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AQUATIC EFFECTS MONITORING PROGRAM ANNUAL 2019 REPORT – PLAIN LANGUAGE BRIEFING AND TECHNICAL REVIEW COMMENTS

Technical Memorandum # 367-21-01

Prepared for:

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1.0 BACKGROUND AND SCOPE OF WORK

Diavik Diamond Mines (2012) Inc. (DDMI) submitted the 2019 Aquatic Effects Monitoring Program (AEMP) Annual Report on April 30, 2020 in accordance with Part J, Condition 8 and Schedule 8, Condition 4 of Water Licence W2015L2-0001 (Golder 2020). DDMI was granted an extension to the deadline of the Report from March 31st to April 30th on January 30, 2020. After Board staff identified a potential non-conformity with a recent Board decision, DDMI provided an updated Report on October 27, 2020. The report was distributed for review by the Wek'eezhii Land and Water Board (WLWB) on November 25, 2020.

North/South Consultants Inc. (NSC) conducted a technical review of the 2019 AEMP Annual Report for the Environmental Monitoring Advisory Board (EMAB). The following aquatic environment components were reviewed by NSC personnel with technical knowledge and expertise in each of the areas: dust; effluent and water chemistry; sediment chemistry; plankton; eutrophication indicators; benthic invertebrates; fish; and a special effects study – dust deposition. As directed by EMAB in their Scope of Work for the review, the following points were considered:

- Diavik responses to previous North/South recommendations, if applicable;
- Appropriateness of sampling timing and frequency;
- Quality of data collected;
- Methods used to analyze data;
- Adequacy of discussion of results;
- Implications of results;
- Defensibility of conclusions and recommendations;
- Emerging issues that may indicate environmental change over time;
- Potential project-related effects;
- Methods, results and conclusions of Diavik's Special Study on effect of Effluent vs. Dust on Lac de Gras;
- Action levels reached and adequacy of proposed follow-up;
- Adaptive management responses; and
- Include recommendations on improvements to monitoring/management actions for EMAB's consideration.

Section 2 provides a plain language briefing of the key review comments, along with recommendations for consideration by EMAB. Detailed technical review comments and recommendations are provided in Table 1 and in the Excel comments template as required for submission to the WLWB (separate excel spreadsheet file).

2.0 PLAIN LANGUAGE BRIEFING

The following sections present a plain language briefing of NSC's comments in relation to the points identified by EMAB for evaluation during the review of the 2019 AEMP Annual Report, and any additional review comments and recommendations borne from this review. The AEMP addresses NSC's previous comments on the 2018 AEMP (NSC 2019).

The following sections present key comments for discussion by EMAB members and refer to:

- Dust monitoring: Control sites;
- Water Quality: Dust deposition analysis;
- Water Quality: Ammonia;
- Plankton: Data integrity;
- Eutrophication indicators: Cumulative effects assessment;;
- Fish: Response plan;
- Fish: Links to the Mine; and
- Fish: Response Framework.

To aid in this discussion, useful figures are included from the 2019 AEMP Annual Report.

The technical review comments (Table 1) include additional detailed comments that recommend various revisions to clarify either the presentation of results and/or their interpretation to improve the overall quality of the report; these comments are excluded from the discussion below.

2.1 DUST DEPOSITION

2.1.1 CONTROL SITES

The report concludes that the three control sites used in the dust deposition monitoring program are and have been affected by the Mine.

Recommendation: Retain the new, more distant control-assessment sites in long-term monitoring and apply these data as reference sites in future analyses.

2.2 EFFLUENT AND WATER QUALITY

2.2.1 DUST DEPOSITION EFFECTS ANALYSIS

The water quality assessment examined effects of dust deposition within a 4 km radius from the center of the Mine (i.e., the zone of influence [ZOI]), which is identified as the area of the lake where potential effects would be expected to be measurable.

Given that the 2019 AEMP Report concludes that the dust monitoring control sites are, and have been, affected by the Mine, is the ZOI for dust deposition that was applied for the analysis of effects of dust on water quality accurate?

Recommendation: Clarify if the ZOI for dust deposition in Lac de Gras is unchanged in light of the conclusion that control sites are affected by dust from the Mine. If this area is no longer accurate, revise the analysis to include an updated ZOI for dust deposition.

2.2.2 AMMONIA

DDMI presented the results of an inter-laboratory (BV vs. ALS Laboratories) comparison study in which samples for analysis of ammonia were collected and submitted to both laboratories, as required under WLWB Directive 2. DDMI noted a number of issues were identified with the samples, including contamination of the pre-added preservative in the sample bottles provided by BV Laboratories. The report indicates that samples from the ice-cover season submitted to BV Laboratories were contaminated and therefore results from ALS Laboratories were used for this season. The opposite occurred for the open-water season in which it is concluded that samples submitted to ALS Laboratories were contaminated by an unknown source.

