GOLDER

# TECHNICAL MEMORANDUM

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**TO** Jessica Huza
Agnico Eagle Mines Limited

**FROM** Jarett Nevill and Colleen Prather

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**RESPONSE TO COMMENTS ON THE CYCLE 1 EEM STUDY DESIGN FOR THE MELIADINE MINE**

Environment and Climate Change Canada (ECCC) reviewed and provided 15 comments to Agnico Eagle Mines Limited (Agnico Eagle) on the Meliadine Gold Mine EEM Cycle 1 Study Design (Golder 2017); comments were issued in a letter dated 25 April 2018. Agnico Eagle requested Golder develop responses to all comments. These comments and draft responses are outlined below and supported with Attachments A and B.

## 1.0 COMMENT ITEM 1.

*The report describes a biological monitoring study to assess the effects of effluent discharged to Meliadine Lake during the dewatering of Lake H17, which occurred from August to October 2016. There has been no further deposit from this final discharge point (MEL-D-1) and the dewatering infrastructure was dismantled in October 2016. A permanent discharge point (MEL-14) has since been constructed, upstream of MEL-D-1. There was no discharge from MEL-14 in 2017, however it is understood that effluent will be discharged in 2018. On p. 14, the report indicates that effluent discharged from MEL-14 is expected to have higher concentrations of constituents than the dewatering effluent.*

*Given that the discharge from MEL-D-1 occurred two years before the biological monitoring study planned for 2018, and the likelihood of a more concentrated effluent discharging from MEL-14 in 2018, the proponent is recommended to relocate the study to assess for the effects of effluent from MEL-14.*

*Note that if there is no discharge from MEL-14 in 2018, the proponent would be recommended to conduct the biological monitoring study in the area previously exposed to the MEL-D-1 discharge.*

**Response to Comment Item 1.**

Agnico Eagle confirms that effluent will be discharged from MEL-14 beginning in June of 2018. Based on this information, the EEM exposure study area will be relocated to better capture the effects of effluent release from MEL-14. The exposure area will be near the diffuser (see Attachment A: Figures 1.1-2 [new] and 6.1-1 [from Golder 2018]) and is aligned with the AEMP Near-field exposure area (Golder 2018).

## 2.0 COMMENT ITEM 2.

*p. 5. What type of effluent will be discharged from MEL-14 in 2018? Will the effluent be treated? How will the discharge rate compare to the dewatering of Lake H17?*

**Response to Comment Item 2.**

The effluent discharged from MEL-14 in 2018 will be treated water from CP1. CP1 receives water from surface runoff from the project footprint and from another surface water runoff collection pond, CP5. Water from CP5 is highly saline and will be treated for total dissolved solids (TDS) (reverse osmosis [RO] membrane treatment technology; Agnico Eagle 2018) prior to transferring to CP1. Water from CP1 is treated at the Effluent Water Treatment Plant (EWTP) prior to discharge into Meliadine Lake. Water quality data collected from CP1 in 2017 is provided in Attachment B. It is expected that the TDS effluent quality will be lower than the 2017 data due to the inclusion of the RO treatment plant at CP5.

As described in the study design (Golder 2017), a total volume of 177,376 $m^3$ of Lake H17 water was transferred to Meliadine Lake during the discharge period (August 22 to October 1, 2016; 41 days; Agnico Eagle 2016). Average daily discharge rate was 4,269 $m^3$/day. Estimated discharge rate from CP1 through the diffuser is 11,688 $m^3$/day with daily discharge between June and October (Tetra Tech 2017).

## 3.0 COMMENT ITEM 3.

*p. 5. The MMER require a description of the manner in which effluent mixes within the exposure area, including an estimate of the effluent concentration at 250 m from the final discharge point (FDP) (MMER Sched. 5, 11(a)).* ***Please provide this information for the MEL-14 final discharge point, where available.***

