Dominion Diamond Ekati Corporation

EKATI DIAMOND MINE
Aquatic Effects Monitoring Program Plan for 2013 to 2015

DOMINION DIAMOND

Rescan™ Environmental Services Ltd.
Suite 908-5201 50th Avenue
Yellowknife, NT Canada X1A 3S9
Tel: (867) 920-2090 Fax: (867) 920-2015

April 2013

April 29, 2013

Ms. Violet Camsell-Blondin
Chair
Wek'èezhìi Land and Water Board
#1, 4905-48th Street
Yellowknife, NT, CA X1A 2P6

Dear Ms. Camsell-Blondin:

Dominion Diamond Ekati Corporation (DDEC) is pleased to submit the *Ekati Diamond Mine Aquatic Effects Monitoring Program Plan for 2013 to 2015.* This report is submitted under Part J Items 1 and 2 of Water Licence W2009L2-0001.

On April 10, 2013, Dominion Diamond Corporation (the "Company") acquired from BHP Billiton Canada Inc. (and its various affiliates) all of BHP Billiton's diamond assets, including BHP Billiton's controlling interest in the Ekati Diamond Mine as well as the associated diamond sorting and sales facilities in Yellowknife, Northwest Territories and Antwerp, Belgium. The Ekati Diamond Mine consists of the Core Zone, which includes the current operating mine and other permitted kimberlite pipes, as well as the Buffer Zone, an adjacent area hosting kimberlite pipes having both development and exploration potential. As of the closing of the transaction, the Company acquired BHP Billiton's 80% interest in the Core Zone and 58.8% interest in the Buffer Zone, with the remaining interests held by other joint venture parties. The Company's indirect wholly-owned subsidiary, Dominion Diamond Ekati Corporation, is the current operator of the Ekati Diamond Mine.

DDEC trusts that you will find this report to be clear and informative. Please contact Erin Forster, Environment Advisor – Fisheries and Aquatics at erin.forster@Ekati.DDCORP.ca or 867-880-2115 and the undersigned at claudine.lee@Ekati.DDCORP.ca or 867-880-2232 should you have any questions.

Sincerely,

Claudine Lee, M.Sc., P.Geol.
Superintendent – Environment Operations

EKATI DIAMOND MINE

AQUATIC EFFECTS MONITORING PROGRAM PLAN FOR 2013 TO 2015

April 2013
Project #648-124-01

Citation:

Rescan. 2013. *Ekati Diamond Mine: Aquatic Effects Monitoring Program Plan for 2013 to 2015*. Prepared for Dominion Diamond Ekati Corporation by Rescan Environmental Services Ltd.: Yellowknife, Northwest Territories.

Prepared for:

Dominion Diamond Ekati Corporation

Prepared by:

Rescan™ Environmental Services Ltd.
Yellowknife, Northwest Territories

Executive Summary

Rescan™
Engineers and Scientists

Executive Summary

The Ekati Diamond Mine (Ekati) Aquatic Effects Monitoring Program (AEMP) is a comprehensive monitoring tool designed to be able to provide first-alert changes in the Ekati aquatic environment. The AEMP is re-evaluated every three years, as required under Dominion Diamond Ekati Corporation's (DDEC) Class A Water Licence (W2009L2-0001), to ensure that the program remains technically current and that it continues to achieve its objectives. The first re-evaluation, in 2003, examined the performance of the AEMP between 1998 and 2002 (Rescan 2003). The 2006 re-evaluation report covered the AEMP during the period of 2003 to 2006 (Rescan 2006). The 2009 re-evaluation reviewed the performance of the AEMP between 2007 and 2009 (Rescan 2010a). A fourth re-evaluation was completed in November 2012 and reviewed the performance of the AEMP between 2010 and 2012 (Rescan 2012b).

The 2012 re-evaluation report, including a list of 33 recommendations, was submitted to the Wek'èezhìi Land and Water Board (WLWB) and presented to stakeholders at workshops in December 2012. Following the workshops, WLWB solicited written comments from stakeholders which were provided to BHP Billiton for consideration. BHP Billiton provided written responses to stakeholder comments, which were reviewed by WLWB. WLWB then provided recommendations to be incorporated into an AEMP design summary for 2013 to 2015. This AEMP plan presents the design summary for 2013 to 2015, incorporating each of the recommendations provided in the 2012 re-evaluation and the two additional suggestions made by the WLWB.

Table of Contents

Rescan™
Engineers and Scientists

EKATI DIAMOND MINE
AQUATIC EFFECTS MONITORING PROGRAM PLAN FOR 2013 TO 2015

Table of Contents

Executive Summary i

Table of Contents iii

List of Figures iv

List of Tables iv

List of Appendices iv

Glossary and Abbreviations v

1. Introduction 1-1

2. Recommendations for the 2013 to 2015 AEMP 2-1

2.1 Changes to the Field Sampling Program 2-1

2.2 Changes to Laboratory Methods 2-2

2.3 Changes to Evaluation of Effects 2-2

2.4 Recommendations for 2015 AEMP Re-evaluation 2-4

3. AEMP Plan for 2013 to 2015 3-1

3.1 Field Program 3-1

3.2 Evaluation of Effects 3-8

3.2.1 Evaluated Variables 3-8

3.2.2 Statistical and Graphical Analysis - Water Quality, Sediment Quality, and Biological Variables Other than Fish 3-10

3.2.2.1 Changes to Comparisons of Temporal Trends in Monitored and Reference Lakes 3-10

3.2.2.2 Changes to Model Fit Selection Procedure for Reference Data 3-10

3.2.2.3 Addition of Model Fit Evaluation for Monitored Lake Data 3-12

3.2.3 Statistical and Graphical Analysis – Slimy Sculpin 3-12

3.2.4 Comparisons to Benchmark Values 3-12

3.2.5 Biological Sample Archiving Program 3-12

4. Additional Studies 4-1

4.1 Lac de Gras Water Quality Monitoring Station 4-1

4.1.1 Background 4-1

4.1.2 Sampling Program 4-1

4.2 Nero-Nema Stream Water Quality 4-1
4.2.1 Background 4-1
4.2.2 Proposed Sampling Program 4-2

References R-1

List of Figures

FIGURE **PAGE**

Figure 3.1-1. AEMP Lake and Stream Sampling Locations 3-5

Figure 3.2-1. Evaluation of Effects Hypothesis Testing for Variables Other than Fish 3-11

Figure 3.2-2. Flow Chart of the General Approach to Fish Statistical Analyses 3-14

List of Tables

TABLE **PAGE**

Table 3.1-1. AEMP Sampling Locations, 2013 to 2015 3-1

Table 3.1-2. AEMP Lake Sampling Scheme, 2013 to 2015 3-2

Table 3.1-3. AEMP Stream Sampling Scheme, 2013 to 2015 3-3

Table 3.1-4. AEMP Sampling Frequency and Replication, 2013 to 2015 3-4

Table 3.1-5. AEMP Water Quality Variables, 2013 to 2015 3-7

Table 3.1-6. AEMP Sediment Quality Parameters, 2013 to 2015 3-7

Table 3.2-1. Proposed Evaluated List of Variables, 2013 to 2015 3-9

Table 3.2-2. Biological Archiving Program 3-12

List of Appendices

Appendix 1. AEMP Re-evaluation Meeting Agenda (December 12, 2012) and Distribution List

Appendix 2. 2012 AEMP Re-evaluation Comment and Response Table

Appendix 3. Wek'èezhìi Land and Water Board Decision for the Report *EKATI Diamond Mine: 2012 Aquatic Effects Monitoring Program Re-Evaluation*

Glossary and Abbreviations

Rescan™
Engineers and Scientists

Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AANDC	Aboriginal Affairs and Northern Development Canada
AEMP	Aquatic Effects Monitoring Program
BHP Billiton	BHP Billiton Canada Inc.
DDEC	Dominion Diamond Ekati Corporation
DFO	Fisheries and Oceans Canada
EC	Environment Canada
ENR-GNWT	Department of Environment and Natural Resources Government of the Northwest Territories
EROD	Ethoxyresorufin-O-deethylase
GSI	Gonadosomatic Index
IEMA	Independent Environmental Monitoring Agency
LSI	Liver Somatic Index
PSD	Pigeon Stream Diversion
Rescan	Rescan Environmental Services Ltd.
SSWQO	Site-specific water quality objective
WLWB	Wek'èezhìi Land and Water Board

1. Introduction

1. Introduction

As defined in the Water Licence (W2009L2-0001) the Aquatic Effects Monitoring Program (AEMP) requires a re-evaluation every three years followed by a revised AEM plan. The 2012 AEMP re-evaluation was conducted based on comments received from stakeholders since the previous re-evaluation in 2009. The 2012 re-evaluation process included the preparation of the report *EKATI Diamond Mine: 2012 Aquatic Effects Monitoring Program Re-Evaluation*, (Rescan 2012b). Following the submission of the re-evaluation report to the Wek'èezhìi Land and Water Board (WLWB), a one-day workshop information session was held on December 12, 2012 to present the main findings of and recommendations resulting from the re-evaluation process. The workshop provided a venue for stakeholder groups to provide comments and discuss any information presented in the report. Both scientific and traditional knowledge experts were invited to the sessions (Appendix 1). The stakeholder and regulator groups consisted of the following:

- BHP Billiton Canada Inc. (BHP Billiton);
- Environment Canada (EC);
- Fisheries and Oceans Canada (DFO);
- Aboriginal Affairs and Northern Development Canada (AANDC);
- Independent Environmental Monitoring Agency (IEMA);
- Wek'èezhìi Land and Water Board (WLWB);
- Yellowknives Dene First Nation; and
- Consultant for BHP Billiton and now DDEC, Rescan Environmental Services Ltd. (Rescan).

The WLWB invited stakeholders to provide written comments on the 2012 AEMP re-evaluation report (Rescan 2012b) by February 8, 2013 in order for BHP Billiton to respond by March 8, 2013. The WLWB provided direction for the design of the 2013 to 2015 AEMP plan, which was used in the preparation of this report, which presents the AEMP plan for the period of 2013 to 2015.

Stakeholder comments on the 2012 re-evaluation and BHP Billiton's responses are provided in Appendix 2. The WLWB decision is included in Appendix 3.

2. Recommendations for the 2013 to 2015 AEMP

Rescan™
Engineers and Scientists

2. Recommendations for the 2013 to 2015 AEMP

The 33 recommendations resulting from the 2012 AEMP re-evaluation are presented below along with additional commitments made during the review process and directives from the WLWB provided in the decision package (Appendix 2 and 3; Rescan 2012b). The list of recommendations and additional commitments and directives have been categorized into changes to the field sampling program, changes to laboratory methods, changes to evaluation of effects, and recommendations for the 2015 AEMP re-evaluation.

