Aboriginal Affairs and Northern Development Canada
Affaires autochtones et Développement du Nord Canada

Nunavut Regional Office
P.O. Box 2200
IQALUIT, NU X0A 0H0

*Your file - Votre référence*
2AM-MEA0815

December 24, 2014

*Our file - Notre référence*
IQALUIT-#877705

Phyllis Beaulieu
Manager of Licensing
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0E 1J0

*Sent via email:* licensing@nwb-one.ca

**Re: Aboriginal Affairs and Northern Development Canada Technical Review of Agnico Eagle Mines Ltd.'s Application to Renew Water Licence #2AM-MEA0815**

Dear Ms. Beaulieu:

Thank you for your email of November 24, 2014, concerning the above mentioned application. Attached are comments and recommendations for the Board's consideration. They have been provided pursuant to Aboriginal Affairs and Northern Development Canada's mandated responsibilities under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Department of Indian Affairs and Northern Development Act*.

Please do not hesitate to contact David Abernethy by telephone at 867-975-4555 or email at david.abernethy@aandc-aadnc.gc.ca for further information.

Sincerely,

Ian Parsons
Regional Coordinator

Encl. 1) Comments prepared by AANDC personnel; and
2) Comments prepared by BGC Engineering Inc (AANDC consultant)

c.c.: Amjad Tariq, Regulatory and Science Advisor, AANDC Nunavut
David Abernethy, Water Resources Regional Coordinator, AANDC Nunavut
Erik Allain, Manager, Field Operations, AANDC Nunavut
Leslie Payette, A/Director, Resource Management, AANDC Nunavut
Stéphane Robert, Manager, Regulatory Affairs, Agnico Eagle Mines Ltd.

**Re: Agnico Eagle Mines Ltd., Meadowbank Project's Type 'A' Water Licence Renewal Application: AANDC Technical Review (Comments and Recommendations)**

The following comments and recommendations have been prepared as a part of the technical review process for the above mentioned licence renewal application. The following documents were reviewed.

**Documents Reviewed:**

*Nunavut Water Board (NWB 2AM MEA0815) Type A Water License Renewal Application– Main Supporting Document (3262 pages)*

The comments and recommendations are summarized in Table 1 (attached).

## Table 1: Review comments and recommendations:

| Item | Reference | Proponent's Statement | AANDC's Comments | AANDC's Recommendations |
|---|---|---|---|---|
| **A** | **Interim Mine Closure and Reclamation Plan** | | | |
| A.1 | Section 3.3.6.3 | Section 3.3.6.3 of the Interim Closure and Reclamation Plan provides the planned reclamation approach and the associated activities. It has been stated that<br><br>'The Portage WRSF will be covered by a layer of NPAG rock to ensure geochemical stability by insulating PAG materials and keeping the waste rock frozen'. | AANDC is concerned that how rock cover can 'insulate' PAG with large voids in it. The potential ingress of air (oxygen) coupled with moisture (water) can oxidize sulphide minerals and instigate acid generation process. The freeze control strategy adopted by the proponent is principally dependent on the climate conditions. The potential temperature rise due to climate change and/or global warming may have adverse effects on frozen PAG materials. As a result, acid rock drainage (ARD) can be a source of water pollution issues for surface water bodies and ground water.<br><br>The proposed approaches to prevent ingress of air (oxygen) and moisture (water) should be documented. The degree of effectiveness of the proposed cover system in terms of ARD control should be determined based on up-to-date scientific knowledge. | Proponent is requested to provide the details of the proposed strategies to prevent water pollution issues. In order to cope with potential water contamination, the degree of effectiveness of the proposed cover system in terms of ARD control should be determined based on up-to-date scientific knowledge.<br><br>In addition to the thermal monitoring program, an action plan based on scientific analysis should be submitted to NWB. |
| A.2 | 3.3.6.3 | Section 3.3.6.3 of the Interim Closure and Reclamation Plan states that<br><br>'Investigations and cover trials will be conducted to verify this thickness layer, and adjustments to the closure design will be made as appropriate.' | Proponent has planned to implement rock fill cover at (approximately 4 meter of thickness) the entire site. The rationale behind the 'assumed thicknesses' should be scientifically analyzed. | AANDC requests that the proponent provide a detailed analysis for waste rock layer thickness, since 4 m is an 'assumed thickness'. Additionally, the proponent is requested to document the variables used in 'cover trials' including thickness of layer, size distribution of rock fill material, environmental conditions, etc. |

