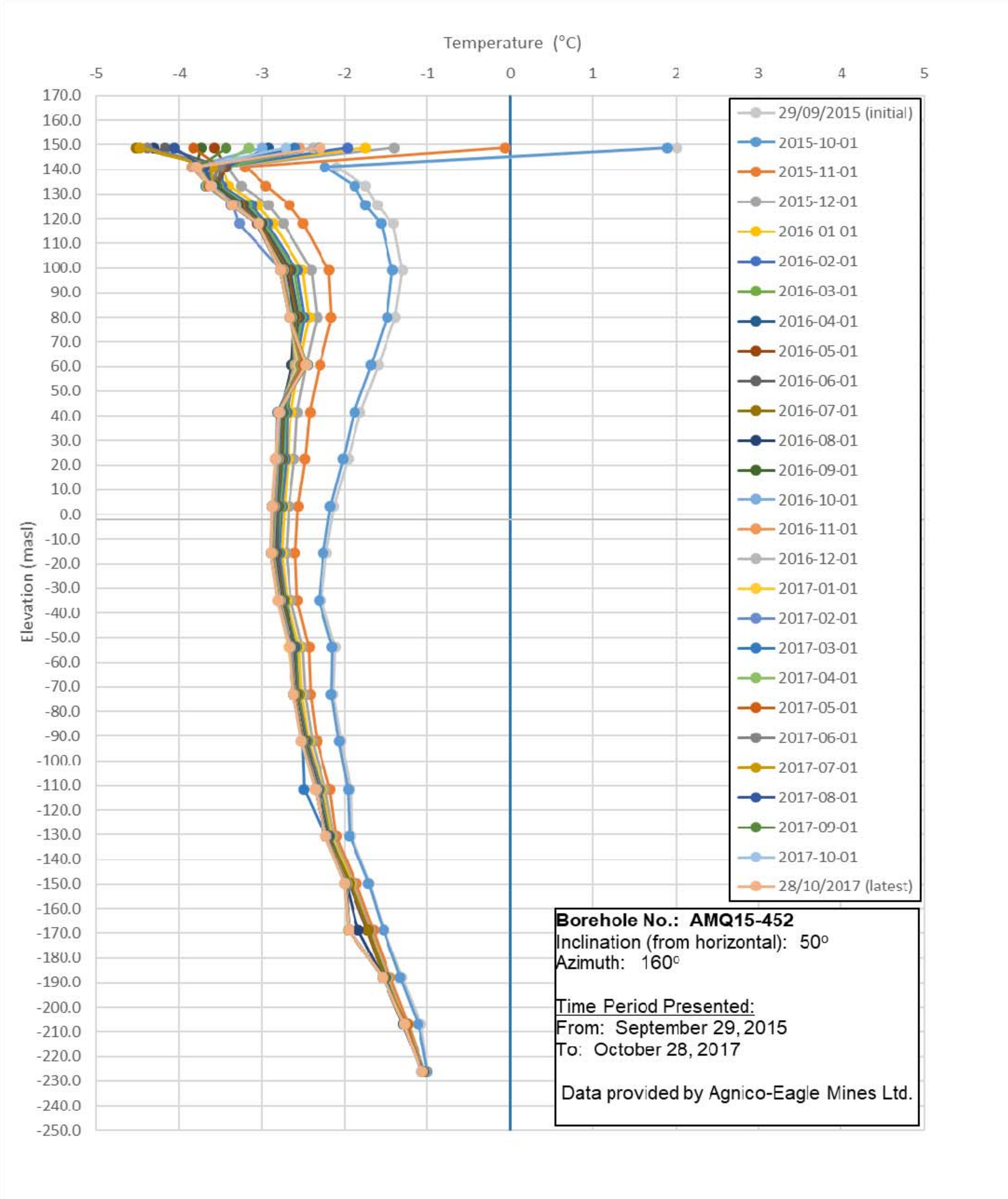

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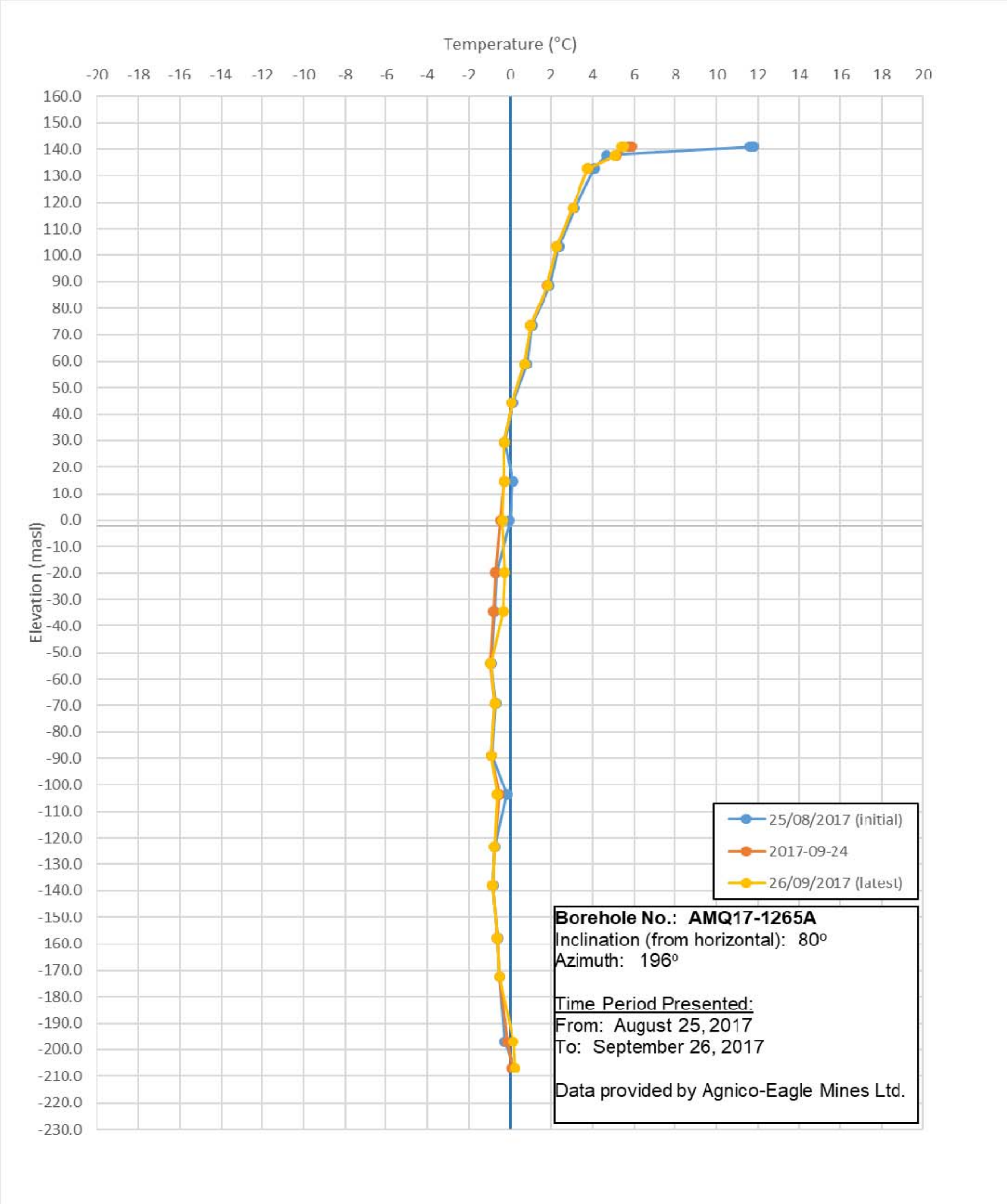

