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Canada

31 March 2016

Dear Ms. Camsell-Blondin:

**Subject: 2014 Annual AEMP Report – Part K Item 10**

The 2014 Aquatic Effects Monitoring Plan (AEMP) Annual Report is attached as specified under the Wek'eezhii Land and Water Board (WLWB) Water Licence W2007L2-0003 Part K Item 10 (current Water Licence W2015L2-0001 Part J Item 8). The [February 20th, 2015 directive](#) from the WLWB requested that Diavik Diamond Mines (2012) Inc. (DDMI) delay submission of the 2014 AEMP Annual Report to allow for development of an AEMP Reference Conditions Report which details the calculation of all background ranges that DDMI proposes to use to evaluate potential effects for all parameters measured as part of the AEMP. The AEMP Reference Conditions Report Version 1.1 was [approved on November 27<sup>th</sup>, 2015](#). The approved normal ranges presented in that report have been incorporated into the analyses and figures prepared in support of the 2014 AEMP Annual Report.

Although the 2014 AEMP Annual Report was a required submission under the previous Water Licence (W2007L2-0003), DDMI has incorporated the revised Water Licence requirements for AEMP submissions (W2015L2-0001) into this 2014 AEMP. The main difference in the current Water Licence that applies to the Annual AEMP reporting is the addition of Action Level exceedance reporting (Part J Item 6) and submission of a Response Plan for each Action Level that is exceeded. An AEMP Response Plan that satisfies the requirements of Schedule 8 Item 3 is provided below for each of the 2014 AEMP Action Level exceedances.

## 2014 Response Plan

Results of the Action Level evaluation completed for the 2014 AEMP identified 19 water quality variables that triggered Action Level 1 and eight variables that triggered Action Level 2, as shown in Table 1. This table also includes the information required by the current Water Licence, W2015L2-0001 under Part J, Item 6 (a) (notification) and (b) (response plan) and the specific requirements for a response plan under Schedule 8, Item 3, as follows:

3. *The **AEMP Response Plan** referred to in Part J, Item 6, shall contain the following information for each parameter that has been reported in the **AEMP Annual Report** to have exceeded an Action Level:*

- a) *a description of the parameter, its relation to Significance Thresholds, and the ecological implication of the Action Level exceedance;*
- b) *a summary of how the Action Level exceedance was determined and confirmed;*

- c) a description of likely causes of the Action Level exceedance and potential mitigation options if appropriate;
- d) a description of actions to be taken by the Licensee in response to the Action level exceedance including:
  - i.) a justification of the selected action(s) which may include a cost/benefit analysis;
  - ii.) a description of timelines to implement the proposed actions;
  - iii.) a projection of the environmental response to the planned actions, if appropriate; and
  - iv.) a schedule to report on the effectiveness of actions and to update the **AEMP Response Plan** as required; and,
- e) any other information necessary to assess the response to an Action Level exceedance or that has been requested by the Board.

Under the existing approved *AEMP Response Framework*, no action is required when a water quality variable triggers Action Level 1.

When a variable triggers Action Level 2, the required management action is to develop an *AEMP Effects Benchmark* for that variable if one does not already exist. Two variables reached Action Level 2 (sodium and antimony) that do not have existing AEMP Aquatic Life Effects Benchmarks.

Under the existing approved *AEMP Response Framework*, DDMI will be required to develop benchmarks for these variables. DDMI proposes this will be done as part of the AEMP Study Design Version 4.0, which is scheduled to be submitted on June 30, 2016.

The results in 2014 also indicated that chlorophyll a triggered Action Level 2 in the Response Framework for Indicators of Eutrophication (Table 1). The required management action when an Action Level 2 is triggered is to develop an AEMP Effects Benchmark for chlorophyll a. This was done as part of the updates to the AEMP Study Design Version 3.1, which was [approved by the board on August 19, 2013](#). No Action Level was triggered for the plankton component in 2014.

If you have any questions regarding the attached submission, please contact the undersigned at 867-669-6500 ext. 5536 or [david.wells@riotinto.com](mailto:david.wells@riotinto.com).

Yours sincerely



David Wells  
Superintendent - Environment

**Table 1. Summary of Action Level Exceedances and Required Management Actions, 2014 AEMP**

Component	Variable	Action Level Classification	How the Action Level Exceedance was Determined	Detailed Results of Action Level Evaluation	Relation to Significance Threshold	Ecological Implication of Exceedance	Likely Cause	Action Required <sup>(a)</sup>	Action Date <sup>(b)</sup>
Water Quality	Specific Conductivity	1	See Appendix II, Section 2.3.4	See Appendix II, Section 3.4	Below Significance Threshold	Not Ecologically Significant	Effluent	None	-
	Total Dissolved Solids (Calculated)	2						Develop <i>AEMP Effects Benchmark</i>	Complete
	Calcium	1						None	-
	Chloride	2						Develop <i>AEMP Effects Benchmark</i>	Complete
	Potassium	1						None	-
	<b>Sodium</b>	<b>2</b>						<b>Develop <i>AEMP Effects Benchmark</i></b>	<b>30-Jun-16</b>
	Sulphate	1						None	-
	Nitrate (as Nitrogen)	2						Develop <i>AEMP Effects Benchmark</i>	Complete
	Aluminum	1						None	-
	<b>Antimony</b>	<b>2</b>						<b>Develop <i>AEMP Effects Benchmark</i></b>	<b>30-Jun-16</b>
	Barium	1						None	-
	Chromium	1						None	-
	Copper	1						None	-
	Lead	1						None	-
	Molybdenum	2						Develop <i>AEMP Effects Benchmark</i>	Complete
	Silicon	1						None	-
	Strontium	2						Develop <i>AEMP Effects Benchmark</i>	Complete
	Tin	1						None	-
	Uranium	2						Develop <i>AEMP Effects Benchmark</i>	Complete
Eutrophication Indicators	Chlorophyll <i>a</i>	2	See Appendix XIII, Section 2.3.6	See Appendix XIII, Section 3.5			Develop <i>AEMP Effects Benchmark</i>	Complete	

a) Management action required under the AEMP Response Framework

b) Timeline to implement the proposed action.

Note: Action Level exceedances are summarized for the 2014 AEMP. Management actions identified as a result of analyses completed for the 2011 to 2013 Aquatic Effects Re-evaluation Report are summarized in that report. **Bolding** indicates a new management action is required.



**DIAVIK DIAMOND MINES (2012) INC.**

**AQUATIC EFFECTS MONITORING PROGRAM  
2014 ANNUAL REPORT**

Submitted to:

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## Executive Summary

Diavik Diamond Mines (2012) Inc. (DDMI) conducts environmental monitoring programs under the terms and conditions of Water Licence #W2015L2-0001 issued for the Diavik Diamond Mine (Mine). The Aquatic Effects Monitoring Program (AEMP) is the primary program specified in the Water Licence for monitoring the aquatic environment of Lac de Gras. The 2014 program was completed under Water Licence W2007L2-0003 (WLWB 2007).

The central purpose of the AEMP is “to determine the short and long-term effects in the aquatic environment resulting from the project, to evaluate the accuracy of impact predictions, to assess the effectiveness of impact mitigation measures, and to identify additional impact mitigation measures to reduce or eliminate environmental effects of the licensed undertaking.” The particular focus of the AEMP is in relation to the primary valued ecosystem components of Lac de Gras, which includes water chemistry, sediment chemistry, lake productivity, planktonic and benthic invertebrate communities, fish, fish habitat, and the use of fisheries resources in Lac de Gras.

To accomplish these objectives, aquatic effects monitoring conducted by DDMI has included an east island-based monitoring program for source waters, as represented by the Surveillance Network Program (SNP), and a lake-based monitoring program. The lake monitoring program includes the following components:

- a water chemistry program in Lac de Gras;
- an aquatic biota monitoring program in Lac de Gras (including fish surveys, plankton and benthic invertebrate community studies, and supporting sediment and water chemistry data collection);
- a dust deposition monitoring program; and
- special effects studies (SES), as required.

The lake monitoring program generally occurs in four areas within Lac de Gras:

- the near-field (NF) exposure area located near the effluent diffusers;
- the mid-field (MF) areas, generally surrounding the east island;
- the far-field (FF) exposure area, FF2; and
- three far-field (FF) reference areas, FF1, FFA and FFB.

The 2014 AEMP was carried out according to the requirements specified in the AEMP Study Design Version 3.5 for an interim monitoring year, which required sampling in exposed areas of the lake (Golder 2014b). The reference areas in Lac de Gras are sampled every third year during the comprehensive monitoring program to allow for a detailed assessment of Mine-related effects. The next comprehensive monitoring program is scheduled for 2016.

This report is intended to communicate the 2014 results of the AEMP. A similar document is produced each March, reporting on the previous year's results. Submission of the 2014 Annual Report was delayed to allow for development and approval of the AEMP Reference Conditions Report Version 1.1, which details the calculation of the normal ranges used to assess effects of the Mine on the aquatic ecosystem of Lac de Gras.

The focus of the assessment for the annual report is a spatial analysis, whereby areas of the lake exposed to effluent are compared to areas of the lake that are not exposed to effluent (i.e., reference areas). Temporal analyses and an assessment of trends over time will be provided in the next three-year summary report (to be submitted by October 15, 2017). The importance of an effect was compared to Action Levels, which are part of a Response Framework. The goal of having a Response Framework is to ensure that significant adverse effects never occur.

To better communicate AEMP results to the range of technical and non-technical parties who are interested in the results, we have provided information in two ways. First, the main body of the report provides a non-technical summary of the most important results from the 2014 studies. Second, technical appendices have been included that provide a full description of analyses conducted and results obtained. These appendices are intended for parties with more technical interests.

Key findings from the 2014 AEMP include the following:

- Dust deposition rates in 2014 were generally lower than in previous years. Deposition rates were highest close to the project infrastructure and decreased with distance from the Mine. Snow chemistry analyte concentrations were below the effluent concentration limits in the Water Licence.
- Mine effluent had an effect on 19 water quality variables (conductivity, total dissolved solids [TDS, calculated], calcium, chloride, potassium, sodium, sulphate, nitrate, aluminum, antimony, barium, chromium, copper, lead, molybdenum, silicon, strontium, tin and uranium). The median concentrations of these variables in the NF area were greater than two times the reference area median concentrations. As a result, these variables demonstrated an effect equivalent to Action Level 1. Of the 19 variables that reached Action Level 1, eight (TDS [calculated], chloride, sodium, nitrate, antimony, molybdenum, strontium and uranium) also reached Action Level 2, because the 5<sup>th</sup> percentile concentration in the NF exposure area was greater than two times the reference area median concentration and greater than the normal range for Lac de Gras. None of the water quality variables reached Action Level 3.
- Results relating to eutrophication indicators suggest that the Mine is causing a mild nutrient enrichment effect, as also reported during previous years of monitoring. Higher concentrations of total phosphorus (TP) and total nitrogen (TN) were observed in the NF area compared to other exposure areas and the reference areas. Concentrations of chlorophyll *a* were above the upper limit of the normal range in an area representing more than 20% of the lake surface. Consequently, the magnitude of the eutrophication effect is equivalent to Action Level 2.
- The 2014 monitoring results suggest that plankton communities in Lac de Gras are exhibiting a Mine-related nutrient enrichment effect, consistent with the water quality results. The 2014 results provided no evidence for toxicological impairment. Overall, the plankton biomass and taxonomic richness data do not indicate that an Action Level 1 for plankton has been reached.
- The study of mercury in Lake Trout documented that in both Lac de Gras and Lac du Sauvage, the concentration of mercury in Lake Trout muscle increased from 1996 to 2008, remained elevated in 2011, and then was detected at concentrations near baseline in 2014. The concentration of mercury in Lake Trout muscle in Lac du Gras was below the Canadian government maximum acceptable level in the edible portion of retail fish (0.5 micrograms per gram [ $\mu\text{g/g}$ ] wet weight [ww]), and the relevant effect threshold/tissue residue guideline (1.0  $\mu\text{g/g}$  ww), such that Lake Trout health is unlikely to be affected.

The results of the 2014/2015 Lake Trout movement study indicate that Lake Trout move between Lac de Gras and Lac du Sauvage.

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## Acronyms and Abbreviations

AEMP	Aquatic Effects Monitoring Program
CFIA	Canadian Food Inspection Agency
DDMI	Diavik Diamond Mines (2012) Inc.
DO	dissolved oxygen
EA	Environmental Assessment
EQC	effluent quality criteria
ERM	ERM Consultants Canada Ltd.
FF	far-field
Golder	Golder Associates Ltd.
LOD	loss on drying
Maxxam	Maxxam Analytics Inc.
MF	mid-field
NF	near-field
NIWTP	North Inlet Water Treatment Plant
PIT	passive integrated transponder
SD	standard deviation
SES	special effects study
SNP	Surveillance Network Program
SOI	substances of interest
Mine	Diavik Diamond Mine
TDS	total dissolved solids
TN	total nitrogen
TP	total phosphorus
WLWB	Wek'èezhii Land and Water Board
ww	wet weight

## Units of Measure

+	plus
±	plus or minus
%	percent
>	greater than
≥	greater than or equal to
<	less than
µg/L	micrograms per litre
µg-N/L	micrograms nitrogen per litre
µg-P/L	micrograms phosphorus per litre
µg/g	micrograms per gram
µm	micrometre
cm	centimetre
km	kilometre

km <sup>2</sup>	square kilometre
L	litre
m	metre
mg/L	milligrams per litre
mg/dm <sup>2</sup> /y	milligrams per square decimetre per year
mg/m <sup>3</sup>	milligrams per cubic metre

# 1 INTRODUCTION

## 1.1 BACKGROUND INFORMATION

Diavik Diamond Mines (2012) Inc. (DDMI) conducts environmental monitoring programs under the terms and conditions of Water Licence W2015L2-0001 (hereafter, the Water Licence) issued for the Diavik Diamond Mine (Mine). The Aquatic Effects Monitoring Program (AEMP) is the primary program specified in the Water Licence for monitoring the aquatic environment of Lac de Gras.

As per the Water Licence, an update to the design of the AEMP is done every three years so that the AEMP can be adjusted to consider the findings of the previous three years. The third version of the AEMP was submitted as Study Design Version 3.0 in October 2011 (Golder 2011). Following revisions, the AEMP study design was approved by the Wek'èezhii Land and Water Board (WLWB) on May 29, 2014 (WLWB 2014). The most current AEMP design is described in the document titled *Diavik Diamond Mines Inc. – Aquatic Effects Monitoring Program – Study Design Version 3.5*, hereafter referred to as the AEMP Study Design Version 3.5 (Golder 2014b). The AEMP design document describes the updated AEMP design and provides a summary of effects and trends from all aquatic monitoring programs conducted by DDMI from baseline conditions (1996) to 2010. As such, the AEMP Study Design Version 3.5 is an important reference when considering ongoing monitoring results. The reader is encouraged to review the document for specifics regarding the basis for the current AEMP design and information regarding past studies.

Sampling for the AEMP is required once during late ice-cover conditions (i.e., April and/or May) and once during open-water conditions (between September 15 and August 15). The ice-cover season sampling program was carried out by DDMI according to the AEMP Study Design Version 3.4 (Golder 2014a), which was the approved version of the AEMP design in April 2014, when the under-ice sampling took place. The open-water sampling program was completed according to the revised AEMP Study Design Version 3.5 (Golder 2014b). Differences in field sampling requirements are discussed in the updated Study Design Version 3.5 and in the individual component appendices, as applicable. The assessment of effects was based on the updated Version 3.5 Study Design (Golder 2014b).

As summarized in the AEMP Study Design Version 3.5 (Golder 2014b), minewater discharge represents the main concern for Lac de Gras. Therefore, minewater discharge (also called effluent), and other Mine-related stressors and its potential impact on the lake ecosystem, is the principal focus of the AEMP. The AEMP has also been designed to include the results of other sources of information on potential effects on the lake, specifically the results of Traditional Knowledge studies.

The magnitude of possible effects was assessed by comparing water chemistry or biological results between exposure areas and reference areas, and to background values or benchmark values. Background values for Lac de Gras are those that fall below the range of natural variability, referred to as the *normal range*. The normal ranges used to assess effects of the Mine on individual components of the AEMP are described in the AEMP Reference Conditions Report, Version 1.1 (Golder 2015), which was approved by the WLWB on November 27, 2015. The intent of AEMP Reference Conditions Report was to present normal ranges for all AEMP variables to be used in subsequent AEMP reports, to evaluate potential effects of the Mine (WLWB 2015). Values that exceed the normal range are above what would be considered natural levels for Lac de Gras, but do not necessarily represent levels that are harmful.

## 1.2 PURPOSE AND OBJECTIVES

As defined in the Water Licence, objectives of the AEMP are “to determine the short and long-term effects in the aquatic environment resulting from the project, test impact predictions, measure the performance of operations, and evaluate the effectiveness of impact mitigation”. The AEMP is focused on the primary valued ecosystem components of Lac de Gras. The valued ecosystem components have been evaluated in previous site investigations, including the Environmental Assessment (EA), and they consist of fish, fish habitat, water quality, sediment quality, lake productivity, plankton, and benthic invertebrate communities, and the use of fisheries resources in Lac de Gras (DDMI 1998).

The 2014 AEMP Annual Report was conducted under the 2007 Water Licence WL2007L2-0003. In 2015, DDMI’s Water Licence was renewed for a period of eight years, effective October 19, 2015 (Licence #W2015L2-0001; WLWB 2015). Since the submission of the 2014 AEMP Report was delayed, and now DDMI is operating under the renewed 2015 Water Licence, DDMI has confirmed that the 2014 AEMP conforms to the conditions of the renewed Water Licence W2015L2-0001.

The 2014 AEMP Annual Report addresses the requirements specified in Part J Item 8 of the Water Licence W2015L2-0001 (Table 1-1).

**Table 1-1 Aquatic Effects Monitoring Program Annual Reporting Requirements Specified in Part J, Item**

Item	Location in Report
a) a summary of activities conducted under the AEMP;	Section 1.2 and 1.3
b) tabular summaries of all data and information generated under the AEMP in an electronic and printable format acceptable to the Board;	Technical Appendices
c) An interpretation of the results, including an evaluation of any identified environmental changes that occurred as a result of the Project;	Section 13.1, Technical Appendices
d) an evaluation of any adaptive management response actions implemented during the year;	Section 12
e) recommendations for refining the AEMP to improve its effectiveness as required; and	Section 13.2
f) an evaluation of the overall effectiveness of the AEMP to date; and, any other information specified in the approved AEMP or that may be requested by the Board.	Section 11, Comprehensive year

AEMP = Aquatics Effects Monitoring Program.

An objective of the AEMP is to monitor the minewater discharge and assess its potential ecological risks so that appropriate actions can be taken in the Mine operations that will prevent adverse effects from occurring. The AEMP is subject to adaptive management, meaning it will be updated as necessary, as new information and findings become available. The AEMP will compare the effluent quality to the discharge limits in the Water Licence, and it will assess compliance monitoring and the effectiveness of operational management (e.g., mitigation) measures.

The 2014 AEMP consists of the following components:

- a water and sediment chemistry program in Lac de Gras;

- an aquatic biota monitoring program in Lac de Gras (including fish surveys, benthic invertebrate surveys, and plankton surveys);
- a dust deposition monitoring program; and
- special effects studies (SES) required as part of the Class A Water Licence and the Fisheries Authorization.

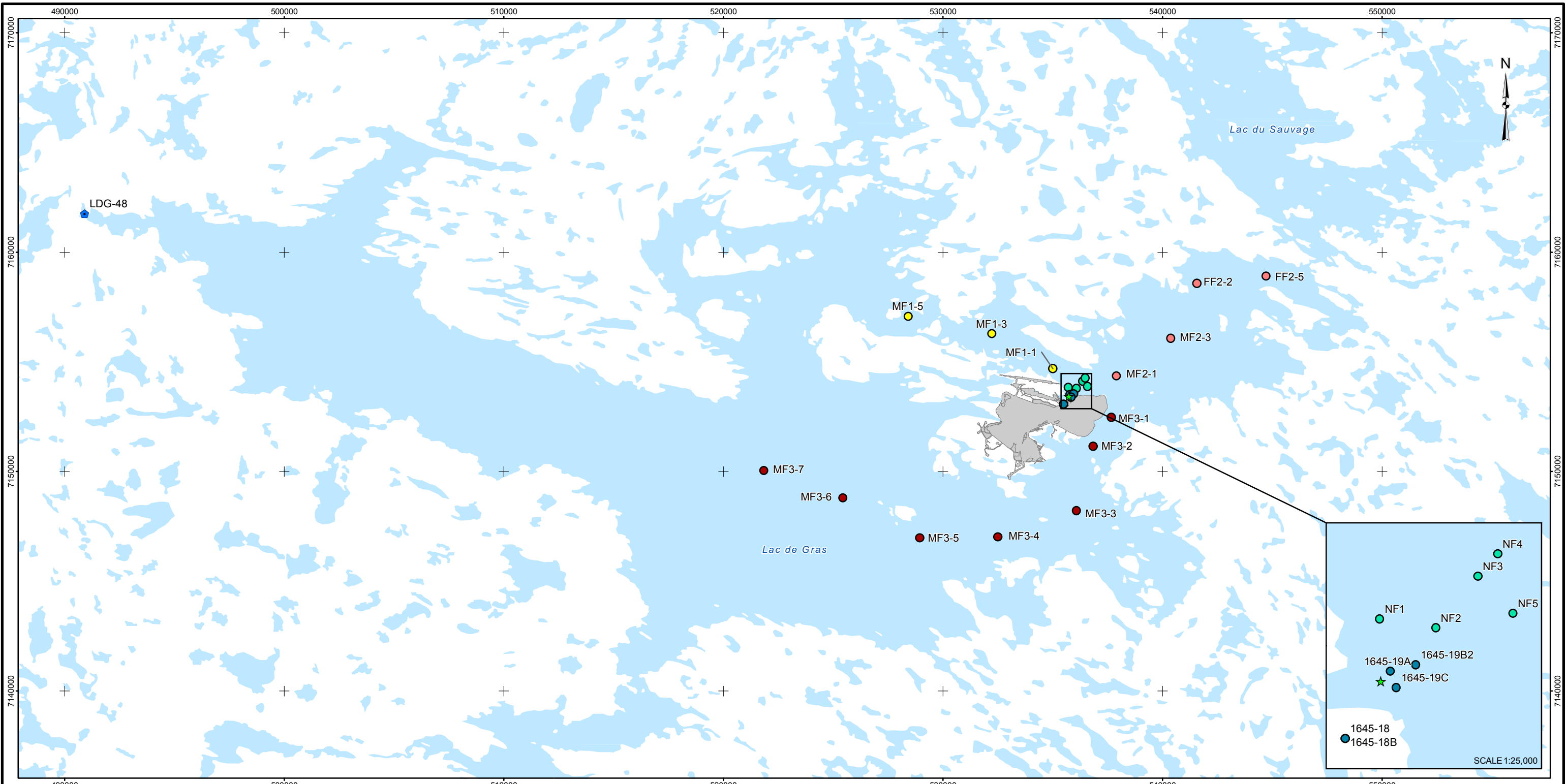
Lake monitoring is carried out in four general areas of Lac de Gras (Figure 1-1):

- the near-field (NF) exposure area located near the effluent diffuser;
- the mid-field (MF) exposure areas (MF1, MF2, MF3);
- the far-field (FF) exposure area (FF2); and
- the far-field (FF) reference areas (FF1, FFA and FFB).

Sampling for the AEMP in 2014 was carried out according to the requirements specified in the AEMP Study Design for an interim monitoring year, which included sampling in exposed areas of the lake (Golder 2014b). The reference areas in Lac de Gras are sampled every third year during the comprehensive monitoring program to allow for detailed assessment of Mine-related effects. The next comprehensive monitoring program is scheduled for 2016.

The objective of this annual report is to communicate the results of monitoring conducted as part of the AEMP in 2014. A similar document is produced each March, reporting on the previous year's results. Submission of the AEMP Annual Report in 2014 was delayed from the usual March 31 submission date to allow for development and approval of the AEMP Reference Conditions Report discussed in Section 1.1. The results from 2007 through to 2013 were reported by DDMI (2008, 2009, 2010, 2011, 2012, 2013 and Golder 2014c). In addition, every third year, AEMP results from the previous three years are integrated into a summary report, referred to as the Aquatic Effects Re-evaluation Report, which includes a comparison of results to impacts predicted during the EA. The last three-year Re-evaluation Report was submitted in February 2016 (Golder 2016).

I:\2011\11-1328\11-1328-0038\Mapping\MXD\2014AEMP\Fig1\_1\_2014\_AEMP\_SamplingStations\_REV0.mxd



- LEGEND**
- ★ DIFFUSERS
  - LDG 48
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - SURVEILLANCE NETWORK PROGRAM
  - DIAVIK FOOTPRINT
  - WATERBODY



**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT			
TITLE			
<b>SAMPLING STATIONS, 2014 AEMP</b>			
	PROJECT	1406208	FILE No.
	DESIGN	LJ 10 Feb. 2015	SCALE AS SHOWN
	GIS	SS 30 Mar. 2016	REV. 0
	CHECK	TD 30 Mar. 2016	<b>FIGURE: 1-1</b>
	REVIEW	ZK 30 Mar. 2016	

### **1.3 AQUATIC EFFECTS MONITORING PROGRAM ANNUAL REPORT CONTENT AND ORGANIZATION**

The organization of this report follows the outline provided in Section 7.2.1 of the AEMP Study Design Version 3.5 (Golder 2014b). To better communicate the results to the range of technical and non-technical parties who are interested in the results, we have provided information in two ways. First, this main body of the report provides a summary of the most important results from the 2014 studies, presented in a non-technical way. Second, the appendices provide a full technical description of analyses conducted and results obtained. These appendices are intended for parties with more technical interests. The technical appendices prepared for the 2014 annual report are:

- Appendix I – Dust Deposition Report;
- Appendix II – Water Chemistry Report;
- Appendix V – Fish Report;
- Appendix XI – Plankton Report; and
- Appendix XIII – Eutrophication Indicators Report.

These technical appendices were prepared by Golder Associates Ltd. (Golder), with the exception of Appendix I, which was prepared by ERM Consultants Canada Ltd. (ERM).

The order in which the appendices appear in the annual report and the appendix number for a given component is the same, even though there may not be a technical report for a given component in each year. This was done to meet reporting commitments stated in the AEMP Study Design Version 3.5 (Golder 2014b) and as a means of tracking available information. The technical report “place holder” appendices which do not contain a technical report for 2014 consist of:

- Appendix III – Sediment Report;
- Appendix IV – Benthic Invertebrate Report;
- Appendix VI – Plume Delineation Survey;
- Appendix VII – Dike Monitoring Study;
- Appendix VIII – Fish Salvage Program;
- Appendix IX – Fish Habitat Compensation Monitoring;
- Appendix X – Fish Palatability, Fish Health, and Fish Tissue Chemistry Survey;
- Appendix XII – Special Effects Study Reports;
- Appendix XIV – Traditional Knowledge; and
- Appendix XV – WOE Report.

Since there is not a technical report for these components in 2014, a note has been inserted in the appropriate appendix place holder stating that the component was not monitored in that year.



## **2 DUST DEPOSITION**

### **2.1 INTRODUCTION AND OBJECTIVES**

Many of the mining-associated activities at the Mine site generate dust, in particular, trucks travelling on roads, the dumping of Mine rock on the waste rock piles, and activities associated with construction. The dust in the air can be transported by wind, but eventually it settles onto the ground or surface waters. The objective of the dust monitoring program is to measure the amount of dustfall at various distances from the Mine project footprint and to determine the chemical characteristics of the dustfall that may be deposited onto, and subsequently into, Lac de Gras.

A detailed technical report prepared by DDMI on the findings from the 2014 dust deposition monitoring program is provided in Appendix I. The following section provides an overview of the dust deposition monitoring program and a summary of the 2014 results.

### **2.2 METHODS**

Two methods are used to monitor dustfall: snow core surveys and dust collection gauges. In a snow core survey, a cylindrical section of snow is collected by drilling into the snow pack with a hollow tube (Photo 2-1). The collected snow is then allowed to melt in the laboratory, and the melt water is analyzed for total suspended solids. This measures the amount of solid particles, which are presumably mostly from dust blown onto the snow. An additional core collected at snow core collection sites on Lac de Gras is analyzed for various chemicals such as nutrients and metals. This is not done for cores collected at sites on land.

Snow survey samples were collected along five transects at 27 predetermined survey stations, including three control stations (Figure 2-1). On average for the 27 sampling locations, the total sampling period was 201 days in 2014 for stations on land and over water (ice). Sampling started on November 3, 2013, which corresponds to the first snowfall for land stations, and the first freeze-up for lake stations.

Passive sampling of airborne particles is done with dust collection gauges. A dust gauge is a hollow cylinder, 52 cm in length and 12.5 cm in diameter, surrounded by a fibreglass shield with the shape of an inverted bell (Photo 2-2). The dust gauges used in 2014 were located around the Mine site as well as at control stations located away from the Mine site, as shown in Figure 2-1.

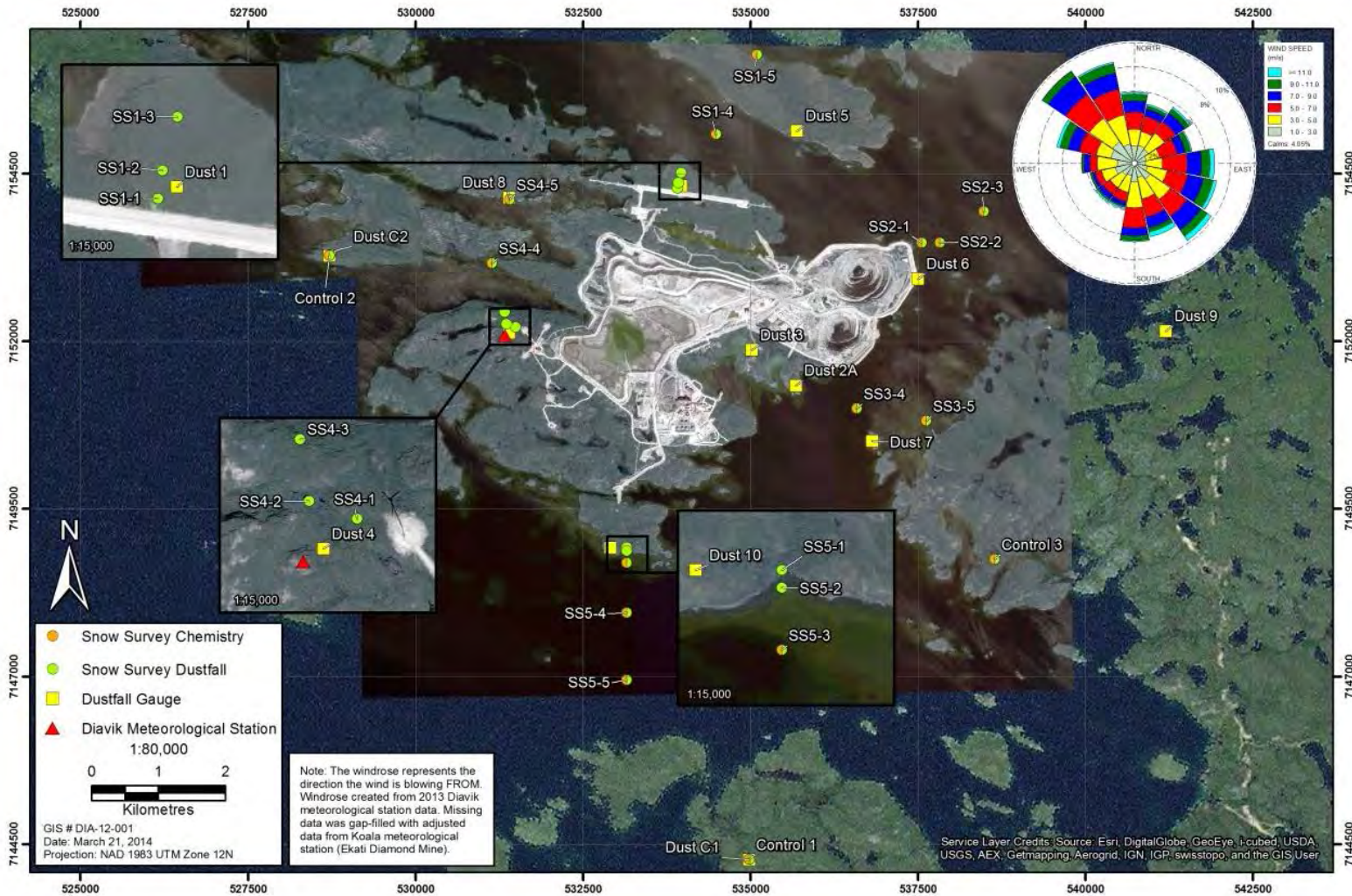


**Photo 2-1** Photo of snow sampling



**Photo 2-2** Dust gauge

Figure 2-1 2014 Dust Gauge and Snow Survey Sampling Stations



In 2014, dust was collected from 12 gauges, which collected dustfall from December 2012 to December 2014. Each gauge collected dustfall year-round, and samples were collected every three months. The dry weight of the material collected in the gauges was recorded.

Estimated dustfall rates were compared to the British Columbia dustfall objective (which ranges from 621 to 1,059 mg/dm<sup>2</sup>/y) for the mining, smelting, and related industries. This objective is used for comparison purposes only, as there are no standards or objectives for the Northwest Territories. It is also used by other mines in the region. Snow water chemistry results were compared to effluent quality criteria (EQC) outlined in DDMI's Water Licence. Snow chemistry analytes of interest included variables with EQC (aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc) or a load limit (phosphorus).

## 2.3 RESULTS AND DISCUSSION

The total dustfall collected from each dustfall gauge and snow survey station is summarized in Table 2-1. As expected, measured dustfall levels generally decreased with distance from the Mine site, and areas that were predominantly downwind of the mine site received more dustfall than areas that were not downwind (Figure 2-2). Dustfall levels were generally lower in 2014 compared to previous years, following a general trend of a reduction in dust levels over the last several years.

The annual dustfall estimated from each of the 12 dustfall gauges ranged from 61 to 479 mg/dm<sup>2</sup>/y. The annualized dustfall estimated from the 2014 snow survey data ranged from 3.8 to 393 mg/dm<sup>2</sup>/y. The 2014 dustfall rates were lower than the British Columbia dustfall objective for the mining industry (621 to 1,059 mg/dm<sup>2</sup>/y).

In general, analyte concentrations in snow melt water decreased with distance from the Mine site. Concentrations of arsenic, chromium and nickel have increased in recent years, while concentrations of copper, lead and zinc have decreased. Concentrations of metals in snow melt water were below their associated effluent discharge limits. The full laboratory analysis of snow water chemistry for each station is included in Appendix 1.

**Table 2-1 2014 Dustfall Deposition Results**

Zone	Station	Approximate Distance from 2014 Project Footprint (m)	Dustfall (mg/dm <sup>2</sup> /y)
0 to 100 m	Dust 1	75	352
	Dust 3	30	479
	Dust 6	25	429
	SS1-1	30	322
	SS3-6	60	287
	SS4-1	100	174
	Mean		321
	Standard Deviation		147
	95% Confidence Interval (Mean ±)		154
	Upper Limit of 95% Confidence Interval		475
	Lower Limit of 95% Confidence Interval		167

**Table 2-1 2014 Dustfall Deposition Results**

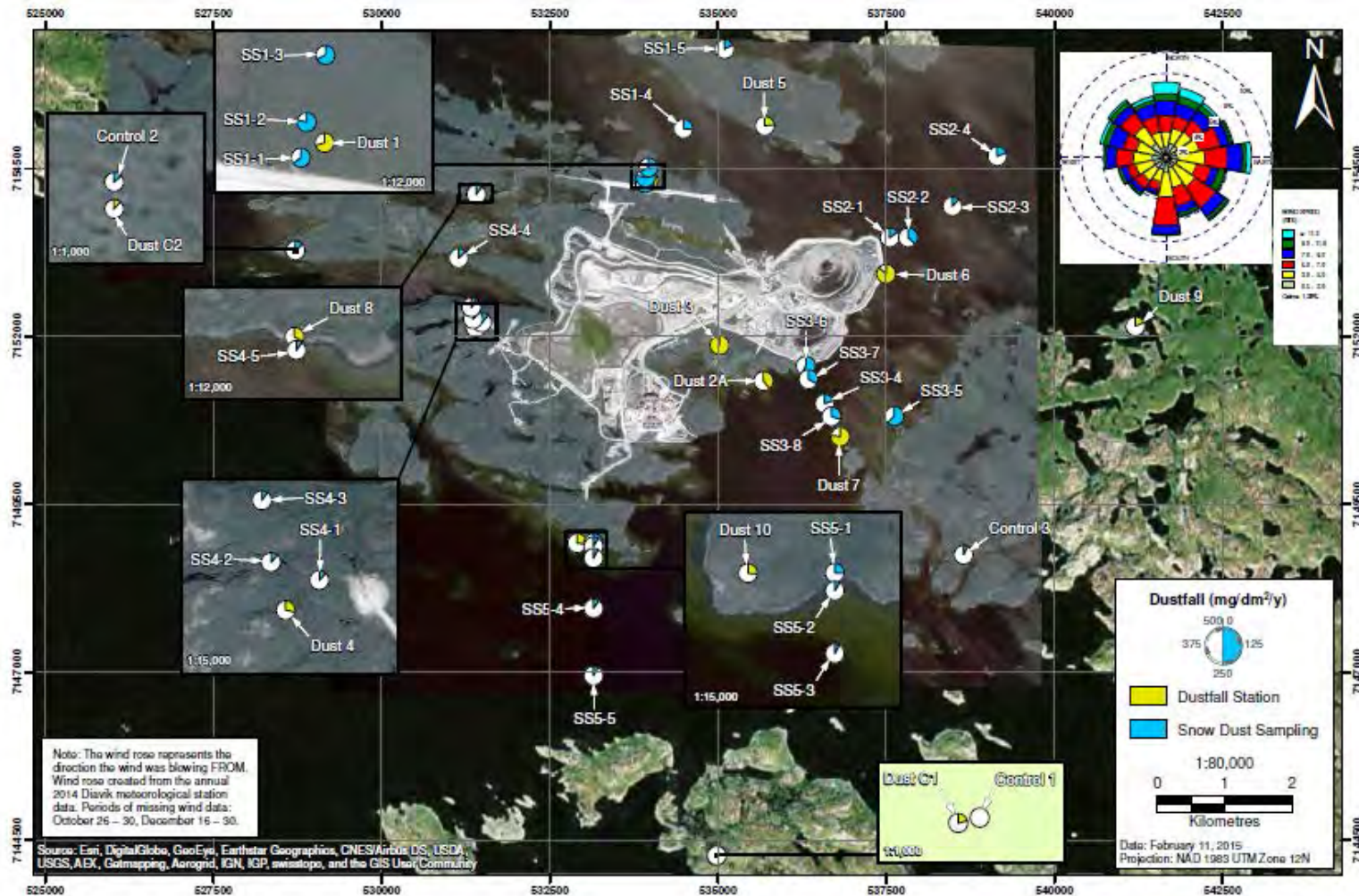
Zone	Station	Approximate Distance from 2014 Project Footprint (m)	Dustfall (mg/dm <sup>2</sup> /y)
101 to 250 m	Dust 4	200	140
	SS1-2	115	393
	SS2-1	180	74
	SS3-7	250	166
	SS4-2	245	59
	Mean		166
	Standard Deviation		134
	95% Confidence Interval (Mean ±)		167
	Upper Limit of 95% Confidence Interval		333
	Lower Limit of 95% Confidence Interval		167
251 to 1,000 m	Dust 2A	435	197
	Dust 10	670	133
	SS1-3	275	337
	SS1-4	920	131
	SS2-2	445	186
	SS3-4	615	97
	SS3-8	830	150
	SS4-3	350	48
	SS5-1	665	128
	SS5-2	710	40
	SS5-3	885	38
	Mean		135
	Standard Deviation		86
	95% Confidence Interval (Mean ±)		58
Upper Limit of 95% Confidence Interval		193	
Lower Limit of 95% Confidence Interval		77	
1,001 to 2,500 m	Dust 5	1,195	116
	Dust 7	1,155	385
	Dust 8	1,220	166
	Dust 9	3,810	89
	SS1-5	2,180	86
	SS2-3	1,220	58
	SS2-4	2,180	96
	SS3-5	1,325	312
	SS4-4	1,065	64
	SS4-5	1,220	50
	SS5-4	1,635	47
	SS5-5	2,635	38
	Mean		126
	Standard Deviation		111
	95% Confidence Interval (Mean ±)		71
	Upper Limit of 95% Confidence Interval		196
Lower Limit of 95% Confidence Interval		55	

**Table 2-1 2014 Dustfall Deposition Results**

Zone	Station	Approximate Distance from 2014 Project Footprint (m)	Dustfall (mg/dm <sup>2</sup> /y)
Control	Dust C1	5,655	105
	Dust C2	3,075	61
	CONTROL 1	5,655	4
	CONTROL 2	3,075	69
	CONTROL 3	3,570	38
	Mean		55
	Standard Deviation		37
	95% Confidence Interval (Mean ±)		47
	Upper Limit of 95% Confidence Interval		102
	Lower Limit of 95% Confidence Interval		9
Reference Levels <sup>(a)</sup>			621–1,059

a) BC MOE (2013) dustfall objective.

Figure 2-2 Dustfall Results, 2014



## **3 EFFLUENT AND WATER CHEMISTRY**

### **3.1 INTRODUCTION AND OBJECTIVES**

Substances released from the Mine must enter the water of Lac de Gras before aquatic organisms can be exposed to the material released, and potentially be affected by this material. Water quality represents a valuable early warning indicator of potential effects on aquatic biota in Lac de Gras. The objective of the water quality monitoring component of the AEMP is to assess the effects of Mine effluent and other Mine-related stressors on water quality in Lac de Gras.

A detailed technical report on the findings from the 2014 effluent and water chemistry monitoring program is included in Appendix II. The following section provides an overview of the effluent and water chemistry program and a summary of the 2014 results.

### **3.2 METHODS**

Water quality sampling at AEMP stations in 2014 was carried out according to the interim monitoring program, which included sampling in exposed areas of the lake (Golder 2014b). Water quality samples were collected from the NF exposure area and the three MF exposure areas (MF1, MF2-FF2, and MF3) of Lac de Gras, and at the outlet of Lac de Gras (Figure 1-1). The AEMP water quality sampling was carried out over two monitoring periods: ice-cover and open-water. Ice-cover season (late winter) sampling was completed from April 22 and April 30, 2014. Open-water sampling was completed from August 20 to September 1, 2014.

Data from the Surveillance Network Program (SNP) were incorporated into the 2014 AEMP report. Effluent samples were collected approximately once every six days from the North Inlet Water Treatment Plant (NIWTP) from both diffusers (stations SNP 1645-18 and SNP 1645-18B), and monthly at the mixing zone boundary (Stations SNP 1645-19a, SNP 1645-19b2, and SNP 1645-19c). The SNP sampling period summarized in this report extended from November 1, 2013 to October 31, 2014.

Water samples were sent to Maxxam Analytics Inc. (Maxxam) in Burnaby, British Columbia, for chemical analysis. Field measurements of water quality were also made at AEMP stations by lowering a specialized electronic device (Hydrolab water quality meter; Photo 3-1) slowly down to the bottom of the lake while recording the measurements of temperature, dissolved oxygen (DO), conductivity, turbidity, and pH.





**Photo 3-1 Hydrolab water quality meter**

Initial data analyses with all chemical analytes were conducted to identify substances of interest (SOI), which are a subset of variables with the potential to show Mine-related effects. The intent of defining SOI was to identify a meaningful set of variables that will undergo further analyses, while limiting analyses on variables that were less likely to be affected. The process of developing the list of SOI considered concentrations in the final effluent (SNP 1645 18 and SNP 1645 18B) as well as in the fully-mixed exposure area of Lac de Gras:

- Effluent chemistry data collected at stations SNP 1645 18 and SNP 1645 18B were first compared to Water Licence discharge limits. Variables that exceeded limits were considered SOI. Variables with effluent concentrations that exceeded AEMP Effects Benchmark values were also included in the SOI list.
- Water quality variables were assessed according to the Action Level framework (Section 3.4). Variables that triggered Action Level 1 were added to the SOI list.

The following analyses were conducted on SOI identified in 2014:

- examination of loading rates and concentrations in Mine effluent;
- assessment of concentrations at the mixing zone boundary in Lac de Gras; and
- assessment of magnitude and extent of effects, as defined by the Action Levels.

Water quality variables were assessed for a Mine-related effect according to the Action Level Framework for water chemistry (Table 3-1). Magnitude of effects on water chemistry variables were determined by comparing analyte concentrations between exposure areas and reference areas, and to background values or benchmark values. Background values for Lac de Gras are those that fall within the range of natural variability, referred to as the *normal range*. The normal ranges used in the Action Level screening for water quality were obtained from the AEMP Reference Conditions Report, Version 1.1 (Golder 2015)

The Effects Benchmarks adopted for the AEMP are consistent with those used in the Project EA (Government of Canada 1999) and are based on the Canadian Water Quality Guidelines for the protection of aquatic life (CCME 1999), the Canadian Drinking Water Quality Guidelines (Health Canada 1996, 2006) and adaptations of general guidelines to site-specific conditions at Lac de Gras (Appendix IV.1 in DDMI 2007).

The full suite of water chemistry variables analyzed in 2014 was initially evaluated in the Action Level assessment, with the exception of pH (which was assessed qualitatively) and nutrients such as phosphorus and nitrogen (which are evaluated in the Eutrophication Indicators Report [Section 4; Appendix XIII]). Variables measured in the field (conductivity, DO, temperature and pH) are discussed qualitatively in Section 3.3, and were not considered for inclusion as SOI. Effects were assessed separately for the ice-cover and open-water seasons.

**Table 3-1 Action Levels for Water Quality, Excluding Indicators of Eutrophication**

Action Level	Magnitude of Effect <sup>(a)</sup>	Extent of Effect	Action/Notes
1	Median of NF greater than 2X median of reference areas (open-water or ice-cover) and strong evidence of link to Mine	Near-field (NF)	Early warning.
2	5 <sup>th</sup> percentile of NF values greater than 2X median of reference areas AND normal range <sup>(b)</sup>	Near-field	Establish Effects Benchmark if one does not exist.
3	75 <sup>th</sup> percentile of MZ values greater than normal range plus 25% of Effects Benchmark <sup>(c)</sup>	Mixing zone (MZ)	Confirm site-specific relevance of Effects Benchmark. Establish Effects Threshold. Define the Significance Threshold if it does not exist. The WLWB to consider developing an Effluent Quality Criteria (EQC) if one does not exist
4	75 <sup>th</sup> percentile of MZ values greater than normal range plus 50% of Effects Threshold <sup>(c)</sup>	Mixing zone	Investigate mitigation options.
5	95 <sup>th</sup> percentile of MZ values greater than Effects Threshold	Mixing zone	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
6	95 <sup>th</sup> percentile of NF values greater than Effects Threshold + 20%	Near-field	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
7	95 <sup>th</sup> percentile of MF values greater than Effects Threshold + 20%	Mid-field (MF)	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
8	95 <sup>th</sup> percentile of FFB values greater than Effects Threshold + 20%	Far-field B (FFB)	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
9	95 <sup>th</sup> percentile of FFA values greater than Effects Threshold + 20%	Far-field A (FFA)	Significance Threshold.

a) Calculations are based on pooled data from all depths.

b) Normal ranges are obtained from the AEMP Reference Conditions Report Version 1.1 (Golder 2015); however, the normal range for open-water is based on the August 15 to September 15 period only.

c) Indicates 25% or 50% of the difference between the benchmark/threshold and the top of the normal range.

### 3.3 RESULTS AND DISCUSSION

The following water quality SOI were identified:

- specific conductivity (laboratory measured);
- TDS (calculated);
- calcium;
- chloride;
- fluoride;
- potassium;
- sodium;
- sulphate;
- ammonia (as nitrogen);
- nitrate (as nitrogen);
- total aluminum;
- total antimony;
- total barium;
- total chromium;
- total copper;
- total lead;
- total molybdenum;
- total silicon;
- total strontium;
- total tin; and
- total uranium.

With the exception of two variables (fluoride and ammonia), each of the SOI triggered Action Level 1 or greater in 2014. Fluoride was included in the list of SOI because concentrations in effluent were slightly greater than the AEMP aquatic life Effects Benchmark (0.012 mg/L) in eight samples (7% of samples) in 2014. Ammonia was conservatively retained as an SOI because data quality issues identified with the ammonia data in 2014 interfered with the evaluation of Action Level exceedances.

#### 3.3.1 Effluent Quality

The water chemistry monitoring data collected from the NIWTP final discharge (SNP 1645 18 and 18B) were compared to the EQC in the Water Licence. The 12 month period from November 2013 to October 2014 was used to describe the NIWTP discharge. Concentrations of SOI and other variables with EQC in effluent were well below discharge criteria. A single elevated oil and grease value of 6.5 mg/L collected at Station SNP 1645-18 on September 22, 2014 exceeded the maximum allowable concentration of 5 mg/L. However, this value was caused by a laboratory quality control issue and was not representative of effluent quality.

The seasonal pattern in the monthly loading rate of most major ions (calcium, chloride, fluoride, potassium, sodium and sulphate) and metals (aluminum, antimony, barium, copper molybdenum, strontium and uranium) from the NIWTP reflected that in TDS, which decreased from November to approximately March or April, reflecting a decrease in the monthly volume of effluent discharged (Figure 3-1). The loads of these SOI generally increased during the late ice-cover to early open-water period as flow rates from the NIWTP increased. The monthly loading rates of ammonia and nitrate decreased from December to May or June as the concentration of nitrogen in Mine effluent decreased. The loading rate of ammonia fluctuated slightly throughout the late ice-cover and open-water period, reflecting variation in effluent concentrations. The

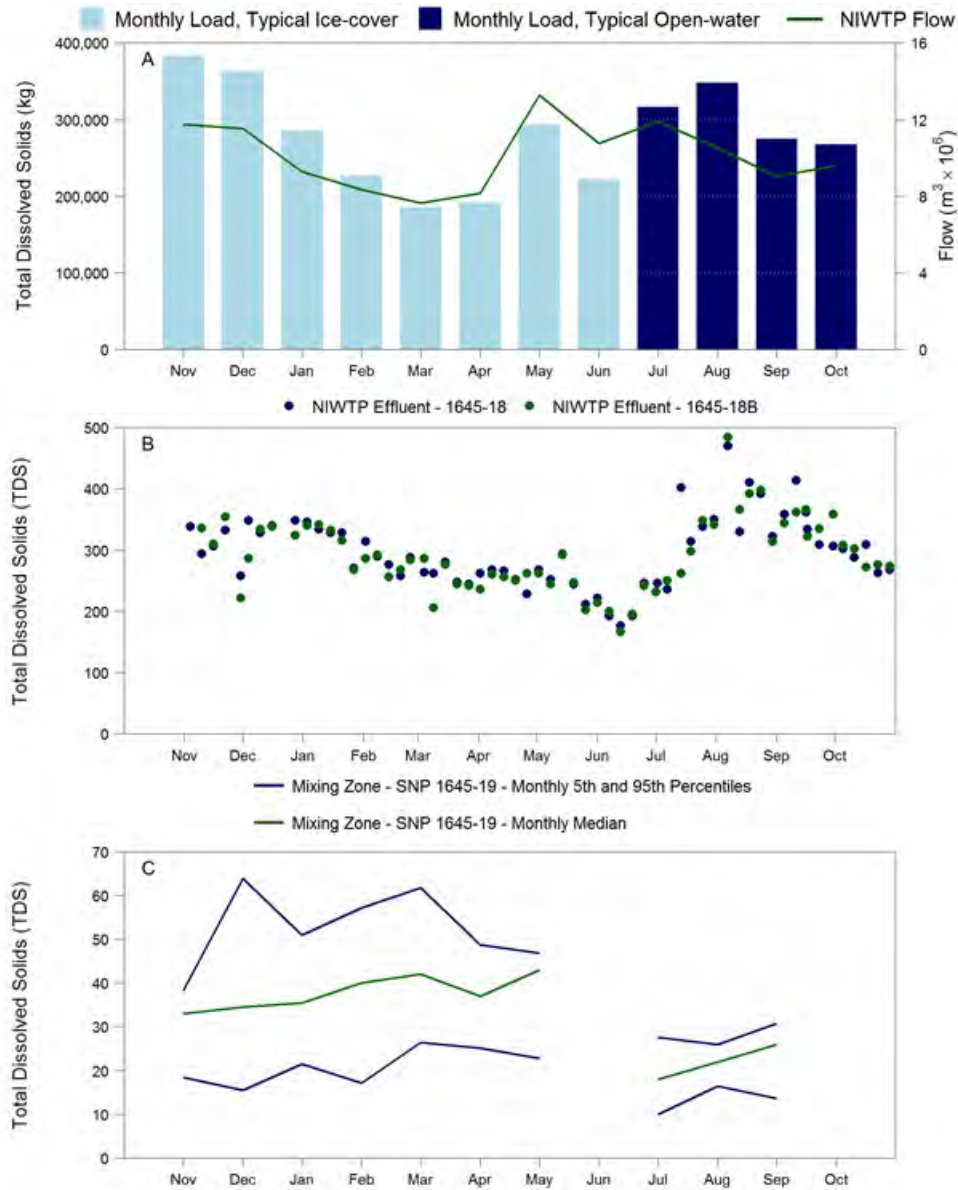
loads and concentrations of nitrate were lowest in June and then increased throughout the early open-water period.

The monthly loads of chromium, silicon and lead followed a different pattern than that observed in TDS. Loads of chromium and silicon decreased during the ice-cover season, and were lower during the open-water season, reflecting a decrease in effluent concentration. No seasonal trend was observed in the monthly load of lead.

Concentrations of SOI in Mine effluent typically declined from approximately January to May or June and then increased over the early open-water period or remained within a similar range over the 2014 reporting period. Concentrations of most SOI at the mixing zone boundary generally reflected trends in effluent loads or concentration. Concentrations were generally greater and more variable at the mixing zone during ice-cover compared to the open-water period.

Toxicity testing results in 2014 indicated that effluent samples were generally not toxic to aquatic test organisms. Toxicity test results demonstrated no toxic effects on aquatic test organisms in all 32 samples submitted for lethal testing. Of the 24 effluent samples submitted for sublethal testing, two demonstrated sublethal effects of greater than or equal to 50% relative to controls. A reduction in reproduction of the water flea, *Ceriodaphnia dubia*, was detected in toxicity testing of the December 2013 and March 2014 effluent samples. In both cases, the observed decrease in reproduction relative to the control group (50% and 53%, respectively) was only marginally greater than the criterion used to designate a test failure ( $\geq 50\%$ ). The six other *C. dubia* tests performed in 2014 passed the tests, and results for all other test species demonstrated no toxic response.

**Figure 3-1 A) Monthly Loading Rate of Total Dissolved Solids (Calculated), from the North Inlet Water Treatment Plant; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: SNP = Surveillance Network Program; NIWTP = North Inlet Water Treatment Plant; TDS = total dissolved solids. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 m, 5 m, 10 m, 15 m, and 20 m).

### 3.3.2 Depth Profiles

Depth profiles were prepared for conductivity, DO, water temperature and pH at AEMP stations. Specific conductivity increased with depth in the NF area during the ice-cover season to approximately 15 m and then declined with increasing depth. The greater specific gravity of the effluent combined with the absence of wind and wave-driven mixing during ice-cover conditions, resulted in elevated conductivity at approximately two thirds depth in the NF area. Complete vertical mixing of the effluent was observed at all stations along the MF1, MF2-FF2 and MF3 transects.

Temperature profiles in Lac de Gras were vertically homogeneous at most stations during both the ice-cover and open-water seasons. During the open-water season, DO concentrations were typically uniform throughout the water column. During the ice-cover season, DO concentrations were highest just below the ice-water interface and declined with increasing depth. The pH values measured in Lac de Gras in 2014 showed a gradual decrease with depth in both seasons. Slightly greater pH values in the NF area likely reflect the presence of Mine effluent, which has a pH of typically greater than 7.

### 3.3.3 Assessment of Effects and Action Levels

Water quality variables were assessed for a Mine-related effect according to Action Levels (Table 3-1). Nineteen variables triggered Action Level 1. These variables had NF area median concentrations that were greater than two times the median concentrations of reference areas and were considered SOI. Each of the SOI had detectable concentrations in the NIWTP effluent or in dust that may be deposited into Lac de Gras from mining activities, indicating that the increase in the NF area could be linked to the Mine.

Of the 19 variables that triggered Action Level 1, eight also triggered Action Level 2 (Table 3-2), which was triggered because the 5<sup>th</sup> percentile concentration in the NF area was greater than two times the reference area median and greater than the normal range for Lac de Gras. Variables that reached Action Level 2 were evaluated for an effect at a magnitude of Action Level 3, provided they had existing AEMP Effects Benchmarks. None of the variables triggered Action Level 3.

Under the Response Framework, when a water quality variable triggers Action Level 2, the required management action is to establish an AEMP Effects Benchmark for that variable if one does not already exist. Two of the variables that triggered Action Level 2 (sodium and antimony) do not have existing AEMP Aquatic Life Effects Benchmarks. Therefore, DDMI will develop benchmarks for these variables as part of the next AEMP Study Design (Version 4.0), which will be submitted in June 2016.

**Table 3-2 Action Level Summary for Water Quality, 2014**

Substance of Interest	Action Level Classification
<b>Conventional Parameters</b>	
Specific Conductivity	1
Total Dissolved Solids (Calculated)	2
<b>Major Ions</b>	
Calcium	1
Chloride	2
Fluoride	0 <sup>(a)</sup>
Potassium	1
Sodium	2
Sulphate	1
<b>Nutrients</b>	
Ammonia (as Nitrogen)	(b)
Nitrate (as Nitrogen)	2
<b>Total Metals</b>	
Aluminum	1
Antimony	2
Barium	1
Chromium	1
Copper	1
Lead	1
Molybdenum	2
Silicon	1
Strontium	2
Tin	1
Uranium	2

0 = Action Level not triggered; 1 = Action Level 1 triggered; 2 = Action Level 2 triggered.

- a) Fluoride was added to the list of SOI because concentrations in effluent were greater than the AEMP Aquatic Life Effects Benchmark in 7% of samples analyzed in 2014.
- b) Action Level results for ammonia are uncertain due to laboratory quality control issues identified in 2014.



## **4 EUTROPHICATION INDICATORS**

### **4.1 INTRODUCTION AND OBJECTIVES**

One of the more important predictions from the EA was that operation of the Mine would release nutrients (nitrogen and phosphorus) into Lac de Gras. Phosphorus naturally occurs in the groundwater that seeps into the Mine workings. Nitrogen enters Mine water as a residue from ammonium nitrate used as an explosive during mining. While phosphorus is reduced to the lowest levels practical in the NIWTP and nitrogen is managed to the extent practical through blasting and water management practices, both phosphorus and nitrogen exist in substantially higher concentrations in the NIWTP effluent compared to baseline concentrations in Lac de Gras.

Lac de Gras is a nutrient-poor (oligotrophic) lake. Aquatic organisms in this lake (algae, invertebrates, and fish) survive with limited nutrient availability and have low abundances compared to more productive lakes. It is expected, and was predicted, that increasing the nutrient levels in Lac de Gras would affect aquatic organisms (Government of Canada 1999). The primary effect of this nutrient enrichment on Lac de Gras was expected to be an increase in primary productivity (i.e., greater abundance of microscopic plants called algae or phytoplankton) referred to as eutrophication.

The objective of this section is to describe the AEMP results for nutrients, chlorophyll *a*, and zooplankton biomass, which are monitored as indicators of eutrophication. Chlorophyll *a* is the green colour in plants, and is a measure of the amount of algae in the water. Algae are the first aquatic organisms to respond to a change in nutrient levels. Zooplankton biomass is a measure of the total mass of tiny animals that live in the water and feed on algae.

The following is a summary of the 2014 analysis of eutrophication indicators. Appendix XIII provides a more complete analysis and presents detailed results for eutrophication indicators.

### **4.2 METHODS**

In 2014, the AEMP eutrophication indicators program was completed over two sampling periods. The ice-cover sampling was conducted from April 22 to 30, 2014, and the open-water sampling was conducted between August 20 and September 1, 2014. Nutrient samples were taken during both ice-cover and open-water conditions from the three general areas (NF, MF, and FF) of Lac de Gras, and at the outlet of Lac de Gras (Figure 1-1). The FFA and FFB reference areas were not sampled in 2014. Chlorophyll *a* and zooplankton biomass were collected during the open-water period, when biological activity is greatest.

During the ice-cover season, nutrient samples were collected from three depths: near the bottom, at the middle depth, and near the surface (or top depth). Water samples from the outlet of Lac de Gras were collected from the middle depth. Water column profile measurements were also made, according to the methods described in Section 3.

During the open-water season, nutrients and chlorophyll *a* were collected using a depth-integrated sampler. This device collects lake water over a range of sample depths. The top 10 m of the water column was sampled for chlorophyll *a* and nutrients during the open-water season, since this is the depth where most of the algae are found. Zooplankton samples were collected using a specially designed fine mesh net (plankton net) that was hauled up through the entire water column (i.e., from 1 m above the bottom to the surface).

The 2014 AEMP results were analyzed to identify and understand patterns in the data collected. A specific focus was to assess the magnitude of effects according to the Action Levels. The Action Levels for chlorophyll *a* are presented in Table 4-1.

**Table 4-1 Action Levels for Chlorophyll a**

Action Level	Magnitude of Effect	Extent of Effect	Action/Notes
1	95 <sup>th</sup> percentile of MF values greater than normal range <sup>(a)</sup>	MF station	Early warning.
2	NF and MF values greater than normal range <sup>(a)</sup>	20% of lake area or more	Establish Effects Benchmark.
3	NF and MF values greater than normal range plus 25% of Effects Benchmark <sup>(b)</sup>	20% of lake area or more	Confirm site-specific relevance of existing benchmark. Establish Effects Threshold.
4	NF and MF values greater than normal range plus 50% of Effects Benchmark <sup>(b)</sup>	20% of lake area or more	Investigate mitigation options.
5	NF and MF values greater than Effects Threshold	20% of lake area or more	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
6	NF and MF values greater than Effects Threshold +20%	20% of lake area or more	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
7	95 <sup>th</sup> percentile of MF values greater than Effects Threshold +20%	All MF stations	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
8	95 <sup>th</sup> percentile of FFB values greater than Effects Threshold +20%	FFB	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
9	95 <sup>th</sup> percentile of FFA values greater than Effects Threshold +20%	FFA	Significance Threshold.

a) The normal range for chlorophyll a was estimated as the 2.5th and 97.5th percentiles using 2007 to 2010 reference data from the far-field reference areas.

b) Indicates 25% or 50% of the difference between the benchmark and the top of the normal range.

NF = near-field; MF = mid-field; FFA = far-field A; FFB = far-field B; WLWB = Wek'èezhii Land and Water Board; EQC = effluent quality criteria.

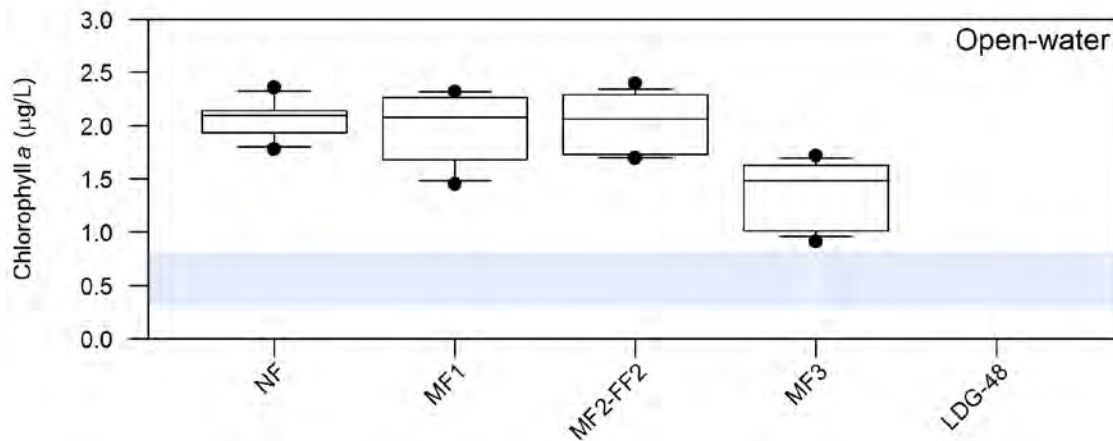
### 4.3 RESULTS AND DISCUSSION

The following text summarizes the key findings from the 2014 AEMP related to total phosphorus (TP), total nitrogen (TN), and chlorophyll *a*. Zooplankton results are not presented, because the samples were accidentally disposed of in the lab before they could be analyzed. Appendix XIII contains more information and a detailed analysis of results.

The 2014 AEMP results showed a very clear nutrient enrichment effect in the NF area compared to the other exposure areas. The levels of chlorophyll *a* and nutrients (TP and TN) in the NF and MF exposure areas and the outlet of Lac de Gras are shown in Figures 4-1 and 4-2.

During the open-water season, chlorophyll *a* concentrations in the NF area were similar to concentrations along the MF1 and the MF2-FF2 transects (Figure 4-1) and were lower along the MF3 transect. Concentrations of TP and TN during ice-cover were greater in the NF area compared to the other exposure areas (Figure 4-2). Open-water concentrations of TP and TN in the NF area were also greater than in the other areas, but the differences were much smaller. Concentrations of TP in the MF areas were near or below the detection limit during ice-cover, whereas concentrations were more variable during open-water. During both seasons, the lowest concentrations of TP and TN were observed at Station LDG-48, at the outlet of Lac de Gras.

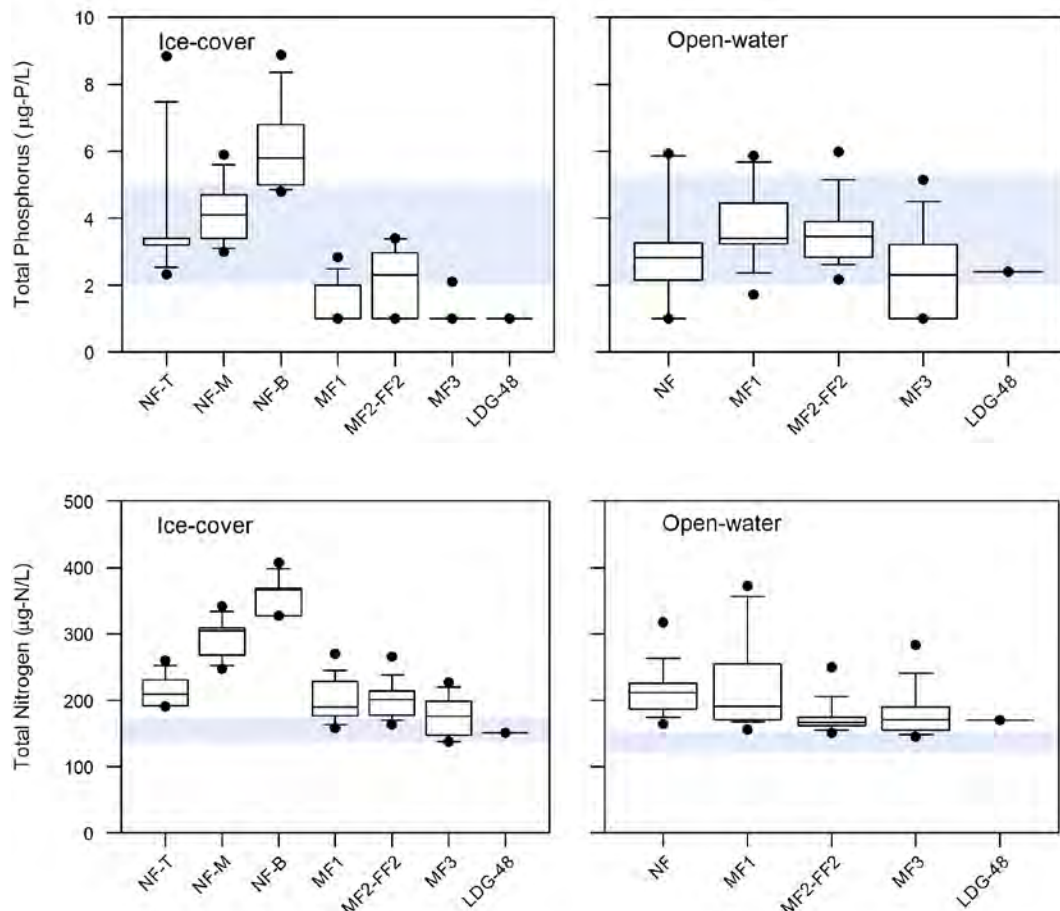
**Figure 4-1 Concentration of Chlorophyll *a* in Lac de Gras during the Open-Water Season, 2014**



Notes: Chlorophyll *a* was not measured during the ice-cover season. Station LDG-48 (Lac de Gras outlet.) was not sampled for chlorophyll *a*. Non-detect values were substituted with a value of half the detection limit before plotting. The normal range is delineated by the shaded area.

µg/L = micrograms per litre; NF = near-field; MF = mid-field; FF = far-field; LDG = Lac de Gras.

**Figure 4-2 Concentrations of Total Phosphorus and Total Nitrogen in Lac de Gras during the Ice-Cover and Open-Water Seasons, 2014**



Note: The mean of samples collected at top, mid-depth, and bottom is plotted for areas MF1, MF2-FF2, and MF3. A single sample was collected at Station LDG-48. Non-detect values were substituted with a value of half the detection limit before plotting. The normal range is delineated by the shaded area.

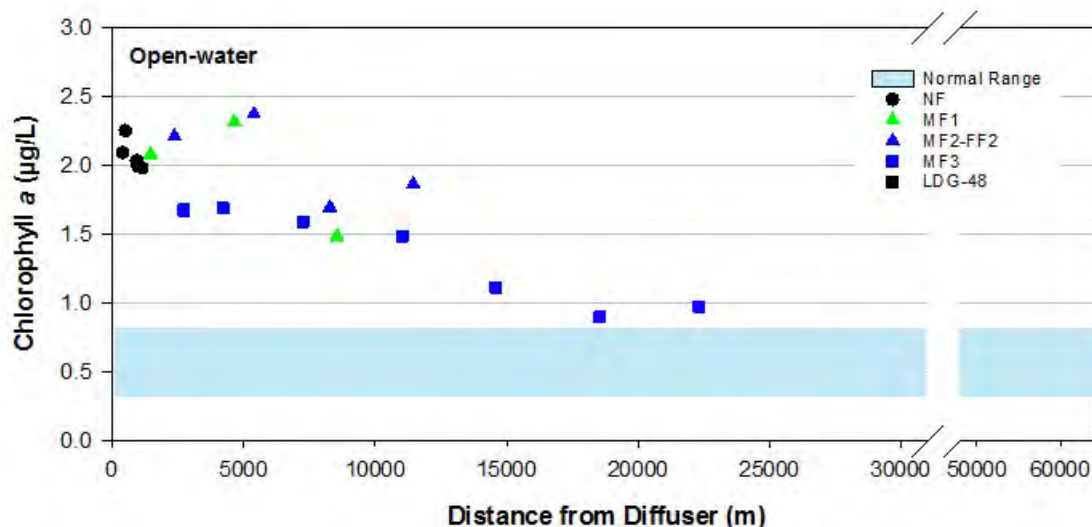
µg-P/L = micrograms of phosphorus per litre; µg-N/L = micrograms of nitrogen per litre; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

Concentrations of TP, TN, and chlorophyll *a* from the NF area and each MF exposure area were compared with the normal range to estimate the extent of the zone of nutrient enrichment. Since only open-water samples were collected for chlorophyll *a*, the open-water data were used for estimating the spatial extent of effects. For TP and TN, the ice-cover season was selected because the greatest extent of effects on nutrients was observed in winter. The bottom depth was chosen, because the greatest extent of effects occurred at the bottom of the lake.

For chlorophyll *a*, the extent of effects during the open-water season encompassed all stations among the three MF areas (Figure 4-3), indicating the effect may extend beyond the stations sampled in 2014. Based on these results, the extent of effects on chlorophyll *a*, was estimated as greater than or equal to 234.1 km<sup>2</sup>.

Compared to the total surface area of Lac de Gras (573 km<sup>2</sup>), the area demonstrating effects on chlorophyll a represents greater than or equal to 40.9% of the lake.

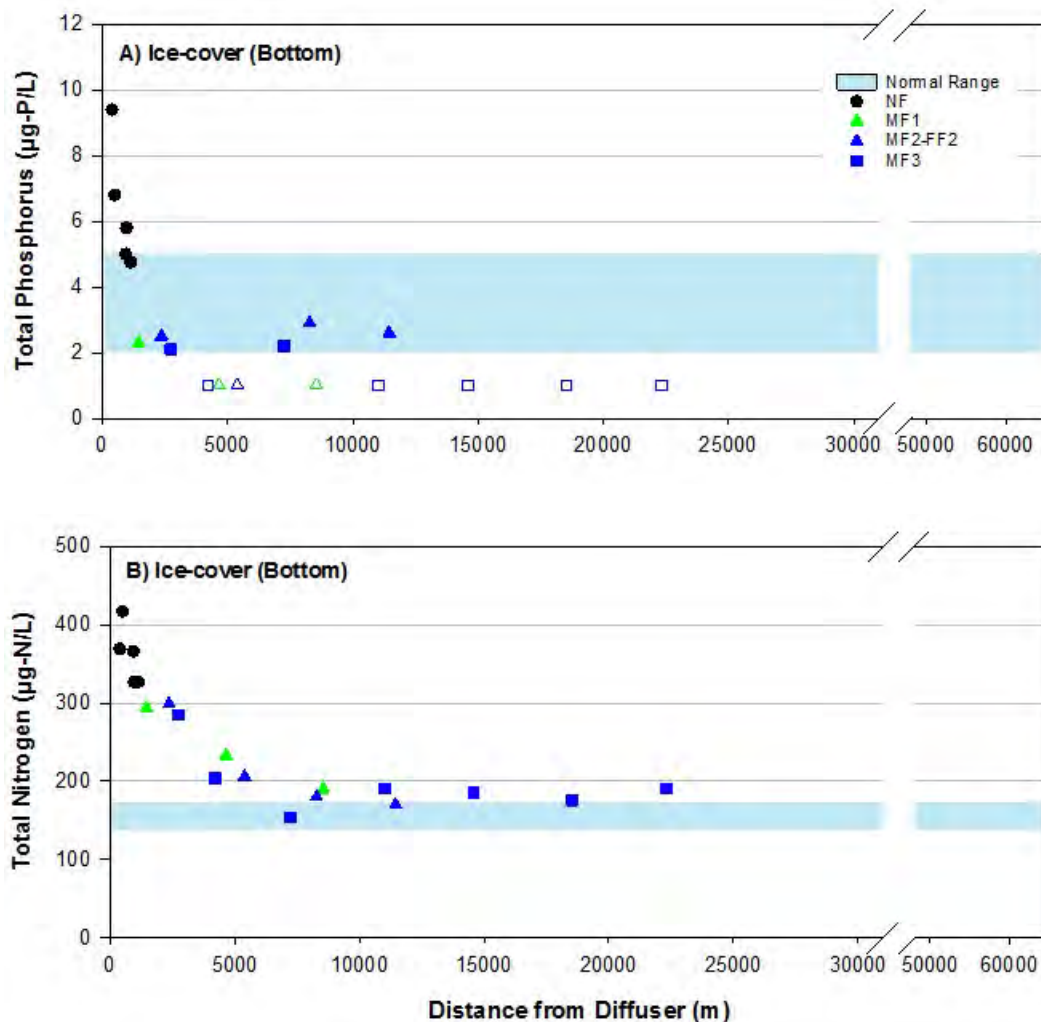
**Figure 4-3 Concentration of Chlorophyll a in Lac de Gras by Distance from the Diffusers during the Open-Water Season, 2014**



NF = near-field; MF = mid-field; FF = far-field; µg/L = microgram per litre.

The extent of effects on TP during the ice-cover season was limited to an area between the NF sampling area and the first MF stations along each of the three transects (Figure 4-4A). All MF stations had TP concentrations well below the upper limit of the normal range. The TP-affected area of the lake in 2014 was estimated as 3.5 km<sup>2</sup>, or less than 1% of the total lake area. All of the NF and MF1 stations, and the majority of the MF2-FF2 and MF3 stations had TN concentrations above the upper limit of the normal range (Figure 4-4B). The boundary of effects on TN to the northwest extended to Station MF1-5, or possibly farther; however, the FF1 area was not sampled in 2014. The extent of effects to the northeast of the Mine, along the MF2-FF2 transect, extended to between stations FF2-2 and FF2-5. The boundary of effects south of the Mine extended to Station MF3-7, or possibly farther; however, the FFB area was not sampled in 2014. The TN-affected area of the lake in 2014 was estimated as greater than or equal to 229.6 km<sup>2</sup>, or 40.1% of the lake.

**Figure 4-4 Concentrations of Total Phosphorus and Total Nitrogen from the Bottom Depth in Lac de Gras by Distance from the Diffusers during the Ice-Cover Season, 2014**



µg-P/L = micrograms of phosphorus per litre; µg-N/L = micrograms of nitrogen per litre; NF = near-field; MF = mid-field; FF = far-field.

The magnitude of the eutrophication effect is equivalent to an Action Level 2. Action Level 2 is identified when chlorophyll a concentrations in the NF and MF exposure areas are greater than the upper limit of the normal range in an area representing more than 20% of the lake surface (Table 4-1). Reaching an Action Level 2 necessitates establishing an Effects Benchmark for chlorophyll a. An Effects Benchmark of 4.5 µg/L has already been set for chlorophyll a; therefore, the 2014 monitoring results for indicators of eutrophication do not require new actions.

## **5        SEDIMENT CHEMISTRY**

Sediment chemistry sampling was not required in 2014. Consequently, Appendix III is a place-holder in this AEMP Annual Report.



## **6 PLANKTON**

### **6.1 INTRODUCTION AND OBJECTIVES**

“Plankton” is a general term referring to small, usually microscopic organisms that live suspended in the open-water. For the purpose of this study, the term “phytoplankton” refers to algae in open-water areas of lakes, and includes five major ecological groups:

- Cyanobacteria;
- Chlorophytes (Chlorophyceae, Prasinophyceae, Trebouxiophyceae, Pedinophyceae, Nephroselmidophyceae, and Conjugatophyceae);
- Microflagellates (Chrysophyceae, and Cryptophyceae);
- Dinoflagellates (Dinophyceae); and
- Diatoms (Bacillariophyceae).

“Zooplankton” refers to microscopic animals that live suspended in lake water, and includes crustaceans, which are animals with hard shells similar to, but much smaller than, crabs or shrimp:

- Cladocera (cladocerans);
- Cyclopoida (cyclopoids);
- Calanoida (calanoids); and
- Rotifera (rotifers).

The primary goal of the plankton component of the Mine’s AEMP is to monitor phytoplankton and zooplankton communities during the open-water sampling period to evaluate the effects of the minewater discharge and other Mine-related stressors. Within the plankton component, phytoplankton and zooplankton community endpoints (i.e., abundance, biomass and taxonomic composition) are monitored as indicators of potential effects.

### **6.2 METHODS**

Plankton samples were collected at the NF stations in Lac de Gras (Figure 1-1). Phytoplankton samples were sent to Eco-Logic Ltd. in Vancouver, British Columbia, and zooplankton samples were sent to Salki Consultants Inc. in Winnipeg, Manitoba, for analyses of abundance and community composition.

A depth-integrated sampler, which collected water from the surface to a depth of 10 m, was used to collect phytoplankton samples. Zooplankton samples were collected using a plankton net that was hauled up through the entire water column at each station.

Limnology profile data, estimates of plankton biomass (chlorophyll *a* for phytoplankton and dry weight for zooplankton) and nutrient concentrations were collected as part of the water chemistry and eutrophication indicators field programs; this information has been included in the Effluent and Water Chemistry Report (Appendix II) and Eutrophication Indicators Report (Appendix XIII).

The importance of effects on phytoplankton or zooplankton biomass and taxonomic richness (number of different types of organisms) has been categorized according to Action Levels, which are summarized in Table 6-1. The magnitude of effect was evaluated by comparing community endpoints in exposure areas to normal ranges for Lac de Gras.

**Table 6-1 Action Levels for Plankton**

Action Level	Plankton	Extent	Action
1	Mean biomass or richness significantly less than reference area means	Near-field	Confirm effect
2	Mean biomass or richness significantly less than reference area means	Nearest Mid-field station	Investigate cause
3	Mean richness less than normal range	Near-field	Examine ecological significance Set Action Level 4 Identify mitigation options
4	TBD <sup>(a)</sup>	TBD <sup>(a)</sup>	Define conditions required for the Significance Threshold
5	Decline in biomass or richness likely to cause a >20% change in fish population(s)	Far-field A (FFA)	Significance Threshold

a) To be determined if Action Level 3 is reached.

> = greater than; % = percent; TBD = to be determined.

## 6.3 RESULTS AND DISCUSSION

During the 2014 open-water period, total phytoplankton biomass and mean biomass of major phytoplankton groups were within normal ranges, but mean phytoplankton richness in the NF exposure area was above the normal range (Table 6-2). Total phytoplankton biomass in the NF area was higher than the reference area mean biomass in 2013.

Phytoplankton community composition exhibited typical seasonal variation, and showed similarities to the 2013 reference area data (reference areas were not sampled in 2014). Based on relative abundance data, the NF exposure area in 2014 and reference areas in 2013 were dominated by cyanobacteria (Figure 6-1). However, relative biomass was dominated by chlorophytes in both the NF area and the reference areas.

**Table 6-2 Phytoplankton Biomass and Taxonomic Richness in Lac de Gras in 2014 Compared to the Normal Range**

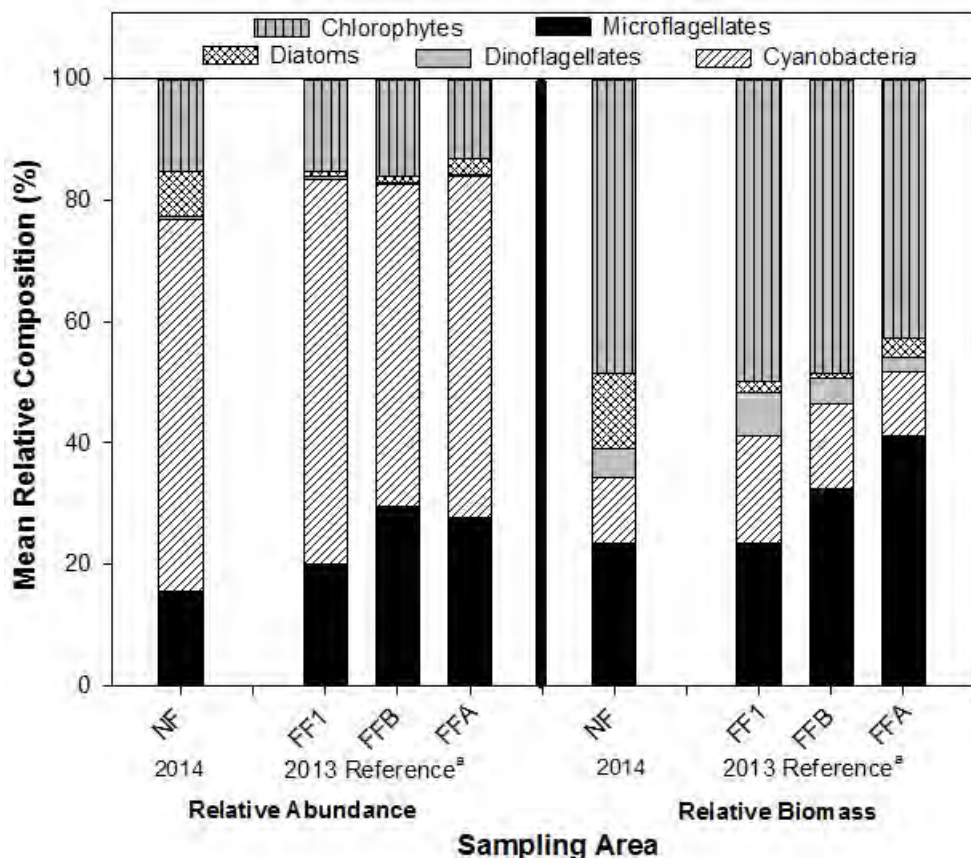
Variable	Unit	Near-Field (NF)		Normal Range <sup>(a)</sup> and 2013 Reference Area Mean		
		n	Mean ± SD	Lower Limit	2013 Reference Area Mean	Upper Limit
Cyanobacteria Biomass	mg/m <sup>3</sup>	5	38 ± 21	4	28	79
Microflagellate Biomass	mg/m <sup>3</sup>	5	71 ± 18	13	56	99
Chlorophyte Biomass	mg/m <sup>3</sup>	5	150 ± 30	25	104	253
Diatom Biomass	mg/m <sup>3</sup>	5	43 ± 52	5	4	66
Dinoflagellate Biomass	mg/m <sup>3</sup>	5	14 ± 8	0	7	19
Total Phytoplankton Biomass	mg/m <sup>3</sup>	5	316 ± 77	140	200	352
Total Phytoplankton Taxonomic Richness	Taxa <sup>(b)</sup>	5	32 ± 5	12	27	25

SD = standard deviation; n = number of samples.

a) The normal range was calculated as defined in the AEMP Reference Conditions Approach Report Version 1.1 (Golder 2015).

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

**Figure 6-1 Mean Relative Phytoplankton Biomass for the Near-field Area of Lac de Gras in 2014, Compared to 2013 Reference Area Data**



Notes: NF = near-field; FF = far-field.

a) Calculated as the mean for each reference area (FF1, FFB, and FFA) in 2013.

Results of the 2014 zooplankton community assessment showed that although total zooplankton biomass in the NF exposure area was within the normal range, biomass of cladocerans and rotifers were slightly above their respective normal ranges (Table 6-3). Total zooplankton biomass in the NF area was higher than the historical reference area mean biomass. Taxonomic richness was similar among the exposure areas of Lac de Gras sampled in 2014.

In terms of relative abundance, rotifers dominated the zooplankton community in the NF area in 2014 and historically, but rotifer dominance was more pronounced in 2014, whereas the relative abundance of cyclopoid copepods was reduced (Figure 6-2). In contrast, zooplankton biomass in the NF area was dominated by the larger-bodied cladocerans and calanoid copepods in 2014, whereas the reference areas were historically dominated by Calanoid copepods.

**Table 6-3 Zooplankton Biomass (calculated) and Taxonomic Richness in Lac de Gras, 2014**

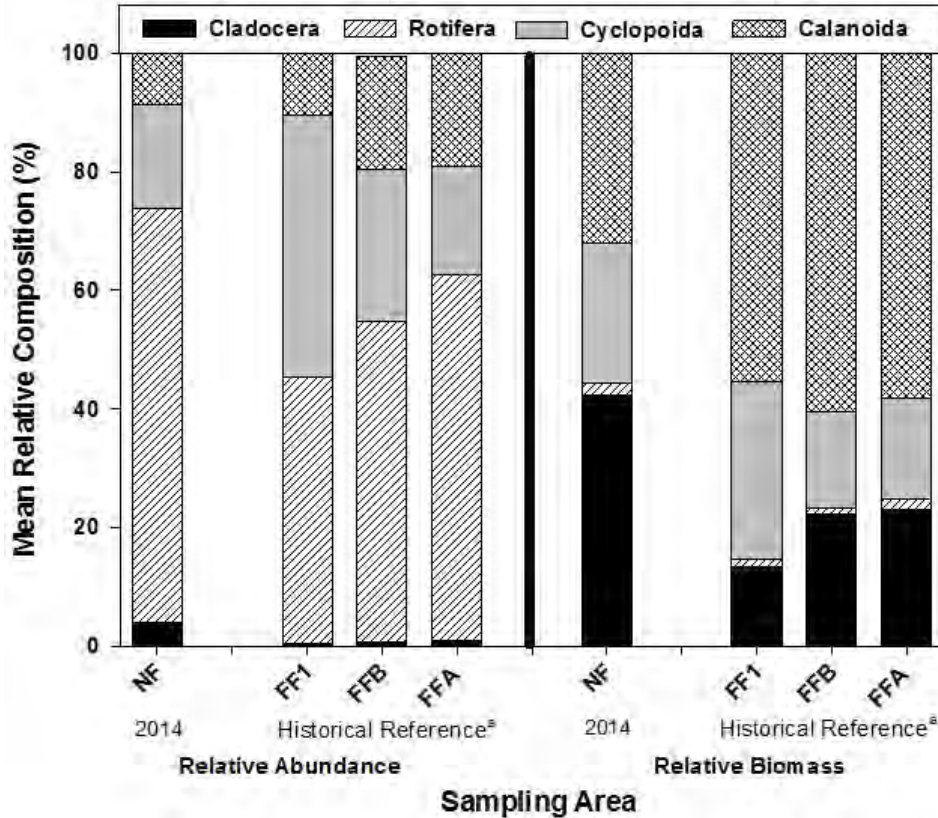
Variable	Unit	Near-Field (NF) Area		Normal Range <sup>(a)</sup>		
		n	Mean ± SD	Lower Limit	2008-2010 Reference Area Mean	Upper Limit
Cladocera Biomass	mg/m <sup>3</sup>	5	138 ± 46	8	63	127
Cyclopoida Biomass	mg/m <sup>3</sup>	5	91 ± 15	13	54	105
Calanoida Biomass	mg/m <sup>3</sup>	5	200 ± 105	61	182	359
Rotifera Biomass	mg/m <sup>3</sup>	5	8 ± 3	2	4	7
Total Zooplankton Biomass	mg/m <sup>3</sup>	5	437 ± 149	132	300	540
Total Zooplankton Taxonomic Richness	Taxa <sup>(b)</sup>	5	15 ± 1	11	14	17

SD = standard deviation; n = number of samples.

a) The normal range was calculated as defined in the AEMP Reference Conditions Approach Report Version 1.1 (Golder 2015).

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

**Figure 6-2 Mean Relative Zooplankton Abundance and Biomass for the Near-field Area of Lac de Gras in 2014, Compared to Historical Reference Area Data**



Notes: % = percent; NF = near-field; FF = far-field.

a) Calculated as the pooled 2008 to 2010 mean for each reference area (FF1, FFB, and FFA).

The 2014 plankton monitoring results suggest that plankton communities in Lac de Gras are exhibiting a mild Mine-related nutrient enrichment effect, but provide no evidence of a toxicological change. This conclusion is based on the following findings:

- Phytoplankton richness and biomass in 2014 were greater in exposure areas relative to 2013 reference area data. Total phytoplankton biomass was within the normal range in 2014, but close to the upper limit of the normal range, and richness was above the normal range. Minor differences were also observed in phytoplankton community composition between the 2014 exposure area data and 2013 reference area data.
- Although total zooplankton biomass in 2014 was within the normal range, it was also close to the upper limit of the normal range, and was greater than the historical mean biomass. In addition, the 2014 mean cladoceran and rotifer biomass values in the NF exposure area were above normal ranges. Differences were observed in zooplankton community composition between the 2014 exposure area data historical reference area data, indicating a greater proportion of total zooplankton biomass contributed by cladocerans.

## **7 BENTHIC INVERTEBRATES**

Benthic invertebrate sampling was not required in 2014. Consequently, Appendix IV is a place-holder in this AEMP Annual Report.

## **8 FISH**

### **8.1 INTRODUCTION AND OBJECTIVES**

In 2007, concentrations of mercury in Slimy Sculpin were greater in the NF exposure area near the mine discharge compared to the reference populations sampled in Lac de Gras. In response, DDMI started a special monitoring program to look at mercury concentrations in a larger, edible species of fish, Lake Trout. However, use of Lake Trout to monitor mercury raised concerns about the possible effects of lethal monitoring on the Lake Trout population. Accordingly, the mercury in Lake Trout program was conducted using non-lethal sampling techniques. The primary objective of the program was to monitor mercury concentrations in Lake Trout muscle. A secondary objective of the 2014 program was to evaluate whether Lake Trout in move between the two study lakes.

The detailed technical report on the findings of the 2014 Lake Trout monitoring is provided in Appendix V. This section provides an overview of the program and a summary of the results.

### **8.2 METHODS**

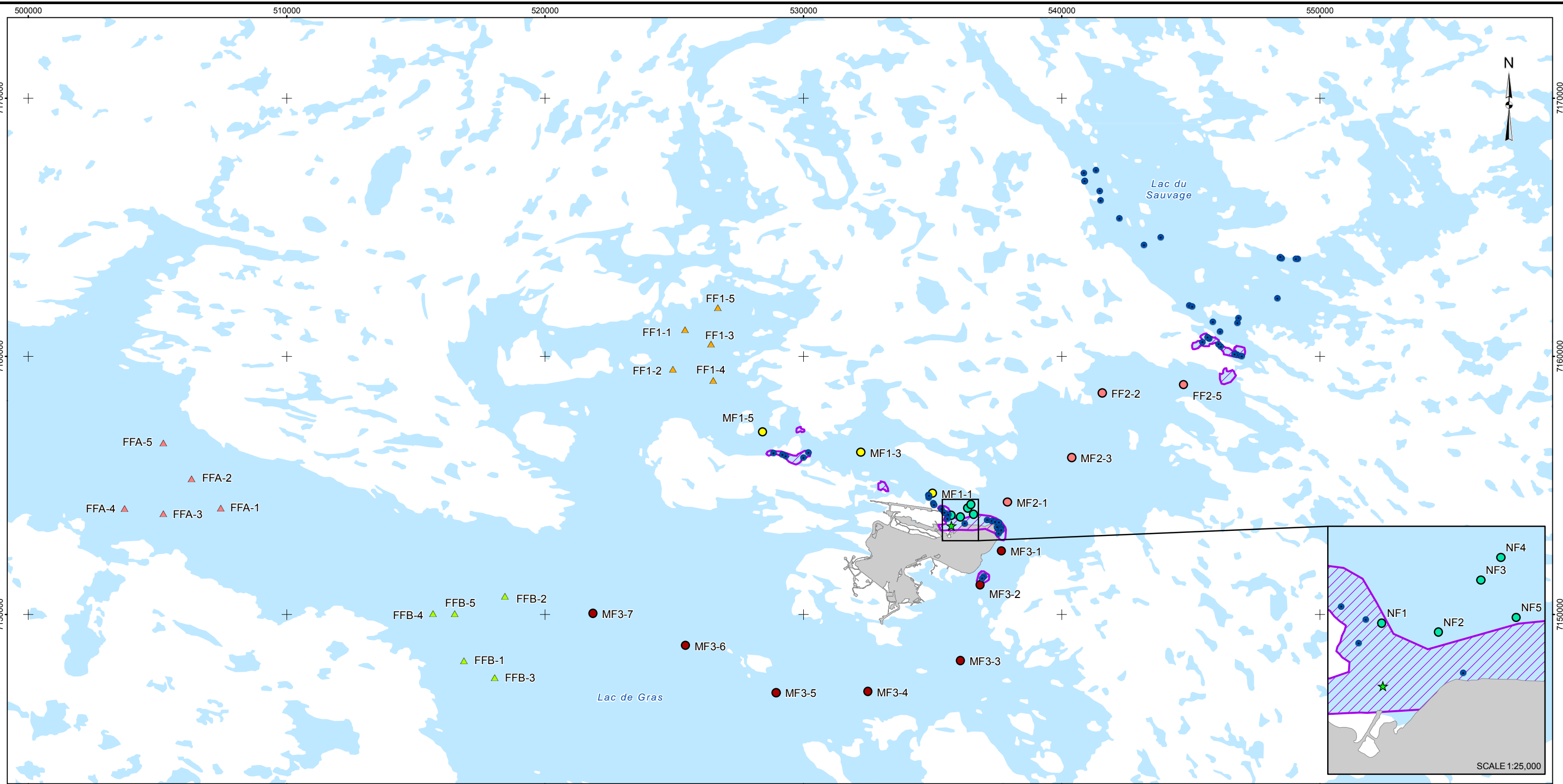
#### **8.2.1 Mercury in Lake Trout**

Field sampling took place from July 29 to August 10, 2014. Lake Trout were captured by angling. Trolling with large spoons and tube jig lures was the primary method of angling. Sampling was initially conducted on Lac de Gras in the NF area, east and southeast of the Mine site (Figure 8-1). Lac du Sauvage was accessed near the south end of the lake close to the Narrows, where Lac du Sauvage flows into Lac de Gras.

Captured Lake Trout were held alive in the lake in a fish cradle before processing (Photo 8-1). Length and weight were recorded for captured Lake Trout, and external observations were made to record features of the fish which did not appear normal.

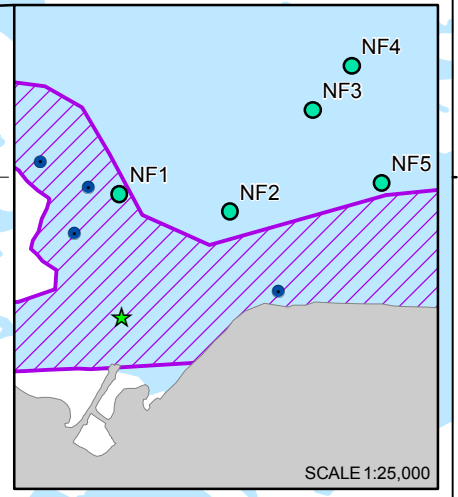
Sampling was performed by anaesthetizing fish and then collecting muscle plugs from the dorsal portion of each fish using a biopsy punch (Photo 8-2). To collect a muscle plug, several scales were removed, and the biopsy punch was placed against the exposed skin. The punch was then inserted, and a small piece of fish muscle and skin was captured in the punch and placed in a sample vial. A sealant was then applied to the biopsy location, and following recovery, the fish were returned live to their original capture location. Samples were shipped to Flett Research Ltd. in Winnipeg, Manitoba, for analysis of total mercury concentration. Left pelvic fin rays were also collected for ageing the fish.

i:\201111-1328\11-1328-0038\Mapping\MXD\2014AEMP\Fig8-1\_2014\_AEMP\_Trout\_Sampling\_Rev0.mxd



- LEGEND**
- ★ DIFFUSERS
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - ▲ FAR-FIELD 1
  - ▲ FAR-FIELD A
  - ▲ FAR-FIELD B
  - DIAVIK FOOTPRINT
  - WATERBODY
  - 2014 LAKE TROUT SURVEY**
  - 2014 Hg FISH CAPTURE LOCATION
  - ▨ 2014 FISH PIT TAGGING AREA

**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83



PROJECT			
TITLE			
<b>LAKE TROUT SAMPLING LOCATIONS, 2014</b>			
	PROJECT	1406208	FILE No.
	DESIGN	JC 10 Nov. 2014	SCALE AS SHOWN
	GIS	SS 30 Mar. 2016	REV. 0
	CHECK	TD 30 Mar. 2016	<b>FIGURE: 8-1</b>
REVIEW	HM 30 Mar. 2016		





**Photo 8-1** Use of net cradle to reduce harm to fish being sampled



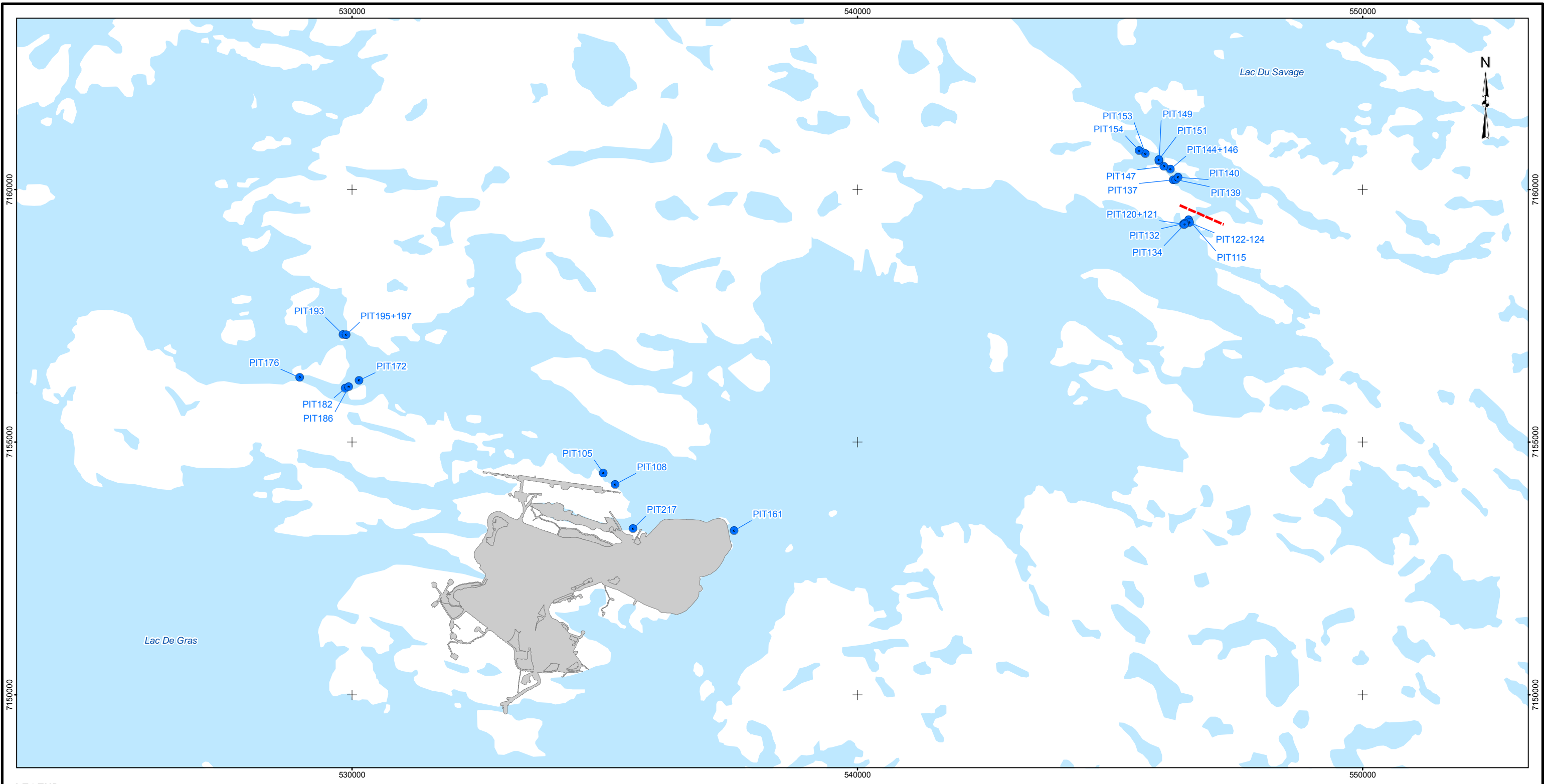
**Photo 8-2** Location on Lake Trout where muscle plug was removed

### 8.2.3 Movement Study

To evaluate whether Lake Trout move between Lac de Gras and Lac du Sauvage, Lake Trout were captured and fitted with a passive integrated transponder (PIT) tag. A total of 126 Lake Trout were tagged, consisting of 106 fish from Lac de Gras and 20 fish from Lac du Sauvage. The PIT tag was implanted into the Lake Trout using a small, curved scalpel ventrally into the body cavity (Photo 8-3), and then sealed using tissue glue. An antenna array that detects when a fish with a PIT tag swims by was installed at the outlet of Lac du Sauvage at the narrows (Figure 8-2), and was activated for the summer of 2015.



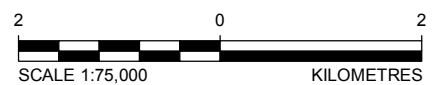
**Photo 8-3** Insertion of PIT tag in Lake Trout



- LEGEND**
- 2014 LAKE TROUT SURVEY**
- 2014 PIT TAGGED FISH CAPTURE LOCATION\*
  - ANTENNA ARRAY
  - DIAVIK FOOTPRINT
  - WATERBODY

**NOTE**  
 \*ONE POINT LOCATION CAN REPRESENT MORE THAN ONE FISH.

**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83



<b>PROJECT</b>				
<b>TITLE</b>	<b>CAPTURE LOCATIONS OF LAKE TROUT DETECTED BY ARRAY AT THE NARROWS, 2015</b>			
	<b>PROJECT</b>	1406208	FILE No.	
	DESIGN	CJ	10 Mar. 2016	SCALE AS SHOWN
	GIS	SS	30 Mar. 2016	REV. 0
	CHECK	TD	30 Mar. 2016	<b>FIGURE: 8-2</b>
REVIEW	HM	30 Mar. 2016		

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## 8.3 RESULTS AND DISCUSSION

### 8.3.1 Mercury in Lake Trout

A full description of the results from the 2014 Lake Trout survey is provided in Appendix V. This summary focuses on the key findings; in particular, if there was a change in mercury concentrations in Lake Trout from concentrations measured before Mine development (1996). Mercury concentrations in muscle of Lake Trout from Lac de Gras and Lac du Sauvage were compared to mercury concentrations in Lake Trout captured at similar locations in 1996. To assist in the interpretation, results from the community-based monitoring camps (2002 to 2005), a fish health survey (2005), and the two previous AEMP surveys of metals in Lake Trout (2008 and 2011) were also included in the analysis.

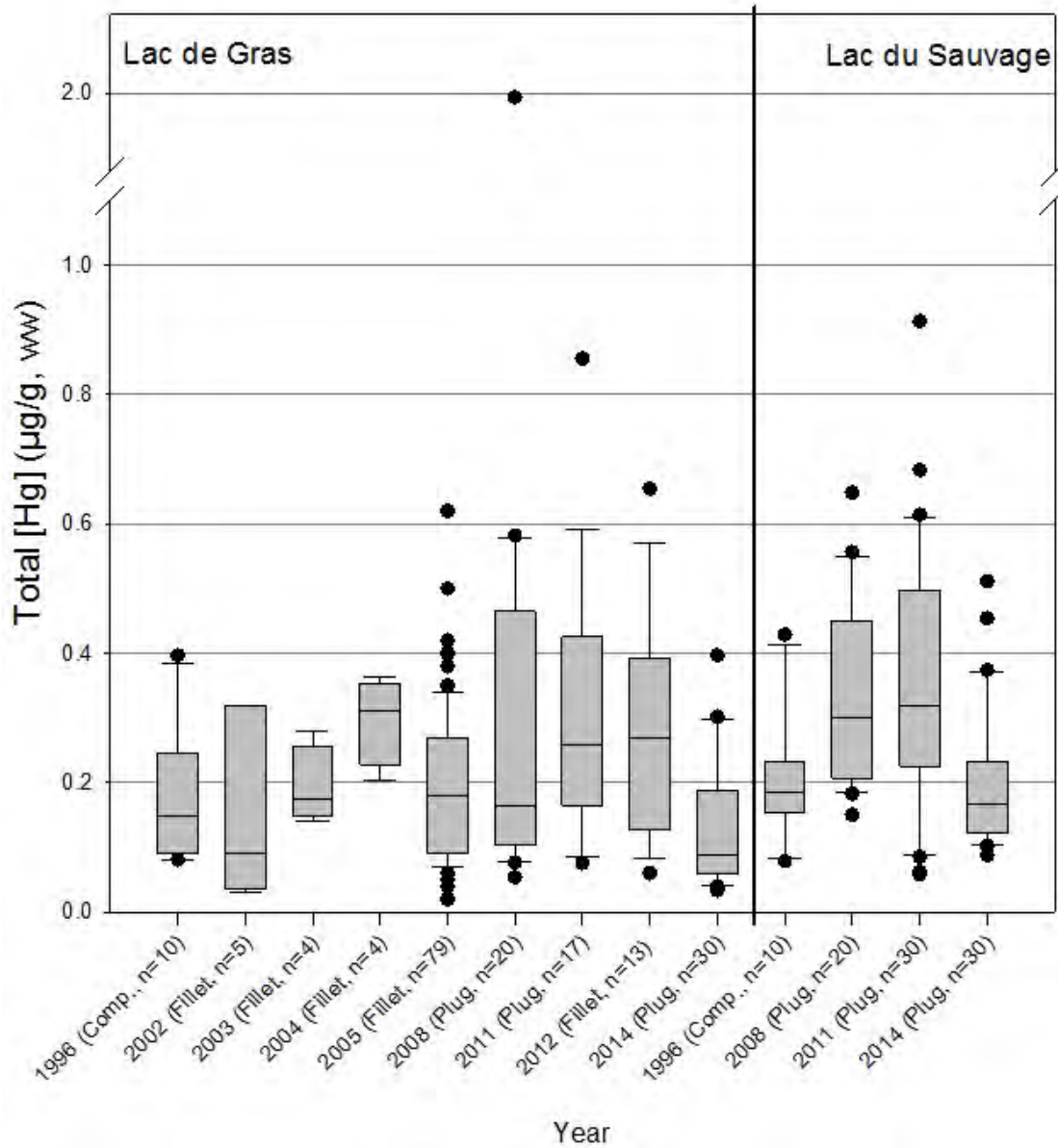
Mercury concentrations for each year are shown as box-and-whisker plots in Figure 8-3. The data from 1996, 2005, 2008 and 2011 show that concentrations of mercury in fish muscle increased over time, with the increase being more obvious in Lac du Sauvage. Subsequently, in 2014, mercury concentrations were detected at concentrations similar to those measured before the Mine was developed (1996), in both Lac de Gras and Lac du Sauvage.

Tissue mercury concentrations are related to fish size. Older, larger fish tend to have higher mercury concentrations than younger, smaller fish. Therefore, when conducting statistical comparisons, mercury concentrations were adjusted by fish length. In 2014, mercury concentrations adjusted by fish size were significantly lower than mercury concentrations analyzed in 2005 (Lac de Gras only), 2008 and 2011 (Figure 8-4).

The concentration of mercury in Lake Trout muscle in each study lake was compared to two guidelines. The Canadian Food Inspection Agency (CFIA) and Health Canada guidelines state that fish collected for commercial use may contain a maximum of 0.5 µg/g ww mercury to be approved for human consumption (CFIA 2015). Secondly, mercury concentrations in Lake Trout muscle in 2014 were compared to an effects benchmark/tissue residue guideline of 1.0 µg/g ww. Above this concentration, adverse effects on fish health may be observed (Jarvinen and Ankley 1998; Scheuhammer et al. 2007).

In 2014, the concentration of mercury in Lake Trout muscle in each study lake was below the CFIA guideline of 0.5 µg/g ww, with the exception of one fish in Lac du Sauvage. The concentration of mercury in Lake Trout muscle in 2014 in both lakes was below the effect threshold/tissue residue guideline of 1.0 µg/g ww, such that Lake Trout health is unlikely to be affected. Therefore, based on the 2014 mercury concentrations measured in Lake Trout in Lac de Gras and Lac du Sauvage, no concerns to human health or fish health are expected.

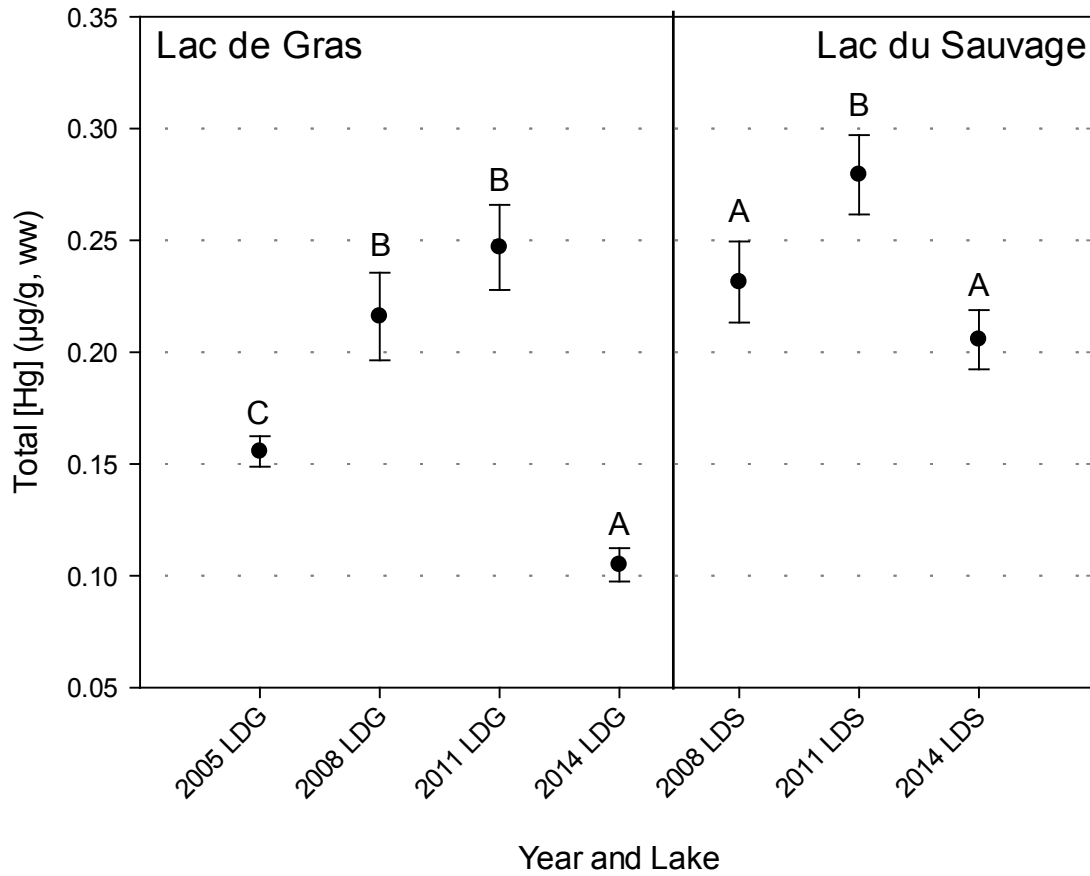
**Figure 8-3 Box and Whisker Plots for Mercury Concentrations in Lake Trout Muscle Over Time**



Comp. = Composite sample; [Hg] = mercury concentration; n = number of samples.

Note: The mercury data for Lake Trout include results from the 2002, 2003, 2004, and 2012 fish palatability studies (DDMI 2003; Thorpe 2013; and unpublished data). Fillet results are uncorrected mercury as the % moisture is close to 80% in fillet data. Plug data was corrected to 80% loss on drying (LOD). Box plots show the distribution of the data in percentiles, with the boundary of the box closest to zero representing the 25<sup>th</sup> percentile, the line within the box representing the median, and the boundary of the box farthest from zero representing the 75<sup>th</sup> percentile. The "whiskers" below and above the box represent the 10<sup>th</sup> and 90<sup>th</sup> percentiles, respectively. Concentrations that lie beyond the 10<sup>th</sup> and 90<sup>th</sup> percentiles are plotted as dots.

**Figure 8-4 Length-Adjusted Mercury Concentration (mean  $\pm$  SE) in Lake Trout Muscle Plugs (2008, 2011 and 2014) or Fillets (2005)**



Notes: SE = standard error; µg/g, ww = microgram per gram wet weight; [Hg] = mercury concentration; %LOD = percent loss on drying; letters above error bars represent within area significant differences, (i.e. within a lake, if letters are the same they are not statistically different, if letters are not the same they are statistically different). Muscle plug data from 2008, 2011 and 2014 corrected to 80%LOD.

### **8.3.2 Movement Study**

Of the 126 Lake Trout tagged in 2014, 29 fish (23%) passed over the array located at the Narrows in 2015. Of these fish, 19 were originally tagged in Lac de Gras, and 10 were tagged in Lac du Sauvage (Figure 8-2). The majority of Lake Trout detected by the array in 2015 were originally captured and tagged near the Narrows in 2014. However, nine Lake Trout that passed over the array in 2015 were originally captured and tagged up to 20 km away from the Narrows in 2014 (Figure 8-2). Of the 29 Lake Trout detected by the array, four were detected only once, and the remaining 25 were detected multiple times. One tagged Lake Trout was detected passing over the array 128 times.

The results of the 2014/2015 Lake Trout movement study indicate that Lake Trout in Lac de Gras and Lac du Sauvage move between the two lakes. The survey did not document direction of the movement, only that Lake Trout did move back and forth. This confirms that Lac du Sauvage should not function as a reference lake for the Lake Trout mercury monitoring program.

## **9 FISHERIES AUTHORIZATION AND SPECIAL EFFECTS STUDIES**

### **9.1 PLUME DELINEATION SURVEY**

Plume delineation surveys did not take place in 2014. Consequently, Appendix VI is a place holder in this AEMP Annual Report.

### **9.2 FISHERIES AUTHORIZATION STUDIES**

#### **9.2.1 Dike Monitoring Studies**

Dike monitoring did not take place in 2014. Consequently, Appendix VII is a place holder in this AEMP Annual Report.

#### **9.2.2 Fish Salvage Programs**

A fish salvage program did not occur in 2014. Consequently, Appendix VIII is a place holder in this AEMP Annual Report.

#### **9.2.3 Fish Habitat Compensation Monitoring**

Fish habitat compensation monitoring was not conducted in 2014. Consequently, Appendix IX is a placeholder appendix in this annual report.

#### **9.2.4 Fish Palatability, Fish Health, and Fish Tissue Chemistry Survey**

A fish palatability survey was not conducted in 2014. As per the AEMP Study Design Version 3.5, the fish palatability surveys will be incorporated into the Traditional Knowledge program. Consequently, Appendix X will remain a placeholder appendix in annual reports, and information relating to the fish palatability surveys will appear in the Traditional Knowledge appendix report.

### **9.3 AEMP SPECIAL EFFECTS STUDY REPORTS**

There were no SES in 2014. Consequently, Appendix XII is a place holder in this AEMP Annual Report.



## **10 TRADITIONAL KNOWLEDGE STUDIES**

Traditional Knowledge Studies did not take place in 2014. Consequently, Appendix XIV is a place holder in this AEMP Annual Report.

## **11 WEIGHT-OF-EVIDENCE**

The weight-of-evidence evaluation was not required in 2014. Consequently, Appendix XV is a place holder in this AEMP Annual Report.

## **12 ADAPTIVE MANAGEMENT RESPONSE ACTIONS**

Part J, Schedule 8, Item 4d of Water Licence W2015L2-0001 requires that the Annual AEMP include an evaluation of any adaptive management response actions implemented during the year. In 2014 there were no specific adaptive management responses to evaluate.

## 13 CONCLUSIONS AND RECOMMENDATIONS

### 13.1 CONCLUSIONS

Conclusions for each section of the 2014 AEMP are summarized below.

#### Dust

- Following the general trend of a reduction in dust levels over the past several years, dustfall levels were generally lower in 2014 than in previous years. Dustfall rates decreased with distance from the Mine, and areas that were predominantly downwind of the Mine received more dustfall than upwind areas.
- Although there are no dustfall standards for the Northwest Territories, 2014 dustfall rates were always less than the 1.7 to 2.8 mg/dm<sup>2</sup>/day (621 to 1,059 mg/dm<sup>2</sup>/y) British Columbia Ministry of the Environment dustfall objective for the mining, smelting, and related industries (BC MOE 2013).
- Snow water chemistry variables of interest included aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, phosphorus and zinc. All 2014 concentrations were below the effluent discharge criteria. Concentrations of arsenic, chromium and nickel have increased in recent years and concentrations of copper, lead and zinc have decreased.

#### Effluent and Water Chemistry

- The Mine effluent had an effect on 19 water quality variables analyzed in 2014 (conductivity, TDS [calculated], calcium, chloride, potassium, sodium, sulphate, nitrate, aluminum, antimony, barium, chromium, copper, lead, molybdenum, silicon, strontium, tin and uranium).
- The NF area median concentrations of these 19 variables were greater than two times the reference area median concentrations. As a result, these variables demonstrated an effect equivalent to Action Level 1, and they were included in the list of SOI.
- Of the 19 SOI that reached Action Level 1, eight (TDS [calculated], chloride, sodium, nitrate, antimony, molybdenum, strontium and uranium) had 5<sup>th</sup> percentile NF concentrations that were greater than two times the reference area median and the normal range, thereby reaching Action Level 2.

#### Eutrophication Indicators

- Concentrations of nutrients showed Mine-related increases in the NF area (TP), and in the NF and MF areas (TN), indicating a Mine-related nutrient enrichment effect in Lac de Gras.
- Zooplankton biomass data are not available for 2014.
- In 2014, greater than or equal to 40.9% of the lake area had chlorophyll *a* concentrations above the normal range.
- Chlorophyll *a* concentration was above the upper limit of the normal range in an area representing more than 20% of the lake surface. Therefore, an Action Level 2 was reached for chlorophyll *a*.

## Plankton

- The 2014 results indicate that the plankton communities in Lac de Gras are exhibiting a Mine-related nutrient enrichment effect, as shown by greater biomass in exposure areas relative to the reference areas, and occasional exceedances of the normal range.
- The 2014 plankton results provide no indication of a toxicological change.
- Given that the differences observed within the plankton community are not indicative of toxicological impairment, an Action Level 1 was not reached for the plankton component in 2014.

## Fish

- In both Lac de Gras and Lac du Sauvage, the concentration of mercury in Lake Trout muscle increased from 1996 to 2008, remained elevated in 2011, and then was detected in 2014 at concentrations similar to baseline.
- In 2014, the concentration of mercury in Lake Trout muscle in each study lake was below the Canadian government maximum acceptable level in the edible portion of retail fish (0.5 µg/g ww).
- The concentration of mercury in Lake Trout muscle in 2014 in both lakes was below the relevant effect threshold/tissue residue guideline (1.0 µg/g ww), such that Lake Trout health is unlikely to be affected.
- The reason for the variations in mercury concentrations in Lake Trout muscle over time are unknown and are outside the scope of the AEMP.
- The results of the 2014/2015 Lake Trout movement study indicate that Lake Trout move between Lac de Gras and Lac du Sauvage.

## 13.2 RECOMMENDATIONS

Where available, each section of the 2014 AEMP provided recommendations for refining the AEMP to improve its effectiveness. These recommendations are summarized below.

### Dust

There are no 2014 recommendations for dust.

### Effluent and Water Chemistry

There are no 2014 recommendations for effluent and water chemistry.

### Eutrophication Indicators

There are no 2014 recommendations for eutrophication indicators.

### Plankton

There are no 2014 recommendations for plankton.

## **Fish**

The next small-bodied fish survey is scheduled for 2016, and a Lake Trout mercury survey is scheduled for 2017. A Mine-related increase in mercury concentration in small-bodied fish has not been observed since 2007, and in 2014, mercury in Lake Trout was found to be at concentrations similar to those before the Mine began operating (1996). Therefore, at this time, it is recommended that the requirement for the 2017 Lake Trout mercury survey be made dependent upon small-bodied fish results. This recommendation will be included in the upcoming AEMP Study Design Version 4.0. Should mercury concentrations in the small-bodied fish indicate an increasing trend caused by the Mine in 2016, then it would be recommended that the mercury in Lake Trout program be conducted in 2017.

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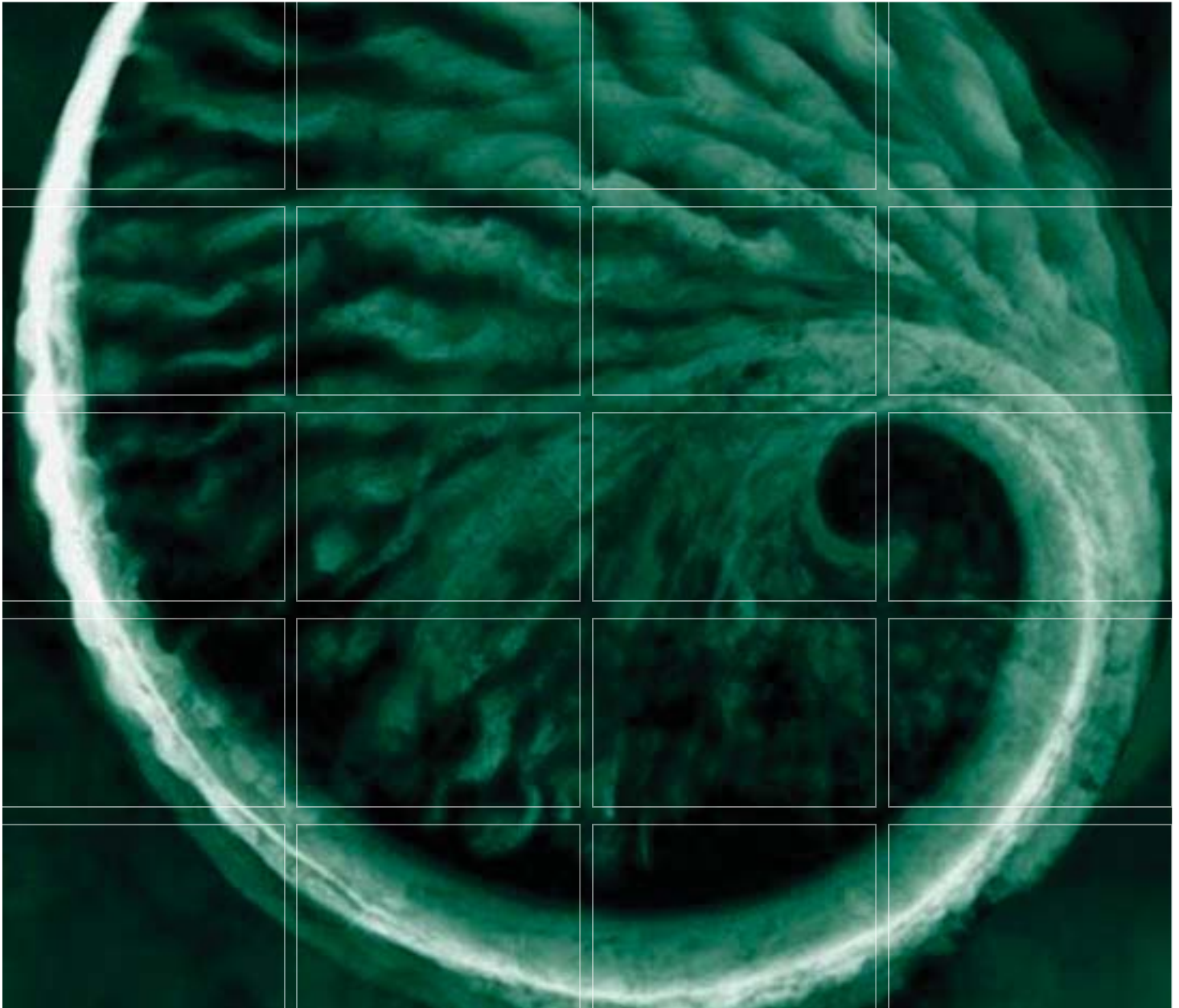
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# **APPENDIX I**

## **DUST DEPOSITION REPORT**



*Prepared for:*



## DIAVIK DIAMOND MINE 2014 Dust Deposition Report

February 2015

**Diavik Diamond Mines (2012) Inc.**

DIAVIK DIAMOND MINE  
**2014 Dust Deposition Report**

**February 2015**

Project #0207514-0006

Citation:

ERM. 2015. *Diavik Diamond Mine: 2014 Dust Deposition Report*. Prepared for Diavik Diamond Mines (2012) Inc. by ERM Consultants Canada Ltd.: Yellowknife, Northwest Territories.

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ERM prepared this report for the sole and exclusive benefit of, and use by, Diavik Diamond Mines (2012) Inc.. Notwithstanding delivery of this report by ERM or Diavik Diamond Mines (2012) Inc. to any third party, any copy of this report provided to a third party is provided for informational purposes only, without the right to rely upon the report.

## EXECUTIVE SUMMARY

Potential air and water quality concerns associated with airborne fugitive dust, which may result from mining activities, were identified in the Diavik Diamond Mine Environmental Assessment (DDMI 1998). In accordance with the Environmental Assessment and requirements associated with the Aquatic Effects Monitoring Program (AEMP), a dust monitoring program was initiated in 2001. The program was designed to achieve the following objectives:

- ≠ Determine dust deposition (dustfall) rates at various distances from the mine project footprint; and
- ≠ Determine the chemical characteristics of dustfall that may be deposited onto, and subsequently into, Lac de Gras as a result of mining activities, in support of the AEMP.

In 2014, dustfall monitoring included three components, with sampling conducted at varying distances around the mine from 25 to 5,655 m away from infrastructure:

1. Dustfall gauges (including ten monitoring and two control locations).
2. Dustfall from snow surveys (including 24 monitoring and three control locations).
3. Snow water chemistry from snow surveys (including 16 monitoring and three control locations).

Following the general trend of a general reduction in dust levels over the last several years, dustfall rates were generally lower in 2014 than in previous years. Overall, as expected, dustfall rates decreased with distance from the mine site, and areas that were predominantly downwind of the mine site received more dustfall than upwind areas.

Annual dustfall estimated from each of the 12 dustfall gauges ranged from 61 to 479 mg/dm<sup>2</sup>/y. The annualized dustfall rates estimated from the 2014 snow survey data ranged from 3.8 to 393 mg/dm<sup>2</sup>/y. Although there are no dustfall standards for the Northwest Territories, 2014 dustfall rates were always less than the 1.7 to 2.9 mg/dm<sup>2</sup>/day (621 to 1059 mg/dm<sup>2</sup>/y) British Columbia Ministry of Environment dustfall objective for the mining, smelting, and related industries (BC MOE 2013).

Snow water chemistry analytes of interest included those variables with effluent quality criteria (EQC; i.e., aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc) or a load limit (i.e., phosphorous) specified in the Type "A" Water Licence (W2007L2-0003). All 2014 sample concentrations were less than their associated reference levels as specified by the "maximum concentration of any grab sample" specified in Water Licence W2007L2-0003. Concentrations of arsenic, chromium, and nickel have increased in recent years, while concentrations of copper, lead and zinc decreased in recent years. Typically, concentrations decreased with distance from the mine site, however, the greatest concentrations of each variable of interest were recorded at Station SS3-8, located in the 251-1000 zone and station SS3-7, located in the 101-150 zone. Concentrations at these two locations were more than double the concentrations recorded at the other sites, including samples collected in the 0-100 zone. Both of these stations are located to the southeast of the site. However, concentrations of all variables were always less than their corresponding EQC.

## ACKNOWLEDGEMENTS

This report was prepared for Diavik Diamond Mines (2012) Inc. (DDMI) by ERM Consultants Canada Ltd. (ERM). Fieldwork and on site sample analyses were completed by DDMI, and other sample analyses were completed by Maxxam Analytics. Data analyses and reporting were completed by Kiri Heal (BSc, MSc) and reviewed by Derek Shaw (M.A.Sc., P.Eng.) and April Hayward (PhD) of ERM. The project was managed by April Hayward; Marc Wen (MSc) was the partner in charge.

# DIAVIK DIAMOND MINE

## 2014 Dust Deposition Report

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- Appendix B. Dustfall Gauge Analytic Results
- Appendix C. Dustfall Snow Survey Field Sheets and Analytic Results
- Appendix D. Snow Water Chemistry Analytic Results
- Appendix E. Dust Gauge Collection Standard Operating Procedure
- Appendix F. Snow Survey Standard Operating Procedure



## 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.

<b>AEMP</b>	Aquatic Effects Monitoring Program
<b>BC</b>	British Columbia
<b>BC MOE</b>	British Columbia Ministry of Environment
<b>d</b>	Day
<b>DDMI</b>	Diavik Diamond Mines (2012) Inc.
<b>dm<sup>2</sup></b>	Square decimetre
<b>Dustfall</b>	Dust deposition
<b>ERM</b>	ERM Consultants Canada Ltd.
<b>EQC</b>	Effluent Quality Criteria
<b>L</b>	Litre
<b>m</b>	Metre
<b>mg</b>	Milligram
<b>QA/QC</b>	Quality Assurance and Quality Control
<b>RPD</b>	Relative Percent Difference
<b>SOP</b>	Standard Operating Procedure
<b>µg</b>	Microgram
<b>WLWB</b>	Wek'èezhìi Land and Water Board
<b>y</b>	Year

# 1. INTRODUCTION

Potential air and water quality concerns associated with airborne fugitive dust, which may result from mining activities, were identified in the Diavik Diamond Mine Environmental Assessment (DDMI 1998). In accordance with the Environmental Assessment and requirements associated with the Aquatic Effects Monitoring Program (AEMP), a dust monitoring program was initiated in 2001. The program was designed to achieve the following objectives:

- ≠ Determine dust deposition (dustfall) rates at various distances from the mine project footprint; and
- ≠ Determine the chemical characteristics of dustfall that may be deposited onto, and subsequently into, Lac de Gras as a result of mining activities, in support of the AEMP.

Since 2001, the dustfall monitoring program has gone through various changes, including an increase in the number of sampling locations, the relocation of some sampling stations, and improvements to the dustfall sampling methodology. A description of annual changes is provided in Appendix A.

Historical dustfall monitoring results have been presented each year in the *Diavik Diamond Mine Dust Deposition* reports from 2001 to 2013 (DDMI 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014).

## 2. METHODOLOGY

The 2014 dustfall monitoring program incorporated three monitoring components, with sampling completed at varying distances around the mine along five transects, including three control locations (Table 2-1, Figure 2-1):

1. Dustfall gauges (ten monitoring and two control locations).
2. Dustfall from snow surveys (24 monitoring and three control locations).
3. Snow water chemistry from snow surveys (16 monitoring and three control locations).

### 2.1 DUSTFALL GAUGES

Dustfall gauges were placed at 12 stations (including two control stations) around the mine site at distances ranging from approximately 25 to 5,655 m from mining operations (Table 2-1). Each gauge collected dustfall year-round, with samples were collected every three months. The average total sampling period for the 12 locations was 367 days.

Dustfall gauges consisted of a hollow brass cylinder (52 cm length, 12.5 cm inner diameter) housed in a Nipher snow gauge (Plate 2.1-1). The cylinder collected dustfall, while the Nipher snow gauge reduced air turbulence around the gauge to increase dustfall catch efficiency. The cylinder was exchanged with an empty, clean cylinder at the end of each sampling period, and the content of the cylinder that was retrieved was processed in the Diavik Diamond Mines (2012) Inc. (DDMI) environment lab to determine the mass of collected dustfall. This processing involved filtration, drying, and weighing of samples as specified in the standard operating procedures (SOPs) ENVR-508-0112 and ENVI-403-0112 (see Appendix E).



*Plate 2.1-1. Dustfall gauge during sample collection. The dustfall gauge consisted of a hollow brass cylinder (centre) housed inside a Nipher snow gauge (right).*

**Table 2-1. Dustfall and Snow Water Chemistry Sampling Locations, Diavik Diamond Mine, 2014**

Transect Line	Station ID	2014 Sampling Dates		Total Sample Exposure Duration (days)	UTM Coordinates <sup>1</sup>		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled <sup>2</sup>
		2014 Sampling Dates			Easting (m)	Northing (m)			
<i>Dustfall Gauges</i>									
	Dust 1	Mar. 21, Jun. 3, Sep. 15, Dec. 7	368	533964	7154321	75	Land	n/a	
	Dust 2A	Mar. 21, Jun. 2, Sep. 13, Dec. 7	366	535678	7151339	435	Land	n/a	
	Dust 3	Mar. 21, Jun. 3, Sep. 15, Dec. 7	366	535024	7151872	30	Land	n/a	
	Dust 4	Mar. 22, Jun. 3, Sep. 15, Dec. 7	368	531397	7152127	200	Land	n/a	
	Dust 5	Mar. 21, Jun. 2, Sep. 14, Dec. 7	368	535696	7155138	1,195	Land	n/a	
	Dust 6	Mar. 22, Jun. 3, Sep. 15, Dec. 7	366	537502	7152934	25	Land	n/a	
	Dust 7	Mar. 21, Jun. 2, Sep. 13, Dec. 7	368	536819	7150510	1,155	Land	n/a	
	Dust 8	Mar. 21, Jun. 2, Sep. 14, Dec. 7	366	531401	7154146	1,220	Land	n/a	
	Dust 9	Mar. 21, Jun. 2, Sep. 13, Dec. 7	368	541204	7152154	3,810	Land	n/a	
	Dust 10	Mar. 22, Jun. 2, Sep. 13, Dec. 7	368	532908	7148924	670	Land	n/a	
	Dust C1	Mar. 22, Jun. 2, Sep. 13, Dec. 7	368	534979	7144270	5,655	Land	n/a	
	Dust C2	Mar. 22, Jun. 2, Sep. 14, Dec. 7	366	528714	7153276	3,075	Land	n/a	
<i>Snow Surveys</i>									
1	SS1-1	Apr. 8	201	533911	7154288	30	Land		
	SS1-2	Apr. 8	201	533924	7154367	115	Land		
	SS1-3 <sup>3</sup>	Apr. 8	201	533966	7154517	275	Land		
	SS1-4	May 11	189	534485	7155094	920	Ice	✓	
	SS1-5	May 11	189	535099	7156279	2,180	Ice	✓	
2	SS2-1	May 11	189	537553	7153473	180	Ice	✓	
	SS2-2	May 11	189	537829	7153476	445	Ice	✓	
	SS2-3	May 11	189	538484	7153939	1,220	Ice	✓	
	SS2-4	May 11	189	539151	7154685	2,180	Ice	✓	

(continued)

**Table 2-1. Dustfall and Snow Water Chemistry Sampling Locations, Diavik Diamond Mine, 2014 (completed)**

Transect Line	Station ID	2014 Sampling Dates		Total Sample Exposure Duration (days)	UTM Coordinates <sup>1</sup>		Approx. Distance from Mining Operations (m)	Surface Description	Snow Water Chemistry Sampled <sup>2</sup>
		2014 Sampling Dates			Easting (m)	Northing (m)			
<i>Snow Surveys (cont'd)</i>									
3	SS3-4	May 11	May 11	189	536585	7151002	615	Ice	✓
	SS3-5	May 11	May 11	189	537623	7150817	1,325	Ice	✓
	SS3-6 <sup>4</sup>	May 11	May 11	189	536305	7151564	60	Ice	✓
	SS3-7 <sup>4,5</sup>	May 11	May 11	189	536344	7151366	250	Ice	✓
	SS3-8 <sup>4</sup>	May 11	May 11	189	536688	7150810	830	Ice	✓
4	SS4-1	Apr. 19	Apr. 19	212	531491	7152211	100	Land	
	SS4-2	Apr. 19	Apr. 19	212	531356	7152261	245	Land	
	SS4-3	Apr. 19	Apr. 19	212	531331	7152434	350	Land	
	SS4-4 <sup>5</sup>	May 12	May 12	190	531141	7153167	1,065	Ice	✓
	SS4-5 <sup>6</sup>	May 12	May 12	190	531405	7154116	1,220	Ice	✓
5	SS5-1 <sup>3</sup>	Apr. 19	Apr. 19	212	533150	7148925	665	Land	
	SS5-2	Apr. 19	Apr. 19	212	533150	7148875	710	Land	
	SS5-3	May 12	May 12	190	533150	7148700	885	Ice	✓
	SS5-4	May 12	May 12	190	533150	7147950	1,635	Ice	✓
	SS5-5	May 12	May 12	190	533150	7146950	2,635	Ice	✓
	Control 1	May 12	May 12	235	534983	7144271	5,655	Land	7
	Control 2	May 12	May 12	235	528714	7153281	3,075	Land	✓ <sup>7</sup>
	Control 3	May 11	May 11	234	538650	7148750	3,570	Land	✓ <sup>7</sup>

<sup>1</sup> UTM Zone 12W, NAD83

<sup>2</sup> n/a = not applicable.

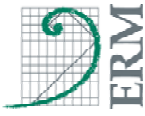
<sup>3</sup> Duplicate sample taken for snowcore dustfall.

<sup>4</sup> Installed in 2014.

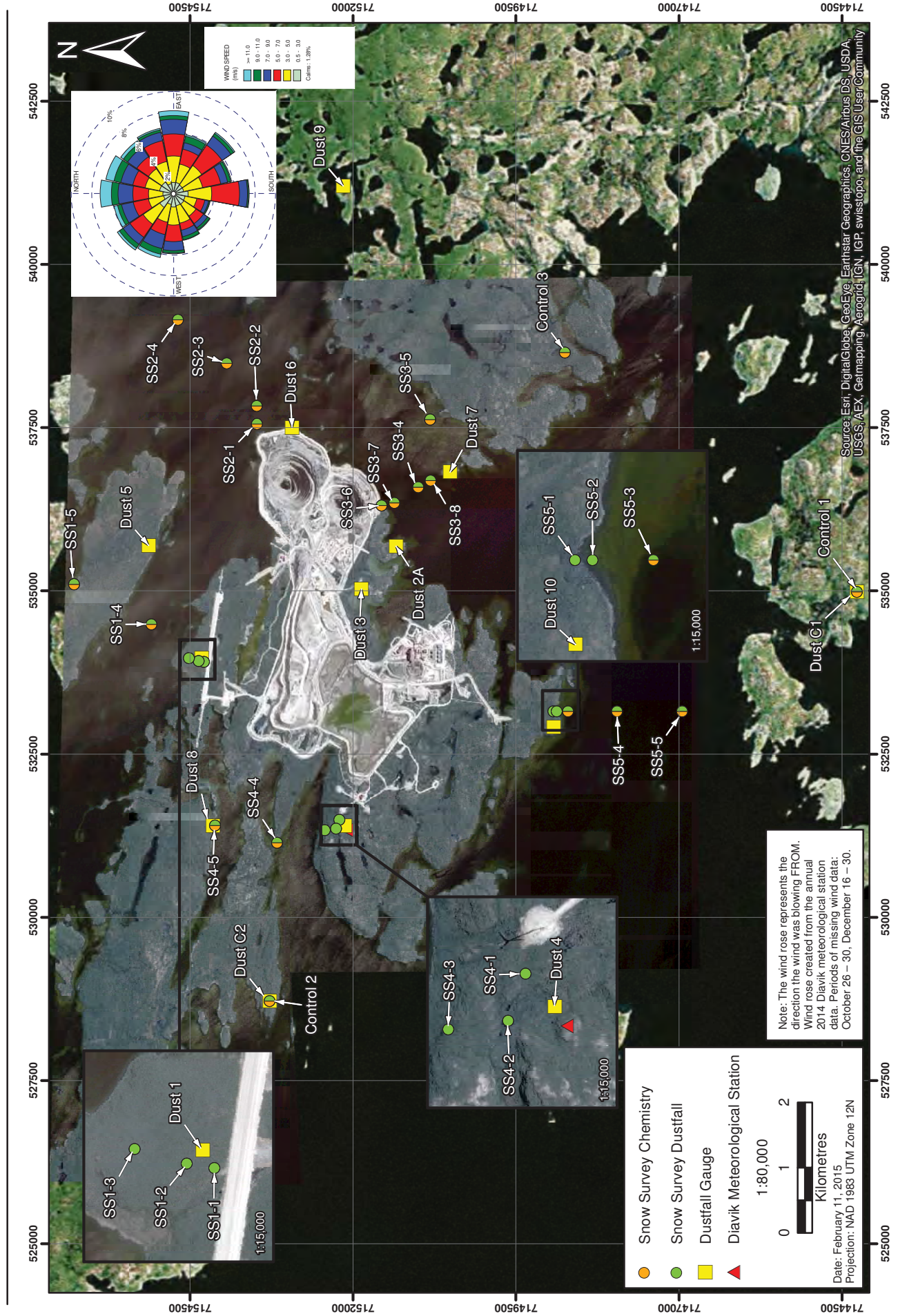
<sup>5</sup> Duplicate sample taken for snow water chemistry.

<sup>6</sup> Blank sample taken for snow water chemistry.

<sup>7</sup> Snow water chemistry was sampled over ice, adjacent to the on-land control station, see Section 2.3 for further details.



**Figure 2-1**  
**Dustfall Gauge and Snow Survey Locations, Diavik Diamond Mine, 2014**



Once the mass of collected dustfall at a station was measured, the mean daily dustfall rate over the collection period was calculated as:

$$D = \frac{M}{A*T} \quad [\text{Equation 2.1-1}]$$

where

$D$  = mean daily dustfall rate (mg/dm<sup>2</sup>/d) during time period  $T$

$M$  = mass of dustfall collected (mg) during time period  $T$

$A$  = surface area of dustfall gauge collection cylinder orifice (dm<sup>2</sup>; approximately 1.227 dm<sup>2</sup>)

$T$  = number of days of dustfall collection (d)

The mean daily dustfall rate (mg/dm<sup>2</sup>/d) was then multiplied by 365 days to estimate the mean annual dustfall rate (mg/dm<sup>2</sup>/y).

Estimated dustfall rates were compared to British Columbia Ministry of Environment (BC MOE) dustfall objectives for the mining, smelting and related industries (Table 2.1-1; BC MOE 2013). The dustfall objectives ranges from 1.7 to 2.9 milligram per decimetre<sup>2</sup> per day (mg/dm<sup>2</sup>/day), averaged over 30 days. The 1.7 mg/dm<sup>2</sup>/day objective is often considered to be applicable at sensitive locations whereas the 2.9 mg/dm<sup>2</sup>/day objective is applicable to areas where it can be shown that unacceptably deleterious changes will not follow. Both values are presented throughout this report. Snow water chemistry data were compared to effluent quality criteria (EQC) set out in Wek'èzhii Land and Water Board (WLWB) Water Licence W2007L2-0003.

**Table 2.1-1. Dustfall and Snow Water Chemistry Reference Values**

Parameter	Value	Unit	Comment	Source
Dustfall Rate	1.7-2.9 (621-1,059)	mg/dm <sup>2</sup> /day (mg/dm <sup>2</sup> /y)	Objective for the mining, smelting, and related industries	BC MOE (2013)
Aluminum-Total	3,000	µg/L	Max. grab sample concentration	W2007L2-0003
Ammonia-N	12,000	µg/L	Max. grab sample concentration	W2007L2-0003
Arsenic-Total	100	µg/L	Max. grab sample concentration	W2007L2-0003
Cadmium-Total	3	µg/L	Max. grab sample concentration	W2007L2-0003
Chromium-Total	40	µg/L	Max. grab sample concentration	W2007L2-0003
Copper-Total	40	µg/L	Max. grab sample concentration	W2007L2-0003
Lead-Total	20	µg/L	Max. grab sample concentration	W2007L2-0003
Nickel-Total	100	µg/L	Max. grab sample concentration	W2007L2-0003
Nitrite-N	2,000	µg/L	Max. grab sample concentration	W2007L2-0003
Zinc-Total	20	µg/L	Max. grab sample concentration	W2007L2-0003

## 2.2 DUSTFALL SNOW SURVEYS

Dustfall snow surveys were performed at 27 stations (including three control stations), along five transects around the mine site (Table 2-1). Across stations, the distance from mining operations ranged from approximately 30 to 5,655 m and the average total sampling period in 2014 was 201 days.

The start dates correspond to the first snowfall for land stations (September 19, 2013), and shortly after ice freeze up, once ice conditions were safe for work, for ice stations (November 3, 2013).

At each snow survey station, a snow corer was used to drill into the snow pack to retrieve a cylindrical snow core (6.1 cm inner diameter; Plate 2.2-1). Cores were extracted at each station and composited in the field to ensure a representative snow sample was obtained for the station. A minimum of three snow cores were collected at each (land and ice) of the snow sampling stations, as outlined in the SOP ENVR-512-0213. Composited samples were bagged and brought to the DDMI environment lab for processing as specified in SOP ENVR-512-0213 and ENVI-403-0112 (see Appendix F). Processing of snow cores involved filtration, drying and weighing. For quality assurance and control, duplicate samples were collected at stations SS1-3 and SS5-1.

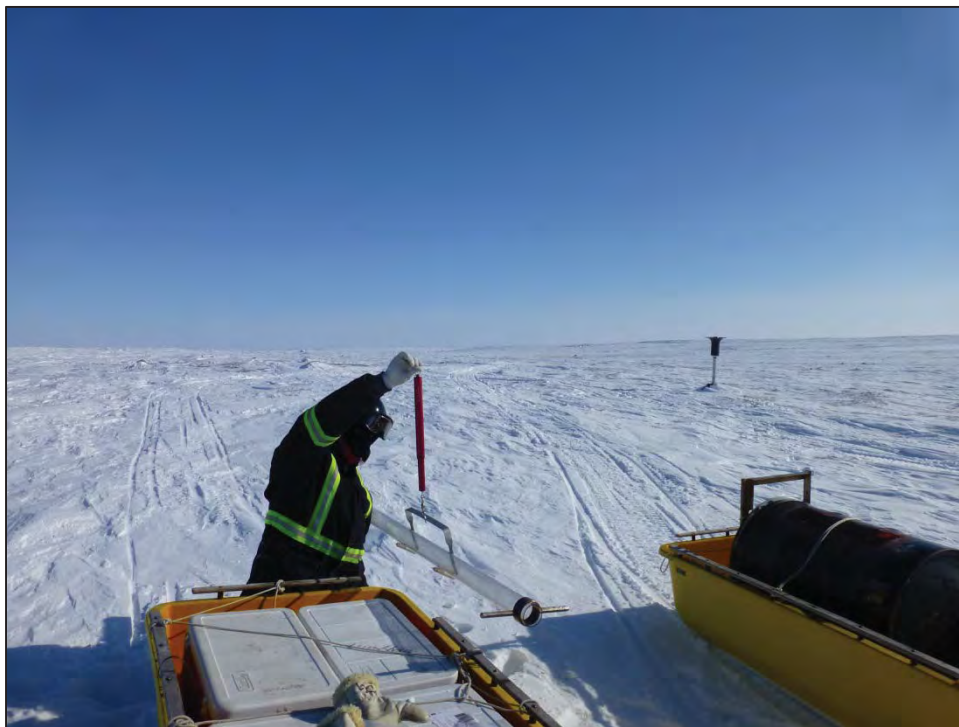


Plate 2.2-1. Snow core sample being weighed, with dustfall gauge in background.

