Environmental Protection Operations Directorate
Prairie & Northern Region
5019 52nd Street, 4th Floor
P.O. Box 2310
Yellowknife, NT X1A 2P7

ECCC File: 6100 000 0010/043
NWB File: 2AM-DOH1335

September 27, 2019

via email at: licensing@nwb-oen.ca

Richard Dwyer
Manager of Licencing
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0

Dear Richard Dwyer:

RE: 2AM-DOH1335 – TMAC Resources – Hope Bay Project – 2018 Annual Water Licence Report – ECCC Response to Proponent responses

Environment and Climate Change Canada (ECCC) has reviewed TMAC's (the Proponent) responses submitted to the Nunavut Water Board (NWB) regarding the above-mentioned annual report and is submitting responses to the proponent's responses via email. ECCC's specialist advice is provided based on our mandate, in the context of the *Canadian Environmental Protection Act*, and the pollution prevention provisions of the *Fisheries Act.*

The following responses to the Proponent's comments are provided:

1. ECCC 6 - Seepage Monitoring

ECCC Original Recommendations

ECCC recommends that the Proponent clarify the apparent contradicting statements about the water quality and contaminants of concern.

ECCC recommends that the proponent provide an explanation of why the tundra is being used or relied on to attenuate contaminants of concern rather than using an actual treatment option.

Proponent Response

TMAC notes that the IR is in reference to Appendix G - 2018 Waste Rock and Ore Monitoring Report, Boston Camp, Hope Bay Project, Section 6 (Conclusions).

The majority of the seepage and runoff from the camp pad flows along poorly defined ephemeral drainages. As part of the annual geochemical monitoring program, seepage samples are collected at the toe of the camp pad with the objective of monitoring the near source “contact water” or flushing of oxidation products from ore and waste rock whereas the objective of the ephemeral sampling program is to monitor the seepage that are upstream of the receiving environment. Sections 4 and 5 of Appendix G present the results of the seepage and ephemeral monitoring programs, respectively.

The seepage and ephemeral monitoring programs were designed in the context of validating a water and load balance (WLB) model for the Boston camp pad (SRK 2009). The objective of the WLB was to evaluate potential impacts of seepage from the ore and waste rock at key locations downstream of the Boston camp pad. The geochemical inputs to the WLB were seepage samples collected in 2009, with contaminants of concern (e.g. modelled parameters) identified based on review of the seepage data.

In support of the WLB, an aquatic specialist from Rescan (now ERM) assessed the downstream environment of the Boston Camp to define environmental receptors and where water quality guidelines should be applied. The ephemeral drainage locations were concluded not to be fish habitat and Aimaokatalok Lake was defined as the receiving environment. The WLB indicated that modelled concentrations for contaminants of concern in the receiving environment were below CCME water quality guidelines for the protection of aquatic life. Accordingly, the trend analysis of contaminants of concern and comparisons to the WLB in Appendix G is a method of assessing potential impacts to the downstream environment.

Attenuation of the parameters in the tundra is not presented as a treatment option but as a geochemical mechanism that explains the decrease in concentrations of arsenic and other contaminants of concern in the ephemeral drainage compared to seepage at the toe of the camp pad.

<u>ECCC Response</u>

The use of the tundra to attenuate contaminants of concern may not have been specifically presented as a treatment option; however, that is what it appears to serve as given the following two statements by the proponent:

a) “some contaminants of concern are not attenuated by the tundra as predicted”

b) “the concentrations observed in the ephemeral streams indicate that the tundra continues to effectively attenuate contaminants of concern and the breakthrough of the effectiveness of the attenuation process has not occurred.”

Additionally, in the response to ECCC’s recommendations, the proponent stated “the majority of the seepage and runoff from the camp pad flows along poorly defined ephemeral drainages. As part of the annual geochemical monitoring program, seepage samples are collected at the toe of the camp pad with the objective of monitoring the near source “contact water” or flushing of oxidation products from ore and waste rock”. It should be noted, that seepage (contact water) out of the camp pad, and or the ore stockpiles is defined as effluent in the MDMER that should be collected, treated if necessary and discharged through a final discharge point (FDP).

Furthermore, the response provided by the proponent raises other questions:

I. Whether attenuation ability or characteristic of the tundra was accounted for in the model?

II. What is the estimated time of breakthrough given that the proponent stated that “the breakthrough of the effectiveness of the attenuation process has not occurred”?
III. If the breakthrough occurs, what would be the impact of that breakthrough on the model?
IV. Was the breakthrough loading included in the model?
V. If the breakthrough is included in the model, then what is the loading from the tundra?

The responses to these questions are necessary because the tundra may then become a secondary point source of contaminants, which may reach Aimaokatalok Lake or any other water body, which is frequented by fish.

