April 9, 2015

To : Distribution List

Re: Ekati Diamond Mine 2014 Air Quality Monitoring Program Report

Dominion Diamond Ekati Corporation (DDEC) is pleased to provide the *2014 Air Quality Monitoring Program* report. This is a 3-year report that provides the results of air quality around the Ekati Diamond Mine from 2012 to 2014.

A summary of the 3 year report highlights are below:

- High Volume Air Samplers were replaced with programmable Partisol samplers that use an external certified laboratory to perform filter weighting;
- Improved data collection from the Continuous Air Monitoring Building due to improved maintenance and the correction of the TSP and PM2.5 data using the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality*;
- Dustfall was higher over the 3 year period on the Misery Haul Road related to increased traffic for the Misery Pushback;
- In all years, dustfall at 300 m downwind of the road decreased below the BC Pollution Objective goal of 2.9 mg/dm$_2$/d, except for the August/September 2013 measurement at Fox Haul Road. At 1,000 m downwind of the road, all dustfall concentrations were at background levels;
- The use of DL-10 and water on roads to mitigate dust release was shown to be effective;
- Spatial analysis of 2014 snow chemistry data suggests that winter loading of Total Suspended Solids and a number of metals likely associated with fugitive dust and fine particulates are elevated in an area directly surrounding the mine footprint and concentrations generally decrease with distance from mining activity;
- Most elemental concentrations, even for impacted areas near the Ekati mine site, are below established background concentrations observed (1998-2011) at the CAPMoN station Snare Rapids; and
- Elemental concentrations in the two indicator lichens collected in the study area show that mine influence of dust is confined to a relatively small area within 10 to 30 km from the mine, and tends to decline with distance from the mine site.

In line with previous reports, the 2014 Air Quality Monitoring Program report shows that the mine has small effects on air quality close to the mine site. The distance of these effects from the mine site are less than approximately 1 kilometre (km) for fugitive dust particles

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from roads and less than approximately 15 km for smaller particles for other sources. This is in line with the 1995 and 2005 predictions. Effects close to the mine site are less than the relevant guidelines or reference values.

DDEC is requesting that you review the attached report and provide comments by June 1, 2015. DDEC will commit to providing responses back to the distribution list on June 22, 2015. At that time, DDEC will be open to scheduling a technical meeting to review the 2014 Air Quality Monitoring Report, comments and responses and discuss the update to the Air Quality Monitoring and Management Plan, which will be designed out of this review process.

DDEC trusts that you will find the report to be clear and informative. Please contact the undersigned at Claudine.Lee@ekati.ddcorp.ca or 867-669-6116 or Laura Malone – Advisor Operations at Laura.Malone@ekati.ddcorp.ca or 867-880-2062 should you have any questions

Yours sincerely,

Dominion Diamond Ekati Corporation

Claudine Lee, M.Sc., P.Geol
Superintendent - Environment

Attached: 2014 Air Quality Monitoring Report

Distribution List:

Bill Ross – Independent Environmental Monitoring Agency
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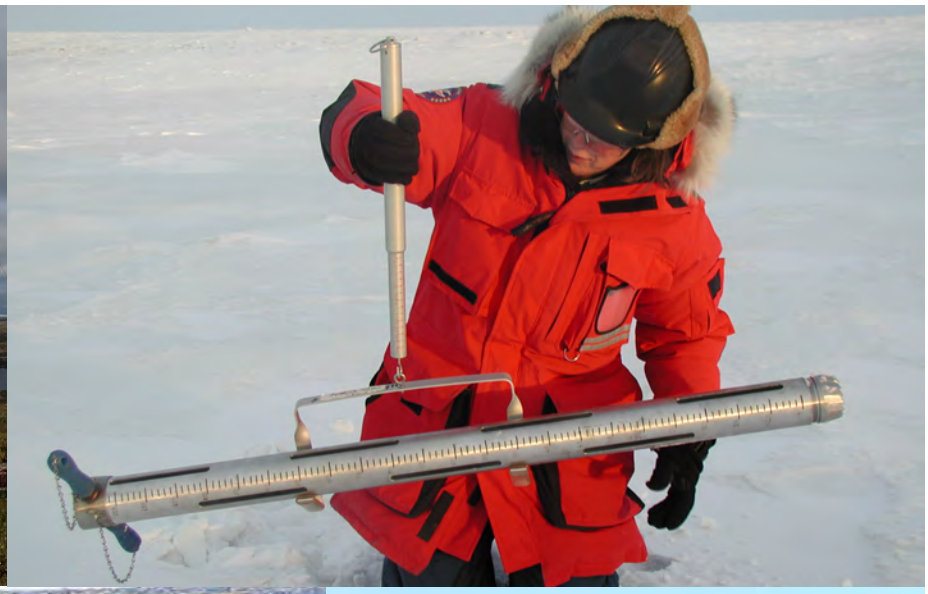
Ekati Diamond Mine

2014 Air Quality Monitoring Program



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Dominion Diamond Ekati Corporation

EKATI DIAMOND MINE
2014 Air Quality Monitoring Program

April 2015

Project #0211136-0025

Citation:
ERM. 2015. *Ekati Diamond Mine: 2014 Air Quality Monitoring Program*. Prepared for Dominion Diamond Ekati Corporation by ERM Consultants Canada Ltd.: Yellowknife, Northwest Territories.

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EXECUTIVE SUMMARY

The Air Quality Monitoring Program (AQMP) at the Ekati Diamond Mine is a requirement under Section VII of the Environmental Agreement to which the original signatories were BHP Billiton Canada Inc. (BHP Billiton), the Government of Canada and the Government of the Northwest Territories. In accordance with that agreement and commitments made in the 1995 Environmental Impact Statement, BHP Billiton initiated an AQMP in 1998 to support the management of air quality throughout the life of the Ekati mine's mining operations. As the new mine operator, Dominion Diamond Ekati Corporation (DDEC) have continued the AQMP program. On April 1, 2014, devolution provided the Government of the Northwest Territories with responsibilities for managing public land, water and resources in the Northwest Territories.

Summary results of the AQMP are reported each year in the Annual Environmental Agreement and Water License Report. Every three years in concert with an extended sampling program, a separate AQMP report is prepared that presents and interprets AQMP results in more detail and evaluates long-term trends. The following report provides and assesses results for the period from 2012 to 2014 in comparison to previous years. The AQMP consists of six components:

1. Meteorological monitoring;
2. Air emissions and greenhouse gas (GHG) calculations;
3. Ambient air quality monitoring including,
   - high volume air sampling (HVAS) and Partisol sampling, and
   - continuous air monitoring (CAM);
4. Dustfall monitoring;
5. Snow chemistry monitoring; and
6. Lichen tissue monitoring.

Emissions calculations and HVAS measurements were conducted annually since the start of the program in 1997, while snow and lichen sampling were conducted every three years. Dustfall monitoring was initiated at the Ekati mine in 2006 in response to a program wide review conducted by BHP Billiton, external consultants and government stakeholders. In 2012, dustfall was temporarily monitored close to the Fox pit waste rock piles, and in 2014, additional dustfall stations were installed beside the Misery Haul Road. CAM has been performed continuously since the beginning of 2008. In 2013, Partisol samplers measuring TSP were installed as an upgrade to replace the HVAS units, and one additional Partisol sampler measuring $PM_{2.5}$ was installed at the CAM building.

A total of 200 kilotonnes of greenhouse gas emissions were calculated to be released as CO_2 equivalencies (CO_2e) in 2014. The average annual GHG emissions from 2012 to 2014 were 190 kilotonnes of CO_2e. This is 20% more than that estimated on average during the previous 2009 to 2011 AQMP (158 kilotonnes of CO_2e) reporting period, as a result of an increase in fuel usage. Fuel

usage increased due to the amount of on-site activity during 2012 to 2014, specifically motive diesel use due to hauling along the Misery Haul Road and other construction activities.

Of the 364 total suspended particulate (TSP) measurements made during the 2012 to 2014 monitoring period from the two HVAS stations and two Partisol stations, three measurements exceeded the 24 hour Government of the Northwest Territories (GNWT) standard of 120 µg/m^3. However, two of these exceedances occurred on days when smoke from distant wildfires was present at the mine site. The other exceedance occurred on a very windy day. All other values were generally below the GNWT standard. A comparison of TSP concentrations observed between 1994 and 2014 indicates a decreasing trend.

The CAM results from 2012 to 2014 indicate that mean monthly NO_2, NO, NO_X and SO_2 have a slight decreasing trend, and that concentrations are higher in the winter compared to the summer in response to seasonal fuel usage for heating. All NO_2 and SO_2 hourly, daily and annual average values were below the GNWT standards. The CAM $PM_{2.5}$ and TSP results indicated that concentrations for both particulates have increased over the 3 year period; however, this apparent increase was due to numerous days with wildfire smoke present at the mine site in 2014. As directed by the GNWT, particulate results were ignored on days when wildfire smoke was present, when comparing the results to the relevant standards. From the resulting filtered dataset, there were no daily or annual $PM_{2.5}$ exceedances. There were six days with daily TSP exceedances when there was no wildfire smoke present. These exceedances were 2%, 15%, 19%, 22%, 50% and 134% greater than the GNWT standard of 120 µg/m^3. The annual mean TSP concentrations for each year were below the GNWT standard.

Dustfall sampling was conducted at 17 regular monitoring locations each year, 15 of which were close to mining operations and 2 were used as control sites. Results indicated that dustfall was greater close to the haul roads in comparison to at a distance, and decreased exponentially with distance from the road. Dustfall samples collected over 1 km away from site activity were found to be close to background reference values. Acid deposition was calculated from nitrate and sulphate concentrations. Non-background samples had an annual median value ranging from 68 to 173 eq/ha/yr. This is below the Canadian standards for acid deposition, which range from 519 to 2,063 eq/ha/yr for different provinces' median values. Metal deposition was also analyzed, with all observed concentrations less than 0.5 mg/dm^2/d.

A total of 33 snow samples were collected for chemical analysis in 2014. Spatial analysis of the data suggests that winter loading of TSS and a number of metals likely associated with fugitive dust and fine particulates are elevated in a zone directly surrounding the mine footprint and concentrations generally decrease with distance from mining activity. Variables associated with gaseous emissions, blasting and long range transport (e.g., ammonia, nitrate, and sulphate) do not show strong trends with distance from mining activity. The 2014 results were generally lower when compared to 2005 observations, but slightly higher than observations in 2008 and 2011. Most elemental concentrations, even for impacted areas near the Ekati mine site, are below established background concentrations. The exceptions are for the sampling locations in close proximity to mining activities and occasional outliers, and even those concentrations are below those typically associated with industrial developments.

A total of 39 lichen plots were sampled, many of which coincided with snow core or dustfall sampling sites to allow for comparisons. Statistical and spatial analysis of lichen tissue data indicate results are generally consistent with snow chemistry data. Elemental concentrations in the two lichens collected in the study area indicate that the influence of dust from the mine is confined to a relatively small area, and tends to decline with distance from the mine site. The lichen tissue concentrations of most dust-borne metals and crustal elements have either decreased or fluctuated when compared over time (2005, 2008, 2011 and 2014) with the exception of barium, mercury and sulphur. However, all 2014 concentrations are low (compared to literature) and most elements are below Arctic background levels at 30 km from the mine.

The 2006 CALPUFF air dispersion model result trends compared well with observed field data (i.e., snow core chemistry, HVAS, lichen, and dustfall). The modeled sulphate deposition contributions from the Ekati mine site, Misery, and Diavik are of the same magnitude as background levels beyond 3 to 5 km from the active mining areas.

Results from the 2012 to 2014 AQMP suggest that management measures implemented at the Ekati mine are currently effective at mitigating the effects of the mine on air quality.

ACKNOWLEDGEMENTS

This report was prepared for Dominion Diamond Ekati Corp. by ERM Consultants Canada Ltd. From 2012 to 2014, the Air Quality Monitoring Program was facilitated by the Ekati mine site environmental personnel Claudine Lee, Andrew Howton and Charlie Campbell. The field monitoring of dust, snow sampling and meteorological instrumentation maintenance was completed by the Ekati mine site Environmental personnel. The Continuous Air Monitoring building was maintained and calibrated by Maxxam Analytics Ltd. with support from the Ekati Diamond Mine. Lichen sampling was done by Katherine Enns (M.Sc., Delphinium Holdings Inc.) with ERM assistants Kiri Heal (M.Sc.) and Amy Elliot (Ph.D.). Data analysis was performed by Daniel Casanova (B.Sc.) and reviewed by Imran Shah (M.Sc., EIT). This report was written by Daniel Casanova with assistance from Joel Crawford (B.A., ADP). Delphinium and their staff are acknowledged specifically for their lichen assessment (Appendix 13, Enns 2015) and related contributions to the main text (Sections 2.7 and 3.7). This report was reviewed by Derek Shaw (M.A.Sc., P.Eng.) and Tonia Robb (Ph.D). The Project was managed by Tonia Robb and Marc Wen (M.Sc., R.P. Bio) of ERM.

Table of Contents

List of Figures

List of Tables

List of Plates

List of Appendices

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.

AEMP	Aquatic Effects Monitoring Program
Al	Aluminum
ALS	ALS Environmental Laboratory
ANFO	Ammonium Nitrate/Fuel Oil Mixture
AQ	Air Quality
AQMP	Air Quality Monitoring Program
Ba	Barium
BC MOE	British Columbia Ministry of Environment
BHP Billiton	BHP Billiton Canada Inc.
Ca	Calcium
CAM	Continuous Air Monitoring
CAPMoN	Canadian Air and Precipitation Monitoring Network
Cd	Cadmium
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Cr	Chromium
Cu	Copper
DDEC	Dominion Diamond Ekati Corporation
EC	Environment Canada
EC EPD	Environment Canada Environment Protection Division
Ekati	Ekati Diamond Mine
ENR	Environment and Natural Resources
EPS	Environmental Protection Services
eq	Equivalent (a unit of measurement, defined as the amount of a substance which will react with or supply one mole of hydrogen ions in an acid-base reaction)
eq/ha/yr	Equivalent per hectare per year

Fe	Iron
GHG	Greenhouse Gases
GNWT	Government of the Northwest Territories
Hg	Mercury
HVAS	High Volume Air Sampling (Tisch model TE-5170)
IEMA	Independent Environmental Monitoring Agency
K	Potassium
$ktCO_2e$	kilotonnes of carbon dioxide equivalent
LLCF	Long Lake Containment Facility
LRT	Long Range Transport
Maxxam	Maxxam Analytics Ltd.
Mg	Magnesium
$mg/dm^2/d$	Milligrams per square decimetre per day
$mg/m^2/d$	Milligrams per square metre per day
N	Nitrogen
N_2O	Nitrous Oxide
Na	Sodium
NE	Number of Exceedances
Ni	Nickel
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NPRI	National Pollutant Release Inventory
NWT	Northwest Territories
O_3	Ozone
OT	Operational Time
PAI	Potential Acid Input
Pb	Lead
Partisol	Thermo Scientific Partisol 2000i sampler for measuring particulate
PM_{10}	Particulate matter that is less than or equal to 10 micrometres in size
$PM_{2.5}$	Particulate matter that is less than or equal to 2.5 micrometres in size

ppb	Parts per billion
S	Sulphur
SO_2	Sulphur Dioxide
SWE	Snow-water-equivalent
tCO_2e	Tonnes of carbon dioxide equivalent
TSP	Total Suspended Particulate
TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency
V	Vanadium
VOC	Volatile Organic Compounds
Zn	Zinc

1. INTRODUCTION

Ambient air quality is a valued ecosystem component at the Ekati mine because of its potential for effects on worker health and safety, and its importance for wildlife, vegetation and water quality (BHP Diamonds Inc and DIA MET Minerals Ltd 1995). Air quality also has aesthetic qualities in terms of visibility and odour. Local air quality can be affected by regional and global influences such as long range transport, arctic haze and acidic deposition (acid rain), forest fires and climate effects (climate change). These large scale atmospheric effects have been understood to collect and concentrate contaminants in the Arctic where they can be deposited as particulate (Cheng et al. 1993).

As a part of the 1995 Environmental Impact Statement (BHP Diamonds Inc and DIA MET Minerals Ltd 1995) for the proposed Ekati Diamond Mine and in the Environmental Agreement (GNWT 1997) BHP Billiton committed to:

- adaptively manage ambient air quality through the implementation of an air quality monitoring plan approved by the Governments of Canada and the Northwest Territories; and
- refine the air dispersion modeling when upper air data became available.

The Air Quality Monitoring Program (AQMP) was initiated in 1998 and is ongoing. The purpose of the program is to monitor ambient air quality and to assess the effectiveness of air quality management plans in maintaining air quality throughout the life of the Ekati mine's mining operations. The results of the AQMP are benchmarked by comparing to:

- applicable ambient air quality guidelines;
- historical and reference air quality data generated at the Ekati mine;
- baseline air quality parameters referenced in the literature; and
- air dispersion modeling predictions.

BHP Billiton continued to meet its commitments through the AQMP. Beginning April 2013, the Dominion Diamond Ekati Corporation (DDEC) took over the operations of the mine and the environmental commitments made by BHP Billiton.

Previous AQMP reports summarized data collected from 1998 to 2001 (ABR Environmental Research Services Inc. 2002; MDA Consulting Ltd. 2002), 2003 to 2005 (Rescan 2006), 2006 to 2008 (Rescan 2011) and 2009 to 2011 (Rescan 2012). The objective of this report is to present and interpret results of air quality monitoring data collected from 2012 to 2014 as part of the AQMP.

Components of the AQMP that are summarized in this report include:

1. Meteorological monitoring;
2. Air emissions and greenhouse gas (GHG) calculations;

3. Ambient air quality monitoring including:
   - high volume air sampling (HVAS) and Partisol sampling, and
   - continuous air monitoring (CAM);
4. Dustfall monitoring;
5. Snow chemistry monitoring; and
6. Lichen tissue monitoring.

Emissions calculations and HVAS measurements were conducted each year since the commencement of the program in 1998; however, there were no HVAS measurements in 2006 while the AQMP was undergoing review and redesign. In June 2012, Thermo Scientific Partisol samplers were installed and operated beside HVAS samplers prior to replacing HVAS units which were decommissioned in June 2013.

Snow and lichen (starting in 2005) sampling are generally conducted every three years (1998, 2001, 2005, 2008, 2011 and 2014). The dustfall monitoring program was initiated in 2006 and has occurred during the summer months of each year since then. The CAM building was originally installed in April 2007 adjacent to the Grizzly Lake pumping station. However, following consultation with regulatory agencies in 2008, the station was moved to the west side of the mine site, near the Polar Explosives building to improve the ability of the CAM to detect changes to air quality. Monitoring at this new location was initiated in October 2008.

1.1 EKATI MINE AIR EMISSIONS

Air quality may be affected by particulate and gaseous emissions from stationary and mobile diesel powered equipment and fugitive dust, which are all by-products of mining activities. Combustion of fossil fuels releases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which are greenhouse gases that are associated with global climate change (IPCC 2013). DDEC monitors GHG emissions and is continuously seeking ways to make its operations more energy efficient and to reduce emissions. High ambient concentrations of particulate matter (especially fine particles < 30 μm) from emissions and fugitive dust could, if not mitigated, have effects on wildlife and vegetation populations (Bell and Treshow 2002). The goal of the Ekati mine AQMP is to provide monitoring data required to track ambient concentrations that determine the need for adaptive management actions that would prevent adverse effects to the environment. The primary sources of particulate, gaseous emissions and fugitive dust at Ekati are:

- emissions from diesel-fired power generation;
- emissions from diesel fired boilers;
- vehicle traffic, including trucks, aircraft, and other mobile equipment on unpaved roads; and
- mining activities, including blasting, and waste rock and ore handling.

The Ekati mine has developed an Air Quality Management and Monitoring Plan (Rescan 2009) to minimise air emissions. The plan includes pro-active measures including:

- use of low sulphur diesel fuel;
- preventative maintenance programs on machinery to ensure optimum operation of all combustion and fugitive emission sources;
- control of fugitive dust emissions through road watering, use of granite waste rock as construction material and vehicle speed regulation;
- application of dust suppressant (DL-10) to areas supporting heavy traffic volume in compliance with the Government of the Northwest Territories (GNWT) Environmental Guideline for Dust Suppression;
- application of Boeing approved EK-35 dust suppressant on the Ekati mine airstrip;
- the construction of a high efficiency incinerator;
- inclusion of a "No Idle" Campaign; and
- an on-site shuttle service.

The Air Quality Monitoring and Management and Monitoring Plan will be updated in 2015 to include improvements and upgrades as a result of the 2012-2014 Air Quality Monitoring Report review process and to incorporate the addition of Lynx Pit Development.

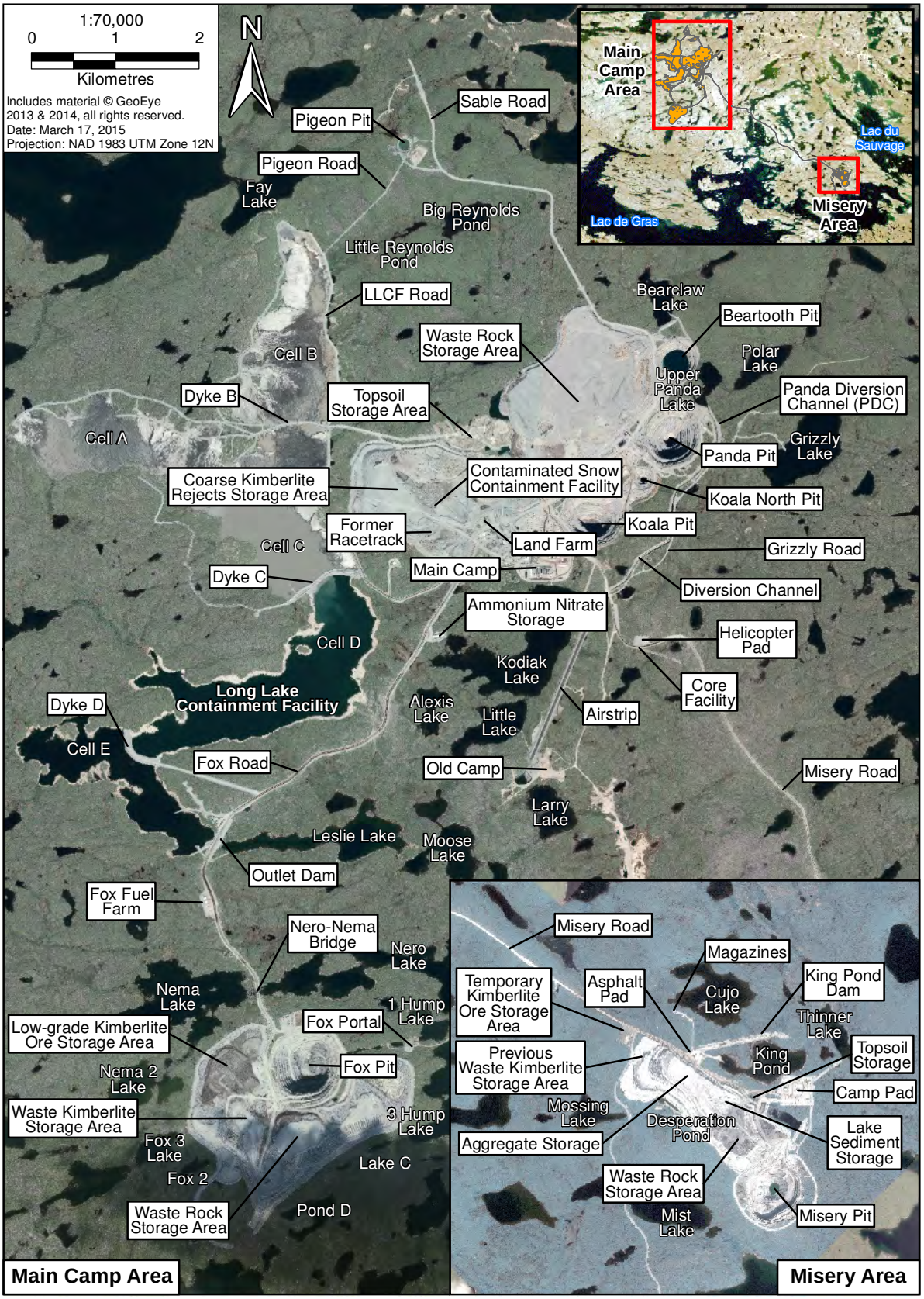
1.2 SUMMARY OF ACTIVITY AT THE EKATI MINE FROM 2012 TO 2014

During the 2012 to 2014 reporting period, ore was extracted from the Fox Pit open mine and underground mining at Koala North Pit and Koala Pit continued. Waste rock was transported to storage areas adjacent to the pits, while ore was transported to the processing plant, located at the Main camp. Although ore was not produced from the Misery Pit, movement of ore and waste rock from the Misery storage areas continued during 2012 to 2014. After processing, kimberlite waste was separated into two size fractions. Coarse kimberlite waste was trucked to the Coarse Ore Storage Area, while fine kimberlite waste was pumped as slurry to the Long Lake Containment Facility (LLCF). Fine processed kimberlite and minewater from underground operations were deposited into Beartooth Pit beginning in 2012. Figure 1.2-1 illustrates the extent of the Ekati mine footprint in 2014.

Additional construction activities during 2012 included:

- phase 2 of the Panda Diversion Channel slope enhancement project;
- construction of the Cell C West Road;
- Beartooth pipeline construction;
- improvements to the structure and mechanics of the incinerator building; and
- re-opening of the Misery camp.

Figure 1.2-1
2014 Ekati Diamond Mine Footprint



Additional construction activities during 2013 included:

- Beartooth fine-processed kimberlite slurry pipeline construction;
- modifications to the Pigeon stream diversion channel;
- modifications to several LLCF Cell C discharge spigots;
- construction of an access road at the south end of the airport runway;
- Misery Haul Road construction and improvement activities; and
- construction of the Cell C West Road.