Mean daily dustfall rate ( $\text{mg}/\text{dm}^2/\text{d}$ ) was then calculated over the collection period using Equation 2.1-1, but with surface area ( $A$ ) equal to the surface area of the snow corer tube orifice ( $0.2922 \text{ dm}^2$ ) multiplied by the number of snow cores used for the composited sample at the station. The mean annual dustfall rate ( $\text{mg}/\text{dm}^2/\text{y}$ ) was estimated by multiplying the mean daily dustfall rate by 365 days.

Dustfall rates were compared to the BC dustfall objective for the mining, smelting and related industries (Table 2.1-1), for comparison purposes only.



## 2.3 SNOW WATER CHEMISTRY

Snow water chemistry analysis was performed on snow cores extracted from 19 locations, including three control locations (Table 2-1). These locations included the 16 dustfall snow survey stations that were located on ice, as well as samples taken on ice adjacent to the three control stations. Across stations, the distance from mining operations ranged from approximately 60 to 5,655 m and the average total sampling period in 2014 was 196 days. At each station, cores were collected for chemistry analysis immediately after the dustfall snow cores were extracted.

Snow water chemistry cores were extracted using a snow corer in accordance with the dustfall snow survey core extraction. A minimum of three cores at each site were extracted and composited to obtain the necessary 3 L of snow water required for the laboratory chemical analysis as required (see Appendix F). Snow cores were then processed and prepared for shipment to Maxxam where the chemical analysis was performed. For quality assurance and control purposes, duplicate samples were collected at stations SS3-7, SS4-4 and SS5-5, and a blank sample was collected at station SS4-5. Snow water chemistry sampling methodology is detailed in SOP ENVR-512-0213 (see Appendix F).

EQC, including “maximum average concentration” and “maximum concentration of any grab sample,” are stipulated in DDMI’s Water Licence (W2007L2-0003) for aluminium, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc (Table 2.1-1). Snow water chemistry results for these variables were compared to the “maximum concentration of any grab sample.” These results are also presented as part of DDMI’s Aquatic Effects Monitoring Program (AEMP) report.

### 3. RESULTS

Dustfall and snow water chemistry results were grouped into zones based on their relative distance from the mine footprint (see Table 3.1-1). Although station groupings into zones were first established at the outset of the program, these groupings were re-established in 2013 using satellite imagery of the site. The following stations have been grouped into different zones compared to previous dust deposition reports:

- ≠ SS1-2 changed from zone 0-100 m to zone 101-250 m;
- ≠ SS1-3 changed from zone 101-250 m to zone 251-1,000 m;
- ≠ SS2-1 changed from zone 0-100 m to zone 101-250 m;
- ≠ SS2-2 changed from zone 101-250 m to zone 251-1,000 m;
- ≠ SS2-3 changed from zone 251-1,000 m to zone 1,001-2,500 m;
- ≠ SS4-2 changed from zone 0-100 m to zone 101-250 m;
- ≠ SS4-3 changed from zone 101-250 m to zone 251-1,000 m; and
- ≠ SS4-4 changed from zone 251-1,000 m to zone 1,001-2,500 m.

In 2014, the primary sources of fugitive dust were associated with unpaved road and airstrip usage. To suppress dust generation, roads were watered during the summer as needed, and EK35 was applied to the airport apron (tarmac) and helipad during the spring. Mine production rate was steady throughout the year, and all mining occurred underground. Fugitive dust generation is expected to be greatest during snow-free periods where and when there is site activity. Therefore, it was expected that the highest fugitive dust generation and resulting dustfall occurred in areas closest to the mine footprint between May and September.

The annual predominant wind directions at the site are from the east, south and southeast, there are also strong winds from the north. The expectation is that airborne material will be deposited primarily west, north, northwest and south of the mine as seen in Figure 3.1-1.

Results of the dustfall gauges, dustfall snow surveys and the snow water chemistry analysis are presented below. Dustfall and snow water chemistry results were grouped into zones based on their relative distance from the mine footprint (see Table 3.1-1).

#### 3.1 DUSTFALL GAUGES

Total dustfall collected from each dustfall gauge throughout the year is summarized in Table 3.1-1; annual 2014 dustfall for each station at its location relative to the mine site is presented in Figure 3.1-1; the historical records of annual dustfall for each station are presented in Figures 3.1-2 and 3.1-3. A comparison of 2014 dustfall versus distance from the mine footprint is presented in Figure 3.1-4. Boxplots summarizing the dustfall measured in each year are presented in Figure 3.1-5. Detailed information on 2014 measurements and calculations for each station are included in Appendix A.

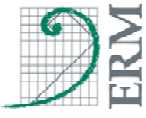


Figure 3.1-1  
Dustfall Results, Diavik Diamond Mine, 2014

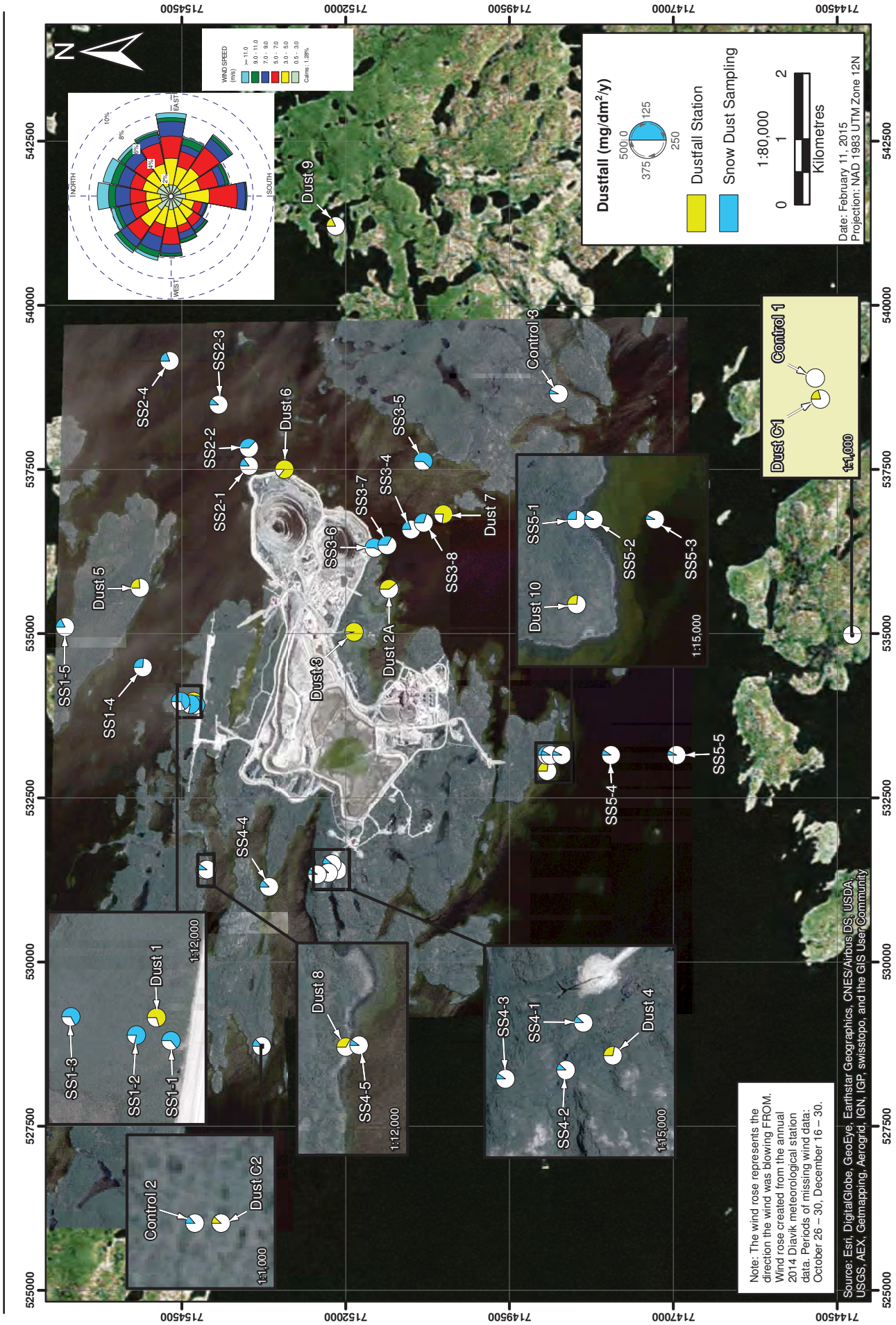


Table 3.1-1. Dustfall and Snow Water Chemistry Results, Diavik Diamond Mine, 2014<sup>a</sup>

Zone	Station	Approx. Distance from 2014 Project Footprint (m)	Dustfall (mg/dm <sup>2</sup> /y) (621-1,059)	Snow Water Chemistry (µg/L) <sup>b,c</sup>																		
				Aluminum (3,000)	Ammonia (12,000)	Arsenic (100)	Cadmium (3)	Chromium (40)	Copper (40)	Lead (20)	Nickel (100)	Nitrite (2,000)	Phosphorous (n/a)	Zinc (20)								
0-100 m	Dust 1	75	352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	Dust 3	30	479	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	Dust 6	25	429	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	SS1-1	30	322	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	SS3-6	60	287	406	49.0	0.21	0.01	6.31	1.61	0.78	0.78	4.80	42.7	7.41	-	-	-	-	-	-		
	SS4-1	100	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	Mean (SD)			321 (147)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	95% Confidence Interval on Mean (Lower - Upper Limit)			154 (167 - 475)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Median			337	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	101-250 m	Dust 4	200	140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		SS1-2	115	393	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		SS2-1	180	74	94.6	73.0	0.09	0.01	1.09	0.90	0.24	2.91	2.00	10.1	7.16	-	-	-	-	-	-	
		SS3-7	250	166	775	119	0.35	0.02	12.6	3.87	1.33	37.0	5.25	89.7	10.5	-	-	-	-	-	-	
		SS4-2	245	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mean (SD)				166 (134)	435 (481)	96.0 (32.5)	0.22 (0.18)	0.01 (0.01)	6.85 (8.14)	2.38 (2.10)	0.78 (0.77)	19.9 (24.1)	3.63 (2.30)	49.9 (56.3)	8.83 (2.36)	-	-	-	-	-	-	
95% Confidence Interval on Mean (Lower - Upper Limit)				167 (167 - 333)	4323 (n/a - 4757)	292 (n/a - 388-n/a)	1.65 (n/a - 1.88-n/a)	0.06 (n/a - 0.07)	73.1 (n/a - 80.0)	18.8 (n/a - 21.2)	6.92 (n/a - 7.70)	216.3 (n/a - 236.2)	20.6 (n/a - 24.3)	505 (n/a - 555)	21.2 (n/a - 30.0)	-	-	-	-	-	-	
Median				140	435	96.0	0.22	0.01	6.85	2.38	0.78	19.9	3.63	49.9	8.83	-	-	-	-	-	-	
251-1,000 m		Dust 2A	435	197	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Dust 10	670	133	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		SS1-3	275	337	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		SS1-4	920	131	128	64.0	0.09	0.01	1.46	0.72	0.27	2.45	2.30	14.5	3.44	-	-	-	-	-	-	
		SS2-2	445	186	196	75.0	0.21	0.01	2.00	0.62	0.42	5.50	2.80	27.4	8.71	-	-	-	-	-	-	
		SS3-4	615	97	250	140	0.19	0.01	3.42	0.90	0.54	10.1	2.70	23.1	4.54	-	-	-	-	-	-	
	SS3-8	830	150	1260	170	0.42	0.02	31.7	4.12	1.88	96.6	7.30	163	12.3	-	-	-	-	-	-		
	SS4-3	350	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	SS5-1	665	128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	SS5-2	710	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	SS5-3	885	38	107.0	34.0	0.06	0.01	3.28	3.00	0.52	8.74	2.60	9.10	2.54	-	-	-	-	-	-		
	Mean (SD)			135 (86)	388 (491)	96.6 (56.4)	0.19 (0.14)	0.0 (0.0)	8.37 (13.1)	1.87 (1.60)	0.72 (0.65)	24.7 (40.3)	3.54 (2.11)	47.4 (65.0)	6.31 (4.10)	-	-	-	-	-	-	
	95% Confidence Interval on Mean (Lower - Upper Limit)			58 (77 - 193)	609 (0.0 - 997)	70.0 (26.6 - 167)	0.18 (0.0 - 0.37)	0.0 (0.0 - 0.0)	16.2 (0.0 - 24.6)	1.98 (0.0 - 3.85)	0.80 (10.0 - 1.54)	50.1 (0.0 - 74.7)	2.62 (0.9 - 6.16)	80.7 (0.0 - 128)	5.09 (1.2 - 11.4)	-	-	-	-	-	-	
	Median			131	196	75.0	0.19	0.0	3.28	0.90	0.52	8.74	2.70	23.1	4.54	-	-	-	-	-	-	

(continued)

**Table 3.1-1. Dustfall and Snow Water Chemistry Results, Diavik Diamond Mine, 2014<sup>a</sup> (completed)**

Zone	Station	Approx. Distance from 2014 Project Footprint (m)	Dustfall (mg/dm <sup>2</sup> /y) (621-1,059)	Snow Water Chemistry (µg/L) <sup>b,c</sup>																			
				Aluminum (3,000)	Ammonia (12,000)	Arsenic (100)	Cadmium (3)	Chromium (40)	Copper (40)	Lead (20)	Nickel (100)	Nitrite (2,000)	Phosphorous (n/a)	Zinc (20)									
1,001-2,500 m	Dust 5	1,195	116	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	Dust 7	1,155	385	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	Dust 8	1,220	166	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	Dust 9	3,810	89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	SS1-5	2,180	86	157	35.0	0.17	0.01	0.86	0.57	0.54	0.27	0.39	1.47	8.35	1.60	1.06	0.43	0.23	5.11	15.2	14.4	4.48	
	SS2-3	1,220	58	81.5	95.0	0.07	0.01	1.02	0.64	0.27	0.39	1.47	8.35	1.60	1.06	0.43	0.23	5.11	15.2	14.4	4.48		
	SS2-4	2,180	96	213	53.0	0.32	0.01	1.47	0.58	0.39	0.39	1.47	8.35	1.60	1.06	0.43	0.23	5.11	15.2	14.4	4.48		
	SS3-5	1,325	312	426	86.0	0.19	0.01	8.35	1.60	0.43	0.23	5.11	15.2	14.4	4.48	2.05	20.5	20.5	20.5	20.5	20.5		
	SS4-4	1,065	64	424	47.0	0.17	0.01	7.62	1.06	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	
	SS4-5	1,220	50	129	57.0	0.06	0.01	2.09	0.43	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	
	SS5-4	1,635	47	200	60.0	0.10	0.01	5.11	0.64	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	
	SS5-5	2,635	38	123	44.0	0.06	0.01	2.87	0.45	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	
		Mean (SD)		126 (111)	219 (134)	59.6 (20.7)	0.14 (0.09)	0.01 (0.00)	3.67 (2.99)	0.74 (0.40)	0.45 (0.23)	0.45 (0.23)	10.6 (6.89)	2.86 (0.95)	22.8 (14.4)	4.60 (1.60)							
		95% Confidence Interval on Mean (Lower - Upper Limit)		71 (55-196)	112 (107-331)	17.3 (42.3-77.0)	0.07 (0.07-0.22)	0.00 (0.00-0.01)	2.50 (1.18-6.17)	0.33 (0.41-1.07)	0.19 (0.26-0.64)	0.19 (0.26-0.64)	7.43 (3.14-18.0)	0.80 (2.07-3.66)	12.1 (10.7-34.8)	1.34 (3.26-5.94)							
		Median		88	179	55.0	0.13	0.01	2.48	0.61	0.37	0.37	7.52	2.65	17.9	4.38							
Control	Dust C1	5,655	105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	Dust C2	3,075	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	CONTROL 1	5,655	4	115	40.0	0.09	0.01	1.97	0.62	0.23	0.23	7.29	3.40	15.9	2.43								
	CONTROL 2	3,075	69	209	54.0	0.09	0.01	2.06	0.52	0.33	0.33	7.26	3.70	31.8	3.13								
	CONTROL 3	3,570	38	453	110	0.24	0.01	6.75	2.50	0.94	0.94	20.10	6.40	82.9	6.58								
		Mean (SD)		55 (37)	259 (174)	68.0 (37.0)	0.14 (0.08)	0.01 (0.00)	3.59 (2.73)	1.22 (1.11)	0.50 (0.38)	0.50 (0.38)	11.6 (7.40)	4.50 (1.65)	43.5 (35.0)	4.05 (2.22)							
		95% Confidence Interval on Mean (Lower - Upper Limit)		47 (9-102)	433 (0.0-692)	92.0 (0.0-160)	0.21 (0.0-0.35)	0.00 (0.0-0.01)	6.79 (0.0-10.4)	2.77 (0.0-3.98)	0.95 (0.0-1.44)	0.95 (0.0-1.44)	18.4 (0.0-29.9)	4.10 (0.4-8.60)	87.0 (0.0-130)	5.52 (0.0-9.57)							
	Median		61	209	54.0	0.09	0.01	2.06	0.62	0.33	0.33	7.29	3.70	31.8	3.13								
<b>Reference Levels<sup>d</sup></b>				621-1059	3000	12000	100	3.0	40	40.0	20.0	100	2000.0	n/a	20.0								

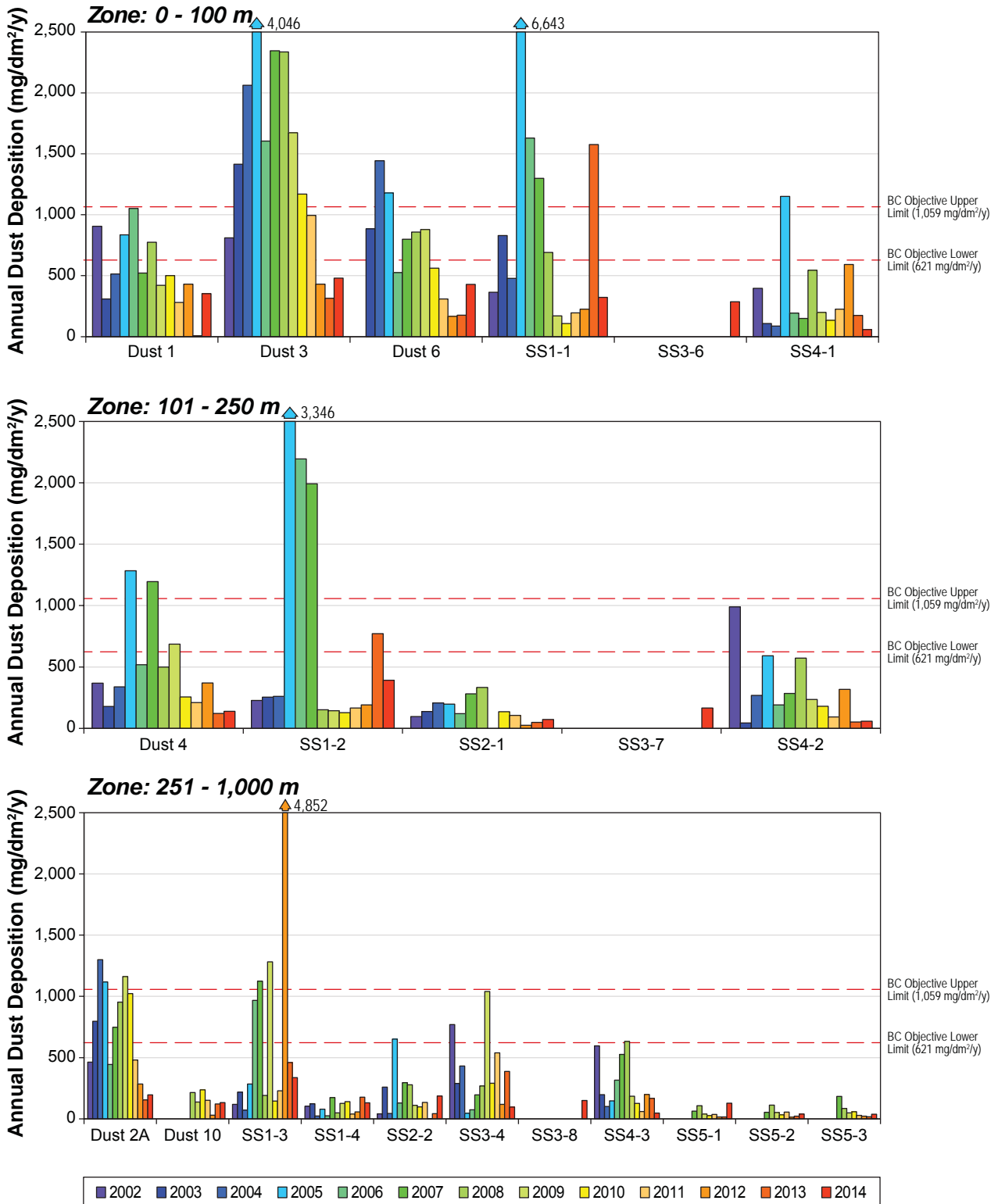
<sup>a</sup> BC MOE (2013) for dustfall and Water Licence W20071.2-0003 for snow water chemistry. See Table 2.1-1 for reference level descriptions.

<sup>b,c</sup> = not available (snow water chemistry not sampled), n/a = not applicable.

<sup>d</sup> For measurements that were less than the detection limit, the detection limit was used for calculations.

Figure 3.1-2

Calculated Annual Dust Deposition Rates at Dustfall Gauges and Snow Survey Locations up to 1,000 m from the Project Footprint, Diavik Diamond Mine, 2002 to 2014

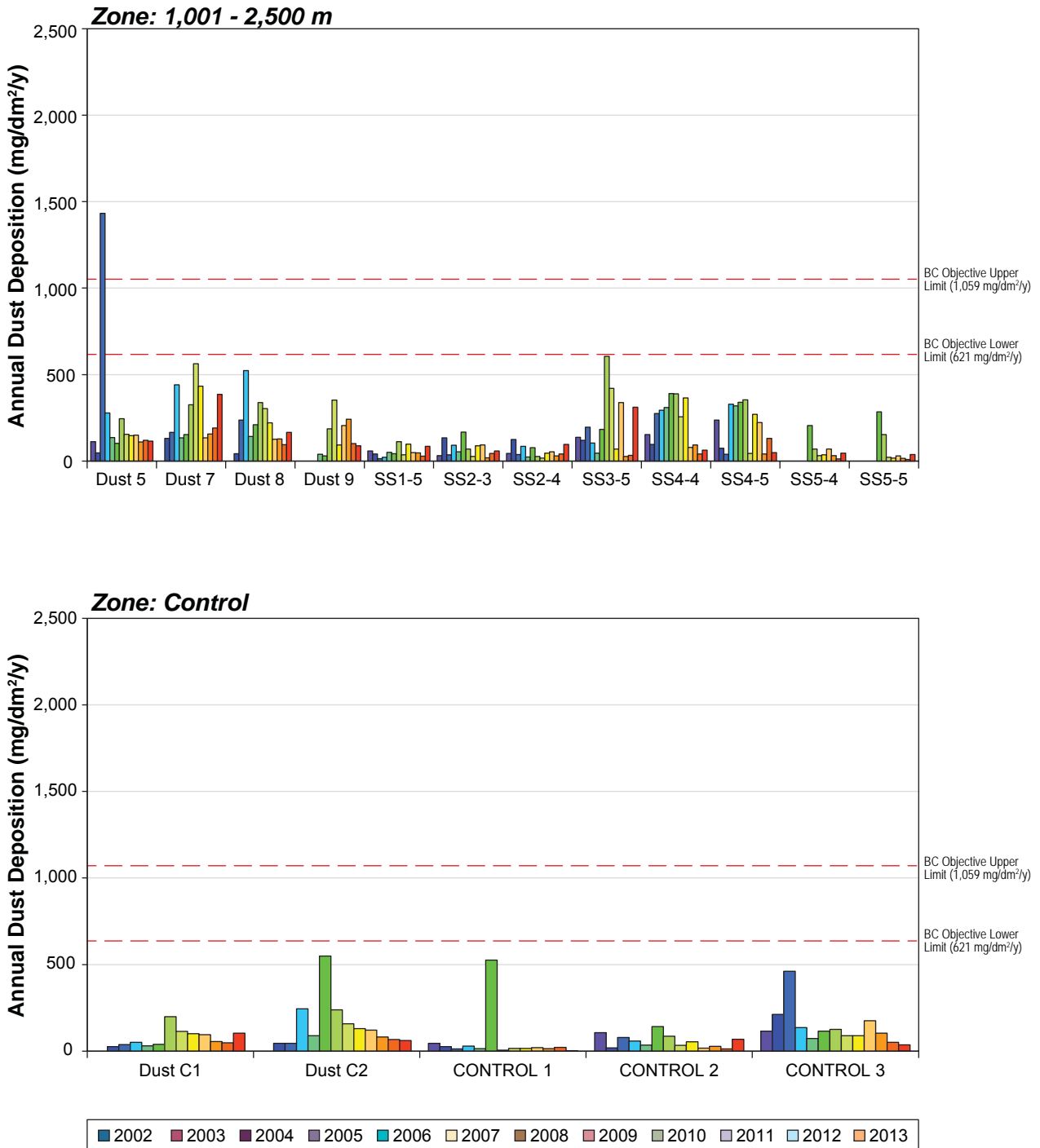


Notes: BC Objective Source: BC MOE (2014).

Annual deposition was calculated using the methodology described in Section 2. See Table 2-1 for actual 2014 sample exposure times. Station locations have been grouped into zones based on their distance from the 2014 Project footprint. Some stations have historically been grouped in different zones based on their distance from the Project footprint when they were first established (see Section 3 for further details).

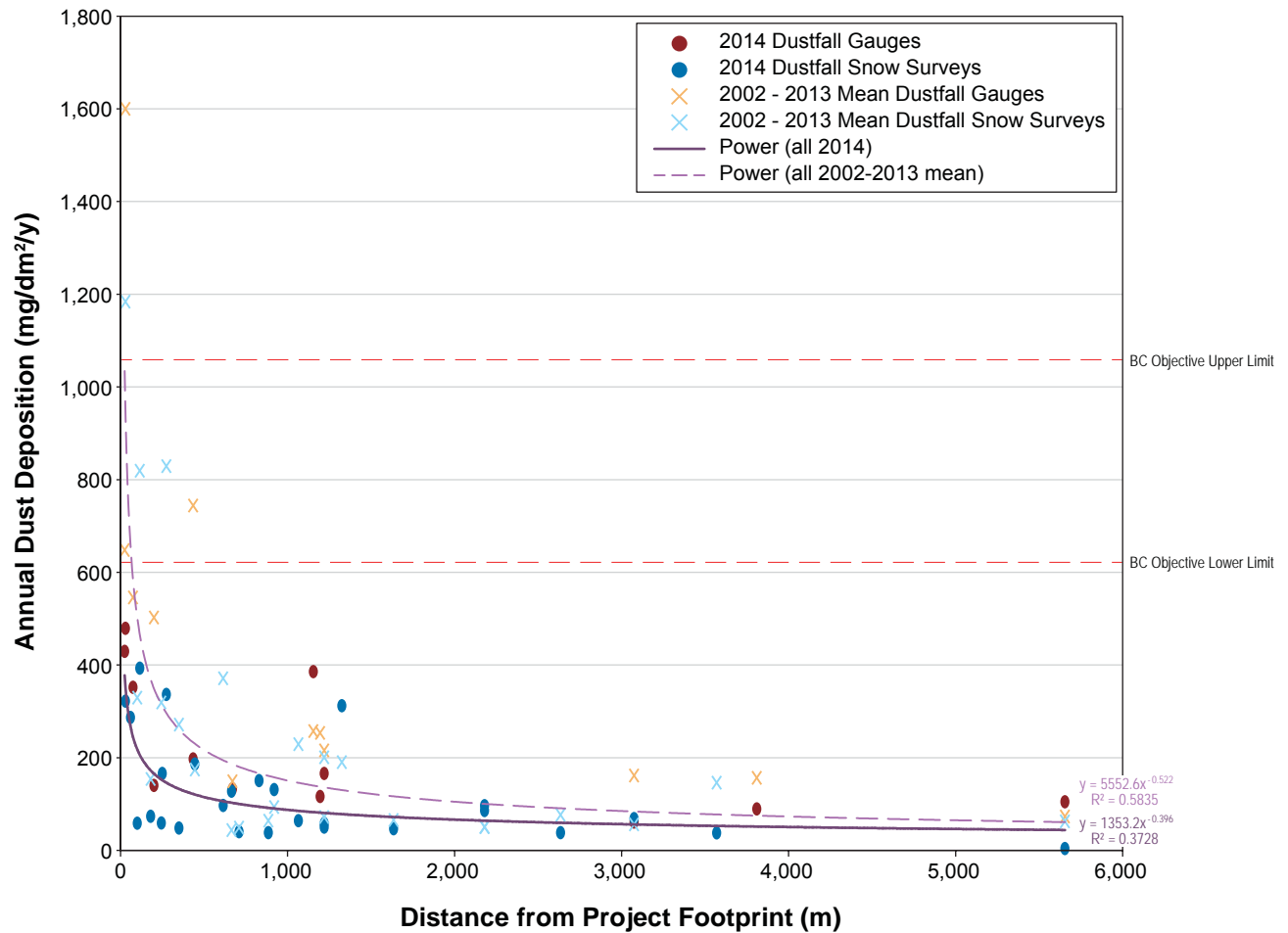
Figure 3.1-3

Calculated Annual Dust Deposition Rates at Dustfall Gauges and Snow Survey Locations greater than 1,000 m from the Project Footprint, Diavik Diamond Mine, 2002 to 2014



Notes: BC Objective Source: BC MOE (2014).  
 Annual deposition was calculated using the methodology described in Section 2. See Table 2-1 for actual 2014 sample exposure times.  
 Station locations have been grouped into zones based on their distance from the 2014 Project footprint. Some stations have historically been grouped in different zones based on their distance from the Project footprint when they were first established (see Section 3 for further details).

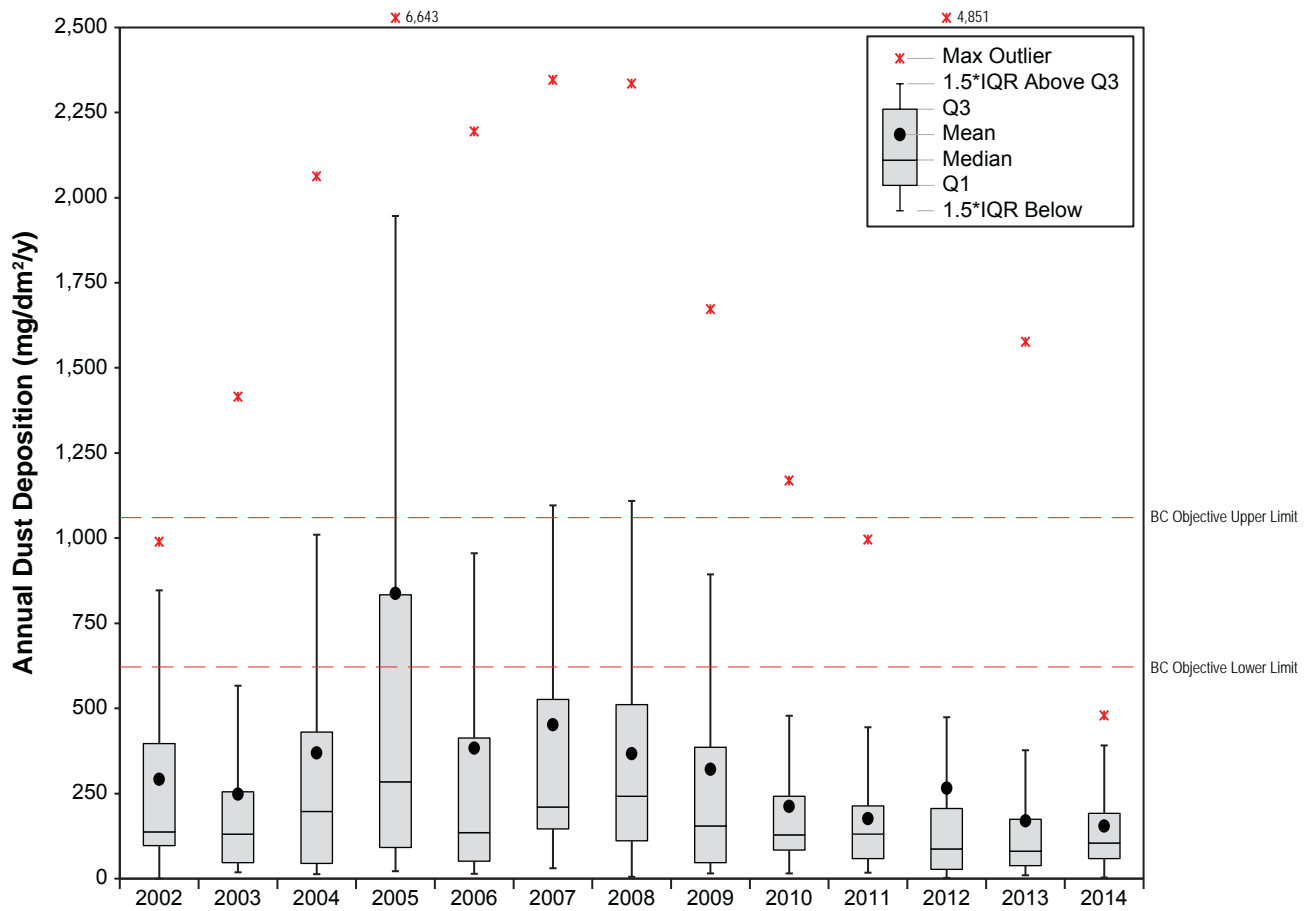
**Figure 3.1-4**  
**Dust Deposition Versus Distance**  
**from Project Footprint, 2014**



Notes: BC Objective Source: BC MOE (2014)  
 Annual deposition is calculated using the methodology described in Section 2. See Table 2-1 for actual 2014 sample exposure times.



**Figure 3.1-5**  
**Dust Deposition Box Plot,**  
**2002 to 2014**



Notes: BC Objective Source: BC MOE (2014)  
 Annual deposition is calculated using the methodology described in Section 2. See Table 2-1 for actual 2014 sample exposure times.

In general, dustfall decreased with increasing distance from the mine site (Table 3.1-1; Figure 3.1-4). The greatest estimated dustfall rates measured using gauges occurred at the two stations closest to (within 30 m of) the mine footprint: Dust 3 (479 mg/dm<sup>2</sup>/y) and Dust 6 (429 mg/dm<sup>2</sup>/y). Dust 3 is downwind of the footprint and Dust 6 is the closest station to (25 m from) the footprint (Figure 3.1-1). The lowest dustfall rates were measured at the two control stations and at Dust 9: Dust C1 (105 mg/dm<sup>2</sup>/y), Dust C2 (61 mg/dm<sup>2</sup>/y) and Dust 9 (89 mg/dm<sup>2</sup>/y; Table 3.1-1; Figures 3.1-3 and 3.1-4).

With the exception of Dust 7, dustfall rates estimated from dustfall gauges in 2014 were less than historical dustfall rate estimates (Figures 3.1-2 and 3.1-3). At Dust 7, 2014 dustfall rates were within the range of historical values (Figure 3.1-3). Comparisons of mean and maximum dustfall values also suggest that dustfall rates were generally lower in 2014 than in previous years (Figure 3.1-4 and 3.1-5).

The annualized dustfall rates estimated from gauges at each station were less than the BC objective for the mining industry (621–1,059 mg/dm<sup>2</sup>/y; Figures 3.1-2 to 3.1-4). This objective was used for comparison purposes only: there are no standards or objectives for the Northwest Territories, but the BC objective is generally used as a standard for comparison at other mines in the region.

## 3.2 DUSTFALL SNOW SURVEYS

Annual dustfall rates estimated from each snow survey station in 2014 are summarized in Table 3.1-1 and shown by location relative to the mine footprint in Figure 3.1-1. Historical records of annual dustfall rates for each station are presented in Figures 3.1-2 and 3.1-3. The relationships between annual dustfall rates and distance from the mine footprint are shown in Figure 3.1-4. Boxplots summarizing dustfall rates measured in each year are presented in Figure 3.1-5. 2014 snow survey field datasheets and laboratory results are included in Appendix B. Duplicate samples were collected at stations SS1-3 and SS5-1 for QA/QC purposes and are discussed in Section 3.4.

Annualized dustfall rates estimated from 2014 snow survey data ranged from 3.8 to 392.9 mg/dm<sup>2</sup>/y (Table 3.1-1; Figures 3.1-2 and 3.1-3). In general, dustfall rates decreased with increasing distance from the mine site, with the lowest dustfall rate recorded at station Control 1 (Table 3.1-1; Figures 3.1-4). Mean dustfall rates estimated using both dustfall gauges and snow surveys within the 0–100, 101–250, 251–1,000, 1,001–2,500 and Control zones were 321, 166, 135, 126 and 55 mg/dm<sup>2</sup>/y, respectively (Table 3.1-1; Figure 3.1-4). Dustfall rates at stations Dust 3, Dust 2A, Dust 7, Dust C-1, SS1-2, SS1-3 and SS3-5 exceeded the upper limit of the 95% confidence interval for their respective zones in 2014, signifying a fair amount of variation between sample locations (Table 3.1-1).

Annualized dustfall estimated from each snow survey station in 2014 was less than historical dustfall estimates (Figures 3.1-2 and 3.1-3). Comparisons of mean and maximum values also suggest that dustfall rates were generally lower in 2014 than in previous years (Figures 3.1-4 and 3.1-5).

Annualized dustfall rates measured at each station during the 2014 snow survey were less than the BC objective for the mining industry (621–1,059 mg/dm<sup>2</sup>/y). This objective was used for comparison purposes only: there are no standards or objectives for the Northwest Territories, but the BC objective is generally used as a standard for comparison at other mines in the region.

### 3.3 SNOW WATER CHEMISTRY

A summary of the snow water chemistry results for each variable of interest (i.e., variables for which EQC exist and phosphorous) is provided below. The full suite of analytical results for snow water chemistry is included in Appendix C. For QA/QC purposes, duplicate samples were collected at stations SS3-7, SS4-4 and SS5-5, and an equipment blank sample was collected at station SS4-5. Results of QA/QC samples are discussed in Section 3.4.

The majority of concentrations were insignificant compared to the standards. Measured concentrations were less than 10% of the objective for all metals except aluminium, chromium, nickel and zinc. Measured concentrations were less than 1% of the objective at all sites for arsenic, cadmium and nitrite.

In general, average concentrations of snow water chemistry variables of interest decreased with increasing distance from the mine site (Figure 3.3-1 to Figure 3.3-4). However, the greatest concentrations of each of the variables of interest were recorded at Station SS3-8, located in the 251-1000 zone, and SS3-7, located in the 101-150 zone. The concentrations at these two locations were more than double the concentrations recorded at the other sites, including samples taken in the 0-100 zone. Both of these stations are located to the southeast of the site (Figure 2-1).

#### 3.3.1 Aluminum

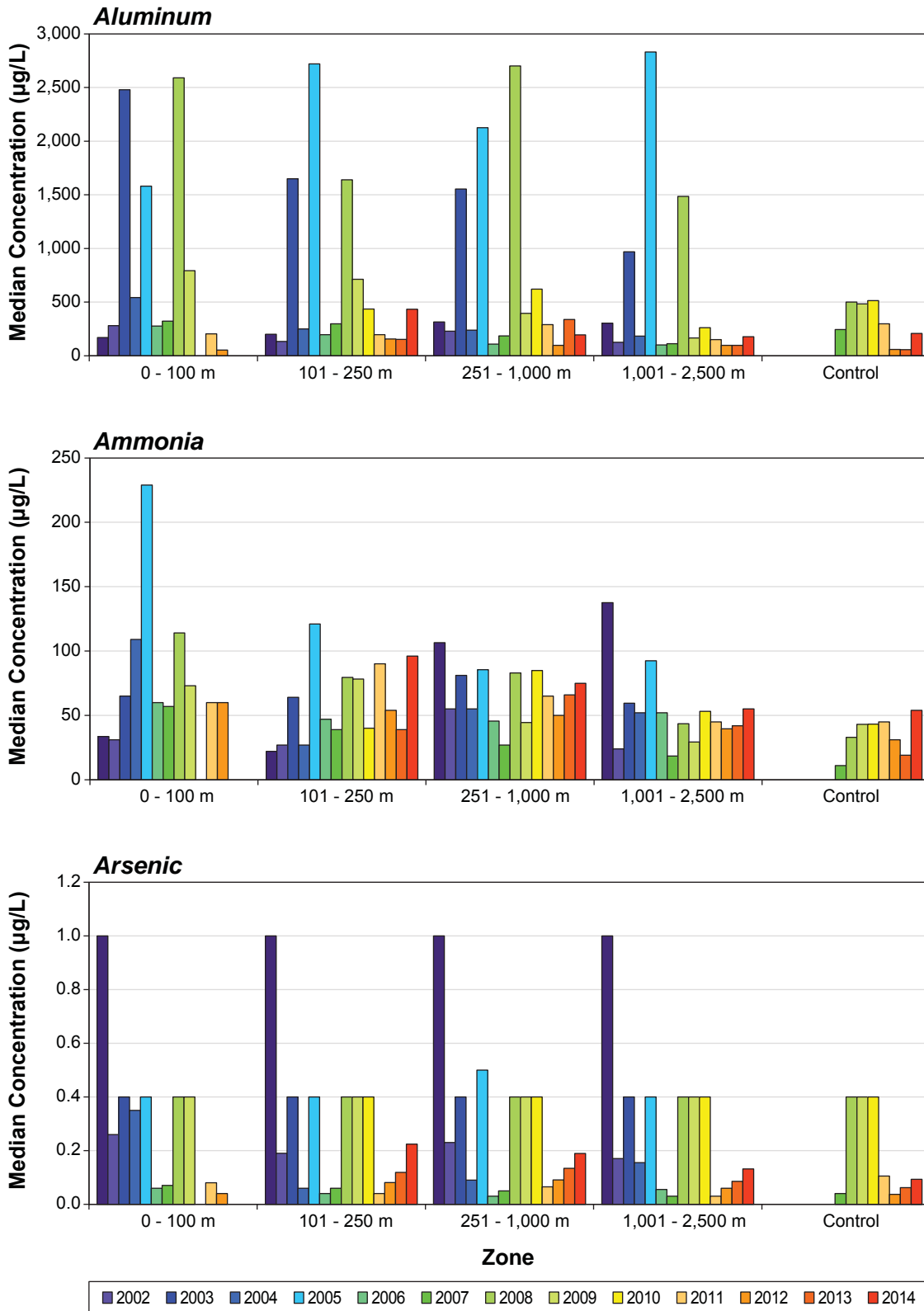
Aluminum concentrations measured in 2014 ranged from 81.5 µg/L at station SS2-3 in the 1,001-2,500 m zone to 1,260 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3.1-1). Median 2014 aluminum concentrations were greatest in the 101-250 m zone and decreased with distance from mine, though the median concentration in the control zone was slightly greater than the median concentration in the 1,001-2,500 m zone (Figure 3.1-1). Compared to previous years, the 2014 median concentration in each zone was relatively low (Figure 3.3-1). All concentrations were much less than the 3,000 µg/L EQC specified in the Water Licence for grab sample concentrations (Table 3.1-1; Figure 3.1-1).

#### 3.3.2 Ammonia

Ammonia concentrations measured in 2014 ranged from 34 µg/L at station SS5-3 in the control zone to 170 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3.1-1). Median 2014 ammonia concentrations were greatest in the 101-250 m zone and decreased with distance from mine (Figure 3.1-1). The 2014 median concentration in each zone were similar to previous years, however the median in the control zone was the highest ever recorded (Figure 3.3-1). All measurements were well less than the value of 12,000 µg/L specified in the Water Licence for grab sample concentrations.

Figure 3.3-1

Snow Water Chemistry Results:  
Aluminum, Ammonia and Arsenic, 2001 to 2014



Notes: Max grab sample concentrations: Aluminium 3,000 µg/L, Ammonia 12,000 µg/L, Arsenic 100 µg/L.

### 3.3.3 Arsenic

Arsenic concentrations measured in 2014 ranged from 0.06 µg/L at station SS5-3 in the control zone to 0.42 µg/L at station SS3-8 in the 251–1,000 m zone (Table 3.1-1). Median 2014 arsenic concentrations were greatest in the 101-250 m zone and decreased with distance from mine (Figure 3.1-1). Compared to previous years, the 2014 median concentration in each zone was relatively low, however there has been a steady increase in concentrations since 2011 (Figure 3.3-1). Prior to 2011 the results were influenced by changes in detection limits, rather than changes in measured values. All measurements were less than the value of 100 µg/L specified in the Water Licence for grab sample concentrations.

### 3.3.4 Cadmium

Cadmium concentrations measured in 2014 ranged from <0.005 µg/L (less than the detection limit) in all zones to 0.023 µg/L at station SS3-8 in the 251–1,000 m zone (Table 3.1-1). Out of the 19 samples, eight were less than the detection limit. Median 2014 cadmium concentrations were greatest in the 101-250 m zone and decreased with distance from mine, though the median concentration in the control zone was greater than the median concentration in the 251-1,000 and 1,001-2,500 m zone (Figure 3.1-1). Compared to previous years, the 2014 median concentration in each zone was relatively low (Figure 3.3-2). Prior to 2011, the results were influenced by changes in detection limits, rather than changes in measured concentrations. All measurements were less than the value of 3 µg/L specified in the Water Licence for grab sample concentrations.

### 3.3.5 Chromium

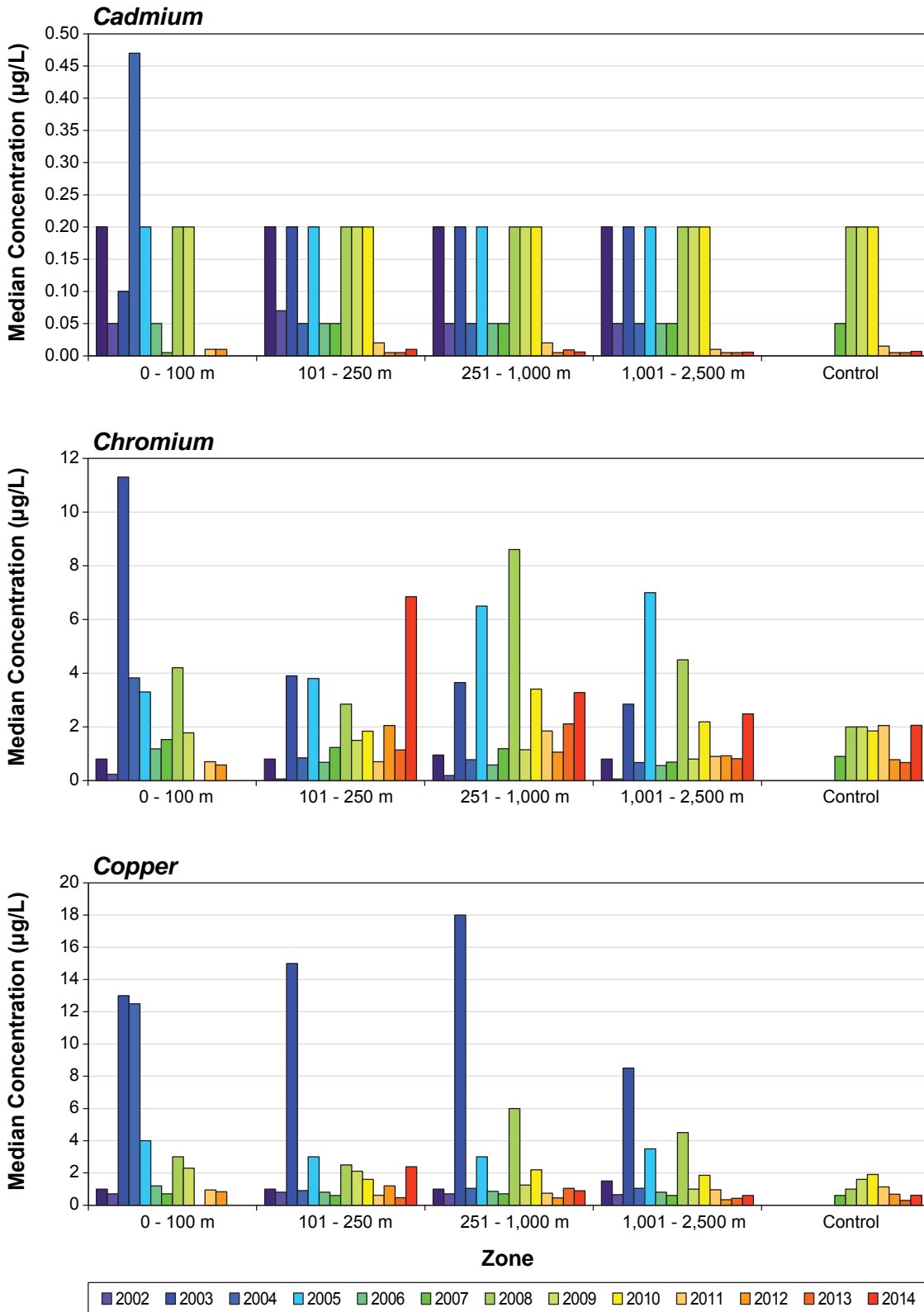
Chromium concentrations measured in 2014 ranged from a low of 0.86 µg/L at station SS1-5 in the 1,001–2,500 m zone, to 31.7 µg/L at station SS3-8 in the 251–1,000 m zone (Table 3.1-1). Median 2014 chromium concentrations were greatest in the 101-250 m zone and decreased with distance from mine (Figure 3.1-1). Compared to previous years, the 2014 median concentration were generally higher, particularly in the 101 – 250 m zone (Figure 3.3-2). All measurements were less than the value of 40 µg/L specified in the Water Licence for grab sample concentrations.

### 3.3.6 Copper

Copper concentrations measured in 2014 ranged from 0.43 µg/L at station SS4-5 in the 1,001–2,500 m zone to 4.12 µg/L at station SS3-8 in the 251–1,000 m zone (Table 3.1-1). Median 2014 copper concentrations were greatest in the 101-250 m zone and decreased with distance from mine, though the median concentration in the control zone was slightly greater than the median concentration in the 1,001-2,500 m zone (Figure 3.1-1). Compared to previous years, the 2014 median concentration in each zone was relatively low. The concentrations have generally been declining since 2009 (Figure 3.3-2). All measurements were less than the value of 40 µg/L specified in the Water Licence for grab sample concentrations.

Figure 3.3-2

Snow Water Chemistry Results:  
Cadmium, Chromium and Copper, 2001 to 2014



Notes: Max grab sample concentrations: Cadmium 3 µg/L, Chromium 40 µg/L, Copper 40 µg/L.

### 3.3.7 Lead

Lead concentrations measured in 2014 ranged from 0.23 µg/L at station SS4-5 in the control zone to 1.88 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3.1-1). Median 2014 lead concentrations were greatest in the 101-250 m zone and decreased with distance from mine (Figure 3.1-1). Compared to previous years, the 2014 median concentration in each zone was relatively low. Concentrations have generally been declining since 2008 (Figure 3.3-3). All measurements were less than the value of 20 µg/L specified in the Water Licence for grab sample concentrations.

### 3.3.8 Nickel

Nickel concentrations measured in 2014 ranged from 1.93 µg/L at station SS1-5 in the 1,001-2,500 m zone to 96.6 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3.1-1). Median 2014 nickel concentrations were greatest in the 101-250 m zone and decreased with distance from mine (Figure 3.1-1). The 2014 median concentrations were generally the highest observed in all zones and were as much as four times greater than the next greatest median concentration in the 101-250 m zone (Figure 3.3-3). All measurements were less than the value of 100 µg/L specified in the Water Licence for grab sample concentrations.

### 3.3.9 Nitrite

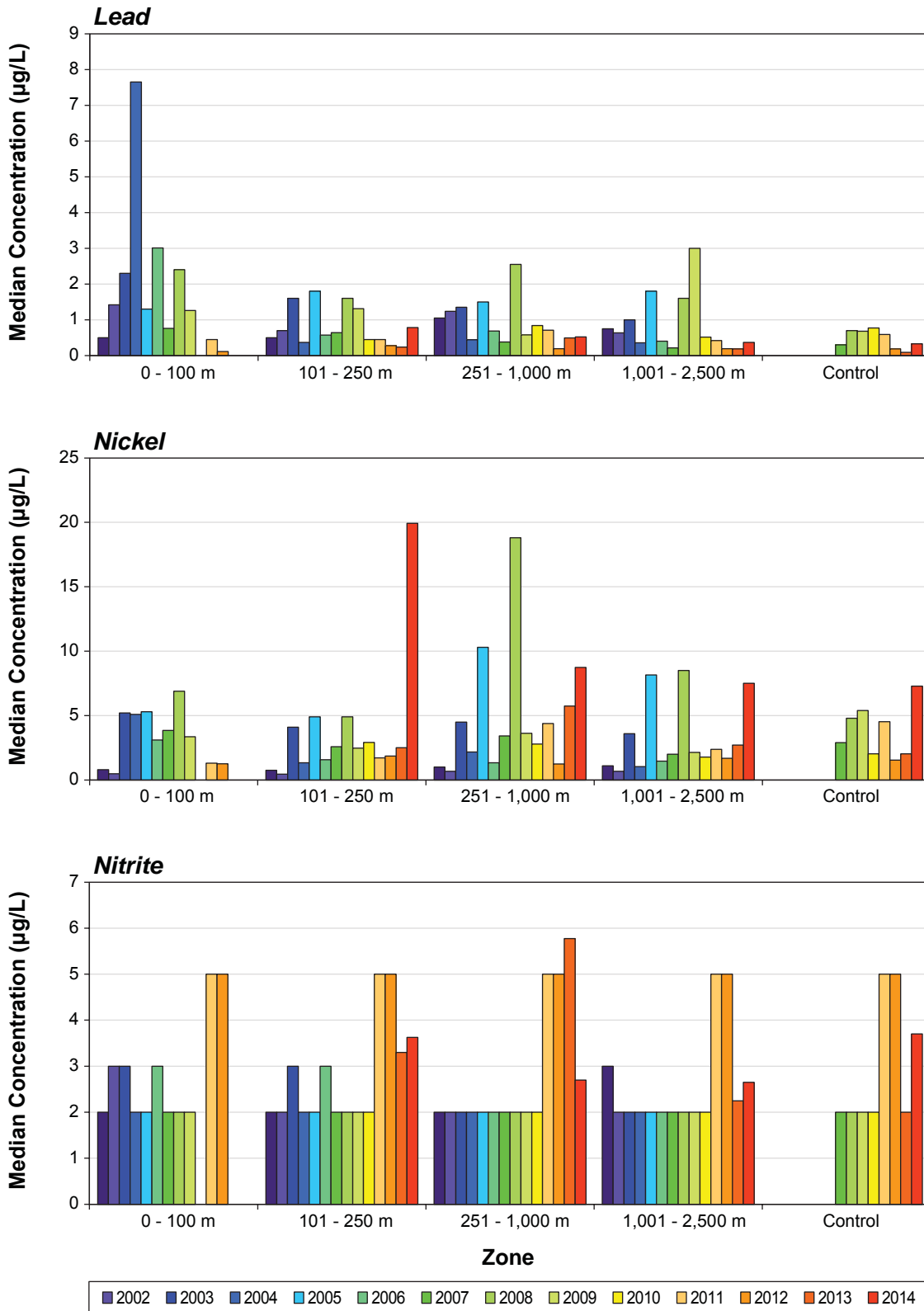
Nitrite concentrations measured in 2014 ranged from <2.0 µg/L (less than the detection limit) at stations SS2-3 and SS4-5 in the 1,001-2,500 m zone, to 10.3 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3.1-1). Median 2014 nitrite concentrations generally decreased with distance from mine, however the median concentration was greatest in the control zone (Figure 3.1-1). Although detection limits have varied somewhat through time, nitrite concentrations have rarely been greater than detection limits. However, a larger proportion of samples were greater than the detection limit in 2014 than in previous years. Whether this indicates that concentrations may be increasing is unclear at this time (Figure 3.3-3). All measurements were less than the value of 2,000 µg/L specified in the Water Licence for grab sample concentrations.

### 3.3.10 Phosphorous

Phosphorous concentrations measured in 2014 ranged from 8.9 µg/L at station SS2-3 in the 1,001-2,500 m zone to 163 µg/L at station SS3-8 in the 251-1,000 m zone (Table 3.1-1). Median 2014 phosphorous concentrations were greatest in the 101-250 m zone and decreased with distance from mine, though the median concentration in the control zone was greater than the median concentration in the 251-1,000 and 1,001-2,500 m zones (Figure 3.1-1). Compared to previous years, the 2014 median concentration in each zone was relatively low (Figure 3.3-4). Although the Water Licence has a load limit for phosphorous, there is no EQC specified in the licence.

Figure 3.3-3

Snow Water Chemistry Results:  
Lead, Nickel and Nitrite, 2001 to 2014

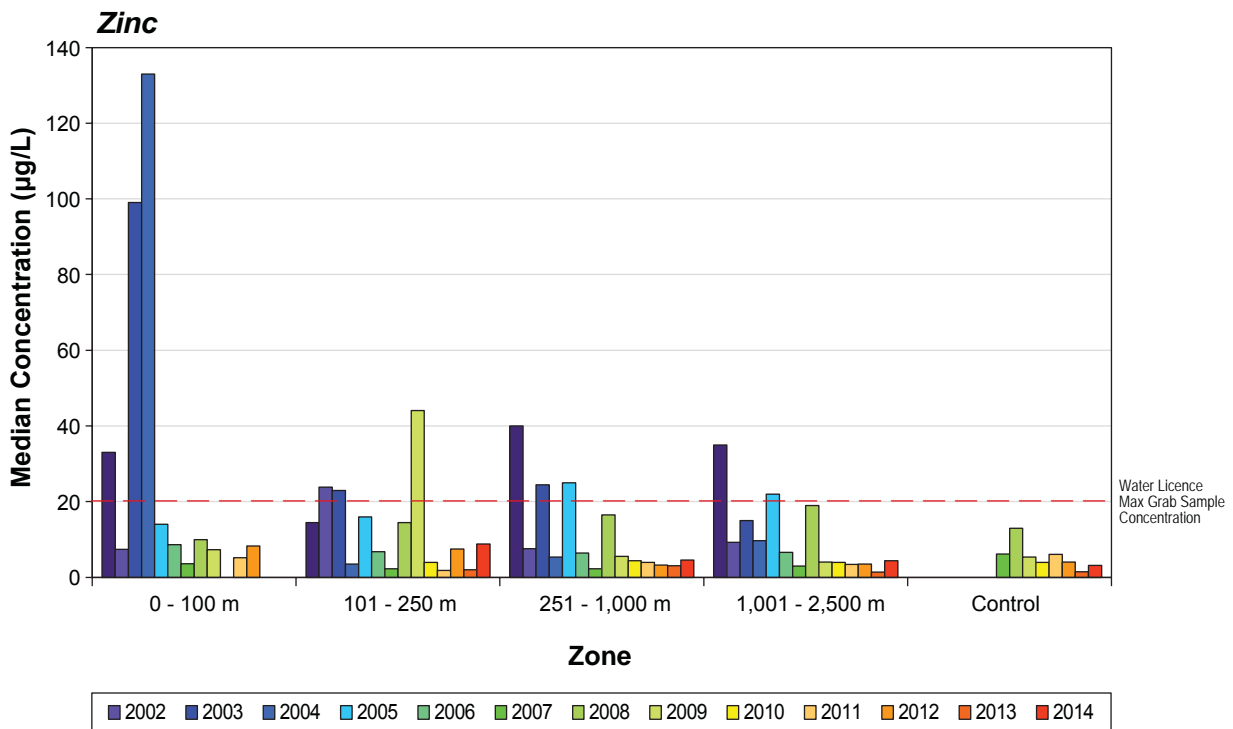
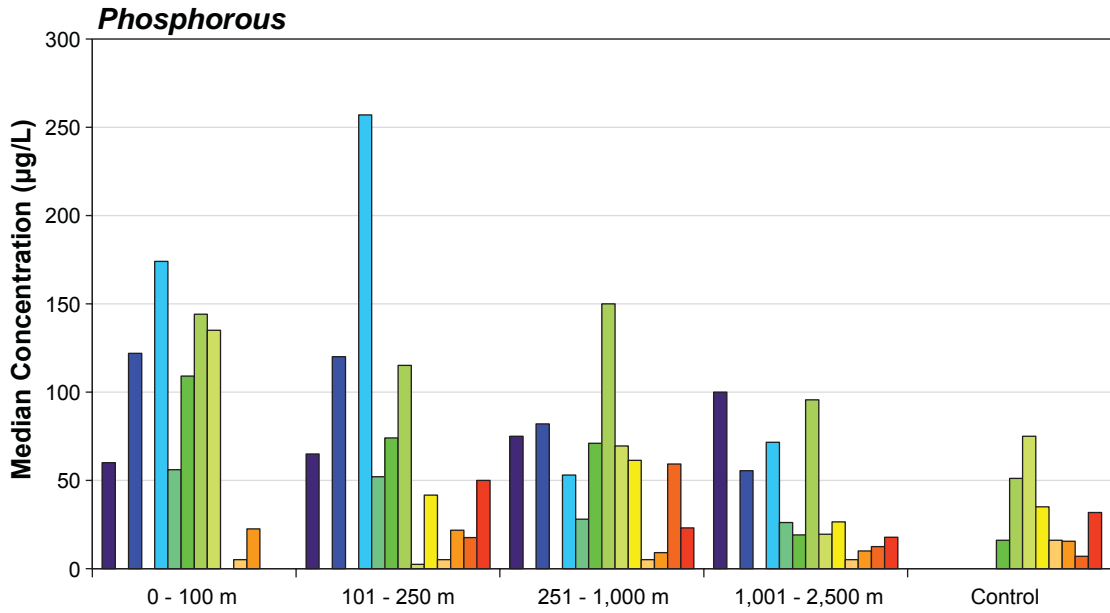


Notes: Max grab sample concentrations: Lead 20 µg/L, Nickel 100 µg/L, Nitrate 2,000 µg/L.



Figure 3.3-4

Snow Water Chemistry Results:  
Phosphorous and Zinc, 2001 to 2014



Notes: Max grab sample concentrations: Zinc 20 µg/L, Phosphorous n/a.

### 3.3.11 Zinc

Zinc concentrations measured in 2014 ranged from 2.43 µg/L at Control 1 to 12.3 µg/L at station SS3-8 in the 251–1,000 m zone (Table 3.1-1). Median 2014 zinc concentrations were greatest in the 101-250 m zone and decreased with distance from mine (Figure 3.1-1). Median zinc concentrations have generally been declining since 2008, though median zinc concentrations in 2014 were somewhat greater than concentrations from 2009 – 2013 (Figure 3.3-4). All measurements were less than the value of 20 µg/L specified in the Water Licence for grab sample concentrations.

## 3.4 QUALITY ASSURANCE AND CONTROL

Dustfall gauge, dustfall snow survey and snow water chemistry sampling and analysis were conducted by experienced technicians following SOPs ENVR-508-0112, ENVR-512-0213 and ENVI-403-0112 to ensure proper field sampling and laboratory analysis. As part of SOP ENVR-512-0213, duplicate and blank samples were taken for some snow survey and snow water chemistry sample sites (Table 2-1). The results from these samples are summarized in Table 3.4-1 below.

**Table 3.4-1. Sample Duplicates and Blanks<sup>a</sup>**

Parameter	Relative Percent Difference <sup>b</sup> (%)					SS4-5 Blank Sample (µg/L)	Percent Below Non-blank SS4-5 Sample (%)
	SS1-3	SS5-1	SS3-7	SS4-4	SS5-5		
Dustfall	22	4.2	n/a	n/a	n/a	n/a	n/a
Aluminum	n/a	n/a	15	4.7	1.6	0.5	100
Ammonia	n/a	n/a	103	51	4.5	26.0	54
Arsenic	n/a	n/a	5.9	16	7.1	<0.02	68
Cadmium	n/a	n/a	0.0	0.0	n/a <sup>c</sup>	<0.005 <sup>d</sup>	n/a
Chromium	n/a	n/a	7.9	2.5	2.1	<0.10	95
Copper	n/a	n/a	82	2.8	15	<0.050	88
Lead	n/a	n/a	5.3	0.0	12.0	n/a <sup>e</sup>	n/a
Nickel	n/a	n/a	8.4	3.6	2.6	0.1	99
Nitrite	n/a	n/a	21	25	n/a <sup>f</sup>	<5 <sup>g</sup>	n/a
Phosphorous	n/a	n/a	23	0.2	11	<2	89
Zinc	n/a	n/a	17	6.0	0.4	0.2	94

<sup>a</sup> n/a = not applicable

<sup>b</sup> Relative difference between duplicates, with respect to their mean:  $RPD = 100 \times |rep1 - rep2| / [(rep1 + rep2)/2]$

<sup>c</sup> Both duplicates were less than the detection limit.

<sup>d</sup> Both blank and non-blank samples were less than the detection limit.

<sup>e</sup> No results available.

<sup>f</sup> One of the two duplicates was less than the detection limit (<2.0 µg/L).

<sup>g</sup> The non-blank sample was less than detection limit.

The relative percent difference (RPD) of duplicate samples from a site represents the amount of variation between duplicates. Generally, RPD values greater than 40% may indicate elevated levels of *in situ* variation and more samples may be required to adequately characterize the site. Ammonia and

copper both had duplicate samples with a RPD over 40%, however the RPD for these variables in the other two duplicate samples were much less than 40%. As expected, all concentrations from the blank sample parameters from station SS4-5 were much less than those from the non-blank sample, suggesting the data were of good quality.

## 4. SUMMARY

In 2014, dustfall was monitored using 12 dustfall gauges and 27 snow survey stations located at varying distances around the mine along five transects. Snow water chemistry was also measured at 19 of the snow survey stations and compared to EQC set out in the WLWB Water Licence W2007L2-0003.

Annual dustfall measured at each of the 12 dustfall gauges ranged from 61 to 479 mg/dm<sup>2</sup>/y. The annualized dustfall rates estimated from the 2014 snow survey sites ranged from 3.8 to 392.9 mg/dm<sup>2</sup>/y. Because dustfall gauges continuously collect dust throughout the year, and the snow surveys are only representative of dustfall accumulated over the snow cover period, the reported annual dustfall results from the dustfall gauges are expected to provide a better estimate of annual dustfall compared to snow survey results for similar geographic areas. However, results obtained from both methods showed similar patterns.

Dustfall levels were generally lower in 2014 than in previous years. Overall, as expected, dustfall rates decreased with distance from the mine site, and areas that were predominantly downwind of the mine site received more dustfall than upwind areas. Although there are no dustfall standards for the Northwest Territories, 2014 dustfall rates were always less than the 1.7 to 2.9 mg/dm<sup>2</sup>/day (621 to 1059 mg/dm<sup>2</sup>/y) BC MOE dustfall objective for the mining, smelting, and related industries (BC MOE 2013).

Snow water chemistry variables of interest included variables with EQC (i.e., aluminum, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, nitrite, and zinc) or load limits (i.e., phosphorous) set out in the WLWB Water Licence W2007L2-0003. All 2014 concentrations were less than their associated "maximum concentration of any grab sample" EQC. Concentrations of arsenic, chromium, and nickel have increased in recent years and concentrations of copper, lead and zinc decreased in recent years. Typically, concentrations decreased with distance from the mine site, however, the greatest concentrations of each variable of interest were recorded at Station SS3-8 located in the 251-1000 zone, and station SS3-7, located in the 101-150 zone. The concentrations at these two locations were more than double the concentrations recorded at the other sites, including samples taken in the 0-100 zone. Both of these locations are located to the southeast of the site. However, concentrations of all variables were always less than their corresponding EQC.

## REFERENCES

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

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W2007L2-0003. Class A Water Licence Issued to Diavik Diamond Mines (2012) Inc. by Wek'ezhì Land and Water Board.

# *Appendix A*

## *Annual Changes to Dustfall Program*

## **APPENDIX A. ANNUAL CHANGES TO DUSTFALL PROGRAM**

### **2001**

The 2001 dust monitoring program was based entirely upon snow survey samples collected along four radial transects emanating from the project footprint outward to a distance of approximately 1,000 meters. All sample locations were analyzed for dust deposition, while only those locations on Lac de Gras were analyzed for snow water chemistry.

### **2002**

DDMI amended the dust monitoring program, in response to recommendations made by the Mackenzie Valley Land and Water Board, to include two snow survey control locations. In addition, five dust gauges (passive dust collectors) were deployed, one along each of the snow survey transects and one at a control location, in efforts to enhance the monitoring program.

### **2003**

In response to further recommendations, the dust monitoring program was modified. All four snow survey transects were extended in length to a distance of approximately 2,000 meters from the project footprint. An additional five dust gauges, including a second control, were deployed.

### **2004**

Increased construction activity necessitated further changes to the dust monitoring program. One dust gauge (Dust 02) was removed from its location to accommodate project footprint expansion, and subsequently relocated and redeployed (Dust 2A).

### **2005**

Dust deposition monitoring was carried out with no modifications to either the snow survey or the dust gauge portion of the program.

### **2006**

An additional dust gauge was deployed bringing the total to eleven (including two controls). Testing of Mini-Vol portable air samplers were conducted to determine feasibility of incorporation into the dust monitoring program. Preliminary findings proved the inclusion of the Mini-Vol samplers would be impractical.

## 2007

The snow survey portion of the program was amended with an additional snow survey transect being incorporated bringing the total number of transects to five. As well, snow water chemistry samples were collected adjacent to the pre-existing control locations as background references.

Two additional dust gauges (temporary) were deployed adjacent to two pre-existing dust gauges. The intent of the temporary gauges was to compare results from the same location when sample collection frequency is altered.

DDMI initiated contact with Environment Canada and Golder Associates with regards to remodeling dust deposition with the intent of revising predictions made in the 1998 environmental effects report.

In light of dust deposition monitoring results from previous years, several control measures were adopted to reduce dust generation on site, including the utilization of EK-35 (suppressant) on the airport apron, taxiway and helipad, and fitting a second 830E haul truck with tank for haul road watering.

## 2008

All of the dust gauges were modified to accommodate the replacement of the polyacrylic dust gauge inserts with brass Nipher gauge inserts, to minimize loss associated with damage during the collection and handling of the dust gauges.

An additional dust gauge was added to the program bringing the total to twelve permanently deployed (including two control), and two temporary (reference) dust gauges.

Three snow survey sample points were not sampled as they had become overtaken by construction activity and expansion of the project footprint.

Additional preparations for dust deposition modelling were completed including data collection, identification of point source inputs, selection of a modelling program and inputs (with regulator input) and discussion of cumulative effects.

## 2009

The two temporary dust gauges deployed in 2007 were decommissioned. All twelve permanent gauges were collected quarterly. An error in collection/deployment resulted in "No Data" being collected for Dust 03 between July 11 and September.

Snow survey sampling was conducted in April. An error in collection/analysis resulted in the Dust Deposition sample for SS2-1 being compromised; as such "No Dust Deposition Data" was available for this location.



## 2010

All twelve permanent dust gauges were collected quarterly during 2010. Overall, there was a reduction of observed dustfall deposition from 2009 to 2010, with the exception of Dust 1 and Dust 10.

Snow survey sampling was conducted throughout the month of April. An error in collection/processing resulted in two missing stations for the water quality analysis. SS2-1 field results were collected; however, the sample was compromised during processing in the lab. An error also resulted with the collection of SS5-2; data collection for water quality analysis was missed in the field. No data for these two stations resulted in Zone 1 having no data for the various water chemistry results and SS5-2 was not represented in Zone 3 data for 2010.

## 2011

All twelve permanent dust gauges were collected quarterly during 2011. During collection and repair to Station Dust 5 in September, the sample was compromised and therefore not processed, which resulted in data loss.

Snow survey sampling was conducted throughout the month of April. Due to an internal error shipping samples, water quality samples for stations SS1-4, SS1-5, SS2-1, SS2-2, SS2-3, SS2-4, and SSC-3 arrived at the Maxxam laboratory past the recommended holding time.

## 2012

All twelve permanent dust gauges were collected quarterly during 2012. During collection in June repairs were conducted on Station Dust 9 as it was found on its side, the sample was compromised, which resulted in data loss. Overall in 2012, 8 of the 12 dust gauges reported lower deposition rates compared to 2011.

Snow survey sampling was conducted on April 30 and on May 4 and 5.

## 2013

All twelve permanent dust gauges were collected quarterly during 2013. Station Dust 5 was dismantled upon arrival in September and the sample was compromised, which resulted in data loss for that quarter.

Snow survey sampling was conducted at 24 locations from April 26 to 28.

## 2014

All twelve permanent dust gauges were collected quarterly during 2014.

Snow survey sampling was conducted at 24 locations from April 7 to May 12. Three additional sites, SS3-6, SS3-7, SS3-8, were installed.

## *Appendix B*

### *Dustfall Gauge Analytic Results*

### Appendix B. Dustfall Gauge Analytic Results

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm <sup>2</sup> )	Days Deployed	Dust Deposition (mg/dm <sup>2</sup> /d)	Dust Deposition (mg/dm <sup>2</sup> /y)	
06-Dec-13	Initial Deployment Date										
21-Mar-14	Dust 3	1	120.1	287.3	167.2	167.2	136.32	105.00	1.30	473.9	
03-Jun-14	Dust 3	1	120.9	274.5	153.6	153.6	125.23	74.00	1.69	617.7	
15-Sep-14	Dust 3	1	116.6	293.6	177	177	144.31	104.00	1.39	506.5	
07-Dec-14	Dust 3	1	121.9	213.2	91.3	91.3	74.44	83.00	0.90	327.3	
					<b>TOTALS</b>	<b>589.1</b>	<b>480.29</b>	<b>366.00</b>	<b>1.31</b>	<b>479.0</b>	
04-Dec-13	Initial Deployment Date										
21-Mar-14	Dust 2A	1	116.5	212.9	96.4	96.4	78.59	105.00	0.75	273.2	
02-Jun-14	Dust 2A	1	121.3	171.2	49.9	49.9	40.68	73.00	0.56	203.4	
13-Sep-14	Dust 2A	1	117	153.2	36.2	36.2	29.51	103.00	0.29	104.6	
07-Dec-14	Dust 2A	1	120.4	180.2	59.8	59.8	48.75	85.00	0.57	209.4	
					<b>TOTALS</b>	<b>242.3</b>	<b>197.54</b>	<b>366.00</b>	<b>0.54</b>	<b>197.0</b>	
04-Dec-13	Initial Deployment Date										
21-Mar-14	Dust 3	1	120.1	287.3	167.2	167.2	136.32	105.00	1.30	473.9	
03-Jun-14	Dust 3	1	120.9	274.5	153.6	153.6	125.23	74.00	1.69	617.7	
15-Sep-14	Dust 3	1	116.6	293.6	177	177	144.31	104.00	1.39	506.5	
07-Dec-14	Dust 3	1	121.9	213.2	91.3	91.3	74.44	83.00	0.90	327.3	
					<b>TOTALS</b>	<b>589.1</b>	<b>480.29</b>	<b>366.00</b>	<b>1.31</b>	<b>479.0</b>	
06-Dec-13	Initial Deployment Date										
22-Mar-14	Dust 4	1	120.8	145.6	24.8	24.8	20.22	108.00	0.19	68.3	
03-Jun-14	Dust 4	1	121.7	161.2	39.5	39.5	32.20	73	0.44	161.0	
15-Sep-14	Dust 4	1	118.1	126.6	8.5	8.5	6.93	104	0.07	24.3	
07-Dec-14	Dust 4	1	118	218.1	100.1	100.1	81.61	83	0.98	358.9	
					<b>TOTALS</b>	<b>172.9</b>	<b>140.96</b>	<b>368</b>	<b>0.38</b>	<b>139.8</b>	
04-Dec-13	Initial Deployment Date										
21-Mar-14	Dust 5	1	119.5	140.6	21.1	21.1	17.20	107.00	0.16	58.7	
02-Jun-14	Dust 5	1	120.6	183.9	63.3	63.3	51.61	73.00	0.71	258.0	
14-Sep-14	Dust 5	1	117.1	158.6	41.5	41.5	33.83	104.00	0.33	118.7	

### Appendix B. Dustfall Gauge Analytic Results

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm <sup>2</sup> )	Days Deployed	Dust Deposition (mg/dm <sup>2</sup> /d)	Dust Deposition (mg/dm <sup>2</sup> /y)
07-Dec-14	Dust5	1	118.8	136.7	17.9	17.9	14.59	84.00	0.17	63.4
			<b>TOTALS</b>		<b>143.8</b>	<b>143.8</b>	<b>117.24</b>	<b>368</b>	<b>0.32</b>	<b>116.3</b>
06-Dec-13			Initial Deployment Date							
22-Mar-14	Dust6	1	123.9	256.4	132.5	132.5	108.03	106.00	1.02	372.0
03-Jun-14	Dust6	1	118.3	442.2	323.9	323.9	264.07	73.00	3.62	1320.4
15-Sep-14	Dust6	4	464.5	497.1	32.6	32.6	26.58	104.00	0.26	93.3
07-Dec-14	Dust6	1	119.9	158.7	38.8	38.8	31.63	83.00	0.38	139.1
			<b>TOTALS</b>		<b>527.8</b>	<b>527.8</b>	<b>430.31</b>	<b>366</b>	<b>1.18</b>	<b>429.1</b>
04-Dec-13			Initial Deployment Date							
21-Mar-14	Dust7	1	120.8	319	198.2	198.2	161.59	107.00	1.51	551.2
02-Jun-14	Dust7	1	123.1	225.3	102.2	102.2	83.32	73.00	1.14	416.6
13-Sep-14	Dust7	2	231.6	250.1	18.5	18.5	15.08	103.00	0.15	53.4
07-Dec-14	Dust7	1	121.9	279.6	157.7	157.7	128.57	85.00	1.51	552.1
			<b>TOTALS</b>		<b>476.6</b>	<b>476.6</b>	<b>388.57</b>	<b>368</b>	<b>1.06</b>	<b>385.4</b>
06-Dec-13			Initial Deployment Date							
22-Mar-14	Dust8	1	121.3	148.9	27.6	27.6	22.50	106.00	0.21	77.5
02-Jun-14	Dust8	1	122.8	163.8	41	41	33.43	72.00	0.46	169.5
14-Sep-14	Dust8	5	578.8	608.7	29.9	29.9	24.38	104.00	0.23	85.6
07-Dec-14	Dust8	1	120.8	226.5	105.7	105.7	86.18	84.00	1.03	374.5
			<b>TOTALS</b>		<b>204.2</b>	<b>204.2</b>	<b>166.48</b>	<b>366</b>	<b>0.45</b>	<b>166.0</b>

### Appendix B. Dustfall Gauge Analytic Results

Sample Date	Dust Gauge ID	Filter #	Weight of Filter (mg)	Filter + Residue (mg)	Weight of Residue (mg)	Cumulative (filters, mg)	Dust Deposition (mg/dm <sup>2</sup> )	Days Deployed	Dust Deposition (mg/dm <sup>2</sup> /d)	Dust Deposition (mg/dm <sup>2</sup> /y)	
04-Dec-13	Initial Deployment Date										
21-Mar-14	Dust 9	1	120.7	146.3	25.6	25.6	20.87	107.00	0.20	71.2	
02-Jun-14	Dust 9	1	123	141.8	18.8	18.8	15.33	73.00	0.21	76.6	
13-Sep-14	Dust 9	1	118.8	145.6	26.8	26.8	21.85	103.00	0.21	77.4	
07-Dec-14	Dust 9	1	121.9	160.9	39	39	31.80	85	0.37	136.5	
					<b>TOTALS</b>	<b>110.2</b>	<b>89.84</b>	<b>368</b>	<b>0.24</b>	<b>89.1</b>	
04-Dec-13	Initial Deployment Date										
22-Mar-14	Dust 10	1	121.2	171.6	50.4	50.4	41.09	108.00	0.38	138.9	
02-Jun-14	Dust 10	1	119.2	171.2	52	52	42.39	72.00	0.59	214.9	
13-Sep-14	Dust 10	1	111.5	138.3	26.8	26.8	21.85	103.00	0.21	77.4	
07-Dec-14	Dust 10	1	120.5	155.3	34.8	34.8	28.37	85.00	0.33	121.8	
					<b>TOTALS</b>	<b>164</b>	<b>133.71</b>	<b>368</b>	<b>0.36</b>	<b>132.6</b>	
04-Dec-13	Initial Deployment Date										
22-Mar-14	Dust C1	1	121.3	180.7	59.4	59.4	48.43	108.00	0.45	163.7	
02-Jun-14	Dust C1	1	121.1	140.4	19.3	19.3	15.74	72.00	0.22	79.8	
13-Sep-14	Dust C1	1	116.3	128.6	12.3	12.3	10.03	103.00	0.10	35.5	
07-Dec-14	Dust C1	1	120.1	158.6	38.5	38.5	31.39	85.00	0.37	134.8	
					<b>TOTALS</b>	<b>129.5</b>	<b>105.58</b>	<b>368</b>	<b>0.29</b>	<b>104.7</b>	
06-Dec-13	Initial Deployment Date										
22-Mar-14	Dust C2	1	119.9	134.8	14.9	14.9	12.15	106.00	0.11	41.8	
02-Jun-14	Dust C2	1	119.4	145.1	25.7	25.7	20.95	72.00	0.29	106.2	
14-Sep-14	Dust C2	1	116.6	139.5	22.9	22.9	18.67	104.00	0.18	65.5	
07-Dec-14	Dust C2	1	120.8	132.5	11.7	11.7	9.54	84.00	0.11	41.4	
					<b>TOTALS</b>	<b>75.2</b>	<b>61.31</b>	<b>366</b>	<b>0.17</b>	<b>61.1</b>	

Note:

<sup>a</sup> Station was dismantled upon arrival, sample was compromised.

<sup>b</sup> Does not include September sample.

## *Appendix C*

*Dustfall Snow Survey Field Sheets and Analytic Results*

DB

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	1 of 2

**GENERAL**

LOCATION NAME: SS1-1      DATE (dd-mmm-yyyy): 2014-Apr-08      TIME (24:00): 1500  
 SAMPLED BY: DD/TJ      TYPE OF SAMPLE: Dust      ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 533940 E 7154353 N (Zone) 12  
 DESCRIPTION: By Dust Gauge @ Airport

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: -13 °C      Wind Direction: E      Wind Speed (knots): 25  
 Precipitation: rain / mist / snow n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (g)	Weight of Empty Tube	Water Content (cm)	Density (%)	Dust Present	
							Yes	No Comments
1	40	38	48	40	8		Y	
2	36	38	48		8		Y	
3	34	31	49		9	25	Y	
4								

Total Volume of Water After Melting : ~~1.270~~ 1.270 (mL)      Water Content = Wt. of tube & core - Wt. of Empty tube

1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Total Volume of Water After Melting : \_\_\_\_\_ (mL)      Water Content = Wt. of tube & core - Wt. of Empty tube

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	116.5 #1	209.6		
2	121.9 #2	189.2		
3	<sup>Total</sup> 238.4	393.8		
4				
<b>Totals</b>				

Coarse Sand particles + a couple of small branches (Removed Branches)

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	125 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



DB

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	1 of 2

**GENERAL**

LOCATION NAME: SS1-2 DATE (dd-mmm-yyyy): 2014-Apr-08 TIME (24:00): 1545  
 SAMPLED BY: DD/TJ TYPE OF SAMPLE: Dust ~~Water Quality~~ QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 533916 E 7154377 N (Zone) 12  
 DESCRIPTION: N of Airport

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: -13 °C Wind Direction: E Wind Speed (knots): 25  
 Precipitation: rain / mist / snow / n/a Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible Not Visible Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (g)	Weight of Empty Tube	Water Content (cm)	Density (%)	Dust Present	
							Yes	No Comments
1	104	75	70	40	30		Y	
2	98	74	66		26		Y	
3	160	74	62		22	78	Y	
4								
Total Volume of Water After Melting : <u>9.200</u> (mL) <u>2.195</u> Water Content = Wt. of tube & core - Wt. of Empty tube								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
Total Volume of Water After Melting : _____ (mL) Water Content = Wt. of tube & core - Wt. of Empty tube								

80

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.7	#2 174.5		
2	116.9	#1 252.8		
3 Total	237.6	427.3		
4				
<b>Totals</b>				

*Few coarse particles in bag.*

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	125 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
Other	Other								

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul

DB

Rio Tinto

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	1 of 2

GENERAL

LOCATION NAME: SS1-3-4 DATE (dd-mmm-yyyy): 2014-Apr-08 TIME (24:00): 1600  
 SAMPLED BY: DD/TJ TYPE OF SAMPLE: Dust ~~Water Quality~~ QAQC Dupl  
 GPS COORDINATES (UTM): 0533963 E 7154515 N (Zone) 12 W  
 DESCRIPTION: N of Airstrip Close to Airstrip

CLIMATE CONDITIONS (if sampling outside)

Air Temp: -13 °C Wind Direction: E Wind Speed (knots): 25  
 Precipitation: rain / mist / snow / n/a Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible Snow Condition: Crystallized, Packed, Wet, Dry

Data Sheet Missing. 4 were collected Documented on Spread sheet.

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present	
							Yes / No	Comments
1	?	?	?	?				
2	?	?	?					
3	?	?	?					
4	?	?	?					
Total Volume of Water After Melting: <u>*965</u> (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube			
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
Total Volume of Water After Melting: _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube			

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.3	361.7		
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles** *Few coarse particles in bag (sticks)*

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul

DB

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	1 of 2

**GENERAL**

LOCATION NAME: SS1-3-5      DATE (dd-mmm-yyyy): 2014-Apr-08      TIME (24:00): 1600  
 SAMPLED BY: DD/TJ      TYPE OF SAMPLE: Dust      ~~Water Quality~~      QA/QC Dup 2  
 GPS COORDINATES (UTM): 6533963      E 7154515      N (Zone) 12W  
 DESCRIPTION: N of Airstrip Close to Dust Gauge

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: -13 °C      Wind Direction: E      Wind Speed (knots): 25  
 Precipitation: rain / mist / snow n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (g)	Weight of Empty Tube	Water Content (cm)	Density (%)	Dust Present	
							Yes	No Comments
1	?	?	?					
2	?	?	?					
3	?	?	?					
4	?	?	?					
<b>Total Volume of Water After Melting:</b> <u>1045</u> (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube			
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
<b>Total Volume of Water After Melting:</b> _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube			

Data Sheet Missing 4 were collected documented on Spreadsheet



Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	122.8	315.3		
2				
3				
4				
<b>Totals</b>				

*Few coarse particles in bag (grass as well)*

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	125 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	1 of 2

**GENERAL**

LOCATION NAME: SS1-4      DATE (dd-mmm-yyyy): 11-May-2014      TIME (24:00): 1148  
 SAMPLED BY: KG/DD      TYPE OF SAMPLE: Dust ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0534486      E 7155095      N (Zone) 12W  
 DESCRIPTION: N of Airport Diavik 4.31 km S

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present	
							Yes / No	Comments
1	18	16	44	39	5		Y	
2	16	15	46		7		Y	
3	16	15/46	45		6/18		Y	
4	16	16	43		4		Y	
Total Volume of Water After Melting: <del>6935</del> (mL) <u>1280</u>					Water Content = Wt. of tube & core - Wt. of Empty tube			
1	15	15/77	46	38	8/30		Y	
2	13	12/89	44		6/36		Y	
3	23	22/112	51		13/49		Y	
4								
5								
6								
7								
8								
9								
10								
11								
12								
Total Volume of Water After Melting: _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube			

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
<b>Task:</b>	Snow Sampling Field Sheet	<b>By:</b>	Dianne Dul
		<b>Page:</b>	2 of 2

### Dust Sample Filters

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.0	258.7	138.7	
2				
3				
4				
<b>Totals</b>				

*Some coarse material*

### Water Quality Bottles

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul





Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	1 of 2

**GENERAL**

LOCATION NAME: SSI-5      DATE (dd-mmm-yyyy): 11-May-2014      TIME (24:00): 12:28  
 SAMPLED BY: KG/DD      TYPE OF SAMPLE: Dust      ~~Water quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0535093      E 7156289      N (Zone) 12W  
 DESCRIPTION: Snow Sampling Dust Diavik 5.57km S

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	15	15	45	39	6				
2	36	35	47		8				
3	36	35	53		14 / 28				
4	36	35	53		14 / 42				
Total Volume of Water After Melting: <u>1450</u> (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting: _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	122.9	#1 141.7		
2	120.5	#2 153.8		
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul

DS

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
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**GENERAL**

LOCATION NAME: SSA-1 DATE (dd-mmm-yyyy): 11-May-2014 TIME (24:00): 13:55  
 SAMPLED BY: KGIDD TYPE OF SAMPLE: Dust ~~Water Quality~~ QA/QC \_\_\_\_\_  
 GPS COORDINATES (UTM): 6537555 E 7153469 N (Zone) 12W  
 DESCRIPTION: Snow core sampling - dust Diavik 4.36 km SW

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C Wind Direction: \_\_\_\_\_ Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a n/a Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100% 100%  
 Dust in area: Visible, Not Visible Not Visible Snow Condition: Crystallized, Packed, Wet, Dry Crystallized

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	28	26	50	40	10				
2	28	28	52		12/22				
3	28	27/81	54		14/36				
4	28	27/108	53		13/49				
Total Volume of Water After Melting : <u>1425</u> (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting : _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
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Task:	Snow Sampling Field Sheet	By:	Dianne Dul
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	119.9	164.5	44.6	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul

TJB

<b>Snow Sampling Field Sheet</b>			
Area: <u>8000</u>	No: <u>ENVI-177-0312</u>		
Effective Date: <u>26-MAR-2012</u>	Revision: <u>R3</u>		
Task: <u>Snow Sampling Field Sheet</u>	By: <u>Dianne Dul</u>		
Page: <u>1</u> of <u>2</u>			

**GENERAL**

LOCATION NAME: SSC-3 DATE (dd-mmm-yyyy): 2014-May-11 TIME (24:00): 1635  
 SAMPLED BY: DDI KG TYPE OF SAMPLE: Dust ~~Water Quality~~ QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0538624 E 7148767 N (Zone) 12W  
 DESCRIPTION: Snow Core Dust Piaik 4.95 km NW

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C Wind Direction: \_\_\_\_\_ Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible Snow Condition: Crystallized ~~Packed~~, ~~Wet~~, ~~Dry~~

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	52	49	52	39	13				
2	53	51	53		14/27				
3	55	50	51		12/39				
4									
Total Volume of Water After Melting : <del>1735</del> (mL) <u>1735</u>					Water Content =Wt. of tube & core - Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting : _____ (mL)					Water Content =Wt. of tube & core - Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
<b>Task:</b>	Snow Sampling Field Sheet	<b>By:</b>	Dianne Dul
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	119.6	140.7	21.1	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles** *Some coarse biomaterial*

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

<b>Revision History</b>			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



<u>Snow Sampling Field Sheet</u>			
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**GENERAL**

LOCATION NAME: SS2-2      DATE (dd-mmm-yyyy): 11-May-2014      TIME (24:00): 14:14  
 SAMPLED BY: KG/DD      TYPE OF SAMPLE: Dust ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0537829      E 7153484      N (Zone) 12W  
 DESCRIPTION: Snowcore Sampling - Dust Diavik 4.59 km SW

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible \_\_\_\_\_      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	23	23	46	39	7				
2	25	24	49		10/17				
3	35	35	56		17/34				
4	35	33/115	52		13/47				
Total Volume of Water After Melting : <u>5</u> 1445 (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting : _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
<b>Task:</b>	Snow Sampling Field Sheet	<b>By:</b>	Dianne Dul
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	122.0	234.6	112.6	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column	08-April-2014	D. Dul





<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
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**GENERAL**

**LOCATION NAME:** SS2-3      **DATE (dd-mmm-yyyy):** 11-May-2014      **TIME (24:00):** 13:27  
**SAMPLED BY:** KG/DD      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QAQC** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0538486      E      7153938      **N (Zone)** 12W  
**DESCRIPTION:** Snowcore sampling - Dust Diavik 5.38km SW

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow / ~~ice~~ / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	21	20	45	39	6				
2	21	20	49		10/16				
3	20	18	47		8/24				
4	21	20/78	46		7/31				
<b>Total Volume of Water After Melting :</b> <u>1515</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1	20	20/99	48	39	9/40				
2	20	19/107	48		9/49				
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	117.5	170.2	52.7	
2				
3				
4				
<b>Totals</b>				

*Some coarse material*

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
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**GENERAL**

**LOCATION NAME:** SS2=4      **DATE (dd-mmm-yyyy):** 11-May-2014      **TIME (24:00):** 13:00  
**SAMPLED BY:** KD/DO      **TYPE OF SAMPLE:** Dust      Water Quality      QAQC  
**GPS COORDINATES (UTM):** 0539159      E      7154686      N (Zone) 12W  
**DESCRIPTION:** Snowcore Sampling Post Diavik 6.37km SW 1.01km to SS2-3

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	22	24	47	39	8				
2	24	22	48		9/17				
3	23	21	48		9/26				
4	21	21/88	47		12 21/38				
<b>Total Volume of Water After Melting:</b> <u>1340</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1	20/21	20/106	48	39	9/47				
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting:</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	119.3	192.1	72.8	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column	08-April-2014	D. Dul



<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
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**GENERAL**

**LOCATION NAME:** SS3-4      **DATE (dd-mmm-yyyy):** 11-May-2014      **TIME (24:00):** 15:16  
**SAMPLED BY:** KG/DD      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QAQC:** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0536539      **E** 7151025      **N (Zone)** 12W  
**DESCRIPTION:** Snowcore Sampling-Dust @ 44Km W-DIAVIK

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	15	14	46	39	7				
2	15	14	43		7/11				
3	15	14	43		9/15				
4	15	15	39		0/15				
<b>Total Volume of Water After Melting :</b> <u>1150</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1	16	16	45	40	5/20				
2	17	16	45		5				
3	16	16 <sup>105</sup> / <del>16</del>	46		6/31				
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.9	223.6	102.7	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column	08-April-2014	D. Dul

08

<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
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**GENERAL**

**LOCATION NAME:** SS3-5      **DATE (dd-mmm-yyyy):** 2014-MAY-11      **TIME (24:00):** 16:00  
**SAMPLED BY:** DDIKG      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      QAQC  
**GPS COORDINATES (UTM):** 0537648      E 7150808      **N (Zone):** 12 W  
**DESCRIPTION:** Snow Core - Dust      Diavik 3.54 km W

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow no      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	28	28	46	40	6				
2	28	27/55	46		6/12				
3	26	26/81	43		3/15				
4	26	26/167	45		5/20				
<b>Total Volume of Water After Melting:</b> <u>1285</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting:</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.6 #1	180.7	(ledge looks nipped)	
2	122.9 #2	251.7		
3 <i>total</i>	243.5	432.4	188.9	
4				
<b>Totals</b>				

**Water Quality Bottles** *lots of coarse material.*

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



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<u>Snow Sampling Field Sheet</u>			
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**GENERAL**

**LOCATION NAME:** SS3-6      **DATE (dd-mmm-yyyy):** 11-May-2014      **TIME (24:00):** 14:36  
**SAMPLED BY:** KG/DP      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QAQC** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0536344      **E** 7151593      **N (Zone)** 12W  
**DESCRIPTION:** Snowcore Sampling - Dark Diavik 2.38km W

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	43	39	54	40	14				
2	43	43	56		16/30				
3	43	41/23	56		16/46				
4									
<b>Total Volume of Water After Melting :</b> <u>1465</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

<u>Snow Sampling Field Sheet</u>			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	122.8	253.0	130.2	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles** *coarse material at bottom*

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



<b>Snow Sampling Field Sheet</b>			
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**GENERAL**

**LOCATION NAME:** S53-7      **DATE (dd-mmm-yyyy):** 11-May-2014      **TIME (24:00):** 14:55  
**SAMPLED BY:** KB/DD      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QAQC** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0530355      **E** 7151370      **N (Zone)** 12W  
**DESCRIPTION:** ⊙ Snowcore sampling - Dust Diavik 232km W

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	14	11	45	40	5				
2	13	12	44		4/9				
3	15	14	44		4/13				
4	15	14	44						
<b>Total Volume of Water After Melting :</b> <u>1200</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1	15	14	45	40	5/18				
2	15	14/9	43		3/21				
3	10	10/89	43		3/24				
4	15	15/104	46		6/30				
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
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### Dust Sample Filters

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	121.5 #1	184.9		
2	121.6 #2	259.2		
3 Total	243.1	444.1	201.0	
4				
<b>Totals</b>				

### Water Quality Bottles

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



<u>Snow Sampling Field Sheet</u>			
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**GENERAL**

LOCATION NAME: SS3-8      DATE (dd-mmm-yyyy): 11-May-2014      TIME (24:00): 15:34  
 SAMPLED BY: KB/DD      TYPE OF SAMPLE: Dust - ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0536727      E 7150821      N (Zone) 12W  
 DESCRIPTION: Snowcore sampling - dust Diavik 2.62Km W

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	14	<del>12</del> 12	46	40	6				
2	12	12	42		2				
3	15	15	43		3				
4	15	15	45		5 / 16				
<b>Total Volume of Water After Melting :</b> <u>1320</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1	15	14	40	39	1				
2	18	<del>17</del> 15	46		7 / 24				
3	17	15 / 100	43		4 / 28				
4	15	14	43		4 / 32				
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.10	176.3	55.7	
2	121.3	<del>246.4</del> 247.6	126.3	
3			182.0	
4				
<b>Totals</b>				

**Water Quality Bottles**

*Some coarse material in bottom of bag*

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul

DB

Snow Sampling Field Sheet			
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**GENERAL**

LOCATION NAME: SS4-1 DATE (dd-mmm-yyyy): 2014 Apr 19 TIME (24:00): 1735  
 SAMPLED BY: DD/DDB TYPE OF SAMPLE: Dust ~~Water Quality~~ QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0531455 E 7152220 N (Zone) \_\_\_\_\_  
 DESCRIPTION: Druck 3.00 km SE

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: -1 °C Wind Direction: E Wind Speed (knots): 6  
 Precipitation: rain / mist / snow / n/a Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present	
							Yes / No	Comments
1	30	25	49	40	9		Y	
2	25	23	48		8		Y	
3	30	24	49		9		Y	
4	34	24	48		8	34	Y	

Total Volume of Water After Melting: 1.075 (mL) Water Content = Wt. of tube & core - Wt. of Empty tube

1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Total Volume of Water After Melting: \_\_\_\_\_ (mL) Water Content = Wt. of tube & core - Wt. of Empty tube

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	121.3	160.9	39.6	
2				
3				
4				
<b>Totals</b>				

*Minimal coarse material → few branches (removed)*

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul





Snow Sampling Field Sheet			
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**GENERAL**

LOCATION NAME: SS 4-2      DATE (dd-mmm-yyyy): 2014-Apr 19      TIME (24:00): 1745  
 SAMPLED BY: DDIDB      TYPE OF SAMPLE: Dust      ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0531337 E 7152272      N (Zone) \_\_\_\_\_  
 DESCRIPTION: Duquik 3.12 Km SE

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: 7 °C      Wind Direction: E      Wind Speed (knots): 6  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	47	42	50	39.5	10.5		Y		
2	47	43	51		11.5		Y		
3	45	41	52		12.5	34.5	Y		
4									
Total Volume of Water After Melting : <u>1.110</u> (mL)					Water Content =Wt. of tube & core – Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting : _____ (mL)					Water Content =Wt. of tube & core – Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	119.1	149.1	30.0	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



<b>Snow Sampling Field Sheet</b>			
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**GENERAL**

**LOCATION NAME:** SS4-3      **DATE (dd-mmm-yyyy):** 2014-Apr-19      **TIME (24:00):** 1800  
**SAMPLED BY:** DD/DB      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QA/QC** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0531337 E 7152428 N (Zone) \_\_\_\_\_  
**DESCRIPTION:** Dianik 3.20 Km SE

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** -1 °C      **Wind Direction:** E      **Wind Speed (knots):** L  
**Precipitation:** rain / mist / snow / va      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	50	34	52	40	12	1	N		
2	50	42	54		14	1	N		
3	54	41	54		14	40	N		
4									
<b>Total Volume of Water After Melting :</b> <u>1180</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	22.5	147.1	24.6	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



Snow Sampling Field Sheet			
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**GENERAL**

LOCATION NAME: SS4-4 DATE (dd-mmm-yyyy): 12-May-2014 TIME (24:00): 11:47  
 SAMPLED BY: KD/DD TYPE OF SAMPLE: Dust ~~Water Quality~~ QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0531132 E 7153163 N (Zone) 12W  
 DESCRIPTION: Snow Core Sampling - Dust Diavik 3.78km SE

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C Wind Direction: \_\_\_\_\_ Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	25	23	47	39	8				
2	21	20	46		7/15				
3	15	14	43		4/19				
4	20	19	46		7/26				
Total Volume of Water After Melting : <u>1140</u> (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				
1	20	17	45	39	6/32				
2	20	19	46		7/39				
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting : _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	121.1	179.3	58.2	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul

03

<u>Snow Sampling Field Sheet</u>			
Area: <u>8000</u>	No: <u>ENVI-177-0312</u>		
Effective Date: <u>26-MAR-2012</u>	Revision: <u>R3</u>		
Task: <u>Snow Sampling Field Sheet</u>	By: <u>Dianne Dul</u>		
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**GENERAL**

LOCATION NAME: SS4-5      DATE (dd-mmm-yyyy): 12-May-2014      TIME (24:00): 11:10  
 SAMPLED BY: KB/DD      TYPE OF SAMPLE: Dust      ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0531902      E 7154118      N (Zone) 12W  
 DESCRIPTION: Snow Core Dust Diavik - 4.27 km SE

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	24.25	15.24	52	39	13				
2	25	24	49		10/23				
3	25	24	46		7/30				
4	25	24	46						
Total Volume of Water After Melting: <u>1345</u> (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				
1	25	24/10	49	39	8/38				
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting: _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	121.0	158.9	37.9	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



03

Snow Sampling Field Sheet			
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**GENERAL**

LOCATION NAME: SSS-1-4      DATE (dd-mmm-yyyy): 2014 Apr 19      TIME (24:00): 1630  
 SAMPLED BY: OD/DB      TYPE OF SAMPLE: Dust      ~~Water Quality~~      QAQC DUP  
 GPS COORDINATES (UTM): 6533143 E 7148925 N (Zone) \_\_\_\_\_  
 DESCRIPTION: Dravik 2.10 km NE

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: -2 °C      Wind Direction: Calm      Wind Speed (knots): 0  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present	
							Yes / No	Comments
1	46	36	52	40.5	11.5		N	
2	45	35	51		10.5		N	
3	40	33	51		10.5	32.5	N	
4								

Total Volume of Water After Melting: 1045 (mL)      Water Content = Wt. of tube & core - Wt. of Empty tube

1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Total Volume of Water After Melting: \_\_\_\_\_ (mL)      Water Content = Wt. of tube & core - Wt. of Empty tube

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
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### Dust Sample Filters

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.6	186.9	64.3	
2				
3				
4				
<b>Totals</b>				

### Water Quality Bottles

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column	08-April-2014	D. Dul

Snow Sampling Field Sheet			
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**GENERAL**

**LOCATION NAME:** SSS-1-5      **DATE (dd-mmm-yyyy):** 2014 Apr 19      **TIME (24:00):** 1630  
**SAMPLED BY:** AD/DB      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QA/QC:** Dupa  
**GPS COORDINATES (UTM):** 0533143      **E** 7148925      **N (Zone)** \_\_\_\_\_  
**DESCRIPTION:** Dravik 2.10 km NE

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** -2 °C      **Wind Direction:** Calm      **Wind Speed (knots):** 0  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes/No	Comments	
1	42	31	50	40	10		N		
2	44	37	52		12		N		
3	41	32	52		12	34	N		
4									
<b>Total Volume of Water After Melting :</b> <u>1040</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.7	184.3	63.4	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

*Few branches*

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column	08-April-2014	D. Dul

DB

<b>Snow Sampling Field Sheet</b>			
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**GENERAL**

**LOCATION NAME:** SSS-2      **DATE (dd-mmm-yyyy):** 2014-Apr-17      **TIME (24:00):** 1625  
**SAMPLED BY:** DDIDB      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QAQC** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0533152      **E** 7148880      **N (Zone)** \_\_\_\_\_  
**DESCRIPTION:** Draught 2.14 km NE

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** -2 °C      **Wind Direction:** Calm      **Wind Speed (knots):** 0  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes/No	Comments	
1	28	27	48	39.5	8.5		N		
2	31	31	50		10.5		N		
3	33	32	50.5		11.0		N		
4	33	33	50		10.5	10.5	N		
<b>Total Volume of Water After Melting :</b> <u>1230</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	120.2	147.3	27.1	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column	08-April-2014	D. Dul



Snow Sampling Field Sheet			
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**GENERAL**

LOCATION NAME: SS5-3      DATE (dd-mmm-yyyy): 12-May-2014      TIME (24:00): 13:35  
 SAMPLED BY: KB/DD      TYPE OF SAMPLE: Dust ~~Water Quality~~      QA/QC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0533153      E 7148698      N (Zone) 12W  
 DESCRIPTION: Snow Core Sampling      Diasvik 2.30km SE

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, (25%), 50%, 75%, 100%  
 Dust in area: Visible, Not (Visible)      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present	
							Yes / No	Comments
1	15	15	44	40	4			
2	17	16	48		8			
3	17	16/47	46		6/18			
4	18	16/47	45		5/23			
Total Volume of Water After Melting : <u>163</u>			525 (mL)		Water Content = Wt. of tube & core - Wt. of Empty tube			
1	<del>15</del> 17	17/18/80	45	40	5/28			
2	17	16/96	47		7/35			
3	17	16/112	47		7/42			
4								
5								
6								
7								
8								
9								
10								
11								
12								
Total Volume of Water After Melting :					Water Content = Wt. of tube & core - Wt. of Empty tube			

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

<b>Snow Sampling Field Sheet</b>			
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**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	121.0	161.5	40.5	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

<b>Revision History</b>			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



08

<u>Snow Sampling Field Sheet</u>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
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**GENERAL**

**LOCATION NAME:** SS5-4      **DATE (dd-mmm-yyyy):** 12-May-2019      **TIME (24:00):** 14:12  
**SAMPLED BY:** KG/DD      **TYPE OF SAMPLE:** Dust      ~~Water Quality~~      **QA/QC** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0533143      **E** 7147929      **N (Zone)** 12W  
**DESCRIPTION:** Snow Core Sampling Diarrhea

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	29	29	52	40	12				
2	28	28	51		11				
3	31	30	51		11 / 34				
4	28	26	50		10 / 44				
<b>Total Volume of Water After Melting:</b> <u>1390</u> (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
<b>Total Volume of Water After Melting:</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube				

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	121.3	149.6	28.3	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul

DB

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	1 of 2

**GENERAL**

LOCATION NAME: SS5-5      DATE (dd-mmm-yyyy): 12-May-2014      TIME (24:00): 14:31  
 SAMPLED BY: KB/DD      TYPE OF SAMPLE: Dust      ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0533145      E 7146942      N (Zone) 12W  
 DESCRIPTION: Snow Core Sampling      DIAVIK 3.99km N

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	19	18	45	39	6				
2	18	18	46		7/13				
3	19	18	46		7/20				
4	20	19	46		7/27				
Total Volume of Water After Melting: <u>1255</u> (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				
1	19	18/9	48	40	8/				
2	18	18/109	46						
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting: _____ (mL)					Water Content = Wt. of tube & core - Wt. of Empty tube				

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
<b>Task:</b>	Snow Sampling Field Sheet	<b>By:</b>	Dianne Dul
		<b>Page:</b>	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	123.1	157.7	34.6	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

<b>Revision History</b>			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
<b>Task:</b>	Snow Sampling Field Sheet	<b>By:</b>	Dianne Dul
		<b>Page:</b>	1 of 2

**GENERAL**

**LOCATION NAME:** SSC-1      **DATE (dd-mmm-yyyy):** 12-May-2014      **TIME (24:00):** 15:10  
**SAMPLED BY:** KB/DD      **TYPE OF SAMPLE:** Dust      Water Quality      **QA/QC** \_\_\_\_\_  
**GPS COORDINATES (UTM):** 0534932      E 7144118      **N (Zone)** 12W  
**DESCRIPTION:** Snow Core Sampling      Diavik - 6.72 km

**CLIMATE CONDITIONS (if sampling outside)**

**Air Temp:** \_\_\_\_\_ °C      **Wind Direction:** \_\_\_\_\_      **Wind Speed (knots):** \_\_\_\_\_  
**Precipitation:** rain / mist / snow / n/a      **Cloud Cover:** 0%, 10%, 25%, 50%, 75%, 100%  
**Dust in area:** Visible, Not Visible      **Snow Condition:** Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present	
							Yes / No	Comments
1	25	24	47	39	8			
2	25	24	47		8/16			
3	25	24	46		8/33			
4	24	23	47		8/41			
<b>Total Volume of Water After Melting :</b> <del>1555</del> (mL) 1225					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube			
1	26	25/20	48	39	9/50			
2								
3	mL =							
4								
5								
6								
7								
8								
9								
10								
11								
12								
<b>Total Volume of Water After Melting :</b> _____ (mL)					<b>Water Content =</b> Wt. of tube & core – Wt. of Empty tube			

**1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis**

Snow Sampling Field Sheet			
Area:	8000	No:	ENVI-177-0312
Effective Date:	26-MAR-2012	Revision:	R3
Task:	Snow Sampling Field Sheet	By:	Dianne Dul
		Page:	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	121.9	125.5	3.6	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

Revision History			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



Snow Sampling Field Sheet			
Area: 8000	No: ENVI-177-0312		
Effective Date: 26-MAR-2012	Revision: R3		
Task: Snow Sampling Field Sheet	By: Dianne Dul		
Page: 1 of 2			

**GENERAL**

LOCATION NAME: Control 2      DATE (dd-mmm-yyyy): 12 May 2012      TIME (24:00): 12:32  
 SAMPLED BY: KG/DD      TYPE OF SAMPLE: Dust ~~Water Quality~~      QAQC \_\_\_\_\_  
 GPS COORDINATES (UTM): 0528725      E 7153300      N (Zone) 12W  
 DESCRIPTION: Snow Core Sampling Diavik - 5.92 km SE

**CLIMATE CONDITIONS (if sampling outside)**

Air Temp: \_\_\_\_\_ °C      Wind Direction: \_\_\_\_\_      Wind Speed (knots): \_\_\_\_\_  
 Precipitation: rain / mist / snow / n/a      Cloud Cover: 0%, 10%, 25%, 50%, 75%, 100%  
 Dust in area: Visible, Not Visible      Snow Condition: Crystallized, Packed, Wet, Dry

Core Number	Depth of Snow (cm)	Length of Snow Core (cm)	Weight of Tube & Core (SWE)	Weight of Empty Tube (SWE)	Water Content (SWE) <sup>1</sup>	Density (%)	Dust Present		
							Yes / No	Comments	
1	35	31	52	39	13				
2	34	31	52		13 / 26				
3	33	24 / 18	42		5				
4	28	27 / 113	49		10 / 41				
Total Volume of Water After Melting: _____ (mL)					1385	Water Content = Wt. of tube & core - Wt. of Empty tube			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
Total Volume of Water After Melting: _____ (mL)						Water Content = Wt. of tube & core - Wt. of Empty tube			

1 - Need 100 SWE for Ice Stations, to have sufficient water for analysis

<b>Snow Sampling Field Sheet</b>			
<b>Area:</b>	8000	<b>No:</b>	ENVI-177-0312
<b>Effective Date:</b>	26-MAR-2012	<b>Revision:</b>	R3
<b>Task:</b>	Snow Sampling Field Sheet	<b>By:</b>	Dianne Dul
		<b>Page:</b>	2 of 2

**Dust Sample Filters**

Filter #	Weight of Filter	Filter + Residue	Residue Weight	Comments
1	119.2	170.8	51.6	
2				
3				
4				
<b>Totals</b>				

**Water Quality Bottles**

Filling Order	Analysis	Bottle Type	Triple Rinse	Preserve	Sample Type	Sample Type	Sample Type	Preserved (circle when added)	Sample Comments (location preserved if not in field, label changes)
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
1	Metals Total	60 mL Falcon Tube	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - HNO <sub>3</sub>	
2	Total Mercury	40 mL clear glass	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1 mL - HCL	
3	Nutrients	120 mL plastic	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1mL - H <sub>2</sub> SO <sub>4</sub>	
4	Routine	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	
5	TSS/Turb/pH	1000 mL plastic	Y	N	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A	

<b>Revision History</b>			
Revision	Revision Description	Date of Revision	Author
0	Initial Release	16-Mar-2012	D. Dul
1	First Revision	13-May-2012	D. Dul
2	Revised Table 1	27-April-2013	D. Dul
3	Revised Table 3 (Total Mercury & TSS/Turb/pH & Filling Order column)	08-April-2014	D. Dul



## *Appendix D*

### *Snow Water Chemistry Analytic Results*

Your P.O. #: K16877  
 Your Project #: SNP-A  
 PO # K16877  
 Your C.O.C. #: 08344705

**Attention: DDMI Environment**

DIAMOND MINES INC.  
 P.O. BOX 2498  
 5007 - 50 AVE.  
 YELLOWKNIFE, NT  
 CANADA X1A 2P8

Report Date: 2014/05/27  
 Report #: R1574213  
 Version: 3R

**CERTIFICATE OF ANALYSIS – REVISED REPORT**

**MAXXAM JOB #: B431879**  
**Received: 2014/04/23, 09:55**

Sample Matrix: Water  
 # Samples Received: 4

Analyses	Quantity	Date		Laboratory Method	Analytical Method
		Extracted	Analyzed		
Acidity pH 4.5 & pH 8.3 (as CaCO <sub>3</sub> )	4	N/A	2014/04/23	BBY6SOP-00037	SM-2310B
Alkalinity - Water	4	2014/04/24	2014/04/24	BBY6SOP-00026	SM2320B
Biochemical Oxygen Demand (1)	2	2014/04/22	2014/04/27	AB SOP-00017	SM 5210 B
Chloride by Automated Colourimetry	4	N/A	2014/04/23	BBY6SOP-00011	SM-4500-CI-
Fecal Coliforms (MF) (1)	2	2014/04/22	2014/04/23	EENV SOP-00157	SM9222D
Conductance - water	4	N/A	2014/04/24	BBY6SOP-00026	SM-2510B
Fluoride - Mining Clients	4	N/A	2014/04/23	BBY6SOP-00012	SM - 4500 F C
Hardness Total (calculated as CaCO <sub>3</sub> )	4	N/A	2014/04/29	BBY7SOP-00002	EPA 6020A
Mercury (Total-LowLevel) by CVAF	4	2014/04/29	2014/04/29	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (total)	4	N/A	2014/04/29	BBY7SOP-00002	EPA 6020A
Elements by ICPMS Low Level (total)	4	N/A	2014/04/29	BBY7SOP-00002	EPA 6020A
Nitrogen (Total)	3	2014/04/24	2014/04/24	BBY6SOP-00016	SM-4500N C
Nitrogen (Total)	1	2014/04/30	2014/04/30	BBY6SOP-00016	SM-4500N C
Ammonia-N (Preserved)	3	N/A	2014/04/26	BBY6SOP-00009	SM-4500NH3G
Ammonia-N (Preserved)	1	N/A	2014/04/29	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	3	N/A	2014/04/24	BBY6SOP-00010	SM 4500NO3-I
Nitrate + Nitrite (N)	1	N/A	2014/04/29	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	3	N/A	2014/04/24	BBY6SOP-00010	EPA 353.2
Nitrite (N) by CFA	1	N/A	2014/04/29	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	3	N/A	2014/04/25	BBY6SOP-00010	SM 4500NO3-I
Nitrogen - Nitrate (as N)	1	N/A	2014/04/29	BBY6SOP-00010	SM 4500NO3-I
pH Water (2)	4	N/A	2014/04/24	BBY6SOP-00026	SM-4500H+B
Orthophosphate by Konelab (low level)	1	N/A	2014/04/23	BBY6SOP-00013	SM 4500 P E
Orthophosphate by Konelab (low level)	3	N/A	2014/04/24	BBY6SOP-00013	SM 4500 P E
Sulphate by Automated Colourimetry	4	N/A	2014/04/23	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	4	2014/04/25	2014/04/28	BBY6SOP-00033	SM 2540C
Hydrocarbons (C10-C30) in Water - GC/FID	2	2014/04/24	2014/04/25	BBY8SOP-00029	BC Env. Lab Manual
TKN (Calc. TN, N/N) total	4	N/A	2014/04/25	BBY6SOP-00022	SM 4500N-C
Total Oil and Grease	2	N/A	2014/04/30	BBY8SOP-00004	BC Lab Manual
Phosphorus-P (LL Tot, dissolved) - UF/UP	4	2014/04/23	2014/04/24	BBY6SOP-00013	SM-4500 PE
Total Phosphorus	4	N/A	2014/04/24	BBY6SOP-00013	SM 4500 P E
Total Suspended Solids	1	N/A	2014/04/29	BBY6SOP-00034	SM - 2540 D
Turbidity	1	N/A	2014/04/23	BBY6SOP-00027	SM - 2130B

\* Results relate only to the items tested.

(1) This test was performed by Maxxam Edmonton Environmental

(2) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key



Namita Sahni

27 May 2014 14:33:57 -07:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Namita Sahni, Burnaby Project Manager

Email: NSahni@maxxam.ca

Phone# (604) 639-2614

=====  
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B431879  
 Report Date: 2014/05/27

DIAVIK DIAMOND MINES INC.  
 Client Project #: SNP-A

Your P.O. #: K16877  
 Sampler Initials: DB

**RESULTS OF CHEMICAL ANALYSES OF WATER**

Maxxam ID	JL0791	JL0792	JL0793	JL0794						
Sampling Date	2014/04/20	2014/04/21	2014/04/21	2014/04/21						
UNITS	SS4-5-1	1645-13	1645-18	1645-18B	QC Batch					
<b>Misc. Inorganics</b>										
Acidity (pH 4.5)	mg/L	<0.50	7461774	<0.50	7461774	<0.50	0.50	<0.50	0.50	7461774
Acidity (pH 8.3)	mg/L	<0.50	7461774	<0.50	7461774	<0.50	0.50	<0.50	0.50	7461774
Fluoride (F)	mg/L	0.011	7461382	0.120	7461382	0.110	0.010	0.110	0.010	7461382
<b>ANIONS</b>										
Nitrite (N)	mg/L	<0.0050(1)	7463805	0.0347(2)	7468658	0.0191	0.0050	0.0249	0.0050	7463805
<b>Calculated Parameters</b>										
Nitrate (N)	mg/L	<0.020	7461364	1.26	7466804	1.29	0.020	1.21	0.020	7461364
<b>Demand Parameters</b>										
Biochemical Oxygen Demand	mg/L					<2.0		<2.0	2.0	7460515
<b>Misc. Inorganics</b>										
Alkalinity (Total as CaCO3)	mg/L	0.79	7463285	58.7	7463285	50.9	0.50	48.2	0.50	7463285
Alkalinity (PP as CaCO3)	mg/L	<0.50	7463285	<0.50	7463285	<0.50	0.50	<0.50	0.50	7463285
Bicarbonate (HCO3)	mg/L	0.96	7463285	71.6	7463285	62.0	0.50	58.8	0.50	7463285
Carbonate (CO3)	mg/L	<0.50	7463285	<0.50	7463285	<0.50	0.50	<0.50	0.50	7463285
Hydroxide (OH)	mg/L	<0.50	7463285	<0.50	7463285	<0.50	0.50	<0.50	0.50	7463285
<b>Anions</b>										
Orthophosphate (P)	mg/L	<0.0010	7461818	0.50	7462822	0.091	0.010	0.099	0.0010	7462822
Dissolved Sulphate (SO4)	mg/L	<0.50	7462853	20.7	7462853	30.0	0.50	31.1	0.50	7462853
Dissolved Chloride (Cl)	mg/L	<0.50	7462842	93	7462842	90	0.50	91	0.50	7462842
<b>Microbiological Param.</b>										
Fecal Coliforms	CFU/100mL					<1.0(3)		<1.0(4)	1.0	7460417
<b>Nutrients</b>										
Ammonia (N)	mg/L	0.026	7465579	0.27	7468848	0.22	0.0050	0.31	0.0050	7465579
Dissolved Phosphorus (P)	mg/L	<0.0020(5)	7461843	0.481	7461843	0.0953	0.0020	0.102	0.0020	7461843
Total Total Kjeldahl Nitrogen (Calc)	mg/L	<0.020	7461247	0.306	7461247	0.303	0.020	0.341	0.040	7461247
Nitrate plus Nitrite (N)	mg/L	<0.020(1)	7463803	1.29(2)	7468648	1.31	0.020	1.23	0.020	7463803
Total Nitrogen (N)	mg/L	<0.020	7463228	1.60	7469953	1.61	0.020	1.57	0.040	7463228
Total Phosphorus (P)	mg/L	<0.0020	7461840	0.496	7461840	0.0959	0.0020	0.101	0.0020	7461840
<b>OIL &amp; GREASE</b>										
Total Oil and grease	mg/L					<1.0		<1.0	1.0	7468979

RDL = Reportable Detection Limit

- (1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.
- (2) - Sample was originally analysed within hold time. Data quality required investigation. Re-analysis was completed past recommended hold time.
- (3) - Sample was past hold time when received, set up 29.25 hours after sample collection.
- (4) - Sample was past hold time when received, set up 29 hours after sample collection.
- (5) - Sample preserved to extend hold time.

Maxxam Job #: B431879  
 Report Date: 2014/05/27

DIAMOND MINES INC.  
 Client Project #: SNP-A

Your P.O. #: K16877  
 Sampler Initials: DB

### RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID	JL0791	JL0792	JL0793	JL0794	
Sampling Date	2014/04/20	2014/04/21	2014/04/21	2014/04/21	
UNITS	SS4-5-1	RDL	QC Batch	RDL	QC Batch
<b>Physical Properties</b>					
Conductivity	1.1	1.0	7463303	464	7463303
pH	5.78		7463300	8.16	7463300
<b>Physical Properties</b>					
Total Suspended Solids	<4.0	4.0	7465272		
Total Dissolved Solids	<10	10	7464217	232	7464217
Turbidity	<0.10	0.10	7461363		

### TOTAL PETROLEUM HYDROCARBONS (WATER)

Maxxam ID	JL0793	JL0794	
Sampling Date	2014/04/21	2014/04/21	
UNITS	1645-18	1645-18B	RDL
<b>Hydrocarbons</b>			
Total Extractables C10 to C30	<0.20	0.20	0.20
<b>Surrogate Recovery (%)</b>			
O-TERPHENYL (sur.)	106	106	7462801

Maxxam Job #: B431879  
Report Date: 2014/05/27

DIAMOND MINES INC.  
Client Project #: SNP-A

Your P.O. #: K16877  
Sampler Initials: DB

### LOW LEVEL TOTAL METALS WITH CV HG (WATER)

Maxxam ID	JL0791	JL0792	JL0793	JL0794	
Sampling Date	2014/04/20	2014/04/21	2014/04/21	2014/04/21	
<b>UNITS</b>	<b>SS4-5-1</b>	<b>1645-13</b>	<b>1645-18</b>	<b>1645-18B</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>					
Total Hardness (CaCO3)	mg/L	95.9	94.3	93.6	7461315
<b>Elements</b>					
Total Mercury (Hg)	ug/L	<0.0020	<0.0020	<0.0020	7467967

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RDL = Reportable Detection Limit

DIAMOND MINES INC.  
Client Project #: SNP-A

Maxxam Job #: B431879  
Report Date: 2014/05/27

Your P.O. #: K16877  
Sampler Initials: DB

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JL0791	JL0792	JL0793	JL0794		
Sampling Date	2014/04/20	2014/04/21	2014/04/21	2014/04/21		
	SS4-5-1	1645-13	1645-18	1645-18B	QC Batch	
	UNITS					
<b>Total Metals by ICPMS</b>						
Total Aluminum (Al)	ug/L	122	172	246	0.50	7462699
Total Antimony (Sb)	ug/L	<0.020	0.238	0.241	0.020	7462699
Total Arsenic (As)	ug/L	<0.020	5.60	3.11	0.020	7462699
Total Barium (Ba)	ug/L	0.036	51.6	43.9	0.020	7462699
Total Beryllium (Be)	ug/L	<0.010	<0.010	<0.010	0.010	7462699
Total Bismuth (Bi)	ug/L	<0.0050	0.060	<0.0050	0.0050	7462699
Total Boron (B)	ug/L	<5.0	28.9	25.1	5.0	7462699
Total Cadmium (Cd)	ug/L	<0.0050	<0.0050	<0.0050	0.0050	7462699
Total Chromium (Cr)	ug/L	<0.10	1.11	0.73	0.10	7462699
Total Cobalt (Co)	ug/L	<0.0050	0.186	0.0990	0.0050	7462699
Total Copper (Cu)	ug/L	<0.050	0.323	0.273	0.050	7462699
Total Iron (Fe)	ug/L	4.4	103	4.1	1.0	7462699
Total Lead (Pb)	ug/L	<0.0050	0.0980	0.0050	0.0050	7462699
Total Lithium (Li)	ug/L	<0.50	13.9	13.3	0.50	7462699
Total Manganese (Mn)	ug/L	0.211	21.3	17.5	0.050	7462699
Total Molybdenum (Mo)	ug/L	<0.050	16.5	16.6	0.050	7462699
Total Nickel (Ni)	ug/L	0.067	4.61	3.42	0.020	7462699
Total Selenium (Se)	ug/L	<0.040	0.045	0.054	0.040	7462699
Total Silicon (Si)	ug/L	<100	6460	5780	100	7462699
Total Silver (Ag)	ug/L	<0.0050	<0.0050	<0.0050	0.0050	7462699
Total Strontium (Sr)	ug/L	0.067	549	547	0.050	7462699
Total Thallium (Tl)	ug/L	<0.0020	0.0050	0.0030	0.0020	7462699
Total Tin (Sn)	ug/L	<0.20	<0.20	<0.20	0.20	7462699
Total Titanium (Ti)	ug/L	0.58	2.97	<0.50	0.50	7462699
Total Uranium (U)	ug/L	<0.0020	1.58	1.40	0.0020	7462699
Total Vanadium (V)	ug/L	<0.20	1.38	1.12	0.20	7462699
Total Zinc (Zn)	ug/L	0.20	1.43	0.29	0.10	7462699
Total Zirconium (Zr)	ug/L	<0.10	<0.10	<0.10	0.10	7462699
Total Calcium (Ca)	mg/L	<0.010	26.0	25.7	0.010	7461646
Total Magnesium (Mg)	mg/L	<0.010	7.50	7.29	0.010	7461646
Total Potassium (K)	mg/L	<0.010	5.89	6.02	0.010	7461646
Total Sodium (Na)	mg/L	<0.010	44.7	43.7	0.010	7461646
Total Sulphur (S)	mg/L	<0.60	6.45	9.61	0.60	7461646

RDL = Reportable Detection Limit

DIAVIK DIAMOND MINES INC.  
Client Project #: SNP-A

Your P.O. #: K16877  
Sampler Initials: DB

Maxxam Job #: B431879  
Report Date: 2014/05/27

Package 1 3.7°C

Each temperature is the average of up to three cooler temperatures taken at receipt

**General Comments**

Revised report (Version 2R) EDD included-NS7



QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7460417	Fecal Coliforms	2014/04/23					<1.0	CFU/100mL	NC	100
7460515	Biochemical Oxygen Demand	2014/04/27			102		<2.0	mg/L	NC	20
7461363	Turbidity	2014/04/27			100		<0.10	NTU	NC	20
7461382	Fluoride (F)	2014/04/23	104	80 - 120	102		0.012, RDL=0.010	mg/L	NC	20
7461774	Acidity (pH 8.3)	2014/04/23			95		<0.50	mg/L	NC	20
7461774	Acidity (pH 4.5)	2014/04/23					<0.50	mg/L	NC	20
7461818	Orthophosphate (P)	2014/04/23	95	80 - 120	96		<0.0010	mg/L	NC	20
7461840	Total Phosphorus (P)	2014/04/24	90	80 - 120	96		<0.0020	mg/L	0.4	20
7461843	Dissolved Phosphorus (P)	2014/04/24	92	80 - 120	95		<0.0020	mg/L	NC	20
7462699	Total Aluminum (Al)	2014/04/28	NC	80 - 120	103		<0.50	ug/L	3.7	20
7462699	Total Antimony (Sb)	2014/04/28	101	80 - 120	98		<0.020	ug/L	NC	20
7462699	Total Arsenic (As)	2014/04/28	106	80 - 120	99		<0.020	ug/L	NC	20
7462699	Total Barium (Ba)	2014/04/28	NC	80 - 120	95		<0.020	ug/L	0.7	20
7462699	Total Beryllium (Be)	2014/04/28	102	80 - 120	95		<0.010	ug/L	NC	20
7462699	Total Bismuth (Bi)	2014/04/28	97	80 - 120	98		<0.0050	ug/L	NC	20
7462699	Total Cadmium (Cd)	2014/04/28	105	80 - 120	97		<0.0050	ug/L	NC	20
7462699	Total Chromium (Cr)	2014/04/28	102	80 - 120	99		<0.10	ug/L	NC	20
7462699	Total Cobalt (Co)	2014/04/28	101	80 - 120	100		<0.0050	ug/L	0.7	20
7462699	Total Copper (Cu)	2014/04/28	104	80 - 120	100		<0.050	ug/L	4.5	20
7462699	Total Iron (Fe)	2014/04/28	NC	80 - 120	106		<1.0	ug/L	2.7	20
7462699	Total Lead (Pb)	2014/04/28	100	80 - 120	100		<0.0050	ug/L	10.3	20
7462699	Total Lithium (Li)	2014/04/28	99	80 - 120	100		<0.50	ug/L	NC	20
7462699	Total Manganese (Mn)	2014/04/28	NC	80 - 120	99		<0.050	ug/L	0.3	20
7462699	Total Molybdenum (Mo)	2014/04/28	108	80 - 120	98		<0.050	ug/L	NC	20
7462699	Total Nickel (Ni)	2014/04/28	103	80 - 120	102		<0.020	ug/L	4.0	20
7462699	Total Selenium (Se)	2014/04/28	114	80 - 120	105		<0.040	ug/L	NC	20
7462699	Total Silver (Ag)	2014/04/28	102	80 - 120	99		<0.0050	ug/L	NC	20
7462699	Total Strontium (Sr)	2014/04/28	NC	80 - 120	94		0.059, RDL=0.050	ug/L	1.8	20
7462699	Total Thallium (Tl)	2014/04/28	100	80 - 120	100		<0.0020	ug/L	NC	20
7462699	Total Tin (Sn)	2014/04/28	97	80 - 120	98		<0.20	ug/L	NC	20
7462699	Total Titanium (Ti)	2014/04/28	100	80 - 120	103		<0.50	ug/L	11.9	20
7462699	Total Uranium (U)	2014/04/28	99	80 - 120	96		<0.0020	ug/L	1.1	20
7462699	Total Vanadium (V)	2014/04/28	104	80 - 120	96		<0.20	ug/L	NC	20
7462699	Total Zinc (Zn)	2014/04/28	117	80 - 120	101		<0.10	ug/L	4.7	20
7462699	Total Boron (B)	2014/04/28					<50	ug/L	NC	20
7462699	Total Silicon (Si)	2014/04/28					<100	ug/L	0.6	20
7462699	Total Zirconium (Zr)	2014/04/28					<0.10	ug/L	NC	20
7462801	O-TERPHENYL (sur.)	2014/04/25	105	60 - 130	109		1.12	%	NC	40
7462801	Total Extractables C:10 to C:30	2014/04/25	94	50 - 130	96		<0.20	mg/L	NC	40

DIAVIK DIAMOND MINES INC.  
 Client Project #: SNP-A

Maxxam Job #: B431879  
 Report Date: 2014/05/27

Your P.O. #: K16877  
 Sampler Initials: DB

**QUALITY ASSURANCE REPORT**

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7462822	Orthophosphate (P)	2014/04/24	97	80 - 120	95	80 - 120	<0.0010	mg/L	NC	20
7462842	Dissolved Chloride (Cl)	2014/04/23	NC	80 - 120	102	80 - 120	<0.50	mg/L	1.1	20
7462853	Dissolve Sulphate (SO4)	2014/04/23	NC	80 - 120	100	80 - 120	<0.50	mg/L	1	20
7463228	Total Nitrogen (N)	2014/04/24	NC	80 - 120	99	80 - 120	<0.020	mg/L	1	20
7463285	Alkalinity (Total as CaCO3)	2014/04/24	NC	80 - 120	97	80 - 120	<0.50	mg/L	5.8	20
7463285	Alkalinity (PP as CaCO3)	2014/04/24					<0.50	mg/L		
7463285	Bicarbonate (HCO3)	2014/04/24					<0.50	mg/L		
7463285	Carbonate (CO3)	2014/04/24					<0.50	mg/L		
7463285	Hydroxide (OH)	2014/04/24					<0.50	mg/L		
7463303	Conductivity	2014/04/24			98	80 - 120	<1.0	uS/cm	0.6	20
7463803	Nitrate plus Nitrite (N)	2014/04/24	105	80 - 120	104	80 - 120	<0.020	mg/L	1.5	25
7463805	Nitrite (N)	2014/04/24	103	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7464217	Total Dissolved Solids	2014/04/28	103	80 - 120	88	80 - 120	<10	mg/L	8.4	20
7465272	Total Suspended Solids	2014/04/29	96	80 - 120	107	80 - 120	<4.0	mg/L	NC	20
7465579	Ammonia (N)	2014/04/26	NC	80 - 120	100	80 - 120	<0.0050	mg/L	0.2	20
7467967	Total Mercury (Hg)	2014/04/29	96	80 - 120	103	80 - 120	<0.0020	ug/L	NC	20
7468648	Nitrate plus Nitrite (N)	2014/04/29	NC	80 - 120	103	80 - 120	<0.020	mg/L	0.1	25
7468658	Nitrite (N)	2014/04/29	NC	80 - 120	98	80 - 120	<0.0050	mg/L	3.0	20
7468848	Ammonia (N)	2014/04/29	NC	80 - 120	98	80 - 120	<0.0050	mg/L	0.7	20
7468979	Total Oil and grease	2014/04/30			88	70 - 130	<1.0	mg/L		
7469953	Total Nitrogen (N)	2014/04/30	105	80 - 120	98	80 - 120	<0.020	mg/L	0.4	20

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify/laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.


NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

## Validation Signature Page

**Maxxam Job #: B431879**

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The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

  
\_\_\_\_\_  
Andy Lu, Data Validation Coordinator

  
\_\_\_\_\_  
Dina Tleugabulova, Ph. D., Ph.D., Scientific Specialist, Inorganics Department

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

B431879

Date Shipped: 2014-Apr-21

Results Received: 64/611(1)  
Maxxam Job #: At-103



Shipping Memo: April 2014



Diavik Diamond Mine	1	2	3	4	5
P.O. Box 2488	6	7	8	9	10
5007-50 Ave	11	12	13	14	15
Yellowknife NT	16	17	18	19	20
X1A 2P8	21	22	23	24	25
	26	27	28	29	30

Direct Information - Sample Inquiry  
 ENVIRONMENT@RIOTINTO.COM  
 In Env. Supervisor  
 DDDMI ENVIRONMENT@RIOTINTO.COM  
 REFERENCE LAB ID: MAXXAM  
 SERVICE REQUESTED:  DDMI ACCOUNTS PAYABLE  
 DDMI AP/RIOTINTO.COM  
 Priority (50% Surcharge)  
 Emergency (100% Surcharge)

Diavik Diamond Mines Inc. - Chain of Custody

Project	Collected By	Date	Type	ROUTINE PARAMETERS: pH, EC, Acidity, Alkalinity, TSS, CL, SO4, PO4, NO2, NO3, Dissolved Phosphorus, TDS	MATERIALS: (Ammonia, Total Phosphorus, TKN) PRESERVED	TOTALS: Low Level - <30.00 PRESERVED	TOTAL MERCURY PRESERVED	DISSOLVED METALS: Low Level + Sp. Gr UNFILTERED & UNPRESERVED	DISSOLVED MERCURY - UNFILTERED & UNPRESERVED	CI & GREASE PRESERVED	TEH (2 bottles)	PAH (TEH + 1 Bottle)	BTEX (2 bottles)	BIOLOGICAL OXYGEN DEMAND (BOD)	Fecal Coliforms (2 bottles)	TSS, Turb, pH
SS4-5-1	SNP-A	DB/DD 2014-Apr-20	EBW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
1645-13	SNP-A	DB/DD 2014-Apr-21	GW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
1645-18	SNP-A	DB/DD 2014-Apr-21	GW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
1645-18B	SNP-A	DB/DD 2014-Apr-21	GW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

JL0791  
JL0792  
JL0793  
JL0794



B431879

SAMPLE CONDITION (Shipped)	TEMP °C	SAMPLE CONDITION (Received)
5.0	6.6	FROZEN
<input checked="" type="checkbox"/>		COLD
		AMBIENT
RELINQUISHED BY: DB	DATE / TIME: 2014-Apr-21	RECEIVED BY: Amanda Hironde 2014-04-22 @ 10:40

20140422  
ice present  
peel absent

Report Uploaded to MP5:

Data Checked for Breaches:

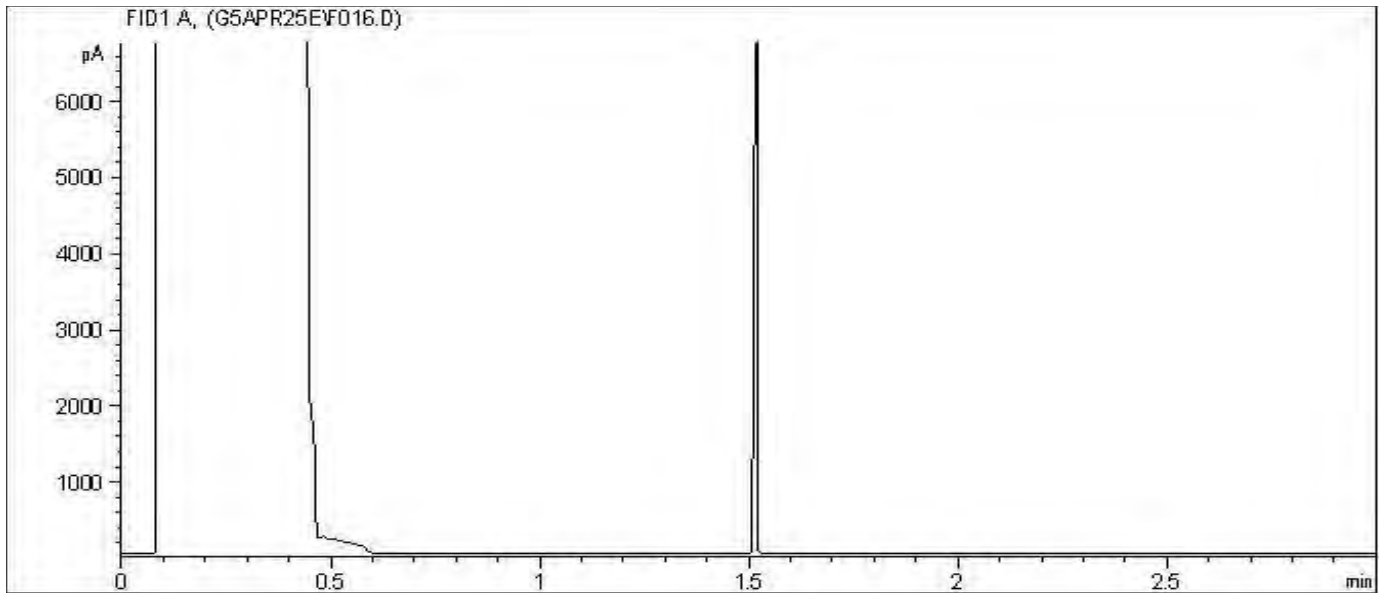
Reiny. Ole Oles  
CHES CUMBY  
2014/04/22 @ 14:35

Revd By: M...laure... 2014/04/25 09:55 434 CS:MP5

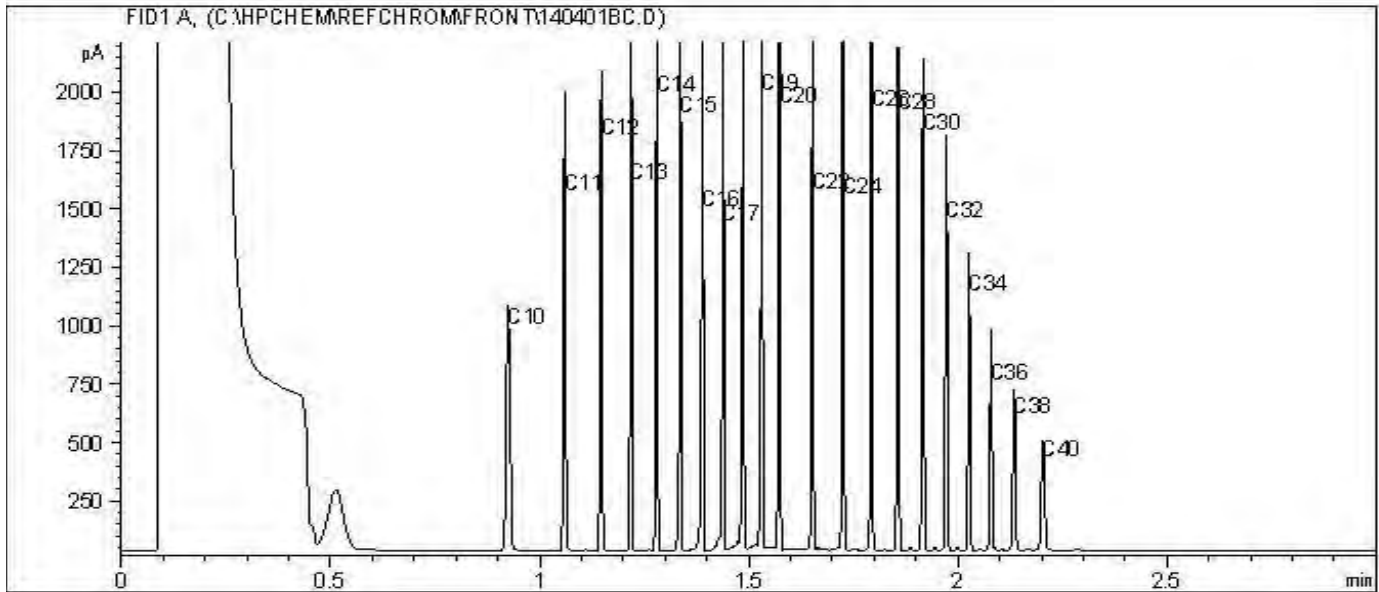
Report Date: 2014/05/27  
 Maxxam Job #: B431879  
 Maxxam Sample: JL0793

DIAMOND MINES INC.  
 Client Project #: SNP-A  
 Client ID: 1645-18

**Hydrocarbons (C10-C30) in Water - GC/FID Chromatogram**



Carbon Range Distribution - Reference Chromatogram



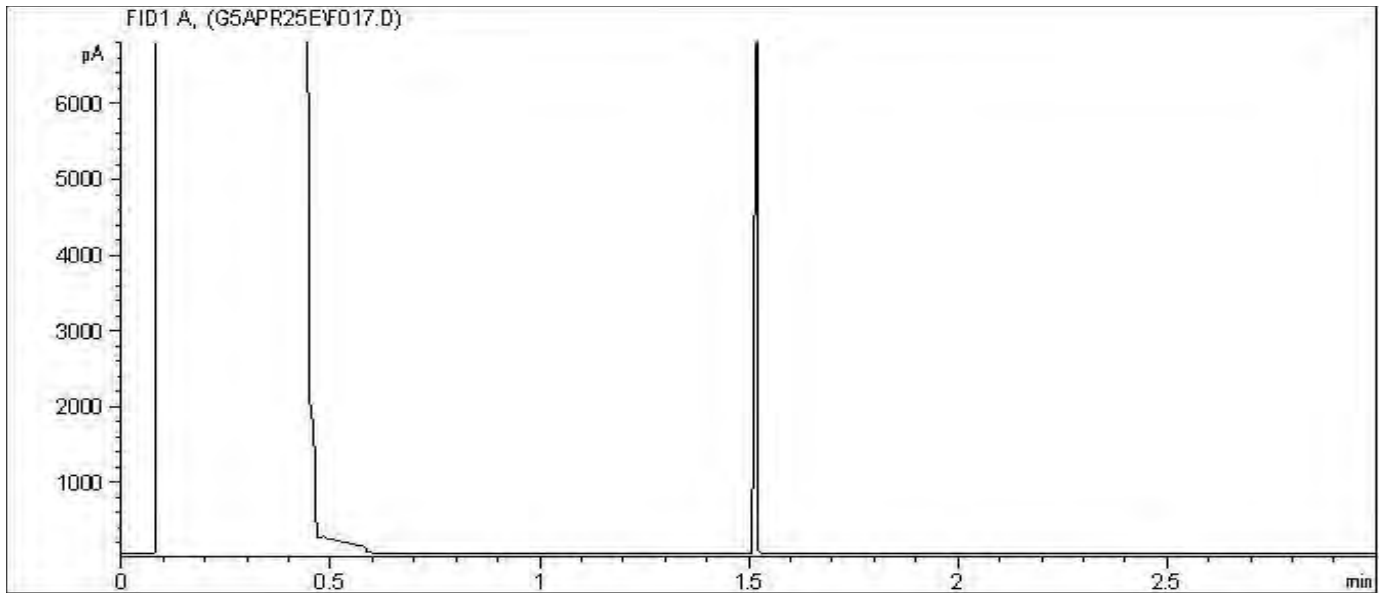
TYPICAL PRODUCT CARBON NUMBER RANGES

**Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.**

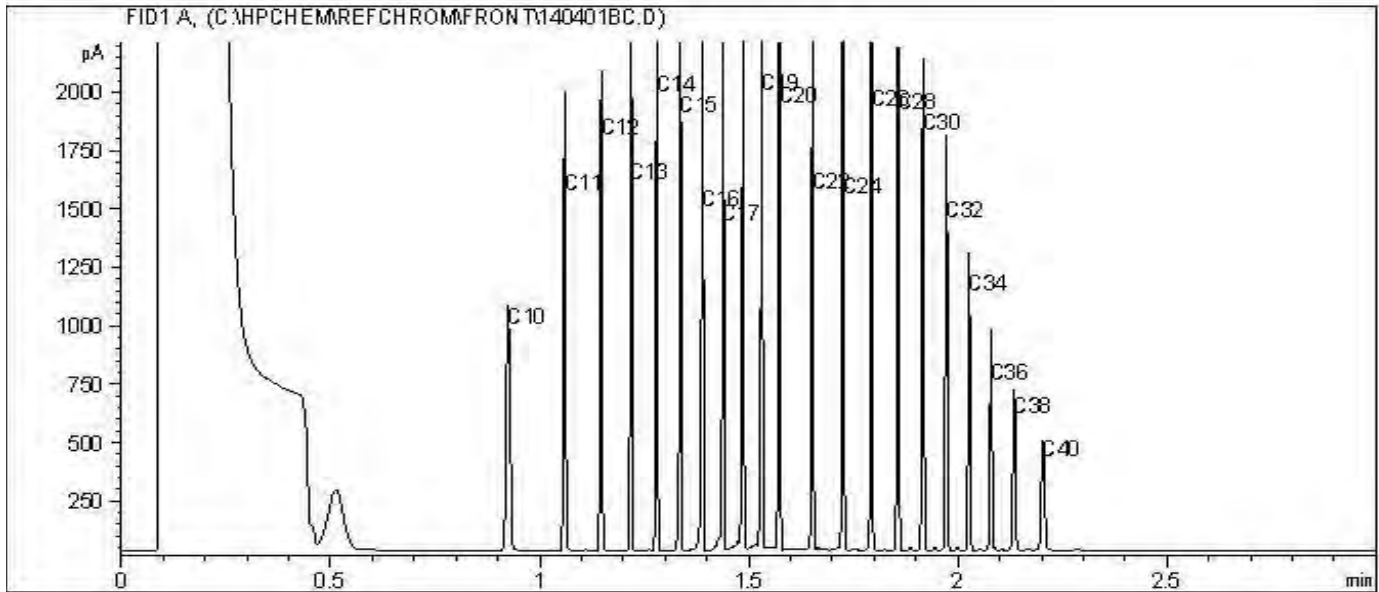
Report Date: 2014/05/27  
 Maxxam Job #: B431879  
 Maxxam Sample: JL0793 Lab-Dup

DIAMOND MINES INC.  
 Client Project #: SNP-A  
 Client ID: 1645-18

Hydrocarbons (C10-C30) in Water - GC/FID Chromatogram



Carbon Range Distribution - Reference Chromatogram



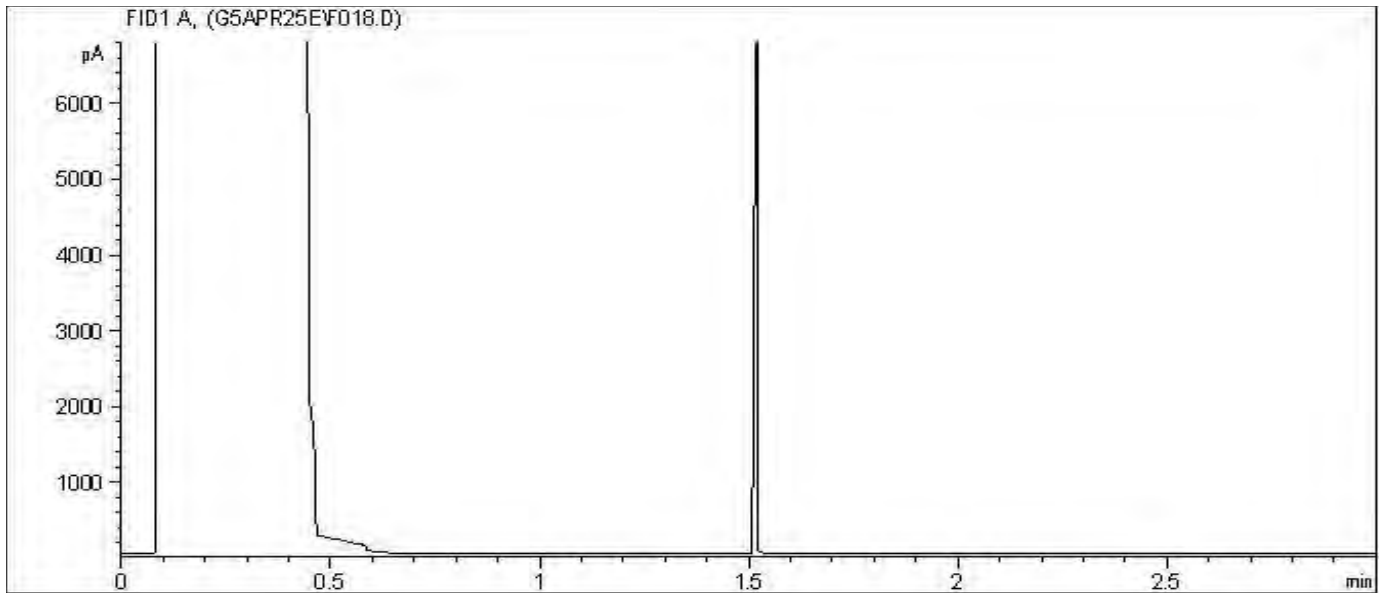
TYPICAL PRODUCT CARBON NUMBER RANGES

**Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.**

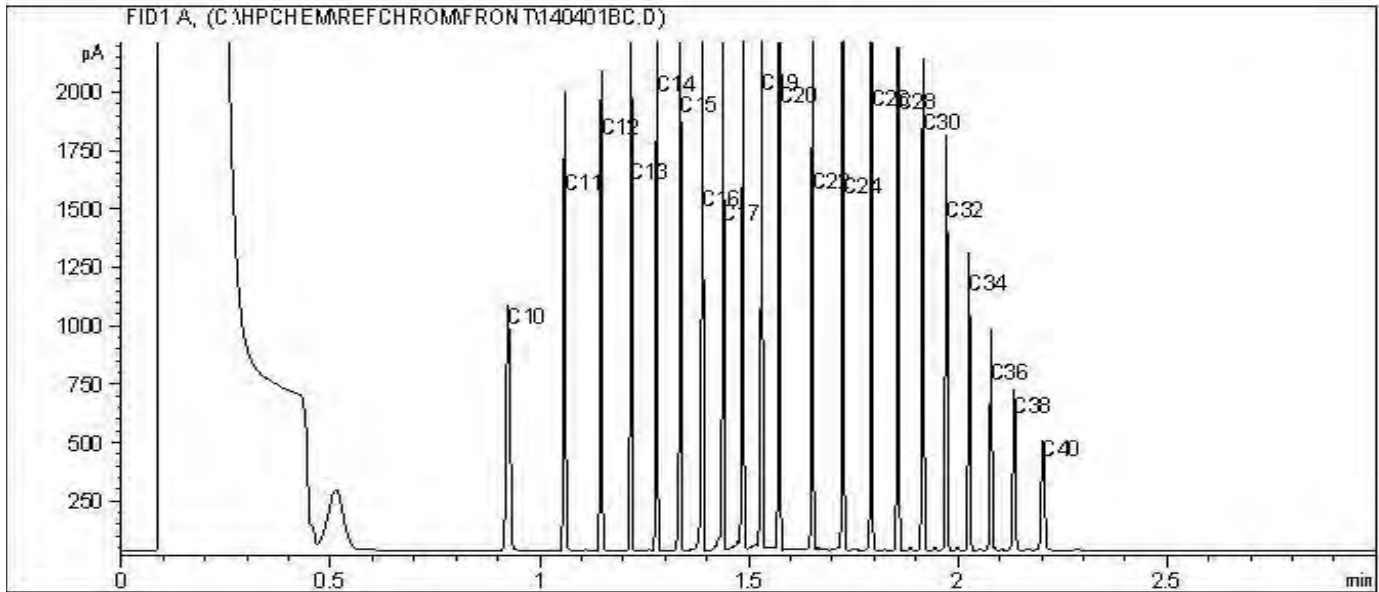
Report Date: 2014/05/27  
 Maxxam Job #: B431879  
 Maxxam Sample: JL0794

DIAMOND MINES INC.  
 Client Project #: SNP-A  
 Client ID: 1645-18B

Hydrocarbons (C10-C30) in Water - GC/FID Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

**Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.**

Your P.O. #: K16877  
 Your Project #: AEMP  
 PO # K16877  
 Your C.O.C. #: 08344662

**Attention: DDMI Environment**

DIAMOND MINES INC.  
 P.O. BOX 2498  
 5007 - 50 AVE.  
 YELLOWKNIFE, NT  
 CANADA X1A 2P8

**Report Date: 2014/06/05**  
**Report #: R1580010**  
**Version: 1**

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B439794**  
**Received: 2014/05/17, 11:10**

Sample Matrix: Water  
 # Samples Received: 7

Analyses	Quantity	Date		Laboratory Method	Analytical Method
		Extracted	Analyzed		
Acidity pH 4.5 & pH 8.3 (as CaCO <sub>3</sub> )	7	N/A	2014/05/21	BBY6SOP-00037	SM-2310B
Alkalinity - Water	7	2014/05/21	2014/05/21	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	7	N/A	2014/05/20	BBY6SOP-00011	SM-4500-CI-
Conductance - water	7	N/A	2014/05/21	BBY6SOP-00026	SM-2510B
Fluoride - Mining Clients	7	N/A	2014/05/20	BBY6SOP-00012	SM - 4500 F C
Hardness Total (calculated as CaCO <sub>3</sub> )	7	N/A	2014/05/27	BBY7SOP-00002	EPA 6020A
Mercury (Total-LowLevel) by CVAF	7	2014/05/23	2014/05/23	BBY7SOP-00015	BC MOE Lab Manual
ICP-AES Dissolved Metals in Water	7	N/A	2014/05/23	BBY7SOP-00018	EPA 6010C
Na, K, Ca, Mg, S by CRC ICPMS (total)	6	N/A	2014/05/27	BBY7SOP-00002	EPA 6020A
Na, K, Ca, Mg, S by CRC ICPMS (total)	1	N/A	2014/06/04	BBY7SOP-00002	EPA 6020A
Elements by ICPMS Low Level (total)	7	N/A	2014/05/26	BBY7SOP-00002	EPA 6020A
Nitrogen (Total)	7	2014/05/21	2014/05/21	BBY6SOP-00016	SM-4500N C
Ammonia-N (Preserved)	7	N/A	2014/05/21	BBY6SOP-00009	SM-4500NH3G
Nitrate+Nitrite (N) (low level)	7	N/A	2014/05/21	BBY6SOP-00010	EPA 353.2
Nitrite (N) (low level)	7	N/A	2014/05/21	BBY6SOP-00010	SM 4500NO3-I
Nitrogen - Nitrate (as N)	7	N/A	2014/05/22	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO <sub>3</sub> Preserve for Metals	7	N/A	2014/05/22	BBY6WI-00001	EPA 200.2
pH Water (1)	7	N/A	2014/05/21	BBY6SOP-00026	SM-4500H+B
Orthophosphate by Konelab (low level)	7	N/A	2014/05/21	BBY6SOP-00013	SM 4500 P E
Sulphate by Automated Colourimetry	7	N/A	2014/05/20	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Calculated)	7	N/A	2014/05/23	BBY WI-00033	Calculated Parameter
Total Dissolved Solids (Filt. Residue)	7	2014/05/23	2014/05/28	BBY6SOP-00033	SM 2540C
TKN (Calc. TN, N/N) total	7	N/A	2014/05/22	BBY6SOP-00022	SM 4500N-C
Phosphorus-P (LL Tot, dissolved) - UF/UP	4	2014/05/20	2014/05/21	BBY6SOP-00013	SM-4500 PE
Phosphorus-P (LL Tot, dissolved) - UF/UP	3	2014/06/05	2014/06/05	BBY6SOP-00013	SM-4500 PE
Total Phosphorus	4	N/A	2014/05/28	BBY6SOP-00013	SM 4500 P E
Total Phosphorus	3	N/A	2014/06/05	BBY6SOP-00013	SM 4500 P E
Total Suspended Solids-Low Level	7	2014/05/23	2014/05/26	BBY6SOP-00034	SM-2540 D
Turbidity	7	N/A	2014/05/20	BBY6SOP-00027	SM - 2130B

\* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.



