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AQUATIC EFFECTS MONITORING PROGRAM 2015 ANNUAL REPORT – PLAIN LANGUAGE BRIEFING AND TECHNICAL REVIEW COMMENTS

Technical Memorandum # 367-16-05

Prepared for:

Environmental Monitoring Advisory Board (EMAB)
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1.0 BACKGROUND AND SCOPE OF WORK

Diavik Diamond Mines (2012) Inc. (Diavik) submitted the 2015 Aquatic Effects Monitoring Program (AEMP) Annual Report on September 15, 2016 in accordance with Part J, Item 8 of Water Licence W2015L2-0001 (Golder 2016a). The Wek'eezhii Land and Water Board (WLWB) noted the following for the review of the 2015 AEMP (the Report):

- The Report (Part J, Item 8) is meant to consider results obtained in the preceding calendar year (the 2015 sampling year for DDMI in this case);
- The Report should include Action Level exceedance reporting based on the approved Response Framework and submission of a Response Plan for each Action Level that is exceeded;
- The Report should use approved reference conditions, as described in the AEMP Reference Conditions Report (Golder 2015), for evaluating effects for all parameters measured in the AEMP;
- Raw data appendices referred to throughout the Report can be found on the registry; and,
- DDMI's AEMP Design Plan (Version 4.0; Golder 2016b) was submitted to the WLWB on July 14, 2016 and is currently under consideration by the Board.

North/South Consultants Inc. (NSC) conducted a technical review of the 2015 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; plankton; and eutrophication indicators. As directed by EMAB in their Scope of Work for the review, the following points were considered:

- Quality of data collected and analyses;
- Appropriateness of timing for sampling considering seasonal patterns (included a brief review of the AEMP Design Plan Version 4.0, and reviewer comments/ recommendations and Proponent responses available at http://lwbors.yk.com/LWB_IMS/ReviewCommentSub/ViewCommentsPrintFriendly.aspx?id=10962);
- Adequacy of discussion of results;
- Defensibility of conclusions;
- Implications of results, particularly any emerging issues that may indicate substantive environmental changes over time;

- Action Levels that were reached and the required Response Plan for each Action Level exceeded;

- If and when Diavik should revisit the plume delineation study to update results (included a brief review of the AEMP Design Plan Version 4.0, and reviewer comments/ recommendations and Proponent responses available at http://lwbors.yk.com/LWB_IMS/ReviewCommentSub/ViewCommentsPrintFriendly.aspx?id=10962, as well as Federal EEM technical guidance on plume delineation studies [Jacques Whitford Environment Ltd. and Natech Environmental Services Inc. 2003]); and

- Responsiveness to previous NSC recommendations (included a brief review of the 2014 AEMP Annual Report [Golder 2016c], and reviewer comments/recommendations and Proponent responses available at http://lwbors.yk.com/LWB_IMS/ReviewCommentSub/ViewCommentsPrintFriendly.aspx?id=10938).

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

2.0 PLAIN LANGUAGE BRIEFING

The 2015 AEMP Annual Report is generally well written in terms of the objectives and methods being sufficiently detailed, and the results and discussions being well thought out and explained. Where applicable, Action Levels have been assessed appropriately as per the Response Framework. The non-technical summary provided in the main body of the report generally reflected the more detailed information presented in the technical appendices; however, there were some inconsistencies noted. For example:

- Table 1 indicates Action Level 2 was reached by chlorophyll a, however, the text on page 2 of 3 states: "The 2015 AEMP results also indicated that chlorophyll a triggered Action Level 1 in the Response Framework for Indicators of Eutrophication (Table 1)." Action Level 1 is described as being triggered in the Eutrophication Indicators Report (Appendix XIII).

- The Eutrophication Indicators (Section 13.1, page 47) section appears to have been either incorrectly updated or not updated from the 2014 AEMP Annual Report version.

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

- specific items requested by EMAB in their Scope of Work for discussion as part of the 2015 AEMP Annual Report review;

- apparent exceedances of BC dustfall objective for the mining industry at SS3-6 (0-100m station) and SS3-8 (251-1000m station);

- discrepancy in reporting between non-technical summary and technical appendix for exceedances of the effluent quality criteria (EQC) for aluminum, chromium, nickel, and zinc in snow chemistry samples;

- inconsistency in results for algal biomass indicators;

- use of most recent updates for CCME and Health Canada guidelines;

- ammonia data quality;

- potential dust effects at the MF3 area;

- incorporation of nutrient ratios within the discussion of changes in the phytoplankton community;

- use of supporting variables (e.g., light and water temperature conditions) within the discussion of phytoplankton and eutrophication indicators; and

- further assessment of the spatial extent of effects on total nitrogen (TN).

To aid in this discussion, useful tables and figures (and corresponding numbering and captions) are included from the 2015 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 SPECIFIC ITEMS REQUESTED BY EMAB IN SCOPE OF WORK

2.1.1 Appropriateness of Timing for Sampling Considering Seasonal Patterns

In the Board Directive for DDMI's 2011 to 2013 Aquatic Effects Re-evaluation Report, Version 3.1, the WLWB indicated that DDMI was to address the frequency of sampling during the open water season, particularly with respect to detecting nutrient enrichment effects, in Version 4.0 of the AEMP Design. In Version 4.0, DDMI proposed no change to the frequency of sampling during the open water season. In their review of Version 4.0, the WLWB recommended that DDMI revisit the relevance of the 2007-2010 seasonal data in the context of the recent marked increases detected in chlorophyll *a* and describe how a single open water season value is sufficient to capture the full magnitude of change in nutrients and chlorophyll *a* concentration in Lac de Gras. DDMI responded on Oct. 20 and indicated that preliminary evaluation of results for 2015 showed that the effect on chlorophyll *a* has declined spatially (only 10.3% of lake area affected in 2015 in comparison to 40.9% in 2014) and is less than the affected areas observed during the 2007-2010 period. DDMI does not believe collection of seasonal data is necessary as the 2014 AEMP results demonstrated that a single month of open water sampling was capable of detecting the larger spatial effect on chlorophyll *a*. They indicate that the goal of the AEMP is to evaluate potential Mine-related changes on an annual scale and an increase in the frequency of sampling nutrients and chlorophyll *a* is not required to meet the overall objectives of the AEMP. It should be noted that the WLWB response/Board Directive for Version 4.0 is pending (as of 31 Oct. 2016). The earliest an approved Version 4.0 study design would be implemented is for the winter 2017 sampling period (to be reported in the 2017 AEMP Annual Report).