The 2019 results, including the ammonia study, clearly indicate ongoing data quality issues that remain unresolved – which DDMI acknowledges. DDMI notes that an inter-laboratory comparison study will be repeated in 2020 and that discussions with the analytical laboratory are ongoing.

Recommendation: We agree that the inter-laboratory comparison study should be undertaken in 2020 given that the 2019 program could not be completed as planned due to multiple laboratory issues.

We recommend inclusion of one additional test in the 2020 ammonia study – specifically, inclusion of analysis of ammonia in preserved and unpreserved samples at both laboratories. This would assist with confirming the utility of the 2019 data set as well as provide information for potential options moving forward.

2.3 PLANKTON AND EUTROPHICATION INDICATORS

2.3.1 Phytoplankton Data Integrity

The AEMP report indicates that phytoplankton samples were incorrectly preserved (a more concentrated preservative was added to samples in error) but that phytoplankton biomass results were similar to recent years and within the normal range. It is indicated that: "for taxonomic richness, the 2019 comparison to previous years is unreliable, due to a sample preservation issue."

Given that fixatives affect not only preservation of biological tissues but also affect moisture content (e.g., shrinkage), it would be most conservative to compare phytoplankton counts in 2019 to previous years to evaluate similarities. Use of a higher concentration of Lugol's could theoretically result in greater effects on phytoplankton size and therefore biomass.

Additionally, the spatial patterns for phytoplankton biomass and chlorophyll *a* are inconsistent which further suggests the biomass results may not be accurate (see Figures 1 and 2 below).

Recommendation: Compare phytoplankton counts for 2019 to results from previous years, including overall counts and counts for major groups.

Compare chlorophyll *a* results, in conjunction with biomass and cell counts for phytoplankton, from 2019 to previous years to further examine the validity of the biomass data for 2019.

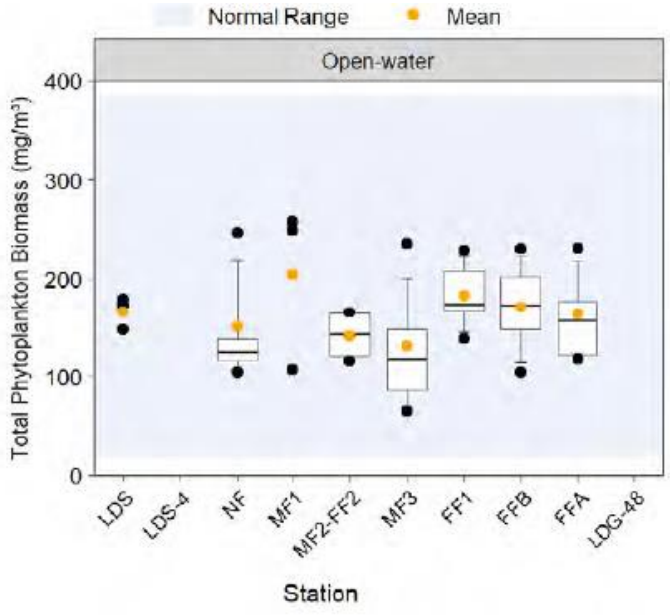

Figure 1. Phytoplankton biomass: 2019 (Figure 3-14, Appendix VIII, p. 39; Golder 2020).