Additional construction activities during 2014 included:

- old camp south pond reclamation;
- construction of Pigeon Waste Rock Storage Area;
- Panda Diversion Channel phase 3;
- Grizzly Road realignment;
- LLCF reclamation vegetation trial;
- Misery power supply phase 1 construction;
- Pigeon Stream Diversion construction;
- Pigeon infrastructure construction; and
- Pigeon Ring Road and water management berms construction.

1.3 SUMMARY OF DUST SUPPRESSION AT THE EKATI MINE FROM 2012 TO 2014

Dust suppression as a mechanism to mitigate the effects of fugitive dust at the Ekati mine has been employed since the commencement of mining in 1998. Various methods of dust suppression are used on-site including road watering, the application of DL-10 around main camp and on the Fox Haul Road, and the use of EK-35 on the airstrip. A summary of dust suppression activities conducted from 2012 to 2014 is outlined below.

Water was used as a dust suppressant on the Misery Haul Road throughout the AQMP reporting period and is approved by GNWT Lands Inspector for usage as a dust suppression method. The application of water on the Misery Haul Road as a dust suppression method was used as necessary during the summer seasons. Approval was granted for the use of water from the Lac de Gras location near the Paul Lake Bridge, from Cell D, and from King Pond. A water truck was deployed periodically from these approved locations to apply water in areas that are prone to generate fugitive dust where DL-10 is not approved, such as some areas around main camp and a 30 m buffer around water bodies and crossings.

The use of DL-10 is approved for some areas around main camp and the Fox Haul Road. DL-10 is not used in the front main camp as it has been determined that light vehicles travelling at the speed

limit (20 km/hr) do not generate significant dust. DL-10 is normally applied in the week of June 15 to 21 of each year and varies depending on road and weather conditions. In 2014, it was applied on June 17. DL-10 was applied on the Fox Haul Road in 2012 and 2013 but not in 2014 as mining and traffic had decreased. DL-10 was applied on the Misery Haul Road in 2012, 2013, and 2014. Envirokleen is also used as a dust suppressant when required to mitigate the effects of fugitive dust underground and is applied as necessary.

EK-35 is used on the Ekati mine airstrip in accordance with Boeing guidelines to assist in the control of fugitive dust from incoming and outgoing aircraft and associated vehicle traffic.

In addition to the application of the above dust suppressants, the Ekati mine continues to implement a reduced speed limit around site, which minimizes the impact of vehicle road dust since emissions increase almost directly with the speed of the vehicle (US EPA 2006). Dust suppression mechanisms used during the 2012 to 2014 AQMP reporting period did not differ significantly from previous AQMP reporting periods.

DDEC continues to work on improving the dust suppression program by investigating and evaluating other products and methods that may be applicable for use at the Ekati mine.

2. AQMP METHODOLOGY

Sampling procedures and monitoring locations of the AQMP were revised in 2006 after consultation with Independent Environmental Monitoring Agency (IEMA), Environment Canada Environment Protection Division (EC EPD), and the Government of the Northwest Territories Environment and Natural Resources Environmental Protection Services (GNWT ENR EPS). The AQMP was modified based on previously obtained results at the site and updated information on air quality monitoring methods.

In general, sampling sites are located in distinct areas close to the mine infrastructure and in areas considered to be background. This sampling pattern is used to assess spatial relationships with respect to the effects on air quality with distance from mining activity. The locations and 2012 to 2014 sampling periods of all monitoring stations are summarized in Table 2-1.

2.1 METEOROLOGY

Meteorological data are collected at the Ekati mine from three sources. The Koala automated meteorological station is located near the airstrip and has operated continuously since 1993. The station has sensors to monitor temperature, relative humidity, precipitation, and wind speed and direction. A micrometeorological station is operated on Polar Lake during the open-water season to provide data to estimate open water evaporation. Results from these two stations are reported annually as part of the Aquatic Effects Monitoring Program (AEMP). Their locations are shown on Figure 2.1-1 and Table 2-1. Weather observations are also collected by personnel at the Ekati mine airport however observations are only available for the hours when the airport is staffed (generally between 05:00 and 17:00 each day). Data from these observations are sent to the Meteorological Service of Canada, and are available for download from their website (EC 2015b).

A summary of the 2012 to 2014 data record at the Ekati mine is provided in Section 3.1, highlighting specific aspects relevant to the AQMP. Results are primarily based on data from the Koala meteorological station, which has the longest and most continuous data record for the site. Data from Lupin airport station (located 123 km north of Koala station) are also used as a historical comparison due to the station's climate normal record (1981 to 2010).

The Koala meteorological station's sensors are mounted on a 10 m high aluminum tower that is anchored to a concrete base and strengthened with guy wires. Wind speed is measured in metres per second (m/s) and wind direction in degrees from true north by a RM Young Model 05103 wind sensor. The temperature and relative humidity sensors are combined into one unit (Vaisala HMP45C, replaced by a Rotronic HC2-S3-L in November 2013). The combination sensor is mounted on the tower protected from direct radiation by a multi-plate solar radiation shield. Air temperature is measured in degrees Celsius, and relative humidity in percent. During the open water season, precipitation is measured with a Sierra Misco 2500-P tipping bucket rain gauge. During winter months, precipitation is measured with a Nipher snow gauge located adjacent to the station. The Nipher gauge is visited by the Ekati mine staff approximately once every week and accumulated snow in the gauge is measured for snow-water-equivalent (SWE). A Geonor T-200B all-weather precipitation gauge was installed in June 2014.

Table 2-1. The Ekati Mine Meteorological, Air Quality, Lichen and Snow Core Monitoring Locations

Station Name	UTM Coordinates (Zone 12)		Sampling Period[1]		
	Easting (m)	Northing (m)	2012	2013	2014
Meteorological Stations					
Koala	518751	7173767	Jan. 1 - Dec. 31	Jan. 1 - Dec. 31	Jan. 1 - Dec. 31
Polar Lake	520795	7178714	Jul. 11 - Oct. 12	Jul. 8 - Sep. 30	Jun. 28 - Oct. 12
Dustfall Stations					
Air-P125	518123	7174006	Jun. 2 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Air-P162	518625	7174826	Jun. 4 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Air-P280	518430	7175890	Jun. 2 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
AQ-49	496949	7181965	Jun. 2 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16
AQ-54	483227	7186765	Jun. 2 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16
Fox-U30	514142	7172778	Jun. 4 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 17	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Fox-D30	514044	7172787	Jun. 4 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 17	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Fox-D90	513987	7172796	Jun. 4 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 17	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Fox-D300	513786	7172825	Jun. 4 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 25	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16
Fox-D1000	513222	7172808	Jun. 2 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16
LLCF-PA	514487	7177769	Jun. 4 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 17	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
LLCF-PB	515783	7178870	Jun. 4 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Mis-U30	522999	7170853	Jun. 2 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 17	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Mis-D30	522986	7170777	Jun. 2 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 17	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Mis-D90	522984	7170709	Jun. 2 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 17	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15
Mis-D300	522982	7170536	Jun. 2 - Jul. 2 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 25	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16
Mis-D1000	522540	7169739	Jun. 2 - Jul. 3 - Aug. 16 - Sep. 14	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 15	Jun. 15 - Jul. 15 - Aug. 15 - Sep. 16
MisNew-D90	522207	7171484	-	-	Aug. 15 - Sep. 15
MisNew-D300	522058	7171336	-	-	Aug. 15 - Sep. 16
MisNew-D1000	521563	7170841	-	-	Aug. 15 - Sep. 16
WasteRock-100	513955	7169575	Jul. 3 - Aug. 16 - Sep. 14	-	-
WasteRock-300	513756	7169534	Jul. 3 - Aug. 16 - Sep. 14	-	-
WasteRock-1000	513054	7169508	Jul. 3 - Aug. 16 - Sep. 14	-	-
High Volume Air Sampling (HVAS) Stations					
TSP-2	521039	7177776	Jan. 1 - Dec. 31	Jan. 1 - Jun. 8	-
TSP-3	515810	7178836	Jan. 1 - Dec. 31	Jan. 1 - Jun. 8	-

(continued)

Table 2-1. The Ekati Mine Meteorological, Air Quality, Lichen and Snow Core Monitoring Locations (continued)

Station Name	UTM Coordinates (Zone 12)		Sampling Period[1]		
	Easting (m)	Northing (m)	2012	2013	2014
Partisol Stations [2]					
Grizzly	521039	7177776	Jun. 27 - Dec. 31	Jan. 1 - Dec. 31	Jan. 1 - Dec. 31
Cell B	515810	7178836	Jun. 27 - Dec. 31	Jan. 1 - Dec. 31	Jan. 1 - Dec. 31
CAMB	516439	7176425	-	-	Jul. 23 - Dec. 31
Continuous Air Monitoring Building (CAMB)[3]					
CAMB	516439	7176425	Jan. 1 - Dec. 31	Jan. 1 - Dec. 31	Jan. 1 - Dec. 31
Snow Chemistry Sampling Locations					
AQ-02	522355	7176481	-	-	Apr. 5
AQ-C2	529142	7172000	-	-	Apr. 6
AQ-04	512937	7171370	-	-	Apr. 19
AQ-C4	534862	7198812	-	-	Apr. 7
AQ-05	514909	7175937	-	-	Mar. 25
AQ-C5	533496	7169491	-	-	Apr. 6
AQ-006	515683	7180688	-	-	Mar. 27
AQ-19	515111	7172743	-	-	Apr. 12
AQ-29	519243	7175875	-	-	Mar. 26
AQ-31	515765	7178215	-	-	Mar. 27
AQ-32	522185	7195057	-	-	Apr. 3
AQ-35	522874	7189423	-	-	Apr. 3
AQ-43	527987	7194535	-	-	Apr. 3
AQ-44	506991	7175693	-	-	Mar. 28
AQ-48	498138	7165042	-	-	Apr. 8
AQ-49	497034	7181893	-	-	Apr. 4
AQ-54	483263	7186671	-	-	Apr. 8
AQ-55	471981	7193964	-	-	Apr. 18
AQ-101	543139	7209320	-	-	Apr. 7
AQ-102	519628	7185037	-	-	Mar. 27
AQ-103	526028	7179266	-	-	Apr. 5
AQ-104	533302	7179033	-	-	Apr. 6
AQ-105	539028	7179210	-	-	Apr. 10
AQ-106	546993	7161156	-	-	Mar. 26

(continued)

Table 2-1. The Ekati Mine Meteorological, Air Quality, Lichen and Snow Core Monitoring Locations (continued)

Station Name	UTM Coordinates (Zone 12)		Sampling Period[1]		
	Easting (m)	Northing (m)	2012	2013	2014
Snow Chemistry Sampling Locations (cont'd)					
AQ-107	558604	7153633	-	-	Apr. 10
AQ-108	493021	7160898	-	-	Apr. 8
AQ-109	504841	7171650	-	-	Apr. 10
AQ-110	485846	7178003	-	-	Apr. 8
AQ-111	493032	7174988	-	-	Apr. 4
AQ-112	502963	7174758	-	-	Mar. 28
AQ-113	511111	7174956	-	-	Mar. 28
AQ-114	502750	7178475	-	-	Mar. 28
AQ-115	490664	7184725	-	-	Apr. 4
Lichen Sampling Locations					
AQ-02	522143	7176831	-	-	Aug. 21
AQ-C2	527909	7171696	-	-	Aug. 21
AQ-04	513080	7172106	-	-	Aug. 22
AQ-C4	535086	7198803	-	-	Aug. 23
AQ-05	514380	7176165	-	-	Aug. 24
AQ-C5	533444	7170260	-	-	Aug. 21
AQ-6-2	515759	7180617	-	-	Aug. 23
AQ-19	515266	7172766	-	-	Aug. 22
AQ-29	519279	7175717	-	-	Aug. 24
AQ-31	516268	7178648	-	-	Aug. 22
AQ-32	522234	7195157	-	-	Aug. 23
AQ-35	522863	7189655	-	-	Aug. 23
AQ-43	527501	7194213	-	-	Aug. 23
AQ-44	507349	7175500	-	-	Aug. 22
AQ-48	498111	7164917	-	-	Aug. 23
AQ-49	496984	7181940	-	-	Aug. 24
AQ-54	483289	7186734	-	-	Aug. 22
AQ-55	471939	7194043	-	-	Aug. 22
AQ-101	543199	7209145	-	-	Aug. 23
AQ-102	519967	7185196	-	-	Aug. 23

(continued)

Table 2-1. The Ekati Mine Meteorological, Air Quality, Lichen and Snow Core Monitoring Locations (completed)

Station Name	UTM Coordinates (Zone 12)		Sampling Period[1]		
	Easting (m)	Northing (m)	2012	2013	2014
Lichen Sampling Locations (cont'd)					
AQ-103	526170	7179210	-	-	Aug. 21
AQ-104	532559	7179223	-	-	Aug. 21
AQ-105	539126	7179216	-	-	Aug. 21
AQ-106	547935	7160670	-	-	Aug. 21
AQ-107	558655	7153711	-	-	Aug. 21
AQ-108	492954	7160811	-	-	Aug. 23
AQ-109	504408	7171637	-	-	Aug. 23
AQ-110	485720	7175180	-	-	Aug. 22
AQ-111	492735	7175118	-	-	Aug. 22
AQ-112	505406	7173734	-	-	Aug. 22
AQ-113	511582	7174690	-	-	Aug. 22
AQ-114	502875	7178534	-	-	Aug. 24
AQ-115	490556	7184820	-	-	Aug. 22
AQ-116	534145	7189287	-	-	Aug. 23
AQ-118	514826	7190111	-	-	Aug. 23
AQ-121	519877	7165090	-	-	Aug. 22
AQ-122	498705	7188564	-	-	Aug. 24
AQ-123	508655	7163631	-	-	Aug. 23
Site1	516617	7182061	-	-	Aug. 24
Site2	522973	7170685	-	-	Aug. 24
Site3	523029	7170761	-	-	Aug. 24
km 16 Misery Rd[4]	529579	7166274	-	-	Aug. 24
km 3 Misery Rd[4]	520409	7174450	-	-	Aug. 24
B Dike Rd W[4]	514430	7178080	-	-	Aug. 24

Notes:

dash (-) = no sampling

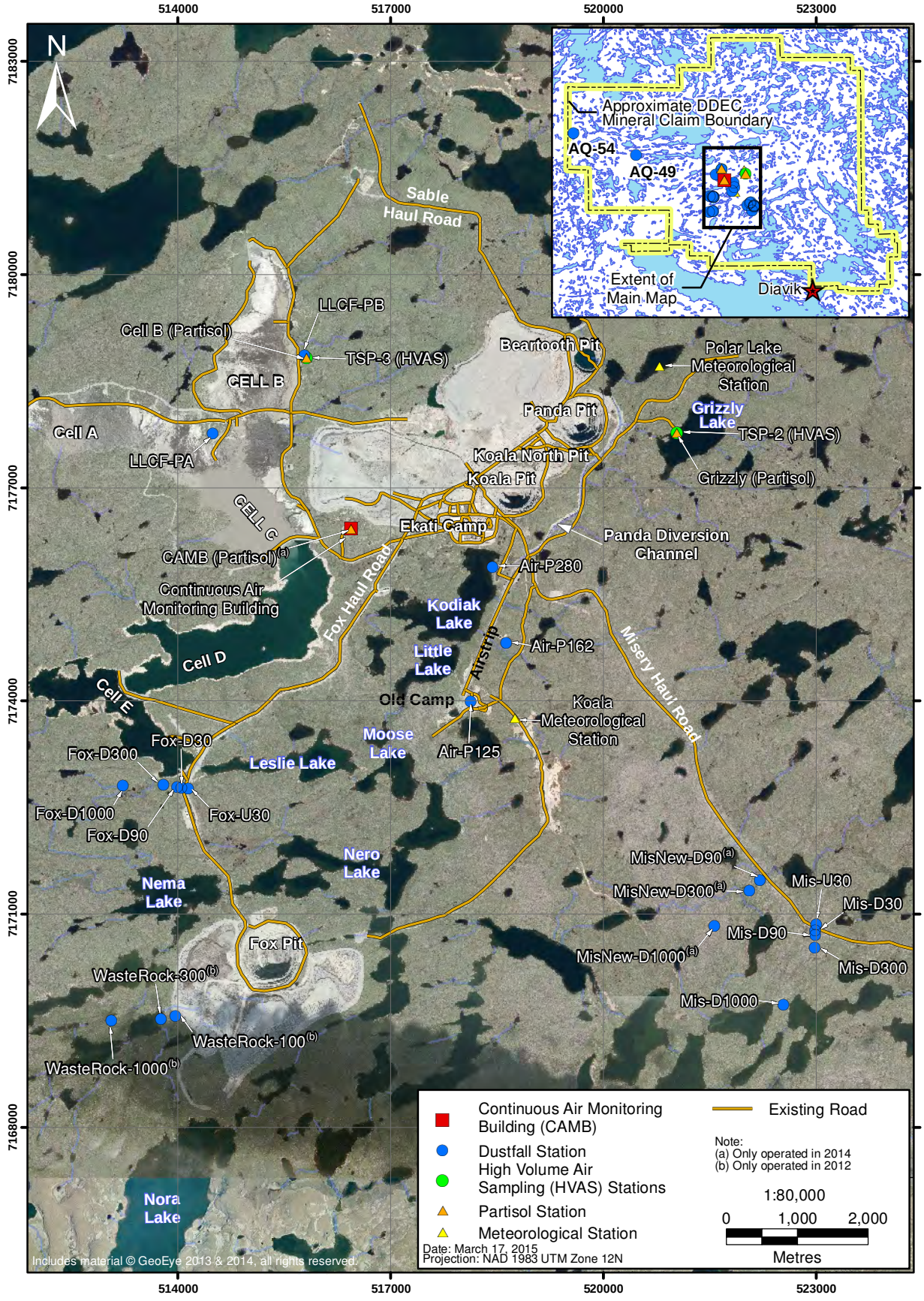
[1] *Does not include times when stations were temporarily shut down due to power outages or had invalid samples, etc. Dustfall station operating periods include the dates of dustfall canister swaps.*

[2] *Grizzly and Cell B Partisol stations collect TSP. CAMB Partisol station collects* $PM_{2.5}$

[3] *CAMB houses equipment that measure hourly TSP,* $PM_{2.5}$, SO_2, *NO,* NO_2, NO_X

[4] *Soil sampling only*

Figure 2.1-1
Meteorological and Air Quality Monitoring Stations, 2012 to 2014



The sensors for the meteorological station are connected to a Campbell Scientific CR10 datalogger that controls the operation of the station. This datalogger was upgraded to a Campbell Scientific CR1000 model in November 2013. The datalogger's program monitors the sensors every five seconds and generates hourly and daily averages or totals. The data is stored internally as well as copied to a memory storage module connected to the datalogger. The modules are changed out on a regular basis and data is downloaded. The station is powered with a 50 Watt solar panel and a 12 volt deep cycle marine battery, with the entire station grounded to prevent lightning from damaging the electronics.

2.2 AIR AND GREENHOUSE GAS (GHG) EMISSIONS

Diesel fuel is consumed every year at the Ekati mine for the transportation of ore and waste rock, heat and production of electricity, blasting, and other mine activities. DDEC calculates the air emissions resulting from the diesel fuel consumption, and reports them annually to the National Pollutant Release Inventory (NPRI) and the Greenhouse Gas Emissions Reporting Program. NPRI tracks criteria air contaminants (carbon monoxide, oxides of nitrogen, sulphur dioxide, volatile organic compounds (VOCs) and particulate matter (TSP, PM_{10} and $PM_{2.5}$)) and a number of other pollutants, while the Greenhouse Gas Emissions Reporting Program tracks total GHG emissions as carbon dioxide equivalent (CO_2e). The annual totals for GHG from 2012 to 2014 are summarised for these sources in Section 3.3; details of the relevant calculations can be found in the Ekati mine Annual Reports, that are available online (http://www.ec.gc.ca/inrp-npri/ and http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=040E378D-1). DDEC uses an Energy and GHG Steering Committee which is responsible for approving and overseeing energy and GHG reduction projects and tracking performance.

2.3 HIGH VOLUME AIR SAMPLING (HVAS) AND PARTISOL SAMPLING

Ambient concentrations of Total Suspended Particulate (TSP) matter at the Ekati mine have been collected seasonally (during the summer) from 1997 to 2013 using the high volume air sampler (HVAS) method outlined in the Ekati mine's High Volume Air Sampling Work Instruction (see Appendix 1). In June 2012, Partisol samplers were commissioned beside the existing HVAS samplers and continued to measure TSP after the HVAS were decommissioned in June 2013.

The HVAS samplers (Tisch Model TE-5170 series) pull large volumes of air (approximately 1,500 L per minute) through a filter that collects TSP. While the capture characteristics of the HVAS are dependent on the approach wind velocity, the effective D50 (i.e., the diameter where 50% of the particles are captured and 50% are not) varies roughly from 25 to 50 µm (US EPA 2011). The samplers, which are run approximately every six days, draw ambient air through the filter for a 24 hr period. Filters are dried and weighed before and after sampling to determine the mass of collected TSP. The filters are composed of binderless glass fibres and measure 20.0 by 25.4 cm (Graseby Model # G810). Historically, the HVAS were operated from June through September. Although the HVAS units are designed to operate in extreme winter conditions, the 2006 review of the sampling program raised some concerns regarding the data quality collected during winter and the probability of introducing uncertainty to the value of data collected. Comments from IEMA, during a 2010 workshop, were incorporated starting in the 2010 monitoring period by extending the monitoring dates to include the winter months.

HVAS station TSP-1 (located on the roof of the accommodations building) was decommissioned in 2003, but HVAS station TSP-2, located on the roof of the pump house at Grizzly Lake, has operated almost annually since 1997, and continued to operate during 2012 and 2013 (Figure 2.1-1, Table 2-1). The TSP-2 HVAS station was out of commission during 2006 while the AQMP was undergoing review and redesign, and was replaced with a new HVAS unit in 2007. A new station (TSP-3) was also installed in 2007 close to an existing power source near the base of a 30 m meteorological wind tower approximately 500 m east of LLCF Cell B (Figure 2.1-1, Table 2-1, Plates 2.3-1 and 2.3-2).

Plate 2.3-1. HVAS station TSP-3, exposed interior view, May 2011.

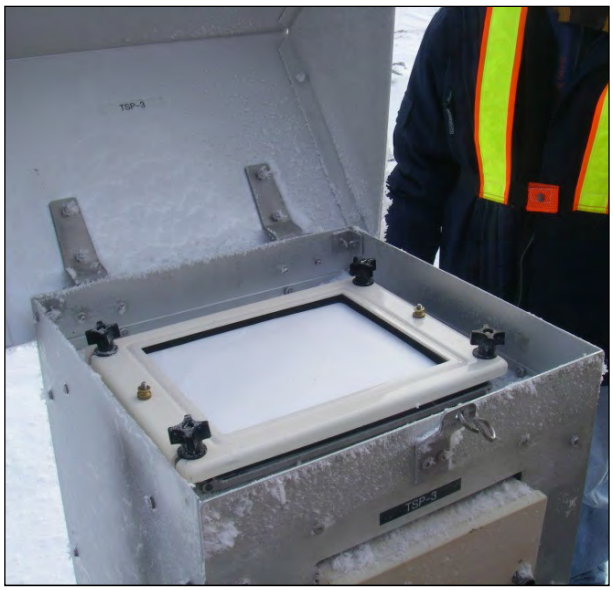


Plate 2.3-2. HVAS station TSP-3, exposed filter view, May 2011.

Beginning in June 2012, TSP was collected by two Partisol sampler stations (named Grizzly and Cell B; Thermo Scientific Partisol 2000i model). These stations were located at the same locations as the existing HVAS stations (Table 2-1, Figure 2.1-1). In response to a suggestion from the GNWT, a third additional Partisol sampler station (named CAMB) was installed on the roof of the CAM building (Plate 2.3-3, Table 2-1, Figure 2.1-1) and, unlike Grizzly and Cell B stations, configured to measure $PM_{2.5}$ instead of TSP. Partisol filter discs are sent to Maxxam for analysis.

Partisol samplers were introduced in order to replace the use of HVAS units. These Partisol samplers have several advantages over the previous HVAS equipment including being more sealed from environmental conditions, digital programmable timers, digital air volume data acquisition, easier sample handling, easier performance checks and certified laboratory analysis of samples. The Ekati operational methodology for these Partisol sampler stations is included in Appendix 3.

The quality assurance and quality control (QA/QC) procedures for HVAS and Partisol stations relate to instrument calibration, sampling methodology and laboratory procedures for determining TSP. Details on the QA/QC procedures can be found in Appendices 1 and 3. HVAS calibration records are included in Appendix 2 and Partisol calibration records are included in Appendix 4.

Plate 2.3-3. The continuous air monitoring (CAM) station. Houses internal equipment to continuously measure SO_2, NO_2, NO, NO_X, TSP and $PM_{2.5}$. The CAMB Partisol sampler configured to sample $PM_{2.5}$ is attached to the right of building, August 2014.

2.4 CONTINUOUS AIR MONITORING (CAM) STATION

A Continuous Air Monitoring (CAM) station is located at the Polar Explosives site (Figure 2.1-1, Table 2-1, Plate 2.3-3). The equipment is housed in a building approximately 3 x 3 m and analyzers continuously measure concentrations of SO_2, NO_X, TSP and $PM_{2.5}$, as well as ambient temperature and wind. Teledyne 100E and 200E analyzers measure SO_2 and $NO/NO_2/NO_X$, respectively, and two Met One BAM-1020 particulate analyzers measure TSP and $PM_{2.5}$. Data are recorded using a data acquisition system housed in the building. Data are manually downloaded by the Ekati mine's environment staff on a regular basis. Data is also manually retrieved by Maxxam personnel on a quarterly basis when Maxxam performs quarterly equipment calibrations. Results are submitted to Maxxam for analysis and reporting. The reported data is used for the Ekati mine Annual Report and AQMP reports. The main benefit of the continuous data set is to ensure the ambient air quality meets the GNWT criteria for all averaging periods. The CAM data can also be viewed remotely which allows for responsive measures to be implemented much faster compared to manual, in-person data retrievals. Remote data viewing was especially valuable during the summer wildfire smoke events in 2014.