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| A.3 | Section 3.3.6.3 | Section 3.3.6.3 of the Interim Closure and Reclamation Plan states that<br><br>'Some of the Portage and Goose Pit waste rock will also be backfilled into a completed portion of the Portage Pit, to be flooded at closure.' | AANDC is concerned about the technical feasibility and design of the proposed water cover system. Water cover system design parameters (water depth analysis, wind erosion, particle re-suspension, etc.) and a maintenance plan should be analyzed in detail. | The proponent should provide a detailed analysis of the water cover system. Such systems also require maintaining a specified depth of water all the time over the PAG material. In addition to other technical considerations (e.g., main lake at closure), the proponent will also need some sort of mechanism to compensate the evaporation loss. |
| A.4 | Section 3.3.7.3 | Section 3.3.7.3 of the Interim Closure and Reclamation Plan states that<br><br>'Tailings management approach for long term stability and control of ARD involves encapsulation of tailings in permafrost. The tailings will be allowed to freeze after deposition and to remain frozen after closure. A closure cover will be placed to insulate the frozen tailings and to protect against erosion.' | In the absence of proponent's technical proposal regarding final cover system for tailings, such speculations are required to be justified.<br><br>AANDC is concerned the possible temperature rise and/or climate change/global warming. Other tailings management approaches should also be considered for the selection of a technically feasible and environmentally acceptable approach. | AANDC requests that proponent provide a detailed design of the final cover system (s) to deal with potential acid generation processes due to possible temperature rise. Measures to control surface and underground water pollution due to potential precipitation and/or surface runoff should be documented.<br><br>AANDC also requests that the proponent consider other tailings management approaches in conjunction with the proposed approach. A detailed comparison and analysis of different tailings management techniques is highly recommended. |
| A.5 | Section 3.3.7.3 | Section 3.3.7.3 of the Interim Closure and Reclamation Plan states that<br><br>'Closure will include the placement of an erosion barrier consisting of a 4 m thick layer of NPAG ultramafic wasterock over the tailings.<br>The surface of the final cover will be graded to blend into the existing topography to allow<br>for surface drainage.' | AANDC is concerned that no rock (being used) is totally NPAG. Surface runoff may dissolve metals and can contaminate underground water and surface water.<br><br>AANDC is further concerned that how the surface of the final cover will be graded? If soil will be used then it must be tested for its physical properties including hydraulic conductivity in compacted state and load bearing capacity etc. Chemical properties of the proposed soil are also required to be documented to ensure compatibility of soil with | AANDC requests that the proponent provide details on final cover system design and technical analysis of the surface drainage issues.<br><br>AANDC request proponent to provide report on physical and chemical interaction of the proposed soil (as cover material) with rock material. Such analysis will dictate the technical feasibility of the proposed methodology for the tailings management.<br><br>Pursuant to Part J, item 6 of the Licence, The Licensee shall implement progressive reclamation, including progressive covering of the tailings and revegetation (where feasible). |

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| | | | metals, etc. The chemical interaction of the proposed soil (as cover material) with the rock material (being used) will dictate the technical feasibility of the proposed approach for tailings management. | |
| A.6 | Section 3.3.7.3 | Section 3.3.7.3 of the Interim Closure and Reclamation Plan states that<br><br>'If water in the Reclaim Pond is not suitable for release, a water treatment plant may be necessary, this plant would be installed at the mill to treat the water prior to release in the Portage Pit Lake.' | AANDC is concerned about the water treatment technology being adopted at the site. Water treatment technology is required to be analyzed in terms of contaminant removal efficiency. | Pursuant to Part F of the Licence, the Licensee is required to comply with the discharge limits. AANDC request proponent to provide the details on water treatment system being adopted in terms of contaminant removal efficiency vs discharge limits. |
| A.7 | Section 3.3.7.1 | Section 3.3.7.1 of the Interim Closure and Reclamation Plan states that 'closure objectives include minimize wind migration of tailings dust'. | The statement needs explanation that how wind migration will be minimized. What steps will be taken to ensure dust suppression, etc? | AANDC recommends that proponent provide details on strategies being adopted for dust suppression and control. |
| A.8 | Section 3.4.1.2 | Section 3.4.1.2 of the Interim Closure and Reclamation Plan states that<br><br>'Thermistors have been (and more are scheduled to be) installed within the Portage WRSF to monitor the rock<br>cover freezing and performance. The results will be used to evaluate the predicted thermal response of the WRSF with the actual thermal response. Results to date from the thermistors indicate that freeze back is<br>occurring in the WRSF structures'. | The Proponent has installed instrumentation for temperature measurement within the Portage WRSF. It has been confirmed that freeze back is occurring in the WRSF structures.<br><br>The details on the planned<br>control strategies to prevent migration of leachate from PAG rock storage areas and tailings storage areas in case of temperature rise have not been mentioned. | The proponent should provide management plans to deal with expected or un-expected temperature rise conditions. The proposed steps to prevent leaching of contaminants from WRSF structures are required to be documented. |