Maxxam Job #: B439794  
Report Date: 2014/06/05

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Your P.O. #: K16877  
Sampler Initials: DD

-2-

Encryption Key



Maxxam  
05 Jun 2014 17:58:52 -07:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Namita Sahni, Burnaby Project Manager  
Email: NSahni@maxxam.ca  
Phone# (604) 639-2614

=====  
This report has been generated and distributed using a secure automated process.  
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B439794  
 Report Date: 2014/06/05

DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

### RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID	JQ2143	JQ2144	JQ2145			
Sampling Date	2014/04/08	2014/04/08	2014/04/19			
UNITS	SS1-4	QC Batch	SS1-5	QC Batch		
			SS2-1	RDL		
<b>Misc. Inorganics</b>						
Acidity (pH 4.5)	mg/L	7492761	<0.50	7492761	0.50	7492761
Acidity (pH 8.3)	mg/L	7492761	0.68	7492761	0.51	7492761
Fluoride (F)	mg/L	7491245	<0.010	7491245	<0.010	7491245
<b>Calculated Parameters</b>						
Filter and HNO3 Preservation	N/A	7493208	LAB	7493208	LAB	N/A
Nitrate (N)	mg/L	7490191	0.122	7490191	0.0709	0.0020
Total Dissolved Solids	mg/L	7492825	1.00	7492825	2.00	0.50
<b>Misc. Inorganics</b>						
Alkalinity (Total as CaCO3)	mg/L	7493436	0.58	7493436	1.23	0.50
Alkalinity (PP as CaCO3)	mg/L	7493436	<0.50	7493436	<0.50	0.50
Bicarbonate (HCO3)	mg/L	7493436	0.71	7493436	1.50	0.50
Carbonate (CO3)	mg/L	7493436	<0.50	7493436	<0.50	0.50
Hydroxide (OH)	mg/L	7493436	<0.50	7493436	<0.50	0.50
<b>Anions</b>						
Orthophosphate (P)	mg/L	7492742	0.0036(1)	7492742	0.0015(1)	0.0010
Dissolved Sulphate (SO4)	mg/L	7491858	<0.50	7491858	<0.50	0.50
Dissolved Chloride (Cl)	mg/L	7491841	<0.50	7491841	<0.50	0.50
<b>Nutrients</b>						
Total Ammonia (N)	mg/L	7493440	0.035	7493440	0.073	0.0050
Dissolved Phosphorus (P)	mg/L	7513177	0.0154(1)	7491863	<0.0020(1)	0.0020
Total Total Kjeldahl Nitrogen (Calc)	mg/L	7490192	0.051	7490192	0.069	0.020
Nitrate plus Nitrite (N)	mg/L	7493580	0.125(1)	7493580	0.0729(1)	0.0020
Nitrite (N)	mg/L	0.0023(1)	0.0022(1)	7493582	0.0020(1)	0.0020
Total Nitrogen (N)	mg/L	0.159	0.175	7493460	0.142	0.020
Total Phosphorus (P)	mg/L	0.0145	0.0178	7500143	0.0101	0.0020
<b>Physical Properties</b>						
Conductivity	uS/cm	3.9	7493445	3.6	7493445	5.8
pH	pH	6.10	7493444	5.68	7493444	6.28
<b>Physical Properties</b>						
Total Suspended Solids	mg/L	14.6(1)	7495665	37.6(1)	7495665	16.8
Total Dissolved Solids	mg/L	<10(1)	7502574	<10(1)	7502574	40(1)
Turbidity	NTU	7.68(1)	7492007	11.8(1)	7492007	1.57(1)

N/A = Not Applicable  
 RDL = Reportable Detection Limit  
 (1) - Sample arrived to laboratory past recommended hold time.

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439794  
Report Date: 2014/06/05

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**RESULTS OF CHEMICAL ANALYSES OF WATER**

Maxxam ID	JQ2146	JQ2147	JQ2148	JQ2149	QC Batch	RDL	QC Batch
Sampling Date	2014/04/19	2014/04/19	2014/04/19	2014/04/19	SS2-4	SS3-4	QC Batch
UNITS	SS2-2	SS2-3	SS2-4	SS3-4	QC Batch	RDL	QC Batch
<b>Misc. Inorganics</b>							
Acidity (pH 4.5)	mg/L	<0.50	7492761	<0.50	7492761	<0.50	7492761
Acidity (pH 8.3)	mg/L	<0.50	7492761	0.62	7492761	<0.50	7492761
Fluoride (F)	mg/L	0.015	7491245	<0.010	7491245	<0.010	7491245
<b>Calculated Parameters</b>							
Filter and HNO3 Preservation	N/A	LAB	7493208	LAB	7493208	LAB	7493208
Nitrate (N)	mg/L	0.128	7490191	0.0679	7490191	0.116	7490191
Total Dissolved Solids	mg/L	2.00	7492825	1.00	7492825	8.00	7492825
<b>Misc. Inorganics</b>							
Alkalinity (Total as CaCO3)	mg/L	1.19	7493436	0.59	7493436	7.02	7493436
Alkalinity (PP as CaCO3)	mg/L	<0.50	7493436	<0.50	7493436	<0.50	7493436
Bicarbonate (HCO3)	mg/L	1.45	7493436	0.72	7493436	8.56	7493436
Carbonate (CO3)	mg/L	<0.50	7493436	<0.50	7493436	<0.50	7493436
Hydroxide (OH)	mg/L	<0.50	7493436	<0.50	7493436	<0.50	7493436
<b>Anions</b>							
Orthophosphate (P)	mg/L	0.0028(1)	7492742	<0.0010(1)	7492742	0.0054(1)	7492742
Dissolved Sulphate (SO4)	mg/L	<0.50	7491858	<0.50	7491858	<0.50	7491858
Dissolved Chloride (Cl)	mg/L	<0.50	7491841	<0.50	7491841	<0.50	7491841
<b>Nutrients</b>							
Total Ammonia (N)	mg/L	0.075	7493440	0.095	7493440	0.14	7493440
Dissolved Phosphorus (P)	mg/L	0.0063(1)	7491863	0.0047(1)	7513177	0.0485(1)	7491863
Total Total Kjeldahl Nitrogen (Calc)	mg/L	0.043	7490192	0.087	7490192	0.123	7490192
Nitrate plus Nitrite (N)	mg/L	0.130(1)	7493580	0.0679(1)	7493580	0.118(1)	7493580
Nitrite (N)	mg/L	0.0028(1)	7493582	<0.0020(1)	7493582	0.0027(1)	7493582
Total Nitrogen (N)	mg/L	0.173	7493460	0.155	7493460	0.241	7493460
Total Phosphorus (P)	mg/L	0.0274	7500143	0.0089	7513219	0.0231	7500143
<b>Physical Properties</b>							
Conductivity	uS/cm	6.8	7493445	3.6	7493445	17.6	7493445
pH	pH	6.26	7493444	5.88	7493444	7.09	7493444
<b>Physical Properties</b>							
Total Suspended Solids	mg/L	60.5	7495665	19.0	7495665	54.8	7495665
Total Dissolved Solids	mg/L	<10(1)	7502574	<10(1)	7502574	<10(1)	7502574
Turbidity	NTU	5.52(1)	7492007	1.25(1)	7492007	7.30(1)	7492007

N/A = Not Applicable  
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(1) - Sample arrived to laboratory past recommended hold time.

DIAMOND MINES INC.  
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Your P.O. #: K16877  
Sampler Initials: DD

Maxxam Job #: B439794  
Report Date: 2014/06/05

**ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)**

Maxxam ID	JQ2143	JQ2144	JQ2145	JQ2146	JQ2147	JQ2148	JQ2149	
Sampling Date	2014/04/08	2014/04/08	2014/04/19	2014/04/19	2014/04/19	2014/04/19	2014/04/19	
UNITS	SS1-4	SS1-5	SS2-1	SS2-2	SS2-3	SS2-4	SS3-4	RDL
	QC Batch	QC Batch	QC Batch	QC Batch	QC Batch	QC Batch	QC Batch	QC Batch
<b>Dissolved Metals by ICP</b>								
Dissolved Aluminum (Al)	mg/L	7494312	7494312	7494312	7494312	7494312	7494312	0.050
Dissolved Antimony (Sb)	mg/L	7494312	7494312	7494312	7494312	7494312	7494312	0.050
Dissolved Arsenic (As)	mg/L	7494312	7494312	7494312	7494312	7494312	7494312	0.030
Dissolved Barium (Ba)	mg/L	0.0025	7494312	0.0021	0.0062	0.0027	0.0256	0.0010
Dissolved Beryllium (Be)	mg/L	<0.0030	7494312	<0.0030	<0.0030	<0.0030	<0.0030	0.0030
Dissolved Bismuth (Bi)	mg/L	<0.050	7494312	<0.050	<0.050	<0.050	<0.050	0.050
Dissolved Boron (B)	mg/L	<0.010	7494312	<0.010	<0.010	<0.010	<0.010	0.010
Dissolved Cadmium (Cd)	mg/L	<0.0050	7494312	<0.0050	<0.0050	<0.0050	<0.0050	0.0050
Dissolved Chromium (Cr)	mg/L	<0.010	7494312	<0.010	<0.010	<0.010	<0.010	0.010
Dissolved Cobalt (Co)	mg/L	<0.020	7494312	<0.020	<0.020	<0.020	<0.020	0.020
Dissolved Copper (Cu)	mg/L	<0.020	7494312	<0.020	<0.020	<0.020	<0.020	0.020
Dissolved Iron (Fe)	mg/L	<0.010	7494312	<0.010	<0.010	<0.010	<0.010	0.010
Dissolved Lead (Pb)	mg/L	<0.030	7494312	<0.030	<0.030	<0.030	<0.030	0.030
Dissolved Lithium (Li)	mg/L	<0.020	7494312	<0.020	<0.020	<0.020	<0.020	0.020
Dissolved Manganese (Mn)	mg/L	0.0038	7494312	0.0036	0.0100	0.0031	0.0036	0.0030
Dissolved Molybdenum (Mo)	mg/L	<0.020	7494312	<0.020	<0.020	<0.020	<0.020	0.020
Dissolved Nickel (Ni)	mg/L	<0.020	7494312	<0.020	<0.020	<0.020	<0.020	0.020
Dissolved Phosphorus (P)	mg/L	<0.050	7494312	<0.050	<0.050	<0.050	<0.050	0.050
Dissolved Selenium (Se)	mg/L	<0.10	7494312	<0.10	<0.10	<0.10	<0.10	0.10
Dissolved Silicon (Si)	mg/L	0.091	7494312	0.058	0.117	<0.050	0.355	0.050
Dissolved Silver (Ag)	mg/L	<0.010	7494312	<0.010	<0.010	<0.010	<0.010	0.010
Dissolved Strontium (Sr)	mg/L	0.0025	7494312	0.0015	0.0057	0.0024	0.0170	0.0010
Dissolved Tin (Sn)	mg/L	<0.030	7494312	<0.030	<0.030	<0.030	<0.030	0.030
Dissolved Titanium (Ti)	mg/L	<0.0050	7494312	<0.0050	<0.0050	<0.0050	<0.0050	0.0050
Dissolved Vanadium (V)	mg/L	<0.010	7494312	<0.010	<0.010	<0.010	<0.010	0.010
Dissolved Zinc (Zn)	mg/L	<0.0050	7494312	<0.0050	<0.0050	<0.0050	<0.0050	0.0050
Dissolved Zirconium (Zr)	mg/L	<0.020	7494312	<0.020	<0.020	<0.020	<0.020	0.020
Dissolved Calcium (Ca)	mg/L	0.433	7494312	0.228	0.829	0.350	2.68	0.050
Dissolved Magnesium (Mg)	mg/L	0.091	7494312	0.109	0.190	0.070	0.328	0.050
Dissolved Potassium (K)	mg/L	<0.30	7494312	<0.30	<0.30	<0.30	<0.30	0.30
Dissolved Sodium (Na)	mg/L	0.21	7494312	0.13	<0.10	<0.10	<0.10	0.10
Dissolved Sulphur (S)	mg/L	0.11	7494312	0.14	0.13	0.10	0.29	0.10

RDL = Reportable Detection Limit

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Your P.O. #: K16877  
Sampler Initials: DD

Maxxam Job #: B439794  
Report Date: 2014/06/05

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2143		
Sampling Date	2014/04/08		
	<b>SS1-4</b>		<b>RDL</b>
	<b>UNITS</b>		<b>QC Batch</b>
<b>Calculated Parameters</b>			
Total Hardness (CaCO3)	mg/L	2.21	0.50
<b>Elements</b>			
Total Mercury (Hg)	ug/L	<0.0020	0.0020
			7490189
			7495575

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RDL = Reportable Detection Limit

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Maxxam Job #: B439794  
 Report Date: 2014/06/05

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2143			
Sampling Date	2014/04/08			
UNITS		RDL		
SS1-4		QC Batch		
<b>Total Metals by ICPMS</b>				
Total Aluminum (Al)	ug/L	128	0.50	7498228
Total Antimony (Sb)	ug/L	0.028	0.020	7498228
Total Arsenic (As)	ug/L	0.093	0.020	7498228
Total Barium (Ba)	ug/L	4.12	0.020	7498228
Total Beryllium (Be)	ug/L	<0.010	0.010	7498228
Total Bismuth (Bi)	ug/L	0.0110	0.0050	7498228
Total Boron (B)	ug/L	<5.0	5.0	7498228
Total Cadmium (Cd)	ug/L	<0.0050	0.0050	7498228
Total Chromium (Cr)	ug/L	1.46	0.050	7498228
Total Cobalt (Co)	ug/L	0.241	0.0050	7498228
Total Copper (Cu)	ug/L	0.722	0.050	7498228
Total Iron (Fe)	ug/L	267	1.0	7498228
Total Lead (Pb)	ug/L	0.268	0.0050	7498228
Total Lithium (Li)	ug/L	0.53	0.50	7498228
Total Manganese (Mn)	ug/L	5.67	0.050	7498228
Total Molybdenum (Mo)	ug/L	0.114	0.050	7498228
Total Nickel (Ni)	ug/L	2.45	0.020	7498228
Total Selenium (Se)	ug/L	<0.040	0.040	7498228
Total Silicon (Si)	ug/L	282	50	7498228
Total Silver (Ag)	ug/L	<0.0050	0.0050	7498228
Total Strontium (Sr)	ug/L	2.08	0.050	7498228
Total Thallium (Tl)	ug/L	0.0040	0.0020	7498228
Total Tin (Sn)	ug/L	0.037	0.010	7498228
Total Titanium (Ti)	ug/L	10.3	0.50	7498228
Total Uranium (U)	ug/L	0.120	0.0020	7498228
Total Vanadium (V)	ug/L	0.38	0.10	7498228
Total Zinc (Zn)	ug/L	3.44	0.10	7498228
Total Zirconium (Zr)	ug/L	0.052	0.050	7498228
Total Calcium (Ca)	mg/L	0.425	0.010	7490190
Total Magnesium (Mg)	mg/L	0.280	0.010	7490190
Total Potassium (K)	mg/L	0.096	0.010	7490190
Total Sodium (Na)	mg/L	0.064	0.010	7490190
Total Sulphur (S)	mg/L	<0.10	0.10	7490190

RDL = Reportable Detection Limit

Maxxam Job #: B439794  
 Report Date: 2014/06/05

DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2144	JQ2145	JQ2146	JQ2147	JQ2148	
Sampling Date	2014/04/08	2014/04/19	2014/04/19	2014/04/19	2014/04/19	
UNITS						
		<b>SS1-5</b>	<b>SS2-1</b>	<b>SS2-2</b>	<b>SS2-3</b>	<b>SS2-4</b>
		<b>RDL</b>	<b>QC Batch</b>			<b>RDL</b>
						<b>QC Batch</b>
<b>Calculated Parameters</b>						
Total Hardness (CaCO3)	mg/L	1.00	3.25	4.65	2.04	2.94
<b>Elements</b>						
Total Mercury (Hg)	ug/L	<0.0020	<0.0020	<0.0020	0.0028	<0.0020
		0.50	7490189	7490189	0.0020	0.0020
		0.0020	7495575	7495575	0.0020	7495575

RDL = Reportable Detection Limit

DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439794  
Report Date: 2014/06/05

Your P.O. #: K16877  
Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2144	JQ2145	JQ2146	JQ2147	JQ2148	
Sampling Date	2014/04/08	2014/04/19	2014/04/19	2014/04/19	2014/04/19	
UNITS	SS1-5	SS2-1	SS2-2	SS2-3	SS2-4	
	RDL	QC Batch	QC Batch	RDL	RDL	QC Batch
<b>Total Metals by ICPMS</b>						
Total Aluminum (Al)	157	94.6	196	81.5	213	7498228
Total Antimony (Sb)	<0.020	0.046	0.027	<0.020	0.024	7498228
Total Arsenic (As)	0.170	0.094	0.210	0.070	0.316	7498228
Total Barium (Ba)	4.31	4.98	9.12	3.94	5.16	7498228
Total Beryllium (Be)	<0.010	<0.010	<0.010	<0.010	<0.010	7498228
Total Bismuth (Bi)	0.0190	0.0120	0.0160	<0.0050	0.0210	7498228
Total Boron (B)	<5.0	<5.0	<5.0	<5.0	<5.0	7498228
Total Cadmium (Cd)	0.0050	0.0050	0.0070	<0.0050	0.0060	7498228
Total Chromium (Cr)	0.862	1.09	2.00	1.02	1.47	7498228
Total Cobalt (Co)	0.172	0.179	0.333	0.149	0.272	7498228
Total Copper (Cu)	0.567	0.902	0.616	0.635	0.575	7498228
Total Iron (Fe)	245	223	394	278	394	7498228
Total Lead (Pb)	0.344	0.236	0.418	0.273	0.391	7498228
Total Lithium (Li)	0.81	<0.50	0.73	<0.50	0.93	7498228
Total Manganese (Mn)	5.78	4.64	9.45	5.24	7.97	7498228
Total Molybdenum (Mo)	<0.050	0.119	0.117	0.085	0.102	7498228
Total Nickel (Ni)	1.93	2.91	5.50	2.44	3.60	7498228
Total Selenium (Se)	<0.040	<0.040	<0.040	<0.040	<0.040	7498228
Total Silicon (Si)	263	263	466	191	466	7498228
Total Silver (Ag)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	7498228
Total Strontium (Sr)	1.62	3.43	4.96	2.24	2.57	7498228
Total Thallium (Tl)	0.0040	0.0020	0.0040	0.0020	0.0050	7498228
Total Tin (Sn)	0.014	0.075	0.025	0.026	0.034	7498228
Total Titanium (Ti)	11.3	7.60	15.5	6.94	14.7	7498228
Total Uranium (U)	0.252	0.116	0.187	0.0760	0.183	7498228
Total Vanadium (V)	0.38	0.32	0.51	0.28	0.56	7498228
Total Zinc (Zn)	4.27	7.16	8.71	3.37	6.78	7498228
Total Zirconium (Zr)	0.073	0.088	0.095	<0.050	0.110	7498228
Total Calcium (Ca)	0.223	0.767	0.790	0.362	0.444	7490190
Total Magnesium (Mg)	0.109	0.324	0.649	0.275	0.445	7490190
Total Potassium (K)	0.080	0.098	0.152	0.075	0.141	7490190
Total Sodium (Na)	0.077	0.342	0.125	0.156	0.426	7490190
Total Sulphur (S)	<0.60	<0.10	<0.10	<0.10	<0.10	7490190

RDL = Reportable Detection Limit



Maxxam Job #: B439794  
 Report Date: 2014/06/05

DIAVIK DIAMOND MINES INC.  
 Client Project #: AEMP

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 Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2149		
Sampling Date	2014/04/19		
	<b>SS3-4</b>		
	<b>UNITS</b>		<b>RDL</b>
<b>Calculated Parameters</b>			<b>QC Batch</b>
Total Hardness (CaCO3)	mg/L	11.6	0.50
<b>Elements</b>			7490189
Total Mercury (Hg)	ug/L	<0.0020	0.0020
			7495575

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RDL = Reportable Detection Limit

DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439794  
Report Date: 2014/06/05

Your P.O. #: K16877  
Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2149			
Sampling Date	2014/04/19			
	SS3-4			
<b>Total Metals by ICPMS</b>				
	UNITS		RDL	QC Batch
Total Aluminum (Al)	ug/L	250	0.50	7498228
Total Antimony (Sb)	ug/L	0.062	0.020	7498228
Total Arsenic (As)	ug/L	0.189	0.020	7498228
Total Barium (Ba)	ug/L	25.9	0.020	7498228
Total Beryllium (Be)	ug/L	<0.010	0.010	7498228
Total Bismuth (Bi)	ug/L	0.0240	0.0050	7498228
Total Boron (B)	ug/L	<5.0	5.0	7498228
Total Cadmium (Cd)	ug/L	0.0060	0.0050	7498228
Total Chromium (Cr)	ug/L	3.42	0.050	7498228
Total Cobalt (Co)	ug/L	0.572	0.0050	7498228
Total Copper (Cu)	ug/L	0.896	0.050	7498228
Total Iron (Fe)	ug/L	570	1.0	7498228
Total Lead (Pb)	ug/L	0.539	0.0050	7498228
Total Lithium (Li)	ug/L	0.77	0.50	7498228
Total Manganese (Mn)	ug/L	11.0	0.050	7498228
Total Molybdenum (Mo)	ug/L	0.150	0.050	7498228
Total Nickel (Ni)	ug/L	10.1	0.020	7498228
Total Selenium (Se)	ug/L	<0.040	0.040	7498228
Total Silicon (Si)	ug/L	998	50	7498228
Total Silver (Ag)	ug/L	<0.0050	0.0050	7498228
Total Strontium (Sr)	ug/L	15.2	0.050	7498228
Total Thallium (Tl)	ug/L	0.0050	0.0020	7498228
Total Tin (Sn)	ug/L	0.059	0.010	7498228
Total Titanium (Ti)	ug/L	19.5	0.50	7498228
Total Uranium (U)	ug/L	0.287	0.0020	7498228
Total Vanadium (V)	ug/L	0.82	0.10	7498228
Total Zinc (Zn)	ug/L	4.54	0.10	7498228
Total Zirconium (Zr)	ug/L	0.143	0.050	7498228
Total Calcium (Ca)	mg/L	2.45	0.010	7490190
Total Magnesium (Mg)	mg/L	1.32	0.010	7490190
Total Potassium (K)	mg/L	0.217	0.010	7490190
Total Sodium (Na)	mg/L	0.334	0.010	7490190
Total Sulphur (S)	mg/L	<0.10	0.10	7490190

RDL = Reportable Detection Limit

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Your P.O. #: K16877  
Sampler Initials: DD

Maxxam Job #: B439794  
Report Date: 2014/06/05

Package 1 5.7°C

Each temperature is the average of up to three cooler temperatures taken at receipt

Sample JQ2144, ICP-AES Dissolved Metals in Water: Test repeated.  
Sample JQ2144, Elements by ICPMS Low Level (total): Test repeated.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7491245	Fluoride (F)	2014/05/20	NC	80 - 120	90	80 - 120	<0.010	mg/L		
7491841	Dissolved Chloride (Cl)	2014/05/20	90	80 - 120	100	80 - 120	<0.50	mg/L	NC	20
7491858	Dissolved Sulphate (SO4)	2014/05/20	NC	80 - 120	99	80 - 120	<0.50	mg/L	NC	20
7491863	Dissolved Phosphorus (P)	2014/05/21	NC	80 - 120	102	80 - 120	<0.0020	mg/L	2.7	20
7492007	Turbidity	2014/05/20			102	80 - 120	<0.10	NTU	2.3	20
7492742	Orthophosphate (P)	2014/05/21	91	80 - 120	98	80 - 120	<0.0010	mg/L	6.3	20
7492761	Acidity (pH 8.3)	2014/05/21			105	80 - 120	<0.50	mg/L	NC	20
7492761	Acidity (pH 4.5)	2014/05/21					<0.50	mg/L	NC	20
7493436	Alkalinity (Total as CaCO3)	2014/05/21	NC	80 - 120	96	80 - 120	<0.50	mg/L	6.5	20
7493436	Alkalinity (PP as CaCO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Bicarbonate (HCO3)	2014/05/21					<0.50	mg/L	6.5	20
7493436	Carbonate (CO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Hydroxide (OH)	2014/05/21					<0.50	mg/L	NC	20
7493440	Total Ammonia (N)	2014/05/21	97	80 - 120	94	80 - 120	<0.0050	mg/L	10.2	20
7493445	Conductivity	2014/05/21			98	80 - 120	1.3, RDL=1.0	uS/cm	0	20
7493460	Total Nitrogen (N)	2014/05/21			96	80 - 120	<0.020	mg/L	1.5	20
7493580	Nitrate plus Nitrite (N)	2014/05/21	101	80 - 120	104	80 - 120	<0.0020	mg/L	0.08	25
7493582	Nitrite (N)	2014/05/21	99	80 - 120	101	80 - 120	<0.0020	mg/L	NC	25
7494312	Dissolved Aluminum (Al)	2014/05/23	112	80 - 120	108	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Antimony (Sb)	2014/05/23	93	80 - 120	93	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Arsenic (As)	2014/05/23	100	80 - 120	98	80 - 120	<0.030	mg/L	NC	20
7494312	Dissolved Barium (Ba)	2014/05/23	110	80 - 120	103	80 - 120	<0.0010	mg/L	1.9	20
7494312	Dissolved Beryllium (Be)	2014/05/23	111	80 - 120	104	80 - 120	<0.0030	mg/L	NC	20
7494312	Dissolved Boron (B)	2014/05/23	107	80 - 120	99	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Cadmium (Cd)	2014/05/23	107	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7494312	Dissolved Chromium (Cr)	2014/05/23	105	80 - 120	100	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Cobalt (Co)	2014/05/23	105	80 - 120	101	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Copper (Cu)	2014/05/23	103	80 - 120	100	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Iron (Fe)	2014/05/23	109	80 - 120	105	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Lead (Pb)	2014/05/23	105	80 - 120	101	80 - 120	<0.030	mg/L	NC	20
7494312	Dissolved Lithium (Li)	2014/05/23	114	80 - 120	106	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Manganese (Mn)	2014/05/23	106	80 - 120	102	80 - 120	<0.0030	mg/L	NC	20
7494312	Dissolved Molybdenum (Mo)	2014/05/23	101	80 - 120	99	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Nickel (Ni)	2014/05/23	106	80 - 120	101	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Phosphorus (P)	2014/05/23	104	80 - 120	102	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Selenium (Se)	2014/05/23	101	80 - 120	98	80 - 120	<0.10	mg/L	NC	20
7494312	Dissolved Silicon (Si)	2014/05/23	98	80 - 120	98	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Silver (Ag)	2014/05/23	98	80 - 120	101	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Strontium (Sr)	2014/05/23	109	80 - 120	101	80 - 120	<0.0010	mg/L	NC	20

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7494312	Dissolved Tin (Sn)	2014/05/23	102	80 - 120	98	80 - 120	<0.030	mg/L	NC	20
7494312	Dissolved Titanium (Ti)	2014/05/23	106	80 - 120	102	80 - 120	<0.0050	mg/L	NC	20
7494312	Dissolved Vanadium (V)	2014/05/23	106	80 - 120	100	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Zinc (Zn)	2014/05/23	108	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7494312	Dissolved Zirconium (Zr)	2014/05/23	106	80 - 120	100	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Calcium (Ca)	2014/05/23	106	80 - 120	102	80 - 120	<0.050	mg/L	1.5	20
7494312	Dissolved Magnesium (Mg)	2014/05/23	106	80 - 120	101	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Potassium (K)	2014/05/23	104	80 - 120	101	80 - 120	<0.30	mg/L	NC	20
7494312	Dissolved Sodium (Na)	2014/05/23	108	80 - 120	103	80 - 120	<0.10	mg/L	NC	20
7494312	Dissolved Sulphur (S)	2014/05/23	103	80 - 120	100	80 - 120	<0.10	mg/L	NC	20
7494312	Dissolved Bismuth (Bi)	2014/05/23					<0.050	mg/L	NC	20
7495575	Total Mercury (Hg)	2014/05/23	98	80 - 120	100	80 - 120	<0.0020	ug/L	NC	20
7495665	Total Suspended Solids	2014/05/26			99	80 - 120	<1.0	mg/L		
7498228	Total Aluminum (Al)	2014/05/26	NC	80 - 120	101	80 - 120	<0.50	ug/L	0.4	20
7498228	Total Antimony (Sb)	2014/05/26	99	80 - 120	104	80 - 120	<0.020	ug/L	NC	20
7498228	Total Arsenic (As)	2014/05/26	98	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
7498228	Total Barium (Ba)	2014/05/26	NC	80 - 120	94	80 - 120	<0.020	ug/L	1.1	20
7498228	Total Beryllium (Be)	2014/05/26	93	80 - 120	98	80 - 120	<0.010	ug/L	NC	20
7498228	Total Bismuth (Bi)	2014/05/26	96	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Cadmium (Cd)	2014/05/26	98	80 - 120	101	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Chromium (Cr)	2014/05/26	96	80 - 120	103	80 - 120	<0.050	ug/L	1.0	20
7498228	Total Cobalt (Co)	2014/05/26	96	80 - 120	100	80 - 120	<0.0050	ug/L	1	20
7498228	Total Copper (Cu)	2014/05/26	93	80 - 120	101	80 - 120	<0.050	ug/L	7.2	20
7498228	Total Iron (Fe)	2014/05/26	NC	80 - 120	107	80 - 120	<1.0	ug/L	5.3	20
7498228	Total Lead (Pb)	2014/05/26	94	80 - 120	97	80 - 120	<0.0050	ug/L	2.1	20
7498228	Total Lithium (Li)	2014/05/26	97	80 - 120	102	80 - 120	<0.50	ug/L	NC	20
7498228	Total Manganese (Mn)	2014/05/26	NC	80 - 120	101	80 - 120	<0.050	ug/L	2.7	20
7498228	Total Molybdenum (Mo)	2014/05/26	95	80 - 120	96	80 - 120	<0.050	ug/L	NC	20
7498228	Total Nickel (Ni)	2014/05/26	NC	80 - 120	103	80 - 120	<0.020	ug/L	8.6	20
7498228	Total Selenium (Se)	2014/05/26	105	80 - 120	109	80 - 120	<0.040	ug/L	NC	20
7498228	Total Silver (Ag)	2014/05/26	98	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Strontium (Sr)	2014/05/26	96	80 - 120	93	80 - 120	<0.050	ug/L	3.3	20
7498228	Total Thallium (Tl)	2014/05/26	95	80 - 120	98	80 - 120	<0.0020	ug/L	NC	20
7498228	Total Tin (Sn)	2014/05/26	96	80 - 120	99	80 - 120	<0.010	ug/L	NC	20
7498228	Total Titanium (Ti)	2014/05/26	NC	80 - 120	104	80 - 120	<0.50	ug/L	6.6	20
7498228	Total Uranium (U)	2014/05/26	97	80 - 120	99	80 - 120	<0.0020	ug/L	1.2	20
7498228	Total Vanadium (V)	2014/05/26	96	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7498228	Total Zinc (Zn)	2014/05/26	99	80 - 120	102	80 - 120	<0.10	ug/L	1.7	20
7498228	Total Boron (B)	2014/05/26					<5.0	ug/L	NC	20

Maxxam Job #: B439794  
 Report Date: 2014/06/05

DIAVIK DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

**QUALITY ASSURANCE REPORT**

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7498228	Total Silicon (Si)	2014/05/26					<50		5.3	20
7498228	Total Zirconium (Zr)	2014/05/26					<0.050		NC	20
7500143	Total Phosphorus (P)	2014/05/28	89	80 - 120	99	80 - 120	<0.0020	mg/L		
7502574	Total Dissolved Solids	2014/05/28	102	80 - 120	92	80 - 120	<10	mg/L	NC	20
7511644	Dissolved Strontium (Sr)	2014/06/04	105	80 - 120	101	80 - 120	<0.0010	mg/L	0	20
7511644	Dissolved Calcium (Ca)	2014/06/04	103	80 - 120	103	80 - 120	<0.050	mg/L	1.2	20
7511644	Dissolved Sodium (Na)	2014/06/04	105	80 - 120	105	80 - 120	<0.10	mg/L	0.8	20
7511644	Dissolved Sulphur (S)	2014/06/04	NC	80 - 120	99	80 - 120	<0.10	mg/L	1.4	20
7512951	Total Strontium (Sr)	2014/06/05			95	80 - 120	<0.050	ug/L		
7513177	Dissolved Phosphorus (P)	2014/06/05	102	80 - 120	100	80 - 120	<0.0020	mg/L	5.3	20
7513219	Total Phosphorus (P)	2014/06/05			100	80 - 120	<0.0020	mg/L		

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Spiked Blank: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

## Validation Signature Page

**Maxxam Job #: B439794**

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The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Rob Reinert, Data Validation Coordinator

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Date Shipped: 2014-May-15

Results Received:

05/S40 (1)

B4 39794

Shipping Memo: 72469

Maxxam Job #:



Diavik Diamond Mines Inc. - Chain of Custody

Contact Information - Sample Inquiry  
 Diavik Diamond Mines Inc.  
 P.O. Box 2488  
 5007-50 Ave  
 Yellowknife, NT  
 X1A 2P8

DDMI ENVIRONMENT  
 DDMIENVIRONMENT@RIOTINTO.COM  
 DMI ENVIRONMENT  
 DMIENVIRONMENT@RIOTINTO.COM

REPORT TO: MAXXAM  
 Site Env. Supervisor  
 Dwight Grubbe / Sam Blvd @ 867-669-6000 ext 5403

REPORT DISTRIBUTION  
 Electronic PDF  
 Electronic Excel  
 Hard Copy

DDMI ACCOUNTS PAYABLE  
 DDMIAP@RIOTINTO.COM  
 Reference PO # K16877- (Maxxam 2014)

SERVICE REQUESTED  
 Regular (Default)  
 Priority (50% Surcharge)  
 Emergency (100% Surcharge)

INVOICE TO  
 PROJECT INFORMATION  
 Project: SS1-4  
 Type: GW

ANALYSIS REQUESTED	RESULTS	DATE	TYPE
Routine Parameters (pH, EC, Acidity, Alkalinity, T, K, Cl, SO4, PO4, NO2, NO3, Dissolved Phosphorus, TDS)	✓	2014-Apr-08	GW
Nutrients (Ammonia, Total Phosphorus, TNQ) PRESERVED	✓	2014-Apr-08	GW
TOC (Total Organic Carbon) - analyses to be taken from the 120ml Nutrient bottle UNPRESERVED	✓	2014-Apr-08	GW
DOC (Dissolved Organic Carbon) UNFILTERED & UNPRESERVED	✓	2014-Apr-08	GW
Total Mercury PRESERVED	✓	2014-Apr-08	GW
Dissolved Metals Low Level + Sb, Se UNFILTERED & UNPRESERVED	✓	2014-Apr-08	GW
Dissolved Mercury - UNFILTERED & UNPRESERVED	✓	2014-Apr-08	GW
Oil & Grease PRESERVED	✓	2014-Apr-08	GW
TEH (2 bottles)	✓	2014-Apr-08	GW
PAH (TEH + 1 bottle)	✓	2014-Apr-08	GW
BTEX (2 bottles)	✓	2014-Apr-08	GW
Biological Oxygen Demand (BOD)	✓	2014-Apr-08	GW
Fecal Coliforms (2 bottles)	✓	2014-Apr-08	GW
TSS/Turb/pH	✓	2014-Apr-08	GW



B439794

SAMPLE CONDITION (SHIPPED)	TEMP °C	PROZEN	COLD	AMBIENT
5.0	6,617			

SPECIAL INSTRUCTIONS	RECEIVED BY:	DATE / TIME:
Final Destination Blumby RC 35 BOTTLES	JOSE RIVERA	2014-May-15

SAMPLE CONDITION (RECEIVED)	TEMP °C	PROZEN	COLD	AMBIENT
	6,617			

RELINQUISHED BY:	DATE / TIME:
DD	2014-May-15

Report Uploaded to MP5:  
 Data Checked for Breaches:

Relinquished by: Jose Rivera  
 2014 page 57 of 67 15:44

Received by: Jose Rivera  
 2014/05/16 10:11

Doc # ENVI-140-0112.R0

JCE: Present  
 Custody Seal: Absent

ADG-6  
 MAY 17 2014 11:10  
 CS: Y65 7,5/5



Your P.O. #: K16877  
Your Project #: AEMP  
PO # K16877  
Your C.O.C. #: 08344670

**Attention:DDMI Environment**

DIAMIK DIAMOND MINES INC.  
P.O. BOX 2498  
300-5201 - 50th AVE.  
YELLOWKNIFE, NT  
CANADA X1A 2P8

**Report Date: 2015/01/21**  
Report #: R1790671  
Version: 5 - Revision

**CERTIFICATE OF ANALYSIS – REVISED REPORT**

**MAXXAM JOB #: B439784**

**Received: 2014/05/17, 11:10**

Sample Matrix: Water  
# Samples Received: 6

Analyses	Quantity	Date		Laboratory Method	Analytical Method
		Extracted	Analyzed		
Acidity pH 4.5 & pH 8.3 (as CaCO3)	6	N/A	2014/05/21	BBY6SOP-00037	SM 22 2310 B m
Alkalinity - Water	6	2014/05/21	2014/05/21	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	6	N/A	2014/05/17	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	6	N/A	2014/05/21	BBY6SOP-00026	SM 22 2510 B m
Fluoride - Mining Clients	6	N/A	2014/05/20	BBY6SOP-00048	SM 22 4500-F C m
Hardness Total (calculated as CaCO3)	6	N/A	2014/05/27	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Total-LowLevel) by CVAF	1	2014/05/23	2014/05/23	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Mercury (Total-LowLevel) by CVAF	5	2014/05/26	2014/05/26	BBY7SOP-00015	BCMOE BCLM Oct2013 m
ICP-AES Dissolved Metals in Water	6	N/A	2014/05/23	BBY7SOP-00018	EPA 6010c R3 m
Na, K, Ca, Mg, S by CRC ICPMS (total)	6	N/A	2014/05/27	BBY7SOP-00002	EPA 6020A R1 m
Elements by ICPMS Low Level (total)	6	N/A	2014/05/26	BBY7SOP-00002	EPA 6020A R1 m
Elements by ICPMS Low Level (total)	1	N/A	2015/01/20	BBY7SOP-00002	EPA 6020A R1 m
Nitrogen (Total)	5	2014/05/21	2014/05/21	BBY6SOP-00016	SM 22 4500-N C m
Nitrogen (Total)	1	2014/05/22	2014/05/23	BBY6SOP-00016	SM 22 4500-N C m
Ammonia-N (Preserved)	6	N/A	2014/05/20	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate+Nitrite (N) (low level)	6	N/A	2014/05/17	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) (low level)	6	N/A	2014/05/17	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	6	N/A	2014/05/17	BBY6SOP-00010	SM 22 4500-NO3- I m
pH Water (1)	6	N/A	2014/05/21	BBY6SOP-00026	SM 22 4500-H+ B m
Orthophosphate by Konelab (low level)	6	N/A	2014/05/17	BBY6SOP-00013	SM 22 4500-P E m
Sulphate by Automated Colourimetry	6	N/A	2014/05/17	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Calculated)	6	N/A	2014/05/23	BBY WI-00033	Calculated Parameter
Total Dissolved Solids (Filt. Residue)	2	2014/05/23	2014/05/28	BBY6SOP-00033	SM 22 2540 C m
Total Dissolved Solids (Filt. Residue)	1	N/A	2014/05/29	BBY6SOP-00033	SM 2540C
Total Dissolved Solids (Filt. Residue)	3	N/A	2014/06/02	BBY6SOP-00033	SM 2540C
TKN (Calc. TN, N/N) total	5	N/A	2014/05/21	BBY WI-00033	Calculation
TKN (Calc. TN, N/N) total	1	N/A	2014/05/26	BBY WI-00033	Calculation
Phosphorus-P (LL Tot, dissolved) - UF/UP	6	2014/05/17	2014/05/21	BBY6SOP-00013	SM 22 4500-P E m
Total Phosphorus	6	N/A	2014/05/21	BBY6SOP-00013	SM 22 4500-P E m

Your P.O. #: K16877  
Your Project #: AEMP  
PO # K16877  
Your C.O.C. #: 08344670

**Attention:DDMI Environment**

DIAMIK DIAMOND MINES INC.  
P.O. BOX 2498  
300-5201 - 50th AVE.  
YELLOWKNIFE, NT  
CANADA X1A 2P8

**Report Date: 2015/01/21**  
Report #: R1790671  
Version: 5 - Revision

**CERTIFICATE OF ANALYSIS – REVISED REPORT**

**MAXXAM JOB #: B439784**

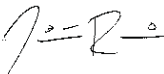
**Received: 2014/05/17, 11:10**

Sample Matrix: Water  
# Samples Received: 6

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Total Suspended Solids-Low Level	6	2014/05/23	2014/05/26	BBY6SOP-00034	SM 22 2540 D
Turbidity	6	N/A	2014/05/20	BBY6SOP-00027	SM 22 2130 B m

\* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key  Tabitha Rudkin  
21 Jan 2015 10:48:02 -08:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.  
Tabitha Rudkin, ASCT, Burnaby Project Manager  
Email: TRudkin@maxxam.ca  
Phone# (604)638-2639

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

**RESULTS OF CHEMICAL ANALYSES OF WATER**

Maxxam ID		JQ2099			JQ2100	JQ2101	JQ2102		
Sampling Date		2014/04/19			2014/04/19	2014/04/19	2014/04/19		
COC Number		08344670			08344670	08344670	08344670		
	Units	SS4-5	RDL	QC Batch	SS5-3	SS5-4	SS5-5-4	RDL	QC Batch
<b>Misc. Inorganics</b>									
Acidity (pH 4.5)	mg/L	<0.50	0.50	7492761	<0.50	<0.50	<0.50	0.50	7492761
Acidity (pH 8.3)	mg/L	<0.50	0.50	7492761	<0.50	<0.50	<0.50	0.50	7492761
Fluoride (F)	mg/L	<0.010	0.010	7491245	<0.010	<0.010	<0.010	0.010	7491245
<b>Calculated Parameters</b>									
Nitrate (N)	mg/L	0.0657	0.0020	7490191	0.0526	0.109	0.0931	0.0020	7490191
Total Dissolved Solids	mg/L	2.00	0.50	7491955	2.00	3.00	2.00	0.50	7491955
<b>Misc. Inorganics</b>									
Alkalinity (Total as CaCO <sub>3</sub> )	mg/L	0.98	0.50	7493436	1.35	1.88	1.04	0.50	7493436
Alkalinity (PP as CaCO <sub>3</sub> )	mg/L	<0.50	0.50	7493436	<0.50	<0.50	<0.50	0.50	7493436
Bicarbonate (HCO <sub>3</sub> )	mg/L	1.20	0.50	7493436	1.65	2.29	1.27	0.50	7493436
Carbonate (CO <sub>3</sub> )	mg/L	<0.50	0.50	7493436	<0.50	<0.50	<0.50	0.50	7493436
Hydroxide (OH)	mg/L	<0.50	0.50	7493436	<0.50	<0.50	<0.50	0.50	7493436
<b>Anions</b>									
Orthophosphate (P)	mg/L	0.0052 (1)	0.0010	7490273	0.0041 (1)	0.0069 (1)	0.0065 (1)	0.0010	7490273
Dissolved Sulphate (SO <sub>4</sub> )	mg/L	<0.50	0.50	7490321	<0.50	<0.50	<0.50	0.50	7490321
Dissolved Chloride (Cl)	mg/L	<0.50	0.50	7490289	<0.50	<0.50	<0.50	0.50	7490289
<b>Nutrients</b>									
Total Ammonia (N)	mg/L	0.057	0.0050	7491802	0.034	0.060	0.045	0.0050	7491802
Dissolved Phosphorus (P)	mg/L	0.0077 (1)	0.0020	7490283	0.0059 (1)	0.0151 (1)	0.0095 (1)	0.0020	7490283
Total Total Kjeldahl Nitrogen (Calc)	mg/L	0.092	0.020	7490192	0.055	0.074	0.054	0.020	7490192
Nitrate plus Nitrite (N)	mg/L	0.0657 (1)	0.0020	7490317	0.0552 (1)	0.112 (1)	0.0931 (1)	0.0020	7490317
Nitrite (N)	mg/L	<0.0020 (1)	0.0020	7490318	0.0026 (1)	0.0032 (1)	<0.0020 (1)	0.0020	7490318
Total Nitrogen (N)	mg/L	0.157	0.020	7493460	0.110	0.186	0.147	0.020	7493460
Total Phosphorus (P)	mg/L	0.0179	0.0020	7492847	0.0091	0.0144	0.0127	0.0020	7492847
<b>Physical Properties</b>									
Conductivity	uS/cm	5.0	1.0	7493445	4.8	7.4	4.6	1.0	7493445
pH	pH	6.18	N/A	7493444	6.30	6.46	6.18	N/A	7493444
<b>Physical Properties</b>									
Total Suspended Solids	mg/L	20.1	1.0	7495665	23.8	28.8	20.7	1.0	7495665
Total Dissolved Solids	mg/L	<10 (1)	10	7502574	<1.0 (1)	6.0 (1)	14.0 (1)	1.0	7504241
Turbidity	NTU	3.97 (1)	0.10	7492007	3.61 (1)	8.54 (1)	4.41 (1)	0.10	7492007
RDL = Reportable Detection Limit N/A = Not Applicable (1) Sample arrived to laboratory past recommended hold time.									

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

**RESULTS OF CHEMICAL ANALYSES OF WATER**

Maxxam ID		JQ2103			JQ2104		
Sampling Date		2014/04/19			2014/04/19		
COC Number		08344670			08344670		
	Units	SS5-5-5	RDL	QC Batch	SSC-1	RDL	QC Batch
<b>Misc. Inorganics</b>							
Acidity (pH 4.5)	mg/L	<0.50	0.50	7492761	<0.50	0.50	7492761
Acidity (pH 8.3)	mg/L	<0.50	0.50	7492761	<0.50	0.50	7492761
Fluoride (F)	mg/L	<0.010	0.010	7491245	<0.010	0.010	7491245
<b>Calculated Parameters</b>							
Nitrate (N)	mg/L	0.100	0.0020	7490191	0.0790	0.0020	7490191
Total Dissolved Solids	mg/L	2.00	0.50	7491955	1.00	0.50	7491955
<b>Misc. Inorganics</b>							
Alkalinity (Total as CaCO <sub>3</sub> )	mg/L	0.93	0.50	7493436	0.85	0.50	7493436
Alkalinity (PP as CaCO <sub>3</sub> )	mg/L	<0.50	0.50	7493436	<0.50	0.50	7493436
Bicarbonate (HCO <sub>3</sub> )	mg/L	1.14	0.50	7493436	1.04	0.50	7493436
Carbonate (CO <sub>3</sub> )	mg/L	<0.50	0.50	7493436	<0.50	0.50	7493436
Hydroxide (OH)	mg/L	<0.50	0.50	7493436	<0.50	0.50	7493436
<b>Anions</b>							
Orthophosphate (P)	mg/L	0.0051 (1)	0.0010	7490273	0.0065 (1)	0.0010	7490273
Dissolved Sulphate (SO <sub>4</sub> )	mg/L	<0.50	0.50	7490321	<0.50	0.50	7490321
Dissolved Chloride (Cl)	mg/L	<0.50	0.50	7490289	<0.50	0.50	7490289
<b>Nutrients</b>							
Total Ammonia (N)	mg/L	0.043	0.0050	7491802	0.040	0.0050	7491802
Dissolved Phosphorus (P)	mg/L	0.0099 (1)	0.0020	7490283	0.0100 (1)	0.0020	7490283
Total Total Kjeldahl Nitrogen (Calc)	mg/L	0.121	0.020	7490192	0.045	0.020	7490192
Nitrate plus Nitrite (N)	mg/L	0.102 (1)	0.0020	7490317	0.0824 (1)	0.0020	7490317
Nitrite (N)	mg/L	0.0021 (1)	0.0020	7490318	0.0034 (1)	0.0020	7490318
Total Nitrogen (N)	mg/L	0.223	0.020	7495092	0.127	0.020	7493460
Total Phosphorus (P)	mg/L	0.0114	0.0020	7492847	0.0159	0.0020	7492847
<b>Physical Properties</b>							
Conductivity	uS/cm	4.5	1.0	7493445	4.4	1.0	7493445
pH	pH	6.08	N/A	7493444	6.12	N/A	7493444
<b>Physical Properties</b>							
Total Suspended Solids	mg/L	13.1	1.0	7495665	9.0	1.0	7495665
Total Dissolved Solids	mg/L	10.0 (1)	1.0	7504241	<10 (1)	10	7502574
Turbidity	NTU	4.08 (1)	0.10	7492007	1.78 (1)	0.10	7492007
RDL = Reportable Detection Limit N/A = Not Applicable (1) Sample arrived to laboratory past recommended hold time.							

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

**ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)**

Maxxam ID		JQ2099	JQ2100	JQ2101	JQ2102	JQ2103	JQ2104		
Sampling Date		2014/04/19	2014/04/19	2014/04/19	2014/04/19	2014/04/19	2014/04/19		
COC Number		08344670	08344670	08344670	08344670	08344670	08344670		
	Units	SS4-5	SS5-3	SS5-4	SS5-5-4	SS5-5-5	SSC-1	RDL	QC Batch
<b>Dissolved Metals by ICP</b>									
Dissolved Aluminum (Al)	µg/L	<50	<50	<50	<50	<50	<50	50	7494312
Dissolved Antimony (Sb)	µg/L	<50	<50	<50	<50	<50	<50	50	7494312
Dissolved Arsenic (As)	µg/L	<30	<30	<30	<30	<30	<30	30	7494312
Dissolved Barium (Ba)	µg/L	5.4	7.8	12.5	6.3	6.2	4.6	1.0	7494312
Dissolved Beryllium (Be)	µg/L	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	3.0	7494312
Dissolved Bismuth (Bi)	µg/L	<50	<50	<50	<50	<50	<50	50	7494312
Dissolved Boron (B)	µg/L	<10	<10	<10	<10	<10	<10	10	7494312
Dissolved Cadmium (Cd)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7494312
Dissolved Chromium (Cr)	µg/L	<10	<10	<10	<10	<10	<10	10	7494312
Dissolved Cobalt (Co)	µg/L	<20	<20	<20	<20	<20	<20	20	7494312
Dissolved Copper (Cu)	µg/L	<20	<20	<20	<20	<20	<20	20	7494312
Dissolved Iron (Fe)	µg/L	<10	<10	<10	<10	<10	<10	10	7494312
Dissolved Lead (Pb)	µg/L	<30	<30	<30	<30	<30	<30	30	7494312
Dissolved Lithium (Li)	µg/L	<20	<20	<20	<20	<20	<20	20	7494312
Dissolved Manganese (Mn)	µg/L	<3.0	3.2	5.0	3.5	3.8	3.0	3.0	7494312
Dissolved Molybdenum (Mo)	µg/L	<20	<20	<20	<20	<20	<20	20	7494312
Dissolved Nickel (Ni)	µg/L	<20	<20	<20	<20	<20	<20	20	7494312
Dissolved Phosphorus (P)	µg/L	<50	<50	<50	<50	<50	<50	50	7494312
Dissolved Selenium (Se)	µg/L	<100	<100	<100	<100	<100	<100	100	7494312
Dissolved Silicon (Si)	µg/L	82	80	106	75	77	59	50	7494312
Dissolved Silver (Ag)	µg/L	<10	<10	<10	<10	<10	<10	10	7494312
Dissolved Strontium (Sr)	µg/L	4.2	5.7	8.6	4.6	4.6	3.4	1.0	7494312
Dissolved Tin (Sn)	µg/L	<30	<30	<30	<30	<30	<30	30	7494312
Dissolved Titanium (Ti)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7494312
Dissolved Vanadium (V)	µg/L	<10	<10	<10	<10	<10	<10	10	7494312
Dissolved Zinc (Zn)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7494312
Dissolved Zirconium (Zr)	µg/L	<20	<20	<20	<20	<20	<20	20	7494312
Dissolved Calcium (Ca)	µg/L	571	560	790	479	464	374	50	7494312
Dissolved Magnesium (Mg)	µg/L	119	153	271	145	162	119	50	7494312
Dissolved Potassium (K)	µg/L	<300	<300	<300	<300	<300	<300	300	7494312
Dissolved Sodium (Na)	µg/L	<100	<100	<100	<100	<100	<100	100	7494312
Dissolved Sulphur (S)	µg/L	109	<100	171	<100	<100	118	100	7494312
RDL = Reportable Detection Limit									

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID		JQ2099	JQ2100		JQ2101		JQ2102		
Sampling Date		2014/04/19	2014/04/19		2014/04/19		2014/04/19		
COC Number		08344670	08344670		08344670		08344670		
	Units	SS4-5	SS5-3	QC Batch	SS5-4	QC Batch	SS5-5-4	RDL	QC Batch
<b>Calculated Parameters</b>									
Total Hardness (CaCO3)	mg/L	4.82	5.68	7490189	9.87	7490189	5.41	0.50	7490189
<b>Elements</b>									
Total Mercury (Hg)	ug/L	<0.0020	<0.0020	7498691	<0.0020	7498691	<0.0020	0.0020	7495575
<b>Total Metals by ICPMS</b>									
Total Aluminum (Al)	ug/L	129	107	7498228	200	7498228	124	0.50	7498228
Total Antimony (Sb)	ug/L	0.030	<0.020	7498228	0.028	7498228	<0.020	0.020	7498228
Total Arsenic (As)	ug/L	0.062	0.055	7498228	0.096	7498228	0.054	0.020	7498228
Total Barium (Ba)	ug/L	7.53	10.8	7498228	17.4	7498228	9.63	0.020	7498228
Total Beryllium (Be)	ug/L	<0.010	<0.010	7498228	<0.010	7498228	<0.010	0.010	7498228
Total Bismuth (Bi)	ug/L	0.0060	<0.0050	7498228	0.0080	7498228	0.0060	0.0050	7498228
Total Boron (B)	ug/L	<5.0	<5.0	7498228	<5.0	7498228	<5.0	5.0	7498228
Total Cadmium (Cd)	ug/L	<0.0050	<0.0050	7498228	0.0080	7498228	<0.0050	0.0050	7498228
Total Chromium (Cr)	ug/L	2.09	3.28	7498228	5.11	7498228	2.90	0.050	7498228
Total Cobalt (Co)	ug/L	0.354	0.414	7498228	0.741	7498228	0.413	0.0050	7498228
Total Copper (Cu)	ug/L	0.427	2.99	7498228	0.635	7498228	0.483	0.050	7498228
Total Iron (Fe)	ug/L	306	371	7498228	672	7498228	377	1.0	7498228
Total Lead (Pb)	ug/L	0.228	0.519	7498228	0.534	7498228	0.305	0.0050	7498228
Total Lithium (Li)	ug/L	<0.50	<0.50	7498228	<0.50	7498228	<0.50	0.50	7498228
Total Manganese (Mn)	ug/L	6.25	7.24	7498228	13.2	7498228	7.71	0.050	7498228
Total Molybdenum (Mo)	ug/L	0.093	0.107	7498228	0.119	7498228	0.083	0.050	7498228
Total Nickel (Ni)	ug/L	6.48	8.74	7498228	15.2	7498228	8.66	0.020	7498228
Total Selenium (Se)	ug/L	<0.040	<0.040	7498228	<0.040	7498228	<0.040	0.040	7498228
Total Silicon (Si)	ug/L	467	527	7498228	883	7498228	503	50	7498228
Total Silver (Ag)	ug/L	<0.0050	<0.0050	7498228	<0.0050	7498228	<0.0050	0.0050	7498228
Total Strontium (Sr)	ug/L	4.16	5.77	7498228	8.76	7498228	4.99	0.050	7498228
Total Thallium (Tl)	ug/L	0.0030	0.0020	7498228	0.0050	7498228	0.0030	0.0020	7498228
Total Tin (Sn)	ug/L	0.024	0.017	7498228	0.014	7498228	0.020	0.010	7498228
Total Titanium (Ti)	ug/L	11.6	9.83	7498228	17.8	7498228	10.4	0.50	7498228
Total Uranium (U)	ug/L	0.105	0.0620	7498228	0.112	7498228	0.0820	0.0020	7498228
Total Vanadium (V)	ug/L	0.36	0.39	7498228	0.68	7498228	0.33	0.10	7498228
Total Zinc (Zn)	ug/L	3.37	2.54	7498228	10.3 (1)	7781850	2.79	0.10	7498228
Total Zirconium (Zr)	ug/L	<0.050	<0.050	7498228	<0.050	7498228	<0.050	0.050	7498228
Total Calcium (Ca)	µg/L	583	563	7490190	832	7490190	511	10	7490190
Total Magnesium (Mg)	µg/L	816	1040	7490190	1890	7490190	1000	10	7490190
Total Potassium (K)	µg/L	119	94	7490190	159	7490190	95	10	7490190
RDL = Reportable Detection Limit									
(1) Reanalysis from the raw bottle.									

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID		JQ2099	JQ2100		JQ2101		JQ2102		
Sampling Date		2014/04/19	2014/04/19		2014/04/19		2014/04/19		
COC Number		08344670	08344670		08344670		08344670		
	Units	SS4-5	SS5-3	QC Batch	SS5-4	QC Batch	SS5-5-4	RDL	QC Batch
Total Potassium (K)	ug/L	119	94	7498228	159	7498228	95	10	7498228
Total Sodium (Na)	µg/L	84	77	7490190	137	7490190	69	10	7490190
Total Sulphur (S)	µg/L	184	<100	7490190	<100	7490190	<100	100	7490190
RDL = Reportable Detection Limit									

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID		JQ2103	JQ2104		
Sampling Date		2014/04/19	2014/04/19		
COC Number		08344670	08344670		
	Units	SS5-5-5	SSC-1	RDL	QC Batch
<b>Calculated Parameters</b>					
Total Hardness (CaCO3)	mg/L	5.40	4.03	0.50	7490189
<b>Elements</b>					
Total Mercury (Hg)	ug/L	<0.0020	<0.0020	0.0020	7498691
<b>Total Metals by ICPMS</b>					
Total Aluminum (Al)	ug/L	122	115	0.50	7498228
Total Antimony (Sb)	ug/L	<0.020	<0.020	0.020	7498228
Total Arsenic (As)	ug/L	0.058	0.088	0.020	7498228
Total Barium (Ba)	ug/L	8.99	7.13	0.020	7498228
Total Beryllium (Be)	ug/L	<0.010	<0.010	0.010	7498228
Total Bismuth (Bi)	ug/L	0.0050	0.0070	0.0050	7498228
Total Boron (B)	ug/L	<5.0	<5.0	5.0	7498228
Total Cadmium (Cd)	ug/L	<0.0050	<0.0050	0.0050	7498228
Total Chromium (Cr)	ug/L	2.84	1.97	0.050	7498228
Total Cobalt (Co)	ug/L	0.415	0.314	0.0050	7498228
Total Copper (Cu)	ug/L	0.416	0.621	0.050	7498228
Total Iron (Fe)	ug/L	417	276	1.0	7498228
Total Lead (Pb)	ug/L	0.344	0.233	0.0050	7498228
Total Lithium (Li)	ug/L	<0.50	<0.50	0.50	7498228
Total Manganese (Mn)	ug/L	7.61	6.03	0.050	7498228
Total Molybdenum (Mo)	ug/L	0.067	<0.050	0.050	7498228
Total Nickel (Ni)	ug/L	8.44	7.29	0.020	7498228
Total Selenium (Se)	ug/L	<0.040	<0.040	0.040	7498228
Total Silicon (Si)	ug/L	506	428	50	7498228
Total Silver (Ag)	ug/L	<0.0050	<0.0050	0.0050	7498228
Total Strontium (Sr)	ug/L	4.50	3.71	0.050	7498228
Total Thallium (Tl)	ug/L	0.0020	0.0030	0.0020	7498228
Total Tin (Sn)	ug/L	0.014	<0.010	0.010	7498228
Total Titanium (Ti)	ug/L	10.3	9.07	0.50	7498228
Total Uranium (U)	ug/L	0.0670	0.0820	0.0020	7498228
Total Vanadium (V)	ug/L	0.39	0.33	0.10	7498228
Total Zinc (Zn)	ug/L	2.80	2.43	0.10	7498228
Total Zirconium (Zr)	ug/L	<0.050	<0.050	0.050	7498228
Total Calcium (Ca)	µg/L	473	408	10	7490190
Total Magnesium (Mg)	µg/L	1030	730	10	7490190
Total Potassium (K)	µg/L	94	83	10	7490190
Total Potassium (K)	ug/L	94	83	10	7498228
RDL = Reportable Detection Limit					



Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID		JQ2103	JQ2104		
Sampling Date		2014/04/19	2014/04/19		
COC Number		08344670	08344670		
	Units	SS5-5-5	SSC-1	RDL	QC Batch
Total Sodium (Na)	µg/L	87	70	10	7490190
Total Sulphur (S)	µg/L	<100	<100	100	7490190
RDL = Reportable Detection Limit					

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

### GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.7°C
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Revised Report (Version:4): Due to client request, sample JQ2101 was reanalyzed for Total Zinc from an unpreserved bottle. The result for Total Zinc has been amended. (TWI)

Revised Report (Version:5): Results have been reported onto an Electronic Data Deliverable (EDD) as per client request (TWI)  
Sample JQ2101, Elements by ICPMS Low Level (total): Test repeated.

**Results relate only to the items tested.**

## QUALITY ASSURANCE REPORT

DLAVIK DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7490273	Orthophosphate (P)	2014/05/17	112	80 - 120	93	80 - 120	<0.0010	mg/L	13	20
7490283	Dissolved Phosphorus (P)	2014/05/21	97	80 - 120	103	80 - 120	<0.0020	mg/L	15	20
7490289	Dissolved Chloride (Cl)	2014/05/17	91	80 - 120	103	80 - 120	<0.50	mg/L	NC	20
7490317	Nitrate plus Nitrite (N)	2014/05/17	99	80 - 120	104	80 - 120	<0.0020	mg/L	0.41	25
7490318	Nitrite (N)	2014/05/17	NC	80 - 120	101	80 - 120	<0.0020	mg/L	NC	25
7490321	Dissolved Sulphate (SO4)	2014/05/17	NC	80 - 120	98	80 - 120	<0.50	mg/L	NC	20
7491245	Fluoride (F)	2014/05/20	NC	80 - 120	90	80 - 120	<0.010	mg/L		
7491802	Total Ammonia (N)	2014/05/20	97	80 - 120	106	80 - 120	<0.0050	mg/L	2.0	20
7492007	Turbidity	2014/05/20		80 - 120	102	80 - 120	<0.10	NTU	4.7	20
7492761	Acidity (pH 4.5)	2014/05/21					<0.50	mg/L	NC	20
7492761	Acidity (pH 8.3)	2014/05/21			105	80 - 120	<0.50	mg/L	NC	20
7492847	Total Phosphorus (P)	2014/05/21	NC	80 - 120	101	80 - 120	<0.0020	mg/L	4.5	20
7493436	Alkalinity (PP as CaCO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Alkalinity (Total as CaCO3)	2014/05/21	NC	80 - 120	96	80 - 120	<0.50	mg/L	7.2	20
7493436	Bicarbonate (HCO3)	2014/05/21					<0.50	mg/L	7.2	20
7493436	Carbonate (CO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Hydroxide (OH)	2014/05/21					<0.50	mg/L	NC	20
7493444	pH	2014/05/22			101	97 - 103			0.71	N/A
7493445	Conductivity	2014/05/22			98	80 - 120	1.3, RDL=1.0	uS/cm	0.49	20
7493460	Total Nitrogen (N)	2014/05/21			96	80 - 120	<0.020	mg/L	0.55	20
7494312	Dissolved Aluminum (Al)	2014/05/23	112	80 - 120	108	80 - 120	<50	µg/L	NC	20
7494312	Dissolved Antimony (Sb)	2014/05/23	93	80 - 120	93	80 - 120	<50	µg/L	NC	20
7494312	Dissolved Arsenic (As)	2014/05/23	100	80 - 120	98	80 - 120	<30	µg/L	NC	20
7494312	Dissolved Barium (Ba)	2014/05/23	110	80 - 120	103	80 - 120	<1.0	µg/L	1.9	20
7494312	Dissolved Beryllium (Be)	2014/05/23	111	80 - 120	104	80 - 120	<3.0	µg/L	NC	20
7494312	Dissolved Bismuth (Bi)	2014/05/23					<50	µg/L	NC	20
7494312	Dissolved Boron (B)	2014/05/23	107	80 - 120	99	80 - 120	<10	µg/L	NC	20
7494312	Dissolved Cadmium (Cd)	2014/05/23	107	80 - 120	101	80 - 120	<5.0	µg/L	NC	20
7494312	Dissolved Calcium (Ca)	2014/05/23	106	80 - 120	102	80 - 120	<50	µg/L	1.5	20
7494312	Dissolved Chromium (Cr)	2014/05/23	105	80 - 120	100	80 - 120	<10	µg/L	NC	20
7494312	Dissolved Cobalt (Co)	2014/05/23	105	80 - 120	101	80 - 120	<20	µg/L	NC	20

**QUALITY ASSURANCE REPORT(CONT'D)**

DLAVIK DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7494312	Dissolved Copper (Cu)	2014/05/23	103	80 - 120	100	80 - 120	<20	µg/L	NC	20
7494312	Dissolved Iron (Fe)	2014/05/23	109	80 - 120	105	80 - 120	<10	µg/L	NC	20
7494312	Dissolved Lead (Pb)	2014/05/23	105	80 - 120	101	80 - 120	<30	µg/L	NC	20
7494312	Dissolved Lithium (Li)	2014/05/23	114	80 - 120	106	80 - 120	<20	µg/L	NC	20
7494312	Dissolved Magnesium (Mg)	2014/05/23	106	80 - 120	101	80 - 120	<50	µg/L	NC	20
7494312	Dissolved Manganese (Mn)	2014/05/23	106	80 - 120	102	80 - 120	<3.0	µg/L	NC	20
7494312	Dissolved Molybdenum (Mo)	2014/05/23	101	80 - 120	99	80 - 120	<20	µg/L	NC	20
7494312	Dissolved Nickel (Ni)	2014/05/23	106	80 - 120	101	80 - 120	<20	µg/L	NC	20
7494312	Dissolved Phosphorus (P)	2014/05/23	104	80 - 120	102	80 - 120	<50	µg/L	NC	20
7494312	Dissolved Potassium (K)	2014/05/23	104	80 - 120	101	80 - 120	<300	µg/L	NC	20
7494312	Dissolved Selenium (Se)	2014/05/23	101	80 - 120	98	80 - 120	<100	µg/L	NC	20
7494312	Dissolved Silicon (Si)	2014/05/23	98	80 - 120	98	80 - 120	<50	µg/L	NC	20
7494312	Dissolved Silver (Ag)	2014/05/23	98	80 - 120	101	80 - 120	<10	µg/L	NC	20
7494312	Dissolved Sodium (Na)	2014/05/23	108	80 - 120	103	80 - 120	<100	µg/L	NC	20
7494312	Dissolved Strontium (Sr)	2014/05/23	109	80 - 120	101	80 - 120	<1.0	µg/L	NC	20
7494312	Dissolved Sulphur (S)	2014/05/23	103	80 - 120	100	80 - 120	<100	µg/L	NC	20
7494312	Dissolved Tin (Sn)	2014/05/23	102	80 - 120	98	80 - 120	<30	µg/L	NC	20
7494312	Dissolved Titanium (Ti)	2014/05/23	106	80 - 120	102	80 - 120	<5.0	µg/L	NC	20
7494312	Dissolved Vanadium (V)	2014/05/23	106	80 - 120	100	80 - 120	<10	µg/L	NC	20
7494312	Dissolved Zinc (Zn)	2014/05/23	108	80 - 120	100	80 - 120	<5.0	µg/L	NC	20
7494312	Dissolved Zirconium (Zr)	2014/05/23	106	80 - 120	100	80 - 120	<20	µg/L	NC	20
7495092	Total Nitrogen (N)	2014/05/23	NC	80 - 120	98	80 - 120	<0.020	mg/L	0.099	20
7495575	Total Mercury (Hg)	2014/05/23	98	80 - 120	100	80 - 120	<0.0020	ug/L	NC	20
7495665	Total Suspended Solids	2014/05/26			99	80 - 120	<1.0	mg/L		
7498228	Total Aluminum (Al)	2014/05/26	NC	80 - 120	101	80 - 120	<0.50	ug/L	0.44	20
7498228	Total Antimony (Sb)	2014/05/26	99	80 - 120	104	80 - 120	<0.020	ug/L	NC	20
7498228	Total Arsenic (As)	2014/05/26	98	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
7498228	Total Barium (Ba)	2014/05/26	NC	80 - 120	94	80 - 120	<0.020	ug/L	1.1	20
7498228	Total Beryllium (Be)	2014/05/26	93	80 - 120	98	80 - 120	<0.010	ug/L	NC	20
7498228	Total Bismuth (Bi)	2014/05/26	96	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Boron (B)	2014/05/26					<5.0	ug/L	NC	20

**QUALITY ASSURANCE REPORT(CONT'D)**

DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7498228	Total Cadmium (Cd)	2014/05/26	98	80 - 120	101	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Chromium (Cr)	2014/05/26	96	80 - 120	103	80 - 120	<0.050	ug/L	1.0	20
7498228	Total Cobalt (Co)	2014/05/26	96	80 - 120	100	80 - 120	<0.0050	ug/L	0.95	20
7498228	Total Copper (Cu)	2014/05/26	93	80 - 120	101	80 - 120	<0.050	ug/L	7.2	20
7498228	Total Iron (Fe)	2014/05/26	NC	80 - 120	107	80 - 120	<1.0	ug/L	5.3	20
7498228	Total Lead (Pb)	2014/05/26	94	80 - 120	97	80 - 120	<0.0050	ug/L	2.1	20
7498228	Total Lithium (Li)	2014/05/26	97	80 - 120	102	80 - 120	<0.50	ug/L	NC	20
7498228	Total Manganese (Mn)	2014/05/26	NC	80 - 120	101	80 - 120	<0.050	ug/L	2.7	20
7498228	Total Molybdenum (Mo)	2014/05/26	95	80 - 120	96	80 - 120	<0.050	ug/L	NC	20
7498228	Total Nickel (Ni)	2014/05/26	NC	80 - 120	103	80 - 120	<0.020	ug/L	8.6	20
7498228	Total Potassium (K)	2014/05/26					<10	ug/L	7.4	20
7498228	Total Selenium (Se)	2014/05/26	105	80 - 120	109	80 - 120	<0.040	ug/L	NC	20
7498228	Total Silicon (Si)	2014/05/26					<50	ug/L	5.3	20
7498228	Total Silver (Ag)	2014/05/26	98	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Strontium (Sr)	2014/05/26	96	80 - 120	93	80 - 120	<0.050	ug/L	3.3	20
7498228	Total Thallium (Tl)	2014/05/26	95	80 - 120	98	80 - 120	<0.0020	ug/L	NC	20
7498228	Total Tin (Sn)	2014/05/26	96	80 - 120	99	80 - 120	<0.010	ug/L	NC	20
7498228	Total Titanium (Ti)	2014/05/26	NC	80 - 120	104	80 - 120	<0.50	ug/L	6.6	20
7498228	Total Uranium (U)	2014/05/26	97	80 - 120	99	80 - 120	<0.0020	ug/L	1.2	20
7498228	Total Vanadium (V)	2014/05/26	96	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7498228	Total Zinc (Zn)	2014/05/26	99	80 - 120	102	80 - 120	<0.10	ug/L	1.7	20
7498228	Total Zirconium (Zr)	2014/05/26					<0.050	ug/L	NC	20
7498691	Total Mercury (Hg)	2014/05/26	102	80 - 120	116	80 - 120	<0.0020	ug/L	NC	20
7502574	Total Dissolved Solids	2014/05/28	102	80 - 120	92	80 - 120	<10	mg/L	NC	20
7504241	Total Dissolved Solids	2014/06/02			98	80 - 120	<1.0	mg/L		

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

### QUALITY ASSURANCE REPORT(CONT'D)

Maxxam Job #: B439784  
Report Date: 2015/01/21

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7781850	Total Zinc (Zn)	2015/01/20			104	80 - 120	<0.10	ug/L		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B439784  
Report Date: 2015/01/21

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

### VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Rob Reinert, Data Validation Coordinator

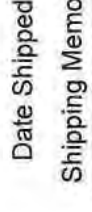
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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

05/538 (1)  
 B4 54784

Results Received:  
 Maxxam Job #:

Date Shipped: 2014-May-15  
 Shipping Memo: 72469



**RioTinto** Diavik Diamond Mines Inc. - Chain of Custody **08344670**

Diavik Diamond Mines Inc.		Contact Information - Sample Inquiry	
DDMI ENVIRONMENT		DDMI ENVIRONMENT	
DDMI ENVIRONMENT@RIOTINTO.COM		DDMI ENVIRONMENT@RIOTINTO.COM	
P.O. Box 2469 5007-50 Ave Yellowknife, NT X1A 2P8		Dwight Grubler / Sam Elni @ 877-669-8800 ext 3403	
REPORT TO		REPORT DISTRIBUTION	
DDMI ENVIRONMENT		Electronic PDF	
DDMI ENVIRONMENT@RIOTINTO.COM		Electronic Excel	
REFERENCE LAB ID #		Hard Copy	
MAXXAM		INVOICE TO	
DDMI ACCOUNTS PAYABLE		DDMI AP@RIOTINTO.COM	
Priority (50% Surcharge)		Reference PO # K16877- (Maxxim 2014)	
Emergency (100% Surcharge)		SAMPLE INFORMATION	
Identification	Project	Collected by	Date
SS4-5	AEMP	DD/DB	2014-Apr-19
SS5-3	AEMP	DD/DB	2014-Apr-19
SS5-4	AEMP	DD/DB	2014-Apr-19
SS5-5-4	AEMP	DD/DB	2014-Apr-19
SS5-5-5	AEMP	DD/DB	2014-Apr-19
SSC-1	AEMP	DD/DB	2014-Apr-19
ROUTINE PARAMETERS: (H, EC, Acidity, Alkalinity, F, I, D, SO4, PO4, NO3, Dissolved Phosphorus, TDS)			
Metals: (Ammonia, Total Phosphorus, TNH)			
TOC (Total Organic Carbon) - analyte to be taken from 100 mL (Municipal bottle)			
DOC (Dissolved Organic Carbon) UNFILTERED &			
Turbidity Low Level < 30.5% PRESERVED			
Total Mercury PRESERVED			
Dissolved Metals Low Level & Sp. Se UNFILTERED &			
Dissolved Mercury - UNFILTERED & UNPRESERVED			
Cl & Orsen PRESERVED			
TEH (2 bottles)			
PAH TEN + 1 bottle			
BTEX (2 bottles)			
Bacterial Oxygen Demand (BOD)			
Fecal Coliforms (2 bottles)			
TSS/Turbidity			

SAMPLE CONDITION (Shipped)	TEMP/C	DATE/TIME
PROZEN	5.0	2014-May-15
COLD		
AMBIENT		
RELINQUISHED BY:	DD	DD
SPECIAL INSTRUCTIONS		
Final Oxidation Burette (B)		
30 BOTTLES		
RECEIVED BY:	DATE/TIME	DATE/TIME
Jose Rivera	2014-May-15	2014/05/16
TEMP/C	8, 8, 8	DATE/TIME
PROZEN		10:11
COLD		
AMBIENT		

Report Uploaded to MP5:  
 Data Checked for Breaches:

Relinquish by Bosu  
 2014/05/16 15:49

Relinquish by Anthony  
 MAY 17 2014 11:10  
 CS: PFS 4,5,5

Test: Present  
 Custody Seal: Absent



Your P.O. #: K16877  
 Your Project #: AEMP  
 PO # K16877  
 Your C.O.C. #: 08344674

**Attention: DDMI Environment**

DIAMOND MINES INC.  
 P.O. BOX 2498  
 5007 - 50 AVE.  
 YELLOWKNIFE, NT  
 CANADA X1A 2P8

Report Date: 2014/06/04  
 Report #: R1578789  
 Version: 1

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B439797**

**Received: 2014/05/17, 11:10**

Sample Matrix: Water  
 # Samples Received: 2

Analyses	Quantity	Date		Laboratory Method	Analytical Method
		Extracted	Analyzed		
Acidity pH 4.5 & pH 8.3 (as CaCO <sub>3</sub> )	2	N/A	2014/05/21	BBY6SOP-00037	SM-2310B
Alkalinity - Water	2	2014/05/21	2014/05/21	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	2	N/A	2014/05/20	BBY6SOP-00011	SM-4500-CI-
Conductance - water	2	N/A	2014/05/21	BBY6SOP-00026	SM-2510B
Fluoride - Mining Clients	2	N/A	2014/05/20	BBY6SOP-00012	SM - 4500 F C
Hardness Total (calculated as CaCO <sub>3</sub> )	2	N/A	2014/05/27	BBY7SOP-00002	EPA 6020A
Mercury (Total-LowLevel) by CVAF	2	2014/05/26	2014/05/26	BBY7SOP-00015	BC MOE Lab Manual
ICP-AES Dissolved Metals in Water	2	N/A	2014/05/23	BBY7SOP-00018	EPA 6010C
Na, K, Ca, Mg, S by CRC ICPMS (total)	2	N/A	2014/05/27	BBY7SOP-00002	EPA 6020A
Elements by ICPMS Low Level (total)	2	N/A	2014/05/26	BBY7SOP-00002	EPA 6020A
Nitrogen (Total)	1	2014/05/21	2014/05/21	BBY6SOP-00016	SM-4500N C
Nitrogen (Total)	1	2014/05/22	2014/05/23	BBY6SOP-00016	SM-4500N C
Ammonia-N (Preserved)	2	N/A	2014/05/21	BBY6SOP-00009	SM-4500NH3G
Nitrate+Nitrite (N) (low level)	2	N/A	2014/05/17	BBY6SOP-00010	EPA 353.2
Nitrite (N) (low level)	2	N/A	2014/05/17	BBY6SOP-00010	SM 4500NO3-I
Nitrogen - Nitrate (as N)	2	N/A	2014/05/17	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO <sub>3</sub> Preserve for Metals	2	N/A	2014/05/22	BBY6WI-00001	EPA 200.2
pH Water (1)	2	N/A	2014/05/21	BBY6SOP-00026	SM-4500H+B
Orthophosphate by Konelab (low level)	2	N/A	2014/05/21	BBY6SOP-00013	SM 4500 P E
Sulphate by Automated Colourimetry	2	N/A	2014/05/20	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Calculated)	2	N/A	2014/05/23	BBY WI-00033	Calculated Parameter
Total Dissolved Solids (Filt. Residue)	2	2014/05/23	2014/05/28	BBY6SOP-00033	SM 2540C
Total Dissolved Solids (Filt. Residue)	1	N/A	2014/05/29	BBY6SOP-00033	SM 2540C
TKN (Calc. TN, N/N) total	1	N/A	2014/05/21	BBY6SOP-00022	SM 4500N-C
TKN (Calc. TN, N/N) total	1	N/A	2014/05/26	BBY6SOP-00022	SM 4500N-C
Phosphorus-P (LL Tot, dissolved) - UF/UP	2	2014/05/23	2014/05/24	BBY6SOP-00013	SM-4500 PE
Total Phosphorus	2	N/A	2014/05/24	BBY6SOP-00013	SM 4500 P E
Total Suspended Solids-Low Level	2	2014/05/23	2014/05/26	BBY6SOP-00034	SM-2540 D
Turbidity	2	N/A	2014/05/20	BBY6SOP-00027	SM - 2130B

\* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Maxxam Job #: B439797  
Report Date: 2014/06/04

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Your P.O. #: K16877  
Sampler Initials: DD

-2-

Encryption Key



Maxxam  
04 Jun 2014 11:12:11 -07:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Namita Sahni, Burnaby Project Manager  
Email: NSahni@maxxam.ca  
Phone# (604) 639-2614

=====  
This report has been generated and distributed using a secure automated process.  
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

**RESULTS OF CHEMICAL ANALYSES OF WATER**

Maxxam ID	JQ2183	JQ2184	UNITS	SSC-2	SSC-3	RDL	QC Batch	RDL	QC Batch
Sampling Date	2014/04/19	2014/04/20							
<b>Misc. Inorganics</b>									
Acidity (pH 4.5)	<0.50	<0.50	mg/L	7492761	<0.50	0.50	7492761	0.50	7492761
Acidity (pH 8.3)	<0.50	<0.50	mg/L	7492761	<0.50	0.50	7492761	0.50	7492761
Fluoride (F)	<0.010	<0.010	mg/L	7491245	<0.010	0.010	7491245	0.010	7491245
<b>Calculated Parameters</b>									
Filter and HNO3 Preservation	N/A	LAB	N/A	7493208	LAB	N/A	7493208	N/A	7493208
Nitrate (N)	0.132	0.138	mg/L	7490191	0.138	0.0020	7490191	0.0020	7490191
Total Dissolved Solids	3.00	5.00	mg/L	7491955	5.00	0.50	7491955	0.50	7491955
<b>Misc. Inorganics</b>									
Alkalinity (Total as CaCO3)	0.94	3.09	mg/L	7493436	3.09	0.50	7493436	0.50	7493436
Alkalinity (PP as CaCO3)	<0.50	<0.50	mg/L	7493436	<0.50	0.50	7493436	0.50	7493436
Bicarbonate (HCO3)	1.15	3.77	mg/L	7493436	3.77	0.50	7493436	0.50	7493436
Carbonate (CO3)	<0.50	<0.50	mg/L	7493436	<0.50	0.50	7493436	0.50	7493436
Hydroxide (OH)	<0.50	<0.50	mg/L	7493436	<0.50	0.50	7493436	0.50	7493436
<b>Anions</b>									
Orthophosphate (P)	0.0057(1)	0.0054(1)	mg/L	7492742	0.0054(1)	0.0010	7492742	0.0010	7492742
Dissolved Sulphate (SO4)	<0.50	<0.50	mg/L	7491858	<0.50	0.50	7491858	0.50	7491858
Dissolved Chloride (Cl)	0.54	<0.50	mg/L	7491841	<0.50	0.50	7491841	0.50	7491841
<b>Nutrients</b>									
Total Ammonia (N)	0.054	0.11	mg/L	7493440	0.11	0.0050	7493440	0.0050	7493440
Dissolved Phosphorus (P)	0.0151(1)	0.0457(1)	mg/L	7496248	0.0457(1)	0.0020	7496248	0.0020	7496248
Total Total Kjeldahl Nitrogen (Calc)	0.064	0.145	mg/L	7490192	0.145	0.020	7490192	0.020	7490192
Nitrate plus Nitrite (N)	0.136(1)	0.145(1)	mg/L	7490317	0.145(1)	0.0020	7490317	0.0020	7490317
Nitrite (N)	0.0037(1)	0.0064(1)	mg/L	7490318	0.0064(1)	0.0020	7490318	0.0020	7490318
Total Nitrogen (N)	0.200	0.289	mg/L	7493460	0.289	0.020	7495092	0.020	7495092
Total Phosphorus (P)	0.0318	0.0829	mg/L	7496234	0.0829	0.0020	7496234	0.0020	7496234
<b>Physical Properties</b>									
Conductivity	5.7	11.3	uS/cm	7493445	11.3	1.0	7493445	1.0	7493445
pH	6.16	6.71	pH	7493444	6.71		7493444		7493444
<b>Physical Properties</b>									
Total Suspended Solids	17.0	42.0	mg/L	7495665	42.0	1.0	7495665	1.0	7495665
Total Dissolved Solids	<10(1)	12.0(1)	mg/L	7502574	12.0(1)	10	7504241	1.0	7504241
Turbidity	7.34(1)	16.1(1)	NTU	7492007	16.1(1)	0.10	7492007	0.10	7492007

N/A = Not Applicable  
RDL = Reportable Detection Limit  
(1) - Sample arrived to laboratory past recommended hold time.

DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439797  
Report Date: 2014/06/04

Your P.O. #: K16877  
Sampler Initials: DD

**ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)**

Maxxam ID	JQ2183	JQ2184		
Sampling Date	2014/04/19	2014/04/20		
	SSC-2	SSC-3	RDL	QC Batch
<b>Dissolved Metals by ICP</b>				
	UNITS			
Dissolved Aluminum (Al)	mg/L	<0.050	0.050	7495821
Dissolved Antimony (Sb)	mg/L	<0.050	0.050	7495821
Dissolved Arsenic (As)	mg/L	<0.030	0.030	7495821
Dissolved Barium (Ba)	mg/L	0.0149	0.010	7495821
Dissolved Beryllium (Be)	mg/L	<0.0030	0.0030	7495821
Dissolved Bismuth (Bi)	mg/L	<0.050	0.050	7495821
Dissolved Boron (B)	mg/L	<0.010	0.010	7495821
Dissolved Cadmium (Cd)	mg/L	<0.0050	0.0050	7495821
Dissolved Chromium (Cr)	mg/L	<0.010	0.010	7495821
Dissolved Cobalt (Co)	mg/L	<0.020	0.020	7495821
Dissolved Copper (Cu)	mg/L	<0.020	0.020	7495821
Dissolved Iron (Fe)	mg/L	<0.010	0.010	7495821
Dissolved Lead (Pb)	mg/L	<0.030	0.030	7495821
Dissolved Lithium (Li)	mg/L	<0.020	0.020	7495821
Dissolved Manganese (Mn)	mg/L	0.0043	0.0030	7495821
Dissolved Molybdenum (Mo)	mg/L	<0.020	0.020	7495821
Dissolved Nickel (Ni)	mg/L	<0.020	0.020	7495821
Dissolved Phosphorus (P)	mg/L	<0.050	0.050	7495821
Dissolved Selenium (Se)	mg/L	<0.10	0.10	7495821
Dissolved Silicon (Si)	mg/L	0.092	0.050	7495821
Dissolved Silver (Ag)	mg/L	<0.010	0.010	7495821
Dissolved Strontium (Sr)	mg/L	0.0047	0.0010	7495821
Dissolved Tin (Sn)	mg/L	<0.030	0.030	7495821
Dissolved Titanium (Ti)	mg/L	<0.0050	0.0050	7495821
Dissolved Vanadium (V)	mg/L	<0.010	0.010	7495821
Dissolved Zinc (Zn)	mg/L	<0.0050	0.0050	7495821
Dissolved Zirconium (Zr)	mg/L	<0.020	0.020	7495821
Dissolved Calcium (Ca)	mg/L	0.513	0.050	7495821
Dissolved Magnesium (Mg)	mg/L	0.184	0.050	7495821
Dissolved Potassium (K)	mg/L	<0.30	0.30	7495821
Dissolved Sodium (Na)	mg/L	0.13	0.10	7495821
Dissolved Sulphur (S)	mg/L	0.17	0.10	7495821

RDL = Reportable Detection Limit

Maxxam Job #: B439797  
 Report Date: 2014/06/04

DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2183	JQ2184		
Sampling Date	2014/04/19	2014/04/20		
<b>UNITS</b>	<b>SSC-2</b>	<b>SSC-3</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>				
Total Hardness (CaCO3)	5.03	14.7	0.50	7490189
<b>Elements</b>				
Total Mercury (Hg)	0.0024	0.0041	0.0020	7498691

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RDL = Reportable Detection Limit

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Your P.O. #: K16877  
Sampler Initials: DD

Maxxam Job #: B439797  
Report Date: 2014/06/04

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2183	JQ2184			
Sampling Date	2014/04/19	2014/04/20			
	SSC-2	SSC-3	RDL	QC Batch	
<b>Total Metals by ICPMS</b>					
Total Aluminum (Al)	ug/L	209	453	0.50	7498221
Total Antimony (Sb)	ug/L	<0.020	0.040	0.020	7498221
Total Arsenic (As)	ug/L	0.093	0.235	0.020	7498221
Total Barium (Ba)	ug/L	9.16	23.7	0.020	7498221
Total Beryllium (Be)	ug/L	<0.010	0.015	0.010	7498221
Total Bismuth (Bi)	ug/L	0.0120	0.0300	0.0050	7498221
Total Boron (B)	ug/L	<5.0	<5.0	5.0	7498221
Total Cadmium (Cd)	ug/L	0.0070	0.0090	0.0050	7498221
Total Chromium (Cr)	ug/L	2.06	6.75	0.050	7498221
Total Cobalt (Co)	ug/L	0.442	1.13	0.0050	7498221
Total Copper (Cu)	ug/L	0.524	2.54	0.050	7498221
Total Iron (Fe)	ug/L	396	992	1.0	7498221
Total Lead (Pb)	ug/L	0.328	0.935	0.0050	7498221
Total Lithium (Li)	ug/L	0.56	1.35	0.50	7498221
Total Manganese (Mn)	ug/L	8.05	19.7	0.050	7498221
Total Molybdenum (Mo)	ug/L	<0.050	0.086	0.050	7498221
Total Nickel (Ni)	ug/L	7.26	20.1	0.020	7498221
Total Selenium (Se)	ug/L	<0.040	<0.040	0.040	7498221
Total Silicon (Si)	ug/L	598	1550	50	7498221
Total Silver (Ag)	ug/L	<0.0050	<0.0050	0.0050	7498221
Total Strontium (Sr)	ug/L	5.12	12.2	0.050	7498221
Total Thallium (Tl)	ug/L	0.0050	0.0110	0.0020	7498221
Total Tin (Sn)	ug/L	0.010	0.032	0.010	7498221
Total Titanium (Ti)	ug/L	14.6	37.5	0.50	7498221
Total Uranium (U)	ug/L	0.124	0.312	0.0020	7498221
Total Vanadium (V)	ug/L	0.44	1.33	0.10	7498221
Total Zinc (Zn)	ug/L	3.13	6.58	0.10	7498221
Total Zirconium (Zr)	ug/L	<0.050	0.084	0.050	7498221
Total Calcium (Ca)	mg/L	0.556	1.43	0.010	7490190
Total Magnesium (Mg)	mg/L	0.884	2.71	0.010	7490190
Total Potassium (K)	mg/L	0.148	0.289	0.010	7490190
Total Sodium (Na)	mg/L	0.118	0.125	0.010	7490190
Total Sulphur (S)	mg/L	<0.10	<0.10	0.10	7490190

RDL = Reportable Detection Limit

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

Package 1 4.7°C

Each temperature is the average of up to three cooler temperatures taken at receipt

**General Comments**

Samples analyzed past recommended hold time for the analysis of Alkalinity, Fluoride, Conductivity, Sulphate, Chloride, total suspended solids, total Nitrogen, Ammonia and total Mercury.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7490317	Nitrate plus Nitrite (N)	2014/05/17	99	80 - 120	104	80 - 120	<0.0020	mg/L	NC	25
7490318	Nitrite (N)	2014/05/17			101	80 - 120	<0.0020	mg/L	NC	25
7491245	Fluoride (F)	2014/05/20	NC	80 - 120	90	80 - 120	<0.010	mg/L		
7491841	Dissolved Chloride (Cl)	2014/05/20	90	80 - 120	100	80 - 120	<0.50	mg/L	NC	20
7491858	Dissolved Sulphate (SO4)	2014/05/20	NC	80 - 120	99	80 - 120	<0.50	mg/L	NC	20
7492007	Turbidity	2014/05/20			102	80 - 120	<0.10	NTU	2.3	20
7492742	Orthophosphate (P)	2014/05/21	91	80 - 120	98	80 - 120	<0.0010	mg/L	6.3	20
7492761	Acidity (pH 8.3)	2014/05/21			105	80 - 120	<0.50	mg/L	NC	20
7492761	Acidity (pH 4.5)	2014/05/21					<0.50	mg/L	NC	20
7493436	Alkalinity (Total as CaCO3)	2014/05/21	NC	80 - 120	96	80 - 120	<0.50	mg/L	6.5	20
7493436	Alkalinity (PP as CaCO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Bicarbonate (HCO3)	2014/05/21					<0.50	mg/L	6.5	20
7493436	Carbonate (CO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Hydroxide (OH)	2014/05/21					<0.50	mg/L	NC	20
7493440	Total Ammonia (N)	2014/05/21	97	80 - 120	94	80 - 120	<0.0050	mg/L	10.2	20
7493445	Conductivity	2014/05/21			98	80 - 120	1.3, RDL=1.0	uS/cm	0	20
7493460	Total Nitrogen (N)	2014/05/21			96	80 - 120	<0.020	mg/L	1.5	20
7495092	Total Nitrogen (N)	2014/05/23	NC	80 - 120	98	80 - 120	<0.020	mg/L	2.9	20
7495665	Total Suspended Solids	2014/05/26			99	80 - 120	<1.0	mg/L		
7495821	Dissolved Aluminum (Al)	2014/05/23	NC	80 - 120	105	80 - 120	<0.050	mg/L	0.3	20
7495821	Dissolved Antimony (Sb)	2014/05/23	92	80 - 120	93	80 - 120	<0.050	mg/L	NC	20
7495821	Dissolved Arsenic (As)	2014/05/23	98	80 - 120	97	80 - 120	<0.030	mg/L	NC	20
7495821	Dissolved Barium (Ba)	2014/05/23	109	80 - 120	102	80 - 120	<0.0010	mg/L	0	20
7495821	Dissolved Beryllium (Be)	2014/05/23	108	80 - 120	104	80 - 120	<0.0030	mg/L	NC	20
7495821	Dissolved Boron (B)	2014/05/23	104	80 - 120	98	80 - 120	<0.010	mg/L	NC	20
7495821	Dissolved Cadmium (Cd)	2014/05/23	105	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7495821	Dissolved Chromium (Cr)	2014/05/23	104	80 - 120	100	80 - 120	<0.010	mg/L	NC	20
7495821	Dissolved Cobalt (Co)	2014/05/23	104	80 - 120	101	80 - 120	<0.020	mg/L	NC	20
7495821	Dissolved Copper (Cu)	2014/05/23	102	80 - 120	100	80 - 120	<0.020	mg/L	NC	20
7495821	Dissolved Iron (Fe)	2014/05/23	107	80 - 120	104	80 - 120	<0.010	mg/L	NC	20
7495821	Dissolved Lead (Pb)	2014/05/23	103	80 - 120	101	80 - 120	<0.030	mg/L	NC	20
7495821	Dissolved Lithium (Li)	2014/05/23	112	80 - 120	105	80 - 120	<0.020	mg/L	NC	20
7495821	Dissolved Manganese (Mn)	2014/05/23	105	80 - 120	101	80 - 120	<0.0030	mg/L	NC	20
7495821	Dissolved Molybdenum (Mo)	2014/05/23	100	80 - 120	99	80 - 120	<0.020	mg/L	NC	20
7495821	Dissolved Nickel (Ni)	2014/05/23	103	80 - 120	101	80 - 120	<0.020	mg/L	NC	20
7495821	Dissolved Phosphorus (P)	2014/05/23	103	80 - 120	103	80 - 120	<0.050	mg/L	NC	20
7495821	Dissolved Selenium (Se)	2014/05/23	99	80 - 120	99	80 - 120	<0.10	mg/L	NC	20
7495821	Dissolved Silicon (Si)	2014/05/23	NC	80 - 120	97	80 - 120	<0.050	mg/L	0.5	20
7495821	Dissolved Silver (Ag)	2014/05/23	101	80 - 120	100	80 - 120	<0.010	mg/L	NC	20



QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7495821	Dissolved Strontium (Sr)	2014/05/23	107	80 - 120	101	80 - 120	<0.0010	mg/L	0	20
7495821	Dissolved Tin (Sn)	2014/05/23	99	80 - 120	97	80 - 120	<0.030	mg/L	NC	20
7495821	Dissolved Titanium (Ti)	2014/05/23	104	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7495821	Dissolved Vanadium (V)	2014/05/23	104	80 - 120	99	80 - 120	<0.010	mg/L	NC	20
7495821	Dissolved Zinc (Zn)	2014/05/23	105	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7495821	Dissolved Zirconium (Zr)	2014/05/23	106	80 - 120	100	80 - 120	<0.020	mg/L	NC	20
7495821	Dissolved Calcium (Ca)	2014/05/23	104	80 - 120	101	80 - 120	<0.050	mg/L	NC	20
7495821	Dissolved Magnesium (Mg)	2014/05/23	104	80 - 120	100	80 - 120	<0.050	mg/L	NC	20
7495821	Dissolved Potassium (K)	2014/05/23	103	80 - 120	99	80 - 120	<0.30	mg/L	NC	20
7495821	Dissolved Sodium (Na)	2014/05/23	106	80 - 120	103	80 - 120	<0.10	mg/L	1.3	20
7495821	Dissolved Sulphur (S)	2014/05/23	NC	80 - 120	100	80 - 120	<0.10	mg/L	0.06	20
7495821	Dissolved Bismuth (Bi)	2014/05/23					<0.050	mg/L	NC	20
7496234	Total Phosphorus (P)	2014/05/24	99	80 - 120	90	80 - 120	<0.0020	mg/L	NC	20
7496248	Dissolved Phosphorus (P)	2014/05/24	NC	80 - 120	93	80 - 120	<0.0020	mg/L	NC	20
7498221	Total Aluminum (Al)	2014/05/26	NC	80 - 120	103	80 - 120	<0.50	ug/L	10.3	20
7498221	Total Antimony (Sb)	2014/05/26	102	80 - 120	96	80 - 120	<0.020	ug/L	NC	20
7498221	Total Arsenic (As)	2014/05/26	102	80 - 120	100	80 - 120	<0.020	ug/L	0	20
7498221	Total Barium (Ba)	2014/05/26	NC	80 - 120	92	80 - 120	<0.020	ug/L	0.5	20
7498221	Total Beryllium (Be)	2014/05/26	97	80 - 120	94	80 - 120	<0.010	ug/L	NC	20
7498221	Total Bismuth (Bi)	2014/05/26	98	80 - 120	99	80 - 120	<0.0050	ug/L	10.5	20
7498221	Total Cadmium (Cd)	2014/05/26	101	80 - 120	98	80 - 120	<0.0050	ug/L	NC	20
7498221	Total Chromium (Cr)	2014/05/26	NC	80 - 120	102	80 - 120	<0.10	ug/L	1.7	20
7498221	Total Cobalt (Co)	2014/05/26	99	80 - 120	100	80 - 120	<0.0050	ug/L	1	20
7498221	Total Copper (Cu)	2014/05/26	88	80 - 120	104	80 - 120	<0.050	ug/L	12.6	20
7498221	Total Iron (Fe)	2014/05/26	NC	80 - 120	109	80 - 120	<1.0	ug/L	1.5	20
7498221	Total Lead (Pb)	2014/05/26	99	80 - 120	97	80 - 120	<0.0050	ug/L	1.9	20
7498221	Total Lithium (Li)	2014/05/26	103	80 - 120	95	80 - 120	<0.50	ug/L	NC	20
7498221	Total Manganese (Mn)	2014/05/26	NC	80 - 120	102	80 - 120	<0.050	ug/L	0.8	20
7498221	Total Molybdenum (Mo)	2014/05/26	92	80 - 120	101	80 - 120	<0.050	ug/L	NC	20
7498221	Total Nickel (Ni)	2014/05/26	NC	80 - 120	107	80 - 120	<0.020	ug/L	1.4	20
7498221	Total Selenium (Se)	2014/05/26	111	80 - 120	107	80 - 120	<0.040	ug/L	NC	20
7498221	Total Silver (Ag)	2014/05/26	103	80 - 120	102	80 - 120	<0.0050	ug/L	NC	20
7498221	Total Strontium (Sr)	2014/05/26	NC	80 - 120	99	80 - 120	<0.050	ug/L	0.3	20
7498221	Total Thallium (Tl)	2014/05/26	101	80 - 120	98	80 - 120	<0.0020	ug/L	0	20
7498221	Total Tin (Sn)	2014/05/26	100	80 - 120	94	80 - 120	<0.20	ug/L	NC	20
7498221	Total Titanium (Ti)	2014/05/26	NC	80 - 120	105	80 - 120	<0.50	ug/L	1.7	20
7498221	Total Uranium (U)	2014/05/26	101	80 - 120	98	80 - 120	<0.0020	ug/L	0	20
7498221	Total Vanadium (V)	2014/05/26	104	80 - 120	100	80 - 120	<0.20	ug/L	8.6	20
7498221	Total Zinc (Zn)	2014/05/26	NC	80 - 120	113	80 - 120	<0.10	ug/L	2.4	20

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439797  
Report Date: 2014/06/04

Your P.O. #: K16877  
Sampler Initials: DD

**QUALITY ASSURANCE REPORT**

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7498221	Total Boron (B)	2014/05/26					<50	ug/L	NC	20
7498221	Total Silicon (Si)	2014/05/26					<100	ug/L	11.7	20
7498221	Total Zirconium (Zr)	2014/05/26					<0.10	ug/L	NC	20
7498691	Total Mercury (Hg)	2014/05/26	102	80 - 120	116	80 - 120	<0.0020	ug/L	NC	20
7502574	Total Dissolved Solids	2014/05/28	102	80 - 120	92	80 - 120	<10	mg/L	NC	20
7504241	Total Dissolved Solids	2014/06/02			98	80 - 120	<1.0	mg/L		

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Spiked Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.


NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

**Validation Signature Page**

**Maxxam Job #: B439797**

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The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

  
\_\_\_\_\_  
Andy Lu, Data Validation Coordinator

=====  
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

05/S39(v)

Results Received:

Maxxam Job #: 72469

Date Shipped: 2014-May-15

Shipping Memo: 72469



08344674

Diavik Diamond Mines Inc. - Chain of Custody

Diavik Diamond Mines Inc.  
 P.O. Box 2469  
 5007-50 Ave  
 Yellowknife NT  
 X1A 2P6  
 REPORT TO: DDMM ENVIRONMENT@RIOTINTO.COM  
 REPORT DISTRIBUTION:  
 Electronic PDF   
 Electronic Excel   
 Hard Copy

Contact Information - Sample Inquiry:  
 DDMM ENVIRONMENT@RIOTINTO.COM  
 Dwyght Grubbe / Sam Blvd @ 667-566-6500 ext 5403  
 Site Env. Supervisor

DDMM ENVIRONMENT  
 DDMM ENVIRONMENT@RIOTINTO.COM  
 REFERENCE LAB ID # **MAXXAM**

SERVICE REQUESTED:  
 Regular (Default)  
 Priority (50% Surcharge)  
 Emergency (100% Surcharge)

DDMM ACCOUNTS PAYABLE  
 DDMM AP@RIOTINTO.COM  
 Reference PO # **K16877 - (Maxxam 2014)**

SAMPLE INFORMATION:  
 Project:  Invoiced By:  Date:  Type:

502183  
502184

IDENTIFICATION	ANALYSIS REQUESTED					SPECIAL INSTRUCTIONS									
	ROUTINE PARAMETERS (pH, EC, Acidity, Alkalinity, FLK, Cl, SO4, PO4, NO2, NO3, Dissolved Phosphorus, TDS)	NUTRIENTS (Ammonia, Total Phosphorus, TNX)	TDC (Total Organic Carbon) - analysis to be taken from the 120ml. Nutrients bottle	DOC (Dissolved Organic Carbon) UNFILTERED & UNPRESERVED	TOTAL METALS LOW LEVEL + SB, SB PRESERVED	TOTAL MERCURY PRESERVED	DISSOLVED METALS LOW LEVEL + SB, SB UNFILTERED & UNPRESERVED	DISSOLVED MERCURY - UNFILTERED & UNPRESERVED	OT & GRASS PRESERVED	TEH (2 bottles)	PAH (TEH + 1 Bottle)	BTEX (2 bottles)	BIOCHEMICAL OXYGEN DEMAND (BOD)	FECAL COLIFORMS (2 bottles)	TSS/Turb/pH
SSC-2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>										<input checked="" type="checkbox"/>
SSC-3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>										<input checked="" type="checkbox"/>
1645-13	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>										
1645-18	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>										
1645-18B	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>										
1645-18B-6	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>										<input checked="" type="checkbox"/>



B439797

SAMPLE CONDITION (Shipped): FROZEN  
 TEMP-C: 5.0  
 SAMPLE CONDITION (Received): FROZEN  
 TEMP-C: 5, S, b  
 COLD  
 AMBIENT

RECEIVED BY: Jose Rivera  
 DATE/TIME: 2014-May-15  
 DATE/TIME: 2014/05/16 10:11

36 BOTTLES  
 Final Destination Bureau/ BC

Report Uploaded to MP5:

Data Checked for Breaches:

RECEIVED BY: Jose Rivera  
 DATE/TIME: 2014/05/16 15:44  
 Reimport by SS  
 2014/05/16 12:00:12

ICE i Present  
Custody Seal: Absent

Arley  
 MAY 17 11:10  
 CS: YES 4, 5, 5

Your P.O. #: K16877  
 Your Project #: AEMP  
 PO # K16877  
 Your C.O.C. #: 08344666

**Attention: DDMI Environment**

DIAVIK DIAMOND MINES INC.  
 P.O. BOX 2498  
 5007 - 50 AVE.  
 YELLOWKNIFE, NT  
 CANADA X1A 2P8

Report Date: 2014/06/03  
 Report #: R1577832  
 Version: 1

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B439793**

**Received: 2014/05/17, 11:10**

Sample Matrix: Water  
 # Samples Received: 7

Analyses	Quantity	Date		Laboratory Method	Analytical Method
		Extracted	Analyzed		
Acidity pH 4.5 & pH 8.3 (as CaCO <sub>3</sub> )	7	N/A	2014/05/21	BBY6SOP-00037	SM-2310B
Alkalinity - Water	7	2014/05/21	2014/05/21	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	7	N/A	2014/05/20	BBY6SOP-00011	SM-4500-CI-
Conductance - water	7	N/A	2014/05/21	BBY6SOP-00026	SM-2510B
Fluoride - Mining Clients	7	N/A	2014/05/20	BBY6SOP-00012	SM - 4500 F C
Hardness Total (calculated as CaCO <sub>3</sub> )	7	N/A	2014/05/27	BBY7SOP-00002	EPA 6020A
Mercury (Total-LowLevel) by CVAf	5	2014/05/23	2014/05/23	BBY7SOP-00015	BC MOE Lab Manual
Mercury (Total-LowLevel) by CVAf	2	2014/05/26	2014/05/26	BBY7SOP-00015	BC MOE Lab Manual
ICP-AES Dissolved Metals in Water	7	N/A	2014/05/23	BBY7SOP-00018	EPA 6010C
Na, K, Ca, Mg, S by CRC ICPMS (total)	7	N/A	2014/05/27	BBY7SOP-00002	EPA 6020A
Elements by ICPMS Low Level (total)	7	N/A	2014/05/26	BBY7SOP-00002	EPA 6020A
Nitrogen (Total)	5	2014/05/21	2014/05/21	BBY6SOP-00016	SM-4500N C
Nitrogen (Total)	2	2014/05/21	2014/05/23	BBY6SOP-00016	SM-4500N C
Ammonia-N (Preserved)	7	N/A	2014/05/21	BBY6SOP-00009	SM-4500NH3G
Nitrate+Nitrite (N) (low level)	7	N/A	2014/05/21	BBY6SOP-00010	EPA 353.2
Nitrite (N) (low level)	7	N/A	2014/05/21	BBY6SOP-00010	SM 4500NO3-I
Nitrogen - Nitrate (as N)	7	N/A	2014/05/22	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO <sub>3</sub> Preserve for Metals	4	N/A	2014/05/22	BBY6WI-00001	EPA 200.2
Filter and HNO <sub>3</sub> Preserve for Metals	3	N/A	2014/05/27	BBY6WI-00001	EPA 200.2
pH Water (1)	7	N/A	2014/05/21	BBY6SOP-00026	SM-4500H+B
Orthophosphate by Konelab (low level)	7	N/A	2014/05/21	BBY6SOP-00013	SM 4500 P E
Sulphate by Automated Colourimetry	7	N/A	2014/05/20	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Calculated)	7	N/A	2014/05/23	BBY WI-00033	Calculated Parameter
Total Dissolved Solids (Filt. Residue)	7	N/A	2014/05/28	BBY6SOP-00033	SM 2540C
TKN (Calc. TN, N/N) total	5	N/A	2014/05/22	BBY6SOP-00022	SM 4500N-C
TKN (Calc. TN, N/N) total	2	N/A	2014/05/26	BBY6SOP-00022	SM 4500N-C
Phosphorus-P (LL Tot, dissolved) - UF/UP	6	2014/05/20	2014/05/21	BBY6SOP-00013	SM-4500 PE
Phosphorus-P (LL Tot, dissolved) - UF/UP	1	2014/05/26	2014/05/27	BBY6SOP-00013	SM-4500 PE
Total Phosphorus	4	N/A	2014/05/21	BBY6SOP-00013	SM 4500 P E
Total Phosphorus	3	N/A	2014/05/27	BBY6SOP-00013	SM 4500 P E
Total Suspended Solids-Low Level	7	2014/05/23	2014/05/26	BBY6SOP-00034	SM-2540 D
Turbidity	7	N/A	2014/05/20	BBY6SOP-00027	SM - 2130B

\* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Maxxam Job #: B439793  
Report Date: 2014/06/03

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Your P.O. #: K16877  
Sampler Initials: DD

-2-

Encryption Key



Maxxam  
03 Jun 2014 08:55:58 -07:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Namita Sahni, Burnaby Project Manager  
Email: NSahni@maxxam.ca  
Phone# (604) 639-2614

=====  
This report has been generated and distributed using a secure automated process.  
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B439793  
 Report Date: 2014/06/03

DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

### RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID	JQ2136	JQ2137	JQ2138			
Sampling Date	2014/04/19 13:45	2014/04/19 12:30	2014/04/19 12:45			
UNITS	SS3-5	SS3-6	SS3-7-4	RDL		
<b>Misc. Inorganics</b>						
Acidity (pH 4.5)	mg/L	7492761	7492761	<0.50	0.50	7492761
Acidity (pH 8.3)	mg/L	7492761	7492761	<0.50	0.50	7492761
Fluoride (F)	mg/L	0.390	7491245	7491245	<0.010	0.010
<b>Calculated Parameters</b>						
Filter and HNO3 Preservation	N/A	7492752	7493208	LAB	N/A	7492752
Nitrate (N)	mg/L	0.131	7490191	0.107	0.161	7490191
Total Dissolved Solids	mg/L	9.00	7492825	8.00	10.0	7492825
<b>Misc. Inorganics</b>						
Alkalinity (Total as CaCO3)	mg/L	7.20	7493436	6.56	7.56	7493436
Alkalinity (PP as CaCO3)	mg/L	<0.50	7493436	<0.50	<0.50	7493436
Bicarbonate (HCO3)	mg/L	8.78	7493436	8.00	9.22	7493436
Carbonate (CO3)	mg/L	<0.50	7493436	<0.50	<0.50	7493436
Hydroxide (OH)	mg/L	<0.50	7493436	<0.50	<0.50	7493436
<b>Anions</b>						
Orthophosphate (P)	mg/L	0.0077(1)	7492742	0.0064(1)	0.0088(1)	0.0010
Dissolved Sulphate (SO4)	mg/L	<0.50	7491858	<0.50	<0.50	0.50
Dissolved Chloride (Cl)	mg/L	0.55	7491841	<0.50	0.53	0.50
<b>Nutrients</b>						
Ammonia (N)	mg/L	0.086	7493440	0.049	0.18	0.0050
Dissolved Phosphorus (P)	mg/L	0.0514(1)	7491863	0.0823(1)	0.0663(1)	0.0020
Total Total Kjeldahl Nitrogen (Calc)	mg/L	0.200	7490192	0.119	0.171	0.020
Nitrate plus Nitrite (N)	mg/L	0.135(1)	7493580	0.112(1)	0.166(1)	0.0020
Nitrite (N)	mg/L	0.0039(1)	7493582	0.0048(1)	0.0047(1)	0.0020
Total Nitrogen (N)	mg/L	0.334	7493460	0.231	0.337	0.020
Total Phosphorus (P)	mg/L	0.0483	7492847	0.0427	0.100	0.0020
<b>Physical Properties</b>						
Conductivity	uS/cm	20.0	7493445	17.3	22.1	1.0
pH	pH	7.06	7493444	7.00	7.12	
<b>Physical Properties</b>						
Total Suspended Solids	mg/L	47.0	7495665	55.2	72.0	1.0
Total Dissolved Solids	mg/L	14.3(1)	7495847	10.2(1)	12.5(1)	1.0
Turbidity	NTU	15.6(1)	7492007	12.8(1)	25.0(1)	0.10

N/A = Not Applicable  
 RDL = Reportable Detection Limit  
 (1) - Sample arrived to laboratory past recommended hold time.

DIAVIK DIAMOND MINES INC.  
 Client Project #: AEMP

 Maxxam Job #: B439793  
 Report Date: 2014/06/03

 Your P.O. #: K16877  
 Sampler Initials: DD

**RESULTS OF CHEMICAL ANALYSES OF WATER**

Maxxam ID	JQ2139	JQ2140	JQ2141	JQ2142	
Sampling Date	2014/04/19 12:45	2014/04/19 13:30	2014/04/19 18:15	2014/04/19 18:15	
UNITS	SS3-7-5	QC Batch	SS4-4-4	SS4-4-5	QC Batch
<b>Misc. Inorganics</b>					
Acidity (pH 4.5)	mg/L	<0.50	7492761	<0.50	7492761
Acidity (pH 8.3)	mg/L	<0.50	7492761	<0.50	7492761
Fluoride (F)	mg/L	<0.010	7491245	<0.010	7491245
<b>Calculated Parameters</b>					
Filter and HNO3 Preservation	N/A	LAB	7493208	LAB	N/A
Nitrate (N)	mg/L	0.157	7490191	0.0886	0.0020
Total Dissolved Solids	mg/L	10.0	7492825	20.0	5.00
<b>Misc. Inorganics</b>					
Alkalinity (Total as CaCO3)	mg/L	8.16	7493436	3.80	3.77
Alkalinity (PP as CaCO3)	mg/L	<0.50	7493436	<0.50	<0.50
Bicarbonate (HCO3)	mg/L	9.96	7493436	4.64	4.60
Carbonate (CO3)	mg/L	<0.50	7493436	<0.50	<0.50
Hydroxide (OH)	mg/L	<0.50	7493436	<0.50	<0.50
<b>Anions</b>					
Orthophosphate (P)	mg/L	0.0095(1)	7492742	0.011(1)	0.0010
Dissolved Sulphate (SO4)	mg/L	<0.50	7491858	<0.50	<0.50
Dissolved Chloride (Cl)	mg/L	0.59	7491841	<0.50	<0.50
<b>Nutrients</b>					
Ammonia (N)	mg/L	0.058	7493440	0.059	0.0050
Dissolved Phosphorus (P)	mg/L	0.0549(1)	7491863	0.0629(2)	0.0020
Total Total Kjeldahl Nitrogen (Calc)	mg/L	0.249	7490192	0.058	0.078
Nitrate plus Nitrite (N)	mg/L	0.163(1)	7493580	0.0936(1)	0.0020
Nitrite (N)	mg/L	0.0058(1)	7493582	0.0073(1)	0.0020
Total Nitrogen (N)	mg/L	0.412	7493460	0.152	0.177
Total Phosphorus (P)	mg/L	0.0793	7492847	0.0421	0.0020
<b>Physical Properties</b>					
Conductivity	uS/cm	22.8	7493445	11.2	1.0
pH	pH	7.18	7493444	6.84	6.78

N/A = Not Applicable

RDL = Reportable Detection Limit

- (1) - Sample arrived to laboratory past recommended hold time.
- (2) - Sample arrived to laboratory past recommended hold time. Dissolved greater than total. Reanalysis yields similar results.
- (3) - Sample arrived to laboratory past recommended hold time. Dissolved greater than total. Reanalysis yields similar results.



Maxxam Job #: B439793  
 Report Date: 2014/06/03

DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

**RESULTS OF CHEMICAL ANALYSES OF WATER**

Maxxam ID	JQ2139	JQ2140	JQ2141	JQ2142	
Sampling Date	2014/04/19 12:45	2014/04/19 13:30	2014/04/19 18:15	2014/04/19 18:15	
<b>UNITS</b>	<b>SS3-7-5</b>	<b>SS3-8</b>	<b>SS4-4-4</b>	<b>SS4-4-5</b>	<b>RDL</b>
<b>Physical Properties</b>					<b>QC Batch</b>
Total Suspended Solids	102	86.5	30.3	30.1	7495665
Total Dissolved Solids	22.0(1)	18.0(1)	10.0(1)	8.0(1)	7495847
Turbidity	22.0(1)	32.4(1)	19.4(1)	12.8(1)	7492007
					0.10
					7492007

RDL = Reportable Detection Limit  
 (1) - Sample arrived to laboratory past recommended hold time.

DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439793  
Report Date: 2014/06/03

Your P.O. #: K16877  
Sampler Initials: DD

**ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)**

Maxxam ID	JQ2136	JQ2137	JQ2138	JQ2139	JQ2140	JQ2141	JQ2142		
Sampling Date	2014/04/19 13:45	2014/04/19 12:30	2014/04/19 12:45	2014/04/19 12:45	2014/04/19 13:30	2014/04/19 18:15	2014/04/19 18:15		
UNITS	SS3-5	SS3-6	SS3-7-4	SS3-7-5	SS3-8	SS4-4-4	SS4-4-5	RDL	
<b>Dissolved Metals by ICP</b>									
Dissolved Aluminum (Al)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	7494312
Dissolved Antimony (Sb)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	7494312
Dissolved Arsenic (As)	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.030	7494312
Dissolved Barium (Ba)	mg/L	0.0313	0.0249	0.0325	0.0339	0.0613	0.0177	0.0010	7494312
Dissolved Beryllium (Be)	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0030	7494312
Dissolved Bismuth (Bi)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	7494312
Dissolved Boron (B)	mg/L	<0.010	<0.010	<0.010	<0.010	0.010	<0.010	0.010	7494312
Dissolved Cadmium (Cd)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	7494312
Dissolved Chromium (Cr)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	7494312
Dissolved Cobalt (Co)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	7494312
Dissolved Copper (Cu)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	7494312
Dissolved Iron (Fe)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	7494312
Dissolved Lead (Pb)	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.030	7494312
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	7494312
Dissolved Manganese (Mn)	mg/L	<0.0030	0.0034	0.0036	0.0043	<0.0030	0.0063	0.0030	7494312
Dissolved Molybdenum (Mo)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	7494312
Dissolved Nickel (Ni)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	7494312
Dissolved Phosphorus (P)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	7494312
Dissolved Selenium (Se)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	7494312
Dissolved Silicon (Si)	mg/L	0.316	0.386	0.430	0.456	0.440	0.203	0.183	7494312
Dissolved Silver (Ag)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	7494312
Dissolved Strontium (Sr)	mg/L	0.0244	0.0184	0.0220	0.0228	0.0446	0.0242(1)	0.0129	7494312
Dissolved Tin (Sn)	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.030	7494312
Dissolved Titanium (Ti)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	7494312
Dissolved Vanadium (V)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	7494312
Dissolved Zinc (Zn)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	7494312
Dissolved Zirconium (Zr)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	7494312
Dissolved Calcium (Ca)	mg/L	2.65	2.73	3.33	3.49	4.14	1.53	1.33	7494312
Dissolved Magnesium (Mg)	mg/L	0.454	0.360	0.380	0.378	0.584	0.756	0.384	7494312
Dissolved Potassium (K)	mg/L	<0.30	<0.30	<0.30	<0.30	0.50	<0.30	<0.30	7494312
Dissolved Sodium (Na)	mg/L	0.19	<0.10	0.11	0.13	0.29	14.8(1)	<0.10	7494312
Dissolved Sulphur (S)	mg/L	0.28	0.20	0.31	0.32	0.36	0.47	0.16	7494312

RDL = Reportable Detection Limit  
(1) - Dissolved greater than total. Reanalysis yields similar results.

Maxxam Job #: B439793  
 Report Date: 2014/06/03

DIAVIK DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2136	JQ2137	JQ2138		
Sampling Date	2014/04/19 13:45	2014/04/19 12:30	2014/04/19 12:45		
UNITS	SS3-5	SS3-6	SS3-7-4	RDL	QC Batch
<b>Calculated Parameters</b>					
Total Hardness (CaCO3)	mg/L	21.0	16.2	7490189	30.3
<b>Elements</b>					
Total Mercury (Hg)	ug/L	<0.0020	<0.0020	7495575	0.0027
				0.0020	7498691

---

RDL = Reportable Detection Limit

Maxxam Job #: B439793  
 Report Date: 2014/06/03

DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2136	JQ2137	JQ2138			
Sampling Date	2014/04/19 13:45	2014/04/19 12:30	2014/04/19 12:45			
UNITS	SS3-5	SS3-6	SS3-7-4	QC Batch		
				RDL		
<b>Total Metals by ICPMS</b>						
Total Aluminum (Al)	ug/L	426	7498228	832	0.50	7498228
Total Antimony (Sb)	ug/L	0.074	7498228	0.096	0.020	7498228
Total Arsenic (As)	ug/L	0.190	7498228	0.214	0.020	7498228
Total Barium (Ba)	ug/L	40.0	7498228	30.4	0.020	7498228
Total Beryllium (Be)	ug/L	0.011	7498228	0.012	0.010	7498228
Total Bismuth (Bi)	ug/L	0.0330	7498228	0.0350	0.0050	7498228
Total Boron (B)	ug/L	<5.0	7498228	<5.0	5.0	7498228
Total Cadmium (Cd)	ug/L	0.0100	7498228	0.0090	0.0050	7498228
Total Chromium (Cr)	ug/L	8.35	7498228	6.31	0.050	7498228
Total Cobalt (Co)	ug/L	1.21	7498228	0.936	0.0050	7498228
Total Copper (Cu)	ug/L	1.60	7498228	1.61	0.050	7498228
Total Iron (Fe)	ug/L	1120	7498228	931	1.0	7498228
Total Lead (Pb)	ug/L	0.923	7498228	0.779	0.0050	7498228
Total Lithium (Li)	ug/L	1.20	7498228	1.15	0.50	7498228
Total Manganese (Mn)	ug/L	20.1	7498228	18.1	0.050	7498228
Total Molybdenum (Mo)	ug/L	0.250	7498228	0.201	0.050	7498228
Total Nickel (Ni)	ug/L	24.4	7498228	17.7	0.020	7498228
Total Selenium (Se)	ug/L	<0.040	7498228	<0.040	0.040	7498228
Total Silicon (Si)	ug/L	2020	7498228	1650	50	7498228
Total Silver (Ag)	ug/L	0.0070	7498228	0.0060	0.0050	7498228
Total Strontium (Sr)	ug/L	24.9	7498228	17.5	0.050	7498228
Total Thallium (Tl)	ug/L	0.0110	7498228	0.0100	0.0020	7498228
Total Tin (Sn)	ug/L	0.130	7498228	0.140	0.010	7498228
Total Titanium (Ti)	ug/L	35.0	7498228	35.2	0.50	7498228
Total Uranium (U)	ug/L	0.475	7498228	0.463	0.0020	7498228
Total Vanadium (V)	ug/L	1.35	7498228	1.24	0.10	7498228
Total Zinc (Zn)	ug/L	7.22	7498228	7.41	0.10	7498228
Total Zirconium (Zr)	ug/L	0.219	7498228	0.597	0.050	7498228
Total Calcium (Ca)	mg/L	2.65	7490190	2.59	0.010	7490190
Total Magnesium (Mg)	mg/L	3.48	7490190	2.36	0.010	7490190
Total Potassium (K)	mg/L	0.404	7490190	0.333	0.010	7490190
Total Sodium (Na)	mg/L	0.294	7490190	0.287	0.010	7490190
Total Sulphur (S)	mg/L	<0.10	7490190	<0.10	0.10	7490190

RDL = Reportable Detection Limit

Maxxam Job #: B439793  
 Report Date: 2014/06/03

DIAMOND MINES INC.  
 Client Project #: AEMP

Your P.O. #: K16877  
 Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2139	JQ2140	JQ2141	JQ2142	
Sampling Date	2014/04/19 12:45	2014/04/19 13:30	2014/04/19 18:15	2014/04/19 18:15	
<b>UNITS</b>	<b>SS3-7-5</b>	<b>QC Batch</b>	<b>QC Batch</b>	<b>SS4-4-5</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>					
Total Hardness (CaCO3)	28.9	7490189	61.6	7490189	16.4
<b>Elements</b>					
Total Mercury (Hg)	<0.0020	7495575	<0.0020	7498691	0.0021
					0.50
					0.0030
					0.0020
					7495575

RDL = Reportable Detection Limit

DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439793  
Report Date: 2014/06/03

Your P.O. #: K16877  
Sampler Initials: DD

**LOW LEVEL TOTAL METALS WITH CV HG (WATER)**

Maxxam ID	JQ2139	JQ2140	JQ2141	JQ2142	
Sampling Date	2014/04/19 12:45	2014/04/19 13:30	2014/04/19 18:15	2014/04/19 18:15	
	SS3-7-5	QC Batch	SS4-4-4	SS4-4-5	RDL
UNITS					
<b>Total Metals by ICPMS</b>					
Total Aluminum (Al)	718	7498228	414	434	0.50
Total Antimony (Sb)	0.095	7498228	0.025	0.031	0.020
Total Arsenic (As)	0.365	7498228	0.154	0.180	0.020
Total Barium (Ba)	48.9	7498228	28.9	28.2	0.020
Total Beryllium (Be)	0.020	7498228	0.013	0.015	0.010
Total Bismuth (Bi)	0.0580	7498228	0.0250	0.0260	0.0050
Total Boron (B)	<5.0	7498228	<5.0	<5.0	5.0
Total Cadmium (Cd)	0.0150	7498228	0.0090	0.0090	0.0050
Total Chromium (Cr)	12.1	7498228	7.52	7.71	0.050
Total Cobalt (Co)	1.97	7498228	1.19	1.23	0.0050
Total Copper (Cu)	2.28	7498228	1.07	1.04	0.050
Total Iron (Fe)	1750	7498228	1010	1080	1.0
Total Lead (Pb)	1.29	7498228	0.590	0.590	0.0050
Total Lithium (Li)	2.20	7498228	1.25	1.21	0.50
Total Manganese (Mn)	34.5	7498228	21.1	21.5	0.050
Total Molybdenum (Mo)	0.330	7498228	0.105	0.110	0.050
Total Nickel (Ni)	35.4	7498228	21.6	22.4	0.020
Total Selenium (Se)	<0.040	7498228	<0.040	<0.040	0.040
Total Silicon (Si)	3000	7498228	1660	1790	50
Total Silver (Ag)	0.0070	7498228	<0.0050	<0.0050	0.0050
Total Strontium (Sr)	26.1	7498228	14.3	14.2	0.050
Total Thallium (Tl)	0.0170	7498228	0.0100	0.0120	0.0020
Total Tin (Sn)	0.149	7498228	0.035	0.036	0.010
Total Titanium (Ti)	63.4	7498228	36.4	40.1	0.50
Total Uranium (U)	0.705	7498228	0.304	0.313	0.0020
Total Vanadium (V)	2.32	7498228	1.39	1.47	0.10
Total Zinc (Zn)	9.60	7498228	4.39	4.66	0.10
Total Zirconium (Zr)	0.263	7498228	0.146	0.155	0.050
Total Calcium (Ca)	3.59	7490190	1.41	1.38	0.010
Total Magnesium (Mg)	4.84	7490190	3.13	3.26	0.010
Total Potassium (K)	0.501	7490190	0.305	0.314	0.010
Total Sodium (Na)	0.310	7490190	0.196	0.102	0.010
Total Sulphur (S)	<0.10	7490190	<0.10	<0.10	0.10

RDL = Reportable Detection Limit

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP  
Your P.O. #: K16877  
Sampler Initials: DD

Package 1 8.0°C

Each temperature is the average of up to three cooler temperatures taken at receipt

**General Comments**

Samples received past recommended hold time for all required tests except ICP-MS metals analysis.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7491245	Fluoride (F)	2014/05/20	NC	80 - 120	90	80 - 120	<0.010	mg/L		
7491841	Dissolved Chloride (Cl)	2014/05/20	90	80 - 120	100	80 - 120	<0.50	mg/L	NC	20
7491858	Dissolved Sulphate (SO4)	2014/05/20	NC	80 - 120	99	80 - 120	<0.50	mg/L	NC	20
7491863	Dissolved Phosphorus (P)	2014/05/21	NC	80 - 120	102	80 - 120	<0.0020	mg/L	2.7	20
7492007	Turbidity	2014/05/20			102	80 - 120	<0.10	NTU	2.3	20
7492742	Orthophosphate (P)	2014/05/21	91	80 - 120	98	80 - 120	<0.0010	mg/L	6.3	20
7492761	Acidity (pH 8.3)	2014/05/21			105	80 - 120	<0.50	mg/L	NC	20
7492761	Acidity (pH 4.5)	2014/05/21					<0.50	mg/L	NC	20
7492847	Total Phosphorus (P)	2014/05/21	NC	80 - 120	101	80 - 120	<0.0020	mg/L	4.5	20
7493436	Alkalinity (Total as CaCO3)	2014/05/21	NC	80 - 120	96	80 - 120	<0.50	mg/L	6.5	20
7493436	Alkalinity (PP as CaCO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Bicarbonate (HCO3)	2014/05/21					<0.50	mg/L	6.5	20
7493436	Carbonate (CO3)	2014/05/21					<0.50	mg/L	NC	20
7493436	Hydroxide (OH)	2014/05/21					<0.50	mg/L	NC	20
7493440	Ammonia (N)	2014/05/21	97	80 - 120	94	80 - 120	<0.0050	mg/L	10.2	20
7493445	Conductivity	2014/05/21			98	80 - 120	1.3, RDL=1.0	uS/cm	0	20
7493460	Total Nitrogen (N)	2014/05/21			96	80 - 120	<0.020	mg/L	1.5	20
7493580	Nitrate plus Nitrite (N)	2014/05/21	101	80 - 120	104	80 - 120	<0.0020	mg/L	0.1	25
7493582	Nitrite (N)	2014/05/21	99	80 - 120	101	80 - 120	<0.0020	mg/L	NC	25
7494312	Dissolved Aluminum (Al)	2014/05/23	112	80 - 120	108	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Antimony (Sb)	2014/05/23	93	80 - 120	93	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Arsenic (As)	2014/05/23	100	80 - 120	98	80 - 120	<0.030	mg/L	NC	20
7494312	Dissolved Barium (Ba)	2014/05/23	110	80 - 120	103	80 - 120	<0.0010	mg/L	1.9	20
7494312	Dissolved Beryllium (Be)	2014/05/23	111	80 - 120	104	80 - 120	<0.0030	mg/L	NC	20
7494312	Dissolved Boron (B)	2014/05/23	107	80 - 120	99	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Cadmium (Cd)	2014/05/23	107	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7494312	Dissolved Chromium (Cr)	2014/05/23	105	80 - 120	100	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Cobalt (Co)	2014/05/23	105	80 - 120	101	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Copper (Cu)	2014/05/23	103	80 - 120	100	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Iron (Fe)	2014/05/23	109	80 - 120	105	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Lead (Pb)	2014/05/23	105	80 - 120	101	80 - 120	<0.030	mg/L	NC	20
7494312	Dissolved Lithium (Li)	2014/05/23	114	80 - 120	106	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Manganese (Mn)	2014/05/23	106	80 - 120	102	80 - 120	<0.0030	mg/L	NC	20
7494312	Dissolved Molybdenum (Mo)	2014/05/23	101	80 - 120	99	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Nickel (Ni)	2014/05/23	106	80 - 120	101	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Phosphorus (P)	2014/05/23	104	80 - 120	102	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Selenium (Se)	2014/05/23	101	80 - 120	98	80 - 120	<0.10	mg/L	NC	20
7494312	Dissolved Silicon (Si)	2014/05/23	98	80 - 120	98	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Silver (Ag)	2014/05/23	98	80 - 120	101	80 - 120	<0.010	mg/L	NC	20



QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7494312	Dissolved Strontium (Sr)	2014/05/23	109	80 - 120	101	80 - 120	<0.0010	mg/L	NC	20
7494312	Dissolved Tin (Sn)	2014/05/23	102	80 - 120	98	80 - 120	<0.030	mg/L	NC	20
7494312	Dissolved Titanium (Ti)	2014/05/23	106	80 - 120	102	80 - 120	<0.0050	mg/L	NC	20
7494312	Dissolved Vanadium (V)	2014/05/23	106	80 - 120	100	80 - 120	<0.010	mg/L	NC	20
7494312	Dissolved Zinc (Zn)	2014/05/23	108	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7494312	Dissolved Zirconium (Zr)	2014/05/23	106	80 - 120	100	80 - 120	<0.020	mg/L	NC	20
7494312	Dissolved Calcium (Ca)	2014/05/23	106	80 - 120	102	80 - 120	<0.050	mg/L	1.5	20
7494312	Dissolved Magnesium (Mg)	2014/05/23	106	80 - 120	101	80 - 120	<0.050	mg/L	NC	20
7494312	Dissolved Potassium (K)	2014/05/23	104	80 - 120	101	80 - 120	<0.30	mg/L	NC	20
7494312	Dissolved Sodium (Na)	2014/05/23	108	80 - 120	103	80 - 120	<0.10	mg/L	NC	20
7494312	Dissolved Sulphur (S)	2014/05/23	103	80 - 120	100	80 - 120	<0.10	mg/L	NC	20
7494312	Dissolved Bismuth (Bi)	2014/05/23					<0.050	mg/L	NC	20
7495092	Total Nitrogen (N)	2014/05/23	NC	80 - 120	98	80 - 120	<0.020	mg/L		
7495675	Total Mercury (Hg)	2014/05/23	98	80 - 120	100	80 - 120	<0.0020	ug/L	NC	20
7495665	Total Suspended Solids	2014/05/26			99	80 - 120	<1.0	mg/L		
7495847	Total Dissolved Solids	2014/05/28	106	80 - 120	94	80 - 120	<1.0	mg/L		
7498228	Total Aluminum (Al)	2014/05/26	NC	80 - 120	101	80 - 120	<0.50	ug/L	0.4	20
7498228	Total Antimony (Sb)	2014/05/26	99	80 - 120	104	80 - 120	<0.020	ug/L	NC	20
7498228	Total Arsenic (As)	2014/05/26	98	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
7498228	Total Barium (Ba)	2014/05/26	NC	80 - 120	94	80 - 120	<0.020	ug/L	1.1	20
7498228	Total Beryllium (Be)	2014/05/26	93	80 - 120	98	80 - 120	<0.010	ug/L	NC	20
7498228	Total Bismuth (Bi)	2014/05/26	96	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Cadmium (Cd)	2014/05/26	98	80 - 120	101	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Chromium (Cr)	2014/05/26	96	80 - 120	103	80 - 120	<0.050	ug/L	1.0	20
7498228	Total Cobalt (Co)	2014/05/26	96	80 - 120	100	80 - 120	<0.0050	ug/L	1	20
7498228	Total Copper (Cu)	2014/05/26	93	80 - 120	101	80 - 120	<0.050	ug/L	7.2	20
7498228	Total Iron (Fe)	2014/05/26	NC	80 - 120	107	80 - 120	<1.0	ug/L	5.3	20
7498228	Total Lead (Pb)	2014/05/26	94	80 - 120	97	80 - 120	<0.0050	ug/L	2.1	20
7498228	Total Lithium (Li)	2014/05/26	97	80 - 120	102	80 - 120	<0.50	ug/L	NC	20
7498228	Total Manganese (Mn)	2014/05/26	NC	80 - 120	101	80 - 120	<0.050	ug/L	2.7	20
7498228	Total Molybdenum (Mo)	2014/05/26	95	80 - 120	96	80 - 120	<0.050	ug/L	NC	20
7498228	Total Nickel (Ni)	2014/05/26	NC	80 - 120	103	80 - 120	<0.020	ug/L	8.6	20
7498228	Total Selenium (Se)	2014/05/26	105	80 - 120	109	80 - 120	<0.040	ug/L	NC	20
7498228	Total Silver (Ag)	2014/05/26	98	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20
7498228	Total Strontium (Sr)	2014/05/26	96	80 - 120	93	80 - 120	<0.050	ug/L	3.3	20
7498228	Total Thallium (Tl)	2014/05/26	95	80 - 120	98	80 - 120	<0.0020	ug/L	NC	20
7498228	Total Tin (Sn)	2014/05/26	96	80 - 120	99	80 - 120	<0.010	ug/L	NC	20
7498228	Total Titanium (Ti)	2014/05/26	NC	80 - 120	104	80 - 120	<0.50	ug/L	6.6	20
7498228	Total Uranium (U)	2014/05/26	97	80 - 120	99	80 - 120	<0.0020	ug/L	1.2	20

DIAVIK DIAMOND MINES INC.  
Client Project #: AEMP

Maxxam Job #: B439793  
Report Date: 2014/06/03

Your P.O. #: K16877  
Sampler Initials: DD

**QUALITY ASSURANCE REPORT**

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7498228	Total Vanadium (V)	2014/05/26	96	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7498228	Total Zinc (Zn)	2014/05/26	99	80 - 120	102	80 - 120	<0.10	ug/L	1.7	20
7498228	Total Boron (B)	2014/05/26					<5.0	ug/L	NC	20
7498228	Total Silicon (Si)	2014/05/26					<50	ug/L	5.3	20
7498228	Total Zirconium (Zr)	2014/05/26					<0.050	ug/L	NC	20
7498691	Total Mercury (Hg)	2014/05/26	102	80 - 120	116	80 - 120	<0.0020	ug/L	NC	20
7499205	Dissolved Phosphorus (P)	2014/05/27	NC	80 - 120	92	80 - 120	<0.0020	mg/L	2.2	20
7499207	Total Phosphorus (P)	2014/05/27			92	80 - 120	<0.0020	mg/L		

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Spiked Blank: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.


NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

**Validation Signature Page**

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**Maxxam Job #: B439793**

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

  
\_\_\_\_\_  
Andy Lu, Data Validation Coordinator

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Date Shipped: 2014-May-15

B439793

Results Received:

Shipping Memo: 72469

Maxxam Job #:



08344666



Diavik Diamond Mines Inc. - Chain of Custody		ANALYSIS REQUESTED		
Contact Information - Sample Inquiry DDMI ENVIRONMENT DDMIENVIRONMENT@RIOTINTO.COM 507-550 Ave Yellowknife NT X1A 2P8 Site Env. Supervisor Dwight Grubbe / Sam Blvd @ 867-668-6500 ext 5403 REPORT TO DDMI ENVIRONMENT DDMIENVIRONMENT@RIOTINTO.COM REFERENCE LAB ID # MAXXAM SERVICE REQUESTED <input checked="" type="checkbox"/> DDMI ACCOUNTS PAYABLE Regular (Default) Priority (50% Surcharge) Emergency (100% Surcharge)		Report Distribution <input checked="" type="checkbox"/> Electronic PDF <input checked="" type="checkbox"/> Electronic Excel <input type="checkbox"/> Hard Copy INVOICE TO DDMI ENVIRONMENT DDMIENVIRONMENT@RIOTINTO.COM Reference PO # K16877- (Maxxam 2014)		
Identification	Project	Collected By	Date	Type
SS3-5	J02136 AEMP	DD/DB	2014-Apr-19	GW
SS3-6	J02137 AEMP	DD/DB	2014-Apr-19	GW
SS3-7-4	J02138 AEMP	DD/DB	2014-Apr-19	GW
SS3-7-5	J02139 AEMP	DD/DB	2014-Apr-19	GW
SS3-8	J02140 AEMP	DD/DB	2014-Apr-19	GW
SS4-4-4	J02141 AEMP	DD/DB	2014-Apr-19	GW
SS4-4-5	J02142 AEMP	DD/DB	2014-Apr-19	GW
Routine Parameters: pH, EC, Atdly, Acidity, T, K, Cl, SO4, PO4, NO2, NO3, Dissolved Phosphorus, TDS Nutrients: (Ammonia, Total Phosphorus, TKN) TOC (Total Organic Carbon) - analysis to be taken from the 120ml Nutrient bottle DOC (Dissolved Organic Carbon) UNFILTERED & UNRESERVED Total Mercury Preserved Dissolved Metals Low Level: + Sb, Se PRESERVED Dissolved Metals Low Level: + Sb, Se UNFILTERED & UNRESERVED Dissolved Mercury - UNFILTERED & UNRESERVED Oil & Grease PRESERVED TEH (2 bottles) PAH (TEH + 1 Bottle) BTEX (2 bottles) Biochemical Oxygen Demand (BOD) Fecal Coliforms (2 bottles) TSS/Turbidity				
SPECIAL INSTRUCTIONS Final Destination Burnaby BC 35 BOTTLES RECEIVED BY: Jose Rivera DATE/TIME: 2014-May-15 RELINQUISHED BY: DD DATE/TIME: 2014/05/16 SAMPLE CONDITION (Received) TEMP°C: 12, 11, 11 FROZEN COLD AMBIENT DATE/TIME: 10:11				



B439793

Doc # ENVI-14D-0112 R0

Report Uploaded to MP5:

Data Checked for Breaches:

Relinquish by Basu  
2014 May 15/16 15:44

Radeco  
LOCKER PACKED  
2-14/05/17

ICE: Present  
Custody Seal: Absent  
Temp: 8, 8, 8  
CS: YES 11:10

## *Appendix E*

### *Dust Gauge Collection Standard Operating Procedure*

<b>ENVIRONMENT STANDARD OPERATING PROCEDURE</b>			
<b>Area No.:</b>	<b>8000</b>	<b>Document #:</b>	<b>ENVR-508-0112</b>
		<b>Revision:</b>	<b>0</b>
<b>Task Title:</b>	<b>SOP – Dust Gauge Collection</b>		
	Supersedes ENV SOP 508		
<b>FOR DOCUMENT CONTROL USE ONLY:</b>			
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<b>Effective Date:</b>	<b>See Area Manager Authorized Signature Date below</b>		

**1 REFERENCES/RELATED DOCUMENTS**

- 1.1 **ENVI-178-0312 - Dust Gauge Collection Field Sheet** – Located in: P:\DDMIEnvironment\10.0 Operational Control\10.2 Forms\2012 Active Forms
- 1.2 **ENVI-403-0112 R0 - SOP Total Suspended Solids** - Located in: Diavik Intranet - SOPs – Environment Folder
- 1.3 **ENVR-301-0112 – SOP General Laboratory Safety** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.4 **ENVR-605-0112 R0 - SOP Snowmobiles** – Located in: Diavik Intranet – SOPs – Environment Folder
- 1.5 **ENVR-602-0112 R0 - SOP Watercraft** – Located in: Diavik Intranet – SOPs – Environment Folder
- 1.6 **ENVR-504-0112 R0- SOP Remote Field Safety** – Located in: Diavik Intranet – SOPs – Environment Folder
- 1.7 **ENVR-601-0112 R0 – SOP Aircraft** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.8 **ENVI-135-0112 R0 - Remote Field Safety Permit Form** – Located in: P:\DDMIEnvironment\10.0 Operational Control\10.2 Forms\2012 Active Forms

<b>Revision History</b>			
<b>Revision</b>	<b>Revision Description</b>	<b>Date of Revision</b>	<b>Author</b>
0	Initial Release	11-Jan-12	D. Meredith

<b>Authorized By:</b>		
<b>Area Superintendent:</b>	D. Wells	<b>Date:</b>
<b>Area Manager:</b>	S. Bourn	<b>Date:</b>

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**ENVIRONMENT**  
**STANDARD OPERATING PROCEDURE**  
**Dust Gauge Collection**



**Dust5**

**Description**

Dust gauge collections involves twelve dust gauge stations including two control stations. Dust gauges are monitored quarterly; in order to measure dust deposition at stations surrounding Diavik Mine site.

**ENVIRONMENT**  
**STANDARD OPERATING PROCEDURE**  
**Dust Gauge Collection**

**2 PURPOSE**

The purpose of this Standard Operating Procedure is to outline the methodology for collecting dust gauges. This program is aimed at understanding dust deposition rates associated with project activities. Results collected for this program are compiled and placed in the Appendix for the annual AEMP report.

**3 SCOPE**

**3.1 Scope of Procedure**

There are 12 dust gauges (10 stations, plus 2 control), established on and around East Island for monitoring airborne dust particles. All dust gauges should be collected quarterly during both summer and winter. Before heading out, be sure to check the clean replacement tubes for leakage by filling them with water and placing them in the sink. If they leak, they must be repaired with acrylic epoxy before use. A map illustrating coordinates and where the gauges are located is on the last page of this SOP.

STATION	EASTING	NORTING		STATION	EASTING	NORTING
Dust 01	533964	7154321		Dust 7	536819	7150510
Dust 2A	535678	7151339		Dust 8	531401	7154146
Dust 3	535024	7151872		Dust 9	541204	7152154
Dust 4	531397	7152127		Dust 10	532908	7148924
Dust 5	535696	7155138		Dust C1	534979	7144270
Dust 6	537502	7152934		Dust C2	528714	7153276

**4 DEFINITIONS**

N/A

**5 RESPONSIBILITIES**

**5.1 Environment Superintendant**

It is the responsibility of the superintendent to ensure that satisfactory provisions for safety and health are made for remote field activities by:

- ≠ Instituting, maintaining and communicating this procedure and ensuring technical best practice requirements are properly incorporated;
- ≠ Ensuring that the responsibilities for safety and health are communicated to all participants;
- ≠ Ensuring that the risks associated with remote field activities are managed effectively;
- ≠ Providing appropriate information, instruction and training to all participants

**5.2 Environment Supervisor**

The Environment Supervisor has a responsibility to ensure that:



<b>ENVIRONMENT</b> <b>STANDARD OPERATING PROCEDURE</b> <b>Dust Gauge Collection</b>
---

- ≠ All personnel have read and understand the appropriate SOPs
- ≠ Ensuring proper tools are used for risk management (JHAs, Take5s, Hazard IDs)
- ≠ All legal requirements are followed
- ≠ All equipment and PPE required for the sampling program are available and have had the scheduled maintenance and repair completed
- ≠ The appropriate quality control/quality assurance practices are followed
- ≠ All personnel have completed the required training before completing the tasks assigned

### 5.3 Technicians and Contractors

Each staff member, student and contractor has a moral and legal responsibility for ensuring that his or her work environment is conducive to good health, safety and environment practices by:

- ≠ Complying with all standard operating procedures;
- ≠ Undertaking relevant safety and health training;
- ≠ Reviewing and becoming familiar with all related documents and reference material;
- ≠ Taking action to eliminate, minimize, avoid and report hazards of which they are aware;
- ≠ Making proper use of all safety devices and PPE;
- ≠ Not placing at risk the safety and health of themselves or any others;
- ≠ Ensuring all equipment is maintained and in a safe working condition;
- ≠ Ensuring samples are obtained using proper quality assurance and control procedures;
- ≠ Attending and participating in daily Field Work Planning sessions;
- ≠ Documenting any safety or procedural issues that occur during the program
- ≠ Ensuring all field equipment is in good repair and ready to work

## 6 PROCEDURE

### 6.1 Key HSEQ Aspects

#### 6.1.1 Remote field work/Environmental Exposure

When travelling further in to the field, the completion of a detailed Remote Field Work Permit ENVI-135-0112 , is mandatory. The plan must be signed by all field personnel as well as the on-site supervisor, and a copy made available to the field crew as well as on-site staff. Environmental exposure can be a significant risk for those who are unprepared. Risks are seasonal, and winter time considerations include frost nip/frostbite, hypothermia, dehydration, windburn, sunburn and snow blindness. Summer time risks include heat exhaustion/heat stroke, insect bites, dehydration, sunburn, windburn and hypothermia (due to cold water exposure/submersion). During winter it is extremely important to dress appropriately for the conditions and bring extra clothing and winter gear with you. Conditions can quickly change in this area; be prepared and continuously

**ENVIRONMENT**  
**STANDARD OPERATING PROCEDURE**  
**Dust Gauge Collection**

monitor the weather while you work. If you notice a front moving in, ensure you allow enough time to get back to site. If you do not think that you can get back to site, consider alternative areas for shelter. The waypoint file GPS\_Essentials on the p-drive should be uploaded into all GPS's; this file contains coordinates for many alternative shelters around Lac de Gras. If you must wait out the storm at your present location, prepare your survival kit and erect a temporary, make-shift shelter. Always be sure to communicate your plans to your on-site designate so that they are aware of the situation and can begin to coordinate a response as required. Environment staff are the first choice for on-site designate. If they are not available, a Safety representative would be assigned this role.

**6.1.2 Equipment Operation and Break Downs**

Operating equipment in this environment can involve risks such as: collision with rocks or other equipment, rollovers, spinning out/loss of control, machine fire, exhaust inhalation, vibration impacts, hearing damage, muscle sprains/strains, spills, cold water submersion (due to man-overboard, boat accident, aircraft crash or falling through the ice), aircraft crash, getting lost and becoming stranded in unfavourable conditions. In order to control these risks, it is important to conduct all required mechanical inspections prior to using equipment for field work. Ensure all field equipment is well maintained throughout the season, and that you are familiar with machine operation and basic field maintenance. Also ensure that you have and use the correct PPE for the equipment you are using. A survival kit must be carried for work farther afield; know the contents of this kit and wilderness survival skills.

**6.2 Tools Required**

Clean Replacement Cylinders	Glass Beakers (1000 mL)
Large/Clear/Heavy-duty Plastic Bags	TSS Filters
Duct Tape	High Temp Oven
Permanent Marker	Fire Proof Gloves/Tongs
Map/GPS With Coordinates	Tweezers
Multi-tool (Leatherman)	Boat/Snowmobile (Seasonal)
Spot Locator / Satellite Phone	Survival Kit
XL Latex Gloves	

**6.3 Procedural Steps**

**6.3.1 Sample Collection**

- ≠ Samples are collected through various methods, depending on location. You can walk, drive, boat, snowmobile or use helicopter to access the various sites. Be sure to bring clean tubes with you to replace the ones you will be collecting. Clean tubes are stored in the Environment field lab.
- ≠ Pull the copper tube out of the center of the fiberglass shield, keeping it upright. If the tube is stuck or frozen to the bottom, try wiggling it from the top, or tapping it with a multi-tool near the bottom. If it will not come free, you can remove the shield and then pop the tube out. Be sure to replace the shield and insert a new copper tube afterwards.

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**Dust Gauge Collection**

- ≠ Once you retrieve the tube, cover it right-side-up with a sampling glove and then with a large, heavy-duty plastic bag. Fold the bag around the tube and secure it to the tube using duct tape. Label the bag with the station number, date and time collected. Keep the tube upright and secure at all times during transport. If it is going to be a rough boat or sled ride, you may want to consider double-bagging the tube with one bag on top and another from below.
- ≠ (Summer Samples) Once sample tubes are back in the lab, the sample is transferred into a labeled glass beaker. Clear as much of the dried-on algae, dust, etc. that is found on the inside of the tube with distilled water and add it to the beaker. Run the water through the TSS analysis (ENVI-403-0112 R0). It may take multiple filters to complete one sample.
- ≠ (Winter Samples) Once sample tubes are back in the lab, let the snow melt within the tube by leaving them at room temperature secured in a cooler. Once all the snow has melted, transfer the sample into a labelled glass beaker. From here, follow the same procedures as those outlined above in summer collection.
- ≠ The resulting filter(s) with the dust particles are put into ceramic crucibles (1 filter per crucible) and dried in DDML's high temperature oven at 650°C for 1 hour. This will burn off any organic materials from the filter. You are required to wear heavy-duty fire-proof gloves and use a long set of tongs designed to hold the crucibles. The high temperature oven should be set up within the fume hood and be sure to turn on the fume hood fan. Ensure that you record the sample number on the crucibles in pencil before they are put into the oven.
- ≠ When samples are removed from the oven, Let the Crucibles initially cool, and then place the crucibles into the labeled tin tray that the filter originally came in. Place this combination into the dessicator to allow the sample to cool off for an hour at minimum.
- ≠ Once cooled, remove the filter from the crucible using tweezers and weigh only the filter according to the procedure outlined in the TSS analysis SOP ENVI-403-0112 R0. If any of the dust has fallen into the crucible during drying in the oven, be sure to tip the crucible and add this dust to the top of the filter prior to weighing.
- ≠ Record the results on the Dust Gauge Data Form (ENVI-178-0312).
- ≠ To determine the dustfall deposition rate, use the equation below:

$$\text{Daily Dustfall Deposition (mg/dm}^2\text{/d)} = (\text{TP (mg)} / \text{SA (dm}^2\text{)}) / \text{TDD (d)}$$

*Where:*

**TP (mg)** = Total Particulate

**SA (dm<sup>2</sup>)** = Surface Area of Dust Gauge Collection Tube

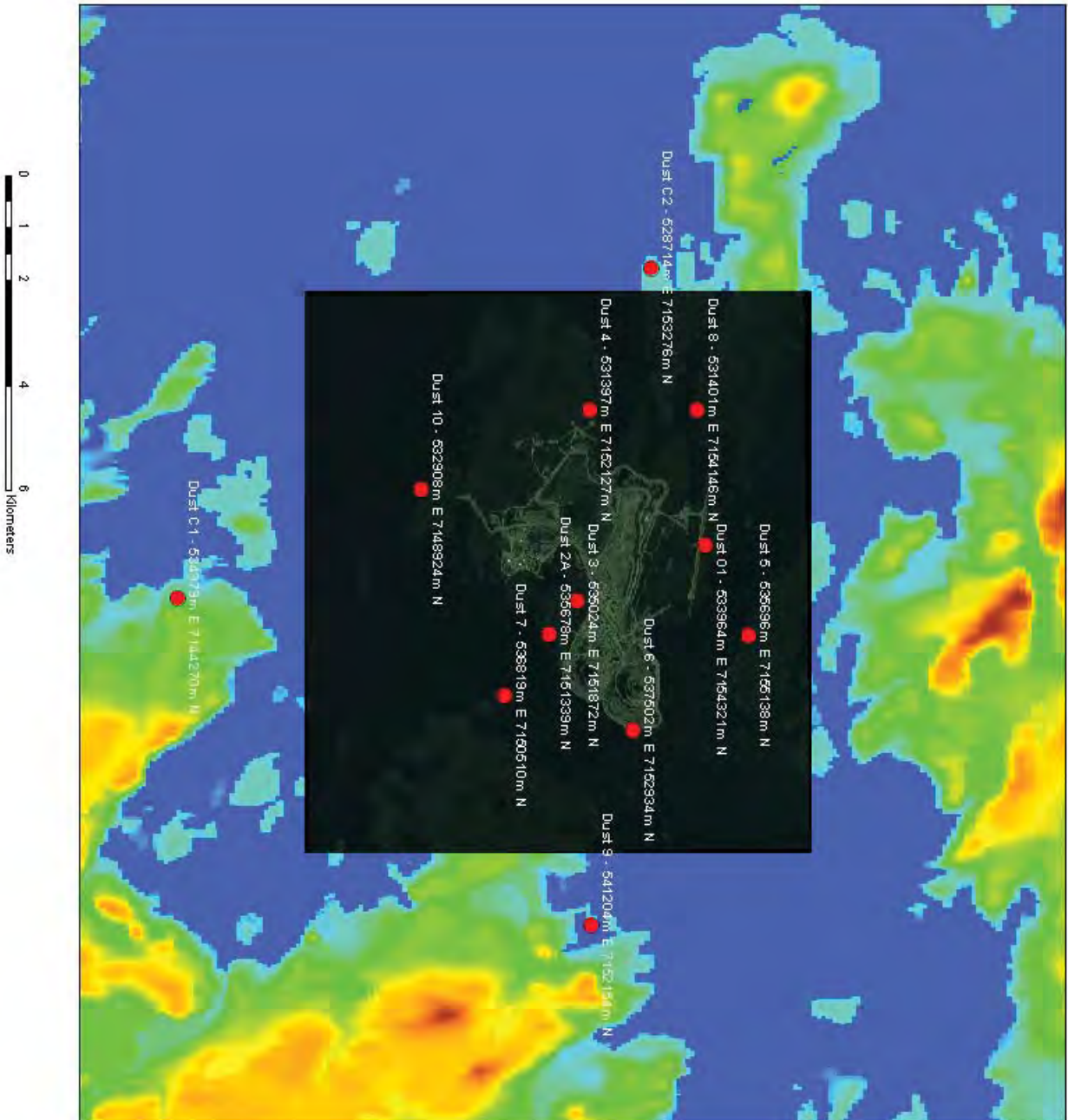
**TDD** = Total Days Gauge was Deployed

## 7 QUALITY OUTCOMES AND EXPECTATIONS

- 7.1 This SOP will allow procedures to be conducted safely in order to avoid injury.
- 7.2 Adherence to this SOP as well as reference to the related documents will ensure successful retrieval of the dust samples for analysis.
- 7.3 It is also expected that all employees and contractors adhere to this SOP.

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**STANDARD OPERATING PROCEDURE**  
**Dust Gauge Collection**

**Rio Tinto**



  
**Snow & Dust**  
**Sampling Locations**  
 Dust Locations

Diavik Diamond Mine  
 Environment et Développement  
 Les de Grac. Northwest Territories  
 2012  
 UTM Zone 12, NAD83

## *Appendix F*

### *Snow Survey Standard Operating Procedure*

<b>ENVIRONMENT STANDARD OPERATING PROCEDURE</b>			
<b>Area No.:</b>	<b>8000</b>	<b>Document #:</b>	<b>ENVR-512-0213</b>
		<b>Revision:</b>	<b>0</b>
<b>Task Title:</b>	<b>Snow Survey</b>		
	<i>supersedes ENV SOP 512</i>		
<b>FOR DOCUMENT CONTROL USE ONLY:</b>			
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<b>Effective Date:</b>	<b>See Area Manager Authorized Signature Date below</b>		

**1 REFERENCES/RELATED DOCUMENTS**

- 1.1 **ENVR-501-0112 – SOP Remote Field Safety** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.2 **ENVR-602-0112 - SOP Snowmobile Operation** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.3 **ENVR-301-0112 - SOP General Laboratory Safety** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.4 **ENVR-303-0112 - SOP Quality assurance and Quality Control** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.5 **ENVR-206-0112 - SOP Chain of Custody and Sample Shipment** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.6 **ENVR-403-0112 - SOP Total Suspended Solids Analysis** - Located in: Diavik Intranet – SOPs – Environment Folder
- 1.7 **ENVI-099-1011- Snowmobile Inspection Checklist** - Located in: P:\DDMI Environment\10.0 Operational Control\10.2 Forms\2012 Active Forms
- 1.8 **ENVI-135-0112 R0 – Remote Field Safety Permit** - Located in: P:\DDMI Environment\10.0 Operational Control\10.2 Forms\2012 Active Forms
- 1.9 **ENVI-177-0312 R0 – Snow Sampling Field Sheet** - Located in: P:\DDMI Environment\10.0 Operational Control\10.2 Forms\2012 Active Forms

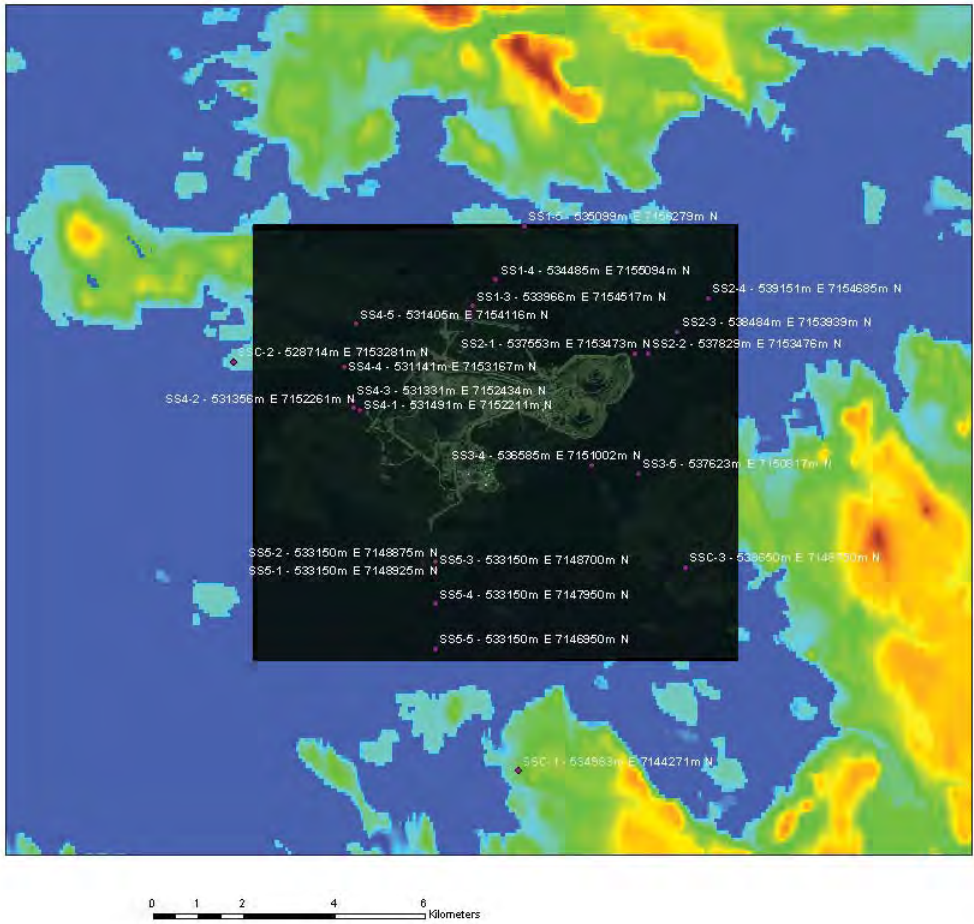
<b>Revision History</b>			
<b>Revision</b>	<b>Revision Description</b>	<b>Date of Revision</b>	<b>Author</b>
0	Original Issue	08-FEB-2012	D.Grabke

**INSERT DEPT NAME HERE**  
**STANDARD OPERATING PROCEDURE**  
 Copy the SOP title from the first page Header or type title here

<b>Authorized By:</b>		
<b>Area Supervisor:</b>	Type names (example) R. Morrison (signature will go beside name)	<b>Date:</b>
<b>Area Manager:</b>	Type name here – signature goes beside	<b>Date:</b>

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**Snow Survey**



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**Snow & Dust Sampling Locations**  
 ♦ Snow Sampling Locations

Diavik Diamond Mine  
 Environnement et Développement  
 Lac de Gar, Nord-Ouest Territoires  
 2012  
 UTM Zone 12, NAD83

**Snow Survey Sample Program Map**

**Description**

Snow sampling at the Diavik Diamond Mine consists of snow core sampling to monitor dust deposition rates relative to predictions outlined in the DDMI Environmental Effects Report (1998), and snow water quality sampling in support of the DDMI Aquatic Effects Monitoring Program (AEMP).



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## 2 PURPOSE

The purpose of this guide is to promote efficient and accurate snow surveying and to establish uniform sampling procedures.

## 3 SCOPE

### 3.1 Scope of Procedure

This standard operating procedure (SOP) describes the responsibilities and processes for collecting, documenting, and processing snow samples from at the Diavik mine site a surrounding Lac de Gras area (during ice cover). This procedure applies to all Diavik Diamond Mines personnel and contractor personnel authorized to collect samples under the current years Aurora Research Institute – Aquatic Effects Monitoring Program (AEMP) Research Permit.

### 3.2 Scope of Activities

This procedure has been developed to be consistent with the requirements of the AEMP design document and Environmental Effects Monitoring.

## 4 DEFINITIONS

### 4.1 QA/QC

≠ quality assurance/quality control. Methods undertaken to ensure sampling procedures and handling are accurate and precise. QA/QC can also refer to a type of sample used to assess field and laboratory performance, e.g. duplicate samples.

## 5 RESPONSIBILITIES

### 5.1 Environment Superintendent

**It is the responsibility of the superintendent to ensure that satisfactory provisions for safety and health are made for remote field activities by:**

- ≠ Instituting, maintaining and communicating this procedure and ensuring technical best practice requirements are properly incorporated;
- ≠ Ensuring that the responsibilities for safety and health are communicated to all participants;
- ≠ Ensuring that the risks associated with remote field activities are managed effectively;
- ≠ Providing appropriate information, instruction and training to all participants;

### 5.2 Environment Supervisor

The Environment Supervisor has a responsibility to ensure that:

- ≠ All personnel have read and understand the appropriate SOPs

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---

- ≠ Ensuring proper tools are used for risk management (JHAs, Take5s, Hazard IDs)
- ≠ All legal requirements are followed
- ≠ All equipment and PPE required for the sampling program are available and have had the scheduled maintenance and repair completed
- ≠ The appropriate quality control/quality assurance practices are followed
- ≠ All personnel have completed the required training before completing the tasks assigned

### 5.3 Environment Technicians and contractors:

Each staff member, student and contractor has a moral and legal responsibility for ensuring that his or her work environment is conducive to good health, safety and environment practices by:

- ≠ Complying with all standard operating procedures;
- ≠ Undertaking relevant safety and health training;
- ≠ Reviewing and becoming familiar with all related documents and reference material;
- ≠ Taking action to eliminate, minimize, avoid and report hazards of which they are aware;
- ≠ Making proper use of all safety devices and PPE;
- ≠ Not placing at risk the safety and health of themselves or any others;
- ≠ Ensuring all equipment is maintained and in a safe working condition;
- ≠ Ensuring samples are obtained using proper quality assurance and control procedures;
- ≠ Attending and participating in daily Field Work Planning sessions;
- ≠ Documenting any safety or procedural issues that occur during the program.

## 6 PROCEDURE

### 6.1 Key HSEQ Aspects

Sampling requires physical labour in a cold environment with potentially inclement weather. All field personnel must be trained to recognize signs of frostbite, hypothermia, fatigue and heat stress; and avoid these symptoms with proper hydration, dress, and work schedules.

Due to the remote nature of sampling locations, all field personnel are to use extreme caution, and must be equipped with appropriate personal protective equipment. This may include cut resistant & latex gloves, hearing protection, safety glasses and emergency survival kits.

Field personnel must be competent, with appropriate training, skills and experience required to carry out the activities safely. Fieldwork requires an awareness of potential hazards and common sense. Under no circumstances should field work be conducted alone, and participants must always be aware of changing weather conditions.

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Completion of a detailed Field Work Permit is mandatory prior to undertaking any off-site activities. The plan must be signed by all field personnel as well as the on-site supervisor, and a copy made available to the field crew as well as on-site staff.

Prior to initiating any off-site sampling programs, personnel must be familiar with the Remote Field Safety ENVR-501-0112

**6.2 Planning**

**6.2.1 Program Management**

The sampling snow survey will be completed annually in April. The survey design consists of 24 sample stations, including 3 control areas established along 5 transect lines originating from East Island and extending onto Lac de Gras.

**Table 1 - Snowcore Sampling Locations**

Transect Line	Station	UTM E (NAD 83)	UTM W (NAD 83)	Description
1	SS1-1	533911	7154288	Land
	SS1-2	533924	7154367	Land
	SS1-3	533966	7154517	Land
	SS1-4	534485	7155094	Ice
	SS1-5	535099	7156279	Ice
2	SS2-1	537553	7153473	Ice
	SS2-2	537829	7153476	Ice
	SS2-3	538484	7153939	Ice
	SS2-4	539151	7154685	Ice
3	SS3-4	536585	7151002	Ice
	SS3-5	537623	7150817	Ice
4	SS4-1	531491	7152211	Land
	SS4-2	531356	7152261	Land
	SS4-3	531331	7152434	Land
	SS4-4	531141	7153167	Ice
	SS4-5	531405	7154116	Ice
5	SS5-1	533150	7148925	Land
	SS5-2	533150	7148875	Land
	SS5-3	533150	7148700	Ice
	SS5-4	533150	7147950	Ice
	SS5-5	533150	7146950	Ice
	Control 1	534983	7144271	Land
	Control 2	528714	7153281	Land
	Control 3	538650	7148750	Land

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**STANDARD OPERATING PROCEDURE**  
**Snow Survey**

**6.2.2 Sampling Requirements – Dust Deposition**

Dust deposition will be measured in-house using standard DDMI Total Suspended Solids laboratory procedures ENVR-403-0112. To facilitate this analysis, a composite sample comprised of a minimum of 3 snow cores will be collected at **ALL** (land and Ice) of the snow sampling stations. In areas with low snow pack a minimum of 35 SWE should be collected to a sufficient volume of water is available for processing. This may require more than the minimum 3 cores.

**6.2.3 Sampling Requirements – Snow Water Quality**

Snow water quality samples are required for all sample stations on Lac de Gras identified as **on-ice** locations, as well as at the **three control** areas Table 1 - Snowcore Sampling Locations. Snow chemistry analysis will be conducted by Maxxam Analytistics. To facilitate the required analysis Table 2- Snow Water Quality Sample Requirements, a composite sample comprised of a minimum of 3 snow cores will be collected at all of the snow water quality stations.

**Table 2- Snow Water Quality Sample Requirements**

Maxxam Bottle	Analysis	Minimum Volume of Sample Required (ml)	Preservative
Metals	Total ICP Metals (Ultra Low)	120	1ml Nitric Acid – HNO <sub>3</sub>
Nutrients	Ammonia	120	0.5 ml Sulfuric Acid
Routine	Sulfates, Nitrates, and Nitrites	1000	None Required
TSS, Turbidity & pH (Routine, 2 <sup>nd</sup> Bottle)	TSS, Turbidity & pH	1000	None Required
Total Sample Volume Required		2240ml + 30% Triple Rinse	<b>3000ml = 100SWE</b>

**Determining anticipated sample volume from Snow Water Equivalent (SWE)**

$$\text{Sample Water (ml)} = \text{SWE (cm)} \times 30(\text{cm}^2)$$

$$3000\text{ml} / 30\text{cm}^2 = \text{SWE} = 100\text{cm SWE}$$

**Therefore the aggregate SWE collected at a sample site must be at least 100cm to ensure sufficient volume for water quality analysis.**

**6.3 Quality Assurance and Quality Control**

Quality Control will be achieved through the use of duplicate and blank samples.

- ≠ Duplicate samples will be collected for a minimum 10% of the total samples (both Dust and Water Quality).

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- ≠ At least **two** duplicate samples for the **dust** deposition samples
- ≠ At least **two** duplicate samples for the **water quality** samples
- ≠ One **equipment blank** will be collected and processed by Maxxam for water quality chemical analysis. Maxxam DI water batch number will be recorded on the field sheet. Equipment blank will be completed from a single batch of DI water. Ensure that information from the DI water is recorded on the field sheet. Batch ID and Expiry date.

Quality assurance will be achieved via the following processes;

- ≠ Field data sheets will be utilized to document any and all observations, or occurrences that may impact the integrity of the samples, as well as corrective actions implemented to deal with those occurrences.
- ≠ If a sample becomes compromised, it will be recorded on the field data sheet, the sample will be discarded and a new sample collected.
- ≠ Individuals collecting the samples will take precautions to eliminate sample contamination during handling. Avoid touching insides of sample bags, avoid contacting the snow samples with anything other than the sampling corer.

Steps will be taken prior to, during, and after sampling to ensure all samples are correctly labeled with the sample date, sample ID, and sample type.

#### 6.4 Equipment Inspection & Preparation

Prior to commencing the sampling program, inspect all sampling equipment for fouling, contamination, or damage. All of the polyacrylic tubes that will be utilized will be rinsed with a 10% Nitric Acid solution to ensure they are clean prior to the initiation of the program.

**Snow Corer** – Inspect the core tube to ensure measurement etchings are legible. Check the cutting edge to ensure blade is not deformed or damaged. Inspect the handles and threads to ensure they will assemble and disassemble without binding. Ensure the corer has been de-contaminated (acid rinsed) prior to commencing the program.

**Weighing Scale and Cradle** – Inspect the scale and cradle for deformity or damage

**Snowmobiles** – Inspection and use of snowmobiles will be in accordance with ENVR-603-0112

**Communication** – Inspect all communication equipment (Radios/Sat Phones, Spot Personal Locator) to ensure they are operational and functional. Ensure batteries (including spares) are fully charged. Ensure check-in times and procedures are clearly identified on the Field Work Permit.

**Navigation** – Inspect GPS and spare batteries to ensure equipment is functioning correctly. Verify that all sample locations are present and correct, and that the GPS Essentials file is loaded. Ensure an appropriate map is present to allow navigation back to site should the GPS fail.

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**Personnel Gear** – In addition to winter survival equipment, each individual participating in off-site activities is expected to carry appropriate personal gear and equipment as is deemed necessary for the individual well being in an emergency situation.

**Survival Kit** – Inspect survival kit and Ice Rescue kits to ensure that they are complete and all items are functional and ready for use.

**Misc** – Individual core samples will be compiled into plastic bags (soil sampling bags) and sealed with zip-ties until they are ready for processing. Prior to the program commencing bags must be inspected to ensure they are new and clean.

**6.5 Tools Required**

**Table 3 - Tools and Gear Required**

Snow Corer & Handles	Snow Survey Map
Transport Case	GPS & Waypoints
Weighing Scale & Cradle	Satellite Phone
Sample Collection Bags & Zip Ties	Spot Personal Locator
Black Permanent Marker	Survival Kit
Field Data Sheets (Pens/Pencils) & Clipboard	Ice Rescue Kit

**6.6 Procedural Steps**

**6.6.1 Sample Collection**

Navigate to the sampling locations – If the sample point falls on or immediately adjacent to the winter road adjust your location to the nearest area with natural snow coverage (ie not impacted by the road or snow clearing).

Assemble the corer by threading the handles onto the tube, and re-inspect the snow corer for fouling and/or damage that may have occurred during transportation.

Fill in station location and weather information on the field data sheet. Identify snow conditions and dust observations in the comments section.

Prior to collecting a sample re-inspect the tube to check for cleanliness.

- ≠ **Take the weight of the empty snowcorer at each station prior to collecting any samples.**
- ≠ **For all station requiring snow water chemistry, collect the dust sample first – this will effectively rinse the corer with ambient snow minimizing cross contamination from locations.**

Hold the corer vertically (cutter end down) and drive it through the snow to the ground/ice surface below. Be sure the cutter contacts the ground/ice as compacted snow/ice may feel like the ground and result in an incomplete core.

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Before raising the corer, read the depth of the snow (nearest cm) and record on the field datasheet.

Turn the corer at least one full turn to cut the core loose from the ground/ice surface. Carefully raise the corer and record the length of the core extracted. [ Note: this could potentially be different from the depth of snow, see next]

Inspect the cutter end of the tube for dirt or litter, with gloves on carefully remove soil and litter from the core. If need be correct the length of the core extracted by subtracting the depth of the soil or litter (plug). Record adjusted core length and litter/soil observations on the field data sheet.

Carefully balance the corer containing the core on the weighing cradle.

≠ **Suspend the corer (like a pendulum) do not hold the corer tube or handles**

To ensure and accurate reading, gently tap the scale to be sure it is not sticking or binding.

Read the weight of the tube and core from the graduations on the scale. The scale is marked in cm of water.

Record the weight of the corer and the core to the nearest one-half cm.

To collect the core, lift the tube from the cradle and turn cutter und up. Gently tap the corer and the extracted core will slide out the top end. Be sure to use a clean/new sample bag to catch the core sample.

≠ **Ensure all sample bags are clearly labelled with the station ID, sample type, date, and number of cores included in the composite**

≠ **Ensure all bags are sealed using a clean zip-tie**

Weigh the empty sampling tube following the first and at least every fourth sample as the weight will change as small particle of water or snow accumulate/cling to the inside and outside of the tube and checking will make the data more accurate. Record the weight of the empty corer on the field data sheet.

Subtract the weight of the empty tube from the weight of the tube and core to obtain the water content of the sample.

Density calculations can be completed back in the lab following the completion of the program.

**Density (g/cm<sup>3</sup>) = Total SWE Collected (g/cm<sup>2</sup>) / Total Snow Core Length Collected (cm)**

**ENVIRONMENT**  
**STANDARD OPERATING PROCEDURE**  
**Snow Survey**

\*assumes pure water density 1g/cm<sup>3</sup>

Prior to moving to the next sampling location ensure the field datasheet is complete.

### 6.6.2 Sample Processing

Prior to processing, all samples must be kept in a frozen state to minimize sample degradation.

When preparing the samples for decanting and analysis, remove the sample bags from the freezer. Check to ensure that the top of the bag is well twisted and the zip-tie is tight. Place the sample bag into a new (clean) sample bag and affix a zip-tie to seal the second bag. This double bagging will help to ensure no sample is lost during the melting process. To process samples, they will require anywhere from 12-36 hours to thaw at room temperature.

Place the sealed sample bags upright in clean coolers in the lab to thaw overnight.

Once a sample is completely melted it is ready for processing.

Sample volume can be determined using a scale accurate to 1g, set up scale, tare the sampling basin with two bags and 2 zip-ties. Place sample bags in the basin and record the weight of each of the bags on the field sheet.

Dust deposition samples will be processed in the DDMI Lab for TSS.

- ≠ **The entire volume of sample must be processed – this may require the use of multiple filters.**
- ≠ **For samples with large quantities of organics (twigs/leaves etc.) it may be necessary to sieve the sample through a course filter prior to processing.**
- ≠ **Given the possibility of the samples containing organic matter, sample filters will be dried in the high temperature oven (650°F) for 1hr to burn off any organics on the filter.**
- ≠ **Allow Samples to cool in the desiccator prior to weighing the filters.**

Snow Water Quality samples will be decanted to fill the appropriate (pre-labelled) Maxxam sample bottles as per standard water sampling procedures. Any excess sample water can be discarded.

### 6.6.3 Sample Chain of Custody

For all samples collected, a complete, accurate and clearly legible field data sheet must be filled out.



**ENVIRONMENT**  
**STANDARD OPERATING PROCEDURE**  
**Snow Survey**

All samples collected must be logged in the Environment Sample Bible immediately following return to the office.

Results from DDMI Lab TSS analysis are to be recorded on the field sheet and electronically input into the MP5 database.

Prior to placing any field samples into the lab refrigerator or freezer for storage, field personnel must recheck all bag labels to ensure accuracy.

Prior to placing any Maxxam samples into the lab refrigerator for storage, personnel must recheck all bottle labels to ensure accuracy.

Samples will be shipped to Maxxam Analytics as per ENVR-206-0112 – CHAIN OF CUSTODY & SAMPLE SHIPPING – and accompanied by CoC documentation.

## 7 QUALITY OUTCOMES AND EXPECTATIONS

- ≠ Successful completion of the Snow Sampling program
- ≠ No safety or environmental incidents for the duration of the program
- ≠ No errors in sample labelling, shipping and analysis
- ≠ Thorough documentation on field datasheets, COCs and program sample schedule

## **APPENDIX II**

### **EFFLUENT AND WATER CHEMISTRY REPORT**



**EFFLUENT AND WATER CHEMISTRY REPORT  
IN SUPPORT OF THE 2014 AEMP ANNUAL  
REPORT FOR THE DIAVIK DIAMOND MINE,  
NORTHWEST TERRITORIES**

Submitted to:

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**DISTRIBUTION**

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- 1 Copy – Golder Associates Ltd., Calgary, AB
- 1 Copy – Wek'èezhii Land and Water Board

March 2016  
1406208

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PO No. D03013



## EXECUTIVE SUMMARY

In 2014, Diavik Diamond Mines (2012) Inc. (DDMI) performed the field component of its Aquatic Effects Monitoring Program (AEMP) in Lac de Gras, Northwest Territories, as required by Water Licence W2007L2-0003 and according to the AEMP Study Design Version 3.5 approved by the Wek'èezhii Land and Water Board (WLWB). This report presents the analyses of effluent and water chemistry data collected during the 2014 AEMP field sampling and from relevant stations in the Surveillance Network Program (SNP). Objectives of the water quality monitoring component of the AEMP were to assess effects of the Mine effluent on water quality in Lac de Gras.

Water quality variables were assessed for a Mine-related effect according to Action Levels in the Response Framework. Nineteen variables demonstrated an effect equivalent to Action Level 1. These consisted of specific conductivity, total dissolved solids (TDS; calculated), calcium, chloride, potassium, sodium, sulphate, nitrate, aluminum, antimony, barium, copper, chromium, lead, molybdenum, silicon, strontium, tin and uranium. With near-field (NF) exposure area median concentrations greater than two times the median concentrations in reference areas, these 19 variables were identified as substances of interest (SOIs).

Of the 19 SOIs that triggered Action Level 1, eight also triggered Action Level 2, which was applicable because the 5<sup>th</sup> percentile concentration in the NF exposure area exceeded two times the median concentrations in reference areas and the normal range for Lac de Gras. None of the SOIs triggered Action Level 3.

Quality control issues identified with the ammonia data in 2014 prevented the evaluation of Action Levels for ammonia. Given the issues with the ammonia analysis, ammonia was retained as an SOI in 2014. Fluoride was also included in the list of SOIs in 2014, because concentrations in the Mine effluent were greater than the AEMP Effects Benchmark for the protection of aquatic life in seven percent of samples. Fluoride did not trigger an Action Level in 2014, and concentrations at lake water monitoring stations were within the AEMP Aquatic Life Effects Benchmark value in all samples.

Toxicity testing of effluent samples indicated that the effluent was generally not toxic as tested. All 32 samples submitted for lethal testing were designated as a pass (i.e., less than 50 percent [%] mortality in the 100% effluent sample). Two of the 24 samples submitted for sublethal testing affected *Ceriodaphnia dubia* reproduction (December 2013 and March 2014 effluent samples); however, in both cases the reduction in reproduction relative to the control was only marginally greater than the criterion used to designate a test failure. Regulated effluent variables were below applicable Effluent Quality Criteria (EQC) for the 2014 monitoring period in all samples, with the exception of one oil and grease sample, which was due to a quality assurance/quality control (QA/QC) issue.

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## Acronyms and Abbreviations

AEMP	Aquatic Effects Monitoring Program
CWQG	Canadian Water Quality Guidelines
DDMI	Diavik Diamond Mines (2012) Inc.
DO	dissolved oxygen
DL	detection limit
DQO	data quality objective
EQC	effluent quality criteria
FF	far-field
HydroQual	HydroQual Laboratories
LOEL	Lowest observable effects level
Maxxam	Maxxam Analytics Inc.
MF	mid-field
Mine	Diavik Diamond Mine
ND	Non detect
NF	near-field
NIWTP	North Inlet Water Treatment Plant
NTU	nephelometric turbidity unit
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SD	standard deviation
SNP	Surveillance Network Program
SOI	substance of interest
SOP	standard operating procedure
TDS	total dissolved solids
WLWB	Wek'èezhii Land and Water Board

## Units and Symbols

%	percent
<	less than
>	greater than
≥	greater than or equal to
kg	kilogram
km <sup>2</sup>	square kilometre
m	metre
m <sup>3</sup>	cubic metre
mg/L	milligram per litre
mm	millimetre

NTU	nephelometric turbidity unit
µm	micrometre
µg/L	microgram per litre
µg-N/L	microgram nitrogen per litre
µg-P/L	microgram phosphorus per litre
µS/cm	microSiemen per centimetre

# **1 INTRODUCTION AND OBJECTIVES**

## **1.1 BACKGROUND**

In 2014, Diavik Diamond Mines (2012) Inc. (DDMI) completed the field component of its Aquatic Effects Monitoring Program (AEMP), as required by Water Licence W2007L2-0003 (WLWB 2007). This report presents the analysis of effluent and water chemistry data collected during the 2014 field program. The ice-cover season sampling program was carried out by DDMI according to the AEMP Study Design Version 3.4 (Golder 2014a) and the open-water season program was completed under the revised AEMP Study Design Version 3.5 (Golder 2014b).

The assessment of effects was based on the updated Version 3.5 Study Design (Golder 2014a), which was approved by the Wek'èezhii Land and Water Board (WLWB) on May 29, 2014 (WLWB 2014). Details on methods are provided in Section 2. Section 3 provides the results of the assessment, while Section 4 provides a summary and discussion of the results. Conclusions from the 2014 AEMP are provided in Section 5.

## **1.2 OBJECTIVES**

Substances released from the Diavik Diamond Mine (Mine) must enter the water of Lac de Gras before aquatic organisms can be exposed to the material released, and potentially be affected by this material. Water quality represents a valuable early warning measurement endpoint to identify potential effects to aquatic biota in Lac de Gras. The objective of the water quality monitoring component of the AEMP is to assess the effects of Mine effluent on water quality in Lac de Gras. Water chemistry data were analyzed to determine whether there were differences in water quality between areas exposed to Mine effluent and reference areas.

## **1.3 SCOPE AND APPROACH**

The 2014 AEMP water quality survey in Lac de Gras was carried out according to the requirements specified in the AEMP Study Design for an interim monitoring year (Golder 2014b). The focus of the annual report for an interim monitoring year is to assess effects on water quality in Lac de Gras by evaluating whether an Action Level has been triggered. The Response Framework used to categorize water quality variables according to Action Levels is described in the AEMP Study Design. The magnitude, extent, and importance of an effect are defined in the Action Level categories. The full suite of water quality variables analyzed in 2014 was included in the Action Level screening. Field measurements (i.e., depth profile data) are discussed qualitatively, and nutrients (phosphorus and nitrogen) are evaluated in the Eutrophication Indicators report (Golder 2016a).

The results of the Action Level screening were used in combination with an assessment of effluent chemistry to identify a subset of variables with potential Mine-related effects. These variables are called substances of interest (SOIs). The intent of defining SOIs was to identify a meaningful set of variables that will undergo further analyses, while limiting analyses for variables that were less likely to be affected. Substances of interest were evaluated for trends in the Mine effluent as well as at the mixing zone boundary in Lac de Gras. The extent and magnitude of effects in the exposure area of Lac de Gras were evaluated for each SOI as defined by the Action Level criteria.

## 2 METHODS

### 2.1 FIELD SAMPLING

The water quality field sampling program included the collection of *in situ* water quality measurements and of water samples for chemical analysis. Water column profile measurements were collected at AEMP stations using multi-parameter water quality meters (Hydrolab and YSI) following the methods described in DDMI's Standard Operating Procedure (SOP), ENVR-608-0112 "Hydrolab Calibration, Deployment and Download." Collection of water samples followed the protocols described in ENVR-014-0311 "AEMP Sampling – Ice Cover" and ENVR-003-0702 "AEMP Monitoring Program – Open Water". Water samples were handled according to ENVR-303-0112 "Laboratory Quality Assurance/Quality Control" and ENVR-206-0112 "Processing Maxxam Samples and Tracking Documentation."

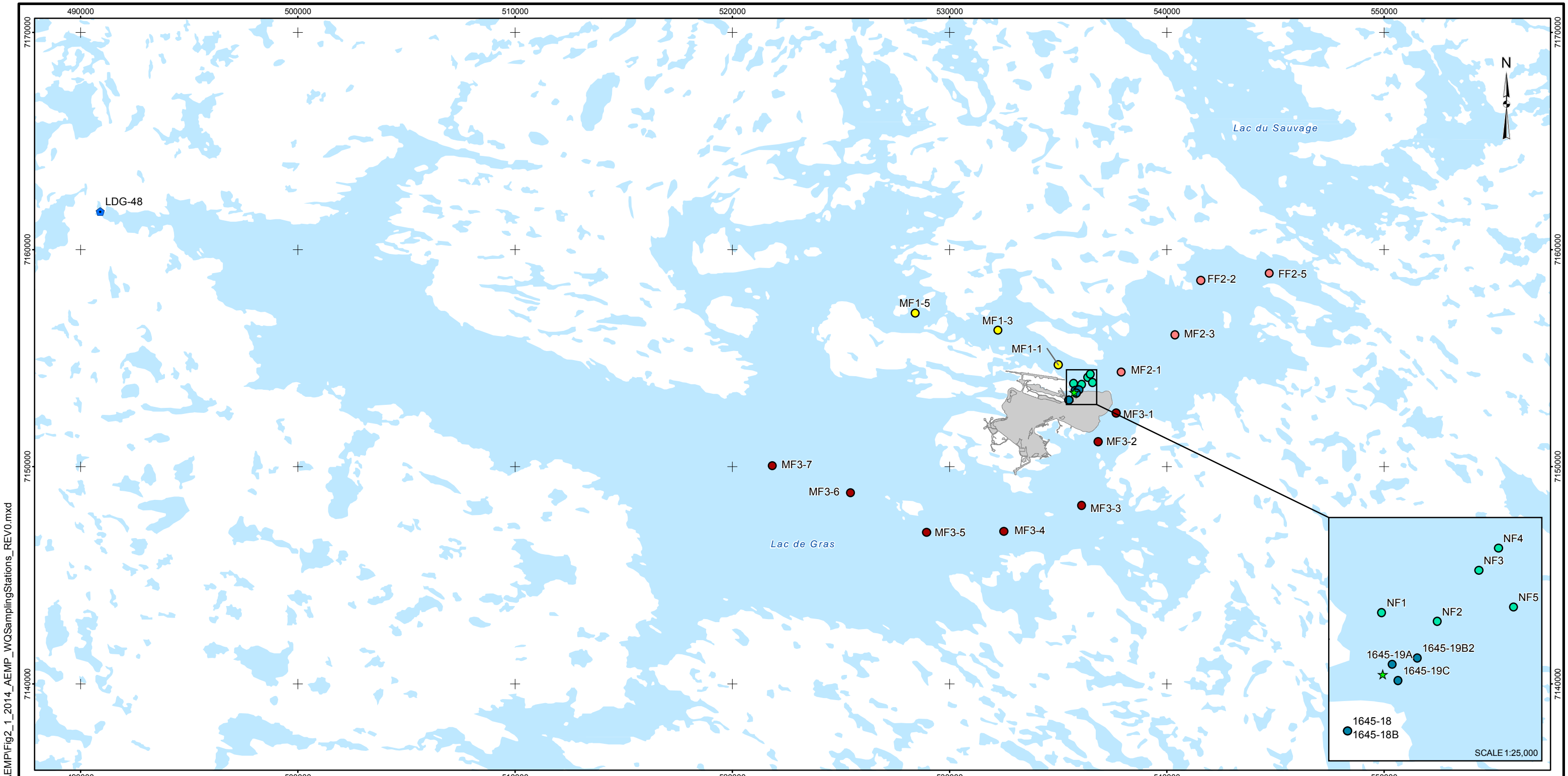
Effluent and lake water quality data collected in support of the Mine's Surveillance Network Program (SNP) were incorporated into the 2014 AEMP report. The SNP monitoring period included data collected from November 1, 2013 to October 31, 2014. Treated effluent from the North Inlet Water Treatment Plant (NIWTP) was sampled from both diffusers. Sampling station SNP 1645-18 is for the original diffuser in Lac de Gras and station SNP 1645-18B is for the second diffuser, which became operational on September 13, 2009 (Figure 2-1). Sampling is completed approximately every six days at these stations.

Water quality sampling at the mixing zone boundary is completed at three stations (SNP 1645-19A, SNP 1645-19B2, and SNP 1645-19C), which are located along a semi-circle, 60 metres (m) from the effluent diffusers (Figure 2-1). These stations represent the edge of the mixing zone, which covers an area of approximately 0.01 square kilometres (km<sup>2</sup>). Station SNP 1645-19B2 was established in 2009 to replace Station SNP 1645-19B after the second diffuser became active in Lac de Gras. Sampling at the mixing zone boundary occurs monthly at the lake water surface and at 5-m depth intervals at each station for the duration of the 2014 monitoring period.

Water quality sampling at AEMP stations in 2014 was carried out during the interim monitoring program, which included sampling in exposed areas of the lake (Golder 2014b). The reference areas in Lac de Gras are sampled every third year during the comprehensive monitoring program to allow for detailed assessment of Mine-related effects. The next comprehensive monitoring program is scheduled for 2016. In 2014, sampling areas consisted of the near-field (NF) exposure area and the three mid-field (MF) exposure areas (MF1, MF2 and MF3), which are located along three transects which extend into the lake from the NF area (Figure 2-1). The study design incorporated a cluster of replicate stations in the NF area and stations located along transects in the MF areas (Golder 2014b). Five stations were sampled in the NF exposure area. Four stations were located in the MF2-FF2 area, three stations within the MF1 area, and seven stations within the larger MF3 area. The AEMP stations were approximately 20 m deep. An additional station located at the Lac de Gras outflow to the Coppermine River (LDG48) was also sampled. Coordinates of the AEMP stations, and their approximate distance from the Mine effluent diffusers by flow path, are provided in Table 2-1.

The AEMP water quality sampling was carried out over two monitoring periods: ice-cover and open-water. Ice-cover season (late winter) sampling was completed from April 22 and April 30, 2014. Open-water sampling was completed from August 20 September 1, 2014. The same locations were sampled in each sampling season. In total, water quality samples were collected from 19 exposure area stations. A detailed sampling schedule for the 2014 AEMP is provided in Appendix A, Table A-1.

Exposure stations (NF and MF areas) were sampled at three depths (top, middle, and bottom) during each season, as these stations are likely to have vertical gradients in water quality as a result of the Mine discharge. Near-surface water samples (top) were collected at a depth of 2 m below the water surface, and bottom samples were collected at 2 m above the lake bottom. Mid-depth samples were collected from the mid-point of the total water column depth. Station LDG-48 was sampled at mid-depth only.



- LEGEND**
- ★ DIFFUSERS
  - LDG 48
  - DIAMOND FOOTPRINT
  - WATERBODY
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - SURVEILLANCE NETWORK PROGRAM



**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT			
TITLE			
<b>WATER QUALITY SAMPLING STATIONS, 2014 AEMP</b>			
	PROJECT	1406208	FILE No.
	DESIGN	LJ 10 Feb. 2015	SCALE AS SHOWN
	GIS	SS 30 Mar. 2016	REV. 0
	CHECK	TD 30 Mar. 2016	
	REVIEW	ZK 30 Mar. 2016	
			<b>FIGURE: 2-1</b>

i:\2011\11-1328\11-1328-0038\Mapping\MXD\2014AEMP\Fig2\_1\_2014\_AEMP\_WQSamplingStations\_REV0.mxd



**Table 2-1 Locations of the 2014 AEMP Water Quality Monitoring Stations**

Area Type	Area	Station	Easting (UTM)	Northing (UTM)	Distance from Diffusers <sup>(a)</sup> (m)
Exposure	Near-field	NF1	535740	7153854	394
		NF2	536095	7153784	501
		NF3	536369	7154092	936
		NF4	536512	7154240	1,131
		NF5	536600	7153864	968
	Mid-field 1	MF1-1	535008	7154699	1,452
		MF1-3	532236	7156276	4,650
		MF1-5	528432	7157066	8,535
	Mid-field 2	MF2-1	538033	7154371	2,363
		MF2-3	540365	7156045	5,386
	Mid-field 3	MF3-1	537645	7152432	2,730
		MF3-2	536816	7151126	4,215
		MF3-3	536094	7148215	7,245
		MF3-4	532545	7147011	11,023
		MF3-5	528956	7146972	14,578
		MF3-6	525427	7148765	18,532
		MF3-7	521859	7150039	22,330
	Far-field 2	FF2-2	541588	7158561	8,276
		FF2-5	544724	7158879	11,444
Outlet of Lac de Gras		LDG-48	490900	7161750	-

UTM = Universal Transverse Mercator, NAD83, Zone 12V.

a) Approximate distance from the diffusers along the most direct path of effluent flow.

## 2.2 LABORATORY ANALYSES

Water samples were shipped to Maxxam Analytics Inc. (Maxxam), Burnaby, British Columbia, for analysis of general parameters, major ions, nutrients and total and dissolved metals. A list of the variables analyzed and the analyte-specific detection limits (DL) used by Maxxam in 2014 are provided in Table 2-2.

**Table 2-2 Detection Limits for Water Quality Analysis, 2014 AEMP**

Variable	Unit	DL	Variable	Unit	DL
<b>Conventional Parameters</b>			<b>Metals (Total and Dissolved)</b>		
Acidity (pH 4.5)	mg/L	0.5	Aluminum	µg/L	0.2
Acidity (pH 8.3)	mg/L	0.5	Antimony	µg/L	0.02
Total Alkalinity	mg/L	0.5	Arsenic	µg/L	0.02
Alkalinity (Phenolphthalein as CaCO <sub>3</sub> )	mg/L	0.5	Barium	µg/L	0.02
Specific Conductivity	µS/cm	1	Beryllium	µg/L	0.01
Dissolved Hardness (CaCO <sub>3</sub> )	mg/L	0.5	Bismuth	µg/L	0.005
Hardness	mg/L	0.5	Boron	µg/L	5
pH	-	0.01	Cadmium	µg/L	0.005
Total Dissolved Solids (Calculated)	mg/L	-	Calcium	mg/L	0.01
Total Dissolved Solids (Measured)	mg/L	1	Chromium	µg/L	0.05
Total Suspended Solids	mg/L	1	Cobalt	µg/L	0.005
Total Organic Carbon	mg/L	0.2	Copper	µg/L	0.05
Turbidity	NTU	0.1	Iron	µg/L	1
<b>Major Ions</b>			Lead	µg/L	0.005
Bicarbonate	mg/L	0.5	Lithium	µg/L	0.5
Calcium	mg/L	0.01	Magnesium	mg/L	0.01
Carbonate	mg/L	0.5	Manganese	µg/L	0.05
Chloride	mg/L	0.5	Mercury	µg/L	0.01
Fluoride	mg/L	0.01	Molybdenum	µg/L	0.05
Hydroxide	mg/L	0.5	Nickel	µg/L	0.02
Magnesium	mg/L	0.01	Potassium	mg/L	0.01
Potassium	mg/L	0.01	Selenium	µg/L	0.04
Sodium	mg/L	0.01	Silicon	µg/L	50
Sulphate	mg/L	0.5	Silver	µg/L	0.005
<b>Nutrients</b>			Sodium	mg/L	0.01
Ammonia (as Nitrogen)	µg-N/L	5	Strontium	µg/L	0.05
Nitrate (as Nitrogen)	µg-N/L	2	Sulphur	mg/L	0.1
Nitrite (as Nitrogen)	µg-N/L	2	Thallium	µg/L	0.002
Nitrate + Nitrite (as Nitrogen)	µg-N/L	2	Tin	µg/L	0.01-0.02
Nitrogen - total Kjeldahl	µg-N/L	20	Titanium	µg/L	0.5
Total Nitrogen	µg-N/L	20	Uranium	µg/L	0.002
Orthophosphate	µg-P/L	1	Vanadium	µg/L	0.1-0.2
Phosphorus - Dissolved	µg-P/L	2	Zinc	µg/L	0.1
Phosphorus - Total	µg-P/L	2	Zirconium	µg/L	0.05-0.1

Note: CaCO<sub>3</sub> = calcium carbonate; DL = detection limit; mg/L = milligram per litre; µS/cm = microSiemen per centimetre; NTU = nephelometric turbidity unit; µg/L = microgram per litre; µg-N/L = microgram nitrogen per litre; µg-P/L = microgram phosphorus per litre; - = not applicable.

## 2.3 DATA ANALYSIS AND INTERPRETATION

### 2.3.1 Overview and Substances of Interest

Initial data analyses with all chemical analytes were completed to identify SOIs, which are a subset of variables with the potential to show Mine-related effects. The process of developing the list of SOIs considered concentrations in the final effluent (SNP 1645 18 and SNP 1645 18B), as well as in the fully-mixed exposure area of Lac de Gras:

- Effluent chemistry data collected at stations SNP 1645 18 and SNP 1645 18B were first compared to Water Licence discharge limits (Section 2.3.3). Variables that exceeded limits were considered SOIs. Variables in effluent with concentrations that exceeded AEMP Effects Benchmark values

(Section 2.3.4.2) were also included in the SOI list, provided there was not a high percentage of values below the DL (greater than [ $>$ ] 90%).

- Water quality variables were assessed according to the Action Level framework (Section 2.3.4). Variables that triggered Action Level 1 were added to the SOI list.

The following analyses were completed on SOIs:

- Examination of loading rates and concentrations in Mine effluent (Section 2.3.3);
- Assessment of concentrations at the mixing zone boundary in Lac de Gras (Section 2.3.3); and
- Assessment of magnitude and extent of effects, as defined by the Action Levels (Section 2.3.4).

## 2.3.2 Data Handling

Initial screening of the SNP and AEMP data sets was completed before data analyses to identify unusually high (or low) values in the datasets and decide whether to retain or exclude anomalous data from further analysis. An explanation of the objectives and approach taken to complete the initial screening is provided in Appendix B. Results of the initial screening for anomalous values in the SNP and AEMP data sets is presented in Appendix B, Tables B-1 to B-3. The SNP initial data screening identified 14 anomalous values in the effluent dataset and seven anomalous values in the mixing zone dataset, representing 0.2% and 0.1% (respectively) of the total data points within each dataset. In total, 27 anomalous values were identified within the AEMP water quality dataset, representing 0.2% of the total data points. In cases where unusual values were identified in the SNP and AEMP datasets, scatter-plots were generated allow a visual review of excluded data (Appendix B, Figures B-1 to B-39).

Prior to data analyses, non-detect values were multiplied by 0.5 times the DL. Substitution with half the DL is a common approach used to deal with censored data (USEPA 2000) and is consistent with the approved methods applied in the calculation of the normal range in the AEMP Reference Conditions Report Version 1.1 (Golder 2015). The non-parametric methods used in this report to assess Action Levels for water quality (Section 2.3.4) minimized the influence of using a substitution method for censored data.

## 2.3.3 Effluent and Mixing Zone Assessment

The effluent discharge from the NIWTP to Lac de Gras was assessed in terms of quantity and quality. The period of effluent discharge summarized in this report included information collected from November 1, 2013, to October 31, 2014, at stations SNP 1645-18 and SNP 1645-18B. Trends in effluent quantity were evaluated graphically by plotting total monthly discharge volumes (cubic metre [ $\text{m}^3$ ]/month) and loading rates (kilogram [ $\text{kg}$ ]/month) of SOIs as bar charts. Mean daily loads for each SOI were calculated by multiplying the discharge rate by the concentration for each effluent diffuser station (SNP 1645-18 and SNP 1645-18B). Linear interpolation was used to estimate the concentrations between sampling events. The total monthly load was estimated as the sum of daily loads from the two diffusers. Two SOIs were excluded

from this assessment because load is not a relevant measure (conductivity), or because concentrations in effluent were frequently below the DL (tin).

Time-series plots showing the concentrations of SOIs in effluent were generated for the 2014 discharge period. Results for individual grab samples were plotted separately for each sampling station (i.e., SNP 1645-18 and SNP 1645-18B). Water sampling at the mixing zone is completed monthly at 5-m depth intervals at the three stations. Therefore, up to 15 samples were collected each month in 2014. Results were summarized by calculating the 5<sup>th</sup> percentile, median and 95<sup>th</sup> percentile concentrations in each month. Water chemistry results at the edge of the mixing zone were also evaluated in the screening for the Action Levels (Section 2.3.4)

The quality of the effluent was assessed by comparing water chemistry results at Stations SNP 1645-18 and SNP 1645-18B with the Effluent Quality Criteria (EQC) defined in the Water Licence and in Table 2-3 (WLWB 2007). In addition to the criteria listed in Table 2-3, all discharges from the NIWTP to Lac de Gras must have a pH between 6.0 to 8.4 (WLWB 2007). The comparison of phosphorus to EQC is discussed in the Eutrophication Indicators Report (Golder 2016a). Analytes with maximum average and maximum grab sample concentrations greater than Water Licence discharge limits were included as SOIs. Variables with effluent concentrations that exceeded AEMP Effects Benchmarks (defined in Section 2.3.4.1) were also included in the SOI list, provided there was not a high percentage (> 90%) of values below the DL.

**Table 2-3 Effluent Quality Criteria for the North Inlet Water Treatment Plant Discharge to Lac de Gras**

Variable	Units	Maximum Average Concentration	Maximum Concentration of Any Grab Sample
Total ammonia	µg-N/L	6,000	12,000
Total aluminum	µg/L	1,500	3,000
Total arsenic	µg/L	50	100
Total copper	µg/L	20	40
Total cadmium	µg/L	1.5	3
Total chromium	µg/L	20	40
Total lead	µg/L	10	20
Total nickel	µg/L	50	100
Total zinc	µg/L	10	20
Nitrite	µg/L	1,000	2,000
Total suspended solids	mg/L	15	25
Turbidity	NTU	10	15
Biochemical oxygen demand	mg/L	15	25
Oil and grease	mg/L	3	5
Fecal coliforms	CFU/100 mL	10	20

Note: NTU = nephelometric turbidity unit; CFU/100 mL = colony forming units per 100 millilitres; µg-N/L= microgram nitrogen per litre; mg/L = milligram per litre; µg/L= microgram per litre.

Part H, Item 7 of the Water Licence (W2007L2-0003; WLWB 2007) requires toxicity testing of effluent discharged to Lac de Gras. The following toxicity testing is completed on a quarterly basis:

- acute lethality to Rainbow Trout, *Oncorhynchus mykiss*, as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/1 3;
- acute lethality to the crustacean *Daphnia magna* as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/1 4;
- chronic toxicity to the amphipod *Hyaella azteca* as per a water-only protocol approved by the WLWB;
- chronic toxicity to Rainbow Trout, *Oncorhynchus mykiss*, as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/28;
- chronic toxicity to the freshwater alga *Pseudokirchneriella subcapitata* as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/25; and
- chronic toxicity to the crustacean *Ceriodaphnia dubia* as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/21.

Acute lethality and sub-lethal toxicity tests were completed by HydroQual Laboratories Ltd. (HydroQual) in Calgary, AB. Chronic survival and growth testing using the amphipod *Hyaella azteca* was completed by Maxxam, Yellowknife, Northwest Territories.

### 2.3.4 Magnitude of Effect and Action Levels

Water quality variables were assessed for a Mine-related effect according to the Action Level framework described for water chemistry in the AEMP Study Design Version 3.5 (Golder 2014b). The Action Level classification for water quality was developed to meet the goals of the draft *Guidelines for Adaptive Management – A Response Framework for Aquatic Effects Monitoring* (WLWB 2010; Racher et al. 2011). The main goal of the Response Framework is to ensure that significant adverse effects never occur. This is accomplished by requiring proponents to take actions at pre-defined Action Levels, which are triggered well before significant adverse effects could occur. A significant adverse effect, as it pertains to water quality, was defined in the Environmental Assessment as a concentration that exceeds an established guideline by more than 20% (Government of Canada 1999). This effect must have a high probability of being permanent or long-term in nature and must occur throughout Lac de Gras.

The Action Level framework for water chemistry was applied for the first time in the 2013 AEMP Annual Report (Golder 2014c). Based on recommendations made in that report, Action Level 2 was revised, because it was often triggered before Action Level 1. The revisions to Action Level 2 were approved by the WLWB on December 22, 2015 (WLWB 2015c). The updated Action Levels for water chemistry are shown in Table 2-4. The revised Action Levels were applied successfully as part of the analyses completed for the 2011 to 2013 Aquatic Effects Re-evaluation Report (Golder 2016b).

Water quality is assessed annually to evaluate effects according to the Action Levels for water chemistry (Golder 2014a). Magnitude of effects to water chemistry variables were determined by comparing analyte concentrations between exposure areas and reference areas, and to background values or benchmark values. Background values for Lac de Gras are those that fall within the range of natural variability, referred to as the *normal range*. The normal ranges used in the Action Level screening for water quality were obtained from the AEMP Reference Conditions Report, Version 1.1 (Golder 2015) and are summarized in Table 2-5. The calculation methods and reference data periods used to estimate the normal range for water quality variables are discussed in the Reference Conditions Report (Golder 2015). The water quality benchmark values used in the Action Level assessment, referred to herein as *AEMP Effects Benchmarks*, are discussed in Section 2.3.4.1 and are presented in Table 2-6. The magnitude of the effect was classified according to the appropriate Action Level (Table 2-4), with Action Level 9 representing a significant adverse effect.

The full suite of water chemistry variables analyzed in 2014 was initially evaluated, with the exception of the following analytes or parameter groups:

- pH, which was assessed qualitatively in Section 3.3;
- nutrients such as phosphorus and nitrogen, which were evaluated in the Eutrophication Indicators Report [Golder 2016a]); and
- dissolved metals; metals were evaluated in terms of the total concentrations.

Effects were assessed separately for the ice-cover and open-water seasons. The open water and ice-cover seasons for the mixing zone dataset were based on conditions in a typical year. The ice-cover season for the mixing zone was defined as November to June, while the open-water season was defined as July to October. The results for all depths and stations sampled, both at the mixing zone and at AEMP stations, were included in the calculation of the exposure area values considered at each Action Level (Table 2-4). Variables with effects that triggered Action Level 1 or greater in either sampling season were classified as SOIs (Section 2.3.1).

Box and whisker plots were created for each SOI to illustrate spatial variation in water quality in Lac de Gras. Box and whisker plots show the 10<sup>th</sup> percentile, 25<sup>th</sup> percentile, median, 75<sup>th</sup> percentile, and 90<sup>th</sup> percentile values in each area. The 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations are also shown. The box and whisker plots show the results in 2014 relative to Action Level values. Non-detect values were plotted at half the DL to be consistent with data handling procedures used in the evaluation of Action Levels and estimation of the normal range (Golder 2015).

**Table 2-4 Action Levels for Water Chemistry, Excluding Indicators of Eutrophication**

Action Level	Magnitude of Effect <sup>(a)</sup>	Extent of Effect	Action/Notes
1	Median of NF greater than two times the median of reference areas (open-water or ice-cover) and strong evidence of link to Mine	NF	Early warning.
2	5th percentile of NF values greater than two times the median of reference areas AND normal range <sup>(b)</sup>	NF	Establish <i>Effects Benchmark</i> if one does not exist.
3	75 <sup>th</sup> percentile of MZ values greater than normal range plus 25% of Effects Benchmark <sup>(c)</sup>	MZ	Confirm site-specific relevance of Effects Benchmark. Establish <i>Effects Threshold</i> . Define the Significance Threshold if it does not exist. The WLWB to consider developing an EQC if one does not exist
4	75 <sup>th</sup> percentile of MZ values greater than normal range plus 50% of Effects Threshold <sup>(c)</sup>	MZ	Investigate mitigation options.
5	95 <sup>th</sup> percentile of MZ values greater than Effects Threshold	MZ	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
6	95 <sup>th</sup> percentile of NF values greater than Effects Threshold + 20%	NF	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
7	95 <sup>th</sup> percentile of MF values greater than Effects Threshold + 20%	MF	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
8	95 <sup>th</sup> percentile of FFB values greater than Effects Threshold + 20%	FFB	The WLWB to re-assess EQC. Implement mitigation required to meet new EQC if applicable.
9	95 <sup>th</sup> percentile of FFA values greater than Effects Threshold + 20%	FFA	Significance Threshold.

NF = near-field; MZ = mixing zone; MF = mid-field; FFA = far-field A FFB = far-field B; + = plus' % = percent; EQC = effluent quality criteria.

a) Calculations are based on pooled data from all depths.

b) Normal ranges are obtained from the Aquatics Effects Monitoring Program Reference Conditions Report Version 1.1 (Golder 2015); however, the normal range for open-water is based on the August 15 to September 15 period only.

c) Indicates 25% or 50% of the difference between the benchmark/threshold and the top of the normal range.

**Table 2-5 Normal Ranges for Water Chemistry**

Variable	Unit	Normal Range			
		Ice-cover		Open-water	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
<b>Conventional Parameters</b>					
Alkalinity, Total (as CaCO <sub>3</sub> )	mg/L	3.2	6.0	3.1	4.7
Specific Conductivity	µS/cm	14.6	19.3	14.7	16.4
Hardness, Total (CaCO <sub>3</sub> )	mg/L	5.0	7.0	4.0	6.0
Total Dissolved Solids (Calculated)	mg/L	2.9	6.5	3.8	5.8
Total Dissolved Solids (Measured)	mg/L	0	24.0	0	20.0
Total Suspended Solids	mg/L	0	1.0	0	1.0
Total Organic Carbon	mg/L	2.0	3.1	1.9	3.0
Turbidity	NTU	0	0.18	0.13	0.29
<b>Major Ions</b>					
Calcium	mg/L	0.9	1.3	0.8	1.1
Carbonate	mg/L	0	0.5	0	0.5
Chloride	mg/L	0	1.0	0	1.0
Fluoride	mg/L	0.02	0.03	0.019	0.03
Hydroxide	mg/L	0	0.5	0	0.5
Magnesium	mg/L	0.6	0.8	0.6	0.8
Potassium	mg/L	0.5	0.8	0.4	0.7
Sodium	mg/L	0	1.0	0	1.0
Sulphate	mg/L	1.9	2.5	1.7	2.1
<b>Nutrients</b>					
Ammonia (as Nitrogen)	µg-N/L	14.3	23.0	0	5.0
Nitrate (as Nitrogen)	µg-N/L	0	15.2	0	2.0
Nitrite (as Nitrogen)	µg-N/L	0	2	0	2
Nitrate + Nitrite (as Nitrogen)	µg-N/L	0	15.2	0	2.0
<b>Total Metals</b>					
Aluminum	µg/L	2.3	3.9	3.4	6.2
Antimony	µg/L	0	0.02	0	0.02
Arsenic	µg/L	0.15	0.22	0.16	0.19
Barium	µg/L	1.74	2.18	1.61	1.94
Beryllium	µg/L	0	0.01	0	0.01
Bismuth	µg/L	0	0.005	0	0.005
Boron	µg/L	0	5	0	5
Cadmium	µg/L	0	0.005	0	0.005
Calcium	mg/L	0.94	1.15	0.87	1.00
Chromium	µg/L	0	0.06	0	0.06
Cobalt	µg/L	0.01	0.02	0.01	0.04
Copper	µg/L	0	0.8	0	0.6
Iron	µg/L	0	5.0	0	7.6
Lead	µg/L	0	0.007	0	0.006
Lithium	µg/L	1.2	1.5	1.2	1.3
Magnesium	mg/L	0.59	0.79	0.58	0.66



**Table 2-5 Normal Ranges for Water Chemistry**

Variable	Unit	Normal Range			
		Ice-cover		Open-water	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
Manganese	µg/L	0.60	1.95	1.54	4.67
Mercury	µg/L	0	0.01	0	0.01
Molybdenum	µg/L	0.06	0.09	0.07	0.13
Nickel	µg/L	0.83	1.10	0.72	1.12
Potassium	mg/L	0.53	0.67	0.50	0.57
Selenium	µg/L	0	0.04	0	0.04
Silicon	µg/L	0	50	0	50
Silver	µg/L	0	0.005	0	0.005
Sodium	mg/L	0.56	0.75	0.55	0.68
Strontium	µg/L	6.70	8.78	6.51	8.01
Sulphur	mg/L	0.84	1.07	0.83	1.32
Thallium	µg/L	0	0.002	0	0.002
Tin	µg/L	0	0.01	0	0.01
Titanium	µg/L	0	0.5	0	0.5
Uranium	µg/L	0.027	0.030	0.024	0.029
Vanadium	µg/L	0	0.1	0	0.1
Zinc	µg/L	0.37	1.53	0.29	2.04
Zirconium	µg/L	0	0.05	0	0.05

Note: µS/cm = microSiemens per centimetre; NTU = nephelometric turbidity unit; µg/L = microgram per litre; mg/L = milligram per litre; µg-N/L microgram nitrogen per litre; CaCO<sub>3</sub> = calcium carbonate.

### 2.3.4.1 Effects Benchmarks

The water quality benchmark values used in the Action Level screening (i.e., at Action Level 3) are the AEMP Effects Benchmarks presented in the Version 3.5 Study Design (Table 5.4-1 in Golder 2014b). The Effects Benchmarks adopted for the AEMP are consistent with those used in the Project Environmental Assessment (Government of Canada 1999) and are based on the Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life (CCME 1999), the Canadian Drinking Water Quality Guidelines (Health Canada 1996, 2006) and adaptations of general guidelines to site-specific conditions at Lac de Gras (Appendix IV.1 in DDMI 2007). These benchmarks represent concentrations intended to protect human health or aquatic life. The benchmarks for individual water chemistry variables were updated in the AEMP Version 3.5 Study Design, and a summary of the benchmarks is presented in Table 2-6.

The CWQG are intended to provide protection of freshwater life from anthropogenic stressors such as chemical inputs or physical changes (CCME 1999). These guidelines are based on current, scientifically-defensible toxicological data and are intended to protect all forms of aquatic life, including the most sensitive life stage of the most sensitive species over the long-term. They are based on the lowest concentration shown to have an adverse effect (Lowest Observable Effects Level [LOEL]) on the most sensitive aquatic organism. A ten-fold safety factor is then applied to the LOEL, to provide added assurance that the guideline will protect aquatic life.

The Canadian Drinking Water Quality Guidelines are based on published scientific research related to health effects, aesthetic effects and operational considerations (Health Canada 1996, 2006). Health-based guidelines are established on the basis of comprehensive review of the known health effects associated with each chemical, exposure levels, and availability of treatment and analytical technologies. Aesthetic effects (e.g., taste, odour) are taken into account when these play a role in determining whether consumers will consider the water drinkable.

## **2.4 QUALITY ASSURANCE/QUALITY CONTROL**

The Quality Assurance Project Plan (QAPP) Version 2.0 (Golder 2013) outlines the quality assurance (QA) and quality control (QC) procedures employed to support the collection of scientifically-defensible and relevant data addressing the objectives of the AEMP (Golder 2014b). The QAPP represents an expansion of the SNP QA/QC plan. The QAPP is designed so that field sampling, laboratory analysis, data entry, data analysis, and report preparation activities produce technically sound and scientifically defensible results. A description of QA/QC practices applied to the water quality component of the 2014 AEMP and an evaluation of the QC data are provided in Appendix B. A brief summary of QC issues identified during the 2014 AEMP sampling is provided below.

Results of QC analyses completed in 2014 and over the last three cycles of the AEMP (2011 to 2013) have indicated ongoing data quality issues for ammonia. In all four years, ammonia concentrations reported in blank samples analyzed by Maxxam were at or above levels in Lac de Gras, while the concentrations reported in lake water samples were appreciably greater than historic values, which were analyzed by ALS. Since the 2014 ammonia data were not comparable with data prior to 2011, the 2014 results were excluded from the assessment of Action Levels presented in Section 3.4. Diavik is currently working with Maxxam to develop a QA/QC plan and updated analytical method that will address the data quality issues identified for ammonia.

In 2014, DDMI identified abnormal results in effluent and lake water samples analyzed for total and dissolved zinc. A follow-up investigation of laboratory and site-based procedures determined that the contamination likely originated from the sampling gloves used by the field crew during sample collection and handling (i.e., preservation, filtration). Samples collected during the open-water season were re-run for total and dissolved zinc from a different sample container (routine chemistry). This sample was not filtered or preserved in the field. The open-water season re-analysis results for zinc were retained in all relevant analyses presented in the 2014 annual report. Due to the timing of when the contamination was identified, the ice-cover samples could not be re-run from the routine chemistry bottle because the samples had been discarded. As a result, the ice-cover season zinc data were excluded from data analyses and summary tables presented in this report.

**Table 2-6 Effects Benchmarks for Water Quality Variables**

Variable	Unit	Effects Benchmarks	
		Protection of Aquatic Life	Drinking Water
<b>Conventional Parameters</b>			
pH	-	6.5 to 9.0	6.5 to 8.5
Dissolved Oxygen	mg/L	Cold water:	-
		early life stages = 9.5; other life stages = 6.5	
Total Dissolved Solids	mg/L	500 <sup>(a)</sup>	500
Total Alkalinity	mg/L	n/a <sup>(b)</sup>	
Total Suspended Solids	mg/L	+5 (24 h to 30 days);	-
		+25 (24-h period) <sup>(c)</sup>	
<b>Major Ions</b>			
Chloride	mg/L	120	250
Sodium	mg/L	-	200
Fluoride	mg/L	0.12	1.5
Sulphate	mg/L	100 <sup>(d)</sup>	500
<b>Nutrients</b>			
Ammonia (as Nitrogen)	µg-N/L	4,730 <sup>(e)</sup>	-
Nitrate (as Nitrogen)	µg-N/L	3,000	10,000
Nitrite (as Nitrogen)	µg-N/L	60	1000
<b>Total Metals</b>			
Aluminum (total)	µg/L	-	100/200 <sup>(f)</sup>
Aluminum (dissolved)	µg/L	Variable with pH	-
		(range = 12 to 50) <sup>(e)</sup>	
Antimony	µg/L	-	6
Arsenic	µg/L	5	10
Barium	µg/L	1,000 <sup>(d)</sup>	1,000
Boron	µg/L	1,500	5,000
Cadmium	µg/L	0.1 <sup>(e)</sup>	5
Chromium	µg/L	1 (Cr VI) <sup>(g)</sup>	50
Copper	µg/L	2	1,000
Iron	µg/L	300	300
Lead	µg/L	1	10
Manganese	µg/L	-	50
Mercury	µg/L	0.026 (inorganic); 0.004 (methyl)	1
Molybdenum	µg/L	73	-
Nickel	µg/L	25	-
Selenium	µg/L	1	10
Silver	µg/L	0.1	-
Strontium	µg/L	30,000 <sup>(h)</sup>	-
Thallium	µg/L	0.8	-
Uranium	µg/L	15	20
Zinc	µg/L	30	5,000

a) Adopted from Alaska DEC (2012).

b) Alkalinity should be no lower than 25% of natural background level. There is no maximum guideline (US EPA 1998).

c) Average increase of 5 (24 hours to 30 days) or maximum increase of 25 mg/L in a 24 h-period.

d) British Columbia Ministry of Environment (2013).

e) Site specific benchmark – see Appendix IV.1 in DDMI (2007a) for description. An error identified with the upper limit of the benchmark has been corrected in the table.

f) 100 µg/L for conventional treatment and 200 µg/L for other treatment types.

g) Measurements of total chromium will be compared to the benchmark for chromium VI.

h) Based on results from HydroQual (2009) and Pacholski (2009).

Note: Unless noted, benchmarks are derived from current CWQGs (CCME 1999a) and Canadian Drinking Water Quality Guidelines (Health Canada 1996, 2006). The Effects Benchmark is the lower of the two values.

- = benchmark not available; mg/L = milligram per litre; µg-N/L = microgram nitrogen per litre; µg/L = microgram per litre.

## 3 RESULTS

### 3.1 SUBSTANCES OF INTEREST

Substances of interest were identified based on the selection procedure described in Section 2.3.1. The following variables met the criteria for inclusion as SOIs in 2014:

- specific conductivity (laboratory measured)
- total dissolved solids (calculated)
- calcium
- chloride
- fluoride
- potassium
- sodium
- sulphate
- ammonia (as nitrogen)
- nitrate (as nitrogen)
- total aluminum
- total antimony
- total barium
- total chromium
- total copper
- total lead
- total molybdenum
- total silicon
- total strontium
- total tin
- total uranium

With the exception of two variables (fluoride and ammonia), each of the variables included as SOIs triggered Action Level 1 or greater in 2014 (Section 3.4.1). Data quality issues identified with the ammonia data in 2014 (Section 2.4, Appendix B) interfered with the determination of Action Levels. Given the issues with the ammonia analysis and because ammonia was identified as an SOI during the AEMP Version 2.0, ammonia was retained as an SOI in 2014. Fluoride was also included in the list of SOIs in 2014 because concentrations in effluent were slightly greater (less than [ $<$ ] 10%) than the AEMP aquatic life Effects Benchmark (0.012 milligram per litre [mg/L]) in eight samples (7%) collected in 2014. All other variables in effluent with AEMP Effects Benchmarks or EQC were within applicable limits (Section 3.2.5); therefore, no additional variables were added to the SOI list from the effluent screening.

Results for nutrients that are generally not toxic to aquatic organisms (i.e., bicarbonate, phosphorus, and some forms of nitrogen) are summarized in the Eutrophication Indicators Report (Golder 2015) and are not assessed in this report. Data for nitrogen species that may be toxic to aquatic organisms at elevated concentrations are summarized in this report. Ammonia and nitrate were included in both sections because these variables have the potential to result in both nutrient enrichment and toxicological effects. Variables measured in the field (conductivity, dissolved oxygen [DO], temperature and pH) were not considered for inclusion as SOIs.

## **3.2 TRENDS IN EFFLUENT AND AT THE MIXING ZONE BOUNDARY**

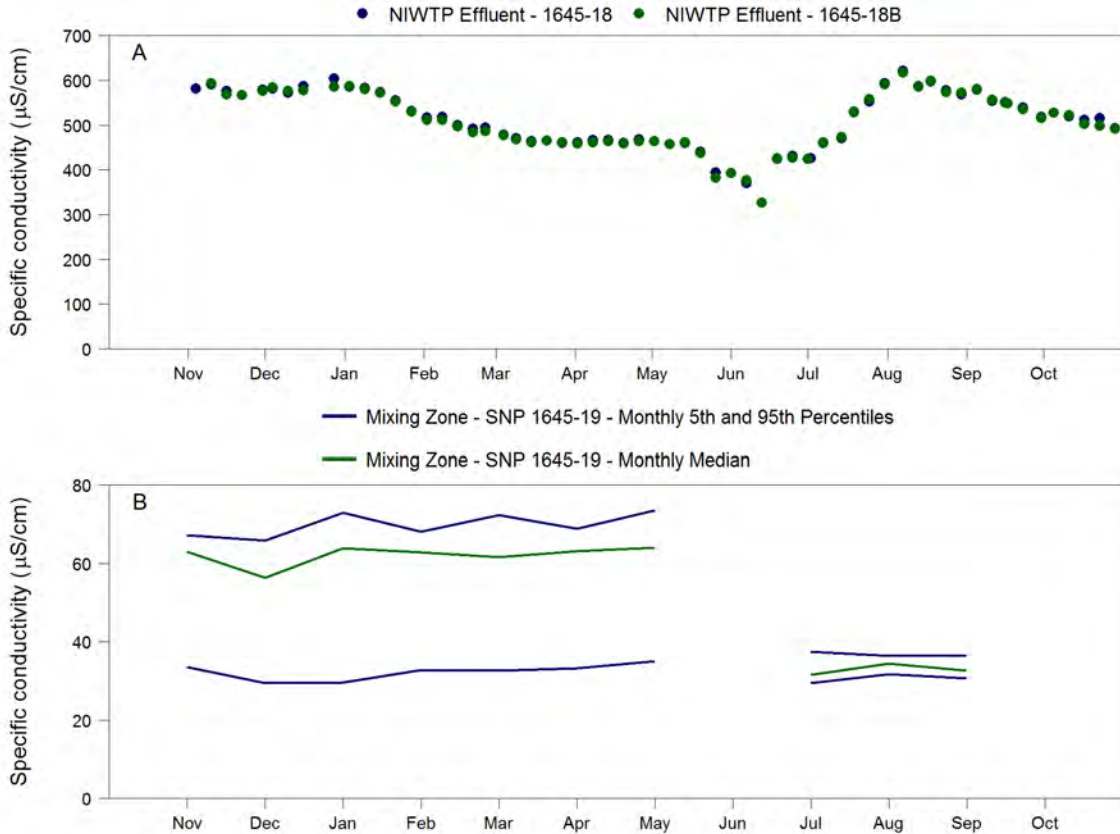
### **3.2.1 Conductivity, Total Dissolved Solids and Associated Ions**

The specific conductivity of the effluent discharged from the NIWTP decreased from January to June, and then increased during the early open-water period (Figures 3-1A and 2-3A). At the mixing zone boundary, the conductivity of the water was greater and more variable during the ice-cover season compared to the open-water period (Figures 3-1B and 2-3B).

The monthly loads of total dissolved solids (TDS) and several associated ions (calcium, chloride, fluoride, and sodium) from the NIWTP decreased from November to approximately March or April, reflecting the decrease in the monthly volume of effluent discharged (Figure 3-3 to 3-6). The decrease in the monthly loads of sulphate and potassium were similar to that of TDS, but there was a more pronounced decrease from January to April that appeared to reflect a decrease in effluent concentration (Figures 3-7 to 3-8). The loads of these seven SOIs generally increased during the late ice-cover to early open-water period as flow rates from the NIWTP increased (Figure 3-3 to 3-8). The increase in load was most pronounced in May, coinciding with a spike in flow during that month.

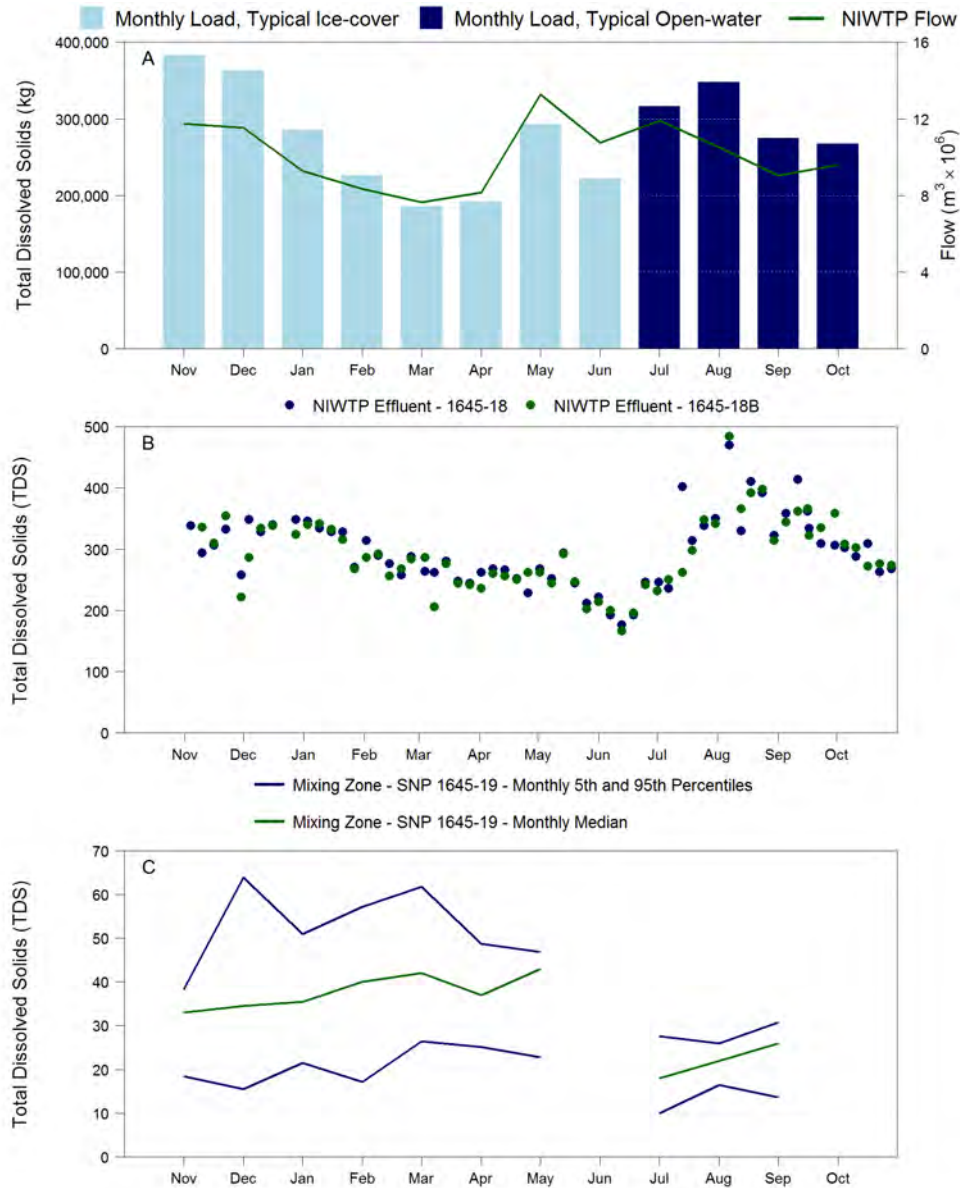
The concentration of TDS and its constituents in Mine effluent remained within a similar range over the ice-cover period or declined from approximately January to May or June (Figure 3-3 to 3-8). Concentrations were typically lowest in June and increased over the early open-water period. The concentrations of TDS, calcium, chloride, fluoride, and sodium increased gradually at the mixing zone boundary over the ice-cover season or remained within a similar seasonal range (Figure 3-3 to 3-6). The concentrations of potassium and sulphate decreased during the ice cover season, reflecting the decreases in effluent loads (Figures 3-7 to 3-8). Concentrations of all seven SOIs were generally greater and more variable during ice-cover compared to the open-water period.

**Figure 3-1 Specific Conductivity in A) North Inlet Water Treatment Plant effluent (SNP 1645-18 and SNP 1645-18B), and B) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



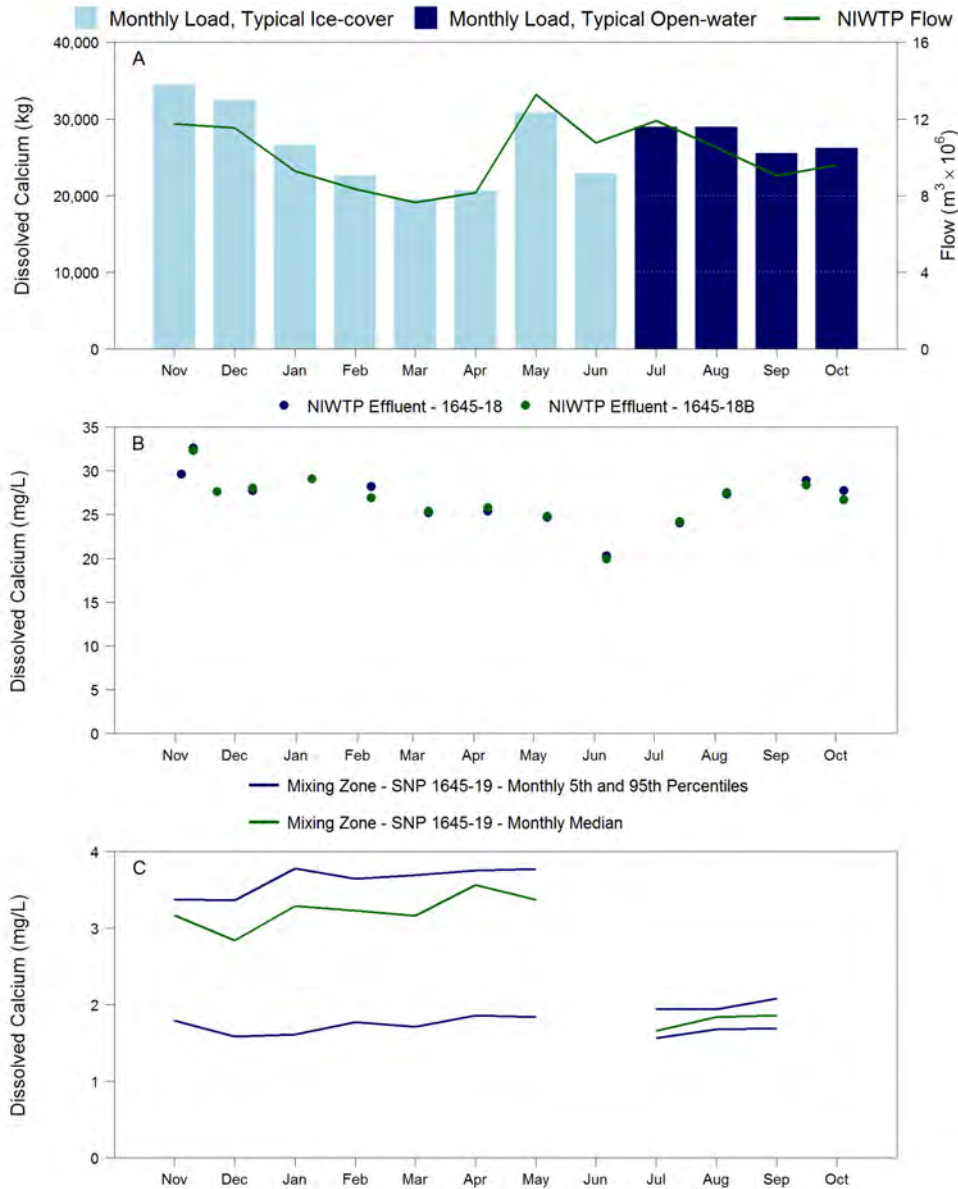
Notes: NIWT = North Inlet Water Treatment Plant; µS/cm = microSiemens per centimetre; SNP = Surveillance Network Program. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-2** A) Monthly Loading Rate of Total Dissolved Solids (Calculated), from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

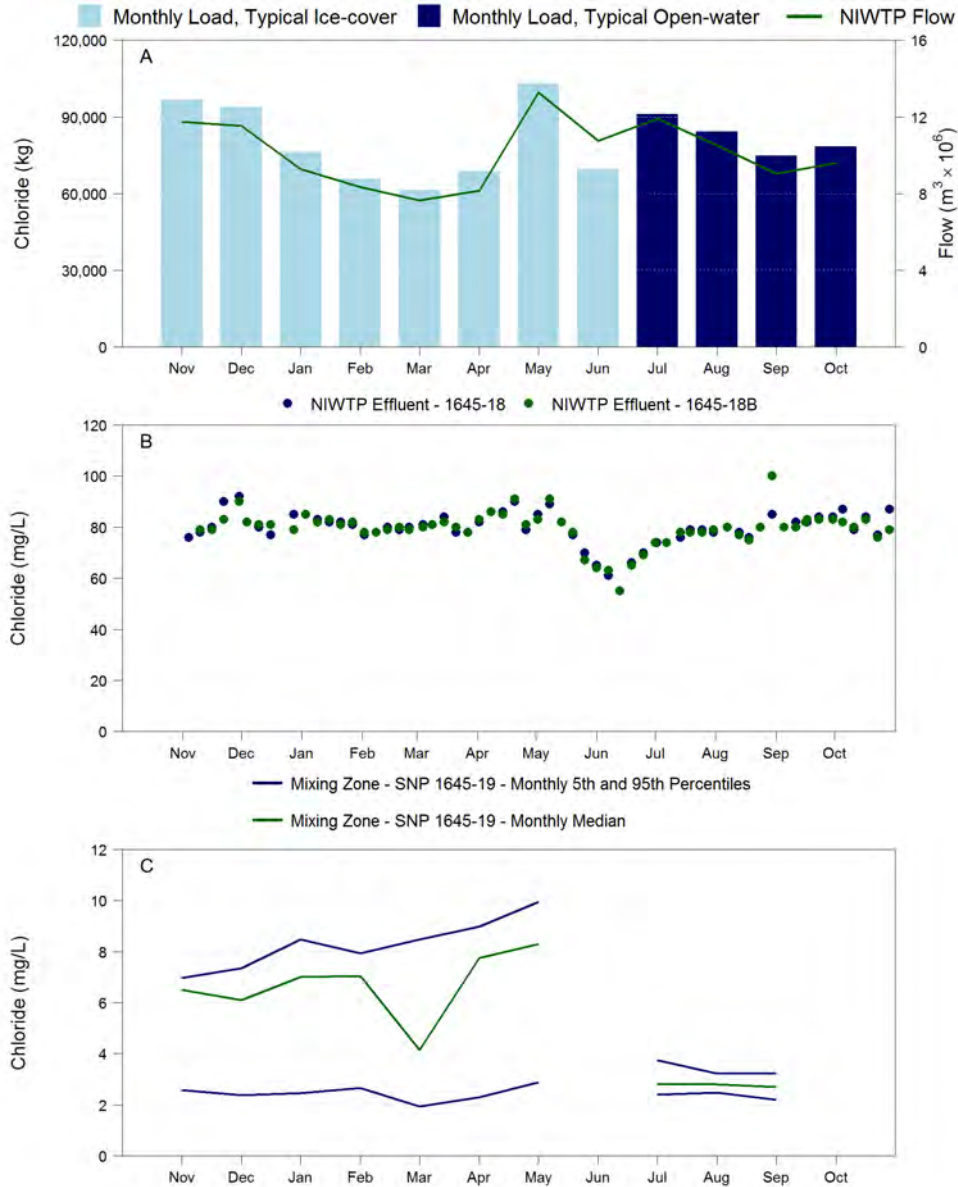
**Figure 3-3 A) Monthly Loading Rate of Calcium from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; mg/L = milligram per litre; kg = kilogram; m<sup>3</sup> = cubic metre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metre [m], 5 m, 10 m, 15 m, and 20 m).



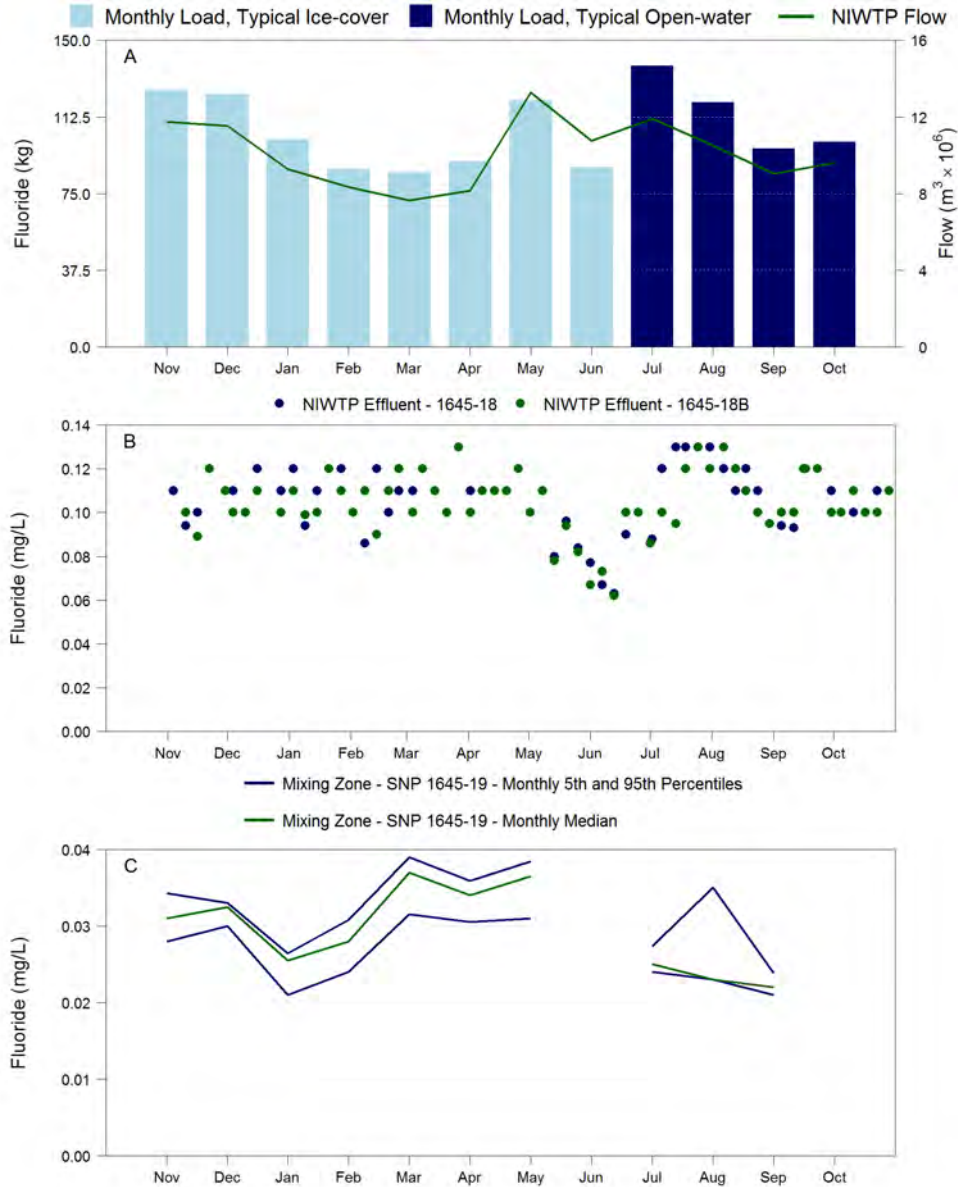
**Figure 3-4 A) Monthly Loading Rate of Chloride from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; mg/L = milligram per litre.

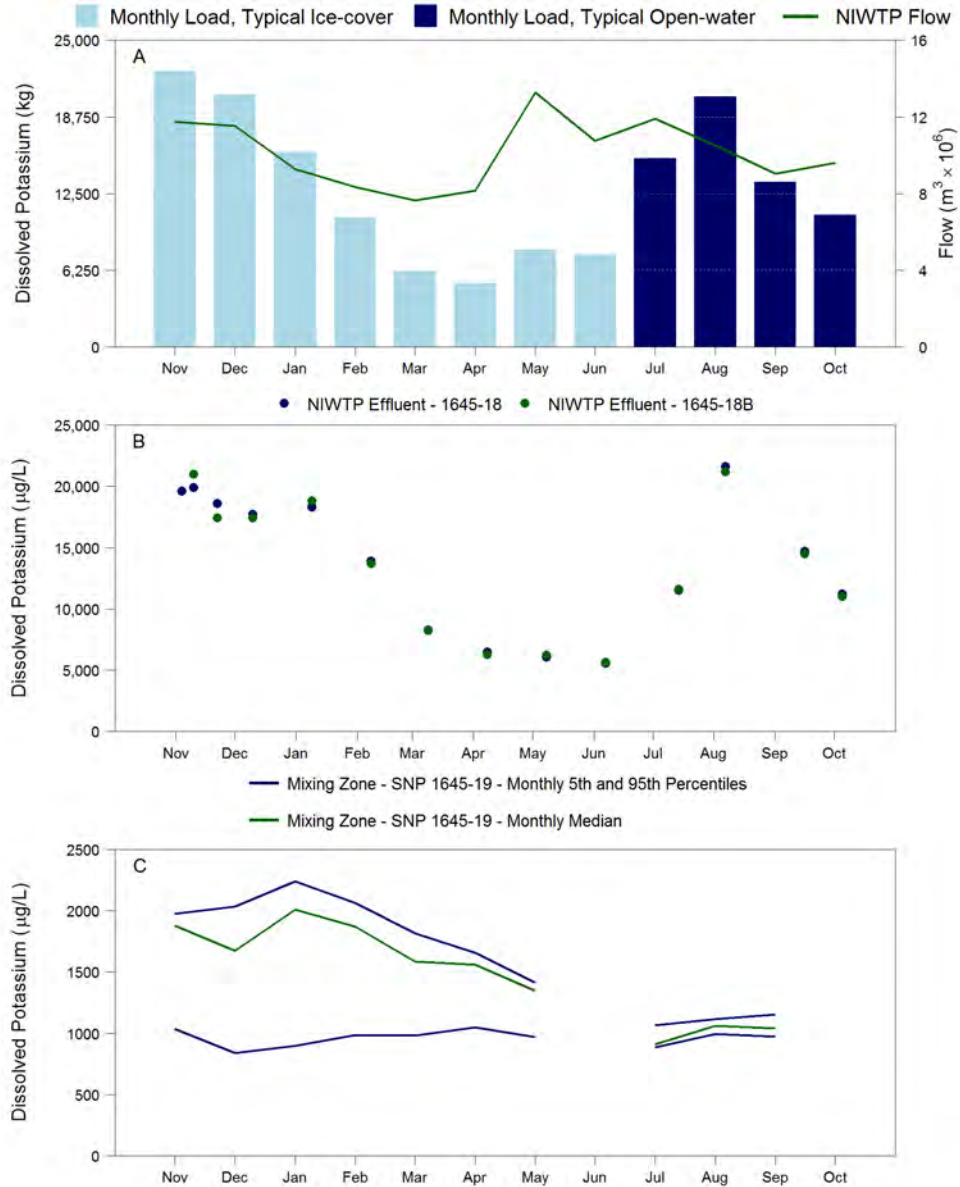
Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-5 A) Monthly Loading Rate of Fluoride from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



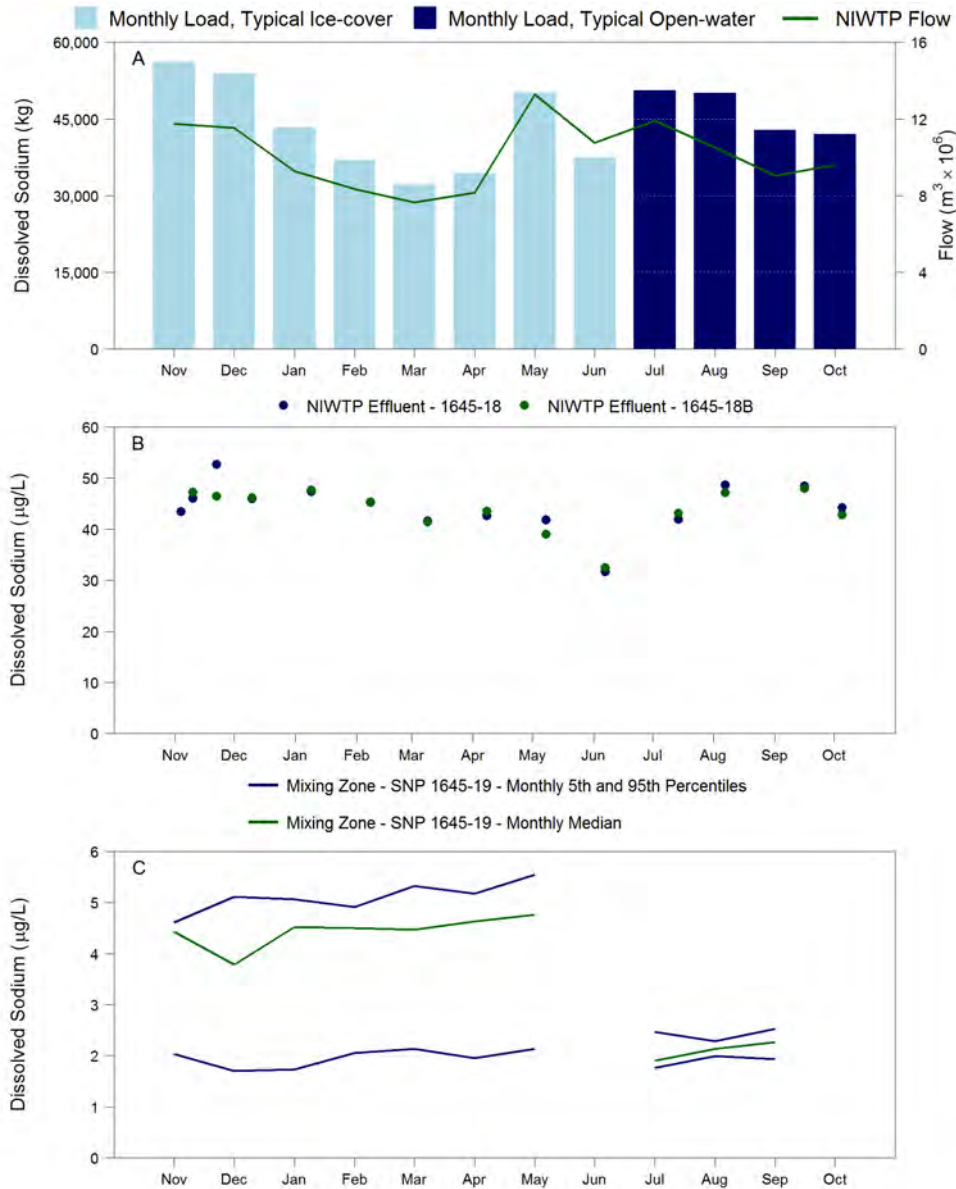
Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; mg/L = milligram per litre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-6 A) Monthly Loading Rate of Potassium from the North Inlet Water Treatment Plant and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



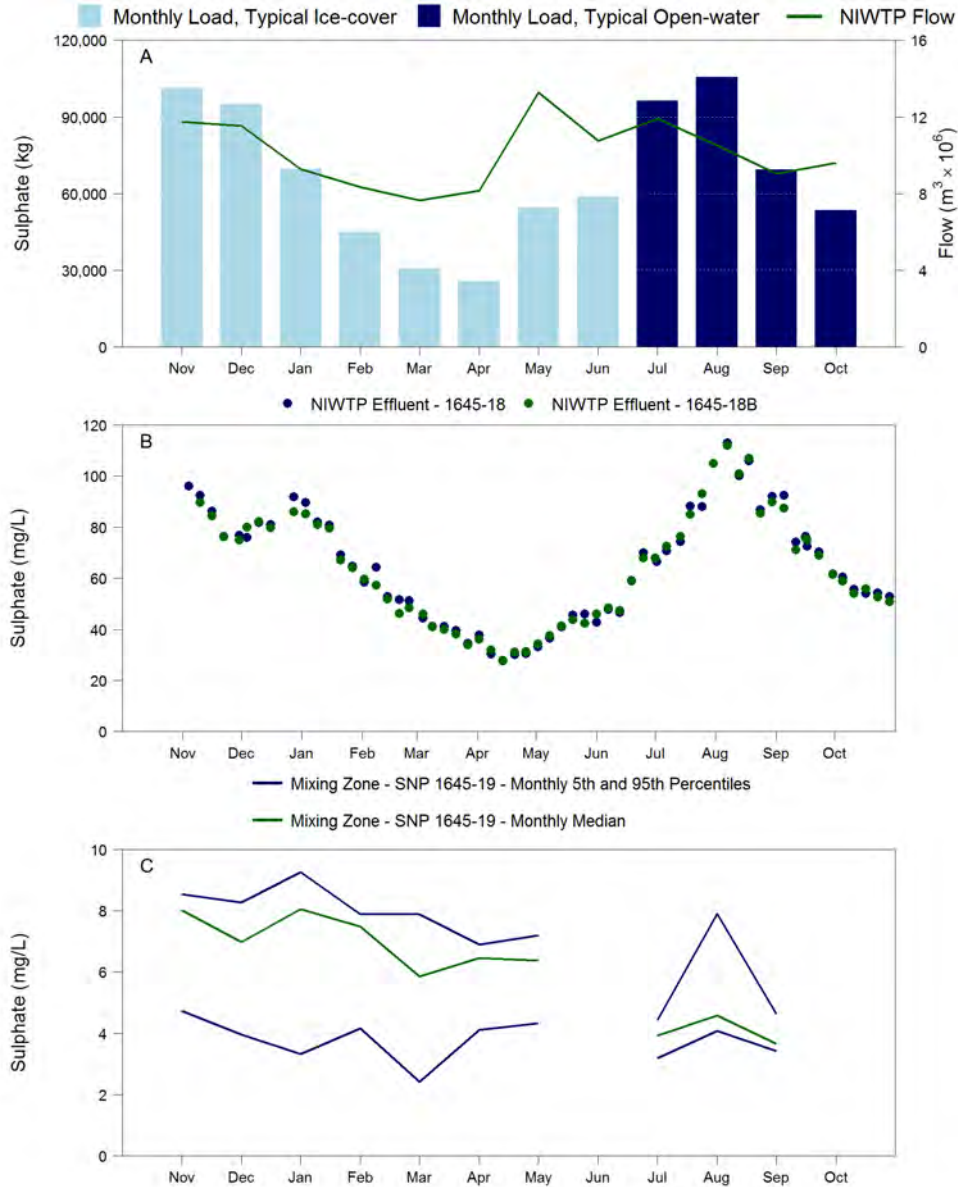
Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-7 A) Monthly Loading Rate of Sodium from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-8 A) Monthly Loading Rate of Sulphate from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**

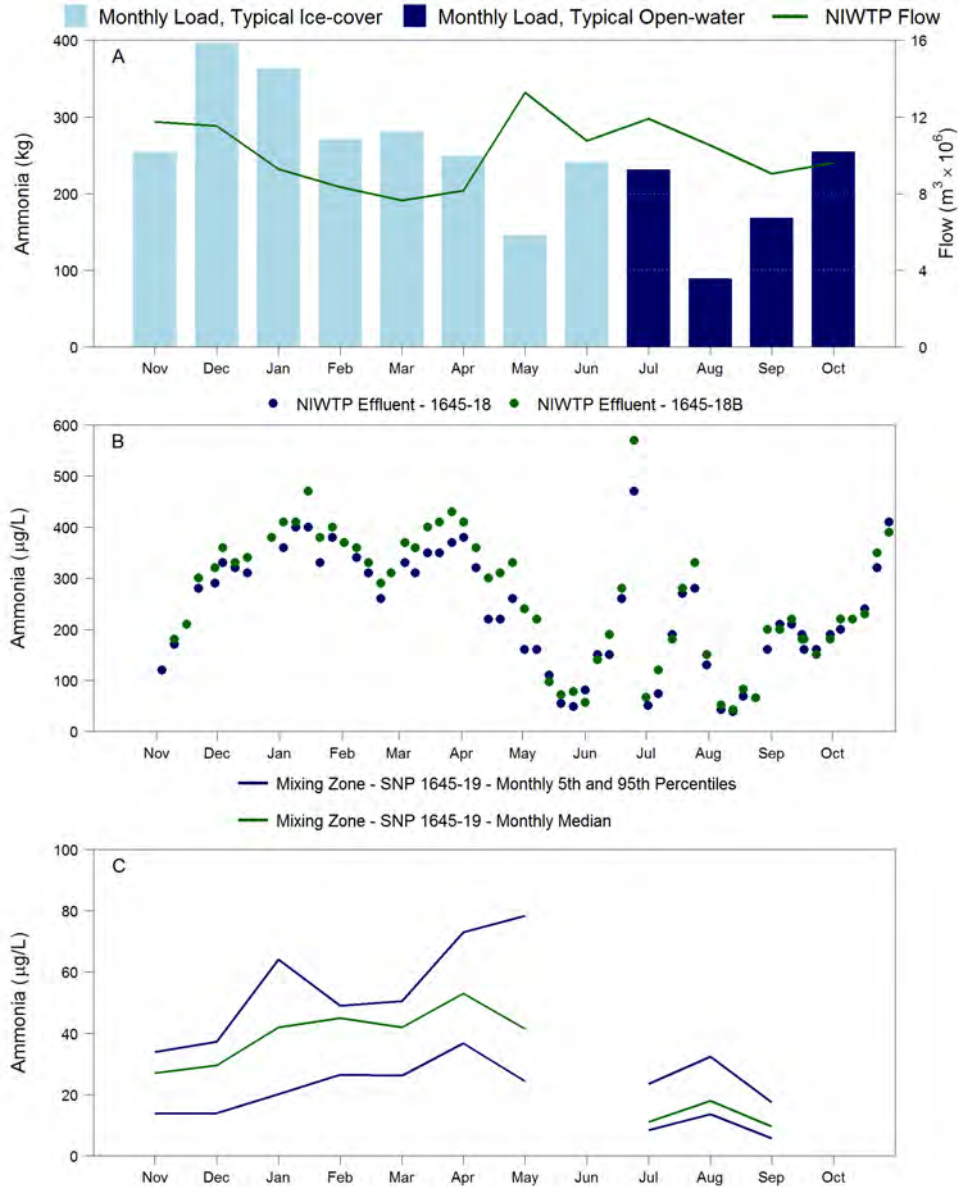


Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program kg = kilogram; mg/L = milligram per litre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

### **3.2.2 Nutrients**

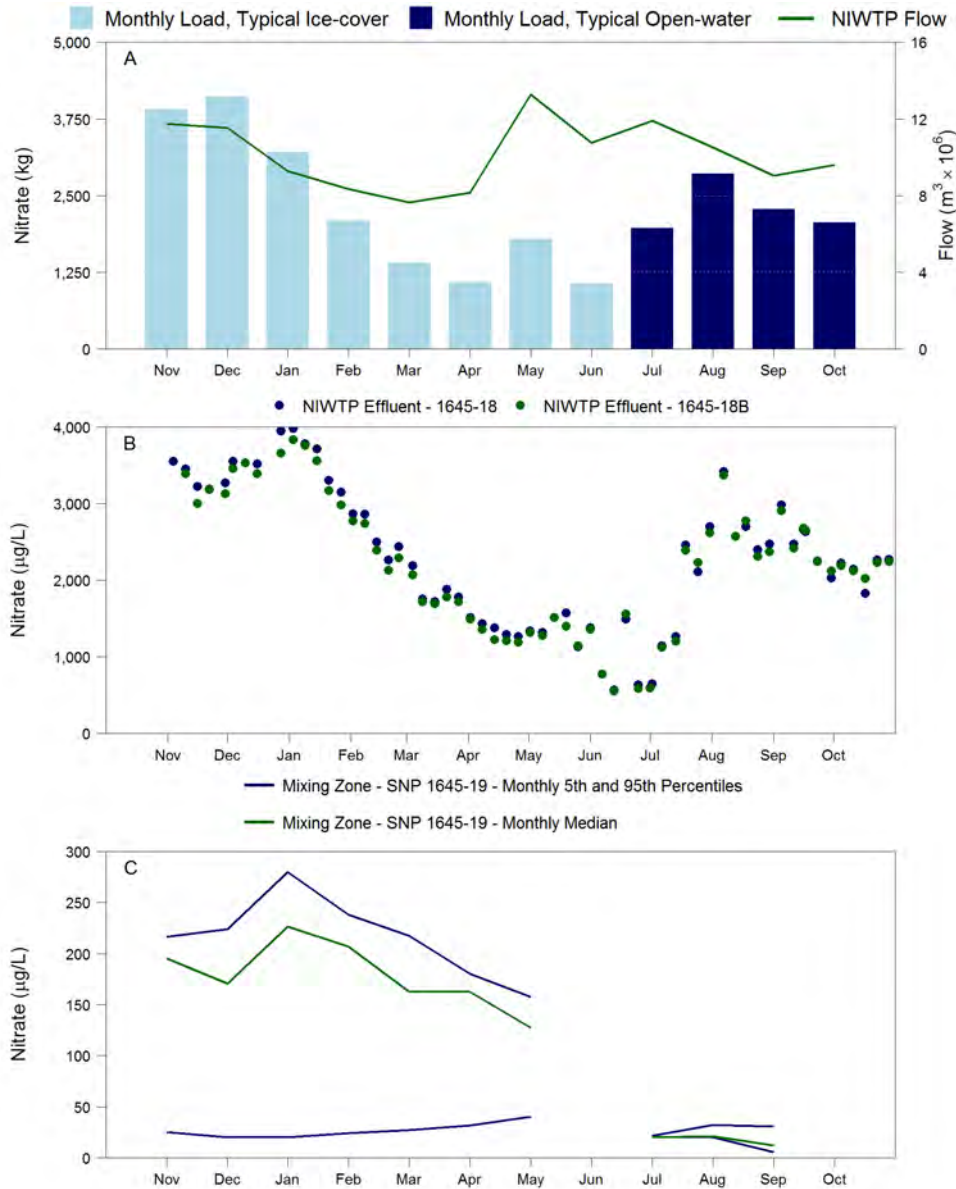
The monthly loading rates of ammonia and nitrate decreased from December to May or June as the concentration of nitrogen in Mine effluent decreased (Figures 3-9 and 3-10). The loading rate of ammonia fluctuated slightly throughout the late ice-cover and open-water period reflecting variation in effluent concentrations. The loads and concentrations of nitrate were lowest in June and then increased throughout the early open-water period. The seasonal pattern in the concentration of nitrogen at the mixing zone boundary generally reflected that in Mine effluent, with greater concentrations observed during the ice-cover season compared to the open water period.

**Figure 3-9 A) Monthly Loading Rate of Ammonia from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-10 A) Monthly Loading Rate of Nitrate from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

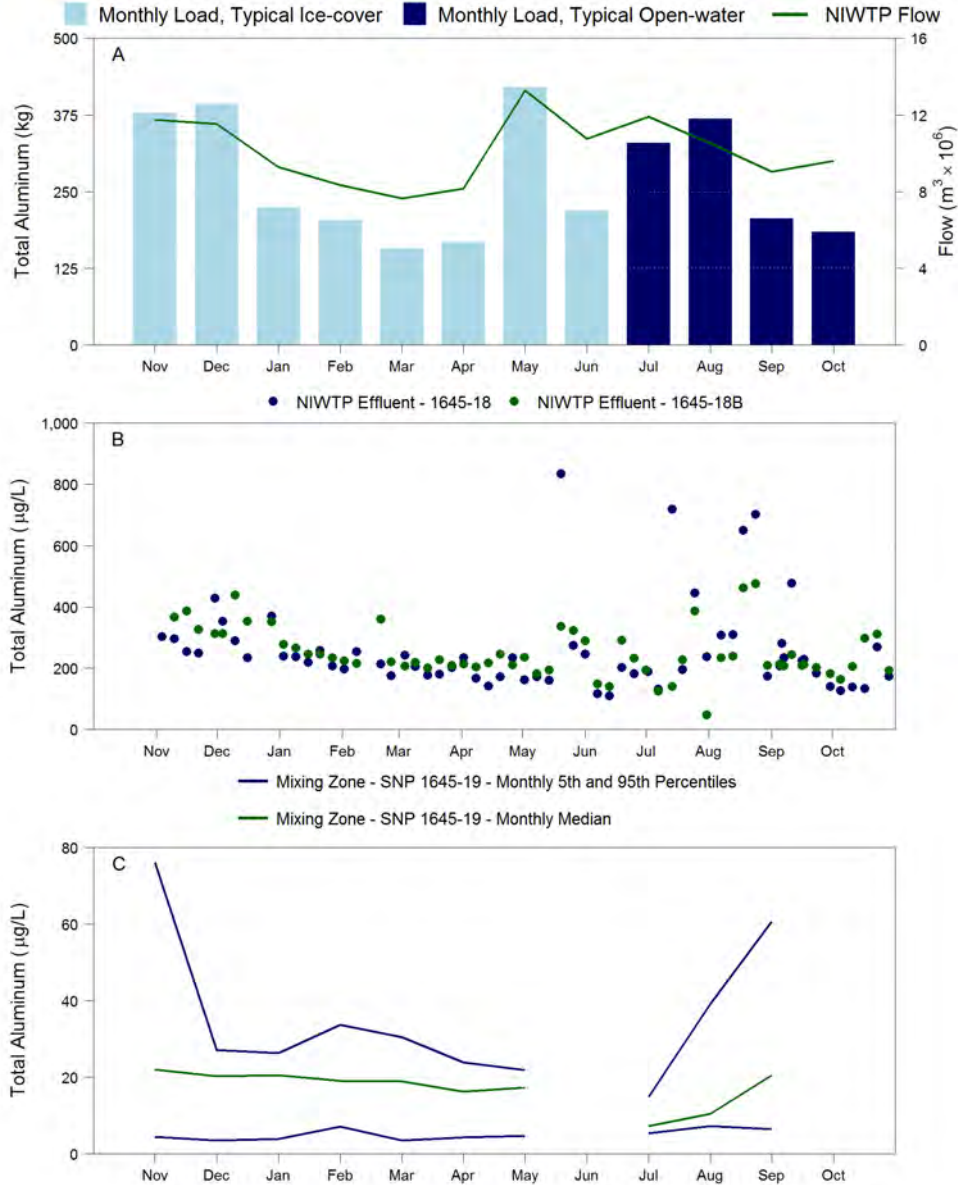


### 3.2.3 Metals

The monthly loading rates of most metals (aluminum, antimony, barium, copper molybdenum, strontium and uranium) followed the same general pattern described for TDS (Section 3.2.2), reflecting variation in the monthly volume of effluent discharged from the NIWTP (Figures 3-11 to 3-13, 3-15, 3-17, 3-19, 3-21). The monthly loads of these seven metals decreased from approximately November to April and then increased throughout the late ice-cover and early open-water period. This pattern was generally more pronounced for molybdenum and uranium (Figures 3-17 and 3-21). Concentrations of these metals in effluent generally decreased throughout the ice-cover period and were lowest in June or July, before increasing again during the early open-water period. An exception occurred for copper (Figure 3-15), which remained within a similar range throughout the 2014 reporting period.

The monthly loads of chromium and silicon (Figures 3-14 and 3-18) followed a different pattern than most other metals. Loads of these two SOIs decreased during the ice-cover season, and were lower during the open-water season, reflecting a decrease in effluent concentration. No seasonal trend was observed in the monthly loading rates and concentrations of lead (Figure 3-16). The loading rate of lead was greatest in May, coinciding with an increase in flow. The concentrations of most metals at the mixing zone boundary were greater and more variable during the ice-cover season than during the open-water season. Monthly loads for tin were not estimated because the majority of concentrations (87%) were less than the DLs used for the SNP (0.2 and 0.01 microgram per litre [ $\mu\text{g/L}$ ]). The high percentage of non detect (ND) values for tin also interfered with evaluation of temporal trends in effluent chemistry and at the edge of the mixing zone.

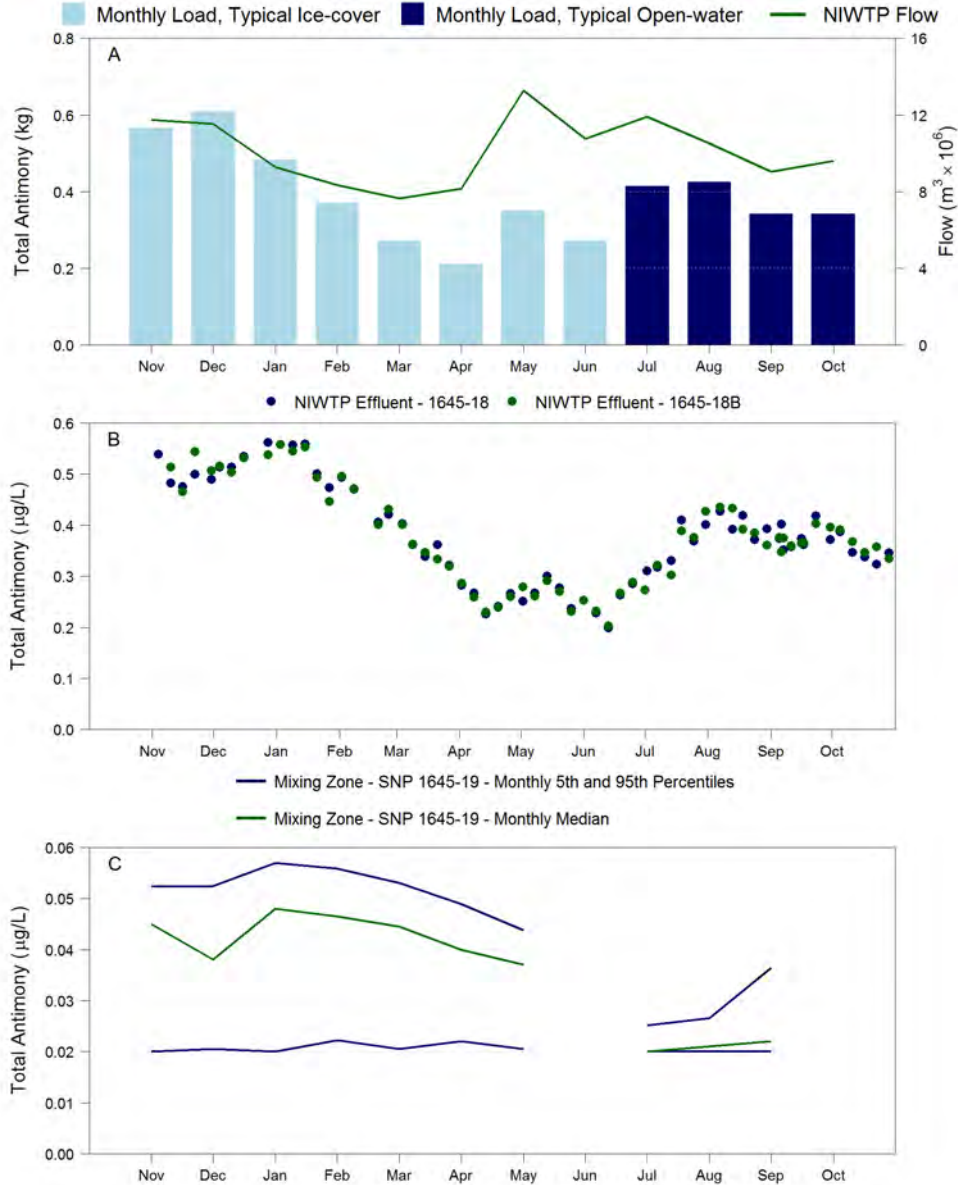
**Figure 3-11 A) Monthly Loading Rate of Total Aluminum from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

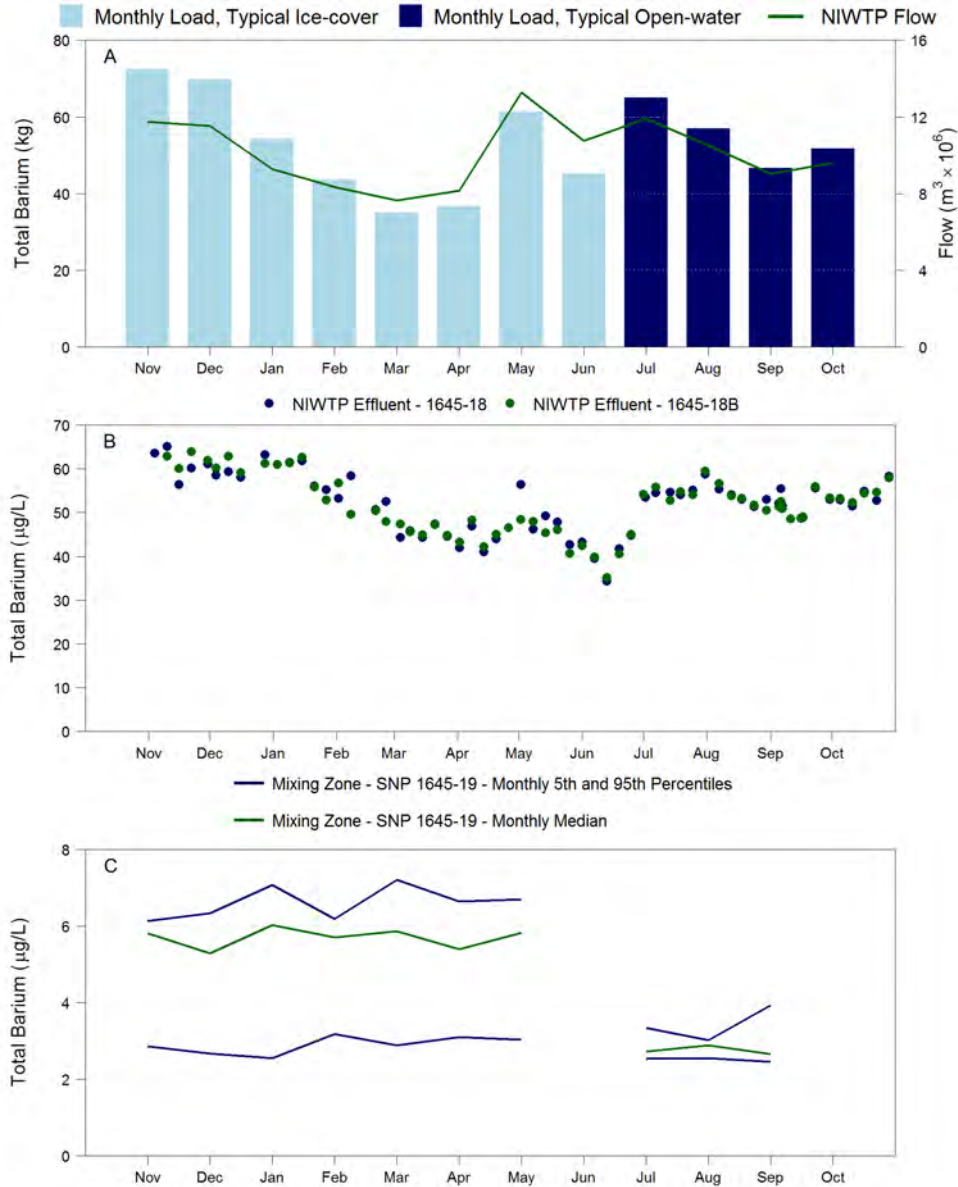
**Figure 3-12 A) Monthly Loading Rate of Total Antimony from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

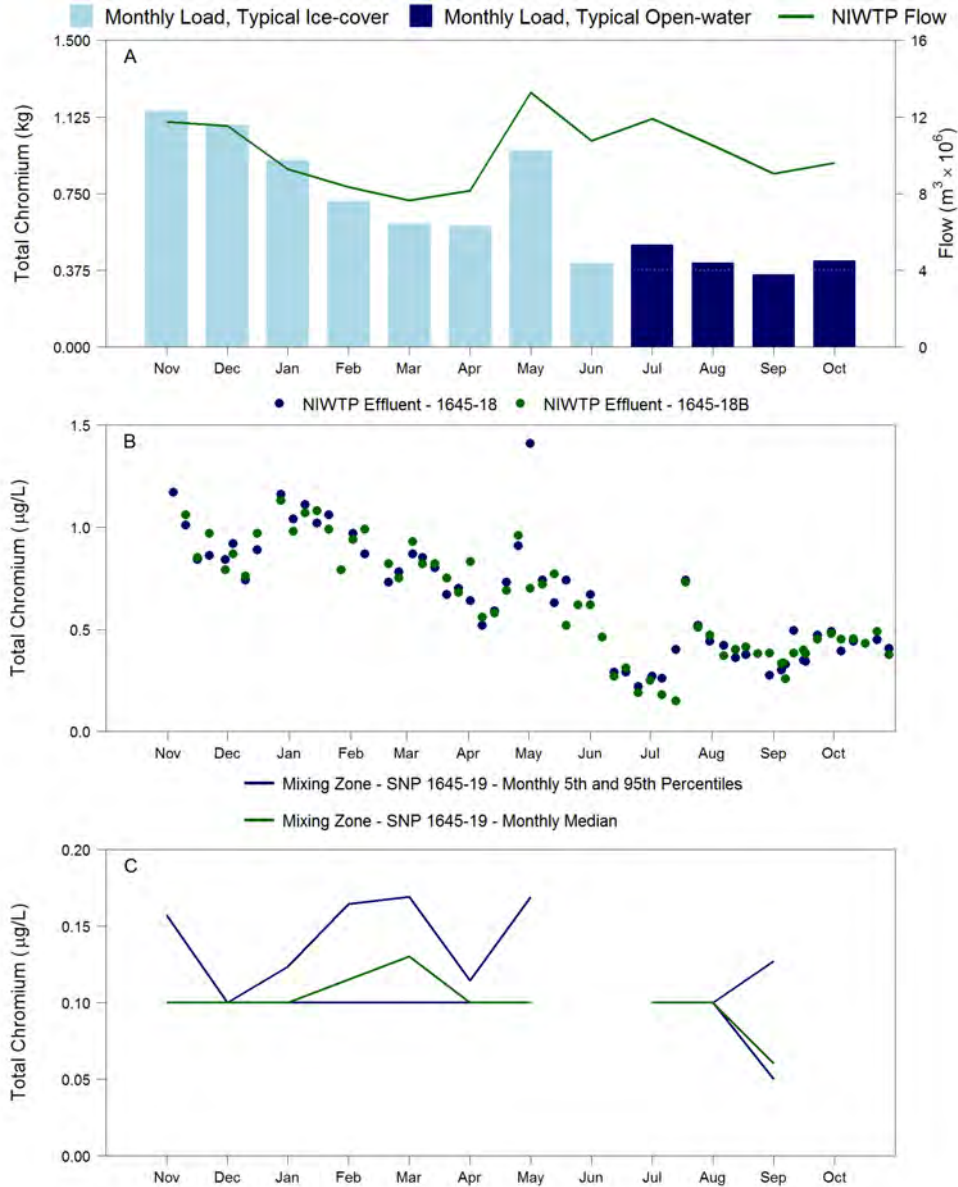
Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-13 A) Monthly Loading Rate of Total Barium from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



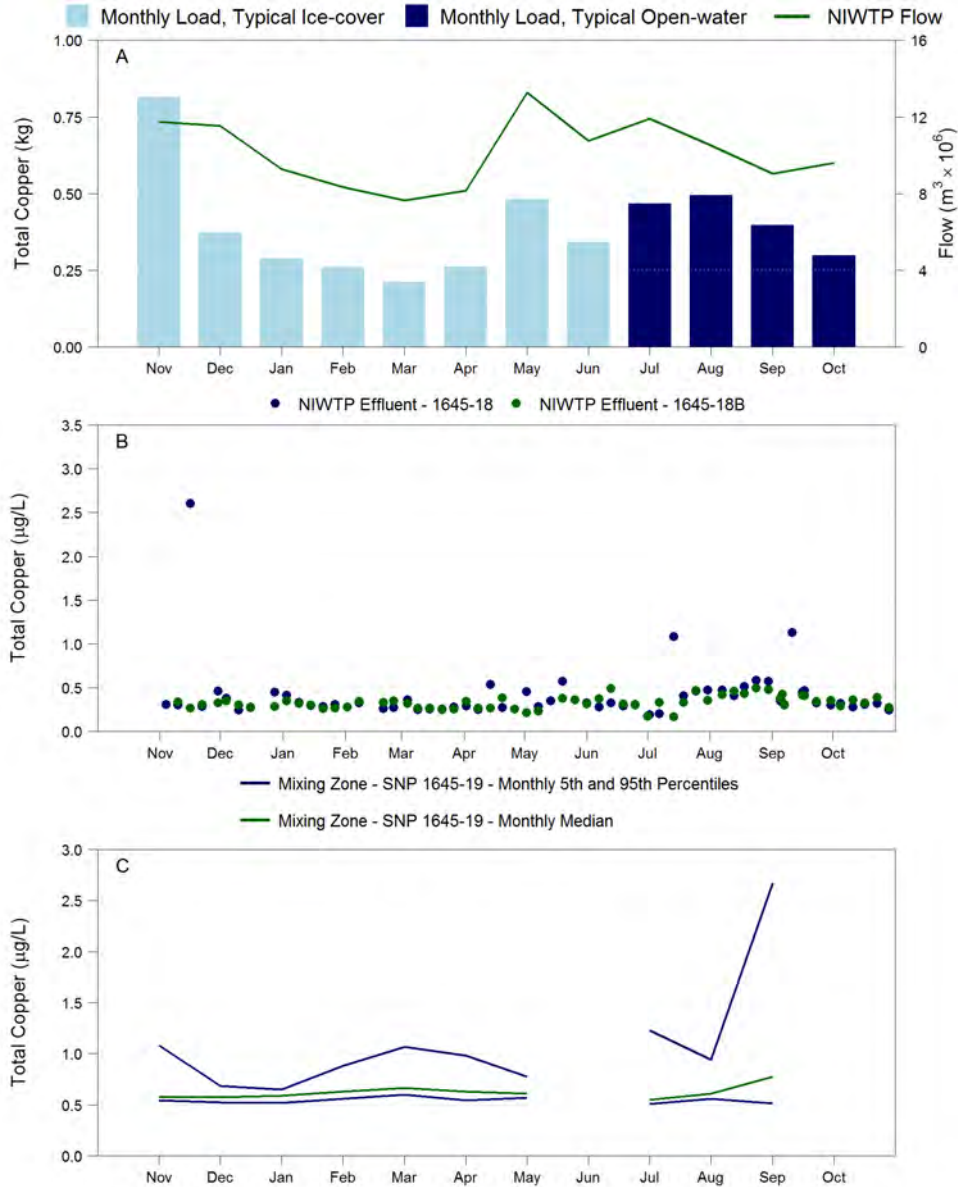
Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-14 A) Monthly Loading Rate of Total Chromium from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

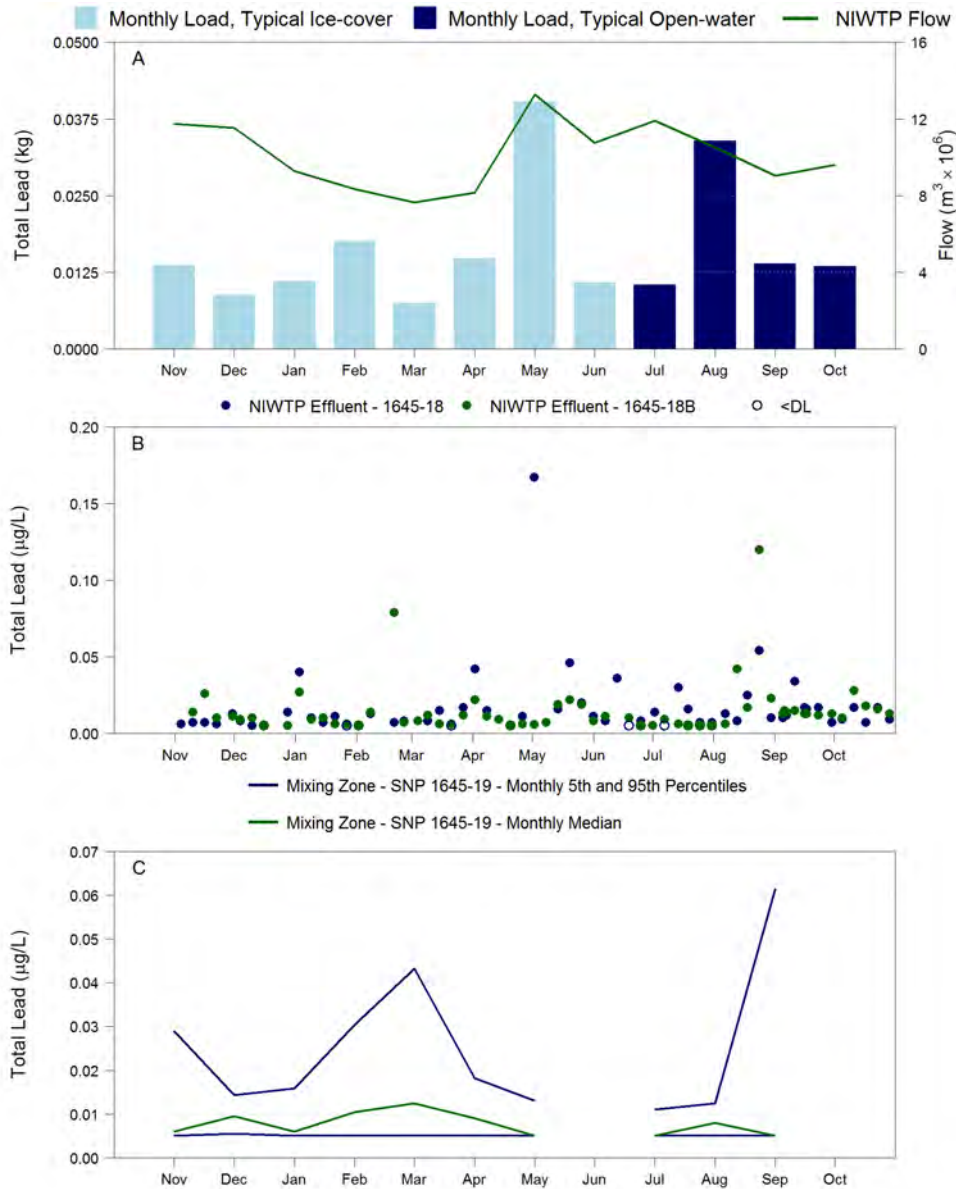
**Figure 3-15 A) Monthly Loading Rate of Total Copper from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

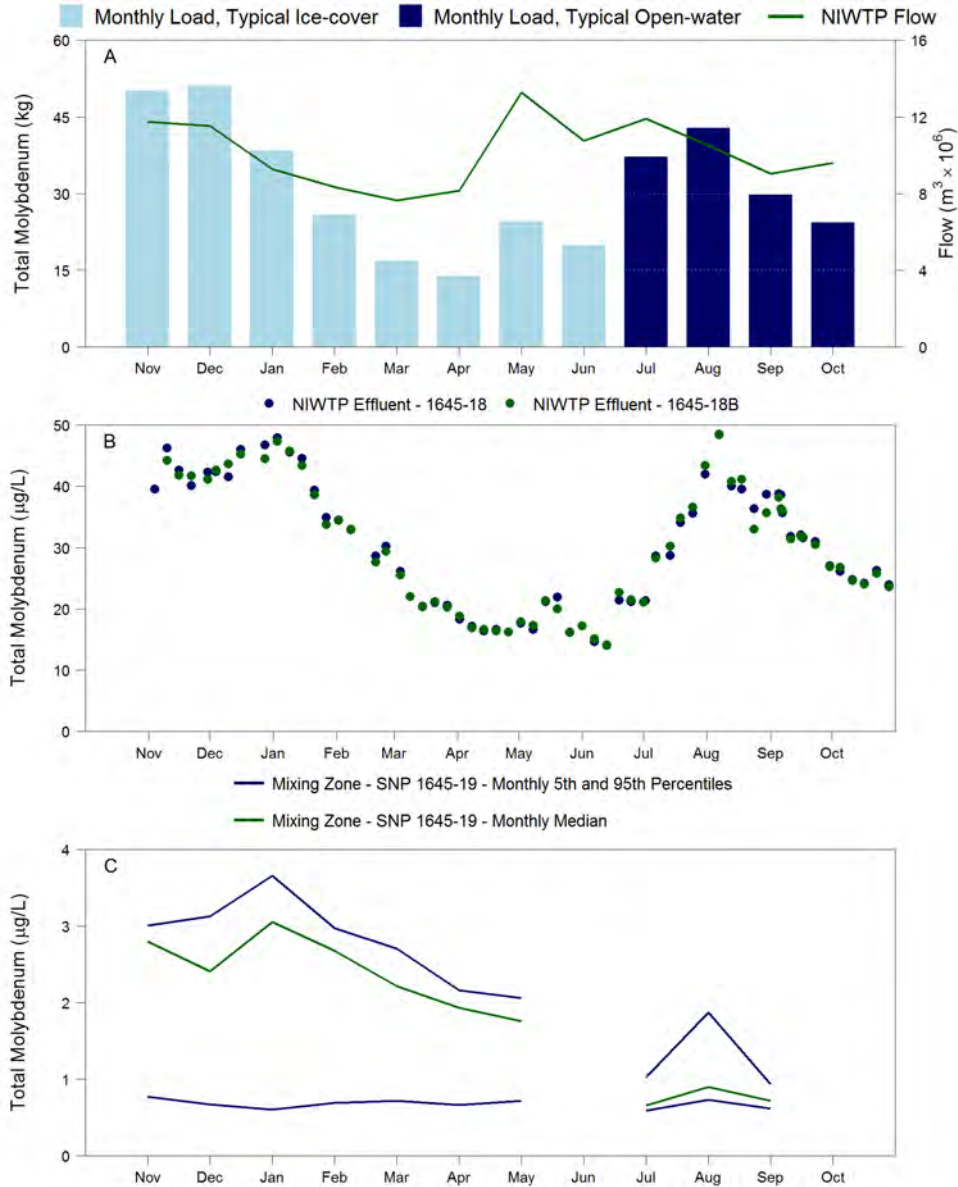
**Figure 3-16 A) Monthly Loading Rate of Total Lead from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-17 A) Monthly Loading Rate of Total Molybdenum from the North Inlet Water Treatment Plant; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**

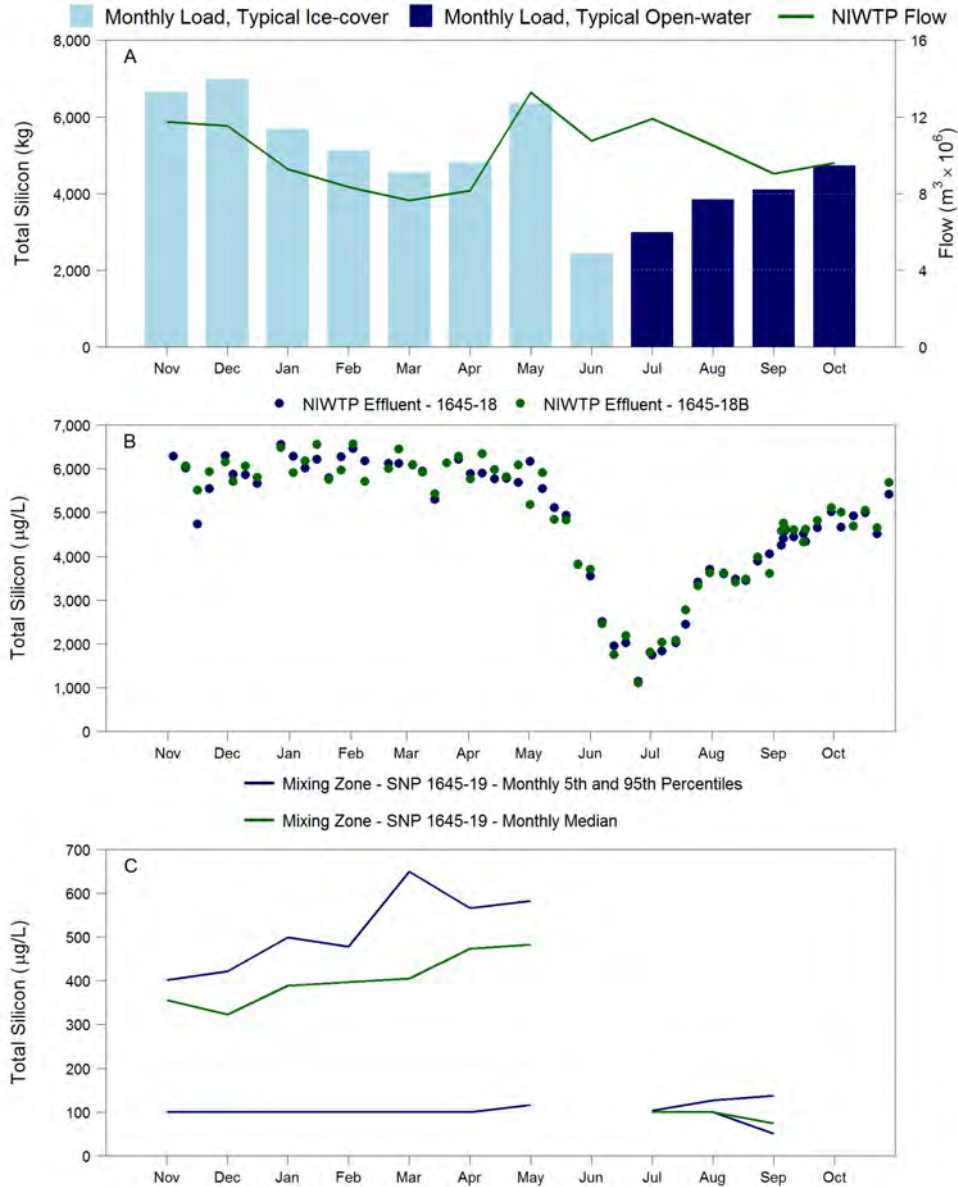


Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).



