# Section 3B

# Groundwater Monitoring Plan
# v2 March 2009

MEADOWBANK GOLD PROJECT

# Groundwater Monitoring Plan

In Accordance with Water License 2AM-MEA0815

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 2
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# EXECUTIVE SUMMARY

This document presents the Meadowbank Mine Groundwater Monitoring Plan, a requirement of the Meadowbank Type A Water License No. 2AM-MEA0815. Conditions applying to groundwater monitoring include the following:

Schedule 1, Table 2: annual monitoring of groundwater quality at well locations that are to be determined.

## IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is outlined below.

This Plan will be immediately implemented (March 2009) subject to any modifications proposed by the NWB as a result of the review and approval process**.**

## DISTRIBUTION LIST

AEM – Geology Superintendent

AEM – Environment Superintendent

AEM – Environmental Coordinator

AEM – Environmental Technician

## DOCUMENT CONTROL

| Version | Date (YMD) | Section | Page | Revision |
|---|---|---|---|---|
| 1 | 08/08/08 | | | Comprehensive plan for Meadowbank Project |
| 2 | 09/03/31 | all | | Comprehensive update of plan to include 2008 well installations |
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# SECTION 1 • INTRODUCTION

This document presents the Meadowbank mine Groundwater Monitoring Plan. The location of each of the groundwater wells, design characteristics of each and the groundwater sampling methodology used to recover water samples for chemical analysis are presented.

## 1.1 PURPOSE OF GROUNDWATER MONITORING

Groundwater quality data has been used to predict the future quality of water that will accumulate in the pits during operation, and to determine baseline groundwater quality underneath the tailings basin (the northwest arm of Second Portage Lake) before tailing deposition. To this end, groundwater monitoring wells have been installed to sample talik water (unfrozen ground beneath large lakes) in areas where through taliks exist. No groundwater monitoring wells will be installed at the Vault deposit, as the Vault pit will be developed in an area where the talik does not extend down through the permafrost.

## 1.2 BACKGROUND

Seven groundwater monitoring wells were installed at the Meadowbank Gold Project site in 2003 and 2006, six of which developed frost-induced internal damage after an initial round of sampling and could no longer be operated. In 2008, a more robust well design that prevents groundwater rising within the wells to the permafrost zone in between the sampling rounds was used to install two additional monitoring wells. The new design also included redundant systems to minimize frost action on the instrumentation. A summary of the design objectives, and field solutions, for the groundwater wells installed in 2008 are presented in Table 1.

During development of monitoring well MW08-02, the heat cable used to prevent the well water from freezing during sampling melted the nylon lines that were part of the pump system used to remove water from the well annulus, and the water between the casing and the monitoring well pipe could not be removed as per the well design. In order to equalize the freezing pressure on both sides of the well pipe wall, the inside packer was not inflated after sampling to allow groundwater to rise into the well pipe. Because of this change, monitoring of well MW08-02 will require activation of the heater cables to melt the ice in the well prior to sampling. For the installation in monitoring well MW08-03, the lead tubing for the pump system was changed from nylon lines to stainless steel tubing, and the well was successfully installed with redundant systems to minimize impact of the permafrost on the instrumentation.

**Table 1: Well Instrumentation Design Objectives and Field Solutions**

| Design Objective | Effect | Field Solution |
|---|---|---|
| Prevent water ingress into the well section that intersects permafrost to avoid ice build-up pressures in the well | Remove ice build-up pressure; Minimizing time and energy requirement for sampling. | Install borehole steel casing from surface to below permafrost interval (at approximately 170m depth), and place one packer between the casing and the monitoring well, and second packer inside well, in the thawed ground (below 170 m depth). |
| Redundant groundwater access system | Continued use of well in case of failure of one or more elements of the design. | Heat trace cables included in design to thaw wells as contingency measure to packer leakage.<br><br>Heat trace cables will be activated prior to sampling to prevent groundwater from freezing during sampling. |
| Increased robustness of system | Improved resistance to ice build-up;<br>Protection of well instrumentation. | Use of stainless steel well pipes; Improved, pre-fabricated heat trace cable connections;<br><br>Well pipe centralizer to avoid pinching of well instrumentation cables upon installation. |