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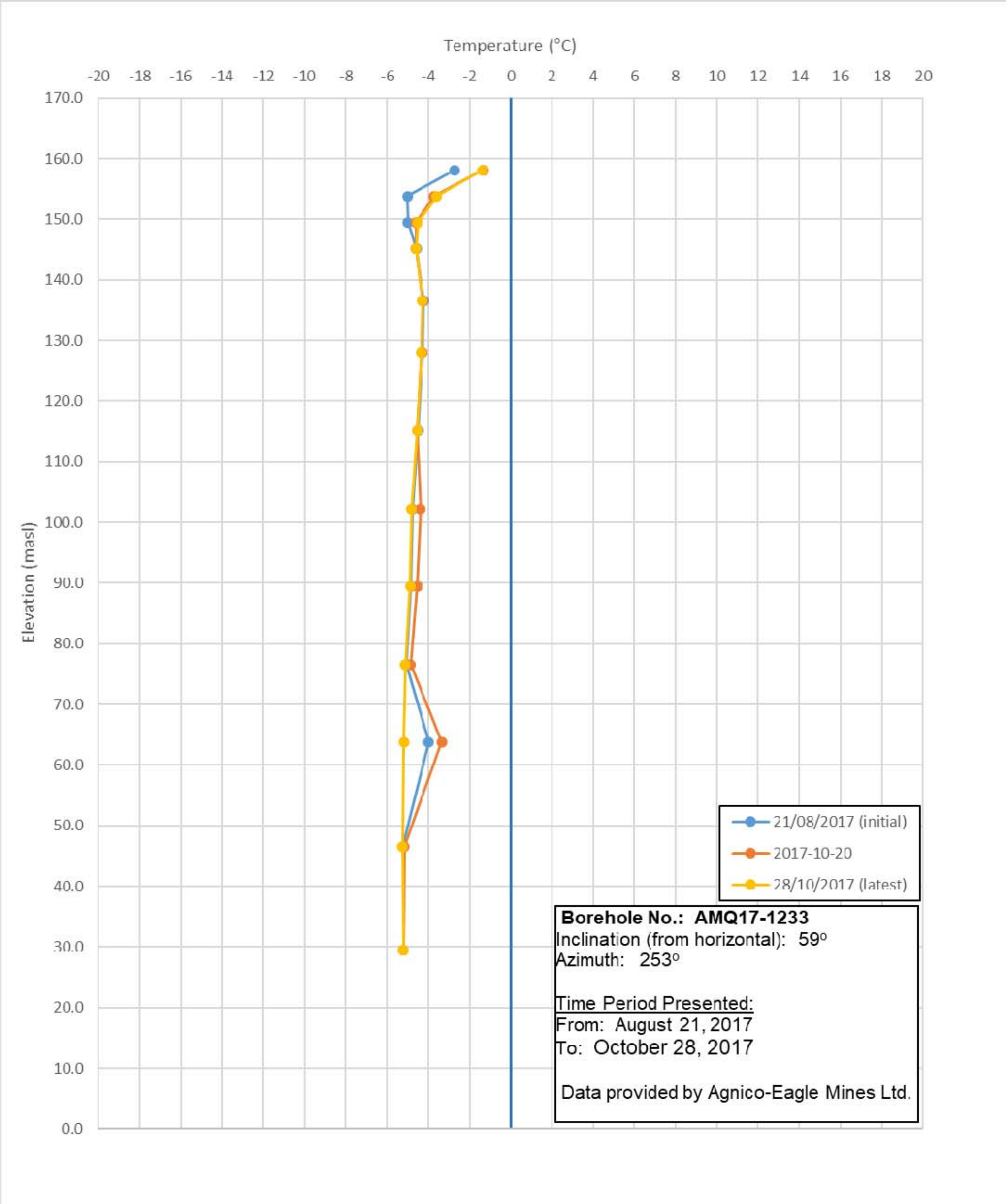

