Atlantic Gold

Appendix B.2

Hydrogeological Modelling Assessment and Groundwater Modelling Conformity - Final
Golder Associates

April 17, 2020 Project No. 1895674

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CONFORMITY REVIEW OUTCOME FOR THE FIFTEEN MILE STREAM GOLD PROJECT ENVIRONMENTAL IMPACT STATEMENT – SECTION 6.5 GROUNDWATER QUALITY AND QUANTITY

The table below provides responses to the information requirements listed for groundwater-based components of the Fifteen Mile Stream Gold Project Environmental Impact Statement. In general, the requested information can be found in the Hydrogeological Modelling Assessment Report; sections of this report that relate to the information request, along with relevant portions of the text, are included in the responses below.

Information Requirement	Response
The EIS requires an appropriate hydrogeologic model for the project area, which discusses the hydrostratigraphy and groundwater flow systems.	The hydrogeological setting is discussed in Section 2 of the Hydrogeological Modelling Assessment Report (pg 2-5), which includes descriptions of the hydrostratigraphic units of the unconsolidated deposits and bedrock, groundwater elevations, and flow directions.
A sensitivity analysis will be performed to test model sensitivity to climatic variations (e.g., recharge) and hydrogeologic parameters (e.g., hydraulic conductivity).	A sensitivity analysis was completed, which involved perturbation of some of the key model input parameters and comparison to the base case results. The sensitivity analysis is detailed in Section 4.4 of the Hydrogeological Modelling Assessment Report (pg 12-13). The analysis encompassed alternative model configurations to assess sensitivity to recharge (SR1), bedrock storage (SR2), enhanced hydraulic conductivity (SR3), and potential intersection of abandoned mine workings (SR4).

Information Requirement	Response
Provide information or a sufficient rationale for the omission of the following from the hydrogeological model: ■ Addressing the zones of “enhanced hydraulic conductivity”	Zones of enhanced hydraulic conductivity were evaluated as a part of the sensitivity analysis. The following text was provided in Section 4.4 of the Hydrogeological Modelling Assessment report: Sensitivity Run 3 (SR3) – Enhanced Hydraulic Conductivity Feature – Although not noted in field testing completed to date (See Section 2.3.2), there is the potential for bedding plans or faulting to enhance hydraulic conductivity at a local scale, providing greater potential for groundwater to flow from surface water features into the open pit. To assess the potential effect of this flow on groundwater inflows to the open pit a 100-metre-wide zone of enhanced hydraulic conductivity was added to the model to better connect the open pit area to surface water sources (i.e., Seloam Brook) west of the pit. The configuration of this zone is shown on Figure 13. Within this zone the horizontal and vertical bedrock hydraulic conductivity, as well as the overburden hydraulic conductivity, was increased by a factor of 10. The inclusion of this enhanced zone of hydraulic conductivity increased the groundwater inflow to the open pit to 690 m3/day (25 percent higher than the base case estimate).
Provide information or a sufficient rationale for the omission of the following from the hydrogeological model: ■ Regional (deep) groundwater flow regime	The deep groundwater flow regime (i.e., flow through the deep bedrock) was considered as a part of the hydrogeological modelling, as detailed in Section 3.3.3 of the Hydrogeological Modelling Report. The hydrostratigraphic succession defined in the model includes overburden (up to 41 m thick), upper bedrock (i.e., the upper 3 m of bedrock), shallow bedrock (15 m in thickness), intermediate bedrock (82 m in thickness), and deep bedrock (to a depth of -190 mASL).
Provide information or a sufficient rationale for the omission of the following from the hydrogeological model: ■ The use of large uniform beds to represent fractured rock	As outlined in Section 3.2 of the Hydrogeological Modelling Report, the base case model assumes no discrete features (i.e., individual fractures) and represents the hydrostratigraphic units using an equivalent porous media (EPM) approach. The degree of bedrock fracturing is considered as a part of the model parameterization of the EPM bedrock units, which decrease in hydraulic conductivity with depth (see Section 3.3.3 of the report). This common approach is considered reasonable given that the scale of the simulated drawdown at the pit is significantly greater than the scale of individual fractures. A sensitivity simulation (SR3), where an enhanced hydraulic conductivity feature was added to the model, was completed to evaluate the potential impact of this approach.
Provide information or a sufficient rationale for the omission of the following from the hydrogeological model: ■ Calibration of the model using baseflow (and not just heads) from streams	Model calibration is detailed in Section 3.4 of the Hydrogeological Modelling Report. Groundwater elevation data comprised the primary targets for model calibration (as baseflow estimates were from streams were not available at the time the modelling was completed). As an additional check on the reasonableness of model results a comparison of groundwater flow patterns (discharge areas, depths to groundwater, etc.), calibrated hydraulic conductivity estimates, and the model recharge were compared to measured or estimated values. It was noted that the model adopts an average recharge estimate (hence baseflow) that aligns well with the assumptions made within the surface water model (Section 3 of the Hydrological Modelling Assessment Report – reference).

Information Requirement	Response
Provide information or a sufficient rationale for the omission of the following from the hydrogeological model: ■ The irregular model extent shape	The model extents were selected to align with hydraulic boundaries as described in Section 3.3.1 of the Hydrogeological Modelling Report, detailed as follows: The groundwater model domain generally aligns with the surface water sub-watershed boundaries along the eastern, western, and southern extents. The northern portion of the model domain truncates the headwaters of the Fifteen Mile Stream catchment along a topographic high. A small portion of the eastern extent of the model domain truncates the eastern portion (the headwaters) of the Moser Lake catchment.
Provide information or a sufficient rationale for the omission of the following from the hydrogeological model: ■ Representative ranges of input parameters that represent the hydrogeologicalconditions that are then assessed in the sensitivity analysis	Details on the parameter variations used in the sensitivity analysis are detailed in Section 4.4 of the Hydrogeological Modelling Report. This includes rationale for selection of alternative recharge rates (based on the seasonal variability in groundwater elevation observations), bedrock storage (order of magnitude increase), and bedrock hydraulic conductivity (based on potential for enhanced hydraulic conductivity of the bedrock through faulting).

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REPORT

Fifteen Mile Stream Gold Project

Hydrogeological Modelling Assessment

Submitted to:

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Distribution List

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Executive Summary

Atlantic Mining NS Corp (AMNS), a wholly owned subsidiary of St. Barbara Ltd. is planning to develop the Fifteen Mile Stream Gold Project (the Project) located approximately 115 km east of Halifax, in Halifax County, in the province of Nova Scotia (Figure 1). The project includes an open pit, a waste rock storage area (WRSA), stockpiles, materials storage, crushing and concentrator facilities, water management and treatment infrastructure, mine haul roads, and an above-ground tailings management facility (TMF). Ore would be crushed and concentrated on site to produce a gold concentrate that would be hauled to AMNS's Touquoy Mine for final processing.

Effects from the Project on the groundwater flow regime are evaluated based on the results of hydrogeological modelling (using FEFLOW). This report provides a summary of the hydrogeological modelling completed for the operations and post-closure phases and the relevant model results including:

- changes in groundwater elevations associated with the open pit, TMF, and WRSA
- the groundwater flow pathways from the TMF and WRSA
- the rates of groundwater flow from the TMF and WRSA to downstream receptors
- the change in groundwater flow to surface water features
- the rate of groundwater inflow to the open pit

The groundwater flow model was constructed based on a conceptual model of groundwater flow at the Project site. The model was then calibrated to current conditions using an iterative process where steady-state model runs were completed with adjustments to the model input parameters (within acceptable ranges) until model results provided an acceptable match to measured conditions (groundwater elevations and groundwater flow directions). After an acceptable model calibration was achieved, the calibrated model was then modified to represent the Project site under operations and post-closure conditions, and transient simulations were completed to evaluate the changes in groundwater conditions associated with the Project. The main findings from the forecast simulations are summarized as follows:

- The steady-state extent of drawdown due to dewatering of the open pit (based on the 1 m drawdown contour at the bedrock-overburden interface) extended a maximum of 830 m from the open pit during operations, and 140 m in post-closure. Increases in groundwater elevations associated with the TMF (based on the 1 m change in elevation contour at the bedrock-overburden interface) generally remained within the footprint of the TMF. A slight (less than 0.5 m) increase in groundwater elevations in the bedrock-overburden interface occurred within the footprint of the WRSA representing the long-term potential for slight mounding of groundwater within the covered WRSA.
- Groundwater seepage from the WRSA travels toward (and ultimately discharges to) the open pit during both operations as well as post-closure.

- The majority of seepage (85%) from the TMF discharges to the internal toe drain or perimeter drainage ditch of the TMF. Some groundwater seepage occurs at depth beyond these collection systems, estimated by the groundwater model as follows: approximately 75 m^3/day discharges northwards to a tributary of Seloam Brook, while approximately 6 m^3/day discharges to the south within the headwaters of the East Lake catchment. The effect of this seepage is assessed in surface water quality modelling for the Project (Golder, 2019d).
- Changes in groundwater flow to surface water features, due to changes in groundwater elevation, were limited to the areas in close proximity to the open pit and the TMF. These changes are assessed in combination with changes to surface water flows in surface water modelling for the Project (Golder, 2019c).
- Simulated steady-state groundwater inflow to the open pit averaged 655 m^3/day during operations and 270 m^3/day under post-closure conditions (to the flooded pit lake). A sensitivity analysis (completed for the operational period) indicated that seasonal variations in groundwater inflow may range from 420 m^3/day to 910 m^3/day (the upper end of the range is anticipated in the spring period, with the lower end of the range occurring in winter). The presence of a local zone of enhanced hydraulic connectivity intersecting the open pit along the west side would increase pit inflows, estimated at 845 m^3/day (on average) if this zone was one order of magnitude larger than considered in the base case model. An increase in storage in the bedrock, either through consideration of an order of magnitude increase in the specific storage of the bedrock or groundwater potentially stored in historic mine workings in the open pit area, results in a potential increase in the total groundwater inflow to the open pit by 47,500 m^3 and 35,000 m^3 respectively (over the seven year life of the open pit). It is noted that surface water runoff and direct precipitation captured by the open pit are calculated external to the groundwater flow model and are not included in the above estimates.

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1.0 INTRODUCTION

1.1 Background

Atlantic Mining NS Corp (AMNS), a wholly owned subsidiary of St. Barbara Ltd. is planning to develop the Fifteen Mile Stream Gold Project (the Project) located approximately 115 km east of Halifax, in Halifax County, in the province of Nova Scotia (Figure 1). The project includes an open pit, a waste rock storage area (WRSA), stockpiles, materials storage, crushing and concentrator facilities, water management and treatment infrastructure, mine haul roads, and an above-ground tailings management facility (TMF). Ore would be crushed and concentrated on site to produce a gold concentrate that would be hauled to AMNS's Touquoy Mine for final processing.

1.2 Objective

The work described in this report was completed as part of the technical support for hydrogeological aspects of the environmental assessment, which includes the evaluation of potential project-related effects to the groundwater flow regime. Results of the hydrogeological assessment are incorporated into the overall environmental impact assessment, documented in Section 6.5 of the Project Environmental Impact Statement (EIS) [AMNS, 2019], and used in surface water quantity and quality modelling completed for the Project (Golder 2019b, Golder 2019c). The objective of this work is to provide the following groundwater modelling results for both operations and post-closure phases of the Project:

- the rates of groundwater inflow to the open pit
- the degree of groundwater elevation changes associated with the open pit, TMF, and WRSA
- the seepage pathways from the TMF and WRSA
- the rates of groundwater flow from the TMF and WRSA to downgradient surface water receptors

1.3 Scope of Work

The following tasks were completed in order to meet the above objectives:

- **Review of Existing Data** – Baseline geotechnical, hydrogeological, and hydrological reports completed by Golder Associates Ltd. (Golder) were reviewed, as was data provided by AMNS, McCallum Engineering Limited (MEL), and Knight Piésold (KP). External data provided included geological contact data, wetland location, and characterization data, landform mapping, TMF design details, Project site water management and water balances, pit shells, and fault mapping. Groundwater elevation data collected at the Project site up to June 4, 2019 have been included in this assessment.
- **Construction and Calibration of the Current-Conditions Groundwater Flow Model** – Following a review of the data, a conceptual model of the Project site was developed. A groundwater flow model was then constructed and calibrated to typical groundwater conditions (i.e., current groundwater elevations and flow directions).
- **Construction of the Operations and Post-Closure Groundwater Flow Simulations** – The calibrated groundwater flow model was then adapted to evaluate the potential impacts associated with the Project at the end of the operations phase and under post-closure conditions.
- **Sensitivity Analysis** – The tasks noted above were completed for the "base case" model parameterization. In order to evaluate the potential uncertainty associated with the predictive simulations, a sensitivity analysis was completed using the base case as a point of comparison.

This document is organized as follows: Section 2 provides an overview of the conceptual hydrogeological model, which serves as the basis for the numerical model; Section 3 outlines the construction and calibration of the groundwater flow model; Section 4 presents the operations and post-closure simulations; while a summary of the assessment is provided in Section 5.

2.0 HYDROGEOLOGICAL SETTING

A description of the Project hydrogeology is provided in the Hydrogeological Factual Report for the Project (Golder, 2019a). The information is summarized herein for completeness in the context of this modelling report. The reader is referred to the Hydrogeological Factual Report (Golder, 2019a) for further details.

2.1 Topography and Drainage

The topography and drainage surrounding the Project site are shown on Figure 2. The proposed open pit is situated in a low-lying area, with ground surface elevations ranging from 110 to 115 m above sea level (relative to CGVD28). The TMF and a portion of the WRSA are situated on a small ridge that runs from the northeast to the southwest of the open pit. Ground surface elevations along this ridge rise to 175 m (relative to CGVD28). Overall the ground surface slopes to the south and west towards the Antidam Reservoir, which discharges at an elevation of approximately 90 m (relative to CGVD28).

The Project site is located in the northeastern portion of the East River Sheet Harbour Secondary Watershed, which drains in a generally southerly direction from the headwaters north of the Project to the Atlantic Ocean. Seloam Lake and Antidam Reservoir serve as water control structures for the Nova Scotia Provincial Hydroelectric System within the Sheet Harbour East River Hydro System (Nova Scotia Power Incorporated, 2009). Seloam Lake spills to Seloam Brook, which drains to the southwest through the area of the proposed open pit. Seloam Brook ultimately discharges to Fifteen Mile Stream northwest of the open pit. Fifteen Mile Stream flows in a southerly direction, draining to Antidam Reservoir. East Lake, to the south of the TMF, sits at the headwaters of a catchment that drains to the south and west, ultimately discharging to the southern end of Antidam Reservoir.

Annual average precipitation is 1,440 mm per year (mm/yr) for the Project site, and annual average runoff is 1,002 mm/yr (Golder, 2019b).

2.2 Geology

2.2.1 Regional Geology

The Project is located within the Goldenville Formation, which is comprised of Cambrian aged sandstone turbidites and slate. Gold mineralization at the Project occurs in rocks of the Moose River member of the Goldenville Formation, in the Meguma Terrane, similar to Atlantic Mining NS Corp's Touquoy Gold Project. The deposits consist of disseminated and vein-hosted gold located within a folded sequence. The open pit will expose an overturned anticline and a syncline with beds dipping mainly to the north. The south limb is offset by a normal fault referred to as the Seigel fault, which marks a change in the bedding dip from moderately north dipping (north of the fault) to steeply north dipping (south of the fault) [NSDNR, 2000].

The regional surficial geology at FMS is characterized by stony till plains and/or silty till plains (ground moraines). The topography is flat to rolling, with many exposed boulders and elongated drumlins or oval hills partially covered by till from the Wisconsinan glaciation. The till is a mix of material derived from local bedrock sources, with a stony to silty sand matrix. The till plains and drumlins are generally 2 m to 30 m in thickness (NSDNR, 1992).

2.2.2 Local and Project Site Geological Conditions

Local geological conditions are described on the basis of the site-specific data collected through the 2018 Hydrogeological Investigation for the Project (Golder, 2019a), which included the drilling of 27 boreholes to depths of up to 25.7 m below ground surface (mbgs). Information was supplemented with the 2017 Geotechnical Investigation for the Project (Golder, 2018) and exploration drilling completed by AMNS.

2.2.2.1 Bedrock Topography and Geology

A bedrock topography map (Figure 3) was generated using the stratigraphic data from borehole drilling at the Project site and terrain analysis completed by Knight Piésold (2018a). Borehole logs from the 2017 geotechnical investigation (Golder, 2018) and the 2018 hydrogeological investigation (Golder, 2019a) are included in Appendix A of Golder (2019a). Outside of the area where borehole data was available, bedrock topography was inferred to control ground surface topography. The average depth to bedrock from the Project stratigraphic information is 4 m and ranges from 1 m to 16 m. This average thickness is inferred to be relatively constant throughout the Project area with the following exceptions:

- Where provincial mapping or the terrain analysis completed by Knight Piésold (2018a) indicated the presence of drumlins, the bedrock surface was inferred to remain flat beneath these features.
- Where terrain analysis completed by Knight Piésold (2018a) indicated the presence of lodgement till, the bedrock surface was inferred to rise to a maximum of 1 m below ground surface.

Bedrock topography generally slopes towards the south from topographic highs in the north, and as described above follows topography. To the southwest and northeast of the TMF the bedrock rises to 170 m (relative to CGVD28) and 160 m (relative to CGVD28) respectively, coinciding with a mapped area of lodgement till. Surface water features including Seloam Brook and Fifteen Mile Stream follow depressions in the bedrock surface that coincide with topographic lows.

The bedrock at the Project site consists of interlayered beds of various thickness of greywacke and argillite.

2.2.2.2 Surficial Geology

The surficial geology at the Project site generally consists of a thin, discontinuous layer of topsoil (less than 0.10 m in thickness), followed by a discontinuous layer of fill, up to 1.52 m in thickness. Underlying the discontinuous topsoil and fill is compact to very dense glacial till, typically consisting of silty sand to silty gravel and frequently containing cobbles and/or boulders, consistent with the provincially mapped till plains. Based on the overburden sampling detailed in Golder (2019a), the surficial geology is considered as a single stratigraphic unit in this study.

The total thickness of the surficial deposits is shown by an isopach map on Figure 4. The thickness of the surficial deposits is generally lowest on topographic highs. The lowest measured thickness of surficial deposits was 1.1 m at FMS-HG18-11A. Surficial deposits are thickest in the areas where drumlins have been mapped. The highest measured thickness of surficial deposits was 16.5 m, at exploration borehole FMS-17-290. Based on the bedrock topographic mapping discussed in Section 2.2.1, a minimum overburden thickness of 1 m and a maximum overburden thickness of 41 m have been inferred.

2.3 Groundwater

2.3.1 Groundwater Elevations and Flow Directions

Given the small depth to bedrock and the relatively low hydraulic conductivity of the bedrock, groundwater flow is inferred to follow surface topography, generally discharging to surface water features at topographic lows in close proximity to the areas of groundwater recharge at local topographic highs. Groundwater discharge provides baseflow to streams and rivers and some wetland features at the Project site. An inferred groundwater elevation map is shown on Figure 5.

Groundwater modelling and the discussion herein is based on groundwater elevations that were collected at the Project site between August 2018 and June 2019. Hydrographs for select wells showing the manual and continuous groundwater levels during this period are presented alongside precipitation records in Appendix D of the Hydrogeological Factual Report (Golder, 2019a). Groundwater elevation monitoring is ongoing, currently on a quarterly basis.

The groundwater levels measured ranged from 0.13 to 4.95 mbgs, ranging from 103.44 m (relative to CGVD28, at FMS-HG18-04B) to 160.52 m (relative to CGVD28, at FMS-HG18-11B). The water table generally lies within the overburden or the upper several metres of bedrock. The groundwater elevations in the overburden and bedrock are similar, with less than 2 m difference when comparing the bedrock (A) and bedrock-overburden interface (B) wells at each location.