The sampling and analytical technologies are sophisticated, sensitive to extreme temperatures and challenging to operate in the sub-Arctic. To ensure the collection of quality data, DDEC environmental specialists inspect the CAMB and send inspection reports to Maxxam on a weekly basis. Calibrations for each analyzer are performed quarterly by Maxxam personnel. Calibration certificates are included in each Maxxam data report included in Appendix 7. (The Maxxam report containing CAM data from November to December 2014 was not available at the time of reporting.)

Data were adjusted by ERM, as required, using the methodology in the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality* (Alberta Environment and Sustainable Resource Development 2014). This includes below zero adjustments for all parameters and baseline adjustments for $PM_{2.5}$. A $PM_{2.5}$ baseline adjustment of + 5.2 µg/m^3 was applied to the data collected from January 1, 2012 to March 15, 2014 as a result of the instrument's blank audit completed on March 16, 2014.

The CAM station was originally installed at Grizzly Lake in May 2007, approximately 200 m west of the existing HVAS at TSP-2. This location was selected based on the presence of a power supply and a secondary generator to act as a back-up during any grid interruptions, as well as providing continuity of data from the TSP-2 site, which has been operating since the inception of the mine.

Prior to 2008, the CAM station did not provide any reportable data as it was in the process of being commissioned. During this commissioning period, multiple set-up phases and calibrations were performed on the equipment to ensure that it was in proper working order for commencement of monitoring in 2008.

Following discussions with Environment Canada (EC), GNWT and the IEMA in March 2008, the station was relocated in September 2008 to the Polar Explosives site. Twelve potential sites were evaluated and ranked for suitability. Consensus led to this site based on its central location at the mine site, and being predominantly downwind of generators and the majority of mine site sources.

2.5 DUSTFALL MONITORING

The dustfall monitoring program, first initiated in 2006, was developed to determine the deposition patterns for fugitive dust from the haul roads. By 2008, the program had expanded to monitor dustfall at additional locations with a total of 17 dustfall monitoring stations around the Ekati mine (Figure 2.1-1, Table 2-1). These dustfall stations were used to monitor the deposition patterns of fugitive dust. Two of the dustfall stations serve as background sites and are approximately 21 km and 36 km west-northwest of the mine (these sites coincide with the snow and lichen collection sites for comparison purposes). Ten stations were established in groups near the Fox and Misery Haul Roads. For each group, one station was established approximately 30 m from the road centreline on the predominant upwind (northeast) side of the road; the other four stations were established on the predominant downwind side (southwest) at 30 m, 90 m, 300 m and 1,000 m from the road centreline. The remaining stations are located at the LLCF (2 stations) and the airstrip (3 stations).

Relocations of stations AQ-49 (Plate 2.5-1) and AQ-54 were based on the results of the Ekati mine CALPUFF modelling published in 2006 (Rescan 2006) and described in Section 3.2. The results of the CALPUFF modelling indicate that locating AQ-49 and AQ-54 at a distance of 21 and 36 km, respectively, from mine sources (taking into account predominant winds) will provide representative data collection of background conditions.

During the three year dustfall monitoring period between 2012 to 2014, samples at all 17 monitoring stations were collected between June to September each year.

In 2012, three additional dustfall stations were temporarily set up downwind of the Fox Pit waste rock area at 100 m, 300 m and 1,000 m away from the pit. These stations were used from July to September of 2012 to measure dustfall levels downwind of the waste rock piles. They were not in use in 2013 or 2014.

In August 2014, three additional permanent dustfall stations were set up downwind of the Misery Haul Road, about a kilometer closer to the main camp compared to the original Misery Haul Road stations. These new stations were better aligned with the predominant summer winds coming from the east-northeast compared to the original Misery Haul Road stations.

The dustfall monitoring stations were constructed and sited in accordance with the methods outlined in ASTM D1739-98 (Reapproved 2010). The stations consist of a canister containing a collection of medium (deionised water with algaecide) that is exposed to the ambient air for a period of approximately 30 days. The collectors are also outfitted with bird-spikes so that bird fecal matter does not get collected (Plate 2.5-2). Each station contains two canisters, one for the particulate, sulphate and nitrate analysis and one for the total metals analysis. The dustfall samples were sent to ALS Environmental Laboratory (ALS) in Burnaby, BC and processed according to the methods published by the BC Ministry of Environment (BC MOE), American Public Health Association and United States Environmental Protection Agency (US EPA). See Appendix 8 for the Ekati mine's dustfall sampling procedure and Appendix 9 for the detailed laboratory methodology.

Plate 2.5-1. Dustfall collectors at background site AQ-49, August 2011.

Plate 2.5-2. Close-up view of a dustfall collector during a non-sampling month, May 2011.

Samples were analyzed for soluble and insoluble particulate, ammonia, chloride, nitrate, sulphate, and total metals. There are no specific guidelines for fugitive dust deposition in the Northwest Territories; however, the 1979 British Columbia Pollution Objective for the Mining, Smelting and Related Industries for total particulate (sum of soluble and insoluble particulate) is 1.7 to 2.9 mg/dm^2/d as a 30 day average. This British Columbia dustfall objective is similar or slightly more stringent than other Canadian jurisdictions and is used in the AQMP for comparison to the monitoring results.

Acid deposition is primarily a result of SO_2 and NO_X emissions from industrial facilities. Environment Canada measures deposition in terms of "critical load", which is defined as the amount of acid deposition a particular region can receive without being adversely affected. Chemical indicators of deposition are sulphate and nitrate anions (EC 2004). The units commonly used to quantify acid deposition and critical loads are eq/ha/yr. Nitrate and sulphate concentrations from the collected dustfall samples were reported in mg/dm^2/d and then converted to the common units of eq/ha/yr to compare against Canadian standards. Estimates of critical load ranges have been established for both aquatic and terrestrial ecosystems for many areas of Canada; these are used for comparison with the acid deposition loadings at the Ekati mine.

2.6 SNOW CORE SAMPLING

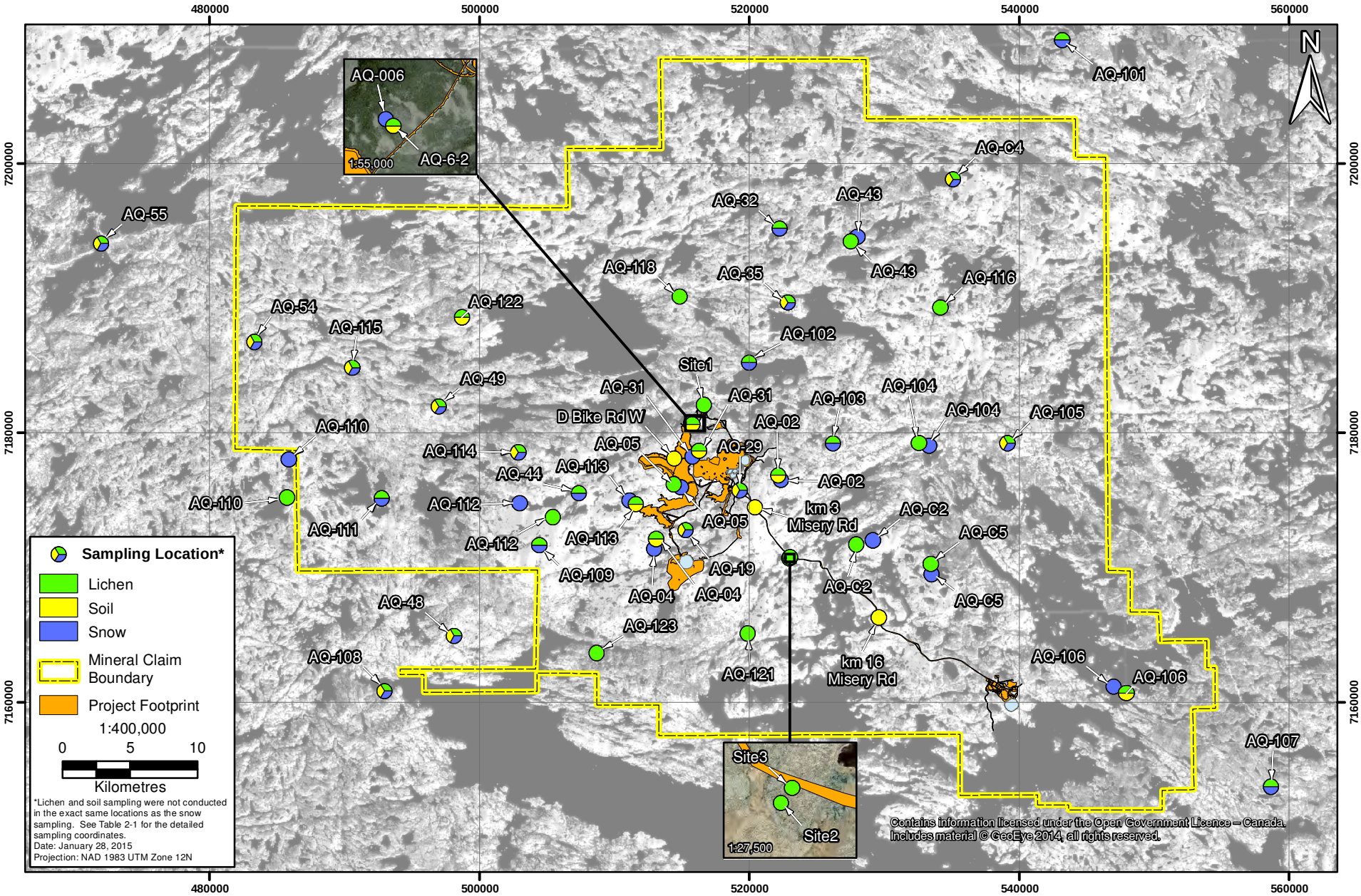
2.6.1 Field Methods

The snow core sampling program has been conducted every three years since 1998. The program was revised in 2008 based on a review in 2005 in consultation with EC, GNWT and IEMA. The revised program defined 33 snow core sampling sites in a generally radial pattern away from the mine site, to measure change in contaminant concentrations with distance from the mine site (Figure 2.6-1, Table 2-1). The sites sampled in 2008 and 2011 were also sampled in 2014.

Snow samples were collected between March 25 and April 12, 2014, following the Ekati mine Snow Core Sampling procedure document (see Appendix 10). The procedure used at the Ekati mine is the same that is used by EC, Canadian Air and Precipitation Monitoring Network (CAPMoN) stations and the US EPA. This was confirmed by Ray Semkin of EC on January 25th, 2011, who also consulted with David MacTavish from the CAPMoN program (T. Alexan, pers. comm.).

The sampling locations represent a variety of terrain types and distances from mine operations. Sloping sites were selected so that adequate snow accumulation was present, with the slope facing toward the mine site to avoid sheltering from the monitored source. At each site, three separate snow samples were collected using a Mt. Rose sampler (Plate 2.6-1) from the upper, middle and lower slope positions. Snow depth and core mass were measured for each sample to allow calculation of the SWE. The three samples were then homogenised and shipped to ALS, in Burnaby, BC, using pre-cleaned sample containers supplied by the laboratory and within the relevant hold times. Blank samples were submitted for quality assurance and quality control purposes (QA/QC) at 3 of the 33 sites. The snow chemistry variables analyzed are the same as those used in the AEMP for water quality (ERM 2015).

Figure 2.6-1
2014 AQMP Snow and Lichen Sampling Locations



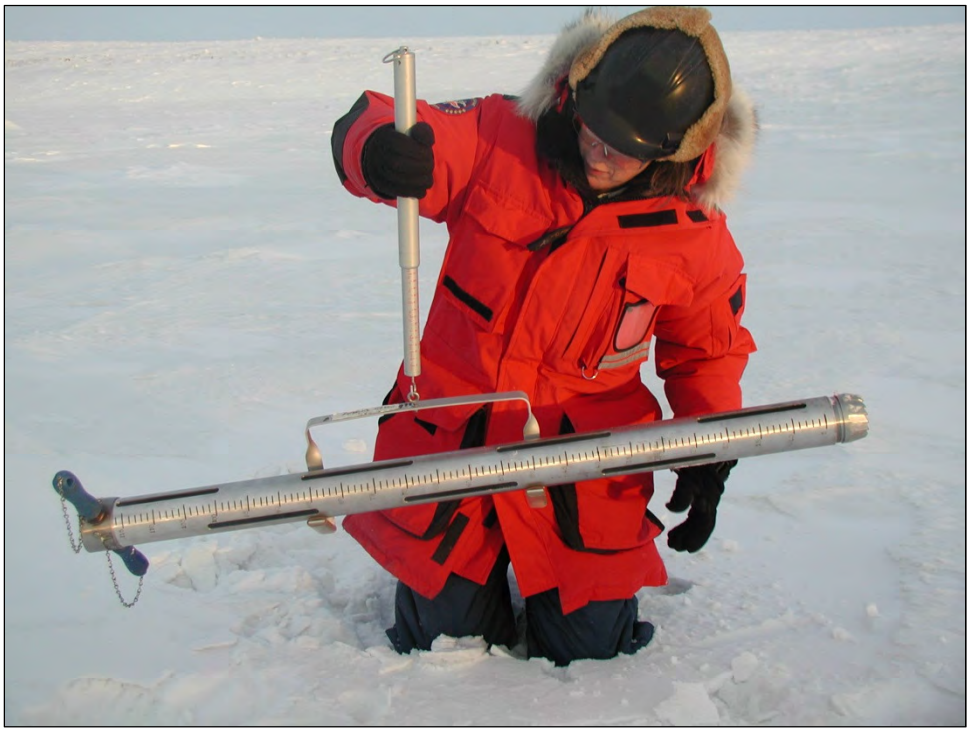


Plate 2.6-1. Mt. Rose snow core sampler being weighed.

A separate study carried out to address *Ekati Diamond Mine Review of 2008 Air Quality Monitoring Program Report* comment 2.4-2 (SENES 2010) was completed at the Ekati mine in 2011 to compare frozen vs. unfrozen snow core samples. Some samples were kept frozen until they reached the laboratory for analysis while others were allowed to melt before shipment. The results of the comparison were inconclusive and no conclusions could be made unless a much larger data set was used. In response to item number 20 from the *Ekati Diamond Mine Review of 2011 Air Quality Monitoring Program Report* (SENES 2013) the results of the 2011 comparison were revisited with a focus on nitrate-N. This parameter was selected for comparison because it was suggested by SENES that nitrate may volatilize in the melted snow sample and therefore laboratory analysis would underestimate the nitrate-N content. It was found that the difference between nitrate-N snow and water samples was not significantly different (Rescan 2013).

2.6.2 Data Analysis

For analysis purposes, concentrations that were below the detection limit were assigned a value of half the detection limit. Due to spatial and inter-annual variability in snow pack depth, observed concentrations (mg/L) were not used to analyze snow samples; due to having larger sample volume while maintaining the same deposition amount, a sample taken in a deep snow pack will have lower concentrations compared to a sample taken from a shallow snow pack. Instead to compare samples spatially and temporally, the surface loading rate (mg/m^2/day) was calculated by multiplying the parameter concentration (mg/L) by the volume of SWE (L) and dividing by the surface area (m^2) of the snow core, and the length of time (days) of the snow season. It was assumed that the snow season began on September 19, 2013 as reported by the neighbouring Diavik Diamond Mine

(K. Gray, pers. comm.). Snow cores were sampled March 25 and April 12, 2014; therefore, the length of the snow season for each sample ranged between 187 and 205 days.

Spatial patterns in snow chemistry data were analyzed based on the distance from the sampling site to the nearest centre of activity (Main Camp, Fox Pit, Misery Pit, Pigeon Pit). To complete the analysis, the distance from each sampling site to the nearest centre of activity was calculated. The majority of activity occurs in the area around the Main Camp, which also includes the Processing Plant, Panda/Koala underground and Beartooth pit, and their associated waste rock storage areas.

2.7 LICHEN TISSUE SAMPLING

Lichens are well known for being good indicators of air quality and are commonly used as monitors for dust and metal accumulation. They concentrate a variety of pollutants in their tissues in direct proportion to ambient air pollution levels and lose concentrations if ambient air quality improves (Olmes, Gulovali, and Gordon 1985; Seaward 1992b, 1992a; Carvalho and Freitas 2011; Enns 2015).

Methodologies describing field sampling, laboratory and data analysis are described in detail in Appendix 13, *Lichen Monitoring at the Ekati Diamond Mine, NWT: 2014 Re-Measurement* (Enns 2015). The text below is generally verbatim of that provided in the Lichen Report (Appendix 13).

2.7.1 Field Methods

Lichen sampling for metals analysis is carried out every three years in conjunction with snow core sampling. In previous reports, data limitations (including small sample size and lack of detailed lichen tissue data in 1998) prevented the analysis of change in lichen tissue concentrations over time. Given improvements to the sampling methods in 2005, 2008, 2011 and 2014 as the program moves forward, this limitation will decrease.

A total of 39 Air Quality (AQ) lichen plots were sampled using helicopter access between August 21 and 24, 2014. Sample areas were within 300 m of the 2011 sample locations and likely overlapped the 2011 locations. Figure 2.6-1 and Table 2-1 show the locations of the lichen plots.

To compare elemental content of lichens with source material, soil samples were collected at 19 random AQ sites adjacent to at least one of the lichen sample subpopulations at the AQ site. Road dust was also sampled from three road locations: two from the Misery Haul Road and one from the Dike B Road.

For each lichen biomonitoring plot, lichens (*Peltigera* (mainly *rufescens*) and *Flavocetraria cucullata*) were collected and placed into three bags by each of the three personnel in the field using the methods described in Bargagli and Nimis (2002). Compositing was not required. Lichen thalli (the equivalent of leaves and stems) were separated from their substrate by hand, using latex gloves, and placed in labeled paper bags. Gloves were changed between lichen plots. The upright foliose lichen *F. cucullata* was collected in all of the lichen plots, and *P. rufescens* was collected whenever it occurred in the sampling area. The rationale for the use of *F. cucullata* and *P. rufescens* is as follows:

1. *Flavocetraria cucullata* was previously sampled by Rescan in 2005, 2008 and 2011 and was re-sampled in 2014 to provide continuity. There are differences in uptake ability in different genera of lichens (Bargagli and Mikhailova 2002) and it is not advised to compare between different genera over time.
2. *Flavocetraria cucullata* also has been used in arctic elemental uptake studies in the past and its mode of accumulation of dust is reasonably well understood and documented (Walker, Crittenden, and Young 2003).
3. *Flavocetraria cucullata* is common throughout the Northwest Territories and is relatively abundant, which is important when sustaining a long term biomonitoring program.
4. *Flavocetraria cucullata* is known to be widely consumed by caribou and is an indicator or dietary uptake of toxic substances.
5. *Peltigera rufescens* was also used in 2005, 2008, 2011 and 2014. Species of *Peltigera* actively take up depositional particulate especially sulphur and nitrogenous compounds (i.e., they are slightly accumulative in comparison to *F. cucullata*), and they are better documented in world-wide literature (Fritz-Sheridan 1985; Hallingback and Kellner 1992).

The lichens were refrigerated between collection, and the drying and sorting lab, where they were cleaned of debris and holdfast tissues. They were not washed. The samples were laid out to dry. The samples were then ground in a stainless steel mill used only for lichen sample processing. Between samples, the mill was cleaned with dry tissue, followed by alcohol, and then wiped dry with clean dry tissue a second time. Tissue from all of the *Flavocetraria cucullata* samples and some of the *Peltigera rufescens* samples were retained from each plot and archived for cross referencing or QA/QC, if required.

Sample analysis methods are described in more detail in Appendix 13 (Enns 2015) and consisted of Inductively Coupled Plasma Analysis Mass Spectrophotometry with the lowest detection limits available. Mercury was determined using a cold vapor technique with an automatic mercury analyzer and Atomic Absorption Spectrophotometry. Sulphur and nitrogen were determined using a LECO furnace and flame spectrophotometry. Nitrogen in soils was determined using a Technicon Autoanalyser on a semi-micro Kjeldahl digest.

2.7.2 Data Analysis

Interpretation of trends and comparisons with literature were verified with statistical analysis. These analyses were conducted to answer the following questions:

1. Is there a relationship between distance from the mine site and the concentration of elements in *Flavocetraria cucullata*?
2. Is there a difference in element concentrations in co-located *Flavocetraria cucullata* between years (2005, 2008, 2011 and 2014)?
3. Is there a relationship between dustfall and snow melt water with the lichen and soil sample collection areas?

The elemental contents in lichen tissue in the 2014 samples were plotted to show the spatial distribution of those elements around the mine site and at distances from the mine site. The relationship between the concentrations of elements in lichen tissue and distance of the sample from the mine site was plotted with concentrations as a function of distance, comparing the three most recent years of sampling (2008, 2011 and 2014).

Data collected at dustfall and snow core sites were compared to element concentrations in lichens from all of the AQ sites. Most snow core sites were co-located with lichen sample collection areas, and 12 of these snow core sites were co-located with soil samples

3. RESULTS AND DISCUSSION

3.1 METEOROLOGY

3.1.1 Temperature

Monitoring temperature is an important component of the AQMP. Day-to-day ambient temperatures control the rate of chemical reactions that generate or transform a number of secondary air pollutants (e.g., O_3 and NO_x) as well as thermal convection. As has been widely reported (e.g., IPCC 2013), Arctic regions are particularly sensitive to global climate change. While global climate change has focussed mainly on greenhouse gas emissions, recent research suggests that long-range transport of aerosols (fine particulates, particularly black carbon) may also be driving a significant portion of the observed Arctic warming (Shindell and Faluvegi 2009).

Temperature data are presented in Table 3.1-1 and Figure 3.1-1. Figure 3.1-1 shows monthly mean temperatures from the Koala meteorological station from 2012 to 2014, and compares them to the historical 1995 to 2011 Koala station temperature trend as well as climate normal temperatures (1981-2010) from Lupin A station (located about 120 km north of Koala station). Clear seasonal trends are evident: daily mean temperatures generally rise above 0ºC in early June, marking the start of the open-water season; summer maximums generally reach around 18ºC; by early October daily temperatures drop below 0ºC, marking the end of the open water season and the start of winter; daily winter minimums commonly reach below -30ºC. Compared to the historical average, the Ekati mine experienced a warmer May to September period in 2012 and 2013 (with the exception of July 2013) and a cooler November to April in 2013 and 2014.

Table 3.1-1 ranks annual temperatures for the Ekati mine and the Mackenzie District Climate Region (EC 2014a, 2015a) from 1995 to 2014 (inclusive). Results are presented as departures from the long-term average of each location's monitoring period. The two data sets were created from different lengths of record: 1995 to 2014 (inclusive) for the Ekati mine and 1948 to 2014 (inclusive) for the Mackenzie District. There are agreements between the two rankings: 1998, 2006 and 2010 were some of the warmest years on record, while 2004 was an especially cold year. At the Ekati mine, the average temperature of 2012 was 0.6ºC higher than the 1995 to 2014 average, and 2013 and 2014 had the same average temperature as this historical average period. When compared to the 1948 to 2014 long-term regional temperatures, all three years were warmer than normal (ranging from 1 to 2ºC higher).

The 1948 to 2014 long-term regional temperatures show the Mackenzie District region is steadily warming each year, on average. This warming trend is also evident in each season, with the winter December to February months warming the fastest of any season (EC 2014a, 2015a).