ECCC Recommendations

ECCC recommends that the Proponent provide the study that concluded that the ephemeral drainage locations are not waters that support to contributing to waters that are fish habitat to ECCC.

ECCC recommends that the Proponent provide responses to the following questions:

I. Was the attenuation ability or characteristic of the tundra was accounted for in the water and load balance model?
II. What is the estimated time of breakthrough given that the proponent stated that “the breakthrough of the effectiveness of the attenuation process has not occurred”?
III. If the breakthrough occurs, what would be the impact of that breakthrough on the water and load balance model?
IV. Was the breakthrough loading included in the water and load balance model?
V. If the breakthrough is included in the model, then what is the loading from the tundra?

2. ECCC 7 – Sample Testing Program

ECCC Original Recommendations

ECCC recommends that the Proponent explain why the higher concentration of arsenic and iron in the waste rock has been attributed to colloids and provide rational for this conclusion including how these high concentrations occur.

ECCC recommends that the Proponent provide the source of the colloids present in the seepage.

ECCC recommends that the proponent clarify what is meant by “when the sample set was screened for samples suspected of containing colloids, the overall arsenic and iron concentrations since 2012 were stable”.

Proponent Response

Dissolved metals is an operational definition, whereby a water sample is passed through a 0.45 micron filter prior to trace element analysis. A colloid in the context of operationally defined dissolved metals is a suspended particle that can pass through a 0.45 micron filter. Sampling turbid waters can result in elevated concentrations of operationally defined dissolved metals due to the presence of colloids.

Seepage samples concluded to contain colloids had the following characteristics: i) high TSS concentrations indicating that seepage samples contained sediment prior to filtration through the 0.45 micron filter. This was further supported by visual observations of turbid seepage; ii) dissolved iron and aluminum concentrations above mineral solubility limits for pH neutral and oxygenated samples, and iii) high arsenic and iron concentrations. Arsenic concentrations are controlled by adsorption to ferric iron hydroxide therefore elevated concentrations of both iron and arsenic suggest colloids. On this basis, selected samples were interpreted to contain colloidal materials (i.e. dirt).

The objective of seepage monitoring is to assess potential metal leaching due to sulphide oxidation. Accordingly, each sample was assessed or “screened” for the presence of colloids, as defined above, as colloids in the seepage samples are not indicative of sulphide oxidation and metal leaching processes. The screened samples had concentrations that are consistent with historically measured concentrations of iron and arsenic.

ECCC Response

ECCC understands the operational definition of colloids provided, however, the visual turbidity and total suspended solids (TSS) are not indicators of colloidal concentrations in the water as TSS is indicative of solids in water that can be trapped by a filter. In addition, colloidal concentrations can be high in waters with low apparent TSS concentrations, as they are soluble. However, the proponent stated that dissolved iron and aluminum concentrations are above mineral solubility limits for pH neutral and oxygenated samples. Which implies that total dissolved solids (TDS) concentration in exceedance of mineral solubility limits is a better indication of colloids in the system. Furthermore, the proponent states “The objective of seepage monitoring is to assess potential metal leaching due to sulphide oxidation”. Accordingly, each sample was assessed or “screened” for the presence of colloids, as defined above, as colloids in the seepage samples are not indicative of sulphide oxidation and metal leaching processes.

ECCC notes that colloids, in particular those comprised of Fe-oxy-hydroxides, can be indicative of sulphide oxidation in a circum-neutral, oxidizing environment. In the oxidation process of iron sulphides, Fe(II) is formed and readily oxidized to Fe(III). As the Fe(III) complexes and oxidizes other nearby metals can form complex Fe minerals and further Fe(II). As this is an acid generating process, in a neutral oxidizing system with buffering capacity, localized enhancement of mineral dissolution is possible. Therefore, iron-oxy-hydroxide colloids may be formed by sulphide oxidation and readily adsorb contaminants of concern such as arsenic within the system, and sulphide oxidation in the system can not be ruled out due to the presence of iron-oxy-hydroxide colloids.

ECCC Recommendations

ECCC recommends that:

a) The Proponent determine the source of colloids present in the seepage.
b) The Proponent determine an alternate method for identifying whether sulphide oxidation is occurring within the waste rock pile than the presence or absence of colloids.

c) The Proponent consider the distances at which colloids, in particular those comprised of iron-oxy-hydroxides can travel in the system and the potential for these iron-oxy-hydroxides colloids to transport contaminants of concern (not just those in excess of solubility limits) downstream and have potential environmental effects.

d) The Proponent consider that once colloids flocculate downstream of the seepage source and precipitate as sediments or move into the dissolved phase, how concentrated metals from adsorption may be eventually released downstream in the dissolved phase due to changes in water chemistry.