2.3.2 Hydraulic Conductivity

The hydraulic conductivity of the subsurface materials at the Project site were determined based on the analysis of packer tests, single well response tests, and grain size analyses completed as part of the hydrogeological (Golder, 2019a) and geotechnical (Golder, 2018) investigations completed by Golder. Packer testing results have been grouped in to shallow bedrock (a 15 m thickness between 3 m and 18 m below the overburden - bedrock interface), intermediate bedrock (an 82 m thickness between 18 m and 100 m below overburden - bedrock interface), and deep bedrock (more than 100 m below the overburden - bedrock interface). Based on observations made while drilling, the upper 3 m of bedrock is inferred to be less competent and more permeable. The hydraulic conductivity of this upper bedrock unit was determined based on the analysis of single well response tests screened across the bedrock-overburden interface. The results are summarized as follows:

- Grain size analysis was completed on 22 samples of the glacial till overburden using the Hazen approximation. Hydraulic conductivity of these samples was found to range from 4×10^{-9} to 4×10^{-6} m per second (m/s) with a geometric mean of 5×10^{-7} m/s.
- Single well response testing was completed in 13 wells screened across the overburden-bedrock interface. Hydraulic conductivity estimates from these tests ranged from 1×10^{-7} to 4×10^{-5} m/s with a geometric mean of 2×10^{-6} m/s.
- Packer testing was completed in 35 intervals in the shallow bedrock (3 m to 18 m below the overburden-bedrock interface). Hydraulic conductivity estimates from these tests ranges from $7\text{x}10^{-8}$ to $6\text{x}10^{-5}$ m/s with a geometric mean of $1\text{x}10^{-6}$ m/s.
- Packer testing was completed in 12 intervals in the intermediate bedrock (18 m to 100 m below the overburden-bedrock interface). Hydraulic conductivity estimates from these tests ranges from $5\text{x}10^{-8}$ to $6\text{x}10^{-7}$ m/s with a geometric mean of $2\text{x}10^{-7}$ m/s.

- Packer testing was completed in 3 intervals in the deep bedrock (greater than 100 m below the overburden-bedrock interface). Hydraulic conductivity estimates from these tests ranges from $3x10^{-8}$ to $8x10^{-8}$ m/s with a geometric mean of $5x10^{-8}$ m/s.

It is noted that two packer tests (at FMS-GT-17-01 and FMS-GT-17-05) intersected fault zones as mapped by AMNS. Analysis of these tests did not indicate an enhancement of hydraulic conductivity associated with these fault zones, as documented in Section 6.5 of the main EIS for the Project (AMNS, 2019).

3.0 GROUNDWATER MODEL CONSTRUCTION AND CALIBRATION

3.1 Modelling Approach

The objective of the groundwater numerical modelling was to estimate the potential influence of Project components (the Open Pit, TMF, and WRSA) on local hydrogeological conditions during both operations and post-closure phases. To achieve this objective, a 3D numerical (FEFLOW) groundwater model was constructed and calibrated to represent the “best estimate” of groundwater flow conditions based on the conceptual model described above. The calibrated model was subsequently adapted to include the Project components so that it could be used for forecast simulations of operations and post-closure. In order to address the uncertainty associated with the “best estimate” configuration, a sensitivity analysis was completed, which involved perturbation of some of the key model input parameters and comparison to the base case results. The use of the model to complete the forecast simulations, including the sensitivity analysis, is presented in Section 4.0, while the remainder of this section describes the construction and calibration of the model to current conditions.

3.2 Code Description

FEFLOW (Finite-Element Simulation System for Subsurface Flow and Transport Processes) [Diersch, 2014] Version 7.1 (October 2017) was used to complete the numerical simulations. FEFLOW is capable of simulating saturated and unsaturated groundwater flow, solute, and heat transport in three dimensions. FEFLOW was selected for this work given its capabilities to efficiently discretize around local features (i.e., surface water bodies and mine components, such as the open pit and TMF) yet maintain a relatively regional overall footprint with which to estimate changes in more regional groundwater elevations and water balances. FEFLOW v7.1 was used to complete the simulations presented in this report. General modelling assumptions are provided in Table 1.

Table 1: General Modelling Assumptions

Groundwater Flow Model (FEFLOW)
■ Flow is laminar and steady and is governed by Darcy's Law.
■ The base case model assumes no discrete features (i.e., individual fractures) and represents hydrostratigraphic units using an equivalent porous media (EPM) approach.
■ The minimum layer thickness used in the model is 0.5 m.
■ Groundwater travel times are simulated using advective particle tracks, which do not account for dispersive or diffusive processes.

Conceptual Model
■ The geometric mean of the measured hydraulic conductivities was used as a starting point for model parameterization. ■ The conceptual model is based on geological and hydrogeological data collected by Golder and AMNS to June 4, 2018. ■ There is no differentiation of the overburden deposits (i.e., the overburden unit is modelled as a single hydrostratigraphic unit). ■ The lower bedrock units are represented by a low hydraulic conductivity value, and groundwater flow is dominated by the overburden and upper bedrock units. ■ A 10:1 horizontal to vertical anisotropy in the geologic strata was assumed. ■ Saturated flow conditions are represented. Depressurization results in the release of water from storage in transient simulations.
Calibration
■ Average groundwater elevations were used in the calibration process (where available). Averages are based on data collected at FMS from August 15 to June 4, 2019. ■ Recharge estimates reflect deeper recharge and discharge characteristics of the groundwater flow system, and do not account for shallow infiltration and discharge to intermittent streams (i.e. interflow). ■ A "regionalized" approach to model calibration was employed, such that parameter values were established for the hydrostratigraphic units on a regional scale.

3.3 Model Construction

3.3.1 Model Extent and Discretization

The extents of the groundwater model are illustrated on Figure 6. The groundwater model domain generally aligns with the surface water sub-watershed boundaries along the eastern, western, and southern extents. The northern portion of the model domain truncates the headwaters of the Fifteen Mile Stream catchment along a topographic high. A small portion of the eastern extent of the model domain truncates the eastern portion (the headwaters) of the Moser Lake catchment. The model domain covers an 8,750 hectare area.

The model domain was discretized into a triangular prismatic mesh with a horizontal nodal spacing of approximately 15 m in the area of the open pit and TMF and 25 m in the location of the main drainage features (Fifteen Mile Stream and East Lake), transitioning to a nodal spacing of approximately 300 m near the edges of the model domain. A total of 42,549 elements were specified per layer in the model, for a total of 1,021,176 model elements across the full 24 layers of the model domain. The vertical discretization of the model is described further in Section 3.3.3.

3.3.2 Boundary Conditions

The boundary conditions were comprised of recharge to the upper surface of the model, and constant head nodes at the locations of the main surface water features within the model domain, as illustrated on Figure 6. Seepage nodes, which allow water to exit the model only, were placed at secondary drainage features and wetlands.

The model recharge distribution was based on ground surface elevation to reflect the conceptual model of local groundwater recharge on topographic highs and groundwater discharge within local low points. A recharge rate of 150 mm/yr was assigned to areas above 135 m (relative to CGVD28), and 75 mm/yr to areas below 135 m (relative to CGVD28). The average recharge across the model domain was 113 mm/yr. This value (approximating 100 mm/yr.) aligns with the average infiltration used in the Surface Water Modelling Assessment (Golder, 2019c), which ranges from 3 mm/yr to 350 mm/yr. Within a small area to the southeast of the TMF, the low elevation recharge value (75 mm/yr) was applied to the higher elevations to improve the calibration of the model in this localized area. The final recharge distribution adopted is shown on Figure 6.

Constant head boundaries were applied along Seloam Lake, Antidam Reservoir, Fifteen Mile Stream, and Seloam Brook at elevations consistent with LiDAR topography, and surface water modelling assumptions (Golder, 2019c). Moser Lake and its southern drainage were interpreted as the location of a groundwater divide and defined as a location of groundwater seepage. The remaining perimeter of the model (i.e., the catchment boundaries and topographic highs) were interpreted as locations of groundwater flow divides, and therefore defined as a “no-flow” boundary condition. The base of the model (at elevation -190 m, relative to CGVD28) was also assigned as a no-flow boundary.

3.3.3 Hydrostratigraphy and Parameterization

Figure 7 shows the hydrostratigraphic parameterization of the model. The geometric mean hydraulic conductivity values presented previously in Section 2.3.2 were used as the starting point for model parameterization. These values were adjusted and refined through the calibration process until an acceptable model calibration was achieved (this is discussed further in Section 3.4 below). The final horizontal hydraulic conductivity values applied in the model ranged from a factor of 1 to 4 times lower than the geometric mean measured value. Vertical anisotropy was assigned, with the vertical hydraulic conductivity ten times lower than the horizontal hydraulic conductivity.

The hydraulic conductivity values applied in the model are summarized with respect to the model layering as follows:

- **Glacial Till Overburden:** Model Layers 1 and 2 define the glacial till overburden from ground surface to the underlying bedrock contact. The total thickness of this unit across the two numerical layers ranged from 1 m in the areas of mapped lodgment till to over 41 m in the area of mapped drumlins. The combined thickness of this unit is generally 4 m, consistent with the average thickness of this unit measured from drillhole information (as discussed in section 2.2.2.1). The horizontal hydraulic conductivity assigned to these layers was $2x10^{-6}$ m/s.
- **Upper Bedrock:** Model Layers 3 and 4 represent the upper bedrock and were specified as a combined constant thickness of 3 m (as described in Section 2.3.2). The horizontal hydraulic conductivity of these layers was specified as $2x10^{-6}$ m/s.
- **Shallow Bedrock:** Model Layers 5 and 6 represent the shallow bedrock and were specified as a combined constant thickness of 15 m (as described in Section 2.3.2). The horizontal hydraulic conductivity of these layers was specified as $9x10^{-7}$ m/s.

- **Intermediate Bedrock:** Model Layers 7 through 14 represent the intermediate bedrock and were specified as a combined constant thickness of 82 m (as described in Section 2.3.2). The horizontal hydraulic conductivity of these layers was specified as $5x10^{-8}$ m/s.
- **Deep Bedrock:** Model Layers 15 through 24 represent the deep bedrock to a depth of -190 m (relative to CGVD28). Layers 15 through 18 were specified as a constant thickness of 12 m. Layers 19 through 21 were specified as a constant thickness of 25 m. Layers 22 through 24 varied in thickness from 14 m to 54 m to accommodate the variations in thickness between ground surface and the -190 m (relative to CGVD28) model base elevation. The horizontal hydraulic conductivity of these layers was specified as $3x10^{-8}$ m/s.

3.4 Calibration

Model calibration was achieved through an iterative process by adjusting hydraulic conductivities of the hydrostratigraphic units until there was a reasonable match between the simulated and measured groundwater elevations (calibration statistics and spatial distribution of residuals), and groundwater flow patterns (discharge areas, depths to groundwater, etc.). Specific calibration targets included average groundwater elevations measured from September 27, 2018 through June 4, 2019 at 27 monitoring wells established through the hydrogeological investigation (Golder, 2019a). Calibration targets are summarized on Table 2 (Appendix D of the Hydrogeological Factual Report [Golder, 2019a]) includes temporal plots of the measured data at each location). A “regionalized” approach to parameterization was adopted where in the calibration process parameter values are associated with regional hydrostratigraphic units and adjusted globally during the calibration process to best match the measured data. Small scale variations (as might be required to match measured data at the scale of individual wells) were not employed.

The results of the model calibration are summarized in Table 2 and illustrated on Figure 8. Table 2 provides a comparison of the simulated and measured groundwater elevations; Figure 8 presents the statistical summary of the calibration process and the simulated groundwater elevations. A review of the results presented in these tables and figures allows the following observations:

- The calibrated model achieved a normalized root mean squared (nRMS) error of 2.9%, with an absolute mean error of 1.2 m, and a residual mean error of -0.4 m (Figure 8). A significant spatial bias was not observed in the simulated groundwater elevations, as shown on the residual error distribution map on Figure 8. Simulated groundwater elevations are generally within 2 m of measured groundwater elevations. This magnitude of difference is within the range of seasonal variability that can be expected at the site.
- The groundwater flow patterns simulated by the model appear reasonable given the conceptual understanding of groundwater flow. As shown on Figure 8, groundwater flow is generally simulated to follow surface water divides at topographic highs, with convergence towards the main surface drainage channels at topographic lows. Consistent with the conceptual model discussed previously, the groundwater elevation generally lies within the contact between the overburden and the upper bedrock, except in topographic lows where the groundwater table intersects topography, resulting in groundwater discharge to surface water features.
- The calibrated model is generally consistent with the measured vertical gradients, with downwards gradients simulated at higher elevations.

Based on the qualitative and quantitative comparison of simulated and measured groundwater elevation data, it is concluded that the results of the simulation provide a reasonable match to the measured conditions. The calibrated hydraulic conductivity estimates are in alignment with those established from the hydraulic conductivity tests presented in Section 2.3.2, and the model adopts an average recharge estimate that aligns well with the assumptions made within the surface water model (Golder, 2019c), recognizing that recharge rates are reflective of infiltration that reaches the water table at depth, and do not consider potential interflow components that may occur near the ground surface above the phreatic surface.

Table 2: Comparison of Simulated vs Measured Groundwater Elevations

Monitoring Well	Northing (m)	Easting (m)	Measured Groundwater Elevation (m CGVD28)	Simulated Groundwater Elevation (m CGVD28)	Simulated Minus Measured Groundwater Elevation (m)
18-02A	5001178	536075	133.11	132.16	-0.95
18-02B	5001174	536074	132.90	132.67	-0.31
18-03A	4999550	537293	117.55	117.82	0.27
18-03B	4999551	537291	117.66	117.88	0.22
18-04A	4998825	535801	105.02	102.59	-2.43
18-04B	4998823	535801	104.31	102.97	-1.34
18-05A	4998507	537263	111.54	112.04	0.50
18-05B	4998509	537262	112.06	112.06	0.00
18-06A	4998697	537513	110.62	110.98	0.36
18-07A	4998796	537889	112.61	113.33	0.72
18-07B	4998796	537884	112.50	113.27	0.77
18-08A	4997771	537613	137.64	133.32	-4.32
18-08B	4997771	537611	137.91	133.50	-4.41
18-09A	4999480	538367	121.89	121.62	-0.27
18-09B	4999477	538367	122.62	121.67	-0.94
18-10A	4998601	539252	139.15	139.91	0.76
18-10B	4998601	539249	139.07	140.14	1.07
18-11A	4997759	538575	158.75	156.91	-1.84
18-11B	4997760	538573	159.74	157.11	-2.63
18-13A	4997839	539919	147.90	149.43	1.54
18-13B	4997839	539919	150.12	149.73	-0.39
18-14A	4998353	536802	112.50	111.96	-0.54
18-14B	4998353	536804	112.74	112.06	-0.68
18-15A	4998747	536367	106.85	106.95	0.10
18-15B	4998744	536367	106.68	107.12	0.45
18-16A	4999568	540443	140.26	141.86	1.60
18-16B	4999567	540445	140.02	142.04	2.02

Note: Coordinates are in UTM Zone 20, NAD83 (CSRS)

4.0 FORECAST SIMULATIONS

The mine plan provided by AMNS consists of a 160 m deep open pit, with an approximate surface footprint of 810 m by 530 m. Tailings are planned to be deposited in a TMF located approximately 1300 m southeast of the open pit (refer to Figure 1 for general configuration of the mine layout). Groundwater model simulations were completed to represent the following phases of the Project:

- Operations: A single transient simulation was completed in which the full build-out of mine infrastructure at the end of mine life was implemented at the beginning of the model simulation. This approach (as opposed to simulation of a transient development of infrastructure) provides a conservative approach with respect to estimating the extent of hydraulic head drawdown at the end of mine life.
- Post-Closure: A single transient simulation was run to steady-state in which the current conceptualization of the mine closure plan was represented. The reclamation phase of the closure period was not simulated, and the open pit is specified as being flooded to its natural spill elevation from the start of the simulation.

The following provides an overview of how the model was parameterized in order to complete the forecast simulations.

Mine plans were provided by AMNS that detail the open pit development through seven years of operations, including a 3D ACAD drawing of the full pit development. During operations, the open pit was represented as a series of seepage boundary conditions (i.e., free-draining boundaries) applied at model nodes located within 15 m of the open pit as mapped in the 3D ACAD drawing. Within the interior of the open pit (i.e., interior to the seepage nodes that define the pit wall), model elements were inactivated. During post-closure, the seepage boundary conditions were changed to constant head boundary conditions, set at an elevation of 109 m (relative to CGVD28). This elevation coincides with the approximate natural spill elevation of the open pit, located on the western side of the open pit, in the former southern channel of Seloam Brook. Constraints to prevent inflow at the constant head nodes were not applied, as the boundary nodes were free-draining throughout the simulation. It is noted that inactivation of model elements within the pit interior will remove recharge on the upper surface of the model from this footprint during operations. Direct precipitation and runoff captured by the pit were calculated externally to the model by Knight Piésold (see Appendix A of Golder [2019c]), and not included as part of the groundwater inflows to the open pit.

During the operations phase, the WRSA will not be covered or lined. A seepage collection ditch at the perimeter of the WRSA is inferred to collect any infiltration through the waste rock that is in excess of the natural infiltration capacity. Recharge rates to the upper surface were not changed from the calibrated model for the operations simulation. During post-closure, the portion of the WRSA, which will contain Potentially Acid Generating (PAG) material, is planned to be covered. The rate of infiltration through the cover system is inferred to be 15% of the annual average precipitation as reported in Golder (2019b). A recharge rate of 150 mm/yr was applied to the upper surface of the model to simulate the effect of the cover system. This rate of recharge exceeds the natural infiltration capacity of the overburden units and allows the representation of the long-term potential for mounding of the water table within/below the covered portion of the WRSA during post-closure.

Design details for the TMF were provided to Golder by Knight Piésold (2018b). The TMF is contained on three sides by a berm. A compacted till apron extends from the berm crest to approximately 70 m towards the center of the TMF. A tailings slurry will be placed in the TMF resulting in the formation of a beach around the perimeter of the facility, and a supernatant pond in the interior. At the end of mine life the supernatant pond (inferred to represent the water level within the tailings) is expected to reach an elevation of 158 m (relative to CGVD28) (Knight Piésold, 2019). The supernatant pond terminates to the southeast at a natural topographic high. For the operations, model constant head boundary conditions were specified at model nodes located within the footprint of the supernatant pond at an elevation of 158 m (relative to CGVD28). Tailings material properties have not yet been characterized to the extent necessary to infer the long-term groundwater elevation within the tailings in post-closure. As such, the constant head boundaries were maintained at 158 m (relative to CGVD28) throughout the post-closure phase. The calibrated value for recharge on the upper surface of the model was specified over the beach portion of the TMF during both operations and post closure. The hydraulic conductivity of the upper model layers was not changed to represent the tailings or the compacted till apron.

The seepage collection system for the TMF consists of an exterior ditch at the exterior toe of the berm, and a toe drain at the interior toe of the berm (Knight Piésold, 2018b). The ditch was represented as a series of seepage boundary conditions, at an elevation equal to the ground surface around the perimeter of the TMF. The toe drain was represented as a series of seepage boundary conditions (i.e., allowing outflow from the model only) at 0.5 mbgs (representing an inferred water level within the toe drain). These seepage collection systems were applied for both the operations and post closure models.

Seloam Brook and its tributaries are planned to be diverted around the open pit. Diversion berms are shown on Figure 1. Pooling of water on the upstream (east) side of the berm is expected. The amount of pooling is expected to be relatively minor (generally less than 1 m higher than the current channel). Constant head boundary conditions assigned along the Brook in calibration were maintained in the Operations phase, as the diversion system is inferred to maintain surface flow in this area.

The remainder of the model domain was parameterized in the same manner as the calibrated model (including the ore and till stockpiles). This includes the recharge rates to the upper surface, hydraulic conductivities for the hydrostratigraphic units, and discharge locations along Fifteen Mile Stream, and Seloam Brook.