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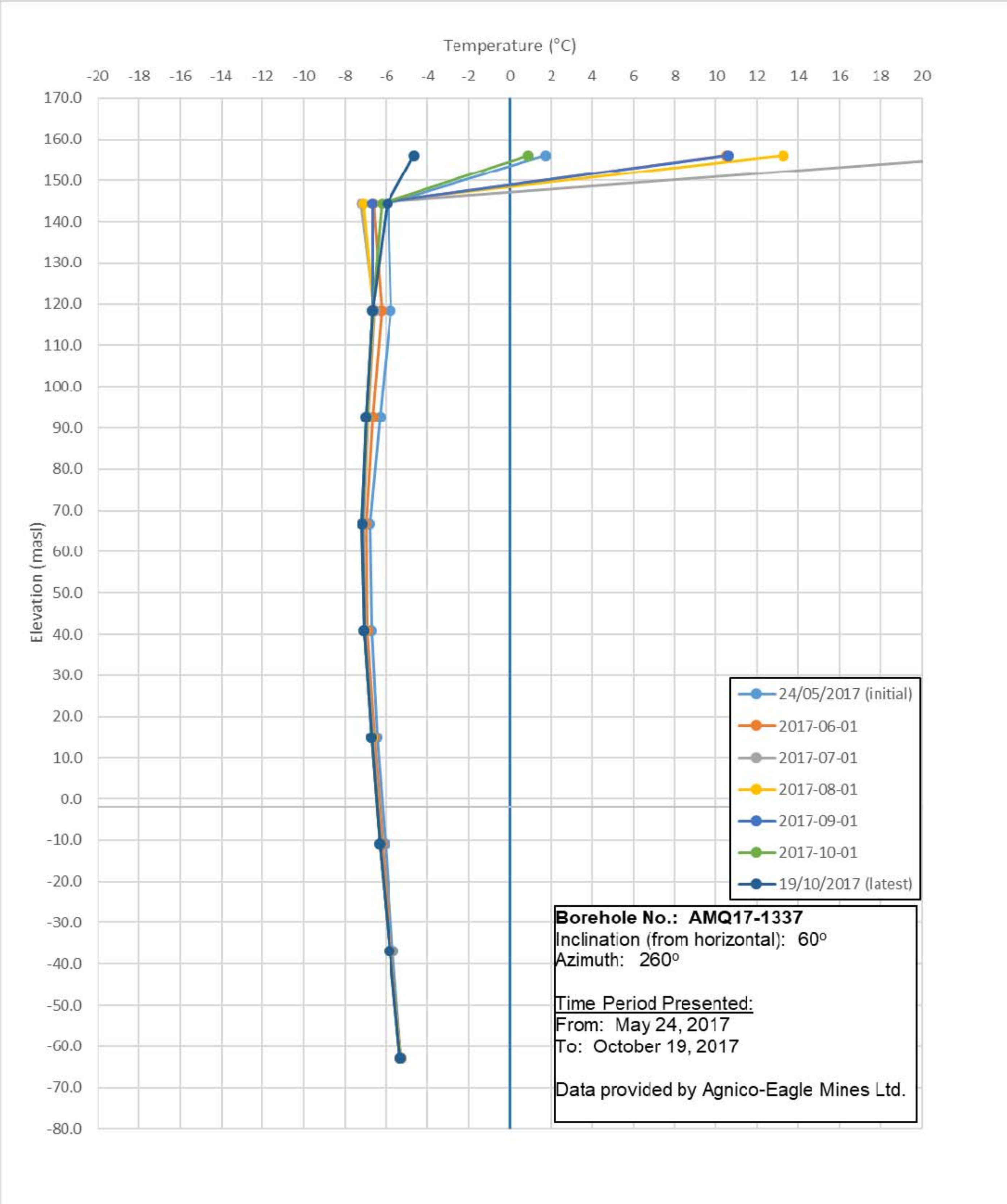

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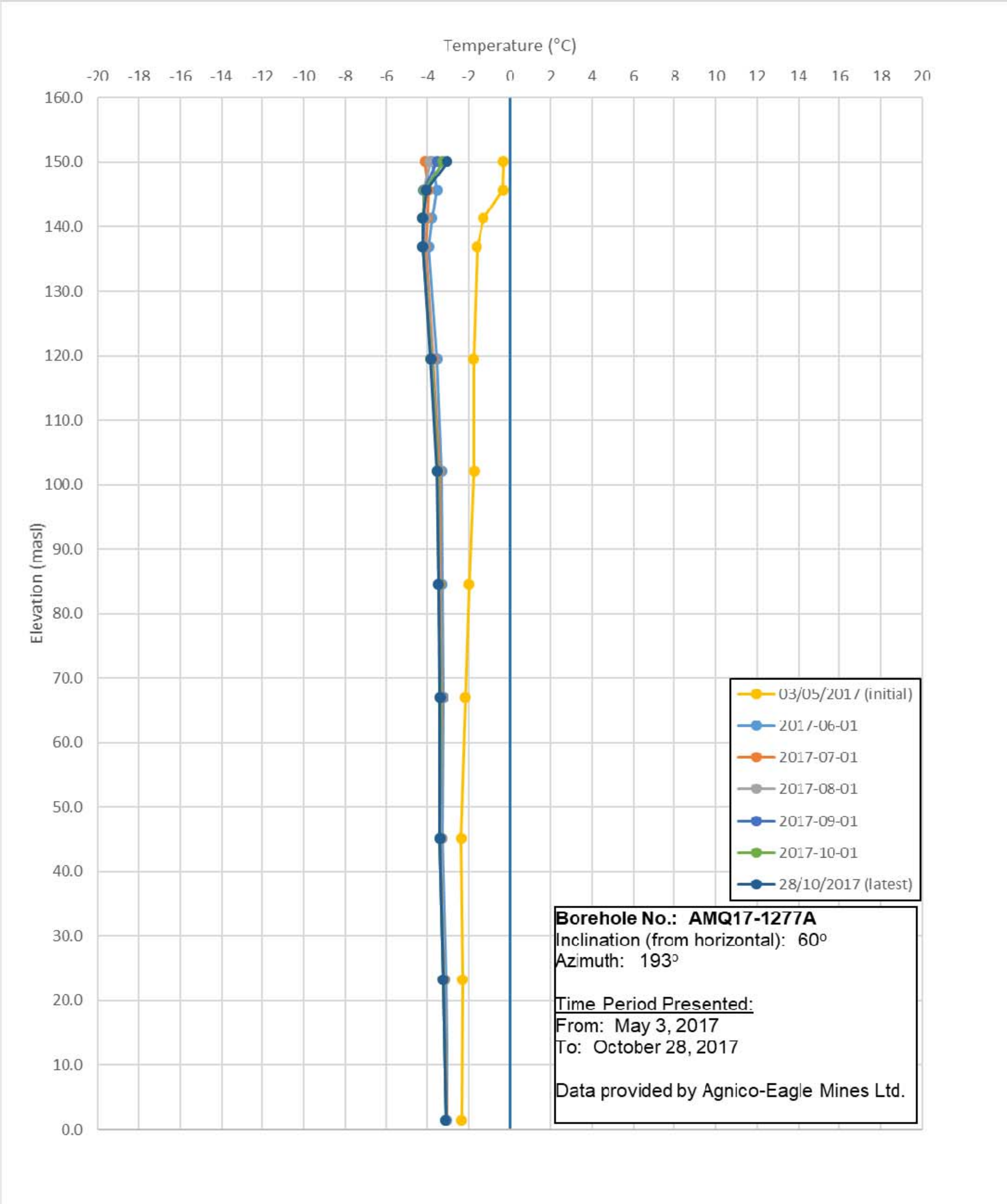

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CONSULTANT GOLDER	YYYY-MM-DD: 2018-08-28 PREPARED: CTM DESIGN: CTM REVIEW: FJ APPROVED: SO	TITLE **THERMISTOR AMQ17-1277A 2017 READINGS**	