2.1 CHANGES TO THE FIELD SAMPLING PROGRAM

1. To provide a more accurate depiction of open water-season water quality in Leslie Lake beginning in 2013, three replicate water quality samples from the lower strata in Leslie Lake will be collected during August AEMP sampling beginning in 2013. The lower strata water quality data will be pooled with upper and middle strata water quality data collected from Leslie Lake during the 2013 AEMP Evaluation of Effects. As part of the 2015 AEMP Re-evaluation the need to continue collection of lower strata samples from Leslie Lake will be reviewed. (Recommendation #8)
2. Mine effects were detected downstream of the Long Lake Containment Facility (LLCF) as far as site S3 in Lac de Gras for nine water quality variables. Thus, an additional sampling program will be conducted during 2013 in Lac de Gras to determine if a new water quality monitoring station is required beyond the current site, S3. If the study determines a new station is warranted, then the station will be added to the AEMP beginning in the summer of 2014. (Recommendation #9)
3. To address potential effects in the Carrie Pond drainage system, a new AEMP water quality monitoring station will be established in Carrie-Mossing Stream. Due to a lack of historical data, water quality data from Carrie-Mossing Stream will be included in the AEMP Data Report (and not the Evaluation of Effects) beginning in 2013. Temporal trends will be evaluated as part of the 2015 AEMP re-evaluation. (Recommendation #10)
4. To avoid false conclusions of mine effects (as a result of earlier underestimation of sediment quality), paired 2 cm Ekman and 1st cm core samples will be collected during the next sediment sampling period. (Recommendation #14)
5. Deep depth sediment quality and benthos sampling will be eliminated because 15 years of monitoring at Ekati indicate that there is some duplication of effort and that it is difficult to discern spatial and temporal trends in deep depth sediment. Mid depth sediment quality and benthos sampling will be retained. (Recommendation #16)
6. Continue the Ekati water clarity monitoring program using Secchi depths measured in August. (Recommendation #19)
7. Continue monitoring at existing hydrometric stations. Existing hydrometric stations should be reinstalled in spring 2013 with new hardware to replace aging station setups. (Recommendation #25)
8. Increase active collection of manual flow measurements during the freshet period, particularly during the period where ice in the channel precludes use of the stage-discharge curve. (Recommendation #26)

9. Ensure that stage-discharge measurements are collected through the remainder of the summer to capture the widest range of flows. (Recommendation #27)
10. Establish permanent survey transects and complete annual cross-sectional geometry profiles at each hydrometric station in order to monitor change in channel geometry that may influence the stage-discharge curve. Further evaluation of the usefulness of annual channel geometry (i.e., variability) will be completed as part of the 2015 AEMP re-evaluation. (Recommendation #28)
11. To improve the understanding of stream hydrology at Ekati a gauge at Nema-Martine Stream should be added as a check for the currently gauged Slipper-Lac de Gras Stream as well as an additional gauge at Christine-Lac du Sauvage as a potential replacement for Cujo Outflow. A review of the data collected form Chirstine-Lac du Sauvage will be completed in 2015 to assess if removal of the Cujo Outflow is warranted. (Recommendation #29)
12. Water quality will be sampled weekly at Nero-Nema stream during effluent discharge in 2013 to investigate differential dilution between hardness and water quality variables with hardness-dependent site-specific water quality objectives (SSWQO; Appendix 3)

2.2 CHANGES TO LABORATORY METHODS

1. Biovolume-based estimates of the relative densities of different genera provide similar results to numerically-based relative densities and few differences in relative density estimations would be found by incorporating taxon-specific biovolume measurements into the evaluation of effects. Therefore continue to monitor the abundance of phytoplankton and zooplankton only as numerically-based relative densities as part of the annual AEMP evaluation of effects. (Recommendation #20)
2. The biological sample archiving program will be amended as outlined in Table 3.2-2 to account for phytoplankton sample degradation over time and to allow annual counted/sorted zooplankton, benthic invertebrate, and fish aging samples to be included in the three year AEMP re-evaluation cycle as needed. (Recommendation #30)

2.3 CHANGES TO EVALUATION OF EFFECTS

1. Results from multivariate analyses will be used to help develop the list of analyzed and evaluated water and sediment quality parameters for the 2013 to 2015 AEMP (Sections 5.2.5 and 5.3.3 of Rescan 2012b). (Recommendation #5)
2. Streamline and provide a more explicit discussion on linkages between physical variables and biotic effects as well as trophic effects the following changes will be completed: (a) Merge phytoplankton, zooplankton, and benthos sections into a single “biology” section comprised of three subsections; (b) Begin the biology section with a summary of how observed changes in water quality might be expected to affect plankton and benthos; (c) Summarise how any observed changes in primary producers might affect consumers in the results and discussion section of the phytoplankton subsection; and (d) Conclude the biology section with a summary of how observed changes in plankton and benthos might be expected to affect fish. (Recommendation #6)
3. Generally open water season temperature and dissolved oxygen profiles have been consistent through time in Ekati lakes thus an evaluation of open water season temperature and dissolved oxygen profiles will again be completed as part of the 2015 AEMP re-evaluation to confirm. Annual evaluation of under-ice temperature and dissolved oxygen profiles will continue. (Recommendation #7)

4. Given that there is now three years of data available, water quality data collected from Leslie-Moose Stream will be analyzed in accordance with the analytical approach employed for other water quality stations in the annual AEMP Evaluation of Effects beginning in 2012. (Recommendation #11)
5. To reflect the results of the water quality statistical analyses and trends, the Koala Watershed Water Quality Model predictions and the current multivariate analyses, the list of AEMP analyzed and evaluated water quality variables is proposed as outlined in Table 3.2-1. (Recommendation #12)
6. To reflect the results of the water quality statistical analyses and the current multivariate analyses, the list of AEMP evaluated sediment quality variables are proposed as outlined in Table 3.2-1 (Recommendation #17)
7. Biovolume-based estimates of the relative densities of different genera provide similar results to numerically-based relative densities and few differences in relative density estimations would be found by incorporating taxon-specific biovolume measurements into the evaluation of effects. Therefore continue to monitor the abundance of phytoplankton and zooplankton only as numerically-based relative densities as part of the annual AEMP evaluation of effects. (Recommendation #20)
8. To better distinguish natural variation from potential mine effects in cases where temporal trends in reference lakes do not share a common slope and the trend in the monitored lake differs from a slope of zero, compare the slope of monitored lakes to the slope of each reference lake in order. Lack of statistical differences between the slope observed in a given monitored lake and at least two reference lakes will indicate natural variability as the underlying cause of temporal trends in the monitored lake. Significant differences between the trend observed in a monitored lake and two or more reference lakes would indicate a potential mine effect. Graphical analysis and best professional judgment will be used to assess the likelihood that a given trend resulted from mining operations. (Recommendation #21)
9. To improve model fit of reference lake data, the reference model will be selected that best fits the data using AIC to directly compare the 'fit' or error associated with each reference model. (Recommendation #22)
10. In the event that both transformed and untransformed data satisfy parametric assumptions, use AIC to determine which transformation provides the best fit to the data and use the best fit model in statistical analyses. (Recommendation #23)
11. Examine the coefficient of determination in cases where there is reason to suspect poor model fit for a given variable and waterbody based on graphical analysis. Low R square values will indicate that results of statistical analyses must be interpreted with caution. (Recommendation #24)
12. Concentrations of evaluated water and sediment quality variables should continue to be compared to benchmarks during the annual AEMP Evaluation of Effects as a means of ensuring that concentrations remain within the range of concentrations tolerated by 95% of the species present at Ekati. (Recommendation #32)
13. The strongest evidence suggests that changes in biological communities at Ekati are related to changes in the total quantities and relative availability of macronutrients rather than the sensitivity of Ekati species to changes in water quality variables. (Recommendation #33)
14. Nitrite will continue to be evaluated in the AEMP (Appendix 2).
15. Cadmium and Copper (King-Cujo watershed only) will be evaluated in the AEMP (Appendix 3).

2.4 RECOMMENDATIONS FOR 2015 AEMP RE-EVALUATION

1. PCA continues to provide an important tool for supporting the annual AEMP results and will be completed again for the 2015 AEMP re-evaluation. (Recommendation #1)
2. PCA regressions including key zero inflated variables (e.g., chloride, selenium, molybdenum, vanadium) will again be completed as part of 2015 AEMP re-evaluation to ensure recently increasing concentrations are evaluated for detection of mine effects. (Recommendation #3)
3. CCA will again be completed as part of the 2015 AEMP re-evaluation to gain a better understanding of mine related trophic effects and species interactions. (Recommendation #2)
4. Bray Curtis analysis (accounting for temporal effects) will again be completed as part of the 2015 AEMP re-evaluation to gain a better understanding of the extent to which biological communities reflect reference communities through time and with distance from the LLCF or KPSF. (Recommendation #4)
5. Generally open water season temperature and dissolved oxygen profiles have been consistent through time in Ekati lakes thus an evaluation of open water season temperature and dissolved oxygen profiles will again be completed as part of the 2015 AEMP re-evaluation to confirm. Annual evaluation of under-ice temperature and dissolved oxygen profiles will continue. (Recommendation #4)
6. To provide a more accurate depiction of open water-season water quality in Leslie Lake beginning in 2013, three replicate water quality samples from the lower strata in Leslie Lake will be collected during August AEMP sampling beginning in 2013. The lower strata water quality data will be pooled with upper and middle strata water quality data collected from Leslie Lake during the 2013 AEMP Evaluation of Effects. As part of the 2015 AEMP re-evaluation the need to continue collection of lower strata samples from Leslie Lake will be reviewed. (Recommendation #8)
7. To address potential effects in the Carrie Pond drainage system, a new AEMP water quality monitoring station will be established in Carrie-Mossing Stream. Due to a lack of historical data, water quality data from Carrie-Mossing Stream will be included in the AEMP Data Report (and not the Evaluation of Effects) beginning in 2013. Temporal trends will be evaluated as part of the 2015 AEMP re-evaluation. (Recommendation #10)
8. Review the list of AEMP evaluated water quality variables during the 2015 AEMP re-evaluation to reflect newly identified trends and the current multivariate analyses. Specifically the following water quality variables should be reviewed for inclusion in the list of evaluated variables: aluminum, copper, iron, cadmium, chromium, lead and manganese. (Recommendation # 13)
9. The necessity of continuing to collect 2 cm Ekman sediment quality samples will be re-evaluated during the 2015 AEMP re-evaluation. (Recommendation # 15)
10. Review the list of AEMP evaluated sediment quality variables during the 2015 AEMP re-evaluation to reflect newly identified trends and the current multivariate analyses. (Recommendation # 18)
11. Establish permanent survey transects and complete annual cross-sectional geometry profiles at each station in order to monitor change in channel geometry that may influence the stage-discharge curve. Further evaluation of the usefulness of annual channel geometry (i.e., variability) will be completed as part of the 2015 AEMP re-evaluation. (Recommendation # 28)
12. To improve the understanding of stream hydrology at Ekati a gauge at Nema-Martine Stream should be added as a check for the currently gauged Slipper-Lac de Gras Stream as well as an

additional gauge at Christine-Lac du Sauvage as a potential replacement for Cujo Outflow. A review of the data collected form Chirstine-Lac du Sauvage will be completed in 2015 to assess if removal of the Cujo Outflow is warranted. (Recommendation # 29)

13. Current analysis indicates that contributions of dustfall to concentrations of water quality variables in aquatic systems at Ekati are negligible. Thus re-evaluation of the potential impact of dustfall on the aquatic environment will be completed if results of future AQMPs indicate that dustfall contributions have increased by an order of magnitude or more. (Recommendation #31)
14. An analysis of phytoplankton and zooplankton biovolume similar to that carried out in the 2012 AEMP re-evaluation will be completed to ensure that densities continue to provide sufficient assessments of food availability (Appendix 2).

3. AEMP Plan for 2013 to 2015

Rescan™
Engineers and Scientists

3. AEMP Plan for 2013 to 2015

The AEMP plan for the 2013 to 2015 period is based on experience from managing the AEMP for fifteen years and analyses, reviews, and comments resulting from the 2012 AEMP re-evaluation process described in Section 1. The proposed program for 2013 to 2015 includes details for AEMP sampling that would be carried out in the Pigeon Watershed if the Pigeon Stream Diversion (PSD) were to be connected to the natural Pigeon stream within the 2013 to 2015 AEMP period. Details of the AEMP sampling program that would be carried out in the Pigeon Watershed are based on the proposed Pigeon AEMP Plan as outlined in Section 7 of the 2012 AEMP re-evaluation (Rescan 2012b).

3.1 FIELD PROGRAM

Tables 3.1-1 to 3.1-4 present summary information on the proposed field program for 2013 to 2015. Figure 3.1-1 provides each of the AEMP sampling locations for lakes and streams. The UTM coordinates for the AEMP stations are provided in Table 3.1-1. The sampling scheme including all field components (e.g., water quality) assessed at each lake and stream is provided in tables 3.1-2 and 3.1-3. Further detail on the frequency and replication of sampling for each of the field components is provided in Table 3.1-4. Tables 3.1-5 and 3.1-6 provide the water quality and sediment quality variables assessed at the laboratory.