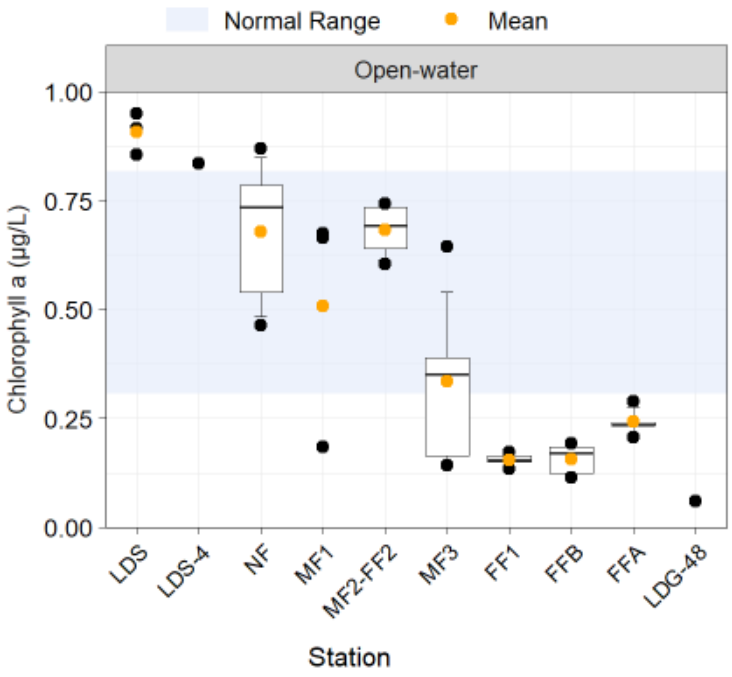

Figure 2. Chlorophyll *a* concentrations: 2019 (Figure 3-13, Appendix VIII, p. 38; Golder 2020).

2.4 EUTROPHICATION INDICATORS

2.4.1 Cumulative Effects

The Eutrophication Indicators section of the 2019 AEMP report presents an assessment of cumulative effects from the Diavik and Ekati mines on eutrophication of Lac de Gras. This assessment considers monitoring data for nutrients from both mines, in conjunction with spatial analysis of conditions in the lake.

There is no metric for algae included in this assessment, which as Golder has noted is the metric of relevance for eutrophication (e.g., see p. 15: "As demonstrated by years of monitoring in Lac de Gras, concentrations of TP do not predict the actual biological response to nutrient enrichment. Rather, the increase in the biomass of algae as measured by chlorophyll *a* has been a useful measure of the effects of nutrient enrichment").

This is particularly relevant for assessing cumulative effects since there may be more complex effects that lead to enhanced productivity. For example, the Diavik Mine may increase nitrogen and the Ekati Mine may increase phosphorus, which collectively could increase phytoplankton abundance. It is noted that available information for 2019 indicates that chlorophyll *a* was not increased by cumulative effects of the mines (i.e., low concentration measured at the lake outflow). However, this information should be considered in annual reporting.

Recommendation: Include chlorophyll *a* and phytoplankton biomass metrics in the cumulative effects assessments.

2.5 FISH

2.5.1 Response Plan

The report indicates that the differences in fish metrics observed in 2019 relative to reference conditions were consistent with the previous study (2016), but concludes that these differences were not attributable to the mine based on the 2014-2016 AEMP Fish Response Plan (Golder 2017) and, therefore, a new Response Plan is not required.

The investigation of cause completed in 2016 (Golder 2017) determined that the differences in fish size and relative liver weight observed in 2016 were "inconsistent with a Mine effect, and [was] likely driven by localized variation among study areas". However, one of the reasons given in the 2016 Fish Supplemental Report for attributing the observed differences in fish health to natural variation rather than the mine was that there were no comparable responses in previous years (p. 40, Section 4.3 Ecosystem Interactions of Golder 2017). Based on the results of the 2019 survey, there are now comparable responses in two consecutive studies.

This argument also implies that similar effects observed in future monitoring programs would similarly be discounted.

Recommendation: Clarify why a response plan is not required given that the same effects (direction and magnitude) were observed in two consecutive monitoring cycles.

2.5.2 Links to the Mine

The report states that a temporal interaction between 2019 and reference conditions was likely driven by inter-annual differences in regional environmental factors such as weather or temperature. It is further stated that the differences in size of age-1+ fish between the 2019 fish survey and reference conditions were more likely influenced by inter-annual variation in regional environmental factors, such as temperature or timing of freshet and spawning,. The argument presented is that similar differences were not observed in 2019 relative to the FF areas.

Given that effluent is known to be affecting FF areas this reasoning is questionable as effects could be occurring to fish in all areas - with the expectation that effects would be greatest in the NF area. The action level assessment has been modified to remove comparisons to FF areas and instead compare results to reference conditions for this reason. Further, if temperature or other environmental factors are believed to be the driver for the observed differences, exploration of these factors is warranted.

Recommendation:

Include a formal discussion of the role of other factors (e.g., temperature) in observed differences in fish metrics if this conclusion is retained OR provide an analysis of potential causes in a response plan.

If needed to support conclusions that effects observed in 2019 were not mine-related, provide a comparison of FF area data to reference conditions to determine if effects may have occurred in these areas.

2.5.3 Response Framework

The annual report concludes that differences in fish size and relative liver weight observed in 2019 and 2016 were inconsistent with mine effects and were likely driven by localized habitat variation among study areas based on the 2014-2016 AEMP Response Plan Fish - Supplemental Report (Golder 2017). However, the 2016 AEMP Response Plan and the assessment of effects on fish metrics prior to 2019 (including 2016) were based on comparisons between NF and MF areas to the FF areas. This section appears to summarize effects relating to the old data analysis approach. Since this approach has now changed to making comparisons to reference conditions, it is unclear if the conclusions from the 2016 AEMP Response Plan are applicable given the change in the framework and data analysis approach.