Table 3.1-1. Ranking of Mean Annual Temperature for the Ekati Mine and the Mackenzie District Climate Region

Ekati (Koala Meteorological station), 1995 - 2014				Mackenzie District, 1995 - 2014		
Rank (20 years)	Year	Mean Temperature (°C)	Temperature Departure (°C)	Rank (67 years)	Year	Temperature Departure (°C)
1	2011[a]	-3.6	5.2	1	1998	3.3
2	1997	-5.9	3.0	2	2010	3.2
3	1998	-6.3	2.6	3	2006	3.1
4	2010	-6.5	2.4	5	2001	2.1
5	2006	-6.8	2.0	7	1999	2.0
6	2003	-7.9	1.0	8	2005	1.9
7	2012	-8.3	0.6	9	2012	1.9
8	1996	-8.8	0.1	11	2011	1.7
9	2014	-8.8	0.0	12	2003	1.5
10	2013	-8.9	0.0	13	1997	1.4
11	1999	-8.9	0.0	15	2014	1.2
12	2001	-9.6	-0.7	16	2000	1.2
13	2002	-9.7	-0.8	18	2013	1.1
14	2007	-9.7	-0.8	21	2007	0.9
15	2009	-9.8	-0.9	23	1995	0.9
16	2005	-9.8	-1.0	25	2002	0.9
17	2008	-10.3	-1.4	26	2009	0.8
18	1995	-10.3	-1.4	27	2008	0.6
19	2004	-12.8	-3.9	37	1996	0.2
20	2000[a]	-14.0	-5.1	57	2004	-0.8

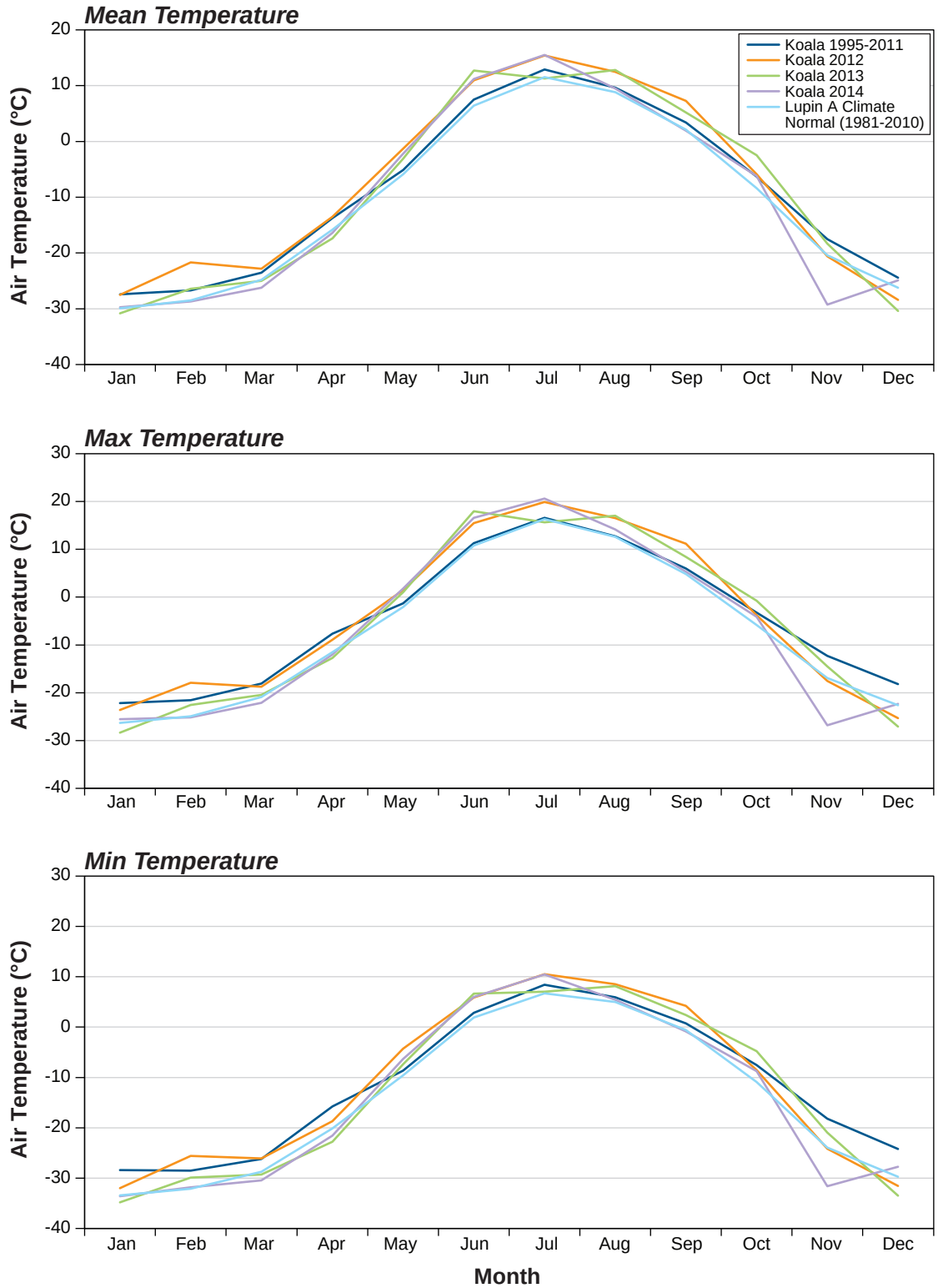
Notes:
Mackenzie District data source: EC (2015a)
[a] *Years 2000 and 2011 do not have accurate ranks and temperature departures due to significant periods of missing data.*

3.1.2 Precipitation

Precipitation data are presented in Table 3.1-2 and Figure 3.1-2. Total precipitation is a combination of snowfall (measured as SWE) and rainfall. SWE at the Ekati mine is measured with a Nipher Snow Gauge located adjacent to the Koala meteorological station and a Geonor T-200B all-weather precipitation gauge (installed in June 2014), as well as through snow core samples collected across the claim block in late winter. Rainfall is measured at the Koala station with a tipping bucket rain gauge and the Geonor T-200B. Precipitation data is missing from June 1 to 5, 2014 as the Geonor T-200B was installed on June 4, 2014 and became operational on June 6. During this June 1 to 5, 2014 period, the tipping bucket rain gauge and the Niher Snow Gauge were also not operational.

Figure 3.1-1

Koala Station Monthly Air Temperatures, 2012 to 2014



Notes: Lupin A station is ~120 km north of Ekati.
Periods of missing data: May 19 to Jun 2, 2012
Nov 11 to 26, 2013
Oct 21 to Nov 20, 2014
Dec 19, 20, 24 - 31, 2014

Table 3.1-2. Ranking of Total Annual Precipitation for the Ekati Mine and the Mackenzie District Climate Region

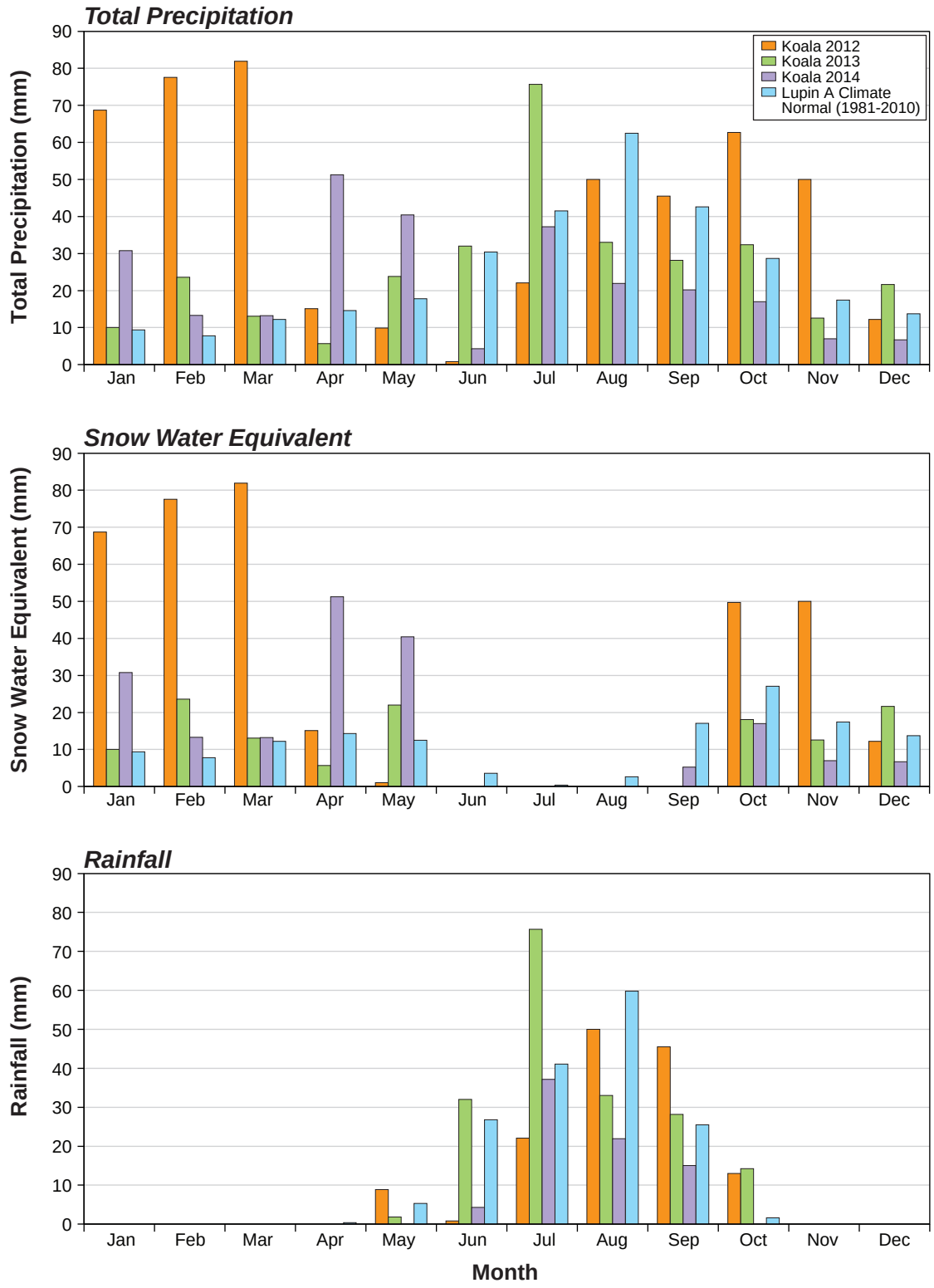
Ekati (Koala Meteorological station), 1994 - 2014					Mackenzie District, 1994 - 2014		
Rank (21 years)	Year	Total Precipitation (mm)	Snowfall (%)	Precipitation Departure (%)	Rank (67 years)	Year	Precipitation Departure (%)
1	1995	519	-	47	2	2007	18
2	1996	510	-	45	4	2008	17
3	2012	497	72	41	5	2012	16
4	2011	471	45	34	6	2009	16
5	1999	458	43	30	7	2005	15
6	2006	426	35	21	8	2010	15
7	2008	422	22	20	9	2011	15
8	1998	371	61	5	10	1996	14
9	2001	336	57	-5	12	2003	14
10	2002	321	24	-9	14	2001	12
11	2009	314	61	-11	15	2013	12
12	2013	312	41	-12	16	1999	11
13	2003	288	59	-18	19	1997	9
14	1994	280	-	-21	22	2002	7
15	2000	272	48	-23	26	1998	5
16	2010	268	51	-24	28	2000	4
17	2014	263	70	-25	29	2006	3
18	2007	257	54	-27	52	1994	-8
19	2005	248	39	-30	53	1995	-8
20	2004	222	35	-37	55	2004	-9
-	1997	-	-	-	63	2014	-17

Notes:
dash (-) = not available
Mackenzie District data source: EC (2015a)

In general, the sub-Arctic climate at the Ekati mine is characterized by stable continental polar air masses that produce relatively low annual precipitation. Figure 3.1-2 summarizes the monthly precipitation distribution. Winter accumulation generally accounts for 0 to 60% of the total precipitation, while August generally records the highest single monthly total rainfall. In 2012, SWE recorded in January, February, March, October and November was much higher than normal and snowfall accounted for 72% of total precipitation. In 2013, there was a high amount of rainfall in July compared to normal. In 2014, April and May experienced much higher snowfall than normal and August experienced lower rainfall.

Figure 3.1-2

Koala Station Monthly Precipitation, 2012 to 2014



Notes: Lupin A station is ~120 km north of Ekati.
A Geonor all-weather precipitation gauge was installed on June 4, 2014.
Snow water equivalent is calculated from the Geonor precipitation data after June 4, 2014.
Periods of missing data: Jun 1 to 5, 2014

Table 3.1-2 summarizes the annual Ekati mine precipitation since 1994 and ranks total annual precipitation for the Ekati mine and the Mackenzie District Climate Region (EC 2014a, 2015a). The regional annual 2012 precipitation ranked the 5th highest in 67 years and the 2014 precipitation ranked 63rd. Like temperature, the annual precipitation is also increasing over time in the Mackenzie District region (EC 2014a, 2015a).

3.1.3 Wind Speed and Direction

Wind speed and direction data are important for assessing how air emissions from the mine will be distributed to the local area and surrounding region. 2012 to 2014 wind data from the Koala station are summarized in Figures 3.1-3 to 3.1-5. The Ekati mine area is fairly windy, with the most common wind speeds between 3 to 5 m/s (~11 to 18 km/h). Winds at the site are omni-directional, however there is a primary component from the east (28% coming from the east-northeast, east and east-northeast averaged over 2012 to 2014), and a secondary component from the northwest (25% from the northwest, west-northwest, and west averaged over 2012 to 2014). Wind speed and direction remain fairly consistent between years; hence, the averaged data collected between 2012 and 2014 are also representative of the long-term historical averages.

There were periods of missing wind data from the Koala meteorological station in all three years, primarily due to the wind sensor freezing during the winter. The percent of available data during the snow cover and snow free periods range from 85 to 100% and are included in Figures 3.1-3 to 3.1-5.

3.2 2006 CALPUFF AIR DISPERSION MODELLING SUMMARY

A CALPUFF air dispersion modelling study was completed in 2006 and published by Rescan (2006). Limited comparison was made to the predictions of the air dispersion model in the 2005 AQMP because the model results at the time were preliminary. The results of the 2014 AQMP presented in this report are therefore reviewed in the context of the 2006 CALPUFF modelling results. A summary of the findings of the Ekati mine CALPUFF air dispersion modelling report (Rescan 2006) are described below.

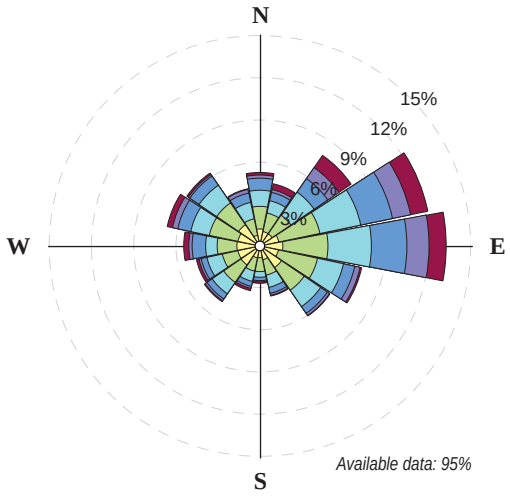
Model predictions of ambient SO_2 and NO_2 concentrations showed that Northwest Territories Ambient Air Quality Standards and Canadian Ambient Air Quality Objectives (those values applicable in 2006, see Table 3.2-1 for 2014 values) were predicted to be met outside of the active mining area when using the Ozone Limiting Method for estimating the NO to NO_2 conversion rate. The active mining area was defined as any footprint area that is subject to or associated with various mining activities (e.g., active open pits, haul roads, plant site and processed kimberlite contaminant areas). Ambient concentrations of SO_2 and NO_2 were predicted to be well below applicable standards outside the Ekati mine claim block.

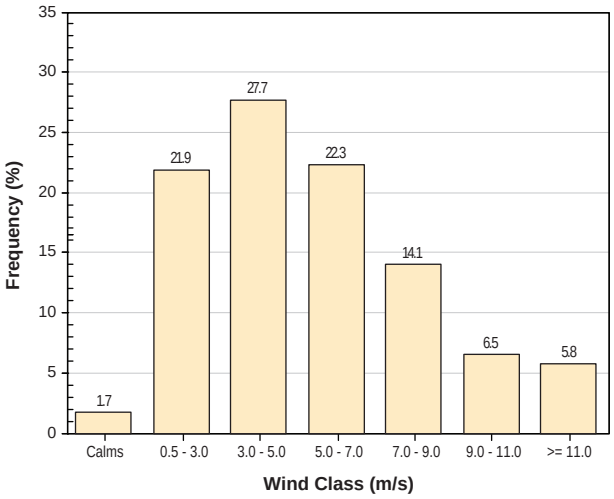
Model predictions of 24-hour $PM_{2.5}$ concentrations exceeded NWT guidelines of 30 $\mu g/m^3$ (value applicable in 2006) within a corridor along the Misery Haul Road and the active mining areas. The corridor was defined in the dispersion model to represent the haul roads between the Ekati mine main camp and Misery. In addition, model concentrations of 24 hour TSP and annual average TSP exceeded NWT guidelines within this corridor. The model predicted that standards for ambient $PM_{2.5}$ and TSP concentrations were met everywhere outside the Ekati mine claim block.

Figure 3.1-3

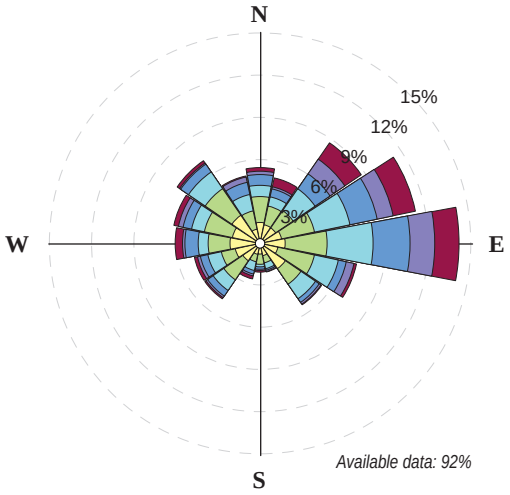
Koala Station Wind Rose and Wind Speed Frequency Distributions, 2012

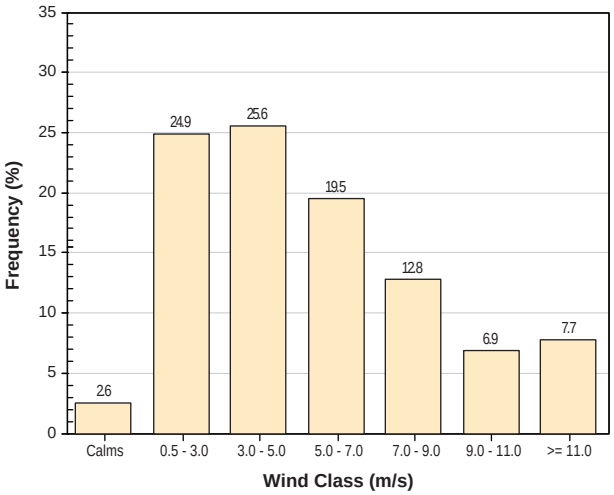
2012 Annual



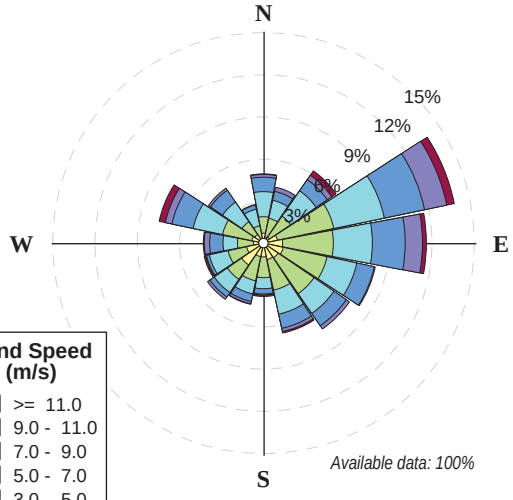


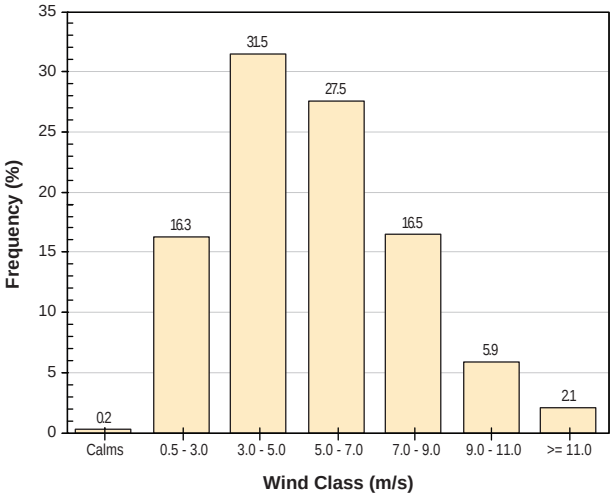
2012 Snow Cover Period (October to May)





2012 Snow Free Period (June to September)





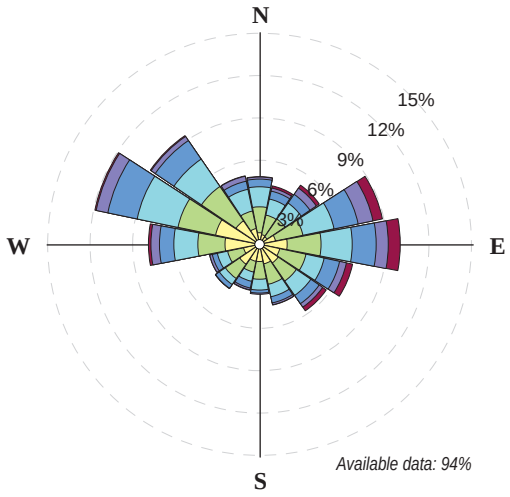
Note: Winds blow from the direction indicated.

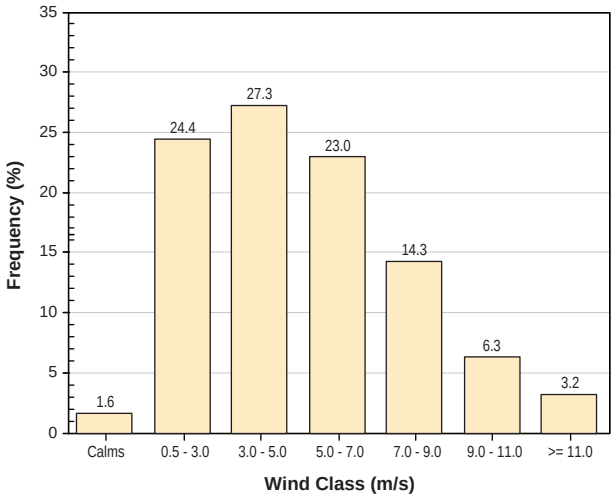
Figure 3.1-4

Koala Station Wind Rose and Wind Speed Frequency Distributions, 2013

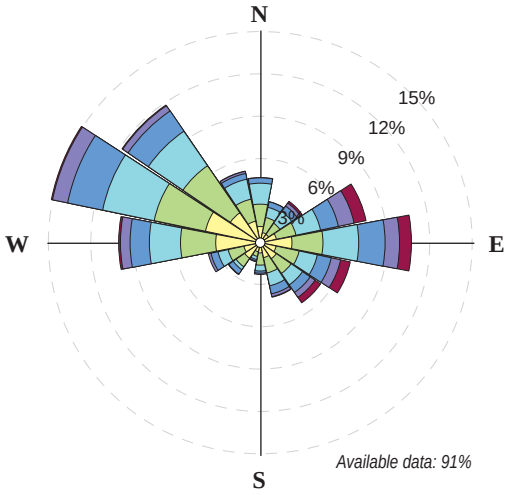
ERM

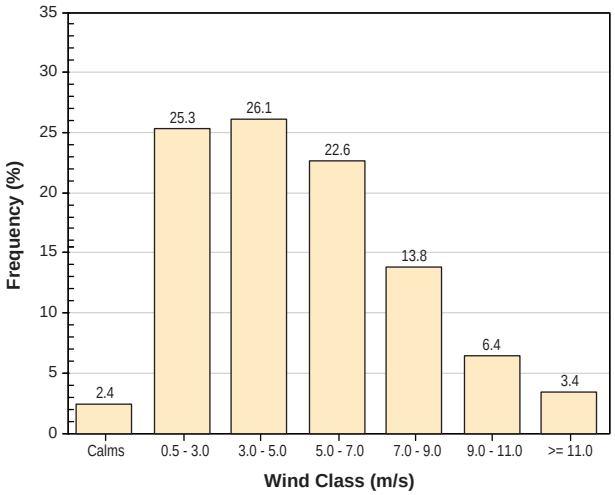
2013 Annual



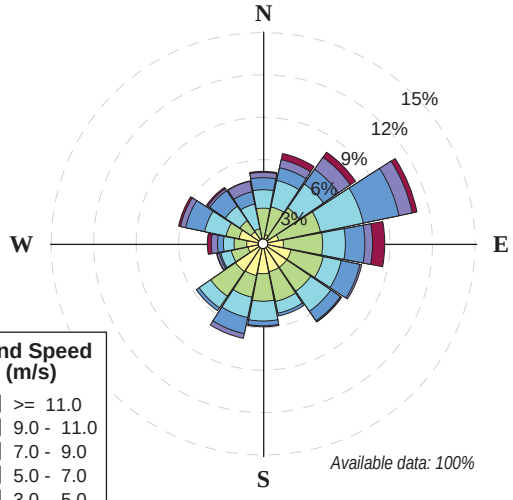


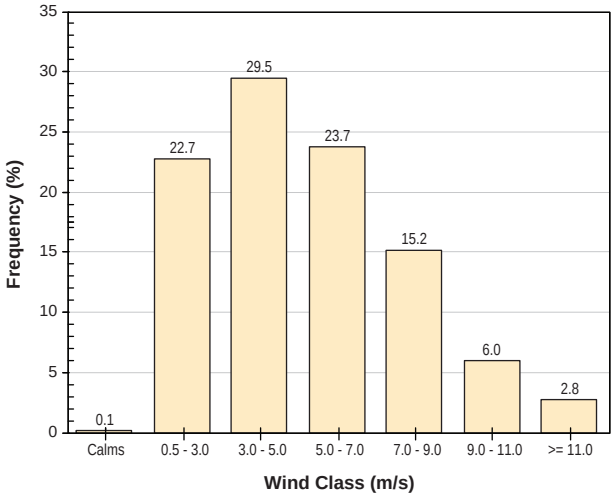
2013 Snow Cover Period (October to May)





2013 Snow Free Period (June to September)



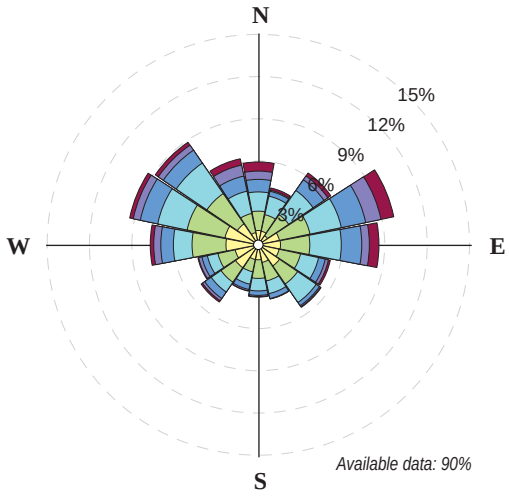


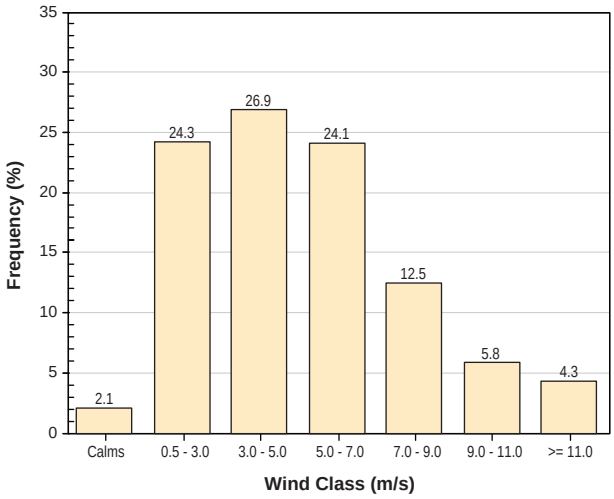
Note: Winds blow from the direction indicated.