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| **B** | **Report on Waste Rock Storage Facility (WRSF) Seepage** | | | |
| B.1 | | Golder Associate's report-Construction Summary Report Rock Storage Facility-Interim Till Plug | The report provides details for the construction of the Interim till plug located on the upstream side of the access road to the north cell ditches, between the waste Rock storage facility and the NP-2 lake. The till plug is constructed to block seepage coming from the RSF to go into NP-2 lake. | Pursuant to Part D, item 1, the Licensee is required to provide final design and construction drawings stamped and signed by a Professional Engineer.<br><br>AANDC request proponent to provide the desired documents stamped by a professional Engineer. |
| B.2 | | The proponent states that<br><br>'The till plug is constructed of low permeability till material placed on a granular filter layer against the rockfill road. This structure is considered to be physically stable. In terms of seepage control, the performance of the till plug and the associated pumping keeping a low water level in the sump at the sampling station ST-16 appears to be effective in managing seepage to Lake NP-2.' | Pursuant to Part D, Item 1, the proposed design needs to be stamped by a Professional Engineer. | AANDC request proponent to provide detailed design stamped by a Professional Engineer. The adequacy of implemented approach (till plug) for the long-term is also required to be ascertained to protect water resource. |
| **C** | **Mine Waste Rock and Management Plan** | | | |
| C.1 | | The Executive Summary of the Mine Waste Rock and Management Plan states that,<br><br>'Tailings are placed sub-aerially as slurry and water from the pond is reclaimed during operation.<br><br>The tailings deposition strategy is to build beaches against the faces of the perimeter dikes to push the pond away, and ultimately produce a tailings surface that directs drainage towards the western | AANDC is concerned that the tailings surface will have significant potential of oxidation of sulphide minerals under 'no drainage' or 'low drainage' conditions. Low moisture content and oxygen ingress in tailings material can give rise to oxidation of sulphide minerals, resulting in an acid generation process. The potential release of metals and arsenic can impact surface and underground water (flow within active layer). | AANDC request proponent to consider the potential of acid drainage on the surface of sub-aerially as slurry under 'no drainage' or 'low drainage' conditions. Such conditions can jeopardize surface and underground water. The proposed approaches to prevent adverse environmental impacts are also required to be analyzed. These include but are not limited to monitoring of supernatant, ensuring isolation of closure cover, etc. |

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| | | abutment of the storm water dike.' | | |
| C.2 | | The Executive Summary of the Mine Waste Rock and Management Plan states that 'A minimum 2-m thick cover of NPAG rock fill will be placed over the tailings as an insulating convective layer to confine the active layer within relatively inert materials.' | The exact types of NPAG rock fill in terms of % of acid generating potential are required to be mentioned and categorized. The cumulative effect of NPAG and ingress of moisture and oxygen through the cover can oxidize underneath PAG tailings.<br><br>Furthermore, freeze control strategy need to be analyzed in light of thermal monitoring results. | AANDC request proponent to consider the thawing conditions due to temperature rise. What action plans are in place to deal with such thawing conditions? |
| **D** | **Water LIcence 2AM-MEA0815 Amendment Submission by Agnico-Eagle (issued on June 9, 2008)** | | | |
| D.1 | Part E, Item 8 | Proponent has proposed a change in the Licence. It has been recommended that the following text be deleted,<br><br>The Licensee shall, on an annual basis during operations, compare the predicted water quantity and quality within the pits, to the measured water quantity and quality. Should the difference between the predicted and measured values be 20% or greater, then the cause(s) of the difference(s) shall be identified and the implications of the difference shall be assessed and reported to the Board. | The proponent has reported that 'These proposed changes were discussed with NWB, KIA, AANDC and EC during a WebEx workshop held on November 28, 2013.' | AANDC requests confirmation of the history on this requested change. And, if the variations between predicted and measured water quality and quantity are maintained below 20 percent. |
| D.2 | Part F, Item 6 and Part F Item 23 | Proponent has proposed a change in the Licence. It has been stated that,<br><br>'AEM is proposing to have consistent discharge limits required for discharge from fuel containment facilities to land - see Part F Item 23' | AANDC is concerned that such consistencies may alter the original spirit of the licence. Proponent has proposed to delete all the parameters in the table including Lead (ug/L).<br><br>The proponent has further recommended change in units for 'Lead' from 1 ug/L to 0.1 mg/L in Part | AANDC request proponent to keep the original spirit of the licence items and correct the units and concentrations accordingly.<br>If proponent wants consistency regarding units then 1ug/L is equal to 0.001 mg/L for Lead. |

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| | | | F, Item 23.<br><br>AANDC has concerns as under,<br><br>1. 1ug/L is equal to 0.001 mg/L | |
| D.3 | Part H, Item 3 | The licence states that,<br><br>'The Licensee shall prevent any chemicals, petroleum products or unauthorized wastes associated with the project from entering water.'<br><br>The proponent has recommended a change in the licence as under,<br><br>'AEM proposes to remove this condition as it is stated in Part D, Item 29'. | AANDC is concerned about the deletion of this item since Part D of the licence is regarding 'conditions applying to new construction' and Part H is about 'conditions applying to Emergency response and contingency planning. | AANDC recommend not deleting the item. |
| D.4 | Schedule I - Conditions Applying to General and Aquatics Effects Monitoring<br><br>Table 1- Monitoring Group | The proponent states that<br><br>'AEM proposes a slightly revised Group 1 list parameters to provide clarity and less redundancy in sampling parameters groups. Group 1 will apply to all mines items related to monitoring and has relevant long term contaminants identified in the original license and those identified in SNC 2014.' | AANDC is concerned since the original grouping was developed by the proponent based on the technical requirements at different zones at mine site. Now proponent has recommended several changes in original grouping. It is not understood that how the grounds are now changed based on which the original grouping was developed. | AANDC request proponent to elucidate the rationale behind the proposed changes in contaminant groups. |