Table 3.1-1. AEMP Sampling Locations, 2013 to 2015

Location	NAD83 UTM Zone 12N		Approximate Water Column Depth (m)
	Easting (m)	Northing (m)	
Lakes			
Reference			
Nanuq	534200	7199287	28
Counts	533825	7169850	15
Vulture	521183	7180882	37
Koala Watershed			
Grizzly	521303	7177743	40
Kodiak	518273	7175550	11
Leslie	515938	7173285	13
Moose	516630	7177852	10
Nema	513575	7171132	9
Slipper	507098	7165297	16
S2	507638	7164468	7
S3	505912	7164439	14
King-Cujo Watershed			
Cujo	538721	7162007	8
LdS2	541240	7164235	2
LdS1	541616	7164530	8

(continued)

Table 3.1-1. AEMP Sampling Locations,2013 to2015 (completed)

Location	NAD83 UTM Zone 12N		Approximate Water Column Depth (m)
	Easting (m)	Northing (m)	
Pigeon Watershed			
Fay Bay[1]	515470	7181355	7
Upper Exeter Lake	513066	7180902	13
Streams			
Reference			
Nanuq Outflow	532197	7199430	NA
Counts Outflow	535488	7169709	NA
Vulture-Polar	521503	7179655	NA
Pigeon Stream - Reach 7[2]	517224	7182256	NA
Koala Watershed			
Lower PDC	518587	7175997	NA
Kodiak-Little	517943	7174808	NA
1616-30 (LLCF)	514021	7173081	NA
Leslie-Moose	516481	7172868	NA
Moose-Nero	517460	7172818	NA
Nema-Martine	513921	7170646	NA
Slipper-Lac de Gras	507643	7164878	NA
King-Cujo Watershed			
1616-43 (KPSF)	538785	7161359	NA
Cujo Outflow	538942	7162432	NA
Christine-Lac du Sauvage	540025	7163840	NA
Carrie-Mossing[3]	-	-	
Pigeon Watershed			
Pigeon Stream - Reach 1[4]	514355	7180927	NA

Dash indicates depth will be determined following first sampling.
NA indicates not applicable.
[1] Site 5 as part of the 2008-2010 Fay Bay Monitoring.
[2] SNP Station 0008-Pi3.
[3] Location to be determined during field work in 2013.
[4] SNP Station 0008-Pi4.

Table 3.1-2. AEMP Lake Sampling Scheme, 2013 to 2015

Location	Water Quality	Limnology	Phytoplankton	Zooplankton	Benthos	Sediment Quality[1]	Fish[2]
Reference							
Nanuq	X	X	X	X	X	X	X
Counts	X	X	X	X	X	X	X
Vulture	X	X	X	X	X	X	X
Koala Watershed							
Grizzly	X	X	-	-	-	-	-
Kodiak	X	X	X	X	X	X	X

(continued)

Table 3.1-2. AEMP Lake Sampling Scheme, 2013 to 2015 (completed)

Location	Water Quality	Limnology	Phytoplankton	Zooplankton	Benthos	Sediment Quality[1]	Fish[2]
Leslie	X	X	X	X	X	X	X
Moose	X	X	X	X	X	X	X
Nema	X	X	X	X	X	X	X
Slipper	X	X	X	X	X	X	X
S2	X	X	X	X	X	X	-
S3	X	X	X	X	-	-	-
King-Cujo Watershed							
Cujo	X	X	X	X	X	X	X
LdS2	X	X	-	-	-	-	-
LdS1	X	X	X	X	X	X	-
Pigeon Watershed							
Fay Bay	X	X	X	-	-	X	-
Upper Exeter Lake	X	X	X	-	-	X	-

Dash indicates not applicable.
[1] Sediment quality to be monitored in 2014 (every 3 years post-baseline) and in the first year of monitoring in Pigeon Watershed.
[2] Slimy sculpin to be monitored in 2015 (every 3 years).

Table 3.1-3. AEMP Stream Sampling Scheme, 2013 to 2015

Stream Sites	Water Quality	Stream Benthos	Hydrology Station	Stream Flows
Reference				
Nanuq Outflow	X	X	-	-
Counts Outflow	X	X	X	X
Vulture-Polar	X	X	X	X
Pigeon Stream - Reach 7	X	-	-	-
Koala Watershed				
Lower PDC	X	-	X	X
Kodiak-Little	X	X	-	-
1616-30 (LLCF)	X	-	(pumps)	(pumps)
Leslie-Moose	X	-	-	-
Moose-Nero	X	X	-	-
Nema-Martine[1]	X	X	X	X
Slipper-Lac de Gras	X	X	X	X
King-Cujo Watershed				
1616-43 (KPSF)	X		(pumps)	(pumps)
Cujo Outflow	X	X	X	X
Christine-Lac du Sauvage[1]	X	-	X	X
Carrie-Mossing	X	-	-	-
Pigeon Watershed				
Pigeon Stream - Reach 1	X	-	-	-

Dash indicates not applicable.
[1] Stations to be installed in 2013.

Table 3.1-4. AEMP Sampling Frequency and Replication, 2013 to 2015

Monitoring	Annual Frequency	Seasonal Frequency	Replication and Depths at each Lake/Stream per Sampling Event
Lakes			
Water quality	each year	April	n=2 @ mid water column depth n=2 @ 2 m from the bottom
	each year	early August	n=3 @ 1 m n=3 @ mid water column depth n=3 @ 2m from the bottom (Leslie Lake only)
	each year	July, September	Pigeon Watershed Only n=2 @ 1 m n=2 @ mid water column depth
Limnology	each year	April	n=1 profile over deepest part of lake, or at lake station
	each year	early August	n=1 profile over deepest part of lake, or at lake station
	each year	July, September	Pigeon Watershed Only n=1 profile over deepest part of lake, or at lake station
Phytoplankton	each year	early August	n=3 @ 1 m
Zooplankton[1]	each year	early August	n=3 vertical hauls from surface to 1 m above bottom, with flowmeter
Benthos[1]	each year	early August	n=3 @ 5-10 m depth (mid)
Sediment quality	every 3 years	early August	n=3 @ 5-10 m depth (mid)
Fish[1]	every 3 years	Mid to Late August	n=30 lethal sampling
Streams			
Water quality	each year	Freshet, July early/mid-August fall high flows (September)	n=2
	first year of monitoring	biweekly during the open water season	Pigeon Stream Reach 1 Only n=2
Benthos[1]	each year	August 1 to September 1	n=5
Hydrology[1]			
Manual flow measurements	each year	2 to 3 times during the freshet period; 4 to 5 times during the remainder of the open water season	-
Automated stations	each year	installation prior to freshet, data collection monthly	-
Staff gauge survey	each year	coupled with manual flow measurements	-
Hydraulic geometry survey	each year	during low flow conditions	-

Dash indicates not applicable.
[1] Reference lakes and lakes of the Koala and King-Cujo watersheds only.

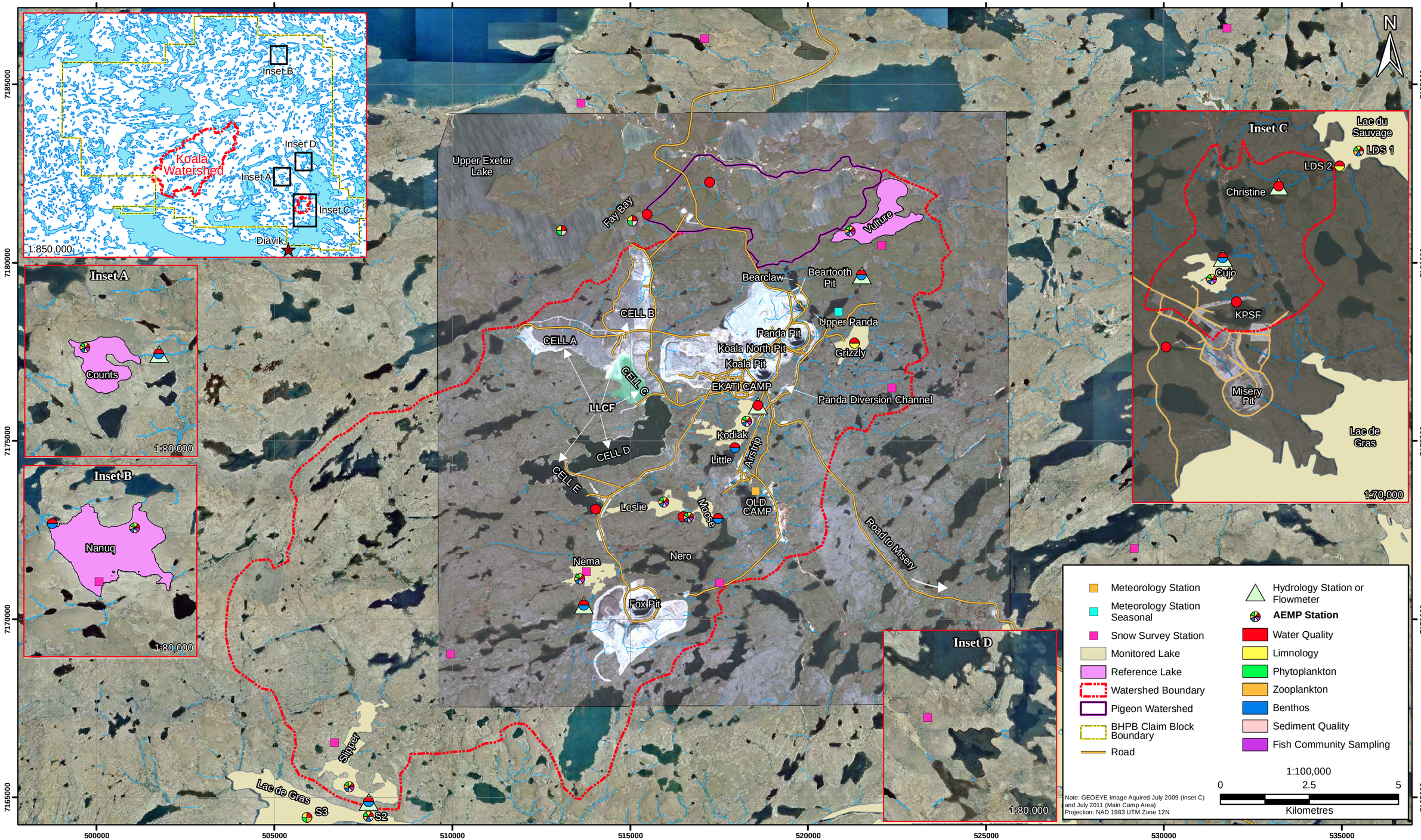


FIGURE 3.1-1

AEMP Lake and Stream Sampling Locations

DOMINION DIAMOND

Rescan

Table 3.1-5. AEMP Water Quality Variables, 2013 to 2015

Variables	Units	Variables	Units
Physical/Ion		**Total Metals**	
Alkalinity, Total	mg/L	Aluminum (Al)	mg/L
Bicarbonate (HCO_3)	mg/L	Antimony (Sb)	mg/L
Carbonate (CO_3)	mg/L	Arsenic (As)	mg/L
Conductivity (EC)	µS/cm	Barium (Ba)	mg/L
Hydroxide	mg/L	Beryllium (Be)	mg/L
pH	pH	Boron (B)	mg/L
Chloride (Cl)	mg/L	Cadmium (Cd)	mg/L
Potassium (K)	mg/L	Calcium (Ca)	mg/L
Silicon (Si)-Total	mg/L	Chromium (Cr)	mg/L
Sulphate (SO_4)	mg/L	Cobalt (Co)	mg/L
Total Suspended Solids	mg/L	Copper (Cu)	mg/L
Turbidity	NTU	Iron (Fe)	mg/L
Hardness	mg/L	Lead (Pb)	mg/L
Ion Balance	%	Magnesium (Mg)	mg/L
Total Dissolved Solids (Calculated)	mg/L	Manganese (Mn)	mg/L
		Mercury (Hg)	mg/L
Nutrients/Organics		Molybdenum (Mo)	mg/L
Total Ammonia-N	mg/L	Nickel (Ni)	mg/L
Nitrate-N	mg/L	Selenium (Se)	mg/L
Nitrite-N	mg/L	Silver (Ag)	mg/L
Orthophosphate (PO_4-P)	mg/L	Sodium (Na)	mg/L
Total Phosphorus	mg/L	Strontium (Sr)	mg/L
Total Organic Carbon	mg/L	Uranium (U)	mg/L
Total Kjeldahl Nitrogen	mg/L	Vanadium (V)	mg/L
		Zinc (Zn)	mg/L

Table 3.1-6. AEMP Sediment Quality Parameters, 2013 to 2015

Parameters	Units	Parameters	Units
Physical/Nutrient		**Total Metals**	
% Moisture	%	Aluminum (Al)	mg/kg
Available Phosphorus (P)	mg/kg	Arsenic (As)	mg/kg
Total Nitrogen (N)	%	Barium (Ba)	mg/kg
Total Organic Carbon	%	Boron (B)	mg/kg
Particle Size	%	Cadmium (Cd)	mg/kg
Gravel (>2.00 mm)		Chromium (Cr)	mg/kg
Sand (2.00 mm–0.063 mm)		Cobalt (Co)	mg/kg
Silt (0.063 mm–4 µm)		Copper (Cu)	mg/kg
Clay (<4 µm)		Iron (Fe)	mg/kg
		Lead (Pb)	mg/kg
		Manganese (Mn)	mg/kg

(continued)

Table 3.1-6. AEMP Sediment Quality Parameters (completed)

Parameters	Units	Parameters	Units
Total Metals (cont'd)		Selenium (Se)	mg/kg
Mercury (Hg)	mg/kg	Silver (Ag)	mg/kg
Molybdenum (Mo)	mg/kg	Uranium (U)	mg/kg
Nickel (Ni)	mg/kg	Vanadium (V)	mg/kg
Phosphorus (P)	mg/kg	Zinc (Zn)	mg/kg

Notes:
Results will be expressed on a dry weight basis.
Detection limits vary with the amount of sediment available.

