



MEADOWBANK GOLD PROJECT

**Groundwater Monitoring Plan**

In Accordance with Water License 2AM-MEA1525

Prepared by:  
Agnico Eagle Mines Limited – Meadowbank Division

Version 6  
September 2015

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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-MEA1525.

The Meadowbank Mine currently has three operating groundwater monitoring wells, drilled in 2008 (MW-08-02 and -03) and 2014 (MW-14-01). A number of wells drilled in 2003, 2006, 2008, and 2011 are now inoperable for various reasons. The Goose Pit sump was added to the sampling program in 2014, as it was identified as occurring in a talik zone. However, the Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015. Methods to obtain groundwater samples from production drill holes continue to be investigated.

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 will be carried out on an annual basis. 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.

A groundwater monitoring report will be submitted by Agnico Eagle Mines Limited to the Nunavut Water Board (NWB) by March 31 annually. This report will include all data from the previous year's results as well as a historical record, dates and methods of sampling, and an assessment of the data obtained with particular regards to salinity parameters and indicators of tailings reclaim water movement (total cyanide and dissolved copper).

## **IMPLEMENTATION SCHEDULE**

This Plan will be implemented immediately (September 2015) subject to any modifications proposed by the NWB as a result of the review and approval process.

## **DISTRIBUTION LIST**

AEM – Geology Superintendent

AEM – Engineering Superintendent

AEM – Geotechnical Engineer

AEM – Environment Superintendent

AEM – Environmental Coordinator


AEM – Environmental Technician

## DOCUMENT CONTROL

Version	Date (YMD)	Section	Revision
1	08/08/08		Comprehensive plan for Meadowbank Project
2	09/03/31	all	Comprehensive update of plan to include 2008 well installations
3	11/12/14		Update Executive Summary; insert Figure 1; update Table 1; addition of information on wells created in 2011; include well installation section;
4	14/01		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	15/04	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	15/09	4.1 and 4.2	Updated list of analyse parameters. QAQC Section to include Trip and Field Blank Remove Goose Pit sump as monitoring station

Version 6

Prepared By: Meadowbank Environment Department

Approved by:   
Kevin Buck  
Environmental Superintendent - Nunavut

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Appendix B - Standard Operation Procedure for Sampling of Production Drill Holes (interim)

## **1 INTRODUCTION**

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This document presents the Meadowbank Mine Groundwater Monitoring Plan, Version 6. This version maintains the principles and sampling methodology for monitoring wells presented in Version 5 (AEM, 2015), which includes the alternative groundwater sampling option for production drill holes as suggested in the 2012 Groundwater Monitoring Report (Golder, 2012). The sampling of pit wall seeps has been discontinued, as only surface water seepage has been identified to date. Sampling of the Goose Pit sump has been added in 2014, as it was identified as groundwater. However, the Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015. Monitoring well and alternative sampling locations, design characteristics, and the sampling methodology used to recover water samples for chemical analysis are included in this Plan.

### **1.1 PURPOSE OF GROUNDWATER MONITORING**

Groundwater data is used to predict the chemistry of water accumulating in open pits (especially salinity as TDS, conductivity and chloride), and to determine any effects of mining on groundwater quality, particularly with respect to tailings 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.

Groundwater sampling has traditionally been conducted using installed monitoring wells, but difficulties in obtaining representative samples by this method prompted the investigation of alternative methods in 2013 and 2014. Based on recommendations by Golder Associates (see 2012 Groundwater Monitoring Report), these included the sampling of pit wall seeps (now discontinued) and production drill holes. Traditional wells are also utilized in the monitoring program.

### **1.2 MONITORING WELLS**

Four monitoring wells were installed at the Meadowbank site in 2003. Three of these wells (MW-03-02, MW03-03 and MW03-04) were damaged by frost action between 2004 and 2006. The fourth (MW03-01) was operable until 2010 when it was also damaged by frost action. The three defective wells were replaced in 2006 (MW06-05, MW06-06 and MW-06-07). The three wells were again damaged by frost action. MW06-05 and MW06-06 were replaced in 2008 with a more robust design (MW08-02 and MW08-03). The replacement of the third defective well (MW06-07), at the tailings storage facility, was deferred until verification of the effectiveness of the new well designs in 2009-2010. In 2011, two