**Response to Comment Item 3.**

The Final Effluent System Design and Construction Drawings for the Meliadine Mine (Tetra Tech 2017) were issued to the Nunavut Water Board in June 2017. As acknowledged by Agnico Eagle in response to the ECCC's recommendation 4 on the Final Effluent System Design and Construction Drawings (Agnico Eagle 2017), field column profiles and samples will be collected from the five Aquatic Effects Monitoring Program (AEMP) near-field exposure area sampling stations (AEMP design plan; Golder 2016), and sampling station MEL-13 (compliance station at mixing zone boundary as per 2AM-MEL1631). Data and results from these stations will be used to describe how the effluent mixes in the near-field exposure area of lake, in combination with plume delineation results (please also see the response to Question 4 regarding plume delineation, once discharge begins at MEL-14). In addition, to address a commitment made to the Kivalliq Inuit Association during the Type A Water Licencing process for the Meliadine Mine (Nunavut Water Board 2016), three stations located at approximately 100 m from the diffuser will be sampled on a regular basis (under-ice and monthly during the open-water season) and will allow further evaluation of the mixing of effluent in the near-field exposure area.

TetraTech (2017) provided information on the diffuser design and predicted concentrations of the released effluent at the edge of the mixing zone (100 m from diffuser); the report does not provide a description of how effluent will mix in the receiving environment beyond the mixing zone. Based on the model results, concentration of effluent at the edge of the mixing zone (100 m from the diffuser) will be equal to or less than the applicable water quality guidelines. At this time, predicted concentrations at 250 m from the diffuser are not available, but the results obtained during the Environmental Effects Monitoring (EEM) and AEMP campaigns will be compared to the modelled predictions at the edge of the mixing zone.

## 4.0 COMMENT ITEM 4.

*p. 5. The proponent is recommended to conduct a plume delineation study once the MEL-14 effluent discharge begins. Please provide a description of the methods that will be used to delineate the effluent plume.*

**Response to Comment Item 4.**

Once the discharge is initiated, an effluent plume delineation study will be conducted and will be based on a water quality monitoring approach. The plume will be assessed for shape, extension and chemical characteristics. As observed in previous experiences from low conductivity sub-artic lakes, conductivity is considered a good tracer to delineate plume extension as the effluent to be discharged to Meliadine Lake as conductivity in the effluent is higher than conductivity of natural lake water. Conductivity in CP1 ranged from 1,100 to 2,500 µS/cm in 2017 (Attachment B, Table 1) while conductivity in Meliadine Lake (Near-field exposure area) ranged from 49 to 99 µS/cm in 2017 (Golder 2018). Depending on the effluent metal concentrations in comparison to lake water, trace metals (e.g. total barium) or other water quality parameters can also be used to corroborate conductivity measurements. The large difference in the concentration of selected trace metals observed between the receiving water and that in the effluent is likely to allow for plume delineation and thus provide useful information regarding the manner in which the effluent mixes. In case conductivity and other tracers do not prove to be good proxies of plume dispersion a dye tracer study might be necessary for that purpose.

The plume delineation study will include vertical profiles for conductivity with 1 m resolution to be taken at least three times during the AEMP field program between July and September 2018. The profiles will be taken at an equally-spaced grid of sampling stations within a buffer of 250 m from the 30 m-long diffuser line. The diffuser line is oriented on a Northeast to Southwest alignment forming a “T” at the end of the pipeline (Tetra Tech 2017). The placement of the diffuser is indicated on Attachment A, Figure 1.1-2. According to TetraTech (2017) the water quality at the edge of the mixing zone (100 m) will meet the CCME guidelines for Protection of Aquatic Life or baseline concentrations. By collecting in situ conductivity measurements in a grid pattern around the diffuser, it will be possible to assess the effluent dispersion in the exposure area, independent of plume direction. The full suite of water quality parameters will be analyzed in five stations (see response to Comment Item 3 for details on the near-field exposure area), three of which will be located at 100 m from the diffuser to allow for comparison of actual water quality with model predictions from TetraTech (2017).

Quality assurance and quality control procedures will be key to ensure the results obtained are unbiased and accurate. The QA/QC will include field staff training, calibration routine and documentation, as well as collection of travel blanks, field blanks, replicate samples and selection of accredited laboratories for chemical analyses.

Detailed methods for the plume delineation study are still in development but are summarized as follows:

- Prior to field work, develop a map with a grid (50 m spacing) overlaying the Near-field exposure area.
- Identify specific stations to collect water column profile measurements for pH, temperature, conductivity, and dissolved oxygen.

- In the field, collect measurements every 1 m through the water column and enter data onto field collection data sheets.
- Immediately after the field work, review the data and develop summary tables and figures. Prepare a brief description of effluent plume size and shape. Use this information to refine the sampling stations for collection of water samples for detailed water quality analysis.