All field methods will follow established sampling protocols, with two adjustments:

1. Water quality samples will be collected in triplicate from lower depth strata in Leslie Lake (only) in response to concerns regarding potential changes in water column structure in Leslie Lake due to increased solute concentrations and results of the 2012 AEMP re-evaluation (Rescan 2011, 2012b). The lower strata water quality data will be averaged with upper and middle strata water quality data collected from Leslie Lake and the average value will be used for the AEMP Evaluation of Effects for 2013 to 2015. The need to continue collection of water quality samples from the lower strata of Leslie Lake will be reviewed as part of the 2015 AEMP re-evaluation (Recommendation #8); and
2. In addition to traditional sediment quality sampling using an Ekman grab sampler, sediment quality samples will also be collected using a K-B corer similar to the 2011 sampling program (Rescan 2012a). At each location, three replicate samples will be collected with each device. In order to collect a sufficient quantity of material, K-B corer replicates will be composed of five composite samples of the top 1cm of sediments collected using the core. Samples from both devices will be analysed for the analytes listed in Table 3.1-6, though particle size will only be assessed from Ekman grab samples due to sample size limitation associated with the core. This will be the third time sediment will be collected by the two methods. A comparison of the methods will be included with the 2015 AEMP re-evaluation in order to evaluate the feasibility of switching from Ekman to K-B core sampling at that time (Reccomendation #14; Rescan 2012b).

3.2 EVALUATION OF EFFECTS

3.2.1 Evaluated Variables

As conducted in previous AEMP reports (e.g., Rescan 2013) each of the variables listed in Table 3.2-1 are evaluated to assess the potential for mine related negative effects to the aquatic environment. The variables included in the list are in accordance with commitments made during the review process (Appendix 2) the WLWB decision letter (Appendix 3) and recommendations 1, 7, 12, 16, 17, 19, 20, and 28 from the 2012 AEMP re-evaluation (Rescan 2012b).

Table 3.2-1. Proposed Evaluated List of Variables, 2013 to 2015

Water Quality (August)	**Sediment Quality *(cont'd)***
General Physical Variables and Anions	*Metals (con'td)*
pH	Cadmium
Total Alkalinity	Molybdenum
Water Hardness	Nickel
Chloride	Phosphorous
Potassium	Selenium
Sulphate	Strontium
Total Suspended Solids[1]	**Hydrology**
Nutrients	Manual Flow Measurements[4]
Total Ammonia	Automated Stations[4]
Nitrate	Staff Gauge Measurements[4]
Nitrite	Hydraulic Geometry Surveys[4]
Total Phosphate-P	**Biological**
Total Organic Carbon	Lake Chlorophyll a concentrations
Metals	Lake Phytoplankton Density
Total Antimony	Lake Phytoplankton Diversity/Community Composition
Total Arsenic	Lake Zooplankton Biomass[3]
Total Barium	Lake Zooplankton Density[3]
Total Boron	Lake Zooplankton Diversity/Community Composition[3]
Total Cadmium	Lake Benthos Density[3]
Total Copper[2]	Lake Benthos Diversity/Community Composition[3]
Total Molybdenum	Stream Benthos Density[4]
Total Nickel	Stream Benthos Diversity/Community Composition[4]
Total Selenium	*Slimy Sculpin*[3]
Total Strontium	Catch-per-unit-effort (CPUE)
Total Uranium	Stomach Contents
Total Vanadium	Modified DELT assessment
Physical Limnology	Parasite prevalence
August Secchi Depth	Length
Winter Dissolved Oxygen	Weight
Sediment Quality	Condition
Nutrients	Age
Available Phosphorus	Growth Rate
Total Nitrogen	Sex (mortalities only)
Total Organic Carbon	Gonad Weight (mortalities only)
Metals	Liver Weight (mortalities only)
Antimony	Whole Body Metals (mortalities only):
Arsenic	Ethoxyresorufin-O-deethylase Activity
Copper[2]	

[1] *Pigeon watershed only.*
[2] *Reference lakes and lakes of the King-Cujo watershed only.*
[3] *Reference lakes and lakes of the Koala and King-Cujo watersheds only.*
[4] *Reference streams and streams of the Koala and King-Cujo watersheds only.*

3.2.2 Statistical and Graphical Analysis - Water Quality, Sediment Quality, and Biological Variables Other than Fish

As conducted in previous AEMP reports, data collected during the annual AEMP sampling program will be evaluated according a hierarchy of steps (e.g., Rescan 2013). For the 2013 to 2015 period, the evaluation framework and hypothesis testing for water quality, sediment quality, and biological variables other than fish for the evaluation of effects will closely follow the steps outlined in the 2010 to 2012 AEMP Plan and that completed for the evaluation of the 2012 AEMP, but hypothesis testing will incorporate recommendations #21 to #24 from the 2012 AEMP re-evaluation (Figure 3.2-1; Rescan 2010b, 2012b). These changes are intended to improve the robustness of the analyses through three minor changes, which are summarized below: Changes to comparisons of temporal trends in monitored and reference lakes, (2) Changes to model fit selection procedure for reference data, and (3) addition of model fit evaluation for monitored lake data.

3.2.2.1 Changes to Comparisons of Temporal Trends in Monitored and Reference Lakes

Historically, the slopes of the monitored lakes were compared to a slope of 0 whenever the temporal trends in the reference lakes cannot be described by a common slope. For the 2013 to 2015 AEMP period, the trend in each monitored lake will first be compared to a slope of 0, as has been done historically. If concentrations of the variable have been stable through time (i.e., the slope does not differ from 0) no further analysis will be required. If the slope differs significantly from 0, indicating that concentrations of the variable have changed through time, the slope will be compared to the slope of each of the reference lakes (Figure 3.2-1). This additional comparison will assist in distinguishing natural variation from potential mine effects through comparisons of patterns observed in the reference lakes. A lack of significant differences between the trend observed in each monitored lake and those observed in at least two reference lakes would indicate natural variability as the underlying cause of the temporal trend in the monitored lake. Significant differences between the trend observed in a monitored lakes and two or more reference lakes would indicate a potential mine effect. Graphical analysis and best professional judgment would then be used to assess the likelihood that a given trend resulted from mining operations. The multiple comparisons tests will be conducted using the same χ^2 tests as described in Test 2 (a, b and c) in the 2010-2012 AEMP Plan (Rescan 2010b).

3.2.2.2 Changes to Model Fit Selection Procedure for Reference Data

In previous years, the selection of which type of linear model should be fit to the data set (i.e., model 1, 2 or 3) was accomplished by first testing whether or not reference lakes differ statistically in slope and intercept, slope only, or if reference lakes share a common slope and intercept. For the 2013 to 2015 AEMP period, the model will be selected using the Akaike Information Criterion (AIC), which provides an assessment of how well data fit a given model. The AIC model selection procedure will be used to determine the single model, from the set of models compared, with the least mean squared error (Yang 2005). In other words, AIC will be used to help select the linear or Tobit model from the set of three reference models that is best able to predict the dataset at hand (Figure 3.2-1). Model assumptions will continue to be assessed through the standard practice of observing quantile and residual plots, since AIC does not evaluate whether the assumptions of the model are satisfied. In addition, in the event that both transformed and untransformed data satisfy parametric assumptions, AIC will be used to determine which transformation provides the best fit to the data and the best fit model will be used in the in the analyses.

Model Form: $y_i(x) = \beta_{0i} + \beta_{1i}x + \beta_{2i}x^2 + \varepsilon_x + \varepsilon_{ix}$

or

$$L(y) = \int_a^b \exp\left(\frac{-1}{2\sigma^2}\left(y - \sum_{i=1}^{p}\beta_i x_i\right)^2\right)dy = \Phi\left(\frac{b - \sum_{i=1}^{p}\beta_i x_i}{\sigma}\right) - \Phi\left(\frac{a - \sum_{i=1}^{p}\beta_i x_i}{\sigma}\right)$$

Reference Model Selection
Akaike Information Criterion (AIC)

Reference Model 3

Test 2a: Comparison between monitored and reference lakes when a common slope and intercept is fit to reference Lake data

H_0: $\beta_{oR} = \beta_{oM}$, $\beta_{1R} = \beta_{1M}$ and $\beta_{2R} = \beta_{2M}$
H_a: $\beta_{iR} \neq \beta_{iM}$ for at least one $i = 0, 1, 2$.

- $p > 0.05$ → Conclusion: There is no evidence of a difference of the mean variable value between the monitored lake and the reference lakes in any year of monitoring.
- $p \leq 0.05$ → Conclusion: There is a difference between the absolute level of the variable in the monitored lake and the reference lakes over time.

Reference Model 2

Test 2b: Comparison between monitored and reference lakes when a common slope is fit to reference lake data and intercepts are ignored

H_0: $\beta_{1R} = \beta_{1M}$ and $\beta_{2R} = \beta_{2M}$
H_a: $\beta_{iR} \neq \beta_{iM}$ for at least one $i = 1, 2$.

- $p > 0.05$ → Conclusion: The trend of the variable over time is not different between the monitored lake and the reference lake, relative to a separate reference value in each lake.
- $p \leq 0.05$ → Conclusion: The trend of the variable over time is different between the monitored lake and the reference lake, relative to a separate reference value in each lake.

Reference Model 1

Test 2c: Comparison between monitored and reference lakes when separate slopes and intercepts are fit to Reference lake data

H_0: $\beta_{1M} = 0$ and $\beta_{2M} = 0$
H_a: $\beta_{iM} \neq 0$ for at least one $i = 1, 2$.

- $p > 0.05$ → Conclusion: The mean value of the variable has not changed over time.
- $p \leq 0.05$ →

Test 3: Comparison of the slope of the monitored lake to each of the reference lakes

H_0: $\beta_{1C} = \beta_{1M}$ and $\beta_{2C} = \beta_{2M}$ and $\beta_{1V} = \beta_{1M}$ and $\beta_{2V} = \beta_{2M}$ and $\beta_{1N} = \beta_{1M}$ and $\beta_{2N} = \beta_{2M}$
H_a: $\beta_{iC} \neq \beta_{iM}$ or $\beta_{iV} \neq \beta_{iM}$ or $\beta_{iN} \neq \beta_{iM}$ for at least one $i = 1, 2$

- $p > 0.05$ → Conclusion: The trend of the variable over time does not differ between the monitored lake and any of the reference lakes.
- $p \leq 0.05$ → Conclusion: The trend of the variable over time in the monitored lake differs from the trend in at least one of the reference lakes.

