Agnico Eagle Mines Limited – Meadowbank Division

2AM-MEA1526 Notice of Application & Commencement of Technical Review

Responses to Natural Resources Canada Technical Review Comments

January 23 2019

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NATURAL RESOURCES CANADA (NRCan)

Natural Resources Canada (NRCan) received a technical memorandum from Agnico Eagle Mines (AEM) on December 14, 2018. That memorandum's stated purpose was to address NRCan's comments on the third version of the thermal and hydrogeological modelling for AEM's proposed In-Pit Tailings Disposal Modification for the Meadowbank Gold Mine. NRCan's comments were provided during the Nunavut Impact Review Board's (NIRB) modification screening process, and culminated in a meeting with AEM and their consultants at the offices of the Geological Survey of Canada (GSC) on September 25, 2018. A summary of this meeting was submitted to the Nunavut Water Board (NWB) on November 21, 2018.

Agnico Eagle's responses to NRCan's comments to the aforementioned technical memorandum are as follows:

Interested Party:	**Natural Resource Canada (NRCan)**	**Rec No.:**	**NRCan#1**
Re:	**State expectations, goals and duration of monitoring.**		

NRCan Recommendation

The proponent, in consultation with appropriate regulators (e.g., Nunavut Water Board (NWB), Department of Fisheries and Oceans (DFO)), should clearly state the explicit goals of the groundwater monitoring program within the context of the overall monitoring expectations of the regulators. For example, NRCan expects that the discharge of tailings pore water from Pit A may result in groundwater discharge concentrations that exceed water quality guidelines (i.e. in the benthic zone where Pit A tailings are in contact with Third Portage Lake). If this is a concern to regulators from a fishery habitat point of view, then groundwater monitoring goals and methods should address this issue. If not, NRCan is satisfied with the proponent's approach to quantifying groundwater mass fluxes for use in their water balance model.

It would be helpful if the groundwater monitoring program could specifically indicate what parameters or variables are to be measured or validated (e.g., contaminant fluxes to lakes, contaminant concentrations in lakes or contaminant concentrations in groundwater discharge). For instance, validating groundwater mass flux is more useful for use in the proponent's surface water quality modelling whereas measuring groundwater concentrations might be required to meet specified groundwater quality criteria. The selected variables will have a significant influence on the effort required.

The proponent, in consultation with appropriate regulators, should also indicate the anticipated duration of the monitoring. Any potential impacts due to groundwater contaminant migration at this site are predicted to occur after several centuries rather than within years or decades. Consequently, the goals, instrumentation and locations of groundwater monitoring should be consistent with the expected duration of sampling (and vice versa).

Agnico Eagle's Response:

The current groundwater monitoring wells network has been used to get additional background chemical conditions in the vicinity of the pits in the modeled groundwater flow paths. The current groundwater monitoring wells have been installed in the most potential groundwater flow paths identified during the mining of the Portage and Goose Pits. These flow paths were identified based on observation of seepage within the pits during the mining of the pits. Prior to the installation of the groundwater wells, thermistor and piezometers were installed to target the ideal elevation of the sampling port. Agnico Eagle believes that the groundwater monitoring wells developed prior to the commencement of in-pit deposition meet the objectives of groundwater monitoring during the operation phase and will help to calibrate the hydrogeological model and review the closure groundwater well network prior to closure. Agnico Eagle would like to clarify that each of these groundwater monitoring locations are composed of a groundwater well, five piezometers and one thermistor. The information collected from these groundwater monitoring locations will help to update and calibrate the hydrogeological model and to perform additional transport simulations prior to the closure phase. Specifically, key objectives are to:

- To validate tailings pore water concentrations and evolution with time, along with hydraulic and thermal properties;
- To determine general background concentrations in the bedrock;
- To update the model and calibrate with thermal, hydraulic and chemical observations in the vicinity of the pits.

Agnico Eagle will continue to comply with the Meadowbank groundwater monitoring plan during the in-pit deposition operation phase. The groundwater monitoring includes a full scan of relevant chemical parameters such as total and dissolved metals, nutrients, cyanide components, conventional parameters and other additional analysis to calculate mass balance reliability check on each analysis. Such a complete scan helps characterize groundwater signature and track any chemical changes.