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| **E** | **Water Management Report and Plan** | | | |
| E.1 | 6. Rock Storage Seepage Water Manage-ment | The proponent states that 'AEM plans to develop a comprehensive plan to manage the seepage based on a combination of Golder's recommendations and AEM's internal Freshet Action Plan. Golder recommendations include:<br>1) AEM should continue to develop and maintain tailings beaches adjacent to RF1 and RF2 and to operate the Reclaim Pond towards the centre of the TSF. These are the key recommendations.<br><br>2) AEM should consider the installation of additional water management infrastructure which could take the form of a permanent collection and pumping system at the sampling station ST-16 current sump. Also, consideration should be given for contact water ditches and sumps in the surrounding areas of the RSF if additional seepages of contaminated water is observed in the future.<br><br>3) The seepage at station ST-16 should continue to be collected and redirected to the TSF and monitored (location, quantity, quality). Continued monitoring is strongly recommended during the winter for seepage water quantity monitoring and possible development of an ice plug in the RSF. The area at ST-16 should be kept clean of snow to allow visual observation and to ensure that water at ST-16 does not overflow | AANDC is concerned that the flow of tailings water through the RSF is complex to track without using an advanced technology. The recently-installed thermistors in the RSF will allow monitoring of the ground temperatures only.<br><br>Contaminant transport modeling can be conducted to determine the pathways of contaminants of concern (COC) or stressors of concern (SOC). | AANDC request proponent to develop an action plan to prevent possible water contamination as a result of thawing conditions. This will be in addition to temperature monitoring program. |

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| | | over the till plug into Lake NP-2.<br><br>4) Regular inspections all around the RSF should be performed, particularly during freshet, to ensure that runoff or any observed seepage is controlled and monitored prior to being released into the environment if the analyses results meet the requirement.<br><br>5) AEM should continue to monitor the tailings and waste rock freeze back following the Thermistor Monitoring Plan in accordance with Part 1, Item 11 of the Type-A water license.<br><br>6) AEM should provide the results of the 2014 monitoring to Golder for review and comment.' | | |
| **F** | **3.1.1 General Sampling and Analysis Program** | | | |
| F.1 | Table 3-1: Monitoring Program | The program prepared by the proponent indicates that the frequency water testing at ST-16 is 'monthly' during open water | In light of AANDC's inspector's report regarding ST-16, the frequency of testing is required to be increased. General monitoring program is no more valid for ST-16. | AANDC request proponent to revise their monitoring program for ST-16 in light of AANDC's Inspector's direction. |

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December 18, 2014
Project No.: 0131-087

David Abernethy,
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P.O. Box 2200
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Via email: david.abernethy@aandc-aadnc.gc.ca

Dear David,

**Re: Technical Review of Type 'A' Water Licence Renewal Application, Meadowbank Mine, NU**

## 1.0 INTRODUCTION

The Meadowbank Gold Mine is situated in Nunavut's Kivalliq Region. Agnico Eagle Mines Ltd. (AEM) is permitted to use water and deposit waste for mining, milling, domestic, and other associated activities under its Type 'A' Nunavut Water Board (NWB) Water Licence, # 2AM-MEA0815, that was issued on June 9, 2008 and will expire on May 31, 2015.

AEM is applying to renew its licence for ten years to take the mine through operations and into closure. Aboriginal Affairs and Northern Development Canada (AANDC) is an interested party in NWB's licencing process because of its mandated responsibilities under the *Nunavut Land Claims Agreement*, the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, and *Department of Indian Affairs and Northern Development Act*.

On November 24, 2014, the NWB submitted a Notice of Application for AEM's water licence renewal application.

BGC Engineering Inc. (BGC) was retained by AANDC to conduct a review of technical information contained in the renewal application submitted by the mine owner, AEM, and assess any high-level information requests required for the water licence process. The scope of the technical review included the following issues:

i. The impacts of re-flooding of the mine pits.

ii. Closure objectives for the tailings storage facility (TSF) and waste rock storage facilities (WRSF).

iii. Desktop analysis of AEM's updated reclamation cost estimate to determine whether it fully addresses the proposed closure plan, post-closure costs, as described in INAC's

2002 *Mine Site Reclamation Policy for Nunavut* and 2007 *Mine Site Reclamation Guidelines for the Northwest Territories*.

The focus of the review was on geotechnical and water management aspects specific to re-flooding of the mine pits and the closure objectives for the mine waste facilities. As such, not all documents in the water licence renewal application were reviewed by BGC.

This work was conducted under the terms of AANDC Standing Offer Agreement No. 01-11-6003/6 Call Up No. 7, dated October 21, 2014.

## 2.0 DOCUMENTS REVIEWED

The renewal application consisted of three main documents (BGC did not review all sections of these documents; only those sections highlighted in yellow below were reviewed by BGC):

1. Agnico Eagle Mines Ltd., 2014. Nunavut Water Board (NWB 2AM MEA0815) Type A Water Licence Renewal Application – Main Supporting Document, July 2014.
    a. Appendix A – List of Leases, Permits, and Authorizations
    b. Appendix B1 – Aquatic Effect Management Plan (AEMP), Version 2, December 2012
    c. Appendix B2 – Core Receiving Environment Monitoring Program (CREMP), Design Document, Version 1, December 2012.
    d. Appendix B3 – Water Quality Monitoring and Management Plan for Dike Construction and Dewatering, Version 4, April 2010.
    e. Appendix B4 – Groundwater Monitoring Plan, Version 4, January 2014.
    f. Appendix B5 – Quality Assurance/Quality Control (QA/QC) Plan, Version 2, July 2014.
    g. Appendix B6 – Water Quality and Flow Monitoring Plan, Version 3, July 2014.
    h. Appendix B7 – Emergency Response Plan, Version 6, August 2013.
    i. Appendix B8 – Hazardous Material Management Plan, Version 3, October 2013.
    j. Appendix B9 – Spill Contingency Plan, Version 4, November 2013.
    k. Appendix B10 – Operational ARD/ML Testing and Sampling Plan, Version 2, November 2013.
    l. Appendix B11 – Baker Lake Bulk Fuel Storage Facility Environmental Performance Monitoring Plan, Version 3, June 2014.
    m. Appendix B12 – Meadowbank Bulk Fuel Storage Facility: Environmental Performance Monitoring Plan, Version 2, June 2014.
    n. Appendix B13 – Incinerator Waste Management Plan, Version 5, July 2014.
    o. Appendix B14 – Interim Closure and Reclamation Plan, Version 2, January 2014.