Notes: β_{oc}, β_{1c} and β_{2c} are regression coefficients for Counts Lake
β_{oN}, β_{1N} and β_{2N} are regression coefficients for Nanuq Lake
β_{oV}, β_{1V} and β_{2V} are regression coefficients for Vulture Lake
β_{oR}, β_{1R} and β_{2R} are regression coefficients for Reference Lakes
β_{oM}, β_{1M} and β_{2M} are regression coefficients for Monitored Lakes

DOMINION DIAMOND

Evaluation of Effects Hypothesis Testing for Variables Other than Fish

Figure 3.2-1

Rescan™ Engineers & Scientists

3.2.2.3 Addition of Model Fit Evaluation for Monitored Lake Data

Historically, the regression modelling procedure fits the data from each water body with its own slope and intercept. For the 2013-2105 AEMP period, the coefficient of determination (R square) will be used evaluate how well a regression model fits data in cases where there is reason to suspect poor model fit for a given variable and waterbody based on graphical analysis. R square values will be used to improve best professional judgment, with low R square values indicating that results of statistical analyses must be interpreted with caution. R squared (r^2) from the final regression model for each lake is calculated following Whitlock and Schluter (2009):

$$(1)\ \ r^2 = regrSS/tSS,$$

where *regrSS* is the regression sum of squares is calculated as:

$$(2)\ \ regrSS = \sum(\hat{y}_i - \bar{Y})^2,$$

where $\hat{y}_i$ is the ith y-value predicted from linear regression and $\bar{Y}$ is the grand mean of y values. *tSS*, the total sum of squares is calculated as:

$$(3)\ \ tSS = regrSS + residSS,$$

where *residSS* is the residual sum of squares calculated as:

$$(4)\ \ residSS = \sum(y_i - \hat{y}_i)^2,$$

where y_i is the ith y-value observed in the data and $\hat{y}_i$ is the ith y-value predicted from linear regression.

3.2.3 Statistical and Graphical Analysis - Slimy Sculpin

Statistical and graphical analyses for slimy sculpin will follow the approach used during the 2012 AEMP Evaluation of Effects, which is similar to the evaluation framework employed for water quality, sediment quality, and biological variables other than fish (Figure 3.2-2; Rescan 2013).

3.2.4 Comparisons to Benchmark Values

Comparisons of water, sediment, and fish tissue concentrations to benchmark values (i.e., SSWQO or CCME, Health Canada, British Columbia Ministry of the Environment, or United States Environmental Protection Agency guidelines) will continue as part of the evaluation of effects in order to assist in the determination of mine impacts.

3.2.5 Biological Sample Archiving Program

Biological samples will be archived in accordance with Table 3.2-2.

Table 3.2-2. Biological Archiving Program

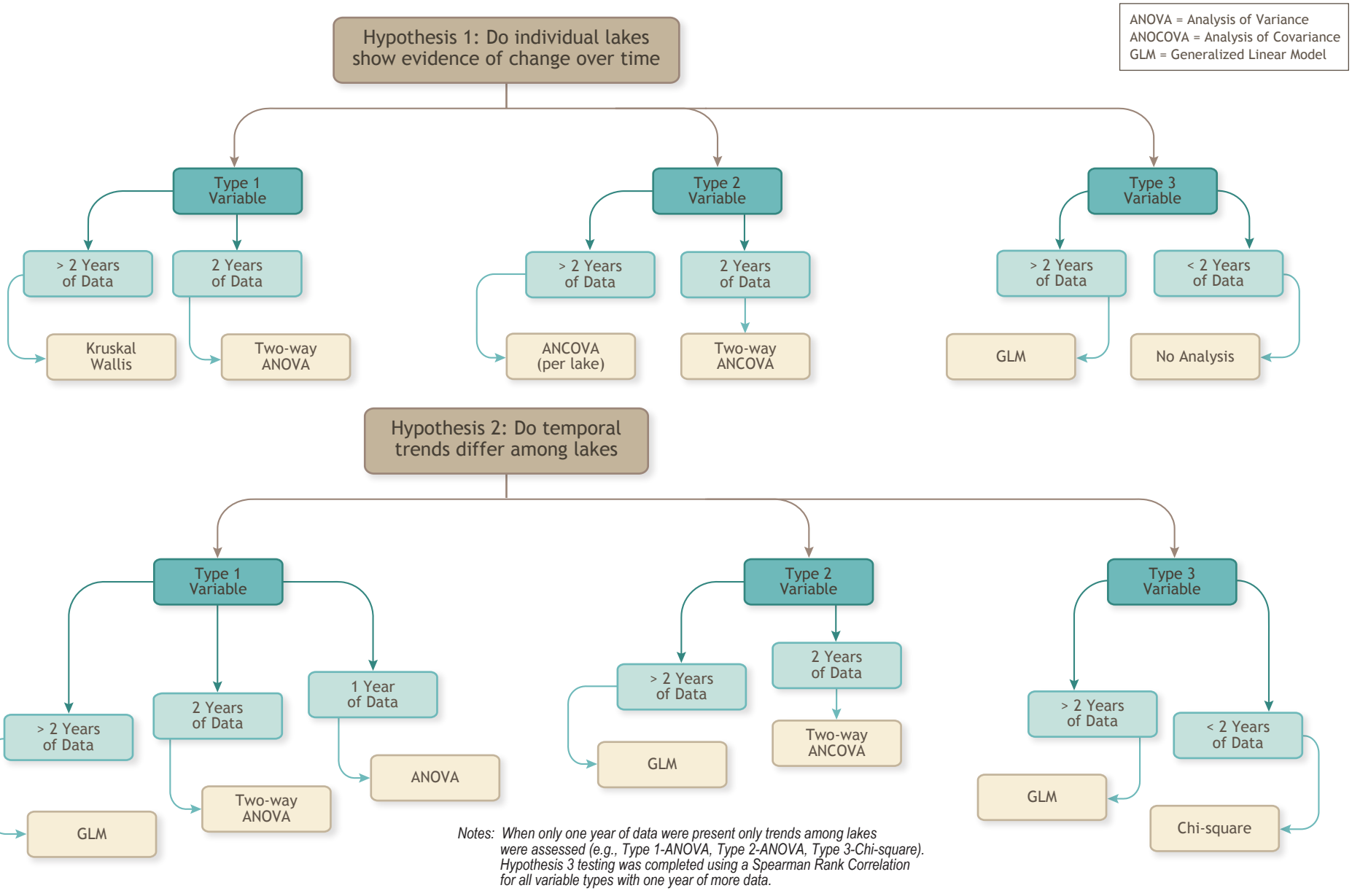
Sample Type	Phytoplankton	Zooplankton	Benthic Invertebrates	Fish Ageing Samples
Baseline Sample • all samples collected from 1994-1997 • all other baseline samples collected after 1997 (e.g. otoliths)	1 year	Life of project	Life of project	Life of project

(continued)

Table 3.2-2. Biological Archiving Program (completed)

Sample Type	Phytoplankton	Zooplankton	Benthic Invertebrates	Fish Ageing Samples
Annual Voucher Collection[1] • any newly identified taxon prepared by taxonomist	1 year	Life of project	Life of project	NA
Annual Representative Sample Collection[1] • a representative sample containing all of the taxa identified in a given year	1 year	NA	NA	NA
Annual Samples Collection[1] • all counted/sorted samples (returned from taxonomist)	1 year	4 years	4 years	7 years

[1] *1998 samples are not separated into counted/sorted samples, voucher, or representative samples because the archiving program was established in 1999.*



Notes: When only one year of data were present only trends among lakes were assessed (e.g., Type 1-ANOVA, Type 2-ANOVA, Type 3-Chi-square). Hypothesis 3 testing was completed using a Spearman Rank Correlation for all variable types with one year of more data.

Figure 3.2-2

DOMINION DIAMOND

Flow Chart of the General Approach to Fish Statistical Analyses

Figure 3.2-2

Rescan Engineers & Scientists

4. Additional Studies

4. Additional Studies

Two additional studies will be conducted as part of the 2013 AEMP only as recommended during the 2012 AEMP re-evaluation, as per the decision letter from the WLWB on the 2012 AEMP re-evaluation (Appendix 3; Rescan 2012b).

1. Lac de Gras water quality monitoring station (Recommendation #9);
2. Nero-Nema stream water quality (Appendix 3); and

The details of each of these additional studies and analysis are provided below.

4.1 LAC DE GRAS WATER QUALITY MONITORING STATION

4.1.1 Background

In 2011, mine effects were detected downstream of the LLCF as far as site S3 in Lac de Gras for nine water quality variables (pH, hardness, TDS, chloride, sulphate, potassium, total molybdenum, total strontium) and one sediment quality variable (strontium; Rescan 2012a). Site S3 marks the current downstream extent of the AEMP sampling program at Ekati. Thus, effects of mine activities on water and sediment quality may have occurred beyond site S3 in Lac de Gras.

The changes in water and sediment quality currently observed at site S3 in Lac de Gras are very small and the lake volume is very large. It is therefore very likely that Lac de Gras water quality reaches background levels not far beyond the current extent of the AEMP sampling program due to water column mixing. However, the establishment of an additional sampling station in Lac de Gras, downstream of site S3, may be warranted.

4.1.2 Sampling Program

A sampling program will be undertaken in the north arm of Lac de Gras beyond the current extent of the AEMP in order to determine the extent to which Ekati water can be detected. The results of the sampling program will be presented as part of the 2013 AEMP report and the data will be used to consider whether an additional sampling station in Lac de Gras is warranted.

4.2 NERO-NEMA STREAM WATER QUALITY

4.2.1 Background

During the Water Licence Renewal Public Hearing, a question was raised regarding whether hardness dependent SSWQO would be protective of the aquatic environment over time. Specifically, it was suggested that hardness might dilute more quickly than other variables with hardness-dependent SSWQO. It was suggested that the issue could be investigated by measuring hardness and concentrations of water quality variables with hardness-dependent SSWQO downstream of discharge from the LLCF. Thus, as part of its decision on the 2012 AEMP re-evaluation the WLWB requested that a study examining possible differences in dilution among water variables including hardness be completed during the 2013 open water season (Appendix 3).

4.2.2 Proposed Sampling Program

Water quality samples will be collected from Nero-Nema stream at weekly intervals during periods of effluent discharge during the open water season of 2013. Water hardness concentrations will be compared to concentrations of water quality variables with hardness-dependent water quality benchmarks to examine the extent to which there may be differential dilution in hardness and water quality variables with hardness-dependent benchmarks. The results of the study will be presented in the 2013 AEMP report.

References

Rescan™
Engineers and Scientists

References

Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

Rescan. 2003. *EKATI Diamond Mine: AEMP Re-evaluation and Refinement Report, Proposed Program for 2003-2007*. Prepared for BHP Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 2006. *EKATI Diamond Mine: AEMP Re-evaluation and Proposed Program for 2007-2009*. Prepared for BHP Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 2010a. *EKATI Diamond Mine: 2009 Aquatic Effects Monitoring Program Re-evaluation*. Prepared for BHP Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 2010b. *EKATI Diamond Mine: Aquatic Effects Monitoring Program Plan for 2010 to 2012*. Prepared for BHP Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 2011. *Long Lake Containment Facility: Water Quality Investigation Summary, 2004-2010*. Prepared for BHP Billiton Canada Inc. by Rescan Environmetnal Services Ltd.: Yellowknife, Northwest Territories.

Rescan. 2012a. *EKATI Diamond Mine: 2011 Aquatic Effects Monitoring Program*. prepard for BHP Billiton Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, Northwest Territories.

Rescan. 2012b. *EKATI Diamond Mine: 2012 Aquatic Effects Monitoring Program Re-evaluation*. Prepared for BHP Billiton Canada Inc. by Rescan Envrinmental Services Ltd.: Yellowknife, Northwest Territories.

Rescan. 2013. *EKATI Diamond Mine: 2012 Aquatic Effects Monitoring Program*. prepared for BHP Billiton Canada Inc. by Rescan Environmental Services Ltd.: Yellowknife, Northwest Territories.

Whitlock, M. and D. Schluter. 2009. *The Analysis of Biological Data*. Greenwood Village, Colorado: Roberts and Co. Publishers.

Yang, Y. 2005. Can the strengths of AIC and BIC be shared? *Biometrika*, 92: 937-50.