monitoring wells were installed. Well MW11-01 was installed on Goose Island adjacent to the Goose pit outline, to replace one of the 2003 wells (MW03-01). Well MW11-02 was installed at the tailings storage facility to replace MW06-07 and to monitor shallow groundwater quality below the basin where tailings are deposited. The well MW08-03 has been partially blocked by an ice bridge since 2010, but attempts to melt the ice have proven somewhat successful and are ongoing. Well MW11-01 was decommissioned in 2012 after being damaged during site operations. Well MW11-02 became obstructed with development materials during the 2012 monitoring program and could not be sampled. Attempts were made in 2013 to remove the material, but these were unsuccessful. This well was replaced in 2014 with well MW-14-01. However, attempts to recover development material from MW-11-02 may continue.

The locations of each former and existing groundwater well are provided in Figure 1.

### **1.3 PIT WALL SEEPS**

Seepage from pit walls commonly occurs in several locations in both the Portage and Goose pits. It was thought that groundwater samples could be readily be obtained directly from the waterfall when sufficient flow occurs. However, samples to date have indicated surface water rather than groundwater flow, so this program has been discontinued.

### **1.4 PRODUCTION DRILL HOLES**

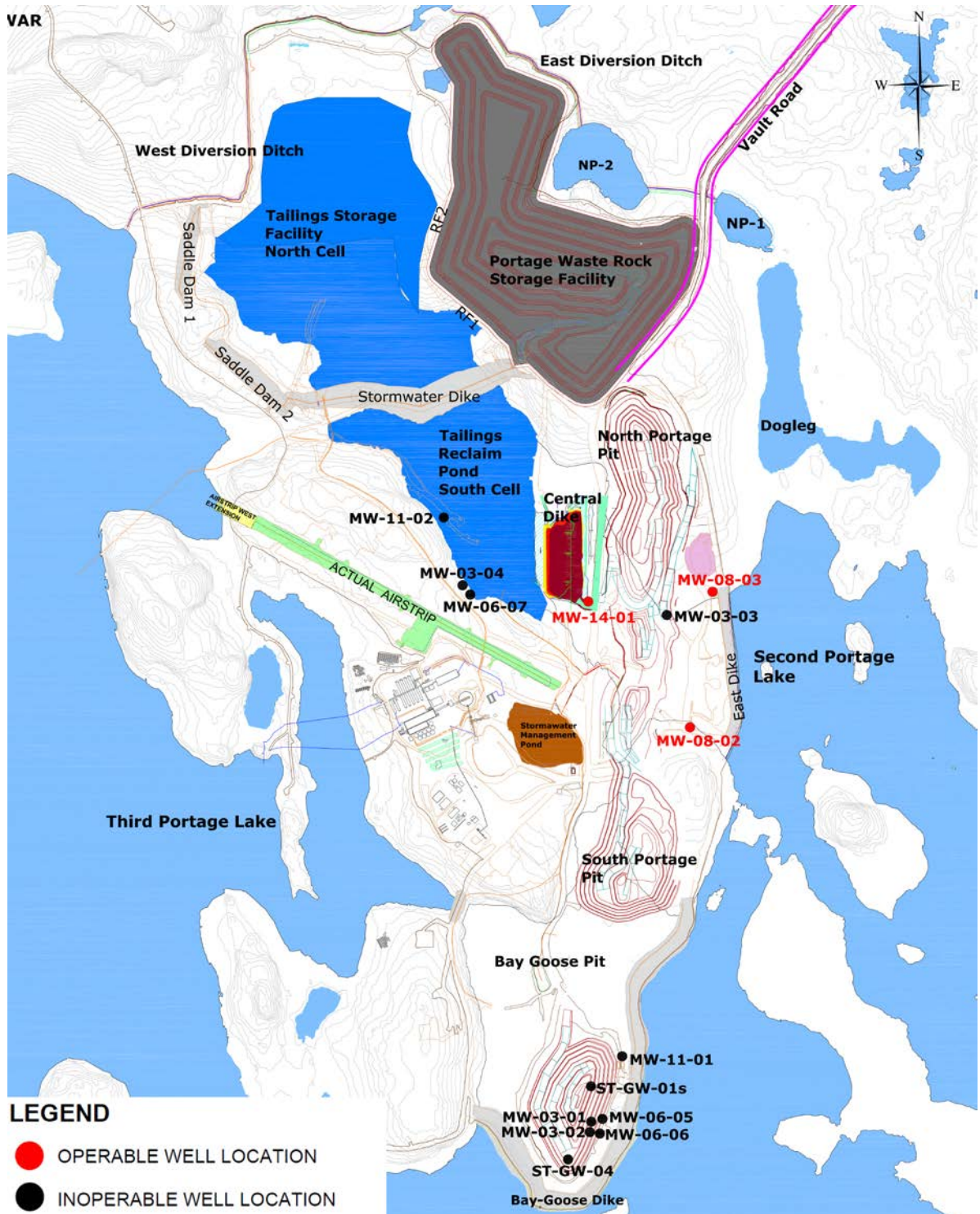
When sufficient groundwater flow from production drill holes is encountered, sampling using this method is likely feasible. Although wells with sufficient flow rates only occur on occasion, AEM is of the opinion that this is a viable method, and will continue attempts to sample production drill holes. Since the sampled locations will change each year depending on where flowing groundwater is encountered, drill hole identification numbers and GPS coordinates will be included in each annual report. This source of groundwater has the potential to be viable in determining any mining affects to groundwater, especially in the Portage Pit as it is directly downstream of the inferred groundwater flow path.