Recommendation: None.

2.1.2 Revisiting the Plume Delineation Study

For DDMI's Water Licence, Schedule 8, Item 1b requires that the AEMP Design Plan includes plume characterization. In their review of Version 4.0 of the AEMP Design, the WLWB asked DDMI if they have any plans to revisit the plume delineation of 2010 to update or confirm these results and if they have any triggers that would help identify when such a study should be revisited. DDMI responded on Oct. 20 that they do not have plans to revisit the plume delineation study of 2010 as it was used to assist with locating AEMP sampling sites and their ongoing analysis of the AEMP has confirmed that the locations are appropriate, and that no formal triggers have been developed. It should be noted that the WLWB response/Board Directive for Version

4.0 is pending (as of 31 Oct. 2016). Additionally, as part of Version 4.0 DDMI proposed the use of calculated total dissolved solids (TDS), rather than barium, as an effluent tracer. DDMI states: "...barium concentration in effluent and in lake water has been decreasing gradually since about 2007, indicating that barium is no longer a reliable effluent tracer. Calculated TDS was identified as a suitable replacement for barium for determining presence/absence of Mine effluent in Lac de Gras. Calculated TDS was selected as a tracer because it is a relatively conservative water quality variable and its concentration in the effluent is relatively high compared to the background concentration in Lac de Gras. Calculated TDS also correlates well with many other water quality SOIs, making it a potentially useful tracer of treated effluent and for representing the general rate of change in concentrations of many SOIs in Lac des Gras."

Technical guidance on how to conduct effluent plume delineation studies to satisfy Environment Canada EEM program requirements for pulp and paper states: "The EEM program requires that effluent plume delineation be conducted only once, provided there are no substantive changes in effluent characteristics, discharge quantity, discharge method or location, or in the hydraulic or hydrographic features of the receiving environment. Plume delineation must be reviewed in the design phase of each subsequent cycle of EEM to evaluate the need for a new delineation." (Jacques Whitford Environment Ltd. and Natech Environmental Services Inc. 2003). Environment Canada guidance for metal mines includes a reference to this document: "For extensive guidance on plume delineation, please consult the *Revised Technical Guidance on How to Conduct Effluent Plume Delineation Studies*, available from Environment Canada (2003) at www.ec.gc.ca/esee-eem/D450E00E-61E4-4219-B27F-88B4117D19DC/PlumeDelineationEn.pdf. This document was prepared for the pulp and paper EEM program but can also be applied to the metal mining EEM program."

It could be reasoned that the changing concentrations of barium in effluent and lake water, and the proposed use of TDS rather than barium as an effluent tracer represent "substantive changes in effluent characteristics".

Recommendation: Revisit the plume delineation of 2010 and update or confirm these results utilizing TDS as the effluent tracer.

2.1.3 Responsiveness to Previous Recommendations

The majority of NSC comments on the 2014 AEMP Annual Report were adequately responded to by DDMI (Sep. 8); however, it should be noted that the WLWB response/Board Directive is pending (as of 31 Oct. 2016) for the 2014 AEMP Annual Report.

The following comment has not been addressed in the 2015 AEMP Annual Report:

Effluent and Water Chemistry, Appendix II, Table 2-5, page 13 - Several elements are listed under both ""major ions"" and ""total metals"" (e.g., calcium and sodium) but different

concentrations are given. Presumably this is because the concentrations listed under ""major ions"" are dissolved concentrations and the latter are total concentrations; however, this is not clearly defined for the reader."

Recommendation: Update table to clearly indicate that the concentrations given under major ions are dissolved. DDMI indicated in their Sep. 8 response that concentrations listed under "major ions" would be clearly indicated as dissolved in future reports; however, this was not done for the 2015 Annual Report, possibly due to limitations around timelines for review and preparation of the subsequent Annual Report.

2.2 EXCEEDANCES OF BC DUSTFALL OBJECTIVE

The non-technical summary and technical appendix for dust indicate that the 2015 dustfall rates were lower than the British Columbia dustfall objective for the mining industry (1.7 to 2.9 $mg/dm^2/d$; 621 to 1059 $mg/dm^2/yr$). Table 2-1, however, indicates that site SS3-6 had an annual rate of dustfall of 1,013 $mg/dm^2/yr$. Assuming a straight calculation to daily rates, this value is higher than the lower BC objective level. Similarly, the rate for site SS3-8 (670 $mg/dm^2/yr$ or 1.84 $mg/dm^2/d$) is above the lower end of the BC objective range (1.7 $mg/dm^2/d$).

Recommendation: Modify the text to reflect these exceedances or add explanatory text if required to clarify the interpretation of these data.

2.3 EXCEEDANCES OF EFFLUENT QUALITY CRITERIA FOR SNOW CHEMISTRY

Page ii of the Executive Summary (non-technical summary) indicates: "Dust deposition rates in 2015 were higher than in 2014. Deposition rates were highest close to the project infrastructure and decreased with distance from the Mine. Snow chemistry analyte concentrations were below the effluent concentration limits in the Water Licence." A similar statement is included in Section 2.3.3 (page 14): "Concentrations of metals in snow melt water were below their associated EQC values."