Recommendation: Please clarify if the conclusions from the 2014-2016 AEMP Response Plan - Fish Supplemental Report (Golder 2017) are applicable given the change in the approach for analysis of fish metrics.

3.0 DETAILED TECHNICAL REVIEW COMMENTS

Detailed technical review comments and recommendations are provided in the following Table 1..

Table 1. Technical review comments and recommendations on the 2018 AEMP Annual Report.

TOPIC	COMMENT	RECOMMENDATION
Diavik Diamond Mine, Dustfall Stations Near A21 Technical Memorandum	In the review of the 2018 AEMP, NSC had commented that some of the control stations for dust monitoring appear to be affected by the Project. NSC recommended: "Provide a discussion of the implications of potential Project effects on dust at the control stations with respect to interpretation of the dust monitoring program results overall (i.e., are effects potentially consequential in terms of monitoring for Project effects or are effects marginal and not consequential for the program)." The WLWB issued a directive (3A) to DDMI: "Assess the potential influence of dust on stations near A21 since the beginning of development and mining activities in that area as part of the 2019 AEMP Annual Report. This assessment should include a consideration of whether any of those stations should no longer be considered as background (either for all years, or during peak construction/activity years)" in review of the 2014-2016 AERR and AEMP Design Plan Version 5.0 (WLWB 2019c). The 2019 AEMP report submission includes a Technical Memorandum (TM) from ERM Consultants in which rates of dust deposition are reviewed for three control sites. The TM concludes: "Even before 2016, when construction started at the A21 pit, the observed annual dustfall rates at the Dust 10 station were higher than at the nearest control/background station, likely due to other Project components such as roads and the other pits. ERM recommends that the Dust 10 and Dust 11 stations not be considered representative of background conditions, for all years of data." We agree with this conclusion and recommendation based on the data and explanation provided by ERM.	Retain the new, more distant control-assessment sites in long-term monitoring and apply these data as reference sites in future analyses.
APPENDIX I, Dust Deposition Report, Section 3.0, Results, p. 3-1	The Dust Deposition Report (Appendix I, Section 3.0, Results, p. 3-1) concludes that only minor differences in rates of dust deposition were observed in summer than winter in 2019. The seasonal rates were reported as annualized rates in the report text results are not presented in tabular format. "Although it is expected that fugitive dust generation is higher during snow-free periods because of exposed road surfaces, the difference between summer and winter rates was minor in most cases with some sites recording a slightly higher summer rate (e.g., Dust 3 rate was 1,024 mg/dm^2/y in the summer and 940 mg/dm^2/y in the winter), and other sites a slightly higher winter rate (e.g. Dust 2 rate was 309 mg/dm^2/y in the summer and 399 mg/dm^2/y in the winter)."	Please provide estimated seasonal dust deposition rates in tabular format.

TOPIC	COMMENT	RECOMMENDATION
APPENDIX I, Dust Deposition Report, Section 3.3, Results, Snow Water Chemistry, p. 3-13	The report includes presentation of results for the snow water chemistry program for each variable of interest (i.e., variables with EQC and phosphorus). As a result of it this approach, results for many other parameters are not presented, analysed, or discussed in the Dust Deposition Report. Analysis of all the results would be informative for assessing what parameters are potentially affected by the Project via dust effects. This information in turn, would be useful to consider with respect to the interpretation of monitoring results for surface water and sediment quality.	Present results for all measured parameters in tabular or graphical format.
APPENDIX II, Effluent and Water Chemistry Report, Section 2.3.4.3, Methods, Comparison to Effects Benchmarks, p. 12	NSC (2019) commented in the review of the 2018 AEMP Report that a number of water quality guidelines – either Health Canada drinking water quality guidelines or Canadian Council of Ministers of the Environment (CCME) for the protection of aquatic life (PAL) had been updated and recommended regular review of these updates and incorporation of guideline revisions into the AEMP (i.e., AEMP benchmark updates). One of these guideline revisions (CCME PAL guideline for silver which was revised in 2015) was incorporated into the 2019 AEMP Report – as directed by the WLWB (Directive 3G; WLWB 2019c). NSC (2019) also noted that in addition to silver, the CCME (1999) also revised the PAL guideline for zinc (CCME 2018) and added guidelines for manganese (CCME 2019), and Health Canada had revised guidelines for pH and selenium. NSC (2020) also noted that drinking water quality guidelines for manganese and strontium were revised in 2019 (Health Canada 2020). NSC has previously suggested that benchmarks be regularly updated to reflect revisions to the CCME (1999) PAL guidelines and the Health Canada drinking water quality guidelines. However, NSC understands that revisions to AEMP benchmarks may out of necessity lag behind guideline updates due to the need to review and formally adopt changes within the AEMP, as well as time lags associated with report preparation. Nothwithstanding these considerations, DDMI incorporated revised Health Canada drinking water quality guidelines for lead, manganese, selenium, and strontium in the 2019 AEMP Report (see p. 12, Appendix II). Given that updated drinking water quality guidelines were incorporated into the 2019 AEMP – including revisions that occurred in 2019 – other revisions to guidelines should also be incorporated for consistency. This would specifically include revising the AEMP PAL benchmark for zinc, adding a PAL benchmark for manganese, and revising the drinking water quality benchmark for pH.	Consider updating AEMP benchmarks to reflect revisions to CCME PAL and Health Canada drinking water quality guidelines on a regular basis. Recommend that should new revised guidelines be incorporated, that all revised guidelines should be included in AEMP reporting.