### **1.5 PIT SUMPS**

The Goose Pit sump was identified as talik-zone groundwater due to the persistent wet ground and lack of permafrost in this area and a thorough comparison of 2014 sample analysis results with historical groundwater results from site monitoring wells. As a result, this location was added to the sampling network in 2014. However, the Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015.



Figure 1 - Map of former and existing monitoring wells on the Meadowbank Site



## **2 MONITORING WELL INSTALLATION**

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Installation details for existing monitoring wells are provided here. Details for decommissioned wells are presented in the Groundwater Monitoring Report for the year of installation.

### **2.1 2008 WELL INSTALLATION**

#### **2.1.1 MW08-02 & MW08-03**

The two boreholes drilled for the replacement monitoring wells MW08-02, and MW08-03 were drilled using standard PQ and HQ size coring method. Heated water from the Second Portage Lake was used as drilling fluid during drilling. The boreholes were drilled to 200m depth along a 60 degree angle. Each borehole was cased to 20 m past the anticipated base of the permafrost using HWT flush-joint casing. The geological information used to was based on the core recovered from each borehole. The first 170 meters of the MW08-02 borehole were drilled without core recovery; the screened interval core was collected to confirm the target lithology. The full length of MW08-03 borehole was logged. Agnico Eagle geologists logged the core from both boreholes.

#### **2.1.2 Instrumentation**

The MW08-02 & MW08-03 wells were constructed with 1.5-inch diameter, schedule 40 stainless steel pipe and 18 m long 2 inch diameter stainless steel screen. The annulus between the casing and the monitoring well pipe was sealed at the base of the casing (169 m depth) with a pneumatic packer inflated with propylene glycol (a non-toxic and biodegradable liquid with low freezing point). This isolated the annular space between the borehole casing and the monitoring well pipe from the borehole interval below the permafrost. A small diameter double valve pump (DPV) driven by inert nitrogen gas was fixed to the outside of the riser pipe to allow removal of water from the well annulus above the packer to keep this area dry and minimize the potential for frost damage to the outside of the monitoring well pipe. A smaller diameter stainless steel pneumatic packer was installed inside of the monitoring well pipe immediately above the screen interval to prevent freezing of the inside of the monitoring well pipe throughout the permafrost. After sample collection, the inside packer is inflated and a portable DPV pump is used to evacuate water above this packer and keep the well pipe dry between the sampling events. A heating cable was attached to the outside of the monitoring well pipe through the entire anticipated interval of permafrost. The heating cables prevent water from freezing during sampling, and constitute a back-up system to melt the ice inside the monitoring well in case of a packer failure.

## **2.2 2011 WELL INSTALLATION**

### **2.2.1 MW11-02**

Although MW11-02 is planned to be replaced in 2014, installation details are included here because decommissioning has not yet occurred. The borehole was drilled using standard HQ size coring method. Heated lake water was used as drilling fluid during drilling. The borehole was drilled to 81 m depth at an angle of 80 degrees below ground surface. The borehole was cased through the overburden and into the first few metres of bedrock. All cores were recovered and logged by Agnico Eagle geologists.

