Appendix 60

Meadowbank Groundwater Monitoring Plan Version 11

MEADOWBANK GOLD PROJECT

Groundwater Monitoring Plan

In Accordance with Water License 2AM-MEA1526

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 11
March 2020

EXECUTIVE SUMMARY

The Groundwater Monitoring Plan herein presents the active and inactive groundwater monitoring stations at Meadowbank mine installed since 2003, the 2018 extensive groundwater monitoring campaign and the groundwater monitoring program adapted for in-pit deposition operations that begun in July 2019.

The annual monitoring plan is a requirement for the Meadowbank Type A Water License No. 2AM-MEA1526 and is a continuation of previous Monitoring Plans.

Five (5) monitoring wells remain operable at this time, including the last four (4) new groundwater monitoring wells installed in 2018. Strategic locations for these wells are based on groundwater numerical simulation results aiming to replicate the in-pit deposition site conditions at post closure period. Moreover, to improve well designs and groundwater sample quality, best practices under arctic climate conditions continue to be investigated.

The following activities were fulfilled in 2019:

- The 2019 groundwater monitoring program covered thirteen (13) monitoring stations, including five (5) groundwater monitoring wells (MW-IPD-01(s), MW-IPD-01(d), MW-IPD-07, MW-IPD-09 and MW-16-01), three (3) dike seepages, three (3) pit wall seepages, two (2) surface water ponds and one (1) reclaim water pond.
- Two (2) groundwater sampling programs were carried out from July 9 to July 17, 2019 and October 7 to October 14, 2019. Low-flow sampling techniques were used for licensing requirements with duplicate, field blanks, and transport blanks.

Groundwater chemistry data is used to predict the quality of water accumulating in open pits and to determine any effects of mining on groundwater quality, particularly with respect to tailings deposition.

Groundwater sampling is carried out twice a year. Analytical parameters will comply as per Schedule 1, Table 1, Group 2 of the Meadowbank Water License. Quality Assurance/Quality Control procedures will be implemented during each sampling event.

This groundwater monitoring plan is submitted by Agnico Eagle Mines Limited to the Nunavut Water Board (NWB) and Nunavut Impact Review Board (NIRB). The report includes all data from the previous year's results as well as a historical record, dates and methods of sampling, and the assessment of salinity parameters and indicators of tailings reclaim water movement, with respect to chloride, sulfate, cyanide, copper, iron and arsenic.

IMPLEMENTATION SCHEDULE

This Plan will be implemented immediately (2020) subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

Agnico Eagle – Geology Superintendent

Agnico Eagle – Engineering Superintendent

Agnico Eagle – Geotechnical Coordinator

Agnico Eagle – Environment Superintendent

Agnico Eagle – Environment General Supervisor

Agnico Eagle – Environmental Coordinator

Agnico Eagle – Environmental Technician

DOCUMENT CONTROL

Version	Date (YMD)	Section	Revision
1	2008/08	all	Comprehensive plan for Meadowbank Project
2	2009/03	all	Comprehensive update of plan to include 2008 well installations
3	2011/12	-	Update Executive Summary; insert Figure 1; update Table 1; addition of information on wells created in 2011; include well installation section;
4	2014/01	1.2, 3.3, 3.4, 5	Update Executive Summary; update Section 1.2 to reflect current wells; add Section 3.3 and 3.4 (seep and production drill hole sampling methods); update Section 5 (additional reporting on tailings-related parameters)
5	2015/04	1.3 and 3.3 2.3	Sampling of pit wall seeps discontinued. Sampling of Goose Pit sump added. Updated with installation information for new well.
6	2015/09	4.1 and 4.2	Updated list of analyse parameters. QAQC Section to include Travel and Field Blank Remove Goose Pit sump as monitoring station
7	2017/03	1.5, 3, 5 and 6	Add Section 5 and 6 and modify section 1.5 and 3
8	2017/11	all	Comprehensive update
9	2019/03	all	Comprehensive update and add 2018 groundwater monitoring report
10	2019/07	all	Comprehensive update following In-Pit Disposal Approval
11	2020/03	all	Comprehensive update

Version 11

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1. INTRODUCTION

The annual monitoring plan is a requirement for Meadowbank Type A Water License No. 2AM-MEA1526.

This document is the 11th version of the Groundwater Monitoring Plan for Meadowbank Mine. This version presents an update of the groundwater monitoring program described in Version 10 (Agnico, July 2019).

This version relates the historic of groundwater monitoring at Meadowbank mine since 2003, presents the extensive groundwater monitoring program achieved on site since 2017 which was adapted for in-pit deposition (IPD) of tailings in 2018. Moreover, this document reviews methodology and best practices for groundwater sampling, especially under arctic climate conditions.

1.1 PURPOSE OF GROUNDWATER MONITORING

Groundwater data is used as a tool to predict the chemistry of water accumulating in open pits and to determine any effects of mining on groundwater quality, particularly with respect to tailings deposition activities. To this end, groundwater monitoring wells have been installed to sample groundwater in open talik areas, where unfrozen ground extends beneath large lakes. No groundwater monitoring wells is installed at the Vault Deposit, as the Vault Pit area is developed in permafrost.

Groundwater monitoring has traditionally been conducted using installed monitoring wells, but difficulties in obtaining representative samples by this method prompted the investigation of alternative methods from 2013 to 2016 based on technical advice from firms of experts. Nevertheless, groundwater samples are still collected in operable monitoring wells.

In 2017, the groundwater monitoring program was revisited, as suggested by Environment and Climate Change Canada (ECCC), to enhance the quality of the data collected for water quality model updates. Due to difficulties in maintaining and sampling monitoring wells, Agnico Eagle received technical advices and field services from a firm of experts to optimize low-flow sampling techniques as well as further sampling improvements and pursued opportunities for sampling groundwater from alternative methods as well as the existing wells. An extensive monitoring program took place in 2017 to collect representative samples across the mine site to infer the groundwater geochemistry and the potential chemical reaction between groundwater and surface water especially in relation to tailing migration. The groundwater investigation was repeated in 2018 with the addition of four (4) new monitoring wells. Groundwater sampling was performed in 2019 with the same methodology as the previous year.

1.2 TAILING STORAGE FACILITY EXPANSION AT MEADOWBANK

Since 2015, Agnico Eagle is evaluating diverse technical options to accommodate additional tailing storage facilities at Meadowbank. After a Multi-Account Assessment (MAA), the In-Pit

Tailings Deposition (IPD) was selected as the preferred option to store tailings waste produced from Whale Tail Mine in addition to its current tailings storage facilities (TSF). IPD demonstrated superior performance capacities in the following categories: health and safety, quality of life, water, air, capital cost, technology, natural hazards, and adaptability (SNC-Lavalin, 2016; 2017a). IPD has started at Meadowbank in July 2019, with tailings deposition in Goose Pit.

To ensure the environment protection and evaluate potential risks for tailing migration into groundwater, a feasibility study was conducted by SNC-Lavalin professionals in 2016-2017 (SNC-Lavalin, 2017a). The feasibility study included a complementary characterization of the geological structures and permafrost extent on site and the development of a detailed hydrogeological numerical 3D model. Main geological structures (Bay Fault, Second Portage Lake Fault and geological contact with quartzite formation) were identified and implemented in the 3D model with defined hydraulic conductivity and porosity to simulate potential reclaim water seepages out from in-pit tailings pore water. The numerical simulations were designed to represent the worst-case scenarios in terms of contaminant transport within the aquifers. Therefore, a groundwater monitoring program was designed in relation to the groundwater flow and contaminant transport simulation results. The hydrogeological model and solute transport simulations were updated to version 4 during the detailed engineering study completed by SNC-Lavalin (2018) and following Natural Resources Canada (NRCan) recommendations addressed during In-Pit Tailings Deposition Project approval process.