## 5.0 COMMENT ITEM 5.

*p. 8. The MMER required a description of the reference and exposure areas where the biological monitoring studies will be conducted (Sched. 5, s. 11(b)), and a description of and scientific rationale for the selection of fish and benthic invertebrate sampling areas (Sched. 5, s. 12(b), 13(a)). It is acknowledged that the report provided information on the sampling areas in Meliadine Lake that were proposed to monitor the discharge from MEL-D-1.* ***Please provide a description of the relocated exposure sampling areas to assess the effects of effluent discharged from MEL-14, including a revised study area map indicating the location of sampling sites for EEM fish and benthic invertebrate surveys. The proponent should also indicate whether or not current reference areas are suitable for comparison to the relocated exposure area. If additional reference areas are needed, please provide a description as required.***

**Response to Comment Item 5.**

An exposure area is defined by the MMER as “fish habitat and waters frequented by fish that are exposed to effluent”. The Metal Mining Technical Guidance for EEM recommends that exposure area sampling should be undertaken in an area closest to the effluent discharge with appropriate habitat for benthic invertebrates, where fish are present, and where one could reasonably expect to find effects (EC 2012).

The near-field exposure area for assessment of effluent discharged from MEL-14 is the same as the AEMP MEL-01 area (Attachment A, Figures 1.1-2 [water, sediment, and benthic invertebrate community] and 6.1-1 [fish]). This area has already been sampled as part of the baseline phase of the AEMP (Golder 2018).

In general, under baseline conditions, water at the MEL-01 area has neutral pH and is well oxygenated, very soft, characterized by low turbidity and metal concentrations, and has nutrient and chlorophyll *a* concentrations indicative of ultra-oligotrophic to oligotrophic waters (Golder 2018). Natural variation was observed for some of the water quality variables during open-water and ice-covered seasons, in particular dissolved oxygen, temperature and ammonia. Bottom sediments were dominated by silt and were naturally enriched in some metals; exceedances for CCME sediment quality guidelines were found for arsenic, chromium and copper.

The diffuser and its pipeline were installed in September 2017 (Tetra Tech 2018). The location of the installed diffuser and AEMP (water, plankton, sediment, and benthic) stations are illustrated in Attachment A Figure 1.1-2 and Table 1. It was always the intention to revise the position of the Near-field exposure stations once the diffuser was installed. The MEL-01 stations will be relocated to match precisely the as-built diffuser location such that they are at least 100 m from the diffuser.

**Table 1: Current Sampling Stations in the Near-field Exposure Area**

| Waterbody | Current AEMP Station ID | UTM Coordinates (NAD 83, Zone 15V)[a] | | Average Total Depth[a] (m) | Distance from Diffuser (m) |
|---|---|---|---|---|---|
| | | Easting (m) | Northing (m) | | |
| Meliadine Lake | MEL-01-01 | 542693 | 6989136 | 9.4 | 100 |
| | MEL-01-02 | 542666 | 6989280 | 8.1 | 150 |
| | MEL-01-03 | 542634 | 6988989 | 9.0 | 225 |
| | MEL-01-04 | 543145 | 6989088 | 8.6 | 325 |
| | MEL-01-05 | 542136 | 6989358 | 8.0 | 675 |

(a) Coordinates and depths are based on the AEMP near-field exposure area and will require minor adjustment based on the location of the installed diffuser.

The 2017 AEMP annual report (Golder 2018) provided results of sediment grain-size analysis and identified a potential confounding factor for the sediment quality and benthic invertebrate community components. Substrates sampled in the near-field area had a higher proportion of fine sediments (i.e., silt and clay) and less sand compared to samples taken from the mid-field and reference areas that were either predominantly sand or a combination of sand and silt. Based on these results, it was determined that a reconnaissance survey in July 2018 was required to identify new reference stations with similar sediment physical characteristics to the near-field area. It is anticipated that any new reference stations will be located within areas similar to the current reference areas, and thus their general characteristics (i.e., water quality, water depth, general location relative to near-field area) will also be similar to those presented in the Cycle 1 study design (Golder 2017) and the 2017 AEMP report (Golder 2018).