TOPIC	COMMENT	RECOMMENDATION
APPENDIX II, Effluent and Water Chemistry Report, Section 2.3.6.4, Methods, Effects from Dust Deposition, p. 25	The water quality assessment examined effects of dust deposition within a 4 km radius from the center of the Mine (i.e., the zone of influence [ZOI], which is identified as the area of the lake where potential effects would be expected to be measurable. Given that the 2019 AEMP Report concludes that the dust monitoring control sites are, and have been, affected by the Mine, is the zone of influence for dust deposition that was applied for the analysis of effects of dust on water quality accurate?	Clarify if the ZOI for dust deposition in Lac de Gras is unchanged in light of the conclusion that control sites are affected by dust from the Mine. If this area is no longer accurate, revise the analysis to include an updated ZOI for dust deposition.
APPENDIX II, Effluent and Water Chemistry Report, Section 3.3, Results, Depth Profiles, p. 57-63	The Report includes depth profile figures and a discussion of the in situ water quality monitoring results - which was previously recommended for inclusion by NSC and is very useful. It is noted that in situ depth profiles do not go beyond a depth of 20 m and it is unclear if 20 m is the maximum depth encountered across all sites of if this is due to a practical constraint (i.e., the length of the water quality meter chord is 20 m). Total water depth at each sampling site is not presented in the report and sampling depth for the water sampling (top, middle, and bottom) is also not presented. If in situ profiles do not extend across the full water column at some sites due to the chord length being exceeded, monitoring would not fully capture water quality conditions - notably where and when water quality varies across depth. This would include - among other scenarios - effects of effluent discharge which may concentrate near the bottom of the lake or conditions such as lower oxygen which tends to be lowest at the sediment-water interface in winter.	Include water quality sampling depth in tables and excel data files for all water quality sampling. Include total water depth in tables and excel data files for all water quality sampling, including in situ profile monitoring. Clarify whether *in situ* depth profiles may not have extended across the entire water column. If this has occurred, recommend either obtaining a meter with a cord of sufficient length to sample across the full depth or an alternative method for sampling the bottom of the water column.

