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Environmental Sciences Ltd.

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# Technical Memorandum

**Date:** **April 15, 2016**

**To:** **Luis Manzo (KIA)**

**From:** **Richard Nesbitt, Dennis Gregor (HESL)**

**Re:** **J160036 – Adverse Water Quality Trends in Meliadine Portal Area**

## 1. Introduction

Luis Manzo of the Kivalliq Inuit Association (KIA) requested that Hutchinson Environmental Sciences Ltd. (HESL) review a letter report provided by Agnico Eagle Mines Ltd. (AEM) regarding:

> *"Meliadine – 2BB-MEL1424.*
> *Meliadine Portal Area – Water Quality Monitoring in Lake A54.*
> *Adverse Trends Noted – Mitigation Measures being implemented."*

This letter summarizes elevated chloride and ammonia concentrations noted during AEM's routine water quality monitoring of the small lakes within the Meliadine project footprint influenced by exploration activities covered under water licence 2BB-MEL1424. In AEM's narrative, confirmed by our review of the provided water quality data, elevated concentrations of chloride and ammonia were noted downstream of the exploration portal in Ponds P1, A54, A38 and Lake A8; these lakes are listed in order of flow from the exploration portal. These water bodies and the pattern of flow are indicated in Figure 1 as adapted from AEM's letter.

Our original review of AEM's letter was provided to the KIA on April 13, 2016. The KIA forwarded HESL an email from AEM later that day which outlined the progress on AEM's proposed corrective actions; AEM's email was dated April 11, 2016.

## 2. Review of elevated concentrations and response

Elevated concentrations were first noted in June, 2015 during freshet. AEM has noted that chloride concentrations in Ponds P1, A54 and A38 are well above the Canadian Council of Ministers of the Environment (CCME) long-term Water Quality Guideline (WQG) for the protection of aquatic life (120 mg/L). Concentrations were measured in September 2015 at approximately 5000 mg/L, 1100 mg/L and 900 mg/L in Ponds P1, A54 and A38, respectively. Nevertheless, these ponds are not considered part of the receiving environment as all freeze solidly to the bottom during winter, are wholly contained within the project footprint and are not fish bearing. All hydraulic connections between these ponds and the final fish bearing receiving water body, Lake A8, are via diffuse flow paths. The direction of flow has been indicated in Figure 1.