1.3 GROUNDWATER MONITORING PROGRAM ADAPTED FOR IN-PIT TAILINGS DEPOSITION

Meadowbank groundwater monitoring program is adapted for the In-Pit tailings deposition (IPD). As of July 2019, ore from Whale Tail Pit located at the Amaruq site, along with some ore from Meadowbank, has been processed at Meadowbank and the tailings has been deposited in Goose Pit, already mined out. Deposition will continue with an alternate filling of Portage Pit A and Pit E (SNC-Lavalin, 2017a). The installation of four (4) new groundwater monitoring wells in 2018 was proposed at strategic locations, based on groundwater numerical simulation results and 2017 borehole data drilled in the same projected areas. Methods to obtain representative groundwater samples and improve well designs under artic climate continue to be developed. The groundwater monitoring program will be updated as the project progresses. New information from the hydrogeological numerical model and from hydrogeological field data will be integrated throughout.

2. GROUNDWATER MONITORING PROGRAM

2.1 PREVIOUS GROUNDWATER MONITORING PROGRAM ACHIEVED SINCE 2003

Groundwater data are used as a tool to predict the chemistry of water accumulating in open pits, and to determine any effects of mining on groundwater quality particularly with respect to tailings deposition activities. Important components surveyed are chloride concentrations, salinity and total dissolved solid (TDS) calculated via conductivity measurements. Copper and cyanide are also monitored to trace potential effects of mining operations on groundwater quality. To this end, groundwater monitoring wells have been installed to sample groundwater in open talik areas, where unfrozen ground extends beneath large lakes. No groundwater monitoring wells are installed at the Vault Deposit, as the Vault Pit is developed in an area of permafrost.

Groundwater samples have traditionally been collected in monitoring wells. Since 2003, seventeen (17) monitoring wells were installed at Meadowbank mine. However, most of the monitoring wells became inoperable due to the challenging arctic conditions and permafrost environment at Meadowbank, and to this day, only one well remain operable.

In 2017, an extensive groundwater sampling program took place. The program aimed to improve the characterization of the baseline groundwater chemistry, identify potential sources of contaminants at the mine site, and identify potential interaction between surface and groundwater. The program included:

- Review of the sampling methodologies and the historical groundwater quality data;
- Testing and maintenance of the sampling equipment;
- Collection of surface and groundwater samples at specific locations and;
- Data compilation and basic interpretation of groundwater quality.

Well installation and groundwater collection have been a major challenge under artic conditions in permafrost environment. Some of the challenges were:

- Well damaged by frost action;
- Heat traces malfunctioning, therefore ice bridges forming in well annulus;
- Well damaged during site operations;
- Well obstructed with development material, once again due to frost action.

Despite multiple attempts to overcome these challenges, the collection of representative groundwater sampled was unsuccessful for most problematic wells. For example, saline solution was used to melt ice bridges formed in well annulus. The concentration of saline solution required to unplug the well could not be purged afterwards, the groundwater flow was not sufficient, and the amount of water needed to be purged out of the well was unrealistic under permafrost conditions.

Since well installation and groundwater collection have been a tremendous challenge at Meadowbank, alternative methods to obtain representative groundwater samples were investigated from 2013 to 2016 (see 2012 Groundwater Monitoring Report and recommendations by Golder Associates). Alternative groundwater monitoring stations were investigated including: pit wall seepages, production drill holes, pit sumps, horizontal wells installed into pit walls, and temporary wells for pit dewatering.

From 2013 to 2016, six (6) groundwater samples were collected from horizontal wells installed in Pit E southeastern wall, one (1) sample from a temporary well for pit dewatering, two (2) samples from pit sumps during exploitation and one (1) production borehole.

Although production and pre-shear drill holes with enough flow rates only occurred on occasion, when enough groundwater flow was encountered, sampling was achieved. Moreover, a sample was collected from a temporary dewatering well (6 inches in diameter, 65 meters depth), installed in Pit E from July to August 2016, to reduce water table and ensure pit slope stability. Prior 2016, seepage from pit walls, commonly occurring at different locations, has indicated surface water rather than groundwater flow.

In 2017, only two (2) wells remain operable for groundwater sampling. Aside from the two wells, none of the previous monitoring stations were available for sampling in 2017. Due to the difficulties encountered in maintaining and sampling monitoring wells, Agnico Eagle contracted experts to obtain technical advice on optimizing low-flow sampling techniques. Moreover, further sampling improvements and pursued opportunities for sampling groundwater from alternative sources as well as the existing wells were carried out. An extensive monitoring field program took place in 2017. The objectives were to: 1) collect representative samples across the mine site; and 2) understand groundwater geochemical conditions and its potential interaction with surface water, especially in relation to tailing migration.

In 2018, only one (1) well (MW-16-01) from previous installed well remains operative and four (4) new wells were installed for groundwater sampling. Aside from the wells, only a station for reclaim water and dike seepages remain available from 2017 hydrogeological field investigation program. Due to the difficulties encountered in maintaining and sampling monitoring wells, Agnico Eagle continue to contract experts to obtain technical advice on optimizing low-flow sampling techniques and get further sampling improvements and pursued opportunities for sampling groundwater from alternative sources as well as the existing wells. Groundwater collected in 2018 from the four (4) newly installed wells fits within the natural groundwater category established with 2017 results and can be use to monitor groundwater quality in the future.

In 2019, the same 5 monitoring wells were sampled with low flow techniques along with alternative stations such as pit wall seepages when safely accessible, dike seepage pumping wells and some water ponds. The 2019 operable monitoring stations and inactive stations are provided in Appendix A. More information can be found in the last Groundwater Monitoring Report (SNCL, 2020).

2.2 ACTIVE GROUNDWATER MONITORING STATIONS AND SAMPLING METHODOLOGIES

Active monitoring stations and their sampling methodologies are described below for monitoring wells and alternative sampling stations (pit wall seepages, dike seepages, pond). Active monitoring stations are located on the map provided in Appendix A.

2.2.1 Active monitoring well

Five (5) monitoring wells were operable in 2019 and will continue to be sample in following years. Installation details for monitoring wells are presented in the Groundwater Monitoring Report related to the year of their installation.

MW-16-01

A portable double valve sampling pump (DVP) is installed at approximately 95 meters down in the well and in front of the screened interval. The well is purged to remove standing water inside the well and to induce a fresh groundwater flow from the rock formation by activating the DVP. The pump is activated by pushing compressed air into a ¼ inch Low Density Polyethylene (LDPE) tubing attached to the DVP. The in-situ physicochemical parameters are measured with a PCStestr 35 Oakton Probe that is calibrated prior usage. Purged water quality is monitored for pH, electrical conductivity, temperature, water clarity and colour (visual observation) during this operation. A minimum of 3 well volumes (volume of water between the in-well packer and bottom of screened interval) are to be removed prior sampling or until the monitored parameters stabilize (values remaining within 10% for three consecutive readings).

Groundwater sampling is carried out immediately after well purging with low-flow techniques. Groundwater samples are collected in the clean laboratory-supplied containers. Groundwater is sampled following quality control procedure on sampling and analysis described in section 2.5 and detailed in Appendix B.