4.1 Groundwater Elevation Changes

Figures 9a through 10b show groundwater elevation contours, and the change in groundwater elevation for both operations and post-closure. Figures 9a, and 10a show the contours for the bedrock-overburden interface, and Figures 9b and 10b show the contours for the deep bedrock (at the base elevation of the open pit). Groundwater flow patterns are generally consistent with pre-mining conditions with the exception of the localized vicinity of the open pit where groundwater elevations are lowered, and flow directions are locally directed towards open pit. In the area of the TMF, groundwater elevations are elevated slightly, but the general groundwater flow directions are unchanged from calibrated conditions.

The simulated drawdown cone from the open pit in the bedrock-overburden interface generally expands radially outward from the pit. Within the bedrock-overburden interface the drawdown cone reaches a maximum extent of approximately 830 m south the open pit (based on the 1 m drawdown contour). Within the deep bedrock, the simulated drawdown from the open pit expands radially, equally in all directions, reaching a maximum extent of approximately 1450 m (based on the 1 m drawdown contour). The simulated increase in groundwater elevations associated with the TMF during operations and post-closure is generally limited to the footprint of the TMF in the overburden - bedrock interface and extends to approximately 350 m from the toe of the berm in the deep bedrock. During post-closure there is a slight (less than 0.5 m) rise in groundwater elevations in the overburden-bedrock interface within the PAG (i.e., clay covered) portion of the WRSA, limited to within the footprint of this portion of the WRSA. Residual drawdown associated with the flooded pit lake in post-closure reaches a maximum extent of approximately 140 m north of the open pit (based on the 1 m drawdown contour). The maximum drawdown associated with the flooded pit lake in post-closure is approximately 5 m (at the southern boundary of the open pit).

4.2 Seepage from Tailings Management Facility and WRSA

Particles were released at the original ground surface beneath the TMF (for both the beach and the pond) and the WRSA, to determine seepage pathways from these facilities. The resulting pathways are shown on Figure 10a for post-closure (steady-state). Particles released at the WRSA travel to the north, ultimately discharging to the open pit. The simulated groundwater flow pathway rates from the WRSA to the open pit are 140 m^3/day in operations and 175 m^3/day in post-closure. Most of the particles released from the TMF are captured by the seepage collection system. Of the particles that bypass this collection system, a portion travel to the north, discharging to a tributary to Seloam Brook, with the remainder travelling to the south, discharging to East Lake or other features within the headwaters of the East Lake Catchment. The simulated rate of groundwater seepage from the TMF was 6 m^3/day to the East Lake Catchment and 75 m^3/day to the tributary to Seloam Brook.

Based on the simulated hydraulic gradients and an assumed porosity of 0.05 for the weathered bedrock, the transport rate from the facilities to the downgradient receivers ranges from 7 to 35 m per year for a conservative solute (the adsorption of non-conservative solutes including most metals in the groundwater flow pathway can be expected to reduce the rate of transport in groundwater by orders of magnitude). Given the distances between the WRSA/TMF to their downgradient receptors (100 to 380 m), the above rate of transport translates to a transport time of 3 to 54 years to the groundwater discharge location (excluding vertical transport times from the facilities to the water table). The effect of TMF and WRSA seepage on surface water quality in the receiving environment is assessed within the surface water quality model for the Project (Golder, 2019d).

4.3 Groundwater Surface Water Interactions

The change in groundwater flow to surface water bodies was assessed by comparing the total groundwater flow to constant head and seepage boundaries in the calibrated model to the groundwater flow to the surface boundaries in the forecast model. The change was assessed for each surface water assessment catchment in which the groundwater and surface water models coincide. The assessment catchment and results are shown on Figure 11. These changes in flow are assessed through surface water modelling for the Project (Golder, 2019c).

4.4 Pit Inflow

Simulated steady-state groundwater inflow to the open pit during operations is 655 cubic m per day (m^3/day). Under post-closure conditions (with the open pit flooded to an elevation of 109 m, relative to CGVD28), the groundwater inflow to the flooded pit lake is estimated at 270 m^3/day. Runoff and direct precipitation captured by the open pit were calculated external to the groundwater flow model and are expected to be on average 1,700 m^3/day during operations, and 1,800 m^3/day in post-closure (from Knight Piésold, see Appendix A of Golder [2019c]). These flows are not included in the groundwater inflow value.

A sensitivity analysis was completed to assess the potential variability in groundwater inflow to the open pit as a function of both conceptual model uncertainty (i.e., other factors that may contribute to groundwater inflow) and general uncertainty in the model input parameters. A total of four additional simulations were completed using the operations phase model as the basis for comparison.

The simulations and their respective results are described below.

- **Sensitivity Run 1 (SR1) – *Seasonal Variation in Recharge* –** While the model was calibrated to the average groundwater elevations collected at the Project site between August 2018 and June 2019, the data collected to date indicates that groundwater elevations may vary seasonally by 0.5 m to 4 m. To assess the potential sensitivity of groundwater inflows to this seasonal variation, a simulation was completed in which the average annual recharge values applied in the calibrated model were divided into monthly values based on the monthly proportions of runoff documented in Golder (2019b), and the assumption that recharge will not occur during frozen ground conditions (assumed to be from December through March). The recharge rates applied in this scenario are summarized on Figure 12. Results for the final year of operations are shown on Figure 12. Seasonal variations in recharge on the upper model surface results in a simulated increase in inflow in the spring to 910 m^3/day, and again in late fall to 800 m^3/day. Groundwater inflows to the open pit drops to a minimum of 420 m^3/day during winter months. These values exclude direct precipitation and runoff as noted previously.
- **Sensitivity Run 2 (SR2) – *Increase in Bedrock Storage* –** In this sensitivity run the specific storage of the bedrock was increased from 1×10^{-6} per metre (m^{-1}) to 1×10^{-5} m^{-1}. This increase resulted in a longer period before steady-state is reached in the simulation. While steady-state inflows did not differ from the base case (655 m^3/day), the total inflow over the seven-year operational phase simulation was 47,500 m^3 higher (equivalent, on average, to an additional 22 m^3/day) due to the increase in specific storage. It is noted that groundwater inflows will vary with pit progression. Time to reach steady-state, and initial groundwater inflows from the release from storage are not evaluated using the current approach of implementing the final pit shell at the start of the transient simulation.
- **Sensitivity Run 3 (SR3) – *Enhanced Hydraulic Conductivity Feature* –** Although not noted in field testing completed to date (See Section 2.3.2), there is the potential for bedding plans or faulting to enhance hydraulic conductivity at a local scale, providing greater potential for groundwater to flow from surface water features into the open pit. To assess the potential effect of this flow on groundwater inflows to the open pit a 100-m-wide zone of enhanced hydraulic conductivity was added to the model to better connect the open pit area to surface water sources (i.e., Seloam Brook) west of the pit. The configuration of this zone is shown on Figure 13. Within this zone the horizontal and vertical bedrock hydraulic conductivity, as well as the overburden hydraulic conductivity, was increased by a factor of 10. The inclusion of this enhanced zone of hydraulic conductivity increased the groundwater inflow to the open pit to 845 m^3/day (30% higher than the base case estimate).
- **Sensitivity Run 4 (SR4) – *Intersection of Abandoned Mine Openings* –** The effect of historic mine workings on groundwater inflow to the open pit was calculated externally to the numerical model. A review of the information contained within the Nova Scotia Abandoned Mine Openings Database (Province of Nova Scotia, 2017) suggests that there are approximately 56 openings within the footprint of the open pit (shown on Figure 13). Where stated in the database, the average depth of these openings is 25 m. By assuming a cross sectional area of 25 m^2, the average volume of groundwater stored in each opening would be 625 m^3. Given that the abandoned openings are shallow relative to the ultimate pit depth it is likely that they would all be intersected within the first three years of pit development. Based on these assumptions the intersection of abandoned openings may contribute on average 32 m^3/day additional groundwater inflow to the pit, or 35,000 m^3 over the life of the mine. Initial higher rates of groundwater inflow from release of storage can be anticipated when an opening is first intersected.

5.0 SUMMARY

AMNS is planning to develop the Fifteen Mile Stream Gold Project (the Project), which will consist of open pit mining, followed by reclamation activities and a post-closure period. Effects from the Project on the groundwater flow regime are evaluated based on the results of hydrogeological modelling (using FEFLOW). The hydrogeological modelling was completed for the operations and post-closure phases to estimate:

- changes in groundwater elevations associated with the open pit, TMF, and WRSA
- the groundwater flow pathways from the TMF and WRSA
- the rates of groundwater flow from the TMF and WRSA to downstream receptors
- the change in groundwater flow to surface water features
- the rate of groundwater inflow to the open pit

This was accomplished by constructing a groundwater flow model based on a conceptual model of groundwater flow at the Project site. The model was then calibrated to current conditions using an iterative process where steady-state model runs were completed with adjustments to the model input parameters (within acceptable ranges) until model results provided an acceptable match to measured conditions (groundwater elevations and groundwater flow directions). After an acceptable model calibration was achieved, the calibrated model was then modified to represent the Project site under operations and post-closure conditions, and transient simulations were completed to evaluate the changes in groundwater conditions associated with the Project. The main findings from the forecast simulations are summarized below.

- The steady-state extent of drawdown due to dewatering of the open pit (based on the 1 m drawdown contour at the bedrock-overburden interface) extended a maximum of 830 m from the open pit during operations, and 140 m in post-closure. Increases in groundwater elevations associated with the TMF generally remained within the footprint of the TMF. A slight (less than 0.5 m) increase in groundwater elevations in the bedrock-overburden interface occurred within the footprint of the WRSA representing the long-term potential for slight mounding of groundwater within the covered WRSA.
- Groundwater seepage from the WRSA travels toward (and ultimately discharges to) the open pit during both operations as well as post-closure.
- The majority of seepage (85%) from the TMF discharges to the internal toe drain or perimeter drainage ditch of the TMF. Some groundwater seepage occurs at depth beyond these collection systems, estimated by the groundwater model as follows: approximately 75 m^3/day discharges northwards to a tributary of Seloam Brook, while approximately 6 m^3/day discharges to the south within the headwaters of the East Lake catchment. The effect of this seepage is assessed in surface water quality modelling for the Project (Golder, 2019d).
- Changes in groundwater flow to surface water features was limited to the areas in close proximity to the open pit and the TMF. These changes are assessed in combination with changes to surface water flows in surface water modelling for the Project (Golder, 2019c).

- Simulated steady-state groundwater inflow to the open pit averaged 655 m^3/day during operations and 270 m^3/day under post-closure conditions (to the flooded pit lake). A sensitivity analysis (completed for the operational period) indicated that seasonal variations in groundwater inflow may range from 420 m^3/day to 910 m^3/day (the upper end of the range is anticipated in the spring period, with the lower end of the range occurring in winter). The presence of a local zone of enhanced hydraulic connectivity intersecting the open pit along the west side would increase pit inflows, estimated at 845 m^3/day (on average) if this zone was one order of magnitude larger than considered in the base case model. An increase in storage in the bedrock, either through consideration of an order of magnitude increase in the specific storage of the bedrock or groundwater potentially stored in historic mine workings in the open pit area, results in a potential increase in the total groundwater inflow to the open pit by 47,500 m^3 and 35,000 m^3 respectively (over the life of the open pit). It is noted that runoff and direct precipitation captured by the open pit are calculated external to the groundwater flow model and are not included in the above estimates.

6.0 LIMITATIONS

General

This report has been prepared for the exclusive use of AMNS. The factual information, descriptions, interpretations, and comments contained herein are specific to the project described in this report and do not apply to any other project or site. Under no circumstances may this information be used for any other purposes than those specified in the scope of work unless explicitly stipulated in the text of this report or formally authorized by Golder. This report must be read in its entirety as some sections could be falsely interpreted when taken individually or out of context. Furthermore, the final version of this report and its content supersedes any other text, opinion, or preliminary version produced by Golder.

Golder shall not be held responsible for damages resulting from unpredictable or unknown underground conditions, from erroneous information provided by and/or obtained from other sources than Golder, and from ulterior changes in the site conditions unless Golder has been notified by AMNS of any occurrence, activity, information, or discovery, past or future, susceptible of modifying the underground conditions described herein, and have had the opportunity of revising its interpretations and comments. Furthermore, Golder shall not be held responsible for damages resulting from any future modification to the applicable regulations, standards and criteria, for any use of this report and its content by a third party, and/or for its use for other purposes than those intended. Golder shall not be held responsible for any decrease, real or perceived, of a property's value or any failure to complete a transaction, as a consequence of this report.

Groundwater Modelling Simulations

Hydrogeologic investigations and groundwater modelling are dynamic and inexact sciences. They are dynamic in the sense that the state of any hydrological system is changing with time, and in the sense that the science is continually developing new techniques to evaluate these systems. They are inexact in the sense that groundwater systems are complicated beyond human capability to evaluate them comprehensively in detail, and we invariably do not have sufficient data to do so. A groundwater model uses the laws of science and mathematics to draw together the available data into a mathematical or computer-based representation of the essential features of an existing hydrogeologic system. While the model itself obviously lacks the detailed reality of the existing hydrogeologic system, the behavior of a valid groundwater model reasonably approximates that of the real system. The validity and accuracy of the model depends on the amount of data available relative to the degree of complexity of the geologic formations, the site geochemistry, the fate and transport of the dissolved compounds, and on the quality and degree of accuracy of the data entered. Therefore, every groundwater model is a simplification of a reality and the models described herein are not an exception.

The professional groundwater modelling services performed as described in this memorandum were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the quantity and quality of available data, the time limits and financial and physical constraints applicable to the services. Unless otherwise specified, the results of previous or simultaneous work provided by sources other than Golder and quoted and/or used herein are considered as having been obtained according to recognized and accepted professional rules and practices, and therefore deemed valid. This model provides a predictive scientific tool to evaluate the impacts on a real groundwater system of specified hydrological stresses. However, and despite the professional care taken during the construction of the model and in conducting the simulations, its accuracy is bound to the normal uncertainty associated to groundwater modelling and no warranty, express or implied, is made.

Signature Page

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MIB/PMM/SD/sg
https://golderassociates.sharepoint.com/sites/23819g/deliverables/1895674-024-r-hydrogeo model fms/rev 0/1895674-024-r-rev0-hydrogeo model fms-0909_19.docx

7.0 REFERENCES

Diersch, H-J G. (2014). FEFLOW, Finite Element Modeling of Flow, Mass and Heat Transport in Porous and Fractured Media. DHI-WASY GmbH, Berlin, Germany.

Golder. 2018. Atlantic Gold Corporation, Fifteen Mile Stream Gold Project Prefeasibility Level Slope Design. April 2018.

Golder. 2019a. Atlantic Mining NS Corp, Fifteen Mile Stream Gold Project Hydrogeological Investigation. Rev. 2, September 2019.

Golder. 2019b. Atlantic Mining NS Corp, Fifteen Mile Stream Gold Project, Hydrology Baseline Report. Rev. 2, September 2019.

Golder. 2019c. Atlantic Mining NS Corp, Fifteen Mile Stream Gold Project, Hydrological Modelling Assessment. Rev. 0, September 2019.

Golder. 2019d. Atlantic Mining NS Corp Fifteen Mile Stream Gold Project, Surface Water Quality Modelling Assessment. Rev. 0, September 2019.

Knight Piésold Ltd. 2018a. Fifteen Mile Stream Project – Desktop Terrain Analysis Study. March 5, 2018.

Knight Piésold Ltd. 2018b. Fifteen Mile Stream Project, Figure 5 Rev A TMF General Arrangement Section and Details. November 29, 2018.

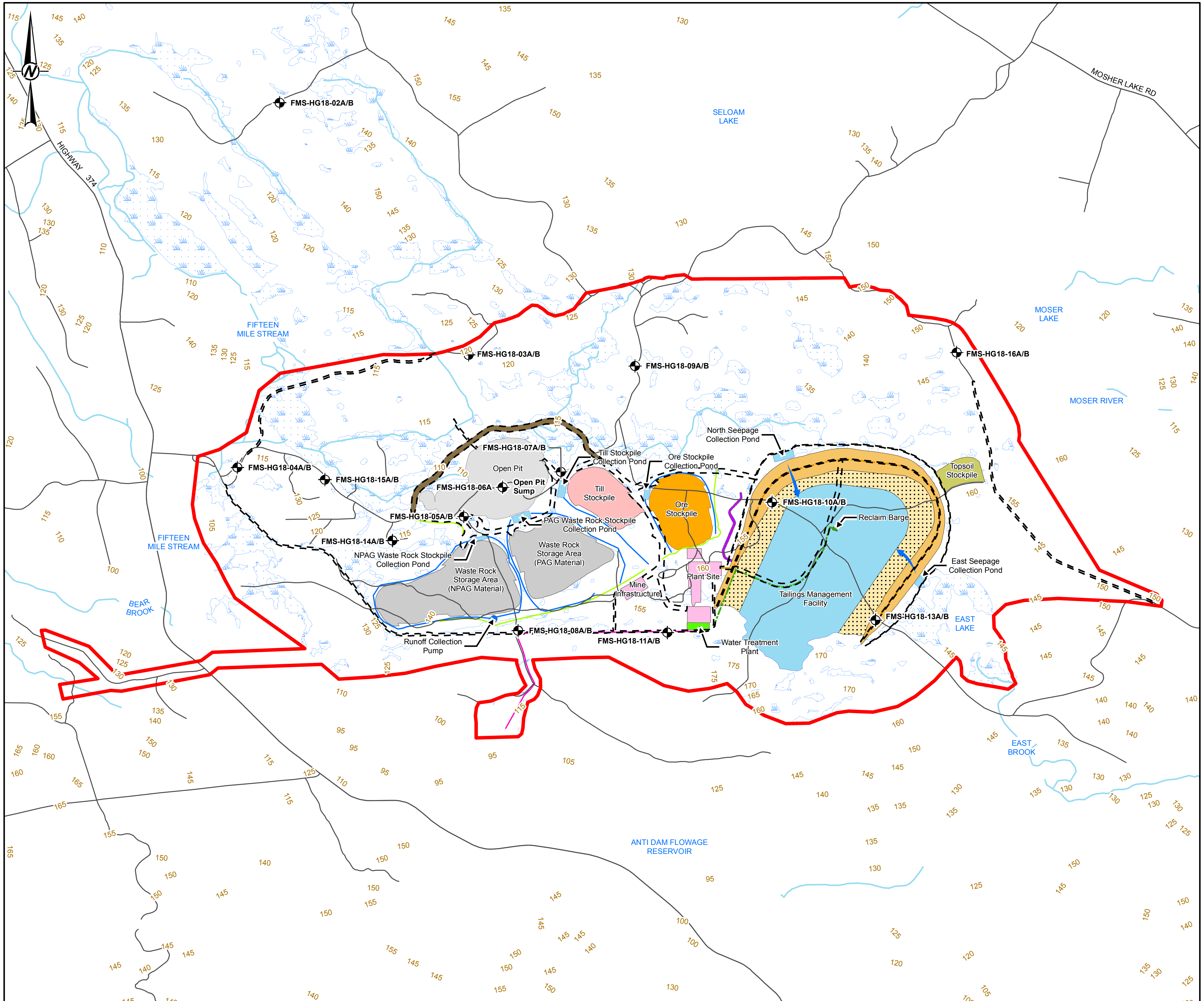
Knight Piésold Ltd. 2019. TMF Details for Egerton-MacLean Extension. Email communication from Daniel Fontaine (Knight Piésold) to Melissa Bunn (Golder) June 12, 2019.

Nova Scotia Department of Natural Resources (NSDNR.). 1992. Surficial Geology of the province of Nova Scotia, Map 92-3. Halifax: Nova Scotia Department of Natural Resources, Mine and Energy Branches, compiled by R.R. Stea, H. Conley, and Y. Brown.

Nova Scotia Department of Natural Resources (NSDNR.). 2000. Geological Map of the province of Nova Scotia, Map ME 2000-1. Halifax: Nova Scotia Department of Natural Resources, Minerals and Energy Branch, compiled by J.D. Keppie.