p. Appendix B15 – Landfarm Design and Management Plan, Version 3, February 2013.
q. Appendix B16 – Landfill Design and Management Plan, Version 2, March 2013.
r. Appendix B17 – 2013 Water Management Report and Plan, Version 1, March 2014.
s. Appendix B18 – Ammonia Management Plan, Version 1, February 2013.
t. Appendix B19 – Dewatering Dike: Operation, Maintenance and Surveillance Manual, Version 3, September 2013.
u. Appendix B20 – Tailings Storage Facility: Operation, Maintenance and Surveillance Manual, Version 3, September 2013.
v. Appendix B21 – Mine Waste Rock and Tailings Management Plan, Version 1, March 2014.
w. Appendix B22 – Operation and Maintenance Manual: Sewage Treatment Plan, Version 4, April 2013.

2. Agnico Eagle Mines Ltd., 2014. NWB 2AM MEA0815: Response to NWB completeness reviews of the Type 'A' water licence renewal application. October 14, 2014.
   a. Appendix A – AEM Letter Proposed Water Level Trigger for Weekly Monitoring in TPL
   b. Appendix B – AEM Freshet Action Plan
   c. Appendix C -- Meadowbank Mine, Assay Road Seepage Phase 2: Environmental Site Assessment and Engineering QA/QC, Report by Tetra Tech EBA, August 2014.
   d. Appendix D -- November 28th, 2013, Meadowbank Annual report workshop minutes.
   e. Appendix E – Laboratory Detection Limit
3. Golder Associates, 2014. Meadowbank Gold Project – Update to 2014 Interim Closure and Reclamation Plan Cost Estimate Using Reclaim 7.0. Technical Memorandum submitted to AEM, December 2, 2014.

In addition, the following reports, available on the Nunavut Impact Review Board (NIRB) ftp site, were retrieved and reviewed:

I. Agnico Eagle Mines Ltd., 2013. Meadowbank Gold Project 2012 Annual Report.
II. Agnico Eagle Mines Ltd., 2014. Meadowbank Gold Project 2013 Annual Report.
III. Golder, 2013. Report on 2012 Annual Geotechnical Inspection, Meadowbank Gold Mine, Nunavut. January 15, 2013. (Appendix B of AEM Meadowbank Gold Project 2012 Annual Report).

IV. Golder, 2014. Report on 2013 Annual Geotechnical Inspection, Meadowbank Gold Mine, March 2014. (Appendix B1 of AEM Meadowbank Gold Project 2013 Annual Report).

## 3.0 MINE DEVELOPMENT AND CLOSURE PLAN SUMMARY (PARAPHRASED FROM AEM)

As described in AEM's renewal application, the Meadowbank Mine is located in an area of continuous permafrost and consists of several gold-bearing deposits that will be mined until 2017. Ore is currently mined in three open pits. Dewatering dikes were constructed to allow for mining of ore beneath shallow lakes. Additional dikes were then constructed to contain and manage tailings within the tailings storage facility (TSF), which includes an attenuation storage pond and a reclaim pond. Tailings are potentially acid-generating (PAG) and are placed sub-aerially as a slurry. Water from the pond is reclaimed during operation. Mining has generated non-potentially-acid-generating (NPAG) and PAG waste rock, which to date have been stored at the Portage Rock Storage Facility (PRSF) and the Vault Rock Storage Facility.

An interim closure and reclamation plan was prepared by Golder Associates in January 2014 (Appendix B14), which updated the original closure and reclamation plan that was prepared by AEM in 2008. The closure objective is guided by the intended end land use of the area, based on stakeholder and local community consultation to date, and consists of "*returning the project-affected areas to the 'natural' state"*. This includes re-contouring and re-grading the general mine area to promote proper drainage of surface runoff and to provide a ground profile consistent with the surroundings. The open pit areas will be flooded to recreate open water areas. Once the re-flooded pits are full and acceptable water quality has been demonstrated, several dikes will be breached. The plan is to cover the waste rock storage facilities (WRSF) with a layer of NPAG rock that is intended to ensure geochemical stability of the PAG materials by insulating them and keeping them frozen. Similarly, the planned tailings management approach for long-term stability and control of acid rock drainage (ARD) is to encapsulate the tailings in permafrost; a closure cover of NPAG is planned to insulate the frozen tailings and to protect against erosion. Temperature measurements from limited thermistor strings installed around the perimeter of the TSF and WRSF indicate that to date, portions of these facilities are frozen. However, because of the active depositional nature of both facilities, no further thermistor strings were installed to date to determine the extent and distribution of frozen mine wastes.