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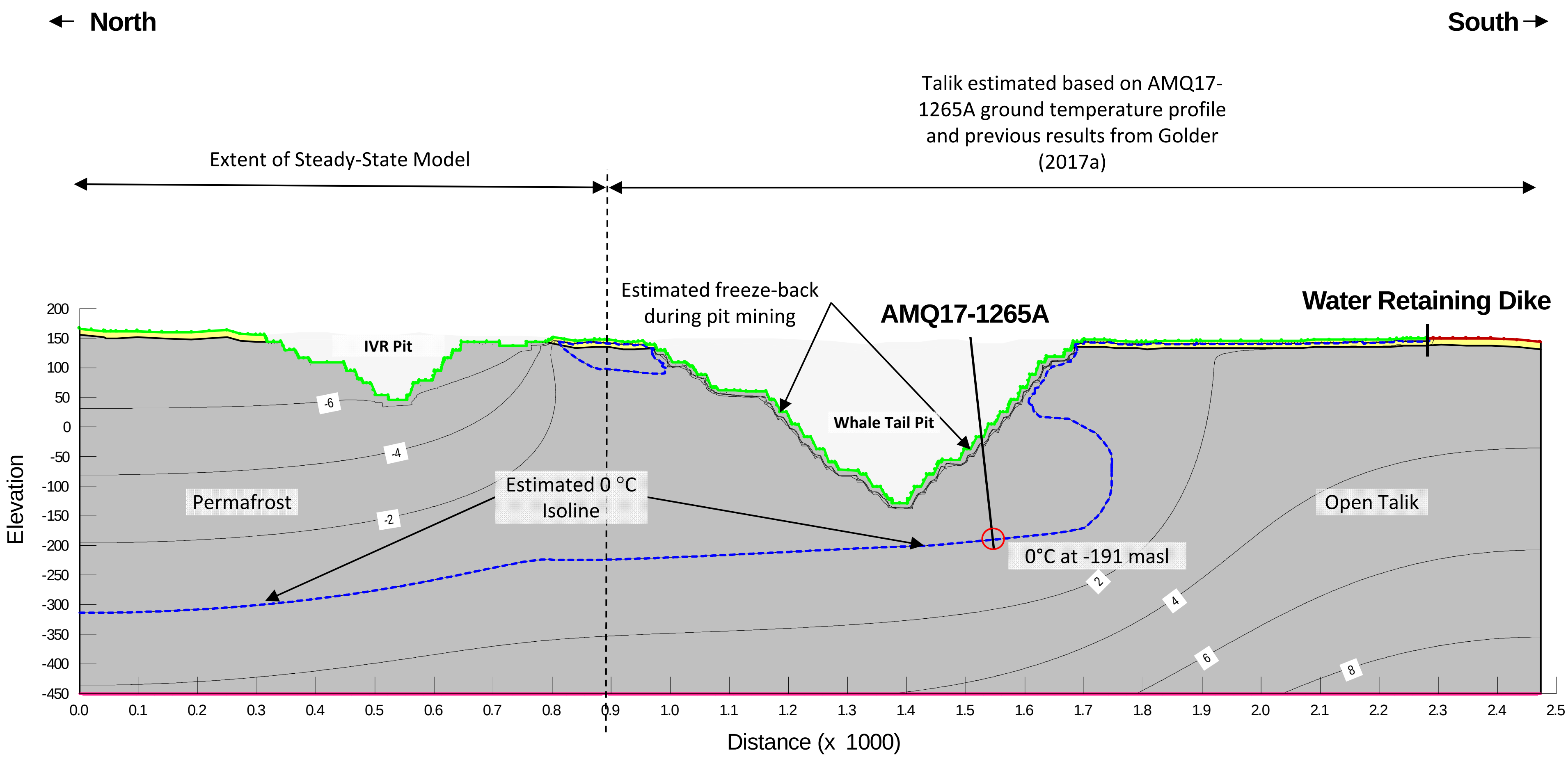
ATTACHMENT 2

Thermal Model Results



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Notes

1. Location of thermistor AMQ17-1265A is approximate.
2. Temperature contour interval 2 °C.

CLIENT	AGNICO EAGLE MINES LIMITED	PROJECT	WHALE TAIL PIT PROJECT POST-CLOSURE PIT LAKE THERMAL ASSESSMENT NUNAVUT
CONSULTANT	YYYY-MM-DD	2018-08-03	
GOLDER	PREPARED	CTM	TITLE **TRANSIENT THERMAL MODELLING ASSUMED INITIAL CONDITION BEFORE PIT FLOODING**
	DESIGN	CTM	
	REVIEW	FJ	PROJECT No. **1789310** / Phase./Task **2000/22030** / Rev. **0** / Figure **2-1**
	APPROVED	SO	

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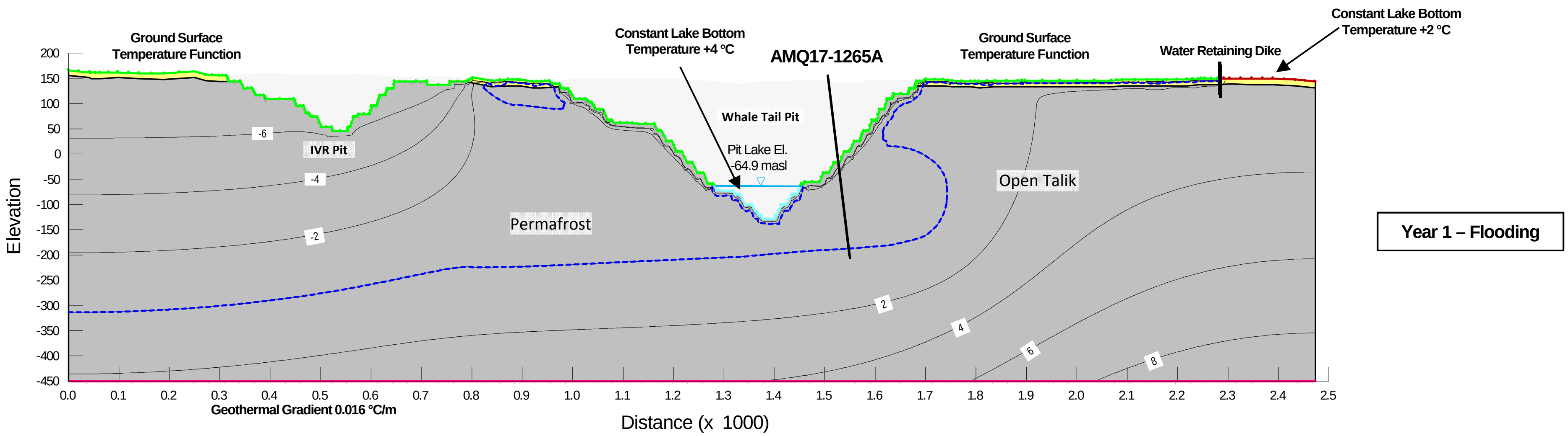