Nova Scotia Department of Natural Resources (NSDNR.). 2017. Nova Scotia Abandoned Mine Openings Database, DP ME 010, Version 7. Halifax: Nova Scotia Department of Natural Resources, compiled by E.W. Hennick and J.C. Poole.

Nova Scotia Power Incorporated, an Emera Company, Environmental Services. 2009. East River Sheet Harbour Hydro System, Relicensing Report.



LEGEND

- Hydrogeological Drilling Location
- Fifteen Mile Stream EIS Project Area
- Existing Road
- Topographic Contour (5m Interval)
- Access Road
- Watercourse
- Wetland
- Waterbody

PROPOSED SITE INFRASTRUCTURE

- Diversion Dam
- Embankment
- Laydown
- Open Pit
- Ore Stockpile
- Plant Site
- Pond; Collection Ponds
- Reclaim Barge
- Runoff Collection Sump
- Spillway Outlet Channel
- Tailings
- Till Stockpile
- Topsoil Stockpile
- Waste Rock Storage Area
- Water Treatment Plant
- Tailings Pipeline
- Collection Ditch
- Reclaim Pipeline
- Non-Contact Water Ditch
- Water Treatment Pipeline

KEY MAP

EXTENT OF MAIN MAP

0 430 860
1:25,000 METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
1. MCCALLUM ENVIRONMENTAL LTD. EIS PROJECT AREA, (VER.190313, RECEIVED 2019-03-18).
2. MCCALLUM ENVIRONMENTAL LTD. PROPOSED INFRASTRUCTURE, (VER.190620, RECEIVED 2019-06-28).
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 20 VERTICAL DATUM: CGVD28

CLIENT
ATLANTIC MINING NS CORP

PROJECT
FIFTEEN MILE STREAM GROUNDWATER MODELLING

TITLE
SITE PLAN

CONSULTANT	YYYY-MM-DD	2019-09-10
	DESIGNED	---
	PREPARED	RRD
	REVIEWED	MB
	APPROVED	SD

PROJECT NO.	CONTROL	REV.	FIGURE
1895674	0024	0	1

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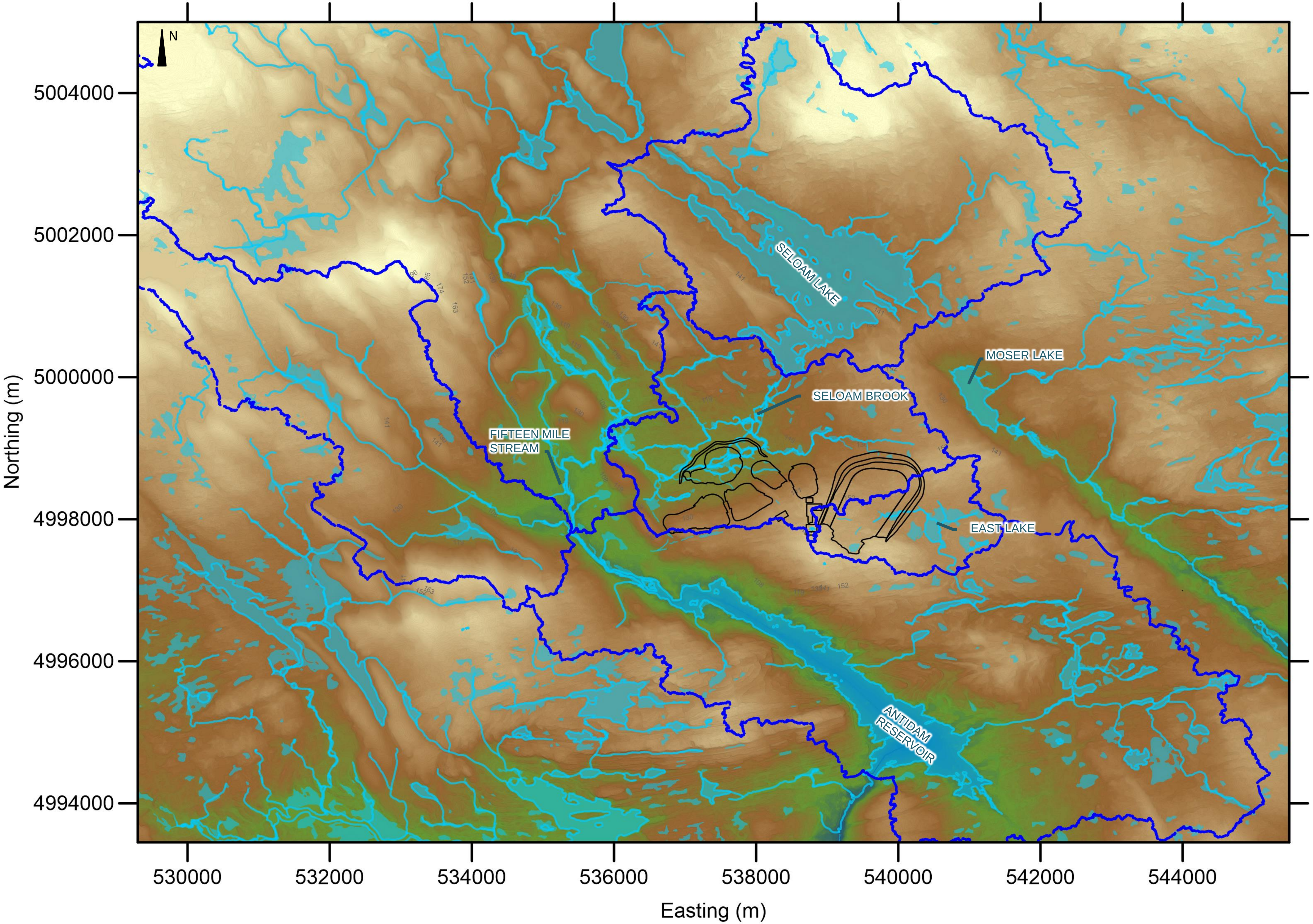

LEGEND:

- WATER COURSE
- WATERBODY
- MINE INFRASTRUCTURE
- WATERSHED BOUNDARY

GROUND SURFACE ELEVATION (masl)

240, 225, 210, 195, 180, 165, 150, 135, 120, 105, 90, 75

NOTES:

1. Water course and waterbody mapping represent a combination of provincially available data, and data collected at the Project site by McCallum Engineering Ltd. (Received October 12, 2018).
2. Project Infrastructure provided by McCallum Engineering Ltd. (Received June 20, 2019).

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PROJECT	Fifteen Mile Stream Gold Project Groundwater Modelling Assessment
CONSULTANT	GOLDER
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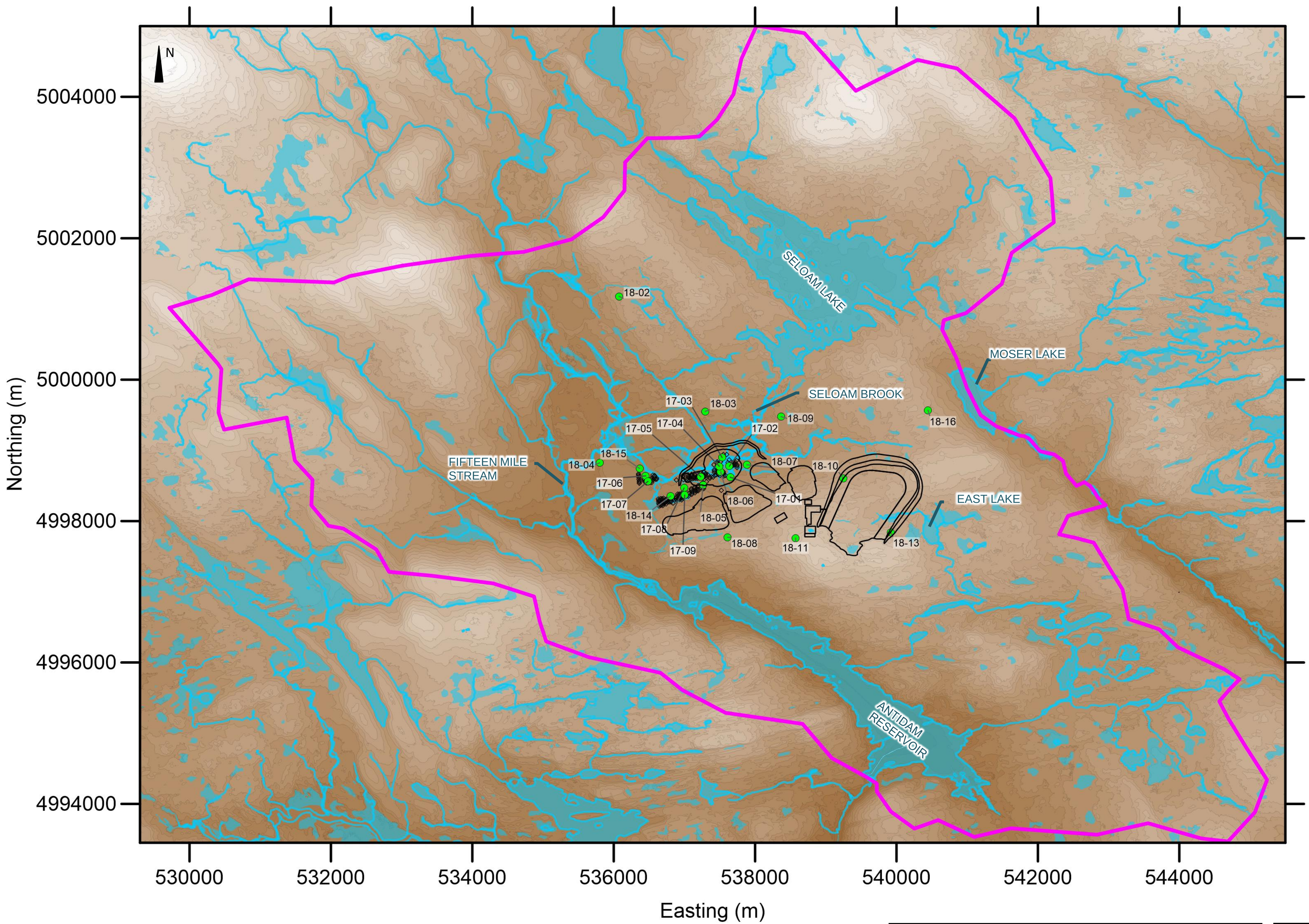
DESIGN	MIB
REVIEW	SD
APPROVED	SD
TITLE	TOPOGRAPHY AND DRAINAGE
PROJECT No.	1895674
Rev.	0
Figure	2



LEGEND:

- MODEL DOMAIN
- WATER COURSE
- WATERBODY
- MINE INFRASTRUCTURE
- 18-01 GOLDER BOREHOLE
- EXPLORATION BOREHOLE

TOP OF BEDROCK ELEVATION (masl)

225, 215, 205, 195, 185, 175, 165, 155, 145, 135, 125, 115, 105, 95, 85, 75

NOTES:

1. Water course and waterbody mapping represent a combination of provincially available data, and data collected at the Project site by McCallum Engineering Ltd. (Received October 12, 2018).
2. Project Infrastructure provided by McCallum Engineering Ltd. (Received June 20, 2019).
3. Exploration borehole database provided by Atlantic Gold Canada (Received August 17, 2018).

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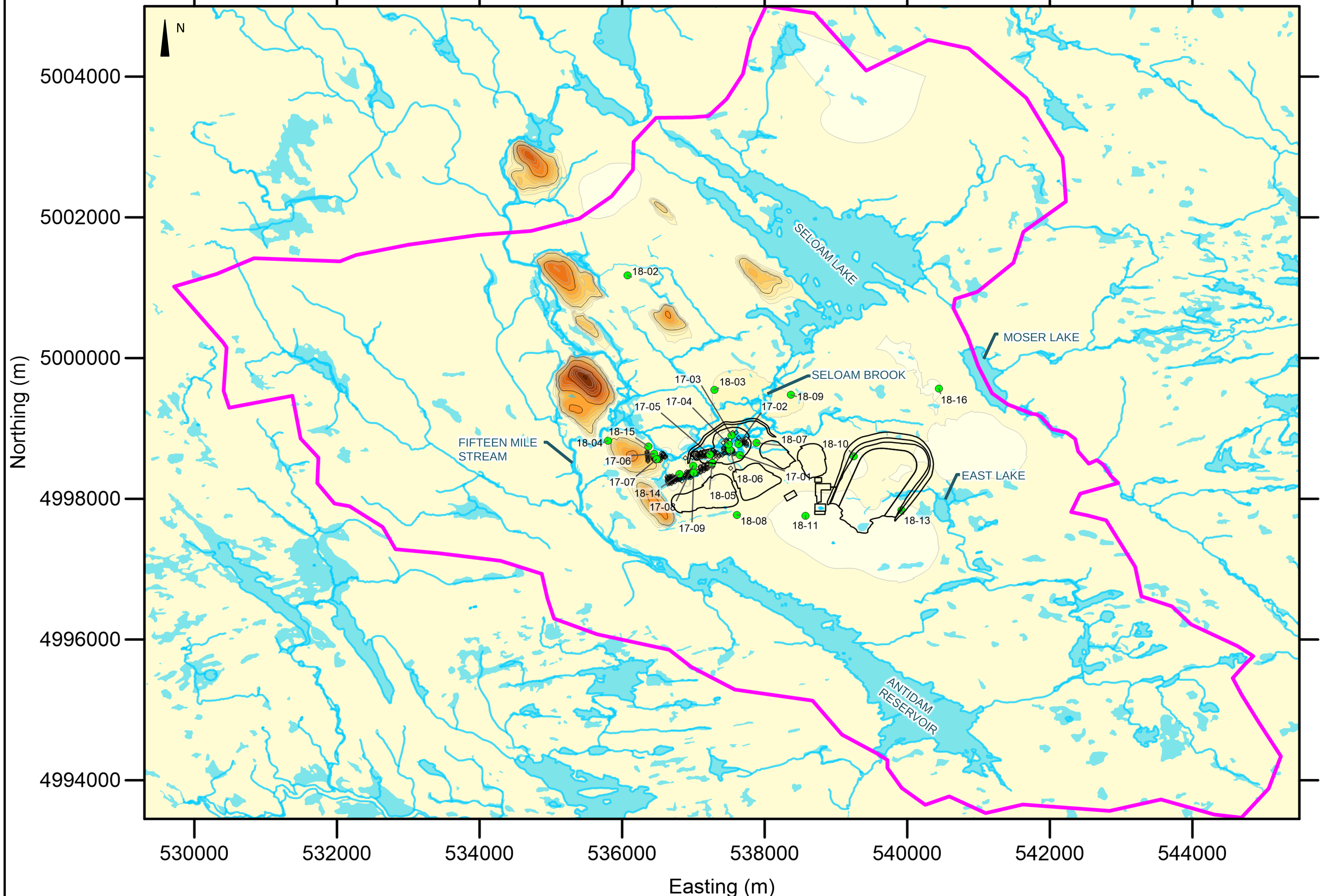
REVIEW	SD
APPROVED	SD
TITLE	**BEDROCK TOPOGRAPHY**
PROJECT No.	1895674
Rev.	0
Figure	3



NOTES:

1. Water course and waterbody mapping represent a combination of provincially available data, and data collected at the Project site by McCallum Engineering Ltd. (Received October 12, 2018).
2. Project Infrastructure provided by McCallum Engineering Ltd. (Received June 20, 2019).
3. Exploration borehole database provided by Atlantic Gold Canada (Received August 17, 2018).

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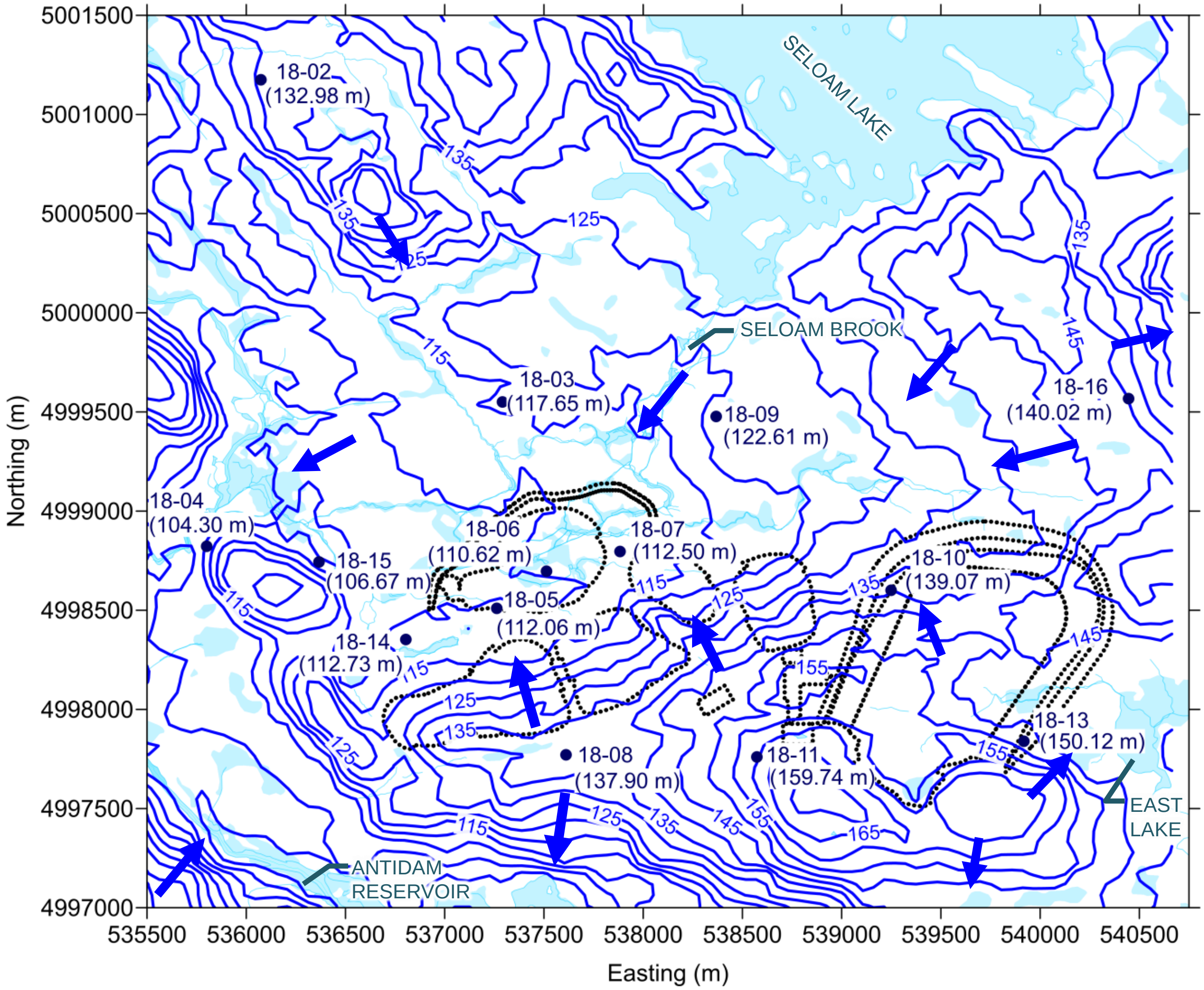
DESIGN	MIB
REVIEW	SD
APPROVED	SD
TITLE	OVERBURDEN ISOPACH
PROJECT No.	1895674
Rev.	0
Figure	4



LEGEND:

- INFERRED GROUNDWATER TABLE ELEVATION (masl)
- INFERRED GROUNDWATER FLOW DIRECTION
- MINE INFRASTRUCTURE
- 18-08 MONITORING WELL (AVERAGE GROUNDWATER ELEVATION IN SHALLOWEST INTERVAL)

NOTES:

1. The groundwater table elevation shown above is based on a fixed depth to water of 2.5 m (based on the average depth to water from the shallow interval of the monitoring wells shown above), with the exception of the following:
   a) Within a 100 m radial distance of a monitoring well location the average groundwater elevation in the shallow interval was used
   b) At major surface water features (i.e., Seloam Lake, Seloam Brook, East Lake, and Antidam Reservoir) the water level of the feature was used