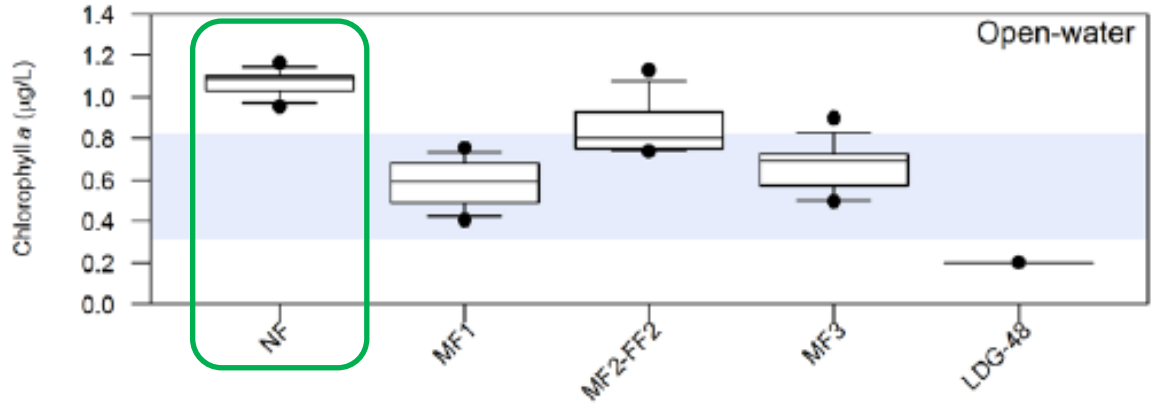
These statements contradict the results presented in Appendix I, Section 3.3 which indicate exceedances of the effluent concentration limits occurred for aluminum, chromium, nickel and zinc in one or two snow chemistry samples. Text excerpt provided here for reference: "All 2015 sample concentrations were less than their associated reference levels as specified by the “maximum concentration of any grab sample” specified in Water Licence W2015L2-0001 except some of the results from the SS3-6 snow core. SS3-6 aluminum, chromium, nickel and zinc concentrations were greater than the respective reference levels. SS3-6 is 60 m from the Project (second closest sample location) and had the highest residue mass per filter (391.7 mg) of any of the snow core samples."

Recommendation: Revise the non-technical summary to reflect the exceedances of the EQC values that occurred at site SS3-6 and the occurrence of an aluminum value that was at the EQC at site SS3-8.

2.4 ALGAL BIOMASS INDICATORS

As noted in Plankton, Appendix XI, there are some potential discrepancies respecting the various phytoplankton metrics evaluated, notably in relation to previous years of monitoring. It is noted that these discrepancies may be related to a change in taxonomists (change happened for 2013). It is noteworthy that the chlorophyll *a* data set indicated concentrations above the normal reference range in the near-field area (indicative of nutrient enrichment), but the phytoplankton biomass data showed lower mean levels relative to reference conditions (indicative of toxicological impairment). DDMI indicates that there is no obvious explanation for the discrepancy in the results between the two algal biomass indicators (i.e., chlorophyll *a* results reported by the Eutrophication Indicators component in contrast with total phytoplankton and cyanobacteria biomass).

It would be useful with respect to interpretation of potential toxicological and nutrient eutrophication responses of phytoplankton to compare chlorophyll *a* concentrations to phytoplankton taxonomic data (i.e., to assess whether chlorophyll *a* is the most sensitive metric for assessing effects related to the eutrophication response pathway). Although chlorophyll *a* provides an indication of phytoplankton biomass, it may not be directly related to biomass as the proportion of pigment varies from 0.3-3.0% of dry weight among algal species (Lee 1980).



Note: The normal range is delineated by the shaded area.
NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

Figure 3-13 Concentration of chlorophyll a in Lac de Gras during the open water season, 2015 (after Golder 2016a)

Table 3-1 Phytoplankton biomass and taxonomic richness in Lac de Gras in 2015 compared to the normal range and the reference area mean (after Golder 2016a)

Variable	Unit	2015 Near-Field (NF)		Normal Range[a] and Reference Area Mean			
		n	Mean[b] ± SD	*n*	Lower Limit	2007-2010 Reference Area Mean	Upper Limit
Cyanobacteria Biomass	mg/m³	5	**10*** ± 10	58	5	41	134
Microflagellate Biomass	mg/m³	5	40^{ns} ± 10	60	1	63	119
Chlorophyte Biomass	mg/m³	5	91^{ns} ± 35	60	26	94	175
Diatom Biomass	mg/m³	5	20^{ns} ± 10	58	5	30	66
Dinoflagellate Biomass	mg/m³	5	0^{ns}	56	0	2	19
Total Phytoplankton Biomass	mg/m³	5	**161*** ± 35	61	140	238	352
Taxonomic Richness	Taxa[c]	5	25^{ns} ± 3	62	12	18	25

Note: **Bolded** 2015 mean is significantly lower than the 2007-2010 reference area mean.

a) Normal ranges were obtained from the AEMP Reference Conditions Report Version 1.1 (Golder 2015a).

b) Results of one-tailed statistical tests comparing 2015 NF area mean to 2007-2010 reference area mean: ns = not significant, $P>0.1$; * = significantly lower than reference area mean, $P<0.1$.

c) Taxonomic richness is the number of taxa at the genus level.

± = plus or minus; SD = standard deviation; n = number of samples.

Recommendation: Assess the relationship between chlorophyll *a* and phytoplankton abundance and biomass using available data to determine if chlorophyll *a* is a sufficient indicator for assessing eutrophication effects on phytoplankton. An inter-laboratory comparison for phytoplankton is also recommended to assess the change in biomass metrics over time (that may be related to a change in taxonomists) and the relationship(s) between chlorophyll *a* and other biomass estimates. It is also suggested that the QA/QC program for phytoplankton include a duplicate measurement of biovolume in addition to a recount of the number of cells/L.

2.5 USE OF MOST RECENT UPDATES FOR CCME AND HEALTH CANADA GUIDELINES

Appendix II (Effluent and Water Chemistry) references "CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Water Quality Guidelines. Prepared by the Task Force on Water Quality Guidelines of the Canadian Council of Ministers of the Environment. With updates to 2006. Ottawa, ON."

Appendix II also references "Health Canada. 2006. Guidelines for Canadian Drinking Water Quality Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. www.healthcanada.gc.ca/waterquality."

Recommendation: Confirm that the most recent CCME updates (or current to the time of preparation of the 2015 AEMP Annual Report) were applied for reporting. Confirm that the most recent Health Canada DWQGs were applied for reporting (i.e., Health Canada. 2014. Guidelines

for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.)