### **2.2.2 Instrumentation**

MW11-02 was constructed with 1.5 inch diameter, schedule 40 stainless steel pipe and 15.25 m of 2 inch diameter slotted stainless steel screen. The well was installed into an open borehole. The annulus between the stainless steel well and the borehole was filled with approximately 16 m of sand. A bentonite seal approximately 4 m thick was placed on top of the sand. The remainder of the annulus was loosely filled with gravel and a grout seal was placed at the top of the well. Although the ground is not frozen at this location in the talik, it is predicted to freeze in time. For this reason, a heating cable was attached to the outside of the stainless steel pipes above the bentonite seal. The heating cable will allow for thawing of the well in the event of permafrost in the area.

## **2.3 2014 WELL INSTALLATION**

### **2.3.1 MW-14-01**

The borehole was drilled using standard HQ size coring for the installation of the well. The hole angle is 73 degrees and the elevation is 119 m. Water brought from the mine water truck was used as drilling fluid. The borehole was cased with HW casing through the overburden and into the first few meters of fractured bedrock (from surface to 25.5 meter depth). The well was constructed with 1.25 inch (3.2 cm) diameter, schedule 40 stainless steel pipe and 1.25 inch (3.2 cm) diameter slotted stainless steel screen. Screened depth is from 85.85 – 95.05 m from top of casing. Filtering number 10 sand was used to surround the screen and the lower part of the casing. This was followed with bentonite to plug the bottom of the annular space and prevent surface water from entering the well. The remaining part of the annular space was filled with grouting, a mixture of concrete and bentonite. Heat tracing was attached all along the casing to allow the melting of ice when sampling is required.

### **3 SAMPLING METHODS**

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Since monitoring results to date have not indicated any effects of mining activity on groundwater quality, the groundwater sampling program will be performed annually using traditional onsite monitoring wells, as well as production drill holes as available. One sample per sampling event will be collected in duplicate and submitted blind (using different reference numbers) to the analytical laboratory. One trip blank and field blank will also be collected per year.

Specific details of sampling methods for monitoring wells and production drill holes are provided here. The collection of samples from production drill holes will occur when flowing conditions are encountered in order to obtain additional samples to assist in the assessment of any potential impacts of mining activity.

#### **3.1 GROUNDWATER WELL MW08-03**

##### **3.1.1 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.

##### **3.1.2 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).

##### **3.1.3 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.

#### **3.1.4 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.

### **3.2 GROUNDWATER WELLS MW08-02, MW11-02, AND MW-14-01**

Although MW11-02 may no longer be sampled methods are provided here in the event that the well is able to be unblocked.

#### **3.2.1 Well Preparation for Sampling**

Because water is allowed to rise and freeze in place within the well pipe, the heat trace cable activation period will be considerably longer, in the order of 4-7 days, to thaw standing water (ice) present in the well pipe. The effective heating cables in the groundwater wells should allow the water present in the well pipe to thaw in a timelier manner.

#### **3.2.2 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.

#### **3.2.3 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 the same parameters as the original sample specified in Table 1 of Schedule 1 of the Meadowbank Water License.

#### **3.2.4 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.

### **3.3 PRODUCTION DRILL HOLES – ST-GW-#P**

The collection of samples from production drill holes will occur whenever flowing drill holes are encountered and the designed methods will be modified as required based on field testing. Standard methods are provided in Appendix B, and summarized here.

AEM's Senior Environmental Technician or Coordinator will request that the Blast Supervisor (Mine Dept.) notify Environment Department staff when a flowing production well is encountered during regular production (for blasting) drilling (it is not a regular occurrence). Sampling needs to be conducted prior to addition of any explosive material.

Before sampling, three well volumes will be purged from the flowing hole. Production wells are usually 0.17 m diameter and 8.5 m deep so approximately 579 L will be removed.

Analysis of field parameters will be used to assist in determining if sufficient purging has occurred. Values are to be stable (within 10%) for three consecutive readings (in accordance with procedures for monitoring wells).

The 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.

For each sampling location, GPS coordinates and the drill hole number/blast pattern number will be recorded.

### **3.4 GOOSE PIT SUMP (ST-GW-04)**

Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015.

Samples from the Goose Pit sump used to be collected directly from the end-of-pipe during pumping of this water to the South Cell TSF. As a precaution to guard against possible contamination due to close proximity to the South Cell tailings reclaim pond, extra purging was conducted. A sample port may need to be installed upstream from the end of pipe to ensure no contamination of samples.