An adaptive management approach has been adopted for completing the detailed engineering designs for closure. Detailed designs for re-flooding of the mine pits and for cover design of the tailings and waste rock storage facilities are ongoing or are planned to be initiated in 2015. AEM has repeatedly stated in their Response to NWB completeness reviews that, "*...AEM will submit the final closure and reclamation plan at least twelve (12) months prior to the expected end of mining (targeted date of Q3 2016)*."

# 4.0 GEOENVIRONMENTAL INCIDENTS AT MEADOWBANK MINE

Since mining began, there have been two geoenvironmental incidents that resulted in uncontrolled discharge of seepage waters that did not meet water quality criteria:

a) Seepage from the TSF through the PRSF, ultimately winding up in Lake NP-2, and

b) A cyanide leak from the mine mill.

BGC is of the opinion that the short-term measures implemented by AEM to manage these issues (described in Appendix B17 of the renewal application and in Appendix C of the Response to NWB completeness review, respectively) are appropriate.

# 5.0 TECHNICAL REVIEW AND INFORMATION REQUESTS

There are currently some data gaps that should be addressed in the water licence renewal application process. As previously mentioned, detailed engineering design for re-flooding of the mine pits and cover designs for the TSF and WRSF have not yet been completed, and so BGC has not made specific comments relative to these designs. Furthermore, AEM has not submitted its final closure and reclamation plan (expected to be due Q3 2016). Given the lack of specific and detailed engineering at the current stage, it can be expected that a number of specific technical issues may be noted and questioned at later review stages relative to the permitting process for the mine.

The following presents BGC's initial concerns with the application and includes high-level recommendations and information requests directed to AEM on behalf of AANDC.

## 5.1. Climate

**Reference:** Annual Monitoring Report

**Observation:**

The climate for a given year is not presented within the annual monitoring reports.

**Comment:**

Climate data provide important input for interpreting site-specific geothermal aspects, such as the rate of mine waste freezeback and active layer thicknesses, for permafrost encapsulation of the mine wastes. In addition, the previous year's climate is useful for interpreting the hydrology and water balance for the site.

**Request/Recommendation:**

BGC recommends that the annual monitoring report summarize monthly climatic conditions at the Meadowbank site over a 12-month period. Data reported should include minimum/maximum air temperature, air thawing index, snowfall, and rainfall, including any intense, short-duration rainfall events. The monitoring report should discuss how the climate over the 12-month period compares to historical norms (e.g., relatively warm/average/cold or wet/dry). In the absence of long-term data at the mine site, comparisons can be inferred from

nearby meteorological stations with a longer-term record, such as Environment Canada's station at Baker Lake.

### 5.2. TSF and RSF Freezeback Monitoring

**Reference:** Annual Monitoring Reports; Mine Waste Rock and Tailings Management Plan

**Observation:**

AEM's annual monitoring reports describe tailings freezing and capping thickness to satisfy the following requirements:

- As required by NIRB Project Certificate No. 004, Condition 19… *Report to NIRB's Monitoring Officer for the annual reporting of freezeback effectiveness,* and
- As required by Water Licence 2AM-MEA0815 Schedule B, Item 17: *A summary of on-going field trials to determine effective capping thickness for the Tailings Storage Facility and Waste Rock Storage Facilities for the purpose of long-term environmental protection*.

In the 2012 and 2013 annual monitoring reports, AEM provided interpretations of ground temperature measurements on Saddle Dam 1 and Saddle Dam 2 (thermistors installed in 2009 and 2010, respectively). The tailings were reported to be frozen, and the foundation soils and rock beneath the rockfill dike reportedly remained in a frozen state. Other thermistors have been installed more recently (since 2011) through the waste rock and tailings. The thermistor measurements are described in qualitative, factual terms, e.g., they are frozen or unfrozen (with 0˚C as the marker for frozen/unfrozen).

**Comment:**

The concept of permafrost encapsulation of mine wastes (PAG waste rock and tailings), which is being proposed for the Meadowbank Project, is technically feasible as a mitigative measure for managing ARD/ML in arctic mines, as discussed in INAC's 2007 *Mine Site Reclamation Guidelines for the Northwest Territories*. Current site conditions (climate and permafrost temperatures) are favourable for permafrost to aggrade into, and persist within, the proposed mine waste deposits. Further monitoring and analyses will be required to relate aspects of acid generation (oxidation potential), evaluate the potential effects of taliks within and below mine waste deposits, and assess the potential for cryo-concentration of solutes in tailings, including the collection and possible treatment of such impacted waters.

Descriptions of the geothermal regime within the TSF and RSF in the annual monitoring reports and annual geotechnical inspections are merely factual, and are not described in the context of whether they met expected performance. BGC acknowledges that the water licence did not specify comparing measured versus predicted performance for the TSF or RSF. However, the Mine Waste Rock and Tailings Management Plan (specifically, Section 8: Thermal Monitoring Plan) describes that the thermal monitoring results in the TSF and RSF "*… are and will continue to be used to evaluate the predicted thermal response of the facilities with the actual*

*thermal response*". As AEM readies to prepare its final closure and reclamation plan, AEM must demonstrate that permafrost encapsulation of the mine wastes is technically feasible, including considerations of future impacts from climate change or from exothermic heat potentially released by oxidation. Closure costs will be significantly influenced by the thickness (quantity) of NPAG cover that will be placed over the tailings and PAG waste dump to promote permafrost encapsulation of these mine wastes. Closure costs will also be impacted by the collection and treatment of tailings pore waters, and related monitoring, that may be expelled during tailings freezeback.