2.6 AMMONIA DATA QUALITY

Quality control (QC) analyses for 2011-2014 AEMP Annual Reports identified data quality issues for ammonia analyzed by Maxxam (i.e., higher concentrations in blank samples in comparison to lake water and concentrations in lake water higher than historic values provided by ALS); as a result, the evaluation of Action Levels for ammonia was problematic as it is based on comparisons of annual Maxxam results with ALS reference conditions. For 2015, Maxxam developed a QA/QC procedure and updated analytical method to address the ammonia data quality issues – Maxxam has recommended a new low level ammonia test method that uses a non-linear (quadratic) calibration method. The revised analytical approach and support for its use are provided in Appendix D and the 2015 data have been summarized using both methods (i.e., new quadratic method and linear calibration method used since 2011); however, there does not appear to be an assessment of the comparability of the 2015 data using the new Maxxam method with the historic ALS data or discussion of any implications for ammonia data analysis going forward.

Recommendation: Provide an assessment of the comparability of the 2015 data (new Maxxam method) with the historic ALS data (i.e., used to describe reference conditions), and describe any implications for ammonia data analysis going forward (e.g., for the 2014-2016 three year summary report).

2.7 POTENTIAL DUST EFFECTS AT THE MF3 AREA

Figures 3-35 and 3-37 (pages 65 and 67, Effluent and Water Chemistry, Appendix II) indicate relatively high aluminum and chromium concentrations in the MF3 area in the open-water season. Results of the dust monitoring program indicated high concentrations of both of these metals (as well as nickel and zinc) in snow water southeast of the mine and near the water quality site MF3-2. Action Level 1 was not triggered for the open-water season for total aluminum or chromium because the NF results were not in exceedance of the Action Level 1 triggers. However, results from the MF3 area were in exceedance of the triggers. Given the results of the dust/snow chemistry program in 2015 in conjunction with the water quality program, it appears possible that there were effects related to dust in the MF3 area. In addition, given that high concentrations of nickel and zinc (i.e., above the effluent concentration limits) were also measured in the snow chemistry program in the vicinity of site MF3-2, consideration of potential effects or changes in these metals in surface water should also be included in the assessment of water quality effects (i.e., as SOIs). It is acknowledged that effects of dust deposition will be explicitly included in reporting moving forward as per the AEMP Study Design Version 4.0 document.

Recommendation: Given that the AEMP Study Design Version 4.0 document has already been developed and includes explicit assessment of the potential effects of dust on water quality, include a discussion of the MF results from the 2015 AEMP Annual Report as they may relate to dust effects, including application of the SOI procedure for assessing potential effects related to dust in all monitored areas. Additionally, consider other sources of these metals (e.g., contribution of metals from A21 dike construction activities) in this assessment.

2.8 NUTRIENT RATIOS

Plankton, Appendix XI, notes that: "Most species of cyanobacteria are capable of fixing atmospheric nitrogen (N_2), giving them a competitive edge in N-limited systems. In Lac de Gras however, the N-load from the treated Mine effluent may be sufficient to cause increased P-limitation, thereby limiting the competitive advantage of cyanobacteria over other groups." It would be useful to consider and present nitrogen to phosphorus ratios within discussions of phytoplankton taxonomy, notably in relation to cyanophytes (i.e., do nutrient ratios suggest P or N limitation and have the ratios changed over time).

Recommendation: Present nutrient ratios within the discussion of effects/changes in the phytoplankton community, notably with respect to potential changes in the ratios over time.

2.9 USE OF SUPPORTING VARIABLES

Light and temperature conditions may have profound effects on phytoplankton growth, abundance, and even taxonomic composition, yet there is no consideration of these variables within the discussion of phytoplankton or eutrophication in the technical appendices (appendices XI and XIII). Additionally, Secchi disk depth is a metric under the AEMP (see Golder Associates Inc. 2016b. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program Study Design Version 4.0. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, July 2016) yet the results are not presented in the 2015 Annual Report or in the raw datasets provided. A similar comment was raised as part of the review of the AEMP Study Design Version 4.0 document.

Recommendation: Include a summary of key supporting variables, including but not necessarily limited to Secchi disk depth and water temperature, within the discussion of results regarding phytoplankton data.

2.10 SPATIAL EXTENT OF EFFECTS ON TOTAL NITROGEN

The assessment of eutrophication indicators data concluded that the Mine is having a nutrient enrichment effect in Lac de Gras, but the spatial extent of the effect in 2015 was smaller than in 2014 for variables (i.e., chlorophyll *a*, total phosphorus, zooplankton biomass) other than total nitrogen (TN). Year-to-year variability in the spatial extent of effects on TN appears to be less in comparison to other eutrophication indicators and has exceeded 40% in 2014 and 2015. It should

be noted that the concentration of TN was above the normal range at the outlet of Lac de Gras, implying an input other than the Mine effluent.

Recommendation: Potential reasons for comparatively less year-to-year variability in TN in comparison to other eutrophication indicators should be discussed. Additionally, comment on the continued large spatial extent of effects on TN in 2015 in comparison to the reduction of extent for other parameters (i.e., total phosphorus, chlorophyll a, zooplankton biomass). Additional input(s) affecting TN concentration in Lac de Gras may be a contributing factor and should be considered in this discussion.