Appendix 1

AEMP Re-evaluation Meeting Agenda (December 12, 2012) and Distribution List

Rescan™
Engineers and Scientists

Appendix 1. AEMP Re-evaluation Meeting Agenda (December 12, 2012) and Distribution List

1.1 AGENDA: 2012 AQUATIC EFFECTS MONITORING PROGRAM RE-EVALUATION PUBLIC WORKSHOP, BHP BILLITON CANADA INC.

Date:

Wednesday, December 12, 2012

Location:

Lower Scotia Centre Boardroom
5102 50th Avenue

Date	Time	Topic
December 12	8:30am – 9:00am	Coffee and Welcome
	9:00am – 9:15am	Round Table Introductions
	9:15am – 9:45 am	AEMP Overview – Sections 1 - 3
	9:45am – 10:15am	Multivariate Analysis – Section 4 PCA
	10:15am – 10:30am	Break
	10:30am - 12:00pm	Multivariate Analysis – Section 4 PCA Regressions CCA Bray-Curtis Conclusions
	12:00pm – 1:00pm	Lunch – Not Provided
	1:00pm – 2:30pm	Review of Overall Report Structure, Sampling Design, Sampling Methods, and Analysis – Section 5
	2:30pm – 2:45pm	Break
	2:45pm – 3:30pm	Special Topics – Section 6
	3:30pm – 4:00pm	Proposed Pigeon AEMP – Section 7
	4:00pm – 4:30pm	Proposed 2013 - 2015 AEMP Sampling Program – Section 8
	4:30pm – 5:00pm	2012 AEMP Re-evaluation Public Workshop Wrap-up

1.2 DISTRIBUTION LIST: BHP BILLITON INVITATION TO AEMP WORKSHOP

- Independent Environmental Monitoring Agency, Bill Ross – Director
- Environmental Assessment and Monitoring Land And Water Division, Department of Environment and Natural Resources GNWT, Patrick Clancy – Environmental Regulatory Analyst
- North Slave Metis Alliance, Sheryl Grieve – Environmental Manager
- Kitikmeot Inuit Association, Luigi Torretti – Senior Environment Officer
- Environment Canada, Lisa Lowman – Senior Environmental Assessment Coordinator

- Fisheries and Oceans Canada, Bruce Hanna – Fish Habitat Biologist
- Environmental Protection-Environment Division Environment and Natural Resources Government of the Northwest Territories , Erika Nyyssonen – Industrial Specialist Mining
- Government of Northwest Territories Environment and Natural Resources, Gavin More – Manager, Environmental Assessment and Monitoring
- Independent Environmental Monitoring Agency, Kevin O'Reilly – Manager
- Aboriginal Affairs and Northern Development Canada, Lionel Marcinkoski – Environmental Scientist
- Aboriginal Affairs and Northern Development Canada, Jason Brennan – Resource Management Officer III
- Aboriginal Affairs and Northern Development Canada Water Resources Division, Paul Green - Regulatory and Science Advisor Renewable Resources and Environment
- Aboriginal Affairs and Northern Development Canada Water Resources Division, Nathen Richea – Manger
- Aboriginal Affairs and Northern Development Canada, Velma Sterenberg – Mineral Development Advisor
- Aboriginal Affairs and Northern Development Canada, Robert Jenkins – Director, Renewable Resources and Environment
- Kitikmeot Inuit Association, Geoff Clark – Director of Lands, Environment, and Resources
- Lutsel K'e Dene First Nation), Wildlife Lands & Environment Committee
- Tlicho Government, – Director, lands Protection Department
- Wek'èezhìi Land and Water Board, Kathy Racher –Technical Director
- Wek'èezhìi Land and Water Board, Ryan Fequet – Regulatory Specialist
- Wek'èezhìi Land and Water Board, Brett Wheler – Regulatory Specialist
- Yellowknife's Dene First Nation, Todd Slack – Land and Environment

Appendix 2

2012 AEMP Re-evaluation Comment and Response Table

Rescan™
Engineers and Scientists

Appendix 2. 2012 AEMP Re-evaluation Comment and Response Table

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
				In general, Recommendations relate the issues raised in the Comment to an action that the Reviewer believes is necessary.	Responses should be as specific as possible, referring directly to the Comment/Recommendation.
2	Environment Canada: Brian Asher	5.2.5 Proposed List of Water Quality Variables	The Proponent recommends that nitrite be removed from the list of evaluated water quality variables, given ammonia and nitrate are already evaluated and nitrite is an intermediate of these two compounds. The Proponent notes that increases in nitrite concentration have been observed and reported in the 2011 AEMP. Evaluation of nitrate and ammonia as an indicator of nitrite concentrations (and associated trends) incorrectly assumes that increases in nitrite concentrations will be reflected in observed concentrations of nitrate and/or ammonia. Imbalances in microbial populations (ammonia-oxidizing bacteria and nitrite-ozidizing bacteria) caused by a range of environmental changes can cause the accumulation of nitrite. In addition, the aquatic toxicity of nitrite is generally greater than that of nitrate or ammonia.	EC recommends that nitrite continue to be evaluated as a water quality variable in the AEMP.	BHP Billiton accepts Environment Canada's recommendation and will continue to evaluate nitrite in the AEMP.
3	Environment Canada: Brian Asher	Treatment of Nondetects and Principal Component Analysis	The Proponent treats data for variables with a high proportion of nondetects using substitution (replace with 1/2 detection limit or the full detection limit) prior to Principal Component Analysis (PCA). Both the substitution of nondetects and the elimination of variables can change PCA results significantly by reducing variability and inducing structure to the data.	EC recommends that other techniques for handling nondetects be reviewed and considered for all statistical analyses in the AEMP (including PCA). Several techniques are available to more appropriately handle nondetect data, e.g. Statistics for Censored Environmental Data Using Minitab and R (Helsel, 2012).	EKATI water quality data consists of a combination of variables with single and multiple detection limits, making the choice of method for imputing data difficult. Moreover, although statisticians generally recommend using imputation rather than substitution (e.g., values equal to half the detection limit) for censored data,

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
			The sensitivity analysis provided by the Proponent compared three methods that all relied on data substitution and/or elimination of variables and therefore is not an adequate test of the legitimacy of the data treatment methods.		"[M]ethod evaluations for estimating a mean do not necessarily carry over to the more difficult issues of how to compute interval estimates, upper percentiles, a correlation coefficient, a regression slope and intercept, or a multidimensional surface when left censoring is present. There are many interesting issues still to be evaluated." (Helsel 2010). For the annual AEMP and the AEMP Re-evaluation, Rescan statisticians evaluate alternatives and employ professional judgment to select the most effective method for estimating values from censored data, given the ultimate goals of the different analyses. For example, the technique employed for handling zero-inflated variables in the multivariate regressions carried out in the 2012 AEMP Re-evaluation was similar to the manner in which Maximum Likelihood Estimation and Kaplan-Meier methods represent nondetects (i.e., "…by the proportion of values falling below the detection limit, without attributing any individual value to them."; Helsel 2010). It is not, however, possible to employ this method when censored data is being plotted over time as completed as part of the annual Evaluation of Effects. Helsel, D. 2010. Much Ado about Next to Nothing: Incorporating Nondetects in Science. Ann.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
					Occup. Hyg. 54 (3): 257-262.
4	Environment Canada: Brian Asher	4.1 Principal Component Analysis of Water and Sediment Quality	The Proponent has made changes to Principal Component Analysis (PCA) over time. For example, variables have been added and removed, and the handling of nondetects has changed. Temporal changes in Principal Component (PC) Score provide valuable information for the interpretation of possible mine effects. To what extent do these PCA changes affect the interpretation of temporal trends?	EC recommends that the Proponent investigate how changes to data treatment techniques and parameters affect analysis of PCA results.	PC loadings are compared to those obtained in previous years in the results and discussion section of the multivariate analyses. PCA results have been largely consistent through time, despite some improvements to data handling techniques and changes to the number or identity of variables included in the analyses. However, the comparison of PCA results between years is not completed to assess temporal trends. Temporal trends are more appropriately assessed using a hypothesis based regression analysis completed on an annual basis as part of the annual AEMP report. The results of the PCA better serve as a comparison and 'check' on the result of the annual AEMPs and are more importantly used in the assessment of relationships between biological and environmental variables.
5	Environment Canada: Brian Asher	Water quality benchmark values	Several variables contain a high proportion of nondetects. Without reverting to raw data, it is difficult to verify if analytical techniques are sufficiently sensitive for the water quality benchmarks employed.	EC recommends that the Proponent present tabulated detection limits (single values or ranges) compared with water quality benchmarks to ensure that analytical techniques are sufficiently sensitive.	Although not specifically provided in the 2012 AEMP Re-evaluation document, a summary of analytical detection limits achieved for evaluated water quality variables are provided in the AEMP report each year (e.g., see tables 3.4-4, 3.4-5 and 3.4-7 of Part 2 - Data Report of the 2011 AEMP). These tables confirm that the analytical techniques used by the laboratory for the AEMP are sufficiently sensitive for comparison against current water quality benchmarks.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
1	Fisheries and Oceans Canada: Bruce Hanna	Lack of reliable data on water clarity	Highly variable Secchi Depths (Fig. 5.4-3) raise questions about reliability of water transparency measurements and in turn detectability of changes in water clarity as a result of mining activities. Moreover, corresponding measurements of chl a and TSS concentrations (primary controls on water clarity) do not seem consistent with the highly variable Secchi Depth observations. Because the depth of 1% incident light determines the physical extent of the euphotic and littoral zones and water clarity along with lake mixing regimes controls the relative availability of light and nutrients required for growth of plankton, accurate measurement of lake water transparency is essential to any lake ecosystem assessment and ought to be carefully monitored.	1) Replace the Secchi Disk method of determining water clarity with measurement of light attenuation using a light meter; 2) In the event water clarity is indeed as variable as Secchi Depth measurements suggest, then synchronous measurement of light attenuation, and concentration of chlorophyll a, CDOC, and TSS is warranted to assess using multiple regression the relative contribution of each constituent to water transparency; 3) Last, if substantive changes to water clarity are indeed attributable to mining activities, for instance due to periodic spikes in TSS loading, then appropriate steps can be taken to reduce TSS at the source.	BHP Billiton does not agree that replacing Secchi disk measurements with the measurement of light attenuation using a light meter would add value to the AEMP for EKATI for the reasons described in Section 5.4.5 of the 2012 AEMP Re-evaluation. Further, potential contributors to changes in water clarity such as TSS, TOC and chlorophyll *a* are also monitored annually in the AEMP. TSS is also regulated as an EQC parameter in the EKATI water licence. These parameters have remained stable through time in the Koala Watershed, and only recently has TOC shown a small but increasing trend in the King-Cujo Watershed. Therefore, despite some variability in Secchi disk readings, there is no reason to believe that there have been substantive changes to water clarity due to mining activities at EKATI. Additionally, the euphotic depths existing in EKATI AEMP lakes are found to extend to the lake bottom in all but the deepest lakes (i.e. see Figure 3.3-2 of the 2011 AEMP Part 2 - Data Report). In 2011 only Nanuq, Vulture, Grizzly, Kodiak and Slipper lakes contained portions of the lake where 1% of incident light would not penetrate to the bottom sediments. These results are very consistent with historical data and indicate that light is sufficient for phytoplankton growth throughout the entirety of most receiving water bodies.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
2	Fisheries and Oceans Canada: Bruce Hanna	Discontinuation of plankton biomass monitoring	Proponents are misguided in claiming data on biovolume of phytoplankton and biomass of zooplankton duplicate information provided by the abundance (or density) of plankton. The basis of the proponent's dismissal of plankton biomass as important is similarity between relative abundance and relative biomass of plankton groups. However it is absolute biomass (not relative biomass) that is of interest as it is the standard indicator of the availability of edible plankton for zooplankton, and supply of zooplankton for fish. For example, increased P-loading may increase fish yields by increasing the absolute biomass of edible phytoplankton (e.g. picocyanobacteria and microflagellates in the range of up to 40 m) and, in turn, the size and density (i.e. biomass) of zooplankton (e.g. daphnia and other cladocerans) that are the forage requirement for planktivorous fish. Further, increased N-loading as a result of blasting may eliminate seasonal N-drawdown and associated blooms of small edible cyanophytes. On the other hand, increased Si-loading may alleviate seasonal Si-depletion and in turn lead to increased prevalence of large inedible diatoms. In short, there is no replacement for measurement of the plankton biomass in the assessment of the availability of edible plankton.	Phytoplankton biovolume and zooplankton biomass should be monitored and used as the basis of assessment of availability of edible plankton.	BHP Billiton annually monitors and evaluates the absolute biomass of the phytoplankton community (i.e. biomass as chlorophyll *a*) and the absolute biomass of the zooplankton community (mg dry weight/m^3). Neither of these parameters were found to have been affected by mine activities in the 2011 AEMP. Additionally, the 2012 AEMP Re-evaluation has shown that, currently, monitoring density provides an adequate picture of relative food availability. Therefore, only if the average biovolumes of different taxa are changing over time, would it become necessary to monitor biovolumes and biomass of the various taxa. While there is some possibility that biovolumes and biomass of taxa may change through time, BHP Billiton proposes that this does not need to be monitored annually and recommends that a similar analysis as carried out in the 2012 AEMP Re-evaluation (Section 5.5) be completed for the 2015 AEMP Re-evaluation.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
3	Fisheries and Oceans Canada: Bruce Hanna	Statistical analyses that do not explicitly link change in water quality with change in availability of edible plankton biomass	In contrast with PC1, PC2, and PC3 (variates generated by PCA) that do little to quantitatively link specific changes in water chemistry and changes in lake biota, plotting and regressing an increase in a nutrient concentration, water clarity, or depth of the thermocline against the biomass of major components of the edible plankton assemblage can provide the action levels and significance thresholds needed to prevent decrease over time in the ratio of edible to inedible plankton biomass. Examples of the danger of using ?inexplicit? statistics include the following two Ekati scenarios: **Scenario 1:** Proponents have reported an increase in cryptophyte abundance and corresponding decrease in phytoplankton diversity in Cujo Lake. Although the increase in crytophyte abundance could not be unambiguously linked with mining activities, the proponents suggested that in the event change in community composition was indeed an effect of mining activities then management should intervene to block any further decrease in phytoplankton diversity. What management might actually do is not addressed; however, if the change in crytophyte abundance were linked to a specific change in lake water chemistry then options for intervention might be identifiable. But cryptophytes are optimal or near optimal food organisms for zooplankton, in particular rotifers. Thus, even in the event an increase in crytophytes was deemed an effect of mining activity, there would be no reason for concern about a corresponding decrease in phytoplankton diversity because the increase in crytophytes is good for the lake food web. Scenario 1 exemplifies two important points, as follows: a) the need to link a specific	The best practice may be to use empirical lake water chemistry and plankton data as the diagnostic of impacts on the lake food web (such as substantive change in availability of edible plankton) and any EIA predictions. Identifying what parameters to alter to avoid ecosystem regime shift will need to be based on relationships that can be developed between changing physiochemical regimes and changes in the biomass of edible plankton species.	Assessment of relationships between biological and environmental variables separately would likely lead to spurious correlations as a result of extreme multicolinearity among the environmental variables at EKATI. This could confuse the assessment of causal relationships. PCA is helpful in understanding relationships between biological and environmental variables because it reduces multiple, strongly correlated water or sediment quality variables to a few, manageable, quantitative variables that capture the major axes of variation (including spatially- and temporally-directed variation) across all of the environmental variables considered. Thus, regressing biological data on PC scores provides a statistically robust, quantitative, and effective method of assessing relationships between biological and environmental data. Interpretation of the underlying causes of emergent correlations between biological variables and PC scores requires professional judgment. For example, the correlations between some biological variables and water quality PC1 were initially suggestive of potentially harmful effects of concentrations of certain environmental variables that correlated strongly with PC1 (e.g., chloride). However, subsequent analysis of the