Figure 3.1-5

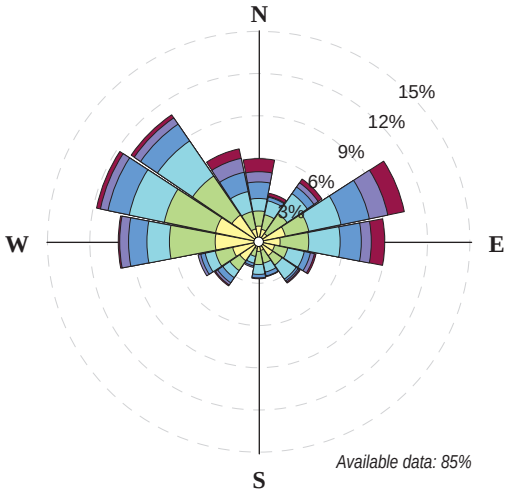
Koala Station Wind Rose and Wind Speed Frequency Distributions, 2014

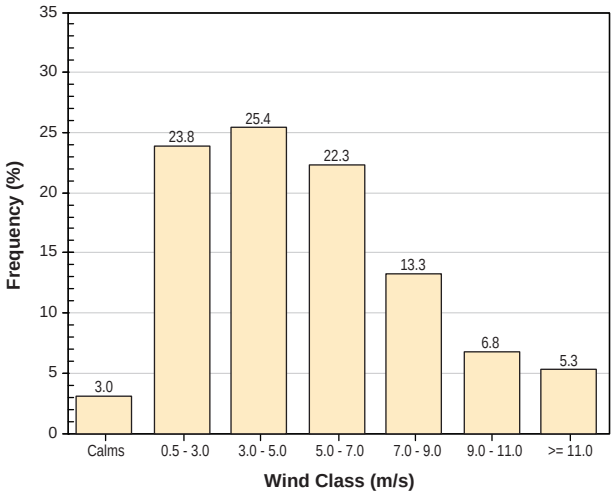
2014 Annual



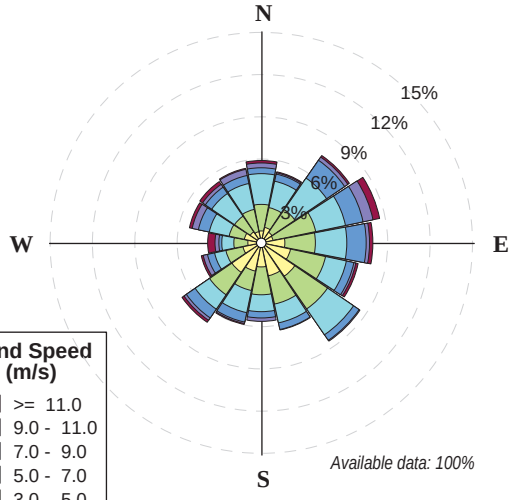


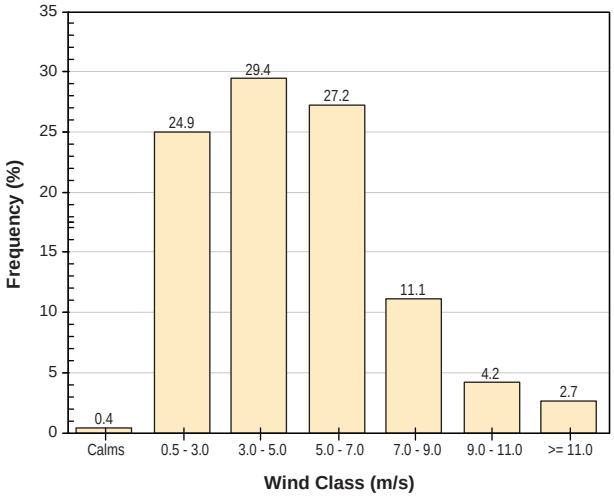
2014 Snow Cover Period (October to May)





2014 Snow Free Period (June to September)





Note: Winds blow from the direction indicated.

Table 3.2-1. Summary of 2014 Ambient Air Quality Standards and Objectives

Parameter	Averaging Period	Unit	Value	Agency
Nitrogen Dioxide (NO_2)	1 hr mean	µg/m³ (ppb)	400 (213)	GNWT
Nitrogen Dioxide (NO_2)	24 hr mean	µg/m³ (ppb)	200 (106)	GNWT
Nitrogen Dioxide (NO_2)	annual mean	µg/m³ (ppb)	60 (32)	GNWT
Sulphur Dioxide (SO_2)	1 hr mean	µg/m³ (ppb)	450 (172)	GNWT
Sulphur Dioxide (SO_2)	24 hr mean	µg/m³ (ppb)	150 (57)	GNWT
Sulphur Dioxide (SO_2)	annual mean	µg/m³ (ppb)	30 (11)	GNWT
Fine Particulate $PM_{2.5}$	24 hr mean[1]	µg/m³	28	GNWT
Fine Particulate $PM_{2.5}$	annual mean[2]	µg/m³	10	GNWT
Total Suspended Particulate (TSP)	24 hr mean	µg/m³	120	GNWT
Total Suspended Particulate (TSP)	annual geometric mean	µg/m³	60	GNWT
Dustfall (Upper Level)	30 day mean	mg/dm²/d	2.9	BC MOE

Notes:
Source: BC MOE (2014); GNWT (2014)
[1] based on 98th percentile value, averaged over 3 consecutive years
[2] based on annual average, averaged over 3 consecutive years

The model results showed that the Potential Acid Input (PAI) loads were less than 250 eq/ha/yr at a distance of 2.5 to 3.0 km from the centre of the Ekati mine or effectively outside the active mine area. PAI quantifies the theoretical maximum possible acid deposition input rather than the most likely acid deposition input. A PAI load of 250 eq/ha/yr is the standard for highly sensitive soils adopted by the Government of Alberta; the Government of Northwest Territories does not currently have critical load standards.

Model predictions for nitrate deposition were not conclusive due to uncertainties associated with chemical reaction rates of NO_X conversion to nitrate. However, model predictions of potential (maximum) nitrate deposition rates show that contributions of mining operations to nitrate deposition are negligible beyond 5 to 10 km from the mine areas. In addition, the observed snow core chemistry and lichen data do not show a defined decreasing trend of nitrate deposition with increasing distance from mining activities (see Sections 3.6 and 3.7). If the mining activities at the Ekati mine resulted in significant local nitrate deposition, a trend of decreasing nitrate loadings with distance from the mine should have been evident in these analysis results.

The model results showed a steep gradient of dust deposition close to sources, and the deposition of dust resulting from mine fugitive emissions was indistinguishable from background deposition rates at a distance of 14 to 20 km from the active mining areas. This finding is consistent with the findings from the 2005, 2008, 2011 AQMP reports, as well as the 2014 AQMP results described in subsequent sections of this report.

3.3 AIR AND GREENHOUSE GAS (GHG) EMISSIONS

At the Ekati mine, the combustion of diesel is the main sources of greenhouse gas emissions. Diesel combustion is used for power generation, building heat, operating mobile equipment around the

site, and blasting. Secondary sources of greenhouse gas emissions are from the combustion of used oil for heating buildings and the combustion of Jet A-1 fuel by helicopters and small aircraft working around the claim block. In order to be consistent with NPRI reporting, fuel usage and emissions reported in this section are based on calendar year data (January 1 to December 31).

Fuel consumption at the Ekati mine between 2012 and 2014 is presented in Table 3.3-1. The diesel consumption used for blasting has been incorporated into the ammonium nitrate/fuel oil mixture (ANFO) values.

Table 3.3-1. Annual Fuel Consumption, ANFO, Emulsion, Fugitive and Biomass Emissions at the Ekati Mine, 2012 to 2014

	2012	2013	2014
Diesel, Other Non-Motive (L)	843,378	628,114	598,606
Diesel, Motive (L)	20,920,868	25,924,182	27,737,685
Diesel, Heating (L)	8,227,515	10,554,628	10,101,671
Diesel, Power Generation (L)	32,368,837	32,151,593	32,607,714
Diesel, Total (L)	62,360,598	69,258,517	71,045,676
Aviation Jet A-1 (L)	120,807	95,808	127,722
Waste Oil (L)	250,109	514,380	440,940
Gasoline (L)	2,050	2,460	5,330
ANFO+Emulsion (kg)	6,966,379	9,284,526	8,923,323
Fugitive Emissions (tCO_2e)	3	0	0
Biomass (tCO_2e)	345	331	262

Notes:
Fuel consumption and emissions are reported as calendar years (January 1 to December 31).
Source: Ekati GHG Inventory Spreadsheet (Charlie Campbell, DDEC)

Between 2012 and 2014, fuel consumption steadily rose back to levels previously reported between 2006 and 2008. This was primarily due to an increase in motive diesel use, mainly a result of the movement of ore and waste rock from the Misery storage areas, as well as many additional construction activities over the course of the three years (see Section 1.2). However, the total fuel use levels are lower than the fuel usage reported from 2002 to 2005.

In comparison to 2011, total diesel fuel consumption increased 13% in 2012, 25% in 2013, and 28% in 2014. This was primarily due to an increase in motive diesel use which increased by 38% in 2012, 71% in 2013 and 83% in 2014 compared to 2011 usage. Heating use also increased between 13% and 45% compared to 2011, but the amount of heating fuel used compared to the total amount is relatively low (14%, averaged from 2012 to 2014). Power generation diesel usage from 2012 to 2014 remained relatively constant compared to 2011 levels (up to 1% increase).

Although increases in the use of motive diesel have taken place between 2012 and 2014, significant efforts were put in place previously to reduce emissions. A "No Idle" Campaign was implemented in 2006; a site wide policy that prohibits users from idling light vehicles when stopped for extended periods of time – such as when parked for lunch. An onsite shuttle service has contributed to the

success of this program by decreasing the need for each business unit to have vehicles, as has the enforcement of the "No Idle" Campaign. In 2013, this campaign was re-launched by DDEC.

In a similar ongoing program, between 250,109 and 514,380 L of waste oil was burned on site annually between 2012 to 2014 to heat air for underground workings. The benefits of use of this oil on site were less diesel burned to heat underground air, and no diesel burned in the transportation of this oil to a southern location as waste.

Table 3.3-2 summarizes monthly GHG emissions in term of tonnes of CO_2 equivalent (tCO_2e). A total of 175, 195 and 200 kt of greenhouse gas emissions were calculated to be released in 2012, 2013 and 2014, respectively. The estimated amount of CO_2e released in 2014 was 29% higher compared to 2011. The mean annual greenhouse gas emissions from 2012 to 2014 were 190 $ktCO_2e$. This is 20% greater than that estimated during the 2009 to 2011 fiscal years (158 $ktCO_2e$), but is 5% less than that estimated during the 2006 to 2008 fiscal years (199 $ktCO_2e$).

Table 3.3-2. Summary of Monthly Emission Sources and Resulting GHG Emissions at the Ekati Mine, 2012 to 2014

	Emission Sources				Resulting GHG Emissions			
Month	Total Fuel[1] (L)	ANFO + Emulsion (kgs)	Fugitive Emissions (tCO_2e)	Biomass (tCO_2e)	CO_2 (tonnes)	CH_4 (tCO_2e)	N_2O (tCO_2e)	Total GHG Emissions (tCO_2e)
Jan-12	6,227,135	426,751	0	29	17,108	16	159	17,283
Feb-12	5,680,510	508,617	0	31	15,633	14	145	15,792
Mar-12	6,083,854	497,365	0	32	16,730	15	156	16,901
Apr-12	5,258,306	562,376	0	29	14,513	13	134	14,660
May-12	5,169,915	606,489	0	31	14,270	13	131	14,415
Jun-12	4,151,690	485,309	3	32	11,459	10	106	11,575
Jul-12	4,085,687	351,681	0	29	11,247	10	105	11,362
Aug-12	4,305,483	695,582	0	27	11,909	11	110	12,030
Sep-12	3,986,872	558,790	0	26	11,014	10	102	11,126
Oct-12	5,213,303	927,510	0	28	14,445	13	132	14,591
Nov-12	6,430,816	741,126	0	26	17,755	16	163	17,934
Dec-12	6,139,993	604,783	0	24	16,908	15	156	17,079
Jan-13	7,606,686	867,226	0	33	20,963	19	193	21,176
Feb-13	6,299,010	801,621	0	34	17,381	16	160	17,557
Mar-13	6,222,102	778,197	0	33	17,192	16	158	17,366
Apr-13	6,635,681	879,344	0	34	18,372	16	168	18,557
May-13	5,558,355	944,208	0	34	15,414	14	141	15,569
Jun-13	4,252,776	713,238	0	35	11,789	11	108	11,908
Jul-13	4,884,404	484,294	0	21	13,444	12	125	13,581
Aug-13	4,450,360	436,487	0	21	12,246	11	115	12,372

(continued)

Table 3.3-2. Summary of Monthly Emission Sources and Resulting GHG Emissions at the Ekati Mine, 2012 to 2014 (completed)

Month	Emission Sources				Resulting GHG Emissions			
	Total Fuel[1] (L)	ANFO + Emulsion (kgs)	Fugitive Emissions (tCO_2e)	Biomass (tCO_2e)	CO_2 (tonnes)	CH_4 (tCO_2e)	N_2O (tCO_2e)	Total GHG Emissions (tCO_2e)
Sep-13	4,823,150	628,302	0	21	13,313	12	123	13,448
Oct-13	5,669,300	883,161	0	22	15,667	14	144	15,826
Nov-13	6,066,748	530,664	0	22	16,708	15	154	16,877
Dec-13	7,402,593	1,337,784	0	21	20,507	19	188	20,713
Jan-14	7,845,065	701,016	0	22	21,573	20	199	21,793
Feb-14	6,766,941	659,952	0	21	18,635	17	172	18,824
Mar-14	6,887,782	734,915	0	23	18,982	17	175	19,175
Apr-14	6,753,427	905,147	0	22	18,659	17	171	18,847
May-14	5,191,669	603,637	0	23	14,347	13	132	14,491
Jun-14	4,385,839	669,492	0	23	12,119	11	112	12,243
Jul-14	4,997,864	787,874	0	21	13,811	13	128	13,951
Aug-14	4,406,149	585,754	0	21	12,156	11	113	12,281
Sep-14	5,098,930	883,143	0	21	14,104	13	130	14,248
Oct-14	5,748,400	561,732	0	23	15,820	14	147	15,981
Nov-14	6,052,777	855,649	0	21	16,716	15	154	16,885
Dec-14	7,484,825	975,012	0	21	20,676	19	190	20,885
2012 Annual Total	62,733,564	6,966,379	3	345	172,992	158	1,599	174,748
2013 Annual Total	69,871,165	9,284,526	0	331	192,996	175	1,778	194,949
2014 Annual Total	71,619,668	8,923,323	0	262	197,600	180	1,824	199,603

Notes:
[1] Total fuel is comprised of diesel, Jet A-1, waste oil and gasoline
Source: Ekati GHG Inventory Spreadsheet (Charlie Campbell, DDEC)

The greenhouse gas emissions for the entire Northwest Territories in 1996, immediately prior to the development of the Ekati mine, were estimated to be 1.090 million tCO_2e. Between 2004 and 2012, the Northwest Territories total annual emissions peaked at approximately 1.89 million tCO_2e in 2008 (EC 2014b), an increase of 73% since 1996. The latest reported value of 2012 emissions in the Northwest Territories is 1.46 million tCO_2e (EC 2014b), an increase of 34% since 1996. Thus, 2012 CO_2e emissions from the Ekati mine represent approximately 12% of the 2012 total Northwest Territories emissions. It should be noted that the Ekati mine is one of the largest industrial developments to date in the Northwest Territories and would be expected to contribute a significant portion of the overall greenhouse gas emissions. Total CO_2e emissions in Canada were estimated to be 699 million tonnes in 2012 (EC 2014b); hence, the Ekati mine emissions in 2012 represent 0.025% of this total. Results suggest air emissions reduction programs at the Ekati mine have been effective and DDEC continues

to explore new methods of reducing diesel consumption and resulting emissions. Territorial and Canadian estimates are not available for 2013 and 2014 at this time for comparison.

3.4 AMBIENT AIR MONITORING

3.4.1 High Volume Air Sampling (HVAS) and Partisol Sampling

The Northwest Territories Ambient Air Quality Standard for 24 hour TSP concentration is 120 µg/m³ (Table 3.2-1). The GNWT standard is adopted from the Canada wide National Ambient Air Quality Objectives and Guidelines. This standard sets the bar for the long-term air quality protection of unpolluted areas in the country. Annual mean TSP measurements from HVAS and Partisol stations are not compared to annual national or territorial standards because the stations are not operated continuously year-round.

Table 3.4-1 provides a summary of HVAS and Partisol data from 1994 to 2014. Figure 3.4-1 plots each TSP measurement from the active HVAS and Partisol stations for the 2012 to 2014 sampling period. This figure also includes the limited $PM_{2.5}$ sampling from the Partisol station (named CAMB) located at the CAM building. Complete laboratory results of the Partisol data are included in Appendix 5. Appendix 6 contains a summary of the HVAS and Partisol station results for individual sampling days from 2012 to 2014.

Table 3.4-1. Summary of Intermittent TSP Sampling from High Volume Air Sampling and Partisol Stations, 1994 to 2014

Year	Sample Station	Number of Samples	Maximum [TSP] 24 hour (µg/m³)	Minimum [TSP] 24 hour (µg/m³)	Arithmetic Mean [TSP] 24 hour (µg/m³)	Geometric Mean [TSP] 24 hour (µg/m³)	Number of Times Daily Maximums Exceeded
1994	TSP-1	30	320.0	4.0	57.2	30.4	4
1997	TSP-1	16	37.6	2.6	15.7	11.4	0
1998	TSP-1	17	137.9	1.9	50.0	28.1	2
1999	TSP-1	15	117.0	2.6	40.4	21.9	0
	TSP-2	15	19.9	0.0	4.5	2.8	0
2000	TSP-1	23	205.9	5.0	69.0	40.0	5
	TSP-2	23	59.4	0.2	13.4	8.0	0
2001	TSP-1	23	561.4	7.3	93.5	55.7	5
	TSP-2	23	94.8	1.3	15.0	8.2	0
2002	TSP-1	21	294.3	8.7	87.1	49.5	5
	TSP-2	21	55.5	2.5	15.6	11.0	0
2003	TSP-2	19	50.9	0.2 [a]	17.2 [a]	6.1 [a]	0
2004	TSP-2	17 [b]	101.4	1.0 [c]	29.7 [c]	17.9 [c]	0
2005	TSP-2	9	12.9	0.7	4.3	2.7	0
2006	TSP-2	Out of Service					

(continued)

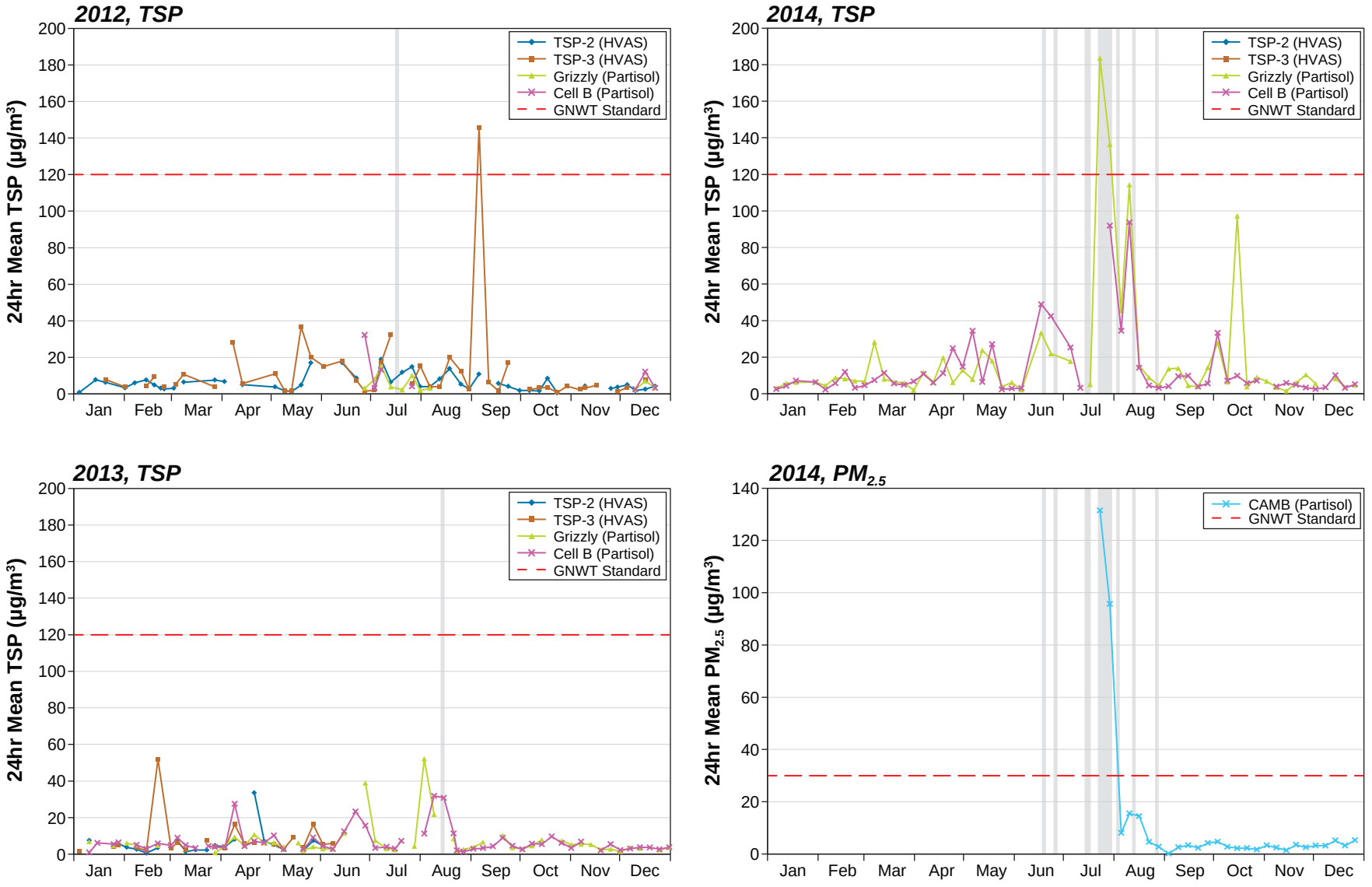
Table 3.4-1. Summary of Intermittent TSP Sampling from High Volume Air Sampling and Partisol Stations, 1994 to 2014 (completed)

Year	Sample Station	Number of Samples	Maximum [TSP] 24 hour (µg/m³)	Minimum [TSP] 24 hour (µg/m³)	Arithmetic Mean [TSP] 24 hour (µg/m³)	Geometric Mean [TSP] 24 hour (µg/m³)	Number of Times Daily Maximums Exceeded
2007	TSP-2	22	15.5	0.3	4.9	3.1	0
	TSP-3	21	35.5	0.0	5.9	2.2	0
2008	TSP-2	30	90.3	0.2 [d]	15.5 [d]	5.4 [d]	0
	TSP-3	30	267.5	0.1 [e]	36.6 [e]	9.8 [e]	2
2009	TSP-2	16	35.6	0.3 [a]	7.9 [a]	4.4 [a]	0
	TSP-3	18	96.7	0.1	28.0	10.8	0
2010	TSP-2	32	171.8	1.4 [d]	24.4 [d]	10.6 [d]	2
	TSP-3	32	87.3 [f]	0.7 [f]	16.2 [f]	8.7 [f]	0
2011	TSP-2	37	40.5	0.3 [g]	9.7 [g]	4.8 [g]	0
	TSP-3	34	54.1	0.5 [d]	9.7 [d]	4.7 [d]	0
2012	TSP-2	47 (12)[h]	18.9	0.6	6.0	4.6	0
	TSP-3	44 (10)[h]	145.6	0.9	11.8	6.1	1
	Grizzly	11 (5)[h]	15.2	2.0	5.6	4.5	0
	Cell B	7 (8)[h]	32.3	2.7	10.2	6.7	0
2013	TSP-2	20 (7)[h]	33.5	0.5	5.8	4.0	0
	TSP-3	22 (5)[h]	51.8	1.5	7.8	5.3	0
	Grizzly	47 (14)[h]	52.1	0.7	7.0	4.9	0
	Cell B	57 (3)[h]	31.9	1.0	6.9	5.1	0
2014	Grizzly	55 (5)[h]	183.6	1.4	19.2	9.5	2[i]
	Cell B	54 (6)[h]	93.7	2.2	13.5	7.8	0

Notes:
Station TSP-1, TSP-2, TSP-3 are Tisch high volume air sampling stations. Stations Grizzly and Cell B are Thermo Scientific Partisol sampling stations.
Station TSP-1 was decommissioned in 2003.
Stations Grizzly and Cell B were commissioned in June 2012.
Stations TSP-2 and TSP-3 were decommissioned in June 2013.
[a] *Two results were considered questionable as they had negative values. These results were not included in this calculation.*
[b] *High Volume Air Sampler failed on August 22, 2004 and was out of order for the remainder of the season. This sample was not included in calculations.*
[c] *One result was considered questionable as it had a negative value. This result was not included in this calculation.*
[d] *Four results were considered questionable as they had negative values. These results were not included in this calculation.*
[e] *Three results were considered questionable as they had negative values. These results were not included in this calculation.*
[f] *Three results were considered questionable as two had negative values, and one had a possible initial filter weighing error. These results were not included in this calculation.*
[g] *Ten results were considered questionable as they had negative values. These results were not included in this calculation.*
[h] *Number outside of bracket represents the number of valid samples. Number inside bracket represents the number of erroneous samples. Erroneous results were not included in the table calculations.*
[i] *Two exceedances occurred on days with visible smoke from wildfires.*

Figure 3.4-1

2012 to 2014 High Volume Air Sampling and Partisol Station Results, TSP and $PM_{2.5}$



Note: Shaded date ranges indicate consecutive days with visible daytime smoke recorded by Ekati Airport.
2012: July 16 - 18; 2013: August 12 - 15
2014: June 18 - 19, 24 - 26; July 3, 13 - 16, 21 - 30; August 2 - 3, 5, 10, 12 - 13, 25 – 26

During 2012, 47 and 44 valid samples of TSP were collected at HVAS stations TSP-2 and TSP-3, respectively. Invalid samples were usually the result of the station not being configured properly, pump failure, power failure, or filter paper sticking to a seal when the filter was removed. The mean annual concentrations were 6.0 and 12 µg/m^3, with maximum 24 hour concentrations of 19 and 146 µg/m^3 measured at TSP-2 and TSP-3. The 146 µg/m^3 TSP exceedance was the only TSP exceedance recorded by the HVAS or Partisol samplers in 2012 and it occurred on September 5. It was noted that this day was very windy and the TSP-3 station filter was noted as being very dirty, likely due to fugitive dust. The Partisol samplers were installed in June 2012 and therefore their results are not representative of the full year.