TOPIC	COMMENT	RECOMMENDATION
APPENDIX II, Effluent and Water Chemistry Report, Section 3.3, Results, Depth Profiles, p. 57-63	DDMI presented the results of an inter-laboratory (BV vs. ALS Laboratories) comparison study in which samples for analysis of ammonia were collected and submitted to both laboratories. DDMI noted a number of issues were identified with the samples, including contamination of the pre-added preservative in the sample bottles provided by BV Laboratories (Appendix II, Effluent and Water Chemistry Report, Section 2.4.1, Methods, Ammonia Investigation, p. 28). Attachment 2 indicates that samples from the ice-cover season submitted to BV Laboratories were contaminated and therefore results from ALS Laboratories were used for this season. The opposite occurred for the open-water season in which it is concluded that samples submitted to ALS Laboratories were contaminated by an unknown source. DDMI further notes that the ammonia results were low relative to toxicological benchmarks such that issues with respect to data quality are unlikely to have a meaningful impact on the overall interpretation of the results of the monitoring program. Ammonia triggered Action Level 1 in the NF and MF areas in 2019 indicating a potential mine-related effect. Though it is agreed that because results were below effects benchmarks risks to aquatic health can be assumed to have been low, concentrations were above background levels and therefore are of immediate relevance with respect to determining mine-related effects. The 2019 results, including the ammonia study, clearly indicate ongoing data quality issues that remain unresolved. DDMI notes that an inter-laboratory comparison study will be repeated in 2020 and that discussions with the analytical laboratory are ongoing.	We agree that the inter-laboratory comparison study should be undertaken in 2020 given that the 2019 program could not be completed as planned due to multiple laboratory issues. Recommend inclusion of one additional test in the 2020 ammonia study – specifically, inclusion of analysis of ammonia in preserved and unpreserved samples at both laboratories. This would assist with confirming the utility of the 2019 data set as well as provide information for potential options moving forward.
APPENDIX III, Sediment Report, Section 2.3.3, Methods, Data Analysis, Substances of Interest, p. 8	The Sediment Report (Appendix III, p. xx) indicates that potential effects of dust deposition are presented and discussed in Appendix II (Section 2.3.3). Appendix II discusses potential effects of dust on surface water quality and does not consider potential effects on sediment quality. While it is acknowledged that potential effects of dust deposition on sediment quality is related to effects on surface water quality, an analysis of the latter pathway is insufficient to assess potential effects on sediment quality overall. The surface water quality sampling program consists of few discrete sampling events which may not adequately capture potential effects of dust; regardless, effects on sediments may be cumulative and should be considered discretely.	Provide an analysis of potential effects of dust deposition on sediment quality.
APPENDIX III, Sediment Report, Section 3.7, Results, Action Level Evaluation, p. 39	Total bismuth in sediments triggered Action Level 2 which requires establishment of an effects benchmark if one does not exist. The development of an effects benchmark for bismuth was attempted in the AEMP Design Plan Version 4.1, but was not successful due to insufficient toxicological data.	Conduct a literature review to determine if there are new sources of information since the preparation of the AEMP Design Plan v. 4.1 to form the basis of development of a benchmark for bismuth.

TOPIC	COMMENT	RECOMMENDATION
APPENDIX III, Sediment Report, Section 3.7, Results, Action Level Evaluation, p. 39	There are several anomalously high concentrations of arsenic reported for the 2019 sediment quality program (e.g., MF3-5 = 616 ug/g dw), which were an order of magnitude higher than the CCME Severe Effect Level (17 ug/g dw). Does DDMI have any explanation for these anomalous values? Are they suspected to be a result of sample contamination issues or actually representative of a highly heterogeneous environment? Has any analysis been conducted to assess if these concentrations are correlated with BMI metrics? It is recognized that any relationships may not be Mine-related, but this information could help inform interpretation of AEMP results in general.	Consider evaluating correlations between arsenic in sediments and BMI metrics to assess if there are effects that may in turn affect interpretation of AEMP results and assessment of Mine-related effects.
APPENDIX V, Plankton Report, Attachment A, p. A-3 - A-5	The AEMP report indicates that phytoplankton samples were incorrectly preserved (a more concentrated preservative was added to samples in error) but that phytoplankton biomass results were similar to recent years and within the normal range. It is indicated that: "for taxonomic richness, the 2019 comparison to previous years is unreliable, due to a sample preservation issue." Given that fixatives affect not only preservation of biological tissues but also affect moisture content (e.g., shrinkage), it would be most conservative to compare phytoplankton counts in 2019 to previous years to evaluate similarities. Use of a higher concentration of Lugol's could theoretically result in greater effects on phytoplankton size and therefore biomass. Additionally, the spatial patterns for phytoplankton biomass and chlorophyll *a* are inconsistent which further suggests the biomass results may not be accurate (see Figures 1 and 2 below).	Compare phytoplankton counts for 2019 to results from previous years, including overall counts and counts for major groups. Compare chlorophyll a results, in conjunction with biomass and cell counts for phytoplankton, from 2019 to previous years to further examine the validity of the biomass data for 2019.
APPENDIX VIII, Eutrophication Indicators Report, Section 3.6.3, Results, Chlorophyll a and Phytoplankton and Zooplankton Biomass, p. 38-39	The phytoplankton biomass data indicate relatively similar densities between areas, but lower densities than the normal range (Figure 3-14). The spatial pattern differs from chlorophyll a (Figure 3-13) which, along with the information presented regarding sample integrity issues, suggests the phytoplankton biomass data may be erroneous. This is further suggested by comparison on spatial patterns for chlorophyll a (Figure 3-13) and zooplankton (Figure 3-15).	Compare phytoplankton counts for 2019 to results from previous years, including overall counts and counts for major groups. Compare chlorophyll a results, in conjunction with biomass and cell counts for phytoplankton, from 2019 to previous years to further examine the validity of the biomass data for 2019.