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
			physicochemical change with a specific change in plankton biomass; and, b) the need to understand the implication for the lake food web of any change in the composition of plankton biomass. **Scenario 2:** Although the proponent's Bray-Curtis statistics may suggest dissimilarity between plankton, or benthic, communities in an impacted lake versus a reference system, the statistic does not reveal whether the change is beneficial or detrimental to the lake food web, nor does it provide any basis for setting an action level by linking a specific change in water chemistry with a specific change in lake biota. Further, although Section 5.1.1 Integration of Biological Effects with Changes in Water Quality may be a step in the right direction, on the other hand there is no attempt by the proponents to utilize the various statistical results in the integration. Further, the effort to integrate change in water quality with change in lake biota ought to begin with a basic set of hypotheses not only informed by the EIA but also by observed trends over time in the empirical water chemistry and lake biota data. As an example of the integration that could be done, if increase in Si concentration were to lead to increase in the biomass of large inedible diatoms at the expense of small edible species, a regression model relating change in Si concentration to change in the ratio of small to large diatom biomass might help set an action level and identify a significance threshold for Si-loading beyond which we might see depression in fish production.		patterns, rooted in the assessment of concentrations of water quality variables relative to species sensitivity distributions for residents and surrogate species at EKATI, suggests that biological communities at EKATI are more likely shifting in response to the availability of a few key nutrients (i.e., N and P) rather than toxicological effects of other elements and molecules in the receiving environment. In this manner, BHP Billiton has identified the change in physiochemical regime that is most likely to be causally associated with observed changes in biological communities and in this case has carried out a number of actions to reduce the quantity of nitrogen entering the receiving environment. The Koala Watershed water quality model is another tool that EKATI uses to predict changes in water quality that may affect the aquatic biological communities downstream of the mine.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
4	Fisheries and Oceans Canada: Bruce Hanna	Lack of data on plankton seasonal dynamics	Seasonal changes in temperature, light, and mixing changes are principle drivers of seasonal succession of plankton. It is not implausible that mining activities, or climate change, could affect seasonal cycles; however, sampling once or twice a year decreases the likelihood of detecting such change. Although the proponents argue that biological communities are assessed in August because it is the month of peak abundance, sampling once a year is insufficient to detect any change in seasonal dynamics.	Because plankton are found in the water column prior to lake ice out, plankton sampling could be coupled with April lake water sampling, which would double sampling frequency and increase the likelihood of detecting change in seasonal plankton dynamics.	While BHP Billiton can appreciate that the composition of the phytoplankton community will be different between winter and summer, the company does not believe that there is reason to add April phytoplankton monitoring at this time. The goal of the AEMP is to detect changes on an annual basis that may be caused by mine activities. The program is not designed or intended to examine short-term changes in already variable plankton assemblages. In addition, no baseline or historical data exists for under ice phytoplankton taxonomy in AEMP lakes and therefore the utility of these additional data would be limited. This question was also addressed in the 2003 AEMP Re-evaluation which examined the validity of including/keeping seasonal measures of plankton at EKATI and determined that seasonal variability made it more difficult to assess temporal trends. The accepted recommendation at that time was to reduce sampling of three times during the open water season to August only.
5	Fisheries and Oceans Canada: Bruce Hanna	Lack of data on lake flushing rates	Hydrological data including lake flushing rates, or the dilution capacity of lakes, would help predict the degree of increase in TDS content to be expected in Cujo and Leslie lakes as a result of loading via effluent discharge. Further, Figures 2.2-1 and 2.2-2 would be more useful if watershed icons were scaled to correspond with catchment area, lake icons scaled to correspond with lake volume, stream flow icons scaled to	Continue to collect the hydrological data needed to link watersheds, stream flows, and lakes, and determine flushing rates, etc.	The continuation of the EKATI hydrological monitoring program for both the Koala and King-Cujo watersheds was proposed in the 2012 AEMP Re-evaluation, the proposed plan includes two stations that are in addition to the stations that were monitored during the 2010 to 2012 period. While data on residence times

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
			correspond with annual discharge, and lake-flushing rate provided for each lake (lake flushing rate = water in /lake volume). This kind of basic hydrological information would allow assessment of the vulnerability/ sensitivity of a particular lake to discharge of effluent. Last, downstream extent of change in water chemistry is currently tracked and possibly effort could be reduced to measurement of a single conservative ion such a Na+1 or Cl-1 (each is harmless, relatively inert, and not used by biota in a great degree) until some threshold value is surpassed at which time sampling effort could be increased.		were not specifically provided in the AEMP Re-evaluation Report, they do exist. Data on lake residence times for lakes of the Koala Watershed are available in the annual AEMP (e.g. see Chapter 6 of Part 1 - 2011 AEMP Evaluation of Effects). Furthermore, water quality predictions for the Koala Watershed are available in a report published in April of 2012 entitled *EKATI Diamond Mine: Water Quality Modeling of the Koala Watershed.* While not published, data on residence times and water quality predictions also exist for the King-Cujo Watershed. These results were provided in the BHP Billiton response to technical session information requests (IRs) (IR #9) for the EKATI water licence renewal submitted to the WLWB on November 30, 2012. DFOs suggestion for improving the clarity of Figures 2.2-1 and 2.2-2 are appreciated and will be considered for future reports.
6	Fisheries and Oceans Canada: Bruce Hanna	Monitoring	Selenium concentrations have increased in slimy sculpin, round whitefish, and lake trout over time in Leslie Lake, downstream of the LLCF. As indicated by Peter Chapman, Golder in the BHPB response to Water Licence renewal interventions, the main concern with selenium is "the potential for dietary accumulation resulting in reproductive effects in egg-laying vertebrates such as fish." Therefore, the preferred approach to measure toxicity effects is to use fish tissue. Based on 2012 data, levels in all three species have reached the BC MoE's 2012 proposed fish muscle/	A fish tissue benchmark should be set for selenium with an associated management response plan as soon as possible. In the BHPB response to interventions Peter Chapman states that "there is no reason to believe that selenium concentrations in fish could increase over the remaining years of mine life above concentrations of potential concern." Please clarify what concentration would be a potential concern (e.g. US EPA criterion) and what options	As stated in the BHP Billiton Response to Interventions for the EKATI Water Licence Renewal, "Selenium concentrations in lake trout muscle are generally similar to the pre-mining background /reference range with the exception of Cell E and Leslie Lake in 2012. Selenium muscle concentrations could be interpreted as showing a trend of increasing concentrations in Leslie and Moose Lakes in recent years

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
			whole body guideline of 4mg/kg dry weight in Leslie Lake. While the BC MoE guideline is still a draft and is less than other existing guidelines (e.g. US EPA) it identifies an issue that needs to be addressed.	might be available to reduce selenium levels in the receiving environment if trends indicate the concentration may be reached.	that is not apparent for other lakes; however, concentrations are still well below the USEPA (2004) draft criterion. Selenium concentrations in slimy sculpin whole bodies are higher in Cell E and Leslie Lake than in the other lakes. However, there appears to be a downward trend; concentrations are all well below the USEPA (2004) draft criterion; and concentrations in all lakes are well within the range of background selenium concentrations in slimy sculpin, which can range from 3.5 to 13.3 mg/kg dry weight (data from Idaho: Hamilton et al. 2002, Hamilton and Buhl 2003; data from the Yukon: EDI 2008; data from Alberta: Mainstream Aquatics 2009). Selenium concentrations in round white fish muscle show a similar pattern to lake trout muscle, but there is relatively high variability in selenium concentrations in round white fish from Nanuq Lake, a reference lake, in 1997 and again in 2007. Concentrations in round white fish from all lakes remained well below the USEPA (2004) draft criterion through 2012. Note that the USEPA (2004) draft criterion of 7.91 mg/kg dry weight is lower than the benchmark of 8.3 mg/kg dry weight fish muscle / whole body developed using CCME