AEM has collected and reported on over five years of temperature data that could be used to design the tailings and waste rock storage facilities, including cover thicknesses. Specific cover trials have yet to be initiated. To date, AEM has not assessed the available geothermal data, nor conducted geothermal analyses, to determine whether the measurements met expected performance or what the measurements tell us about the expected future permafrost conditions (i.e., distribution of permafrost temperatures, active layer thicknesses).

**Request/Recommendation:**

BGC recommends that the annual monitoring reports include the following:

1. A map showing the mean bathymetry of the reclaim pond over the monitoring year and the area(s) of the TSF and RSF in which complete freezeback has been confirmed by thermistor measurements,
2. Assessment of potential taliks under current water covers in tailings or thawed areas in waste rock relative to freezeback and cryo-concentration impacts,
3. Discussion of measured versus expected thermal performance and active layer thicknesses (related to seasonal ambient air temperatures), and
4. Interpretation of permafrost aggradation for all monitored instruments in the TSF and RSF (related to seasonal ambient air temperatures), including pore water pressure measurements within the TSF and RSF.

### 5.3. Permafrost Encapsulation of TSF and RSF

**Reference:** Mine Waste Rock and Tailings Management Plan (Section 7.3.2, p. 48)

**Observation:**

The management plan states that, "*If, during monitoring, it is found that the freezeback of the dike and tailings deposit are occurring at a rate less than predicted, then enhancement by artificial freezing methods may be considered*."

**Comment:**

Neither the rate or extent of permafrost aggradation into the tailings or waste rock storage facilities that is required, or even expected, for design, are explicitly described in the renewal application. Artificial freezing of mine wastes may be a very expensive, and even impractical,

undertaking, particularly during closure. Such contingency costs were not explicitly included in the 2014 closure and reclamation cost estimate.

**Request/Recommendation:**

BGC recommends that AEM clarify the design intent of permafrost encapsulation as a mine waste management strategy for the TSF and RSF. AEM must also clearly describe the benchmarks (e.g., rate and extent of freezeback, temperature of mine waste) that would trigger AEM to implement artificial freezing methods.

### 5.4. RSF Seepage

**Reference:** 2013 Water Management Report and Plan (Appendix C: Rock Storage Facility Seepage)

**Observation:**

The Summer 2013 RSF seepage incident indicated that water from the TSF flowed through the RSF and ultimately, into Lake NP-2.

**Comment:**

BGC is of the opinion that the measures implemented by AEM in response to this event were appropriate for the short term. However, the incident showed that there were zones within the RSF that were either unfrozen, or if they were frozen, they were initially porous, with many air-filled voids that did not prevent the flow of tailings seepage waters through the rockfill mass. Thus, it is possible that precipitation waters infiltrating the PAG stockpile may ultimately become released to the environment because the pore spaces are unfrozen and/or not ice-filled.

**Request/Recommendation:**

BGC recommends that AEM carry out the following:

1. Install piezometers within the RSF, including for cover trials, to show the possible presence or levels of liquid water within the RSF. The measurements should be described and assessed in the annual monitoring reports as part of discussions on freezeback effectiveness, and
2. For the final closure and reclamation plan, conduct a water balance of the RSF, in terms of closure quantity and water quality, to determine closure water collection and treatment requirements. These items should be accounted for within the water balance and water treatment costs during closure.

### 5.5. Geochemistry/Oxidation

**Reference:** Interim Closure and Reclamation Plan, Section 2.3.4.5, p. 24.

**Observation:**

Mine tailings have both high potential for ARD and metals leaching (ML). Some of the pit rock have high potential for ARD, ML, or both.

**Comment:**

Oxidation of mine wastes may cause exothermic reactions that could impact the rate of freezeback of the tailings and PAG waste rock or prevent full encapsulation of PAG materials in permafrost.

**Request/Recommendation:**

BGC recommends that studies be conducted, and/or thermistors be installed, in the TSF or PAG areas of the RSF to assess if oxidation reactions of PAG waste rock or tailings are impacting the rate of freezeback. Such studies should form part of the cover trials that are being planned.

### 5.6. TSF and RSF Diversion Ditches at Closure

**Reference:** Freshet Action Plan, Section 2.2.1: North Cell Tailings Storage Facility, pp. 11-19.

**Observation:**

A number of diversion ditches have been constructed around the TSF and RSF to "*maintain their integrity and prevent any adverse environmental impacts*".

**Comment:**

Currently, portions of the diversion ditches are susceptible to ponding or erosion due to blockages from snow or ice, and require manual removal of the snow or ice with an excavator. It is unclear how the diversion ditches were sized and whether they are required during closure.

**Request/Recommendation:**

BGC requests clarification from AEM with respect to the requirement of water management structures around the TSF and RSF for closure. Design details, including hydrologic events for sizing of the channel and erosion protection requirements, should be included in the final closure and reclamation plan. Should snow and ice blockages need to be actively managed during closure, then those costs need to be specifically reflected in the closure cost estimate.