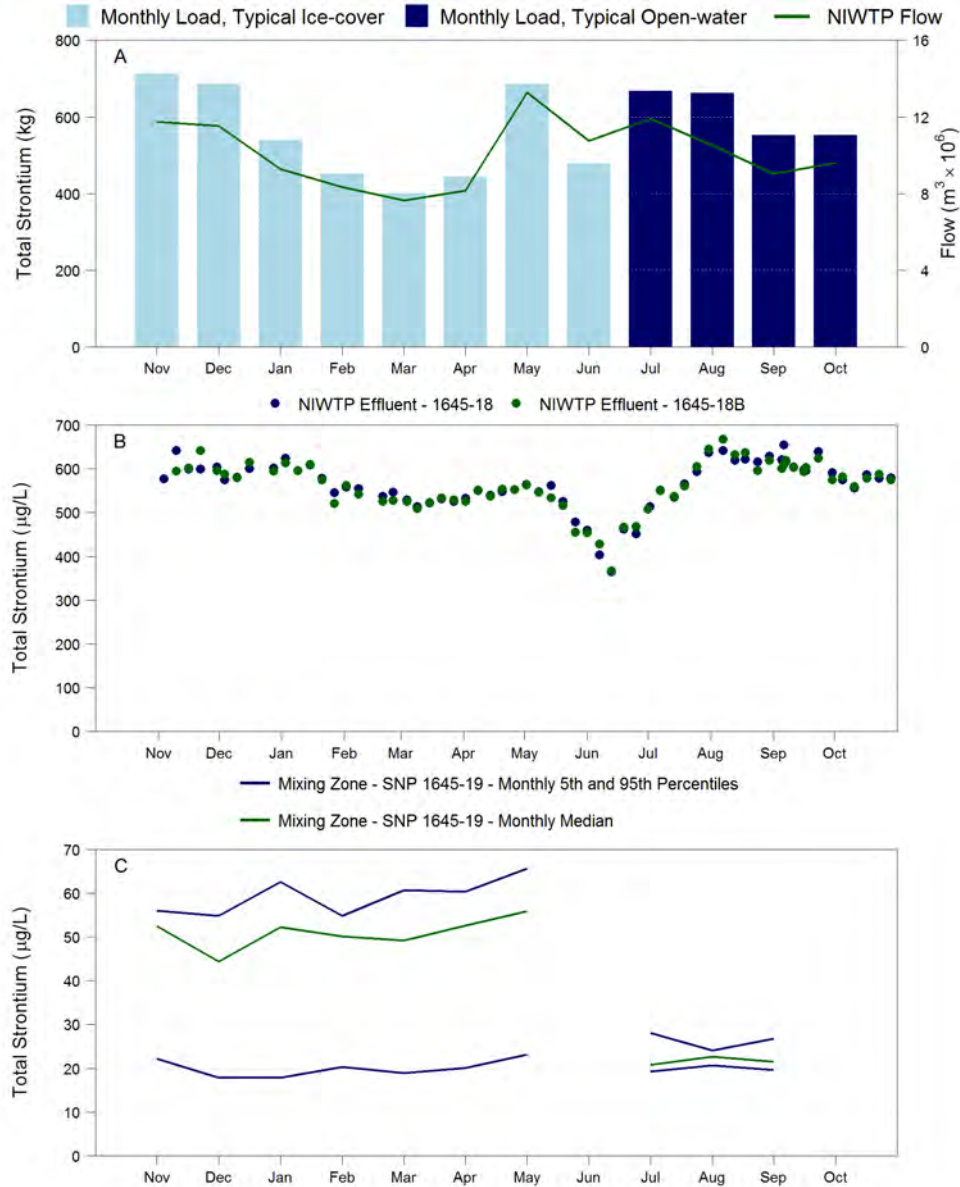
**Figure 3-18 A) Monthly Loading Rate of Total Silicon from the North Inlet Water Treatment Plant ; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

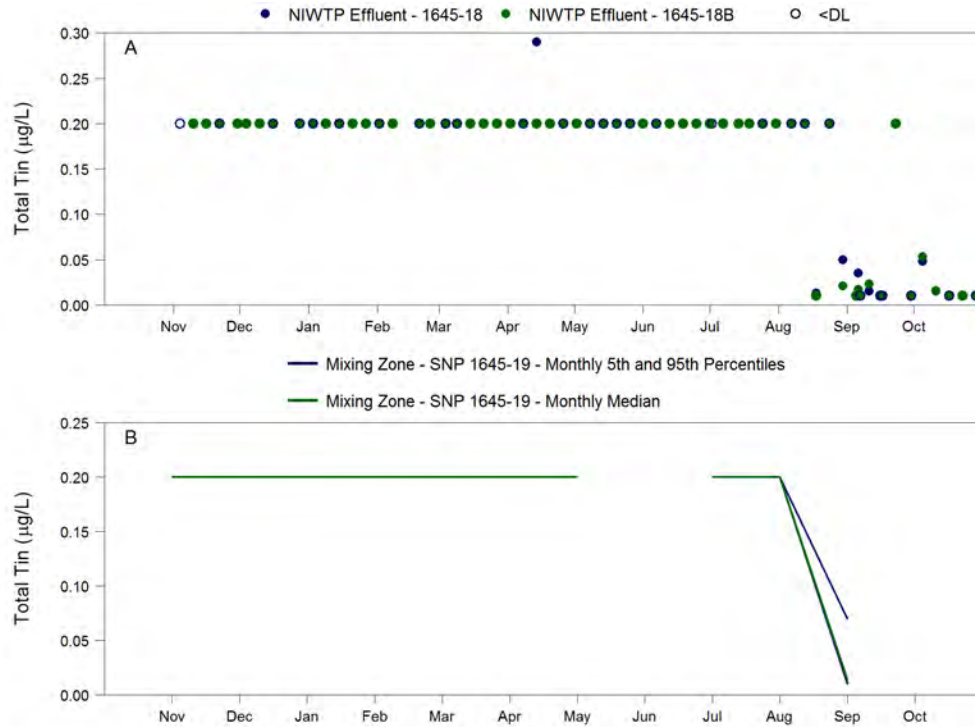
**Figure 3-19 A) Monthly Loading Rate of Total Strontium from the North Inlet Water Treatment Plant; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

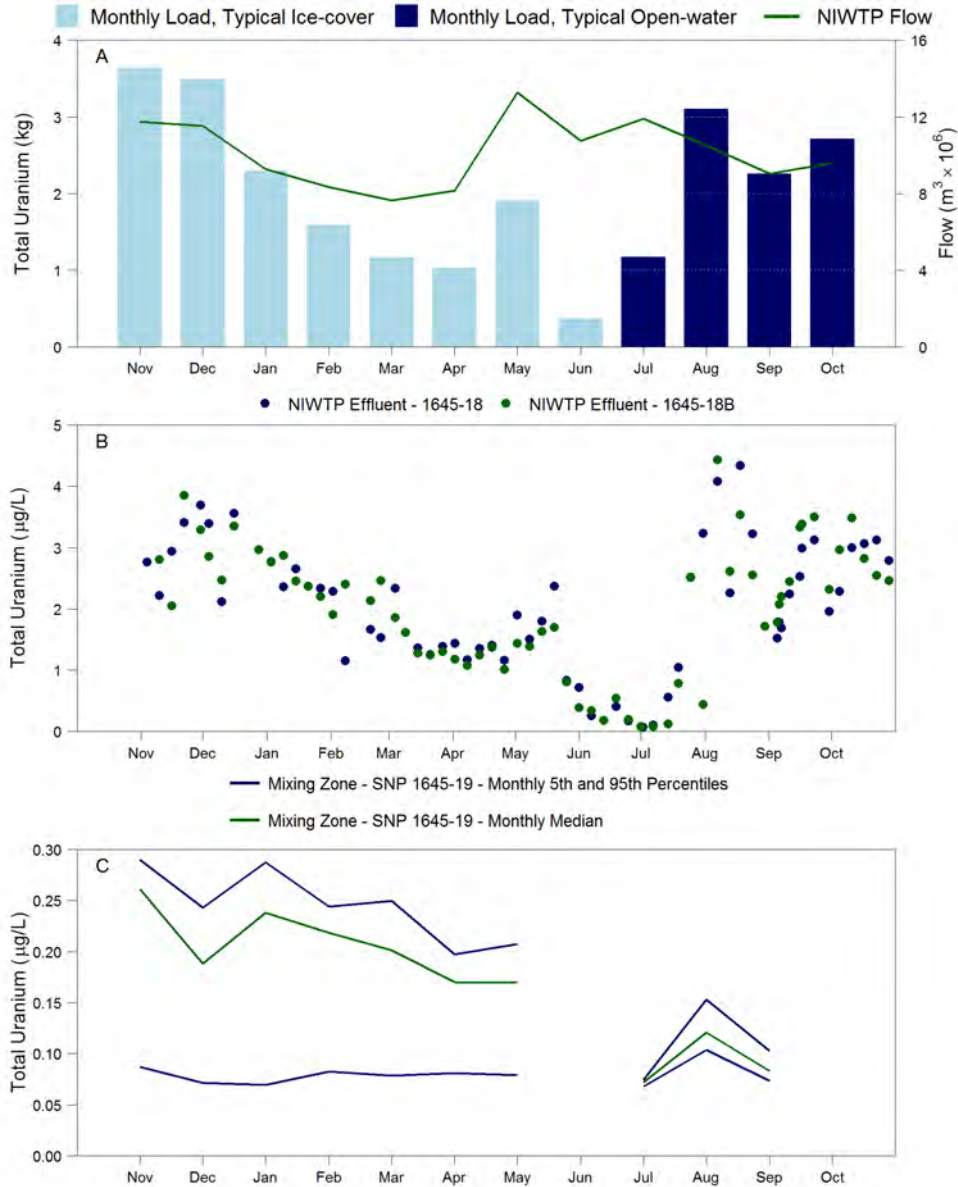
Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-20 A) Monthly Loading Rate of Total Tin from the North Inlet Water Treatment Plant; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.  
Monthly loads for total tin were not calculated because concentrations in effluent were frequently below the detection limit. Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

**Figure 3-21 A) Monthly Loading Rate of Total Uranium from the North Inlet Water Treatment Plant; and Concentration in B) Effluent (SNP 1645-18 and SNP 1645-18B), and C) at the Mixing Zone Boundary (SNP 1645-19), November 1, 2013 to October 31, 2014**



Notes: NIWTP = North Inlet Water Treatment Plant; SNP = Surveillance Network Program; kg = kilogram; µg/L = microgram per litre.

Effluent values represent concentrations in individual samples. Mixing zone values represent the monthly 5th percentile, median and 95th percentile concentrations at three stations (1645-19A, 1645-19B2, 1645-19C) and five depths (2 metres [m], 5 m, 10 m, 15 m, and 20 m).

### 3.2.4 Comparison to Effluent Quality Criteria

Concentrations of SOIs in treated effluent were below both the maximum allowable concentration in any grab sample and the maximum average concentration during the 2014 sampling period (Table 2-3). A single elevated oil and grease value of 6.5 mg/L collected at Station SNP 1645-18 on September 22, 2014, exceeded the maximum allowable concentration of 5 mg/L. However, this result was due to a QA/QC issue, which was disclosed to the WLWB, and is not generally representative of oil and grease concentrations in effluent. All other oil and grease samples were well below the maximum allowable concentration, with the majority (89%) being lower than the DL. All additional variables (i.e., non-SOIs in Table 2-3) that have Water Licence limits were within applicable EQC in all samples.

### 3.2.5 Effluent Toxicity

The results of lethal and sublethal toxicity testing carried out on effluent samples from Stations SNP1645-18 and SNP 1645-18B were summarized for the 2014 reporting period. Results for lethal tests are presented as a “pass” or “fail” to be consistent with laboratory procedures and standards. A lethal test was considered a fail if a result of greater than or equal to 50% mortality in 100% effluent was obtained. Although not a requirement under the Water Licence, a sublethal test was considered a fail if the test results demonstrated sublethal effects greater than or equal to 50% relative to the control.

Toxicity testing results in 2014 indicated that effluent samples were generally not toxic to aquatic test organisms (Tables 3-1 and 3-2). A total of 32 treated effluent samples were submitted for acute and chronic lethality testing during the 2014 reporting period, and a total of 24 samples were submitted for sublethal testing. Toxicity test results demonstrated no toxic effects to aquatic test organisms in all 32 samples submitted for lethal testing.

Of the 24 effluent samples submitted for sublethal testing, two demonstrated sublethal effects of greater than or equal to 50% relative to controls. A reduction in *C. dubia* reproduction was detected in toxicity testing of the December 2013 and March 2014 effluent samples. In both cases, the observed decrease in reproduction relative to the control (50% and 53%, respectively) was only marginally greater than the criterion used to designate a test failure (greater than or equal to  $\geq$  50%; Table 3-1). The six other *C. dubia* tests performed in 2014 passed the tests, and results for all other test species demonstrated no toxic response. Finally, although not considered a toxic response, results of the sublethal *P. subcapitata* growth inhibition tests indicated that the effluent stimulated algal growth.

**Table 3-1 Acute and Chronic Lethality Toxicity Testing Results, North Inlet Water Treatment Plant Effluent, 2014**

Test Organism	Month	Station	
		SNP 1645-18	SNP 1645-18B
		100% Effluent	100% Effluent
Rainbow Trout	December	Pass	Pass
	March	Pass	Pass
	June	Pass	Pass
	September	Pass	-
	October	-	Pass
<i>Ceriodaphnia dubia</i>	December	Pass	Pass
	March	Pass	Pass
	June	Pass	Pass
	September	Pass	-
	October	-	Pass
<i>Daphnia magna</i>	December	Pass	Pass
	March	Pass	Pass
	June	Pass	Pass
	September	Pass	-
	October	-	Pass
<i>Hyalella azteca</i>	December	Pass	Pass
	March	Pass	Pass
	June	Pass	Pass
	September	Pass	-
	October	-	Pass

Notes: - = data not available. Test is considered a "fail" if mortality is greater than or equal to 50%.

**Table 3-2 Sub-lethal Toxicity Testing Results, North Inlet Water Treatment Plant Effluent, 2014**

Test Organism	Month	Station	
		SNP 1645-18	SNP 1645-18B
		100% Effluent	100% Effluent
Rainbow Trout <sup>(a)</sup>	December	Pass	Pass
	March	Pass	Pass
	June	Pass	Pass
	September	Pass	-
	October	-	Pass
<i>Pseudokirchneriella subcapitata</i> <sup>(b)(c)</sup>	December	Pass	Pass
	March	Pass	Pass
	June	Pass	Pass
	September	Pass	-
	October	-	Pass
<i>Ceriodaphnia dubia</i> <sup>(d)</sup>	December	Fail <sup>(e)</sup>	Pass
	March	Fail <sup>(f)</sup>	Pass
	June	Pass	Pass
	September	Pass	-
	October	-	Pass

- = data not available.

a) Trout embryo (Early Life Stage) survival test is considered a "fail" if reduction in viable embryos is greater than or equal to 50% compared to controls.

b) Test is considered a "fail" if reduction in growth compared to controls is  $\geq 50\%$ .

c) Lab results indicate enhanced algal growth.

d) Test is considered a "fail" if the inhibitory effect on reproduction compared to control is  $\geq 50\%$ .

e) The result for this test was a marginal fail (inhibitory effect on reproduction compared to the control was 50%).

f) The result for this test was a marginal fail (inhibitory effect on reproduction compared to the control was 53%).

### 3.3 DEPTH PROFILES

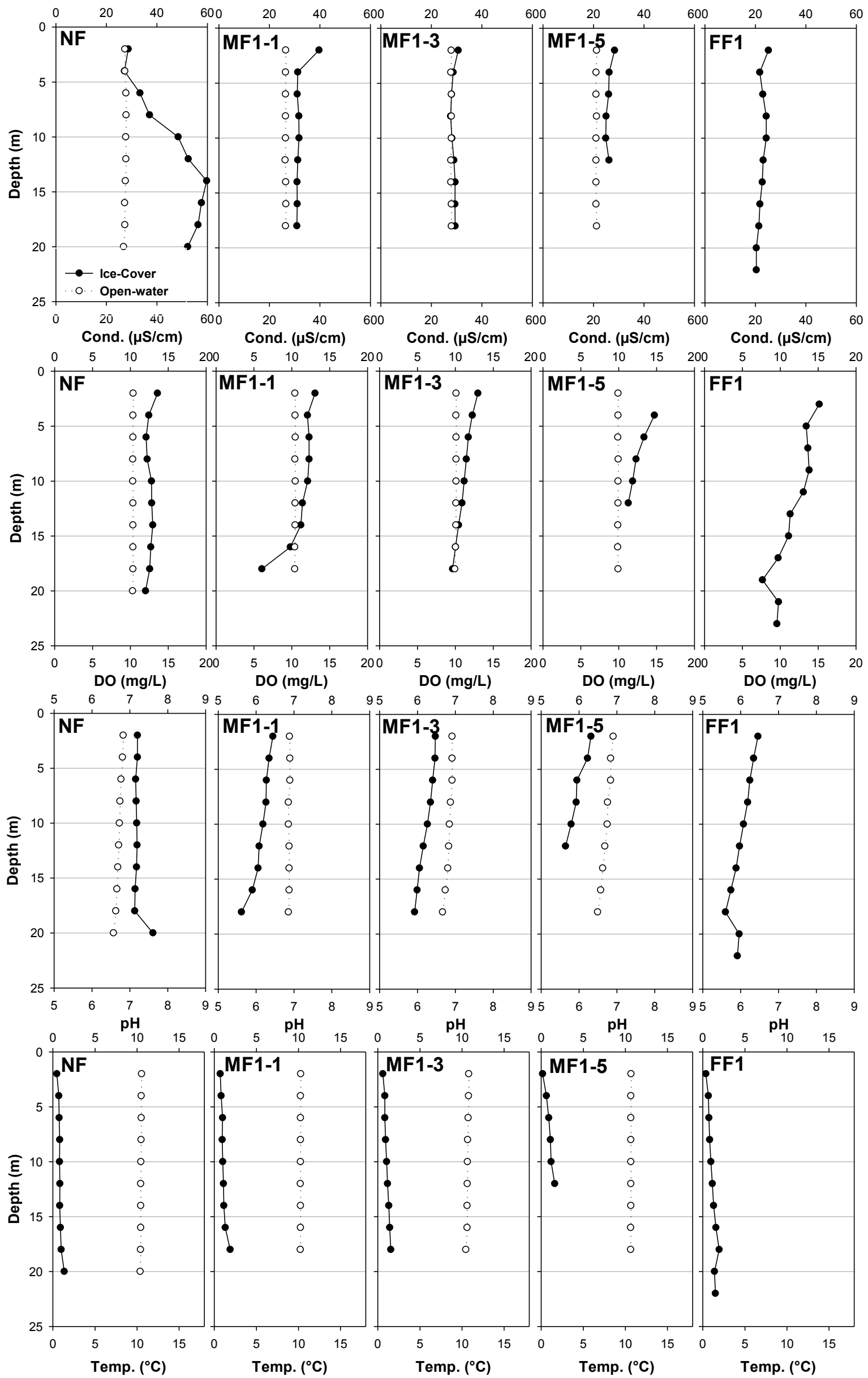
This section describes the *in-situ* (i.e., field measured) water quality measurements for conductivity, DO, water temperature and pH recorded at AEMP stations. During the ice-cover season sampling program, depth profiles were collected both at exposure and reference stations as required by the AEMP Study Design Version 3.4 (Golder 2014a), which was the approved version of the design plan at that time. In the current version of the AEMP (Version 3.5), the sampling frequency for effluent plume monitoring is annually at exposure areas (NF, MF and FF2) and every three years at reference areas (FF1, FFA, and FFB; Golder 2014b). Since the open-water program was conducted under the revised AEMP Study Design Version 3.5, sampling included collection of profile data at exposure areas only.

Specific conductivity increased with depth in the NF area during the ice-cover season to approximately 15 m and then declined with increasing depth (Figures 3-22 to 3-24). The greater specific gravity of the effluent combined with the absence of wind and wave-driven mixing during ice-cover conditions, resulted in elevated conductivity at approximately two thirds depth in the NF area. The peak in conductivity at this location indicates the point where the effluent plume was most concentrated. Complete vertical mixing of the effluent was observed at all stations along the MF1 transect, which extends to the northwest of the Mine. Conductivity data were not available at station MF2-1 and at most stations along the MF3 transect due to a malfunction that occurred with the Hydrolab meter during the ice-cover sampling program. Complete vertical mixing of the effluent, however, was observed at all MF2 and MF3 area stations where profile data were available.

Temperature profiles in Lac de Gras were vertically homogeneous at most stations during the open-water season and showed a slight tendency to increase with depth during the ice-cover season (Figures 3-22 to 3-24). During the open-water season, DO concentrations were typically uniform throughout the water column. During the ice-cover season, DO concentrations were greatest just below the ice-water interface and declined with increasing depth. There was no evidence of reduced DO concentration at any station.

The pH values measured in Lac de Gras in 2014 showed a gradual decrease with depth in both seasons (Figures 3-22 to 3-24). Slightly greater near-surface pH values observed at some stations likely reflected the removal of dissolved carbon dioxide through photosynthesis. Also, the somewhat greater pH values observed in the NF area likely reflect the presence of Mine effluent, which has a pH typically greater than 7.

Figure 3-22 Specific Conductivity, Dissolved Oxygen, pH and Temperature Profiles at Mid-field 1 Transect Stations, 2014

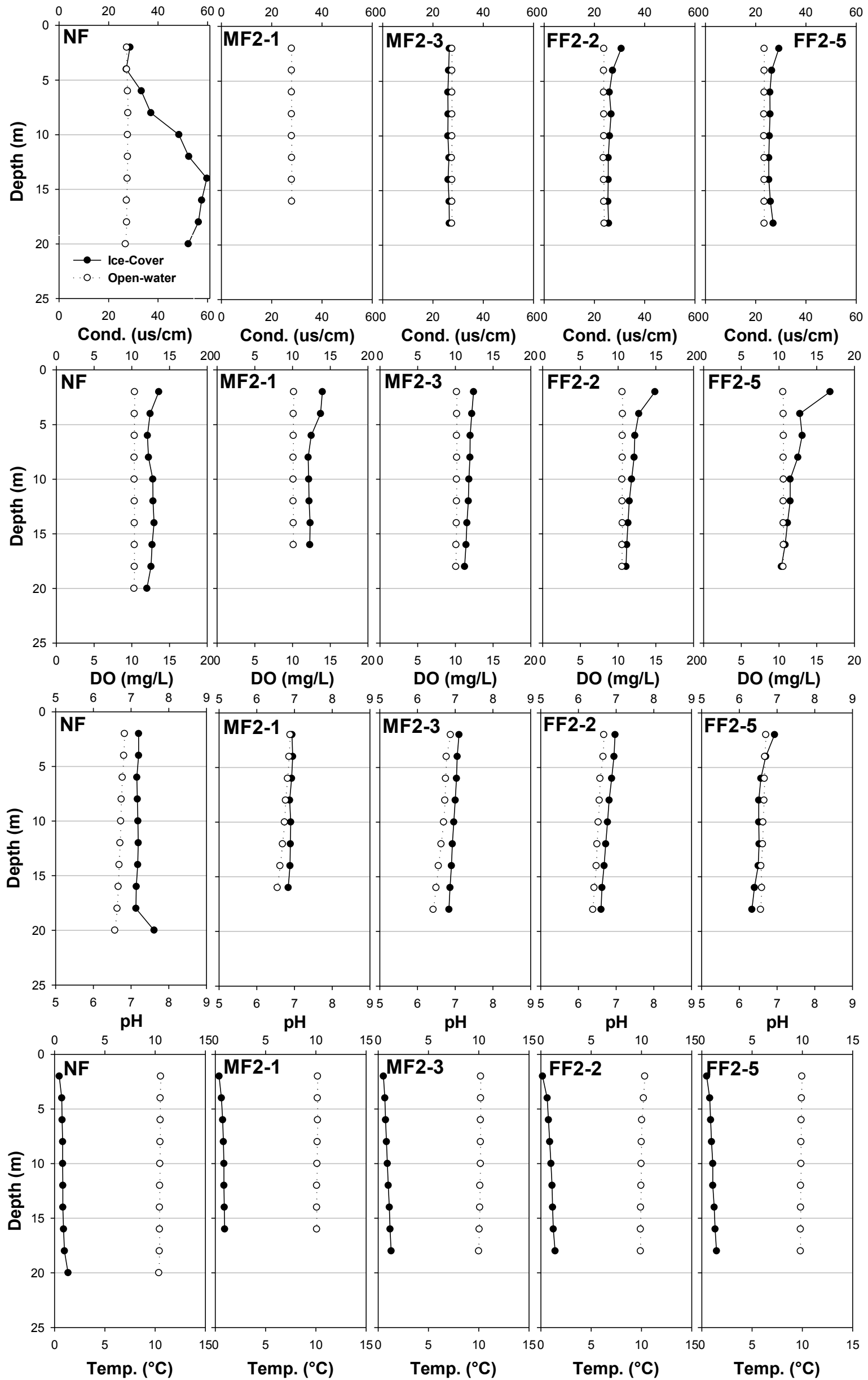


Notes: NF = near-field; MF = mid-field; FF = far-field; Cond. = specific conductivity; µS/cm = microSiemens per centimetre; DO = dissolved oxygen; Temp. = temperature; m = metre; °C = degrees Celsius; mg/L = milligrams per litre.

NF and FF1 area values represent the average of 5 stations

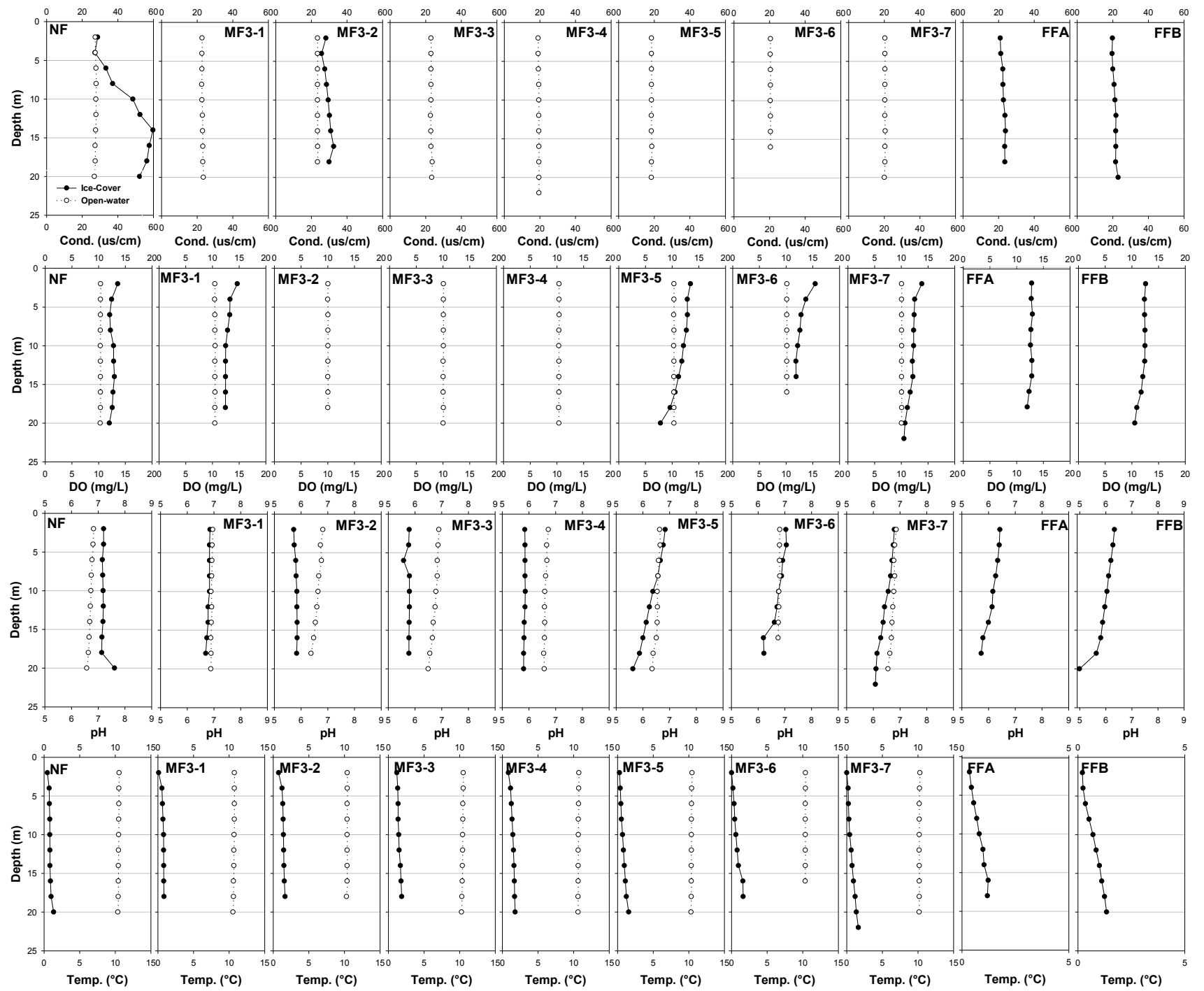


Figure 3-23 Conductivity, Dissolved Oxygen, pH and Temperature Profiles at MF2 Transect Stations, 2014



Notes: NF = near-field; MF = mid-field; FF = far-field; Cond. = specific conductivity; DO = dissolved oxygen; Temp. = temperature; m = metre; °C = degree Celsius; mg/L = milligram per litre;  $\mu\text{S}/\text{cm}$  = microSiemen per centimetre.  
The conductivity profile at sampling station MF2-1 was not collected due to a malfunction of the Hydrolab meter.  
NF area values represent the average of 5 stations

**Figure 3-24 Conductivity, Dissolved Oxygen, pH and Temperature Profiles at MF3 Transect Stations, 2014**



Notes: NF = near-field; MF = mid-field; FF = far-field; Cond. = specific conductivity; DO = dissolved oxygen; Temp. = temperature; m = metre; °C = degree Celsius; mg/L = milligram per litre;  $\mu\text{S/cm}$  = microSiemen per centimetre  
 NF, FFA and FFB area values represent the average of 5 stations Conductivity and dissolved oxygen profiles were not collected at a subset of MF3 area stations due to a malfunction of the Hydrolab meter.

## 3.4 ASSESSMENT OF EFFECTS AND ACTION LEVELS

Mine-related effects on water quality were categorized according to the Action Levels (Table 2-4). Results of the Action Level screening are organized sequentially for each Action Level. Spatial variation in the concentrations of water quality variables that were identified as SOIs in 2014 is shown relative to Action Level values in Figures 3-25 to 3-3-45.

### 3.4.1 Action Level 1

Action Level 1 was triggered for variables that had a two-fold difference between the NF area median concentration and the reference area median concentration. In addition, the increase in concentration in the NF area had to be linked to the Mine (i.e., present in the Mine effluent or in dust) to trigger Action Level 1.

A total of 19 of the 55 water quality variables assessed had NF area median concentrations that were greater than two times the reference area median value (Table 3-4). Each of the 19 variables that triggered Action Level 1 was detected in the NIWTP effluent at a concentration higher than the concentration in Lac de Gras. Several variables that triggered Action Level 1 were also detected in dust, which may be deposited into Lac de Gras from mining activities (Appendix I). This provided evidence of the linkage to the Mine, which is required for an Action Level 1 to be triggered. As described in Section 3.1, these 19 variables were retained as SOIs. No management action is required under the Response Framework (Table 2-4) when a water quality variable triggers Action Level 1.

Nine SOIs (TDS [calculated], chloride, sodium, nitrate, copper, lead, molybdenum, strontium, uranium) had NF area median concentrations that exceeded the two times reference area median criterion both during the ice-cover and open-water seasons. The other ten SOIs (conductivity, calcium, potassium, sulphate, aluminum, antimony, barium, chromium, silicon, and tin) triggered Action Level 1 during the ice-cover season only. Fluoride, which was added to the SOI list from the effluent screening (Section 3.1), did not trigger an Action Level 1 in either season.

Data quality issues with ammonia in 2014 did not allow an evaluation of Action Level exceedance for this variable. Ammonia concentrations in blank samples analyzed by Maxxam were at or above levels found in Lac de Gras (Appendix C), while concentrations reported in lake water samples were greater and more variable than values previously provided by ALS (2007-2010). As a result, ammonia data reported in 2014 could not be compared to concentrations from 2007 to 2010, upon which background concentrations are based (Golder 2015). Given these issues with the ammonia analysis, ammonia was retained as an SOI in 2014.

For some substances that were analyzed in more than one form, or as different fractions (e.g., total and dissolved; measured and calculated), the most representative of these was included in the Action Level evaluation to avoid duplication. For example, both nitrite and nitrate were analyzed in water samples;

however, since most samples (96%) had nitrite concentrations below the DL, and the results for nitrate + nitrite were generally identical to those for nitrate, only nitrate was evaluated against the Action Levels. Although the total fractions of calcium, potassium and sodium triggered Action Level 1 in 2014, only the dissolved fractions of these chemicals are presented as having triggered an Action Level. Finally, measured TDS triggered Action Level 1 in 2014; however, Action Level 1 was applied to the calculated values only, to be consistent with previous AEMP reports which have typically reported calculated TDS.

### **3.4.2 Action Level 2**

All SOIs that triggered Action Level 1 were evaluated against Action Level 2. Action Level 2 was triggered if the 5<sup>th</sup> percentile concentration in the NF area was greater than two times the reference area median and greater than the normal range for Lac de Gras. Of the 19 SOIs that triggered Action Level 1, eight (TDS, chloride, sodium, nitrate, antimony, molybdenum, strontium and uranium) triggered Action Level 2 in one or both sampling seasons (Table 3-5). In general, Action Level 2 was triggered during both the ice-cover and open-water seasons. The exceptions were nitrate and antimony, which triggered Action Level 2 only during the ice-cover season.

Under the Response Framework, when a water quality variable triggers Action Level 2, the required management action is to establish an AEMP Effects Benchmark for that variable if one does not already exist. Two of the variables that triggered Action Level 2 (sodium and antimony) do not have existing AEMP Aquatic Life Effects Benchmarks. Therefore, DDMI will be required to develop AEMP Effects Benchmarks for these variables. This will be done as part of the next AEMP Study Design (Version 4.0), which will be submitted in June 2016.

### **3.4.3 Action Level 3**

Variables that triggered Action Level 2 were evaluated for an effect at Action Level 3. Action Level 3 was triggered if the 75<sup>th</sup> percentile concentration at the mixing zone boundary was greater than the normal range plus 25% of the distance between the top of the normal range and the AEMP Effects Benchmark. Only water quality variables that have existing AEMP Aquatic Life Effects Benchmarks (Table 2-6) were evaluated against Action Level 3.

None of the water quality variables triggered an effect equivalent to Action Level 3 (Table 3-6). The 75<sup>th</sup> percentile concentrations at the mixing zone during the ice-cover season were one to two orders of magnitude lower than the Action Level 3 criterion for strontium and uranium. Other variables (TDS [calculated], chloride, nitrate and molybdenum) had 75<sup>th</sup> percentile concentrations that were between three and ten times lower than the Action Level 3 criterion during ice-cover.

**Table 3-4 Comparison of 2014 Water Quality Data to Action Level 1**

Variable	Unit	2014 Detection Limit	Action Level 1					
			Magnitude of Effect		2014 AEMP		Action Level 1 Triggered? (Yes/No)	
			2 x Median of Reference Areas <sup>(a)</sup>		Median of NF values <sup>(b)</sup>			
			Ice-cover	Open-water	Ice-cover	Open-water	Ice-cover	Open-water
<b>Conventional Parameters</b>								
Alkalinity, Total (as CaCO <sub>3</sub> )	mg/L	0.5	8.8	8.0	7.3	5.0	No	No
Specific Conductivity	µS/cm	1	34.2	31.0	42.0	30.4	Yes	No
Hardness, Total (CaCO <sub>3</sub> )	mg/L	0.5	10.8	10.0	10.5	8.2	No	No
Total Dissolved Solids (Calculated)	mg/L	-	10.7	10.6	20.8	15.0	Yes	Yes
Total Dissolved Solids (Measured)	mg/L	1	30	20	32	17	<sup>(d)</sup>	No
Total Suspended Solids	mg/L	1	1	1	<1	<1	No	No
Total Organic Carbon	mg/L	0.2	5.2	4.4	2.3	2.3	No	No
Turbidity	NTU	0.1	0.1	0.42	<0.1	0.27	No	No
<b>Major Ions</b>								
Calcium	mg/L	0.01	2.20	2.00	2.18	1.69	<sup>(e)</sup>	No
Carbonate	mg/L	0.5	0.5	0.5	<0.5	<0.5	No	No
Chloride	mg/L	0.5	1.6	2.0	3.6	2.6	Yes	Yes
Fluoride	mg/L	0.01	0.048	0.044	0.037	0.027	No	No
Hydroxide	mg/L	0.5	0.5	0.5	<0.5	<0.5	No	No
Magnesium	mg/L	0.01	1.38	1.40	1.38	1.00	No	No
Potassium	mg/L	0.01	1.26	1.2	1.27	0.9	Yes	No
Sodium	mg/L	0.01	1	1	3	2	Yes	Yes
Sulphate	mg/L	0.5	4.4	3.8	5.1	3.4	Yes	No
<b>Nutrients</b>								
Ammonia (as Nitrogen)	µg-N/L	5	35.6	5	34.0	17	No	<sup>(f)</sup>
Nitrate (as Nitrogen)	µg-N/L	2	6.8	2	65.3	3.6	Yes	Yes
Nitrite (as Nitrogen)	µg-N/L	2	2	2	<2	<2	No	No
Nitrate + Nitrite (as Nitrogen)	µg-N/L	2	6.8	2	65.3	3.6	<sup>(d)</sup>	<sup>(d)</sup>
<b>Total Metals</b>								
Aluminum	µg/L	0.2	5.8	8.8	9.1	7.2	Yes	No
Antimony	µg/L	0.02	0.02	0.02	0.04	<0.02	Yes	No
Arsenic	µg/L	0.02	0.38	0.34	0.33	0.24	No	No
Barium	µg/L	0.02	3.86	3.62	4.09	2.49	Yes	No
Beryllium	µg/L	0.01	0.01	0.01	<0.01	<0.01	No	No
Bismuth	µg/L	0.005	0.005	0.005	<0.005	<0.005	No	No
Boron	µg/L	5	5	5	<5	<5	No	No
Cadmium	µg/L	0.005	0.005	0.005	<0.005	<0.005	No	No
Calcium	mg/L	0.01	2.04	1.92	2.10	1.68	<sup>(d, e)</sup>	No

**Table 3-4 Comparison of 2014 Water Quality Data to Action Level 1**

Variable	Unit	2014 Detection Limit	Action Level 1					
			Magnitude of Effect		2014 AEMP		Action Level 1 Triggered? (Yes/No)	
			2 x Median of Reference Areas <sup>(a)</sup>		Median of NF values <sup>(b)</sup>			
			Ice-cover	Open-water	Ice-cover	Open-water	Ice-cover	Open-water
Chromium	µg/L	0.05	0.06	0.06	0.10	0.05	Yes	No
Cobalt	µg/L	0.005	0.022	0.04	0.012	0.015	No	No
Copper	µg/L	0.05	0.6	0.6	0.81	0.62	Yes	Yes
Iron	µg/L	1	5	10	3.2	6.4	No	No
Lead	µg/L	0.005	0.005	0.005	0.008	0.006	Yes	Yes
Lithium	µg/L	0.5	2.8	2.4	2.0	1.6	No	No
Magnesium	mg/L	0.01	1.32	1.26	1.31	0.99	No	No
Manganese	µg/L	0.05	2.42	4.88	1.37	1.39	No	No
Mercury	µg/L	0.002	0.01	0.01	<0.002	0.005	No	No
Molybdenum	µg/L	0.05	0.14	0.18	1.05	0.66	Yes	Yes
Nickel	µg/L	0.02	1.94	1.90	0.96	0.67	No	No
Potassium	mg/L	0.01	1.16	1.08	1.21	0.89	<sup>(d)</sup>	No
Selenium	µg/L	0.04	0.04	0.04	<0.04	<0.04	No	No
Silicon	µg/L	50	50	50	127	<50	Yes	No
Silver	µg/L	0.005	0.005	0.005	<0.005	<0.005	No	No
Sodium	mg/L	0.01	1.28	1.26	2.71	1.84	<sup>(d)</sup>	<sup>(d)</sup>
Strontium	µg/L	0.05	15.2	14.6	30.9	20.9	Yes	Yes
Sulphur	mg/L	0.1	1.96	1.82	1.73	1.17	No	No
Thallium	µg/L	0.002	0.002	0.002	<0.002	<0.002	No	No
Tin	µg/L	0.01	0.01	0.01	0.023	<0.01	Yes	No
Titanium	µg/L	0.5	0.5	0.5	<0.5	<0.5	No	No
Uranium	µg/L	0.002	0.056	0.056	0.101	0.080	Yes	Yes
Vanadium	µg/L	0.1-0.2	0.1	0.1	0.05	0.05	No	No
Zinc	µg/L	0.1	1.8	1.5	<sup>(g)</sup>	0.41	<sup>(g)</sup>	No
Zirconium	µg/L	0.05-0.1	0.05	0.05	0.025	0.025	No	No

µS/cm = microSiemens per centimetre; NTU = nephelometric turbidity unit; µg/L = microgram per litre; mg/L – milligram per litre; µg-N/L = microgram nitrogen per litre; CaCO<sub>3</sub> = calcium carbonate.

a) The 2 x median value used in the assessment of Action Levels was based on the reference area median concentrations presented in the AEMP Reference Conditions Report, Version 1.1 (Golder 2015). In cases where the median concentration was less than the DL, the reference area median value was considered to be equal to 0.5 of the DL.

b) The median of NF area values was calculated from data pooled across all sample depths, dates and stations (n = 15 samples).

c) pH is evaluated qualitatively in Section 3.3.

d) Action Level 1 comparison was applied to an alternate form or fraction of this substance (e.g., dissolved rather than total) to avoid duplication.

e) Total calcium concentration in the NF area triggered Action Level 1 in 2014, however, Action Level 1 was applied to the dissolved form even though the NF area concentration in 2014 was just below the threshold value used at Action Level 1. This approach was taken to be consistent with the convention used for other major ions that triggered Action Level 1 (e.g., potassium and sodium).

f) Action Level results for ammonia are uncertain due to laboratory quality control issues (Appendix C).

g) Total zinc was excluded from the Action Level screening during the ice-cover season due to sample contamination (Section 2.4, Appendix C).

**Table 3-5 Comparison of 2014 Water Quality Data to Action Level 2**

Variable	Unit	2014 Detection Limit	Action Level 2									
			Magnitude of Effect				2014 AEMP				Action Level 2 Triggered? (Yes/No)	
			2 x Median of Reference Areas <sup>(a)</sup>		Top of Normal Range <sup>(b)</sup>		5th Percentile of NF values <sup>(c)</sup>					
			Ice-cover	Open-water	Ice-cover	Open-water	Ice-cover	Open-water	Ice-cover	Open-water	Ice-cover	Open-water
<b>Conventional Parameters</b>												
Specific Conductivity	µS/cm	1	34.2	31	19.3	16.4	33.1	29.2	No	No		
Total Dissolved Solids (Calculated)	mg/L	-	10.7	10.6	6.5	5.8	15	14	Yes	Yes		
<b>Major Ions</b>												
Calcium	mg/L	0.01	2.20	2.00	1.3	1.1	1.7	1.5	No	No		
Chloride	mg/L	0.5	1.6	2	1	1	2.3	2.3	Yes	Yes		
Potassium	mg/L	0.01	1.26	1.2	0.8	0.7	1.0	0.9	No	No		
Sodium	mg/L	0.01	1	1	1	1	2.0	1.8	Yes	Yes		
Sulphate	mg/L	0.5	4.4	3.8	2.5	2.1	3.7	3.1	No	No		
<b>Nutrients</b>												
Ammonia (as Nitrogen)	µg-N/L	5	35.6	5	23	5	19	9	No	<sup>(d)</sup>		
Nitrate (as Nitrogen)	µg-N/L	2	6.8	2	15.2	2	24	2	Yes	No		
<b>Total Metals</b>												
Aluminum	µg/L	0.2	5.8	8.8	3.9	6.2	4.1	5.7	No	No		
Antimony	µg/L	0.02	0.02	0.02	0.02	0.02	0.023	<0.02	Yes	No		
Barium	µg/L	0.02	3.86	3.62	2.18	1.94	2.78	2.37	No	No		
Chromium	µg/L	0.05	0.06	0.06	0.06	0.06	<0.05	<0.05	No	No		
Copper	µg/L	0.05	0.6	0.6	0.8	0.6	0.624	0.558	No	No		
Lead	µg/L	0.005	0.005	0.005	0.007	0.006	<0.005	<0.005	No	No		
Molybdenum	µg/L	0.05	0.14	0.18	0.09	0.13	0.55	0.53	Yes	Yes		
Silicon	µg/L	50	50	50	50	50	50	<50	No	No		
Strontium	µg/L	0.05	15.2	14.6	8.78	8.01	18.12	18.50	Yes	Yes		
Tin	µg/L	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	No	No		
Uranium	µg/L	0.002	0.056	0.056	0.03	0.029	0.068	0.068	Yes	Yes		

AEMP = Aquatic Effects Monitoring Program; µS/cm = microSiemens per centimetre; NTU = nephelometric turbidity unit; NF = near-field µg/L = microgram per litre; mg/L – milligram per litre; µg-N/L = microgram nitrogen per litre.

a) The 2 x median value used in the assessment of Action Levels was based on the reference area median concentrations presented in the AEMP Reference Conditions Report, Version 1.1 (Golder 2015). In cases where the median concentration was less than the DL, the reference area median value was considered to be equal to 0.5 of the DL. Normal ranges used at Action Level 2 are those presented in the AEMP Reference Conditions Report, Version 1.1 (Golder 2015).

b) The median of NF area values were calculated from data pooled across all sample depths, dates and stations (n = 15 samples).

c) The 5th percentile concentration of NF area values was calculated from data pooled across all sample depths, dates and stations (n = 15 samples).

d) Action Level results for ammonia are uncertain due to laboratory quality control issues (Appendix C).

**Table 3-6 Comparison of 2014 Data to Action Level 3**

Variable	Unit	2014 Mixing Zone Detection Limit	AEMP Effects Benchmark <sup>(a)</sup>	Action Level 3				Action Level 3 Triggered? (Yes/No)	
				Magnitude of Effect		2013 AEMP			
				Normal Range <sup>(b)</sup> + 25% of Effects Benchmark		75th Percentile of Mixing Zone Values <sup>(c)</sup>			
				Ice-cover	Open-water	Ice-cover	Open-water	Ice-cover	Open-water
<b>Conventional Parameters</b>									
Total Dissolved Solids (Calculated)	mg/L	-	500	125	125	33	18	No	No
<b>Major Ions</b>									
Chloride	mg/L	0.5	120	30	30	7.7	3.0	No	No
<b>Nutrients</b>									
Ammonia	µg-N/L	5	4,730	1,183	1,183	48	18	No	No
Nitrate (as Nitrogen)	µg-N/L	2-20	3,000	750	750	210	21	No	No
<b>Total Metals</b>									
Molybdenum	µg/L	0.05	73	18	18	2.83	0.91	No	No
Strontium	µg/L	0.05	30,000	7,500	7,500	55.15	23.40	No	No
Uranium	µg/L	0.002	15	4	4	0.238	0.114	No	No

AEMP = Aquatic Effects Monitoring Program; mg/L = milligram per litre; µg-N/L = microgram nitrogen per litre; µg/L = microgram per litre.

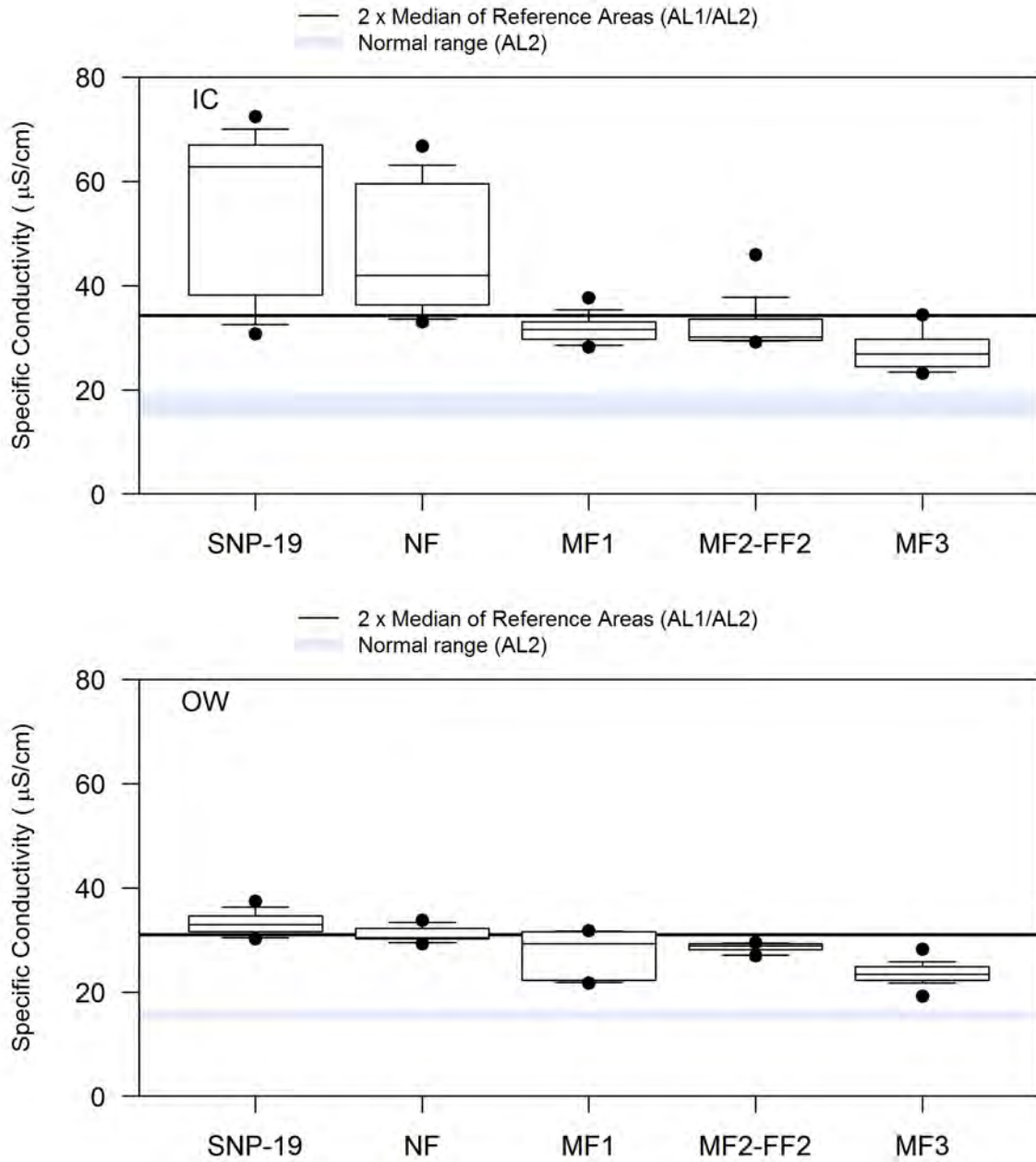
a) The AEMP Effects Benchmarks are the Aquatic Life Benchmarks described in the AEMP Study Design Version 3.5 (Golder 2014b) and in Section 2.3.4.2, Table 2-6.

b) Normal ranges used at Action Level 3 are those presented in the AEMP Reference Conditions Report, Version 1.1 (Golder 2015).

c) The 75th percentile of mixing zone values were calculated from the annual ice-cover season (November to June) data pooled across all sample depths, dates and stations.

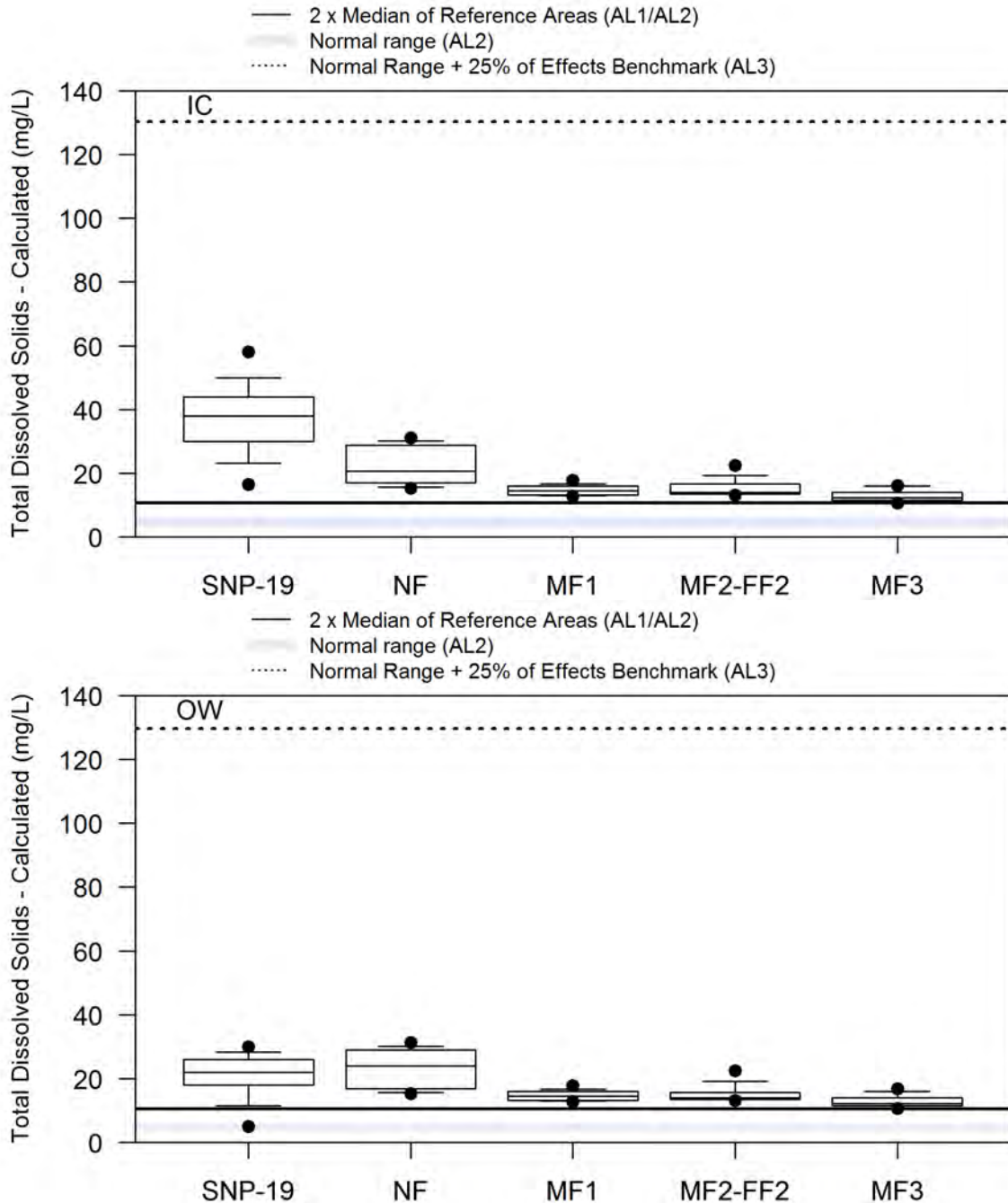


Figure 3-25 Specific Conductivity at Exposure Stations Relative to Action Level Values, 2014



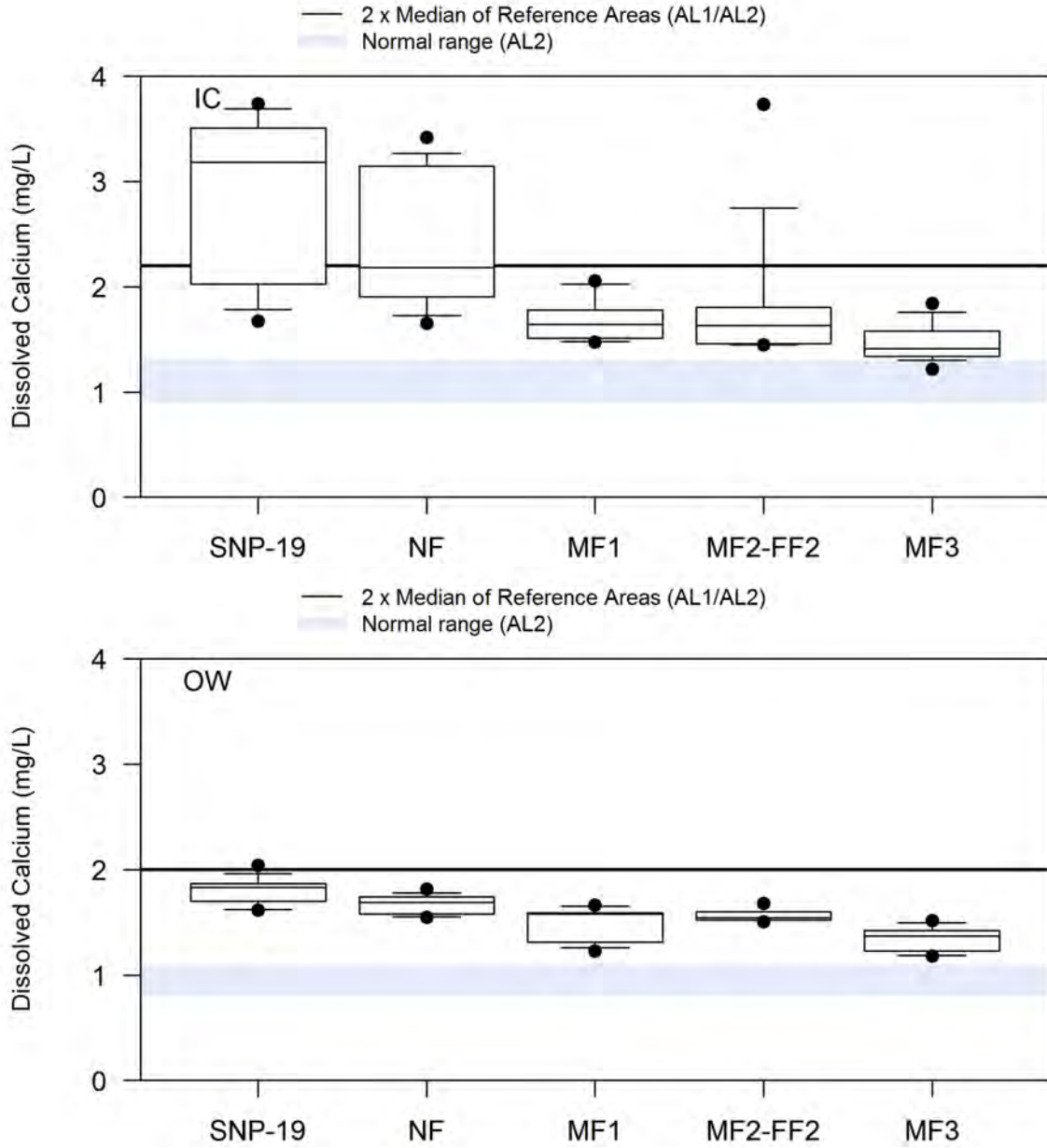
Notes: µS/cm= microSiemens per centimetre; IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-26 Concentration of Total Dissolved Solids (Calculated) at Exposure Stations Relative to Action Level Values, 2014**



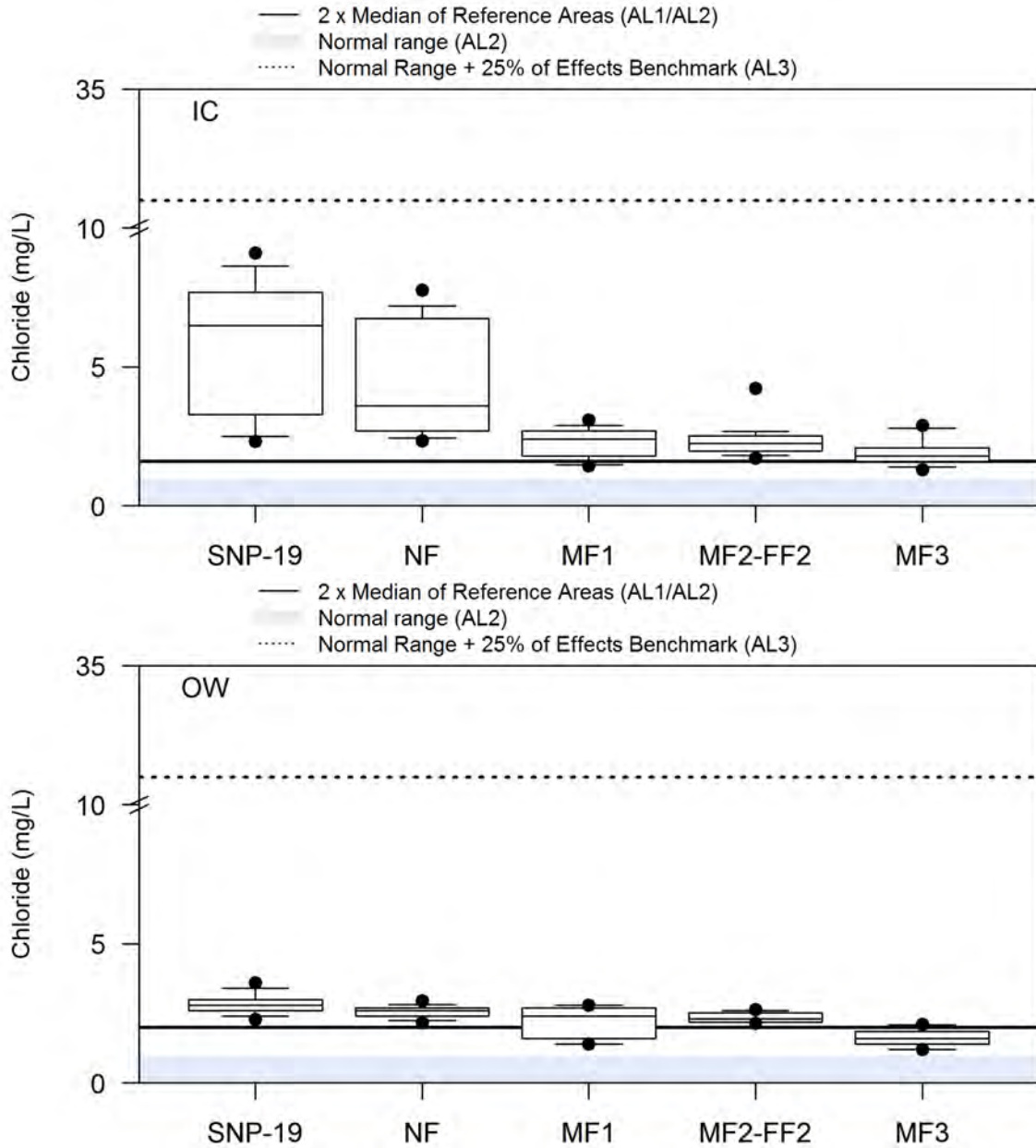
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; mg/L = milligram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-27 Concentration of Calcium at Exposure Stations Relative to Action Level Values, 2014**



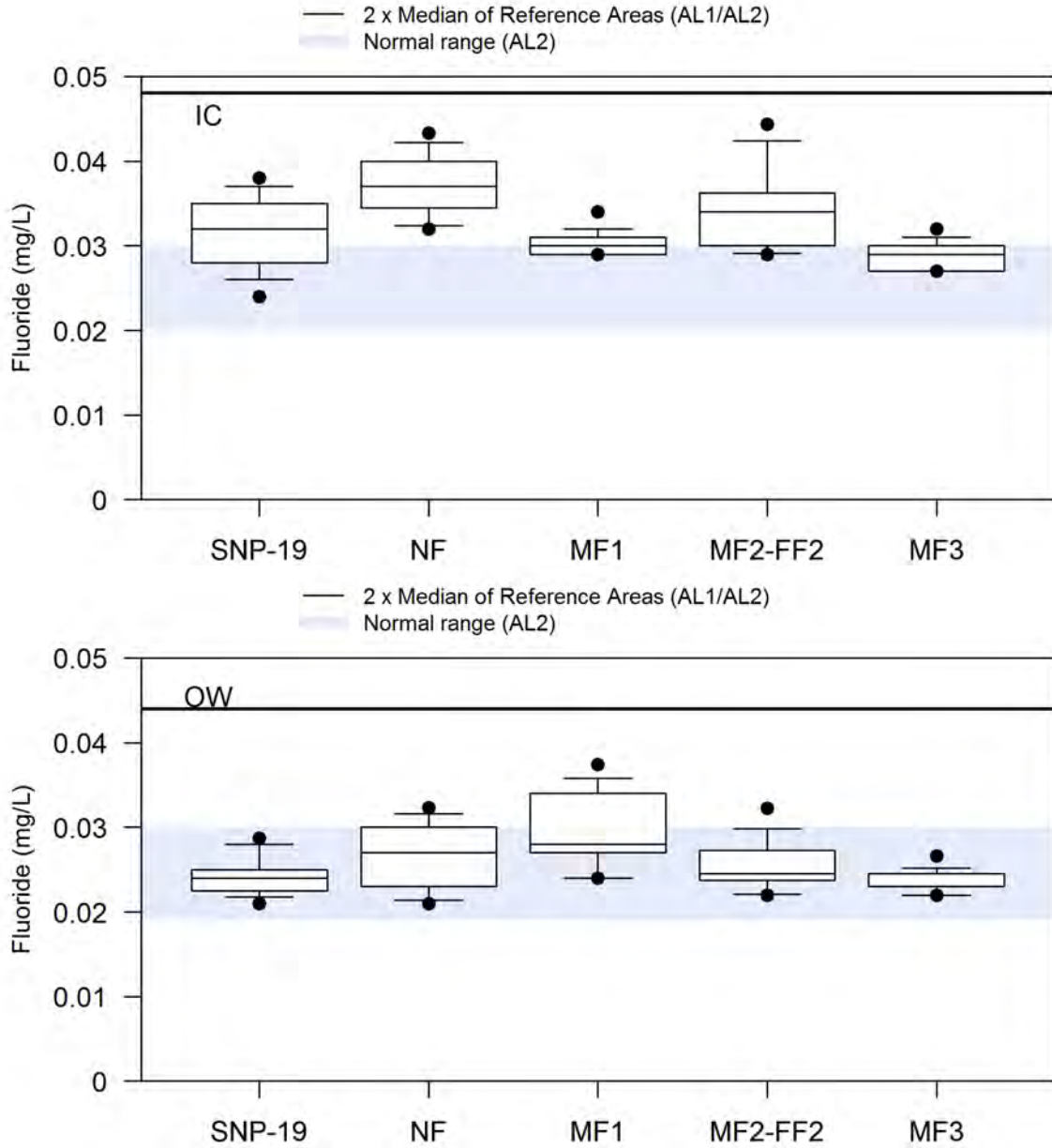
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone.; mg/L = milligram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-28 Concentration of Chloride at Exposure Stations Relative to Action Level Values, 2014**



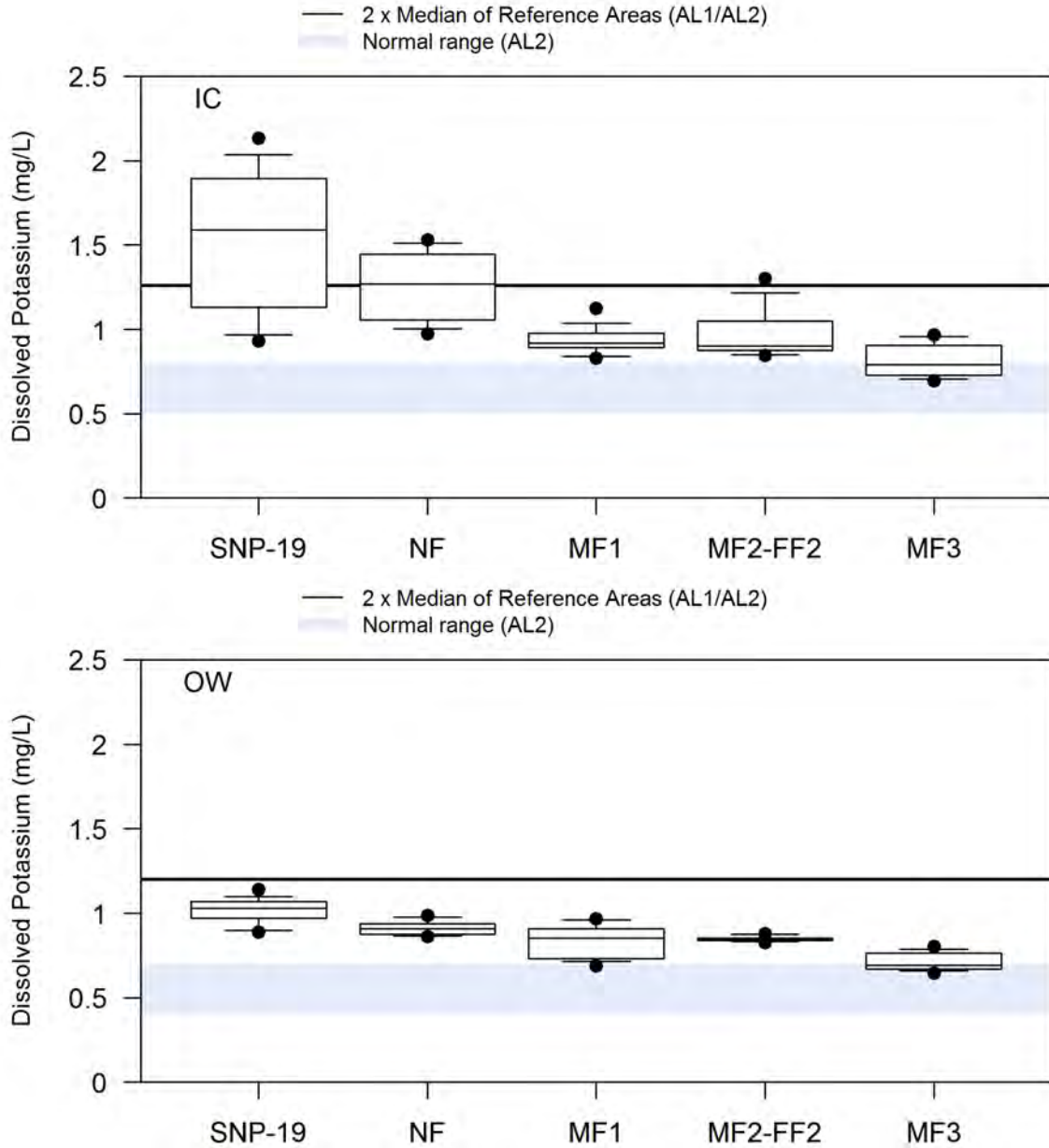
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; mg/L = milligram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-29 Concentration of Fluoride at Exposure Stations Relative to Action Level Values, 2014**



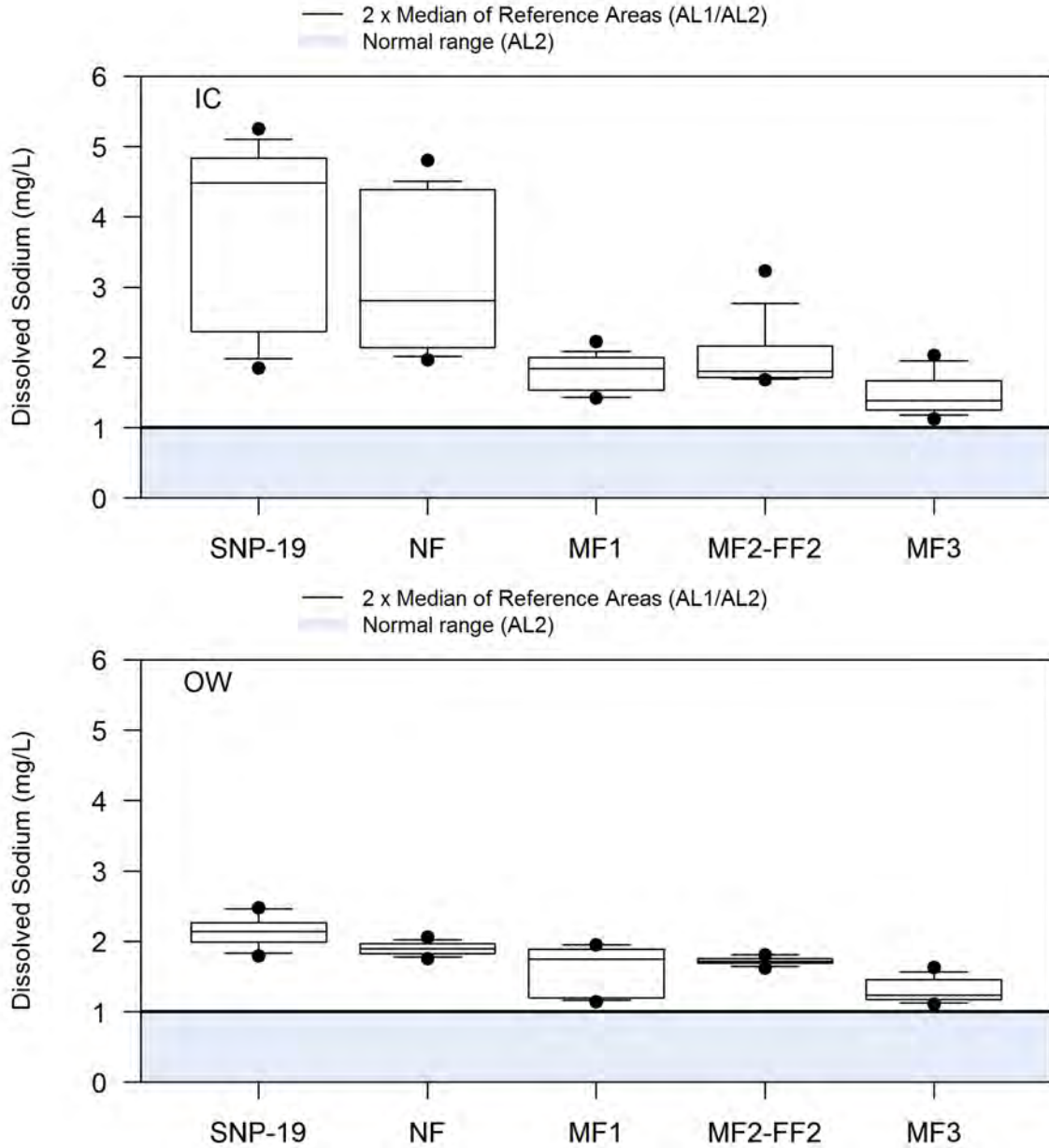
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; mg/L = milligram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-30 Concentration of Potassium at Exposure Stations Relative to Action Level Values, 2014**



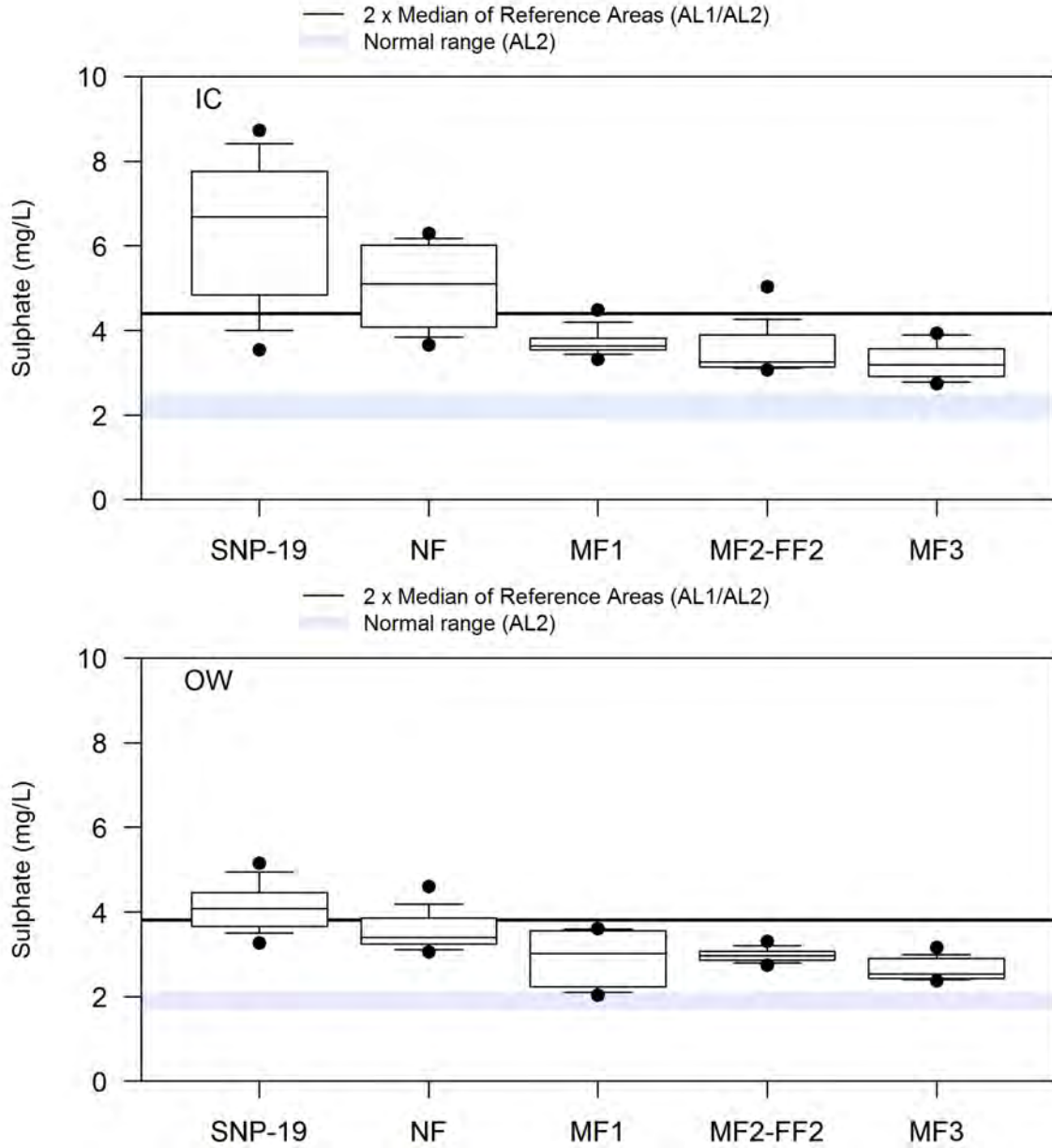
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; mg/L = milligram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-31 Concentration of Sodium at Exposure Stations Relative to Action Level Values, 2014**



Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; mg/L = milligram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

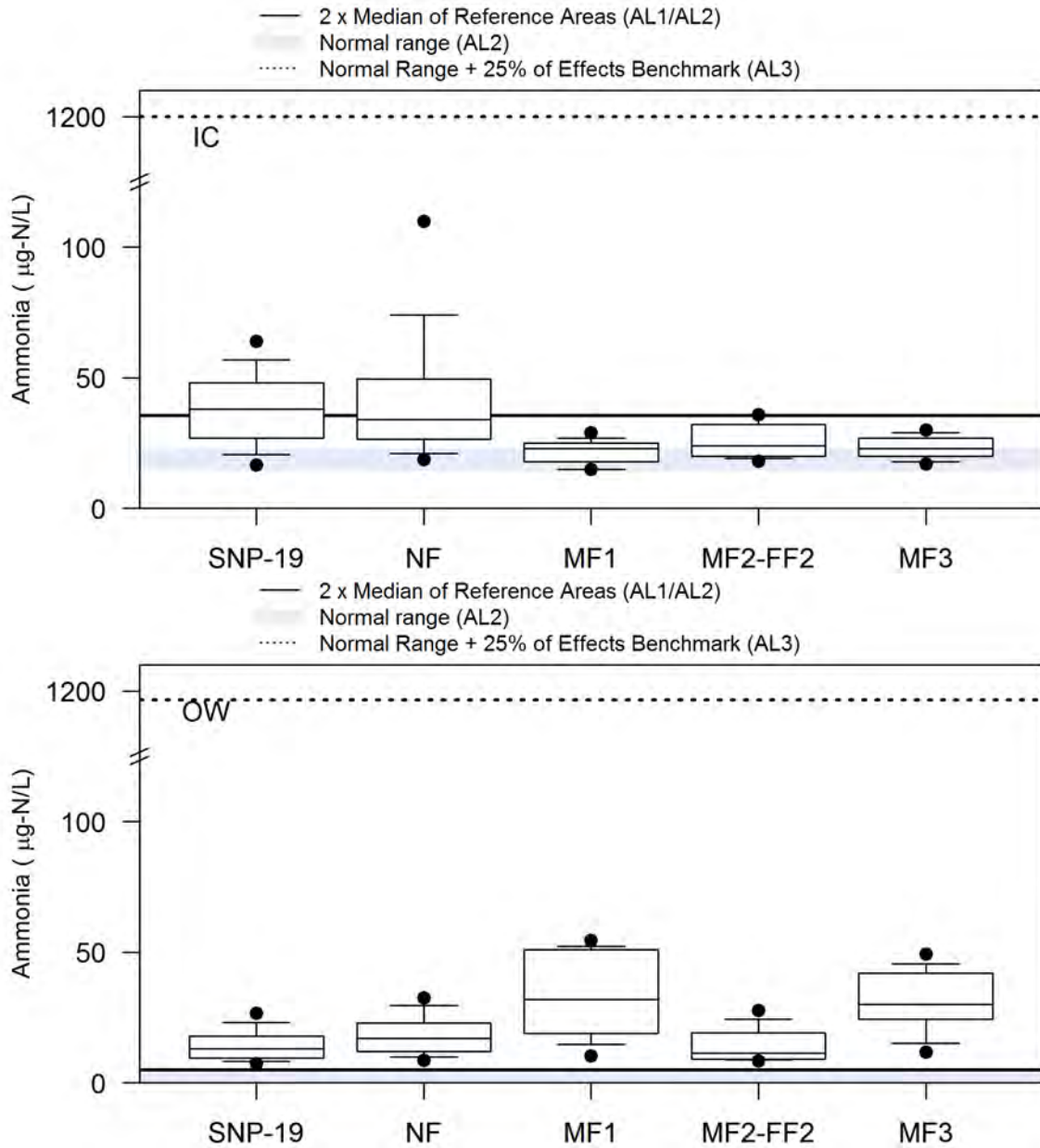
**Figure 3-32 Concentration of Sulphate at Exposure Stations Relative to Action Level Values, 2014**



Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; mg/L = milligram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

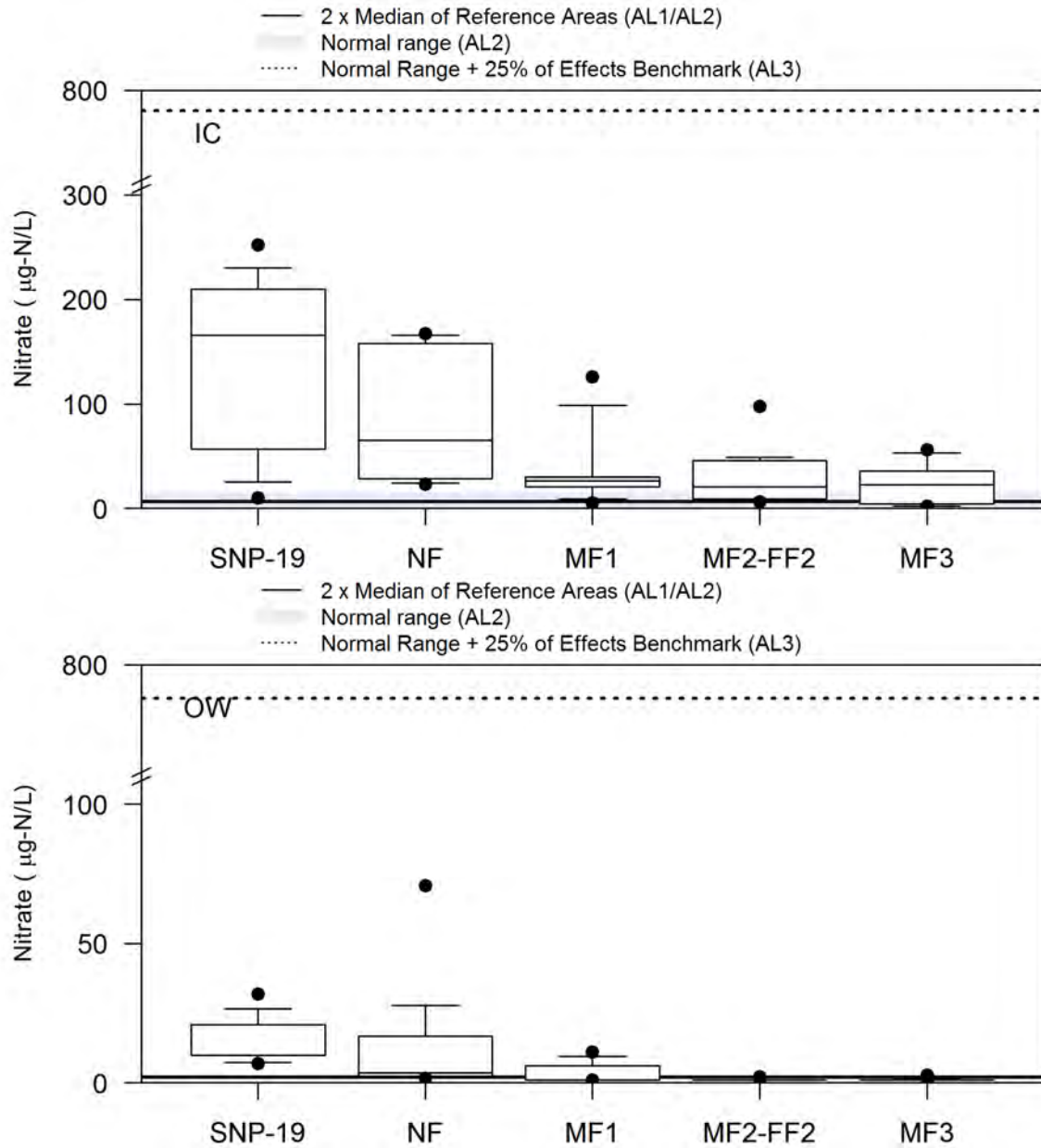


**Figure 3-33 Concentration of Ammonia (as Nitrogen) at Exposure Stations, 2014**



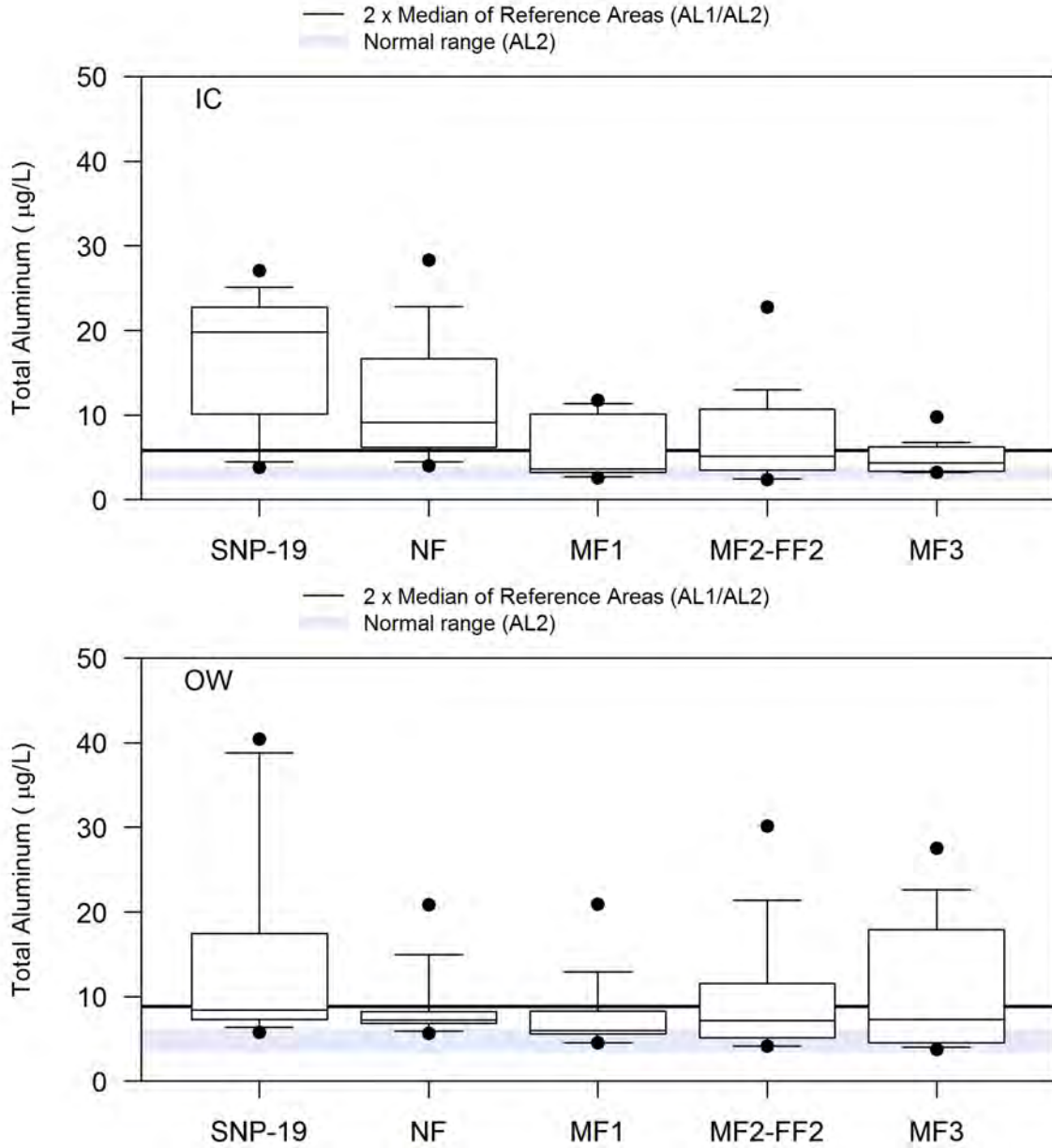
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg-N/L = microgram nitrogen per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations. Action Levels for ammonia are uncertain due to quality control issues (Section 2.4, Appendix C).

**Figure 3-34 Concentration of Nitrate at Exposure Stations Relative to Action Level Values, 2014**



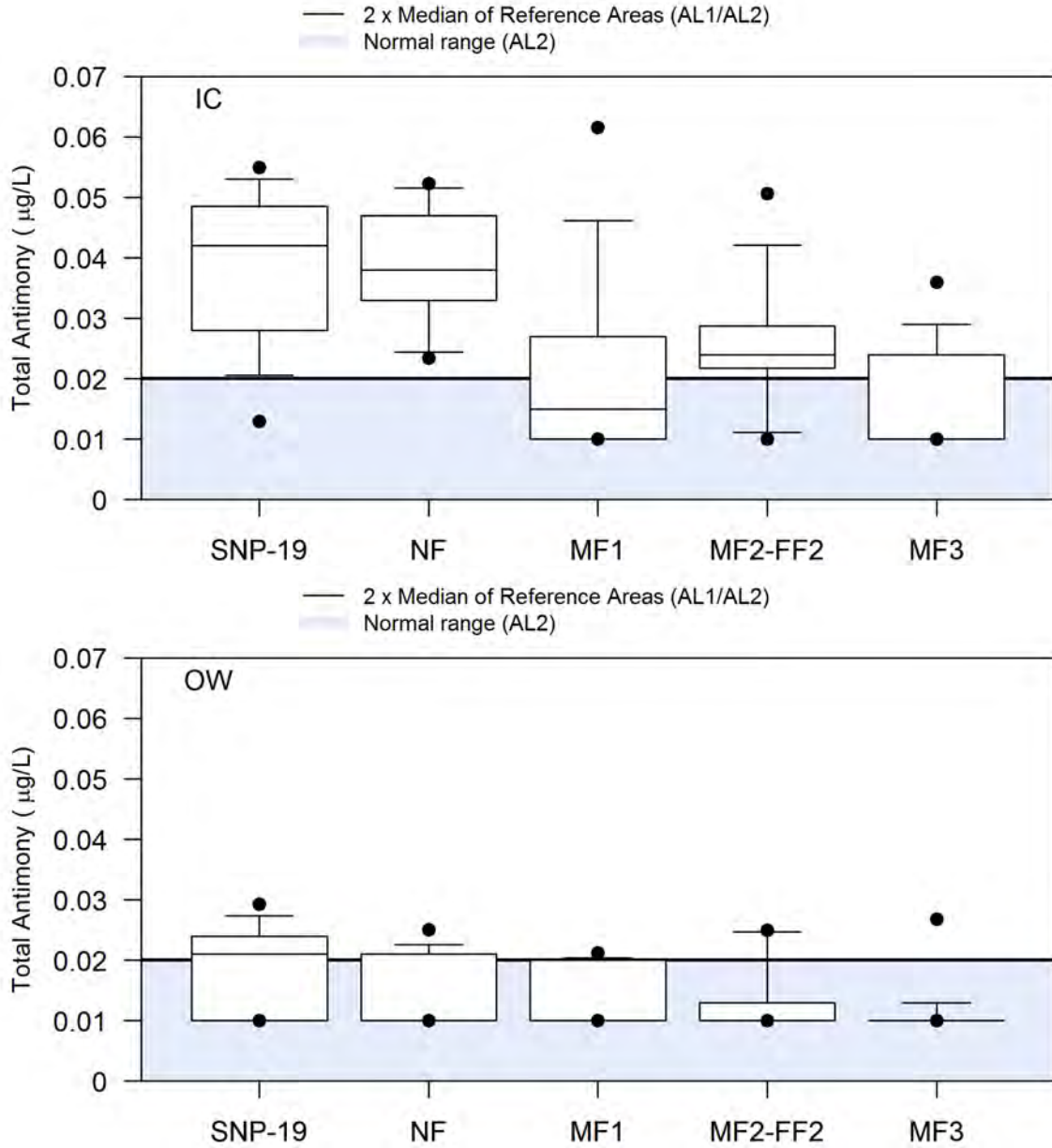
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg-N/L = microgram nitrogen per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations. The DL for nitrate at the Mixing Zone (20 µg/L) was greater than that used at AEMP stations (2 µg/L).

**Figure 3-35 Concentration of Total Aluminum at Exposure Stations Relative to Action Level Values, 2014**



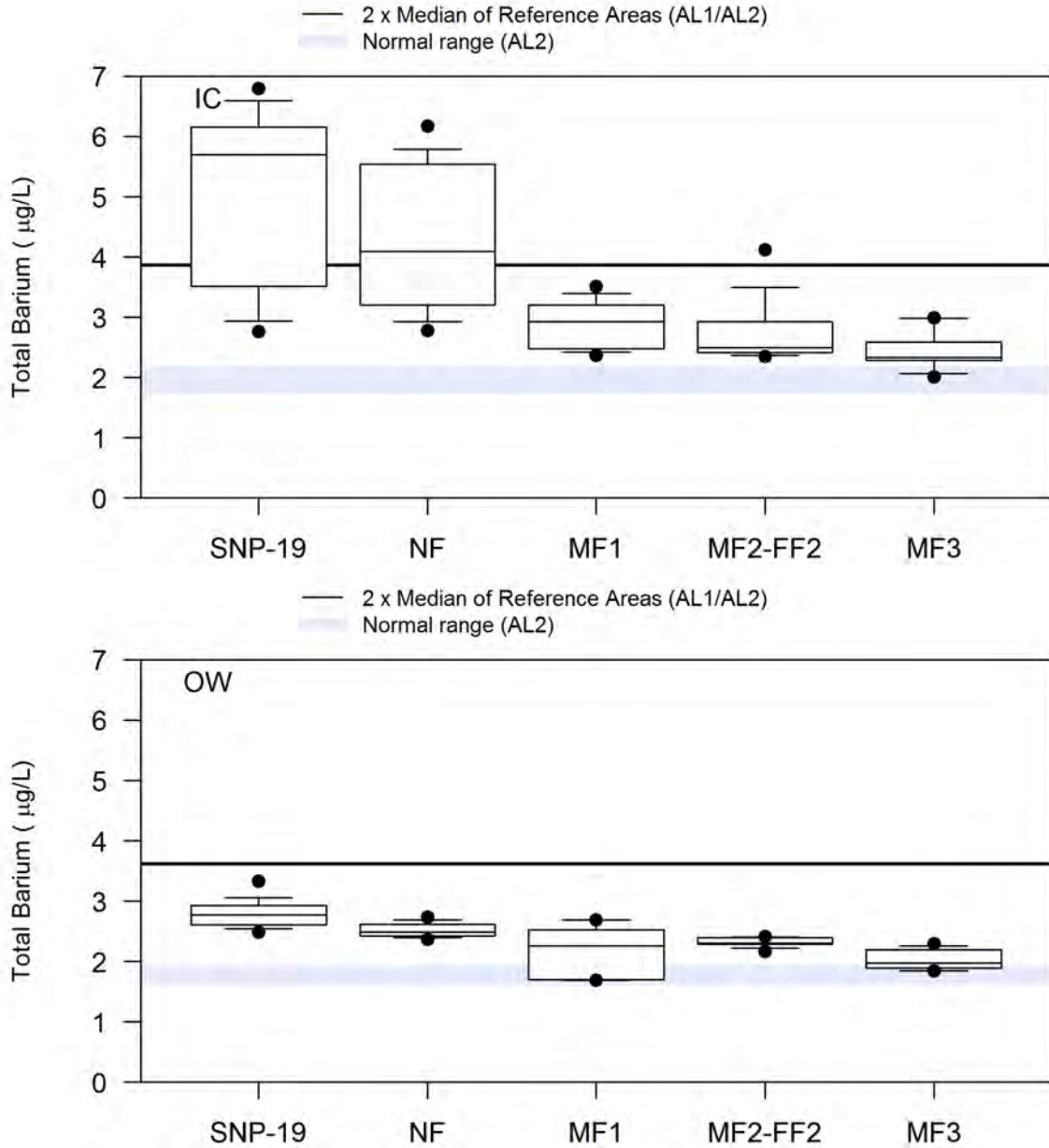
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-36 Concentration of Total Antimony at Exposure Stations Relative to Action Level Values, 2014**



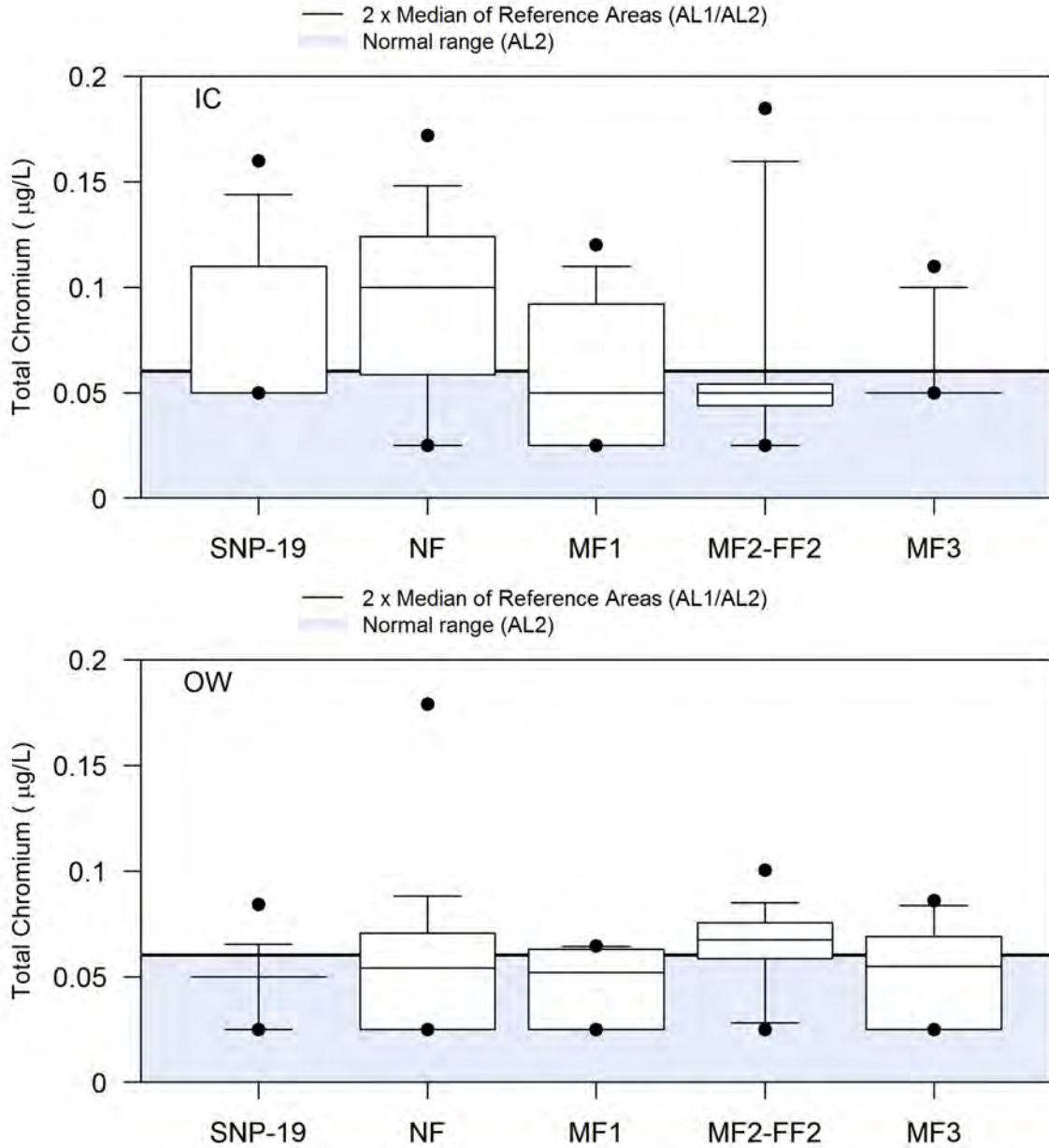
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-37 Concentration of Total Barium at Exposure Stations Relative to Action Level Values, 2014**



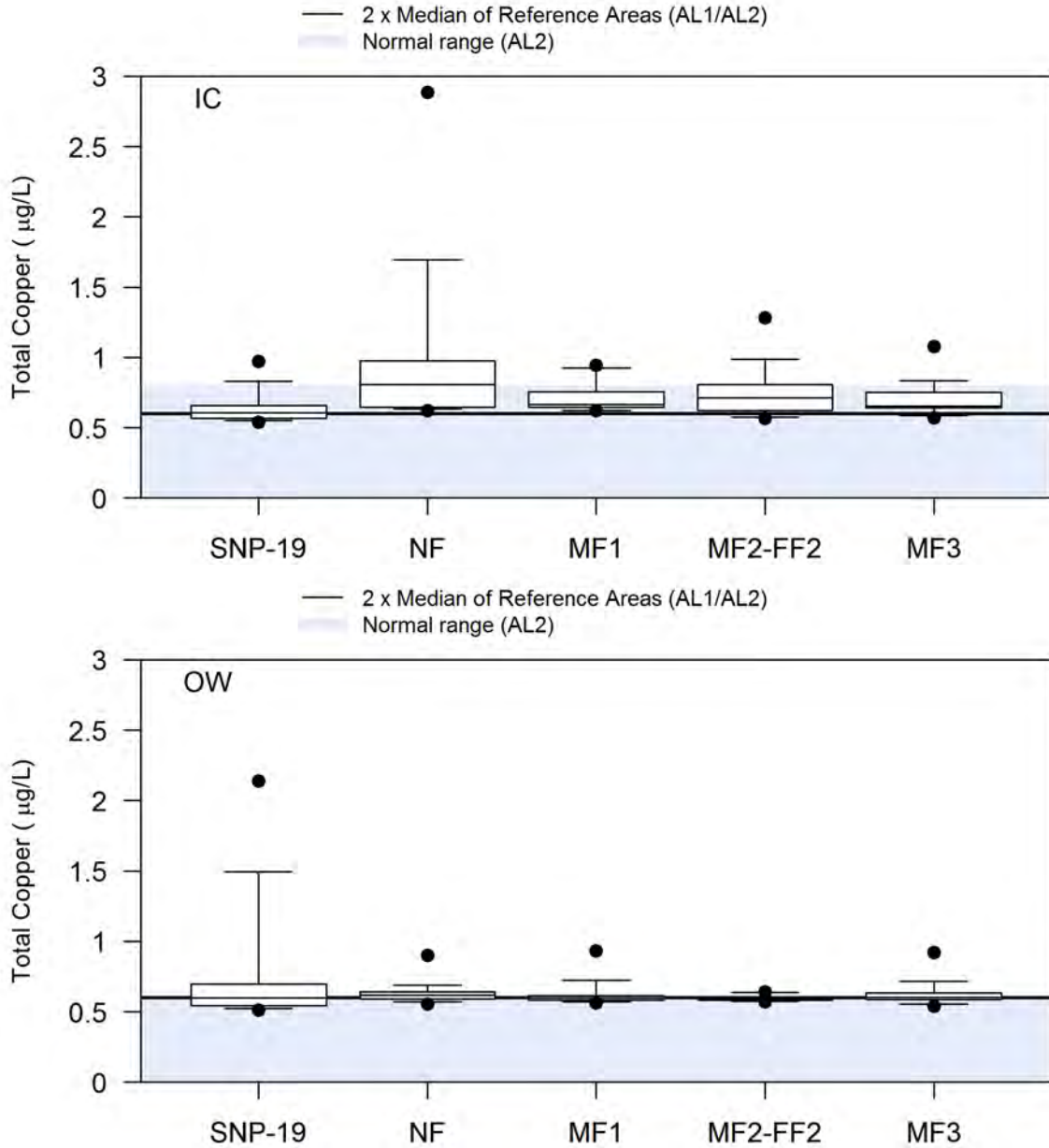
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-38 Concentration of Total Chromium at Exposure Stations Relative to Action Level Values, 2014**



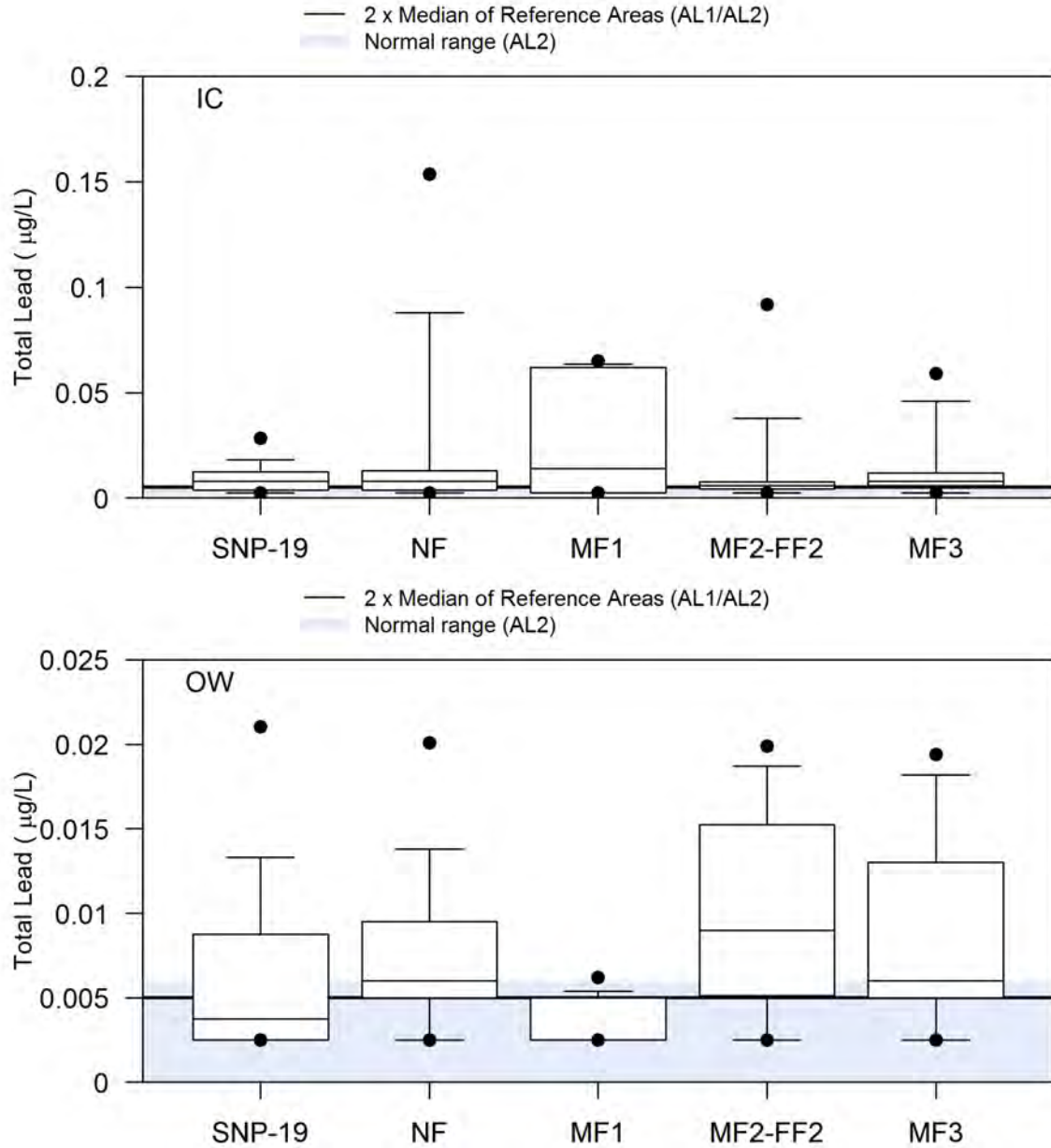
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations. The DL for chromium at the Mixing Zone (0.1 µg/L) was greater than for AEMP stations (0.05 µg/L).

**Figure 3-39 Concentration of Total Copper at Exposure Stations Relative to Action Level Values, 2014**



Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

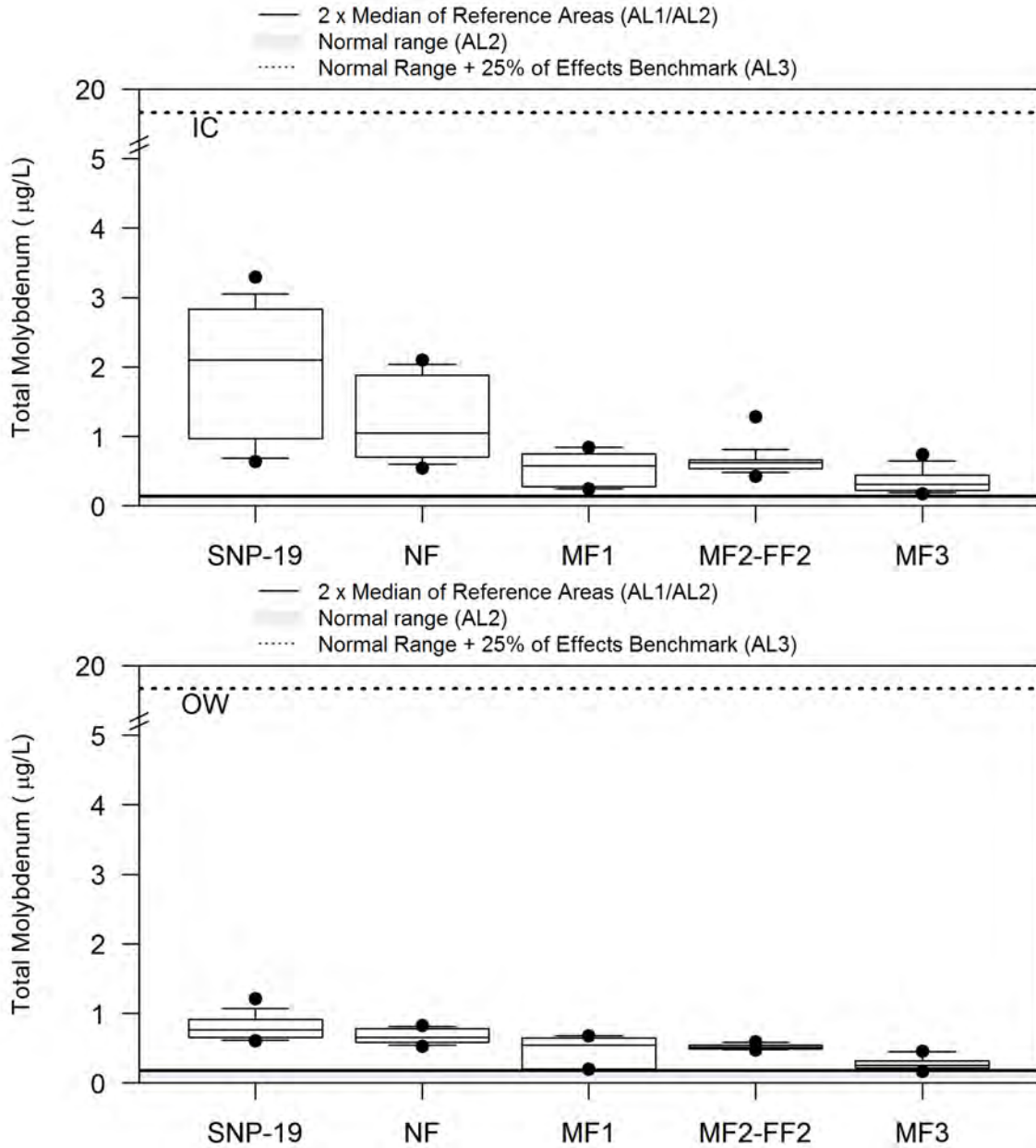
**Figure 3-40 Concentration of Total Lead at Exposure Stations Relative to Action Level Values, 2014**



Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

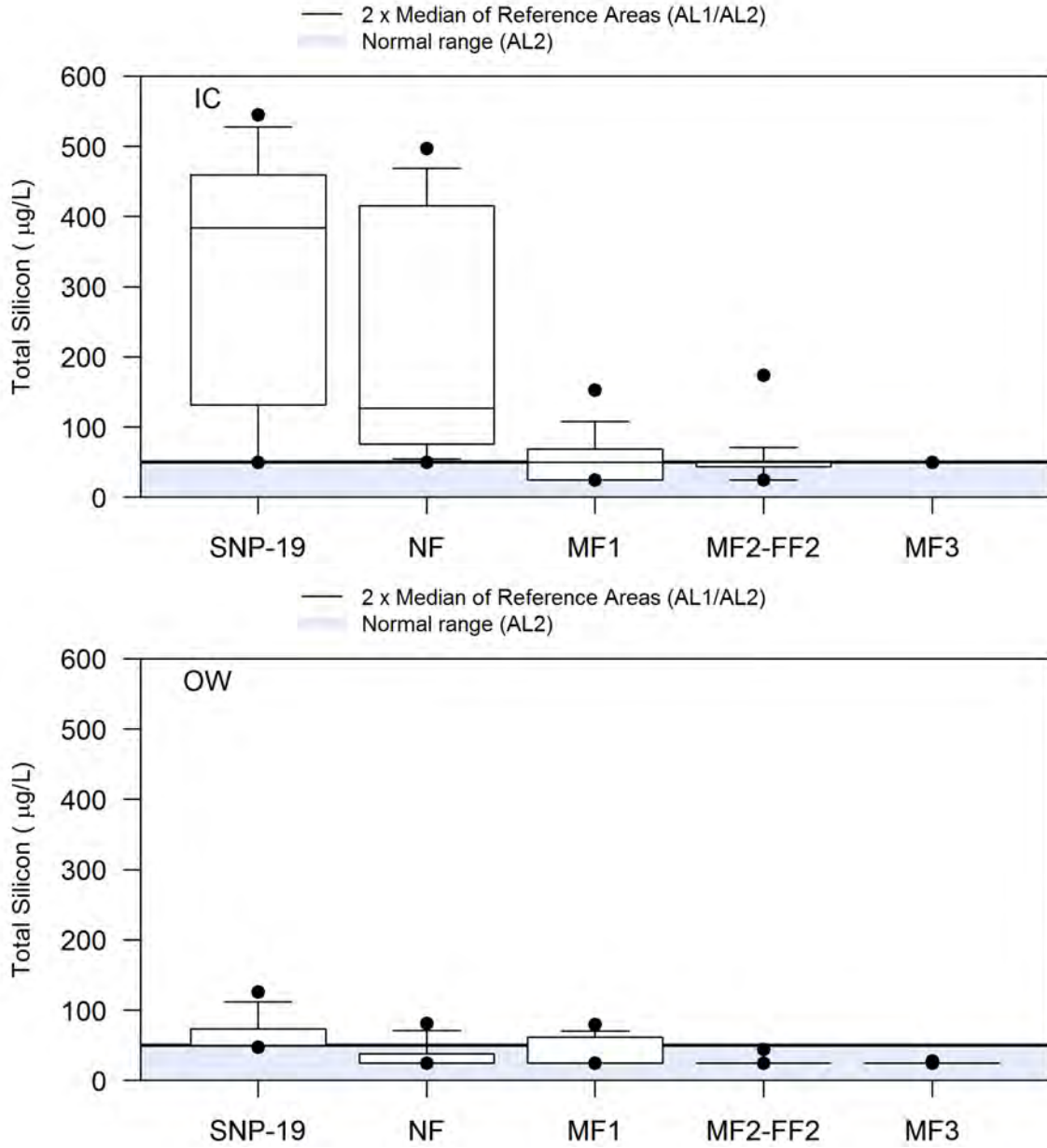


**Figure 3-41 Concentration of Total Molybdenum at Exposure Stations Relative to Action Level Values, 2014**



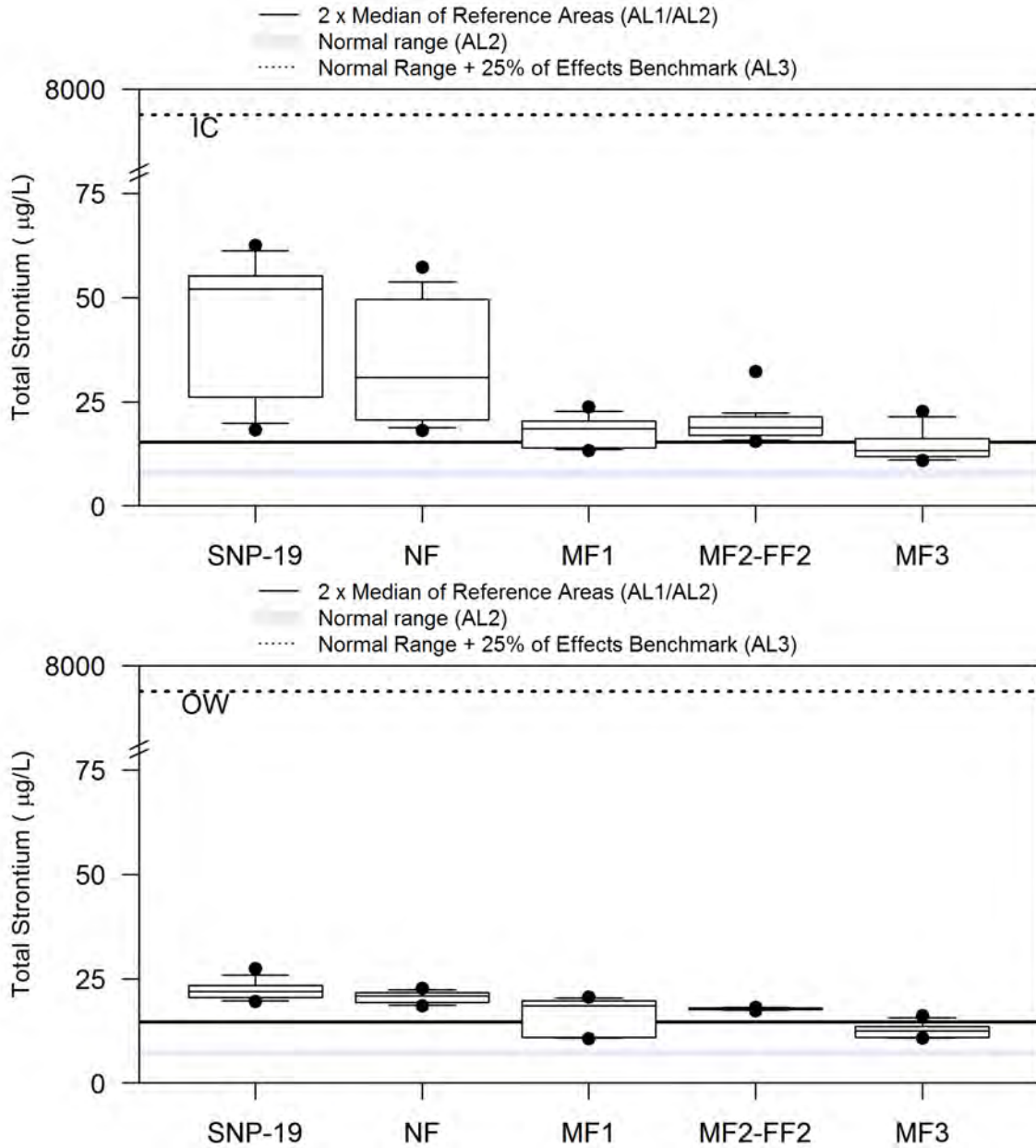
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-42 Concentration of Total Silicon at Exposure Stations Relative to Action Level Values, 2014**



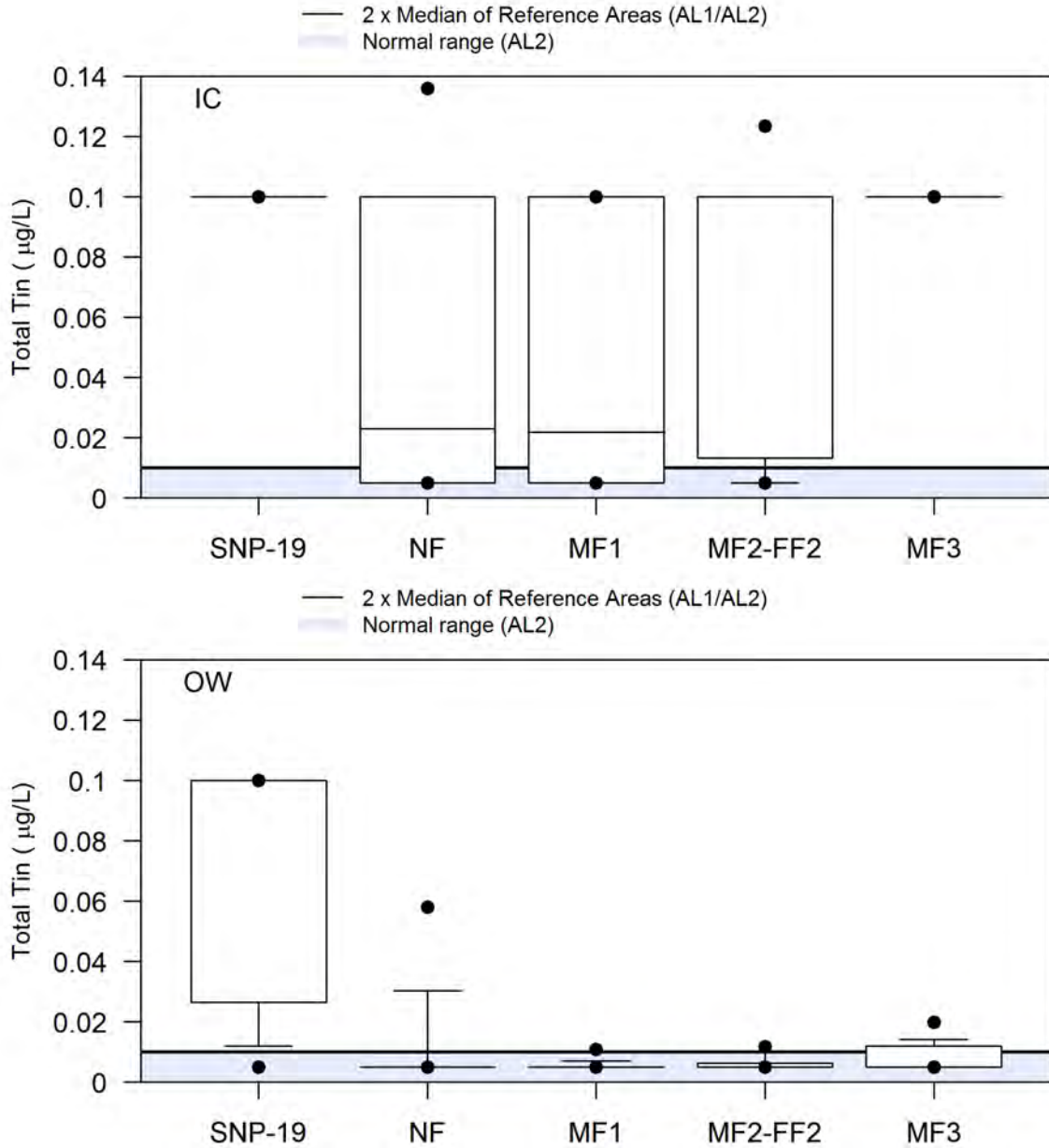
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-43 Concentration of Total Strontium at Exposure Stations Relative to Action Level Values, 2014**



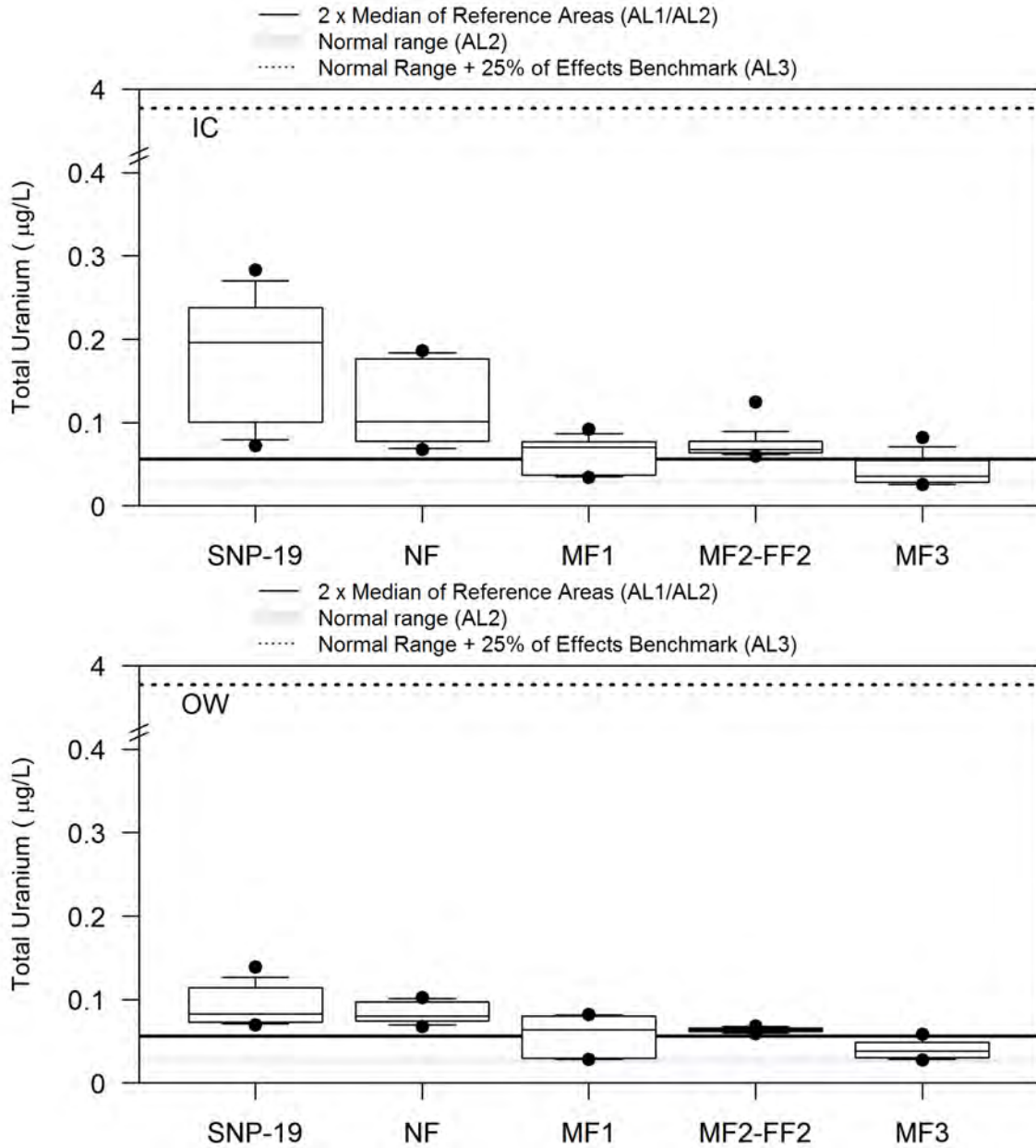
Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

**Figure 3-44 Concentration of Total Tin at Exposure Stations Relative to Action Level Values, 2014**



Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations. The DL for tin at the Mixing Zone (typically 0.2 µg/L) was greater than for AEMP stations (0.01 µg/L).

**Figure 3-45 Concentration of Total Uranium at Exposure Stations Relative to Action Level Values, 2014**



Notes: IC = Ice-cover; OW = Open-water; AL = Action Level; SNP-19 = Mixing Zone; µg/L = microgram per litre. Boxplots represent the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 90<sup>th</sup> percentile concentrations in each sampling area. Black circles represent the 5<sup>th</sup> and 95<sup>th</sup> percentile concentrations.

### **3.5 STATION LDG-48**

The results for water quality samples collected at station LDG-48, which is located at the Lac de Gras outflow to the Coppermine River are provided in Appendix E. Concentrations at this station were below the AEMP Effects Benchmarks (Table 2-6) for aquatic life and/or drinking water in all samples collected in 2014.

## 4 SUMMARY AND DISCUSSION

Water quality variables measured in Lac de Gras as part of the 2014 AEMP were assessed for a Mine-related effect according to Action Levels. Nineteen variables triggered Action Level 1, which is considered an early-warning indicator of effects in the exposure area. These variables had NF area median concentrations that were greater than two times the median concentrations of reference areas, and were retained as SOIs in 2014. Each of the 19 SOIs had detectable concentrations in the NIWTP effluent, indicating that the increase observed in the NF area could be linked to the Mine. No management action is required under the Response Framework when a water quality variable triggers Action Level 1.

Of the 19 variables that triggered Action Level 1, eight also triggered Action Level 2, because the 5<sup>th</sup> percentile concentration in the NF exposure area was greater than two times the reference area median concentration and greater than the normal range for Lac de Gras. When a water quality variable triggers Action Level 2 the required management action is to establish an Effects Benchmark for that variable if one does not already exist. Two of the variables that triggered Action Level 2 (sodium and antimony) do not have existing AEMP Aquatic Life Effects Benchmarks. Therefore, DDMI will be required to develop benchmarks for these variables. This will be done as part of the updated AEMP Study Design Version 4.0, which will be submitted in June 2016. None of the remaining six SOIs evaluated at Action Level 3 (i.e., those with existing AEMP Effects Benchmarks) triggered Action Level 3 in 2014.

Quality control issues identified with ammonia analyzed by Maxxam in 2014 means that these data are not comparable with ammonia data from 2007 to 2010, which is the reference data period used to estimate the normal range (Golder 2015). Graphical evaluation of the ammonia data at exposure stations, however, indicated that concentrations were greater at stations closest to the diffusers during ice-cover conditions. These results suggest the mine is having an effect on ammonia concentrations in Lac de Gras, which is consistent with findings in previous years.

In 2014, DDMI identified a QA/QC issue that compromised the results for total and dissolved zinc analyzed during the 2014 ice-cover and open-water AEMP sampling. An investigation determined that the gloves used during sample collection were a likely source of the contamination. Although this issue resulted in the exclusion of the ice-cover season zinc data from 2014 annual report, the interpretation of mine-related effects based on the open-water zinc data obtained from the routine chemistry sample container (i.e., no action level triggered) was not impeded. This finding is consistent with the results of the Action Level screening completed for the 2011 to 2013 Aquatic Effects Re-evaluation Report Version 3.1 (Golder 2016b), which indicated that zinc did not trigger an Action Level from 2007 to 2013.

Effluent quality was similar to that observed in previous years. Toxicity testing results in 2014 indicated that effluent samples were generally not toxic to aquatic test organisms. Concentrations of all variables with Water Licence discharge criteria were within applicable limits in all samples collected in 2014 with the exception of one oil and grease grab sample which appears to be an outlier.

## 5 CONCLUSIONS

Based on analysis of the water quality data collected during the 2014 AEMP field program, the following conclusion are reached:

- Of the 55 variables analyzed, 19 variables (conductivity, TDS [calculated], calcium, chloride, potassium, sodium, sulphate, nitrate, aluminum, antimony, barium, chromium, copper, lead, molybdenum, silicon, strontium, tin and uranium) demonstrated an effect equivalent to Action Level 1, and were included in the list of SOIs in 2014 (Table 5-1).
- Of the 19 SOIs that triggered Action Level 1, eight (calculated TDS, chloride, sodium, nitrate, antimony, molybdenum, strontium and uranium) also triggered Action Level 2 (Table 5-1). The management action required under the Response Framework when a variable triggers Action Level 2 is to develop an AEMP Effects Benchmark for variables that do not have existing Aquatic Life benchmarks (sodium and antimony). This will be done as part of the next AEMP Study Design (Version 4.0), which will be submitted in June 2016.
- None of the SOIs triggered Action Level 3.
- The ammonia data analyzed by Maxxam in 2014 were excluded from the Action Level screening due to data quality issues. Diavik has been working with Maxxam to develop a QA/QC plan that will address the data quality issues identified with the low-level ammonia analysis. This plan will be in place for the 2015 AEMP, and is expected to improve the accuracy of the ammonia analysis. Visual evaluation of the ammonia data in 2014 suggested that the mine is having an effect on ammonia, which is consistent with findings in previous years.
- Fluoride was included as an SOI in 2014 because concentrations in effluent exceeded the AEMP aquatic life Effects Benchmark in seven percent of samples. Fluoride did not trigger an Action Level in 2014, and concentrations at lake water monitoring stations were well below the AEMP Effects Benchmark in all samples.
- The 2014 effluent toxicity results indicated that the effluent discharged to Lac de Gras in 2014 was generally non-toxic. All effluent samples submitted for lethal toxicity testing passed the relevant tests. Two of 24 samples (8%) submitted for sublethal testing demonstrated sublethal effects (*Ceriodaphnia dubia* reproduction in December 2013 and March 2014). However, in both cases the observed decrease in reproduction compared to the control group was only slightly above the criterion used to designate a test failure ( $\geq 50\%$ ).
- Regulated effluent parameters were below applicable EQC, with the exception of one elevated oil and grease value, which was due to a QA/QC issue.



**Table 5-1 Action Level Summary for Water Quality Substances of Interest, 2014 AEMP**

Substance of Interest	Action Level Classification
<b>Conventional Parameters</b>	
Specific Conductivity	1
Total Dissolved Solids (Calculated)	2
<b>Major Ions</b>	
Calcium	1
Chloride	2
Fluoride	0 <sup>(a)</sup>
Potassium	1
Sodium	2
Sulphate	1
<b>Nutrients</b>	
Ammonia (as Nitrogen)	(b)
Nitrate (as Nitrogen)	2
<b>Total Metals</b>	
Aluminum	1
Antimony	2
Barium	1
Chromium	1
Copper	1
Lead	1
Molybdenum	2
Silicon	1
Strontium	2
Tin	1
Uranium	2

0 = Action Level not triggered; 1 = Action Level 1 triggered; 2 = Action Level 2 triggered.

a) Fluoride was added to the list of SOIs because concentrations in effluent were greater than the AEMP Aquatic Life Effects Benchmark in 7% of samples analyzed in 2014.

b) Action Level results for ammonia are uncertain due to laboratory quality control issues identified in 2014.

## **6 CLOSURE**

We trust the information in this report meets your requirements at this time. If you have any questions relating to the information contained in this report, please do not hesitate to contact the undersigned.

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**APPENDIX A**  
**2014 AEMP SAMPLING SCHEDULE**

**Table A-1 2014 AEMP Sampling Schedule**

Sites	Ice-cover										Open-water																	
	April										August											September						
	21	22	23	24	25	26	27	28	29	30	18	19	20	21	22	23	24	25	26	27	28	29	30	31	01	02	03	
NF1						An							Anp															
NF2						An								Anp														
NF3					An										Anp													
NF4		An												Anp														
NF5				An										Anp														
MF1-1										An							An											
MF1-3										An									An									
MF1-5										An															An			
MF2-1								An													An							
MF2-3								An																An				
FF2-2								An																An				
FF2-5								An							An													
MF3-1								An										An										
MF3-2									An												An							
MF3-3									An														An					
MF3-4									An										An					An				
MF3-5									An															An				
MF3-6									An										An									
MF3-7									An														An					
LDG-48			Mn																						Mn			

Notes: M = water quality mid-depth sample only, A = water quality surface, mid-depth and bottom samples collected, n = nutrients, p = plankton sample collected.  
QAQC Samples color coded = Grab Water (GW), Equipment Blank (EBW), Field Blank (FBW), Trip Blank (TBW), Duplicate 1/Duplicate 2 (DUP1/DUP2).

**APPENDIX B**

**INITIAL EFFLUENT AND WATER QUALITY DATA SCREENING**

**Abbreviations Used for Graphs in this Appendix:**

OW	open-water season.
IC	ice-cover season
DL	below detection limit
NTU	nephelometric turbidity units
<	less than
µg/L	microgram per litre
µS/cm	microSiemen per centimetre
mg/L	milligram per litre



## INTRODUCTION

Data screening is the initial phase of data handling when analyzing chemistry datasets, which are subject to occasional extreme values that are frequently incorrect, reflecting field or laboratory errors, data transcription or calculation errors, or extreme natural variability. This initial step is undertaken prior to data analysis and interpretation to verify that the data quality objectives established by the Quality Assurance Project Plan and the study design have been met. The purpose of this step is to initially identify unusually high or low values (referred to as anomalous data), correct them if possible, and make a decision whether to retain or exclude remaining anomalous data from further analysis.

In previous Diavik Diamond Mines (2012) Inc. (DDMI) Aquatic Effects Monitoring Plan (AEMP) reports, the judgment whether to retain an anomalous value in the analysis was made based on a visual inspection of the data using scatter-plots, and logical consistency with results for other parameters. To prepare data for analyses presented in this report, a revised approach was used to identify anomalous data to address concerns noted by the Wekèezhii Land and Water Board (WLWB) and other reviewers regarding the handling of outliers in AEMP datasets. The revised data screening approach includes a numerical method to aid in the identification of outliers, thus removing the subjectivity of classifying values based on visual evaluation of data alone. This initial screening is primarily applicable to chemistry data, because anomalous results are less common in biological (e.g., taxonomy) data and are typically resolved through contacting the taxonomist.

## METHODS

Initial screening of the annual AEMP datasets, was completed using a method based on Chebyshev's theorem (Mann 2010) combined with the visual examination of scatter-plots. This method allows for detection of multiple outliers at one time and assumes that the data being screened contain a relatively small percentage of outliers (Amidan et al. 2005). The theorem states that at least  $1-1/k^2$  proportion of the data of any distribution (i.e., no assumption of normality) lies within  $k$  standard deviations (SD) of the mean. Setting  $1-1/k^2 = 0.95$  and solving for  $k$  results in 4.47 SD, indicating that 95% of the data, regardless of distribution, will be within about 4.5 SD of the mean. In the case of a normal distribution, 95% of the data is expected to be within 2 SD, suggesting that the method based on Chebyshev's inequality is conservative (i.e., identifies values that are far removed from the mean). The method is applied by first identifying data that lie outside the 4.47 SD on a scatter-plot of annual data, and then visually verifying the anomalous values based on potential spatial trends. No data were identified as anomalous based on visual evaluation alone.

In cases where the Chebyshev screening method identified an elevated value in the near-field (NF) area or at the mixing zone boundary as anomalous, the identified value was conservatively retained in the dataset used for analysis if the SD distance from the mean was less than two times the 4.5 SD criterion discussed above. Hence, only very extreme values, which were greater than approximately 9 SDs from the mean were removed from the further analysis of NF area data. Finally, in cases where the annual datasets

contained a large proportion of non-detect data, only values that were greater than or equal to 5 times the detection limit (DL) were considered anomalous and were removed from the analysis.

## RESULTS

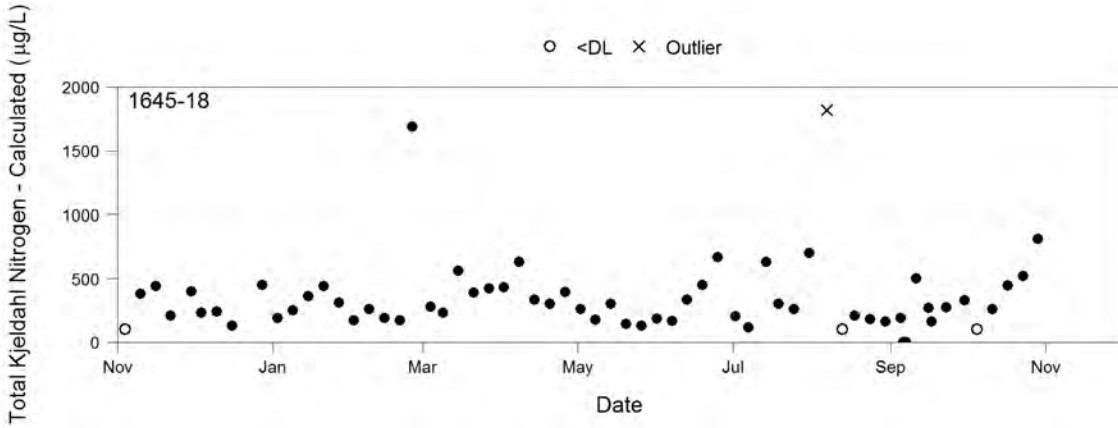
Results of the initial data screening are summarized for effluent, mixing zone and AEMP data sets. Results consist of a table of anomalous values removed from each dataset and scatter-plots, which allow visual review of anomalous data and provide transparency. Overall, the number of anomalous values identified by the data screening procedure was very low compared to the amount of data summarized, accounting for less than half of a percent of the total data points per component.