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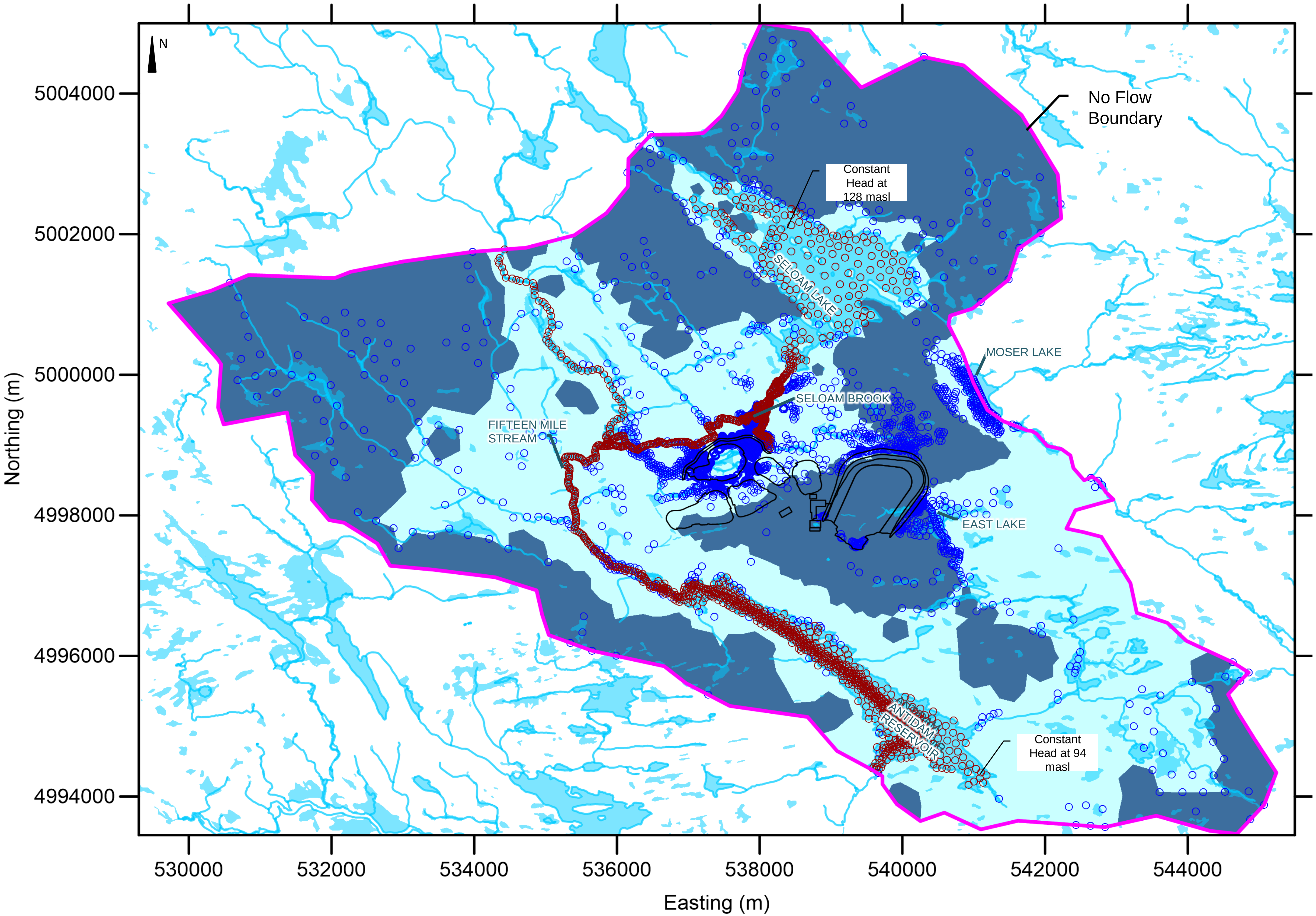
TITLE
INFERRED GROUNDWATER TABLE ELEVATION

PROJECT No.	Rev.	FIGURE
1895674	0	5



LEGEND:

- MODEL DOMAIN
- WATER COURSE
- WATERBODY
- MINE INFRASTRUCTURE
- CONSTANT HEAD BOUNDARIES
- SEEPAGE BOUNDARIES

RECHARGE ON THE UPPER MODEL SURFACE (mm/year)

- 75
- 150

NOTES:

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2. Project Infrastructure provided by McCallum Engineering Ltd. (Received June 20, 2019).

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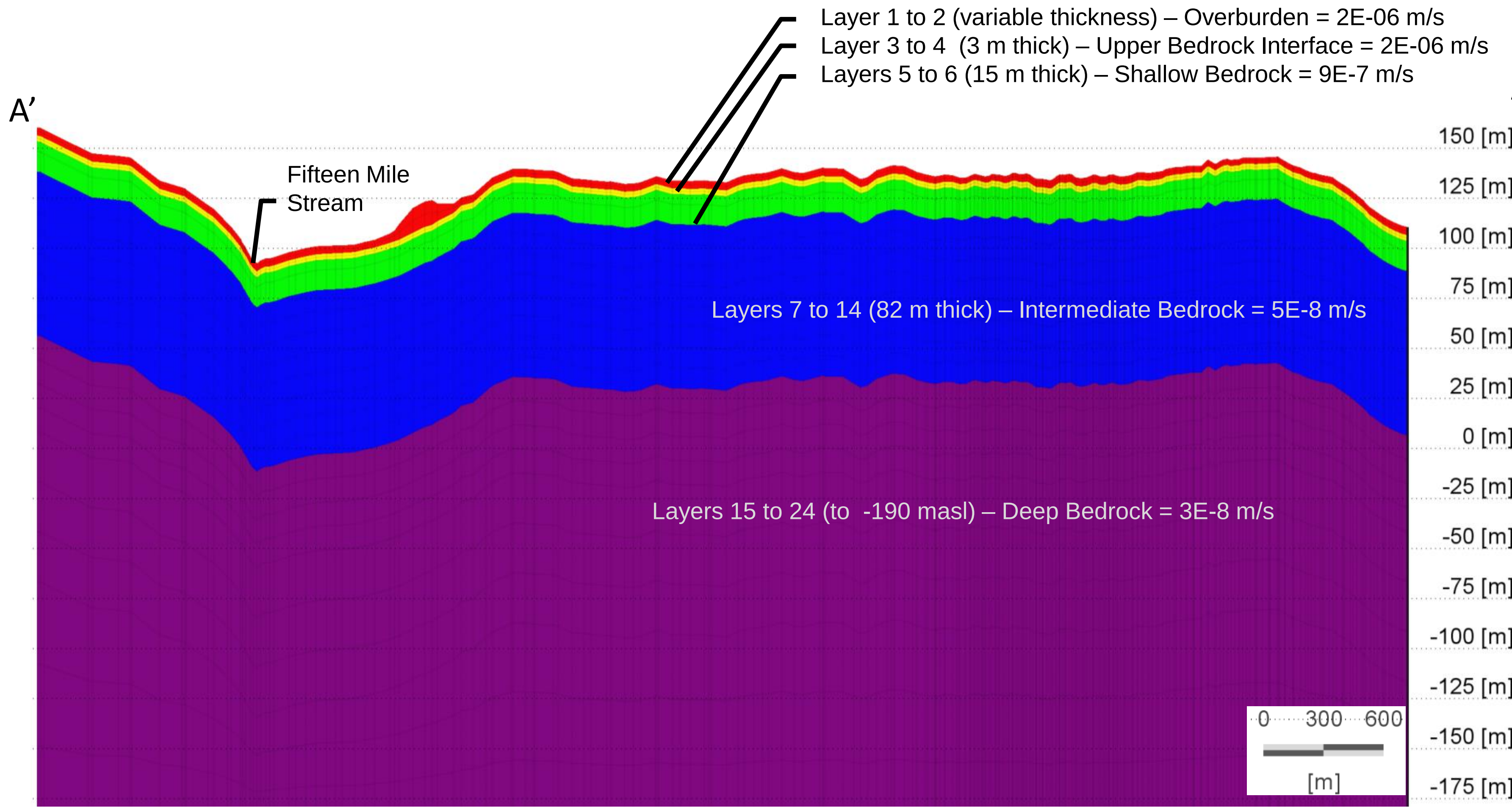
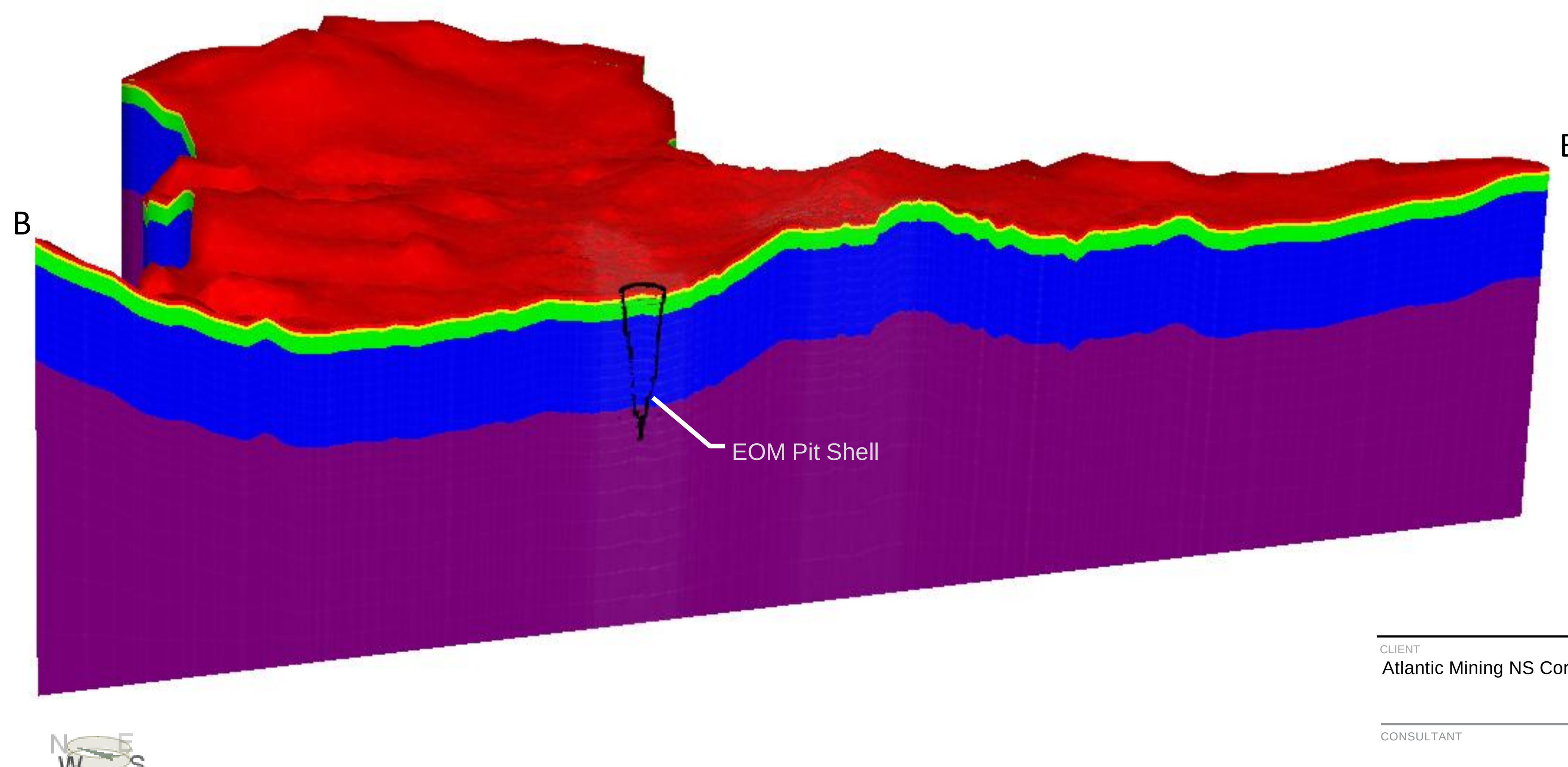
CONSULTANT GOLDER	YYYY-MM-DD: 2019-09-05 PREPARED: SPS DESIGN: MIB REVIEW: SD APPROVED: SD	TITLE **MODEL BOUNDARIES AND RECHARGE ON UPPER SURFACE**	
		PROJECT No. 1895674	Rev. 0 / Figure 6





LEGEND:

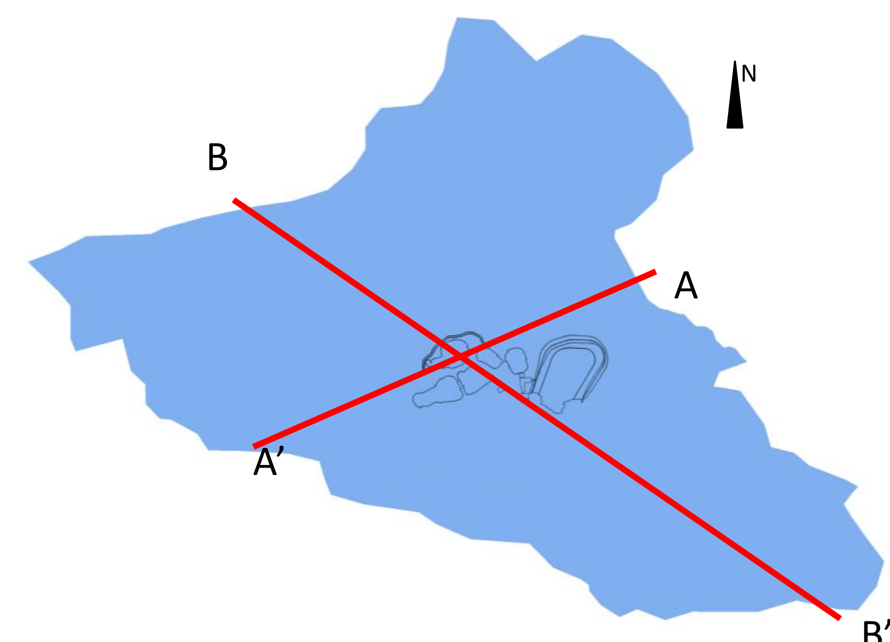
MINE INFRASTRUCTURE

MODEL HORIZONTAL HYDRAULIC CONDUCTIVITY (m/s)

- 2.0E-06
- 2.0E-06
- 9.0E-07
- 5.0E-08
- 3.0E-08

NOTES:

1. Hydraulic conductivity values for the horizontal orientation are reported. All vertical hydraulic conductivities are lower by a factor of 10.



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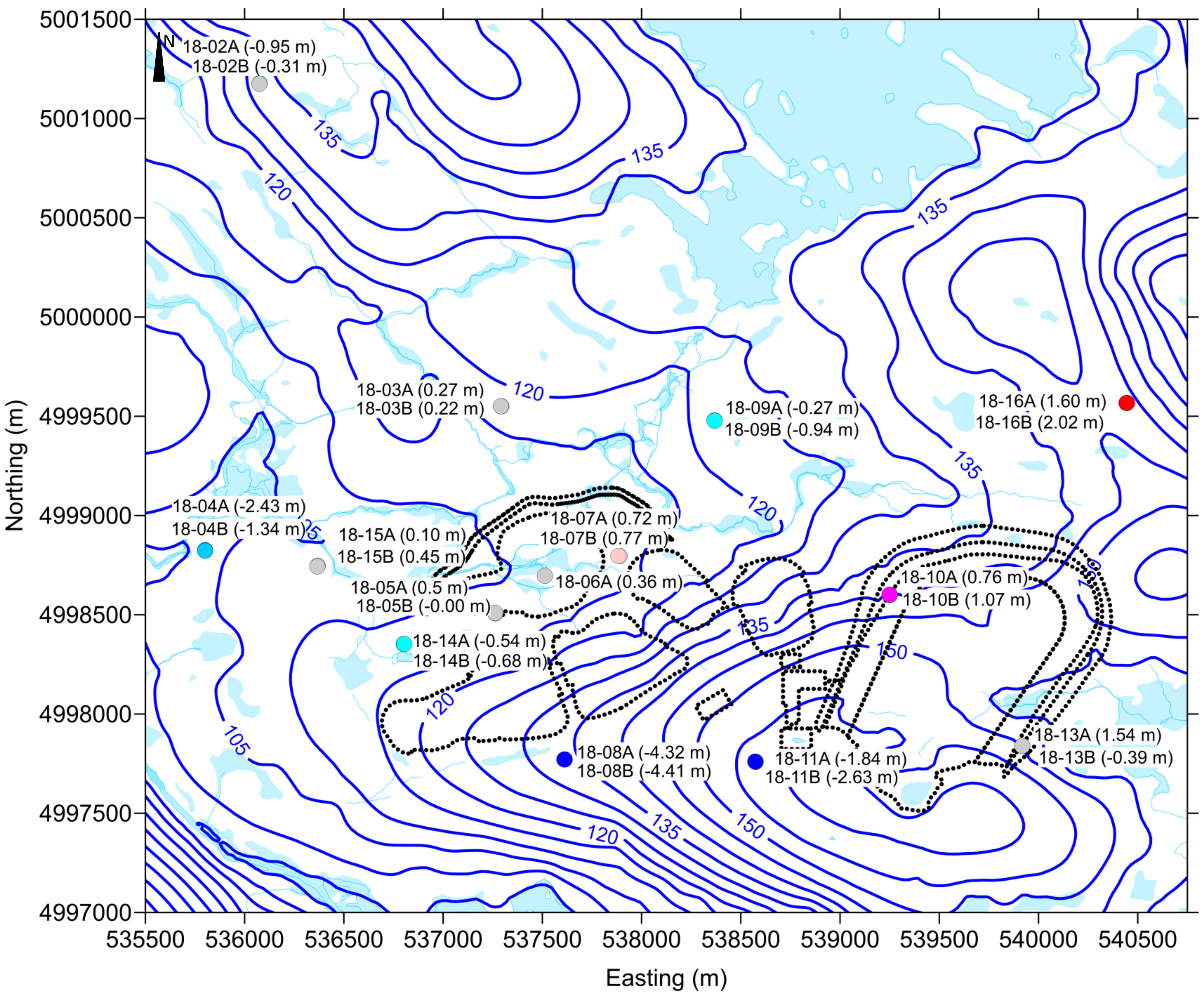
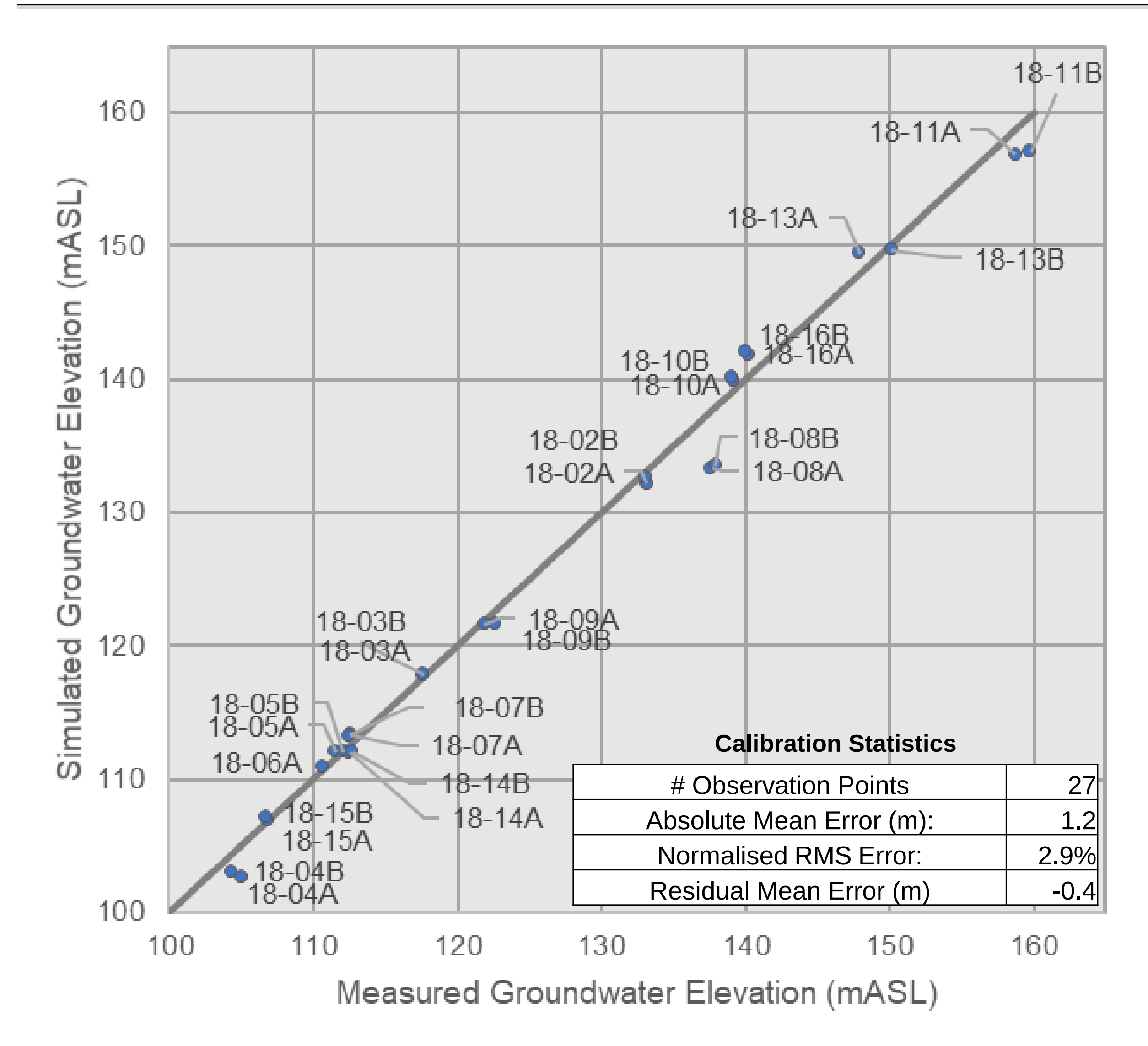
TITLE
CALIBRATED MODEL HYDRAULIC CONDUCTIVITY DISTRIBUTION