IPD monitoring wells (MW-IPD-01(s)&(d), MW-IPD-07 and MW-IPD-09)

Four (4) monitoring wells were installed in 2018 to complete the monitoring network and to adapt it to the in-pit tailings deposition (IPD) project. Well screens were sealed with prepack bentonite composed of a 2-inch diameter stainless steel pipe and bentonite sleeve. Modified foam bridges were installed between the monitoring well screens and the bentonite sleeve to prevent the bentonite to seep downwards in the monitoring well screen interval. Lake water and environmentally safe drilling additives (DD2000) were used as drilling fluid. As recommended by SNCL, no other additives, such as de-icing salt or calcium chloride that could impact the water chemistry, were used during drilling or installation.

The new monitoring wells were implemented considering the state of knowledge at this period and the monitoring wells were installed in talik areas. Heat traces cables were installed along the monitoring well pipes within the permafrost zones to prevent the riser pipe to be damages by the frost action. A double valve pump (DVP), tubing and a well head were dedicated to each monitoring well and installation equipment was inspected, replaced or calibrated when required and cleaned to prevent any contamination during sampling operations. Low flow technique with nitrogen is used for groundwater sampling, after stabilisation of in situ physicochemical readings (temperature, pH, electric conductivity, oxygen reduction potential).

2.2.2 Dike seepage

The name "dike seepage" as a monitoring station applies to samples collected from dewatering wells (ST-8-North and ST-8-South), installed at the bedrock surface (6 m depth), to control East dike seepages. For these two stations, samples are collected through a tap connected to a dewatering pump.

Dike seepage stations also includes sumps created at the downstream toe of Central dike (ST-S-5) or the sump found nearby Goose dike near a rock stockpile (BG Lagoon). At these two (2) stations, samples are collected directly in the pond at about 1 meter below the water level, using a small ¼ diameter LDPE tubing and a peristaltic low-flow pump. New tubing sections are used once for each sample.

These sampling stations can be monitored though time even if not fully representative of groundwater conditions. These sampling results contribute to the understanding of the geochemistry at the mine site and can be kept in the monitoring program.

2.3 INACTIVE MONITORING STATIONS

Inactive groundwater monitoring stations and former alternative stations are also located on the map provided in Appendix A.

2.3.1 Inactive monitoring wells

From the total seventeen (17) monitoring wells installed since 2003 at the site, twelve (12) are now inactive. Most of these wells were damaged by the frost action or by the formation of an ice bridge inside the well. Multiple field operations and adapted well designs were investigated to extend the life time of these monitoring wells. Specific reasons of the end of monitoring wells operation can be found in previous Groundwater monitoring reports.

Inactive groundwater monitoring stations are shown in Appendix A.

2.3.1 Geotechnical investigation holes

A geotechnical investigation drilling campaigns was carried out in 2017 at Meadowbank. Attempt was made to collect a groundwater sample at borehole IPD-17-06. Although geotechnical holes are made under controlled conditions when compared to production holes, the inside diameter of metal casing are filled with grease, water is dirty and full of particles.

After interpreting the physicochemical parameters for groundwater coming from geotechnical holes, and geochemical data from production holes and pre-shear holes, it can be stated that these holes are not a proper environment to retrieve representative groundwater samples. No further investigations were conducted with and they are neither considered relevant for further sampling program.

2.3.1 Pit wall seepage

The name "pit wall seepage" as a monitoring station applies to groundwater collected on pit walls and where water comes directly through the bedrock. For samples collection, a small ¼ diameter LDPE tubing is inserted into small fracture to prevent the sample to be in contact with the atmosphere. The groundwater runs through the tubing by gravity and physicochemical parameters are recorded and standard sampling procedures are followed.

These sampling stations can be monitored though time, contribute to the understanding of groundwater quality at the mine and were added to the groundwater monitoring program to gathered alternative samples which were considered closely-representative of groundwater geochemical conditions.

However, due to safety considerations during sampling (possible rock fall), field technicians are no longer allowed to collect samples close to a pit wall and pit wall seepage sampling was removed from the monitoring program.

2.3.2 Pit sump

The name "Pit sump" as a monitoring station applies to groundwater collected at the bottom of a pit when groundwater filled a cavity during exploitation. After interpreting the geochemical data, it can be stated that there is too much ambiguity of the provenance of some elements found in this analysis to pursue the sampling of this well as is. Excavated ground is reworked and a lot of mine operations occur around the sumps such as drilling, blasting, and excavating. Moreover, the exact location of the sampling can never be reproduced year after year. For the mentioned reasons, pit sumps are not considered as representative groundwater samples and are no longer integrated in the monitoring program.

2.3.3 Deep lake

The name "Deep Lake" as a monitoring station applies to water collected near lake bottom at its deepest point. Water was collected in Dogleg Lake and Second Portage Lake through a small ¼ inch diameter LDPE tubing, connected to a peristaltic pump. These samples were collected to verify the quality of groundwater at lake's bottom. Also, it aims to compare the different water geochemistry signatures originating from an open talik and a close talik, and to compare the data with the ones collected on site. These stations were monitored only once in 2017.

2.4 PHYSICOCHEMICAL AND GEOCHEMICAL PARAMETERS

2.4.1 Groundwater parameters required by the Water License

For each sample, field physicochemical parameters are recorded (pH, turbidity, salinity and electrical conductivity) during well purging when possible and just before water sampling. Analytical parameters included the following (per Schedule 1, Table 1, Group 2 of the Meadowbank Water License):

Total and Dissolved Metals: aluminum, antimony, arsenic, boron, barium, beryllium, cadmium, copper, chromium, iron, lithium, manganese, mercury, molybdenum, nickel, lead, selenium, tin, strontium, titanium, thallium, uranium, vanadium and zinc.

Nutrients: Ammonia-nitrogen, total kjeldahl nitrogen, nitrate nitrogen, nitrite-nitrogen, ortho-phosphate, total phosphorous, total organic carbon, total dissolved organic carbon and reactive silica.

Conventional Parameters: bicarbonate alkalinity, chloride, carbonate alkalinity, conductivity, hardness, calcium, potassium, magnesium, sodium, sulphate, pH, total alkalinity, TDS, and TSS, turbidity.

Total cyanide and Free cyanide. If total cyanide is detected above 0.05 mg/L at a monitoring station in receiving environment; further analysis of Weak Acid Dissociable Cyanide (CN WAD) will be triggered.

2.4.2 Additional parameters

Each groundwater sample has a distinctive geochemical signature. Geochemical interpretation of groundwater data can be very useful to support a conceptual model by improving the understanding of groundwater movements and processes along pathways as water composition varies. It can also help identifies zones where surface water is continually interacting with groundwater or only during permafrost thawing.

The geochemical composition of groundwater is defined by its main anions (HCO_3^-, SO_4^{2-} and Cl^-) and its main cations (Ca^{2+}, Na^+, Mg^{2+} and K^+) contents. Charge balance calculations for main ions dissolved in groundwater are a mandatory reliability check for any geochemical analysis (Hounslow, 1995). Charge balance calculations are useful to gain a first insight into water chemistry. From these calculations, groundwater chemical composition can be represented in Piper and Stiff diagrams, which facilitate its interpretation.