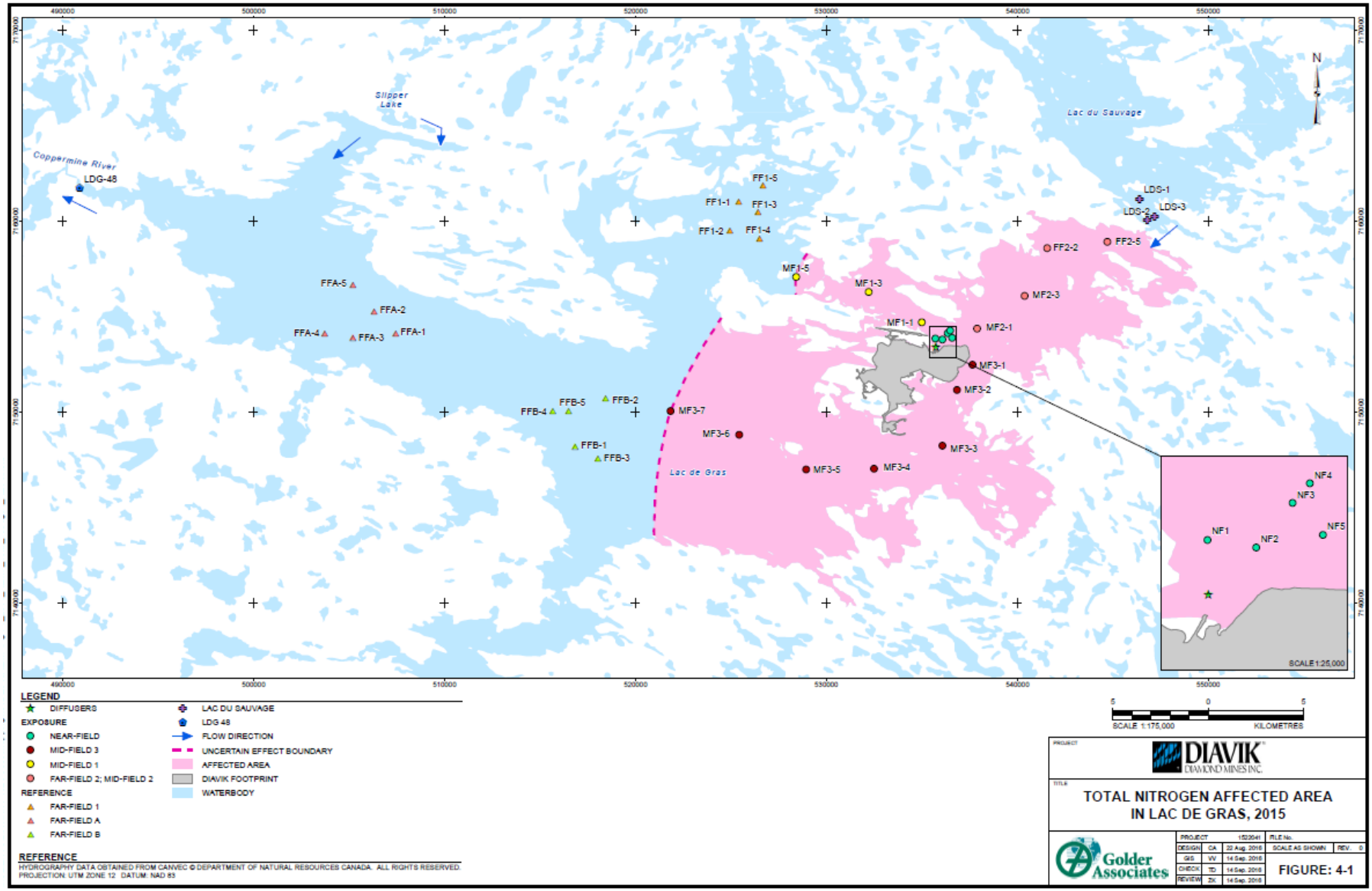


Figure 4-1 Total nitrogen affected area in Lac de Gras, 2015 (after Golder 2016)

2.11 SPECIFIC AEMP COMPONENT REVIEWS

Detailed technical review comments and recommendations are provided in the following Table 1; these are also provided in the Excel comments template as required for submission to the WLWB.

Table 1. Technical review comments and recommendations on the AEMP 2015 Annual Report

TOPIC	COMMENT	RECOMMENDATION
GENERAL COMMENT, If and when DDMI should revisit the plume delineation study to update results	For DDMI's Water Licence, Schedule 8, Item 1b requires that the AEMP Design Plan includes plume characterization. In the review of Version 4.0 of the AEMP Design, the WLWB asked DDMI if they have any plans to revisit the plume delineation of 2010 to update or confirm these results and if they have any triggers that would help identify when such a study should be revisited. DDMI responded on Oct. 20 that they do not have plans to revisit the plume delineation study of 2010 as it was used to assist with locating AEMP sampling sites and their ongoing analysis of the AEMP has confirmed that the locations are appropriate, and that no formal triggers have been developed. It should be noted that the WLWB response/Board Directive for Version 4.0 is pending (as of 28 Oct. 2016). Additionally, as part of Version 4.0 DDMI proposed the use of calculated total dissolved solids (TDS), rather than barium, as an effluent tracer. DDMI states: "...barium concentration in effluent and in lake water has been decreasing gradually since about 2007, indicating that barium is no longer a reliable effluent tracer. Calculated TDS was identified as a suitable replacement for barium for determining presence/absence of Mine effluent in Lac de Gras. Calculated TDS was selected as a tracer because it is a relatively conservative water quality variable and its concentration in the effluent is relatively high compared to the background concentration in Lac de Gras. Calculated TDS also correlates well with many other water quality SOIs, making it a potentially useful tracer of treated effluent and for representing the general rate of change in concentrations of many SOIs in Lac des Gras."	(CONTINUED BELOW)

TOPIC	COMMENT	RECOMMENDATION
GENERAL COMMENT, If and when DDMI should revisit the plume delineation study to update results (CONTINUED)	Technical guidance on how to conduct effluent plume delineation studies to satisfy Environment Canada EEM program requirements for pulp and paper states: "The EEM program requires that effluent plume delineation be conducted only once, provided there are no substantive changes in effluent characteristics, discharge quantity, discharge method or location, or in the hydraulic or hydrographic features of the receiving environment. Plume delineation must be reviewed in the design phase of each subsequent cycle of EEM to evaluate the need for a new delineation." (Jacques Whitford Environment Ltd. and Natech Environmental Services Inc. 2003). Environment Canada guidance for metal mines includes a reference to this document: “For extensive guidance on plume delineation, please consult the Revised Technical Guidance on How to Conduct Effluent Plume Delineation Studies, available from Environment Canada (2003) at www.ec.gc.ca/esee-eem/D450E00E-61E4-4219-B27F-88B4117D19DC/PlumeDelineationEn.pdf. This document was prepared for the pulp and paper EEM program but can also be applied to the metal mining EEM program.” It could be reasoned that the changing concentrations of barium in effluent and lake water, and the proposed use of TDS rather than barium as an effluent tracer represent "substantive changes in effluent characteristics".	Revisit the plume delineation of 2010 and update or confirm these results utilizing TDS as the effluent tracer.
MAIN DOCUMENT, Table 1, pages 2 of 3 and 3 of 3	Table 1 indicates Action Level 2 was reached by chlorophyll a, however, the text on page 2 of 3 states: "The 2015 AEMP results also indicated that chlorophyll a triggered Action Level 1 in the Response Framework for Indicators of Eutrophication (Table 1)."	Correct Table 1.