## 6.0 COMMENT ITEM 6.

*p. 16. The study design proposes the collection of a single sentinel species, three-spine stickleback. It is noted that three-spine stickleback have been the most abundant species in previous surveys; however, the proponent is recommended to include a second sentinel species, as per the EEM Technical Guidance Document (TGD, Section 3.3). Please provide additional information for a second sentinel species, including rationale for the species selected, target sample sizes, sampling methods, and endpoints to be assessed. If there are concerns over the size of the population and potential impacts of sampling on the second sentinel species, a non-lethal survey could be considered.*

**Response to Comment Item 6.**

The EEM Technical Guidance Document (TGD; EC 2012) recommends the use of standard adult fish surveys using two sentinel species; however, alternative approaches such as a non-lethal fish survey are acceptable under conditions were the standard adult fish survey is not effective or practical. Previous fishing efforts show limited diversity of abundant small bodied fishes in Meliadine Lake. The AEMP for the Meliadine Mine does include lethal sampling of Lake Trout as a second sentinel species; Lake Trout will be collected from the near-field area during the 2019 fish field program. Therefore, given the potential impacts of lethally sampling the Lake Trout population in two consecutive years (i.e., 2018 and 2019), lethal sampling of Lake Trout in 2018 is not recommended. Rather, a fish health survey and a non-lethal fish survey (as per EEM recommendations) targeting Threespine Stickleback as the sentinel species is recommended. Ninespine Stickleback were captured in low abundance during the 2015 and 2017 sampling programs, and are not present and/or catchable in sufficient numbers to support a fish health survey. The proponent will, however, commit to collecting non-lethal data for Ninespine Stickleback captured during the 2018 fish health program, and include these data as a second sentinel species (i.e., in place of non-lethal sampling of Threespine Stickleback) if samples sizes are sufficient (i.e., at least 100 individuals captured per sampling area).

## 7.0 COMMENT ITEM 7.

*p. 16. For small-bodied fish surveys, the TGD recommends collection of 20 immature fish to aid in the analysis of effect endpoints (Section 3.3.3). Please describe the fish sampling techniques to be used for the collection of immature fish.*

**Response to Comment Item 7.**

The proponent will collect 20 immature fish from each sampling location. Field crews will use backpack electrofishing effort as a means to capture immature fish.

## 8.0 COMMENT ITEM 8.

*p. 17. The proponent is recommended to determine fish age from otoliths. While there may some uncertainty in the results due to the small size of ageing structures, ageing data could be compared to length frequency distributions to determine age classes. Ageing results should be independently verified as recommended in the TGD (Section 3.9.6). Please describe QA/QC protocols for the fish ageing data.*

**Response to Comment Item 8.**

The uncertainty in aging results from small bodied fish in Canada's north is not related to the small size of the aging structures, but is instead related to the lack of validation of the aging method and inconsistency in the aging results achieved. For the Meliadine Mine, the proponent will collect and submit otoliths to North/South Consultants for age determination. A second qualified biologist will QA/QC 10% of otoliths. Otolith age results will be compared against, and used in support of, length frequency distributions for age class determination.

## 9.0 COMMENT ITEM 9.

*p. 21. The report proposed to sample for benthic invertebrates in profundal areas (8 to 10 m depth) near the location of the MEL-D-1 diffuser. As noted in Comment #1, the sampling area should be relocated to assess exposure to effluent from the MEL-14 discharge point. As part of the description of the relocated benthic sampling areas requested in Comment #5, please indicate the distance from the MEL-14 discharge point. If the effluent from MEL-14 will be discharged from a diffuser at depth, sampling nearby profundal areas may be appropriate. However, if the discharge is from shore and exposure is greatest in littoral areas, the proponent could consider locating benthic stations in this habitat, provided the substrate is suitable. Similar consideration should be given to the selection of fish sampling areas near the MEL-14 discharge.*

**Response to Comment Item 9.**

The near-field sampling stations located near to the MEL-14 discharge point are at a standard depth (8 to 10 m) across stations, which is important when assessing the potential impact of the effluent discharge on benthic invertebrate communities. Because the discharge is being released at depth (via a long pipe extending from shore; Attachment A, Figure 1.1-2) and the MEL-14 discharge point is within this depth range, these areas are appropriate for assessing effluent exposure. Baseline data (Golder 2018) were collected at individual stations distributed throughout the near-field area at distances of 100 to 675 m from the diffuser at the MEL-14 discharge point (Response to comment 5, Table 1).