Following the recommendations of our external groundwater consultants, the installation of a fourth groundwater well under the tailings basin has been postponed until 2010. As the actual performance of the groundwater wells installed in 2008 is unknown at this time, particularly under winter conditions, it was recommended to postpone the installation of any additional wells until the performance of the individual components of the 2008 wells are evaluated. This will allow further modifications to future groundwater well designs, if deemed necessary.

## 1.3 EXISTING MONITORING WELLS

One groundwater well (MW03-01, installed in 2003) remained operable at the end of the 2008 groundwater monitoring program. This well is located in the southeast portion of Goose Island Pit. The two groundwater wells installed in 2008 are located along the East dike; MW08-02 at the southern tip of the dike, and MW08-03 at the northern tip of the dike. These 2008 well locations allow monitoring of groundwater flow and quality between the proposed open pit and the lake on the other side of the dike (area with the greatest hydraulic head). The coordinates for each of the groundwater wells and specific design characteristics are provided in Table 2.

**Table 2: Monitoring Well Locations**

| Well ID | Location UTM coordinates | | Dip | Borehole depth | Rock Formation |
|---|---|---|---|---|---|
| | Easting | Northing | | | |
| MW03-01 | NA | NA | 50 | 200 m | UM |
| MW08-02 | 639185.90 | 7213901.29 | 60 | 200 m | IV |
| MW08-03 | 639282.24 | 7214483.46 | 60 | 200 m | IV |

These well locations represent two of the three main lithologies that will be encountered in the Goose Island and Portage pits: Intermediate Volcanic (IV) and Ultramafic (UM) rock. Iron Formation (IF) is present on Goose Island; however, this area is not currently accessible for monitoring well installation.

# SECTION 2 • SAMPLING METHOD

## 2.1 GROUNDWATER WELL MW08-03

Well Preparation for Sampling

At the time of purging and sampling the heat trace cables will be activated to warm the well pipe. Once the new well has been warmed up the pneumatic valve inside the well pipe will be deflated to allow groundwater to flow into the well pipe.

Well Purging

The well is then purged to remove standing water inside the well and to induce the flow of fresh groundwater from the rock formation. Purging is done by lowering a portable double valve sampling pump (DVP) into the well pipe to approximately 10 to 20 meters above the top of the screened interval and activating the DVP. The pump is activated by pumping compressed air into a ¼" Low Density Polyethylene (LDPE) tubing attached to the DVP. The quality of the purged water is to be monitored for pH, electrical conductivity, temperature, water clarity and colour (visual observation) during this activity. A minimum of 3 well volumes (volume of water between the in-well packer and bottom of screened interval) are to be removed prior to sampling or until the monitored parameters stabilize (values remaining within 10% for three consecutive readings).

Groundwater Sampling

Groundwater is to be sampled immediately after purging, by lowering the intake of the DVP tubing to 3 to 5 meters above the screened interval. The same DVP pump and tubing used for purging is to be used for sampling but utilizing compressed nitrogen gas to evacuate water that entered the sampler unit. Nitrogen gas is stable (inert) and avoids alteration of groundwater chemistry during sampling. Chemical parameters are to continue to be measured during sampling.

A groundwater sample is to be collected in clean, laboratory-supplied containers. Where required, preservatives will be added to the sample bottles prior to sample collection, to minimize chemical alteration during transport to the laboratory. Samples analyzed for dissolved metals are to be filtered through a 45 μm inline filter.

Samples are to be collected in duplicate and submitted as blind duplicates (using different reference numbers) to the analytical laboratory. Duplicate samples are to be analyzed for chloride and dissolved metals only.