### 5.7. ST-16 RSF Seepage Management at Closure

**Reference:** Freshet Action Plan, Section 2.4 RSF Seepage, pp. 20-21.

**Observation:**

It is understood that a permanent pumping system was installed at sampling location ST-16 to minimize migration of RSF seepage across this area and into Lake NP-2. The till plug, installed

against the rockfill road, was only designed and constructed as an interim measure to minimize RSF seepage through the rockfill road.

**Comment:**

RSF seepage management measures for this area at closure are unclear.

**Request/Recommendation:**

As part of the final closure and reclamation plan, water management plans for this area should be clarified. If specific measures or monitoring are to be included, then they should be explicitly stated in the closure cost estimate.

### 5.8. Closure Contingencies

**Reference:** Interim Closure and Reclamation Plan, Section 3.5 Closure Contingency Activities, pp. 80-81; Meadowbank Gold Project – Update to 2014 Interim Closure and Reclamation Plan Cost Estimate Using Reclaim 7.0.

**Observation:**

The Type-A Water Licence 2AM-MEA0815, Part J – Conditions Applying to Abandonment, Reclamation, and Closure, Item 1, requires that the interim closure and reclamation plan include contingency measures for all reclamation components, including action thresholds that are linked to the monitoring programs.

**Comment:**

The contingency measures described in the interim closure and reclamation plan are general and not detailed, particularly with respect to action thresholds linked to the monitoring programs. Therefore, it is difficult to assess whether the possible contingency measures have been adequately costed or validated against the 15% contingency allowance provided in the reclamation plan cost estimate.

**Request/Recommendation:**

As part of the final closure and reclamation plan, action thresholds and performance measures should be clarified. Scoping-level costs associated with implementing these contingency measures should be worked out to validate that the contingency costs are adequately covered in the reclamation plan cost estimate.

### 5.9. Site Specific Closure Criteria

**Reference:** Interim Closure and Reclamation Plan

**Observation:**

INAC's 2007 *Mine Site Reclamation Guidelines for the Northwest Territories* recommends that the Interim Closure and Reclamation Plan include specific closure criteria regarding reclamation components.

**Comment:**

Many aspects of site-specific closure criteria have not been discussed in detail, such as: design hydrologic events for the design of water management structures; how climate change will be incorporated in the closure plan; design maximum credible earthquake for assessing structure stability; etc. Site-specific closure criteria will have a significant impact on engineered structures regarding both construction quantities and related costs. Following from this, it is likely that the costs developed for the final closure and reclamation plan will increase.

**Request/Recommendation:**

BGC recommends that the final closure and reclamation plan explicitly describe the design criteria for which structures are being designed for closure and reclamation.

### 5.10. Interim Closure and Reclamation Plan, Other Deficiencies

**Reference:** Interim Closure and Reclamation Plan

**Observation:**

The 2014 Interim Closure and Reclamation Plan was reviewed relative to the content guidelines presented in INAC's 2007 *Mine Site Reclamation Guidelines for the Northwest Territories*.

**Comment:**

The 2007 *Mine Site Reclamation Guidelines for the Northwest Territories* suggested that the following elements be included in the Interim Closure and Reclamation Plan:

- Updated reclamation research plan, and
- Renewed or updated descriptions of the likely post-reclamation risks to human and wildlife health and the environment relevant to the information available (Risk Assessments).

These two elements were not presented in detail in the interim closure and reclamation plan.

**Request/Recommendation:**

BGC recommends that these elements be included in the final closure and reclamation plan.

### 5.11. Reclamation Plan Cost Estimate

**Reference:** 2014 Updated Reclamation Plan Cost Estimate

**Observation:**

Indirect costs for engineering and project management were each assumed to be 5% of direct costs. Indirect costs for contingency were assumed to be 15% of direct costs. The mobilization/demobilization (mob/demob) cost line item was estimated to be $4.8M, based on some barge access and camp accommodation costs only.

**Comment:**

The basis for developing the indirect costs was not explicitly described and so cannot be audited. As mentioned in Section 5.8, contingency measures were not described in detail in the interim closure and reclamation plan. Mob/demob cost line items typically include many more aspects, such as equipment, staff and materials transport, and these costs can be significant for a remote northern mine site. Based on preliminary review, these costs appear low for a remote site such as the Meadowbank Project, where goods, equipment, and labour will likely need to be brought in from distant sources.

**Request/Recommendation:**

For the final closure and reclamation plan, all indirect costs need to be detailed relative to a formal construction plan and rational construction schedule. Based on development of this plan and schedule, all indirect costs, including mob/demob, project management, engineering (including construction monitoring and field engineering), and contingency costs should be developed from actual requirements rather than by applying assumed percentages.

## 6.0 LIMITATIONS AND CLOSURE

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We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

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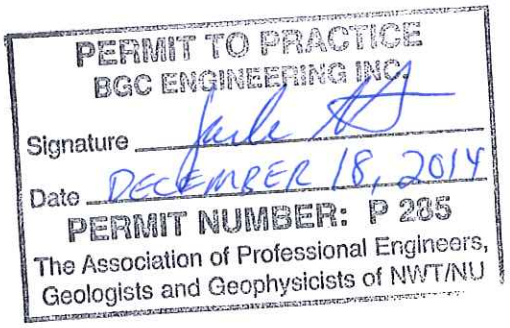


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