## 10.0 COMMENT ITEM 10.

*p. 23. Please describe the methods for the collection of water samples from fish and benthic sampling areas. The study design did not appear to propose water sample collection for the fish sampling areas; the proponent should ensure that water quality monitoring is conducted at fish and benthic sampling areas as required (MMER, Sched. 5, s. 7(2)(b)).*

**Response to Comment Item 10.**

Water samples are collected annually under the AEMP, within all monitoring areas of Meliadine Lake (i.e. near-field, mid-field and reference areas) and during under-ice and open water periods (Golder 2016). These areas match the fish and benthic sampling areas proposed for the EEM Study Design. The water quality fieldwork includes collection of field-measured data and collection of samples for laboratory analysis of water quality, plus supporting environmental data (e.g., water profile measurements and Secchi depth), as per the AEMP Design Plan (Golder 2016). Field measurements includes profiling of physico-chemical variables (i.e. conductivity, dissolved oxygen, pH, turbidity and water temperature) at surface (0.1 m), 0.5 m below surface and every 1 m thereafter ending at 1 m above the bed. Water samples are collected for chemical analysis with Kemmerer bottles or equivalent. Samples are collected from the depth of maximum conductivity, or mid-depth, if no conductivity gradient is observed. After collection, samples are processed as required, added to laboratory supplied bottles, and submitted to a laboratory for analysis.

## 11.0 COMMENT ITEM 11.

*p. 16. Ensure that sampling effort with different fishing methods is proportionally similar between exposure and reference areas, to avoid any potential confounding effects related to size selection bias.*

**Response to Comment Item 11.**

Noted. Fish capture methods will be applied to both exposure and reference areas in equal proportions, as much as reasonably achievable (e.g., based on accessibility, habitat differences, etc.).

## 12.0 COMMENT ITEM 12.

*p. 16. Note that the recommended level of effort to achieve sample sizes in the fish survey is 7 days per sampling area.*

**Response to Comment Item 12.**

Noted. The fish health field program is budgeted for a total of fourteen days, seven days of effort at each sampling location (i.e., exposure and reference areas).

## 13.0 COMMENT ITEM 13.

*p. 16. Ensure balances are sufficiently sensitive and field lab conditions appropriate for weighing small-bodied fish.*

**Response to Comment Item 13.**

All weights, including internal organs, will be weighed to ±0.001 g as per the TDG (EEM 2012). Balances will be calibrated daily according to manufactures specifications. All measurements will be taken indoors or in protected areas, where the confounding effects of wind and/or uneven terrain are minimized.

## 14.0 COMMENT ITEM 14.

*p. 22. The proponent is recommended to sort subsamples rather than pooling them in the field, in order to evaluate variability within stations and determine the appropriate number of subsamples for future studies (TGD, Section 4.4.2).*

**Response to Comment Item 14.**

Compositing of benthic field sub-samples is practiced in many Northern Canadian mining operations, as stated in their respective AEMPs. By taking field-samples and then compositing them for each station, a wider spatial area is sampled that is more representative of spatial variability in the benthic community, as opposed to that captured in a single grab sample. In order to document and understand variability between sub-samples, sub-samples can be taken from one station per sampling area and processed separately, with the data presented for each individual sub-sample as well as for the combined station sample (i.e., composite). This approach was adopted for the 2017 AEMP Interpretative Report and associated baseline sampling in 2015 and 2016; within station variability was discussed in the interpretative report (Golder 2018).

## 15.0 COMMENT ITEM 15.

*p. 27. Regarding QA/QC protocols for benthic sorting, note that if sorting efficiency does not meet the criterion of <10% of total organisms missed, the samples should be resorted. If subsampling is used, 10% of samples should be assessed for precision and accuracy. If estimates differ from true counts by >20%, the method should be modified to achieve higher accuracy, or the entire sample should be sorted (TGD, Section 4.6.4).*

**Response to Comment Item 15.**

Noted. The taxonomists, Cordillera Consulting, are experienced with processing samples for EEM and other protocols and already implement these QA/QC measures.

**GOLDER ASSOCIATES LTD.**

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Attachment A – GIS maps: Figure 1.1-2 and 6.1-1
Attachment B - CP1 Water Quality Table

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