TOPIC	COMMENT	RECOMMENDATION
MAIN DOCUMENT, Table 1, pages 2 of 3 and 3 of 3	Action Level exceedances documented by the AEMP in 2015 are summarized in Table 1. As part of the AEMP Response Plan, the ecological implication of an Action Level exceedance for a parameter is to be described. In Table 1, the ecological implication of an exceedance is stated to be: "Not Ecologically Significant"; however, this statement is not defined.	Describe what is meant by "Not Ecologically Significant" for each parameter with an Action Level exceedance.
MAIN DOCUMENT, Section 2.3.2 and Table 2-1, pages 10 to 12 and 14; DUST DEPOSITION, APPENDIX I, page i and Section 3.2, page 3-11	The report indicates that the 2015 dustfall rates were lower than the British Columbia dustfall objective for the mining industry (1.7 to 2.9 mg/dm2/d; 621 to 1059 mg/dm2/yr). Table 2-1, however, indicates that site SS3-6 had an annual rate of dustfall of 1,013 mg/dm2/yr. Assuming a straight calculation to daily rates, this value is higher than the lower BC objective level. Similarly, the rate for site SS3-8 (670 mg/dm2/yr or 1.84 mg/dm2/d) is above the lower end of the BC objective range (1.7 mg/dm2/d).	Modify the text to reflect these exceedances or add explanatory text if required to clarify the interpretation of these data.

TOPIC	COMMENT	RECOMMENDATION
MAIN DOCUMENT, Executive Summary, page ii, and Section 2.3.3, page 13; DUST DEPOSTION, APPENDIX I, Section 3.3	Page ii of the Executive Summary indicates: "Dust deposition rates in 2015 were higher than in 2014. Deposition rates were highest close to the project infrastructure and decreased with distance from the Mine. Snow chemistry analyte concentrations were below the effluent concentration limits in the Water Licence." A similar statement is included in Section 2.3.3 (page 14): "Concentrations of metals in snow melt water were below their associated EQC values." These statements contradict the results presented in Appendix I, Section 3.3 which indicate exceedances of the effluent concentration limits occurred for aluminum, chromium, nickel and zinc in one or two snow chemistry samples. Text excerpt provided here for reference: "All 2015 sample concentrations were less than their associated reference levels as specified by the “maximum concentration of any grab sample” specified in Water Licence W2015L2-0001 except some of the results from the SS3-6 snow core. SS3-6 aluminum, chromium, nickel and zinc concentrations were greater than the respective reference levels. SS3-6 is 60 m from the Project (second closest sample location) and had the highest residue mass per filter (391.7 mg) of any of the snow core samples."	Revise the Main Document to reflect the exceedances of the EQC values that occurred at site SS3-6 and the occurrence of an aluminum value that was at the EQC at site SS3-8.
MAIN DOCUMENT, Snow Water Chemistry, Section 2.3.3, page 14	The text reads: "In general, analyte concentrations in snow melt water decreased with distance from the Mine site. High and variable concentrations for aluminum, chromium and nickel were recorded at stations SS3-8 and SS4-4. Selected metal concentrations at these two locations were more than double the concentrations recorded at other stations." However, the highest concentrations of aluminum, chromium, nickel, and zinc (concentrations that were in fact in exceedance of the effluent quality criteria) occurred at site SS3-6.	Revise text to include discussion of results for site SS3-6.

TOPIC	COMMENT	RECOMMENDATION
MAIN DOCUMENT, Section 6.3, page 39, PLANKTON, APPENDIX XI, AND EUTROPHICATION INDICATORS, APPENDIX XIII: Phytoplankton General Comment	As noted in Plankton, Appendix XI, there are some potential discrepancies respecting the various phytoplankton metrics evaluated, notably in relation to previous years of monitoring. It is noted that these discrepancies may be related to a change in taxonomists (change happened for 2013). It is noteworthy that the chlorophyll a data set indicated concentrations above the normal reference range in the near-field area (indicative of nutrient enrichment), but the phytoplankton biomass data showed lower mean levels relative to reference conditions (indicative of toxicological impairment). DDMI indicates that there is no obvious explanation for the discrepancy in the results between the two algal biomass indicators (i.e., chlorophyll a results reported by the Eutrophication Indicators component in contrast with total phytoplankton and cyanobacteria biomass). It would be useful with respect to interpretation of potential toxicological and nutrient eutrophication responses of phytoplankton to compare chlorophyll a concentrations to phytoplankton taxonomic data (i.e., to assess whether chlorophyll a is the most sensitive metric for assessing effects related to the eutrophication response pathway). Although chlorophyll a provides an indication of phytoplankton biomass, it may not be directly related to biomass as the proportion of pigment varies from 0.3-3.0% of dry weight among algal species (Lee 1980).	Assess the relationship between chlorophyll a and phytoplankton abundance and biomass using available data to determine if chlorophyll a is a sufficient indicator for assessing eutrophication effects on phytoplankton. An inter-laboratory comparison for phytoplankton is also recommended to assess the change in biomass metrics over time (that may be related to a change in taxonomists) and the relationship(s) between chlorophyll a and other biomass estimates. It is also suggested that the QA/QC program for phytoplankton include a duplicate measurement of biovolume in addition to a recount of the number of cells/L.