### Effluent Chemistry

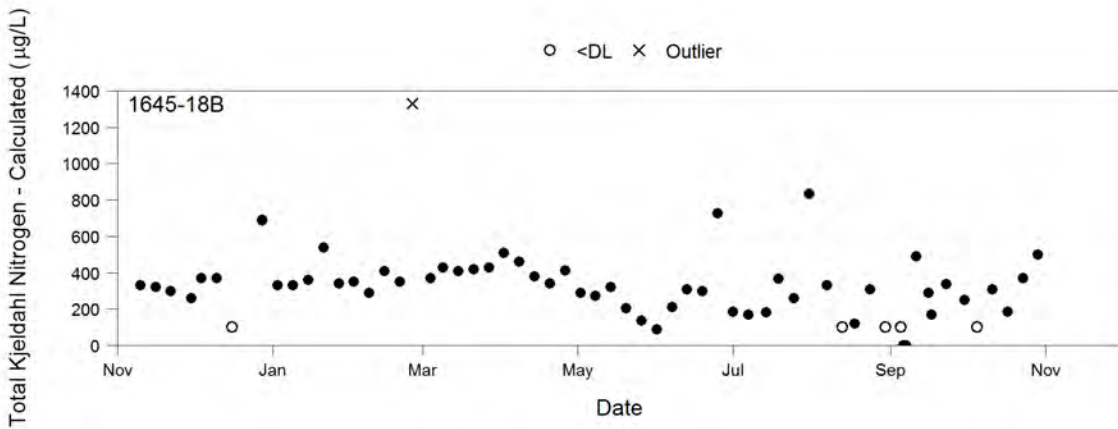
**Table B-1 List of Anomalous Values Removed from SNP Analyses, Stations 1645-18 and 1645-18B**

Variable	Unit	Date	Station	Value	Standard Deviation Distance <sup>(a)</sup>
Total Kjeldahl Nitrogen	µg-N/L	25/02/2014	18B	1.33	4.806
Total Kjeldahl Nitrogen	µg-N/L	8/7/2014	18	1.82	4.771
Total Arsenic	µg/L	5/2/2014	18	5.68	4.486
Total Cadmium	µg/L	12/28/2013	18	0.037	5.56
Total Cadmium	µg/L	12/28/2013	18B	0.042	6.084
Total Copper	µg/L	11/16/2013	18	2.6	5.697
Total Copper	µg/L	14/05/2014	18B	1.79	4.977
Total Copper	µg/L	11/09/2014	18B	1.92	5.436
Total Iron	µg/L	20/05/2014	18	286	5.958
Total Lead	µg/L	14/04/2014	18	0.206	5.683
Total Lead	µg/L	5/2/2014	18	0.167	4.496
Total Lead	µg/L	13/06/2014	18B	0.731	7.541
Total Lithium	µg/L	12/10/2013	18	27.3	4.625
Total Titanium	µg/L	02/05/2014	18	6.36	7.585

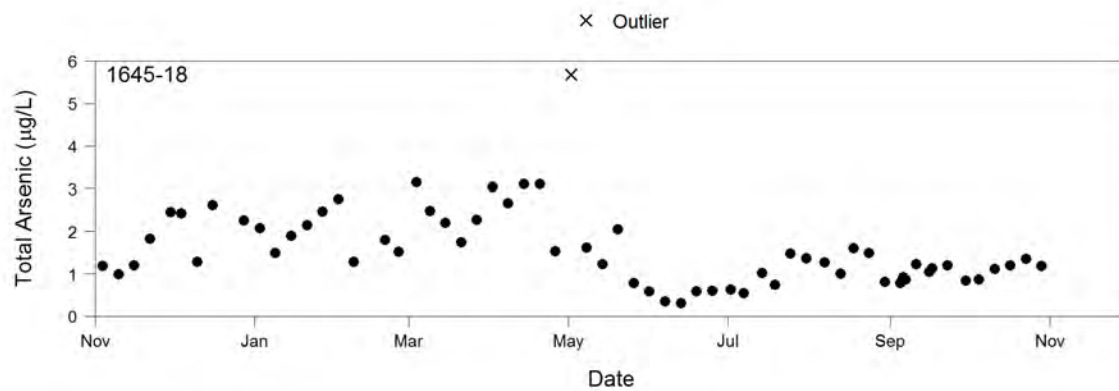
**Figure B-1 Anomalous Data Removed from SNP Analyses Completed for Total Kjeldahl Nitrogen, Station 1645-18, 2014**



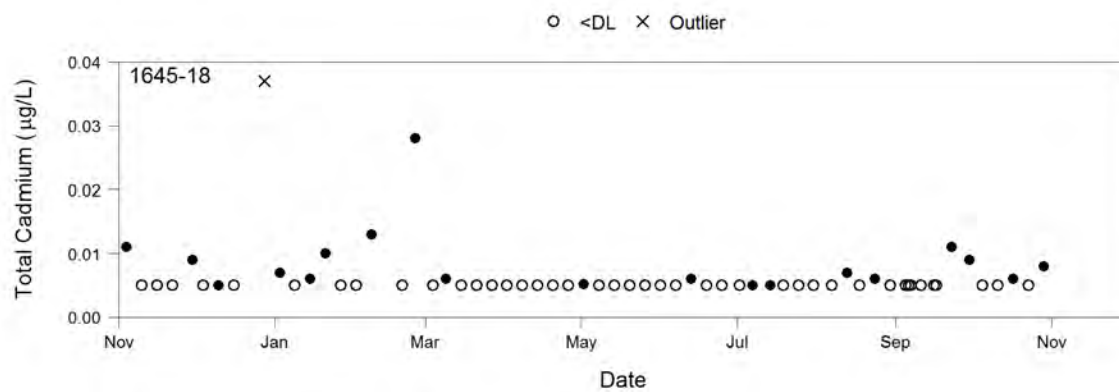
**Figure B-2 Anomalous Data Removed from SNP Analyses Completed for Total Kjeldahl Nitrogen, Station 1645-18B, 2014**



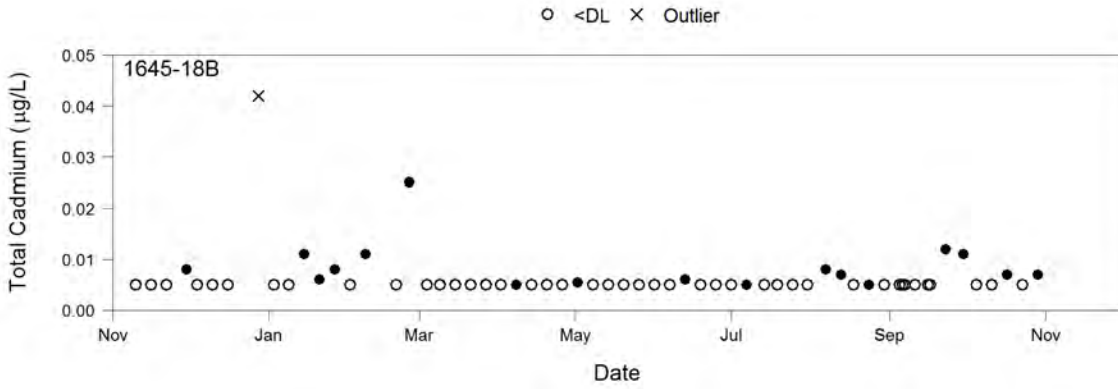
**Figure B-3 Anomalous Data Removed from SNP Analyses Completed for Total Arsenic, Station 1645-18, 2014**



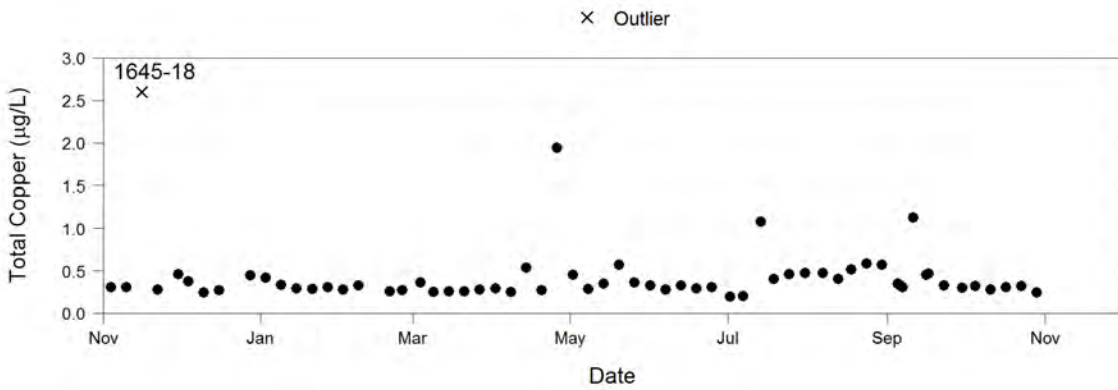
**Figure B-4 Anomalous Data Removed from SNP Analyses Completed for Total Cadmium, Station 1645-18, 2014**



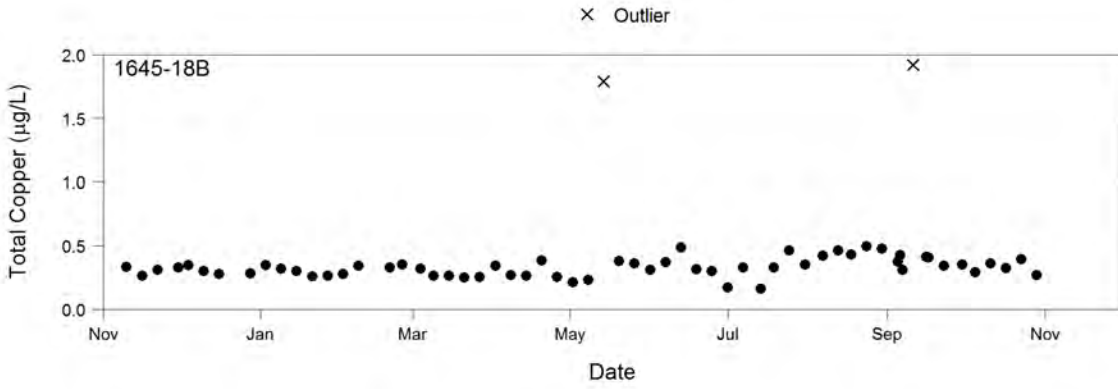
**Figure B-5 Anomalous Data Removed from SNP Analyses Completed for Total Cadmium, Station 1645-18B, 2014**



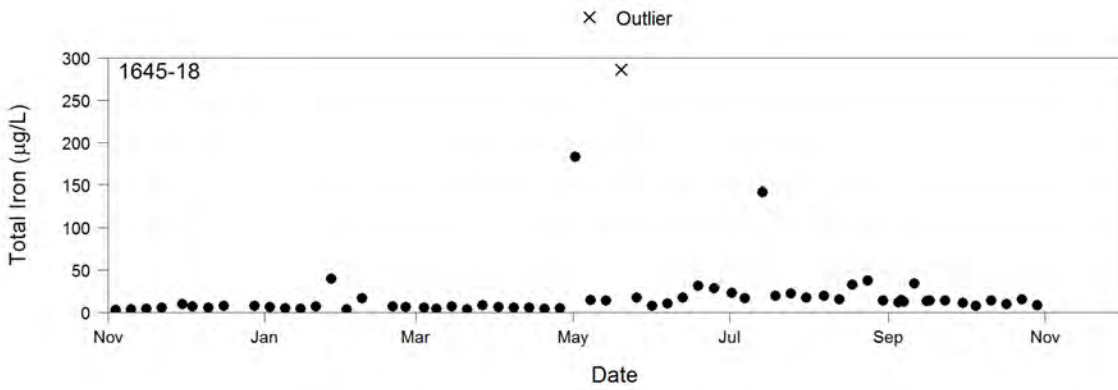
**Figure B-6 Anomalous Data Removed from SNP Analyses Completed for Total Copper, Station 1645-18, 2014**



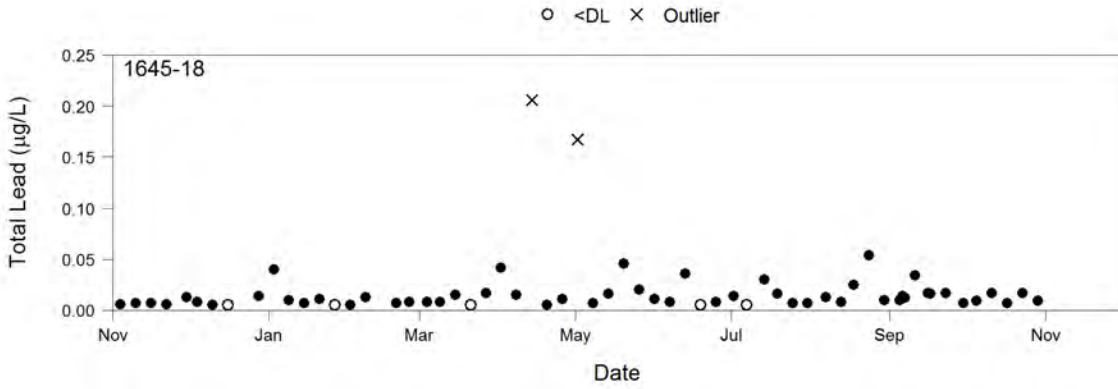
**Figure B-7 Anomalous Data Removed from SNP Analyses Completed for Total Copper, Station 1645-18B, 2014**



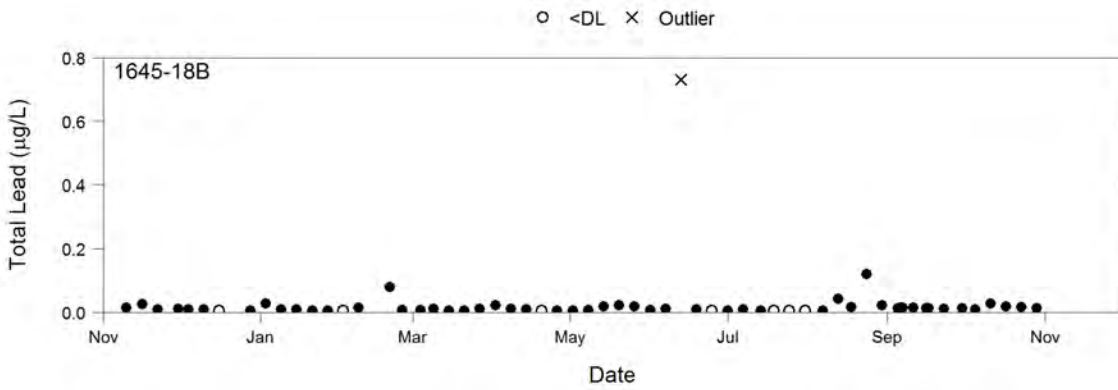
**Figure B-8 Anomalous Data Removed from SNP Analyses Completed for Total Iron, Station 1645-18, 2014**



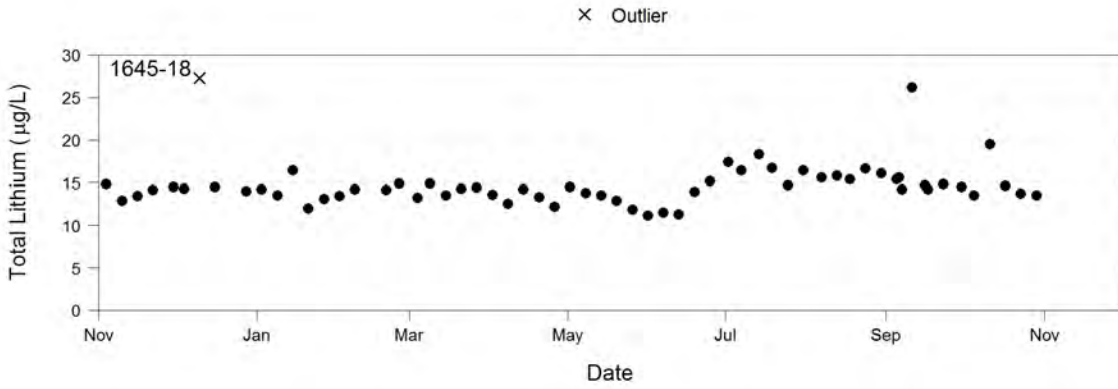
**Figure B-9 Anomalous Data Removed from SNP Analyses Completed for Total Lead, Station 1645-18, 2014**



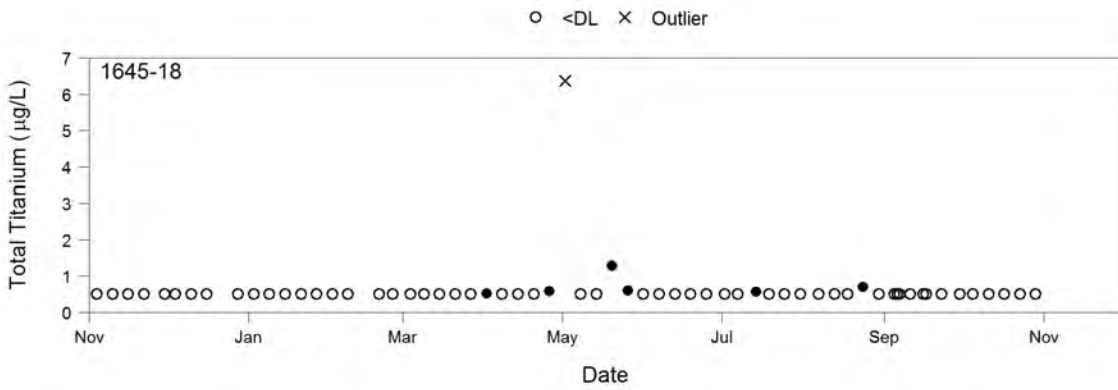
**Figure B-10 Anomalous Data Removed from SNP Analyses Completed for Total Lead, Station 1645-18B, 2014**



**Figure B-11 Anomalous Data Removed from SNP Analyses Completed for Total Lithium, Station 1645-18, 2014**



**Figure B-12 Anomalous Data Removed from SNP Analyses Completed for Total Titanium, Station 1645-18, 2014**





## Mixing Zone Boundary

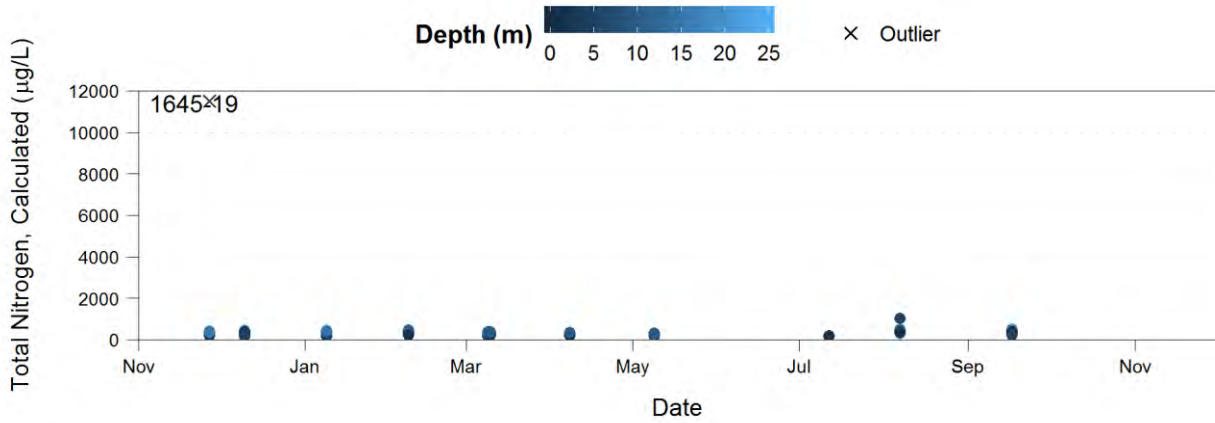
**Table B-2 List of Anomalous Values Removed from SNP Analyses, Stations 1645-19A, 1645-19B and 1645-19C**

Variable	Unit	Date	Station	Value	Standard Deviation Distance <sup>(a)</sup>
Total Nitrogen (Calculated)	µg-N/L	11/27/2013	19	11.5	11.067
Total Kjeldahl Nitrogen	µg-N/L	11/27/2013	19	11.3	11.083
Total Aluminum	µg/L	17/09/2014	19	314	8.969
Total Bismuth	µg/L	12/10/2013	19	0.038	10.265
Total Boron	µg/L	17/09/2014	19	27.1	10.56
Total Lead	µg/L	17/09/2014	19	0.92	11.037
Total Manganese	µg/L	12/10/2013	19	254	9.931

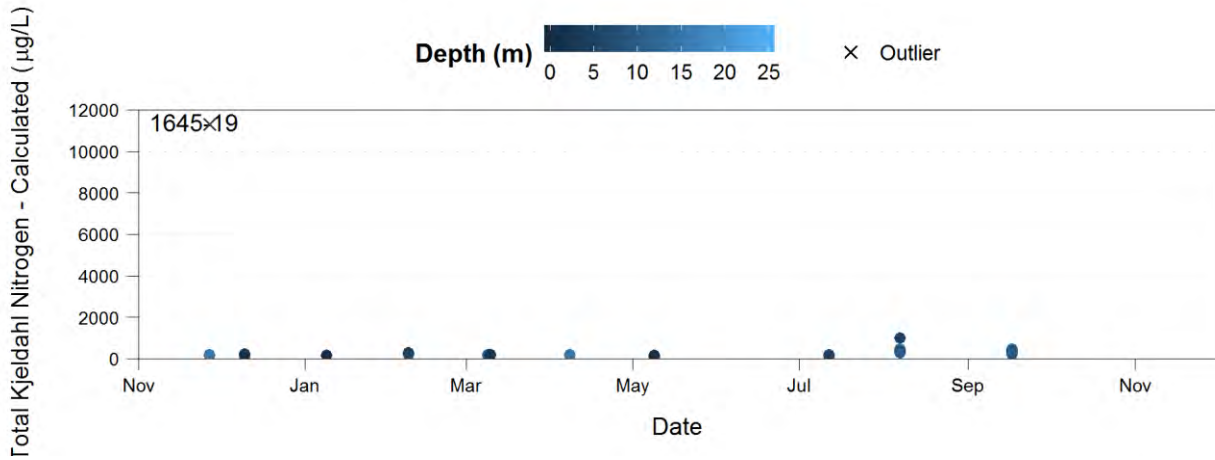
µg-N/L = micrograms nitrogen per litre; µg/L = microgram per litre.

a) Number of standard deviations from the mean calculated for the 2014 monitoring period.

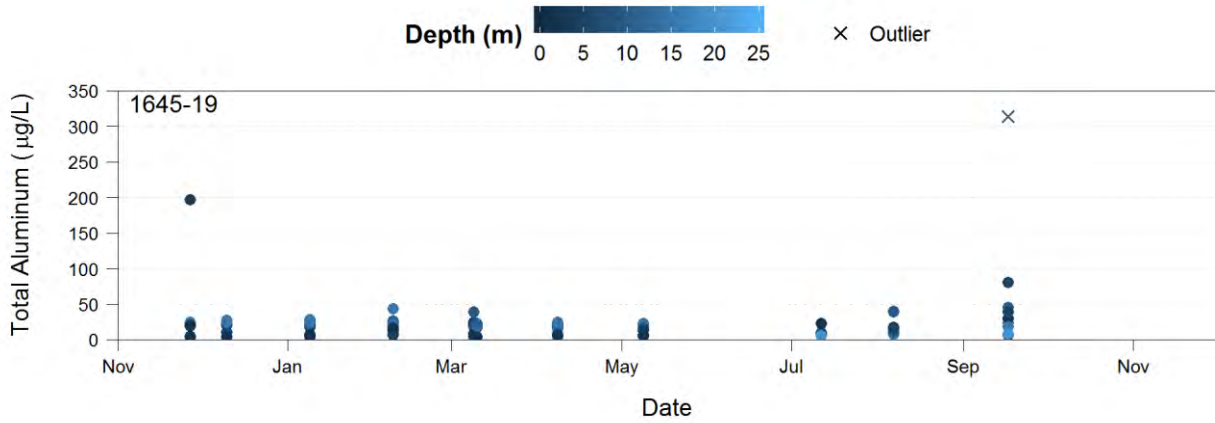
**Figure B-13 Anomalous Data Removed from SNP Analyses Completed for Total Nitrogen, Station 1645-19, 2014**



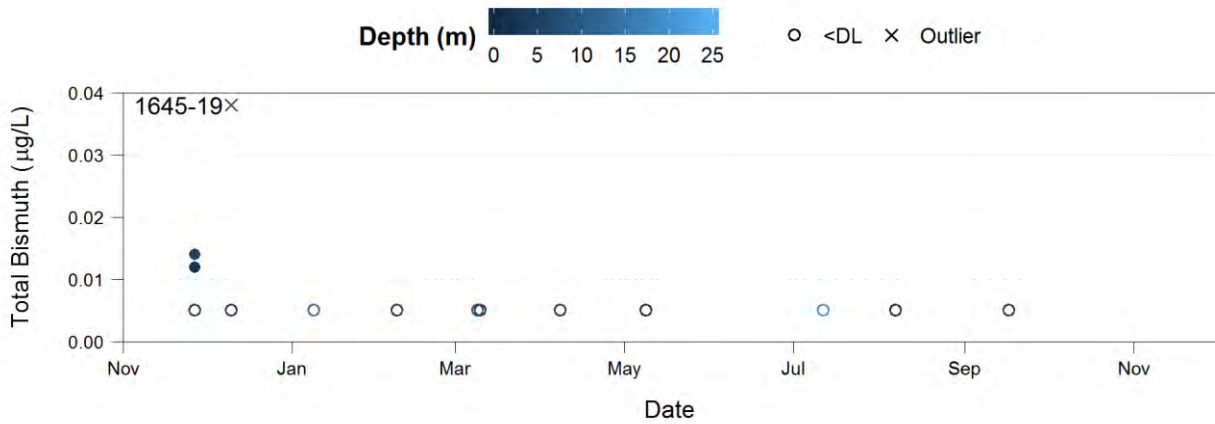
**Figure B-14 Anomalous Data Removed from SNP Analyses Completed for Total Kjeldahl Nitrogen, Station 1645-19, 2014**



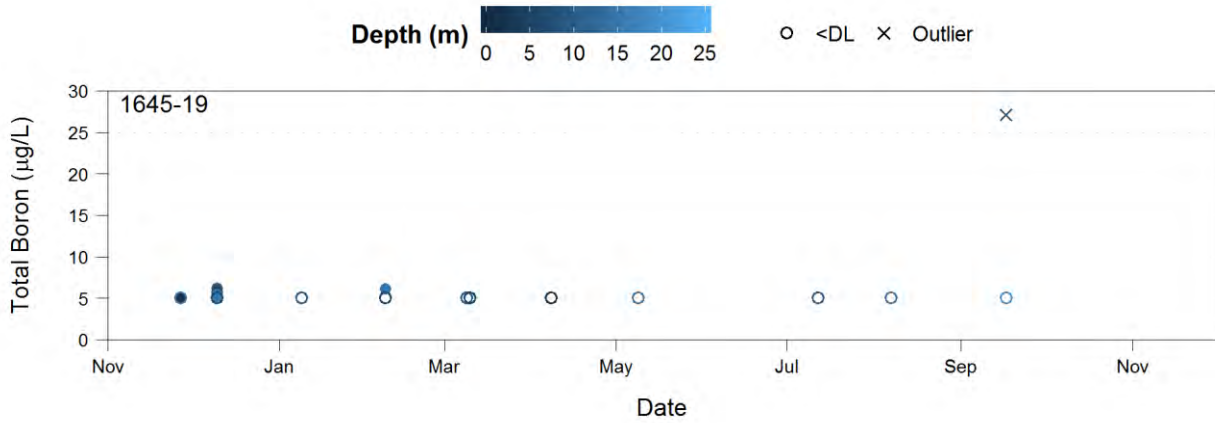
**Figure B-15 Anomalous Data Removed from SNP Analyses Completed for Total Aluminum, Station 1645-19, 2014**



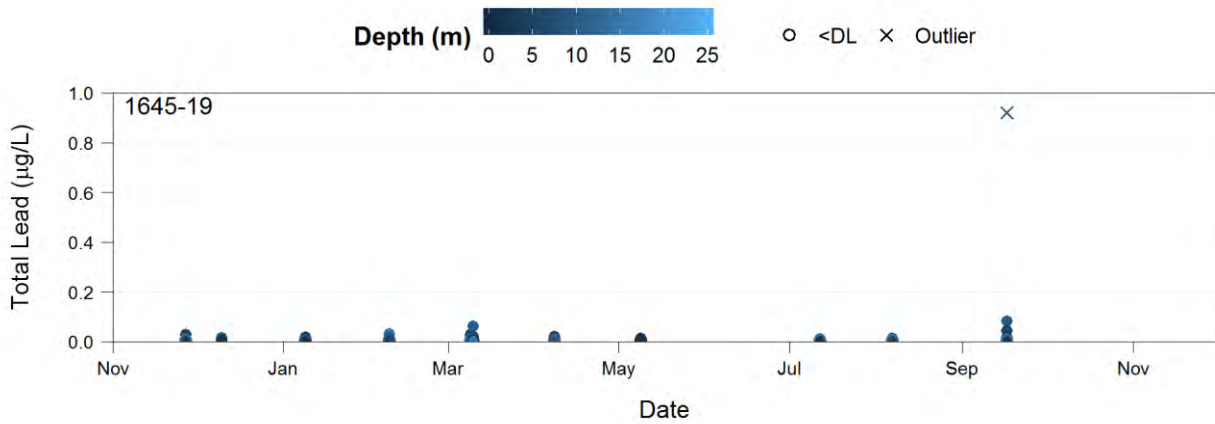
**Figure B-16 Anomalous Data Removed from SNP Analyses Completed for Total Bismuth, Station 1645-19, 2014**



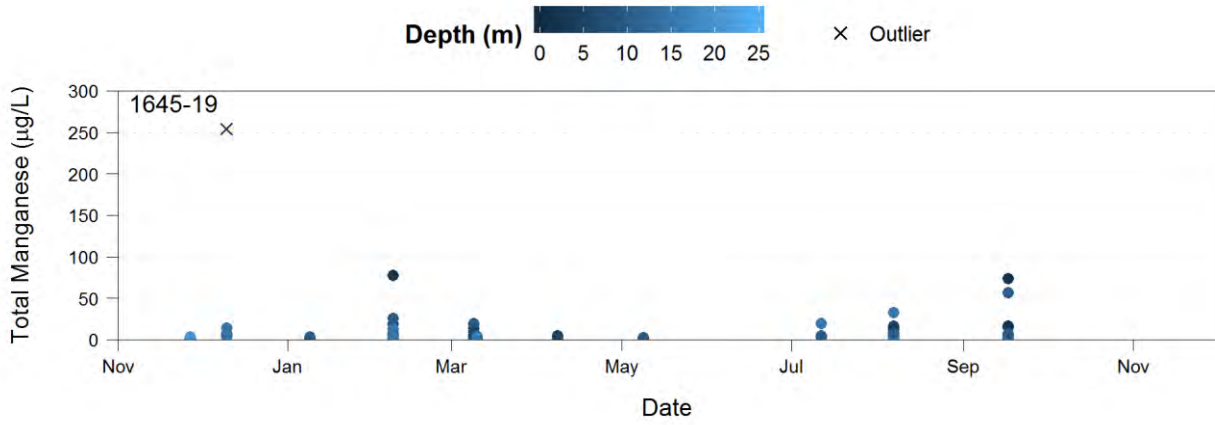
**Figure B-17 Anomalous Data Removed from SNP Analyses Completed for Total Boron, Station 1645-19, 2014**



**Figure B-18 Anomalous Data Removed from SNP Analyses Completed for Total Lead, Station 1645-19, 2014**



**Figure B-19 Anomalous Data Removed from SNP Analyses Completed for Total Manganese, Station 1645-19, 2014**



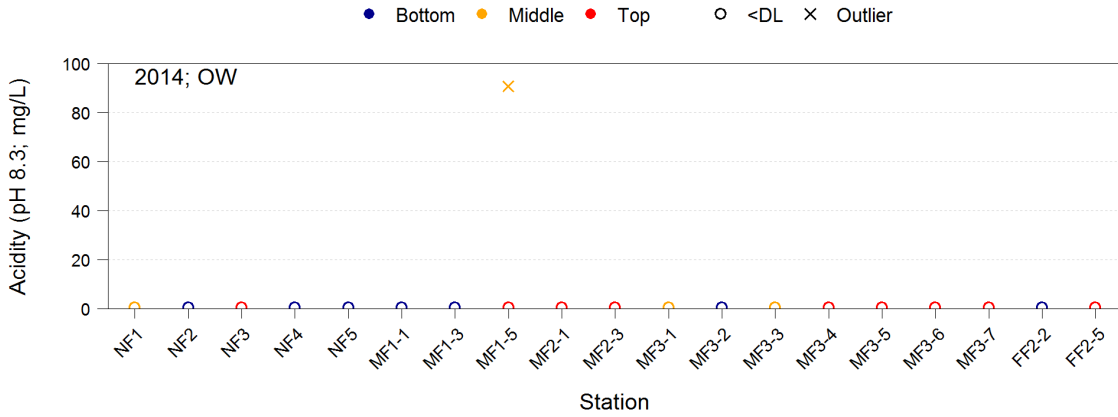
**AEMP****Table B-3 List of Anomalous Values Removed from AEMP Analyses**

Variable	Unit	Season	Station	Value	Standard Deviation Distance <sup>(a)</sup>
Acidity (pH 8.3)	mg/L	OW	MF1-5	90.7	7.281
Specific Conductivity	µS/cm	OW	MF3-1	1	5.069
Total Suspended Solids	mg/L	OW	MF3-1	8.6	7.155
Total Organic Carbon	mg/L	IC	FF2-5	4.1	5.595
Turbidity	NTU	OW	MF3-4	0.5	5.156
Total Antimony	µg/L	IC	MF1-3	0.165	5.762
Total Cadmium	µg/L	IC	FF2-2	0.025	6.988
Total Cobalt	µg/L	IC	MF3-6	0.371	7.49
Total Copper	µg/L	IC	MF3-7	7.14	5.782
Total Iron	µg/L	IC	FF2-5	43.6	4.911
Total Iron	µg/L	OW	MF3-3	18.3	4.742
Total Manganese	µg/L	IC	MF3-6	43.2	7.417
Total Mercury	µg/L	IC	FF2-5	0.01	11.347
Total Tin	µg/L	OW	MF3-2	0.121	5.209
Total Vanadium	µg/L	IC	FF2-2	2.25	7.451
Total Zinc	µg/L	OW	MF3-3	4.49	6.577
Dissolved Aluminum	µg/L	IC	FF2-5	341	7.537
Dissolved Chromium	µg/L	IC	FF2-5	0.309	5.073
Dissolved Cobalt	µg/L	IC	MF3-6	0.477	7.499
Dissolved Iron	µg/L	IC	FF2-5	29.4	6.986
Dissolved Lead	µg/L	IC	FF2-5	0.252	7.39
Dissolved Manganese	µg/L	IC	MF3-6	55.2	7.328
Dissolved Silver	µg/L	OW	MF1-3	0.022	5.303
Dissolved Tin	µg/L	OW	MF3-2	0.076	5.157
Dissolved Zinc	µg/L	OW	MF3-4	2.37	6.098

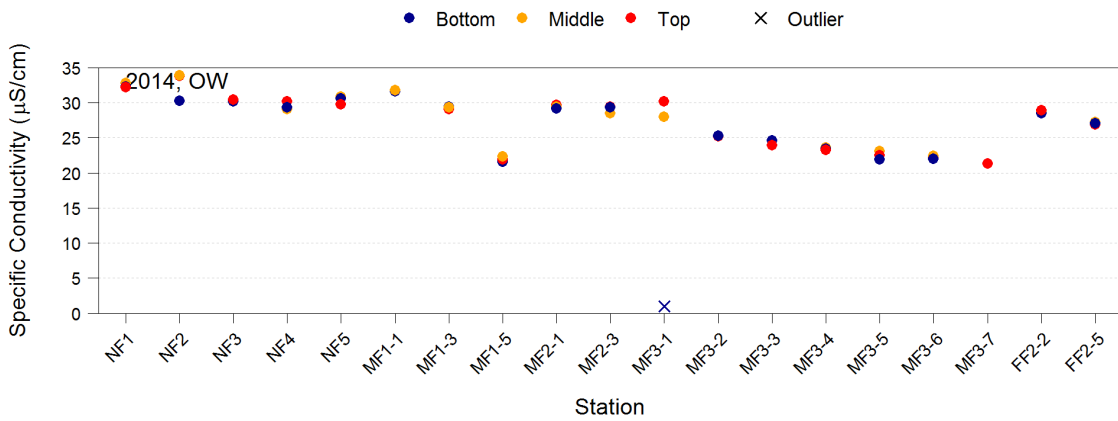
Mg/L = milligram per litre; µS/cm = microSiemens per litre; NTU = nephelometric turbidity unit; µg/L = microgram per litre; OW = open-water season; IC = ice-cover season.

a) Number of standard deviations from the mean calculated for the 2014 monitoring period.

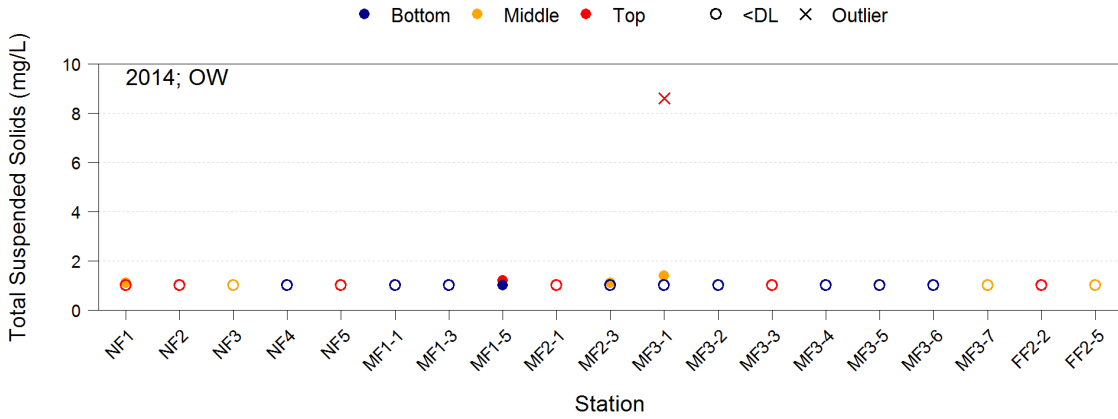
**Figure B-20 Anomalous Data Removed from AEMP Analyses Completed for Acidity (pH 8.3), Open-Water Season, 2014**



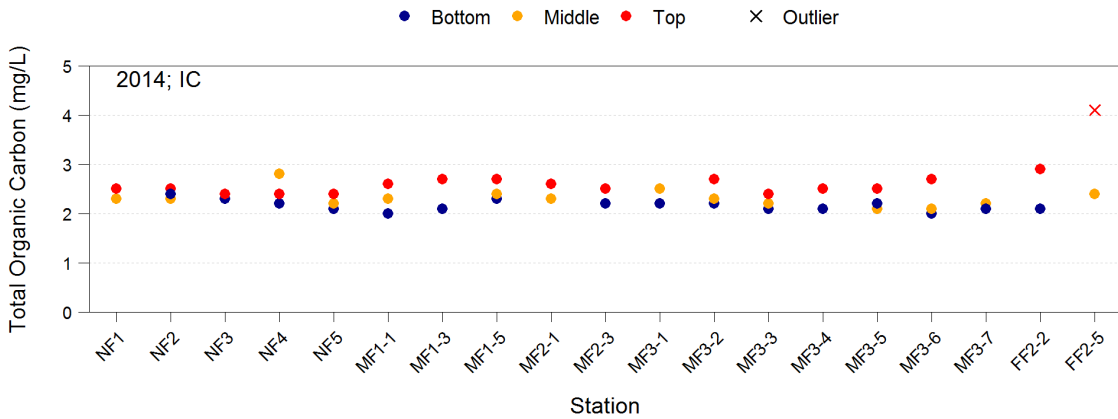
**Figure B-21 Anomalous Data Removed from AEMP Analyses Completed for Specific Conductivity, Open-Water Season, 2014**



**Figure B-22 Anomalous Data Removed from AEMP Analyses Completed for Total Suspended Solids, Open-Water Season, 2014**

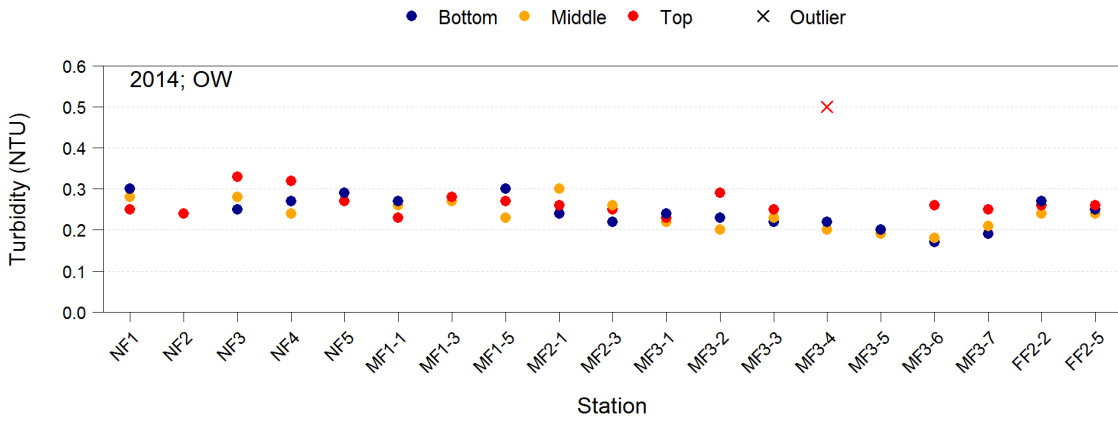


**Figure B-23 Anomalous Data Removed from AEMP Analyses Completed for Total Organic Carbon, Ice-Cover Season, 2014**

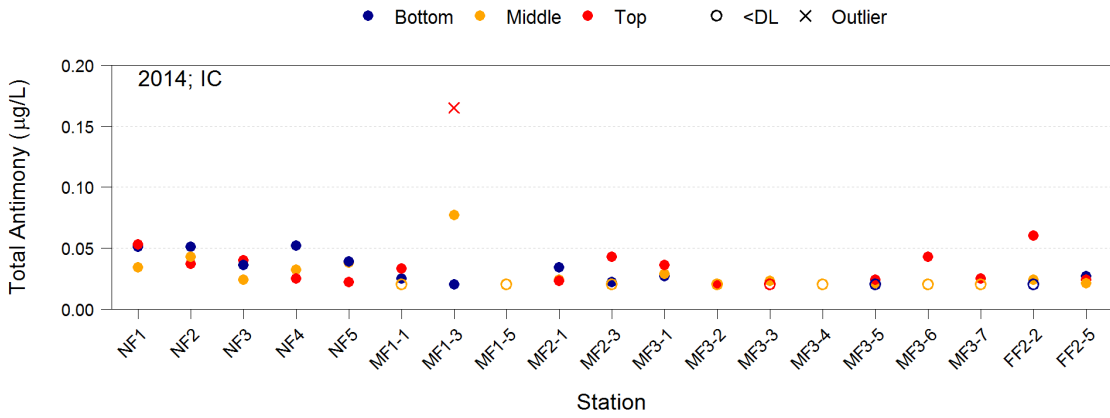




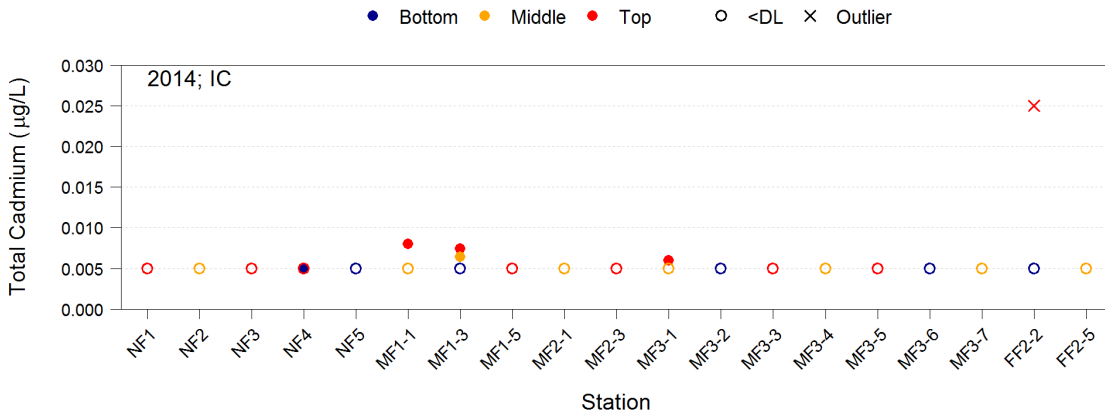
**Figure B-24 Anomalous Data Removed from AEMP Analyses Completed for Turbidity, Open-Water Season, 2014**



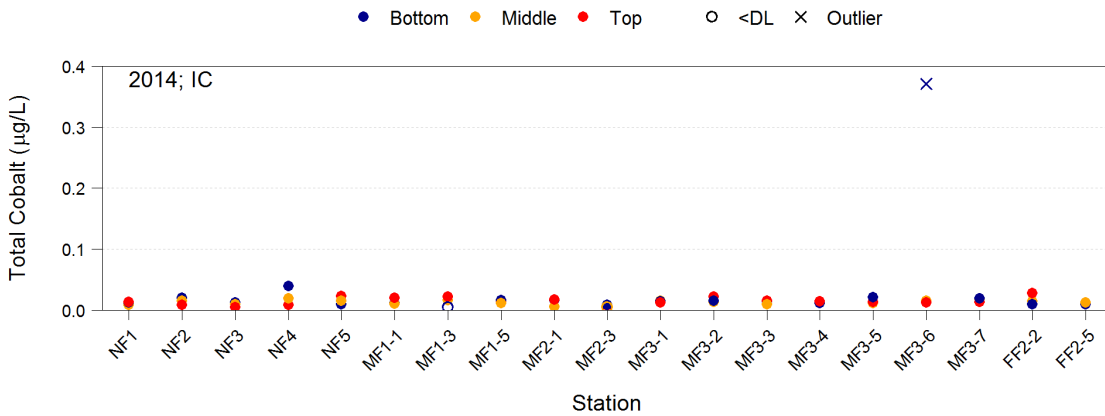
**Figure B-25 Anomalous Data Removed from AEMP Analyses Completed for Total Antimony, Ice-Cover Season, 2014**



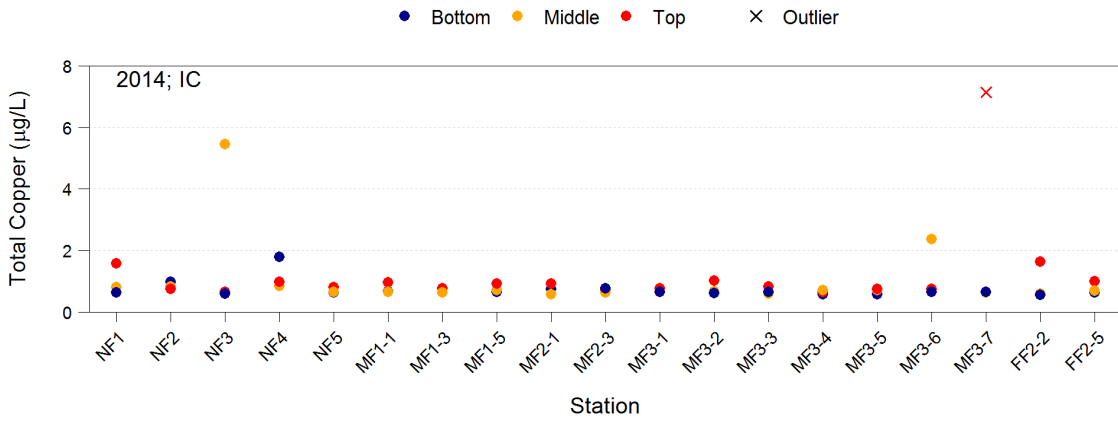
**Figure B-26 Anomalous Data Removed from AEMP Analyses Completed for Total Cadmium, Ice-Cover Season, 2014**



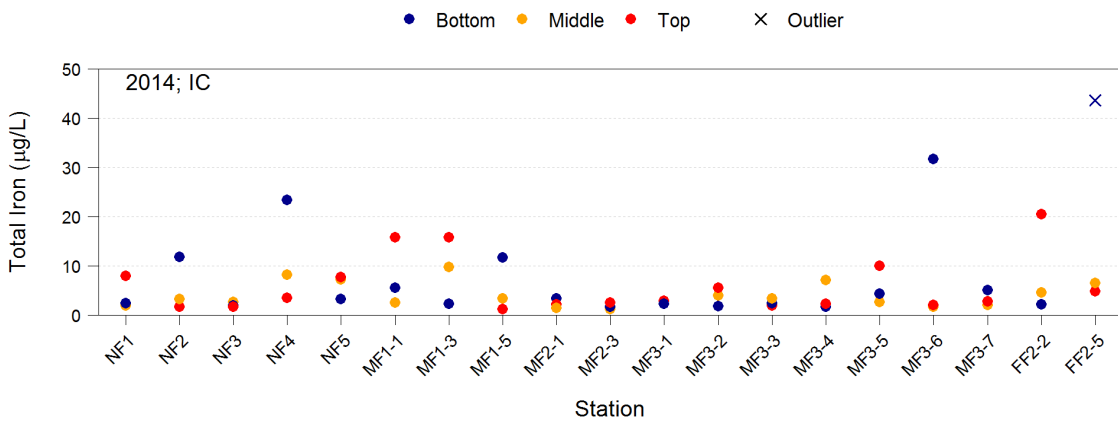
**Figure B-27 Anomalous Data Removed from AEMP Analyses Completed for Total Cobalt, Ice-Cover Season, 2014**



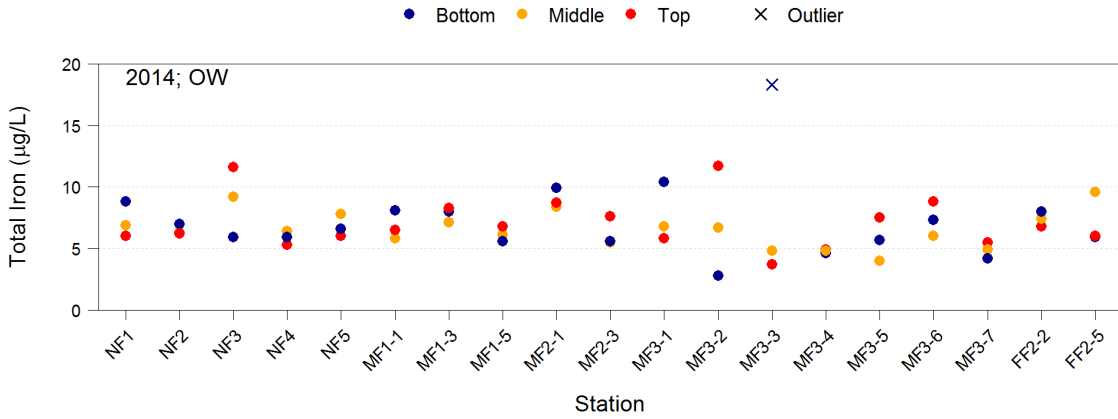
**Figure B-28 Anomalous Data Removed from AEMP Analyses Completed for Total Copper, Ice-Cover Season, 2014**



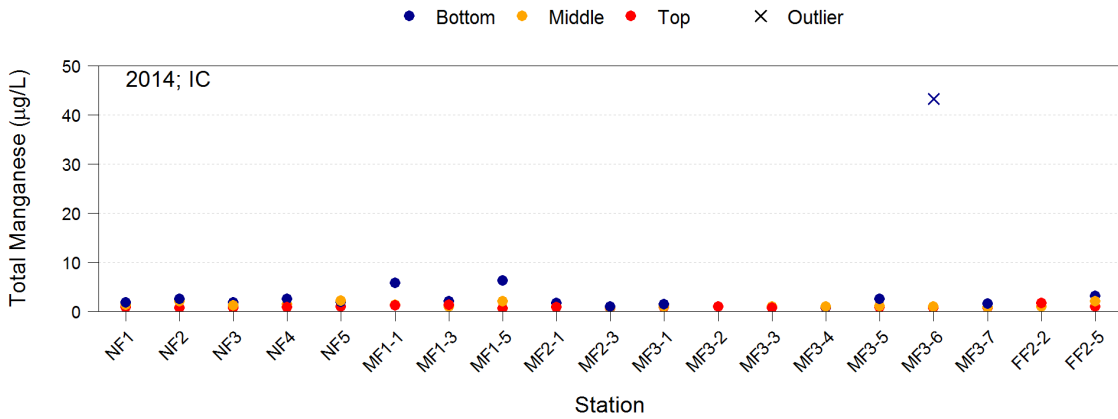
**Figure B-29 Anomalous Data Removed from AEMP Analyses Completed for Total Iron, Ice-Cover Season, 2014**



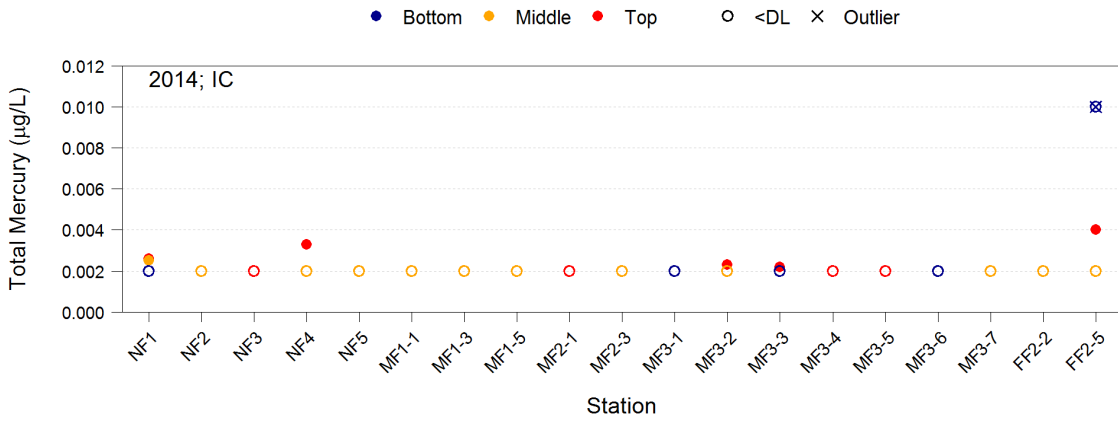
**Figure B-30 Anomalous Data Removed from AEMP Analyses Completed for Total Iron, Open-Water Season, 2014**



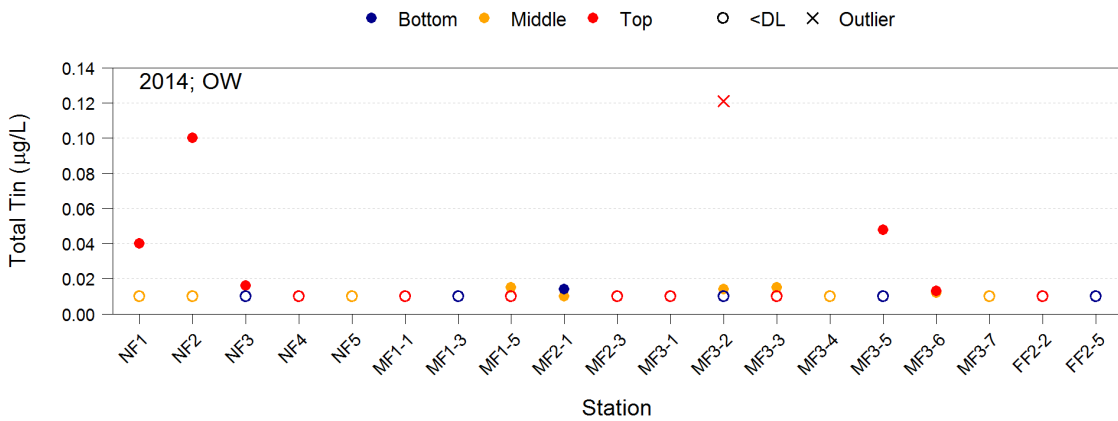
**Figure B-31 Anomalous Data Removed from AEMP Analyses Completed for Total Manganese, Ice-Cover Season, 2014**



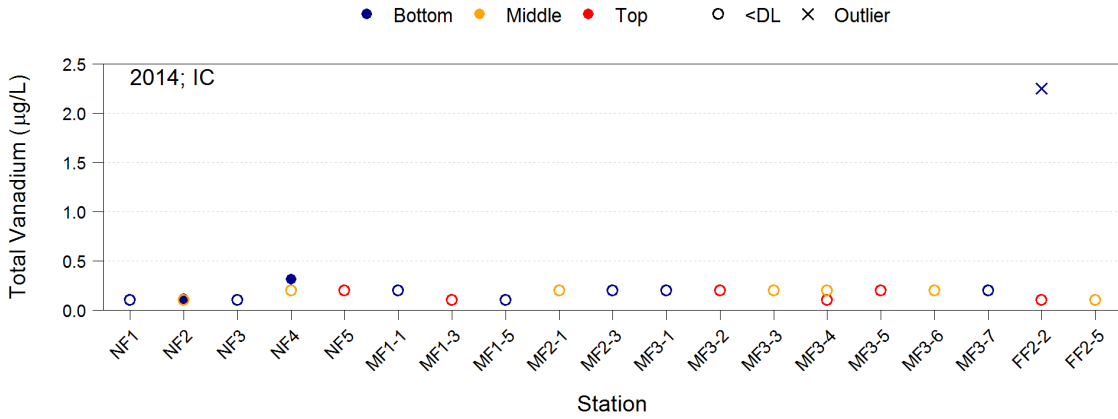
**Figure B-32 Anomalous Data Removed from AEMP Analyses Completed for Total Mercury, Ice-Cover Season, 2014**



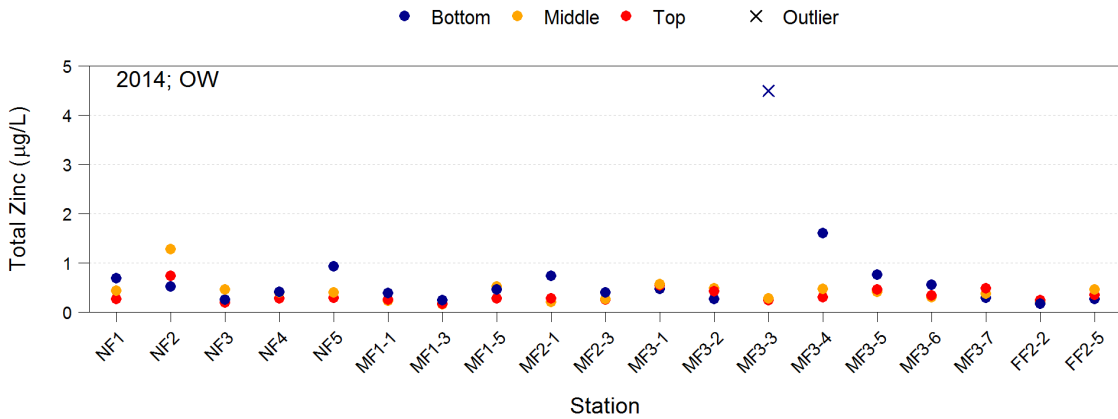
**Figure B-33 Anomalous Data Removed from AEMP Analyses Completed for Total Tin, Open-Water Season, 2014**



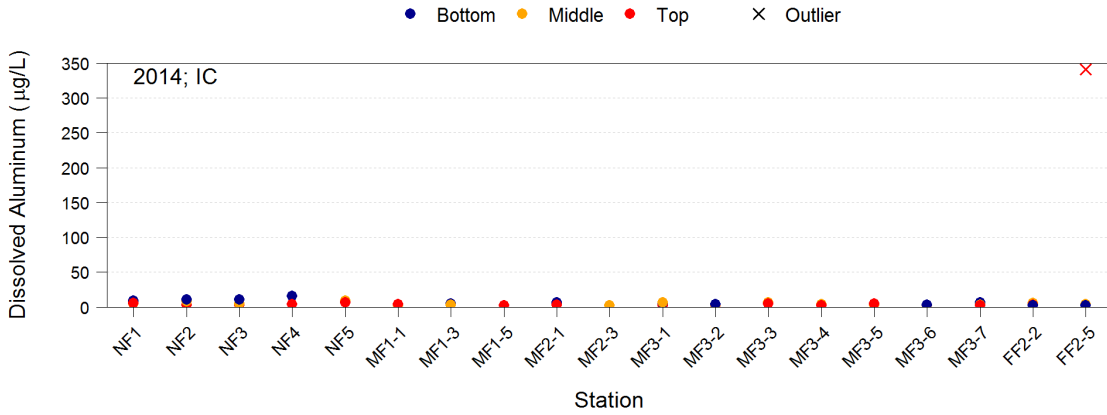
**Figure B-34 Anomalous Data Removed from AEMP Analyses Completed for Total Vanadium, Ice-Cover Season, 2014**



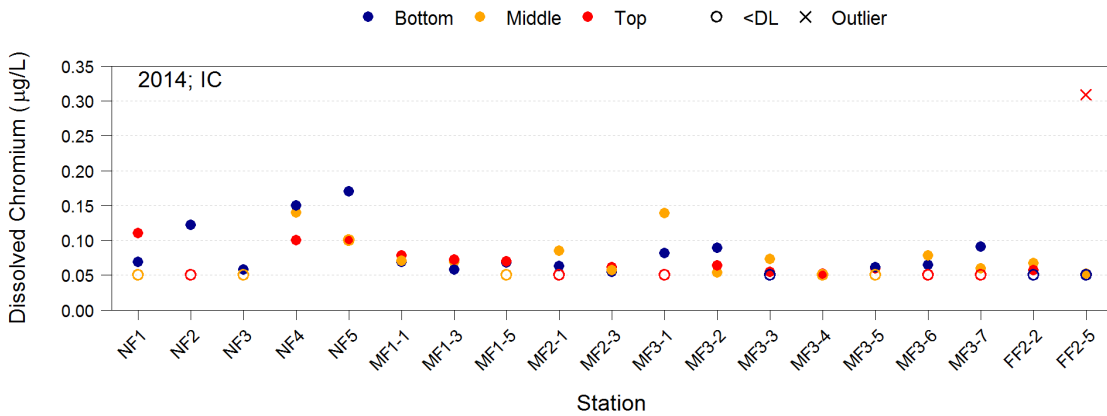
**Figure B-35 Anomalous Data Removed from AEMP Analyses Completed for Total Zinc, Open-Water Season, 2014**



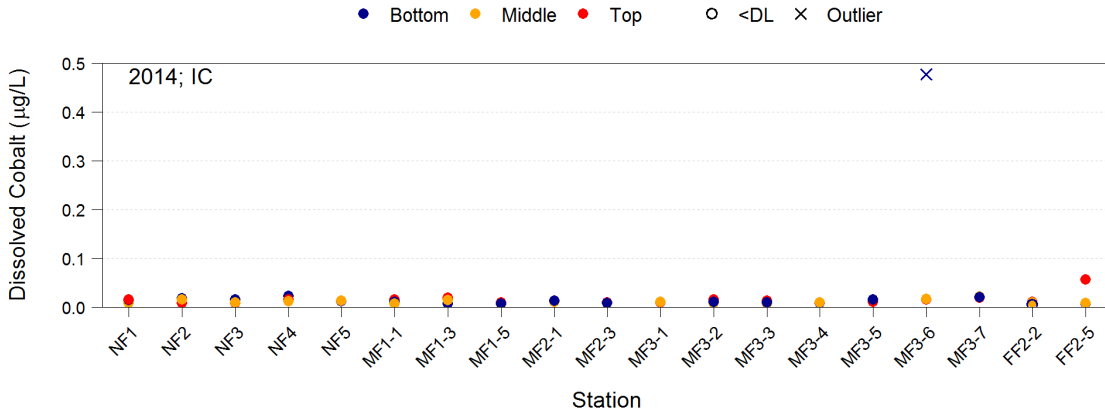
**Figure B-36 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Aluminum, Ice-Cover Season, 2014**



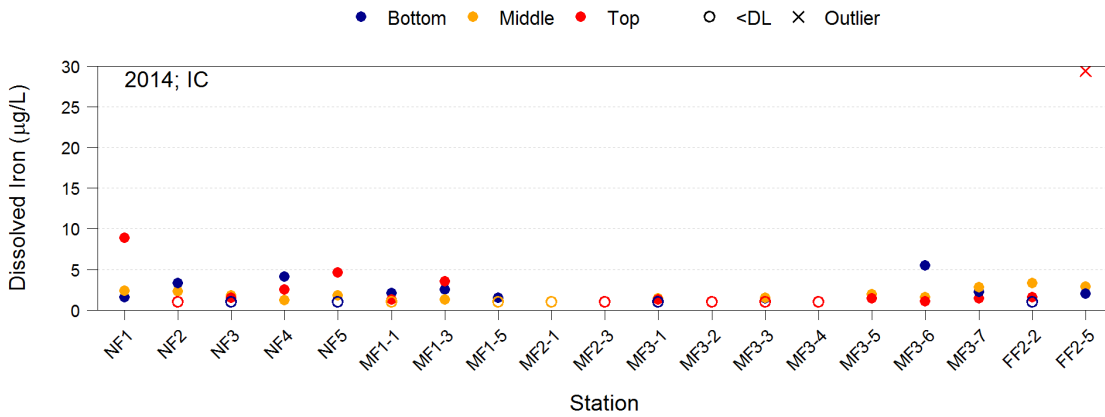
**Figure B-37 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Chromium, Ice-Cover Season, 2014**



**Figure B-38 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Cobalt, Ice-Cover Season, 2014**

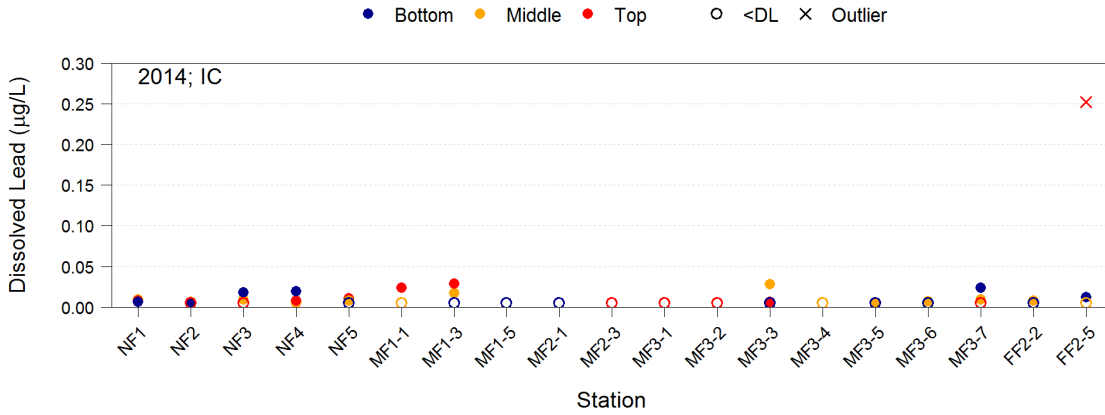


**Figure B-39 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Iron, Ice-Cover Season, 2014**

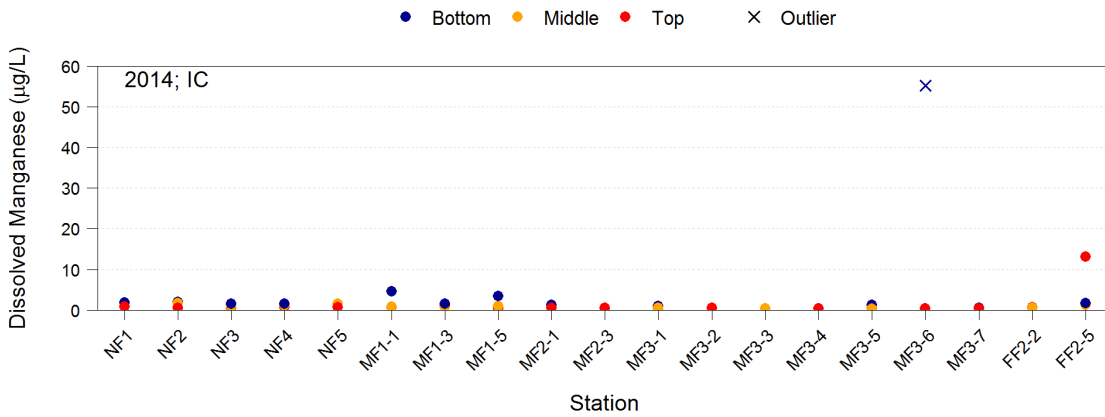




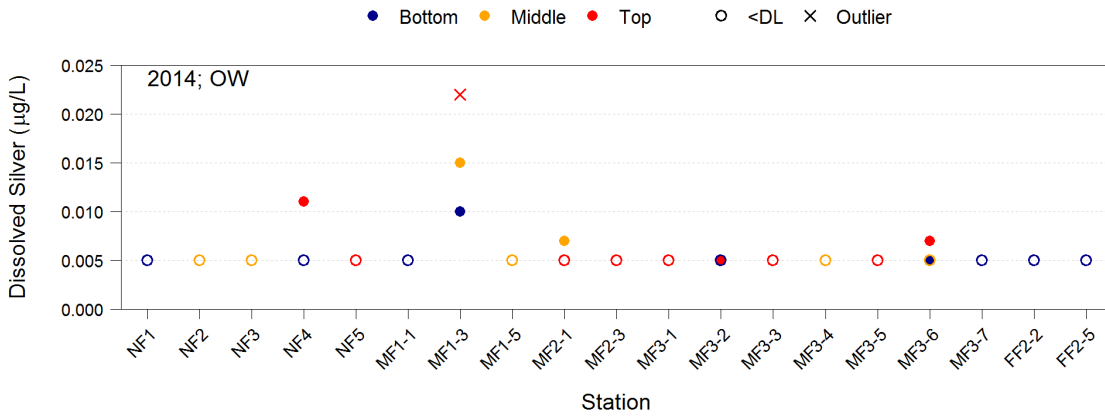
**Figure B-40 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Lead, Ice-Cover Season, 2014**



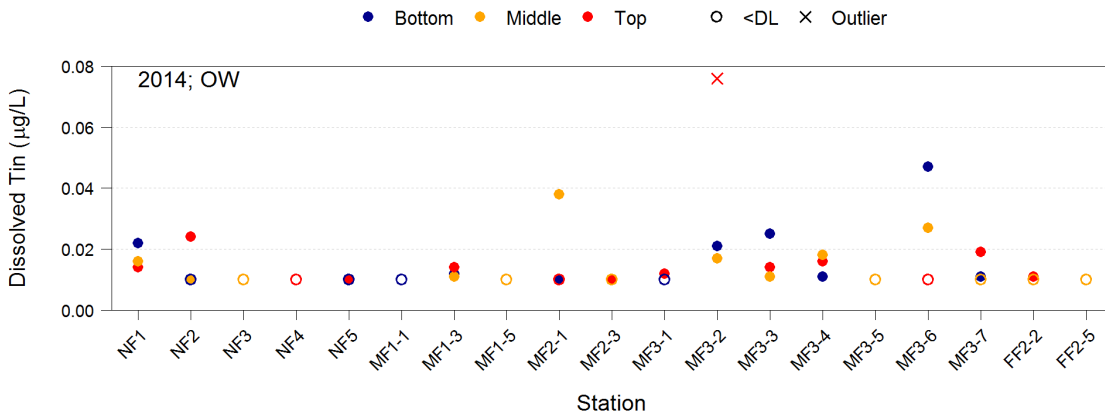
**Figure B-41 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Manganese, Ice-Cover Season, 2014**



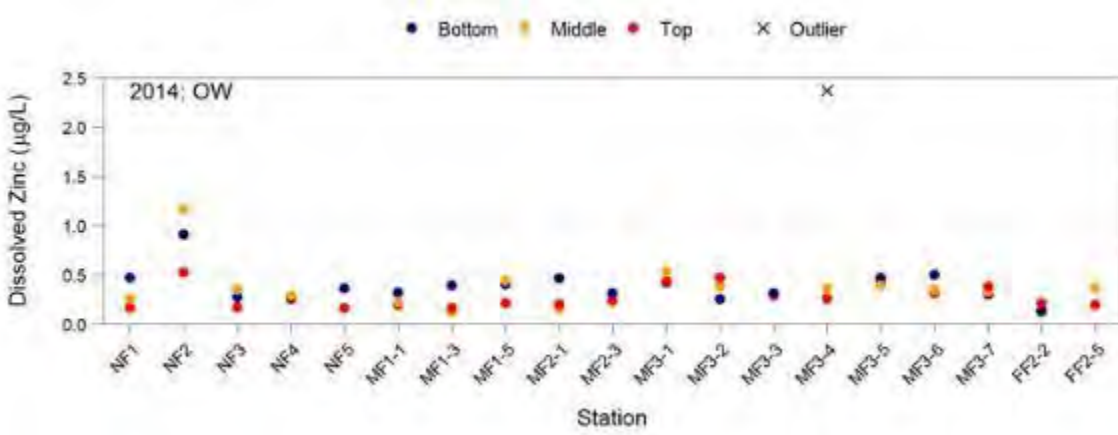
**Figure B-42 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Silver, Open-Water Season, 2014**



**Figure B-43 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Tin, Open-Water Season, 2014**



**Figure B-44 Anomalous Data Removed from AEMP Analyses Completed for Dissolved Zinc, Open-Water Season, 2014**



## **APPENDIX C**

### **QUALITY ASSURANCE AND QUALITY CONTROL METHODS AND RESULTS**

## INTRODUCTION

Quality assurance (QA) and quality control (QC) practices determine data integrity and are relevant to all aspects of a study, from sample collection to data analysis and reporting. Quality assurance encompasses management and technical practices designed to generate consistent, high quality data. Quality control is an aspect of QA and includes the techniques used to assess data quality and the corrective actions to be taken when the data quality objectives are not met. This appendix describes QA/QC practices applied during the 2014 Aquatic Environment Monitoring Program (AEMP), evaluates QC data, and describes the implications of QC results to the interpretation of study results.

## QUALITY ASSURANCE

### Field Staff Training and Operations

Diavik Diamond Mines (2012) Inc. (DDMI) field staff are trained to be proficient in standardized field sampling procedures, data recording, and equipment operations applicable to water quality sampling. Field work was completed according to specified instructions and standard operating procedures (SOP). The procedures are described in:

- ENVR-003-0702 R9 AEMP Monitoring Program – Ice Cover;
- ENVR-014-0311 R3 AEMP Sampling – Ice Cover;
- ENVR-303-0112 R0 Laboratory Quality Assurance/Quality Control;
- ENVR-206-0112 R0 Processing Maxxam Samples and Tracking Documentation;
- ENVR-402-0112 R0 DDMI Lab – Dissolved Oxygen;
- ENVR-404-0112 R0 DDMI Lab – pH;
- ENVR-405-0112 R0 DDMI Lab – Turbidity;
- ENVR-403-0112 R0 DDMI Lab – Total Suspended Solids;
- ENVR-604-0112 R0, ENVR-608-0112 R0 Field Meter Calibration;
- ENVR-014-0311 R3, Biophysical Measuring; and
- ENVR-608-0112 R0 Hydrolab Calibration, Deployment and Download.

These SOPs include guidelines for field record-keeping and sample tracking, guidance for use and calibration of sampling equipment, relevant technical procedures, and sample labelling, shipping and tracking protocols.

## Laboratory

Samples were sent for analysis to Maxxam Analytics Inc. (Maxxam), Burnaby, British Columbia, a laboratory accredited by the Canadian Association of Laboratory Accreditation. Under the accreditation program, performance assessments are completed annually for laboratory procedures, analytical methods, and internal quality control.

Quality assurance at the DDMI Environmental Laboratory encompasses all quality-related activities related to aquatic testing and analysis, and relevant technical support (SOPENV-LAB-12).

DDMI's QA places an emphasis on four aspects:

- infrastructure (instruments, testing capabilities, calibrations, SOPs);
- control measures (internal/external);
- personnel (competence, ethics and integrity); and
- data management.

## Office Operations

A data management system was established as an organized system of data control, analysis and filing. Relevant elements of this system are as follows:

- pre-field meetings to discuss specific work instructions with field crews;
- field crew check-in with task managers every 24 to 48 hours to report work completed during that period;
- designating two crew members responsible for:
  - collecting all required samples;
  - immediate download and storage of electronic data;
  - completing chain-of-custody and analytical request forms; labelling and documentation; and
  - processing, where required, and delivering samples to analytical laboratory in a timely manner;
- cross-checking chain-of-custody forms and analysis request forms by the task manager to verify that the correct analysis packages had been requested;
- review of field sheets by the task manager for completeness and accuracy;
- reviewing laboratory data as they are received from the analytical laboratory;
- creating backup files before data analysis; and

- completing appropriate logic checks for accuracy of calculations.

## QUALITY CONTROL

Quality control is a specific aspect of QA and includes the techniques used to assess data quality and the remedial measures to be taken when the data quality objectives are not met. The field QC program included collection of field blanks, trip blanks, equipment blanks, and duplicate samples to assess potential sample contamination, and within-station variation/sampling precision. Quality control samples were submitted to Maxxam for analysis of the full list of variables.

Field blanks consisted of samples prepared in the field using laboratory-provided de-ionized water to fill a set of sample bottles, which were then submitted to the appropriate laboratory for the same analyses as the original water samples. Trip blanks consisted of sample bottles filled with high-grade de-ionized water from the laboratory. They accompanied the other samples through sample collection, handling, shipping and analysis, but remained sealed. Equipment blanks consisted of de-ionized water exposed to all aspects of sample collection and analysis, using the same procedures used in the field, including contact with all sampling devices and other equipment (filters, tubing). Equipment blanks provide information regarding potential cross-contamination between samples and field equipment.

The field, trip and equipment blanks were used to detect potential sample contamination during collection, shipping and analysis. Although concentrations should be below detection limits (DL) in these blanks, their concentrations were considered notable if they were greater than five times the corresponding DL. This threshold is based on the Practical Quantitation Limit defined by the United States Environmental Protection Agency (USEPA 1985), which takes into account the potential for data accuracy errors when variable concentrations approach or are below DLs. This criterion was not applied to pH, which is expected to be above the laboratory-reported DL in the de-ionized water used to prepare the blanks.

Notable results observed in the blanks were evaluated relative to variable concentrations observed in the lake water samples to determine whether sample contamination was limited to the QC sample. If, based on this comparison, sample contamination was not isolated to the QC sample; the field data were flagged and all further interpretations were made with this limitation in mind.

Duplicate samples consisted of two samples collected from the same location at the same time, using the same sampling and sample handling procedures. They were labelled and preserved individually and submitted separately to the analytical laboratory for identical analyses. Duplicate samples are used to check within-station variation and the precision of field sampling and analytical methods. Differences between concentrations measured in duplicate water samples were calculated as the Relative Percent Difference (RPD) for each variable. Before calculating the RPD, concentrations below the DL were replaced with 0.5 times the DL value. The RPD was calculated using the following formula:

$$RPD = (|difference\ in\ concentration\ between\ duplicate\ samples| / mean\ concentration) \times 100$$

The RPD value for a given variable was considered notable if:

- it was greater than 20%; and
- concentrations in one or both samples were greater than or equal to five times the DL.

These criteria are similar to those used by Maxxam for internal QC of laboratory duplicate samples, and take into account the potential for data accuracy error as variable concentrations approach DLs.

The number of variables which exceeded the assessment criteria was compared to the total number of variables analyzed to evaluate analytical precision. The analytical precision was rated as follows:

- high, if less than 10% of the total number of variables were notably different from one another;
- moderate, if 10% to 30% of the total number of variables were notably different from one another; and
- low, if more than 30% of the total number of variables were notably different from one another.

## Quality Control Results

### ***Detection Limits***

Maxxam used analyte-specific DLs) to report results for water quality variables analyzed in 2014 (*i.e.*, the same DL was used for all samples for a particular analyte, unless matrix interference necessitated the use of a higher DL). The DLs used by Maxxam in 2014 are listed in Section 2.2 Table 2-2 of the 2014 Effluent and Water Chemistry Report. These DLs were compared with those originally requested by DDMI to determine the reason(s) for any differences in DLs and whether this difference would affect data quality. Several variables were initially identified as having DLs not matching the requested values. These issues, however, either did not affect data quality (*i.e.*, sample concentrations were greater than the adjusted DL) or the DL was corrected by re-running the affected samples.

### ***Blank and Duplicate Samples***

A total of 8 variables (measured total dissolved solids [TDS]; total and dissolved calcium; dissolved sodium; total and dissolved aluminum; and total and dissolved barium) measured in blank samples collected during the ice-cover season had concentrations that exceeded the data quality objective (DQO) of less than five times the DL (Table C-1). Among the four blank samples collected during the ice-cover season, one variable (TDS [measured]), exceeded background concentrations in the equipment blank collected at station MF1-1B. The remaining seven variables exceeded



background concentrations in a single field blank collected at station FF2-5M. Analyte concentrations in the equipment blank collected at station NF5B and in the trip blank collected at station MF3-5T were within the DQO of less than five times the DL for all variables analyzed. During the open-water season, a total of four variables (dissolved sodium, ammonia, total zinc, and dissolved aluminum) measured in blank samples had concentrations that were greater than five times the DL (Table C-1). Exceedances of the DQO for ammonia occurred in the equipment blank collected at MF1-5T and in the trip blank collected at FF2-2T. The remaining three variables exceeded the DQO in a single equipment blank collected at station NF5B.

A total of 22 out of 99 water quality variables analyzed in 2014 (22%; Table C-2) exceeded both the 20% RPD and 5 times DL criteria for duplicate samples (Table C-2). This indicates a moderate level of analytical precision for duplicate samples in 2014. Of the 22 variables that exceeded the DQOs for duplicate samples, 12 variables (measured TDS; ammonia; nitrate; nitrate + nitrite; dissolved aluminum; total cobalt; total copper; total iron; total lead; dissolved manganese; total sulphur; total zinc) had RPD values that were greater than 50%. These results were considered notable, because the differences in concentrations between duplicate samples for these analytes were appreciably higher than the QC objective values used by Maxxam to identify unacceptable differences between laboratory duplicate samples (RPD of 20% to 25%). Laboratory duplicates consist of two independently analyzed portions of the same sample and would therefore be expected to have lower variability among paired duplicate samples than field duplicates, which consist of two separate grab samples.

During the ice-cover season, seven variables had RPD values that were greater than 50% in the duplicate sample pair collected at station NF4B. Three variables also exceeded the 50% RPD and 5 times DL criteria in the duplicate sample pair collected at station MF3-1M (Table C-2). During the open-water season, concentrations of five variables were greater the 50% RPD and 5 times DL criteria in a single sample collected at station MF3-3T.

Of the 8 analytes that exceeded the DQO for blank samples, only one variable, ammonia, was clearly elevated both in the blank samples and in the AEMP dataset. This finding is consistent with the results of QC analyses completed over the previous three years of the AEMP (2011 to 2013). In all four years (2011 to 2014), ammonia concentrations in blank samples analyzed by Maxxam were at or above levels in Lac de Gras, while the concentrations reported for lake water samples were elevated compared to historic values. In general, concentrations in the trip blanks (i.e., which are prepared in the laboratory and taken into the field unopened) have been similar to or greater than the values reported for equipment blanks and field blanks (which are opened and filled with DI water during field sampling). This combination of elevated concentrations in the blank samples and in the field data suggest a systematic error that should be investigated by Maxxam. Diavik is currently working with the analytical laboratory to develop a QA/QC plan that will address the data quality issues identified for ammonia.

**Table C-1 Blank Sample Results, 2014**

Variable	Unit	DL	Ice-cover				Open-water			
			NF5B-1	MF3-5T-3	MF1-1B-1	FF2-5M-2	NF5B-1	MF1-5T-1	FF2-2T-3	MF3-1B-2
			Equipment Blank	Trip Blank	Equipment Blank	Field Blank	Equipment Blank	Equipment Blank	Trip Blank	Field Blank
			25-Apr-14	29-Apr-14	1-May-14	27-Apr-14	21-Aug-14	1-Sep-14	22-Aug-14	25-Aug-14
<b>Conventional Parameters</b>										
Acidity (pH 4.5)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acidity (pH 8.3)	mg/L	0.5	<0.5	<0.5	<0.5	0.51	0.6	<0.5	<0.5	<0.5
Alkalinity, Total (as CaCO <sub>3</sub> )	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	0.99	0.73	0.7	0.88
Alkalinity (Phenolphthalein as CaCO <sub>3</sub> )	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Specific Conductivity	µS/cm	1	<1	1	<1	1.1	1.1	1.1	1.2	1.2
Hardness, Dissolved (CaCO <sub>3</sub> )	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hardness, Total (CaCO <sub>3</sub> )	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH	-	-	5.42	5.61	5.49	5.59	5.91	6.42	6.02	6.42
Total Dissolved Solids (Calculated)	mg/L	-	1.0	1.0	1.0	1.1	1.4	1.2	1.2	1.3
Total Dissolved Solids (Measured)	mg/L	1	<1	<1	<b>6</b>	<1	<1	<1	<1	<1
Total Suspended Solids	mg/L	1	<1	<1	<1	<1	<1	<1	<1	1.3
Total Organic Carbon	mg/L	0.2	0.21	0.26	0.23	0.23	0.32	0.3	0.32	0.35
Turbidity	NTU	0.1	<0.1	<0.1	0.11	<0.1	<0.1	0.11	<0.1	<0.1
<b>Major Ions</b>										
Bicarbonate	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	1.21	0.89	0.85	1.07
Calcium	mg/L	0.01	<0.01	<0.01	<0.01	<b>0.106</b>	0.018	<0.01	<0.01	0.04
Carbonate	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloride	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride	mg/L	0.01	0.011	<0.01	<0.01	0.013	<0.01	0.017	<0.01	<0.01
Hydroxide	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Potassium	mg/L	0.01	<0.01	0.013	<0.01	<0.01	0.012	<0.01	<0.01	<0.01
Sodium	mg/L	0.01	<0.01	<0.01	<0.01	<b>0.057</b>	<b>0.073</b>	<0.01	0.012	0.043
Sulphate	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<b>Nutrients</b>										
Ammonia (as Nitrogen)	µg-N/L	5	11	-	7.7	8.7	15	<b>28</b>	<b>62</b>	14
Nitrate (as Nitrogen)	µg-N/L	2	<2	2.3	<2	2.8	<2	<2	<2	<2
Nitrite (as Nitrogen)	µg-N/L	2	<2	<2	<2	<2	<2	<2	<2	<2
Nitrate + Nitrite (as Nitrogen)	µg-N/L	2	<2	2.3	<2	2.8	<2	<2	<2	<2
Nitrogen - Kjeldahl, Total	µg-N/L	20	54	<20	<20	40	21	20	99	<20
Nitrogen - Kjeldahl, Dissolved	µg-N/L	20	28	-	<20	<20	87	<20	92	28
Nitrogen, Total	µg-N/L	20	54	<20	<20	43	21	20	99	<20
Nitrogen, Dissolved	µg-N/L	20	28	-	<20	<20	87	<20	92	28
Orthophosphate	µg-P/L	1	<1	<1	<1	<1	<1	<1	<1	<1
Phosphorus, Dissolved	µg-P/L	2	<2	<2	<2	<2	<2	<2	<2	2
Phosphorus, Total	µg-P/L	2	<2	<2	<2	<2	<2	<2	2.2	<2
<b>Total Metals</b>										
Aluminum	µg/L	0.2	0.64	<0.5	0.78	<b>6.15</b>	0.43	0.24	0.83	<0.2
Antimony	µg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic	µg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Barium	µg/L	0.02	0.035	<0.02	0.022	<b>0.145</b>	<0.02	<0.02	<0.02	<0.02
Beryllium	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bismuth	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	µg/L	5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	mg/L	0.01	<0.01	<0.01	<0.01	<b>0.14</b>	<0.01	<0.01	<0.01	<0.01

**Table C-1 Blank Sample Results, 2014**

Variable	Unit	DL	Ice-cover				Open-water			
			NF5B-1	MF3-5T-3	MF1-1B-1	FF2-5M-2	NF5B-1	MF1-5T-1	FF2-2T-3	MF3-1B-2
			Equipment Blank	Trip Blank	Equipment Blank	Field Blank	Equipment Blank	Equipment Blank	Trip Blank	Field Blank
			25-Apr-14	29-Apr-14	1-May-14	27-Apr-14	21-Aug-14	1-Sep-14	22-Aug-14	25-Aug-14
Chromium	µg/L	0.05	<0.05	<0.1	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05
Cobalt	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	µg/L	0.05	<0.05	<0.05	0.066	0.124	<0.05	0.133	<0.05	<0.05
Iron	µg/L	1	1.5	<1	<1	4.6	<1	1.1	<1	<1
Lead	µg/L	0.005	<0.005	<0.005	0.0054	0.008	<0.005	<0.005	<0.005	<0.005
Lithium	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese	µg/L	0.05	<0.05	<0.05	<0.05	0.138	<0.05	<0.05	<0.05	<0.05
Mercury	µg/L	0.002	0.0027	-	<0.002	<0.002	0.0069	0.0079	0.0033	0.0022
Molybdenum	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	µg/L	0.02	0.053	<0.02	0.034	0.079	<0.02	<0.02	0.038	0.04
Potassium	mg/L	0.01	0.012	<0.01	<0.01	0.016	<0.01	<0.01	<0.01	<0.01
Selenium	µg/L	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Silicon	µg/L	50	<50	<100	<50	<100	62	<50	<50	<50
Silver	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	mg/L	0.01	<0.01	<0.01	<0.01	0.038	<0.01	<0.01	0.016	0.029
Strontium	µg/L	0.05	<0.05	<0.05	<0.05	0.111	<0.05	<0.05	<0.05	<0.05
Sulphur	mg/L	0.1	0.4	<0.6	<0.1	<0.6	<0.1	0.21	<0.1	<0.1
Thallium	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin	µg/L	0.01-0.2	<0.01	<0.2	<0.01	<0.2	<0.01	<0.01	<0.01	<0.01
Titanium	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Uranium	µg/L	0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002
Vanadium	µg/L	0.1-0.2	<0.1	<0.2	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
Zinc <sup>(a)</sup>	µg/L	0.1	-	-	-	-	<b>0.59</b>	0.4	<0.1	<0.1
Zirconium	µg/L	0.05-0.1	<0.05	<0.1	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05
<b>Dissolved Metals</b>										
Aluminum	µg/L	0.5	0.86	<0.5	0.7	<b>5.17</b>	<b>3.06</b>	0.47	0.81	0.48
Antimony	µg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic	µg/L	0.02	<0.02	<0.02	<0.02	0.021	<0.02	<0.02	<0.02	<0.02
Barium	µg/L	0.02	0.027	<0.02	<0.02	<b>0.187</b>	0.083	0.025	<0.02	<0.02
Beryllium	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bismuth	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	µg/L	5	<5	<5	<5	<50	<5	<5	<5	<5
Cadmium	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	µg/L	0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05
Cobalt	µg/L	0.005	<0.005	<0.005	<0.005	0.006	0.006	<0.005	<0.005	0.008
Copper	µg/L	0.05	<0.05	<0.05	0.068	<0.05	<0.05	<0.05	<0.05	0.079
Iron	µg/L	1	2.9	<1	<1	3.7	1	1.8	<1	<1
Lead	µg/L	0.005	0.009	<0.005	<0.005	0.005	<0.005	0.006	<0.005	0.01
Lithium	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Manganese	µg/L	0.05	<0.05	<0.05	<0.05	0.204	<0.05	<0.05	<0.05	<0.05
Mercury	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	0.0061	0.0044	<0.002	0.002
Molybdenum	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	µg/L	0.02	0.068	<0.02	0.03	0.044	0.041	<0.02	<0.02	0.08
Selenium	µg/L	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Silicon	µg/L	50	<50	<50	<50	<100	<50	<50	<50	<50
Silver	µg/L	0.005	<0.005	<0.005	<0.005	0.013	<0.005	<0.005	<0.005	0.014

**Table C-1 Blank Sample Results, 2014**

Variable	Unit	DL	Ice-cover				Open-water			
			NF5B-1	MF3-5T-3	MF1-1B-1	FF2-5M-2	NF5B-1	MF1-5T-1	FF2-2T-3	MF3-1B-2
			Equipment Blank	Trip Blank	Equipment Blank	Field Blank	Equipment Blank	Equipment Blank	Trip Blank	Field Blank
			25-Apr-14	29-Apr-14	1-May-14	27-Apr-14	21-Aug-14	1-Sep-14	22-Aug-14	25-Aug-14
Strontium	µg/L	0.05	0.055	<0.05	<0.05	0.123	0.073	0.057	<0.05	0.089
Sulphur	mg/L	0.1	<0.1	<0.1	<0.1	<0.6	0.15	0.16	0.2	<0.1
Thallium	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin	µg/L	0.01-0.2	<0.01	<0.01	<0.01	<0.2	<0.01	<0.01	<0.01	0.014
Titanium	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.59
Uranium	µg/L	0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	0.005
Vanadium	µg/L	0.1-0.2	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1
Zinc <sup>(a)</sup>	µg/L	0.1	-	-	-	-	<0.1	0.1	<0.1	<0.1
Zirconium	µg/L	0.05-0.1	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05

Notes: mg/L = milligrams per litre; NTU = nephelometric turbidity units; µS/cm = microSiemens per centimetre; µg/L = micrograms per litre; DL = detection limit; CaCO<sub>3</sub> = calcium carbonate.

**Bolded** values an exceedance of the data quality objective for blanks samples (concentration greater than 5 times the DL).

a) Values for total and dissolved zinc were removed for the ice-cover sampling program due to contamination.

**Table C-2 Duplicate Sample Results, 2014**

Variable	Unit	DL	Ice-cover						Open-water								
			NF4B			MF3-1M			NF3M			MF2-3B			MF3-3T		
			22-Apr-14	22-Apr-14	RPD	28-Apr-14	28-Apr-14	RPD	22-Aug-14	22-Aug-14	RPD	31-Aug-14	31-Aug-14	RPD	29-Aug-14	29-Aug-14	RPD
			Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2	
<b>Conventional Parameters</b>																	
Acidity (pH 4.5)	mg/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Acidity (pH 8.3)	mg/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	0.52	-	<0.5	<0.5	-
Alkalinity, Total (as CaCO <sub>3</sub> )	mg/L	0.5	7.82	7.63	2%	5.8	5.87	1%	5.24	5.78	10%	5.2	5.19	0%	4.96	5.60	12%
Alkalinity (Phenolphthalein as CaCO <sub>3</sub> )	mg/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Specific Conductivity	µS/cm	1	55.3	56.1	1%	34.1	36.4	7%	30.4	31.3	3%	29.3	28.8	2%	23.9	24.2	1%
Hardness, Dissolved (CaCO <sub>3</sub> )	mg/L	0.5	13.7	13.3	3%	8.96	9.43	5%	8.3	8.54	3%	7.86	8.92	13%	7.25	6.88	5%
Hardness, Total (CaCO <sub>3</sub> )	mg/L	0.5	13.7	13.8	1%	9.1	9.71	6%	8.18	8.12	1%	8.13	8.19	1%	6.96	6.84	2%
pH	-	-	7.03	7.03	0%	6.96	6.96	0%	7.16	7.05	2%	6.91	6.9	0%	7.09	7.03	1%
Total Dissolved Solids (Calculated)	mg/L	-	27.7	27.6	0%	16.2	17.4	7%	14.5	14.7	1%	13.7	14.3	5%	12.6	12.1	4%
Total Dissolved Solids (Measured)	mg/L	1	28	50	<b>56%</b>	34.7	25	<b>32%</b>	19	21	10%	18.7	13.3	<b>34%</b>	20.7	19.3	7%
Total Suspended Solids	mg/L	1	<1	<1	-	<1	<1	-	<1	<1	-	<1	1	-	<1	<1	-
Total Organic Carbon	mg/L	0.2	2.2	2.1	5%	2.5	2.3	8%	2.3	2.5	8%	2.2	2.1	5%	2	2.1	5%
Turbidity	NTU	0.1	<0.1	<0.1	-	0.11	0.11	-	0.28	0.28	-	0.22	0.24	-	0.25	0.25	-
<b>Major Ions</b>																	
Bicarbonate	mg/L	0.5	9.54	9.31	2%	7.08	7.16	1%	6.39	7.05	10%	6.34	6.33	0%	6.05	6.83	12%
Calcium	mg/L	0.01	2.96	2.8	6%	1.84	1.93	5%	1.67	1.75	5%	1.6	1.82	13%	1.49	1.33	11%
Carbonate	mg/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Chloride	mg/L	0.5	5.8	5.8	0%	2.9	3.1	7%	2.5	2.4	-	2.3	2.3	-	2.1	1.6	-
Fluoride	mg/L	0.01	0.039	0.036	-	0.03	0.03	-	0.028	0.023	-	0.024	0.023	-	0.023	0.023	-
Hydroxide	mg/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Magnesium	mg/L	0.01	1.53	1.53	0%	1.06	1.12	6%	1	1.01	1%	0.939	1.06	12%	0.859	0.867	1%
Potassium	mg/L	0.01	1.55	1.54	1%	0.957	1.03	7%	0.886	0.865	2%	0.823	0.991	19%	0.703	0.724	3%
Sodium	mg/L	0.01	4.18	4.27	2%	1.95	2.31	17%	1.83	1.95	6%	1.81	1.77	2%	1.46	1.35	8%
Sulphate	mg/L	0.5	6.21	6.3	1%	3.93	4.15	5%	3.45	3.24	6%	3.05	3.23	6%	2.93	2.84	3%
<b>Nutrients</b>																	
Ammonia (as Nitrogen)	µg/L	5	-	33	-	29	31	7%	18	14	-	10	11	-	18	39	<b>74%</b>
Nitrate (as Nitrogen)	µg/L	2	164	168	2%	22.9	56	<b>84%</b>	2.7	2.1	-	2.2	2.1	-	10.5	2.3	<b>128%</b>
Nitrite (as Nitrogen)	µg/L	2	2.5	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-
Nitrate + Nitrite (as Nitrogen)	µg/L	2	167	168	1%	22.9	56	<b>84%</b>	2.7	2.1	-	2.2	2.1	-	2.7	2.3	-
Nitrogen - Kjeldahl, Total	µg/L	20	163	156	4%	192	169	13%	254	210	19%	150	152	1%	200	187	7%
Nitrogen - Kjeldahl, Dissolved	µg/L	20	155	147	5%	147	157	7%	229	168	<b>31%</b>	138	136	1%	160	189	17%
Nitrogen, Total	µg/L	20	330	324	2%	215	225	5%	256	212	19%	152	154	1%	147	174	17%
Nitrogen, Dissolved	µg/L	20	322	315	2%	170	213	<b>22%</b>	232	171	<b>30%</b>	140	138	1%	170	191	12%
Orthophosphate	µg/L	1	<1	<1	-	<1	1.4	-	1.4	1.2	-	<1	<1	-	1.8	1.6	-
Phosphorus, Dissolved	µg/L	2	2.1	2.2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-
Phosphorus, Total	µg/L	2	5.2	4.3	-	<2	<2	-	2.6	<2	-	3.4	3.2	-	<2	<2	-

**Table C-2 Duplicate Sample Results, 2014**

Variable	Unit	DL	Ice-cover						Open-water								
			NF4B			MF3-1M			NF3M			MF2-3B			MF3-3T		
			22-Apr-14	22-Apr-14	RPD	28-Apr-14	28-Apr-14	RPD	22-Aug-14	22-Aug-14	RPD	31-Aug-14	31-Aug-14	RPD	29-Aug-14	29-Aug-14	RPD
			Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2	
<b>Total Metals</b>																	
Aluminum	µg/L	0.2	24.8	30.3	20%	4.42	5.6	24%	6.21	6.06	2%	5.35	5.36	0%	3.67	4.15	12%
Antimony	µg/L	0.02	0.052	0.046	-	0.029	0.021	-	0.021	0.021	-	<0.02	<0.02	-	<0.02	0.031	-
Arsenic	µg/L	0.02	0.348	0.364	4%	0.258	0.282	9%	0.239	0.25	4%	0.233	0.254	9%	0.187	0.188	1%
Barium	µg/L	0.02	5.78	5.01	14%	2.98	3.12	5%	2.64	2.42	9%	2.31	2.51	8%	1.98	2.07	4%
Beryllium	µg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-
Bismuth	µg/L	0.005	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Boron	µg/L	5	<5	<5	-	<5	<5	-	<5	<5	-	<5	<5	-	<5	<5	-
Cadmium	µg/L	0.005	0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Calcium	mg/L	0.01	3.01	2.99	1%	1.84	2	8%	1.73	1.67	4%	1.67	1.66	1%	1.33	1.29	3%
Chromium	µg/L	0.05	0.2	0.15	-	0.12	<0.1	-	0.078	0.057	-	0.057	0.16	-	<0.05	<0.05	-
Cobalt	µg/L	0.005	0.039	0.016	<b>84%</b>	0.015	0.015	-	0.017	0.013	-	0.014	0.012	-	0.016	0.017	-
Copper	µg/L	0.05	1.78	0.759	<b>80%</b>	0.656	0.676	3%	0.568	0.555	2%	0.571	0.694	19%	0.542	0.561	3%
Iron	µg/L	1	23.3	3.6	<b>146%</b>	2.3	2.4	-	9.2	8	14%	5.6	5.9	5%	3.7	4.3	-
Lead	µg/L	0.005	0.137	0.006	<b>183%</b>	0.008	<0.005	-	0.015	0.006	-	<0.005	<0.005	-	<0.005	<0.005	-
Lithium	µg/L	0.5	2.34	2.32	-	1.78	1.81	-	1.61	1.57	-	1.42	1.43	-	1.44	1.47	-
Magnesium	mg/L	0.01	1.5	1.55	3%	1.09	1.15	5%	0.939	0.961	2%	0.96	0.982	2%	0.884	0.875	1%
Manganese	µg/L	0.05	2.51	1.83	<b>31%</b>	0.875	0.978	11%	1.7	1.41	19%	1.33	1.7	<b>24%</b>	1.13	1.06	6%
Mercury	µg/L	0.002	<0.002	<0.002	-	<0.002	<0.002	-	0.0048	0.0042	-	0.004	0.0055	-	<0.002	<0.002	-
Molybdenum	µg/L	0.05	2.08	2.07	0%	0.645	0.895	<b>32%</b>	0.577	0.6	4%	0.521	0.536	3%	0.266	0.245	8%
Nickel	µg/L	0.02	1	0.942	6%	0.985	1.13	14%	0.613	0.65	6%	0.571	0.568	1%	0.811	0.812	0%
Potassium	mg/L	0.01	1.45	1.57	8%	0.988	1.07	8%	0.871	0.885	2%	0.858	0.919	7%	0.726	0.695	4%
Selenium	µg/L	0.04	<0.04	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	-
Silicon	µg/L	50	329	339	3%	<100	111	-	<50	<50	-	<50	<50	-	<50	<50	-
Silver	µg/L	0.005	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Sodium	mg/L	0.01	3.96	4.2	6%	1.96	2.3	16%	1.79	1.86	4%	1.59	1.9	18%	1.35	1.34	1%
Strontium	µg/L	0.05	44.8	44.5	1%	21.4	25.5	17%	19.5	18.4	6%	17.6	19.4	10%	13.3	13.4	1%
Sulphur	mg/L	0.1	1.16	2.29	<b>66%</b>	1.02	1.83	<b>57%</b>	0.91	1.51	<b>50%</b>	0.96	0.8	18%	0.62	0.64	3%
Thallium	µg/L	0.002	0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	-
Tin	µg/L	0.01-0.2	0.22	<0.2	-	<0.2	<0.2	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-
Titanium	µg/L	0.5	0.86	1.07	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Uranium	µg/L	0.002	0.185	0.172	7%	0.071	0.089	<b>23%</b>	0.079	0.075	5%	0.063	0.094	<b>39%</b>	0.043	0.044	2%
Vanadium	µg/L	0.1-0.2	0.31	0.29	-	<0.2	<0.2	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-
Zinc <sup>(a)</sup>	µg/L	0.1	-	-	-	-	-	-	0.39	0.37	-	0.41	0.29	-	0.31	0.84	<b>92%</b>
Zirconium	µg/L	0.05-0.1	<0.1	<0.1	-	<0.1	<0.1	-	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	-
<b>Dissolved Metals</b>																	
Aluminum	µg/L	0.5	15.6	8.35	<b>61%</b>	6.19	3.82	<b>47%</b>	13.8	16.3	17%	4.43	1.63	<b>92%</b>	1.78	1.75	-

**Table C-2 Duplicate Sample Results, 2014**

Variable	Unit	DL	Ice-cover						Open-water								
			NF4B			MF3-1M			NF3M			MF2-3B			MF3-3T		
			22-Apr-14	22-Apr-14	RPD	28-Apr-14	28-Apr-14	RPD	22-Aug-14	22-Aug-14	RPD	31-Aug-14	31-Aug-14	RPD	29-Aug-14	29-Aug-14	RPD
			Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2		Duplicate 1	Duplicate 2	
Antimony	µg/L	0.02	0.046	0.047	-	0.021	0.021	-	<0.02	0.023	-	<0.02	<0.02	-	0.02	<0.02	-
Arsenic	µg/L	0.02	0.348	0.368	6%	0.256	0.262	2%	0.233	0.25	7%	0.236	0.246	4%	0.192	0.188	2%
Barium	µg/L	0.02	4.98	4.98	0%	2.87	2.99	4%	2.54	2.76	8%	2.37	2.32	2%	2.18	2	9%
Beryllium	µg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-
Bismuth	µg/L	0.005	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Boron	µg/L	5	<5	<5	-	<5	<5	-	<5	<5	-	<5	<5	-	<5	<5	-
Cadmium	µg/L	0.005	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Chromium	µg/L	0.05	0.15	0.13	-	0.139	0.089	-	0.053	0.071	-	<0.05	0.055	-	0.124	<0.05	-
Cobalt	µg/L	0.005	0.023	0.016	-	0.01	0.008	-	0.008	0.009	-	0.007	<0.005	-	0.011	0.008	-
Copper	µg/L	0.05	0.744	1.21	<b>48%</b>	0.64	0.613	4%	0.558	0.54	3%	0.534	0.461	15%	0.675	0.659	2%
Iron	µg/L	1	4.1	1.7	-	1.4	<1	-	2.4	3.7	-	1.4	<1	-	4.5	1.6	-
Lead	µg/L	0.005	0.019	0.005	-	<0.005	<0.005	-	0.005	0.01	-	<0.005	<0.005	-	0.008	<0.005	-
Lithium	µg/L	0.5	2.34	2.25	-	1.59	1.9	-	1.51	1.7	-	1.63	1.57	-	1.41	1.64	-
Manganese	µg/L	0.05	1.49	1.48	1%	0.579	0.668	14%	0.394	0.386	2%	0.132	<0.05	-	0.464	0.241	<b>63%</b>
Mercury	µg/L	0.002	<0.002	<0.002	-	<0.002	<0.002	-	0.0058	0.0049	-	<0.002	<0.002	-	<0.002	<0.002	-
Molybdenum	µg/L	0.05	2.01	1.88	7%	0.644	0.843	<b>27%</b>	0.589	0.61	4%	0.5	0.56	11%	0.314	0.292	7%
Nickel	µg/L	0.02	1.02	0.849	18%	0.976	0.844	15%	0.604	0.659	9%	0.562	0.501	11%	0.85	0.888	4%
Selenium	µg/L	0.04	<0.04	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	-
Silicon	µg/L	50	328	322	2%	80	101	-	<50	<50	-	<50	<50	-	<50	<50	-
Silver	µg/L	0.005	0.007	0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Strontium	µg/L	0.05	45.9	45.7	0%	19.7	24.1	20%	19.6	19.1	3%	17.6	18.1	3%	13.4	13.1	2%
Sulphur	mg/L	0.1	1.64	1.78	8%	1.65	1.36	19%	1.26	1.01	<b>22%</b>	1.14	1.06	7%	0.68	0.92	<b>30%</b>
Thallium	µg/L	0.002	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	-	<0.002	<0.002	-
Tin	µg/L	0.01-0.2	<0.2	<0.2	-	<0.01	<0.01	-	<0.01	0.011	-	<0.01	<0.01	-	0.014	<0.01	-
Titanium	µg/L	0.5	0.66	0.7	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Uranium	µg/L	0.002	0.169	0.165	2%	0.062	0.081	<b>27%</b>	0.071	0.07	1%	0.061	0.047	<b>26%</b>	0.04	0.04	0%
Vanadium	µg/L	0.1	0.36	0.25	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-
Zinc <sup>(a)</sup>	µg/L	0.1	-	-	-	-	-	-	15.8	18.2	14%	0.36	0.13	-	0.28	0.16	-
Zirconium	µg/L	0.05-0.1	<0.1	<0.1	-	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	-

RPD = relative percent difference; - = not applicable; NTU = nephelometric turbidity unit; µS/cm = microSiemens per centimetre; DL = detection limit; CaCO<sub>3</sub> = calcium carbonate.

Note: **Bolded** values identify duplicate samples that had RPD values greater than 20%, and concentrations in one or both samples that were greater than or equal to five times the DL. **Bolded and underlined** values identify RPD values greater than 50% and concentrations in one or both samples that were greater than or equal to five times the DL.

a) Values for total and dissolved zinc were removed for the ice-cover sampling program dataset due to contamination.

## Other QC Issues

### Zinc Sample Contamination

In 2014, DDMI identified contamination in effluent and lake water samples analyzed for total and dissolved zinc. A follow-up investigation determined that the gloves used during sample collection and handling (i.e., preservation, filtering) were a likely source of the elevated zinc in these samples. The anomalous results for zinc were first identified for Surveillance Network Program (SNP) samples that were screened against various QA/QC checks performed by DDMI's database. DDMI implemented a QA/QC review of the analytical results, which included a re-run of total and dissolved zinc from a different sample container (routine chemistry). This sample was not preserved or filtered in the field. In most cases, concentrations in the routine chemistry container were at least an order of magnitude lower, compared to the original results.

Only samples collected during the open-water AEMP could be re-analyzed for zinc (Table C-3) because the ice-cover season samples had been disposed of when the contamination was identified. The zinc data from the ice-cover sampling program, therefore, were excluded from the 2014 AEMP report. The open-water zinc data analyzed from the routine chemistry sample container were retained in all relevant analyses completed in support of 2014 AEMP report. The QA/QC procedures used to address the zinc contamination identified within the SNP dataset are described by DDMI (2014a) (1645-18 Discharge Exceedance – Total Zinc) and DDMI (2014b) (UPDATE 1645-18 Discharge Exceedance – Total Zinc).

**Table C-3 Filter Blank Sample Results, Open-water Season 2014**

Sample	Date	Sample Type	Zinc Concentration (µg/L)			
			Total		Dissolved	
			Metals Container (Original Result)	Routine Chemistry Container	Metals Container (Original Result)	Routine Chemistry Container
NF1T	8/20/2014	GW	1.87	0.26	11.5	0.16
NF1M	8/20/2014	GW	12.8	0.43	12.4	0.26
NF1B	8/20/2014	GW	5.41	0.68	12.3	0.47
NF2T	8/21/2014	GW	1.60	0.73	2.47	0.52
NF2M	8/21/2014	GW	2.44	1.28	3.32	1.17
NF2B	8/21/2014	GW	3.55	0.51	3.68	0.91
NF3T	8/22/2014	GW	9.19	0.19	2.62	0.17
NF3M-4	8/22/2014	GW	0.39	0.45	15.8	0.35
NF3M-5	8/22/2014	FD	0.37	0.32	18.2	0.25
NF3B	8/22/2014	GW	2.42	0.25	2.65	0.27
NF4T	8/21/2014	GW	1.07	0.27	2.91	0.25
NF4M	8/21/2014	GW	1.75	0.40	3.72	0.29
NF4B	8/21/2014	GW	0.86	0.41	0.75	0.27
NF5T	8/21/2014	GW	1.12	0.28	5.06	0.16
NF5M	8/21/2014	GW	32.3	0.39	5.02	0.36
NF5B	8/21/2014	GW	7.05	0.92	0.89	0.36
MF1-1T	8/24/2014	GW	3.09	0.25	4.66	0.19



**Table C-3 Filter Blank Sample Results, Open-water Season 2014**

Sample	Date	Sample Type	Zinc Concentration ( $\mu\text{g/L}$ )			
			Total		Dissolved	
			Metals Container (Original Result)	Routine Chemistry Container	Metals Container (Original Result)	Routine Chemistry Container
MF1-1M	8/24/2014	GW	2.72	0.23	1.91	0.22
MF1-1B	8/24/2014	GW	24.2	0.38	5.42	0.32
MF1-3T	8/26/2014	GW	0.66	0.17	10.6	0.16
MF1-3M	8/26/2014	GW	0.31	0.15	8.00	0.12
MF1-3B	8/26/2014	GW	0.65	0.24	2.30	0.39
MF1-5T	9/1/2014	GW	0.94	0.27	0.47	0.21
MF1-5M	9/1/2014	GW	3.28	0.52	1.21	0.44
MF1-5B	9/1/2014	GW	0.58	0.45	2.75	0.40
MF2-1T	8/28/2014	GW	14.7	0.27	1.72	0.20
MF2-1M	8/28/2014	GW	3.54	0.20	11.7	0.15
MF2-1B	8/28/2014	GW	12.1	0.73	4.89	0.46
MF2-3T	8/31/2014	GW	1.59	0.25	1.30	0.24
MF2-3M	8/31/2014	GW	0.54	0.26	5.69	0.22
MF2-3B-4	8/31/2014	GW	0.41	0.40	0.36	0.31
MF2-3B-5	8/31/2014	FD	0.29	0.23	0.16	0.13
FF2-2T	8/22/2014	GW	4.29	0.24	3.93	0.21
FF2-2M	8/22/2014	GW	8.27	0.20	1.26	0.11
FF2-2B	8/22/2014	GW	21.3	0.17	2.21	0.13
FF2-5T	8/22/2014	GW	0.97	0.35	2.89	0.19
FF2-5M	8/22/2014	GW	0.76	0.46	1.49	0.36
FF2-5B	8/22/2014	GW	1.14	0.26	4.46	0.19
MF3-1T	8/25/2014	GW	5.85	0.54	22.3	0.43
MF3-1M	8/25/2014	GW	9.20	0.56	3.69	0.53
MF3-1B	8/25/2014	GW	14.5	0.47	19.0	0.42
MF3-2T	8/28/2014	GW	12.1	0.42	7.16	0.47
MF3-2M	8/28/2014	GW	17.9	0.48	9.54	0.38
MF3-2B	8/28/2014	GW	0.70	0.26	6.26	0.25
MF3-3T-4	8/29/2014	GW	0.31	0.24	0.28	0.28
MF3-3T-5	8/29/2014	FD	0.84	0.20	0.16	0.16
MF3-3M	8/29/2014	GW	3.18	0.27	2.75	0.30
MF3-3B	8/29/2014	GW	0.92	4.49	4.70	0.31
MF3-4T	8/26/2014	GW	0.94	0.30	6.92	0.26
MF3-4M	8/26/2014	GW	3.96	0.47	17.1	0.36
MF3-4B	8/26/2014	GW	1.66	1.60	2.80	2.37
MF3-5T	8/29/2014	GW	5.93	0.46	1.22	0.43
MF3-5M	8/29/2014	GW	0.70	0.41	1.01	0.39
MF3-5B	8/29/2014	GW	2.10	0.76	3.54	0.47
MF3-6T	8/26/2014	GW	19.9	0.33	2.38	0.31
MF3-6M	8/26/2014	GW	1.74	0.30	2.44	0.35
MF3-6B	8/26/2014	GW	4.58	0.55	9.34	0.50

**Table C-3 Filter Blank Sample Results, Open-water Season 2014**

Sample	Date	Sample Type	Zinc Concentration ( $\mu\text{g/L}$ )			
			Total		Dissolved	
			Metals Container (Original Result)	Routine Chemistry Container	Metals Container (Original Result)	Routine Chemistry Container
MF3-7T	8/29/2014	GW	5.69	0.48	7.24	0.38
MF3-7M	8/29/2014	GW	1.86	0.37	3.48	0.33
MF3-7B	8/29/2014	GW	1.42	0.29	6.38	0.30
LDG48	8/30/2014	GW	1.12	0.56	2.06	0.44
NF5B-1	8/21/2014	EB	1.10	0.59	3.52	<0.1
MF1-5T-1	9/1/2014	EB	0.92	0.40	0.97	0.1
FF2-2-3	8/22/2014	TB	0.72	<0.1	<0.1	<0.1
MF3-1B-2	8/25/2014	FB	0.61	<0.1	4.16	<0.1

< less than; GW = grab water, FD = field duplicate, EB = equipment blank, TB = trip blank; FB = field blank.

### ***Nutrient Filter Blank Results***

During the open-water sampling program in 2014, two different types of filters were provided by the analytical laboratory to filter samples intended for low-level dissolved metals and dissolved nutrients analyses. These included a non-sterile 45-micrometre ( $\mu\text{m}$ ), 25 millimetre (mm) diameter filter for the dissolved nutrients analysis bottle and a sterile 45- $\mu\text{m}$ , 32 mm diameter filter for the dissolved metals analysis bottle. During the early stages of the field program, the non-sterile filter was inadvertently used to filter some of the dissolved metals samples. Since the non-sterile filter is not verified as suitable for use for analysis of dissolved metals, two filter blank samples were submitted to the analytical lab using the non-sterile filter to determine if there was an effect on the dissolved metals results.

The filter blank results show that the DQO for blank samples (concentration less than 5 times the DL) was met for all metals analyzed (Table C-4). Low level concentrations of nickel and sulphur were present in the MF1-5-12 filter blank; however, concentrations were less than or similar to values reported in other blank samples collected during the 2014 AEMP. These results indicate that the use of the non-sterile filter has not resulted in data quality issues with the 2014 open-water dissolved metals results.

**Table C-4 Filter Blank Sample Results, Open-water Season, 2014**

Variable	DL	MF1-5-12	MF1-5-13	Variable	DL	MF1-5-12	MF1-5-13
		Filter Blank	Filter Blank			Filter Blank	Filter Blank
		4-Sep-14	4-Sep-14			4-Sep-14	4-Sep-14
<b>Dissolved Metals</b>							
Aluminum	0.5	<0.2	<0.2	Molybdenum	0.05	<0.05	<0.05
Antimony	0.02	<0.02	<0.02	Nickel	0.02	0.03	<0.02
Arsenic	0.02	<0.02	<0.02	Selenium	0.04	<0.04	<0.04
Barium	0.02	<0.02	<0.02	Silicon	50	<50	<50
Beryllium	0.01	<0.01	<0.01	Silver	0.005	<0.005	<0.005
Bismuth	0.005	<0.005	<0.005	Strontium	0.05	<0.05	<0.05
Boron	5	<5	<5	Sulphur	0.1	0.15	<0.1
Cadmium	0.005	<0.005	<0.005	Thallium	0.002	<0.002	<0.002
Chromium	0.05	<0.05	<0.05	Tin	0.01	<0.01	<0.01
Cobalt	0.005	<0.005	<0.005	Titanium	0.5	<0.5	<0.5
Copper	0.05	<0.05	<0.05	Uranium	0.002	<0.002	<0.002
Iron	1	<1	<1	Vanadium	0.1	<0.1	<0.1
Lead	0.005	<0.005	<0.005	Zinc	0.1	<0.1	<0.1
Lithium	0.5	<0.5	<0.5	Zirconium	0.05	<0.05	<0.05
Manganese	0.05	<0.05	<0.05				

DL = detection limit; &lt; = less than.

## **APPENDIX D**

### **2014 WATER QUALITY RAW DATA – AEMP AND SNP (SNP 1645-18 AND SNP 1645-19)**

These data are provided electronically as an Excel file.

## **APPENDIX III**

### **SEDIMENT REPORT**

No information was available for this appendix in 2014.

## **APPENDIX IV**

### **BENTHIC INVERTEBRATE REPORT**

No information was available for this appendix in 2014.

# **APPENDIX V**

## **FISH REPORT**



**MERCURY IN LAKE TROUT REPORT  
IN SUPPORT OF THE 2014 AEMP ANNUAL  
REPORT FOR THE DIAVIK DIAMOND MINE,  
NORTHWEST TERRITORIES**

Submitted to:

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X1A 2P8, Canada

**DISTRIBUTION**

- 1 Copy – Diavik Diamond Mines (2012) Inc., Yellowknife, NT
- 1 Copy – Golder Associates Ltd., Calgary, AB
- 1 Copy – Wek'èezhii Land and Water Board

March 2016  
1406208

Doc No. RPT-1508 Ver. 0  
PO No. D03013





## EXECUTIVE SUMMARY

In 2014, Diavik Diamond Mines (2012) Inc. (DDMI) completed the field component of its Aquatic Effects Monitoring Program (AEMP), as required by Water Licence W2007L2-0003. The mercury (Hg) in Lake Trout survey is a component of the AEMP, conducted every three years. The main objective of the Hg in Lake Trout program is to monitor Hg concentrations in Lake Trout muscle in Lac du Gras and Lac du Sauvage. A secondary objective of the study was to determine if Lake Trout in Lac de Gras and Lac du Sauvage move between the two study lakes.

### Mercury Concentrations in Lake Trout Muscle

In 2014, Hg concentrations in Lake Trout muscle returned to near baseline concentrations. A summary of key points of this study are as follows:

- In both Lac de Gras and Lac du Sauvage, the concentration of Hg in Lake Trout muscle increased from 1996 to 2008, remained elevated in 2011, and then was detected at concentrations near baseline in 2014.
- In 2014, the concentration of Hg in Lake Trout muscle in Lac de Gras was below the Canadian government maximum acceptable levels in the edible portion of retail fish (0.5 micrograms per gram [ $\mu\text{g/g}$ ] wet weight [ww]) and only one fish in Lac du Sauvage was higher (0.51 $\mu\text{g/g}$  ww).
- The concentration of Hg in Lake Trout muscle in 2014 in both lakes is below a relevant effect threshold/tissue residue guideline (1.0 $\mu\text{g/g}$  ww) such that Lake Trout health is unlikely to be affected.
- Hg continues to be undetected in Mine effluent and surrounding surface water.
- The reason for the variations in tissue concentrations in Lake Trout muscle over time are outside the scope of this study.

### Movement between Study Lakes

In previous AEMP reports, it was identified that large-bodied fish from Lac de Gras and Lac du Sauvage may move between the two lakes, raising uncertainty that Lac du Sauvage could be used as a reference lake for large-bodied fisheries surveys. During the Lake Trout fish tissue sampling program in 2014, passive integrated transponder (PIT) tags were installed in a subset of Lake Trout. In 2015, DDMI activated an array in the narrows between Lac de Gras and Lac du Sauvage. The array documented movements of Lake Trout between lakes.

The results of DDMI's movement survey indicated that 23% of Lake Trout tagged in 2014 travelled between lakes through the narrows connecting Lac de Gras and Lac du Sauvage in 2015. The survey did not document direction of the movement, only that Lake Trout did move back and forth. This confirms that Lac du Sauvage should not function as a reference lake for the Lake Trout Hg monitoring program. This result applies only to Lake Trout and not to small-bodied fish. The Hg concentrations detected in Lake Trout muscle in both study lakes are valid; no attempt to statistically compare Lake Trout concentrations from the lake exposed to treated mine effluent (Lac de Gras) to a reference lake (Lac du Sauvage) was made herein.

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**Acronyms and Abbreviations**

AEMP	Aquatic Effects Monitoring Program
ALS	ALS Laboratory Group
ANCOVA	Analysis of Covariance
BrCl	bromine monochloride
CFIA	Canadian Food Inspection Agency
COC	chain-of-custody
CPUE	catch-per-unit-effort
CVAAS	Cold Vapor Atomic Absorption Spectrometry
DDMI	Diavik Diamond Mines (2012) Inc.
DFO	Fisheries and Oceans Canada
dw	dry weight
Flett	Flett Research Ltd.
Golder	Golder Associates Ltd.
Hg	mercury
<i>K</i>	Fulton's condition factor
KS	Kolmogorov-Smirnov
%LOD	percent loss on drying
MeHg	methylmercury
MF	mid-field
Mine	Diavik Diamond Mine
<i>n</i>	sample size
NF	near-field
<i>P</i>	probability
PIT	passive integrated transponder
QA/QC	quality assurance/quality control
$R^2$	coefficient of determination
RPD	relative percent difference
SD	standard deviation
SOP	standard operating procedure
SR	studentized residuals
USEPA	U. S. Environmental Protection Agency
WLWB	Wek'èezhii Land and Water Board
ww	wet weight

**Units of Measure**

°C	degrees Celsius
km	kilometres
±	plus minus
%	percent
<	less than
>	greater than
g	gram
µg/g	micrograms per gram
mL	millilitre
mm	millimetre

# **1 INTRODUCTION**

## **1.1 BACKGROUND**

In 2014, Diavik Diamond Mines (2012) Inc. (DDMI) completed the field component of its Aquatic Effects Monitoring Program (AEMP), as required by Water Licence W2007L2-0003 (WLWB 2007). A component of the AEMP is the non-lethal assessment of mercury (Hg) in Lake Trout (*Salvelinus namaycush*) muscle. During the 2007 AEMP, elevated Hg concentrations were detected in Slimy Sculpin (*Cottus cognatus*) captured from the near-field (NF) exposure area compared to the reference populations (Golder 2008). In response, DDMI initiated a monitoring program for Hg in Lake Trout that was subsequently added as a component of the AEMP in the AEMP Study Design Version 3.0 (Golder 2011). This report presents the results of a survey to assess Hg concentrations in Lake Trout muscle using a non-lethal monitoring method. The survey was conducted during the 2014 field program by Golder Associates Ltd. (Golder) according to AEMP Study Design Version 3.5 (Golder 2014a), which was approved by the Wek'èezhii Land and Water Board (WLWB) on May 29, 2014 (WLWB 2014). Details on methodology are provided in Section 2. Section 3 provides results of the survey, while Section 4 provides a discussion of the results. Conclusions are provided in Section 5.

## **1.2 OBJECTIVES**

### **Mercury tissue concentrations**

The objective of the 2014 non-lethal Lake Trout survey was to monitor Hg concentrations in Lake Trout muscle.

### **Movement between study lakes**

During the Lake Trout tissue sampling program in 2014, passive integrated transponder (PIT) tags were installed in a subset of Lake Trout and in 2015 a movement study was conducted by DDMI. The objective of the movement study was to determine if Lake Trout in Lac de Gras and Lac du Sauvage move between the two lakes.

## 2 METHODS

This study consisted of a non-lethal survey of Lake Trout for total Hg concentrations in muscle tissue and was designed to examine possible changes in Hg concentrations over time. A review of the relevant methods employed in the previous Lake Trout tissue studies and the approach to deal with differences in inter-year sampling methodology is outlined in Section 2.1. Methods employed for the 2014 Lake Trout survey are described in Section 2.2 to Section 2.4 and for the PIT tag study in Section 2.5. Quality Assurance/Quality Control (QA/QC) methods are outlined in Section 2.6. Photographs of the field methods and conditions are provided in Appendix A.

### 2.1 APPROACH

#### Historical data

Total Hg data from five studies (1996 [Golder 1997]; 2005 [CRI 2006]; 2008 [Golder 2009a,b]; 2011 [Golder 2012]; 2014 [present study]), as well as data from the annual DDMI palatability surveys (DDMI 2003; Thorpe 2013; and unpublished data), were used in the comparison of Hg concentrations over time. Given differences between years, specific statistical trend analyses are not completed but a comparison between years is done. Every attempt was made to allow comparisons between years to be made in an appropriate manner.

#### Sampling methods

Descriptions of the methods used for the 1996, 2005, 2008 and 2011 fish surveys are provided in Golder (1997, 2009a, b, 2012) and CRI (2006). For ease of reference, a brief review of these methods in relation to the 2014 sampling program are provided below.

**Non-lethal method:** The non-lethal Hg sampling method was first tested in a pilot study conducted in concurrence with the 2008 metals in Lake Trout sampling program (Golder 2009b). The objective of the pilot study was to assess the accuracy of non-lethal sampling methods for monitoring Hg concentrations in Lake Trout from Lac de Gras. The non-lethal muscle plug was found to be accurate for measuring Hg concentrations in Lake Trout muscle based on the high level of agreement between dermal plug and muscle Hg concentrations from the same fish. Therefore, for subsequent studies, the non-destructive, dermal punch method was utilized as the sole sampling technique for monitoring Hg in Lake Trout muscle.

**Analytical laboratory:** Different analytical methods and laboratories were used in the past. In 1996 and 2005 Hg analysis was conducted by Enviro-Test Laboratories (Winnipeg, Manitoba; now ALS Laboratory Group [ALS]). In 2008, Hg analysis was performed by ALS (Vancouver, British Columbia), and by Flett Research Ltd. (Flett). In the 2008 pilot study, it was concluded that dermal plugs analyzed by Flett were better predictors of Hg concentration than fillets analyzed at ALS (Golder 2009a). Therefore, for the purpose of comparison of 2014 to past studies, for 2008 muscle

plug samples analyzed by Flett, and not filets analyzed by ALS, were included in the statistical analyses of data.

**Plug processing:** In 2008, two dermal plugs were collected from each fish and composited into one sample by the laboratory with skin/scale included. In 2011, two dermal plugs were collected and stored in same vial but run separately with skin/scale removed. In 2014, two dermal plugs were collected from each fish and stored in separate vials and analyzed individually with skin/scales removed. This allowed analyses between plugs to be compared. In each year, the sample weight is measured as sample with skin/scale on.

**Tissue type:** In 2008, Hg concentration in caudal fins was measured and compared to the results from the dermal punch and muscle fillet. Analyses of the dermal punch data showed it better approximated the whole fillet concentration. In 2014, caudal fin samples were collected and archived but not analyzed.

**Composite samples:** The objective of the 1996 study was to establish a baseline of metals in several lakes and fish species. Consequently, Lake Trout tissue samples were not submitted for metals analysis as individual samples, but rather were submitted to the laboratory as composite samples, with each sample consisting of tissue samples from two to six fish. Each composite comprised fish of the same species, sex, and capture location, but was not composited based on length, weight, age or state of sexual maturity. Consequently, comparisons to baseline Hg data from 1996 are qualitative; statistical comparisons between baseline and subsequent years, which analyzed individual samples and not composites samples, were not conducted in 2014.

**Gear type:** In 1996 and 2005, Lake Trout were captured primarily with gill nets (Golder 1997; CRI 2006). In 2008, Lake Trout were captured exclusively by angling (Golder 2009a), and in 2011, a combination of both angling and gill netting was used (Golder 2012). In 2014, angling was used exclusively as this reduced mortality.

**Sample location:** In both 1996 and 2005 sampling was conducted in the NF exposure area with two additional locations in Lac de Gras being sampled in 2005. Lac du Sauvage was not sampled in 2005. In 1996, the Lac du Sauvage capture location was the same as that in 2008 and 2011, at the south end of the lake, near the narrows. In 2014, sampling effort was concentrated on areas further from the narrows due to the concern of fish near the narrows moving between the two lakes. Sampling locations are shown on Figure 2-1 and Figure 2-2.

**Sample size:** Target sample sizes were 40 Lake Trout from both lakes in 1996, 20 Lake Trout from each of the two lakes in 2008 and 30 Lake Trout from each lake in 2011. Target sample size in 2014 was set at 30 per lake in a set group of size classes. For the annual palatability studies (DDMI 2003; Thorpe 2013; and unpublished data) sample sizes are low (typically less than [ $<$ ] five) but are included in select tables herein for completeness.



## **2.2 2014 FIELD METHODS**

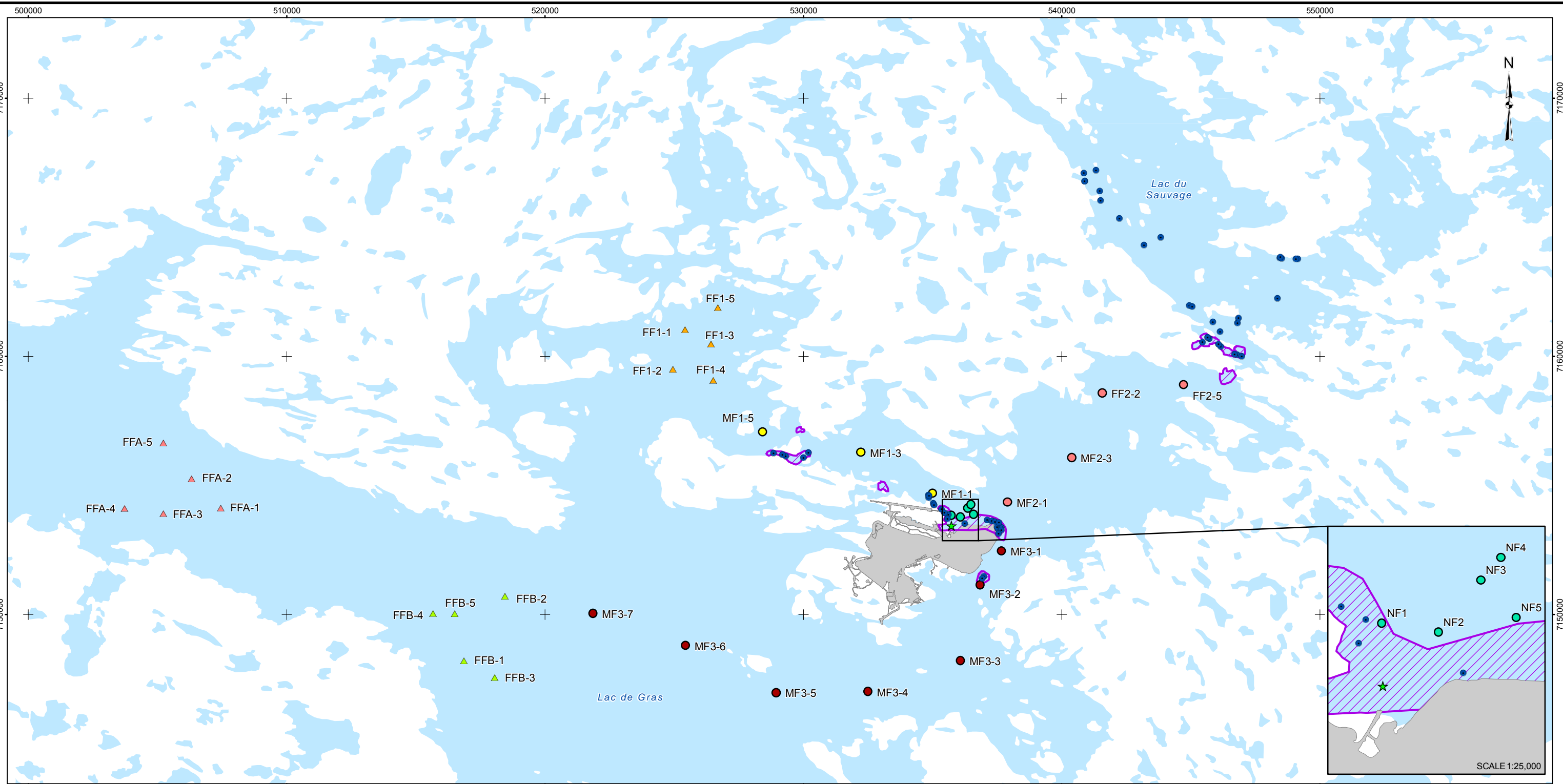
The 2014 non-lethal Hg in Lake Trout survey was conducted in Lac de Gras and Lac du Sauvage according to the methods described in DDMI Standard Operating Procedures ([SOP]; Mercury in Lake Trout – Nonlethal Analysis; SOPENV-AQU-25 Rev. 1) and the Fisheries and Oceans Canada (DFO) Fisheries Licence to collect specimens for scientific purposes (Licence# S-14/15-1028-NU).

### **2.2.1 Study Location**

Sampling was conducted on the two study lakes, Lac de Gras and Lac du Sauvage. Sampling was conducted on Lac de Gras in the NF exposure area, in the mid-field (MF) MF-1 area to the northwest and in the MF-3 area south of the Diavik Diamond Mine (Mine) footprint (Figure 2-1). GPS coordinates for each capture location was recorded. Given that Lake Trout move large distances, the capture location was documented; however, analysis of Hg concentration relative to Mine proximity was not completed.

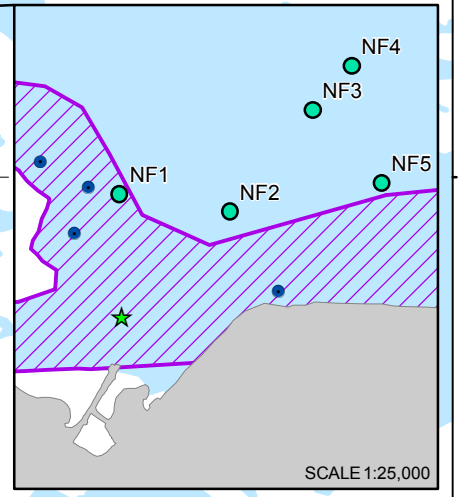
Lac du Sauvage was accessed by boat through the narrows from Lac de Gras. Fishing in Lac du Sauvage commenced near the southwest shoreline and then northwest along that shoreline and out into the southeast basin of the lake. Sampling was focussed in areas away from the narrows connecting to Lac de Gras (Figure 2-1).

i:\201111-1328\11-1328-0038\Mapping\MXD\2014AEMP\Fig2-1\_2014\_AEMP\_Trout\_Sampling\_Rev0.mxd



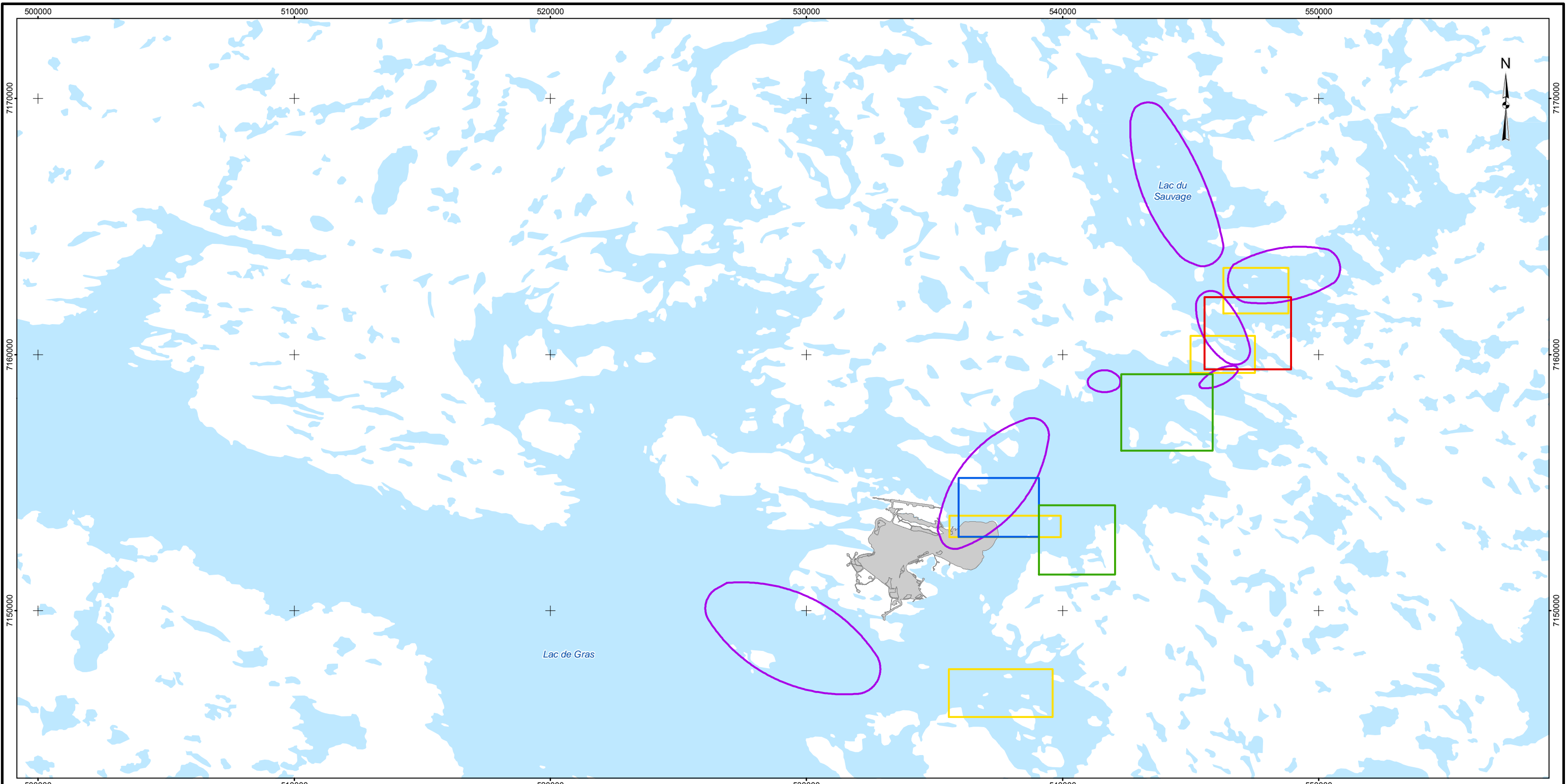
- LEGEND**
- ★ DIFFUSERS
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - ▲ FAR-FIELD 1
  - ▲ FAR-FIELD A
  - ▲ FAR-FIELD B
  - DIAVIK FOOTPRINT
  - WATERBODY
  - 2014 Hg FISH CAPTURE LOCATION
  - ▨ 2014 FISH PIT TAGGING AREA

**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83










PROJECT			
TITLE			
<b>LAKE TROUT SAMPLING LOCATIONS, 2014</b>			
	PROJECT	1406208	FILE No.
	DESIGN	JC 10 Nov. 2014	SCALE AS SHOWN
	GIS	SS 30 Mar. 2016	REV. 0
	CHECK	TD 30 Mar. 2016	<b>FIGURE: 2-1</b>
REVIEW	HM 30 Mar. 2016		

i:\2011\11-1328\11-1328-0038\Mapping\MXD\2014AEMP\Fig2\_2\_2014\_AEMP\_TroutCaptureLocations\_Rev0.mxd





**LEGEND**

 1996	 DIAVIK FOOTPRINT
 1996 AND 2005	 WATERBODY
 2005	
 2008	
 2011	



**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT			
TITLE			
<b>LAKE TROUT CAPTURE LOCATIONS, 1996, 2005, 2008 AND 2011</b>			
	PROJECT	11-1328-0038	FILE No.
	DESIGN	DR 22 Feb. 2012	SCALE AS SHOWN
	GIS	SS 30 Mar. 2016	REV. 0
	CHECK	TD 30 Mar. 2016	<b>FIGURE: 2-2</b>
	REVIEW	HM 30 Mar. 2016	

## 2.2.2 Study Timing

Field sampling occurred from July 29 to August 10, 2014. These dates were selected as they coincided with the spawning season for Lake Trout, and the timing of the previous sampling programs.

## 2.2.3 Sample Size and Gear

Lake Trout were captured exclusively by angling, trolling using large spoons, and tube jig lures. The target sample size was 30 Lake Trout from each of Lac de Gras and Lac du Sauvage. Five fish from the following six size classes, based on fork length were targeted:

- 450 to 500 millimetres (mm);
- 501 to 550 mm;
- 551 to 600 mm;
- 601 to 650 mm;
- 651 to 700 mm; and
- greater than (>) 700 mm.

These size classes were selected to target fish across the size range of Lake Trout previously captured in Lac de Gras and Lac du Sauvage (Golder 2009a, 2012).

## 2.2.4 Fish Processing

Captured Lake Trout were immediately transferred to a net cradle at the site of capture (Photo 10, Appendix A). Once the hook was removed, total length (plus minus [ $\pm$ ] 1 mm), fork length ( $\pm$  1 mm) and total body weight ( $\pm$  50 gram [g] wet weight [ww]) were recorded for each captured Lake Trout (Photo 14 and Photo 16, Appendix A). Fish were examined for the presence of external abnormalities. Fish features examined consisted of the eyes, gills, pseudobranchs, thymus, skin, body form, fins and opercula. Any features that appeared abnormal (e.g., wounds, tumours, parasites, fin fraying, gill parasites or lesions) were noted and photographed. Captured fish that were not in the target size class were weighed, measured and released alive at the point of capture.

Once a fish was determined to be of the appropriate size class, duplicate dermal plugs were collected from the dorsal portion of the fish using a 4-mm sterile, disposable biopsy punch (CDMV; St-Hyacinthe, Quebec). The biopsy punch is a sharp, hollow stainless steel punch attached to a plastic holder (Photo 19, Appendix A). To collect a dermal plug, several scales were removed, and the biopsy punch was placed against the exposed epidermis (Photo 20, Appendix A). The punch was then inserted into the dorsal musculature, and a small piece of muscle and epidermis was captured in the distal end of the punch (Photo 21, Appendix A). To retrieve the sample, the dermal plug was mouth-blown into a 4-millilitre (mL) centrifuge tube. Two dermal plugs taken adjacent to

one another were placed into separate centrifuge tubes. An antibacterial sealant was then applied to the biopsy location (Vetbond tissue glue; CDMV) (Photo 22, Appendix A) and following recovery, fish were returned to their original capture location. A small piece of the caudal fin was also removed from each fish using a ceramic knife and placed in a 4-mL centrifuge tube (Photo 17 and 18, Appendix A).

Left pelvic fin rays were used as the primary aging structures for Lake Trout (Photo 24, Appendix A). The first two leading fin rays were removed from each sampled Lake Trout, placed into individually-labelled envelopes, and sealed.

Several precautionary procedures were followed to avoid potential tissue contamination and to maintain sample integrity. A new pair of clean, non-chlorinated, non-powdered latex gloves were used for each fish that was processed. A new biopsy punch was used for each individual fish sample.

The centrifuge tubes containing the samples were placed in individual Ziploc bags, labelled, and placed in a cooler with ice. At the end of each day, the samples were transferred from the coolers to a freezer located in the DDMI field laboratory.

Upon program completion, dermal plug samples were shipped to Flett for analysis of total Hg concentration. Caudal fin samples were frozen and archived at the Golder Yellowknife office for possible Hg analysis in future. For QA/QC purposes, six dermal plug samples, which is 10 percent (%) of the number of fish sampled, were analyzed as split samples (14-LDG-LKTR-021-DP1, 14-LDG-LKTR-017-DP2, 14-LDG-LKTR-007-DP2, 14-LDS-LKTR-229-DP2, 14-LDS-LKTR-213-DP1, and 14-LDS-LKTR-205-DP2; Appendix B).

## **2.3 LABORATORY ANALYSES**

### **2.3.1 Total Mercury Determination**

#### **Analysis**

Samples were received at the laboratory and the skin and scales were removed from each sample. For each sample, a sample weight of approximately 0.010 g was digested overnight in 3 mL of 1:2.5 nitric:sulphuric acid at 150 degrees Celsius (°C), diluted to 10 mL with low Hg de-ionized water, spiked with 0.2 mL of bromine monochloride (BrCl) and then transferred into an acid clean 40-mL vial for storage. Small aliquots (0.5 mL) of the digest were analyzed by Cold Vapor Atomic Absorption Spectrometry (CVAAS) according to U. S. Environmental Protection Agency (USEPA) Method 1631 (USEPA 2002). The high sensitivity of this method makes it preferable over USEPA Method 7473 (DMA-80) in cases where the Hg concentrations may be low and/or when sample weights are very small (USEPA 2007). The achieved detection limit was 0.017 micrograms per gram (µg/g). The estimated uncertainty of this method was determined to be ± 23% at concentrations between 0.001 and 27.4 µg/g (95% confidence).

Duplicate dermal plug samples were analyzed for each fish. One duplicate plug from Lac du Sauvage was not provided to the lab due to field error (Fish #209; Appendix B). The total sample size was 30 fish from Lac de Gras with two duplicate plugs from each (sample size [n]= 60) and 30 fish from Lac du Sauvage with two duplicate plugs from 29 fish (n=59). Split samples (10% of total number of fish) were also analyzed for internal laboratory quality assurance and quality control (QA/QC) procedures (six samples in total, three samples from each study lake).