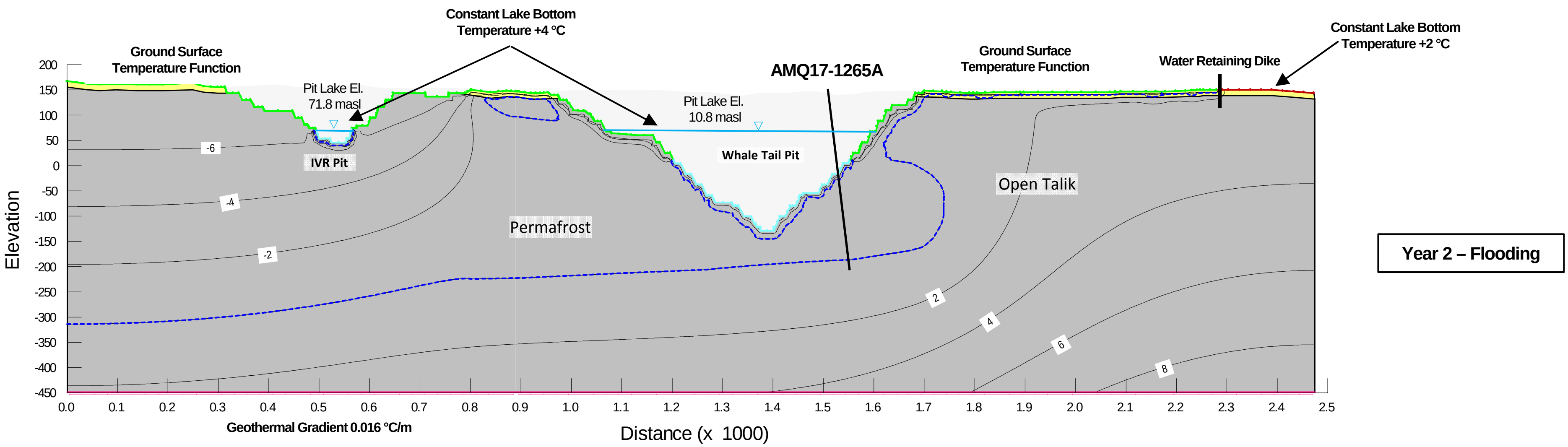

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Notes

1. Location of thermistor AMQ17-1265A is approximate.
2. Temperature contour interval 2 °C.

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POST-CLOSURE PIT LAKE THERMAL ASSESSMENT
NUNAVUT

TITLE
TRANSIENT THERMAL MODELLING
PIT FLOODING
YEARS 1 & 2

PROJECT No.	Phase./Task	Rev.	Figure
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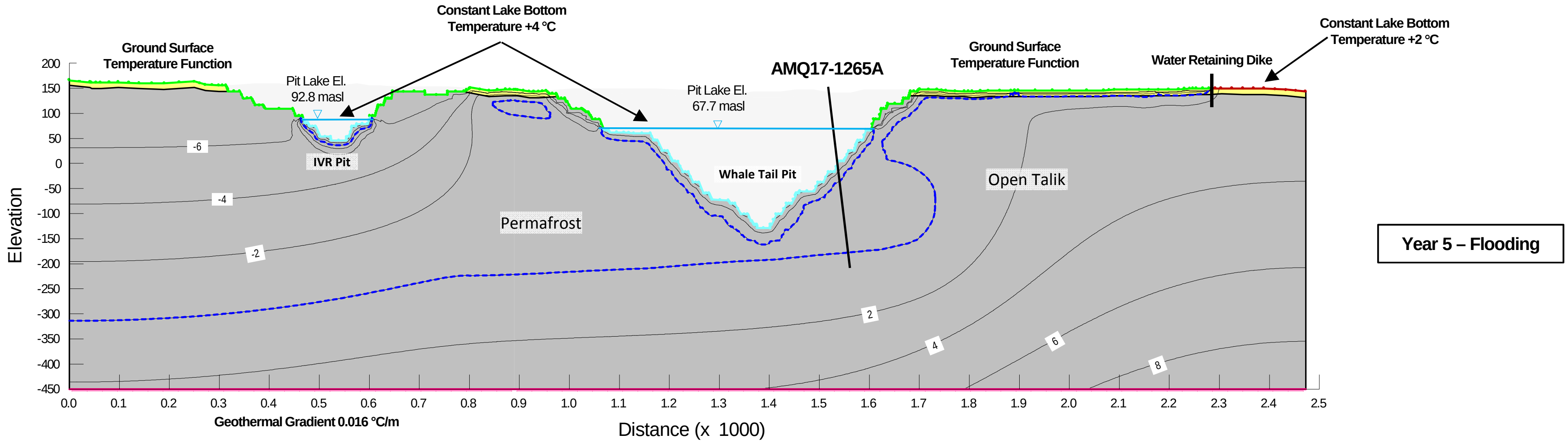

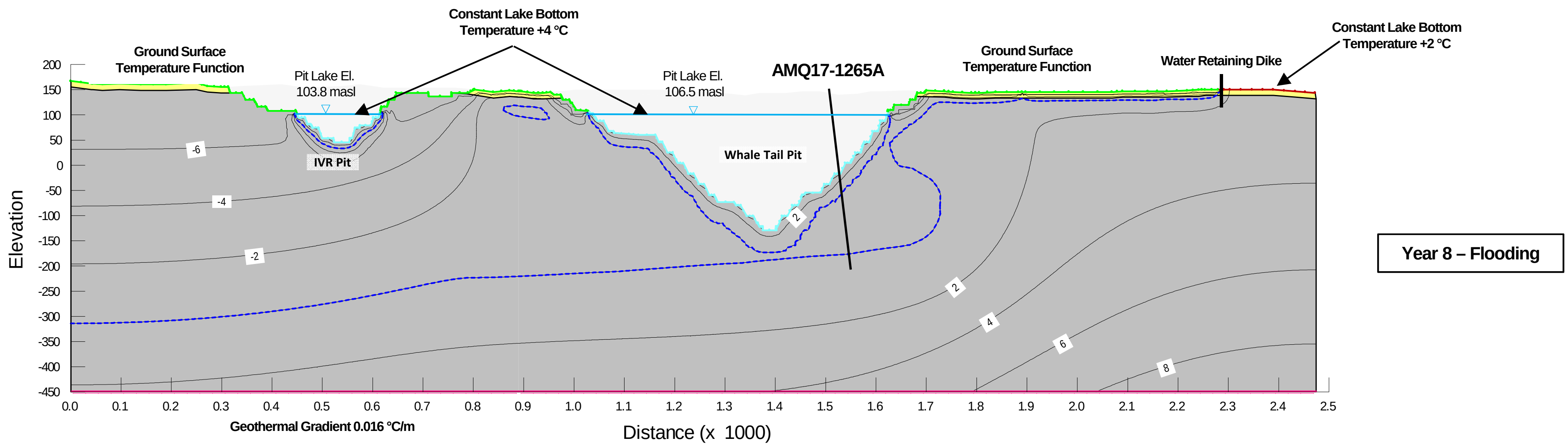

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2. Temperature contour interval 2 °C.