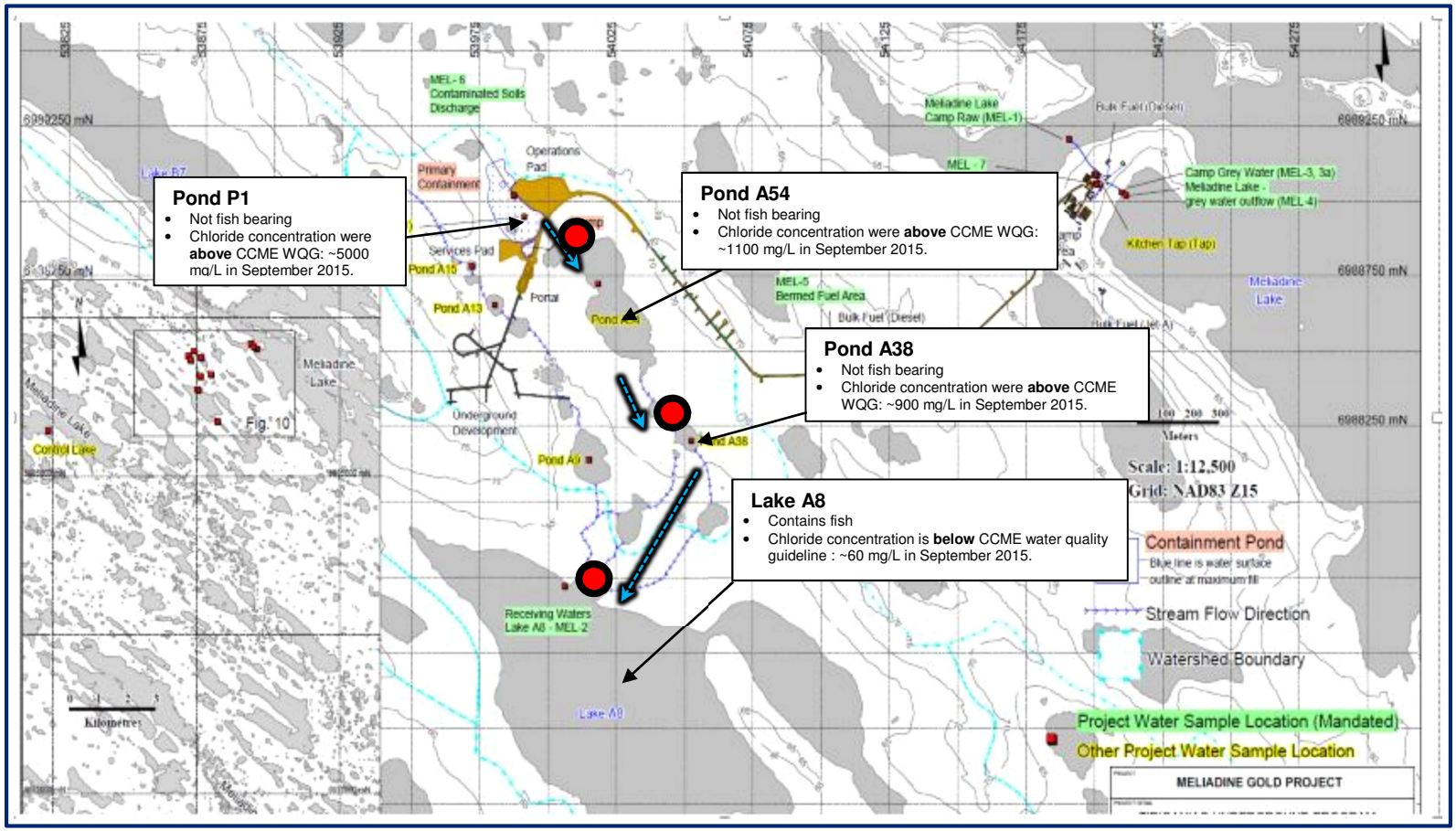


**Figure 1. Impacted water bodies at Meliadine Exploration Camp. Blue dotted arrows with black boarder indicate direction of flow. Red dots with a black circle indicate where photographs should be taken.**

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AEM's letter notes that chloride concentrations have increased in Lake A8 since June 2015 but has not exceed the CCME WQG. Measured concentrations are also within the range reported since 2007 (Figure 2).

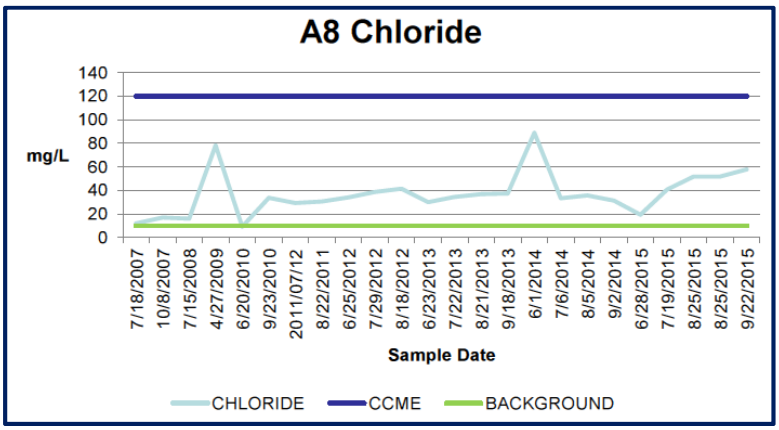


**Figure 2. Measured chloride concentrations in Lake A8.**

As noted by AEM, elevated concentrations were first noted in June, 2015 during freshet and likely at the onset of the development of the active layer. We further note that in P1, the Cl concentrations have increased by a factor of about 500 times over background, A54 Cl has increased by a factor of 10X and A38 has increased by a factor of about 5X over their respective backgrounds. This suggests that the problem is predominantly within P1 and its drainage basin. Seepage from P1 through the roadbed does not appear to be picking up significant quantities of Cl from the calcium chloride as evidenced by the dilution in A54. We note several key points in AEM's correspondence that support the conclusion that the drainage into Pond 1 is the main factor in contributing to the rising Cl concentrations. Specifically:

1. *All waste rock is placed in a series of rockfill platforms constructed on both sides and to the north of the decline entrance;*
2. *All precipitation runoff from the rockfill platform areas drain into Pond 1;*
3. *Runoff from the area immediately adjacent to the portal enters the decline and is collected in a sump constructed for this purpose just below the ground surface at Sump 1;*
4. *All water reporting to the surface sump including that pumped from Sump 1, appears to be lost by either evaporation or* ***natural seepage****; and,*
5. *Currently, no water has been sent from the underground workings to the surface.*

*We also note that there appears to be no indication of increases to the Cl concentrations between P1 and A54 suggesting that calcium chloride usage on the road way is a minor contributor.*

In general, we agree with AEM's interpretation of these results, which concludes that the probable source of this increase in chloride and ammonia concentrations was from underground mine development activities particularly related to seepage from the rockfill platforms in the vicinity of the portal. This source would also explain the increase in ammonia concentrations that are most evident in P1. Ammonia is a major component of the standard explosive employed at the site, ammonia nitrate fuel oil (ANFO) explosive, and may serve as a conservative tracer for the source of the chloride in this location due to the

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fact that it is not degraded in the rock storage piles during the winter season. AEM has proposed five actions to evaluate and mitigate these elevated concentrations. Their actions and our comments on these actions are provided in Table 1.

**Table 1. AEM's Proposed Actions to Address Elevated Chloride and Ammonia Concentrations and HESL's Comments**

| # | AEM's Proposed Action | HESL Comment |
|---|---|---|
| 1 | Increased frequency and more intensive sampling of the underground sources to allow for a better understanding of where the increased chloride and ammonia is coming from; | AEM has indicated that no water from the mine has been discharged to Pond P1. While increased sampling will characterize concentrations in the underground workings, it is unlikely that this will provide information regarding the source of elevated chloride and ammonia concentrations in Pond P1 at least until mine water is discharged to the Pond. |
| 2 | A review of explosives use practices in the underground to tighten up any wastage | This is a prudent response to the observations reported. |
| 3 | Engineering review to find alternatives to construct a larger and tighter containment facility on surface at containment pond P1 to ensure long term containment of all underground mine water to prevent further release of chloride and ammonia into Lake A8. The immediate focus is on increasing storage capacity in containment pond P1 to accommodate the 2016 spring freshet and to limit to the greatest extent practical any seepage from containment pond P1 into Lake A54 | We have two concerns with this action item. While increasing the storage of Pond P1 may be desirable, AEM will eventually need to release water stored in Pond P1 as there is limited evaporation and seepage is controlled through the roadbed. Additionally, this proposed action item does not deal with the source of the chloride or ammonia to Pond P1 from the rockfill platforms.<br><br>We recommend that AEM, in addition to constructing a larger and possibly tighter containment facility, install shallow piezometers downstream of the surface water sump toward Pond P1 to determine the quality of water moving through the active layer apparently from this sump. Alternatively, this sump could be lined to minimize infiltration into the active layer or eliminated as proposed in #4. Piezometers should also be installed in the vicinity of the waste rock piles to monitor subsurface seepage, including water quality.<br><br>AEM should confirm whether surface drainage from the rockfill platforms that does not report to Sump 1 are collected by means of berms and routed to Pond P1. If this is not currently the situation, the use of berms to direct this flow to Pond P1 and to minimize infiltration should be considered. This will also permit sampling for water quality and determination of quantity of water reporting to Pond P1 through runoff and seepage from the rockfill platforms.<br><br>Finally, an engineering review should be conducted to minimize seepage from snowfall and rainfall into the waste rock piles (present and future) so that the volume of Cl and ammonia contaminated water reaching Pond P1 is reduced. |
| 4 | Engineering review to eliminate the surface sump at the top of the exploration decline and to re-route all water pumped from sump 1 located just inside the portal directly into containment pond 1; and | This is a prudent response to the observations reported. If the sumps are not eliminated, they should be lined to minimize infiltration. |
| 5 | A review of current practices to improve the management on surface of calcium chloride storage and the management of potentially contaminated snow. | This is good practice but is not likely to stem the source of chloride to Pond P1. |