For the reasons presented above, additional parameters are also analyzed: dissolved calcium, dissolved potassium, dissolved magnesium, dissolved sodium, fluorides, bromides, and ammonium-nitrogen. In addition to the required field measurements, the following physicochemical in-situ parameters are also recorded on site: Oxydo-reduction Potential (ORP) and Dissolved Oxygen (DO).

2.5 QUALITY CONTROL ON SAMPLING AND ANALYSIS

2.5.1 Handling

The following procedures will be followed to provide data quality control:

- Measurement of field parameters at selected intervals until stable readings (within 10% of each other);
- Minimization of the exposure of the sampled water to the atmosphere;
- Use of compressed gas to evacuate water during sample collection;
- In-situ measurement of sensitive chemical parameters (pH, electrical conductivity, dissolved oxygen, alkalinity), where applicable;
- Abiding by sample preservation methods (refrigeration and use of preservatives where needed), and specified holding times;
- Filtering for dissolved metal analysis with a 0.45 microns filter on site, when possible, or shipping the samples to be filtered at the laboratory, within required delay.

2.5.2 Duplicates, field and travel blank

A duplicate sample will be collected for one monitoring well per sampling event and submitted as a blind duplicate to the analytical laboratory. When both results are higher than five times the method detection limit (MDL), the relative percent difference (RPD) will be calculated as:

RPD = absolute difference in concentration/average concentration x 100

USEPA (1994) indicates that an RPD of 20% or less is acceptable. Where one or both results are less than five times the MDL, a margin of +/- MDL is acceptable.

One field blank and one travel blank will also be collected at each sampling campaign.

Travel blanks will accompany the sample bottles throughout the collection, handling, storage and shipping of the samples.

2.2 COMPARISON CRITERIA AND TRENDS

Groundwater analytical results will be compared to the criteria prescribed in the site Water License 2AM-MEA1526 for the maximum average concentration discharged to Third Portage Lake. Trends in analytical results will be presented in the Annual Groundwater Monitoring Report for the following selected parameters: chloride, sulfate, total cyanide, total copper, total iron and total arsenic. These parameters are typically associated with the reclaim water chemical signature.

3. ADAPTED GROUNDWATER MONITORING PROGRAM FOR IPD

Since 2015, Agnico Eagle has been evaluating various technical options to store tailings from the mining of Whale Tail ore deposit. After a Multi-Account Assessment (MAA), the In-Pit Tailings Deposition (IPD) was selected as the preferred option to store tailings waste produced from Whale Tail Mine in addition to its current TSF (SNC-Lavalin, 2016; 2017a). Meadowbank Dike Review Board (the "MDRB") supported the use of early in-pit tailings disposal as an attractive alternative in addition to current practices at Meadowbank. Specifically, in-pit disposal of tailings has advantages with respect to health and safety, quality of life, water, air, capital cost, technology, natural hazards and adaptability. The MDRB accepted that in-pit disposal would be recognized as the best available technology.

The current monitoring well network is for operational needs, but it can be also used for long term monitoring (closure & post-closure). Before deposition, the monitoring well network should be used to increase the understanding of the pre-deposition groundwater geochemistry at the site and further quality changes to groundwater associated with the in-pit tailings disposal.

As long as the water level in the pits will not have completely return to the natural state (before dewatering), the pits will behave like hydraulic capture zones, preventing contaminant migration outside pit shells. IPD has begin in July 2019 in Goose Pit, already mined out, and will be followed by an alternate filling of Portage Pit A and Pit E (SNC-Lavalin, 2017a).

To ensure the environment protection and evaluate potential risks for tailing migration into groundwater, a feasibility study was conducted by SNC-Lavalin professionals in 2016-2017 (SNC-Lavalin, 2017a). The detailed engineering study completed by SNC-Lavalin (2018) included a complementary characterization of the geological structures and permafrost extent on site and the development of a detailed hydrogeological numerical 3D model. Main geological structures (Bay Fault, Second Portage Lake Fault and geological contact with quartzite formation) were identified and implemented in the 3D model with defined hydraulic conductivity and porosity to simulate potential reclaim water seepages out from in-pit tailings pore water.

The groundwater numerical model aimed at representing the hydrogeological conditions found at the mine site at the end of deposition to reproduce the groundwater flow and contaminant transport in talik zones located throughout the permafrost environment. The idea is to reproduce, in this context, realistic groundwater and contaminant transport within talik zones located throughout the permafrost environment. Considering that groundwater flow is strongly influenced by permafrost conditions, thermal cross-sections were modeled to assess the long-term impacts of in-pit tailing deposition on permafrost thawing around Goose Pit, Portage Pit A and Portage Pit E. Thermal modeling results were used to refined permafrost representation in the 3D model, for closure and post-closure period.

The numerical simulations were designed to represent the worst-case scenarios in terms of contaminant transport within the bedrock. Therefore, a groundwater monitoring program can be designed in relation to groundwater flow and contaminant transport simulation results.

In 2018, the latest version of the groundwater numerical model was used to forecast the post closure evolution of chloride concentrations at existing wells, including the four new wells installed in 2018. Breakthrough chloride concentration curves (predicted concentrations of chloride over time at a specific point of the 3D model) were extracted from the model at each monitoring well. Concentration increases over time showed that monitoring wells could intercept the contaminant plume from Pit A, Pit E and Goose Pit after closure over different period and at different concentrations.

As the in-pit deposition project will continue, updates of the hydrogeological model will be performed at closure period using the gathered site data such as ground temperature, hydraulics heads, in-pit tailings pore water quality, etc. Breakthrough curves (Figure 2) will be reviewed at this time to adapt the Groundwater Monitoring Plan.

As Goose Pit, Portage Pit A and Portage Pit E are mined out, faults mapping and (location, azimuth, dip, aperture) could be carry out in each current final pit shells. Other former and new structural information can be revisited such as existing televiewer surveys performed in few geotechnical boreholes, specifically in IPD boreholes and in the Central Dike area. Other available investigation results such the pit wall stability analysis or any rock core logging database could be also reviewed to identify main fracture zones or lithology contacts. Relevant information will be integrated to the revised 3D model, at closure period.