PROJECT No.	Rev.	Figure
1895674	0	7





Comparison of Simulated vs Measured Hydraulic Gradient Direction

Well Pair Name	Vertical Gradient Measured	Vertical Gradient Simulated
18-2	Down	Down
18-3	Down	Down
18-4	Up	Down
18-5	Down	Down
18-7	Up	Up
18-8	Down	Down
18-9	Down	Down
18-10	Neutral	Down
18-11	Down	Down
18-13	Down	Down
18-14	Down	Down
18-15	Up	Down
18-16	Up	Down

LEGEND:

- WATER COURSE
- WATERBODY
- MINE INFRASTRUCTURE
- SIMULATED GROUNDWATER ELEVATION (masl)

RESIDUAL ERROR - SIMULATED MINUS MEASURED GROUNDWATER ELEVATION (m)

- -5 to -2
- -2 to -1
- -1 to -0.5
- -0.5 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 5

NOTES:

1. Simulated groundwater elevations are representative of model slice 4 (Overburden-Bedrock Interface).
2. Simulated groundwater elevation contours are specified as 5 m intervals.
3. Neutral gradient indicates that less than 1 cm difference in groundwater elevation was measured at the specified well pair.

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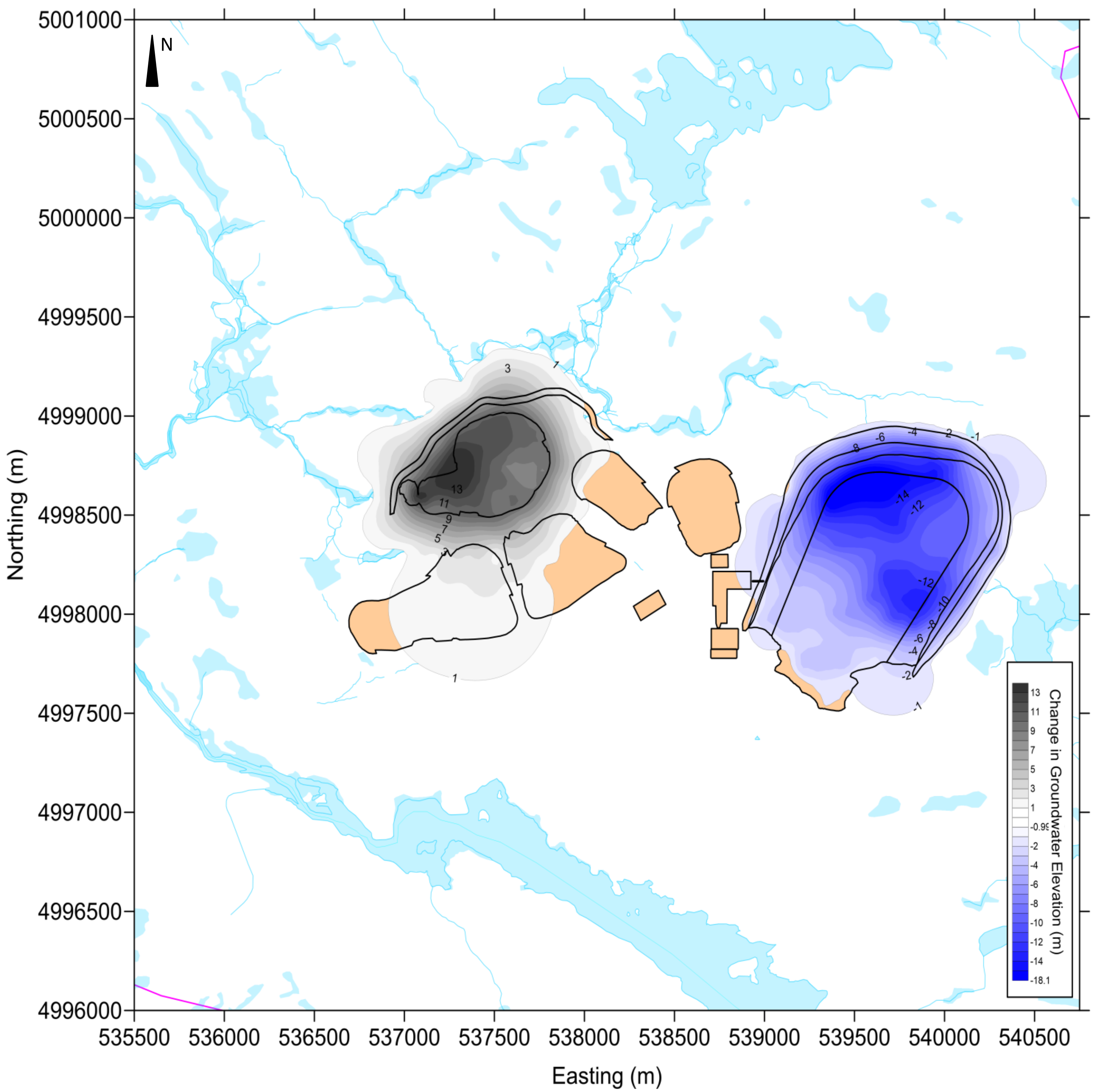
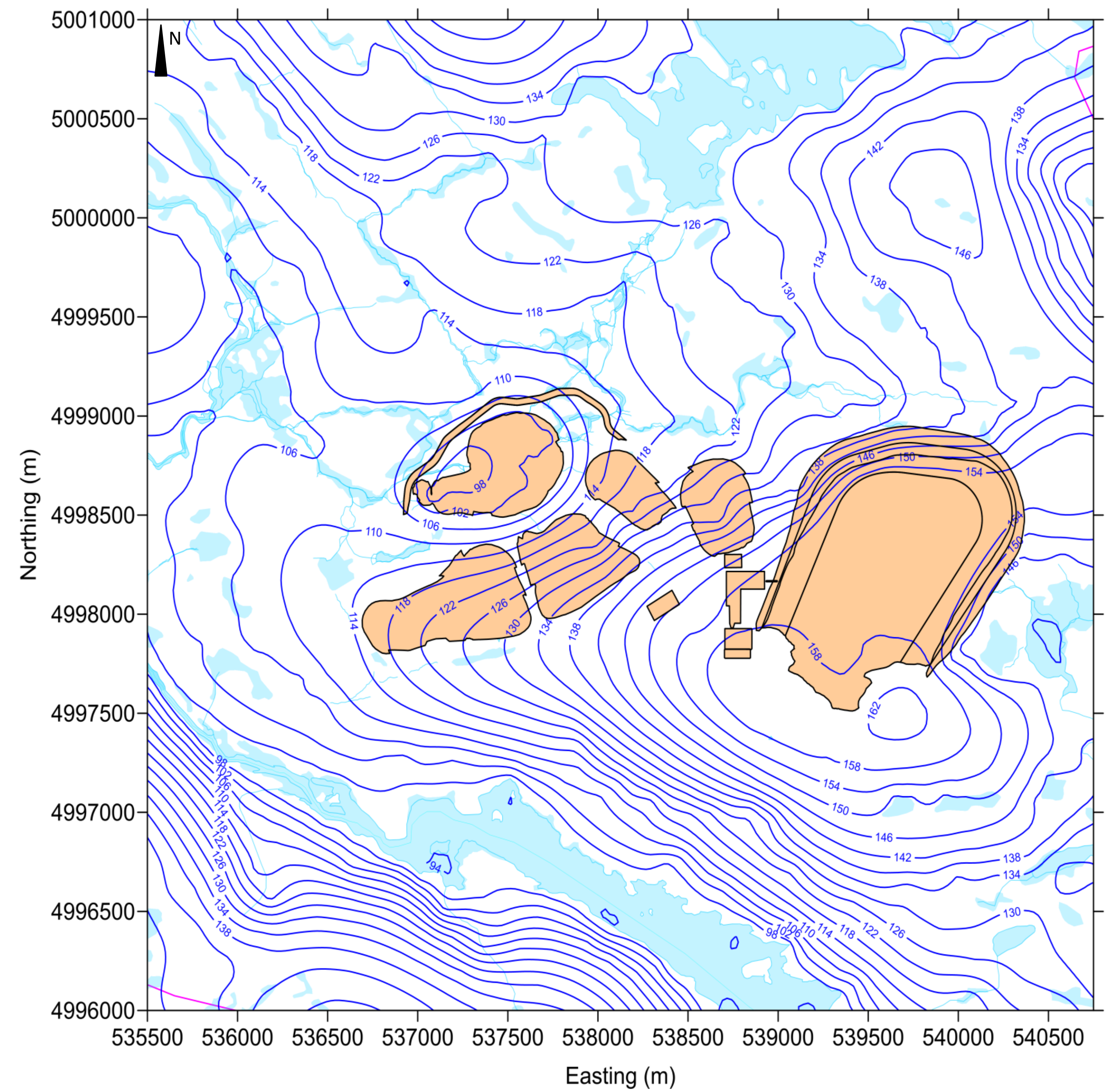
TITLE
SUMMARY OF MODEL CALIBRATION

PROJECT No.	Rev.	Figure
1895674	0	8

CHANGE IN SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER ELEVATION



NOTES:

1. Groundwater elevations and drawdown are representative of model slice 4 (Interface between overburden and upper bedrock) at model simulation time 2190 days.
2. Drawdown/Change in water level elevation contours are specified as 1 m intervals, with scale bar indicating range. Change is calculated as *Calibration – Forecast* groundwater elevation values.
3. Simulated groundwater elevation contours specified as 4 m intervals.

LEGEND:

- SIMULATED GROUNDWATER ELEVATION (masl)
- MINE INFRASTRUCTURE
- MODEL DOMAIN

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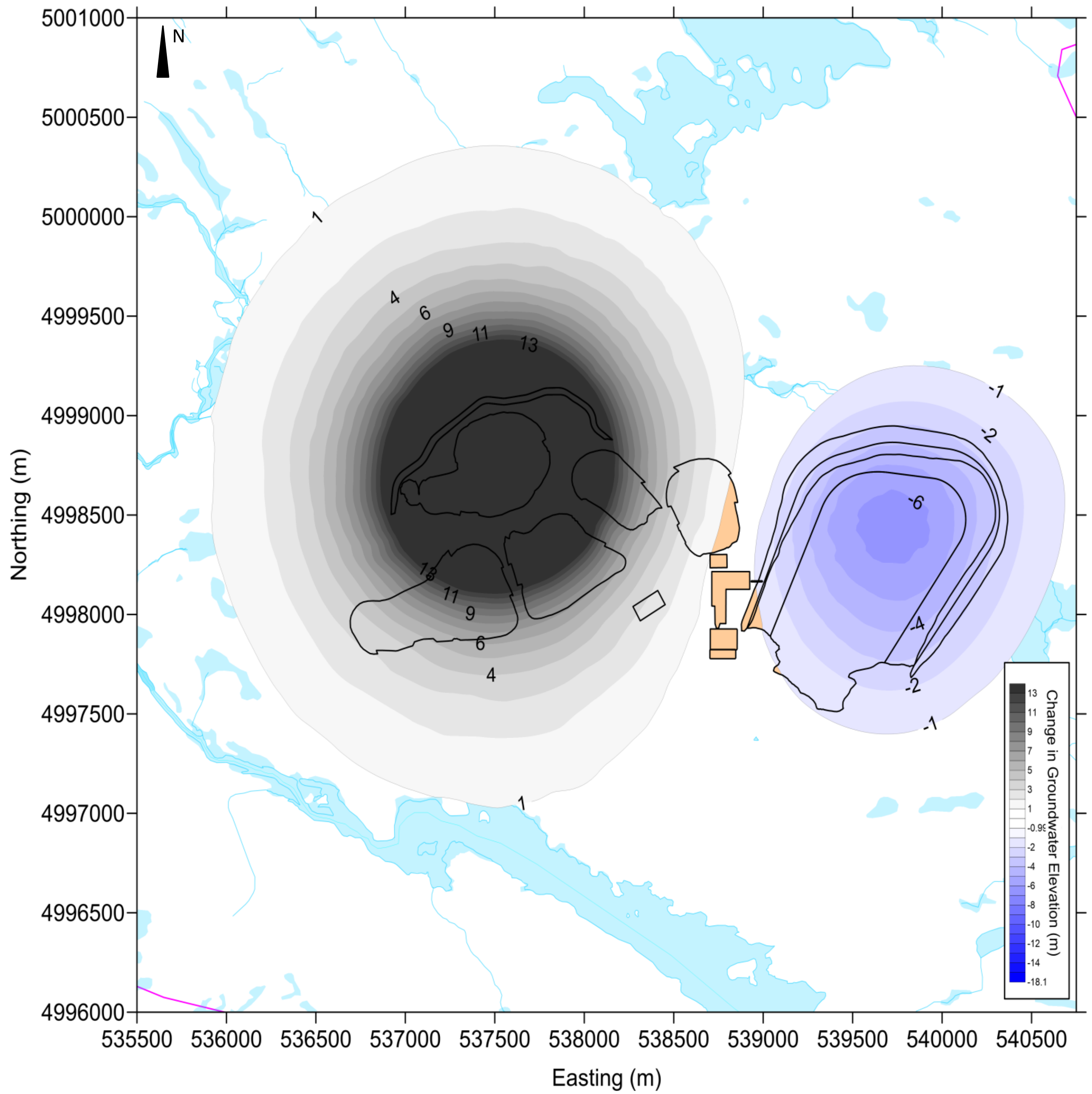
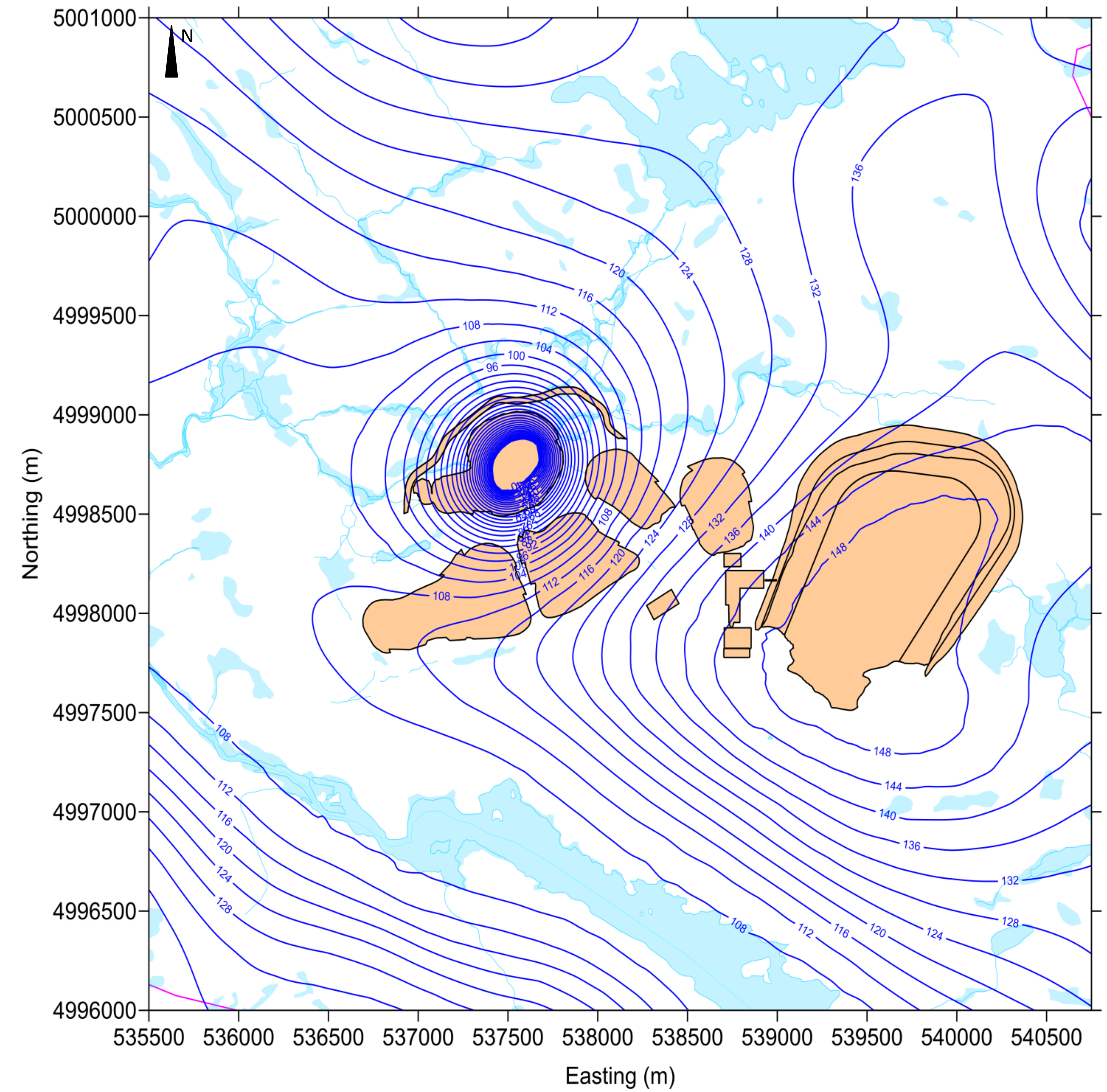
TITLE
SIMULATED GROUNDWATER ELEVATIONS, DRAWDOWN, AND SEEPAGE PATHWAYS – END OF OPERATIONS PHASE (OVERBURDEN-BEDROCK INTERFACE)

PROJECT No.	Rev.	Figure
1895674	0	9A

CHANGE IN SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER ELEVATION



NOTES:

1. Groundwater elevations and drawdown are representative of model slice 17 (Deep Bedrock at pit base) at model simulation time 2190 days.
2. Drawdown/Change in water level elevation contours are specified as 1 m intervals, with scale bar indicating range. Change is calculated as *Calibration – Forecast* groundwater elevation values.
3. Simulated groundwater elevation contours specified as 4 m intervals.