TOPIC	COMMENT	RECOMMENDATION
APPENDIX VIII, Eutrophication Indicators Report, Section 3.11, Results, Cumulative Effects, p. 68-75	The Eutrophication Indicators section of the 2019 AEMP report presents an assessment of cumulative effects from the Diavik and Ekati mines on eutrophication of Lac de Gras. This assessment considers monitoring data for nutrients from both mines, in conjunction with spatial analysis of conditions in the lake. There is no metric for algae included in this assessment, which as Golder has noted is the metric of relevance for eutrophication (e.g., see p. 15: "As demonstrated by years of monitoring in Lac de Gras, concentrations of TP do not predict the actual biological response to nutrient enrichment. Rather, the increase in the biomass of algae as measured by chlorophyll a has been a useful measure of the effects of nutrient enrichment"). This is particularly relevant for assessing cumulative effects since there may be more complex effects that lead to enhanced productivity. For example, the Diavik Mine may increase nitrogen and the Ekati Mine may increase phosphorus, which collectively could increase phytoplankton abundance. It is noted that available information for 2019 indicates that chlorophyll a was not increased by cumulative effects of the mine (i.e., low concentration measured at the lake outflow). However, this information should be considered in annual reporting.	Include chlorophyll a and phytoplankton biomass metrics in the cumulative effects assessments.
APPENDIX VII, Special Effects Study - Dust Deposition, General	The Special Effects Study examines three lines of evidence to assess the relative effect of dust deposition on water quality and provides useful information. Additional analysis of the snow water chemistry datasets may also be useful for assessing potential effects of dust on bioavailable phosphorus fractions. For example, the dust deposition report only presents total phosphorus results in the discussion. Further review of the various forms of phosphorus (e.g., dissolved vs. total phosphorus) may provide additional insight.	Review snow chemistry dust monitoring results for phosphorus species to assess potential effects on bioavailable phosphorus in Lac de Gras. Additional studies could include dust dissolution studies to characterize effects on phosphorus fractions in water if warranted.
Main Report, Section 8.2, Fish, Methods, Results, Table 8-1, p. 71	Table 8-1 (Action Level Framework) presented in the main document differs from Table 3-20 presented in Appendix V and appears to be in error. As per the WLWB Directive 3Q, comparisons to reference conditions, as opposed to FF area means, in Biological Action Levels 1 and 2 are to be implemented starting with the 2019 AEMP season. Therefore Table 8-1 and associated text appears to be incorrect	Review text and table and revise as required.
APPENDIX V, Fish Report, Section 3.3.12, Results, Stomach Contents, p. 47	There appear to be some differences in the stomach content results between areas (Figure 3-9). Can this information be discussed in terms of the relative abundance of benthic invertebrates measured in these areas?	Include some discussion of the stomach content results in consideration of the benthic invertebrate results.
APPENDIX V, Fish Report, Section 3.4.1, Results, Fish Tissue Chemistry, Statistical Comparisons, p. 53	In 2019, analysis of fish mercury data was conducted by ANCOVA with weight as the covariate; mercury was not significantly higher in NF or MF areas relative to the FF area. It would be useful to present the results in a figure showing regression lines between weight and mercury concentrations, as well as R2 values to assess the strength of the data sets.	Please provide a figure presenting the regressions between fish weight and mercury concentrations.

TOPIC	COMMENT	RECOMMENDATION
APPENDIX V, Fish Report, Section 3.5, Results, Action Level Evaluation, p. 62-63	The report indicates that the differences in fish metrics observed in 2019 relative to reference conditions were consistent with the previous study (2016), but concludes that these differences were not attributable to the mine based on the 2014-2016 AEMP Fish Response Plan (Golder 2017) and, therefore a new Response Plan is not required. The investigation of cause completed in 2016 (Golder 2017) determined that the differences in fish size and relative liver weight observed in 2016 were "inconsistent with a Mine effect, and [was] likely driven by localized variation among study areas". However, one of the reasons given in the 2016 Fish Supplemental Report for attributing the observed differences in fish health to natural variation rather than the mine was that there were no comparable responses in previous years (p. 40, Section 4.3 Ecosystem Interactions of Golder 2017). Based on the results of the 2019 survey, there are now comparable responses in two consecutive studies. This argument also implies that similar effects observed in future monitoring programs would similarly be discounted.	Clarify why a response plan is not required given that the same effects (direction and magnitude) were observed in two consecutive monitoring cycles.
APPENDIX V, Fish Report, Section 4.1, Summary and Conclusions, Fish Population Health, p. 64	The report states that a temporal interaction between 2019 and reference conditions was likely driven by inter-annual differences in regional environmental factors such as weather or temperature. It is further stated that the differences in size of age-1+ fish between the 2019 fish survey and reference conditions were more likely influenced by inter-annual variation in regional environmental factors, such as temperature or timing of freshet and spawning,. The argument presented is that similar differences were not observed in 2019 relative to the FF areas. Given that effluent is known to be affecting FF areas this reasoning is questionable as effects could be occurring to fish in all areas - with the expectation that effects would be greatest in the NF area. The action level assessment has been modified to remove comparisons to FF areas and instead compare results to reference conditions for this reason. Further, if temperature or other environmental factors are believed to be the driver for the observed differences, exploration of these factors is warranted.	Include a formal discussion of the role of other factors (e.g., temperature) in observed differences in fish metrics if this conclusion is retained OR provide an analysis of potential causes in a response plan. If needed to support conclusions that effects observed in 2019 were not mine-related, provide a comparison of FF area data to reference conditions to determine if effects may have occurred in these areas.