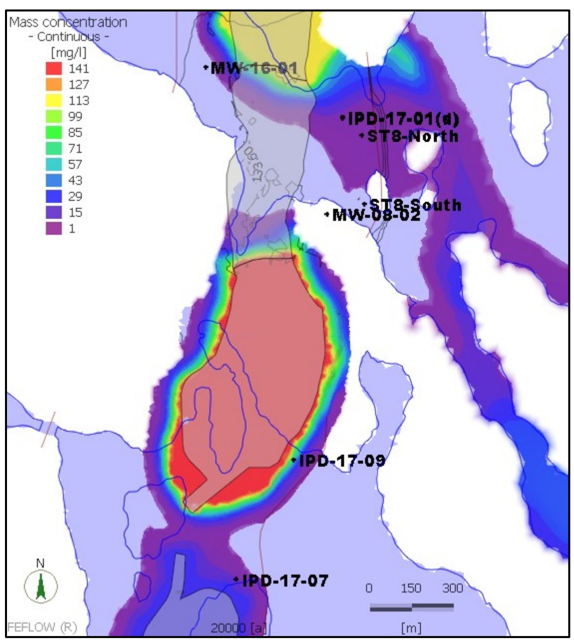


Figure 1 : Chloride transport simulation and existing monitoring wells network

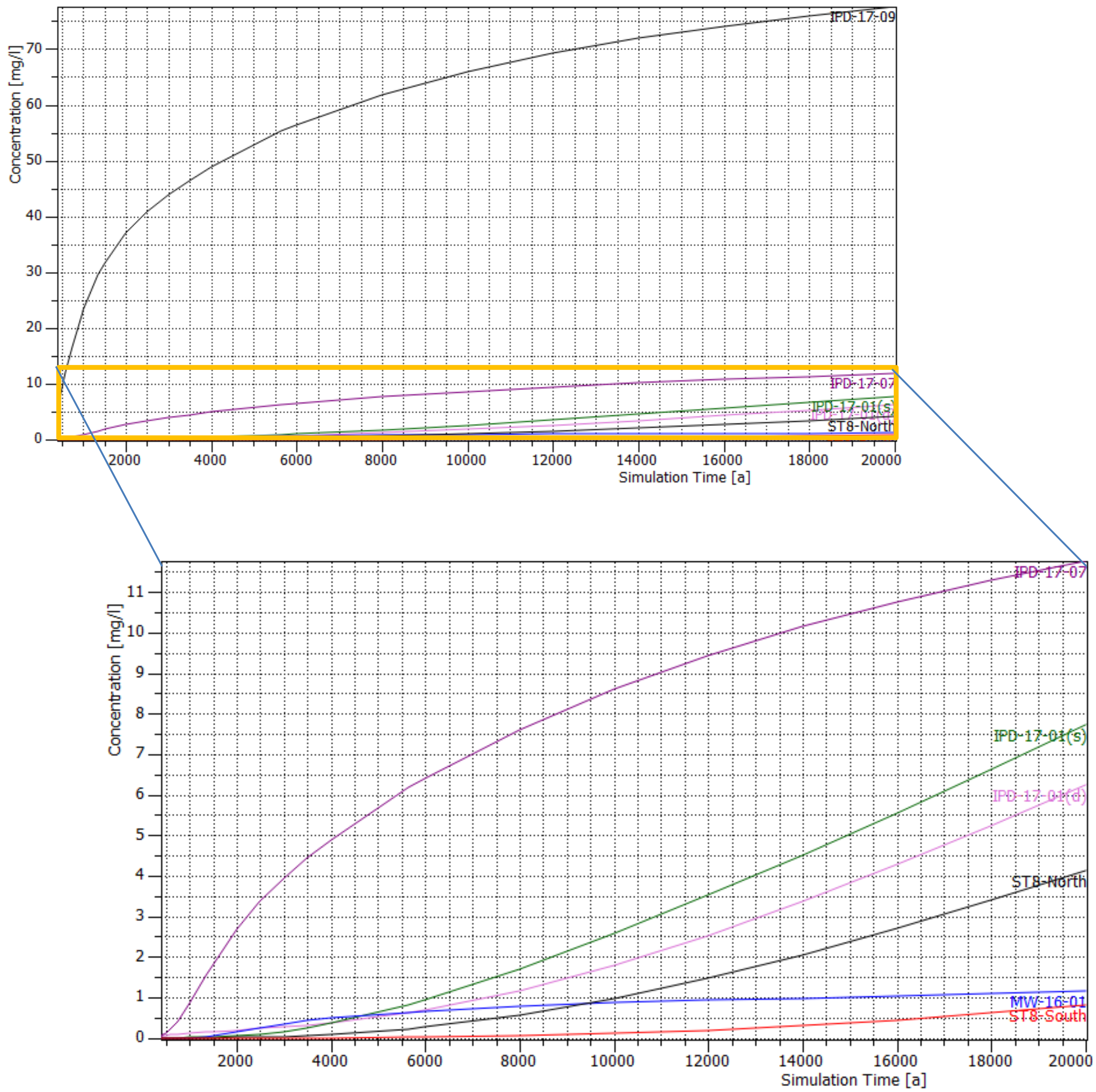


Figure 2: Breakthrough chloride concentration curves at existing monitoring wells, time after post-closure initiation

Table 1: Summary table of chloride concentration from breakthrough curves at existing monitoring wells

GW monitoring well	Location	Screen depth interval (m BGS)	Screen Elevation interval (masl)	Mid-screen Elevation (masl)	Interception Date of 1mg/L (Model Version4)	Conc. of chloride at t = 6000 y (mg/L)
IPD-17-01(d)	East flat	162 to 181	-32 to-51	-42	7,000	0.3
IPD-17-01(s)	East flat	51 to 70	79 to 60	70	6,000	1.0
IPD-17-07	Goose Pit	41 to 51	92 to 93	87	1,000	6.5
IPD-17-09	Pit E	62 to 81	71 to 52	62	0	57
MW-16-01	Central Dike	89 to 101	31 to 19	25	12,000	0.6
ST8-North	East flat	6	125	125	9,500	0.3
ST8-South	East flat	6	125	125	>20,000	0.1

The thermal modelling, hydrogeological modelling and contaminant transport simulations will be updated after in-pit tailings deposition and will be used as a predictive tool, along with field observations, to adapt the post-closure groundwater monitoring program (well locations, frequency, parameters) and if required, install additional monitoring wells in simulated groundwater flow paths. Breakthrough curves will be produced with the hydrogeological model to support the selection of monitoring wells screen location and depth.

Future groundwater monitoring program will be adapted for in-pit deposition at Meadowbank and the monitoring network will be used to confirm contaminant transport model prediction at closure and post-closure. Based on monitoring results, model calibration on transport parameters will be assessed at closure.

Additionally, physical and chemical laboratory analyses were performed on Whale Tail's tailings, intended to be deposited, to verify their properties and their potential for acid rock drainage (ARD) and release of chemicals (Golder, 2017). Finally, the updated groundwater monitoring program will be adapted to monitor the groundwater quality near pit shells with considerations of IPD operations. Moreover, methods to obtain representative groundwater samples and improve well designs under arctic climate continue to be developed. The groundwater monitoring program will be updated as the project progresses. New information from the hydrogeological numerical model and from hydrogeological field data will be integrated throughout.

Groundwater samples were collected from the new wells preceding the first stages of in-pit deposition. In addition, a pore water quality monitoring program (Agnico Eagle, 2020) was developed and aims to characterize and monitor the chemical composition of the pore water that exists in the tailings during operation and to confirm predictions for mine closure. The data collected will be used to monitor pore water quality over time and to update and calibrate the hydrogeological and contaminant transport models developed for the tailings in-pit deposition. For feasibility and safety reasons mentioned in Agnico Eagle (2020), monitoring wells will not be installed as part of the Pore Water Quality Monitoring Program. Instead, the quality of the reclaim water and process water in the plant effluent slurry will be monitored. These two waters are expected to bracket the potential range of quality of the tailings pore water.

The groundwater sampling data collected so far represent background geochemistry data prior to in-pit tailings deposition. The groundwater sampling program will continue to be carried out twice a year during in-pit tailings deposition operation using on-site monitoring wells and other monitoring stations. One sample per sampling event will be collected in duplicate to the analytical laboratory. One transport blank and field blank will also be collected each year.

4. KEY POINTS AND RECOMMENDATIONS

› No additional groundwater monitoring well installation is planned by Agnico Eagle during in-pit deposition period. The groundwater monitoring program will be updated as the in-pit deposition project progresses. New information gathered during operation (ground temperature profiles, additional faults mapping, water level readings in piezometers and monitoring wells, groundwater and tailings pore water chemistry) will be considered in the revised hydrogeological numerical model to be performed at closure period.