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| # | AEM's Proposed Action | HESL Comment |
|---|---|---|
| 6* | Reviewing treatment options including use of evaporators. | Evaporators will likely increase the long-term storage capacity. However, evaporators are unlikely to improve the capacity of Pond P1 to accommodate freshet as runoff will be collected at a faster rate than evaporation will occur. We are also concerned that evaporation will not address the source of chloride and ammonia to Pond P1, and will concentrate both within Pond P1. Any flow to the downstream waterbodies will likely contain higher concentrations of both parameters than is presently the case.<br><br>We also note that operation of evaporators will increase the greenhouse gas emissions associated with exploration activities. |

** = Action 6 was added in AEM's April 11, 2016 email to the KIA.*

AEM's April 11, 2016 email also indicated that they are working to obtain a *"minimal capacity of 32,400m$^3$"* for Pond 1. It is unclear how AEM arrived at this value or how much of an increase in capacity this represents. AEM's primary approach for increasing their capacity to store water associated with the portal area is as follows:

*"Pond 1 will be divided in two ponds (a new Pond 1 and a small Pond 2) and by adding Pond 3.*

- *Pond 1 would be located at the northern area of the existing containment.*
- *Pond 2 would be located at the southern area of the existing containment.*
- *Pond 3 would be constructed downstream of the existing south road and would serve multi-purposes. It would serve firstly to collect any seepage that could come from pond 2 confining structure and its abutments. A pumping station would be installed to collect and pump any water to Pond 1."*

AEM has indicated that dykes designed by Tetra Tech will be used to segregate the ponds as per Figure 3. Our concerns regarding AEM's reliance on increasing storage capacity are outlined in our response to action item 3 of Table 1. That is the current source of the chloride and ammonia contaminated water arriving at Pond 1 is not being reduced. However, we note AEM's intention to install and use a pumping station to return seepage water to Pond 1. If used correctly, this will limit that quantity of contaminated water reaching the receiving environment and mitigate impacts to Lake A8. Increasing capacity should only be considered part of the mitigation efforts to address the contaminated water.