TOPIC	COMMENT	RECOMMENDATION
APPENDIX V, Fish Report, Section 4.2, Fish Tissue Chemistry, p. 65	The report concludes: "Considering the marginal increase in molybdenum and relatively stable concentrations of lead, silver, strontium, uranium, and vanadium over time, it is unlikely the response patterns observed in fish health were linked to concentrations of these metals in fish tissue". An increase of 34% (since 2013) for molybdenum could be argued to be substantive or at a minimum not "marginal". The 2014-2016 AEMP Fish Response Plan (Golder 2017) compared molybdenum concentrations to Ninespine Stickleback and Lake Chub from other regional waterbodies and concluded concentrations were similar to the former and higher than the latter and sculpin from other lakes. Comparing the mean (0.051 mg/kg w.w.) concentration for the NF area in 2019 to data presented in Figure 14 (Golder 2017) indicates the mean is notably higher than these regional data sets. It is also noted that molybdenum was higher in the NF area than both the FF and reference conditions (Action Level 1) and the mean was above the normal range (Action Level 2). The 2014-2016 AEMP Fish Response Plan (Golder 2017) indicates: "There are no studies to date, to our knowledge, linking environmentally relevant concentrations of molybdenum to effects on whole-body fish health (i.e., growth or energy use)."	Clarify how the observed absolute concentration and the magnitude of increase in molybdenum concentrations in the NF area in 2019 are marginal and not worthy of further consideration.
APPENDIX V, Fish Report, Section 5, Response Framework, p. 66	The text states that "An action level 2 is identified when a statistical difference between the NF, MF and FF areas is reported and is indicative of changes that could be a toxicological response. The text should read that action levels 1 and 2 are based on comparisons to the reference conditions not the FF area.	Correct text.
APPENDIX V, Fish Report, Section 5, Response Framework, p. 66	The annual report concludes that differences in fish size and relative liver weight observed in 2019 and 2016 were inconsistent with mine effects and were likely driven by localized habitat variation among study areas based on the 2014-2016 AEMP Response Plan Fish - Supplemental Report (Golder 2017). However, the 2016 AEMP Response Plan and the assessment of effects on fish metrics prior to 2019 (including 2016) were based on comparisons between NF and MF areas to the FF areas. This section appears to summarize effects relating to the old data analysis approach. Since this approach has now changed to making comparisons to reference conditions, it is unclear if the conclusions from the 2016 AEMP Response Plan are applicable given the change in the framework and data analysis approach.	Please clarify if the conclusions from the 2014-2016 AEMP Response Plan - Fish Supplemental Report (Golder 2017) are applicable given the change in the approach for analysis of fish metrics.
APPENDIX XV, WOE, Section 4.1, Toxicological Impairment Finding, p. ii	The report states: "However there was uncertainty as to whether these elevated metals in fish tissues were related to the effluent released from the Mine". This statement appears to be an error and appears to be contradicted by previous statements. For example, Section 4.1, Toxicological Impairment Findings (p, 47) states "The AEMP for WQ, sediment quality, and fish tissue chemistry indicate that Mine effluent has resulted in increases in the concentrations of metals and other potentially toxic substances in the NF area."	Correct the text or provide evidence to support this statement.
APPENDIX XV, WOE, Table 2-5, p. 19	There seems to be some disconnect with the endpoints used in the WOE for Fish Health and what appears in Table 2-5. For example, in the Permanence of Effects Rationale column, it is stated that there is a low resilience of fish populations to a high incidence of deformities.	Ensure table is up to date.

4.0 REFERENCES

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