› Moreover, the possibility to get more accurate mapping of faults from pit shells, available televiewer surveys, available structural information from core logging database, should be investigated and if relevant, implemented in the update version of the hydrogeological model to be performed at closure.

› Methods to obtain representative groundwater samples and improve well designs under artic climate will continue to be investigated. Recommendations for drilling and well designs in deep permafrost environment were already presented in former Groundwater Monitoring Plan (SNC-Lavalin, 2019).

› It is recommended to standardize the presentation of all former and active monitoring wells by showing the following information on the same log, if available: geological description, geomechanical description, well installation details (inner/outer diameters, material type, etc.) and thermistor profile. Moreover, specific notes should be added to the log as difficulties encounter during drilling and during well installation.

› It is recommended to follow the same sampling procedures as previous sampling campaign using low-flow techniques and to carry out the two (2) sampling campaign at the same periods, each year.

› Groundwater sample contamination can come from many sources and can affect the representativity of samples. It is important to minimize and prevent the effect of sample contamination as much as possible (avoid drill/brine fluid, purge well as much as possible, clean purging and sampling equipment before use, installed well properly to avoid leakage of cross-contamination of fluid).

› To improve the groundwater well installation and sampling program, Agnico Eagle will make additional efforts to apply the proposed innovative solutions and best practices when possible.

5. REPORTING

An annual groundwater monitoring report will be submitted by Agnico Eagle Mines Limited to the NWB and NIRB with the Meadowbank Annual Report of the following year. This report will include the following information:

- Installation logs for any new monitoring wells;
- Location in UTM coordinates of all groundwater monitoring locations;
- Description of the working condition of the existing wells;
- Date of groundwater sampling;
- Details of sampling methods;
- Analytical results including: field data, laboratory analytical data and QA/QC information;
- Comparative assessment of parameters indicative of mine impacts to groundwater, with regard to tailings (chloride, sulfate, total cyanide, total copper, total iron and total arsenic);
- Historical trending of key parameters (such as chloride, sulfate, total cyanide, total copper, total iron and total arsenic) will be included in further groundwater monitoring reports; and,
- Actions taken regarding recommendations for the groundwater sampling program.

6. REFERENCE

Agnico Eagle Mines Ltd (2020). Pore Water Quality Monitoring Program. Meadowbank Gold Mine. Version 2. March 2020.

Agnico Eagle Mines Ltd (2017). 2016 Groundwater Monitoring Report. Meadowbank Gold Mine. March 2017.

Franz T. (2009). Peer Review of Monitoring Well designs to Minimize the Effects of permafrost Damage at Agnico Eagle's Meadowbank Mine in Nunavut. Franz Environmental Inc.

Freifeld B., Perkins E., Underschultz J., Boreham C. (2009). The U-tube sampling methodology and real-time analysis of geofluids. URL: http://escholarship.org/uc/item/4jc2m4g9

Freifeld B.M., Chan E, Onstott T.C., Pratt L.M., Johnson A., Stotler R., Holden B., Frape S. Pfiffner S.M., DiFurio S., Ruskeeniemi T., and Neill I. (2008). Deployment of a Deep Borehole Observatory at the High Lake Project Site, Nunavut, Canada. NINTH INTERNATIONAL CONFERENCE ON PERMAFROST (28 June - 3 July 2008) Fairbanks, Alaska, USA

Golder (2017). Whale Tail Pit Project, Laboratory Testing on Tailings. October 16th. Project no.: 001-1775467-MTA-Rev B.

Golder (2012). 2012 Groundwater Monitoring Report, Meadowbank Mine.

Golder (2009b). 2009 Groundwater Quality Monitoring Program, Meadowbank Mine. October 29, 2009.

Golder (2009a). 2008 Groundwater Quality Monitoring Program, Meadowbank Mine. Doc. No. 801 Ver. 0, January 14, 2009.

Golder (2008b). Technical Memorandum: 2008 Groundwater Monitoring Plan Meadowbank Gold Project. August 1, 2008.

Golder (2008a). Technical Memorandum: 2008 Groundwater Monitoring Well Design DRAFT for Client Review Only. May 23, 2008.

Golder (2007). Meadowbank Gold Project. 2006 Baseline Ground Water Monitoring. August 16, 2007.

Golder (2006). 2006 baseline groundwater quality. Meadowbank Gold Project., Doc. No. 317. December 4, 2006.

Golder (2004). Meadowbank Baseline Groundwater Quality. April 26, 2004.

Henkemans E. (2016). Geochemical Characterization of Groundwaters, Surface Waters and Water-Rock Interaction in an Area of Continuous Permafrost Adjacent to the Greenland Ice Sheet, Kangerlussuaq, Southwest Greenland. Ph.D. Thesis, Waterloo University, 308 p.

Hounslow AW (1995). Water Quality Data: analysis and interpretation. CRC Press, Florida

Pfiffner S.M., Onstott T.C., Ruskeeniemi T., Talikka M., Bakermans C., McGown D., Chan E., Johnson A., Phelps T.J., Le Puil M., Difurio S.A., Pratt L.M., Stotler R., Frape S. Telling J., Sherwood B.L., Neill I., and Zerbin B. (2008). Challenges for Coring Deep Permafrost on Earth and Mars ASTROBIOLOGY Volume 8, Number 3 © Mary Ann Liebert, Inc. DOI: 10.1089/ast.2007.0159

SNC-Lavalin (2020). 2019 Groundwater Monitoring Report. Technical Note. Version 00. Ref.: 665965-4000-4EER-0001. April 17, 2020.

SNC-Lavalin (2019). Meadowbank Annual Groundwater Quality Report – Historical Groundwater Analytical Results. Memorandum. version A00. Ref.: 663133-7000-40ER-0001. April 5, 2019.

SNC-Lavalin (2018). 2018 Groundwater Monitoring Report. Technical Note. Version 00. Ref.: 645182-3000-4EER-0001. December 17, 2018.

SNC-Lavalin (2018). 2017 Factual Field Report – Meadowbank. Technical Note. Version 00. Ref.: 645182-0000-4EER-0001. March 14, 2018.

SNC-Lavalin (2018). TSFE Project - In-Pit Tailings Deposition. Hydrogeological modelling. Technical Note. Version A01, Ref.: 651196-3000-4WER-0002. December 14, 2018.

SNC-Lavalin (2017). TSFE Final Report. Version A00. Ref.: 637215-6000-4GER-0001. January 30, 2017.

SNC-Lavalin (2017). TSFE - In-Pit Deposition - Prefeasibility Study. Final Report. Version 00, Ref.: 637215-7000-40ER-0001.

SNC-Lavalin (2016). Multiple Account Analysis for the tailings facility extension project. Version A00, Ref.: 637215-5000-4GER-0001. October 24, 2016.

Stotler R.L., Frape S.K., Freifeld B.M., Holden B., Onstott T.C., Ruskeeniemi T, and Chan E. (2010) Hydrogeology, chemical and microbial activity measurement through deep permafrost. Groundwater. DOI: DOI: 10.1111/j.1745-6584.2010.00724.x.

Stotler R.L., Frape S.K., Ruskeeniemi T, Ahonen L., Onstott T.C., and Hobbs M.Y. (2009). Hydrogeochemistry of groundwaters in and below the base of thick permafrost at Lupin, Nunavut, Canada. Journal of Hydrology 373: 80–95.