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

A separate container was used to collect water for immediate measurement of field parameters (pH, conductivity).

## **4 SAMPLE ANALYSIS**

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### **4.1 ANALYSIS**

These samples will have field parameters taken (pH, turbidity, salinity and conductivity). Analytical parameters will include the following, per Schedule 1, Table 1, Group 2 of the Meadowbank Water License: bicarbonate alkalinity, carbonate alkalinity, total alkalinity, calcium, potassium, magnesium, sodium, hardness, ammonia nitrogen, total kjeldahl nitrogen, nitrate, nitrite, ortho-phosphate, total phosphorus, total organic carbon (TOC), total dissolved organic carbon (DOC), reactive silica, chloride, sulphate, total dissolved solids (TDS), total suspended solids (TSS), total and free cyanide and the following total and dissolved metals: aluminum, antimony, arsenic, boron, barium, beryllium, cadmium, copper, chromium, iron, lithium, lead, manganese, mercury, molybdenum, nickel, selenium, strontium, tin, titanium, thallium, uranium, vanadium and zinc.

### **4.2 QUALITY ASSURANCE / QUALITY CONTROL**

#### **4.2.1 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, 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.

#### **4.2.2 Duplicates, field and trip blank**

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



$RPD = \text{absolute difference in concentration} / \text{average concentration} \times 100$

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 and one trip blank will also be collected once a year.

## 5 REPORTING

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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:

- Installation logs for any new monitoring wells;
- Location in UTM coordinates of all groundwater sample 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 data obtained to date to input values used in the Water Quality Model for the site (relevant salinity parameters); and
- Comparative assessment of parameters indicative of mine impacts to groundwater, with particular regard to tailings (total cyanide and dissolved copper).

## **APPENDIX A**

### **Standard Operating Procedure for Sampling of Groundwater Monitoring Wells**

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## **WORK INSTRUCTION**

### **Purpose:**

This procedure is used to ensure that groundwater (GW) sampling is conducted in a safe and orderly manner. All samples need to be taken in the same manner to provide continuity of samples regardless of who is taking the samples. The Environment Department is required to conduct a GW sampling program to determine if there are any mining impacts to the local GW regime. This is in accordance with both our NWB and NIRB permits. In 2013 AEM environment staff will conduct the GW sampling program at Meadowbank.

### **Groundwater Sampling SOP:**

GW sampling consists of measuring field parameters and collecting GW samples within the designated bottles.

### **Material needed:**

Waterra 1 inch  
 Waterra ¼ inch  
 2 Genset (Atlas Copco, QAS 30) (GEN 30 and 34)  
 1 compressor (environment compressor)  
 3 Nitrogen tanks (JDE number 134720)  
 Nitrogen regulator  
 Solinst pump  
 Clean pails  
 Cond./pH/Temperature probe (PCStestr 35 or multi-parameter probe)  
 Water level probe  
 Control box  
 Red hose for NO2  
 Black hose with moisture trap for NO2  
 Adaptor, Fitting, Ring, Tools  
 Sampling bottle and syringe

### **Procedures to be done in 2013 for existing GW Wells**

#### **MW-11-02**

In accordance with the 2012 Golder Groundwater Technical Memorandum Env Dept staff needs to retrieve a melted waterra that has plugged this well at a depth of 28 meters. This will require the use of at least a 30 meter RW drill rod with a fitting containing external thread. Orbit Gallant will conduct this drilling to remove the blockage (Ask Orbit to drill with size A casing).

Also there is a short on the heat trace cable in this well so the electrician must be informed prior to plug the heat trace to avoid overheating.

	Date printed: 18/07/2013
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### **MW-08-03**

This well has been determined to have an ice blockage, below the existing heat trace, at a depth of 150 meters. To melt the ice, Carlon tubing HDPE is required (about 200 meters). Orbit Garant will thaw the blockage below the heat trace cable with hot water. Once the ice melts we can push the tubing down to continue the purge and characterization of the water prior to obtain a sample. Temperature of the heated water shouldn't exceed 60 °C

### **MW-08-02**

Nothing special. This well was sampled last year using regular unthawing and purging techniques.