TOPIC	COMMENT	RECOMMENDATION
MAIN DOCUMENT, Section 13.1, Eutrophication Indicators, page 47	This section appears to have been either incorrectly updated or not updated from the 2014 AEMP Annual Report version. For example, it indicates that zooplankton biomass data are not available for 2015 (however, 2015 zooplankton biomass data are presented for both Eutrophication Indicators [Section 4] and Plankton [Section 6]) and that in 2015, greater than or equal to 40.9% of the lake area had chlorophyll a concentrations above the normal range (however, 2015 results indicated a spatial extent of effects of 10.3%, Section 4.3, page 30).	Review text and update to reflect 2015 AEMP results.
DUST DEPOSITION, APPENDIX I, Section 3 and Figure 3.1-1, pages 3-1 and 3-2	This section indicates that the main sources of dust were associated with upaved road and airstrip usage, construction activities at A21, and truck traffic along the ice road to the Project. Figure 3.1-1 would benefit from having the primary sources of dust labelled (e.g., airstrip, A21).	Label/indicate primary sources of dust on Figure 3.1-1.
DUST DEPOSITION, APPENDIX I, Section 3.3, page 3-12: Snow Chemistry	For snow chemistry, the 2015 Annual Report indicates that "It should be noted that the 0-100 zone has one (1) sampling location; therefore, no median was reported and are not included in Figures 3.3-1 to 3.3-4." While this is understood, it would be useful for reviewers to see the data for the single station plotted on these figures, in particular given that exceedances for several metals were observed for this station in 2015.	Include results for Station SS3-6 on Figures 3.3-1 to 3.3-4.
DUST DEPOSITION, APPENDIX I, Section 3.3.5, page 3-14	It would be pertinent to point out that the median chromium concentrations measured in snow water were highest in 2015 in the control zone and provide discussion regarding potential reasons for this observation.	Indicate that chromium was highest in the control zone in 2015 and provide discussion concerning the potential reasons for this increase as well as any discussion regarding how this observation may affect the interpretation of results for other zones.

TOPIC	COMMENT	RECOMMENDATION
DUST DEPOSITION, APPENDIX I, Section 3.4, pages3-17 to 3-19)	The results of the snow chemistry program indicated relatively high levels of variability between duplicate samples (i.e., relative percent mean differences of the pre-defined benchmark [> 20%]), but the QA/QC data, including the results of duplicate samples, are not presented. Similarly, while the results of the blank sample are presented in Table 3.4-1, the analytical detection limits are not presented and are required to evaluate the results of the blank sample. Overall, there is a limited ability to critically review the results of the snow chemistry QA/QC program with the information as its provided.	Provide a table of all QA/QC sample results, including analytical detection limits.
EFFLUENT AND WATER CHEMISTRY, APPENDIX II, Section 2.2 and Table 2-2, page 6	The detection limit indicated in Table 2-2 for mercury (0.01 ug/L) does not agree with the detection limits indicated in the raw datasets (Appendix E: 0.002 ug/L).	Correct the value in Table 2-2.
EFFLUENT AND WATER CHEMISTRY, APPENDIX II, Section 2.3.4.1, pages 14 to 16	The report references "CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Water Quality Guidelines. Prepared by the Task Force on Water Quality Guidelines of the Canadian Council of Ministers of the Environment. With updates to 2006. Ottawa, ON."	Confirm that the most recent updates (or current to the time of preparation of this report) were applied for reporting.
EFFLUENT AND WATER CHEMISTRY, APPENDIX II, Section 2.3.4.1, pages 14 to 16	The report references "Health Canada. 2006. Guidelines for Canadian Drinking Water Quality Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. www.healthcanada.gc.ca/waterquality."	Confirm that the most recent Health Canada DWQGs were applied for reporting. Reference: Health Canada. 2014. Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

TOPIC	COMMENT	RECOMMENDATION
EFFLUENT AND WATER CHEMISTRY, APPENDIX II, Section 2.4, pages 16-17 and Appendix D	Quality control (QC) analyses for 2011-2014 AEMP Annual Reports identified data quality issues for ammonia analyzed by Maxxam (i.e., higher concentrations in blank samples in comparison to lake water and concentrations in lake water higher than historic values provided by ALS); as a result, the evaluation of Action Levels for ammonia was problematic as it is based on comparisons of annual Maxxam results with ALS reference conditions. For 2015, Maxxam developed a QA/QC procedure and updated analytical method to address the ammonia data quality issues – Maxxam has recommended a new low level ammonia test method that uses a non-linear (quadratic) calibration method. The revised analytical approach and support for its use are provided in Appendix D and the 2015 data have been summarized using both methods (i.e., new quadratic method and linear calibration method used since 2011); however, there does not appear to be an assessment of the comparability of the 2015 data using the new Maxxam method with the historic ALS data or discussion of any implications for ammonia data analysis going forward.	Provide an assessment of the comparability of the 2015 data (new Maxxam method) with the historic ALS data (i.e., used to describe reference conditions), and describe any implications for ammonia data analysis going forward (e.g., for the 2014-2016 three year summary report).
EFFLUENT AND WATER CHEMISTRY, APPENDIX II, Section 3.3, page 44	The report indicates: "The greatest declines in DO near the lake bottom were measured at stations MF1-5 and MF1-1, where near-bottom DO concentrations were at or below the effects benchmark of 6.5 mg/L for the protection of aquatic life, for “other” life stages (i.e., non-early life stages)." The more stringent guideline (9.5 mg/L) is arguably the more appropriate and more conservative benchmark to apply for the ice-cover season given the presence of fall-spawning fish (i.e., Lake Trout).	Revise the text to reflect application of the 9.5 mg/L benchmark for the period in which early life stages of Lake Trout may be present. Comment on whether or not the lower DO concentrations observed are mine-related.

TOPIC	COMMENT	RECOMMENDATION
EFFLUENT AND WATER CHEMISTRY, APPENDIX II, Section 3.4 and Figures 3-35 and 3-37, pages 48 to 73	Figures 3-35 and 3-37 (pages 65 and 67, Effluent and Water Chemistry, Appendix II) indicate relatively high aluminum and chromium concentrations in the MF3 area in the open-water season. Results of the dust monitoring program indicated high concentrations of both of these metals (as well as nickel and zinc) in snow water southeast of the mine and near the water quality site MF3-2. Action Level 1 was not triggered for the open-water season for total aluminum or chromium because the NF results were not in exceedance of the Action Level 1 triggers. However, results from the MF3 area were in exceedance of the triggers. Given the results of the dust/snow chemistry program in 2015 in conjunction with the water quality program, it appears possible that there were effects related to dust in the MF3 area. In addition, given that high concentrations of nickel and zinc (i.e., above the effluent concentration limits) were also measured in the snow chemistry program in the vicinity of site MF3-2, consideration of potential effects or changes in these metals in surface water should also be included in the assessment of water quality effects (i.e., as SOIs). It is acknowledged that effects of dust deposition will be explicitly included in reporting moving forward as per the AEMP Study Design Version 4.0 document.	Given that the AEMP Study Design Version 4.0 document has already been developed and includes explicit assessment of the potential effects of dust on water quality, include a discussion of the MF results from the 2015 AEMP Annual Report as they may relate to dust effects, including application of the SOI procedure for assessing potential effects related to dust in all monitored areas. Additionally, consider other sources of these metals (e.g., contribution of metals from A21 dike construction activities) in this assessment.
EFFLUENT AND WATER CHEMISTRY, APPENDIX II, Appendix C, page C-2	As part of DDMI's data management system, laboratory data are reviewed immediately after receipt from the analytical laboratory. Does this review include follow-up communications with the laboratory regarding any anomalous values (e.g., requesting re-runs for specific samples)? Does the data manager assess duplicates and blanks during the sampling program or once data for the entire program are available? If done during the sampling program, there may be a greater ability to correct problems as they arise (e.g., ammonia data quality issues).	Provide additional description of/clarification for DDMI's data validation procedures.