Agnico Eagle agrees with NRCan to review, optimize and adapt the location of the monitoring wells as part of the final closure plan in collaboration with the regulators. In addition, available thermistors and piezometer across the site will continue to be monitored and used to update the hydrogeological model and update the groundwater monitoring plan. Agnico Eagle is looking forward to continue working with the regulators to achieve the mentioned objectives.

Interested Party:	Natural Resource Canada (NRCan)	Rec No.:	NRCan#2
Re:	Assess the current groundwater monitoring network		

NRCan Comment:

NRCan disagrees with SNC-Lavalin's assessment of the adequacy of the current groundwater monitoring well locations. It appears to NRCan that several monitoring wells are not located directly downflow of the tailings and therefore are poor sentinels of contamination migration. NRCan recommends that the proponent assess the 3-D groundwater flowpaths and travel times to each monitoring well screen. This can be easily accomplished in FEFLOW using backwards pathlines (i.e. reverse particle tracking, with the option of random-walk to include the effects of dispersion). Wells with backwards particle tracks that do not cross the tailings or originate near the edge of the tailings are likely of limited value to the monitoring network.

Agnico Eagle's Response:

Agnico Eagle does not agree with NRCan comments. The methodology used to locate the current groundwater monitoring well screen was based on borehole logging, parker testing and thermal profiling completed in a first borehole drilled one year prior to the installation of the well at the same location. This methodology helps to identify the most probable fracture zone and adapt the monitoring screen depth interval. Then, monitoring wells are not only based on the simulated contaminant plume, but also with in-situ bedrock conditions and field observation. Existing well location have been selected according to current thermal conditions and also based on fractures observation within the pit during the mining phase.

Agnico Eagle agrees with NRCan that new monitoring wells might be needed closer to the pit rims and be used as sentinel at closure. However, Agnico Eagle would like to clarify that the thermal condition at the proximity of the pit wall is not favorable during operation for the installation of such groundwater well. During the mining of the pits, the temperature of the wall drops rapidly below zero as the pit wall is exposed to cold temperature and permafrost. The installation of such sentinel well will need to be evaluated as part of the final closure plan with the additional information provided from the current monitoring station.

Agnico Eagle believes that the existing selected approach of using breakthrough curve is the best way to select the monitoring well location in the plume flow path. In comparison to backward particle tracking, breakthrough curves consider all contaminant migration processes (advection, dispersion, diffusion) and expected concentrations are available.

Groundwater monitoring will be reviewed and will be addressed as part of the final closure plan. The hydrogeological model will be updated with updated thermal and hydraulic conditions at closure and the groundwater monitoring well locations will be reassessing and new well might be installed according to the modeling results.

Interested Party:	**Natural Resource Canada (NRCan)**	**Rec No.:**	**NRCan#3**
Re:	**Strategically locate new monitoring wells**		

NRCan Recommendation

It is not possible to monitor the groundwater plumes from three pits with such a small number of wells. The data from existing wells will do little to improve the contaminant transport modelling. With such a sparse network, the most useful wells will be those that indicate the first arrivals of groundwater contaminants and help define the maximum groundwater and contaminant velocities along the main axis of the groundwater plume. NRCan suggests that the proponent install monitoring wells that will intercept the main axis(es) of each groundwater plume during the monitoring period. The purpose, location and screen interval of each new monitoring well should be justified and initially guided by modelling results (including pathlines as in recommendation 2). NRCan is not convinced of the effectiveness of the proposed new wells and recommends that the current model be used to assess pathlines, travel times and breakthrough curves for these wells. The proposed use of long well screens should be justified.

Agnico Eagle's Response:

Agnico Eagle appreciates the recommendation of NRCan and will consider this approach in the selection of the future groundwater monitoring. As previously mentioned in the response to NRCan #1 and #2 comments, Agnico Eagle will consider the installation of new groundwater monitoring well as part of the final closure plan based on the results from the updated contaminant groundwater modelling. Agnico Eagle would like to clarify that each of these groundwater monitoring stations are composed of a groundwater well, five piezometers and one thermistor. The information collected from these stations will help to update and calibrate the hydrogeological model and to perform additional transport simulations prior to the closure phase.