### **Thaw and Purge Procedures**

#### **A) Melt the ice in the monitoring well**

- 1- Measure the depth of the ice in the well – use existing well logs to document all activity. This is important for report preparation.
- 2- Ask for an electrician to plug the heat trace to the generator (Atlas Copco, QAS 30)

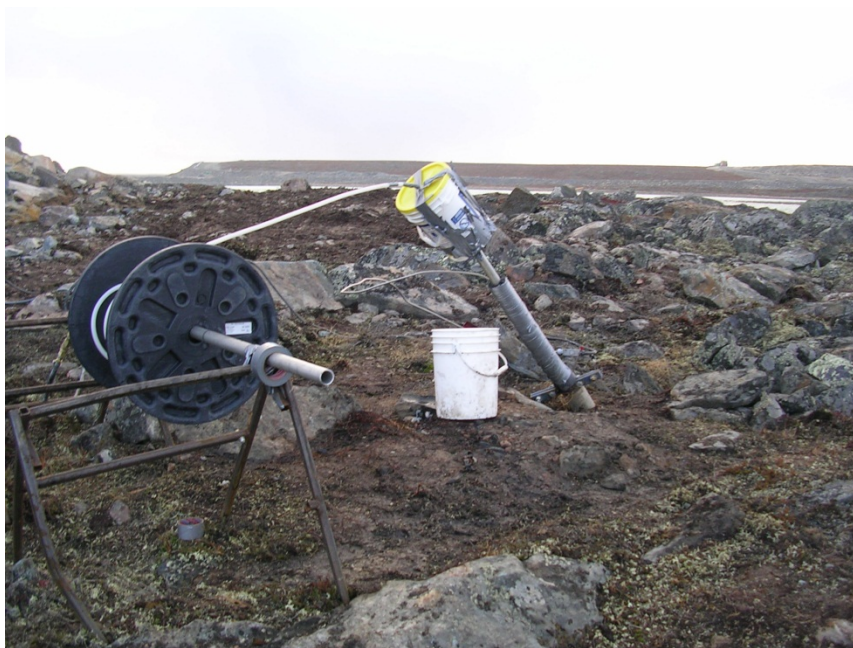


- 3- Monitor the ice and water depth every twelve hours or so.
- 4- Once the ice level has been melted to a depth of over 150 meters, we can start to purge.

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B) Purge the water in the well

- 1- Place a pail upside down on top of the well to avoid having water flow all over and place an additional pail on the ground underneath to collect the purged water (see photo below).



- 2- Place the 1 inch Waterra into the well to about 30 meters below the water level.
- 3- Place the rings (the smaller one first and then larger one after) onto the tubing and screw the fitting on the Waterra.
- 4- Connect the fitting to the red hose and then connect the red hose to the compressor.
- 5- Plug the compressor into the generator (make sure that the valves are close).





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- 6- Once the compressor reaches 125 psi, open the valve and wait for the water to flow out (can take between 30 seconds to 2 minutes).
- 7- Once there is no water flowing, close the valve, measure the pH, conductivity, temperature, amount of water purge (by number of pails), level of the water and then, lower the waterra, wait for 10 minutes and start over. This will equal one volume purged.
- 8- At the end of the day, take the waterra of the well and take the water level.
- 9- Once you purge 3 times the amount of water in the well and parameters are stabilized (all results within +/-10% ), you can sample the well

C) Sample the water in the well

- 1- Place the ¼ inch double waterra line on the Solinst double valve pump.
- 2- Tighten the waterra with the rings



- 3- One Waterra line will be bring the sample water and one will send Nitrogen to the pump. Make sure to identify which line is the one for Nitrogen and which one is the line for water (longest metal tale on the pump is for nitrogen) (see photos).
- 4- On the nitrogen waterra line, place 2 rings and a bolt and place it on the 90°adaptr and the black hose with the moisture trap.

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- 5- Connect the black hose to the Nitrogen control box (AIR OUT)
- 6- Plug the red hose to the control box (AIR IN).
- 7- Plug the other end of the red hose to the ``T`` regulator with the gauge.