### **Assessment of Quality of Dermal Plugs in 2014**

The laboratory reported that the moisture content (as percent loss on drying [%LOD]) of the 2014 samples was outside the expected normal for dermal plugs. On the basis of several years of fish tissue analysis, %LOD typically ranges between 78 and 82% (Flett 2014, pers. comm.). The values from 2014 averaged approximately 75% in each lake, but some samples were below this at approximately 63% and a few were above at approximately 93% in each lake (Table B-4, Appendix B). Therefore, for consistency a standard %LOD value of 80% was used in place of each measured %LOD value. As such, 2008 and 2011 ww data were also corrected to the standard 80% %LOD so temporal comparisons could be conducted. All Hg results reported in the 2014 report for 2008, 2011 and 2014 have been corrected. Further discussion of the weight and moisture content of plugs is provided in Appendix C.

### **2.3.2 Fish Ageing**

Pelvic fin rays were sent to Otolith Technologies (Dartmouth, Nova Scotia) for ageing analysis. In previous years ageing structures were sent to North Shore Environmental (Thunder Bay ON.). The ageing structures were prepared several different ways for ageing; however, it was determined that many of the fish were not showing any growth annuli and could not reliably be aged using fin rays. As such, ageing was not conducted for these fish. Otolith Technologies have found greater success in aging certain Lake Trout populations with pectoral fin rays (Campana 2014, pers. comm.). In future surveys, pectoral fin rays, rather than pelvic fin rays, will be collected for age determination. The lack of age data did not compromise the findings from this survey since length data and not age data are considered in the analysis of Hg concentrations for this study.

## **2.4 DATA ANALYSIS**

### **2.4.1 Catch-per-Unit-Effort**

The number of Lake Trout captured was standardized as catch-per-unit-effort (CPUE), which provides an estimate of relative abundance among sampling areas by standardizing the catch data according to the fishing effort. The CPUE results are shown as number of fish captured per hour of angling effort.

## 2.4.2 Descriptive Statistics

Summary statistics (i.e., sample size, arithmetic mean and standard deviation [SD]) were calculated by year and sampling area for each biological variable. Fulton's condition factor [*K*], a common index for describing body metric relationships, was calculated using fork length and total body weight, as follows:

$$K = 10^5 \times (\text{total body weight}/\text{fork length}^3).$$

## 2.4.3 Data Screening

Untransformed data on fish size and Hg concentration were screened for potential outliers by visual examination of box-and-whisker plots (Appendix D) and linear regression plots. Extreme values were removed from the data set if they were determined to be the results of sampling, measurement or data entry errors. This was confirmed by an additional review of the field notes to confirm no data transcription errors were incurred. Studentized residuals (SR) and leverage values from the linear regression analyses were used as additional screening tools. An SR >3.5 was considered an outlier. Outliers and influential observations detected during the regression testing were removed from further statistical comparisons (Appendix E, Table E-1) It is important to examine the data with and without outliers because many statistical procedures are not robust against outliers (Daniel 1960). If the removal of outliers influenced the results, then the conclusions were based on results with the outliers removed (Appendix E, Table E-1). No outliers were removed from 2014 data; outliers from historic data (2005 and 2008) were identified.

## 2.4.4 Statistical Comparisons

### 2.4.4.1 Approach

Given that the concentration of Hg varies according to the size of the fish, it is important to account for the size of the fish when making comparisons. Analysis of Covariance (ANCOVA) was used to compare Hg concentrations among years while considering the influence of fish size. In addition, this test provides a size-adjusted mean Hg concentration for a given lake and year. Statistical analyses were conducted with SYSTAT, version 13.0 for Windows (SYSTAT 2009).

### 2.4.4.2 Testing Assumptions for Statistical Analysis

Like other parametric tests, ANCOVA assume that the data fit the normal distribution (i.e., the residuals of the statistical models are assumed to fit a normal distribution). If a measurement variable is not normally distributed, there is an increased chance of a false positive result (Type 1 error). To test the data for normality, a non-parametric, two-sample Kolmogorov-Smirnov (KS) test was carried out. Since many data sets that are highly non-normal are still suitable for analysis with ANCOVA (Sokal and Rohlf 2012), strong evidence of non-normality (e.g., probability [*P*] < 0.01) was required to justify the use of non-parametric equivalents in place of these parametric tests.

Another assumption of ANCOVA is that group variances are equal. The Levene's test was used to test for violations of this assumption (e.g.,  $P < 0.01$ ). If the data were clearly non-normal and/or the assumption of homogeneity of variances were violated, the data were then log-transformed in an attempt to meet these assumptions. A table outlining the results of the tests to assess the goodness-of-fit of the data to the normal distribution (the KS test) and to test the homogeneity of variance of the data (Levene's test) is provided in Appendix E, Table E-2. The assumptions for ANCOVA were met.

### 2.4.4.3 Analysis of Covariance

To determine the most suitable covariate for the ANCOVA model, regression analyses were performed for Hg concentrations relative to fork length (mm), total weight (g), and condition factor [K]. Regression analysis and ANCOVA were performed on various combinations of log-transformed and non-transformed data to improve model fit.

Analysis of the differences in mean Hg concentration among years were conducted separately for Lac de Gras and Lac du Sauvage. An overall difference was considered statistically significant at  $P < 0.1$ . If a significant difference was found ( $P < 0.1$ ), multiple a priori comparisons (planned contrasts) within the overall ANCOVA were conducted to test for differences between individual years. To confirm that the probability of making any type I error at all in the entire series of tests does not exceed 0.1 (i.e., the experiment-wise error rate) a conservative approach was employed in which the type I error of the statistic of significance for each comparison was lowered. This was achieved with a Bonferroni adjustment.

An assumption of ANCOVA is that the slopes of the regression lines for each year are parallel. A test for homogeneity of slopes among years was carried out. The combination of log-transformed and non-transformed data that yielded the best equality of slopes was used in the ANCOVA. If the slopes were parallel (i.e.,  $P > 0.05$ ), then ANCOVA was performed, and length-adjusted (least-square) mean Hg concentrations were calculated. The adjusted means are the mean values of the dependent variable (i.e., Hg concentration) adjusted to the mean value of the independent variable (e.g., length).

Note that statistical analyses were conducted on data from 2005, 2008, 2011 and 2014 for Lac de Gras and 2008, 2011, and 2014 for Lac du Sauvage. Statistical comparisons were conducted on muscle plug data only with the exception of the 2005 data (only available for Lac de Gras), which consisted of concentrations in fillets. Data from the fish palatability studies were not included in the statistical analysis because of the small sample sizes in those surveys. The 1996 baseline data were not used in the statistical analysis since they consisted of Hg concentrations in composite samples.



#### **2.4.4.4 Guideline Comparison**

##### **Human Health**

Hg concentrations in Lake Trout muscle in 2014 were compared to available national guidelines for human health. The Canadian Food Inspection Agency (CFIA) and Health Canada guidelines state that fish collected for commercial use may contain a maximum of 0.5 ug/g ww Hg to be approved for human consumption (CFIA 2015).

##### **Fish Health**

Excessive levels of Hg can adversely affect fish health. Hg concentrations in Lake Trout muscle in 2014 were compared to a potential effects benchmark/tissue residue guideline of 1.0 µg/g ww. Above this concentration, adverse effects to fish health may be observed (Jarvinen and Ankley 1998, Scheuhammer et al. 2007).

## **2.5 MOVEMENT STUDY**

To obtain a preliminary understanding of the movement of Lake Trout between Lac de Gras and Lac du Sauvage, Lake Trout were captured, fitted with a PIT tag, and their movements documented. Golder assisted with the installation of the PIT tags for fish that were captured during the Lake Trout Hg study, DDMI installed the fish antenna array and collected the PIT tag data.

The PIT tagging of Lake Trout was conducted in the two study lakes starting on August 6, 2014. PIT tagging equipment was not available earlier in the summer; therefore, only a few fish that were sampled for Hg were tagged. Fishing for Lake Trout to PIT tag occurred in similar areas as the Hg study on Lac de Gras; fishing on Lac du Sauvage focussed on areas within 10 kilometres (km) of the narrows (Figure 2-1). A sample size of > 200 Lake Trout per lake was targeted. A total of 126 Lake Trout were tagged. The type of PIT tag used was a 23 mm HDX tag (Oregon RFID; Oregon Michigan) (Photo 30, Appendix A).

Fish were captured, handled, and processed following the same method as those fish processed for Hg determination. Following enumeration and external examination, PIT tags were implanted into the fish using a small curved scalpel ventrally into the body cavity just anterior of the pelvic girdle (Photo 31, Appendix A), and sealed using Vetbond tissue glue (Photo 33, Appendix A). Scalpels were disinfected between fish using 70% ethanol.

A custom antenna array was installed by DDMI staff on July 14, 2015, across the outlet of Lac du Sauvage at the narrows; (Figure 2-3; Photo 36, Appendix A). The array was deployed by tying a rope to one end of the array and then boating to the opposite shore (Photo 37, Appendix A). The rope was pulled across the channel to bring the array across and then each end was securely anchored (Appendix A, Photo 38).

The array was activated by DDMI one year later, on July 15, 2015 and removed on October 7, 2015 prior to freeze-up. Once operational, data from the array was downloaded by DDMI staff on August 26, September 19 and October 7, 2015.

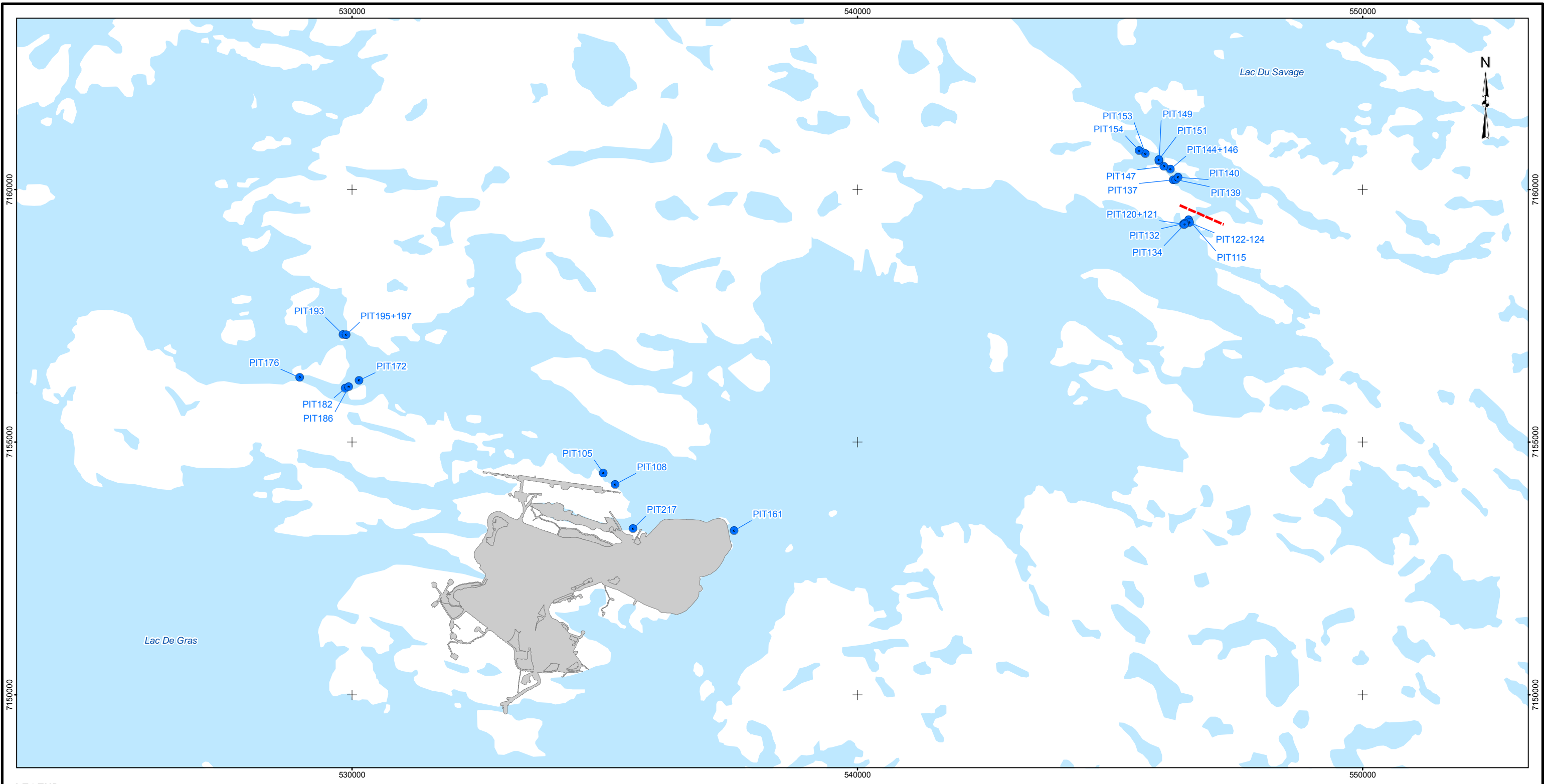
## **2.6 QUALITY ASSURANCE/QUALITY CONTROL**

The field and laboratory QA/QC procedures are outlined by the DDMI SOPs and the DDMI Quality Assurance Project Plan Version 2.0 (Golder 2013). QA/QC procedures were conducted to confirm the field sampling, data entry, data analysis and report preparation produced technically-sound and scientifically defensible results.

Detailed specific work instructions outlining each field task were provided to the field personnel prior to the field program. Samples were collected by experienced personnel and were labelled, preserved and shipped according to DDMI SOPs. Data sheets and labels were checked at the end of each field day for completeness and accuracy, and were scanned into electronic copies at the completion of the field program. Chain-of-custody (COC) forms were used to track the shipment of samples. Individual QA/QC procedures were undertaken by the laboratory performing Hg analyses.

Data in spreadsheets were verified by a second person to identify any transcription errors. Results of statistical data analyses were independently reviewed by a biologist with appropriate technical qualifications. Tables containing data summaries and statistical results were reviewed and values were verified by a second independent individual.

Key results of the QA/QC review are presented in Appendix C; a summary is presented in Section 3. The data were accepted as valid for use.



- LEGEND**
- 2014 LAKE TROUT SURVEY**
- 2014 PIT TAGGED FISH CAPTURE LOCATION\*
  - ANTENNA ARRAY
  - DIAVIK FOOTPRINT
  - WATERBODY

**NOTE**  
 \*ONE POINT LOCATION CAN REPRESENT MORE THAN ONE FISH.

**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83



<b>PROJECT</b>				
<b>TITLE</b>	<b>CAPTURE LOCATIONS OF LAKE TROUT DETECTED BY ARRAY AT THE NARROWS, 2015</b>			
	<b>PROJECT</b>	1406208	FILE No.	
	DESIGN	CJ	10 Mar. 2016	SCALE AS SHOWN
	GIS	SS	30 Mar. 2016	REV. 0
	CHECK	TD	30 Mar. 2016	<b>FIGURE: 2-3</b>
	REVIEW	HM	30 Mar. 2016	

I:\201111-1328\11-1328-0038\Mapping\MXD\2014AEMP\Fig2-3\_2015\_AEMP\_Trout\_Sampling\_Rev0.mxd

### 3 RESULTS

#### 3.1 FISH CAPTURE

A total of 219 Lake Trout were angled from Lac de Gras and Lac de Sauvage in 2014 (Table 3-1; Appendix B). Thirty fish from each lake were sampled for Hg; the target sample size for Hg analysis for each size class was achieved in each lake. Eighteen Lake Trout were captured and released, three escaped and were observed only, and 126 were PIT tagged for the movement study (Table 3-1; Appendix B).

The CPUE was similar between lakes at approximately 1.3 fish per hour (Table 3-1). Additional fishing effort was employed at Lac de Gras for PIT tagging. Captured fish appeared healthy with few abnormalities or parasites (Appendix B). Raw catch data, including external examination details, are provided in Appendix B, Table B-1 and Table B-2.

In 2014, mean fork length of Lake Trout captured in both Lac de Gras and Lac de Sauvage was approximately 600 mm (Table 3-2). Mean total body weight of fish captured in Lac de Gras was slightly heavier than those from Lac du Sauvage (Table 3-2). Condition factor for Lake Trout in both lakes was approximately 1.2. Lake Trout captured in 2014 had a greater body condition than those captured in 2005 and 2011, but was similar to condition documented in 1996 (Table 3-2).

**Table 3-1 Catch-Per-Unit-Effort by Angling in Lac de Gras and Lac du Sauvage, 2014**

Site	Start		End		Angling Time (hr)	Anglers	Number of Fish Captured and CPUE		Number of Fish Sampled for Hg
	Date	Time	Date	Time			Lake Trout	CPUE (fish/angler-hr)	
Lac de Gras	29-Jul-14	16:00	29-Jul-14	17:00	1:00	2	2	1.00	2
	31-Jul-14	9:00	31-Jul-14	16:30	7:30	3	13	0.58	13
	1-Aug-14	9:00	1-Aug-14	17:00	8:00	3	14	0.58	8
	2-Aug-14	10:00	2-Aug-14	12:00	2:00	2	2	0.50	1
	2-Aug-14	15:00	2-Aug-14	18:00	3:00	2	1	0.17	0
	4-Aug-14	9:50	4-Aug-14	12:00	2:10	3	8	1.23	3
	4-Aug-14	15:00	4-Aug-14	18:00	3:00	3	9	1.00	2
	6-Aug-14	14:00	6-Aug-14	17:30	3:30	3	15	1.43	1
	8-Aug-14	9:30	8-Aug-14	12:00	2:30	3	30	4.00	0
	9-Aug-14	8:30	9-Aug-14	10:00	1:30	3	6	1.33	0
	9-Aug-14	10:15	9-Aug-14	16:30	6:15	3	38	2.67	0
10-Aug-14	9:45	10-Aug-14	14:00	4:15	3	20	1.57	0	
	<b>TOTAL</b>						<b>158</b>	<b>Average 1.34</b>	<b>30</b>
Lac du Sauvage	30-Jul-14	10:00	30-Jul-11	16:30	6:30	2	12	0.92	12
	3-Aug-14	9:30	31-Jul-11	16:45	7:15	3	10	0.43	10
	5-Aug-14	9:50	2-Aug-11	14:00	4:10	3	17	1.36	8
	8-Aug-14	12:30	3-Aug-11	15:45	3:15	3	22	2.26	0
	<b>TOTAL</b>						<b>61</b>	<b>Average 1.24</b>	<b>30</b>

Notes: CPUE = catch per unit effort; hr = hour fish/angler-hr = fish per angler-hour.

**Table 3-2 Non-lethal Lake Trout Measurements and Mercury Concentration in Fillets (1996, 2005) and Dermal Plugs (2008, 2011, 2014) from Lac de Gras and Lac du Sauvage**

Variable	Units	1996		2005		2008		2011		2014	
		LDG	LDS	LDG	LDS	LDG	LDS	LDG	LDS	LDG	LDS
Sample size	n	10	10	79	-	20	20	17	30	30	30
Age (Mean ± SD)	year	12 ± 2	13 ± 3	17 ± 7	-	17 ± 7	19 ± 7	15 ± 4	15 ± 4	-	-
K (Mean ± SD)	-	1.48 ± 0.27	1.16 ± 0.08	1.08 ± 0.13	-	1.06 ± 0.16	1.08 ± 0.11	1.02 ± 0.18	0.90 ± 0.16	1.23 ± 0.15	1.15 ± 0.12
Fork Length (Mean ± SD)	mm	543 ± 98	617 ± 39	631 ± 134	-	601 ± 138	649 ± 68	634 ± 91	643 ± 113	609 ± 94	598 ± 88
Total body weight (Mean ± SD)	g	2408 ± 959	2755 ± 459	3010 ± 1507	-	2513 ± 1382	3026 ± 920	2627 ± 915	2460 ± 942	2930 ± 1299	2615 ± 1166
Total Hg (Mean ± SD)	µg/g ww	0.182 ± 0.102	0.202 ± 0.094	0.191 ± 0.118	-	0.360 ± 0.552	0.300 ± 0.171	0.313 ± 0.193	0.360 ± 0.195	0.124 ± 0.093	0.199 ± 0.106
	µg/g dw	-	-	-	-	1.799 ± 2.757	1.498 ± 0.855	1.565 ± 0.966	1.798 ± 0.973	0.620 ± 0.467	0.993 ± 0.533
Length-adjusted Total Hg (Mean ± SE)	µg/g ww	n/a <sup>(a)</sup>	n/a <sup>(a)</sup>	0.156 ± 0.007	-	0.216 ± 0.020	0.231 ± 0.018	0.247 ± 0.023	0.279 ± 0.018	0.105 ± 0.007	0.206 ± 0.013

Notes: SD = standard deviation; SE = standard error; µg/g ww= microgram per gram wet weight; µg/g dw= microgram per gram dry weight; mm = millimetre; g = gram; LDG = Lac de Gras; LDS = Lac du Sauvage; K = Fulton's condition factor "-" = not collected; n/a = not applicable. Wet-weight Hg concentration for plugs in 2008, 2011, and 2014 was corrected for the percent loss of drying of 80% (see Section 2).

(a) = length-adjusted mean Hg concentration could not be calculated in 1996 since samples were composites.

## 3.2 MERCURY IN LAKE TROUT

### 3.2.1 2014 Results

In 2014, Lake Trout muscle Hg concentrations varied between study lakes (Table 3-2). Mean concentrations in Lac de Gras were 0.12 µg/g ww and 0.62 µg/g dry weight (dw). Mean concentrations in Lac de Sauvage were 0.2 µg/g ww and 0.99 µg/g dw.

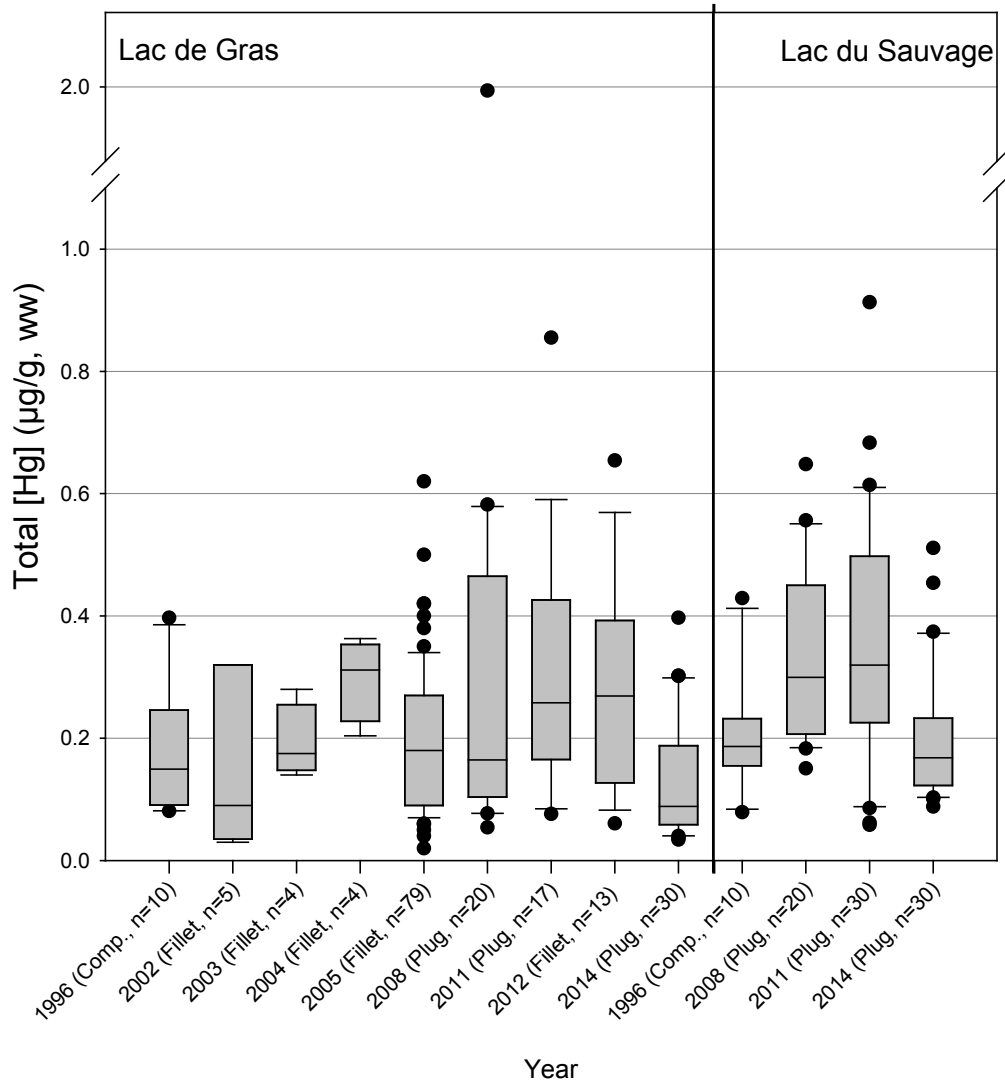
### 3.2.2 Comparison over time

On the basis of the data from 1996, 2005, 2008 and 2011, concentrations of Hg in fish muscle showed an increasing pattern from 2005 to 2008, with the increase being more pronounced in Lac du Sauvage (Figure 3-1). In 2014, Hg was detected at near or below baseline concentrations in both Lac de Gras and Lac du Sauvage. The distribution of Hg concentration (ww) among years is shown with box and whisker plots (or box plots) in Figure 3-1. While sample wet weights were different between years, a comparison of dw concentrations of Hg in fish muscle over time also showed a similar trend as the ww concentrations for each lake (Figure 3-2).

Fork length was the covariate that explained most of the variation in Hg concentrations and was used as the covariate in the ANCOVA analysis for both Lac de Gras (regression analysis  $P < 0.001$ , adjusted coefficient of determination  $[R^2] = 0.62$ ) and Lac du Sauvage (regression analysis  $P < 0.001$ , adjusted  $R^2 = 0.58$ ). The relationship between fork length and Hg concentration is shown in Figure 3-3 and listed in Table 3-2.

In 2014, Hg concentrations in Lac de Gras were significantly less than Hg concentrations analyzed in 2005, 2008 and 2011. There was a significant difference in the length-adjusted Hg concentration among years for both Lac de Gras ( $P < 0.001$ ) and Lac du Sauvage ( $P = 0.003$ ); although, in Lac de Gras there was no significant difference between 2008 and 2011 ( $P = 0.291$ ), and in Lac du Sauvage there was no significant difference between 2008 and 2014 ( $P = 0.236$ ) (Figure 3-4, Table 3-3).

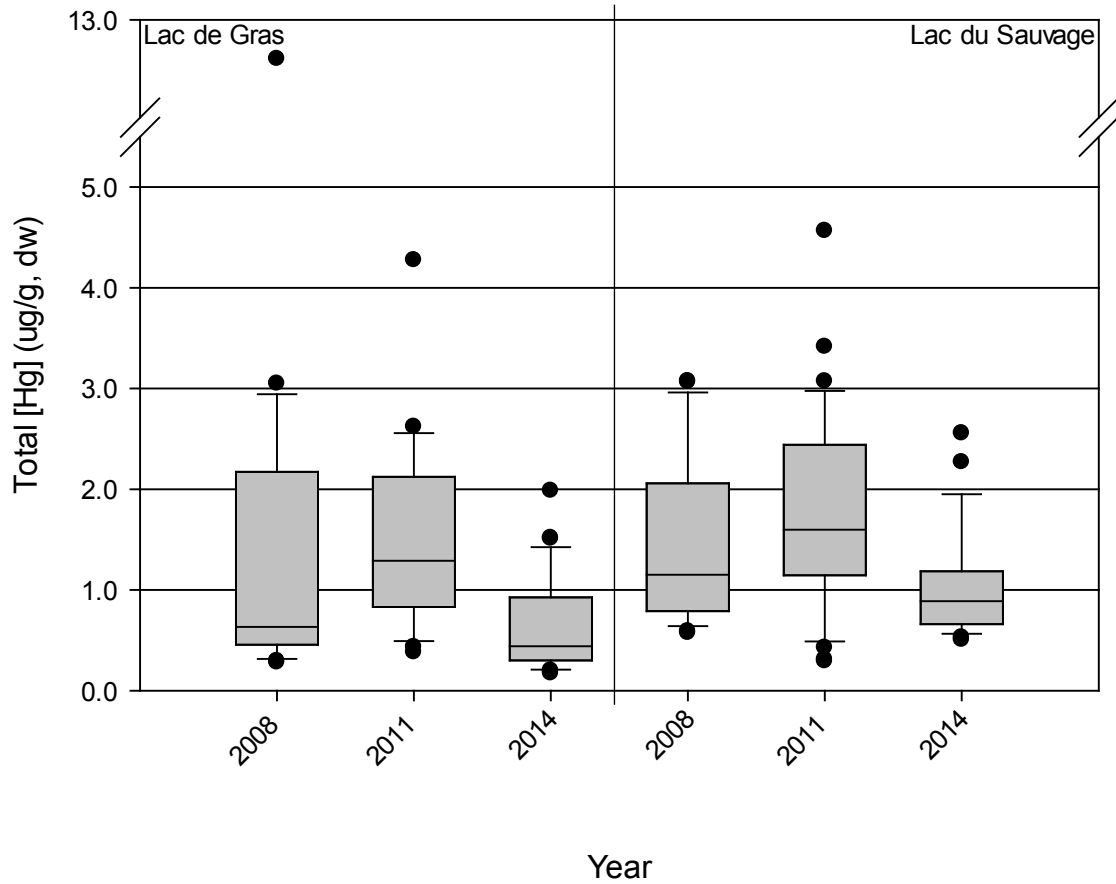
**Figure 3-1 Box and Whisker Plot for Mercury Concentrations in Lake Trout Muscle over Time**



Comp. = Composite sample; [Hg] = mercury concentration; µg/g, ww = microgram per gram wet weight.

Note: The Hg data for Lake Trout include results from the 2002, 2003, 2004, and 2012 fish palatability studies (DDMI 2003; Thorpe 2013; and unpublished data). Fillet results are uncorrected Hg as the % moisture is close to 80% in fillet data. Plug data was corrected to 80%LOD. Box plots show the distribution of the data in percentiles, with the boundary of the box closest to zero representing the 25th percentile, the line within the box representing the median, and the boundary of the box farthest from zero representing the 75th percentile. The "whiskers" below and above the box represent the 10th and 90th percentiles, respectively. Concentrations that lie beyond the 10th and 90th percentiles are plotted as dots.

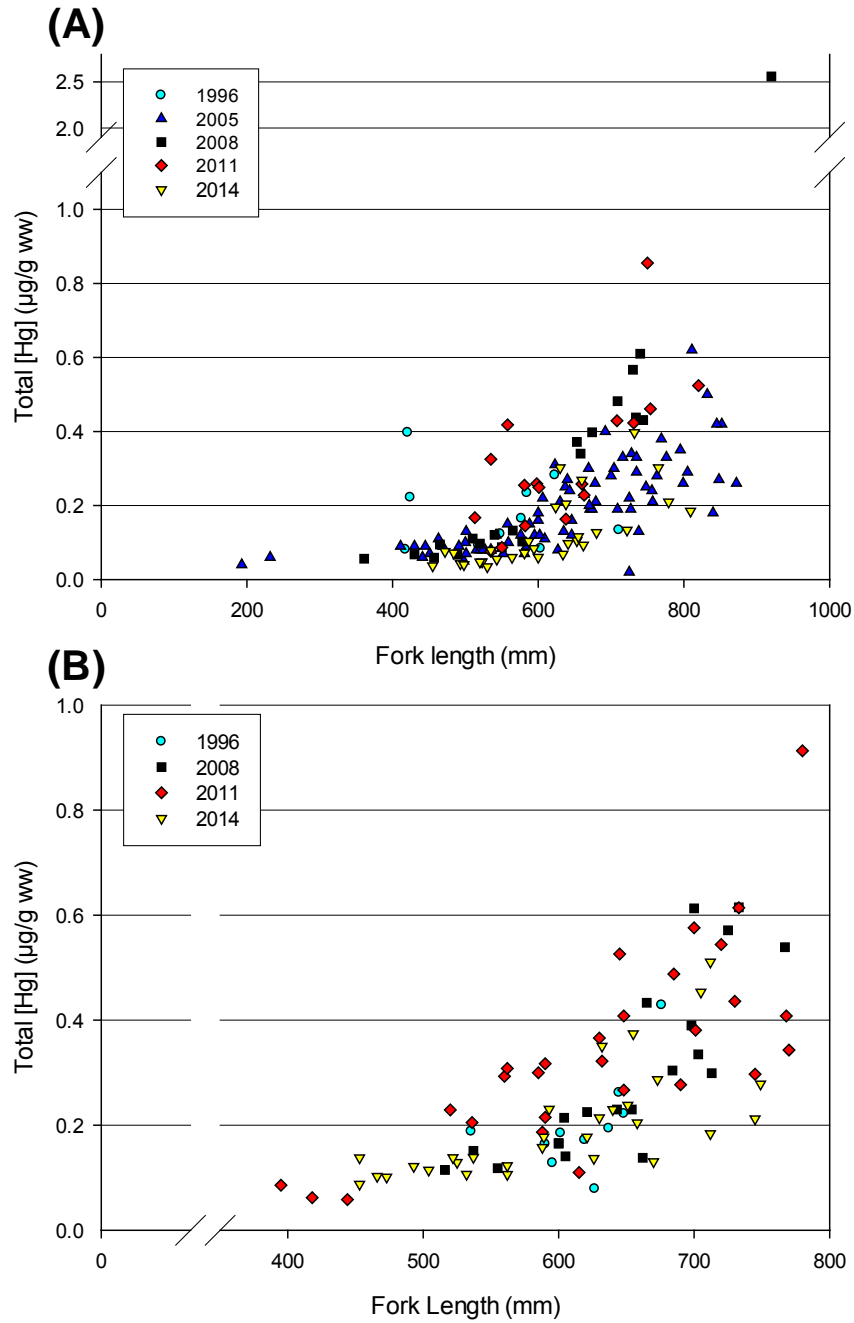
**Figure 3-2 Box and Whisker Plot for Mercury Dry Weight Concentrations in Lake Trout Muscle Plugs over Time**



Notes: [Hg] = mercury concentration; µg/g, dw = microgram per gram dry weight. Box plots show the distribution of the data in percentiles, with the boundary of the box closest to zero representing the 25th percentile, the line within the box representing the median, and the boundary of the box farthest from zero representing the 75th percentile. The “whiskers” below and above the box represent the 10th and 90th percentiles, respectively. Concentrations that lie beyond the 10th and 90th percentiles are plotted as dots.

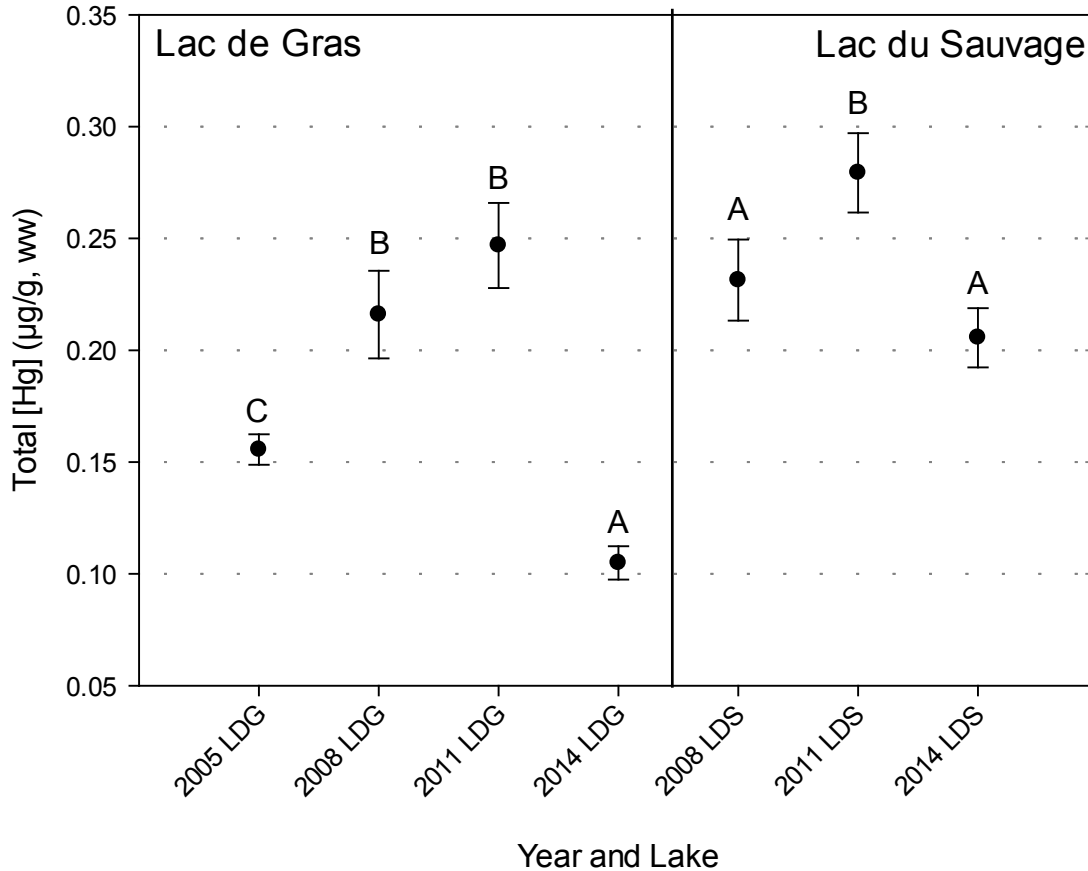


**Figure 3-3 Relationship between Mercury and Fork Length of Lake Trout in (A) Lac de Gras and (B) Lac du Sauvage**



Notes: mm = millimetre;  $\mu\text{g/g, ww}$  = microgram per gram wet weight; [Hg] = mercury concentration.

**Figure 3-4 Length-Adjusted Mercury Concentration (mean ± SE) in Lake Trout Muscle Plugs (2008, 2011 and 2014) or Fillets (2005) or Fillets (2005)**



Notes: SE = standard error; µg/g, ww = microgram per gram wet weight; [Hg] = mercury concentration; %LOD = percent loss on drying; letters above error bars represent within area significant differences, (i.e. within a lake, if letters are the same they are not statistically different, if letters are not the same they are statistically different). Muscle plug data from 2008, 2011 and 2014 corrected to 80%LOD.

### 3.2.3 Comparison to guidelines

In 2014, the concentration of Hg in Lake Trout muscle in each study lake was below the CFIA guideline of 0.5 µg/g ww, and only one fish in Lac du Sauvage was higher (0.51µg/g ww). The concentration of Hg in Lake Trout muscle in 2014 in both lakes was below a relevant effect threshold/tissue residue guideline (1.0 µg/g ww) such that Lake Trout health is unlikely to be affected. On the basis of the 2014 Hg concentrations in Lake Trout from each lake, no concerns to human health or fish health are expected.

### 3.3 MOVEMENT STUDY

A total of 106 and 20 Lake Trout were PIT tagged in Lac de Gras, and Lac du Sauvage, respectively. Of the 126 Lake Trout tagged in 2014, 29 (23%) passed over the array in 2015. A total of 19 of the Lake Trout were originally tagged in Lac de Gras, and 10 were tagged in Lac du Sauvage (Figure 2-3, Table 3-3).

The majority of Lake Trout detected by the array in 2015 were originally captured and tagged near the narrows in 2014. However, nine Lake Trout that passed over the array in 2015 were tagged in Lac de Gras up to 20 km away from the narrows in 2014 (Figure 2-3). Of the 29 Lake Trout detected by the array, four were detected only once, and the remaining 25 were detected multiple times. The maximum number of detections by one Lake Trout was 128 times.

**Table 3-3 PIT Tagged Lake Trout Detections, 2015**

Tagging Origin (2014)	PIT Tag ID	Number of Detections (2015)	Range of dates detected
Lac de Gras	900228000031105	3	September 27, 2015
	900228000031108	1	September 11, 2015
	900228000031115	3	August 25 - 26, 2015
	900228000031120	1	August 23, 2015
	900228000031121	4	August 20 - October 2, 2015
	900228000031122	5	August 16 - September 13, 2015
	900228000031123	2	August 15 - 16, 2015
	900228000031124	2	August 15, 2015
	900228000031132	52	September 4 - October 7, 2015
	900228000031134	5	August 15 - 28, 2015
	900228000031161	6	July 31, 2015
	900228000031172	60	July 28 - 31, 2015
	900228000031176	5	July 27 - September 23, 2015
	900228000031182	7	July 27 - September 8, 2015
	900228000031186	7	July 26 - September 17, 2015
	900228000031193	2	July 26, 2015
	900228000031195	4	August 27 - 28, 2015
900228000031197	15	August 27 - September 30, 2015	
900228000031217	4	July 15 - 22, 2015	
Lac du Sauvage	900228000031137	4	August 14 - September 14, 2015
	900228000031139	1	September 18, 2015
	900228000031140	30	August 3 - October 7, 2015
	900228000031144	1	August 3, 2015
	900228000031146	128	August 1 - 26, 2015
	900228000031147	2	August 1, 2015
	900228000031149	2	August 1, 2015
	900228000031151	2	September 15, 2015
	900228000031153	3	July 31, 2015
	900228000031154	5	July 31 - September 9, 2015

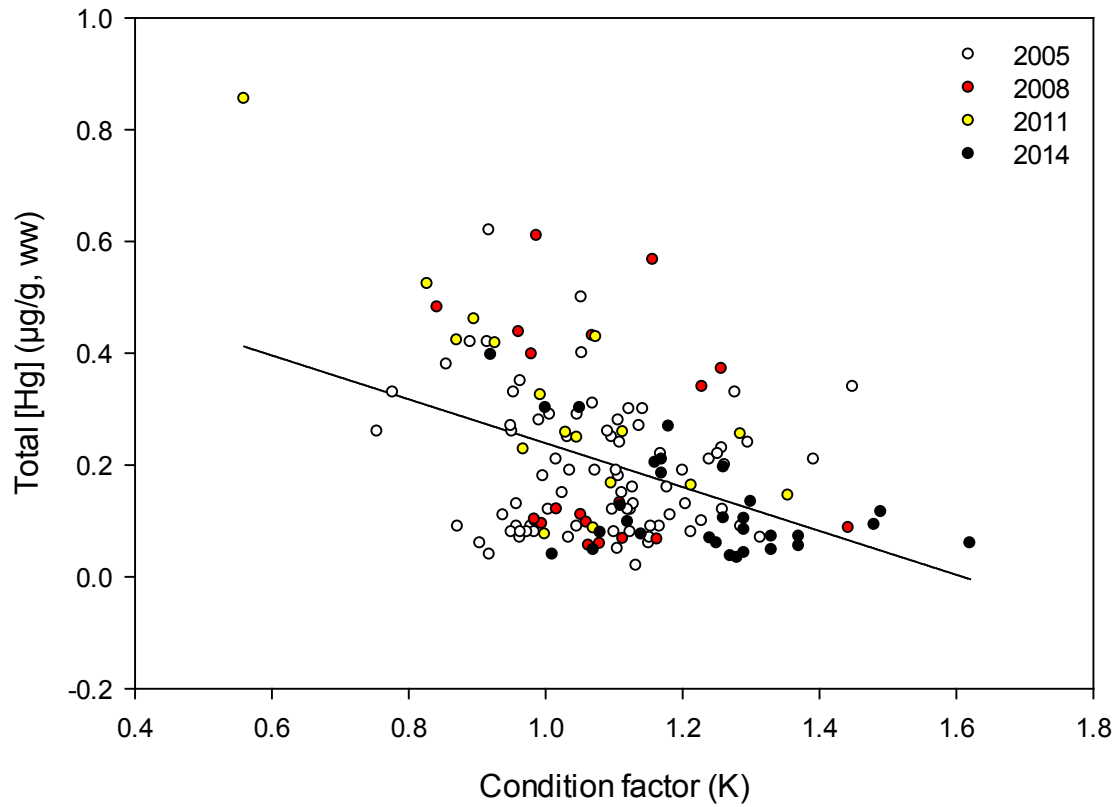
Notes: m = metre; PIT = passive integrated transponder.

## 4 DISCUSSION

In 2014, Hg concentrations in Lake Trout muscle were documented at, to near, baseline (1996) conditions in both Lac de Gras and Lac du Sauvage. Even when adjusted for fish length, the 2014 concentrations in Lac de Gras were significantly lower than in previous years (Figure 3-3). These results were unexpected since trends to 2011 indicated Hg concentrations to be on the rise in Lake Trout in both lakes. Elimination rates of methylmercury (MeHg) are negatively correlated with fish size and water temperature (Trudel and Rasmussen 1997). Since the Lac de Gras and Lac du Sauvage Lake Trout are large-bodied fish occupying cold sub-arctic lakes, without removal of an actual point source of Hg, it is unlikely Lake Trout have depurated Hg to the extent observed in the current study within three years. Moreover, Hg concentrations in effluent, water and sediments have consistently been below detection limits (Golder 2014b); therefore, it is equally unlikely that the decrease in fish muscle concentrations of Hg is due to a concentration decrease in the environment.

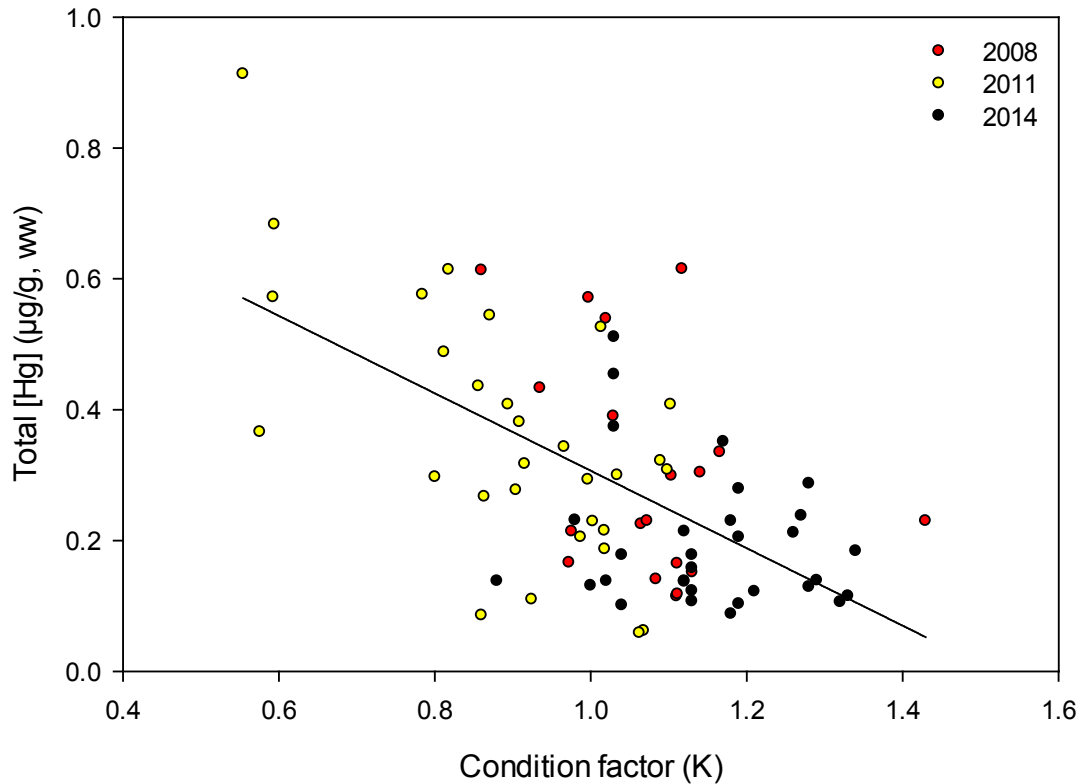
Lake Trout measurements were examined to determine whether there were any differences in the Lake Trout captured in 2014 compared to previous years. Fish *K* appears to mirror the trends in Hg concentration in both lakes (Appendix B, Figures B-1 and B-2). When combining all years, excluding 1996, Hg concentrations are negatively correlated with condition factor for both Lac de Gras ( $R^2 = -0.18$ ,  $P < 0.0001$ , Figure 3-5) and Lac du Sauvage ( $R^2 = -0.39$ ,  $P < 0.0001$ , Figure 3-6).

**Figure 3-5 Relationship between Mercury and Condition Factor in Lac de Gras (n = 145)**



Notes: K = Fulton's condition factor; µg/g, ww = microgram per gram wet weight; [Hg] = mercury concentration.

**Figure 3-6 Relationship between Mercury and Condition Factor in Lac du Sauvage (n = 80)**



Notes: K = Fulton's condition factor; µg/g, ww = microgram per gram wet weight; [Hg] = mercury concentration.

The correlation between condition factor and Hg concentration may indicate that fish condition can influence Hg concentration in Lake Trout. This has been previously documented in Striped Bass captured in Lake Mead in Nevada, USA (Cizdziel et al. 2002). Cizdziel et al. (2002) postulated that malnourished fish catabolize muscle tissue for energy; therefore, muscle tissue is reduced faster than the MeHg associated with it leaving higher Hg concentrations in the remaining muscle tissue. Condition factor has also been shown to be positively correlated with lipid content (Herbinger and Friars 1991) and it may be possible that increased lipid concentrations temporarily displace and dilute MeHg concentrations in the muscle of more robust fish.

Outside a brief review of differences in body size between sampling years, no further analysis of the cause of the decrease in Lake Trout Hg was completed. Reviews of causal factors such as lake size, temperature, and fish diet are outside the scope of this study. In addition, a possible normal pattern of pulsing of Hg concentrations in large lakes was not reviewed.

The movement study, while limited in duration, indicated that Lake Trout were crossing the narrows between Lac de Gras and Lac du Sauvage. This has implications on the validity of Lac du Sauvage as a reference area for Lake Trout Hg monitoring. Given the similar trends in Hg concentrations in

both Lac de Gras and Lac du Sauvage, Lake Trout captured during this study could originate or overwinter in either lake. However, due to the time gap between tagging and array installation, the location of fish at the point of array activation and their direction of travel cannot be determined. Further studies would be required to establish whether Lake Trout populations residing in Lac de Gras and Lac du Sauvage are separate; however, for the purposes of this study, it can be concluded that the captured Lake Trout used for the Hg study could have originated from either of the two lakes. Differences in Hg concentrations between Lac de Gras and Lac du Sauvage should be interpreted with this in mind.

In summary, for both Lac de Gras and Lac du Sauvage, the concentration of Hg in Lake Trout muscle increased from 1996 to 2008, remained elevated in 2011, and then was detected at concentrations near baseline in 2014. Additionally, Hg concentrations declined in small-bodied fish in Lac de Gras (Golder 2014a). In 2014, the concentration of Hg in Lake Trout muscle in each study lake was below relevant CFIA guideline for Hg and a relevant effect threshold/tissue residue guideline for fish, with the exception of one fish in Lac du Sauvage. Concentrations of Hg are undetected in Mine effluent. As such, no concerns to human health or fish health are expected given the 2014 Hg concentrations in Lake Trout from each lake. On the basis of the 2014 data, further monitoring of Hg in Lake Trout muscle in relation to mine activities is currently unwarranted.

## **5 CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 CONCLUSIONS**

The conclusions of the 2014 Hg in Lake Trout survey are as follows:

- In both Lac de Gras and Lac du Sauvage, the concentration of Hg in Lake Trout muscle increased from 1996 to 2008, remained elevated in 2011, and then were detected at concentrations near baseline in 2014.
- In 2014, the concentration of Hg in Lake Trout muscle in each study lake was below the Canadian government maximum acceptable levels in the edible portion of retail fish (0.5 µg/g ww), and only one fish in Lac du Sauvage was higher (0.51µg/g ww)..
- The concentration of Hg in Lake Trout muscle in 2014 in both lakes is below a relevant effect threshold/tissue residue guideline (1.0 µg/g ww) such that Lake Trout health is unlikely to be affected.
- The reason for the variations in Hg concentrations in Lake Trout muscle over time are outside the scope of this study. However, differences in fish condition were observed between years.
- Concentrations of Hg measured as dw should be analysed in any future studies. This may assist in correcting potential biases of ww concentrations as plug weights can be variable between years, which is normal for these small tissue weights and low tissue concentrations.

### **5.2 RECOMMENDATIONS**

The next small-bodied fish survey is scheduled for 2016, and the Hg in Lake Trout is scheduled for 2017. A Mine-related increase in Hg concentration in small-bodied fish has not been observed since 2007, and in 2014 Hg in Lake Trout was found to be at concentrations similar to baseline. Therefore, at this time, it is recommended that the requirement for the 2017 Hg in Lake Trout survey be made dependent upon small-bodied fish results. Should Hg concentrations in the small-bodied fish indicate an increasing trend caused by the Mine in 2016, then it would be recommended that the Hg in Lake Trout program be conducted in 2017. This recommendation will be further described in the upcoming AEMP Design Plan Version 4.0.



## **6 CLOSURE**

We trust the information in this report meets your requirements at this time. If you have any questions relating to the information contained in this document please do not hesitate to contact us.

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**APPENDIX A**  
**PHOTOGRAPHS**



*Photo 1: Preparing to sample a Lake Trout on Lac de Gras*



*Photo 2: Using a curved scalpel to make a small incision for PIT tag implantation*



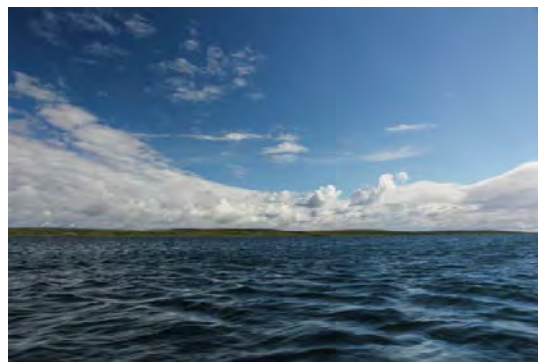
*Photo 3: Roll of PIT tags*



*Photo 4: Angling on Lac de Gras*



*Photo 5: Preparing for lunch on Lac du Sauvage*



*Photo 6: Typical day on Lac du Sauvage*



*Photo 7: Lake Trout captured by DDMI Environment staff*



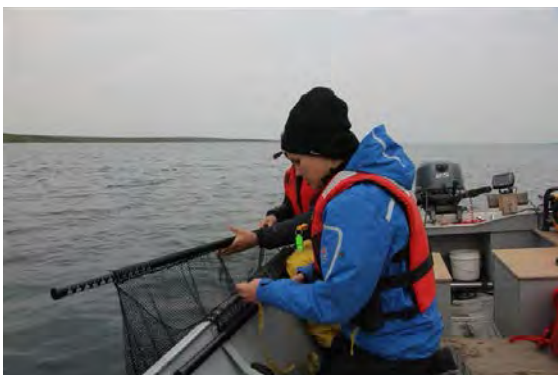
*Photo 8: Team work processing a fish in net cradle*



*Photo 9: DDMI Environment staff*



*Photo 10: Use of net cradle to reduce harm on fish being sampled*



*Photo 11: Measuring length of Lake Trout in cradle*



*Photo 12: Angling for Lake Trout*



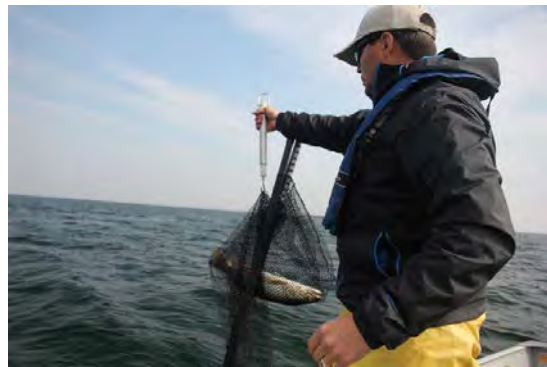
*Photo 13: Large watercraft used for boating on Lac de Gras during rough water conditions*



*Photo 14: Measuring fork and total length of Lake Trout in cradle*



*Photo 15: Data collection*



*Photo 16: Weighing Lake Trout in cradle; weight of cradle subtracted from total weight*



*Photo 17: Removal of caudal fin for archive using ceramic knife and plastic cutting board wrapped in plastic wrap*



*Photo 18: Caudal fin for mercury analysis archive*



*Photo 19: Dermal tissue punch used to extract plug tissue sample*



*Photo 20: Location on Lake Trout dermal tissue plug was removed*



*Photo 21: Example of dermal tissue plug*



*Photo 22: Vetbond antibacterial sealant used to close incisions and dermal plug holes*



*Photo 23: Removal of pelvic fin rays for ageing analysis*



*Photo 24: Pelvic fin rays removed for ageing analysis*





*Photo 25: Landing a Lake Trout in the cradle for sampling*



*Photo 26: Rotund Lake Trout captured on Lac du Sauvage*



*Photo 28: Example of two dermal plug holes after tissue was extracted using dermal punch*



*Photo 29: Preparing to sample a Lake Trout*



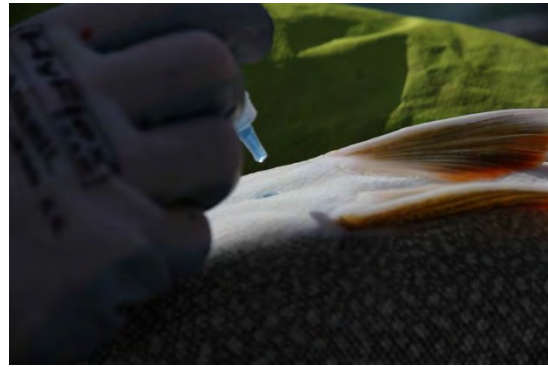
*Photo 30: Example of HDX 23 mm PIT tag used*



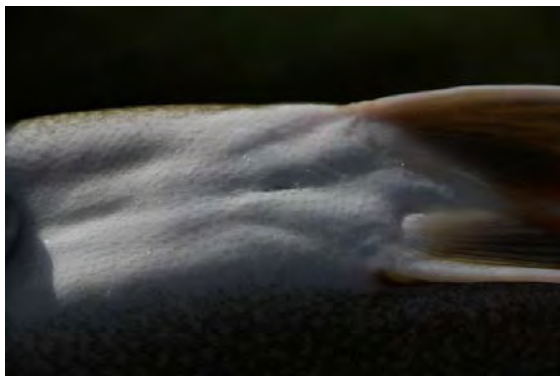
*Photo 31: Location of small incision made for PIT tag implantation*



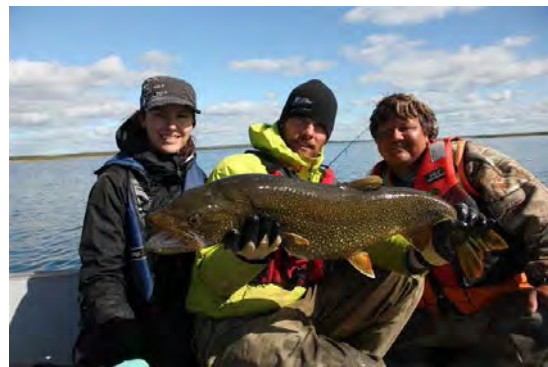
*Photo 32: Insertion of PIT tag*



*Photo 33: Using Vetbond to seal small PIT tag incision*



*Photo 34: Fully sealed incision*



*Photo 35: Lake Trout captured on Lac de Gras*



*Photo 36: Lake Trout being captured by angling*



*Photo 37: Release of Lake Trout following sampling procedure*



*Photo 36: Aerial photograph of antenna array across narrows*



*Photo 37: DDMI staff using boat to stretch antenna array across narrows*



*Photo 38: DDMI staff anchoring antenna array in narrows*

## **APPENDIX B**

### **MERCURY IN LAKE TROUT (RAW DATA)**

These data are provided electronically as an Excel file.

**APPENDIX C**

**RELEVANT QUALITY ASSURANCE/QUALITY CONTROL RESULTS**

Relevant Quality Assurance/Quality Control (QA/QC) results from the 2014 sampling program are presented herein.

**Relative Percent Difference (RPD)**

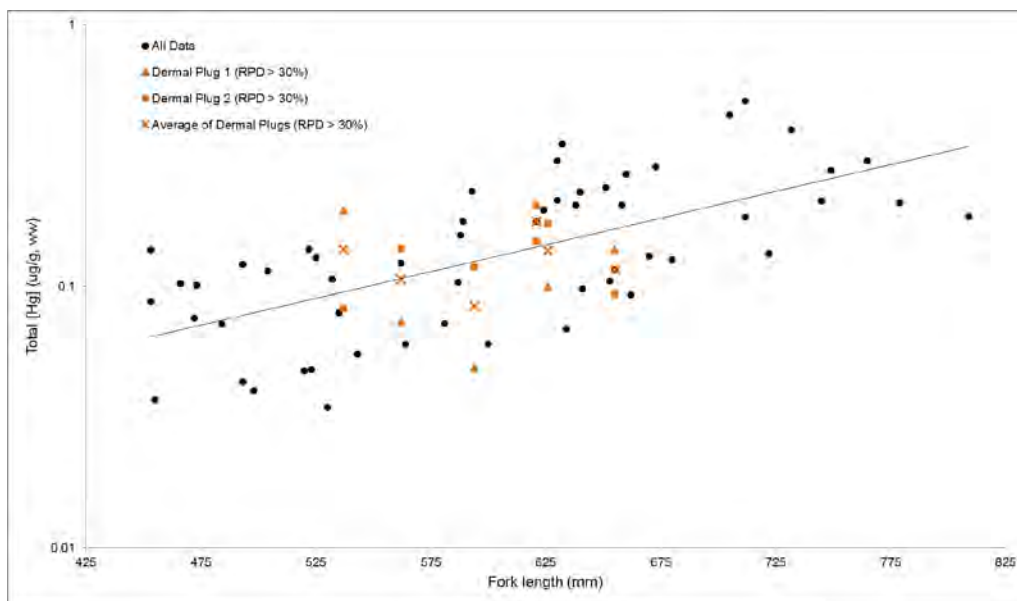
**Split Samples**

The average relative percent difference (RPD) in total mercury (Hg) concentration among six split samples was 12.3 percent (%) (range = 2.2 to 18.6%; Appendix B, Table B-4). The Flett Research Ltd. (Flett) laboratory RPD criteria for split samples is plus minus (+/-) 20%. The 2014 split sample results fell within this criteria.

**Duplicate Plug Samples**

The RPD in total Hg concentration between each dermal plug taken from an individual fish ranged from 0.5 to 84.0% and averaged 15.3%. Flett laboratory suggests the RPD between multiple plugs collected from the same fish should be similar the RPD limit for split samples (+/- 20%) but 30% should be considered as a cut-off based on the variation in the 2014 data. A total of six fish (10%) collected in 2014 had RPD's above 30% between dermal plugs. The lab observed color differences between samples with higher RPD and concluded the fat content was likely causing the high variation in RPD. The average total Hg concentration of the duplicate dermal plugs with greater than (>) 30% RPD were plotted with the fork length-Hg relationship of all 2014 data, and the values were visually consistent with the relationship (Figure C-1). Therefore, these data were deemed valid and were not removed from the dataset.

**Figure C-1 Scatter Plot of Total Mercury against Fork Length in Lake Trout Including Duplicate Dermal Plug Samples with Relative Percent Difference > 30%, 2014**



Notes: mm = millimetre; RPD = relative percent difference; µg/g, ww = microgram per gram wet weight; [Hg] = mercury concentration.

### Variability in Plug Moisture and Weight

As noted in Section 2.3.1, a number of samples were outside the range of a normal moisture content (as percent loss on drying [%LOD]) and had lower sample wet weight (ww) than previous years (Appendix B, Table B-3). An extensive review of the variability in sample weights was conducted with Flett Laboratories.

### Plug Moisture

The typical range of %LOD observed in the lab for whole fillets is 78 to 82%. It should be expected that the %LOD for dermal plugs falls within the same range as observed in fillets but due to their small and delicate nature, this is often not the case. Samples with a %LOD above the typical range likely accumulate excess moisture during the sampling process and samples with a low %LOD could be due to either the compression of the muscle plugs during sampling or by loose vial caps, which are not air tight removing moisture within the vial. In 2014, 82% of samples fell outside the typical range observed in %LOD (78 to 82%) and %LOD ranged from 63.2 to 94.8% and averaged 76%. A number of vials were noted by the lab as loose and is likely the major cause of moisture loss observed in 2014. To account for a large portion of samples that fell outside the acceptable range of %LOD, the lab replaced the actual %LOD with a standard 80%. The average %LOD in 2014 was similar to 2008 but was lower than 2011 (Table C-1). The high average %LOD observed in 2011 was likely due to additional moisture accumulated during sample collection.

### Plug weight

The ww of sample plugs prior to the removal of skin and scales in 2014 varied from 0.034 to 0.215g with an average of 0.072 g (Table C-1). In 2011 the average ww of muscle plugs collected was nearly double that of 2014 but the dry weights were similar (Table C-1). This supports the %LOD results for each year. There was more moisture in the samples collected in 2011 and thus greater sample weights. Likewise, the low sample weights in 2014 are likely a result of moisture loss due to loose vial caps. The average dw collected in 2008 was approximately double both 2011 and 2014 but is expected because the 2008 samples were composites consisting of two dermal plugs from one fish. Given the similarities in dry weights between all 3 years, valid comparisons of total Hg concentrations could be made.

**Table E-1 Comparison of Sample Weight and Percent Loss on Drying of Lake Trout Muscle Plugs Among Years**

Year	Average Wet Muscle Plug Weight (g)	Average Dry Muscle Plug Weight (g)	Average % Loss on Drying
2008	0.189	0.042	77.29
2011	0.142	0.020	84.13
2014	0.072	0.017	75.52

Notes: g = gram.

**Conclusions**

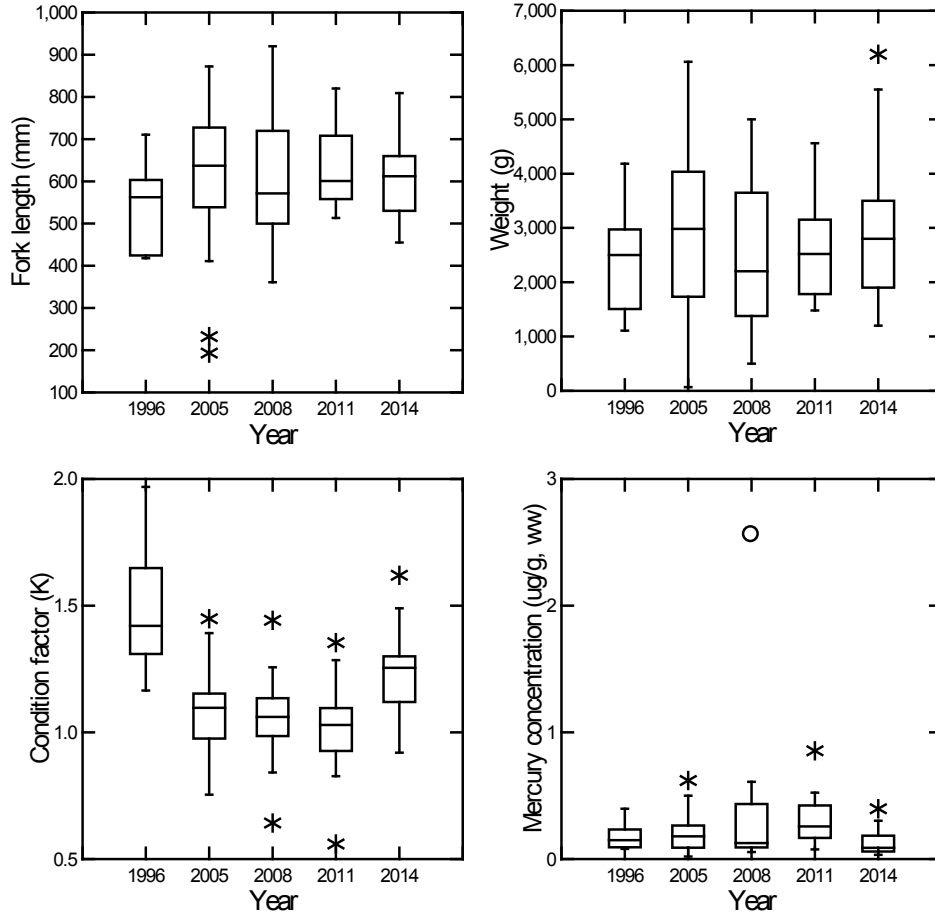
After review, it is reasonable to assume that the comparisons in total Hg concentrations between years are valid for several reasons:

- sample dry weights are similar between years;
- variability in %LOD is common for dermal plugs, given their small and delicate nature;
- Flett Laboratories is confident in the use of a standard 80% %LOD to replace actual %LOD for total Hg concentrations (ww) because it falls within the consistent range observed in fillets; and
- lab results met Flett internal quality control criteria.



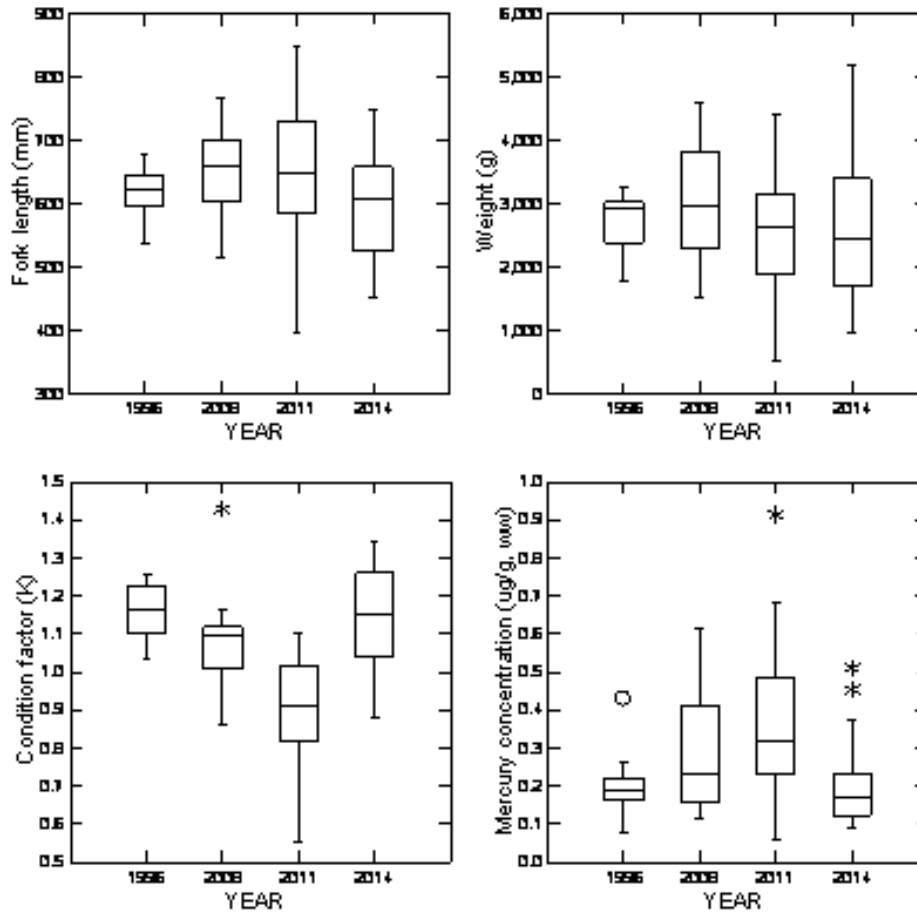
**APPENDIX D**  
**BOX AND WHISKER PLOTS**

**Figure D-1 Box and Whisker Plots for Parameters Measured in Lake Trout from Lac de Gras**



Notes: K = Fulton's condition factor; µg/g, ww = microgram per gram wet weight; [Hg] = mercury concentration; mm = millimetres; g= grams. For 2008, 2011, and 2014, the tissue percentage moisture was adjusted to 80% and the corresponding mercury result was corrected to the moisture level.

**Figure D-2 Box and Whisker Plots for Parameters Measured in Lake Trout from Lac du Sauvage**



Notes: Lac du Sauvage not sampled in 2005.

K = Fulton's condition factor; µg/g, ww = microgram per gram wet weight; [Hg] = mercury concentration; mm = millimetres; g = grams. For 2008, 2011, and 2014, the tissue percentage moisture was adjusted to 80% and the corresponding mercury result was corrected to the moisture level.

**APPENDIX E**  
**STATISTICAL RESULTS TABLES**

**Table E-1 Statistical Outliers**

Year	Lake	Comparison	Fork Length (mm)	Mercury Concentration (ug/g ww)	Rationale
2005	Lac de Gras	Mercury <sup>log</sup> versus Fork Length <sup>log</sup>	193	0.04	High leverage - statistical outlier
2005	Lac de Gras	Mercury <sup>log</sup> versus Fork Length <sup>log</sup>	232	0.06	High leverage - statistical outlier
2005	Lac de Gras	Mercury <sup>log</sup> versus Fork Length <sup>log</sup>	725	0.02	Studentized Residual = -6.3
2008	Lac de Gras	Mercury <sup>log</sup> versus Fork Length <sup>log</sup>	920	2.56	Student leverage plot

Notes: mm = millimeter; ug/g ww = microgram per gram wet weight.

**Table E-2 Summary of Results of the Kolmogorov-Smirnov Test of Normal Distributions and Levene's Test of Means for Homogeneity of Variance between Samples**

Lake	Comparison	Statistical Test	Levene's Test	2005	2008	2011	2014
				Normality	Normality	Normality	Normality
Lac de Gras	Mercury <sup>og</sup> versus Fork Length <sup>og</sup>	ANCOVA	ns	ns	ns	ns	***
Lac du Sauvage	Mercury <sup>og</sup> versus Fork Length	ANCOVA	ns	-	ns	*	*

Notes: Probability of Type 1 Error: \* = < 0.05, \*\* = < 0.01, \*\*\* = < 0.001; \*\*\*\* = < 0.0001, ns = not significant; '-' = not applicable; ANCOVA = Analysis of Covariance; log = base 10 log transformation

## **APPENDIX VI**

### **PLUME DELINEATION SURVEY**

No information was available for this appendix in 2014.

## **APPENDIX VII**

### **DIKE MONITORING STUDY**

No information was available for this appendix in 2014.

## **APPENDIX VIII**

### **FISH SALVAGE PROGRAM**

No information was available for this appendix in 2014.



## **APPENDIX IX**

### **FISH HABITAT COMPENSATION MONITORING**

No information was available for this appendix in 2014.

## **APPENDIX X**

### **FISH PALATABILITY, FISH HEALTH, AND FISH TISSUE CHEMISTRY SURVEY**

No information was available for this appendix in 2014.

# **APPENDIX XI**

## **PLANKTON REPORT**



**PLANKTON REPORT  
IN SUPPORT OF THE 2014 AEMP ANNUAL  
REPORT FOR THE DIAVIK DIAMOND MINE,  
NORTHWEST TERRITORIES**

Submitted to:

Diavik Diamond Mines (2012) Inc.  
P.O. Box 2498  
300 - 5201 50<sup>th</sup> Avenue  
Yellowknife, NT  
X1A 2P8, Canada

**DISTRIBUTION**

- 1 Copy – Diavik Diamond Mines (2012) Inc., Yellowknife, NT
- 1 Copy – Golder Associates Ltd., Calgary, AB
- 1 Copy – Wek'èezhii Land and Water Board

March 2016  
1406208

Doc No. RPT-1384 Ver. 0  
PO No. D03013



## **EXECUTIVE SUMMARY**

This report presents an analysis of the phytoplankton and zooplankton data collected during the 2014 Aquatic Effects Monitoring Program (AEMP) field program. It addresses the main objective of the plankton annual report, which is to compare the current year's plankton community data to the response framework to assess whether Mine-related toxicological changes in the plankton community in the near-field (NF) area of Lac de Gras are occurring.

The 2014 monitoring results suggest that the zooplankton and phytoplankton communities in the NF area of Lac de Gras are not exhibiting notable differences when compared to the reference data. In addition, the plankton biomass and taxonomic richness data indicate that an Action Level 1 for adaptive management response actions for plankton has not been reached.

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**Abbreviations and Acronyms**

AEMP	Aquatic Effects Monitoring Program
DDMI	Diavik Diamond Mines (2012) Inc.
FF	far-field (sampling areas include: FFA, FFB, FF1)
Mine	Diavik Diamond Mine
NF	near-field
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
SD	standard deviation
SOP	standard operating procedure
UTM	Universal Transverse Mercator
WLWB	Wek'èezhii Land and Water Board

**Units of Measure**

%	percent
±	plus or minus
µm	micrometre
cm	centimetre
cells/L	cells per litre
ind/L	individuals per litre
m	metre
mg/m <sup>3</sup>	milligrams per cubic metre
mL	millilitre



# 1 INTRODUCTION

## 1.1 BACKGROUND

“Plankton” is a general term referring to small, usually microscopic organisms that live suspended in non-flowing waterbodies such as lakes. For the purpose of this study, “phytoplankton” refers to the algal component of plankton and includes the following five major ecological groupings:

- cyanobacteria;
- chlorophytes (Chlorophyceae, Prasinophyceae, Trebouxiophyceae, Pedinophyceae, Nephroselmidophyceae, and Conjugatophyceae);
- microflagellates (Chrysophyceae, and Cryptophyceae);
- dinoflagellates (Dinophyceae); and
- diatoms (Bacillariophyceae).

“Zooplankton” refers to small animals, ranging from microscopic to visible with the naked eye, and includes crustaceans (i.e., Cladocera [cladocerans], Cyclopoida [cyclopoids], Calanoida [calanoids], and Rotifera [rotifers]).

Plankton data have been shown to be a useful and sensitive monitoring endpoint for the Diavik Diamond Mine (Mine) (Golder 2011; Golder 2016). In 2013, Diavik Diamond Mines (2012) Inc. (DDMI) revised its Aquatic Effects Monitoring Program (AEMP), as required by Water Licence W2007L2-0003 (WLWB 2007). Among the revisions in the AEMP Study Design Version 3.5 was the addition of plankton as a monitoring component. It was decided that plankton monitoring would occur annually during a single open-water monitoring season (between August 15 and September 15), which is consistent with the other AEMP components (Golder 2014).

This report presents the assessment of the plankton data collected during the 2014 AEMP field program, which was carried out by DDMI staff according to the AEMP Study Design Version 3.5 (Golder 2014). Detailed methods are provided in Section 1.2. Section 1.3 provides results of the assessment, while Section 8.4 provides a discussion of the results. Conclusions are provided in Section 8.5.

## 1.2 OBJECTIVES

The principal goal of the AEMP is to monitor the Mine water discharge and other stressors from the Mine, and to assess potential ecological effects. Within the plankton component, phytoplankton and zooplankton community endpoints (i.e., abundance, biomass and taxonomic composition) are monitored and assessed as indicators of potential effects.

### **1.3 SCOPE AND APPROACH**

The plankton component is designed to monitor both spatial and temporal changes in phytoplankton and zooplankton community composition and biomass. As described in the Study Design Version 3.5 (Golder 2014), the objective of the AEMP annual report is to assess whether Mine-related toxicological changes are occurring in the plankton community in the near-field (NF) area of Lac de Gras.

The effects on plankton communities were evaluated by comparing plankton variables in the exposure area to background values (i.e., values falling within the range of natural variability). These background values are referred to as the normal range. Normal ranges were obtained from the AEMP Reference Conditions Report Version 1.1 (Golder 2015a).

The importance of effects observed on community endpoints was determined according to the Action Level classification defined by Golder (2014).

## 2 METHODS

### 2.1 FIELD PROGRAM

Five stations located in the NF area of Lac de Gras were sampled by DDMI during the 2014 plankton program (Figure 2-1). Universal Transverse Mercator (UTM) coordinates for the NF stations are provided in Table 2-1.

Sampling occurred from August 20 to August 22, 2014, in accordance with Study Design Version 3.5 (Golder 2014) and the DDMI Standard Operating Procedure (SOP): ENVR-003-0702 R13. The SOP is not reproduced within this report, but it has been previously provided to the Wek'èezhìi Land and Water Board (WLWB). Water column profile measurements and samples for water chemistry were collected concurrently as part of the water quality component (Golder 2015b).

A depth-integrated sampler, which collected water from the surface to a depth of 10 metres (m), was used to collect phytoplankton samples. Twelve depth-integrated samples from each station were composited, and the composite sample was used to fill a sample bottle for phytoplankton taxonomy.

A Wisconsin plankton net with a 75 micrometres ( $\mu\text{m}$ ) mesh and a 30.5 centimetre (cm) mouth diameter was used to collect duplicate zooplankton samples at each station. Each sample consisted of a composite of three vertical hauls from the entire water column, beginning at a depth of 1 m above the bottom. Field sampling was conducted by DDMI staff, who did not report deviations from the SOP during sample collection.

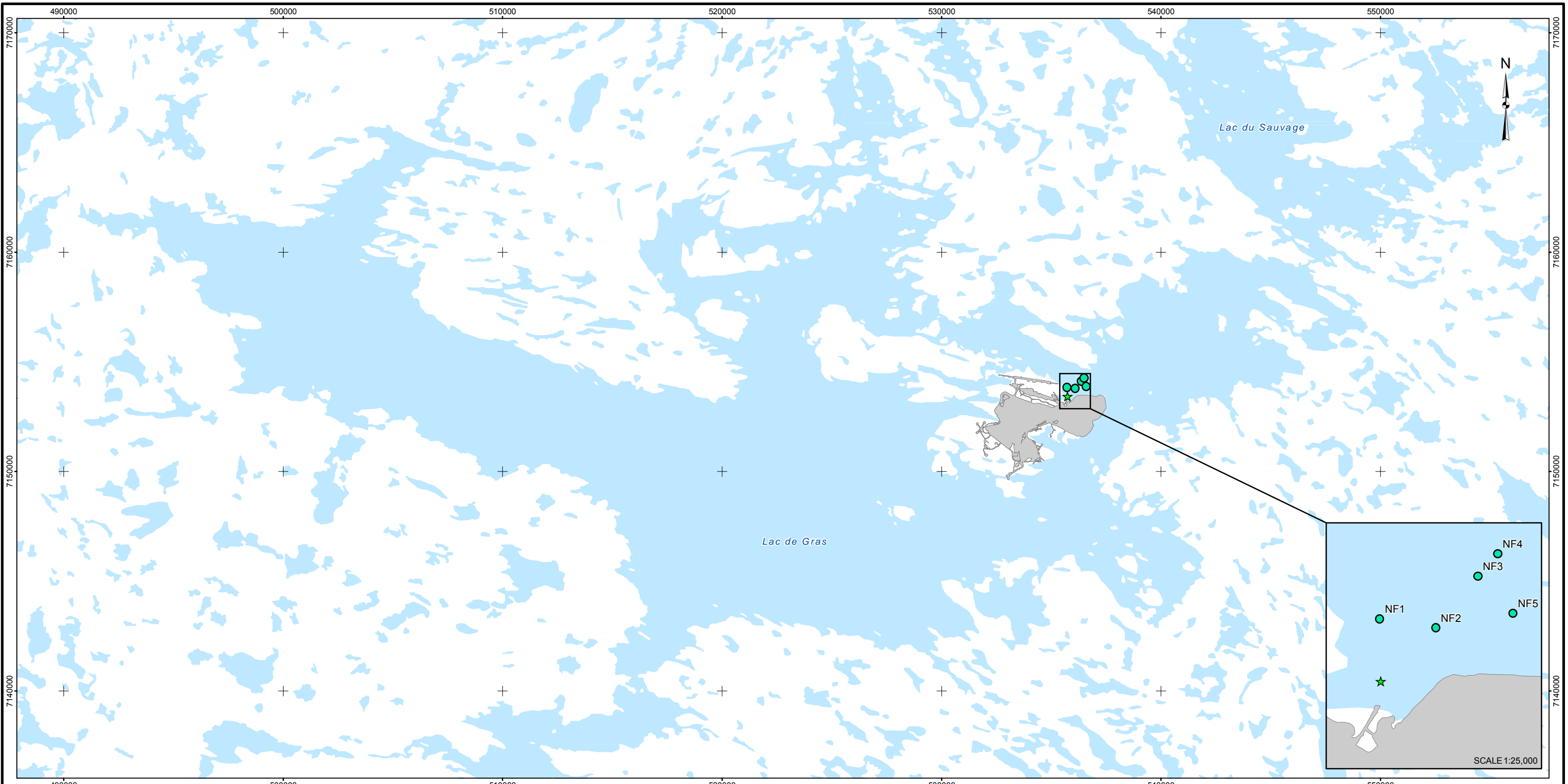
**Table 2-1 UTM Coordinates (NAD 83 Zone 12) and Sampling Dates for the 2014 AEMP Sampling Stations**

Station <sup>(a)</sup>	Date	Depth (m)	Easting	Northing
NF1	August 20, 2014	18.7	535725	7153839
NF2	August 21, 2014	21.0	536095	7153784
NF3	August 22, 2014	19.1	536385	7154101
NF4	August 21, 2014	22.0	536513	7154250
NF5	August 21, 2014	19.8	536625	7153873

Notes: NF = near-field; UTM = Universal Transverse Mercator; NAD = North American Datum; AEMP = Aquatic Effects Monitoring Program.

a - Stations are shown in Figure 2-1.

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- LEGEND**
- ★ DIFFUSERS
  - NEAR-FIELD
  - DIAVIK FOOTPRINT
  - WATERBODY



**REFERENCE**  
HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT			
TITLE			
<b>PLANKTON SAMPLING STATIONS, 2014 AEMP</b>			
	PROJECT	1406208	FILE No.
	DESIGN	DH 20 Jan. 2015	SCALE AS SHOWN
	GIS	SS 30 Mar. 2016	REV. 0
	CHECK	TD 30 Mar. 2016	<b>FIGURE: 2-1</b>
	REVIEW	ZK 30 Mar. 2016	

## **2.2 SAMPLE PROCESSING AND TAXONOMIC IDENTIFICATION**

### **2.2.1 Phytoplankton Community**

A composite phytoplankton sample from each of the five NF stations and a split sample were submitted to Eco-Logic Ltd., Vancouver, British Columbia, for analysis of taxonomic composition, and abundance and biomass. Samples were analyzed according to methods provided by Eco-Logic Ltd., as summarized below.

Phytoplankton samples were homogenized by gently shaking for 60 seconds. Aliquots of 25 millilitres (mL) were then removed and poured into settling chambers, and allowed to settle for a minimum of 4 hours. Quantitative counts were done on a Carl Zeiss Inverted phase-contrast plankton microscope at a high power of 1,560 times magnification followed by a low power scan at 625 times magnification. The lower power scans were performed to confirm both a uniform settlement of the sample on the bottom of the plate and to evaluate the occurrence of rare species (Utermohl 1958). A minimum of 250 and a maximum of 300 cells or counting units were enumerated in each sample for statistical accuracy (Lund et al. 1958). Taxonomic identifications were based primarily on Prescott (1978), Canter-Lund and Lund (1995), and Wehr and Sheath (2003). Phytoplankton taxa were identified to the genus level, and abundance was reported as cells per litre (cells/L).

Fresh weight biomass was calculated from recorded abundance and biovolume estimates based on geometric solids (Rott 1981). Biovolumes were estimated from the average dimensions of 10 to 15 individuals; the biovolumes of colonial taxa were based on the number of individuals within each colony. Assuming a specific gravity of one, the biovolume of each species was converted to biomass, reported in milligrams per cubic metre (mg/m<sup>3</sup>).

### **2.2.2 Zooplankton Community**

A total of 11 zooplankton samples, consisting of duplicates from each of the five NF stations and an additional split sample from one station, were submitted to Salki Consultants Inc., Winnipeg, Manitoba, for analysis of taxonomic composition. Samples were analyzed for abundance and biomass of crustaceans and rotifers according to the methods provided by Salki Consultants Inc., which are summarized below. Each sample underwent three levels of analysis, as follows:

- A 1/40 or 1/80 portion of each sample was examined under a compound microscope at 63x or 160x magnification. All specimens of crustaceans and rotifers were identified to the lowest taxonomic level (typically species) and assigned to size categories as indicated in the species list.

- A second sub-sample, representing 11 percent (%) of the sample volume, was examined under a stereoscope at 12 times magnification for the large species (e.g., *Heterocope septentrionales*, *Holopedium gibberum*, *Daphnia middendorffiana*, and *D. longiremis*) and rare species (e.g., *Eubosmina longispina*, *Diaptomus ashlandi*, *Epischura nevadensis*, *Chydorus sphaericus*, and *Cyclops capillatus*). These were enumerated and assigned to size classes.
- The entire sample was examined under the stereoscope to improve abundance estimates for the largest species (e.g., adult male and female *Heterocope septentrionales*, *Holopedium gibberum*, *Daphnia middendorffiana*, and *D. longiremis*).

Cyclopoida and Calanoida specimens (mature and immature) were identified to species, with the exception of nauplii, which were classified as either Calanoida or Cyclopoida, as appropriate. Cladocera were identified to species. Rotifers were identified to genus. Zooplankton abundance was reported as individuals per litre (ind/L). Taxonomic identifications were based primarily on Brooks (1957), Wilson (1959) and Yeatman (1959).

Biomass estimates for each taxon were obtained using mean adult sizes determined during the analysis of the 2007 zooplankton samples (Golder 2008) and from length-weight regression equations developed by Malley et al. (1989). Additional measurements were made on all newly encountered species. Zooplankton biomass was reported in mg/m<sup>3</sup>.

## 2.3 DATA ANALYSES

### 2.3.1 Phytoplankton Community Analysis

The following methods were used to summarize the 2014 phytoplankton data:

- Abundance and biomass data were divided into the five major ecological groups present in the 2014 samples (cyanobacteria, chlorophytes, microflagellates, dinoflagellates, and diatoms). The relative abundance and biomass (expressed as a percentage) accounted for by each major group was calculated for the NF sampling area.
- Richness was calculated at the genus level. This variable provides an indication of the diversity of phytoplankton in an area; a greater richness value typically indicates a more healthy and balanced community.
- The mean plus or minus standard deviation ( $\pm$ SD) was calculated for total phytoplankton biomass and taxonomic richness.

Potential effects were evaluated by comparing mean total biomass, the biomass of each ecological group, and phytoplankton taxonomic richness in the NF exposure area to the normal range obtained from the AEMP Reference Conditions Report V.1.1 (Golder 2015a). In addition, 2014 phytoplankton community composition (i.e., relative abundance and biomass) in the NF area, was compared to the composition in each of the three reference areas from 2013.

## 2.3.2 Zooplankton Community Analysis

The following methods were used to summarize the 2014 zooplankton data:

- Abundance and biomass data were divided into the four major ecological groups (calanoids, cyclopoids, cladocerans, and rotifers).
- Mean abundance and biomass were calculated for each station.
- Relative abundance and biomass accounted for by each major taxonomic group was calculated for the NF sampling area.
- Richness was calculated at the lowest taxonomic level: species level for cladocerans, cyclopoids, and calanoids; and genus level for rotifers.
- The mean  $\pm$ SD was calculated for total zooplankton biomass and taxonomic richness.

Potential effects were evaluated by comparing zooplankton mean total biomass and the biomass of each ecological grouping in the NF exposure area to the normal range as outlined in the AEMP Reference Conditions Report Version 1.1 (Golder 2015a). In addition, 2014 phytoplankton community composition (i.e., relative abundance and biomass) in the NF area, was compared to the composition in each of the three reference areas from 2013.

## 2.4 ACTION LEVELS FOR PLANKTON

The importance of effects to a phytoplankton or zooplankton assessment endpoint (i.e., biomass or taxonomic richness) was categorized according to Action Levels described by Golder (2014). The Action Level classifications were developed to meet the goals of the draft *Guidelines for Adaptive Management – A Response Framework for Aquatic Effects Monitoring* (WLWB 2010; Racher et al. 2011). The goal of the Response Framework is to ensure that significant adverse effects never occur. A significant adverse effect, as it pertains to aquatic biota, was defined in the Environmental Assessment as a change in fish population(s) that is greater than 20% (Government of Canada 1999). This effect must have a high probability of being permanent or long-term in nature and must occur throughout Lac de Gras. The Significance Thresholds for all aquatic biota, including plankton, are therefore related to impacts that could result in a change in fish population(s) that is greater than 20%.

Although the AEMP addresses two broad impact hypotheses for Lac de Gras, the toxicological impairment hypothesis and the nutrient enrichment hypothesis (Golder 2014), the Action Levels for plankton address the toxicological impairment hypothesis. The nutrient enrichment hypothesis is addressed in the Eutrophication Indicators component (Golder 2015c).

Phytoplankton and zooplankton biomass and taxonomic richness are assessed annually to evaluate effects as described in the *Action Levels for Biological Effects* section (5.3.3) of Golder (2014). This involves testing biomass and richness in the NF exposure area against the mean of the reference area data. The occurrence of an Action Level 1 will be determined by finding significantly lower biomass or richness in the exposure area compared to the mean of reference area data. Phytoplankton mean total biomass and taxonomic richness were compared to reference area data from 2013, which were used to estimate normal ranges for these variables, as outlined in the AEMP Reference Conditions Report Version 1.1 (Golder 2015a). Previous data could not be used, due to a change in taxonomist. Zooplankton mean total biomass and taxonomic richness were compared to the means of 2008 to 2010 reference area data, which were used to estimate normal ranges (Golder 2015a). Conditions required for Action Levels 1 to 3 are defined in Table 2-2. Action Level 4 will be defined if Action Level 3 is reached. Defining higher Action Levels after initial effects are encountered is consistent with the draft guidelines for preparing a response framework for AEMPs (WLWB 2010; Racher et al. 2011).

**Table 2-2 Action Levels for Plankton Effects**

Action Level	Plankton	Extent	Action
1	Mean biomass or richness significantly less than reference area means	Near-field	Confirm effect
2	Mean biomass or richness significantly less than reference area means	Nearest Mid-field station	Investigate cause
3	Mean richness less than normal range	Near-field	Examine ecological significance Set Action Level 4 Identify mitigation options
4	TBD <sup>(a)</sup>	TBD <sup>(a)</sup>	Define conditions required for the Significance Threshold
5 <sup>(b)</sup>	Decline in biomass or richness likely to cause a >20% change in fish population(s)	Far-field A (FFA)	Significance Threshold

Notes: > = greater than; % = percent.

a – To be determined if Action Level 3 is reached.

b – Significance Threshold.

## 2.5 QUALITY CONTROL

The Quality Assurance Project Plan (QAPP) Version 2.0 outlines the quality assurance/quality control (QA/QC) procedures employed to support the collection of scientifically-defensible and relevant data required to meet the objectives of the AEMP (Golder 2013). The QAPP is designed so that field sampling, laboratory analysis, data entry, data analysis, and report preparation activities produce technically-sound and scientifically-defensible results. A description of the QA/QC program is provided in Appendix A.



### 3 RESULTS

The 2014 raw phytoplankton abundance and biomass data, as well as the quality control results pertaining to taxonomic analysis, are provided in Appendix B. The 2014 zooplankton abundance and biomass data, and associated quality control results are provided in Appendix C.

#### 3.1 PHYTOPLANKTON COMMUNITY

##### 3.1.1 Phytoplankton Biomass and Taxonomic Richness

In 2014, mean phytoplankton richness in the NF exposure area was above the normal range (Table 3-1). Biomass values for the diatom and dinoflagellate ecological groups were highly variable among stations, although the mean values were within the normal ranges. The means of all other ecological groups and total phytoplankton biomass were within normal ranges.

**Table 3-1 Phytoplankton Biomass and Taxonomic Richness in Lac de Gras in 2014 Compared to the Normal Range**

Variable	Unit	Near-Field (NF)		Normal Range <sup>(a)</sup> and 2013 Reference Area Mean		
		<i>n</i>	Mean ± SD	Lower Limit	2013 Reference Area Mean	Upper Limit
Cyanobacteria Biomass	mg/m <sup>3</sup>	5	38 ± 21	4	28	79
Microflagellate Biomass	mg/m <sup>3</sup>	5	71 ± 18	13	56	99
Chlorophyte Biomass	mg/m <sup>3</sup>	5	150 ± 30	25	104	253
Diatom Biomass	mg/m <sup>3</sup>	5	43 ± 52	5	4	66
Dinoflagellate Biomass	mg/m <sup>3</sup>	5	14 ± 8	0	7	19
Total Phytoplankton Biomass	mg/m <sup>3</sup>	5	316 ± 77	140	200	352
Total Phytoplankton Taxonomic Richness	Taxa <sup>(b)</sup>	5	32 ± 5	12	27	25

mg/m<sup>3</sup> = milligrams per cubic metre; ± = plus or minus; SD = standard deviation; *n* = number of samples.

a - The normal range was calculated as defined in the AEMP Reference Conditions Approach Report Version 1.1 (Golder 2015a).

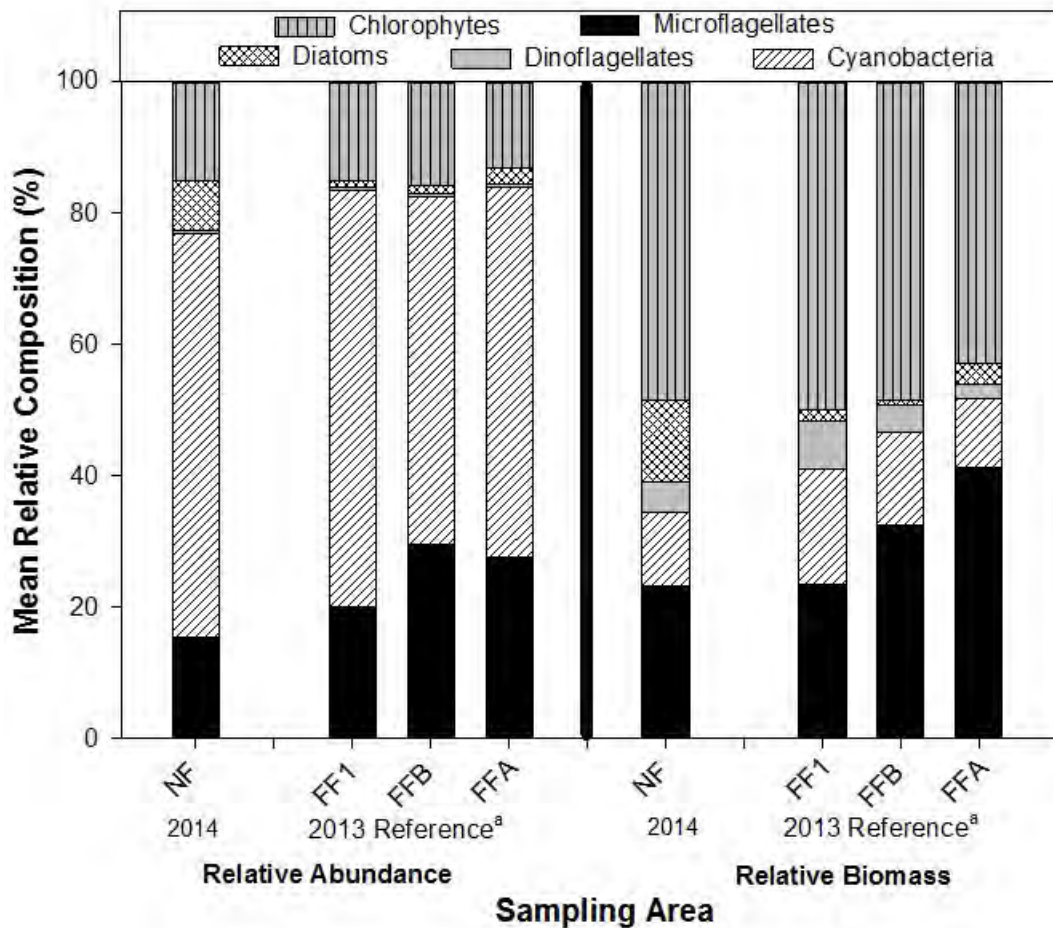
b - Taxonomic richness is the number of taxa at the genus level.

##### 3.1.2 Phytoplankton Community Structure

In 2014, phytoplankton community composition in the NF exposure area of Lac de Gras, by both abundance and biomass, was similar to that observed in the reference areas in 2013, with the

exception of greater relative abundance of diatoms in the NF area in 2014 (Figure 3-1). In terms of mean relative abundance, the phytoplankton communities in the NF area in 2014 and the historical reference areas were dominated by cyanobacteria (61%), followed by microflagellates (16%), and chlorophytes (15%), with a greater proportion of diatoms (7%) and lower proportion of microflagellates (15%) in the NF area compared to the historical reference areas (diatoms: 1% to 3% and microflagellates: 20% to 30%). Mean relative biomass, community composition in the NF exposure area and reference areas was dominated by chlorophytes (49%), followed by microflagellates (23%), and cyanobacteria (11%). The NF area had slightly greater relative biomass of diatoms (12%) than the historical reference area community (2% to 3%) in 2014.

**Figure 3-1 Mean Relative Phytoplankton Abundance and Biomass in the Near-field Area of Lac de Gras in 2014 Compared to the Reference Areas in 2013**



NF = near-field; FF = far-field.

a – calculated as the mean for each reference area (FF1, FFB, and FFA) in 2013.

## 3.2 ZOOPLANKTON COMMUNITY

### 3.2.1 Zooplankton Biomass (calculated) and Taxonomic Richness

Zooplankton mean total biomass in the NF exposure area in 2014 was highly variable but remained within the normal range (Table 3-2). The biomass of the zooplankton ecological groups in the NF area in 2014 displayed high variability among the stations. Cladoceran biomass and rotifer biomass were above the normal range for Lac de Gras in 2014.

In total, 18 zooplankton taxa were identified in 2014 in the NF area of Lac de Gras (Appendix C-5). Taxonomic richness was similar among NF stations in 2014 (ranging from 14 to 17 taxa) with the mean taxonomic richness in the NF area within the normal range, although nearing the upper limit (Table 3-2).

**Table 3-2 Zooplankton Biomass (calculated) and Taxonomic Richness in Lac de Gras, 2014**

Variable	Unit	Near-Field (NF)		Normal Range <sup>(a)</sup>		
		n	Mean ± SD	Lower Limit	2008-2010 Reference Area Mean	Upper Limit
Cladocera Biomass	mg/m <sup>3</sup>	5	138 ± 46	8	63	127
Cyclopoida Biomass	mg/m <sup>3</sup>	5	91 ± 15	13	54	105
Calanoida Biomass	mg/m <sup>3</sup>	5	200 ± 105	61	182	359
Rotifera Biomass	mg/m <sup>3</sup>	5	8 ± 3	2	4	7
Total Zooplankton Biomass	mg/m <sup>3</sup>	5	437 ± 149	132	300	540
Total Zooplankton Taxonomic Richness	Taxa <sup>(b)</sup>	5	15 ± 1	11	14	17

mg/m<sup>3</sup> = milligrams per cubic metre; SD = standard deviation; n = number of samples; ± = plus or minus.

a – The normal range was calculated as defined in the AEMP Reference Conditions Approach Report Version 1.1 (Golder 2015a).

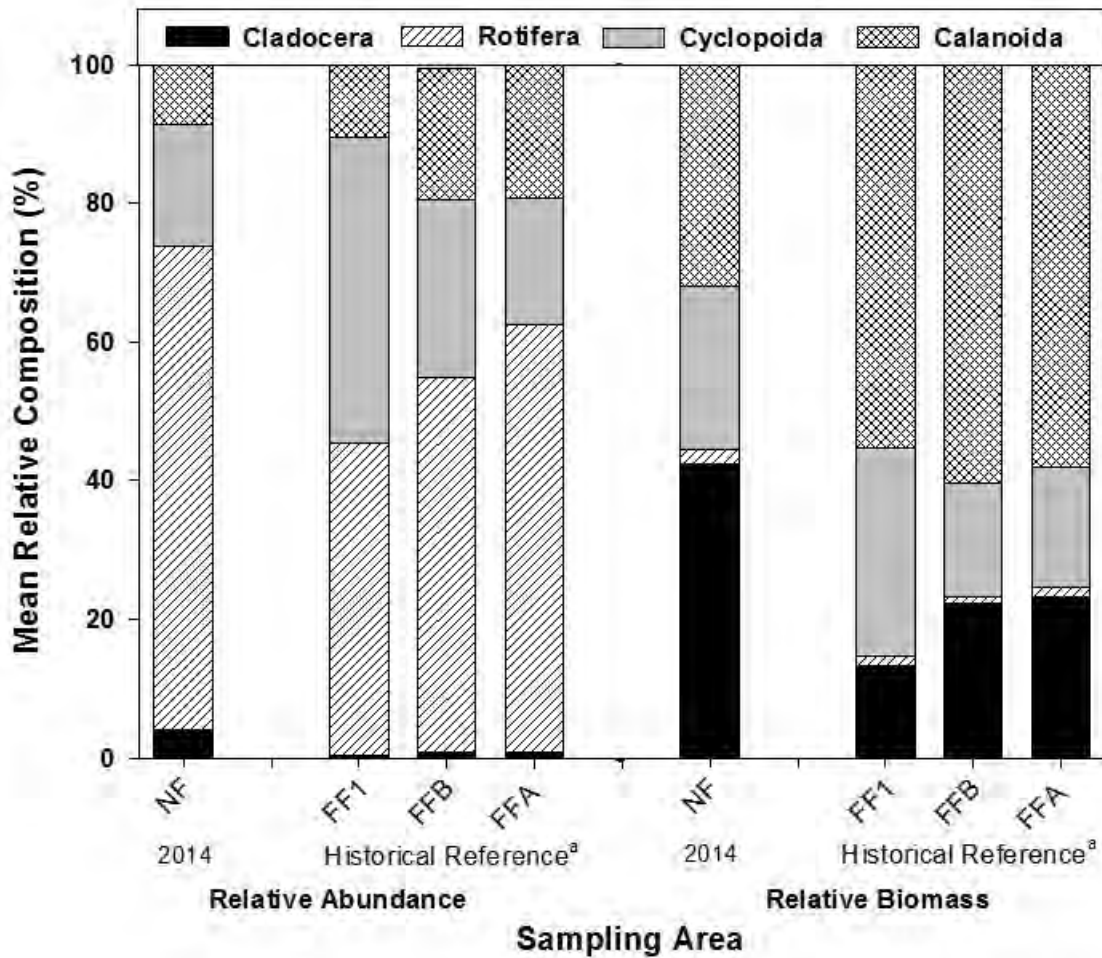
b – Taxonomic richness is the number of taxa at the genus level.

### 3.2.2 Zooplankton Community Structure

Zooplankton community composition in the NF area of Lac de Gras differed slightly from the historical reference area composition (Figure 3-2). In terms of relative abundance, the zooplankton community in the NF area in 2014 consisted of a greater number of rotifers (70%) and cladocerans (4%), and fewer cyclopoid (17%) and calanoid copepods (9%) compared to the historical reference area. In terms of mean relative biomass, the zooplankton community in the NF area was

co-dominated by cladocerans (42%), calanoid copepods (32%), followed by cyclopoid copepods (23%), while the historical reference areas were dominated by calanoid copepods (55% to 61%) followed by cyclopoid copepods (16% to 30%). A lower biomass of cladocerans was observed in the historical reference areas compared to the NF area in 2014. Despite accounting for a large proportion of relative abundance, rotifers accounted for a small proportion of the biomass (2%) in NF area, reflective of their small size. In contrast, cladocerans accounted for a small proportion of zooplankton community relative abundance in the NF area (4%), but contributed a large proportion to the zooplankton community biomass (42%), because of their relatively large body size.

**Figure 3-2 Mean Relative Zooplankton Abundance and Biomass in the Near-field Area of Lac de Gras in 2014 Compared to the Reference Area Means from 2008 to 2010**



NF = near-field; FF = far-field.

a – calculated as the pooled 2008 to 2010 mean for each reference area (FF1, FFB, and FFA).

### **3.3 ACTIONS LEVELS FOR PLANKTON**

The Action Levels for plankton effects address the toxicological impairment hypothesis. An Action Level 1 would be reached when significantly lower biomass or richness is observed in the exposure area compared to the reference area (Table 2-2). The NF area mean values for all variables considered, for both phytoplankton and zooplankton, were higher than the reference area means, requiring no statistical comparisons of the 2014 NF area data with reference area data.

Results for both phytoplankton and zooplankton biomass and taxonomic richness indicate that an Action Level 1 for plankton has not been reached.

## **4 DISCUSSION**

### **4.1 PHYTOPLANKTON COMMUNITY**

Total phytoplankton biomass in the NF area exceeded the normal range from 2006 to 2012, and fell within the normal range in 2013 and 2014 (Table 3-1). A decreasing trend in phytoplankton biomass has been observed since 2010. Microflagellate biomass in the NF area exceeded the normal range for all years sampled except 2003 and 2006; since 2006 it has declined and was within the normal range in 2014. Dinoflagellates have been within the normal range for all years sampled, with the exception of 2007. In contrast, mean diatom biomass was highly variable and some individual stations exceeded the normal range in the NF area in 2014. Often, an increase in diatom biomass is the result of increased nutrient concentrations, specifically increased silica (Wetzel 2001).

Phytoplankton community structure did not differ substantially in terms of mean relative biomass or abundance in the NF exposure area in 2014 when compared to the 2013 reference area communities. The main difference was the greater proportion of diatoms in the NF community compared to the 2013 reference areas. The mean number of taxa in the NF area was beyond the upper end of the normal range, which was also observed in 2012 and 2013 (Golder 2016).

The 2014 phytoplankton community displayed a response seen in previous years, which is reflective of nutrient enrichment. There was no evidence of toxicological impairment, and, as a result, an Action Level 1 was not reached.

### **4.2 ZOOPLANKTON COMMUNITY**

In 2014, the mean total zooplankton biomass in the NF area was similar to that encountered in 2012 and 2013. Total biomass was greater than the normal range at some NF stations, demonstrating the within-area variability that exists in Lac de Gras. The mean biomass of cladocerans and rotifers in the NF area was greater than the normal range, although calanoid copepods exhibited high variability among stations. In the NF area, exceedances of the normal range by mean cladoceran biomass were seen in most years, and exceedances by cyclopoid copepod and rotifer biomass were also periodically observed (Golder 2016).

In terms of relative abundance, the zooplankton community in the NF area in 2014 was slightly different than the historical zooplankton communities in the far-field (FF) reference areas FF1, FFB, and FFA areas of Lac de Gras. The mean relative abundance of rotifers was slightly greater, and the mean relative abundance of cyclopoid copepods was slightly lower in the NF area compared to the historical mean zooplankton communities. In terms of relative biomass, increased cladoceran and decreased cyclopoid copepod biomass was observed in the NF exposure area in 2014

compared to the historical zooplankton communities. Zooplankton taxonomic richness in the NF area of Lac de Gras remains within the normal range.

There was no evidence of toxicological impairment, and, as a result, an Action Level 1 was not reached. The zooplankton biomass and taxonomic richness data suggest that there are slight changes in the community as a result of nutrient enrichment.

## **5 CONCLUSIONS**

This report presents an analysis of the phytoplankton and zooplankton data collected during the 2014 AEMP field program. It addresses the main objective of the plankton annual report, which is to compare the current year's plankton community data to the response framework to assess whether Mine-related toxicological changes are occurring in the plankton community in the NF area of Lac de Gras.

Overall, the phytoplankton and zooplankton biomass and taxonomic richness data do not suggest that a toxicological effect is occurring in Lac de Gras. Therefore, an Action Level 1 for plankton was not reached in 2014.



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## **7 CLOSURE**

We trust that the information in this report meets your requirements at this time. If you have any questions relating to the information contained in this document please do not hesitate to contact us.

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**APPENDIX A**  
**QUALITY ASSURANCE/QUALITY CONTROL**

## **Introduction**

The quality assurance/ quality control (QA/QC) program followed during the 2014 Aquatic Effects Monitoring Program (AEMP) sampling program is detailed in the Quality Assurance Project Plan (QAPP) Version 2.0 (Golder 2013). The QAPP outlines the QA/QC procedures employed to support the collection of scientifically defensible and relevant data. The QAPP is designed so that field sampling, laboratory analysis, data entry, data analysis, and report preparation activities produce technically sound and scientifically defensible results. Results of the 2014 plankton QA/QC program are presented below.

## **Quality Assurance**

### ***Field Operations***

Field work was completed by Diavik staff according to specified instructions and the following SOPs:

- Plankton Sampling ENVR-003-0702 R13;
- Quality Assurance/Quality Control ENVR-303-0112 R0; and,
- Chain-of-Custody ENVR-206-0112 R0.

These SOPs include guidelines for field record keeping and sample tracking, relevant technical procedures, and sample labelling, shipping, and tracking protocols.

### ***Office Operations***

A data management system provides an organized system of data control, analysis, and filing. Relevant operations included:

- reviewing taxonomy data as they were received from the subconsultants;
- creating backup files prior to beginning data analysis; and,
- completing appropriate data reviews to verify the accuracy of calculations.

## **Quality Control**

### ***Methods***

Quality control is a specific aspect of quality assurance. The DDMI field quality control program consisted of collecting duplicate zooplankton samples. The laboratory quality control program consisted of one phytoplankton split sample and one zooplankton split sample, which were analyzed by the same taxonomist. The duplicate samples are used to check within-station variation, while split samples are used to check the taxonomist's counting efficiency. The data were entered

into electronic format by the taxonomist and were double-checked by the same taxonomist upon entry; errors were corrected as necessary before transferring the electronic files to DDML.

Duplicate zooplankton samples consisted of two samples collected from the same station at the same time, using the same sampling and sample handling procedures. They were labelled and preserved individually, and were submitted separately to the taxonomist for identical analyses.

The inherent variability associated with the plankton samples makes the establishment of a quality control threshold value difficult. For the purposes of the plankton quality control, samples were flagged and assessed further if there was a greater than 50% difference, calculated as the relative percent difference (RPD), in total abundance between the original and duplicate samples. Similarly, samples were flagged and assessed further if there was a greater than 50% difference in total abundance between the taxonomist's split samples.

In addition, the Bray-Curtis dissimilarity index, which is a measure of ecological distance between two communities, was used to assess the overall similarity between the taxonomist's split samples. The value of the Bray-Curtis index ranges from zero (identical communities) to one (very dissimilar communities) and is calculated using the following formula:

$$b = \frac{\sum_{k=1}^n |x_{ik} - x_{jk}|}{\sum_{k=1}^n (x_{ik} + x_{jk})}$$

where  $x_{ik}$  and  $x_{jk}$  are abundance from the original and re-counted samples respectively.

Index values greater than 0.5 were flagged and follow-up discussions with the taxonomist were initiated. Due to the high variability in species present in the original compared to the recounted samples, the Bray-Curtis comparisons were performed on species grouped at the major ecological grouping level for the phytoplankton community (i.e., chlorophytes, microflagellates, dinoflagellates, cyanobacteria, and diatoms) and zooplankton community (i.e., cladocerans, cyclopoids, calanoids, and rotifers).

Duplicate zooplankton data were not automatically rejected because of an exceedance of the acceptance criterion; rather, they were evaluated on a case-by-case basis, as some level of within-station variability is expected for duplicate samples. If there were departures from the acceptance criterion, the samples were flagged, and a variety of follow-up assessments were performed. These assessments included plotting the data for visual identification of outliers. If there were visual outliers, the data were plotted with the corresponding 2008 to 2013 data for a range comparison. If the data were outside the corresponding 2008 to 2013 range, laboratory re-analysis was requested. If laboratory re-analysis confirmed the results, the outlier points were retained in the final data set, unless there was a technically defensible reason to exclude them.

## Results

The 2014 phytoplankton quality control data indicate that the abundances of dominant species and major ecological groups were consistent between the split samples. In addition, the split sample results did not exceed a RPD of 50% for total abundance, and had a Bray-Curtis Index value below 0.5 (Table A-1). Therefore, further follow-up assessments were not performed.

The 2014 zooplankton quality control data indicated that the occurrence of dominant species was consistent between the split samples. In addition, the split sample results did not exceed an RPD of 50% for total abundance, and the Bray-Curtis Index value was below 50% (Table A-1). The comparison of duplicate samples for zooplankton total abundance indicated overall similarity between duplicate samples, as all RPD values were well below 50% (Table A-2).

**Table A-1 Summary of Counting Efficiency from Quality Control Samples for Plankton, 2014**

Sample Type	Station	Result 1	Result 2	Relative Percent Difference (%)	Bray-Curtis Index	QC Flag
Phytoplankton Abundance (cells/L)	NF4	3,517,495	3,051,199	4	0.08	No
Zooplankton Abundance (ind/L)	NF2	34.3	32.5	1	0.04	No

Note: NF = near-field; cells/L = cells per litre; ind/L = individuals per litre; QC = quality control; % = percent.

**Table A-2 Summary of Duplicate Sample Results for Zooplankton Abundance, 2014**

Station	Result 1	Result 2	Relative Percent Difference (%)	QC Flag
NF1	25	27	2	No
NF2	34	35	2	No
NF3	28	39	8	No
NF4	35	41	4	No
NF5	20	22	2	No

Note: NF = near-field; ind/L = individuals per litre; % = percent; QC = quality control.

## **APPENDIX B**

### **PHYTOPLANKTON COMMUNITY DATA (RAW DATA AND QUALITY CONTROL DATA)**

These data are provided electronically as an Excel file.



## **APPENDIX C**

### **ZOOPLANKTON COMMUNITY DATA (RAW DATA AND QUALITY CONTROL DATA)**

These data are provided electronically as an Excel file.

## **APPENDIX XII**

### **SPECIAL EFFECTS STUDY REPORT**

No information was available for this appendix in 2014.

## **APPENDIX XIII**

# **EUTROPHICATION INDICATORS REPORT**



**EUTROPHICATION INDICATORS REPORT IN  
SUPPORT OF THE 2014 AEMP ANNUAL REPORT  
FOR THE DIAVIK DIAMOND MINE, NORTHWEST  
TERRITORIES**

Submitted to:

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**DISTRIBUTION**

- 1 Copy – Diavik Diamond Mines (2012) Inc., Yellowknife, NT
- 1 Copy – Golder Associates Ltd., Calgary, AB
- 1 Copy – Wek'èezhii Land and Water Board

March 2016  
1406208

Doc No. RPT-1383 Ver. 0  
PO No. D03013



## EXECUTIVE SUMMARY

In 2014, Diavik Diamond Mines (2012) Inc. (Diavik) completed the field component of an Aquatic Effects Monitoring Program (AEMP) in Lac de Gras, Northwest Territories, as required by Water Licence W2007L2-003 and according to the AEMP Study Design Version 3.4 for ice-cover and Version 3.5 for open-water sampling. This report presents the assessment of eutrophication indicators data collected during the 2014 AEMP.

To evaluate whether effluent from the Diavik Diamond Mine (Mine) is causing eutrophication in Lac de Gras, indicators of eutrophication, including concentrations of total phosphorus (TP), total nitrogen (TN), and chlorophyll *a* were measured in areas exposed to effluent (near-field [NF] and mid-field [MF] exposure areas). Zooplankton biomass, which is also used as an indicator of eutrophication, could not be reported because of a laboratory error.

The assessment of the eutrophication indicators data concluded that the Mine is having a nutrient enrichment effect in Lac de Gras. Nutrient concentrations were greatest under ice-cover at the bottom in the NF area, and greater concentrations of nutrients were present in the NF area relative to MF areas. During both the ice-cover and open-water seasons, the effects on concentrations of TP covered less than 4% of the lake surface area. The area of the lake showing effects on TN and chlorophyll *a* concentrations was substantially larger. Concentrations of TN exceeded the normal range in  $\geq 40.1\%$ <sup>1</sup> of the lake. Concentrations of chlorophyll *a* exceeded the normal range (i.e., upper limit of 0.82  $\mu\text{g/L}$ ) over an area representing  $\geq 42.4\%$ <sup>2</sup> of the lake. Given that chlorophyll *a* concentrations were greater than the normal range plus 25% of Effects Benchmark (i.e., 1.74  $\mu\text{g/L}$ ) in less than 20% of the lake area, the magnitude of the eutrophication effect is equivalent to an Action Level 2 in the Response Framework.

According to the Response Framework, the action corresponding to Action Level 2 is to establish an Effects Benchmark for chlorophyll *a*. The Effects Benchmark has been established and was presented in AEMP Study Design Version 3.5. Consequently, no further action is required based on the 2014 monitoring results.

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<sup>1,2</sup> Percent lake area affected could not be estimated with certainty, because stations FF1, FFA, and FFB were not sampled in 2014.

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- Appendix D Eutrophication Indicators Raw Data
- Appendix E Letter From HydroQual Laboratories



**Abbreviations and Acronyms**

AEMP	Aquatic Effects Monitoring Program
AFDM	ash-free dry mass
DDMI	Diavik Diamond Mines (2012) Inc.
DL	detection limit
DO	dissolved oxygen
EA	environmental assessment
e.g.	for example
et al.	and more than one additional author
EQC	effluent quality criteria
Golder	Golder Associates Ltd.
i.e.	that is
mean $\pm$ SD	mean plus or minus standard deviation
MF	mid-field
Mine	Diavik Diamond Mine
n	sample size/count
NAD	North American Datum
NF	near-field
NH <sub>4</sub>	ammonia
NIWTP	North Inlet Water Treatment Plant
NO <sub>3</sub>	nitrate
NO <sub>2</sub>	nitrite
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RPD	relative percent difference
SD	standard deviation
SNP	surveillance network program
SOP	standard operating procedure
SRP	soluble reactive phosphorus
TN	total nitrogen
TP	total phosphorus
TDN	total dissolved nitrogen
TDP	total dissolved phosphorus
UofA	University of Alberta
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
WLWB	Wek'èezhìi Land and Water Board

**Units of Measure**

%	percent
x	times
<	less than
>	greater than
±	plus or minus
≤	less than or equal to
≥	greater than or equal to
kg	kilogram
km <sup>2</sup>	square kilometre
m	metre
m <sup>3</sup>	cubic metre
mg/L	milligrams per litre
µg/L	micrograms per litre
µg-N/L	micrograms of nitrogen per litre
µg-P/L	micrograms of phosphorus per litre
µS/cm	microSiemens per centimetre

# 1 INTRODUCTION

## 1.1 BACKGROUND

As required by Water Licence W2007L2-003 issued by the Wek'èezhii Land and Water Board (WLWB), Diavik Diamond Mines (2012) Inc. (DDMI) has been monitoring indicators of eutrophication in Lac de Gras as a component of the Aquatic Effects Monitoring Program (AEMP) since 2007 (WLWB 2007). This has been a key component of the AEMP, because the Environmental Assessment (EA) predicted that the discharge of effluent from the Diavik Diamond Mine (Mine) would cause a slight increase in the trophic status (a classification of productivity) in up to 20% of Lac de Gras (by area) as a result of nutrient enrichment (Government of Canada 1999).

This report presents the assessment of eutrophication indicators data collected during the 2014 AEMP field program, which was carried out by DDMI according to the AEMP Study Design Version 3.4 for the ice-cover period and Version 3.5 for the open-water period (Golder 2014a,b). Methods are provided in Section 2. Section 3 provides results of the assessment, while Sections 4 and 5 provide a discussion of the results and conclusions, respectively.

## 1.2 OBJECTIVES

The overall objective of this work was to evaluate if effluent from the Mine is having an effect on concentrations of nutrients, chlorophyll *a*, and zooplankton biomass in Lac de Gras.

## 1.3 SCOPE AND APPROACH

The Eutrophication Indicators component is designed to monitor both spatial and temporal changes in nutrients, chlorophyll *a*, and zooplankton biomass. As described in Study Design Version 3.5 (Golder 2014b), the objective of the annual reports is to assess the spatial extent and magnitude of effluent effects in Lac De Gras.

The spatial extent of effects was established by determining the surface area of the lake demonstrating effects that exceed background values. The magnitude of effects was assessed by comparing eutrophication indicator endpoints in exposure areas (near-field and mid-field areas) to background values. Background values for Lac de Gras are those that fall within the range of natural variability, referred to as the *normal range*, as described in Section 3.3.5. Values above the normal range exceed what would be considered natural levels for Lac de Gras. The importance of effects observed on eutrophication endpoints was assessed according to the Action Level classification defined by Golder (2014b).

## **2 METHODS**

### **2.1 SAMPLING NUTRIENTS IN EFFLUENT AND THE MIXING ZONE**

Treated effluent was sampled from the North Inlet Water Treatment Plant (NIWTP) for both diffusers under the Surveillance Network Program (SNP). Station SNP 1645-18 is located at the original diffuser, which has discharged continuously to Lac de Gras since 2002, and Station SNP 1645-18B is located at the second diffuser, which became operational on September 13, 2009. Samples were collected approximately every six days at these SNP stations.

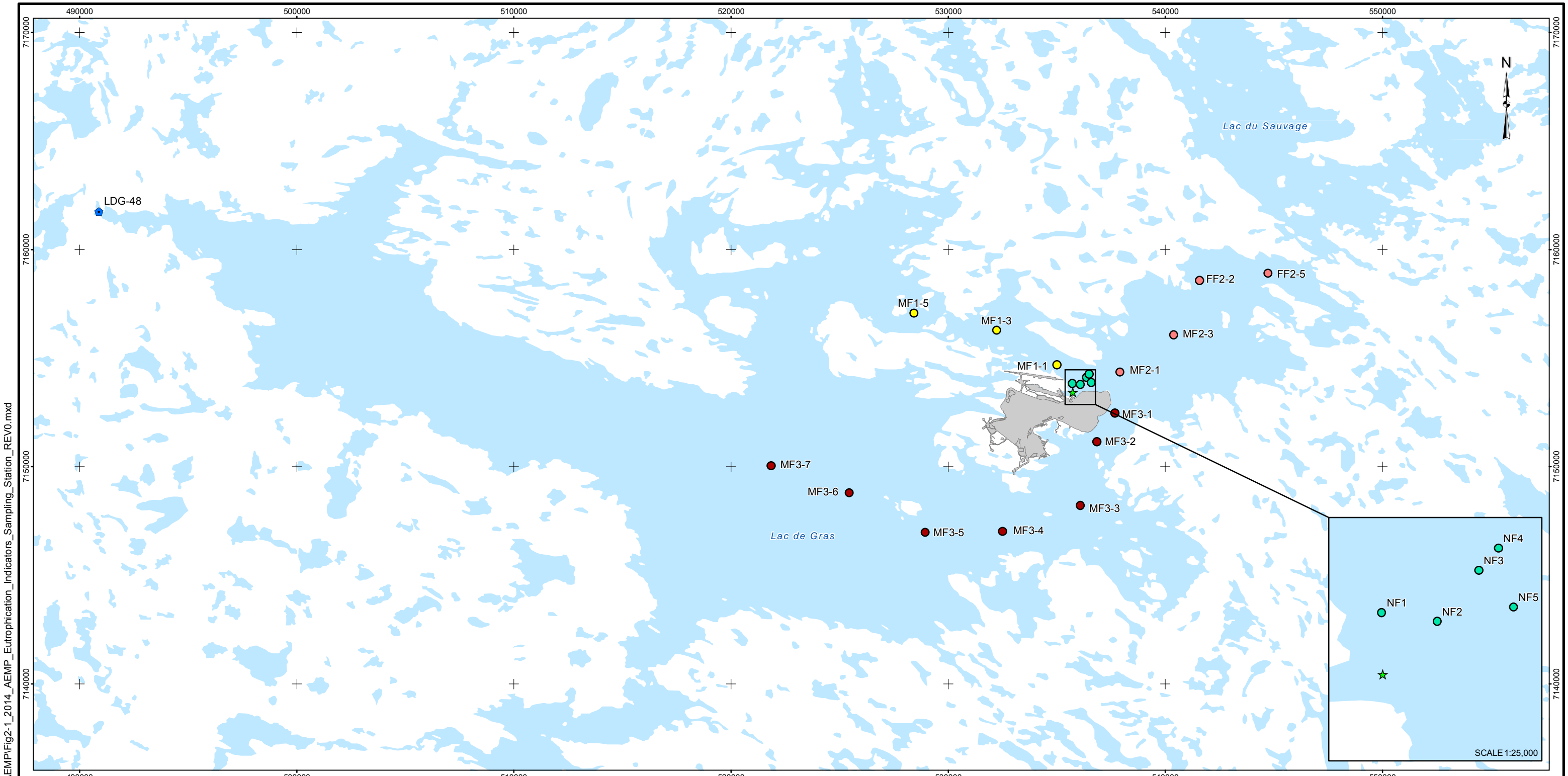
Water quality samples were collected at the mixing zone boundary in Lac de Gras at three stations (SNP 1645-19A, SNP 1645-19B2, and SNP 1645-19C), which are located along a semi-circle, 60 m from the effluent diffusers. These stations represent the edge of the mixing zone, which covers an area of approximately 0.01 km<sup>2</sup>. Station SNP 1645-19B2 was established in 2009 to replace Station SNP 1645-19B, after the second diffuser became active in Lac de Gras. Sampling at the mixing zone boundary was conducted monthly at the lake water surface and at 5-m depth intervals at each station.

### **2.2 SAMPLING IN LAC DE GRAS**

Nineteen stations located within four general areas of Lac de Gras were sampled by DDMI during the 2014 AEMP (Figure 2-1, Table 2-1). Sampling areas were selected based on exposure to the Mine effluent (Golder 2014b), and consisted of the near-field (NF) area and three mid-field (MF) areas. Sampling stations in the MF areas follow transect lines that run from the NF area to the far-field (FF) areas. The MF1 transect is located northwest of the NF area towards the FF1 reference area. The MF2-FF2 transect is located to the northeast, towards the FF2 area near the Lac du Sauvage inlet. The MF3 transect is located south of the NF area, towards the FFB and FFA reference areas.

Five stations were sampled in the NF exposure area. Four stations were sampled along the MF2-FF2 transect, three stations were sampled along the MF1 transect, and seven stations were sampled along the MF3 transect (Figure 2-1). In addition to stations in Lac de Gras, nutrients were sampled at the outlet of Lac de Gras to the Coppermine River (Station LDG-48).

The FFA and FFB reference areas were not sampled for eutrophication indicators in 2014.



- LEGEND**
- ★ DIFFUSERS
  - LDG 48
  - EXPOSURE
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - DIAVIK FOOTPRINT
  - WATERBODY

**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83



PROJECT			
TITLE			
<b>EUTROPHICATION INDICATORS SAMPLING STATIONS, 2014 AEMP</b>			
	PROJECT 1406208		FILE No.
	DESIGN LJ	10 Feb. 2015	SCALE AS SHOWN
	GIS SS	30 Mar. 2016	REV. 0
	CHECK TD	30 Mar. 2016	
	REVIEW ZK	30 Mar. 2016	
			<b>FIGURE: 2-1</b>

i:\201111-1328\11-1328-0038\Mapping\MXD\2014AEMP\Fig2-1\_2014\_AEMP\_Eutrophication\_Indicators\_Sampling\_Station\_REV0.mxd

**Table 2-1 Eutrophication Indicators Sampling Station Locations, 2014**

Area	Station	UTM Coordinates <sup>(a)</sup>		Distance from Diffuser <sup>(b)</sup> (m)
		Easting (m)	Northing (m)	
Near-field	NF1	535732	7153836	394
	NF2	536098	7153779	501
	NF3	536371	7154113	936
	NF4	536499	7154260	1,131
	NF5	536598	7153873	968
Mid-field 1	MF1-1	535013	7154689	1,452
	MF1-3	532245	7156235	4,650
	MF1-5	528435	7157076	8,535
Mid-field 2	MF2-1	537911	7154347	2,363
	MF2-3	540362	7156048	5,386
Mid-field 3	MF3-1	537646	7152434	2,730
	MF3-2	536856	7151148	4,215
	MF3-3	536097	7148109	7,245
	MF3-4	532511	7147016	11,023
	MF3-5	528970	7146968	14,578
	MF3-6	525451	7148806	18,532
	MF3-7	521919	7150030	22,330
Far-field 2	FF2-2	541594	7158586	8,276
	FF2-5	544739	7158890	11,444
Outlet of Lac De Gras	LDG-48	490900	7161750	-

a) UTM coordinates are reported as Zone 12, North American Datum (NAD) 83.

b) Approximate distance from the diffuser along the most direct path of effluent flow.

AEMP = Aquatic Effects Monitoring Program; UTM = Universal Transverse Mercator coordinate system.

The field sampling program, undertaken by Diavik staff, included the collection of samples for nutrients, chlorophyll *a*, and zooplankton biomass, as well as the collection of *in situ* water quality measurements. Sampling was conducted once under ice-cover conditions and once during the open-water season (Appendix C, Table C-1):

- Ice-cover season: April 22 to April 30, 2014; and
- Open-water season: August 20 to September 1, 2014.

The sampling protocol for nutrients differed between the ice-cover and open-water sampling events. During the ice-cover season, three samples were collected at three discrete depths (top, mid, and bottom) at each of the NF and MF stations. The effluent is not mixed through the water column during ice-cover; therefore, water chemistry will differ among depths. Surface samples were collected at a depth of 2 m from water surface, and bottom samples were collected 2 m from the lake bottom. Mid-depth samples were collected at the middle of the total water column depth. Water samples from Station LDG-48 were collected from mid-depth. During the ice-cover season, water samples were collected according to protocols described in DDMI Standard Operating Procedure (SOP), ENVR-014-0311 R5 "AEMP Sampling (Ice-Cover)". In addition to water samples, water column profile measurements were made using multi-parameter water quality meters (Hydrolab and YSI) according to the methods described in DDMI SOP, ENVR-608-0112 "Hydrolab Calibration, Deployment and Download."

During the open-water season, duplicate depth-integrated samples of nutrients, chlorophyll *a*, and phytoplankton were collected. Depth-integrated samples were collected for nutrients during the open-water season to provide an estimate of the concentrations of nutrients to which phytoplankton are exposed. Chlorophyll *a* and phytoplankton samples were collected in conjunction with the nutrient samples. Zooplankton samples were collected independently using a plankton net for the determination of zooplankton biomass (as ash-free dry mass [AFDM]). Plankton samples were collected during the open-water season only.

Depth-integrated samples for nutrients, chlorophyll *a*, and phytoplankton were collected from the top 10 m of the water column using a depth-integrated sampler. A second depth-integrated sample was collected to produce duplicate samples. Procedures followed during the open-water season are outlined in DDMI SOP, ENVR-003-0702 R14 "AEMP Sampling (Open-Water)". Water samples were handled according to DDMI SOPs, ENVR-303-0112 R0 "Quality Assurance Quality Control" and ENVR-206-0112 R0 "Processing Maxxam Samples and Tracking Documentation".

Data presented in this report for bicarbonate were taken from the AEMP water quality component data set (Golder 2016a). During the water quality sampling program, both ice-cover and open-water samples were taken from the same three discrete depths as described above for the ice-cover sampling program.

Zooplankton samples were collected with a plankton net (30.5 cm mouth diameter, 75 µm mesh), and each sample consisted of a composite of three vertical hauls through the entire water column. Duplicate samples (each consisting of three hauls) were collected at each station.

Nutrient samples collected during the ice-cover and open-water seasons were sent to Maxxam Analytics (Maxxam), Burnaby, British Columbia. A list of the nutrients analyzed and the analyte-specific detection limits (DL) used by Maxxam in 2014 are provided in Table 2-2. Raw nutrient data for the ice-cover and open-water seasons are provided in Appendix D.

**Table 2-2 Detection Limits for Nutrient Analysis, 2014**

Analyte	Unit	Detection Limit
Major Ions		
Bicarbonate	mg/L	0.5
Nutrients		
Phosphorus - Total	µg/L	2
Phosphorus - Dissolved	µg/L	2
Orthophosphate	µg/L	1
Total Nitrogen	µg/L	20
Nitrogen - Kjeldahl	µg/L	20
Ammonia (as Nitrogen)	µg/L	5
Nitrate (as Nitrogen)	µg/L	2
Nitrite (as Nitrogen)	µg/L	2
Nitrate + Nitrite (as Nitrogen)	µg/L	2

mg/L = milligrams per litre; µg-P/L= micrograms of phosphorus per litre; µg-N/L= micrograms of nitrogen per litre.

Depth-integrated chlorophyll *a* samples were sent to the Biogeochemical Analytical Laboratory at the University of Alberta (UofA), Edmonton, Alberta. The determination of zooplankton biomass (as AFDM) was to be conducted by HydroQual Laboratories Ltd. (HydroQual), Calgary, Alberta. Unfortunately, the zooplankton samples were accidentally disposed of in the lab prior to analysis (Appendix E).

## **2.3 DATA ANALYSIS**

### **2.3.1 Data Handling**

Initial screening of the 2014 nutrient, chlorophyll *a* and zooplankton biomass datasets was completed before data analyses to identify unusually high (or low) values and decide whether to retain or exclude anomalous data from further analysis. Data screening was conducted using a method based on Chebyshev's theorem (Mann 2010) combined with the visual examination of scatter-plots. The outlier screening approach is described in Appendix A.

Data screening for anomalous values in the 2014 eutrophication indicators dataset identified one anomalous value within the 2014 dataset, representing 0.1% of the total data points. The concentration of total dissolved phosphorus (TDP) in the open-water sample collected from Station MF3-6 was equal to 114 µg-P/L, resulting in a standard deviation distance of 6.06. In cases where unusual values were identified in the dataset, scatter-plots were generated to allow a visual review of anomalous data and provide transparency (Appendix A, Figure A-1).

### **2.3.2 Censored Data**

For the purposes of the AEMP, censored data are concentrations reported below the analytical DL. Due to the location of Lac de Gras on the Canadian Shield, concentrations of many water quality variables are low and at or below the DL at reference stations. A frequently used, simple approach to deal with censored data is the substitution of a surrogate value (e.g., the DL or some fraction of the DL) for non-detect data, which is considered generally acceptable in cases when a relatively small proportion of the data (e.g., <25%) are below the DL.

Prior to data analyses, duplicate data were averaged and non-detect values (i.e., values below the DL) were multiplied by 0.5 times the DL. Substitution with half the DL is a common approach used to deal with censored data (USEPA 2000) and is consistent with the approved methods applied in the calculation of the normal range in the AEMP Reference Conditions Report Version 1.1 (Golder 2015).

### **2.3.3 Nutrients in Effluent and the Mixing Zone**

The quantity of nutrients in effluent was evaluated graphically by plotting total monthly loads of nutrients. The daily load from each diffuser was calculated by multiplying the effluent discharge rate by the nutrient concentration at each effluent diffuser station (i.e., SNP 1645-18 and SNP 1645-18B). Linear interpolation was used to estimate the concentrations between sampling events. The total daily load was calculated as the sum of loads from the two diffusers. Total monthly loads represent the sum of the total daily loads for a given month. The period of effluent discharge summarized in this report consisted of information collected from November 3, 2013, to October 31, 2014.

Time series plots showing the concentrations of nutrients in effluent were generated for the reporting period. Results for individual grab samples were plotted separately for each effluent diffuser station (i.e., SNP 1645-18 and SNP 1645-18B).

Water sampling at the mixing zone is conducted monthly at five depths (2, 5, 10, 15 and 20 m) at each of the three mixing zone stations (i.e., SNP 1645-19A, SNP 1645 -19B, SNP 1645-19C). Hence, up to 15



samples were collected each month. Results for the mixing zone were summarized by showing the 5<sup>th</sup> percentile, median, and 95<sup>th</sup> percentile concentrations in each month.

The quality of the effluent was assessed by comparing water chemistry results at Stations SNP 1645-18 and SNP 1645-18B with the Effluent Quality Criteria (EQC) defined in the Water Licence (WLWB 2007). Total phosphorus has an EQC specified in terms of load, rather than concentration. The Licence specifies that the load of TP must not exceed a maximum of 300 kg per month, an average annual load of 1,000 kilograms per year during the life of the Mine, and a maximum load of 2,000 kg per year in any year during the life of the Mine.

### 2.3.4 Normal Ranges

Magnitude of effects to indicators of eutrophication were evaluated by comparing nutrient concentrations, chlorophyll *a*, and zooplankton biomass in exposure areas (NF and MF areas) to background values. Background values for Lac de Gras are those that fall within the range of natural variability, referred to as the *normal range*. Normal ranges were calculated using data from three AEMP far-field reference areas (FFA, FFB, and FF1) using data from 2007 to 2010 (with some exceptions).

The normal ranges used to evaluate potential effects for indicators of eutrophication were obtained from the AEMP Reference Conditions Report, Version 1.1 (Golder 2015) and are summarized in Table 2-3.

**Table 2-3 Normal Ranges for Eutrophication Indicators**

Variable	Normal Range				
	Unit	Ice-cover		Open-water	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
Total phosphorus	µg-P/L	2.0	5.0	2.0	5.3
Total dissolved phosphorus	µg-P/L	1.1	3.2	0	3.5
Soluble reactive phosphorus	µg-P/L	0	1.5	0	1
Total nitrogen	µg-N/L	137.7	172.5	121.5	152.7
Total dissolved nitrogen	µg-N/L	130	166	105	133
Ammonia	µg-N/L	11	17	0	6
Nitrate + nitrite	µg-N/L	5	10	0	1
Chlorophyll <i>a</i>	µg/L	-	-	0.31	0.82
Zooplankton biomass as AFDM	mg/m <sup>3</sup>	-	-	16.4	40.5

Source: AEMP Reference Conditions Report, Version 1.1 (Golder 2015).

AFDM = ash-free dry mass.

### 2.3.5 Spatial Analysis

To visually evaluate spatial trends relative to the Mine discharge, concentrations of nutrients and chlorophyll *a* were plotted against distance from the diffuser. Values in the NF exposure area and MF areas were plotted against the appropriate normal range. The area of the lake with values greater than the normal range was estimated, and this measure was used to estimate the extent of effects. The extent of effects calculated for 2014 was compared with those estimated in previous years to evaluate whether effects are expanding further into the lake with time. To provide the most conservative view of effluent effects, the season and depth with the greatest extent of effects was selected for this evaluation.

### 2.3.6 Magnitude of Effect and Action Levels

The severity of possible effects to an assessment endpoint has been categorized according to the Action Level framework described for indicators of eutrophication in the AEMP Study Design Version 3.5 (Golder 2014b). The Action Level classifications were developed to meet the goals of the draft *Guidelines for Adaptive Management – A Response Framework for Aquatic Effects Monitoring* (WLWB 2010) and Racher et al. (2011). The main goal of the Response Framework is to ensure that significant adverse effects never occur. This is accomplished by requiring proponents to take actions at predefined Action Levels, which are triggered well before significant adverse effects could occur.

Termed a Significance Threshold in the Action Levels, a significant adverse effect for TP was defined in the EA (Government of Canada 1999). The magnitude of effect for TP at the Significance Threshold level was defined as a concentration that exceeds the EA benchmark by more than 20%. Therefore, in keeping with the intent of this definition, the Significance Threshold for the indicators of eutrophication is a concentration of chlorophyll *a* that exceeds the Effects Threshold by more than 20% in the FFA area of Lac de Gras (Table 2-4). In contrast to toxicological impairment responses to water chemistry (e.g., concentrations of metals), eutrophication responses are difficult to link to nutrient concentrations. As demonstrated by years of monitoring in Lac de Gras, concentrations of TP do not predict the actual biological response to nutrient enrichment. Rather, the increase in the biomass of algae as measured by chlorophyll *a* has been a very good measure of the effects of nutrient enrichment.

Elevated concentrations of nutrients were expected in approximately 20% of Lac de Gras (Government of Canada 1999). Specifically, up to 20% (116 km<sup>2</sup>) of the surface area of Lac de Gras was expected to exceed the EA Benchmark for phosphorus during peak operations during the open-water season, and up to 11% (64 km<sup>2</sup>) of the lake during the ice-cover season. The “extent of effect” for the chlorophyll *a* Action Levels reflects this prediction (Table 2-4).

**Table 2-4 Action Levels for Chlorophyll a**

Action Level	Magnitude of Effect	Extent of Effect	Action/Notes
1	95 <sup>th</sup> percentile of MF values greater than normal range <sup>(a)</sup>	MF station	Early warning.
2	NF and MF values greater than normal range <sup>(a)</sup>	20% of lake area or more	Establish <i>Effects Benchmark</i> .
3	NF and MF values greater than normal range plus 25% of Effects Benchmark <sup>(b)</sup>	20% of lake area or more	Confirm site-specific relevance of existing benchmark. Establish <i>Effects Threshold</i> .
4	NF and MF values greater than normal range plus 50% of Effects Threshold <sup>(c)</sup>	20% of lake area or more	Investigate mitigation options.
5	NF and MF values greater than Effects Threshold	20% of lake area or more	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
6	NF and MF values greater than Effects Threshold +20%	20% of lake area or more	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
7	95 <sup>th</sup> percentile of MF values greater than Effects Threshold +20%	All MF stations	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
8	95 <sup>th</sup> percentile of FFB values greater than Effects Threshold +20%	FFB	The WLWB to re-assess EQC for phosphorus. Implement mitigation required to meet new EQC if applicable.
9	95 <sup>th</sup> percentile of FFA values greater than Effects Threshold+20%	FFA	Significance Threshold.

a) The upper limit of the normal range is 0.82 µg/L.

b) Indicates 25% of the difference between the benchmark and the top of the normal range.

c) Indicates 50% of the difference between the effects threshold and the top of the normal range.

NF = near-field; MF = mid-field; FFA = far-field A; FFB = far-field B; WLWB = Wek'èezhii Land and Water Board; EQC = Effluent Quality Criteria.

### **2.3.6.1 Benchmarks for Indicators of Eutrophication**

Given that an Action Level 2 for chlorophyll *a* has been reached in previous years (Golder 2014c), an Effects Benchmark for chlorophyll *a* was developed. The chlorophyll *a* Effects Benchmark concentration of 4.5 µg/L that was established is appropriate in terms of both the aesthetic quality and food web functionality in Lac de Gras. Aesthetic qualities are likely to be preserved at chlorophyll *a* concentrations up to 10 µg/L, while a benchmark of 4.5 µg/L maintains the trophic classification of the lake as oligotrophic (Golder 2014b).

## **2.4 QUALITY ASSURANCE/QUALITY CONTROL**

The Quality Assurance Project Plan (QAPP) Version 2.0 (Golder 2013) outlined the quality assurance/quality control (QA/QC) procedures employed to support the collection of scientifically-defensible and relevant data required to meet the objectives of the AEMP Study Design Version 3.5 (Golder 2014b). The QAPP is designed so that field sampling, laboratory analysis, data entry, data analysis, and report preparation activities produce technically sound and scientifically defensible results. A description of the QA/QC program is provided in Appendix B.

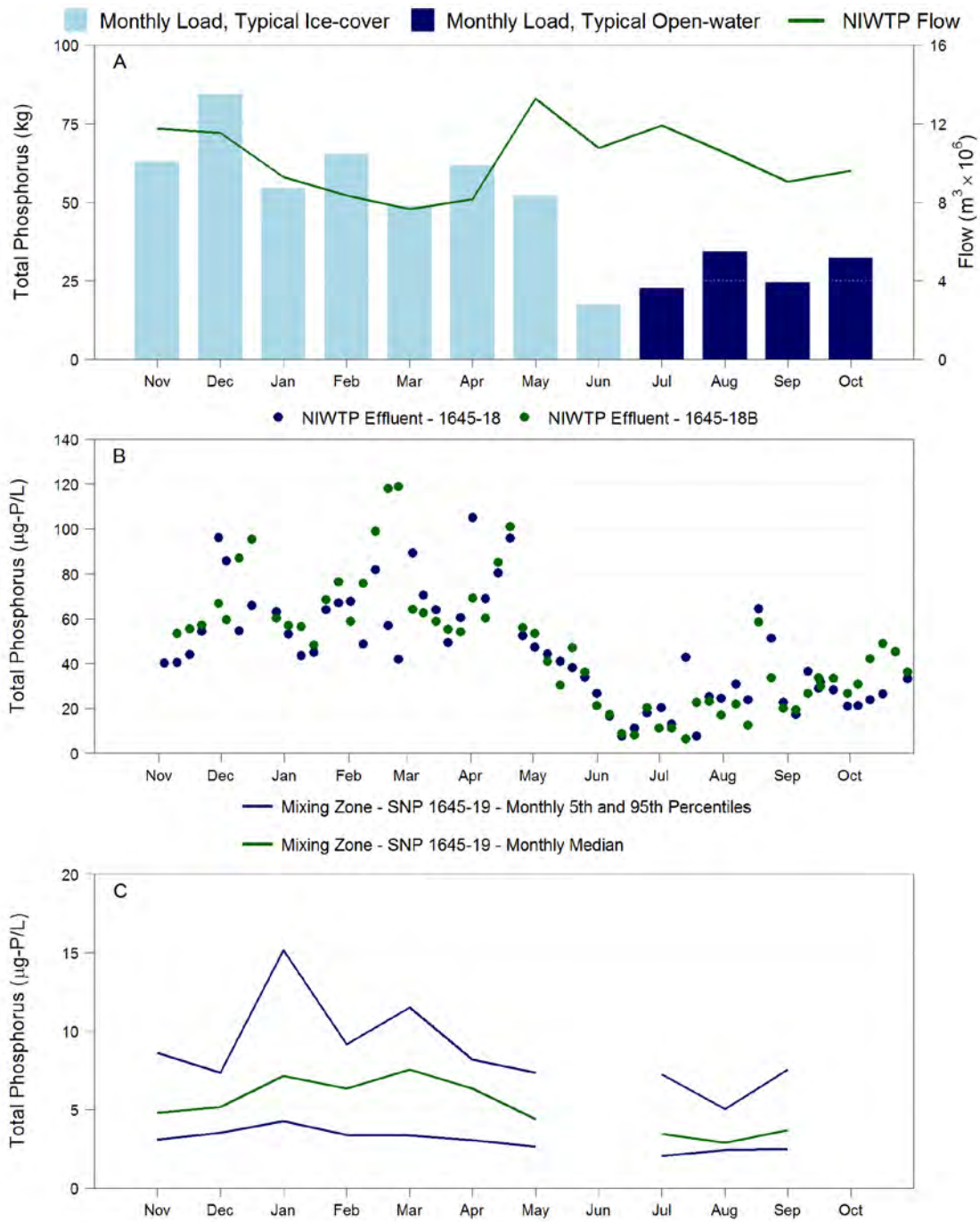
## **3 RESULTS**

### **3.1 NUTRIENTS IN EFFLUENT AND THE MIXING ZONE**

The temporal trends in nutrient loads tended to reflect effluent concentrations rather than the effluent volume. Phosphorus in the effluent existed primarily in the dissolved form; therefore, concentrations and loads of TP and TDP were similar. The loading rates and concentrations of TP, TDP, and soluble reactive phosphorus (SRP) in the effluent were all greater during ice-cover (November to May) than in the open-water months (Figures 3-1 to 3-3). Discharge volumes in open-water months were within the range of discharge volumes recorded in winter. Temporal patterns in the concentration of TP and TDP at the mixing zone boundary generally reflected patterns observed in the Mine effluent. Concentrations of SRP peaked at the mixing zone in December, and again in April. The monthly TP load did not exceed the 300 kg per month loading criterion, with the greatest monthly load of TP (84 kg) occurring in December 2013. The TP annual load in 2014 (560 kg) was below the average annual loading criterion of 1,000 kg, as defined in the Water Licence (W2007L2-003).