In 2013, the HVAS samplers were removed from service in June and therefore their results are not representative of the full year. From the half year of results, the maximum 24 hour concentration was 52 µg/m^3 measured at TSP-3. The Partisol samplers were in place for the full year as they were installed to replace the HVAS samplers. During 2013, 47 and 57 valid samples of TSP were collected by Partisol stations Grizzly and Cell B, respectively. The mean annual concentrations were 7.0 and 6.9 µg/m^3, with maximum 24 hour concentrations of 52 and 32 µg/m^3 measured at Grizzly and Cell B, respectively.

During 2014, 55 and 54 TSP samples were collected at Grizzly and Cell B. The mean annual concentrations were 19 and 14 µg/m^3, with maximum 24 hour concentrations of 184 and 94 µg/m^3 measured at Grizzly and Cell B, respectively. The annual and maximum daily TSP concentrations were higher in 2014 compared to 2012 and 2013 due to the significant wildfires which occurred in throughout the Northwest Territories during the summer of 2014. The Partisol stations recorded two 24 hour TSP exceedances, both of which occurred on days when there was wildfire smoke present on the Ekati mine site as reported by the Ekati Airport (EC 2015b):

- 184 µg/m^3 on July 23, 2014 (Grizzly station); and
- 136 µg/m^3 on July 29, 2014 (Grizzly station).

Other days during the summer of 2014 had elevated daily TSP concentrations due to wildfire smoke which occurred on 28 days in total (Figure 3.4-1; EC 2015b). There is a long-term trend of decreasing TSP concentrations over time since sampling began in 1998 (Table 3.4-1). This decreasing trend is evident in the maximum, minimum and mean 24 hour concentrations, with the exception of 2014 which experienced elevated readings during the summer due to the large amount of wildfire smoke.

The HVAS and Partisol data suggest the Ekati mine operations produce suspended particulates; however, concentrations are generally within the guidelines. These findings support the CALPUFF air dispersion modelling prediction that deposition of TSP resulting from mine fugitive dust emissions would be indistinguishable from background rates at a distance of 14 to 20 km from active mining areas (Rescan 2006).

3.4.2 Continuous Air Monitoring (CAM)

CAM data from January 2012 to December 2014 was collected at the Polar Explosives CAM station. The data was collected on a quarterly basis by Maxxam personnel to be analyzed and reported upon.

These Maxxam reports and calibration records are included in Appendix 7. (The Maxxam report containing CAM data from November to December 2014 was not available at the time of reporting.)

The results presented in this section were provided by the Ekati mine and have gone through a quality control review by ERM Rescan. Some summary results presented in this report are slightly different than what was reported by Maxxam and were determined by ERM to be more accurate. For example, the Maxxam reports did not filter out suspicious large spikes in the data that occurred before and/or after a station was offline for a temporary period (due to power failures, maintenance, sensor failure, etc.). The Maxxam reports also did not adjust $PM_{2.5}$ data using the methodology in the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality* (Alberta Environment and Sustainable Resource Development 2014).

The Ekati mine site has adopted GNWT ambient air quality standards as operational targets. A summary of the GNWT standards is presented in Tables 3.2-1 above. Monthly maximum values for hourly and daily mean concentrations of the six air quality parameters (SO_2, NO_2, NO, NO_X, $PM_{2.5}$ and TSP) collected between 2012 and 2014 are presented in Table 3.4-2 and Figures 3.4-2 and 3.4-3.

As directed by the GNWT, for those dates with visible wildfire smoke at the Ekati mine, the TSP and $PM_{2.5}$ concentrations were not considered representative of the Ekati Diamond Mine activities and were not to be compared to the relevant GNWT standards (M. Seaboyer, pers. comm.). For data completeness purposes these values are still included in tables and figures with relevant notes highlighting days with wildfire smoke. The difference between the particulate data with wildfire smoke versus without wildfire smoke was significant. For example, monthly mean $PM_{2.5}$ values without wildfire smoke from June to August 2014 were 28% to 77% lower than the monthly mean values that included wildfire smoke (Table 3.4-2). For the same comparison, the monthly mean TSP values without wildfire smoke were 6% to 70% lower than the values that included wildfire smoke.

All hourly, daily and annual average concentrations of SO_2 and NO_2 are below the NWT standards. The daily GNWT standards for $PM_{2.5}$ (28 µg/m^3) and TSP (120 µg/m^3) were exceeded 28 and 15 times, respectively, during the monitoring period. All $PM_{2.5}$ exceedances occurred during days when smoke from wildfires was observed at the Ekati Airport (EC 2015b). The majority of TSP exceedances also occurred during days when the project was experiencing smoke from wildfires; however, there were six days when there were TSP exceedances without visible wildfire smoke present:

- May 23, 2012 (138 µg/m^3 TSP, 15% over);
- May 24, 2012 (143 µg/m^3 TSP, 19% over);
- May 25, 2012 (180 µg/m^3 TSP, 50% over);
- May 26, 2012 (281 µg/m^3 TSP, 134% over);
- June 1, 2013 (146 µg/m^3 TSP, 22% over); and
- May 28, 2014 (122 µg/m^3 TSP, 2% over).

The annual mean $PM_{2.5}$ and TSP concentrations (ignoring periods with wildfire smoke) were below the GNWT standards for each year.

Table 3.4-2. Continuous Ambient Air Monitoring, 2012 to 2014 Monthly Summary

	SO_2 (ppb)						NO_2 (ppb)						NO (ppb)				NO_X (ppb)				$PM_{2.5}$ (ug/m^3)					TSP (ug/m^3)					
	Max 1hr		Max 24hr		Mean	OT	Max 1hr		Max 24hr		Mean	OT	Max 1hr	Max 24hr	Mean	OT	Max 1hr	Max 24hr	Mean	OT	Max 1hr	Max 24hr		Mean	OT	Max 1hr	Max 24hr		Mean	OT	Days with Visible
Month	Value	NE	Value	NE	Monthly	(%)	Value	NE	Value	NE	Monthly	(%)	Value	Value	Monthly	(%)	Value	Value	Monthly	(%)	Value	Value	NE	Monthly	(%)	Value	Value	NE	Monthly	(%)	Daytime Smoke
Jan-12	10.6	0	2.9	0	0.9	100	60	0	32	0	8.7	100	454	102	22.3	100	480	128	31.1	100	-	-	-	-	0[b]	-	-	-	-	0[b]	0
Feb-12	6.2	0	1.7	0	0.3	100	54	0	25	0	5.0	100	322	58	8.0	100	365	83	13.5	100	-	-	-	-	0[b]	-	-	-	-	0[b]	0
Mar-12	7.8	0	3.0	0	0.8	99	62	0	36	0	9.5	99	380	124	22.9	99	416	162	33.4	99	11	6.7	0	5.3	21[b]	36	9.8	0	7.3	22[b]	0
Apr-12	10.3	0	2.3	0	0.3	100	71	0	20	0	4.0	100	483	114	12.3	100	510	133	17.5	100	12	5.7	0	3.6	100	155	42.2	0	13.2	100	0
May-12	7.1	0	2.0	0	0.6	100	37	0	14	0	3.6	100	122	29	6.2	100	148	44	10.2	100	15	9.4	0	4.1	100	992	281.4	4	46.4	86[f]	0
Jun-12	7.3	0	2.1	0	1.5	82	44	0	15	0	3.9	80	276	48	8.2	81	319	62	11.9	81	25	13.7	0	6.7	79	119	38.7	0	21.5	17[f]	0
Jul-12	13.6	0	9.0	0	0.6	41[a]	26	0	7	0	2.6	82	155	19	3.2	82	177	26	5.4	82	115	27.2	0	11.8	70[c]	208	65.3	0	24.6	82	3
Aug-12	16.1	0	11.5	0	4.1	47[a]	23	0	9	0	2.5	100	126	28	4.5	100	143	36	6.8	100	22	15.4	0	8.2	88[c]	432	62.2	0	24.8	100	0
Sep-12	5.7	0	3.2	0	2.4	100	29	0	10	0	2.2	100	159	24	3.6	100	179	30	5.4	100	25	11.4	0	6.2	90[d]	110	23.5	0	11.6	81	0
Oct-12	6.5	0	3.0	0	1.6	100	51	0	10	0	3.4	99	301	45	6.2	99	351	55	9.7	99	15	2.3	0	2.0	7[d]	41	8.6	0	5.6	7	0
Nov-12	5.2	0	2.4	0	0.4	100	45	0	26	0	3.1	100	251	103	5.9	100	295	135	9.4	100	11	4.8	0	2.0	91	92	42.1	0	6.7	100	0
Dec-12	8.3	0	4.3	0	0.7	91	55	0	32	0	10.7	91	340	145	16.3	91	359	172	27.6	91	13	4.2	0	1.6	90	21	7.8	0	3.7	91	0
Jan-13	4.2	0	1.2	0	0.5	88	46	0	8	0	2.2	88	190	32	2.0	88	219	45	4.9	88	29	5.3	0	2.1	88	18	8.3	0	3.5	88	0
Feb-13	10.8	0	3.4	0	1.2	100	65	0	36	0	12.2	100	472	148	34.5	100	498	173	47.6	100	22	7.8	0	2.4	100	36	12.7	0	3.6	100	0
Mar-13	8.2	0	2.6	0	0.5	97	66	0	31	0	6.7	97	356	142	19.0	97	450	173	26.2	97	15	8.3	0	3.0	78[e]	67	36.1	0	8.9	98	0
Apr-13	6.8	0	0.9	0	0.3	100	47	0	21	0	2.7	100	369	46	4.4	100	397	54	7.0	100	13	6.2	0	3.4	100	340	47.5	0	12.1	100	0
May-13	6.5	0	1.4	0	0.4	100	50	0	15	0	4.8	100	361	55	9.3	100	403	69	13.0	100	160	22.9	0	4.2	100	516	70.2	0	18.3	100	0
Jun-13	9.9	0	1.3	0	0.5	97	39	0	24	0	3.7	96	234	79	7.1	96	272	96	9.9	96	40	12.8	0	7.2	91	994	146.0	1	26.0	97	0
Jul-13	3.3	0	1.1	0	0.5	100	29	0	11	0	2.4	100	163	32	3.9	100	191	42	5.4	100	66	26.1	0	6.5	99	45	17.0	0	3.1	100	0
Aug-13	5.4	0	2.1	0	1.2	89	41	0	12	0	3.3	89	110	17	3.4	89	131	28	5.7	89	101	39.2	5	10.4	88	128	38.5	0	15.2	38	4
Sep-13	4.4	0	2.2	0	0.9	89	30	0	12	0	3.2	89	167	41	7.0	89	192	53	10.0	89	69	8.8	0	5.0	89	176	68.8	0	11.1	53	0
Oct-13	1.6	0	0.6	0	0.1	80	21	0	4	0	1.2	80	69	6	1.1	80	89	9	2.3	80	10	4.2	0	2.7	80	72	25.2	0	4.5	80	0
Nov-13	5.0	0	1.1	0	0.3	96	49	0	20	0	4.1	96	297	69	7.6	96	345	93	11.7	96	8	3.7	0	1.6	95	38	9.2	0	2.7	96	0
Dec-13	7.8	0	1.2	0	0.3	97	88	0	27	0	2.5	97	397	71	3.4	97	433	98	6.0	97	13	3.2	0	1.3	97	30	4.5	0	2.2	97	0
Jan-14	4.7	0	1.6	0	0.5	100	54	0	15	0	4.6	100	264	41	7.2	100	317	63	12.0	100	12	2.9	0	1.4	99	132	8.0	0	2.6	100	0
Feb-14	8.8	0	2.4	0	0.4	100	69	0	32	0	5.0	100	406	111	9.7	100	446	141	14.7	100	30	2.4	0	1.2	100	31	6.5	0	2.6	87	0
Mar-14	7.2	0	2.8	0	0.6	99	46	0	24	0	4.7	99	362	119	10.1	99	401	142	14.5	99	21	5.1	0	1.7	89	110	23.0	0	4.3	86	0
Apr-14	10.1	0	2.5	0	0.8	100	62	0	25	0	7.0	100	436	125	15.2	100	467	154	22.5	100	20	6.2	0	3.1	99	202	90.4	0	19.0	100	0
May-14	4.1	0	1.2	0	0.6	96	43	0	13	0	5.1	96	240	42	9.4	96	279	55	13.8	96	111	15.3	0	4.2	93	979	122.4	1	25.7	96	0
Jun-14	4.8	0	1.3	0	0.5	94	34	0	19	0	4.6	94	219	65	11.4	94	247	84	14.6	94	92	60.6	2	8.3	80	599	137.8	1	42.9	83	5
Jul-14	1.7	0	0.2	0	0.0	100	30	0	9	0	2.4	100	156	31	2.7	100	181	41	5.4	100	625	316.2	14	63.8	100	699	339.9	8	81.3	100	15
Aug-14	4.2	0	0.6	0	0.0	100	27	0	10	0	2.1	100	284	49	4.9	100	310	60	7.3	100	322	121.2	7	27.4	100	354	115.5	0	31.3	71[g]	8
Sep-14	2.6	0	1.2	0	0.1	99	26	0	9	0	1.1	99	121	30	2.0	99	148	42	3.4	99	56	12.9	0	6.6	86	104	42.3	0	8.7	99	0
Oct-14	4.8	0	2.2	0	0.7	86	47	0	26	0	6.7	86	257	86	16.6	86	304	115	24.0	86	22	11.7	0	5.6	83	50	17.9	0	7.3	86	0
Nov-14	4.6	0	1.1	0	0.3	98	55	0	20	0	2.9	98	250	35	3.6	98	301	55	6.6	98	15	6.3	0	2.8	95	191	13.7	0	4.5	98	0
Dec-14	5.9	0	1.9	0	0.7	99	59	0	25	0	5.0	99	233	64	10.3	99	293	83	15.9	99	18	9.3	0	3.5	97	44	11.2	0	4.5	92	0

Notes:

OT=Operational Time

NE=Number of Exceedances

dash (-) = Not Available

Data were adjusted as required using the methodology in the Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality (Alberta Environment and Sustainable Resource Development 2014). This includes below zero adjustments for all parameters and baseline adjustments for $PM_{2.5}$.

All $PM_{2.5}$ exceedances occurred on days when the Project area experienced smoke from wildfires.

Days with visible daytime smoke reported by the Ekati Airport weather observations

2012: July 16 - 18

2013: August 12 - 15

2014: June 18 - 19, 24 - 26; July 3, 13 - 16, 21 - 30; August 2 - 3, 5, 10, 12 - 13, 25 - 26

Short durations of missing data were primarily caused by routine maintenance, power failures, erroneous data spikes, or other unknown reasons.

Longer periods of missing data are were caused by the following:

[a] *SO_2 analyser failed between July 19 and August 17, 2012.*

[b] *New $PM_{2.5}$ and TSP analog input modules were installed and final configurations were completed on March 25, 2012.*

[c] *$PM_{2.5}$ analyser failed between July 29 and August 4, 2012.*

[d] *Invalid continuous $PM_{2.5}$ measurements of approximately 5 µg/m3 persisted from September 28 to October 29, 2012.*

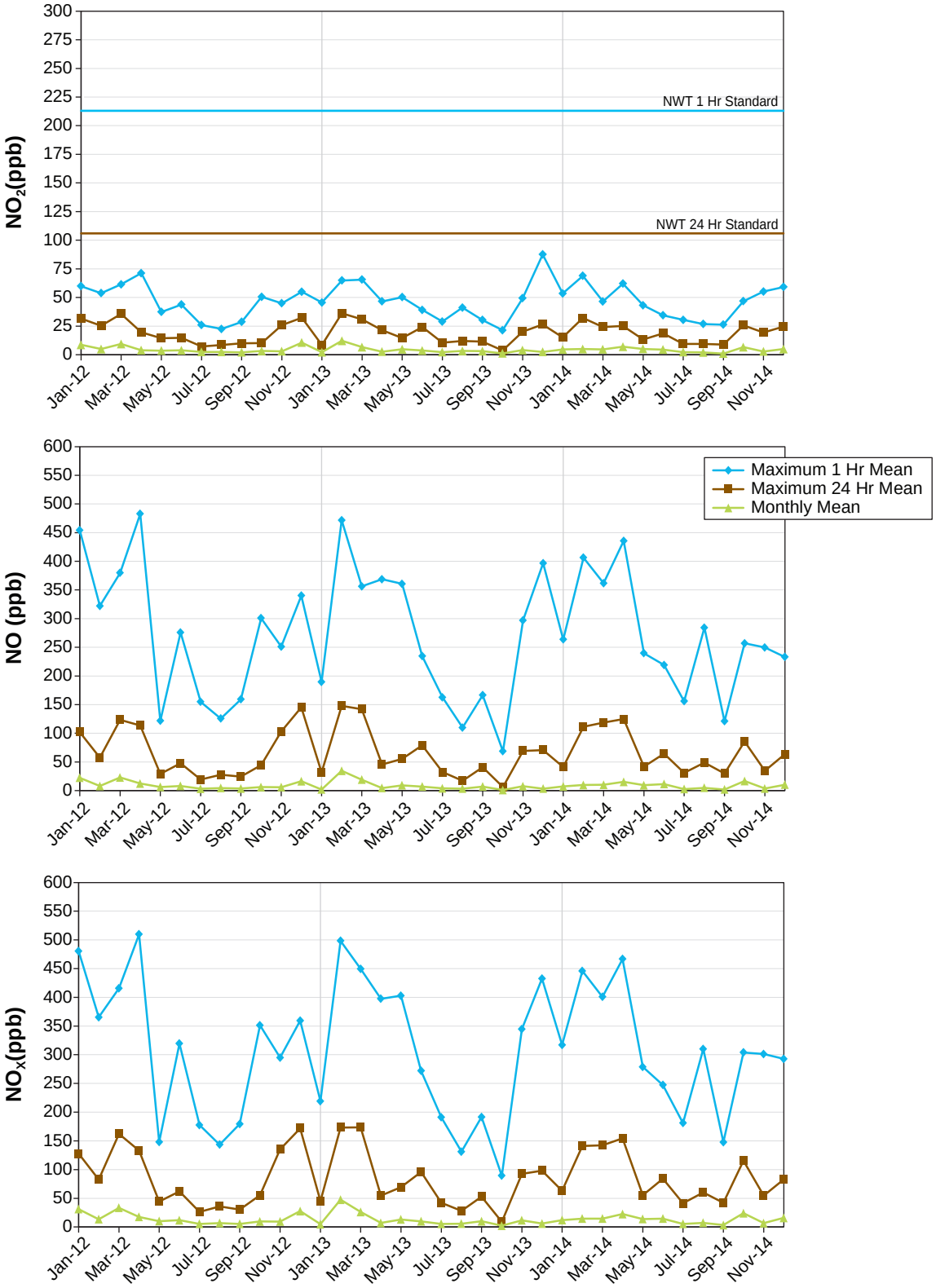
[e] *$PM_{2.5}$ analyser failed between March 9 and 15, 2013.*

[f] *Invalid continuous TSP measurements of approximately 150 and 20.7 µg/m^3 persisted from May 28 to June 20, 2012.*

[g] *Invalid continuous $PM_{2.5}$ measurements of approximately 4.8 µg/m^3 persisted from August 19 to 28, 2014.*

Figure 3.4-2

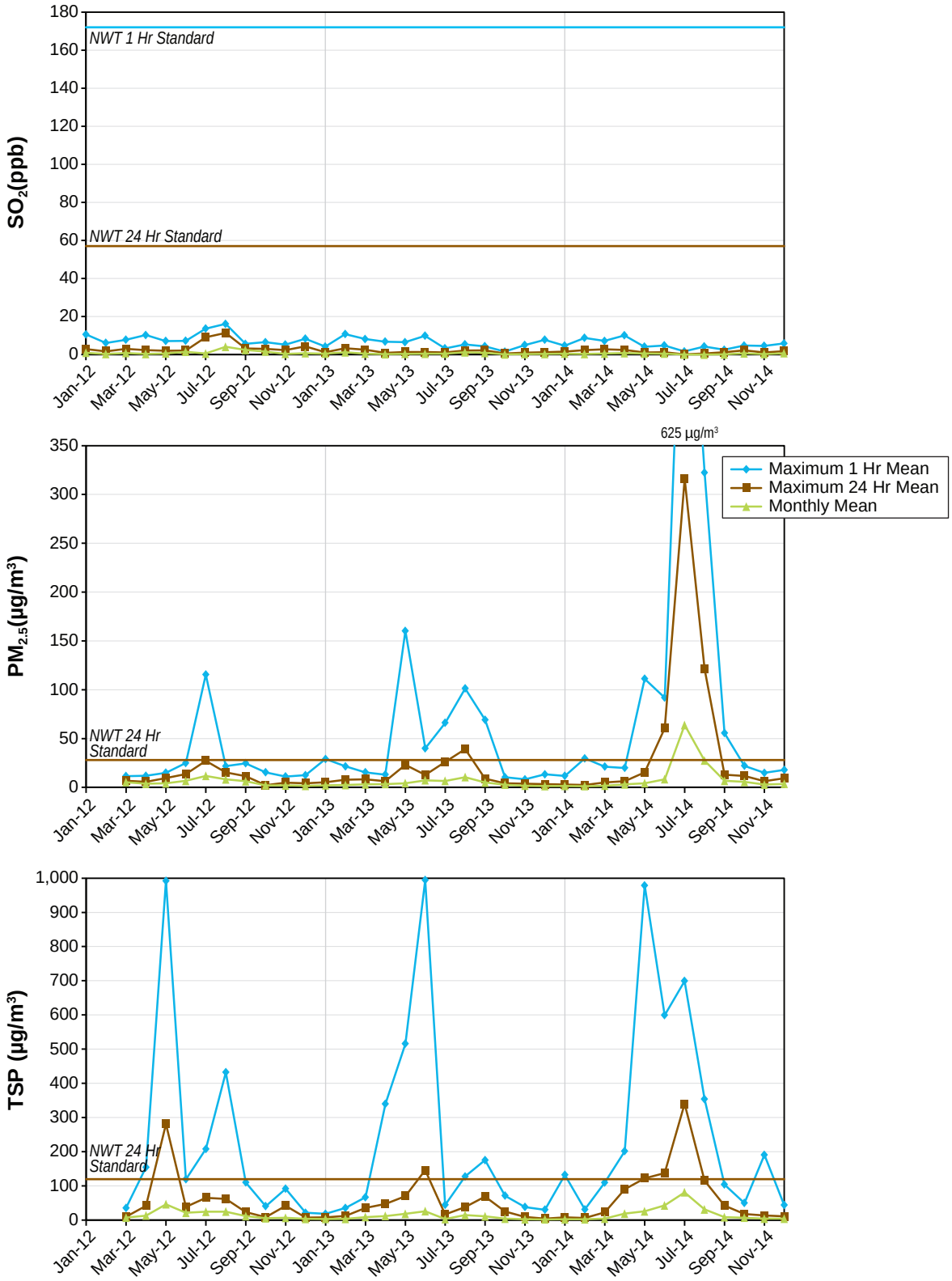
2012 to 2014 CAM Monthly Results: NO_2, NO and NO_X



Note: Dates with visible daytime smoke recorded by Ekati Airport:
2012: July 16 - 18
2013: August 12 - 15
2014: June 18 - 19, 24 - 26; July 3, 13 - 16, 21 - 30; August 2 - 3, 5, 10, 12 - 13, 25 - 26

Figure 3.4-3

2012 to 2014 CAM Monthly Results: SO_2, $PM_{2.5}$ and TSP



Note: All $PM_{2.5}$ exceedances occurred on days when the Project area experienced smoke from wildfires.
Dates with visible daytime smoke recorded by Ekati Airport:
2012: July 16 - 18
2013: August 12 - 15
2014: June 18 - 19, 24 - 26; July 3, 13 - 16, 21 - 30; August 2 - 3, 5, 10, 12 - 13, 25 - 26

Limited temporal patterns of maximum 24 hour mean concentrations of NO_2, NO, SO_2, $PM_{2.5}$ and TSP were observed (Figures 3.4-2 and 3.4-3). NO_2 maximum values and monthly means have decreased slightly between 2012 and 2014, with increased concentrations in the winter months of each year. These elevated NO_2 concentrations are likely due to the increase in winter diesel heating fuel usage (Table 3.3-2). There are no standards for NO and NO_X; however, as expected the concentrations generally follow the same trend as the NO_2 concentrations.