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WHALE TAIL PIT PROJECT
POST-CLOSURE PIT LAKE THERMAL ASSESSMENT
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TITLE
TRANSIENT THERMAL MODELLING
PIT FLOODING
YEARS 5 & 8

PROJECT No.	Phase./Task	Rev.	Figure
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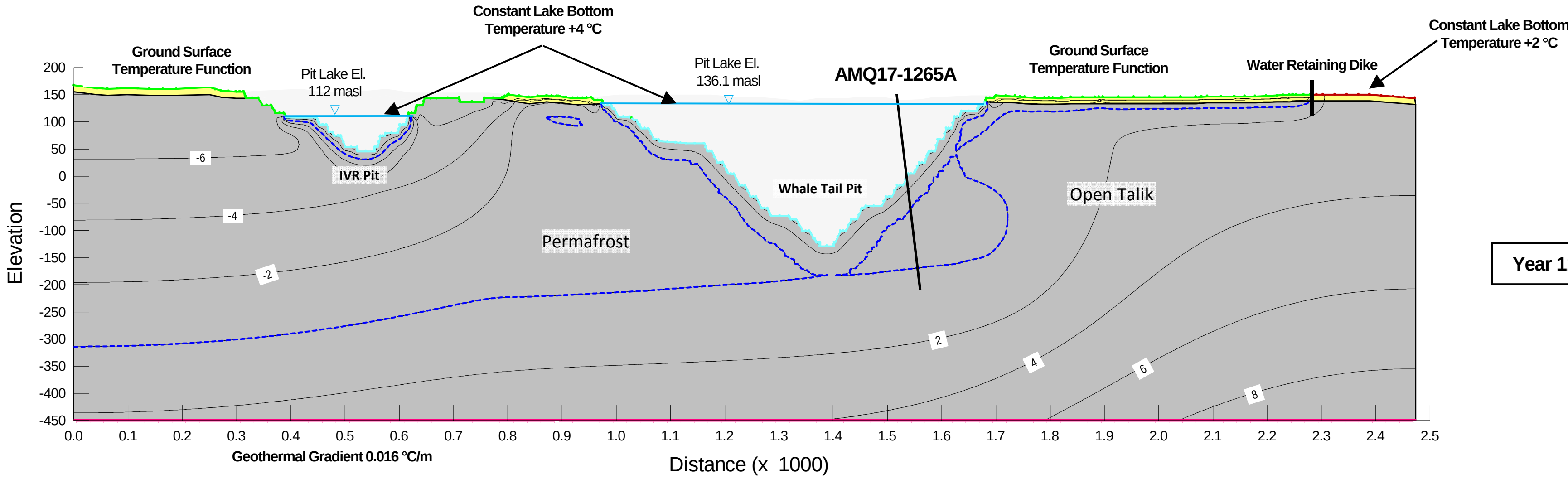
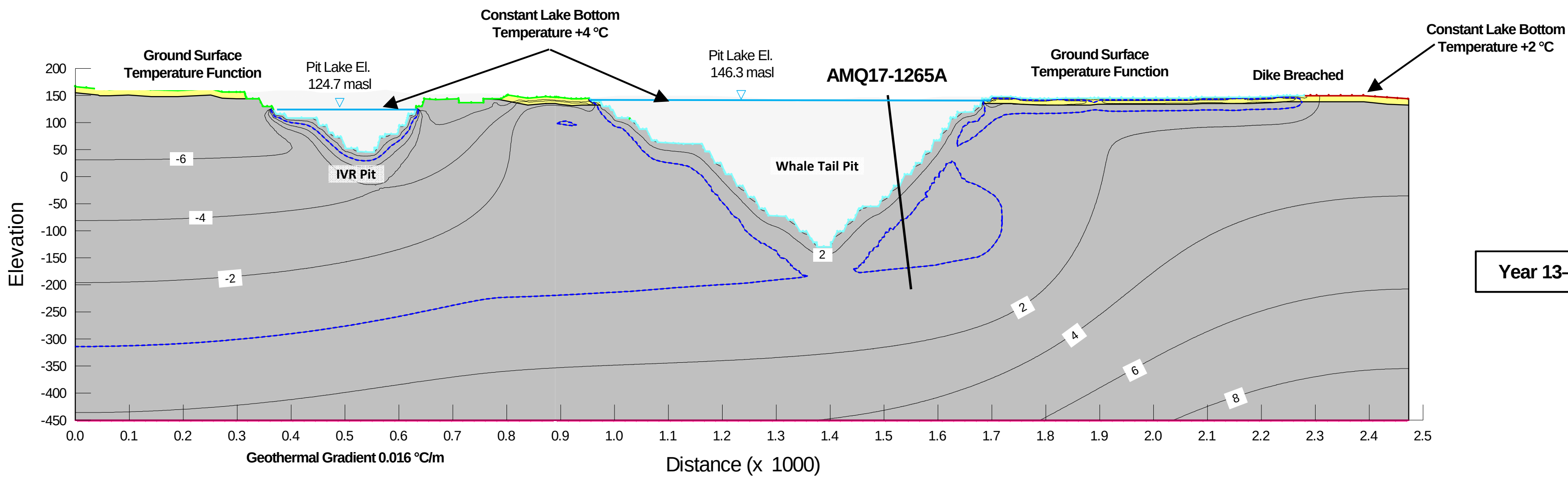


Year 11 – Flooding



Year 13– Flooding

File Name: Section A_19FEB18_Operation

Notes

1. Location of thermistor AMQ17-1265A is approximate.
2. Temperature contour interval 2 °C.

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CONSULTANT GOLDER	YYYY-MM-DD: 2018-08-03	TITLE **TRANSIENT THERMAL MODELLING** **PIT FLOODING** **YEARS 11 & 13**	
	PREPARED: CTM		
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	APPROVED: SO	Rev.: 0	Figure: 2-4