3. ECCC 8 – Rock Sampling Depths

ECCC Original Recommendation

ECCC recommends that the Proponent provide clarification on the rationale that led to not selecting samples from a depth deeper than 25 cm and why these samples are considered representative.

Proponent Response

Sulphide oxidation is due to the reaction of sulphide minerals with air (oxygen). Samples collected are considered representative of sulphide weathering based on the following:

- Visual observations of secondary minerals on the surface of the selected stockpiles indicates that weathering products are present (not flushed from the stockpile).
- The ore stockpiles contain fine material that physically limits oxygen ingress into the deeper stockpile materials. Samples and sulphides located near the surface of the stockpile are exposed to the highest concentrations of oxygen and therefore are the most weathered.
- Values of rinse conductivity for the sample set ranged from 99 to 4,100 µS/cm in the 2018 survey. Rinse conductivity in this case indicates the presence of soluble oxidation products in the samples collected. Lower values of rinse conductivity do not necessarily indicate that flushing of oxidation products, but rather, low sulphide content within the sample.

ECCC Response

ECCC agrees that Samples and sulphides located near the surface of the stockpile are exposed to the highest concentrations of oxygen and therefore are the most weathered". However, it is important to note that oxidation does not stop at the surface, it goes deeper. ECCC also agrees that the lower values of rinse conductivity on the surface sample indicates that there is lower sulphide content at this depth. This is because some or most of the sulphides have oxidized and/or depleted at the surface, and some oxidation products are removed by seepage or carried away with any drainage out of that depth, leaving behind evidence of oxidation products that are observed visually. An accurate state of oxidation of the pile may be best determined by sampling at different depths (depth profile) that will reflect how deep the oxidation is and how deep oxygen and water has migrated (penetrated) into the pile. ECCC also agreed that fine materials might limit the oxygen and water ingress into the deeper stockpile. However, unless the fine materials are made of non-permeable material, it does not completely prevent ingress of oxygen and water, which will cause oxidation below 25cm depth to continue.

Therefore, a rinse result of the surface materials does not provide an accurate oxidation profile or potential ARD/ML of the pile.

ECCC Recommendation

ECCC continues to recommends that the Proponent provide clarification on the rationale that led to not selecting samples from a depth deeper than 25 cm and why these samples are considered representative.

4. ECCC 9 – Waste Rock and Ore Monitoring Report, Boston Camp, Hope Bay Project

ECCC Original Recommendations

ECCC recommends that the Proponent analyse the monitoring results of the years in between 2008 and 2018 in order to check for evidence of ARD/ML or verify trends, if any.

ECCC also recommends that the Proponent provide an explanation as to why the only the 2018 monitoring results are being compared to that of 2008 and not the years in between.

Proponent Response

TMAC notes that the IR is in reference to Appendix G - 2018 Waste Rock and Ore Monitoring Report, Boston Camp, Hope Bay Project, Section 3.2 (Ore Stockpile Rinse Survey – Results).

The rinse test survey of the waste rock pad and ore stockpiles is conducted every ten years, i.e. 2008 and 2018. Geochemical characterization of the waste rock and ore indicates that all waste rock and the majority of the ore is non-PAG with a small proportion of ore having an uncertain potential for ARD. However, there is a low risk of acidic seepage developing due to the high carbonate content in the underlying pad.

The objective of the rinse test survey is to assess if locally acidic conditions are developing in the ore stockpiles. The 2018 rinse test survey confirmed that all stockpiles are pH neutral and consistent with the initial survey conducted in 2008.

TMAC would like to clarify that seepage monitoring is conducted and results reviewed annually, e.g. Appendix G - 2018 Waste Rock and Ore Monitoring Report, Boston Camp, Hope Bay Project, Section 4.2 (Monitoring of Boston Seepage – Results). Annual seepage monitoring has consistently indicated pH neutral drainage from the ore stockpiles and waste rock.

ECCC Response

ECCC notes that annual seepage monitoring data has consistently shown neutral pH drainage, and that the objective of the rinse test survey is to assess if locally acidic conditions are developing in the ore stockpiles. However, The Proponent did not provide rationale to support why the rinse test is conducted every 10 years and not at shorter intervals. In order to be able to detect any locally developing acid rock drainage (ARD) conditions (hot spots), a shorter time interval between sampling and sampling over a breadth of temperature and seasonal conditions should be considered. In addition, it is not clear to ECCC how the rinse results compare to the annual seepage survey.

ECCC Recommendations

ECCC recommends that the Proponent clarify how the rinse results compare to the annual seepage survey.

Please contact Eva Walker at (867) 669-4744 or Eva.Walker@Canada.ca should you require more information.

Sincerely,

[original signed by]

Eva Walker
Environmental Assessment Coordinator

Attachment(s):

cc: Georgina Williston, Head, Environmental Assessment North (NT and NU)