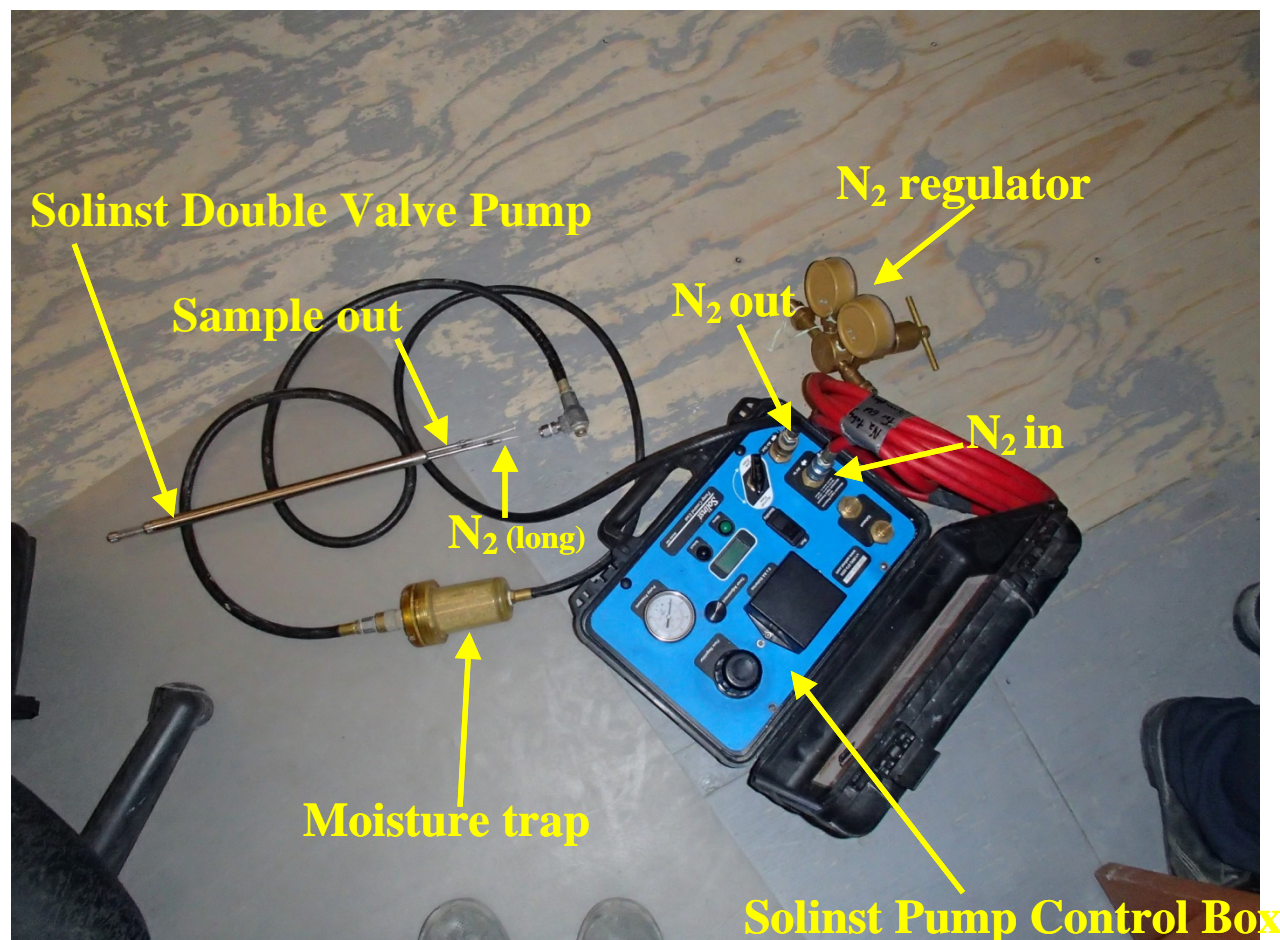


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- 8- Connect the regulator to the nitrogen tank and slowly open the Nitrogen tank to a pressure of 140 PSI.
- 9- On the control box press RUN then put the menu on AUTO mode.
- 10- With the SELECT button adjust the pressure so that when it's pumping the pressure is at 140 PSI and when it's venting, it goes back to 0 PSI.
- 11- This should take about 5 minutes before there is a water flow.
- 12- Let it run for 10 to 15 minutes, measure parameters with the PCSTestr 35 or the multi-parameter probe and sample the water. Record all field parameters results.
- 13- For filtering, place the pumped GW in a clean container, rinse 3 times and use a syringe to sample.

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Control box



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Control box

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### Valve and Ring

Take a triplicate for every sample, send 2 to the lab and keep a backup sample.