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
					protocols for Canadian fish species by DeForest et al. (2012). The BCMoE's (2012) proposed (draft) fish muscle / whole body guideline of 4 mg/kg dry weight incorporates an uncertainty factor (also called a safety factor) of 2, the rationale for which has been questioned by reviewers; without this uncertainty factor the benchmark would be between those proposed by USEPA (2004) and DeForest et al. (2012). USEPA (2004) does not incorporate an uncertainty factor; DeForest et al. (2012) explain why an uncertainty factor is unnecessary; and, BCMoE (2012) remains draft and may be revised following extensive critical review from stakeholders and from provinces (e.g., Saskatchewan provided critical peer review). In summary, the best available data (i.e., fish selenium body burden data) through 2012 do not indicate any potential risk to fish from selenium over the 15 years that the mine has operated. There is no reason to believe that selenium concentrations in fish could increase over the remaining years of mine life above concentrations of potential concern." Given the low risk demonstrated for selenium, the best way to manage selenium is to identify a benchmark for selenium in fish tissue in the Response Framework.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
					From there, appropriate management actions for selenium would be identified if the need for action is triggered under the Response Framework. BCMoE (BC Ministry of the Environment). 2012. DRAFT Water Quality Guidelines for Selenium Technical Appendix Update. Prepared by Beatty JM, Russo GA, September 20 2012, Water DeForest DK, Guilron G, Armstrong SA, Robertson EL. 2012. Species sensitivity distribution evaluation for selenium in fish eggs: Considerations for development of a Canadian tissuebased guideline. Integr Environ Assess Manage 8: 6-12. EDI (Environmental Dynamics Inc.). 2008. Natural sources of contaminants In the Yukon. MPERG (Mining and Petroleum Environment Research Group), Whitehorse, YT, Canada. Hamilton SJ, Buhl KJ. 2003. Selenium and other trace elements in water, sediment, aquatic plants, aquatic invertebrates, and fish from streams in southeastern Idaho near phosphate mining operations: May 2001. US Geological Survey, Yankton, SD, USA.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
					Hamilton SJ, Buhl KJ, Lamothe PJ. 2002. Selenium and other trace elements in water, sediment, aquatic plants, aquatic invertebrates, and fish from streams in southeastern Idaho near phosphate mining operations: June 2000. USGS, Yankton, SD and Denver, CO, USA. 72 pp. Mainstream Aquatics. 2009. Grande Cache Coal Corporation fish monitoring program - 2008. Edmonton, AB. USEPA (U.S. Environmental Protection Agency). 2004. Draft Aquatic Life Water Quality Criteria for Selenium- 2004. EPA-822-D-04-001. Office of Water, Office of Science and Technology, Washington, DC, USA.
7	Fisheries and Oceans Canada: Bruce Hanna	Nitrite as an evaluated variable	BHPB is recommending that nitrite-N be removed from the list of evaluated variables because nitrite-N is intermediate to total ammonia-N and nitrate-N. However, nitrite is the more toxic form to aquatic life.	Nitrite should remain as an evaluated variable.	Please see our response to Environment Canada #2
8	Fisheries and Oceans Canada: Bruce Hanna	Response Framework for AEMP	It is important that the AEMP is developed and reported within a response framework rather than treating them as two separate entities.	AEMP reports/ re-evaluations should include applicable action levels and management actions for each required component , providing a summary of whether current monitoring results show that an action level has been reached or not and if it has, what management action is being taken.	This topic is being addressed through the EKATI Water Licence renewal process. BHP Billiton agrees that the AEMP data should feed into a Response Framework where data can be compared against action levels set to determine whether management action is required for a particular parameter.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
1	GNWT - Environment and Natural Resources: Patrick Clancy	General Comment	No Comment	No Comment	No comment
2	Independent Environmental Monitoring Agency: Kevin O'Reilly	Recommendation #12 BHPB proposes to delete a number of variables as "evaluated parameters" in the AEMP (see Table 5.2-4).	(Submitted after Due Date) The Agency is concerned with a number of the proposed deletions by BHPB, namely TDS, Aluminum, Copper, Iron, and Nitrite from the list of evaluated water quality variables. We are not convinced that TDS is adequately represented by the PC1 group. Given the concerns raised around Aluminum toxicity for fish that is pH dependent, we believe this variable should be retained. Elevated Copper and Iron concentrations in Kodiak Lake continue to increase and may emanate from the PDC. With the continuing work on widening the PDC, we recommend that these variable continue to be watched closely. We believe it would be wise to continue to evaluate Nitrite, as a form of nitrogren, until the concerns around nutrient enrichment and changing water quality and biota downstream have been resolved. If BHPB does not intend to carry out any further phosphate additions within the LLCF to attempt to reduce nitrate levels, we could agree with dropping Organophosphate.	Retain TDS, Aluminum, Copper, Iron, and Nitrite as evaluated variables and reconsider again as part of the next three-year AEMP review. If BHPB again adds phosphate to the LLCF to attempt to reduce nitrogen, Organophosphate should be evaluated in the AEMP.	BHP Billiton's position is that for the evaluation of mine effects at this stage of the mine life, TDS is better represented by its major constituents (i.e. chloride, nitrate, sulphate and potassium). BHP Billiton has developed SSWQOs for these parameters and proposes to continue to evaluate these parameters individually. Aluminum, copper and iron are proposed to be eliminated from the list of evaluated water quality variables because there are currently no increasing trends for these parameters in AEMP lakes (including Kodiak Lake). Additionally, where CCME WQG are exceeded for copper and iron in receiving lakes, these guidelines are also exceeded naturally at reference sites. BHP Billiton accepts the continued evaluation of nitrite. BHP Billiton currently has no plans for further additions of phosphate to the LLCF and therefore appreciates IEMAs support to remove orthophosphate from the list of AEMP evaluated parameters in order to ensure focus on those parameters that are of highest importance. BHP Billiton notes that all parameters will be reconsidered for the list of evaluated water quality variables in 2015.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
3	Independent Environmental Monitoring Agency: Kevin O'Reilly	Recommendation #12 BHPB proposes a number of variables as "evaluated parameters" in the AEMP (see Table 5.2-4).	(Submitted after Due Date) The Agency recommends that Cadmium be added to the list of evaluated water quality variables. We understand that the CCME may be revising its Cadmium guideline for the protection of the aquatic environment soon, but Cadmium is now well above the current CCME guideline downstream of the LLCF.	BHPB should include Cadmium as an evaluated water quality variable at least until a new CCME guideline is released, after which further evaluation can then be reviewed.	BHP Billiton does not propose cadmium as an evaluated water quality variable because there is no current increasing trend for cadmium in AEMP lakes. The addition of cadmium (and all other parameters) as an evaluated variable will be reassessed in 2015 at which time it can be added if necessary.
4	Independent Environmental Monitoring Agency: Kevin O'Reilly	Recommendation #9 additional monitoring site in Lac de Gras (see pages 5-27 and 5-28).	(Submitted after Due Date) The Agency supports additional monitoring and assessment into Lac de Gras. From the rationale provided by BHPB, it is not clear on what basis or how BHPB will decide whether to establish another monitoring station in Lac de Gras and how such data may contribute to a cumulative effects assessment on this water body.	BHPB should provide some rationale as to how it will decide to establish another monitoring station in Lac de Gras. BHPB should also provide some rationale and explanation as to how data from this site can be used to get a better understanding of BHPB's contribution to cumulative effects on Lac de Gras.	The design of the additional sampling program proposed to be conducted in Lac de Gras in 2013 has not yet been determined, however, it is not intended as a cumulative effects assessment tool. While BHP Billiton is open to contributing to a cumulative effects study on Lac de Gras, the company is not in the position to lead such a study. The study will be designed to inform whether a new sampling station in Lac de Gras is necessary to detect effects from the EKATI mine, other considerations will include the logistics and safety of sampling in Lac de Gras.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
5	Independent Environmental Monitoring Agency: Kevin O'Reilly	BHPB proposes (Recommendation #16) to delete deep-water sediment sampling in AEMP lakes. (p.5-48)	(Submitted after Due Date) Seems reasonable, but still require some comparative index of sediment quality in deep vs mid-depth.	BHPB should retain deep-water sampling for Leslie Lake (depending on bathymetry) to keep tabs on sediment quality, especially if concentrations higher in deep-water compared to mid-depth.	Statistical analysis of sediment quality suggests that concentrations of some variables (i.e., aluminum, copper, and zinc) in Leslie Lake are greater in deep depth sediments than in mid-depth sediments (ANOVA, $p < 0.05$). However, mean observed concentrations of all of these variables in 2011 were the lowest they have been since monitoring began in Leslie Lake in 2005 and, for some other variables (e.g., molybdenum), concentrations were greater at mid-depths than at deep depths in 2011. Regardless, as in other lakes, mid- and deep depth sediment concentrations provide similar information about spatial and temporal patterns and concentrations of all variables were at least three times lower than CCME guidelines in 2011. Moreover, only a small fraction (~0.7% of sediment surface area) of Leslie Lake is classified as 'deep depth' (i.e., > 10 m). Thus it is not necessary to continue deep depth sediment quality sampling in Leslie Lake, which would also necessitate deep depth sediment sampling in the reference lakes in order to complete a robust effects assessment.

ID	Reviewer	Topic	Comment	Recommendation	Proponent Response
6	Independent Environmental Monitoring Agency: Kevin O'Reilly	BHPB sets out the list of AEMP evaluate sediment quality variables in Table 5.3-4	(Submitted after Due Date) The Agency is concerned that BHPB proposes to drop a number of sediment quality variables including Aluminum, Copper, and Iron. The Agency is of the view that these variables should not be dropped so as to ensure that sediment analysis mirrors water quality analysis.	BHPB should ensure that the sediment quality analysis should more closely mirror the water quality evaluated variable analysis.	BHP Billiton is in agreement that the evaluated sediment quality variables should be similar to the evaluated water quality variables and has based its assessment on which sediment parameters to evaluate for this reason. BHP does not agree that aluminum, copper and iron should be included in this list based on the reasons described in our response to IEMA #2.
7	Independent Environmental Monitoring Agency: Kevin O'Reilly	Fay Bay Baseline Studies as described in s. 7.4 and Table 7.4-1.	(Submitted after Due Date) The Agency has no objections to the proposed Pigeon AEMP except when BHPB sets out the available baseline data for the watershed. Processed kimberlite spilled from Cell B into Fay Bay in May 2008, and resulting depostion of this material in the sediments in Fay Bay. It would be inappropriate to charaterize this period and the following recovery as reflecting baseline conditions.	BHPB should remove the Fay Bay spill period from consideration as baseline data for the Pigeon watershed.	BHP Billiton is in agreement with the Agency and does not intend for data collected between May 2008 and present to be represented as baseline data in the effects analysis for the Pigeon AEMP.

Appendix 3

Wek'èezhìi Land and Water Board Decision for the Report *EKATI Diamond Mine: 2012 Aquatic Effects Monitoring Program Re-Evaluation*

Rescan™
Engineers and Scientists

Wek'èezhìi Land and Water Board

Box 32, Wekweètì, NT X0E 1W0
Tel: 867-713-2500 Fax: 867-713-2502
(Main)

#1-4905 48th Street, Yellowknife, NT X1A 3S3
Tel: 867-765-4592 Fax: 867-669-9593

March 22, 2013 File: W2009L2-0001

Ms. Claudine Lee
Superintendent – Environment Operations
EKATI Diamond Mine
BHP Billiton Canada Inc.
#1102, 4920-52nd Street
Yellowknife, NT X1A 3T1

Dear Ms. Lee,

Board Directive RE: EKATI Diamond Mine 2012 Aquatic Effects Monitoring Program Re-evaluation and revised AEMP Design

The Wek'èezhìi Land and Water Board met on March 19, 2012 to consider BHP Billiton's 2012 Aquatic Effects Monitoring Program Re-evaluation and revised AEMP Design in accordance with Part J, Item 7-f and Part J, Item 1 of Water Licence W2009L2-0001.

The Board has approved the revised AEMP Design with two additions:

i. Cadmium shall be included as an evaluated parameter; and
ii. Copper shall be included as an evaluated parameter for the King-Cujo watershed.

On or before April 30, 2013, the Board requires the Licensee to submit a revised AEMP Design Summary that incorporates the two additions above. The Board's Reasons for Decision will be provided following the next meeting of the Board.

The Board notes that water quality objectives for several parameters of potential concern are related to hardness and that BHP (in Closing Arguments for the Water Licence Renewal Public Hearing) has offered to increase sampling frequency at Nero/Nema stream to weekly during effluent discharge in 2013 to investigate differential dilution between hardness and parameters with hardness-related objectives. The Board supports this investigation and requests that BHP submit the results and interpretation with the 2013 AEMP Annual Report.

If you have any questions, please feel free to contact Brett Wheler at brett@wlwb.ca or by phone at 867-765-4590.

Sincerely,

Violet Camsell-Blondin
Chair, WLWB

Copied: BHPB Distribution List