Thermal and hydraulic regime will change over time as the pit will be filled with tailings and monitoring well network will be adapted at closure based on the monitoring results and model updates. Monitoring well characteristics (location, depth, screen length, etc.) will be adapted at closure to make sure to intercept the plume, in agreement with monitoring period defined with the regulators as part of the final closure plan.

Interested Party:	Natural Resource Canada (NRCan)	Rec No.:	NRCan#4
Re:	Assess the potential impact of sub-permafrost groundwater discharge to Third Portage Lake		

NRCan Recommendation

The thawing of permafrost below Pit A will not only allow tailings pore water to discharge to Third Portage Lake but will also allow sub-permafrost groundwater to discharge. The potential effects of sub-permafrost groundwater discharge to Third Portage Lake have not been considered or discussed to date. NRCan is not aware whether sub-permafrost groundwater chemistry has been measured at Meadowbank. If so, these values should be used to assess whether there is the potential for impacts to receptors in Third Portage Lake. If not, conservative estimates of sub-permafrost groundwater chemistry could be used to assess the potential for impacts.

Agnico Eagle's Response:

Agnico Eagle would like to clarify that during post closure, small hydraulic head gradients will be observed and saline sub-permafrost groundwater tend to sink rather than rise due to higher density in these conditions. Agnico Eagle consider that background groundwater quality will be similar to the background chemical results at Meadowbank which indicate very low chloride concentrations in natural groundwater seepage areas such as in BH10-1, sampled in the former Second Portage Lake arm before the construction of the South Cell TSF, which was the discharge area of the regional groundwater system. It that case, chloride concentration was below 20 mg/L, while arsenic concentration was 0.002 mg/L. Additional samplings points such as seepage zones within the pits validate these low concentrations. In the case of Goose Pit wall seepages zone, chloride concentration was below 35 mg/L at the deepest seepage point (80 m below the pit surface).

Moreover, the hydrogeological model suggests that upward flow will be limited to the northern portion of Pit A, once the open talik is developed. Groundwater hydraulics gradients from Goose Pit and Pit E will be oriented downward, thus eliminating the possibility of saline groundwater seepages in Third Portage Lake. Agnico Eagle believes that the existing hydrogeological model is representing a conservative prediction of the water quality in the receivers and could be used to assess potential impacts.

Interested Party:	**Natural Resource Canada (NRCan)**	**Rec No.:**	**NRCan#5**
Re:	**Suggestion for sub-permafrost groundwater**		

NRCan Recommendation

A slight increase in the modelled sub-permafrost groundwater heads appears to have greatly reduced the predicted time for contaminant first arrivals in Second Portage Lake. This suggests that groundwater transport may be sensitive to sub-permafrost heads. One measurement that has the greatest potential to reduce the uncertainty in the groundwater modelling and improve transport prediction is the sub-permafrost hydraulic head at the north end of Pit A. This value is currently estimated using groundwater modelling based on the water levels of lakes assumed to have open taliks. Installing a monitoring well beneath the permafrost at the north end of Pit A would define the vertical hydraulic gradient (for upward flow into Third Portage Lake) and would effectively constrain the horizontal hydraulic gradient in sub-permafrost groundwater. This data may prove to be more useful for improving the groundwater modelling than the data obtained from most of the existing monitoring wells. Such a well could also be sampled to define sub-permafrost water chemistry. As useful as such data would be, NRCan also realizes the expense and difficulty of installing such a well and therefore only mentions it as a suggestion rather than as a recommendation.

Agnico Eagle's Response:

As agreed with NRCan, the northern boundary elevations selected for the version 4 of the hydrogeological model were conservative as they are higher than the surveyed elevation in the lake surrounding the location of the northern boundaries. Agnico Eagle considers that the version 4 of the hydrogeological model represents a conservative prediction of the potential upward groundwater flow in the north end of Pit A and addresses the uncertainty related to the groundwater modelling. Agnico Eagle would like to clarify that each groundwater monitoring stations are composed of a groundwater well, five piezometers and one thermistor and Agnico will explore the potential of installing a groundwater monitoring station in the vicinity of pit A as part of the final closure plan. As the Portage Pit A is currently located in permafrost the installation of a deep groundwater well or a deep vibrating wire piezometers will be ineffective.