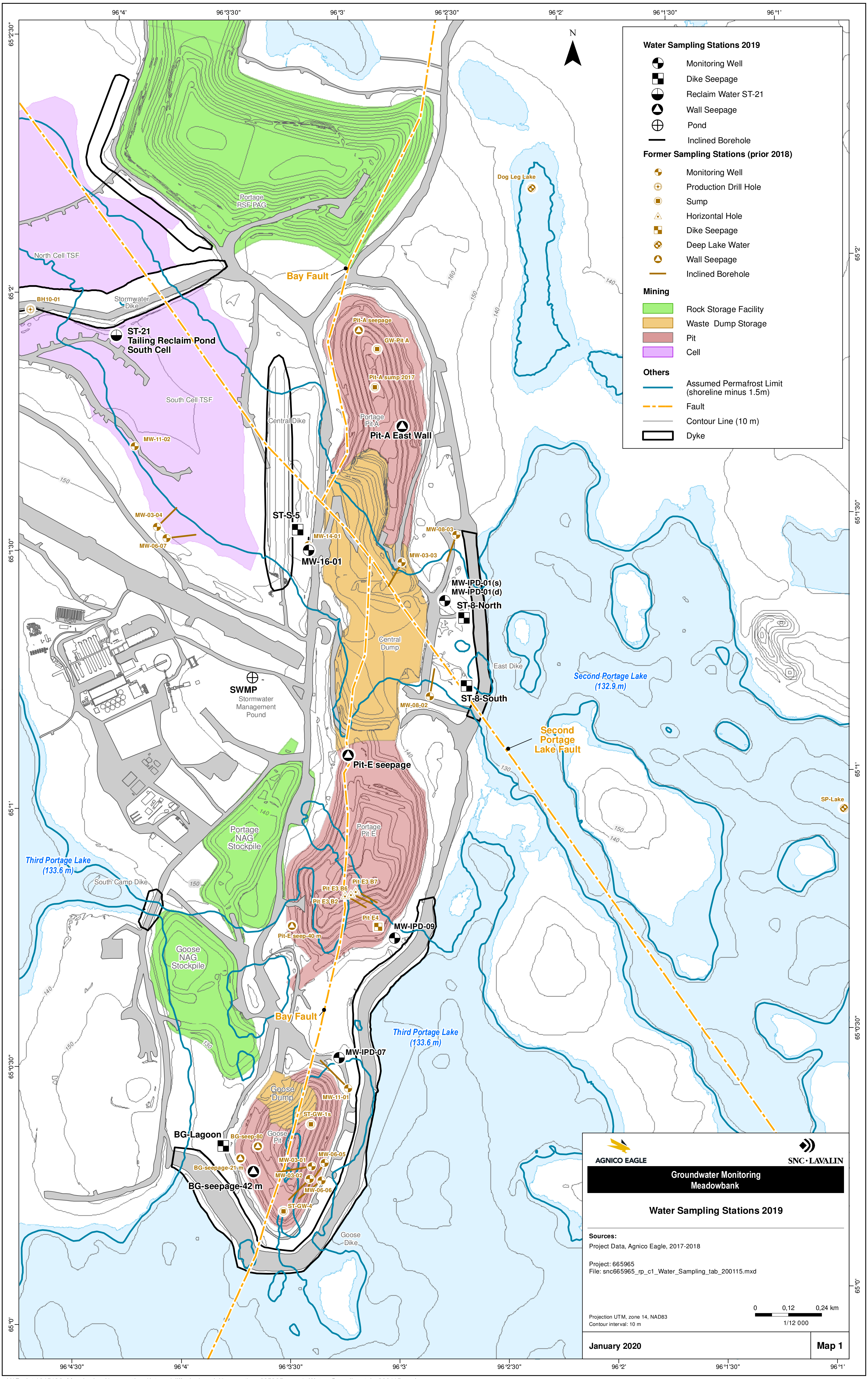
Stotler R.L. (2008). Evolution of Canadian Shield Groundwatersand Gases: Influence of Deep Permafrost. PH.D. Thesis. Waterloo University, 265 p.

Sutphin J.D., Atkinson L.C., and Mahoney J.J. (2016). Monitoring and sampling of groundwater beneath deep permafrost. Sea to Sky Geotechnique 2006 59th Canadian Geotechnical Conference and 7th Joint CGS and IAH-CNC, Vancouver B.C., 1613-1618.

Wilkins MJ, Daly R.A., Mouser P.J., Trexler R., Sharma S., Cole D.R., Wrighton K.C., Biddle J.F., Denis E.H., Fredrickson J.K., Kieft T.L., Onstott T.C., Peterson L., Pfiffner S.M., Phelps T.J. and Schrenk M.O. (2014). Trends and future challenges in sampling the deep terrestrial biosphere. Frontiers in Microbiology, perspective article. DOI: 10.3389/fmicb.2014.00481

APPENDIX A

Groundwater monitoring stations at Meadowbank



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APPENDIX B

Standard operating procedure for sampling of groundwater monitoring wells

Purpose:

- Conduct a groundwater (GW) monitoring program to investigate mining impacts on local GW. This is in accordance with both Meadowbank NWB and NIRB permits.
- Standardize methodologies

Groundwater Sampling SOP:

GW sampling consists of measuring field parameters and collecting GW samples within the designated bottles, twice a year, at the same period of the year (early July and early September).

Wells to sample:

Well name	x	y	Screens depth (m)	Pump depth (m)
MW-16-01	638750.9	7214427.3	89-101	95
MW-IPD-01 (s)	639240.3	7214249.9	51-69	60
MW-IPD-01 (d)	639240.0	7214245.0	163-181	175
MW-IPD-07	638859.6	7212597.2	42-50	40
MW-IPD-09	639065.2	7213024.5	62-80	70

A week before sampling check for:

- Heat trace cables functionality (can't be check at MW-IPD-01 (d) since heat trace cables start 2 m below ground, so the lines won't feel warm);
- Make sure the light tower generator are running at MW-IPD-07 and MW-IPD-09
- Make sure the nitrogen tanks are in place and secured

Light tower generator at MW-IPD-07 and MW-IPD-09 to keep the heat trace cables working

Material required for sampling:

- Nitrogen tanks (JDE number 134720) already installed at each sampling station
- Solinst double valve pump (already in the monitoring well), two spare pumps are in the cooler
- Nitrogen regulator
- Solinst Control unit 464 ECU 250 psi
- Black drive line and supply line
- Clean pails
- Graduated measuring cups
- Calibrated multi-parameter probe and a flow through cell (to prevent the water sample to be in contact with oxygen): temperature, specific conductivity, pH, oxydoreduction potential, dissolved oxygen, total dissolved solid, salinity, turbidity;
- Water level probe
- Sampling bottles (see list below)
- Syringe and adapted 0,45 micron filters
- Nitrile gloves
- Permanent marker

Sampling bottle check list:

- 1 * 1 L clear plastic bottle with no preservative
- 1 * 250 ml clear plastic bottle with no preservative
- 1 * 125 ml clear plastic bottle with H_2SO_4
- 2 * 125 ml clear plastic bottle with nitric acid (HNO_3)
- 1 *125 ml clear plastic bottle with NaOH
- 1 * 125 ml clear plastic bottle with NaOH - SGS laboratory bottle
- 1 * 125 ml clear plastic bottle with HCl

Well name	Pressure left in the nitrogen tank	Gas used for each sampling even	Comment
	psi	psi	
MW-IDP-01s	1600	200	-
MW-IDP-01d	200	800	Need a new nitrogen tank
MW-IDP-07	2200	150	-
MW-IDP-09	2000	150	-
MW-16-01	1000	500	Need a new nitrogen tank soon