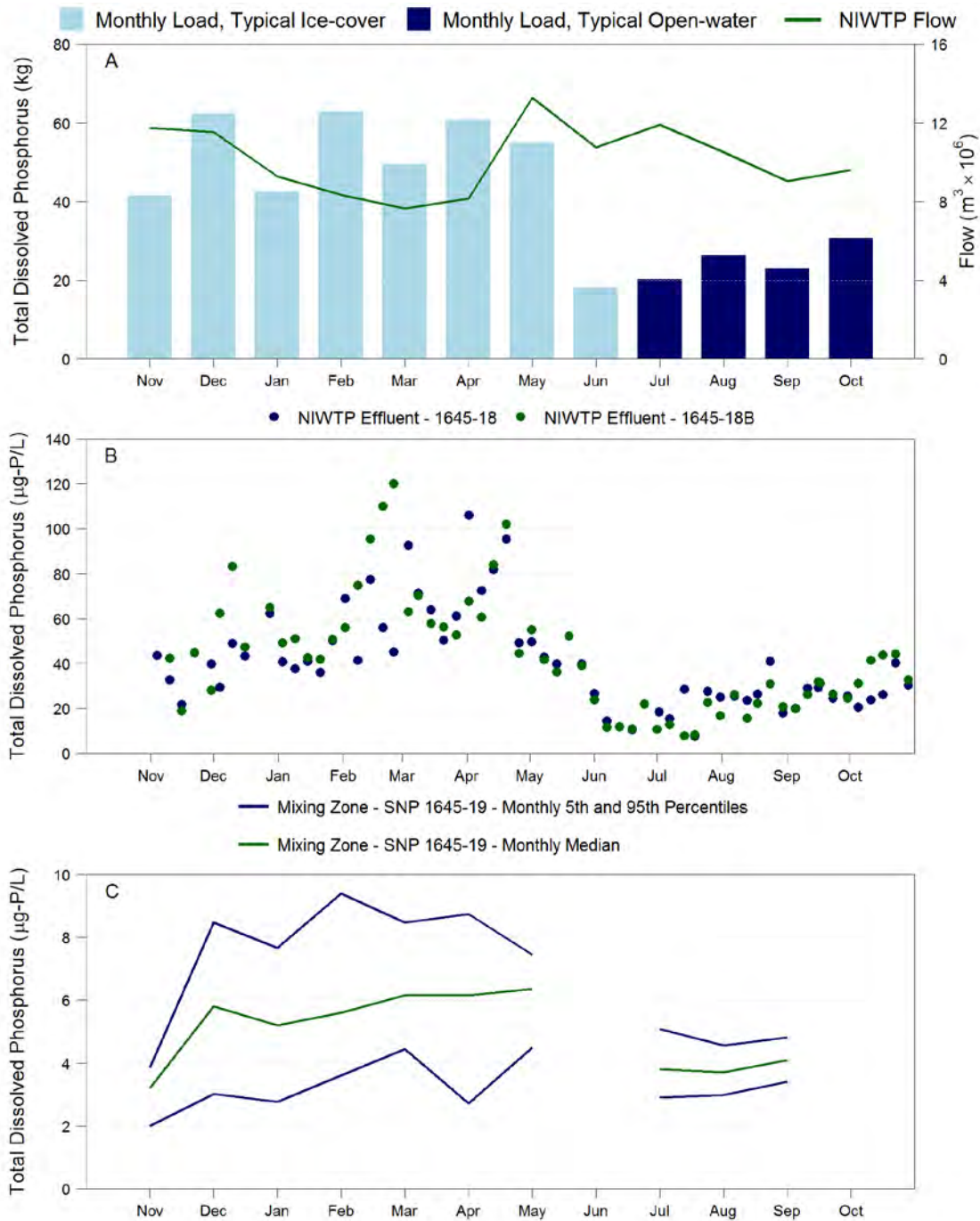
The TN load decreased from December to April with a corresponding decrease in discharge volume (Figure 3-4). A peak in TN concentration at the mixing zone was observed in August, though the median concentration was within the annual range (Figure 3-4C). Ammonia loadings were generally greater in winter than in summer, with the greatest loadings in December and January and the lowest loading in August (Figure 3-5). Concentrations of ammonia at the mixing zone appeared to reflect this seasonal difference in loads. However, as in all areas of the lake, the mixing zone concentrations of ammonia were considerably lower during the open-water season. Although nitrate loadings and concentrations in effluent increased in summer relative to late winter and spring, concentrations in the mixing zone remained low (Figure 3-6). As seen with ammonia throughout the lake, this sharp decrease reflects quick assimilation by algae. Nitrite loadings peaked in December and July, and were lowest from February to May (Figure 3-7); loadings followed nitrite concentrations in the effluent. However, concentrations of nitrite in the mixing zone were less than detection throughout most of the ice-cover and open-water season.

**Figure 3-1 Total Monthly Loads of Total Phosphorus in Effluent (A), and Concentrations in Effluent (B), and at the Mixing Zone Boundary (C), November 2013 to October 2014**



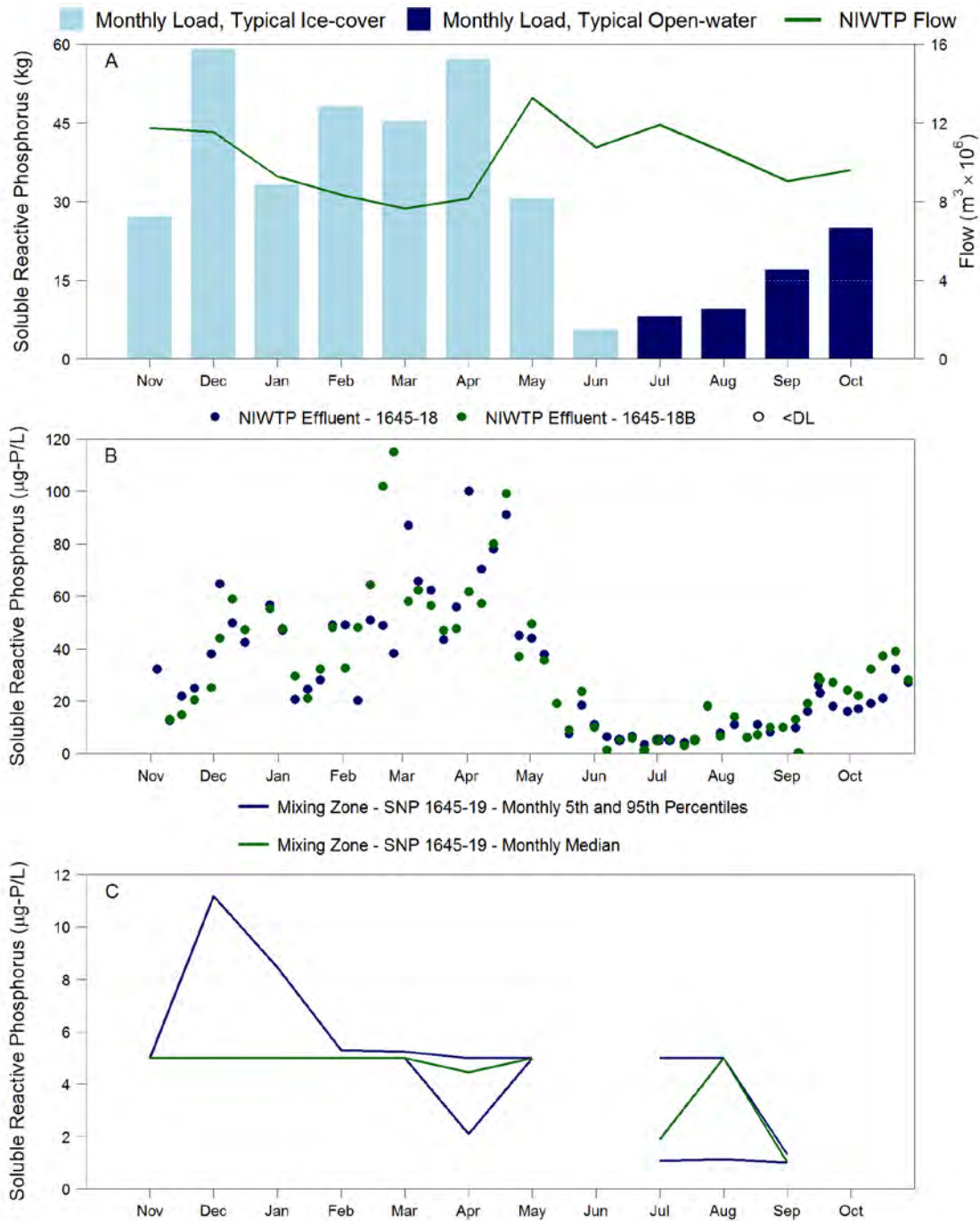
Notes: Effluent concentrations are for individual samples. Samples were not collected in June and October at SNP 1645-19. µg-P/L= micrograms of phosphorus per litre; NIWTP = North Inlet Water Treatment Plant; SNP= surveillance network program.

**Figure 3-2 Total Monthly Loads of Total Dissolved Phosphorus in Effluent (A), and Concentrations in Effluent (B), and at the Mixing Zone Boundary (C), November 2013 to October 2014**



Notes: Effluent concentrations are for individual samples. Samples were not collected in June and October at SNP 1645-19. µg-P/L= micrograms of phosphorus per litre; NIWTP = North Inlet Water Treatment Plant; SNP= surveillance network program.

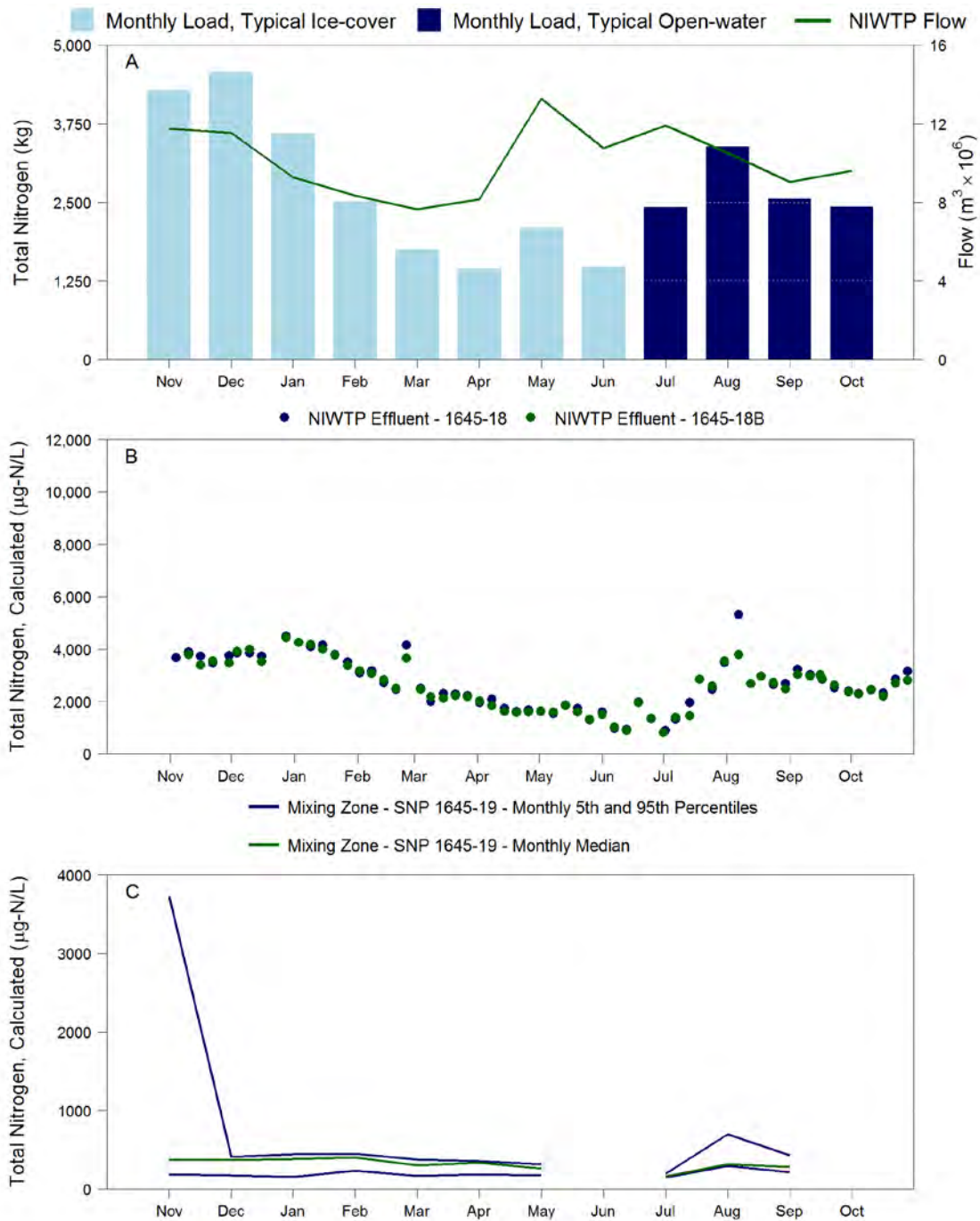
**Figure 3-3 Total Monthly Loads of Soluble Reactive Phosphorus in Effluent (A), and Concentrations in Effluent (B), and at the Mixing Zone Boundary (C), November 2013 to October 2014**



Notes: Effluent concentrations are for individual samples. Samples were not collected in June and October at SNP 1645-19. µg-P/L= micrograms of phosphorus per litre; NIWTP = North Inlet Water Treatment Plant; SNP= surveillance network program.

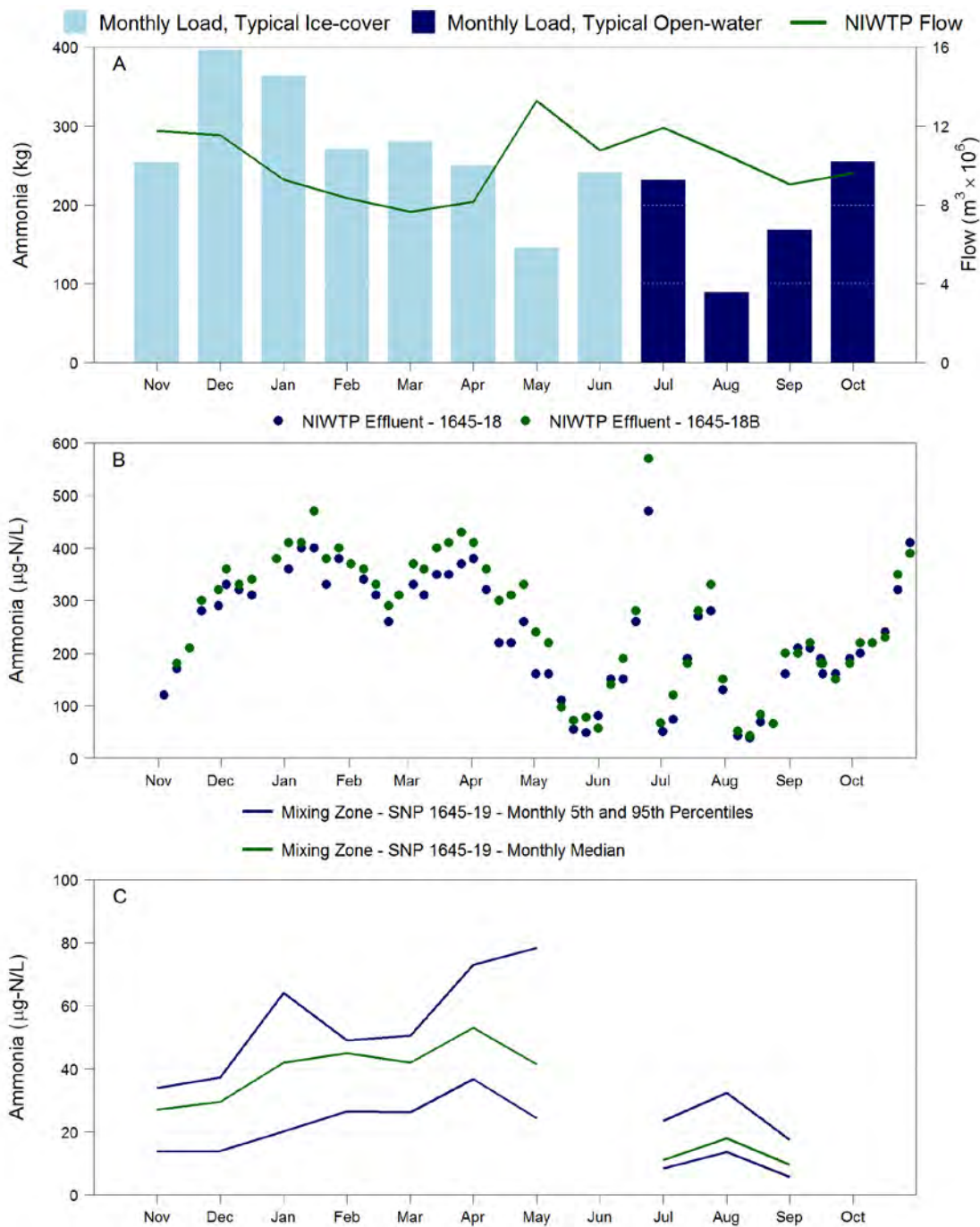


**Figure 3-4 Total Monthly Loads of Total Nitrogen in Effluent (A), and Concentrations in Effluent (B), and at the Mixing Zone Boundary (C), November 2013 to October 2014**



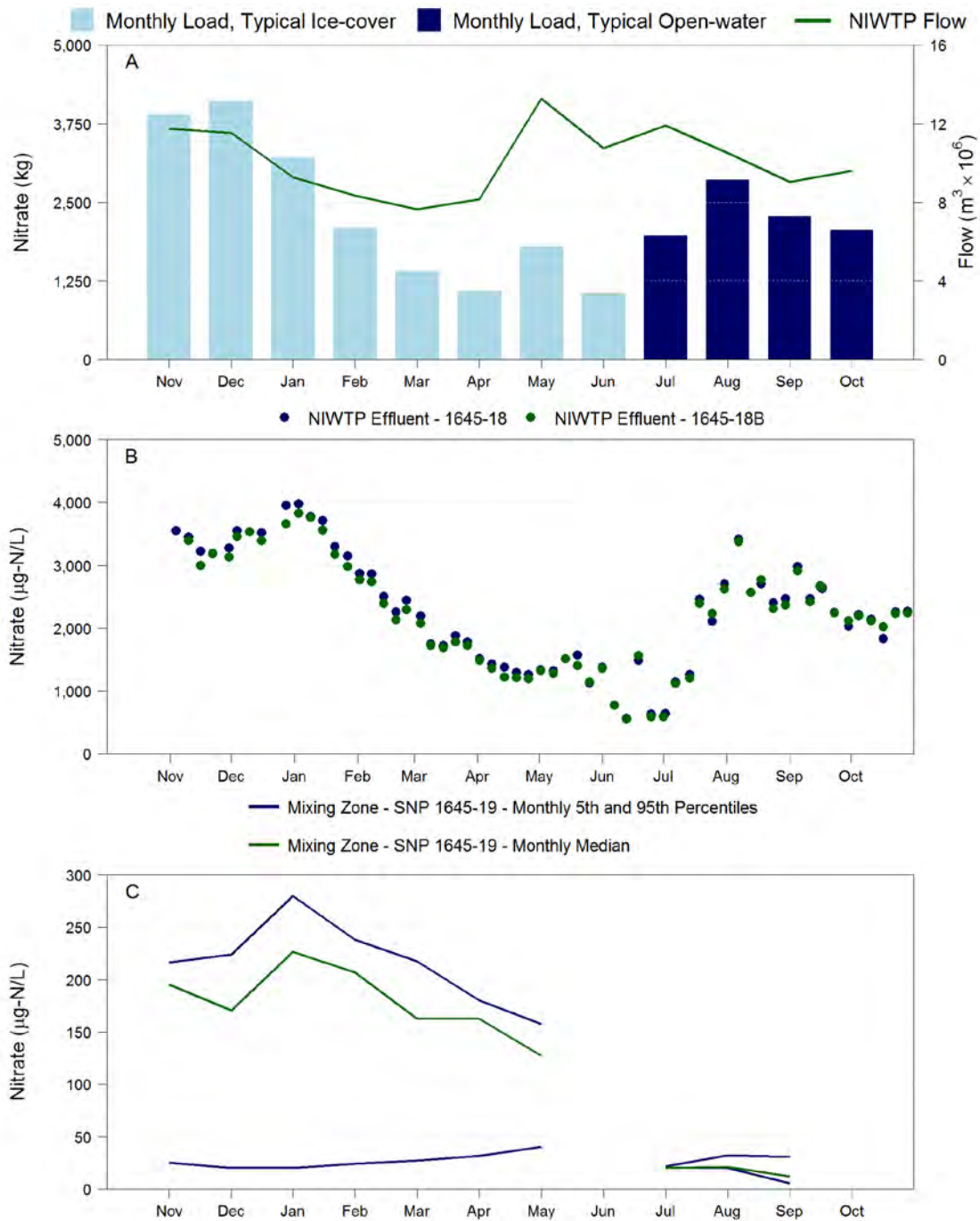
Notes: Effluent concentrations are for individual samples. Samples were not collected in June and October at SNP 1645-19. µg-N/L= micrograms of nitrogen per litre; NIWTP = North Inlet Water Treatment Plant; SNP= surveillance network program.

**Figure 3-5 Total Monthly Loads of Ammonia in Effluent (A), and Concentrations in Effluent (B), and at the Mixing Zone Boundary (C), November 2013 to October 2014**



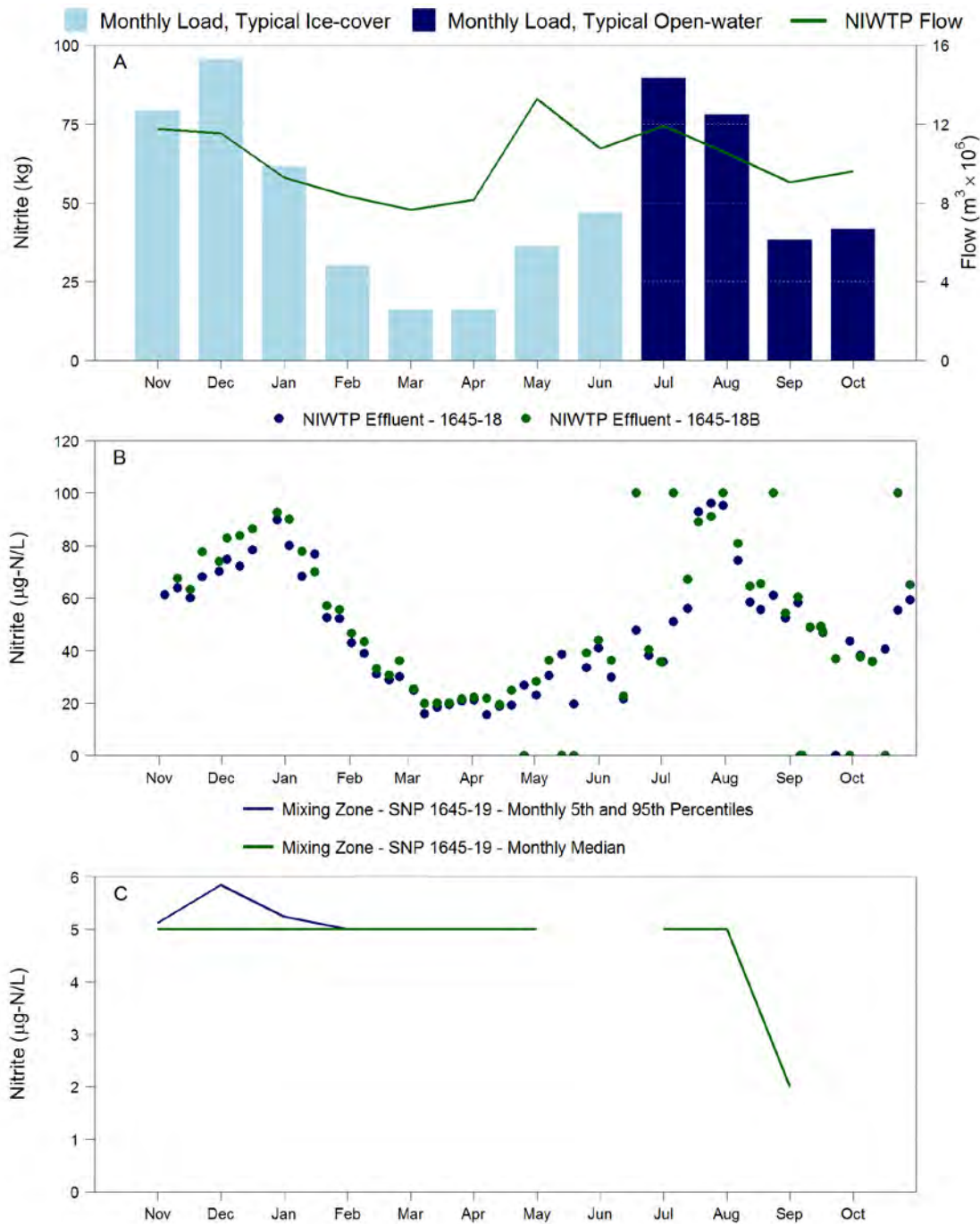
Notes: Effluent concentrations are for individual samples. Samples were not collected in June and October at SNP 1645-19. µg-N/L= micrograms of nitrogen per litre; NIWTP = North Inlet Water Treatment Plant; SNP= surveillance network program.

**Figure 3-6 Total Monthly Loads of Nitrate in Effluent (A), and Concentrations in Effluent (B), and at the Mixing Zone Boundary (C), November 2013 to October 2014**



Notes: Effluent concentrations are for individual samples. Samples were not collected in June and October at SNP 1645-19. µg-N/L= micrograms of nitrogen per litre; NIWTP = North Inlet Water Treatment Plant; SNP= surveillance network program.

**Figure 3-7 Total Monthly Loads of Nitrite in Effluent (A), and Concentrations in Effluent (B), and at the Mixing Zone Boundary (C), November 2013 to October 2014**



Notes: Effluent concentrations are for individual samples. Samples were not collected in June and October at SNP 1645-19. µg-N/L= micrograms of nitrogen per litre; NIWTP = North Inlet Water Treatment Plant; SNP= surveillance network program.

## 3.2 NUTRIENTS AND WATER CHEMISTRY IN LAC DE GRAS

Total phosphorus and nitrogen concentrations during ice-cover were greater in the NF area compared to the other exposure areas (Figures 3-8A and 3-9A). Open-water concentrations of TN in the NF area were also greater than in the other areas, but the differences were much smaller; TP concentrations in the NF area during open-water were similar to those in other sampling areas. Concentrations of TP in the MF areas were near or below the DL during ice-cover, whereas concentrations were more variable during open-water. During both seasons, the lowest concentrations of TP and TN were observed at Station LDG-48.

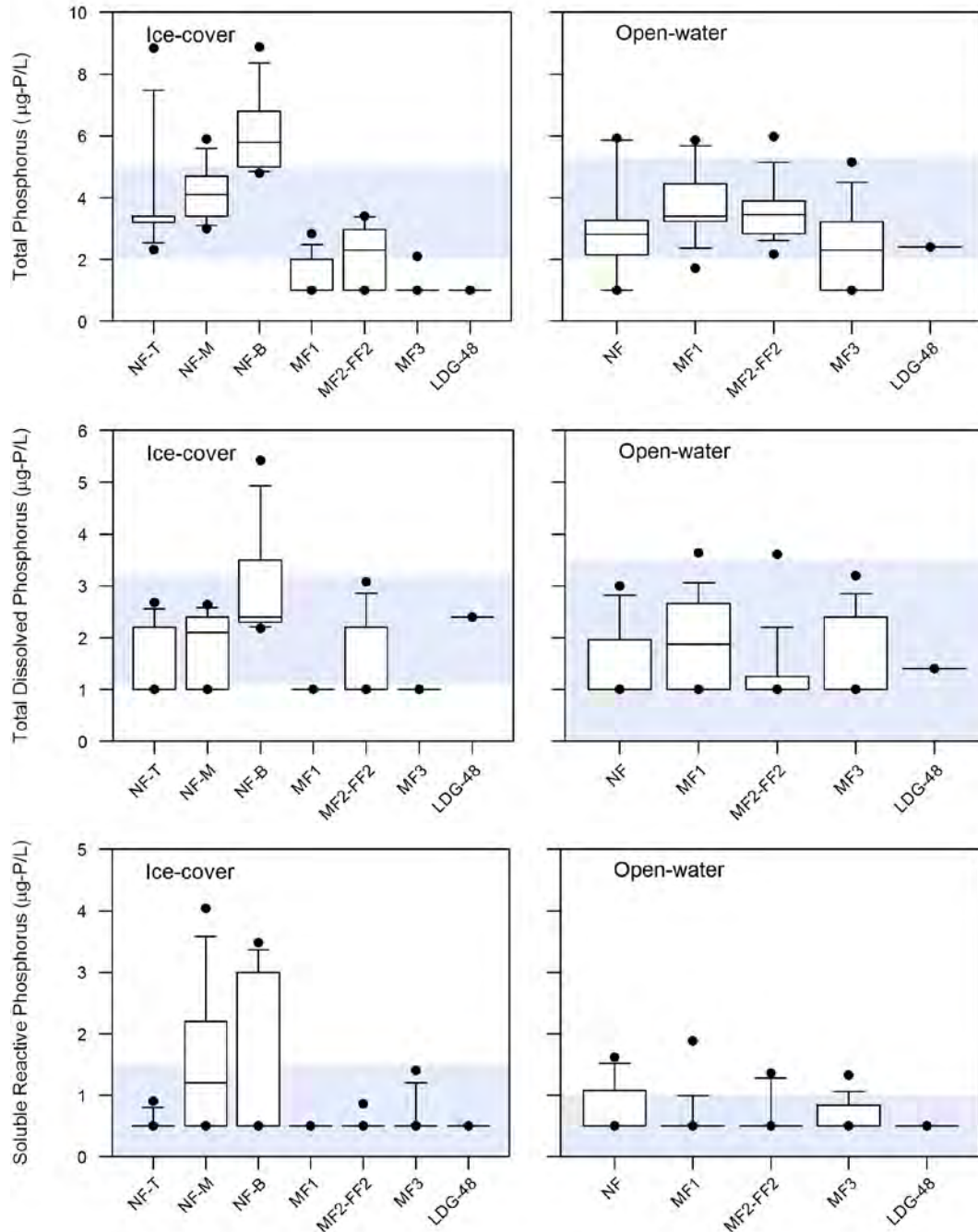
During the ice-cover season, TDP and total dissolved nitrogen (TDN) concentrations were greatest in the NF area at the bottom, reflecting the discharge of effluent (Figures 3-8B and 3-9B). Concentrations of TDP and SRP were low in all areas during both seasons, but SRP concentrations were more variable at the mid-depth and bottom depths in the NF area during ice-cover (Figure 3-8B and 3-8C). Concentrations of TDN were greater under ice-cover compared to the open-water season (Figure 3-9B). This pattern is typically observed as the algae assimilate the dissolved nutrients to grow during the open-water season. With the exception of mid-depth and bottom values in the NF area, ice-cover concentrations of TDN were similar among exposure areas. Nitrate+nitrite (mainly nitrate) concentrations, however, were variable, reflecting the gradients along the MF area transects (Figure 3-10B). Total dissolved nitrogen concentrations during open-water were slightly greater in the NF area, and similar among the other exposure areas (Figure 3-9B).

Ammonia concentrations during the ice-cover season were similar among the MF areas and the top depth in the NF area, but were higher at mid-depth and the bottom in the NF area (Figure 3-10A), as also observed for other nitrogen variables. During the open-water season, concentrations of ammonia were variable and did not reflect the gradients along the MF area transects. Quality control issues identified with ammonia analyzed by Maxxam in 2014 means that these data are not comparable with ammonia data from 2007 to 2010, which is the reference data period used to estimate the normal range (Golder 2015).

As with inorganic nitrogen and phosphorus, the greatest bicarbonate concentrations were observed under ice-cover in the NF area, with the greatest concentration at the bottom (Figure 3-11A). A seasonal pattern was evident, with higher concentrations during the ice-cover season. When phytoplankton began to grow during the open-water season, uptake of dissolved inorganic carbon by the phytoplankton would have caused a decrease in carbon dioxide, resulting in an increase in pH. This was evident along the MF1 and MF3 transects (Figure 3-11B). The input of bicarbonate from effluent was sustained throughout the open-water season, as seen from concentrations along the NF and MF2-FF2 transects. As a consequence, the increase in pH typically associated with a decrease in carbon dioxide was not observed in these areas.

The water column appeared to be well-oxygenated throughout the year (Figure 3-12A). The vertical gradient seen in all areas of the lake during the ice-cover season likely reflects a combination of the input of oxygen at the surface as water freezes and the uptake of oxygen at the bottom as organic matter decomposes. The oxygen profile gradient was less pronounced at the NF area likely because of the well-oxygenated effluent (as indicated by conductivity) that concentrates at lower depths under ice-cover in the NF area (Figure 3-12B). During the open-water season, conductivity indicated vertically well-mixed conditions throughout the lake.

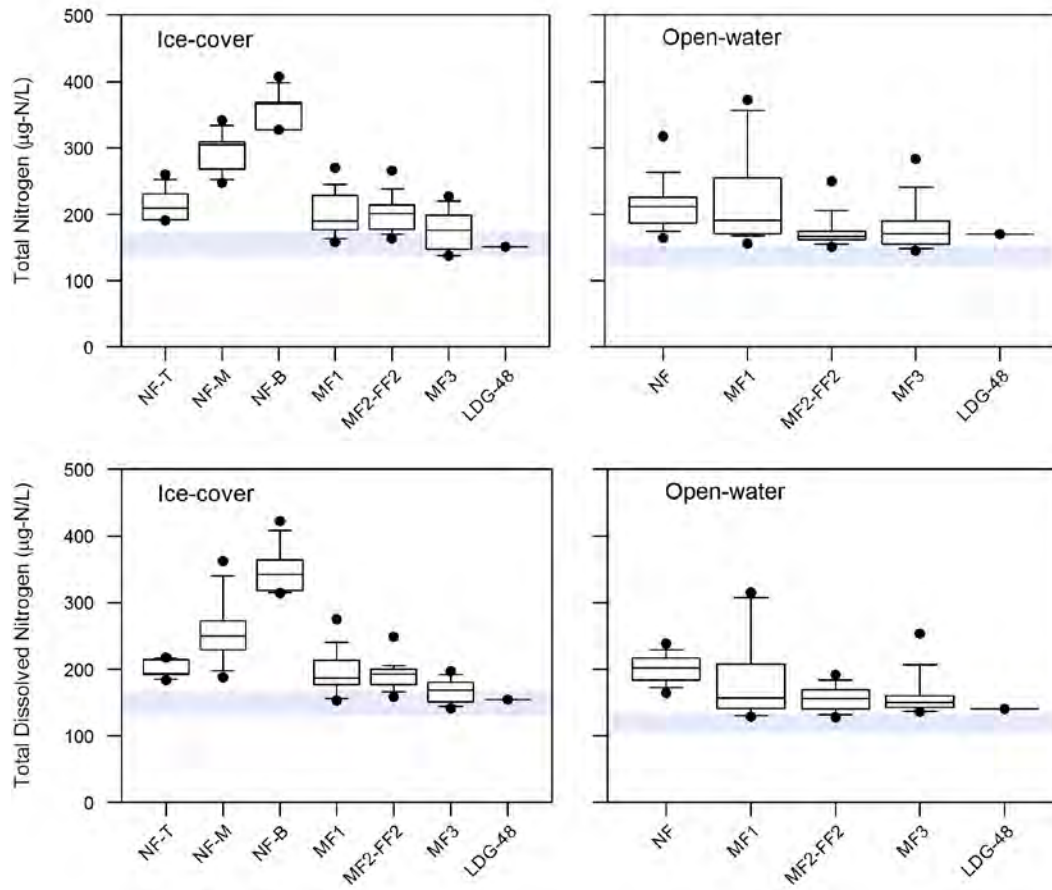
**Figure 3-8 Concentrations of Total Phosphorus (A), Total Dissolved Phosphorus (B), and Soluble Reactive Phosphorus (C) in Lac de Gras during the Ice-Cover and Open-Water Season, 2014**



Notes: The normal range is delineated by the shaded area. Soluble reactive phosphorus was analyzed by Maxxam as ortho-phosphorus.

µg-P/L = micrograms of phosphorus per litre; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

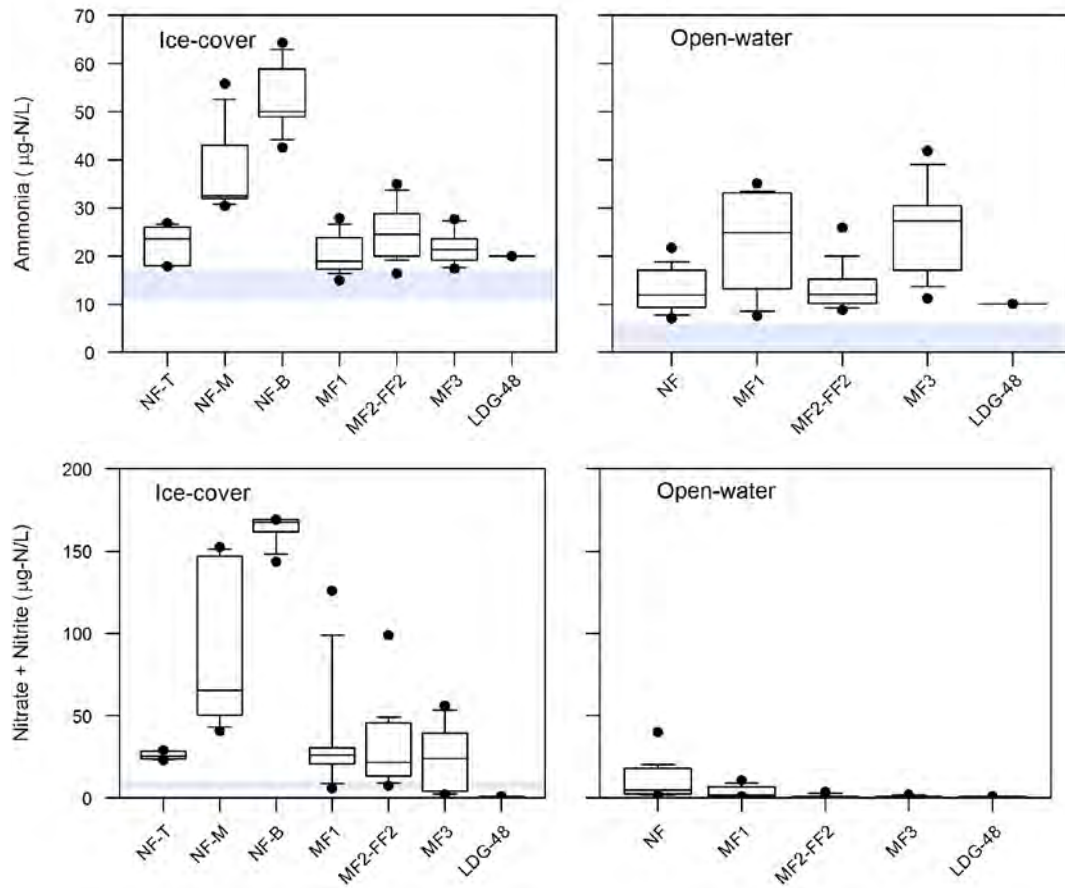
**Figure 3-9 Concentrations of Total Nitrogen (A) and Total Dissolved Nitrogen (B) in Lac de Gras during the Ice-Cover and Open-Water Season, 2014**



Notes: The normal range is delineated by the shaded area.

µg-N/L = micrograms of nitrogen per litre; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

**Figure 3-10 Concentrations of Ammonia (A) and Nitrate + Nitrite (B) in Lac de Gras during the Ice-Cover and Open-Water Season, 2014**

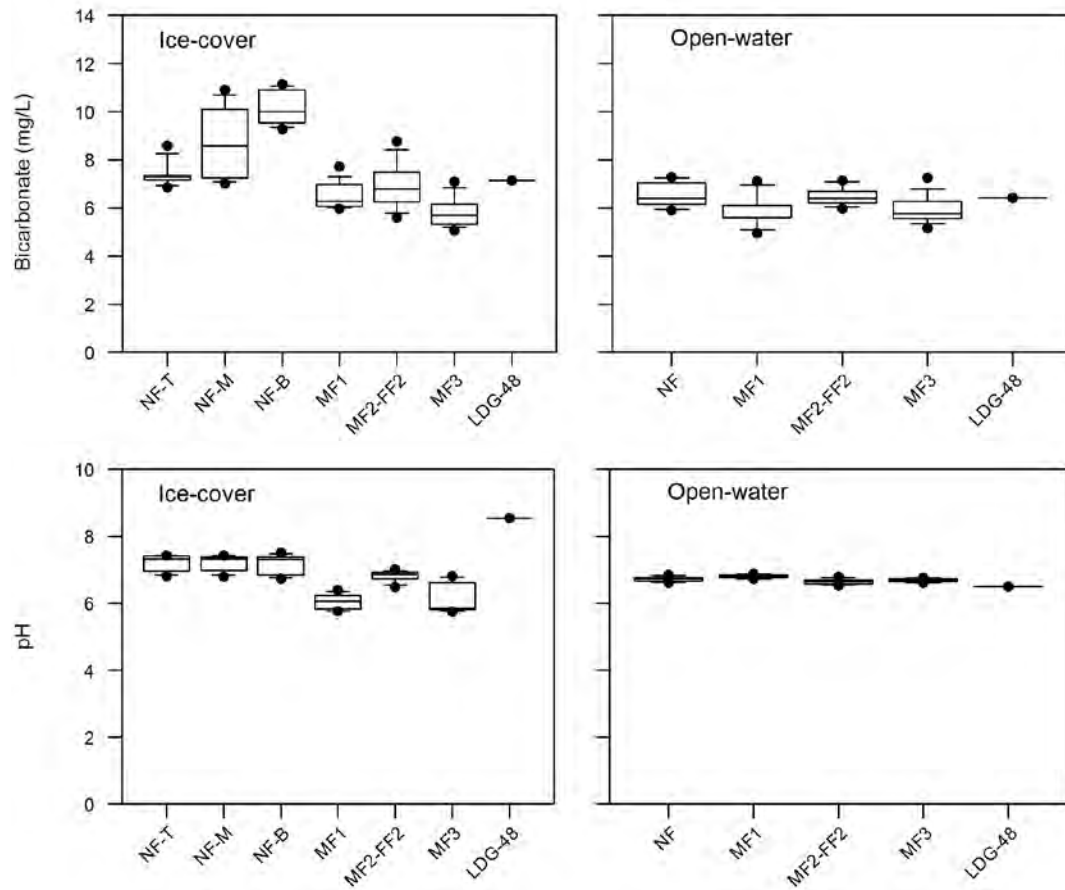


Notes: The normal range is delineated by the shaded area. Quality control issues identified with ammonia analyzed by Maxxam in 2014 means that these data are not comparable with ammonia data from 2007 to 2010, which is the reference data period used to estimate the normal range (Golder 2015).

µg-N/L = micrograms of nitrogen per litre; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

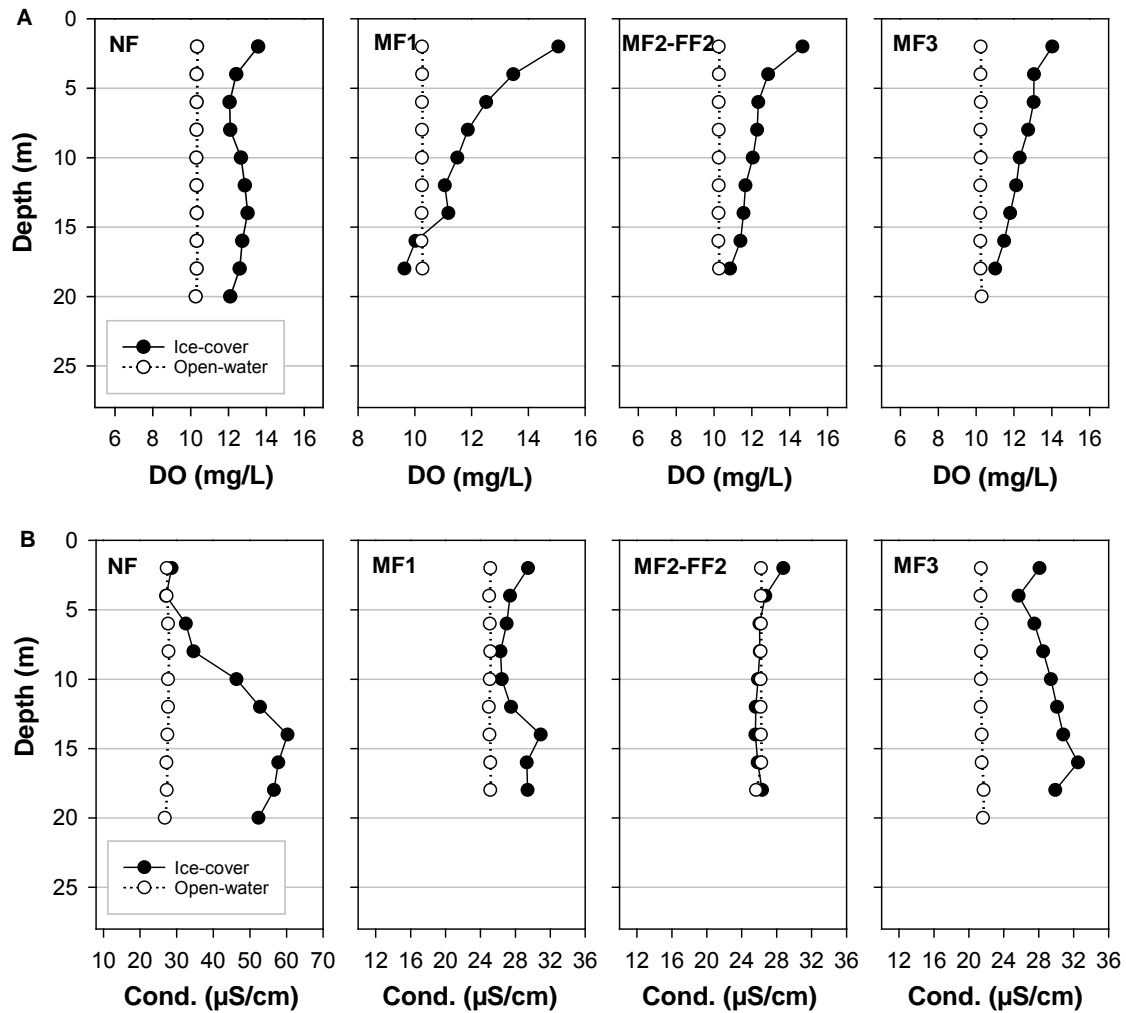


**Figure 3-11 Concentrations of Bicarbonate (A) and pH (B) in Lac de Gras during the Ice-Cover and Open-Water Season, 2014**



Notes: pH is based on field profile data where the top = 2 to 6 m, mid-depth = 8 to 12 m, and bottom = 14 to 20 m.  
mg/L = milligrams per litre; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet; m = metre.

**Figure 3-12 Dissolved Oxygen Concentration (A) and Conductivity (B) in Lac de Gras during the Ice-Cover and the Open-Water Seasons, 2014**



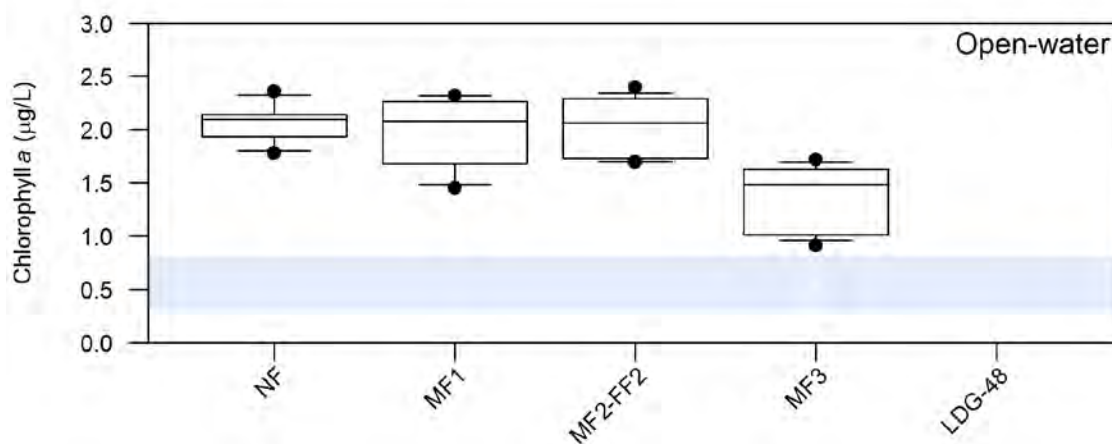
Notes: Profile data collection did not include Station LDG-48 (Lac de Gras outlet).

DO = dissolved oxygen; m = metre; mg/L = milligrams per litre; Cond = conductivity;  $\mu\text{S/cm}$  = microSiemens per centimetre; NF = near-field; MF = mid-field; FF = far-field.

### 3.3 CHLOROPHYLL A

Chlorophyll *a* concentration is used as an indicator of phytoplankton standing crop in Lac de Gras during the open-water season. Ice and snow reduce the amount of light entering the lake to a fraction of surface solar radiation; consequently, algal growth under ice-cover is limited by light resulting in low chlorophyll *a* concentrations (Golder 2008). Chlorophyll *a* concentrations in the NF area were similar to concentrations along the MF1 and MF2-FF2 transects, but were lower along the MF3 transect (Figure 3-13).

**Figure 3-13 Concentration of Chlorophyll *a* in Lac de Gras during the Open-Water Season, 2014**



Notes: Station LDG-48 (Lac de Gras outlet.) was not sampled for chlorophyll *a*. The normal range is delineated by the shaded area. NF = near-field; MF = mid-field; FF = far-field.

### 3.4 SPATIAL ANALYSIS IN LAC DE GRAS

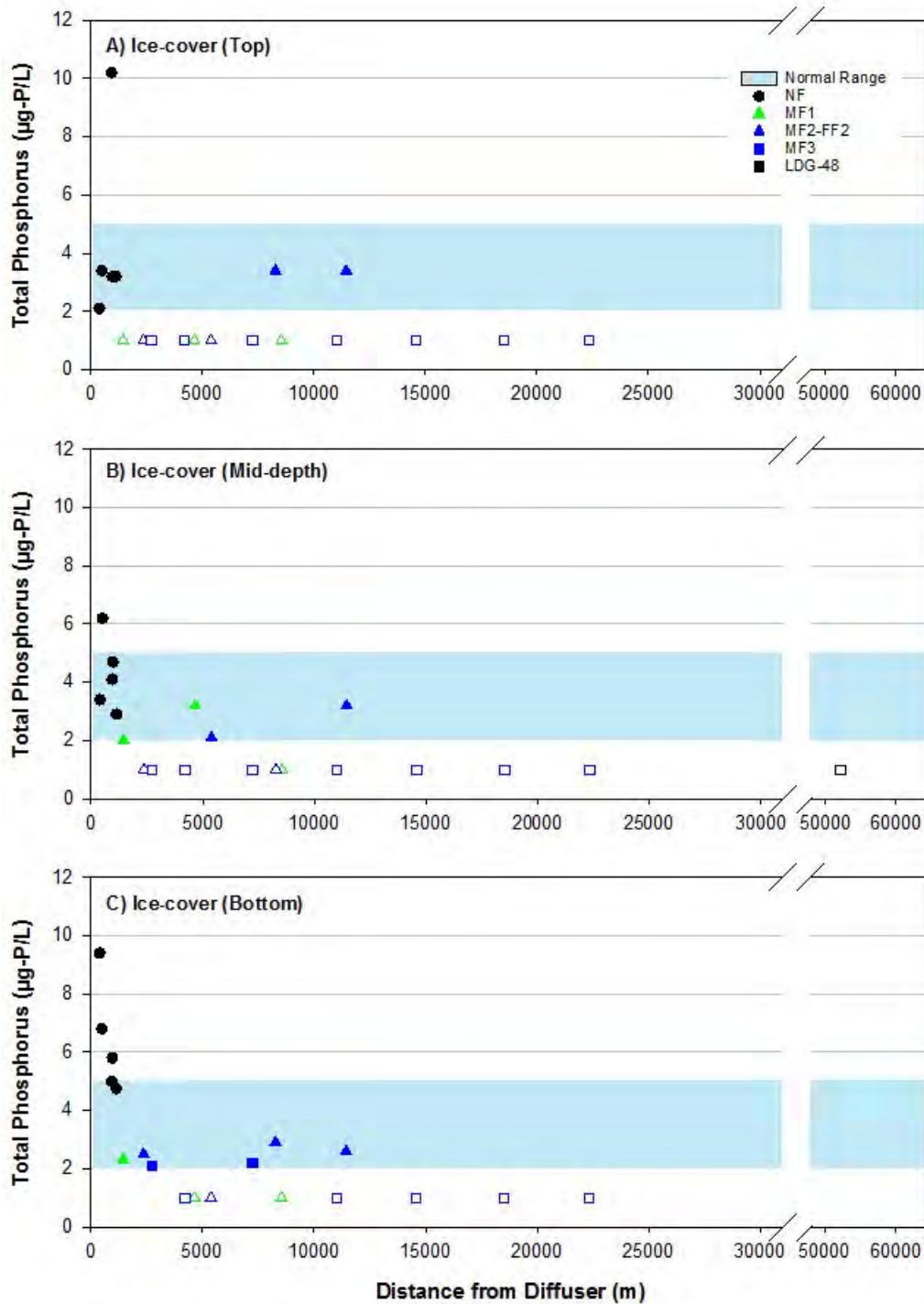
During the ice-cover season, TP concentrations in the NF area exceeded the upper limit of the normal range at the bottom (Figure 3-14C). Only one station in the NF area had a concentration above the upper limit of the normal range at the mid-depth (Station NF2) and top of the water column (Station NF3) (Figure 3-14B and 3-14A). The extent of effects on TP during ice-cover was limited to the NF area. Concentrations at all other stations under ice-cover were either within the normal range or below the DL.

Concentrations of TN decreased with distance from the diffuser at all depths under ice-cover, and exceeded the upper limit of the normal range at all depths and stations in the NF area (Figure 3-15). The greatest extent of effects under ice-cover were observed at the bottom, where TN concentrations were above the upper limit of the normal range at the majority of stations along the MF transects (Figure 3-15C).

During the open-water season, the extent of effects on TP concentrations was limited to four stations (NF1, NF5, MF1-1, and MF2-3), where it was above the upper limit of the normal range (Figure 3-16A). At all other stations, concentrations were either within or lower than the normal range, or below the DL. Unlike TP, the extent of effects on TN in open-water was not limited to a few stations in the NF and MF areas. Concentrations of TN exceeded the upper limit of the normal range at all NF and MF stations, and at the outlet of Lac de Gras (Figure 3-16B).

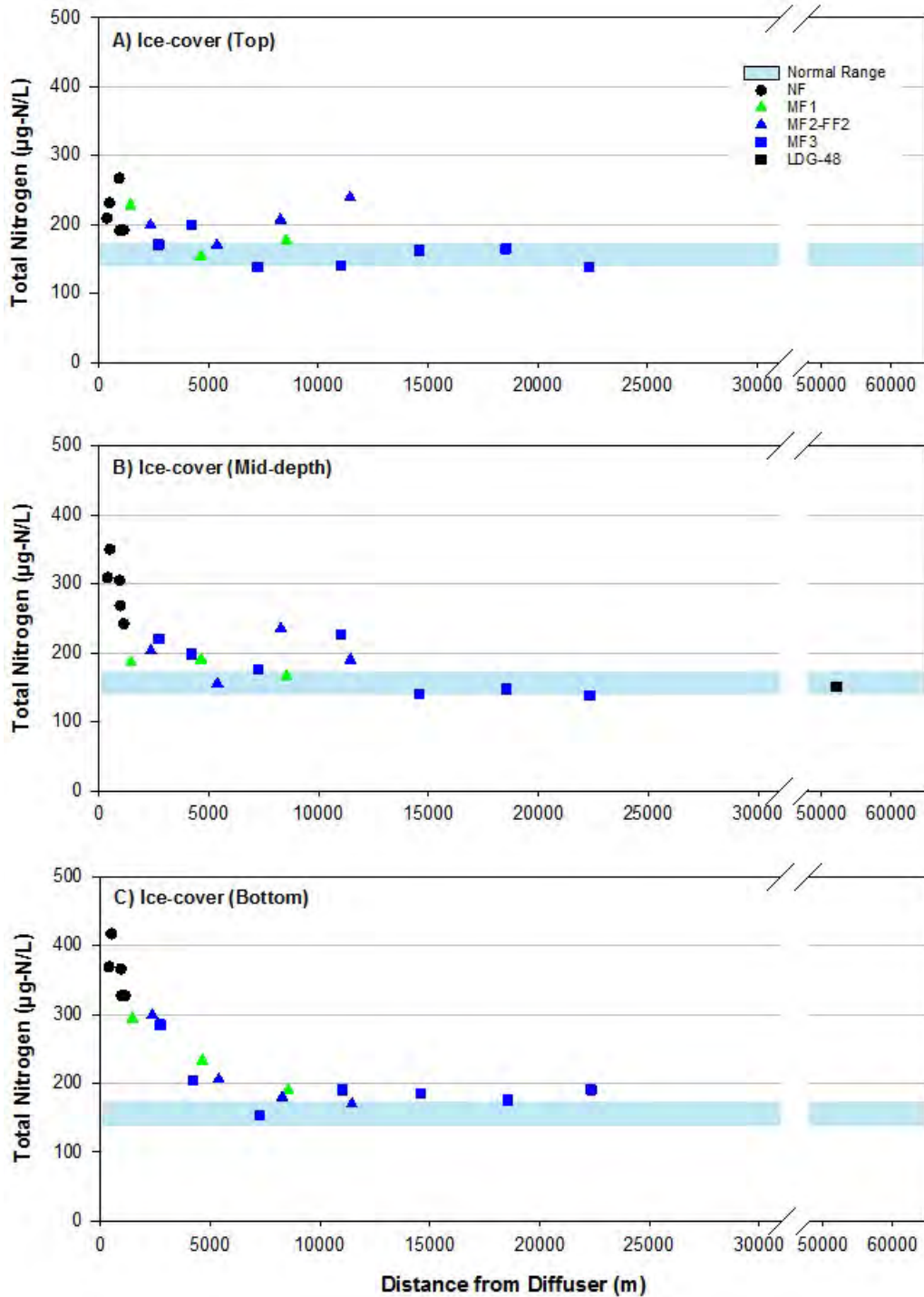
Open-water chlorophyll *a* concentrations exceeded the upper limit of the normal range in the NF area and at all stations along the three MF transects (Figure 3-16C). Although there was a declining trend with distance from the diffuser, the extent of nutrient enrichment effects on chlorophyll *a* concentrations reached the end of the three MF transects in 2014.

**Figure 3-14 Total Phosphorus Concentrations in Lac de Gras According to Distance from the Effluent Discharge during the Ice-Cover Season, 2014**



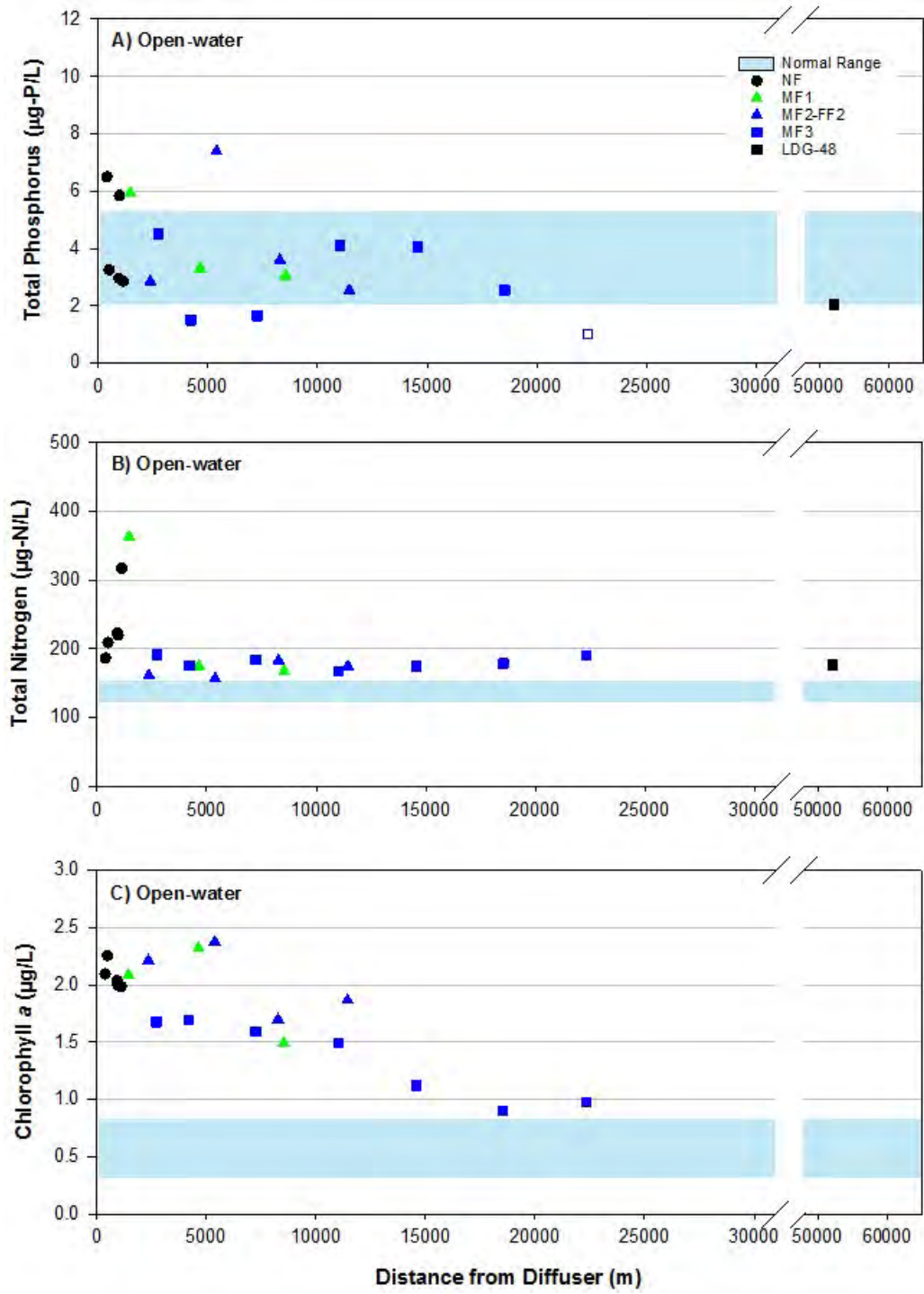
µg-P/L = micrograms of phosphorus per litre; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

**Figure 3-15 Total Nitrogen Concentrations in Lac de Gras According to Distance from the Effluent Discharge during the Ice-Cover Season, 2014**



$\mu\text{g-N/L}$  = micrograms of nitrogen per litre; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

**Figure 3-16 Concentrations of Total Phosphorus (A), Total Nitrogen (B), and Chlorophyll a (C) in Lac de Gras According to Distance from the Effluent Discharge during the Open-Water Season, 2014**

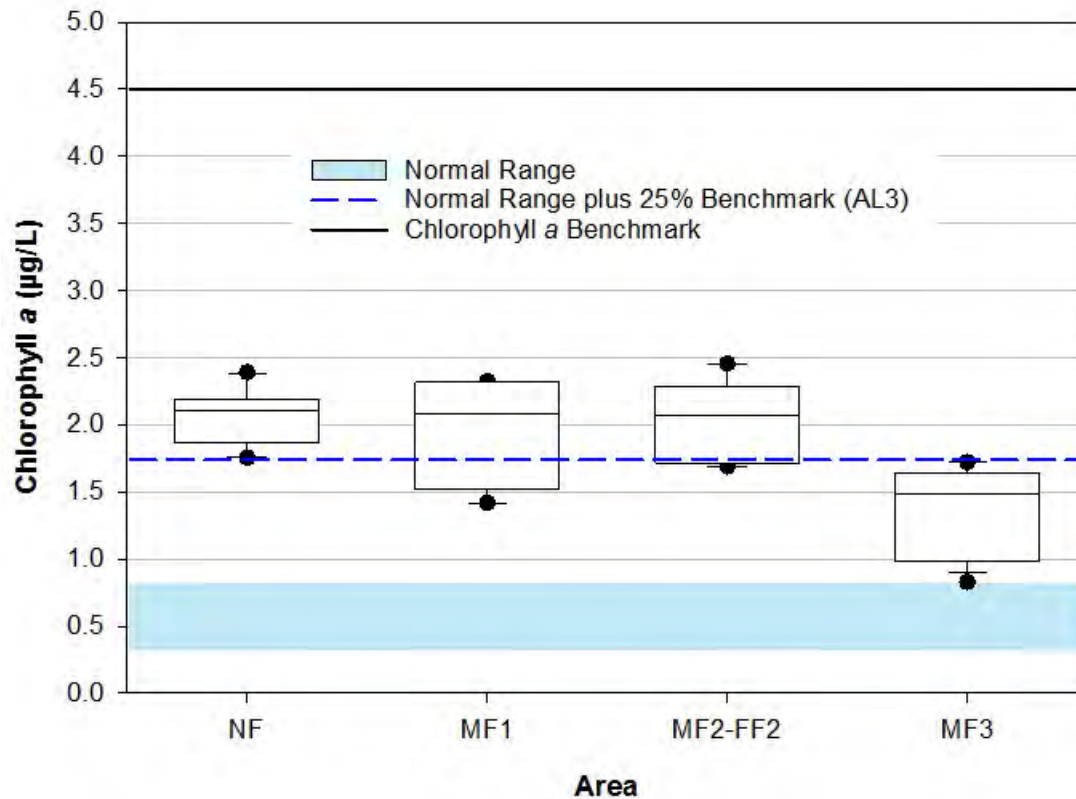


$\mu\text{g-P/L}$  = micrograms of phosphorus per litre;  $\mu\text{g-N/L}$  = micrograms of nitrogen per litre; NF = near-field; MF = mid-field; FF = far-field.

### 3.5 ACTION LEVELS FOR EUTROPHICATION

Current conditions indicate that an Action Level 2 has been reached. An Action Level 2 is identified when chlorophyll a concentrations in the NF and MF exposure areas are greater than the upper limit of the normal range in an area representing more than 20% of the lake surface (Table 3-1). In 2014, more than 40%<sup>1</sup> of the lake area had chlorophyll a concentrations above the upper limit of the normal range (i.e., 0.82 µg/L) (Figures 3-16C and 3-17; Table 3-1).

**Figure 3-17 Chlorophyll a Concentrations by Area in Lac de Gras, 2014**



Note: The AL3 definition also incorporates spatial extent of the effect as percent lake area (Table 3-1).  
 NF = near-field; MF = mid-field; FF = far-field; AL = action level.

<sup>1</sup> Percent lake area affected could not be estimated with certainty, because stations FF1, FFA, and FFB were not sampled in 2014.



**Table 3-1 Action Levels Classification for Chlorophyll a, 2014**

Action Level	Action Level Classification				2014 Assessment	
	Magnitude of Effect	Extent of Effect	Description	Value (µg/L)	Value (µg/L)	Extent of Effects
1	Top of normal range <sup>(a)</sup>	MF station	95 <sup>th</sup> percentile of MF values greater than normal range <sup>(a)</sup>	0.82	2.3	MF area
2	Top of normal range <sup>(a)</sup>	20% of lake area or more	NF and MF values greater than normal range <sup>(a)</sup>	0.82	>0.82	≥42.4% <sup>(d)</sup> of lake
3	Normal range plus 25% of Effects Benchmark <sup>(b)</sup>	20% of lake area or more	NF and MF values greater than normal range plus 25% of Effects Benchmark <sup>(b)</sup>	1.74	>1.74	13.2% of lake
4	Normal range plus 50% of Effects Threshold <sup>(c)</sup>	20% of lake area or more	NF and MF values greater than normal range plus 50% of Effects Threshold <sup>(c)</sup>	_(e)	_(e)	_(e)
5	Effects Threshold	20% of lake area or more	NF and MF values greater than Effects Threshold	_(e)	_(e)	_(e)
6	Effects Threshold + 20%	20% of lake area or more	NF and MF values greater than Effects Threshold +20%	_(e)	_(e)	_(e)
7	Effects Threshold + 20%	All MF stations	95 <sup>th</sup> percentile of MF values greater than Effects Threshold +20%	_(e)	_(e)	_(e)
8	Effects Threshold + 20%	FFB	95 <sup>th</sup> percentile of FFB values greater than Effects Threshold +20%	_(e)	_(e)	_(e)
9	Effects Threshold + 20%	FFA	95 <sup>th</sup> percentile of FFA values greater than Effects Threshold+20%	_(e)	_(e)	_(e)

a) The upper limit of the normal range is 0.82 µg/L.

b) Indicates 25% of the difference between the benchmark and the top of the normal range.

c) Indicates 50% of the difference between the effects threshold and the top of the normal range.

d) Percent lake area affected could not be estimated with certainty, because stations FF1, FFA, and FFB were not sampled in 2014.

e) Undefined, because the Effects Threshold has not been established.

NF = near-field; MF = mid-field; FFA = far-field A; FFB = far-field B; > = greater than.

## **4 DISCUSSION**

### **4.1 NUTRIENTS IN EFFLUENT AND THE MIXING ZONE**

During 2014, the highest loading and concentrations of TP in effluent occurred under ice-cover. Concentrations of TP at the mixing zone reflected this seasonal difference. Seasonal differences in the loading and effluent concentrations of nitrogen were less evident, though concentrations of dissolved nitrogen (i.e., ammonia, nitrate, and nitrite) at the mixing zone were considerably lower in open-water. Under ice-cover, vertical mixing was limited, and the effluent tended to remain in deeper water; hence, greater 95<sup>th</sup> percentile concentrations of all nutrients were observed during winter. The lower concentrations of nitrogen at the mixing zone in the open-water season reflect quick assimilation of nutrients by algae. Annual TP loading in 2014 (564 kg) was lower than in 2013 (710 kg).

### **4.2 NUTRIENTS AND CHLOROPHYLL A IN LAC DE GRAS**

Phosphorus and nitrogen enter Lac de Gras with Mine effluent throughout the year, although, as described above, seasonal cycles in effluent concentrations are apparent (Section 3.1; Golder 2011, 2014c). These seasonal differences were also observed in the NF area of Lac de Gras, with ice-cover season concentrations typically greater than open-water concentrations. As a result, the difference in concentrations between the NF and MF areas are more pronounced during the ice-cover season. The assimilation of nutrients by algae during the open-water season results in very low concentrations of dissolved inorganic nutrients in all areas of Lac de Gras.

An effect of nutrient enrichment on the primary producers of Lac de Gras was evident in 2014, as also indicated by the plankton community analysis (Golder 2016b). Chlorophyll *a* concentrations were greatest at stations nearest the effluent diffusers, reflecting nutrient loading from effluent. Chlorophyll *a* concentrations decreased with distance from the diffuser, reflecting a point source of nutrients into Lac de Gras and a decreasing gradient of nutrient availability with distance.

### **4.3 EXTENT OF EFFECTS**

To provide the most conservative view of the effluent-related enrichment effect, the season and depth for each variable with the greatest extent of effects was selected. Since only open-water samples were collected for chlorophyll *a*, the open-water data were used for this variable to estimate the spatial extent of effects. For TP and TN, the bottom-depth data collected during the ice-cover season was selected for estimating the spatial extent of effects.

The extent of effects on TP concentrations was limited to an area between the NF sampling area and the first MF stations along each of the three transects. All MF stations had TP concentrations below the upper limit of the normal range (Figure 3-14A). The boundary of effects on concentrations of TP to the northwest extended to between the NF area and Station MF1-1. The extent of effects to the northeast of the Mine, along the MF2-FF2 transect, extended to between the NF area and Station MF2-1. The boundary of effects south of the Mine extended to between the NF area and Station MF3-1. The resulting area of the lake demonstrating effects on concentrations of TP was estimated as 3.5 km<sup>2</sup>, or less than 1% of the lake. This area, along with the same value calculated in 2012, is the smallest affected area observed since 2007 (Table 4-1).

All of the NF and MF1 stations and the majority of the MF2-FF2 and MF3 stations had TN concentrations above the upper limit of the normal range (Figure 3-15A). The boundary of effects on concentrations of TN to the northwest extended to Station MF1-5, and possibly farther; however, station FF1 was not sampled in 2014. The extent of effects to the northeast of the Mine, along the MF2-FF2 transect, extended to between stations FF2-2 and FF2-5. The boundary of effects south of the Mine extended to Station MF3-7, and possibly farther; however, the FFB and FFA areas were not sampled in 2014. The resulting affected area of the lake based on concentrations of TN was estimated as 229.6 km<sup>2</sup>, or ≥40.1%<sup>1</sup> of the lake (Table 4-1), which is greater than the affected area calculated in previous years.

For chlorophyll *a*, the extent of effects during the open-water season encompassed all stations among the three MF areas (Figure 3-15C). Effects may extend farther along the MF transects; however, stations FF1, FFA, and FFB were not sampled in 2014. The extent of effects on concentrations of chlorophyll *a*, based on the affected stations, was calculated to be 234.1 km<sup>2</sup> (Table 4-1). Compared to the total surface area of the lake (573 km<sup>2</sup>), the area demonstrating effects on concentrations of chlorophyll *a* represents ≥42.4%<sup>2</sup> of the lake (Table 4-1). This is the greatest extent of effect observed to date.

The spatial extent of effects on zooplankton biomass could not be estimated in 2014, due to the loss of the zooplankton samples.

**Table 4-1 Spatial Extent of Effects on Concentrations of Total Phosphorus, Total Nitrogen and Chlorophyll *a*, and on Zooplankton Biomass, 2007 to 2014**

Year	Total Phosphorus		Total Nitrogen		Chlorophyll <i>a</i>		Zooplankton Biomass (ash-free dry mass)	
	Area (km <sup>2</sup> ) <sup>(a)</sup>	Lake Area (%) <sup>(b)</sup>	Area (km <sup>2</sup> ) <sup>(a)</sup>	Lake Area (%) <sup>(b)</sup>	Area (km <sup>2</sup> ) <sup>(a)</sup>	Lake Area (%) <sup>(b)</sup>	Area (km <sup>2</sup> ) <sup>(a)</sup>	Lake Area (%) <sup>(b)</sup>
2007	29.4	5.1	-(d)	-(d)	89	15.5	-(d)	-(d)
2008	112 <sup>(c)</sup>	19.6	84.8	14.8	77.1	13.5	-(e)	-(e)
2009	53.5 <sup>(c)</sup>	9.3	180	31.5	121	21.0	0	0
2010	23.8 <sup>(c)</sup>	4.2	132 <sup>(c)</sup>	23.1	88.5	15.5	52.3	9.1
2011	9.2 <sup>(c)</sup>	1.6	213 <sup>(c)</sup>	37.2	89.3	15.6	129	22.5
2012	3.6 <sup>(c)</sup>	0.6	118	20.7	17.0	3.0	76.7	13.4
2013	80.6 <sup>(c)</sup>	14.1	183 <sup>(c)</sup>	31.9	129	22.6	355	62.1
2014	3.5 <sup>(c)</sup>	0.6	229.6 <sup>(c)</sup>	≥40.1 <sup>(f)</sup>	242.8	≥42.4 <sup>(f)</sup>	-(g)	-(g)

a) Lake area reported is the greater of the area affected during the open-water or ice-covered season.

b) The lake area affected represents the percentage (%) of lake area experiencing levels greater than the normal range, and was calculated relative to the total surface area of Lac de Gras (573 km<sup>2</sup>).

c) Lake area reported is for the ice-cover season.

d) Data not available due to field subsampling errors (Golder 2016c).

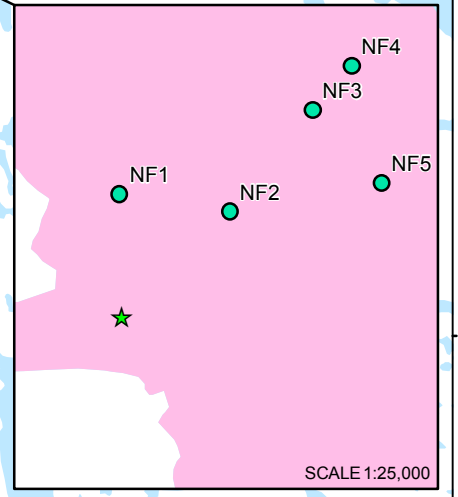
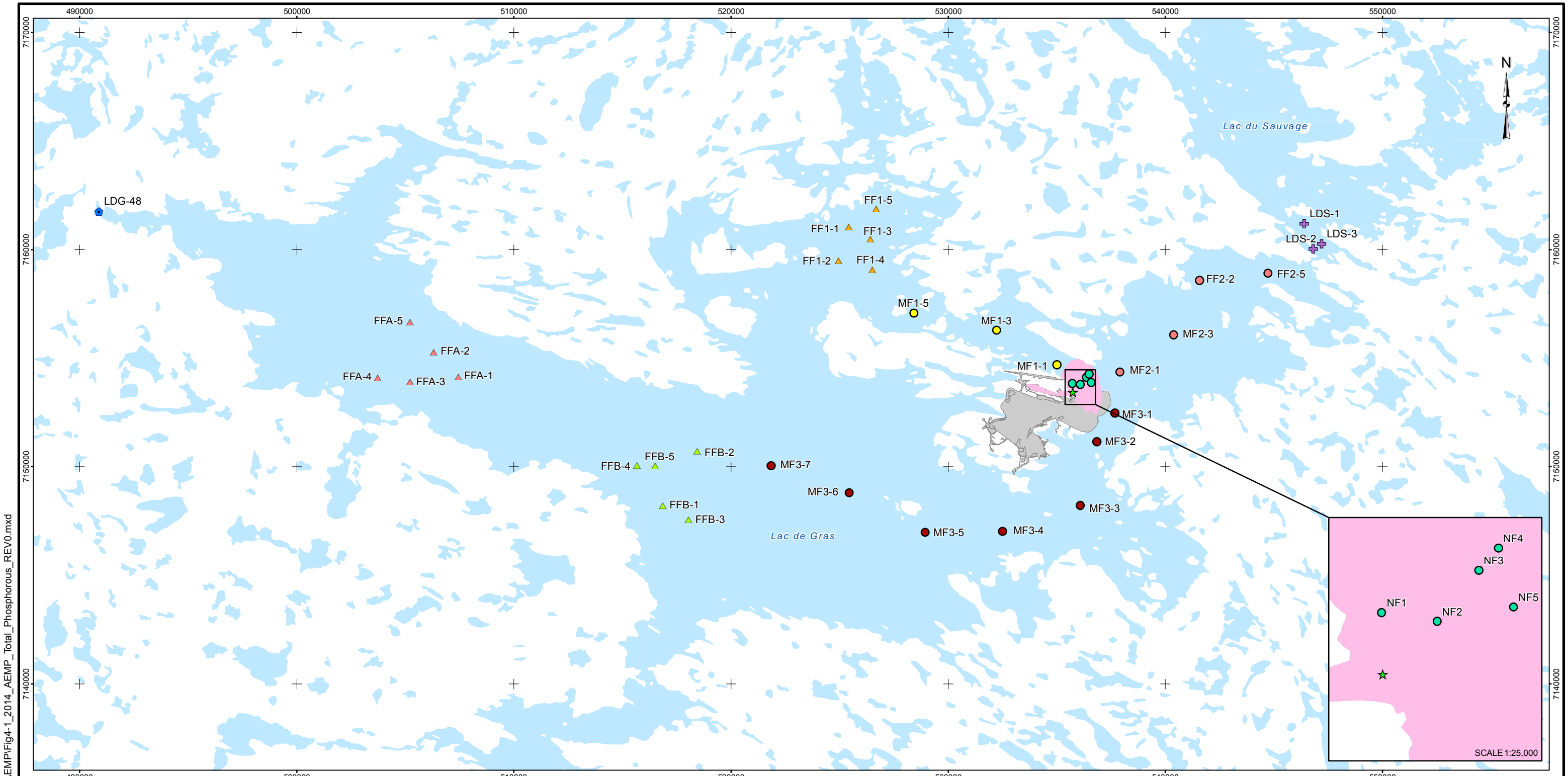
e) Data not available due to differences in sample collection procedures (Golder 2016c).

f) Percent lake area affected could not be estimated with certainty, because stations FF1, FFA, and FFB were not sampled in 2014.

g) Data not available due to the loss of the zooplankton samples (Appendix E).

- = not determined.

<sup>1,2</sup> Percent lake area affected could not be estimated with certainty, because stations FF1, FFA, and FFB were not sampled in 2014.



- LEGEND**
- ★ DIFFUSERS
  - ⊕ LAC DU SAUVAGE
  - ⬠ EXPOSURE
  - ⬠ LDG 48
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - ▲ FAR-FIELD 1
  - ▲ FAR-FIELD A
  - ▲ FAR-FIELD B
  - ⬠ AFFECTED AREA
  - ⬠ DIAVIK FOOTPRINT
  - ⬠ WATERBODY

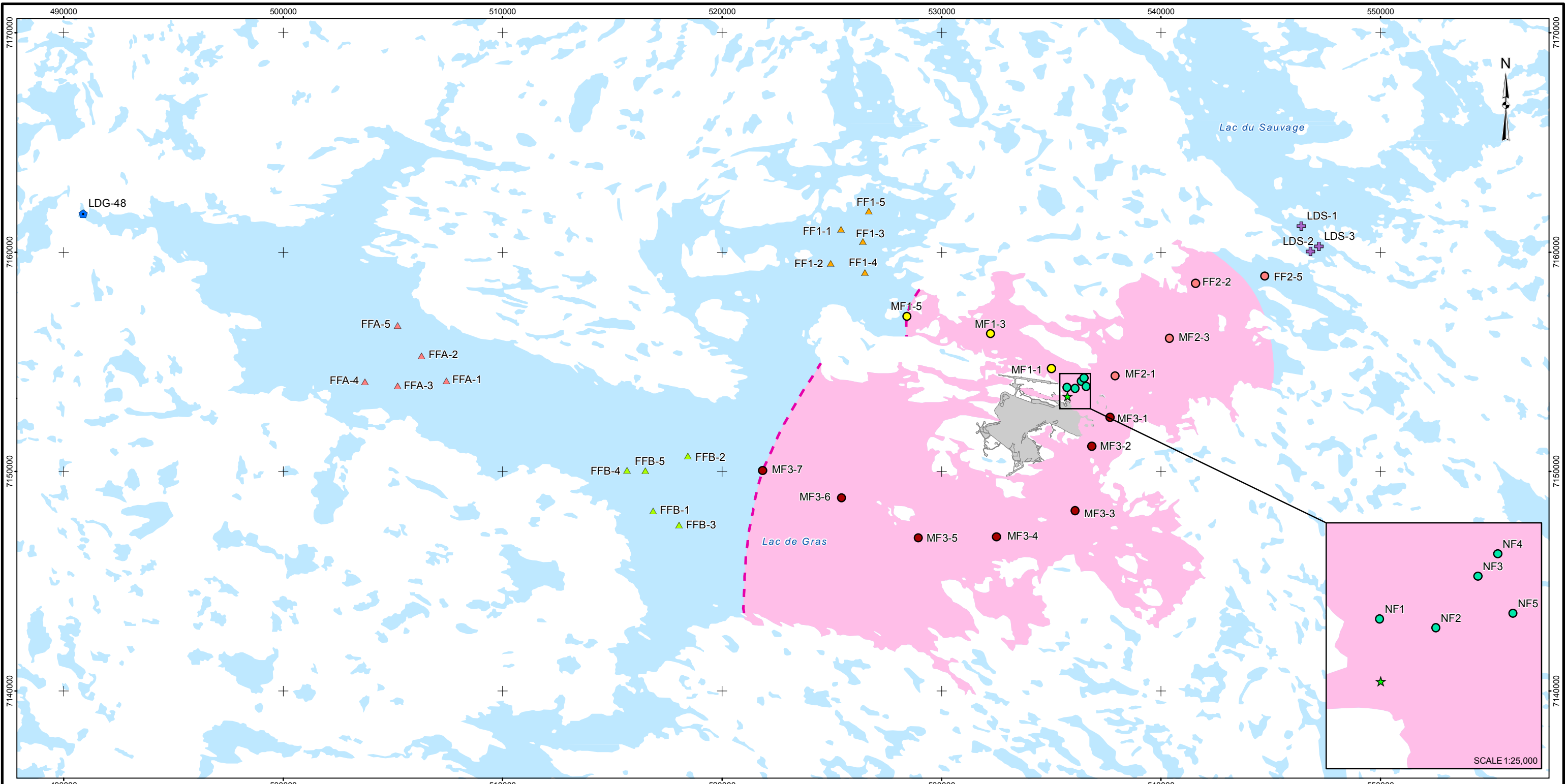


PROJECT			
<b>TITLE</b>			
<b>TOTAL PHOSPHORUS AFFECTED AREA IN LAC DE GRAS, 2014</b>			
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	DESIGN	TD 18 Mar. 2016	SCALE AS SHOWN
	GIS	SS 30 Mar. 2016	REV. 0
	CHECK	TD 30 Mar. 2016	<b>FIGURE: 4-1</b>
REVIEW	ZK 30 Mar. 2016		

**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83

i:\201111-1328\11-1328-0038\mapping\IXD\2014AEMP\Fig4-1\_2014\_AEMP\_Total\_Phosphorous\_REV0.mxd

i:\201111-1328\11-1328-0038\Mapping\IXD\2014AEMP\Fig4-2\_2014\_AEMP\_Total\_Nitrogen\_REV0.mxd



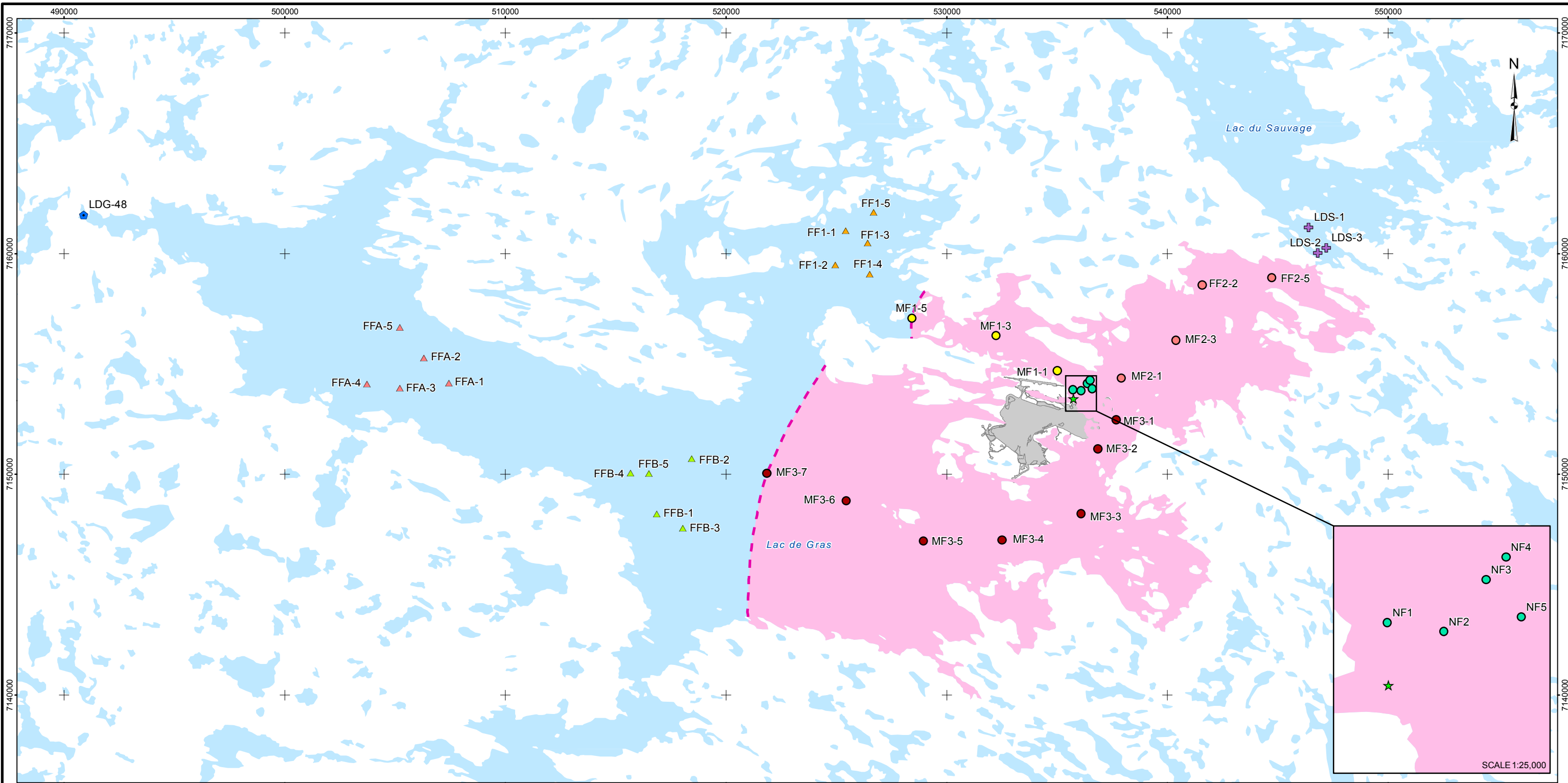
- LEGEND**
- ★ DIFFUSERS
  - ⊕ LAC DU SAUVAGE
  - ⬠ LDG 48
  - ⬠ UNCERTAIN EFFECT BOUNDARY
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - ▲ FAR-FIELD 1
  - ▲ FAR-FIELD A
  - ▲ FAR-FIELD B
  - AFFECTED AREA
  - DIAVIK FOOTPRINT
  - WATERBODY

**REFERENCE**  
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 PROJECTION: UTM ZONE 12 DATUM: NAD 83



PROJECT			
TITLE		<b>TOTAL NITROGEN AFFECTED AREA IN LAC DE GRAS, 2014</b>	
	PROJECT	1406208	FILE No.
	DESIGN	TD	18 Mar. 2016
	GIS	SS	30 Mar. 2016
	CHECK	TD	30 Mar. 2016
	REVIEW	ZK	30 Mar. 2016
SCALE AS SHOWN		REV.	0
			<b>FIGURE: 4-2</b>

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- LEGEND**
- ★ DIFFUSERS
  - ⊕ LAC DU SAUVAGE
  - ⬠ EXPOSURE
  - NEAR-FIELD
  - MID-FIELD 3
  - MID-FIELD 1
  - FAR-FIELD 2; MID-FIELD 2
  - ▲ FAR-FIELD 1
  - ▲ FAR-FIELD A
  - ▲ FAR-FIELD B
  - ⊕ LAC DU SAUVAGE
  - LDG 48
  - - - UNCERTAIN EFFECT BOUNDARY
  - AFFECTED AREA
  - DIAVIK FOOTPRINT
  - WATERBODY

**REFERENCE**  
 HYDROGRAPHY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.  
 PROJECTION: UTM ZONE 12 DATUM: NAD 83



PROJECT			
TITLE			
<b>CHLOROPHYLL A AFFECTED AREA          IN LAC DE GRAS, 2014</b>			
	PROJECT	1406208	FILE No.
	DESIGN	TD	18 Mar. 2016
	GIS	SS	30 Mar. 2016
	CHECK	TD	30 Mar. 2016
REVIEW	ZK	30 Mar. 2016	SCALE AS SHOWN
			REV. 0
			<b>FIGURE: 4-3</b>

## 5 CONCLUSIONS

This report presents the assessment of data collected by DDMI for the indicators of eutrophication component of the 2014 AEMP. Results of the eutrophication assessment concluded that:

- The Mine is having a nutrient enrichment effect on Lac de Gras, as evidenced by greater concentrations of nutrients in the NF exposure area and concentrations of chlorophyll *a* that exceeded the upper limits of the normal range in the NF and MF areas. The introduction of higher levels of nutrients by the minewater discharge, particularly phosphorus, was predicted to result in an increase in primary productivity.
- The concentration of TP was expected to exceed the EA threshold for nutrient enrichment (i.e., 5 µg/L of TP) in up to 20% of the surface area of Lac de Gras. In 2014, the extent of effects on TP was less than 1% of the lake area.
- The extent of effects on TN and chlorophyll *a* was more than 40%<sup>1</sup> of the lake area.
- The magnitude of the eutrophication effect is equivalent to an Action Level 2 in the Response Framework. This conclusion is based on concentrations of chlorophyll *a* exceeding the upper limit of the normal range (i.e., 0.82 µg/L) in greater than 20% of the lake area, and concentrations greater than the normal range plus 25% of the Effects Benchmark (i.e., 1.74 µg/L) in less than 20% of the lake area.
- According to the Response Framework, the corresponding action to Action Level 2 is to establish an Effects Benchmark for chlorophyll *a*. The Effects Benchmark has been established and was presented in AEMP Study Design Version 3.5 (Golder 2014b). Therefore, no further action is required.
- The evaluation of the annual extent of effects on zooplankton biomass could not be completed in 2014 due to the loss of the zooplankton samples. However, the lack of zooplankton data in 2014 will not impact the interpretation of longer-term temporal trends nor the assessment of Action Levels for eutrophication (Appendix E).

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<sup>1</sup> Percent lake area affected could not be estimated with certainty, because stations FF1, FFA, and FFB were not sampled in 2014.

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## **7 CLOSURE**

We trust that the information in this report meets your requirements at this time. If you have any questions relating to the information contained in this document please do not hesitate to contact the undersigned.

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**APPENDIX A**

**EUTROPHICATION DATA SCREENING**

## OUTLIER SCREENING METHODS

Data screening is the initial phase of data handling when analyzing chemistry datasets, which are subject to occasional extreme values that are frequently incorrect, reflecting field or laboratory errors, data transcription or calculation errors, or extreme natural variability. This initial step is undertaken prior to data analysis and interpretation to verify that the data quality objectives established by the Quality Assurance Project Plan and the study design have been met. The purpose of this step is to initially identify unusually high or low values (referred to as anomalous data), correct them if possible, and make a decision whether to retain or exclude remaining anomalous data form further analysis.

In previous DDMI AEMP reports, the judgment whether to retain an anomalous value in the analysis was made based on a visual inspection of the data using scatter-plots, and logical consistency with results for other parameters. To prepare data for summaries presented in the latest version of the Re-evaluation Report, a revised approach was used to identify anomalous data to address concerns noted by the WLWB and other reviewers regarding the handling of outliers in AEMP datasets (Golder 2016c). The revised data screening approach includes a numerical method to aid in the identification of outliers, thus removing the subjectivity of classifying values based on visual evaluation of data alone.

Initial screening of the 2014 nutrient and chlorophyll *a* datasets was completed before data analyses to identify unusually high (or low) values in the datasets and decide whether to retain or exclude anomalous data from further analysis. Data screening was conducted using a method based on Chebyshev's theorem (Mann 2010) combined with the visual examination of scatter-plots. This method allows for detection of multiple outliers at one time and assumes that the data being screened contain a relatively small percentage of outliers (Amidan et al. 2005). The theorem states that at least  $1-1/k^2$  proportion of the data of any distribution (i.e., no assumption of normality) lies within  $k$  standard deviations (SD) of the mean. Setting  $1-1/k^2 = 0.95$  and solving for  $k$  results in 4.47 SD, indicating that 95% of the data, regardless of distribution, will be within about 4.5 SD of the mean. In the case of a normal distribution, 95% of the data is expected to be within 2 SD, suggesting that the method based on Chebyshev's inequality is conservative (i.e., identifies values that are far removed from the mean). The method was applied by first identifying data that lie outside the 4.47 SD on a scatter-plot of annual data, and then visually verifying the anomalous values based on potential spatial trends. No data were identified as anomalous based on visual evaluation alone.

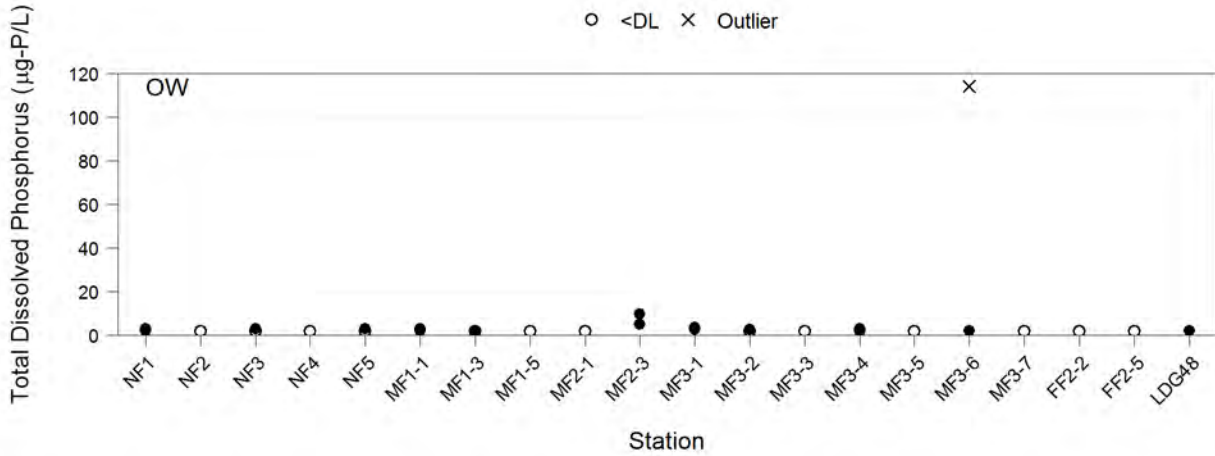
In cases where the above screening method identified an elevated value in the NF area or at the mixing zone boundary as anomalous, the identified value was conservatively retained in the dataset used for analysis if the SD distance from the mean was less than two times the 4.5 SD criterion discussed above. Hence, only very extreme values, which were greater than approximately 9 SDs from the mean were removed from the further analysis of NF area data. Finally, in cases where the annual datasets contained a large proportion of non-detect data, only values that were greater than or equal to 5 times the DL were considered anomalous and were removed from the analysis.

## OUTLIER SCREENING RESULTS

Data screening for anomalous values in the 2014 eutrophication indicators dataset identified one anomalous value within the 2014 dataset, representing 0.1% of the total data points. The concentration of total dissolved phosphorus (TDP) in the open-water sample collected from Station MF3-6 was equal to 114  $\mu\text{g-P/L}$ , resulting in a standard deviation distance of 6.06. In cases where unusual values were

identified in the dataset, scatter-plots were generated to allow a visual review of anomalous data and provide transparency (Figure A-1).

**Figure A-1 Anomalous Data Removed from AEMP Analyses Conducted for Total Dissolved Phosphorus, Open-water Season, 2014**



µg-P/L = micrograms of phosphorus per litre; < = less than; DL = detection limit; OW = open-water; x = anomalous value; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet.

## **APPENDIX B**

### **QUALITY ASSURANCE AND QUALITY CONTROL**

## **QUALITY ASSURANCE AND QUALITY CONTROL**

The quality assurance (QA) and quality control (QC) program followed during the 2014 AEMP is detailed in the QAPP (Golder 2013a). The Quality Assurance Project Plan (QAPP) outlines the QA/QC procedures employed to support the collection of scientifically defensible and relevant data. The QAPP is designed to ensure that field sampling, laboratory analysis, data entry, data analysis, and report preparation activities produce technically sound and scientifically defensible results. Results of the 2014 eutrophication indicators QA/QC program are presented below.

### **Quality Assurance**

#### Field Operations

Field work was completed by Diavik staff according to specified instructions outlined in the following standard operating procedures (SOP):

- ENVR-014-0311 R5 AEMP Sampling (Ice-Cover);
- ENVR-003-0702 R14 AEMP Sampling (Open-Water);
- ENVR-608-0112 R0 Hydrolab;
- ENVR-303-0112 R0 Laboratory Quality Assurance/Quality Control; and
- ENVR-206-0112 R0 Processing Maxxam Samples and Tracking Documentation.

These SOPs include guidelines for field record keeping and sample tracking, guidance for use of sampling equipment, relevant technical procedures, and sample labelling, shipping and tracking protocols.

#### Office Operations

A data management system was in place to facilitate an organized system of data control, analysis, and filing. Relevant operations included the following:

- reviewing laboratory data as they were received from the analytical laboratory;
- creating backup files prior to beginning data analysis; and
- completing appropriate logic checks to ensure the accuracy of all calculations.

### **Quality Control**

#### Methods

Quality control is a specific aspect of QA that includes the techniques used to assess data quality. The field QC program consisted of the collection of field blanks, equipment blanks, filter blanks, and

duplicate samples. The blanks are used to assess potential sample contamination in the field, and the duplicates are used to assess within-station variation and sampling precision. Field, travel, and equipment blank samples were submitted to Maxxam Analytics (Maxxam), Burnaby, British Columbia for nutrient analysis during both the open-water and ice-cover seasons. QC samples were submitted to the Biogeochemical Analytical Laboratory at the University of Alberta (UofA), Edmonton, Alberta for the analysis of open-water chlorophyll *a* samples. Duplicate samples were collected and submitted for analysis of nutrients and chlorophyll *a*.

### Field, Travel, and Equipment Blanks

Blanks contained de-ionized water obtained from the laboratory. Field blanks consisted of samples prepared in the field. Equipment blanks were exposed to all aspects of sample collection and analysis, including the same procedures used in the field, and contact with all sampling devices and other equipment. Travel blanks were transported with the crew during daily sampling procedures and remained unopened during field sampling. Blanks were submitted blind to the laboratory for the same analyses as the field samples. Equipment and travel blanks provide information regarding potential sample contamination from equipment or sample transport.

The field, travel, and equipment blanks were also used to detect potential contamination during collection, shipping and analysis. Analytes should not have been detected in the field blanks. If they were detected, their concentrations were considered notable if they were greater than five times the corresponding detection limit (DL). This threshold is based on the Practical Quantitation Limit defined by US EPA (1985), which takes into account the potential for data accuracy error when variable concentrations approach or are below the DL.

Notable results observed in the field blanks were evaluated relative to analyte concentrations observed in the field samples to determine whether sample contamination was limited to the QC sample or was apparent in other samples as well. Where, based on this comparison, sample contamination was not an isolated occurrence, the field data were flagged and interpreted with this limitation in mind.

### Duplicate Samples

Duplicate samples consisted of two separate samples collected from the same location, at the same time, using the same sampling and handling procedures. They were labelled and preserved individually, and submitted separately to the analytical laboratories for identical analyses. Duplicate samples are used to check within-station variation and the precision of field sampling methods.

For the AEMP QC analysis, differences in concentrations of analytes between the duplicate nutrient and chlorophyll *a* samples were considered notable if the relative percent difference (RPD) was greater than 50 percent (%) and concentrations in duplicate samples were greater than five times the DL.

To calculate the RPD between duplicate samples, non-detect values (i.e., values below the DL) were multiplied by 0.5 times the DL. Substitution with half the DL is a common approach used to deal with censored data (US EPA 2000) and is consistent with the approved methods applied in the calculation of the normal range in the AEMP Reference Conditions Report Version 1.1 (Golder 2015).



The QC duplicate criterion utilized for the AEMP program was developed and approved to be consistent with the QC criterion set by the laboratories for assessing precision (i.e., the degree of similarity between replicate measurements) between duplicate samples, as well as maintaining consistency with other regulatory agencies (BC MOE 2006). Each laboratory establishes its own acceptance criteria for assessing precision through analysis of laboratory duplicate samples. The acceptance criterion is often expressed as the RPD when the comparison between two replicates (i.e., duplicates) is analyzed. This acceptance criterion often varies among analytes or groups of analytes. For example, a laboratory may specify an acceptance criterion of less than or equal to ( $\leq$ ) 20% RPD for one group of analytes, and  $\leq$ 50% RPD for another analyte group. Because precision decreases as analyte concentrations approach DL, laboratories typically qualify their acceptance criteria so that they are only applied when the analyte is detected in both the original and the duplicate sample, at concentrations at least five times the DL. In this study, field duplicates were used and variability was expected between samples. Therefore, an acceptance criterion of greater than ( $>$ ) 50% RPD was used for all analytes.

For the AEMP duplicate QC analysis, QC data that met the acceptance criteria were considered acceptable with respect to accuracy. Duplicate data were not automatically rejected because of an exceedance of the acceptance criterion; rather, they were evaluated on a case-by-case basis, as some level of within-station variability is expected for duplicate samples. If there were departures from the acceptance criterion, the samples were flagged, and a variety of follow-up assessments were performed. These assessments included plotting the data for visual identification of outliers. If there were visual outliers, the data were plotted with the corresponding 2007 to 2013 data for a range comparison. If the data were outside the corresponding 2007 to 2013 range, laboratory re-analysis was requested. If laboratory re-analysis confirmed the results, the outlier points were retained in the final dataset, unless there was a technically defensible reason to exclude them.

### Total Versus Dissolved Forms

The concentrations of total nitrogen (TN) and total phosphorus (TP) consist of both particulate and dissolved forms of the analyte. Thus, total dissolved nitrogen (TDN) and total dissolved phosphorus (TDP) should be equal to or less than the total concentrations. Typically, the RPD between the two forms should not exceed 20%. If the RPD was found to be  $>$ 20%, these data were flagged, and the validity of the data was investigated.

## RESULTS

Three travel blanks, five field blanks, and ten equipment blanks were collected during the 2014 AEMP; four samples were collected under ice-cover and 14 samples were collected during the open-water season. Each blank was analyzed for seven nutrient analytes (Table B-1). Nineteen duplicate samples were analyzed for chlorophyll *a* during the open-water season, and 22 duplicate samples (each station for open-water; 2 stations for ice-cover) were analyzed for nutrients.

### **Field, Travel, Equipment Blanks**

None of the three travel blank results, had concentrations greater than five times the DL for the analytes reported. There were detectable concentrations of ammonia in the majority of open-water travel blanks.

None of the five field blank results, had concentrations greater than five times the DL for the analytes reported. There were detectable concentrations of ammonia in the majority of open-water field blanks.

Three of the ten equipment blanks had concentrations greater than five times the DL. These values were for MF3 stations for nitrate-nitrite, and MF1 for ammonia (ice-cover). There were detectable concentrations of ammonia in the majority of open-water equipment blanks.

Ammonia concentrations reported in blank samples analyzed by Maxxam were at or above levels in Lac de Gras (Golder 2016a).

### **Nutrient Duplicate Samples**

Three results out of a total of 134 (2%) had an RPD of more than 50% between duplicates, while having concentrations greater than five times the DL (Table B-2). Flagged samples varied among locations (MF3-6, NF4-B, MF3-1M) and analytes (TDP, ammonia, and nitrate-nitrite). One of the three flagged sample pairs (MF3-6) had an anomalous value that was identified during data screening (Appendix A).

Open-water ammonia data were not used in the data analyses, because of flags in the QC data and considerable variation between duplicates. Six of 20 (30% of total) open-water ammonia samples had an RPD of more than 50% and exceeded five times the DL at over 50% of stations.

**Table B-1 Concentrations of Nutrients in Field, Equipment, and Travel Blanks, 2014**

Sample Type	Season	Station	Total Phosphorus (µg-P/L)			Total Dissolved Phosphorus (µg-P/L)			Soluble Reactive Phosphorus (µg-P/L)		
			DL	Result	>5xDL	DL	Result	>5xDL	DL	Result	>5xDL
Travel Blank	IC	MF3-5T	2	<DL	N	2	<DL	N	1	<DL	N
	OW	FF2-2-4	2	-	-	2	-	-	1	<DL	N
	OW	FF2-2-5	2	-	-	2	-	-	1	<DL	N
Field Blank	OW	NF1-4	2	<DL	N	2	<DL	N	1	-	-
	OW	NF1-5	2	<DL	N	2	<DL	N	1	-	-
	OW	MF3-1-4	2	2.6	N	2	<DL	N	1	<DL	N
	OW	MF3-1-5	2	<DL	N	2	<DL	N	1	<DL	N
	IC	FF2-5M	2	<DL	N	2	<DL	N	1	<DL	N
Equipment Blank	OW	MF1-5-4	2	<DL	N	2	<DL	N	1	<DL	N
	OW	MF1-5-5	2	<DL	N	2	<DL	N	1	<DL	N
	OW	MF3-3-4	2	<DL	N	2	<DL	N	1	<DL	N
	OW	MF3-3-5	2	<DL	N	2	<DL	N	1	<DL	N
	OW	MF3-7-4	2	<DL	N	2	<DL	N	1	<DL	N
	OW	MF3-7-5	2	<DL	N	2	<DL	N	1	<DL	N
	OW	NF5-4	2	<DL	N	2	<DL	N	1	<DL	N
	OW	NF5-5	2	<DL	N	2	<DL	N	1	<DL	N
	IC	MF1-1B	2	<DL	N	2	<DL	N	1	<DL	N
IC	NF5B	2	<DL	N	2	<DL	N	1	<DL	N	

; DL = detection limit; > = greater than; < = less than; x = times; IC = ice-cover; OW = open-water; NF = near-field; MF = mid-field; FF = far-field; N = no; - not applicable or data not available.

µg-P/L = micrograms of phosphorus per litre; µg-N/L = micrograms of nitrogen per litre; DL = detection limit; > = greater than; < = less than; x = times; IC = ice-cover; OW = open-water; NF = near-field; MF = mid-field; FF = far-field; N = no; Y = yes; - not applicable or data not available.

Note: **Bolded** terms indicate QC flags for concentrations that were greater than five times the corresponding DL.

**Table B-1 Concentrations of Nutrients in Field, Equipment, and Travel Blanks, 2014 (continued)**

Sample Type	Season	Station	Total Nitrogen (µg-N/L)			Total Dissolved Nitrogen (µg-N/L)			Ammonia (µg-N/L)			Nitrate+Nitrite (µg-N/L)		
			DL	Result	>5xDL	DL	Result	>5xDL	DL	Result	>5xDL	DL	Result	>5xDL
Travel Blank	IC	MF3-5T	20	10	N	20	-	-	5	-	-	2	2.3	N
	OW	FF2-2-4	20	-	-	20	-	-	5	58	Y	2	<DL	N
	OW	FF2-2-5	20	-	-	20	-	-	5	53	Y	2	<DL	N
Field Blank	OW	NF1-4	20	10	N	20	24	N	5	8	N	2	<DL	N
	OW	NF1-5	20	26	N	20	25	N	5	13	N	2	<DL	N
	OW	MF3-1-4	20	25	N	20	10	N	5	28	Y	2	2.6	N
	OW	MF3-1-5	20	10	N	20	31	N	5	18	N	2	<DL	N
	IC	FF2-5M	20	43	N	20	10	N	5	9	N	2	2.8	N
Equipment Blank	OW	MF1-5-4	20	40	N	20	10	N	5	6	N	2	<DL	N
	OW	MF1-5-5	20	22	N	20	39	N	5	12	N	2	<DL	N
	OW	MF3-3-4	20	33	N	20	86	N	5	49	Y	2	10.6	Y
	OW	MF3-3-5	20	10	N	20	77	N	5	38	Y	2	55.4	Y
	OW	MF3-7-4	20	57	N	20	55	N	5	16	N	2	7.2	N
	OW	MF3-7-5	20	68	N	20	59	N	5	43	Y	2	<DL	N
	OW	NF5-4	20	33	N	20	88	N	5	11	N	2	<DL	N
	OW	NF5-5	20	75	N	20	64	N	5	22	N	2	<DL	N
	IC	MF1-1B	20	10	N	20	10	N	5	81	Y	2	<DL	N
	IC	NF5B	20	54	N	20	28	N	5	11	N	2	<DL	N

**Table B-2 Summary of Duplicate Sample Results for Nutrient Analytes, 2014**

Analyte	Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Relative Percent Difference (%)	5*DL	>5*DL	QC Fail
<b>Total Phosphorus (µg-P/L)</b>	IC	MF3-1M	2	1.0	1.0	0.0	10	N	N
	IC	NF4-B	2	5.2	4.3	18.9	10	N	N
	OW	FF2-2	2	3.2	4.0	22.2	10	N	N
	OW	FF2-5	2	2.8	2.3	19.6	10	N	N
	OW	LDG48	2	2.1	2.0	4.9	10	N	N
	OW	MF1-1	2	6.9	5.0	31.9	10	N	N
	OW	MF1-3	2	3.4	3.2	6.1	10	N	N
	OW	MF1-5	2	2.5	3.6	36.1	10	N	N
	OW	MF2-1	2	2.8	2.9	3.5	10	N	N
	OW	MF2-3	2	4.9	9.9	67.6	10	N	N
	OW	MF3-1	2	5.0	4.0	22.2	10	N	N
	OW	MF3-2	2	2.0	1.0	66.7	10	N	N
	OW	MF3-3	2	1.0	2.3	78.8	10	N	N
	OW	MF3-4	2	6.1	2.1	97.6	10	N	N
	OW	MF3-5	2	5.6	2.5	76.5	10	N	N
	OW	MF3-6	2	2.6	2.5	3.9	10	N	N
	OW	MF3-7	2	1.0	1.0	0.0	10	N	N
	OW	NF1	2	5.5	7.5	30.8	10	N	N
	OW	NF2	2	3.0	3.5	15.4	10	N	N
	OW	NF3	2	3.3	2.6	23.7	10	N	N
OW	NF4	2	2.8	2.9	3.5	10	N	N	
OW	NF5	2	2.2	9.5	124.8	10	N	N	

**Table B-2 Summary of Duplicate Sample Results for Nutrient Analytes, 2014**

Analyte	Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Relative Percent Difference (%)	5*DL	>5*DL	QC Fail
Total Dissolved Phosphorus (µg-P/L)	IC	MF3-1M	2	1.0	1.0	0.0	10	N	N
	IC	NF4-B	2	2.1	2.2	4.7	10	N	N
	OW	FF2-2	2	1.0	1.0	0.0	10	N	N
	OW	FF2-5	2	1.0	1.0	0.0	10	N	N
	OW	LDG48	2	1.0	2.2	75.0	10	N	N
	OW	MF1-1	2	3.0	2.3	26.4	10	N	N
	OW	MF1-3	2	2.3	1.0	78.8	10	N	N
	OW	MF1-5	2	1.0	1.0	0.0	10	N	N
	OW	MF2-1	2	1.0	1.0	0.0	10	N	N
	OW	MF2-3	2	5.2	9.9	62.3	10	N	N
	OW	MF3-1	2	3.6	2.8	25.0	10	N	N
	OW	MF3-2	2	2.8	1.0	94.7	10	N	N
	OW	MF3-3	2	1.0	1.0	0.0	10	N	N
	OW	MF3-4	2	2.9	2.0	36.7	10	N	N
	OW	MF3-5	2	1.0	1.0	0.0	10	N	N
	OW	MF3-6 <sup>(b)</sup>	2	114.0	2.1	192.8	10	Y	Y
	OW	MF3-7	2	1.0	1.0	0.0	10	N	N
	OW	NF1	2	2.9	2.3	23.1	10	N	N
	OW	NF2	2	1.0	1.0	0.0	10	N	N
	OW	NF3	2	2.9	1.0	97.4	10	N	N
OW	NF4	2	1.0	1.0	0.0	10	N	N	
OW	NF5	2	3.0	1.0	100.0	10	N	N	

**Table B-2 Summary of Duplicate Sample Results for Nutrient Analytes, 2014**

Analyte	Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Relative Percent Difference (%)	5*DL	>5xDL	QC Fail
<b>Soluble Reactive Phosphorus (µg-P/L)</b>	IC	MF3-1M	1	0.5	1.4	94.7	5	N	N
	IC	NF4-B	1	0.5	0.5	0.0	5	N	N
	OW	FF2-2	1	0.5	0.5	0.0	5	N	N
	OW	FF2-5	1	0.5	0.5	0.0	5	N	N
	OW	LDG48	1	0.5	0.5	0.0	5	N	N
	OW	MF1-1	1	0.5	0.5	0.0	5	N	N
	OW	MF1-3	1	0.5	1.6	104.8	5	N	N
	OW	MF1-5	1	0.5	0.5	0.0	5	N	N
	OW	MF2-1	1	1.3	1.4	7.4	5	N	N
	OW	MF2-3	1	0.5	0.5	0.0	5	N	N
	OW	MF3-1	1	0.5	0.5	0.0	5	N	N
	OW	MF3-2	1	1.1	0.5	75.0	5	N	N
	OW	MF3-3	1	1.4	0.5	94.7	5	N	N
	OW	MF3-4	1	0.5	1.4	94.7	5	N	N
	OW	MF3-5	1	0.5	1.1	75.0	5	N	N
	OW	MF3-6	1	0.5	0.5	0.0	5	N	N
	OW	MF3-7	1	0.5	0.5	0.0	5	N	N
	OW	NF1	1	-	-	-	-	-	-
	OW	NF2	1	0.5	0.5	0.0	5	N	N
	OW	NF3	1	1.2	0.5	82.4	5	N	N
OW	NF4	1	0.5	0.5	0.0	5	N	N	
OW	NF5	1	0.5	0.5	0.0	5	N	N	

**Table B-2 Summary of Duplicate Sample Results for Nutrient Analytes, 2014**

Analyte	Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Relative Percent Difference (%)	5*DL	>5xDL	QC Fail
<b>Total Nitrogen (µg-N/L)</b>	IC	MF3-1M	20	215	225	4.5	100	Y	N
	IC	NF4-B	20	330	324	1.8	100	Y	N
	OW	FF2-2	20	165	202	20.2	100	Y	N
	OW	FF2-5	20	170	179	5.2	100	Y	N
	OW	LDG48	20	190	164	14.7	100	Y	N
	OW	MF1-1	20	397	330	18.4	100	Y	N
	OW	MF1-3	20	168	182	8.0	100	Y	N
	OW	MF1-5	20	199	136	37.6	100	Y	N
	OW	MF2-1	20	170	154	9.9	100	Y	N
	OW	MF2-3	20	155	159	2.5	100	Y	N
	OW	MF3-1	20	220	163	29.8	100	Y	N
	OW	MF3-2	20	187	165	12.5	100	Y	N
	OW	MF3-3	20	193	176	9.2	100	Y	N
	OW	MF3-4	20	166	168	1.2	100	Y	N
	OW	MF3-5	20	195	155	22.9	100	Y	N
	OW	MF3-6	20	168	218	25.9	100	Y	N
	OW	MF3-7	20	159	198	21.8	100	Y	N
	OW	NF1	20	183	190	3.8	100	Y	N
	OW	NF2	20	221	197	11.5	100	Y	N
	OW	NF3	20	224	222	0.9	100	Y	N
OW	NF4	20	381	253	40.4	100	Y	N	
OW	NF5	20	254	186	30.9	100	Y	N	



**Table B-2 Summary of Duplicate Sample Results for Nutrient Analytes, 2014**

Analyte	Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Relative Percent Difference (%)	5*DL	>5*DL	QC Fail
<b>Total Dissolved Nitrogen (µg-N/L)</b>	IC	MF3-1M	20	170	213	22.5	100	Y	N
	IC	NF4-B	20	322	315	2.2	100	Y	N
	OW	FF2-2	20	203	151	29.4	100	Y	N
	OW	FF2-5	20	195	154	23.5	100	Y	N
	OW	LDG48	20	158	142	10.7	100	Y	N
	OW	MF1-1	20	340	245	32.5	100	Y	N
	OW	MF1-3	20	170	148	13.8	100	Y	N
	OW	MF1-5	20	130	127	2.3	100	Y	N
	OW	MF2-1	20	171	155	9.8	100	Y	N
	OW	MF2-3	20	189	128	38.5	100	Y	N
	OW	MF3-1	20	231	163	34.5	100	Y	N
	OW	MF3-2	20	162	146	10.4	100	Y	N
	OW	MF3-3	20	141	187	28.0	100	Y	N
	OW	MF3-4	20	149	149	0.0	100	Y	N
	OW	MF3-5	20	141	130	8.1	100	Y	N
	OW	MF3-6	20	169	142	17.4	100	Y	N
	OW	MF3-7	20	121	170	33.7	100	Y	N
	OW	NF1	20	173	173	0.0	100	Y	N
	OW	NF2	20	210	171	20.5	100	Y	N
	OW	NF3	20	177	230	26.0	100	Y	N
OW	NF4	20	213	233	9.0	100	Y	N	
OW	NF5	20	219	211	3.7	100	Y	N	

**Table B-2 Summary of Duplicate Sample Results for Nutrient Analytes, 2014**

Analyte	Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Relative Percent Difference (%)	5*DL	>5*DL	QC Fail
Ammonia (µg-N/L)	IC	MF3-1M	5	29.0	31.0	6.7	25	Y	N
	IC	NF4-B	5	170.0	33.0	135.0	25	Y	Y
	OW	FF2-2	5	25.0	53.0	71.8	25	Y	Y
	OW	FF2-5	5	31.0	12.0	88.4	25	Y	Y
	OW	LDG48	5	11.0	11.0	0.0	25	N	N
	OW	MF1-1	5	47.0	20.0	80.6	25	Y	Y
	OW	MF1-3	5	34.0	40.0	16.2	25	Y	N
	OW	MF1-5	5	7.4	8.9	18.4	25	N	N
	OW	MF2-1	5	7.5	13.0	53.7	25	N	N
	OW	MF2-3	5	7.9	11.0	32.8	25	N	N
	OW	MF3-1	5	27.0	21.0	25.0	25	Y	N
	OW	MF3-2	5	32.0	32.0	0.0	25	Y	N
	OW	MF3-3	5	25.0	24.0	4.1	25	N	N
	OW	MF3-4	5	46.0	26.0	55.6	25	Y	Y
	OW	MF3-5	5	13.0	70.0	137.3	25	Y	Y
	OW	MF3-6	5	38.0	46.0	19.0	25	Y	N
	OW	MF3-7	5	39.0	53.0	30.4	25	Y	N
	OW	NF1	5	13.0	21.0	47.1	25	N	N
	OW	NF2	5	16.0	20.0	22.2	25	N	N
	OW	NF3	5	14.0	48.0	109.7	25	Y	Y
OW	NF4	5	12.0	5.8	69.7	25	N	N	
OW	NF5	5	12.0	25.0	70.3	25	N	N	

**Table B-2 Summary of Duplicate Sample Results for Nutrient Analytes, 2014**

Analyte	Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Relative Percent Difference (%)	5*DL	>5*DL	QC Fail
Nitrate+Nitrite (µg-N/L)	IC	MF3-1M	2	22.9	56.0	83.9	10	Y	Y
	IC	NF4-B	2	167.0	168.0	0.6	10	Y	N
	OW	FF2-2	2	1.0	1.0	0.0	10	N	N
	OW	FF2-5	2	1.0	1.0	0.0	10	N	N
	OW	LDG48	2	1.0	1.0	0.0	10	N	N
	OW	MF1-1	2	8.7	9.6	9.8	10	N	N
	OW	MF1-3	2	2.1	1.0	71.0	10	N	N
	OW	MF1-5	2	1.0	2.7	91.9	10	N	N
	OW	MF2-1	2	2.6	4.4	51.4	10	N	N
	OW	MF2-3	2	7.9	1.0	155.1	10	N	N
	OW	MF3-1	2	1.0	1.0	0.0	10	N	N
	OW	MF3-2	2	1.0	1.0	0.0	10	N	N
	OW	MF3-3	2	1.0	1.0	0.0	10	N	N
	OW	MF3-4	2	3.6	1.0	113.0	10	N	N
	OW	MF3-5	2	2.5	1.0	85.7	10	N	N
	OW	MF3-6	2	1.0	1.0	0.0	10	N	N
	OW	MF3-7	2	1.0	1.0	0.0	10	N	N
	OW	NF1	2	16.2	22.1	30.8	10	Y	N
	OW	NF2	2	17.4	18.5	6.1	10	Y	N
	OW	NF3	2	2.5	1.0	85.7	10	N	N
OW	NF4	2	4.2	3.9	7.4	10	N	N	
OW	NF5	2	6.0	5.4	10.5	10	N	N	

Note: **Bolded** terms indicate QC flags for relative percent difference (RPD) values that were greater than 50% and concentrations in both duplicate samples that were greater than five times the corresponding DL.

a) Open-water ammonia data were excluded from data analysis due to high variability and QC issues with the blank samples.

b) One sample (station MF3-6 from the open-water season) was identified as an anomalous value during data screening (Appendix A). This value was removed from the data analysis.

DL = detection limit; > = greater than; x = times; QC = quality control; µg-P/L = micrograms of phosphorus per litre; µg-N/L = micrograms of nitrogen per litre; IC = ice-cover; OW = open-water; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet; N = no; Y = yes; - not applicable or data not available.

### Chlorophyll a Duplicate Samples

None of the 19 chlorophyll a duplicate samples exceeded the 50% QC threshold criterion (Table B-3).

**Table B-3 Summary of Duplicate Sample Results for Chlorophyll a, 2014**

Season	Station	DL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Maximum Result (µg/L)	Relative Percent Difference (%)	>5xDL	QC Fail
OW	NF1	0.2	2.09	2.09	2.09	0.1	Y	N
OW	NF2	0.2	2.11	2.39	2.39	12.3	Y	N
OW	NF3	0.2	1.75	2.32	2.32	27.6	Y	N
OW	NF4	0.2	2.15	1.81	2.15	17.3	Y	N
OW	NF5	0.2	1.88	2.10	2.10	11.0	Y	N
OW	MF1-1	0.2	2.05	2.11	2.11	2.9	Y	N
OW	MF1-3	0.2	2.32	2.31	2.32	0.4	Y	N
OW	MF1-5	0.2	1.56	1.42	1.56	9.6	Y	N
OW	MF2-1	0.2	2.29	2.13	2.29	7.1	Y	N
OW	MF2-3	0.2	2.46	2.29	2.46	6.9	Y	N
OW	MF3-1	0.2	1.64	1.72	1.72	4.9	Y	N
OW	MF3-2	0.2	1.72	1.66	1.72	3.5	Y	N
OW	MF3-3	0.2	1.62	1.57	1.62	3.1	Y	N
OW	MF3-4	0.2	1.51	1.47	1.51	2.5	Y	N
OW	MF3-5	0.2	1.14	1.09	1.14	4.1	Y	N
OW	MF3-6	0.2	0.97	0.83	0.97	15.5	N	N
OW	MF3-7	0.2	0.99	0.96	0.99	3.1	N	N
OW	FF2-2	0.2	1.71	1.69	1.71	1.2	Y	N
OW	FF2-5	0.2	1.99	1.74	1.99	13.8	Y	N

DL = detection limit; > = greater than; x = times; QC = quality control; OW = open-water; NF = near-field; MF = mid-field; FF = far-field; N = no; Y = yes.

### ADDITIONAL QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

The RPD between TN and TDN did not exceed 20% for any stations; however, phosphorus had RPDs greater than 20% in six samples (Tables B-4 and B-5). Half of these samples were below detection, which was likely the reason for the observed differences. The concentration of TDP measured in the sample from Station MF3-6 was flagged as an anomalous value (Appendix A Figure A-1).

**Table B-4 Summary of Relative Percent Difference Between Total and Dissolved Nitrogen, 2014**

Season	Station	DL	Total Nitrogen (µg-N/L)	Dissolved Nitrogen (µg-N/L)	Maximum Result (µg-N/L)	Relative Percent Difference (%)	QC Fail
IC	FF2-2B	20	180	192	192	6.5	N
IC	FF2-5B	20	170	199	199	15.7	N
IC	FF2-5M	20	190	193	193	1.6	N
IC	LDG-48	20	151	154	154	2.0	N
IC	MF1-1B	20	294	310	310	5.3	N
IC	MF1-1M	20	186	192	192	3.2	N
IC	MF1-3T	20	154	177	177	13.9	N
IC	MF2-1B	20	299	302	302	1.0	N
IC	MF2-1M	20	203	204	204	0.5	N
IC	MF2-3T	20	170	179	179	5.2	N
IC	MF3-3B	20	154	167	167	8.1	N
IC	MF3-3T	20	138	152	152	9.7	N
IC	MF3-4T	20	140	144	144	2.8	N
IC	MF3-5B	20	185	189	189	2.1	N
IC	MF3-5M	20	140	168	168	18.2	N
IC	MF3-6B	20	176	180	180	2.2	N
IC	MF3-7M	20	138	150	150	8.3	N
IC	NF1T	20	209	214	214	2.4	N
IC	NF2B	20	417	437	437	4.7	N
IC	NF2M	20	350	385	385	9.5	N
IC	NF4M	20	242	250	250	3.3	N
IC	NF4T	20	192	193	193	0.5	N
IC	NF5M	20	268	272	272	1.5	N
OW	MF2-1	20	162	163	163	0.6	N
OW	MF2-3	20	157	159	159	1.0	N
OW	MF3-1	20	192	197	197	2.8	N

Notes: Only cases where the total dissolved nitrogen was greater than the total nitrogen are presented in this table.

DL = detection limit; µg-N/L = micrograms of nitrogen per litre; > = greater than; x = times; QC = quality control; OW = open-water; IC = ice-cover; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet; N = no.

**Table B-5 Summary of Relative Percent Difference Between Total and Dissolved Phosphorus, 2014**

Season	Station	DL	Total Phosphorus (µg-P/L)	Dissolved Phosphorus (µg-P/L)	Maximum Result (µg-P/L)	Relative Percent Difference (%)	QC Fail
IC	FF2-2M	2	1.0	2.9	2.9	97.4	<b>Y</b>
IC	LDG-48	2	1.0	2.4	2.4	82.4	<b>Y</b>
IC	MF3-4B	2	1.0	2.9	2.9	97.4	<b>Y</b>
OW	MF2-3	2	4.9	5.2	5.2	5.9	N
OW	MF3-2	2	2.0	2.8	2.8	33.3	<b>Y</b>
OW	MF3-6	2	2.6	114.0	114.0	191.1	<b>Y</b>
OW	NF5-4	2	2.2	3.0	3.0	30.8	<b>Y</b>

Notes: Only cases where the total dissolved phosphorus was greater than the total phosphorus are presented in this table. **Bolded** terms indicate QC flags for relative percent difference values that were greater than 20% and both concentrations were greater than five times the corresponding DL.

DL = detection limit; µg-P/L = micrograms of phosphorus per litre; QC = quality control; OW = open-water; IC = ice-cover; NF = near-field; MF = mid-field; FF = far-field; LDG-48 = Lac de Gras outlet; N = no; Y = yes.

**APPENDIX C**

**2014 AEMP SAMPLING SCHEDULE**

**Table C-1 2014 AEMP Sampling Schedule**

Sites	Ice-cover										Open-water																	
	April										August											September						
	21	22	23	24	25	26	27	28	29	30	18	19	20	21	22	23	24	25	26	27	28	29	30	31	01	02	03	
NF1						An							Anp															
NF2						An								Anp														
NF3					An										Anp													
NF4		An												Anp														
NF5				An										Anp														
MF1-1										An							An											
MF1-3										An									An									
MF1-5										An															An			
MF2-1								An													An							
MF2-3								An																An				
FF2-2								An							An													
FF2-5								An							An													
MF3-1								An										An										
MF3-2								An													An							
MF3-3								An															An					
MF3-4								An											An									
MF3-5								An															An					
MF3-6								An											An									
MF3-7								An															An					
LDG-48				Mn																					Mn			

Notes: M = water quality mid-depth sample only, A = water quality surface, mid-depth and bottom samples collected, n = nutrients, p = plankton sample collected.  
QAQC Samples color coded = Grab Water (GW), Equipment Blank (EBW), Field Blank (FBW), Trip Blank (TBW), Duplicate 1/Duplicate 2 (DUP1/DUP2).



## **APPENDIX D**

### **EUTROPHICATION INDICATORS RAW DATA**

These data are provided electronically as an Excel file.

**APPENDIX E**

**LETTER FROM HYDROQUAL LABORATORIES**

Diavik Diamond Mines (2012) Inc.  
P.O. Box 2498  
300, 5102 – 50<sup>th</sup> Avenue  
Yellowknife, NT X1A 2P8  
Canada  
T (867) 669 6500  
F (867) 669 9058

Violet Camsell-Blondin, Chair  
Wek'eezhii Land and Water Board  
#1, 4905 – 48<sup>th</sup> Street  
Yellowknife, NT X1A 3S3  
Canada

22 January 2015

Dear Ms. Camsell-Blondin:

**Subject: 2014 Zooplankton Biomass Analysis**

As part of the Open Water AEMP, zooplankton samples are collected for the analysis of total biomass. In 2014, 38 samples were collected and submitted to our analytical laboratory. The analytical laboratory notified Diavik on December 11, 2014 that the samples were accidentally disposed of prior to analysis. A letter explaining this incident is attached.

The lack of zooplankton biomass data for the 2014 AEMP will not impact our ability to detect effects for the following reasons:

1. There are no action levels related to zooplankton biomass. In Lac de Gras, the primary response to the discharge of nutrients from Diavik has been the increase in the amount of chlorophyll *a* and aerial expansion of this increase. Therefore, the Action Levels related to indicators of eutrophication are for chlorophyll *a* only.
2. The 2014 AEMP was conducted under the interim sampling program, versus the comprehensive sampling program which occurs every 3 years. In 2014, zooplankton biomass samples were collected at the NF and FF2 exposure stations, but not at the reference area stations. As such, the 2014 samples were not required for the purposes of defining the normal range.
3. Temporal trends (i.e., changes over time) and weight of evidence rankings are evaluated every three years. The next three-year summary is scheduled for October 2017. In the 2017 three-year summary, the temporal trends and weight of evidence rankings will be evaluated using zooplankton biomass data collected from 2009 to 2016, with a one year gap in 2014 due to the lack of zooplankton biomass information for that given year. Therefore, while we will not be able to evaluate the annual extend of effects on zooplankton in 2014 due to the missing data, we will still be able to determine the longer-term temporal trends and there will be no impact to the interpretation conducted in the three-year AEMP summary report.

Diavik is exploring options to avoid this issue reoccurring in the future.

If you have any questions or concerns regarding the above, please contact the undersigned.

Yours sincerely



David Wells  
Superintendent - Environment  
Encl.: Hydroqual Laboratories 17-December-2014 Letter



#4, 6125 12<sup>th</sup> Street SE Calgary, Alberta Canada T2H 2K1  
Tel (403) 253-7121 Fax (403) 252-9363 www.hydroqual.ca

## Transmittal

---

**Date:** 2014/12/17

**From:** Holly Stewart, B. Sc.  
Technical Lead

Tamara McClure, B. Sc.  
Quality Assurance Manager

**To:** Kristin Moore  
Environmental Supervisor  
Diavik Diamond Mines Inc.

---

Re: Zooplankton Analysis

On September 5, 2014, 38 zooplankton samples were collected by Diavik Diamond Mines Inc. (Diavik) and were shipped via Canadian North to HydroQual Laboratories Inc. (HydroQual). HydroQual received the samples, in good condition, on September 8, 2014. Upon receipt to the lab, the 38 samples were logged into HydroQual's sample log, and assigned a unique reference number (14-1329) which was written on the chain of custody. The reference number from the 2013 zooplankton samples (13-1992) was also written on the chain of custody so the reports could be cross-referenced if needed. A screenshot of the sample log, and the chain of custody that was included with the samples are attached below. The cooler containing the samples was placed into a sample storage chamber until the samples were ready to be analyzed.

On December 3, 2014, when the samples were going to be analyzed, it was noted that the cooler containing the samples was empty. It was suspected that the samples had been accidentally disposed of during routine sample disposal procedures due to a technical error. HydroQual staff immediately searched the waste disposal bin and all of the chambers and fridges in the facility; however, the samples could not be recovered. Diavik was notified on December 11, 2014 about the issues with the zooplankton samples; however, due to the nature of these samples and the time of year (winter), they were unable to re-sample the sites for zooplankton analysis.

HydroQual is currently reviewing its sample disposal procedure and measures have been implemented to reduce the likelihood of this occurring again in the future.

If you have any questions or require any additional details, please do not hesitate to contact us.

Sincerely,

A handwritten signature in black ink that reads "Holly Stewart".

Holly Stewart

A handwritten signature in black ink that reads "Tamara McClure".

Tamara McClure

---

The document(s) included in this transmission are intended only for the recipient(s) named above and contain privileged and confidential information. Any unauthorized disclosure, dissemination or copying of this transmission is strictly prohibited. If you have received this transmission in error, please immediately notify us by telephone and destroy the transmission. Thank you.

---

Diavik Diamond Mines Inc.  
P.O. Box 2498  
5007 - 50<sup>th</sup> Avenue  
Yellowknife, NT X1A 2P8  
Canada  
T (867) 669 6500  
F (867) 669 9058

in  
CH 11  
green  
cooler.

13-1992  
14-1329

**Private and confidential**

Charles Ehman  
HydroQual Laboratories  
#3, 6125 - 12<sup>th</sup> Street SE  
Calgary, AB  
T2H 2K1  
Canada

Sept 4<sup>th</sup>, 2014

Dear Charles Ehman,

**Zooplankton Biomass Analysis – Diavik Diamond Mine**

Enclosed please find zooplankton biomass samples for analysis. Each station listed below will have 2 bottles for analysis – A & B. Please ensure that the entire sample volume is analyzed.

Please reference PO# **K25336** for all invoicing pertaining to the above analysis.

Please do not hesitate to contact Darcy Bourassa or Kristin Moore at 867.766.5403 should you have any questions.

Yours sincerely,



Supervisor, Environment

Encl

2014/09/10  
HS 1420.  
14.6°C  
S11-NO.  
Canadian North  
38 bottles.

Sample Location	Sampled By	Date
NF1	KM,JG,CU	2014-Aug-20
NF2	KG,FN	2014-Aug-21
NF3	KG,FN	2014-Aug-22
NF4	JG,CU	2014-Aug-21
NF5	JG,CU	2014-Aug-21
MF1-1	KG,CU,FN	2014-Aug-24
MF1-3	FN,KG,SS,CU	2014-Aug-26
MF1-5	FN,DD	2014-Sept-01
MF2-1	KG,FN	2014-Aug-28
MF2-3	VM,DD,KG,FN	2014-Aug-31
MF3-1	DW,CU,FN	2014-Aug-25
MF3-2	FN,KG	2014-Aug-28
MF3-3	VM,DD,KG,FN	2014-Aug-29
MF3-4	CU,SS	2014-Aug-26
MF3-5	DD,VM	2014-Aug-29
MF3-6	FN,KG	2014-Aug-26
MF3-7	KG,FN	2014-Aug-29
FF2-2	JG,CU	2014-Aug-22
FF2-5	JG,CU	2014-Aug-22

**Total number of bottles: 38.**

518 YZF 69814090

Shipper's name and address Nom et adresse de l'expéditeur	Shipper's Account Number N° de compte de l'expéditeur	<b>NOT NEGOTIABLE</b> <b>AIR WAYBILL (AIR CONSIGNMENT NOTE)</b>
DIAMIK DIAMOND MINES 600-4920 52ND ST YELLOWKNIFE NT CANADA X1A 3T1		<b>NON NEGOCIABLE</b> <b>LETTRÉ DE TRANSPORT AERIEN</b>
		ISSUED BY EMISE PAR
		CANADIAN NORTH 5601 30 AVE. YELLOWKNIFE

Consignee's name and address Nom et adresse du destinataire	Consignee's account number N° de compte du destinataire	It is agreed that the goods described herein are accepted in apparent good order and condition (except as noted) for carriage SUBJECT TO THE CONDITIONS OF CONTRACT ON THE REVERSE HEREOF. ALL GOODS MAY BE CARRIED BY ANY OTHER MEANS INCLUDING ROAD OR ANY OTHER CARRIER UNLESS SPECIFIC CONTRARY INSTRUCTIONS ARE GIVEN HEREON BY THE SHIPPER, AND SHIPPER AGREES THAT THE SHIPMENT MAY BE CARRIED VIA INTERMEDIATE STOPPING PLACES WHICH THE CARRIER DEEMS APPROPRIATE. THE SHIPPER'S ATTENTION IS DRAWN TO THE NOTICE CONCERNING CARRIER'S LIMITATION OF LIABILITY. Shipper may increase such limitation of liability by declaring a higher value for carriage and paying supplemental charge if required.  Il est entendu que les marchandises décrites dans la présente lettre de transport aérien sont acceptées pour le transport apparemment en bon état (sauf tel que noté) et sous réserve des conditions du contrat indiquées au verso de la présente lettre de transport aérien. Toutes les marchandises peuvent être transportées par n'importe quel autre mode, notamment par la route, ou par n'importe quel autre transporteur, sauf si des instructions contraires sont données par l'expéditeur, et si ce dernier accepte que l'envoi soit acheminé par des escales intermédiaires que le transporteur jugera appropriées. On attire l'attention de l'expéditeur sur l'avis à propos de la limite de responsabilité du transporteur. L'expéditeur peut augmenter cette limite de responsabilité en déclarant une valeur supérieure pour le transport et en payant un supplément, le cas échéant.
*CASH* *ONLY* 545952	B	
HYDROQUAL LABORATORIES 5125 12TH ST SE BAY 3 CALGARY AB CANADA T2H 2K1		

Issuing carrier's agent, name and city Nom et ville de l'agent du transporteur émetteur	Accounting Information Renseignements comptables
	111 8/Sept 14

Agent's IATA code Code IATA de l'agent	Account no. N° de compte	Airport of departure address of first carrier and requested routing Aéroport de départ (adresse du 1 <sup>er</sup> transporteur) et itinéraire demandé
		YELLOWKNIFE
To - A	Routing and destination - Itinéraire et destination	To - A
YEG	BT	YYC AC
By first carrier - Par 1 <sup>er</sup> transporteur		By Car
		BY AIR
Airport of destination Aéroport de destination	Flight Date Date de vol	Flight Date Date de vol
CALGARY	08/14/05	08/14/05

Amount of insurance Montant de l'assurance	INSURANCE - If Carrier offers insurance, and such insurance is requested in accordance with conditions on reverse hereof, indicate amount to be insured in figures in box marked "amount of insurance". ASSURANCE - Si le transporteur offre une assurance que l'expéditeur veut contracter conformément aux conditions décrites au verso, indiquer le montant à assurer, en chiffres, dans la case ci-contre.
X X X	
Handling information Précisions sur le traitement de l'expédition	
SPX CR1-003-233-7121 SR-A-0832 05SEP:ADAM NEMICH	

No. of Pieces Nombre de colis PCP	Gross weight Poids brut	kg lb	Rate Class - Classif. du tarif Commodity item no. Référence de l'article	Chargeable weight Poids de taxation	Rate / Charge Tarif / Montant	Total *	Nature and quantity of goods (incl. dimensions or volume) Nature et quantité des marchandises (avec dimensions ou volume)
1	23.0K		UNAF	25.0	57.20	57.20	WATER SAMPLES NON HAZ 024*13*14IN*10
1	23.0K					57.20	

AIR CANADA CARGO NYC  
 AGENT ID# \_\_\_\_\_  
 WH ID# \_\_\_\_\_  
 AGENT ID# \_\_\_\_\_  
 OK TO RELEASE

Prepaid - Port payé	Weight Charge - Taxation au poids	Collect - Port dû	Other Charges - Autres frais
57.20			1-BULK/F
Valuation charge - Taxation à la valeur			
Tax - Taxe			
Total other Charges Due Agent - Total des autres frais dus à l'agent			
Shipper certifies that the particulars on the face hereof are correct and that insofar as any part of the consignment contains dangerous goods, such part is properly described by name and is in proper condition for carriage by air according to the applicable Dangerous Goods Regulations.			
Total other Charges Due Carrier - Total des autres frais dus au transporteur			
L'expéditeur certifie que les indications portées sur le présent document sont exactes et que, dans la mesure où une partie quelconque de l'expédition contient des marchandises dangereuses, cette partie d'expédition est correctement désignée et bien préparée pour le transport aérien, conformément à la Réglementation pour le transport des marchandises dangereuses applicable.			
Total prepaid - Total port payé		Total collect - Total port dû	
70.34			
Currency Conversion Rates Taux de conversion monnaie	cc charges in Dest. Currency Port dû en monnaie du pays de destination	05SEP14 YELLOWKNIFE	
1.000000CAD		Executed on - Établie le	
		(Date)	
		At - A	
		(Place)	
		Signature of Issuing Carrier or its Agent	
		Signature du transporteur émetteur ou de son agent	
For Carrier Use only Réservé au transporteur à destination	Charges at Destination - Frais à destination	Total collect Charges - Total dû	
		MATCHED:05SEP14 518-89414090	
		05SEP14 14:07:10	

IMPRIMÉ AU CANADA  
PRINTED IN CANADA  
ACF284T (2011-01)

Reference #	Course	Waybill #	Pieces/Containers (all samples)	Temp	Time Sample Received	Date Sample Received	Date Sample Signed-In	Initial of Who Received/Signed-In Sample	Date Sample Collected	Test Abbr.	Client #	Client	Description (sample ID)	
0	14-1329-1	Canadian North	na	1 x cooler/38 x bottles	15	1420	2014/09/08	2014/09/09	AH	various dates	AFDW	DIA102	Diavik Diamond Mines	NF1A
1	14-1329-2										AFDW			NF1B
2	14-1329-3										AFDW			NF2A
3	14-1329-4										AFDW			NF2B
4	14-1329-5										AFDW			NF3A
5	14-1329-6										AFDW			NF3B
6	14-1329-7										AFDW			NF4A
7	14-1329-8										AFDW			NF4B
8	14-1329-9										AFDW			NF5A
9	14-1329-10										AFDW			NF5B
0	14-1329-11										AFDW			MF1-1A
1	14-1329-12										AFDW			MF1-1B
2	14-1329-13										AFDW			MF1-3A
3	14-1329-14										AFDW			MF1-3B
4	14-1329-15										AFDW			MF1-5A
5	14-1329-16										AFDW			MF1-5B
6	14-1329-17										AFDW			MF2-1A
7	14-1329-18										AFDW			MF2-1B
8	14-1329-19										AFDW			MF2-3A
9	14-1329-20										AFDW			MF2-3B
0	14-1329-21										AFDW			MF3-1A
1	14-1329-22										AFDW			MF3-1B
2	14-1329-23										AFDW			MF3-2A
3	14-1329-24										AFDW			MF3-2B
4	14-1329-25										AFDW			MF3-3A
5	14-1329-26										AFDW			MF3-3B
6	14-1329-27										AFDW			MF3-4A
7	14-1329-28										AFDW			MF3-4B
8	14-1329-29										AFDW			MF3-5A
9	14-1329-30										AFDW			MF3-5B
0	14-1329-31										AFDW			MF3-6A
1	14-1329-32										AFDW			MF3-6B
2	14-1329-33										AFDW			MF3-7A
3	14-1329-34										AFDW			MF3-7B
4	14-1329-35										AFDW			FF2-2A
5	14-1329-36										AFDW			FF2-2B
6	14-1329-37										AFDW			FF2-5A
7	14-1329-38										AFDW			FF2-5B



## **APPENDIX XIV**

### **TRADITIONAL KNOWLEDGE STUDIES**

No information was available for this appendix in 2014.

## **APPENDIX XV**

### **WEIGHT-OF-EVIDENCE REPORT**

No information was available for this appendix in 2014.