Limited temporal trends in SO_2 concentrations were also observed (Figure 3.4-3). Similar to patterns observed for NO_2, SO_2 concentrations also increase during the winter months, primarily in response to the increase in diesel usage. Due to the low sulphur content of diesel fuel used, the resulting SO_2 concentrations are many times lower than the GNWT limits.

The majority of $PM_{2.5}$ measurements between January 2009 and March 2014 were negative, and were therefore adjusted using the methodology in the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality* (Alberta Environment and Sustainable Resource Development 2014), including baseline adjustments using the results from the periodic zero calibration audits. The monthly patterns show that $PM_{2.5}$ increases during the snow free months, as expected, primarily due to vehicle movement on snow free ground. As discussed, all $PM_{2.5}$ exceedances were due to wildfires in the region, particularly during the summer of 2014 which resulted in very high $PM_{2.5}$ concentrations during periods of on-site wildfire smoke.

There were a significant number of negative TSP measurements between October 2012 and May 2014, which were also corrected using the methodology in the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality*. Monthly TSP patterns resemble those of the $PM_{2.5}$ concentrations with the snow free summer months having higher TSP compared to those months with snow cover. Wildfire smoke also had a significant impact on the hourly, daily and monthly mean TSP concentrations during the summer of 2014.

The 2006 CALPUFF air dispersion modeling results (Section 3.2) predicted that SO_2, NO_2, NO_X, $PM_{2.5}$ and TSP concentrations would be below GNWT standards outside the active mining area. The CAM station is located at the Polar Explosives site, which is close to the active mining area; hence, pollution values outside this area are expected to be lower than pollution measured at the CAM station, on average, because airborne pollution concentrations generally decrease with distance from the source. Taking into account external wildfire smoke, these model predictions followed the patterns of the 2012 to 2014 CAM measurements.

3.5 DUSTFALL MONITORING

3.5.1 Total Dustfall

The dustfall monitoring program, first initiated in 2006, was developed to determine the deposition patterns for fugitive dust from the haul road. In 2008, the program expanded to sample at additional locations. The 2012 to 2014 monitoring period for this report uses the same sample locations as used in 2008 to 2011, as well as six additional new locations (three permanent in 2014 and three temporary in 2012). There are no specific guidelines for fugitive dust deposition in the Northwest Territories. The 1979 British Columbia Pollution Objective for the Mining, Smelting and Related Industries for total particulate (sum of soluble and insoluble particulate) is 1.7 to 2.9 milligrams per decimetre

squared per day (mg/dm^2/d) as a 30 day average. This British Columbia dustfall objective is similar to or slightly more stringent than other Canadian jurisdictions.

Results for the complete suite of parameters for the 2012 to 2014 dustfall dataset are provided in Appendix 9. A summary of the key findings of the analysis is provided in the text below and in Table 3.5-1, Figures 3.5-1 and 3.5-2. The results of the dustfall monitoring program are aligned with site activity for the monitoring years from 2012 to 2014.

In 2012, total dustfall was significantly higher near the Fox Haul Road compared to the Misery Haul Road. In 2013, the Misery Haul Road dust increased compared to 2012, likely due to the increase in activity at Misery camp and Misery Haul Road construction activities creating more traffic (see Section 1.2 for a summary of activities in different years). In 2014, the Misery Haul Road dust further increased compared to 2013, due to convoys of ore transported from Misery to the processing plant. On average, the Fox Haul Road dust levels decreased in 2014 compared to 2012 and 2013. This dust decrease from the Fox Haul Road is likely due to the reduced activity at Fox Pit in 2014 (only some material sorting and moving).

Within 90 m downwind of the Misery and Fox roads, dustfall concentrations were generally higher than the BC Pollution Objective goal of 2.9 mg/dm^2/d. At a distance of 300 m downwind of the road, all measured dustfall concentrations were below this goal except for August/September of 2013 at the Fox road (3.4 mg/dm^2/d). At 1,000 m downwind, all dustfall concentrations were comparable to levels measured by background dustfall stations AQ-49 (19 km from Pigeon Pit) and AQ-54 (34 km from Pigeon Pit). The 2006 CALPUFF model predictions agree with these dustfall trends in terms of their spatial distributions and relative concentration levels.

From July to September 2012, dustfall sampling was also performed downwind of the Fox Pit waste rock area to determine if the waste rock was a source of dustfall due to wind erosion and material handling. The dustfall stations placed 100, 300 and 1,000 m downwind of the waste rock area collected low dustfall concentrations, comparable to background dustfall levels measured at AQ-49 and AQ-54 (Table 3.5-1, Figure 3.5-1). Due to the low dustfall levels measured, monitoring was not continued in 2013 or 2014.

In response to comments received on the dustfall program, in August 2014 additional dustfall stations were installed downwind of the Misery Haul Road that were better aligned along the downwind path from the road in comparison to the original Misery Haul Road dustfall stations (Figure 2.1-1). These new stations collected varying amounts of dustfall compared to the original stations during the same August/September monitoring period. At 90 m downwind, the new station MisNew-D90 collected 2.2 mg/dm^2/d more than the original Mis-D90. At 300 m downwind of the road, both MisNew-D300 and Mis-D300 collected the same amount of dustfall and at 1,000 m, MisNew-D1000 collected 0.3 mg/dm^2/d less than Mis-D1000 (Table 3.5-1, Figure 3.5-1).

Dustfall concentrations measured from the three airport stations and two LLCF stations showed that average dustfall levels were higher in 2013 and 2014 compared to 2012 (Table 3.5-1, Figure 3.5-2). However, the majority of measurements were below the BC Objective of 2.9 mg/dm^2/d. The exceptions include LLCF-PB (3.5 mg/dm^2/d) during July/August 2012, AIR-P280 (4.1 mg/dm^2/d) and LLCF-PB (5.3 mg/dm^2/d) during June/July 2014 and LLCF-PA (7.0 mg/dm^2/d) during July/August 2014.

Table 3.5-1. Dustfall and Acid Deposition, 2012 to 2014

	2012				2013				2014			
Start Date:	Jun. Jun. 2, 4	Jul./Aug. Jul. 2, 3	Aug./Sep. Aug. 16		Jun./Jul. Jun. 15	Jul./Aug. Jul. 15	Aug./Sep. Aug. 15		Jun./Jul. Jun. 15	Jul./Aug. Jul. 15	Aug./Sep. Aug. 15	
End Date:	Jul. 2, 3	Aug. 16	Sep. 14	Mean	Jul. 15	Aug. 15	Sep. 15, 16, 17, 25	Mean	Jul. 15	Aug. 15	Sep. 15, 16	Mean
Dustfall (mg/dm²/day)												
Air-P125	0.5	0.6	0.2	0.4	1.4	0.7	0.9	1.0	0.8	1.3	2.3	1.4
Air-P162	0.3	0.9	0.3	0.5	1.3	1.3	0.4	1.0	0.8	1.7	2.6	1.7
Air-P280	2.0	1.3	0.6	1.3	2.1	1.6	1.2	1.6	4.1	1.9	1.9	2.6
AQ-49	<0.1	0.5	0.2	0.3	1.0	0.8	0.5	0.8	0.3	0.8	0.2	0.4
AQ-54	<0.1	0.2	0.2	0.2	0.6	0.3	0.3	0.4	0.3	0.6	0.2	0.3
Fox-U30	27.6	23.8	16.4	22.6	17.2	18.3	25.1	20.2	19.5	11.5	9.0	13.3
Fox-D30	7.6	21.9	17.9	15.8	23.0	12.4	35.7	23.7	32.3	7.4	3.4	14.4
Fox-D90	6.9	4.4	4.0	5.1	4.3	2.9	6.0	4.4	5.5	2.3	1.2	3.0
Fox-D300	2.7	1.6	1.5	1.9	2.7	1.1	3.4	2.4	2.2	1.5	0.4	1.4
Fox-D1000	0.8	0.8	0.6	0.7	0.9	0.6	0.4	0.6	0.8	0.9	0.2	0.6
LLCF-PA	0.4	0.7	1.7	0.9	1.3	0.8	2.3	1.5	0.8	7.0	0.6	2.8
LLCF-PB	0.2	3.5	0.5	1.4	1.3	0.9	1.2	1.2	5.3	1.8	0.4	2.5
Mis-U30	5.5	7.8	7.1	6.8	4.7	35.9	14.9	18.5	27.7	25.0	20.1	24.3
Mis-D30	3.4	6.9	3.5	4.6	5.9	11.2	7.5	8.2	40.1	13.8	18.1	24.0
Mis-D90	1.8	1.5	0.7	1.3	1.8	3.0	2.0	2.3	5.5	3.1	4.1	4.2
Mis-D300	0.4	0.4	0.2	0.3	1.5	1.1	0.5	1.1	2.4	1.2	1.2	1.6
Mis-D1000	0.1	0.3	0.4	0.3	1.0	0.5	0.4	0.6	0.6	0.6	0.6	0.6
MisNew-D90	-	-	-	-	-	-	-	-	-	-	6.3	-
MisNew-D300	-	-	-	-	-	-	-	-	-	-	1.2	-
MisNew-D1000	-	-	-	-	-	-	-	-	-	-	0.3	-
WasteRock-100	-	0.3	0.3	-	-	-	-	-	-	-	-	-
WasteRock-300	-	0.4	0.4	-	-	-	-	-	-	-	-	-
WasteRock-1000	-	0.5	0.2	-	-	-	-	-	-	-	-	-

(continued)

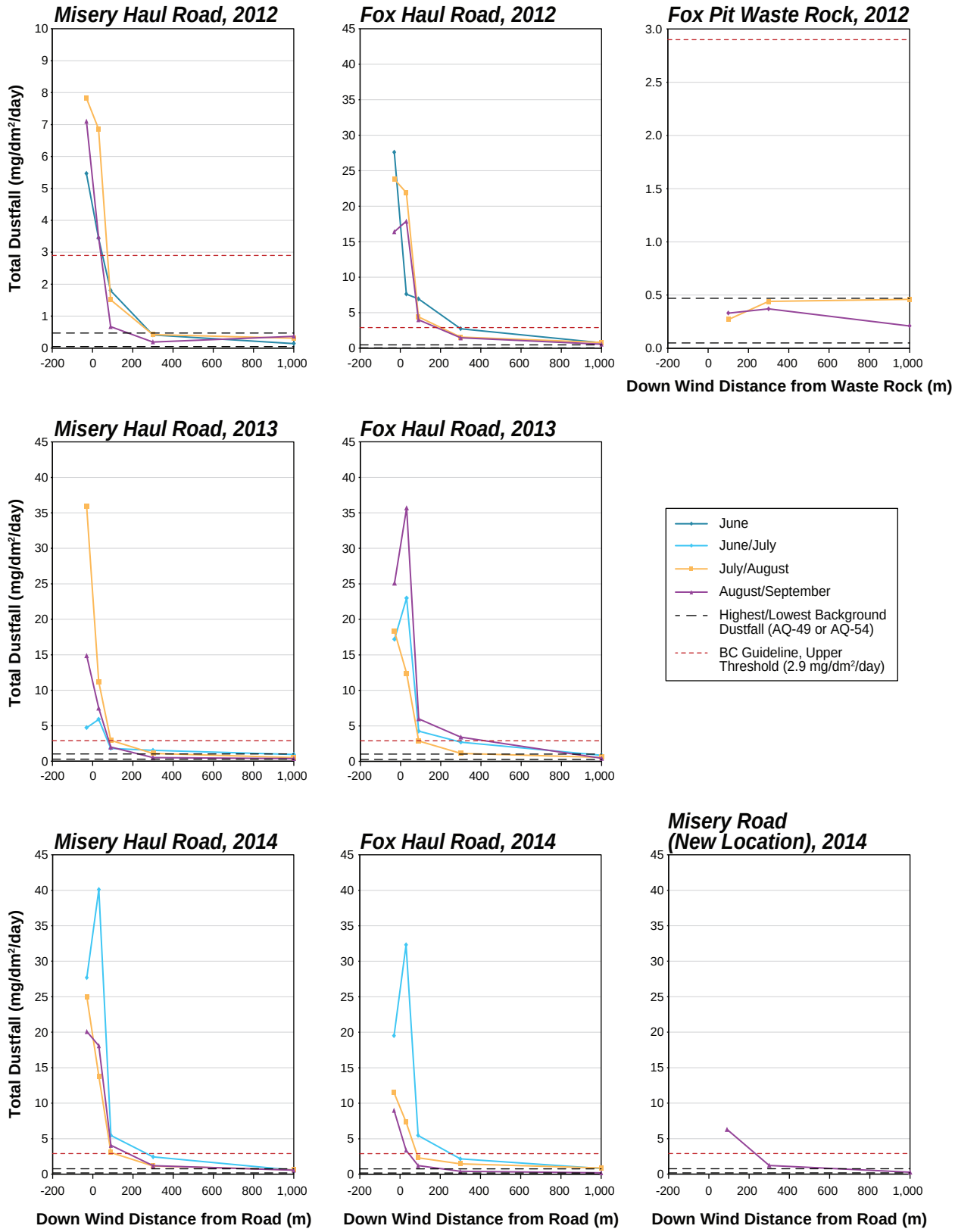
Table 3.5-1. Dustfall and Acid Deposition, 2012 to 2014 (completed)

	2012				2013				2014			
Start Date:	Jun. Jun. 2, 4	Jul./Aug. Jul. 2, 3	Aug./Sep. Aug. 16		Jun./Jul. Jun. 15	Jul./Aug. Jul. 15	Aug./Sep. Aug. 15		Jun./Jul. Jun. 15	Jul./Aug. Jul. 15	Aug./Sep. Aug. 15	
End Date:	Jul. 2, 3	Aug. 16	Sep. 14	Mean	Jul. 15	Aug. 15	Sep. 15, 16, 17, 25	Mean	Jul. 15	Aug. 15	Sep. 15, 16	Mean
Acid Deposition (eq/ha/yr)												
Air-P125	21	58	58	46	53	84	68	68	40	354	118	171
Air-P162	21	62	62	48	58	99	90	82	37	282	90	136
Air-P280	64	71	71	68	99	106	66	90	88	311	120	173
AQ-49	25	75	75	58	82	54	64	67	30	325	65	140
AQ-54	20	78	78	59	111	73	63	82	35	197	76	103
Fox-U30	404	386	386	392	189	350	333	291	180	475	181	279
Fox-D30	147	418	418	328	256	261	382	300	347	409	157	304
Fox-D90	135	161	161	153	111	136	122	123	116	376	71	188
Fox-D300	78	78	78	78	75	87	110	90	100	299	53	151
Fox-D1000	41	80	80	67	68	69	47	62	63	290	46	133
LLCF-PA	232	62	62	119	127	72	82	94	562	1575	372	836
LLCF-PB	31	45	45	40	89	35	69	65	335	511	113	320
Mis-U30	98	151	151	133	84	375	258	239	329	389	215	311
Mis-D30	76	132	132	113	125	263	160	183	291	380	166	279
Mis-D90	45	57	57	53	61	99	66	75	97	259	118	158
Mis-D300	18	40	40	33	70	71	64	68	56	252	39	116
Mis-D1000	20	44	44	36	45	43	58	49	53	273	39	122
MisNew-D90	-	-	-	-	-	-	-	-	-	-	167	-
MisNew-D300	-	-	-	-	-	-	-	-	-	-	281	-
MisNew-D1000	-	-	-	-	-	-	-	-	-	-	49	-
WasteRock-100	-	31	57	-	-	-	-	-	-	-	-	-
WasteRock-300	-	70	66	-	-	-	-	-	-	-	-	-
WasteRock-1000	-	72	55	-	-	-	-	-	-	-	-	-

Notes:
dash (-) = not available
Values below detection limit are presented as half the detection limit.

Figure 3.5-1

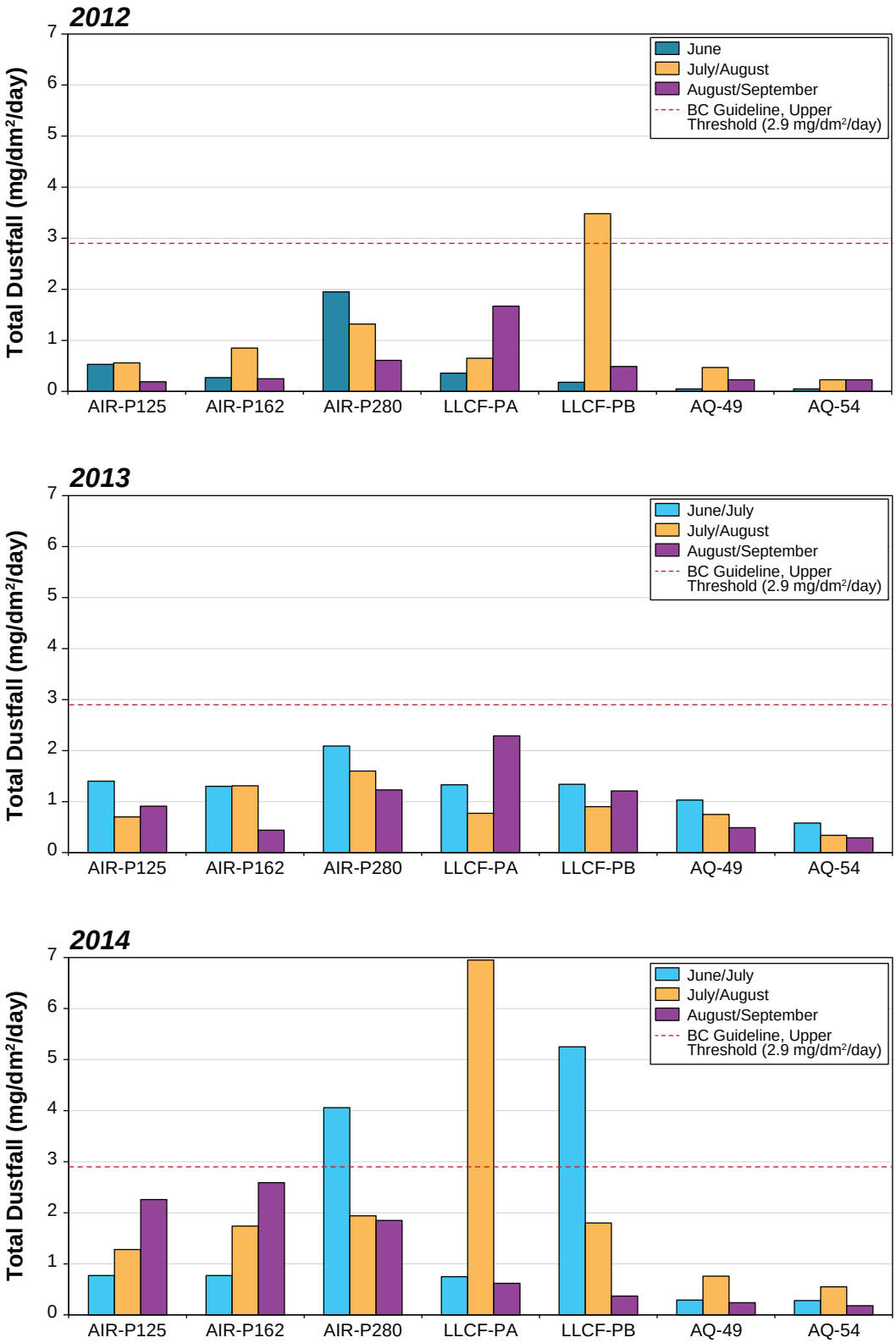
2012 to 2014 Dustfall Measured at Misery Haul Road, Fox Haul Road and Fox Pit Wast Rock Monitoring Stations



Note: Nagative downwind distances represent upwind distance from road.

Figure 3.5-2

2012 to 2014 Dustfall Measured at Airstrip, LLCF and Background Monitoring Stations



3.5.2 Acid Deposition

Estimates of critical load ranges have been established for both aquatic and terrestrial ecosystems for many areas of Canada. Terrestrial critical loads have yet to be established for the NWT or other regions characterized by tundra. Table 3.5-2 shows the range of established critical loads for soil in other Canadian jurisdictions that can be compared to loadings at the Ekati mine to provide some context as to the likely effect of the mine on acid deposition (EC 2004).

Table 3.5-2. Established Critical Loads for Soil in Canadian Jurisdictions

Province	Median (eq/ha/yr)	5th Percentile (eq/ha/yr)
Newfoundland	572	247
Nova Scotia	817	277
Prince Edward Island	2063	715
New Brunswick	1169	559
Quebec	519	358
Ontario	548	388
Total	559	358

Source: Table 8.4 from EC (2004)

Sulphate and nitrate results were reported as loadings of mg/dm^2/day (see Appendix 9). The maximum loadings for sulphate and nitrate deposition observed in dustfall samples at any site between 2012 and 2014 were:

- nitrate – 0.01 mg/dm^2/d (261 eq/ha/yr) (August/September, 2014 at MisNew-D300; lab report L1523186); and
- sulphate – 0.21 mg/dm^2/d (1,571 eq/ha/yr) (July/August, 2014 at LLCF-PA; lab report L1506803).

Acid deposition was calculated from the sum of monthly nitrate and sulphate loads, once converted to units of eq/ha/yr, for each sampling location within the project area (Table 3.5-1). For samples that had nitrate and sulphate loads that were below the laboratory detection limits, it was assumed that the value was half of the detection limit, for calculation purposes.

The average acid depositions from each consecutive annual summer monitoring period were compared against the provincial critical load standards (Table 3.5-2). The highest of these acid deposition rates was calculated to be 836 eq/ha/yr, from LLCF-PA between mid-June and mid-September 2014 (Table 3.5-1). The second highest value was 392 eq/ha/yr from FOX-U30 between June and mid-September 2012. The highest annual median value from all non-background sites (excluding WasteRock and MisNew stations) was 173 eq/ha/yr. This median value is below all provincial median critical load standards (Table 3.5-2), as well as the Alberta PAI load standard of 250 eq/ha/yr. In comparison, calculated acid deposition rates from background monitoring sites AQ-49 and AQ-54 ranged from 58 to 140 eq/ha/yr (Table 3.5-1). These results for the Ekati mine are within the established Canadian critical acid deposition loads for soil. In addition, the acid

deposition calculations neglect the effect of neutralizing compounds found in dustfall and soil. Therefore, actual loading is likely less than the calculated estimates.

3.5.3 Metal Deposition

Metal deposition analytical results are summarized in Table 3.5-3 and results are included in Appendix 9. Figure 3.5-3 shows the maximum deposition for select metals at each station, associated with soil nutrient cations.

The results from 2012, 2013 and 2014 are as expected, compared to historical data, with many metals below or close to the detection limit. All metal concentrations were below 0.5 mg/dm^2/d (Table 3.5-3). All metal deposition values at the two background monitoring stations were below 0.03 mg/dm^2/d (value of potassium from AQ-54 in 2014; Figure 3.5-3).

In general, the metal deposition levels are proportional to the amount of total dustfall. Dustfall monitoring locations close to the Fox and Misery Haul Roads had higher metal deposition amounts for the majority of metals compared to the other stations (Table 3.5-3, Figure 3.5-3).

3.6 SNOW CHEMISTRY MONITORING

Summary statistics of the snow core chemistry are provided in Table 3.6-1. Field notes for each sampling location in 2014 are provided in Appendix 11. Laboratory results for the complete suite of parameters for the 2014 dataset are provided in Appendix 12.

The 2014 results were compared to historical averages from 1998 to 2011. In general, the 2014 results are within the historical range, and the average values for the majority of parameters are less than average values observed from 1998 to 2011. The notable exception is the 2014 loading result for magnesium. The average loading of 0.54 mg/m^2/d (Table 3.6-1) is due to one outlier site (AQ-05), where the observed loading was 11.3 mg/m^2/d. At sample location AQ-05, it was noted that there was visible dust in the snow of the toe sample which may account for elevated contaminant values for the majority parameters compared to other sample locations. Other possible explanations include errors in SWE reporting or sample contamination; however, there was no evidence in the field notes or lab analysis reports to support these two theories.

Spatial trends in the 2014 snow chemistry data were assessed using regression analysis of surface loading rates against distance from the nearest centre of mining activity (Main Camp, Fox Pit, Misery Pit, Pigeon Pit). In 2005 and 2008, positive relationships were observed for a number of variables likely associated with fugitive dust and fine particulates. The 2014 loadings for the crustal elements aluminum and chromium were mapped (Figure 3.6-1). The 2014 loading rates for the same crustal elements were compared with the 2005, 2008, and 2011 loading rates as a function of distance from nearest centres of activity (Figure 3.6-2).