Well Close-Down Procedure

Once the water sample is obtained, the pneumatic valve will be re-inflated and the well water above the valve will be removed using the portable DVP pump. The DVP pump fixed to the outside of the well will also be activated to remove water accumulated in the annulus of the well during purging and sampling (if any). The heating cable will be de-activated and the cap will be replaced on the casing.

## 2.2 GROUNDWATER WELLS MW03-01 AND MW08-02

Well Preparation for Sampling

Because water is allowed to rise and freeze in place within the MW03-01 well pipe, the heat trace cable activation period will be considerably longer, in the order of 4 days, to thaw standing water (ice) present in the well pipe. The effective heating cables on groundwater well MW08-02 should allow the water present in the well pipe to thaw in a more timely manner.

Well Purging

Once ice is fully thawed purging is initiated in the same way as for the 2008 wells, by inserting the DVP and tubing at 10 to 20 meters above the screened interval and removing well water by pumping compressed air. Groundwater will be continually pumped from the well until electrical conductivity and pH readings stabilized. This process may require more than 3 well volumes. In consideration of the low hydraulic conductivity of the rock causing a very slow recovery of groundwater level (only a few litres of groundwater can be removed at a time), this process can take up to 4 days to complete.

Groundwater Sampling

Groundwater sampling will be carried out immediately after well purging, in the same manner as for the 2008 design wells (same equipment, elevation of tube intake for water sample, use of nitrogen gas, monitoring of water quality parameters during this process). Groundwater samples are to be collected in clean, laboratory-supplied containers. Where required, preservatives will be added to the sample bottles prior to sample collection, to minimize chemical alteration during transport to the laboratory. Samples analyzed for dissolved metals are to be filtered through a 45 μm inline filter.

Samples are to be collected in duplicate and submitted as blind duplicates (using different reference numbers) to the analytical laboratory. Duplicate samples are to be analyzed for chloride and the suite of dissolved metals specified in Table 1 of Schedule 1 of the Meadowbank Water License.

Well Close-Down Procedure

Once the water sample is obtained, the heating cable will be de-activated and the cap will be replaced on the well.

## 2.3 CHEMICAL ANALYSES ON GROUNDWATER SAMPLES

Measurements of groundwater temperature, pH, electrical conductivity, redox, alkalinity, total dissolved solids (TDS), and dissolved oxygen will be obtained in the field during purging and sampling. Measurements will be recorded for future reference and to check against laboratory data.

All groundwater samples will be stored in coolers with ice packs and shipped to Maxaam Analytical laboratory in Montreal, QC. A record of samples collected and requested analytical parameters will accompany each shipment of samples. Analytical parameters will include the following, per Schedule 1, Table 1, Group 3 of the Meadowbank Water License: pH, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, total dissolved solids (TDS), total and free cyanide (for well located in the flow path of the tailings containment area) and the following dissolved metals: aluminum, arsenic, barium, cadmium, copper, iron lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium and zinc.

## 2.4 QUALITY ASSURANCE / QUALITY CONTROL

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, inert gas (nitrogen) to evacuate water for sample collection;
- In-situ measurement of sensitive chemical parameters (pH, conductivity, dissolved oxygen, alkalinity, where applicable); and

Abiding by sample preservation methods (refrigeration and use of preservatives where needed); and specified holding times.

## SECTION 3 • REPORTING

An annual groundwater monitoring report will be submitted by Agnico-Eagle Mines Limited to the Nunavut Water Board (NWB) by March 31 of the following year. This report will include the following information:

- Description of the instrumentation and location in UTM coordinates of monitoring wells;
- Description of the working condition of the existing wells;
- Date of groundwater sampling;
- Name and title of personnel who completed groundwater quality monitoring;
- Analytical results including: field data, laboratory analytical data and QAQC information; and
- Comparative assessment of data obtained to date to input values used in the Water Quality Model for the site.