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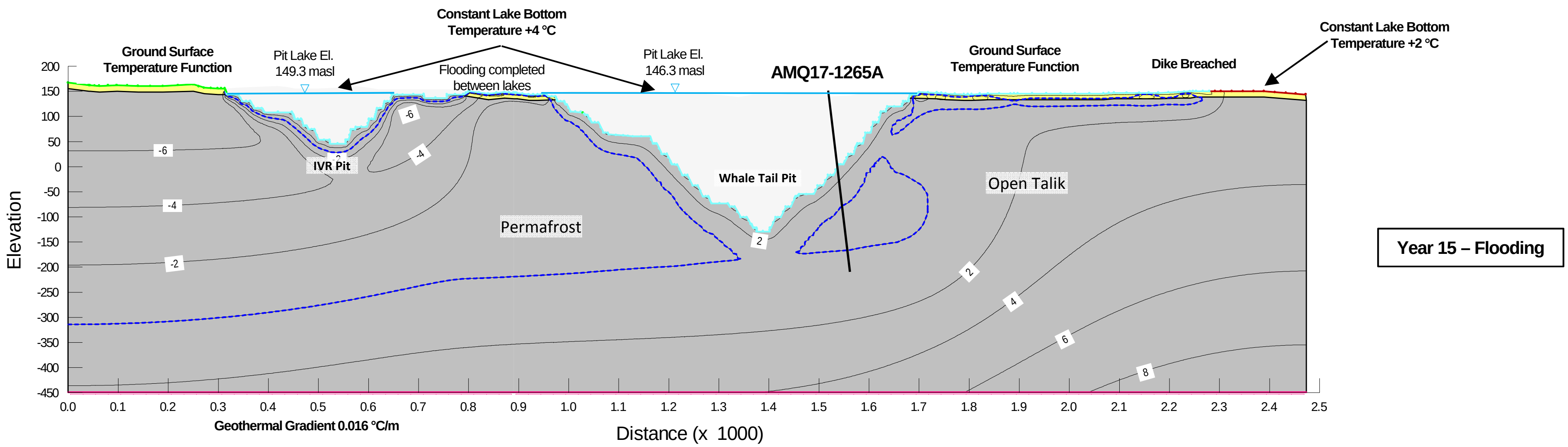

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Notes

1. Location of thermistor AMQ17-1265A is approximate.
2. Temperature contour interval 2 °C.

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REVIEW	FJ
APPROVED	SO
PROJECT	WHALE TAIL PIT PROJECT POST-CLOSURE PIT LAKE THERMAL ASSESSMENT NUNAVUT
TITLE	**TRANSIENT THERMAL MODELLING PIT FLOODING YEAR 15**

PROJECT No.	Phase./Task	Rev.	Figure
1789310	2000/22030	0	2-5

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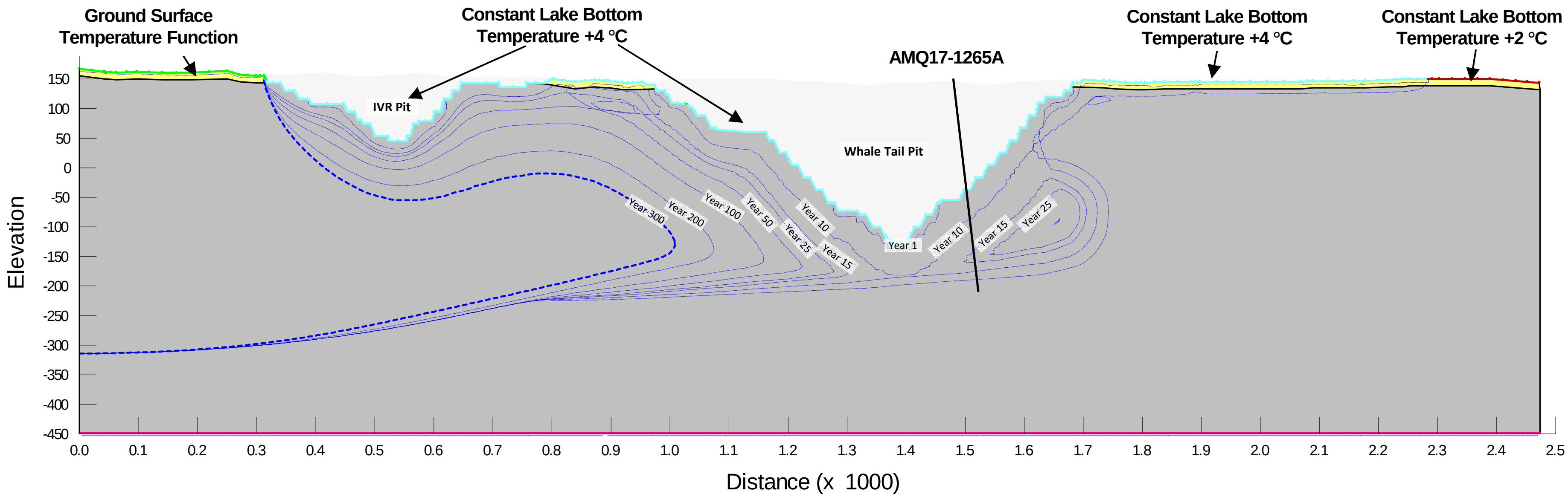