TOPIC	COMMENT	RECOMMENDATION
EFFLUENT AND WATER CHEMISTRY, APPENDIX II (Appendix E) AND EUTROPHICATION INDICATORS, APPENDIX XIII (Appendix D): General Comment	Raw in situ results are not provided in the data appendices and the 2015 Annual Report only presents mean values for depth profiles collected in the NF area. There may be substantive variability among stations, including potential occurrences of critically low DO conditions, which can not be ascertained from the information as it is presented.	Provide raw in situ water quality data (including Secchi disk depths) and include discussion of results for individual NF sites where conditions were unusual or notable. In particular include a discussion of instances where sites were thermally stratified and/or experienced DO concentrations below the benchmarks of 6.5 mg/L and 9.5 mg/L. If conditions are similar across NF sites, please include a statement to that effect.
PLANKTON, APPENDIX XI, Section 2.2.2, page 4; Section 2.3.2, page 6	For the zooplankton community, 11 samples, consisting of duplicates from each of five NF stations and an additional split sample from one station, were submitted for analysis of taxonomic composition. Zooplankton community analysis does not indicate how results from duplicates and split were handled (e.g., are abundance and biomass data presented separately for duplicates or as a mean of the two samples).	Clarify the presentation of results of duplicate and split samples as either individual or mean values.
PLANKTON, APPENDIX XI, Section 4.1, page 13	The 2015 Annual Report notes that: "Most species of cyanobacteria are capable of fixing atmospheric nitrogen (N2), giving them a competitive edge in N-limited systems. In Lac de Gras however, the N-load from the treated Mine effluent may be sufficient to cause increased P-limitation, thereby limiting the competitive advantage of cyanobacteria over other groups." It would be useful to consider and present nitrogen to phosphorus ratios within discussions of phytoplankton taxonomy, notably in relation to cyanophytes (i.e., do nutrient ratios suggest P or N limitation and have the ratios changed over time).	Present nutrient ratios within the discussion of effects/changes in the phytoplankton community, notably with respect to potential changes in the ratios over time.
PLANKTON, APPENDIX XI, Section 4.1, page 13	It would be useful to identify that the sublethal toxicity testing conducted in 2015 indicated that effluent stimulated phytoplankton growth (as presented in Appendix II, Section 3.2.5) to provide additional information for interpreting results.	Include statements on effluent toxicity results in discussions related to the phytoplankton community.

TOPIC	COMMENT	RECOMMENDATION
PLANKTON, APPENDIX XI AND EUTROPHICATION INDICATORS, APPENDIX XIII: Phytoplankton General Comment	Light and temperature conditions may have profound effects on phytoplankton growth, abundance, and even taxonomic composition, yet there is no consideration of these variables within the discussion of phytoplankton or eutrophication in the technical appendices. Additionally, Secchi disk depth is a metric under the AEMP (see Golder Associates Inc. 2016b. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program Study Design Version 4.0. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, July 2016) yet the results aren't presented in the 2015 Annual Report or in the raw datasets provided. A similar comment was raised as part of the review of the AEMP Study Design Version 4.0 document.	Include a summary of key supporting variables, including but not necessarily limited to Secchi disk depth and water temperature, within the discussion of results regarding phytoplankton data.
EUTROPHICATION INDICATORS, APPENDIX XIII, Section 3.5 and Figure 3-19, page 32	Action Level 3 value is not visible on Figure 3-19.	Revise Figure 3-19.
EUTROPHICATION INDICATORS, APPENDIX XIII, Section 3.4, Section 4.3 and Table 4-1, pages 27, 35 and 36	The assessment of eutrophication indicators data concluded that the Mine is having a nutrient enrichment effect in Lac de Gras, but the spatial extent of the effect in 2015 was smaller than in 2014 for variables (i.e., chlorophyll a, total phosphorus, zooplankton biomass) other than total nitrogen (TN). Year-to-year variability in the spatial extent of effects on TN appears to be less in comparison to other eutrophication indicators and has exceeded 40% in 2014 and 2015. It should be noted that the concentration of TN was above the normal range at the outlet of Lac de Gras, implying an input other than the Mine effluent.	Potential reasons for comparatively less year-to-year variability in TN in comparison to other eutrophication indicators should be discussed. Additionally, comment on the continued large spatial extent of effects on TN in 2015 in comparison to the reduction of extent for other parameters (i.e., total phosphorus, chlorophyll a, zooplankton biomass). Additional input(s) affecting TN concentration in Lac de Gras may be a contributing factor and should be considered in this discussion.
EUTROPHICATION INDICATORS, APPENDIX XIII, Appendix D (raw data)	Chlorophyll a data are not included in Appendix D.	Provide chlorophyll a data in the raw data appendices.

3.0 SUPPORTING MATERIALS FOR REVIEW

Golder (Golder Associates Inc.). 2015. AEMP Reference Conditions Report Version 1.1. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, September 2015.

Golder. 2016a. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program 2015 Annual Report. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, September 2016.

Golder. 2016b. Diavik Diamond Mines Inc. Aquatic Effects Monitoring Program Study Design Version 4.0. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, July 2016.

Golder. 2016c. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program 2014 Annual Report. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, March 2016.

Jacques Whitford Environment Ltd. and Natech Environmental Services Inc. 2003. Revised Technical Guidance on how to Conduct Effluent Plume Delineation Studies. Final Report to Environment Canada. March 2003.

Lee, R.E. 1980. Phycology. Cambridge University Press, New York, NY. 478 pp.