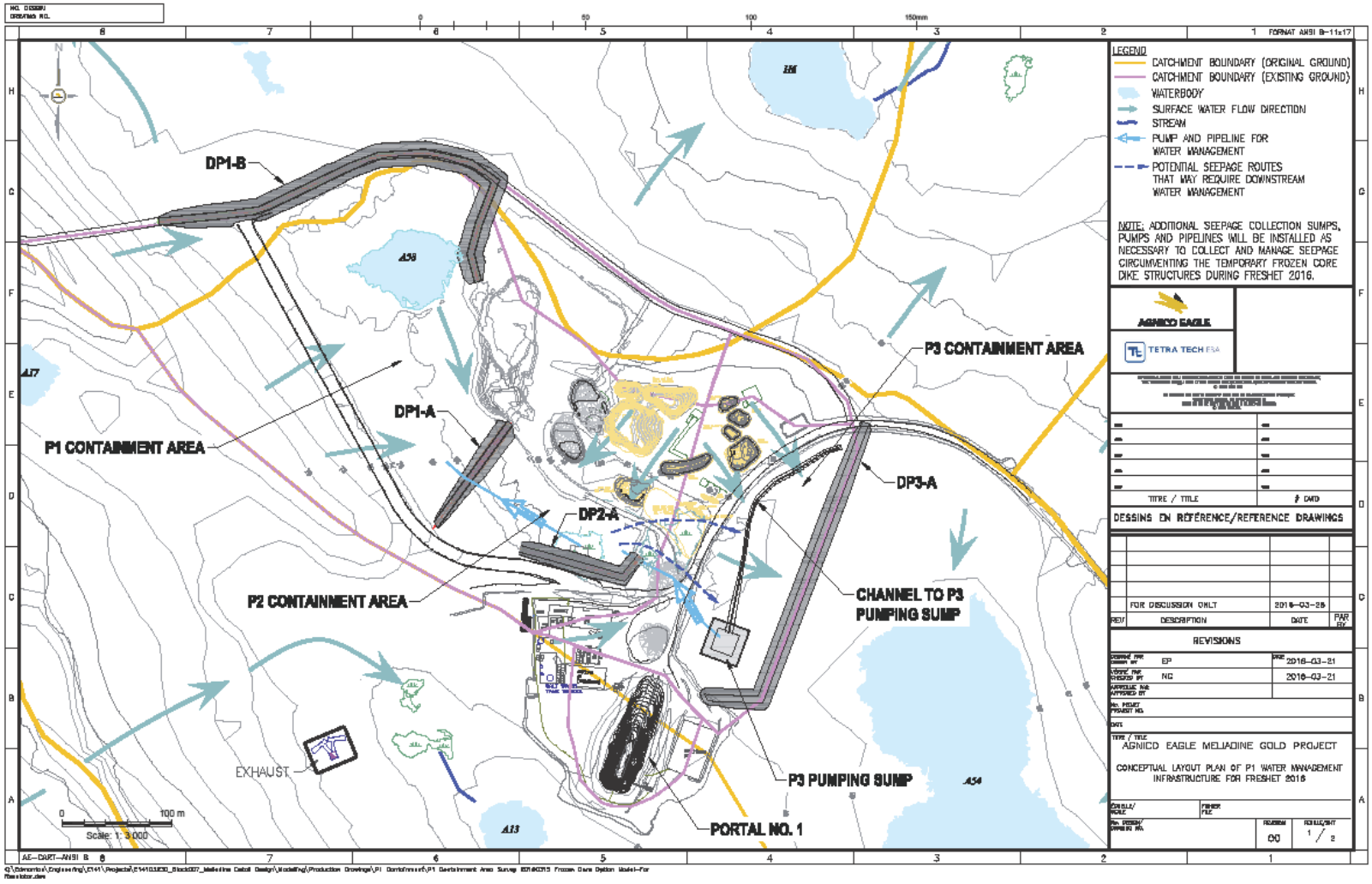


**Figure 3. Conceptual layout plan of P1 Water Management Infrastructure for Freshet 2016 as provided by AEM.**

# 3. Recommendations and Conclusion

We recommend that AEM continue to collect weekly water quality samples during freshet and monthly water quality samples during the rest of the open water season from the affected waterbodies. AEM should also install the recommended piezometers and collect water quality samples at the same frequency as those collected from the water bodies. A report should be prepared after the 2016 open water season and provided to the KIA. This report should summarize the results of the water quality field program including a complete suite of parameters (those assessed under the Meliadine Type A Aquatic Effects Monitoring Program (AEMP)) and the findings of the five proposed action items, modified as noted above. AEM should include:

- A discussion of how the required volume of additional storage capacity in Pond P1 was derived. This may be presented as part of a site water balance for exploration activities;
- An assessment of the volume of water reaching Lake A8 (both surface flow and through the active layer) from the impacted waterbodies to characterize the potential loading of contaminants to the fish bearing receiving environment. This may also be used to characterize a mixing zone in Lake A8, at the edge of which CCME water quality guidelines or a site specific water quality objective will be met;
- Potential management options to stem the source of chloride and ammonia if it is verified that it is coming from the rockfill platforms; and
- Options for next steps if the source of ammonia and chloride has not been determined at the end of the 2016 open water season. These options should consider whether or not chloride and ammonia will continue to be released from the rockfill for the foreseeable future, what the trend in chloride will be in the ponds, and whether or not additional management actions are required to protect receiving waters.

The concentrations of ammonia and chloride as presented in AEM's report do not pose an immediate threat to aquatic life. However, we recommend that the KIA conduct monthly inspections of the site during the open water season, photographing the diffuse flow patterns linking Pond P1, A54, A38 and Lake A8. The KIA should ensure that the first inspection occurs during freshet. A photograph looking upstream and downstream should be taken monthly at the locations indicated in Figure 1 throughout the open water season starting at freshet. These photographs are intended to inform the results provided in AEM's report and may assist in a compensation claim should concentrations of chloride and ammonia increase beyond the appropriate CCME WQG.

We hope this memorandum meets your current needs. Should you have any questions, please do not hesitate to contact the undersigned. We would be happy to answer any questions you may have.

Sincerely,
Per: Hutchinson Environmental Sciences Ltd.

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