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Author:		
Environmental Technician	Martin Theriault	
Print Title	Print Name	Signature

Approval:		
Environmental Coordinator	Jeffrey Pratt	
Print Title	Print Name	Signature

## **APPENDIX B**

### **Standard Operating Procedure for Sampling of Production Drill Holes (Interim)**

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## **Procedure for Groundwater Sampling from Flowing Production Drill Holes/Wells**

### **Purpose:**

This procedure is to ensure that groundwater (GW) sampling from flowing production drill holes/wells is conducted in a safe and orderly manner. Production holes are drilled to place explosives for blasting. All samples need to be taken in the same manner to provide continuity of samples regardless of who is taking the samples. Using the Environment Department PCSTestr 35 conductivity and salinity readings are to be taken from flowing production wells, when notification is received, and compared to results from previous GW sampling events conducted by Golder (see chart below). If these parameters are determined to be similar we can conclude that the water is representative of area GW. A sample can then be taken. The drilling of production wells involves the use of freshwater and this water will be purged when a flowing well is encountered. It is important to ensure that this water is purged prior to taking a sample (which is why the meter is used – to take continuous samples until it is determined that the water is GW).

### **Groundwater sampling from production holes SOP:**

GW sampling from production holes consists of measuring field parameters (conductivity, TDS and salinity) with the PCSTestr 35 and comparing the results with past results (Golder) from the GW wells. If the results are similar in chemistry to previous results then a sample is collected using the designated sample bottles prior to the addition and use of explosives in the hole. The location, time, depth of hole and procedural notes are documentation that will be required from each sampling event.

### **Material needed for the job:**

Calibrated Multi-parameter PCSTestr 35  
Watch  
Clean Pail  
Sampling gloves  
Sampling bottles  
GPS  
Camera

### **Procedures to be done in 2013**

- 1- Senior Environmental Technician or Coordinator will request that the Blast supervisor (Mine Dept) notify Env staff when a flowing production well is drilled (it is not a regular occurrence). We need to make sure no explosive material is added to the hole before sampling. Env Dept should have equipment ready and proceed to site upon notification if possible.
- 2- Before sampling, make sure that 3 well volumes have been purged from the flowing hole. Production wells are usually 0.17 meter diameter and 8.5 meters deep so approximately 579L



needs to have been discharged. It will not always be possible to determine the purged volume due to the time it takes to travel to the location. In field sampling will assist in determining if the GW is representative of the area GW.

- 3- Calculate the amount of time needed before sampling according to the flow.
- 4- Take at least 3 readings during the purging with the multi-parameter probe (conductivity, TDS and salinity) and compare your results with Golder's results (see table below). Parameters need to be stable (within 10% of each other).
- 5- If results are similar, once the purge is completed, put on the nitrile gloves and sample the hole with the appropriate bottles. For filtering, let the water flow into a clean container, rinse 3 times and use a syringe to sample.
- 6- Take the GPS coordinates and the identification of the hole (blast pattern) of the sampling location and also take some pictures of the overflowing hole.

### Golder's results for TDS, Conductivity and Salinity


measured are summarized in Table 1.

**Table 1: Concentration of Constituents that Relate to Groundwater Salinity**

Location	Monitoring Well	Lithology	Sample Year	TDS <sup>1</sup> (mg/L)	Conductivity (µS/cm)	Chloride (mg/L)
Goose Island	MW03-01	Ultramafic	2003	793	1,855	626
			2004	1,335	2,900	845
			2006	315*	460*	81*
			2007	389	588	126
			2008	1,100	3,200	950
			2009	1,900*	3,350*	970*
			2010	340	335*	5.7
Third Portage	MW11-01	Intermediate Volcanic	2011	14,840	3,999	10,271
	MW08-02	Intermediate Volcanic	2008	510*	808*	160
			2009	520*	705*	160*
			2010	450	690*	160
			2011	523	782*	169
			2012	307**	616*	111
South basin of Second Portage Arm	BH10-01	Intermediate Volcanic	2010	670*	935*	17
	MW11-02	Intermediate Volcanic	2011	263	400*	20.9

**Notes:** <sup>1</sup> Laboratory measurement except for in 2011 which reported values as dissolved solids  
 \* Average value  
 \*\* TDS value calculated from laboratory measured values of dissolved constituents  
*italic* - field measured value

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 Golder Associates

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Author:

Environmental Technician

Print Title

Martin Theriault

Print Name

Signature