Sampling procedures

Prior sampling the water in the monitoring well

1- Remove well head cap
2- Remove the red plug on well head
3- Lower the small water level probe into the hole where the red cap was located and measure the water level from the well head hole level
4- Place the ¼ inch waterra line on the well head

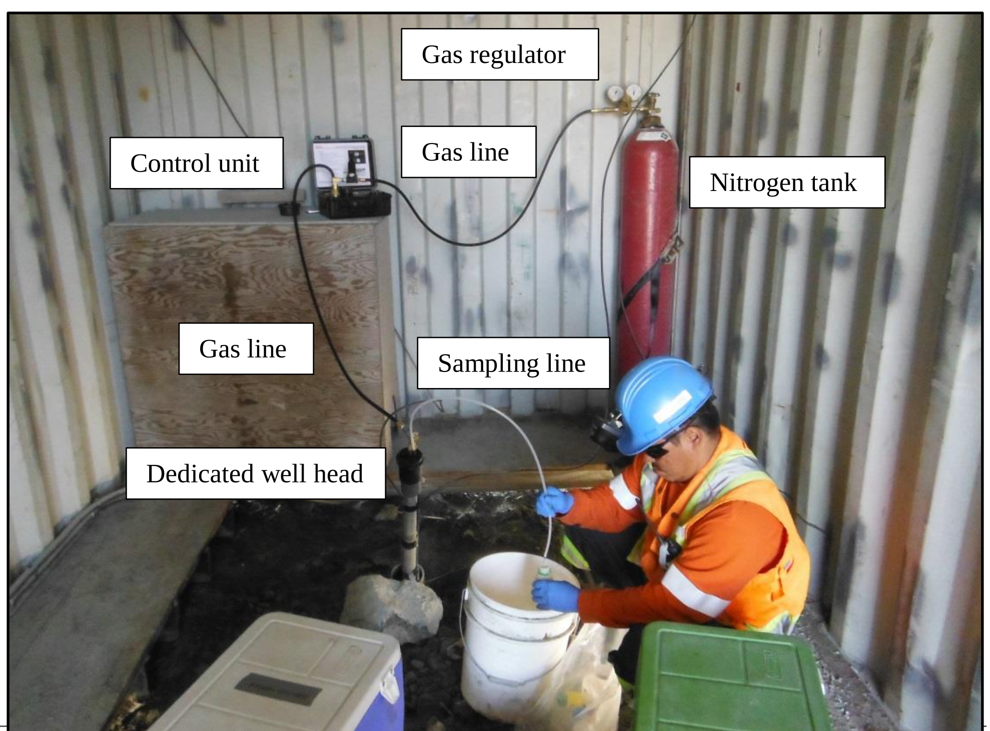
Well name	Water level at plastic well head level	HWT casing above ground level	Well casing above ground level	casing above ground level with PVC and well head addition
	m	m	m	m
MW-IDP-01 (s)	18,19	0,17	0,29	0,75
MW-IDP-01 (d)	18,07	0,00	0,28	0,35
MW-IDP-07	1,79	0,06	0,19	0,45
MW-IDP-09	2,36	0,00	0,26	0,45
MW-16-01	5,30	0,17	?	0,745

Setting up the nitrogen tank and the gas line

5- Screw on the nitrogen regulator on the nitrogen tank and tighten lightly with a 1 1/8in wrench ((ideally not an adjustable wrench since it will damage the bolt)
6- Connect the supply line into the regulator to "air in" on the control box
7- Connect the drive line from the air out on the control box to the well head

This end goes into the nitrogen

Manual Control Button
Air Out
Air In
Regulator
Pressure Gauge
Battery Enclosure



Gas regulator
Control unit
Gas line
Nitrogen tank
Gas line
Sampling line
Dedicated well head

8- **<u>Open</u>** to its maximum position (turning towards the left side) the handle/valve located on the gas pressure regulator at the maximum (the close position would send the maximum nitrogen pressure to the air line and we want to avoid that). The valve should feel loose, not tighten;

9- **<u>Slowly open</u>** (1/4 turn to the left) the valve located on the nitrogen tank. You should be able to read the pressure left in the nitrogen tank on the pressure gage located on the right side of the regulator;

10- **<u>Slowly closed</u>** (a tiny bit, less than 1/8 turn to the right) the valve located on the gas pressure regulator until the gauge on the left side indicated 150 psi. **NEVER EXCEED 250 psi** or you are going to blow up the controller box**.**

11- On the control box press RUN than select the menu on AUTO mode for Preset Flow Rate.

12- This should take 1 minute before the water is flowing.

Well name	Pressure set on control unit box (flow rate set to medium)	Flow setting on controller unit	GW flow rate measured while pumping	Comments
	psi		mL/min	
MW-IDP-01s	50	medium	100	
MW-IDP-01d	110	medium	50	
MW-IDP-07	40	medium	200	Rate too fast, water level was decreasing
MW-IDP-09	50	high	165	
MW-16-01	50	high	100	

13- While the water is purging from the monitoring well measure the flow rate with a measuring cup and a timer. The ideal flow rate is equal or below 100 ml/min. Keep measuring and recording the water level. If the water level is not stable and diminishes it means that you are pumping the water from the well and not from the bedrock formation and you want to avoid that. You want to keep a flow rate that will keep your water level stable.
14- Let it run for 45 minutes, measure and record physicochemical parameters and record every 15 minutes.
15- Sample the water from the well when you have more than 3 consecutive readings that are:
    a. pH is within 0.1 or 0.2 of a standard unit;
    b. temperature is within 0.2 °C or 3%;
    c. specific conductance is within 5% for values equal to or less than 100 microsiemens and 3% for values greater than 100 microsiemens;
    d. DO (dissolved oxygen) is within 10%;
    e. Eh/ORP (oxido-reduction potential) is within 10 millivolts;
    f. Turbidity is within 10% for values greater than 1 NTU but less than 100 NTU;
16- To filter the sample for the dissolved metal analysis, use a larger filter and hold it to ¼ diameter LDPH tubing (respect the flow direction indicated by an arrow) or fill the syringe directly with the water coming out of the ¼ diameter LDPH tubing, install a small filter on the syringe and fill the dissolved metal bottles.
17- Remove the filter and fill all the other bottles.
18- See instruction to set up personalised drive and vent ranges.

https://www.solinst.com/products/groundwater-samplers/464-pneumatic-pump-control-units/electronic-control-unit-datasheet/

Optimizing Pumping Pressure

To collect a representative sample, especially when monitoring for volatiles, it is important to avoid the drive gas to enter the pump and aerate the sample water during a drive period. This means, you need to carefully calculate the appropriate pumping pressure to be applied. To do so, it is important to measure the depth of the static water level.

The pumping pressure needed is calculated due that it takes about 1 psi of pressure to raise 2.3 ft. of water plus 10 psi fo line loss. To calculate the pumping pressure needed in psi, take depth to static level in feet, and multiply by 0.43 psi/ft. (1 psi /2.3 feet = 0.43 psi/ft.). E.g., if depth to static water level is 50 ft., the pumping pressure needed is calculated by the following:

50 ft. to static level x 0.43 psi/ft. + 10 psi = 32 psi needed.

Refer to Solinst Website for more instruction: https://www.solinst.com/products/groundwater-samplers/408-double-valve-pumps/technical-bulletins/getting-best-quality-samples-double-valve-pump.php