LEGEND:

- SIMULATED GROUNDWATER ELEVATION (masl)
- MINE INFRASTRUCTURE
- MODEL DOMAIN

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PROJECT
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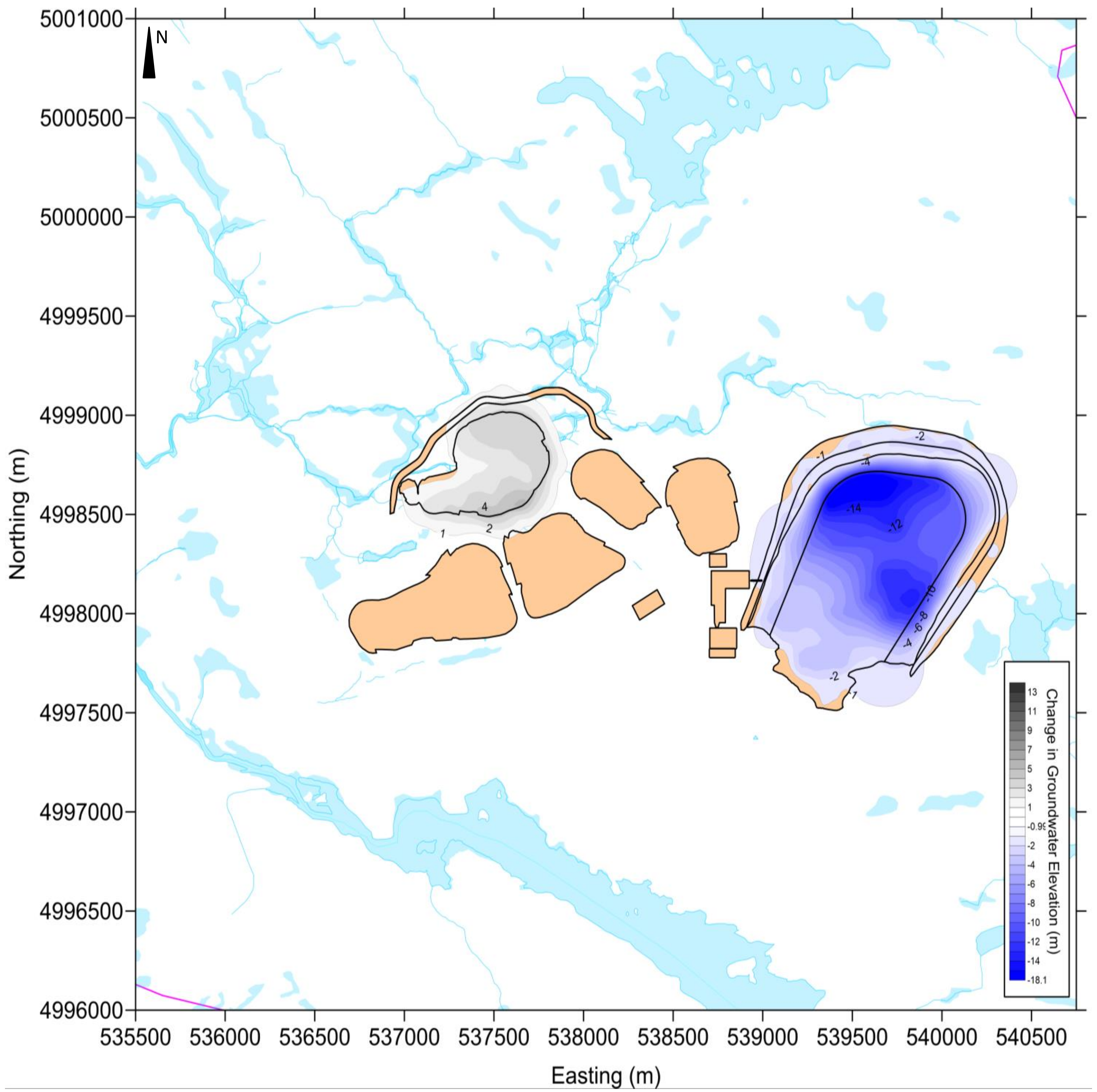
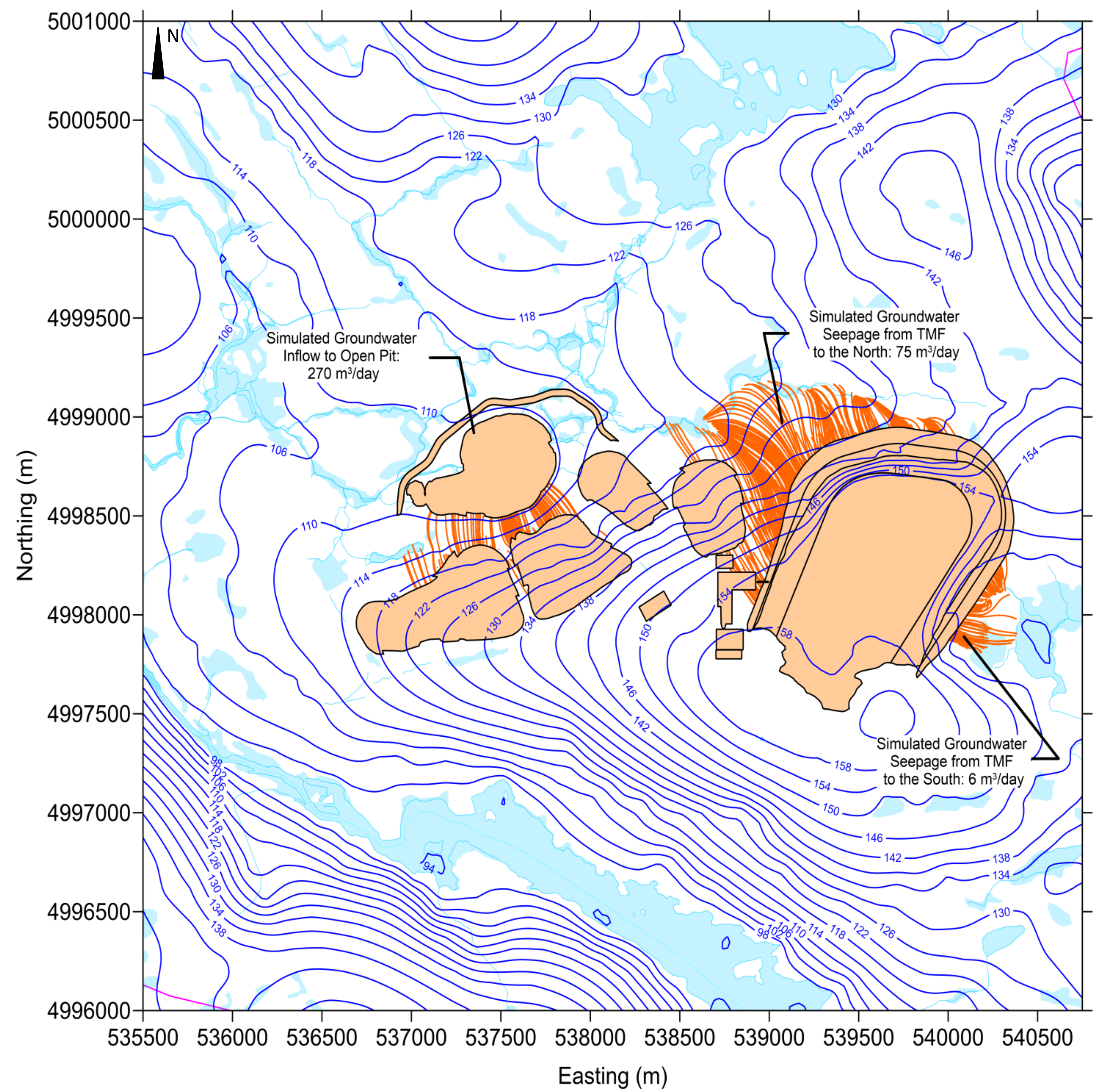
TITLE
SIMULATED GROUNDWATER ELEVATIONS, DRAWDOWN, AND SEEPAGE PATHWAYS – END OF OPERATIONS PHASE (DEEP BEDROCK)

PROJECT No.	Rev.	Figure
1895674	0	9B

CHANGE IN SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER ELEVATION



NOTES:

1. Groundwater elevations and drawdown are representative of model slice 4 (Interface between overburden and upper bedrock) at model simulation time 2190 days.
2. Drawdown/Change in water level elevation contours are specified as 1 m intervals, with scale bar indicating range. Change is calculated as *Calibration – Forecast* groundwater elevation values.
3. Simulated groundwater elevation contours specified as 4 m intervals.
4. Orange lines show the direction of groundwater seepage based on particles released beneath the WRSA and TMF (at steady-state).

LEGEND:

- SIMULATED GROUNDWATER ELEVATION (masl)
- PARTICLE TRACKING RESULTS
- MINE INFRASTRUCTURE
- MODEL DOMAIN

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PROJECT
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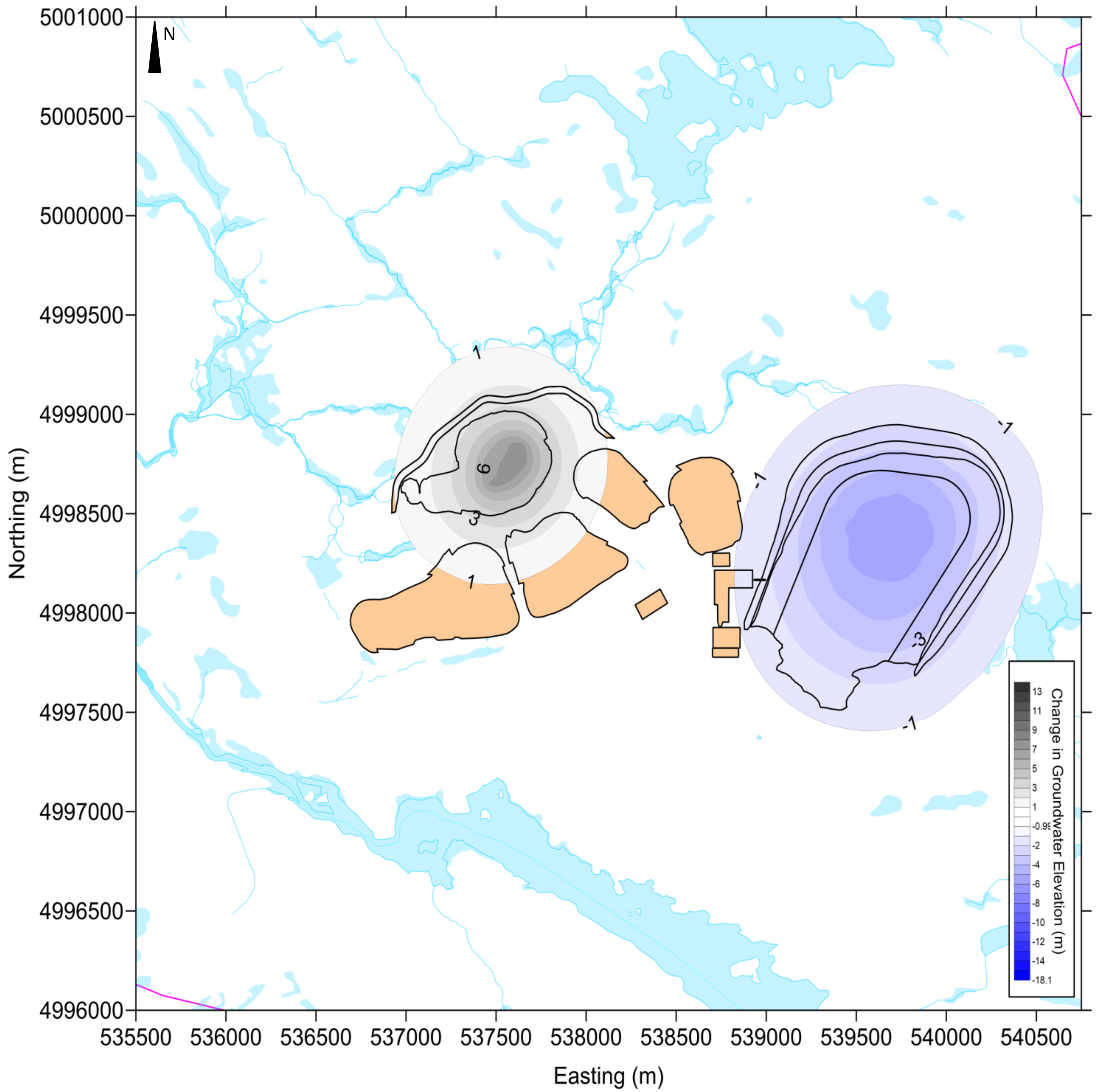
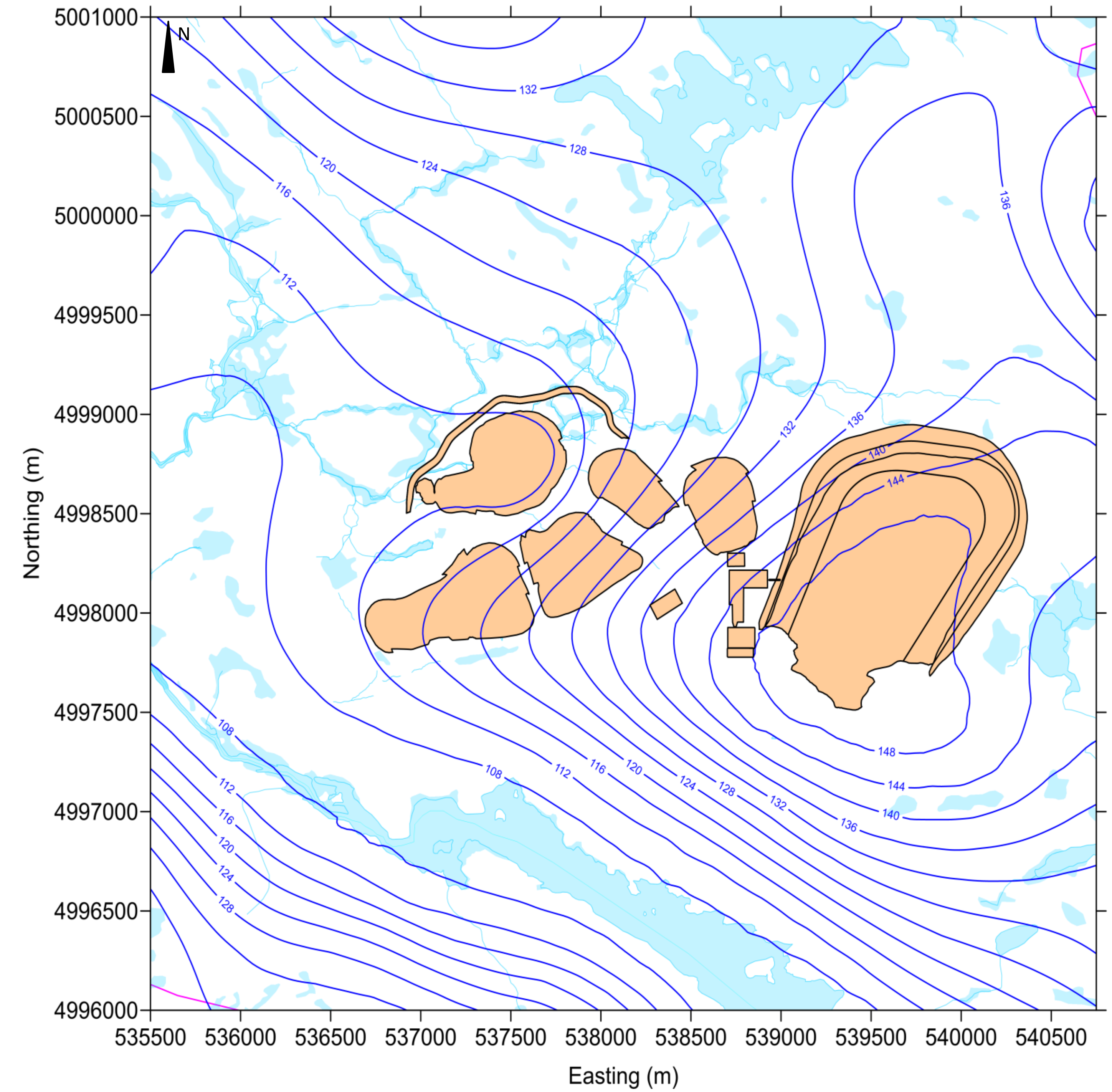
TITLE
SIMULATED GROUNDWATER ELEVATIONS, DRAWDOWN, AND SEEPAGE PATHWAYS – POST-CLOSURE PHASE (OVERBURDEN-BEDROCK INTERFACE)

PROJECT No. 1895674 | Rev. 0 | Figure 10A

CHANGE IN SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER ELEVATION



NOTES:

1. Groundwater elevations and drawdown are representative of model slice 17 (Deep Bedrock at pit base) at model simulation time 2190 days.
2. Drawdown/Change in water level elevation contours are specified as 1 m intervals, with scale bar indicating range. Change is calculated as *Calibration – Forecast* groundwater elevation values.
3. Simulated groundwater elevation contours specified as 4 m intervals.