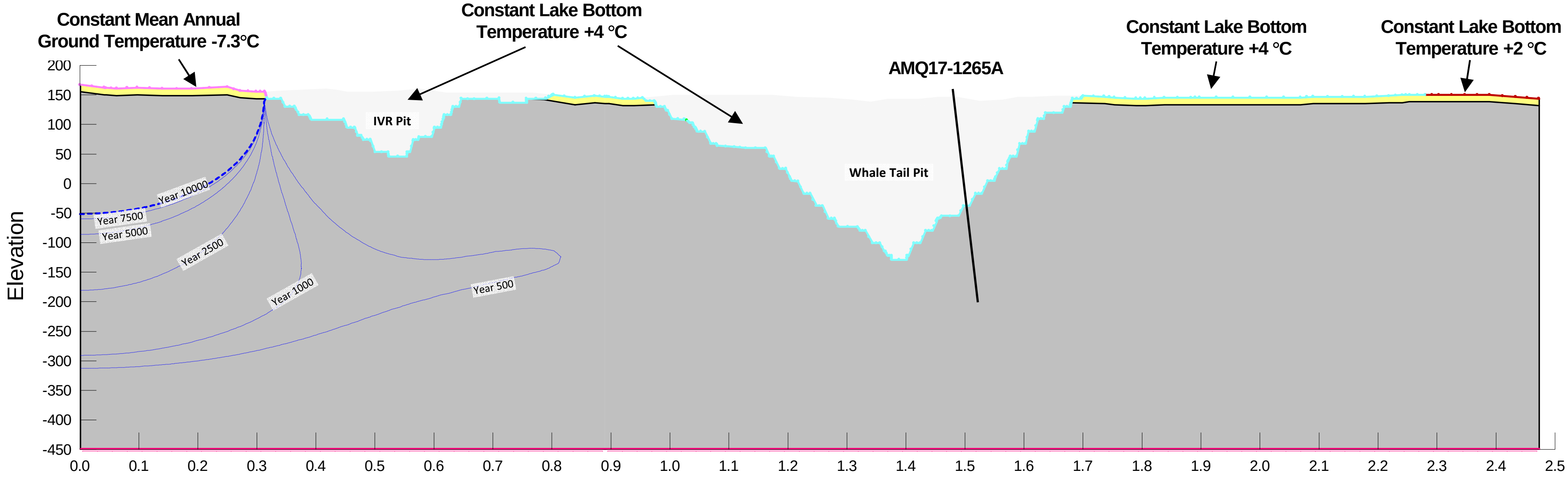

File Name: Section A_12JAN17 Long Term 1

Notes

1. Location of thermistor AMQ17-1265A is approximate.
2. Isotherms include the 15 years of back-flooding.

CLIENT
AGNICO EAGLE MINES LIMITED

CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-03
PREPARED	CTM
DESIGN	CTM
REVIEW	FJ
APPROVED	SO

PROJECT
WHALE TAIL PIT PROJECT
POST-CLOSURE PIT LAKE THERMAL ASSESSMENT
NUNAVUT

TITLE
TRANSIENT THERMAL MODELLING
POST-CLOSURE PIT LAKE
ZERO DEGREE ISOTHERMS AT SELECT YEARS

PROJECT No.	Phase./Task	Rev.	Figure
1789310	2000/22030	0	2-6

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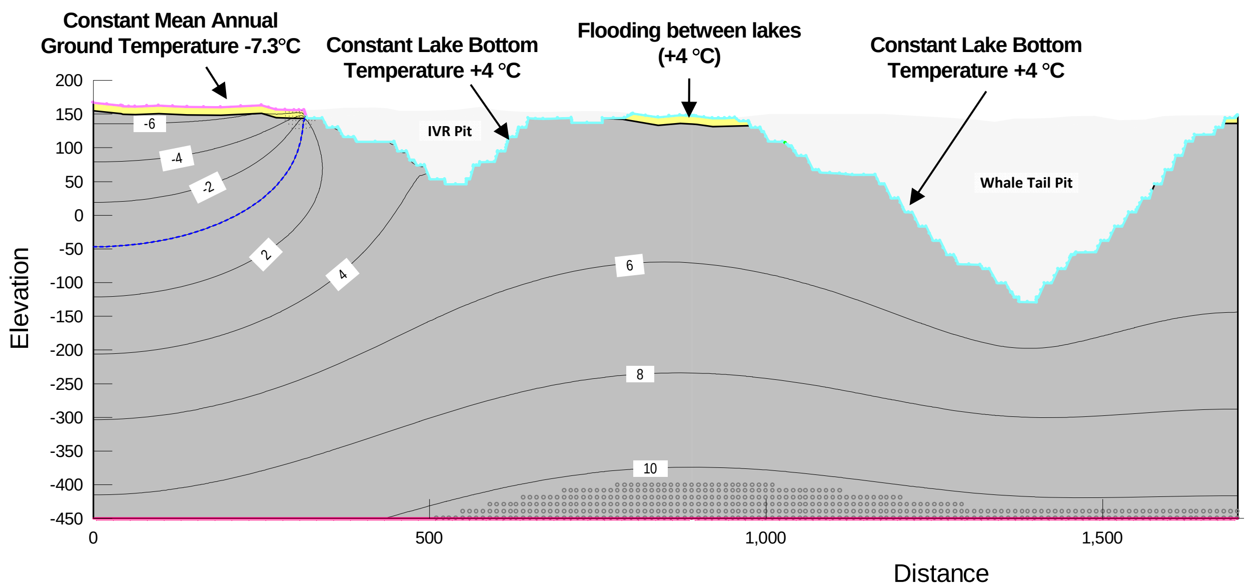

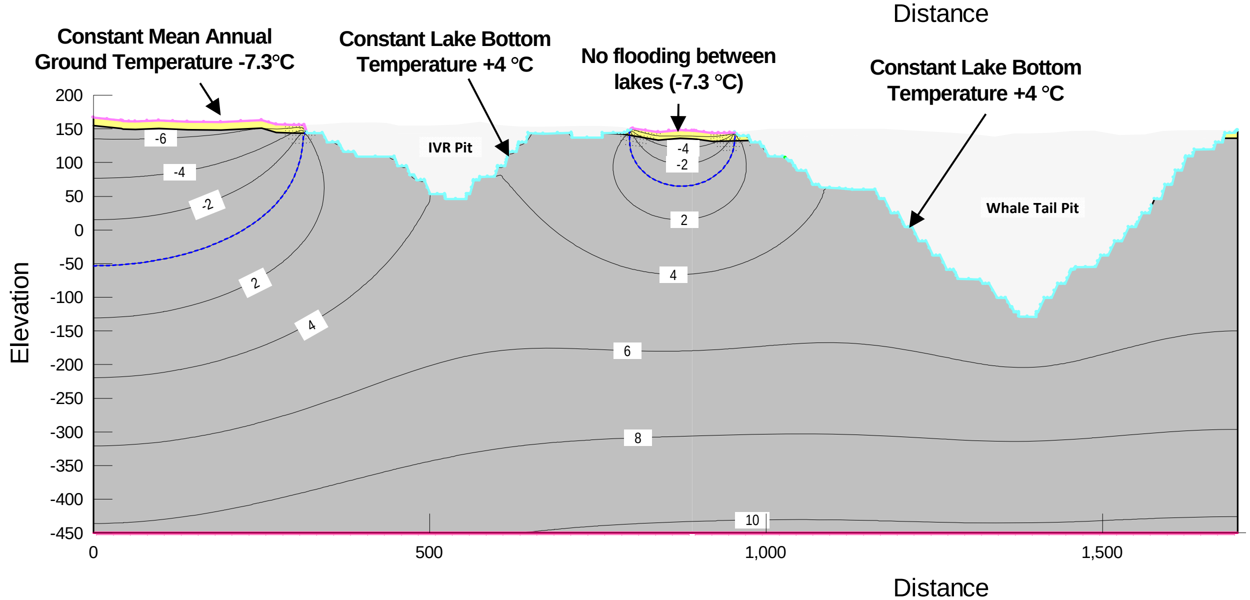

File Name: Section A_12JAN17 Long Term 1

Notes

1. Location of thermistor AMQ17-1265A is approximate.
2. Isotherms include the 15 years of back-flooding.

CLIENT
AGNICO EAGLE MINES LIMITED

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YYYY-MM-DD	2018-08-03
PREPARED	CTM
DESIGN	CTM
REVIEW	FJ
APPROVED	SO

PROJECT
WHALE TAIL PIT PROJECT
POST-CLOSURE PIT LAKE THERMAL ASSESSMENT
NUNAVUT

TITLE
STEADY STATE THERMAL MODELLING
POST-CLOSURE PIT LAKES

PROJECT No.	Phase./Task	Rev.	Figure
1789310	2000/22030	0	2-7

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