LEGEND:

- SIMULATED GROUNDWATER ELEVATION (masl)
- MINE INFRASTRUCTURE
- MODEL DOMAIN

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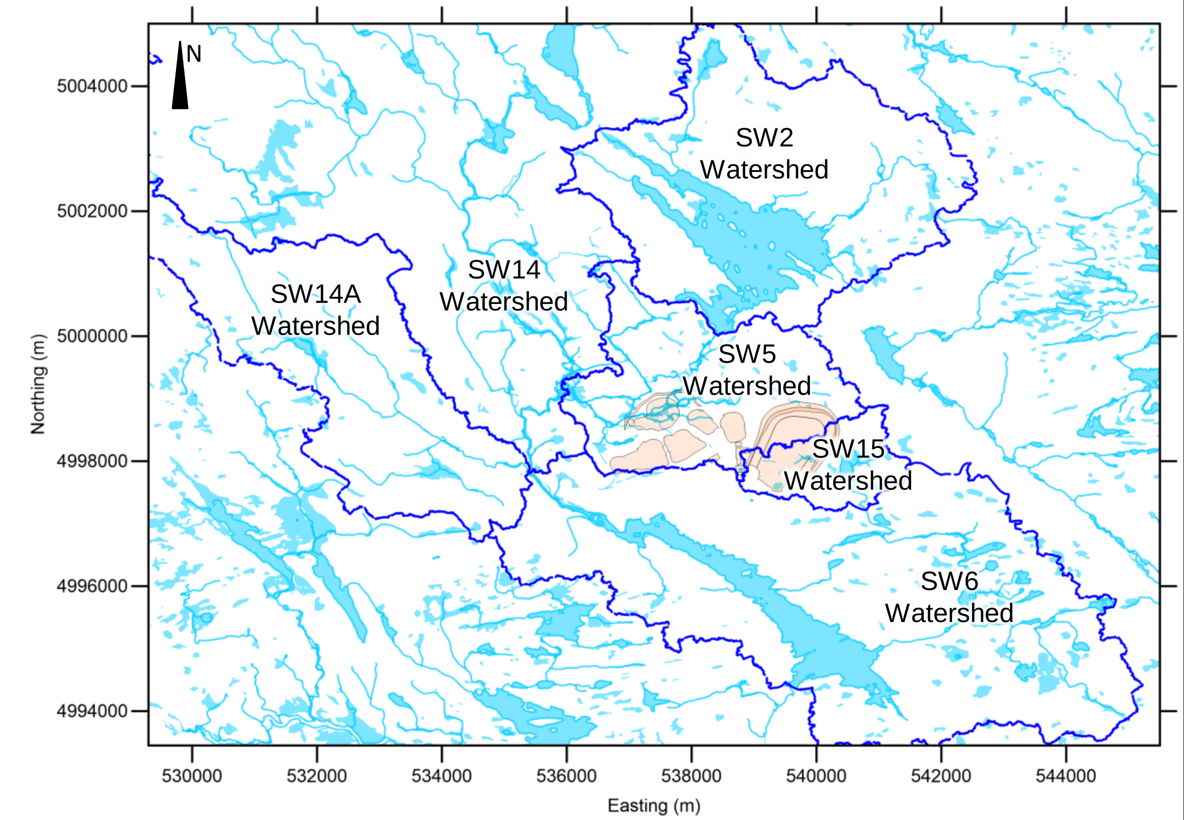
TITLE
SIMULATED GROUNDWATER ELEVATIONS, DRAWDOWN, AND SEEPAGE PATHWAYS – POST-CLOSURE PHASE (DEEP BEDROCK)

PROJECT No.	Rev.	Figure
1895674	0	10B

OPERATIONS

Watershed	Groundwater Flux to Surface Water (m^3/day): Calibrated Conditions	Operations Conditions	Change (Current minus Operations)	Notes
SW14A	4570	4570	0	Model domain includes approximately 80% of Watershed
SW14	3250	3240	10	Model domain includes approximately 13% of Watershed
SW2	6520	6520	0	--
SW5	2740	1950	790	Groundwater Inflow to Pit : 655m^3/day Seepage from the TMF: 380 m^3/day Inflow to the Toe Drain of TMF: 360 m^3/day Inflow to TMF Seepage Collection Ditch: 80 m^3/day Additional Inflow from streams to Pit: 45 m^3/day Seepage Bypassing Toe Drain to Environment: 75 m^3/day
SW6	7690	7650	40	--
SW15	680	370	310	Seepage from the TMF: 60 m^3/day Inflow to the Toe Drain of TMF: 150 m^3/day Inflow to TMF Seepage Collection Ditch: 60 m^3/day Seepage Bypassing Toe Drain to Environment: 6 m^3/day



LEGEND:

- SURFACE WATER ASSESSMENT WATERSHED
- MINE INFRASTRUCTURE
- WATER COURSE
- WATERBODY

POST-CLOSURE

Watershed	Groundwater Flux to Surface Water (m^3/day): Calibrated Conditions	Post-Closure Conditions	Change (Current minus Operations)	Notes
SW14A	4570	4570	0	Model domain includes approximately 80% of Watershed
SW14	3250	3240	10	Model domain includes approximately 13% of Watershed
SW2	6520	6520	0	--
SW5	2740	2280	460	Groundwater Inflow to Pit : 270 m^3/day Seepage from the TMF: 380 m^3/day Inflow to the Toe Drain of TMF: 406 m^3/day Inflow to TMF Seepage Collection Ditch: 140 m^3/day Seepage Bypassing Toe Drain to Environment: 75 m^3/day
SW6	7690	7670	20	--
SW15	680	370	310	Seepage from the TMF: 60 m^3/day Inflow to the Toe Drain of TMF: 160 m^3/day Inflow to TMF Seepage Collection Ditch: 62 m^3/day Seepage Bypassing Toe Drain to Environment: 6 m^3/day

NOTES:

1. Groundwater inflow to pit does not include groundwater seepage that discharges to streams upgradient of the the pit, that ultimately discharge to the pit.
2. For SW5 groundwater flux to surface water estimates exclude: groundwater inflow to pit; TMF seepage discharge to TMF toe drain; and, TMF seepage discharge to TMF seepage collection ditch. However, it does include seepage bypassing the TMF toe drain to the environment.
3. For SW15 groundwater flux to surface water estimates exclude: TMF seepage discharge to TMF toe drain; and, TMF seepage discharge to TMF seepage collection ditch. However, it does include seepage bypassing the TMF toe drain to the environment.

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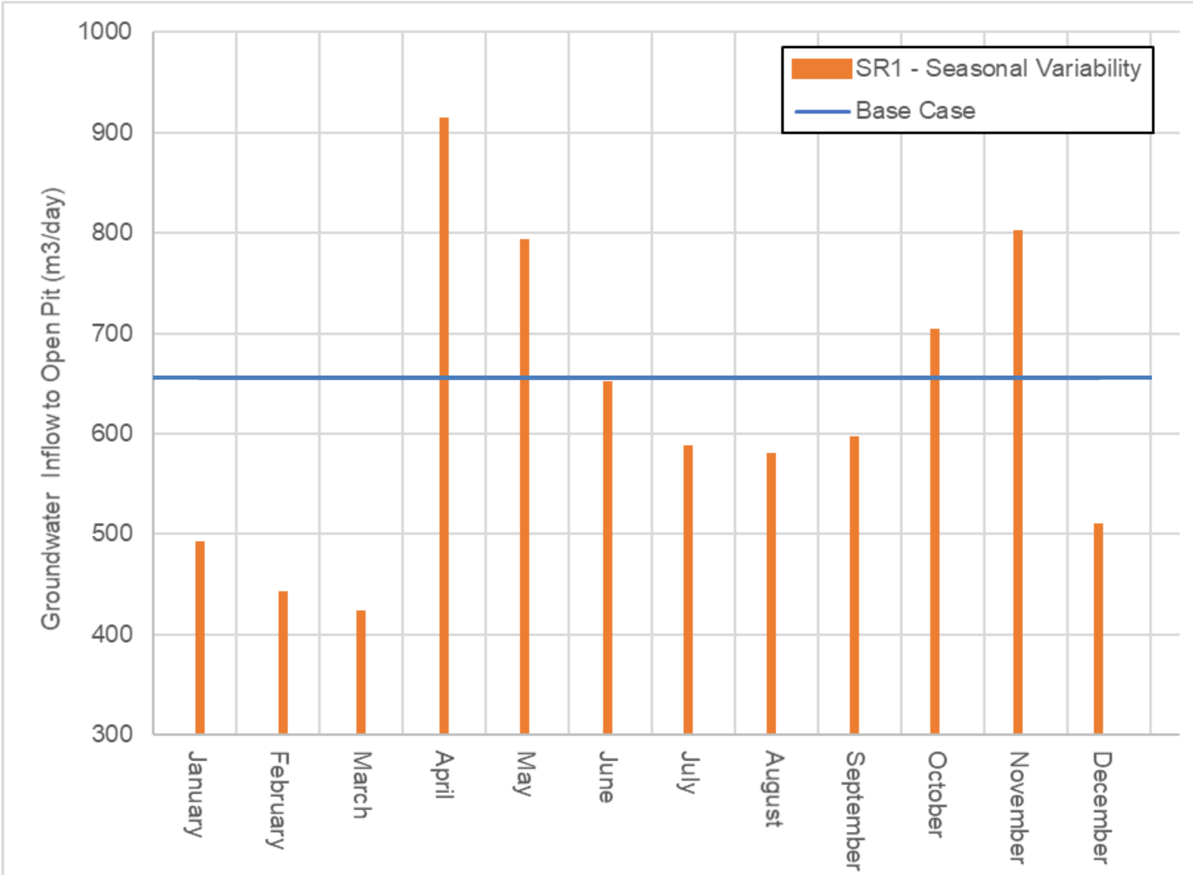
TITLE
SIMULATED CHANGE IN GROUNDWATER-SURFACE WATER INTERACTION

PROJECT No. 1895674 Rev. 0 Figure 11



	Recharge on Upper Surface (mm)	
	Upper Elevations (>135 masl)	**Lower Elevations (<135 masl)**
Total Annual	**150**	**75**
January	0	0
February	0	0
March	0	0
April	43	21
May	27	13
June	12	6
July	7	4
August	7	4
September	9	4
October	17	9
November	28	14
December	0	0

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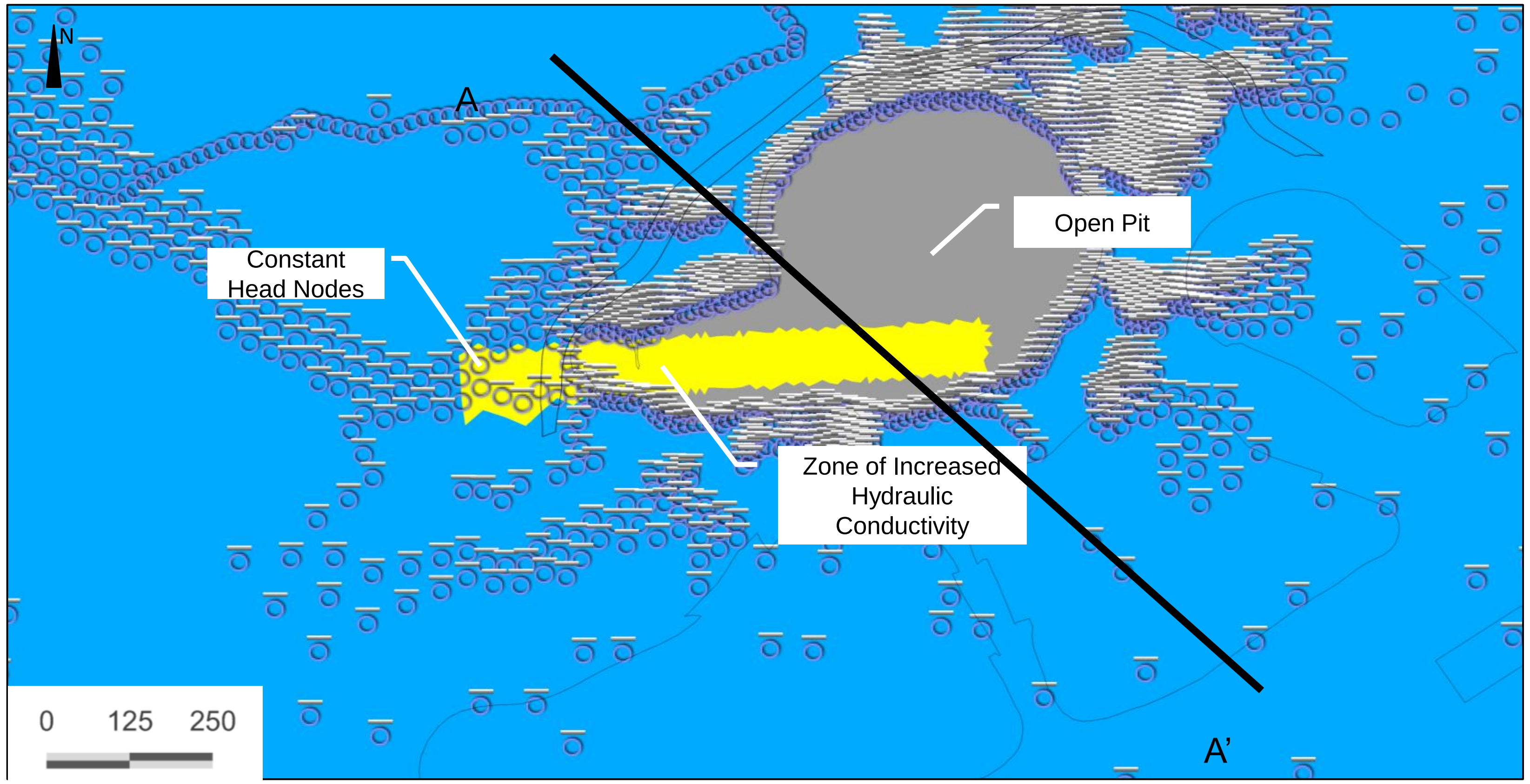
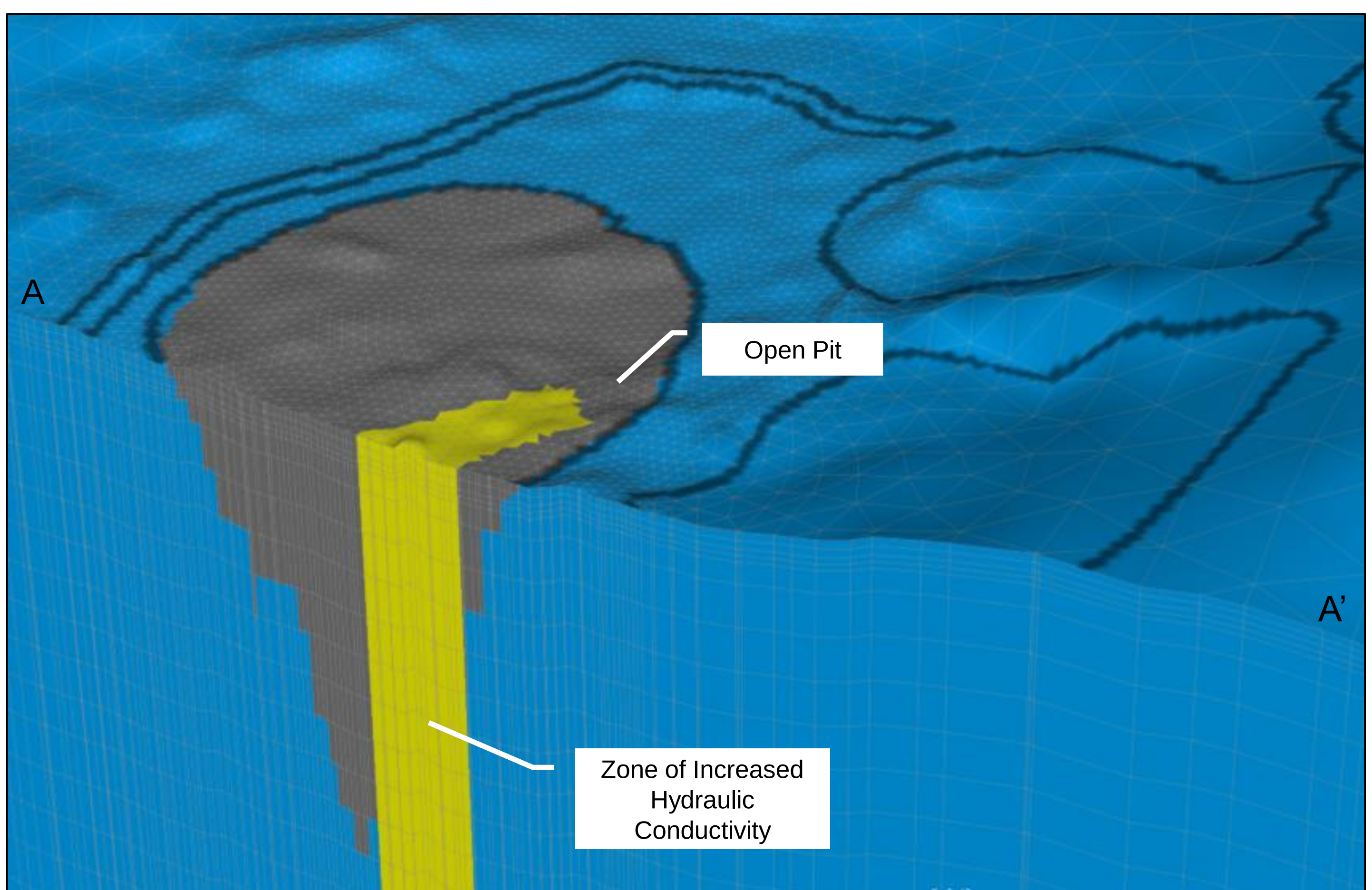
TITLE
SENSITIVITY RUN 1 – EFFECT OF SEASONAL VARIABILITY IN RECHARGE ON GROUNDWATER INFLOW TO OPEN PIT

PROJECT No. **1895674** Rev. **0** FIGURE **12**

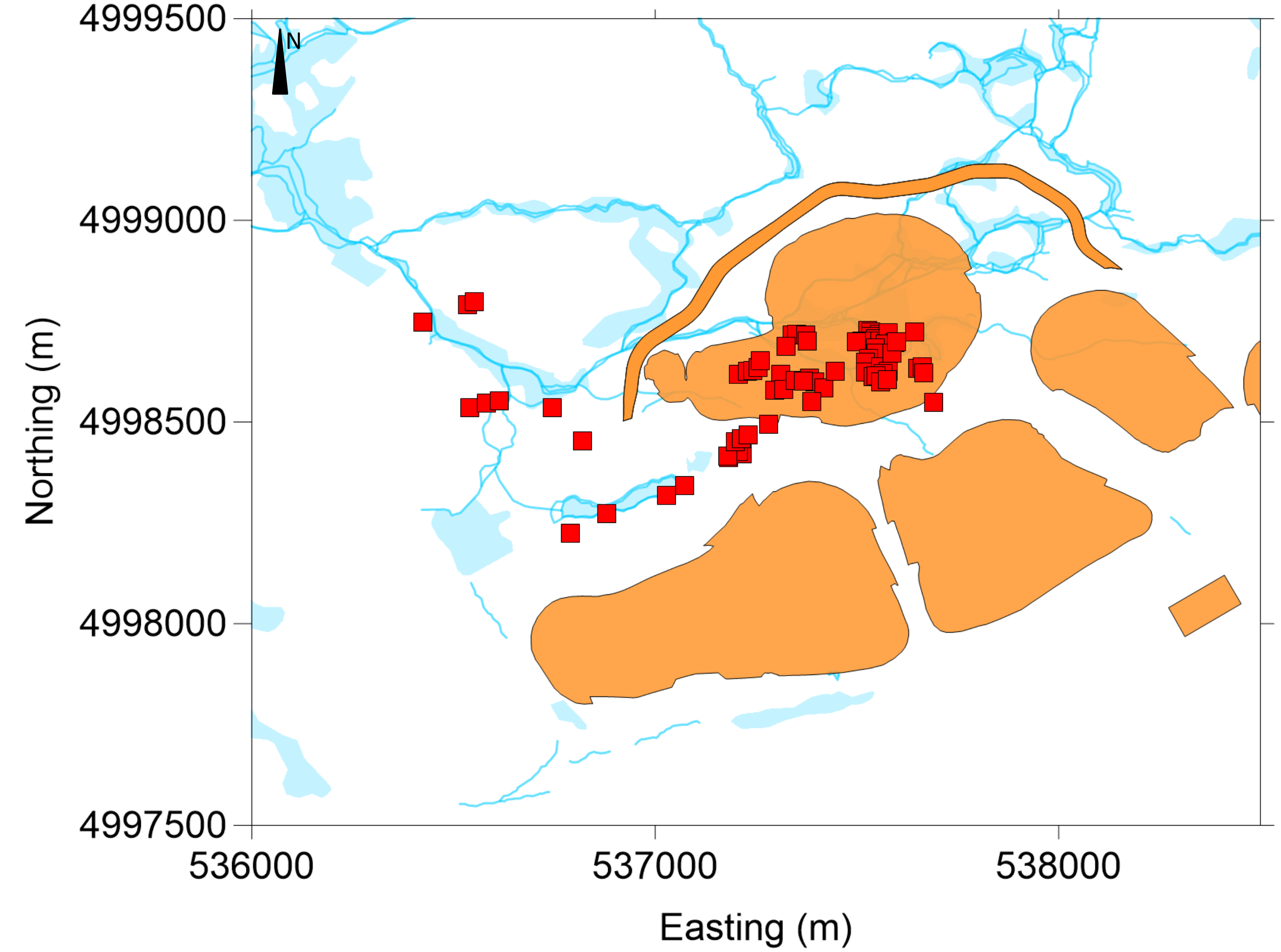
SENSITIVITY RUN 3 – PLAN VIEW



SENSITIVITY RUN 3 – CROSS-SECTION



SENSITIVITY RUN 4 – PLAN VIEW



NOTES:

1. For sensitivity run 3, hydraulic conductivity within the zone indicated by the yellow shading was increased by a factor of 10.
2. Abandoned mine opening data from Nova Scotia Department of Natural Resources Abandoned Mine Openings Database (2017).

LEGEND:

- WATER COURSE
- WATERBODY
- MINE INFRASTRUCTURE
- ABANDONED MINE OPENING

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TITLE
GROUNDWATER INFLOW TO OPEN PIT – SENSITIVITY TO CONDUCTIVE FEATURE (SR3) AND ABANDONED OPENINGS (SR4)

PROJECT No.	Rev.	Figure
1895674	0	13

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