Table 3.5-3. Summary of Metal Deposition from Dustfall Stations, 2012 to 2014

Paramater ($mg/dm^2/day$)	2012							2013							2014						
	Number Below Detection Limit	Mean	Median	Std. Dev.	Min.	Max.	Station with Max. Value	Number Below Detection Limit	Mean	Median	Std. Dev.	Min.	Max.	Station with Max. Value	Number Below Detection Limit	Mean	Median	Std. Dev.	Min.	Max.	Station with Max. Value
Aluminum (Al)	1	0.0444	0.0085	0.0675	8.0E-05	0.2320	FOX-D30	0	0.0420	0.0065	0.0771	2.4E-04	0.3580	Mis-U30	0	0.0759	0.0185	0.1145	6.6E-04	0.4250	Mis-D30
Antimony (Sb)	55	6.1E-07	5.5E-07	2.1E-07	4.0E-07	1.1E-06	FOX-D30	51	6.9E-07	6.0E-07	1.7E-07	5.5E-07	1.1E-06	-	51	7.1E-07	5.5E-07	4.5E-07	5.5E-07	3.5E-06	LLCF-PA
Arsenic (As)	14	2.6E-05	1.8E-06	4.0E-05	5.5E-07	1.1E-04	MIS-D300	25	3.3E-06	1.3E-06	4.8E-06	5.5E-07	2.1E-05	Mis-U30	19	2.6E-05	8.8E-06	3.2E-05	5.5E-07	1.7E-04	MisNew-D90
Barium (Ba)	1	9.0E-04	2.5E-04	0.0013	7.0E-06	0.0047	FOX-U30	0	8.5E-04	1.9E-04	0.0015	1.1E-05	0.0070	Mis-U30	0	0.0015	5.2E-04	0.0022	3.1E-05	0.0091	Mis-U30
Beryllium (Be)	57	2.9E-06	2.7E-06	9.7E-07	2.0E-06	5.0E-06	-	51	3.4E-06	2.9E-06	8.8E-07	2.8E-06	5.5E-06	-	54	3.1E-06	2.8E-06	8.8E-07	2.7E-06	6.0E-06	-
Bismuth (Bi)	57	2.9E-06	2.7E-06	9.7E-07	2.0E-06	5.0E-06	-	51	3.4E-06	2.9E-06	8.8E-07	2.8E-06	5.5E-06	-	53	3.2E-06	2.8E-06	1.3E-06	2.7E-06	1.0E-05	Fox-U30
Boron (B)	56	6.0E-05	5.5E-05	2.0E-05	4.0E-05	1.0E-04	AIR-P162	51	6.9E-05	6.0E-05	1.7E-05	5.5E-05	1.1E-04	-	53	6.4E-05	5.5E-05	2.2E-05	5.5E-05	1.7E-04	LLCF-PA
Cadmium (Cd)	51	8.5E-07	3.2E-07	2.5E-06	2.0E-07	1.6E-05	LLCF-PA	46	7.8E-07	2.9E-07	2.2E-06	2.8E-07	1.5E-05	LLCF-PB	37	1.5E-06	2.9E-07	6.2E-06	2.7E-07	4.5E-05	LLCF-PA
Calcium (Ca)	3	0.0170	0.0049	0.0255	5.0E-04	0.1060	FOX-U30	0	0.0213	0.0075	0.0310	0.0012	0.1460	Fox-D30	0	0.0331	0.0187	0.0360	0.0028	0.1340	Mis-U30
Chromium (Cr)	9	1.6E-04	5.2E-05	2.4E-04	2.0E-06	8.6E-04	FOX-D30	9	1.6E-04	3.0E-05	2.9E-04	2.8E-06	0.0012	Mis-U30	6	2.6E-04	7.5E-05	3.9E-04	2.7E-06	0.0015	Mis-U30
Cobalt (Co)	8	3.4E-05	1.0E-05	5.1E-05	4.0E-07	1.8E-04	FOX-D30	6	3.1E-05	5.5E-06	5.6E-05	5.5E-07	2.6E-04	Mis-U30	3	5.7E-05	1.9E-05	8.2E-05	5.5E-07	3.3E-04	Mis-U30
Copper (Cu)	44	1.2E-04	8.0E-05	1.2E-04	1.4E-05	6.2E-04	MIS-D30	0	2.6E-04	2.3E-04	1.4E-04	7.2E-05	9.2E-04	Air-P162	0	2.5E-04	2.3E-04	1.6E-04	1.8E-05	7.4E-04	LLCF-PA
Lead (Pb)	31	7.9E-06	3.8E-06	9.3E-06	8.0E-07	3.8E-05	FOX-D30	0	9.2E-06	5.3E-06	1.0E-05	1.0E-06	4.8E-05	Mis-U30	17	1.2E-05	6.6E-06	1.3E-05	1.2E-06	5.8E-05	Mis-D30
Lithium (Li)	39	8.9E-05	4.0E-05	1.1E-04	2.0E-05	4.0E-04	FOX-D30	37	8.8E-05	3.5E-05	1.3E-04	2.8E-05	7.2E-04	Mis-U30	33	1.3E-04	2.9E-05	1.9E-04	2.7E-05	7.9E-04	Mis-U30
Magnesium (Mg)	2	0.0477	0.0133	0.0711	1.6E-04	0.2550	FOX-U30	0	0.0427	0.0105	0.0753	3.9E-04	0.3280	Mis-U30	0	0.0769	0.0303	0.1070	0.0012	0.4140	Mis-U30
Manganese (Mn)	1	7.1E-04	2.1E-04	0.0010	8.0E-06	0.0036	FOX-D30	0	6.9E-04	1.8E-04	0.0012	2.1E-05	0.0059	Mis-U30	0	0.0014	6.6E-04	0.0017	1.1E-04	0.0074	Mis-U30
Mercury (Hg)	40	3.0E-07	2.4E-07	1.1E-07	2.0E-07	5.0E-07	AIR-P162	51	3.4E-07	2.9E-07	8.3E-08	2.8E-07	5.5E-07	-	34	2.9E-07	2.9E-07	4.6E-08	2.8E-07	5.5E-07	AQ-49
Molybdenum (Mo)	28	2.4E-06	5.6E-07	3.7E-06	2.0E-07	1.4E-05	FOX-U30	17	2.8E-06	1.1E-06	4.3E-06	2.8E-07	2.1E-05	Fox-D30	11	4.3E-06	1.7E-06	6.1E-06	2.7E-07	3.4E-05	LLCF-PA
Nickel (Ni)	15	2.1E-04	5.0E-05	3.4E-04	2.0E-06	0.0012	FOX-D30	3	2.0E-04	5.1E-05	3.5E-04	2.8E-06	0.0017	Fox-D30	1	3.4E-04	1.5E-04	4.5E-04	5.5E-06	0.0017	Mis-U30
Potassium (K)	0	0.0344	0.0110	0.0465	6.8E-04	0.1730	FOX-D30	1	0.0378	0.0190	0.0507	4.5E-04	0.2610	Mis-U30	0	0.0596	0.0257	0.0768	0.0014	0.3090	Mis-U30
Selenium (Se)	57	5.9E-06	5.5E-06	2.0E-06	4.0E-06	1.0E-05	-	51	6.9E-06	6.0E-06	1.7E-06	5.5E-06	1.1E-05	-	53	6.3E-06	5.5E-06	1.9E-06	5.5E-06	1.3E-05	LLCF-PA
Silver (Ag)	35	1.3E-07	8.0E-08	1.1E-07	4.0E-08	4.7E-07	FOX-D30	24	1.8E-07	1.2E-07	1.4E-07	5.5E-08	6.0E-07	Mis-U30	15	2.8E-07	2.2E-07	2.3E-07	5.5E-08	1.1E-06	LLCF-PA
Sodium (Na)	3	0.0079	0.0024	0.0115	2.0E-04	0.0443	FOX-U30	3	0.0099	0.0043	0.0130	4.1E-04	0.0606	Fox-D30	3	0.0154	0.0064	0.0211	2.7E-04	0.0982	Fox-D30
Strontium (Sr)	4	2.2E-04	5.6E-05	3.5E-04	2.3E-06	0.0015	FOX-U30	6	2.6E-04	7.4E-05	4.3E-04	2.7E-06	0.0020	Fox-D30	0	4.0E-04	1.8E-04	4.8E-04	1.2E-05	0.0016	Mis-D30
Thallium (Tl)	45	1.0E-06	7.0E-07	9.1E-07	4.0E-07	4.2E-06	FOX-U30	42	1.0E-06	6.0E-07	1.0E-06	5.5E-07	6.5E-06	Mis-U30	39	1.4E-06	5.5E-07	1.8E-06	5.5E-07	8.5E-06	Mis-D30
Tin (Sn)	40	1.3E-06	8.0E-07	1.4E-06	4.0E-07	5.9E-06	FOX-U30	38	3.4E-06	6.0E-07	1.5E-05	5.5E-07	1.1E-04	Fox-D1000	29	2.1E-06	6.0E-07	2.4E-06	5.5E-07	9.6E-06	Mis-D30
Uranium (U)	10	2.0E-06	5.4E-07	2.9E-06	4.0E-08	9.9E-06	FOX-D30	14	2.0E-06	3.7E-07	3.9E-06	5.5E-08	1.9E-05	Mis-U30	3	3.6E-06	1.2E-06	5.2E-06	5.5E-08	2.0E-05	Mis-U30
Vanadium (V)	19	1.3E-04	2.5E-05	2.0E-04	4.0E-06	6.9E-04	FOX-D30	21	1.1E-04	1.9E-05	2.1E-04	5.5E-06	0.0011	Mis-U30	11	2.1E-04	5.1E-05	3.3E-04	5.5E-06	0.0013	Mis-U30
Zinc (Zn)	23	2.0E-04	7.8E-05	2.5E-04	2.1E-05	0.0011	FOX-D30	0	2.3E-04	1.2E-04	2.6E-04	5.1E-05	0.0013	Mis-U30	0	4.2E-04	2.7E-04	4.1E-04	6.4E-05	0.0016	Mis-U30

Notes:

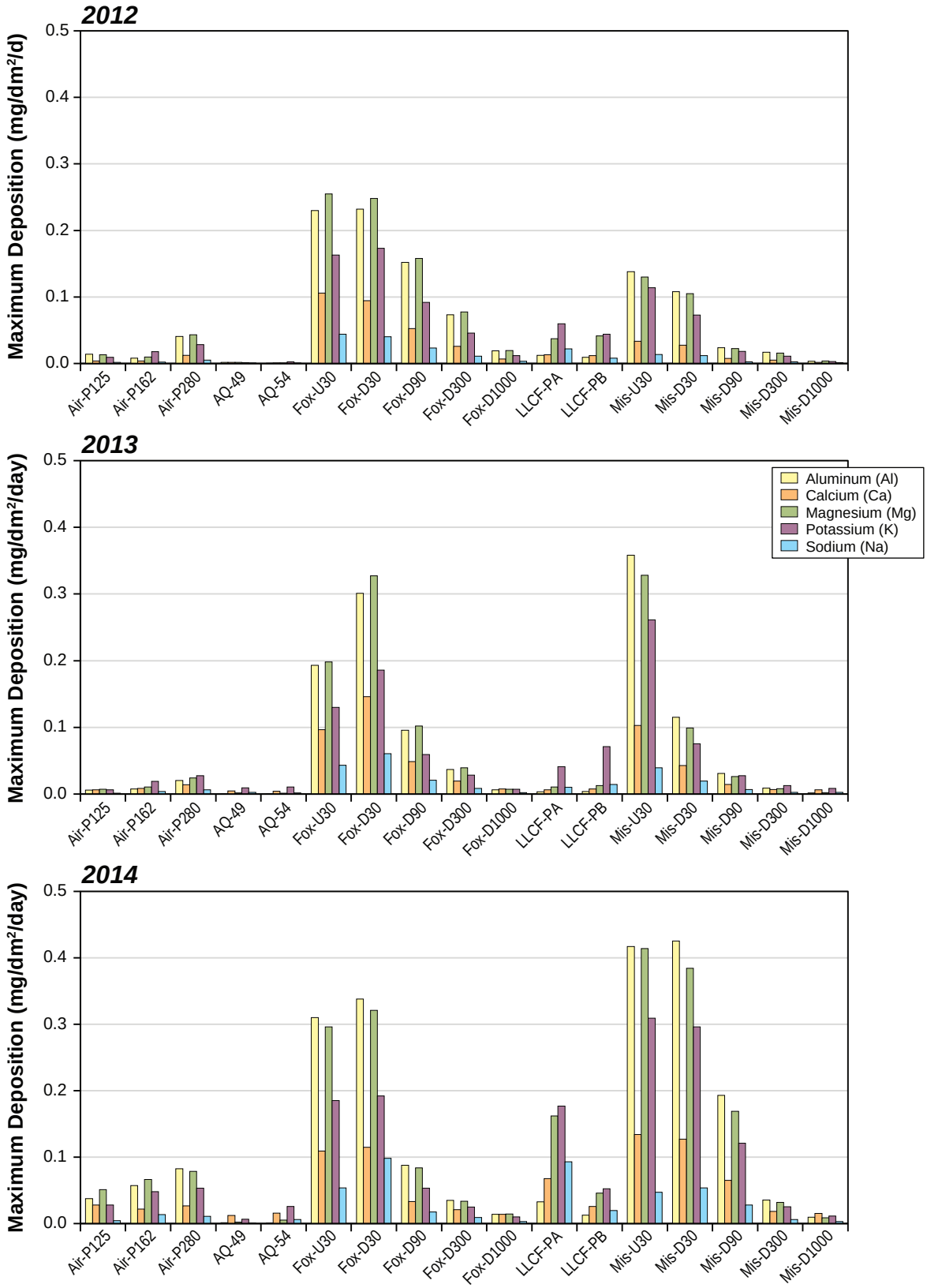
dash (-) = not applicable, all values below detection limit

For those values below laboratory detection limits, it was assumed that their value was half the detection limit for calculation purposes.

Values below 0.001 are presented in scientific notation.

Figure 3.5-3

2012 to 2014 Maximum Metal Deposition for Any Month



Note: The waste rock and new Misery Road stations are not included as they did not have the same number of annual sampling months compared to the other stations.

Table 3.6-1. Summary of Chemical Analyzes for Selected Parameters from 2014 Snow Core Sampling

Parameter	Units	# Below Detection Limit	Mean	Median	Standard Deviation	Minimum	Maximum	Station with Maximum Value	1998-2011 Mean
Alkalinity	mg/m^2/day	31	1.0237	0.5325	1.4959	0.1500	6.7662	AQ-108	-
Ammonia	mg/m^2/day	1	0.0140	0.0076	0.0169	0.0012	0.0753	AQ-110	0.0268
Anion Sum	meq/m^2/day	32	0.0469	0.0259	0.0669	0.0075	0.3383	AQ-108	-
Cation Sum	meq/m^2/day	24	0.1304	0.0330	0.2903	0.0075	1.6243	AQ-05	-
Chloride	mg/m^2/day	31	0.2376	0.1293	0.3313	0.0375	1.6915	AQ-108	-
Conductivity	uS/cm	0	5.6727	4.7000	4.0477	2.7000	24.3000	AQ-05	5.3012
Fluoride	mg/m^2/day	30	0.0141	0.0053	0.0322	0.0015	0.1789	AQ-49	-
Nitrate	mg/m^2/day	0	0.0750	0.0407	0.1290	0.0102	0.7104	AQ-108	0.0639
pH	pH	0	5.3491	5.1800	0.5460	4.5700	7.2000	AQ-05	5.4114
Phosphorus	mg/m^2/day	2	0.0121	0.0043	0.0192	4.7E-04	0.0831	AQ-49	-
Sulfate	mg/m^2/day	30	0.2749	0.1331	0.3818	0.0375	1.6915	AQ-108	0.3182
Kjeldahl Nitrogen	mg/m^2/day	14	0.0496	0.0303	0.0523	0.0063	0.2424	AQ-06	-
Organic Carbon	mg/m^2/day	0	2.0041	1.0972	3.5759	0.3589	21.1751	AQ-49	-
Total Suspended Solids	mg/m^2/day	14	7.4438	2.5151	13.2852	0.3750	68.8503	AQ-05	18.1284
Turbidity	NTU	0	4.7367	2.0500	8.5730	0.4600	44.0000	AQ-05	8.1022
Total Metals									
Aluminum	mg/m^2/day	0	0.2884	0.0510	0.6700	0.0055	3.0015	AQ-49	0.3187
Arsenic	mg/m^2/day	15	7.4E-05	3.7E-05	1.1E-04	1.1E-05	6.1E-04	AQ-05	-
Barium	mg/m^2/day	0	0.0066	0.0018	0.0173	4.0E-04	0.0989	AQ-05	0.0084
Beryllium	mg/m^2/day	31	2.9E-05	2.4E-05	2.3E-05	1.3E-06	1.0E-04	AQ-49	-
Boron	mg/m^2/day	33	0.0034	0.0026	0.0033	6.3E-04	0.0169	-	-
Cadmium	mg/m^2/day	16	9.2E-06	4.3E-06	1.4E-05	1.1E-06	5.6E-05	AQ-110	-
Calcium	mg/m^2/day	1	0.2334	0.0669	0.4590	0.0153	2.5468	AQ-05	0.2974
Chromium	mg/m^2/day	4	0.0016	2.9E-04	0.0043	1.3E-05	0.0241	AQ-05	0.0016
Cobalt	mg/m^2/day	22	2.8E-04	3.7E-05	8.9E-04	7.5E-06	0.0051	AQ-05	0.0002
Copper	mg/m^2/day	12	0.0020	2.0E-04	0.0062	3.5E-05	0.0358	AQ-49	0.0017
Iron	mg/m^2/day	2	0.2426	0.0457	0.6662	0.0043	3.7166	AQ-05	0.3799
Lead	mg/m^2/day	0	8.6E-04	9.6E-05	0.0024	2.5E-05	0.0118	AQ-49	-
Magnesium	mg/m^2/day	11	0.5416	0.0663	1.9618	0.0075	11.2968	AQ-05	0.3037
Manganese	mg/m^2/day	0	0.0061	0.0017	0.0121	4.6E-04	0.0560	AQ-05	0.1496
Mercury	mg/m^2/day	33	4.3E-06	2.6E-06	6.5E-06	7.5E-07	3.4E-05	-	-
Molybdenum	mg/m^2/day	9	2.4E-04	1.3E-04	4.4E-04	3.8E-06	0.0025	AQ-05	-
Nickel	mg/m^2/day	8	0.0038	5.4E-04	0.0145	3.5E-05	0.0836	AQ-05	0.0035

(continued)

Table 3.6-1. Summary of Chemical Analyzes for Selected Parameters from 2014 Snow Core Sampling (completed)

Parameter	Units	# Below Detection Limit	Mean	Median	Standard Deviation	Minimum	Maximum	Station with Maximum Value	1998-2011 Mean
Total Metals (cont'd)									
Potassium	$mg/m^2/day$	19	0.1387	0.0373	0.2507	0.0075	1.2901	AQ-05	0.2179
Selenium	$mg/m^2/day$	31	5.9E-05	2.6E-05	1.7E-04	5.0E-06	9.9E-04	AQ-108	-
Silicon	$mg/m^2/day$	5	0.7575	0.1119	2.5259	0.0063	14.4385	AQ-05	-
Silver	$mg/m^2/day$	27	7.6E-06	3.1E-06	1.2E-05	7.5E-07	5.3E-05	AQ-49	-
Sodium	$mg/m^2/day$	0	0.1396	0.0660	0.2253	0.0164	1.2099	AQ-05	0.1158
Strontium	$mg/m^2/day$	0	0.0027	5.5E-04	0.0082	1.1E-04	0.0472	AQ-05	0.0029
Uranium	$mg/m^2/day$	17	2.0E-05	5.4E-06	4.2E-05	1.1E-06	2.3E-04	AQ-05	-
Vanadium	$mg/m^2/day$	25	5.6E-04	2.7E-04	0.0010	1.2E-05	0.0058	AQ-05	0.0007
Zinc	$mg/m^2/day$	15	0.0030	9.9E-04	0.0047	2.8E-04	0.0186	AQ-110	0.0094

Notes:

dash (-) = not available

For those values below laboratory detection limits, it was assumed that their value was half the detection limit for calculation purposes.

Values below 0.001 are presented in scientific notation.

The results presented in Figure 3.6-2 for TSS indicate that the observed 2014 loadings are generally lower than those for 2008 to 2011. For aluminum and chromium, the 2014 loadings were generally similar to those observed in 2008 to 2011, with the exception of loadings measured from station AQ-49. The 2005, 2008 and 2014 results showed high loadings nearest to the centre of mine activity, with a sharp decline between 0 and 10 km from the centre of activity (Figure 3.6-2). However, the 2011 loadings followed a different pattern, as discussed in the 2011 AQMP report (Rescan 2012). Monitoring site AQ-49 was an exception to this pattern, with an elevated TSS loading, the highest aluminum loading (3.0 $mg/m^2/d$) and the second highest chromium loading (0.0083 $mg/m^2/d$). Possible explanations as to why elevated contaminants were recorded from AQ-49 include errors in SWE reporting or sample contamination; however, there was no evidence in the field notes or laboratory analysis reports to support these explanations.

The 2014 loading rates for nitrate, ammonia and sulphate were also compared with 2005 to 2011 data as a function of distance from nearest centres of activity (Figure 3.6-3). These compounds are associated with combustion and blasting at the mine. Nitrate and sulphate are of special concern as they are associated with acid deposition, which is known to have harmful effects on terrestrial and aquatic ecosystems. Limited spatial trends were observed in these elements with distance (up to 50 km) from mining activity (Figure 3.6-3). The majority of nitrate and sulphate loadings were below the expected background concentrations. Notable exceptions were observed at AQ-108 (24 km from Fox Pit) and AQ-110 (31 km from Fox Pit) for all three chemicals, as well as AQ-43 (17 km from Pigeon Pit) for sulphate.

Background conditions are presented based on 23 years of monitoring data (1989 to 2011) from Snare Rapids. Snare Rapids is a Canadian Air and Precipitation Monitoring (CAPMoN) station located approximately 150 km northwest of Yellowknife and 150 km southwest of the Ekati mine. CAPMoN stations are situated in locations considered to be remote and pristine. Recent data collected at the station has not yet been updated and made available, as of March 2015.

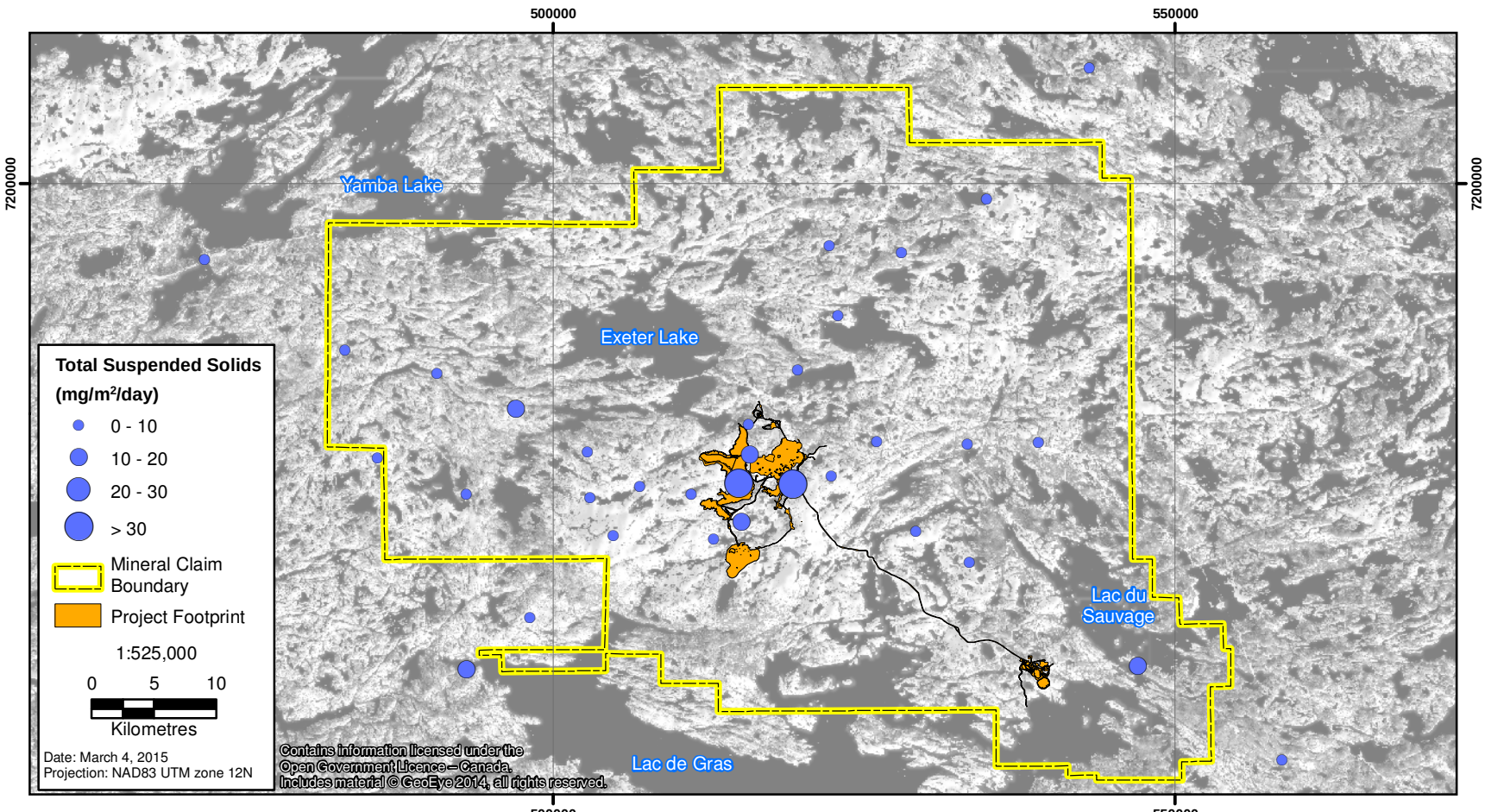
The effects of sulphur and nitrogen are limited to the active mining areas surrounding the Ekati mine. The concentrations observed at reference sites are likely to be attributed to external sources such as Arctic haze or long range transport. These findings are in agreement with the results from the CALPUFF air dispersion modelling and also those presented in the 2008 and 2011 AQMP reports. The 2014 coefficients of correlation (R^2) of the trend lines for ammonia, nitrate, and sulphate and distance from nearest source are very low; 0.0067, 0.054 and 0.033, respectively (Figure 3.6-3). This suggests that there is not a direct relation between these concentrations and the distance from mining activities. This also suggests that the mining activities do not have a significant effect on the measured level of these compounds.

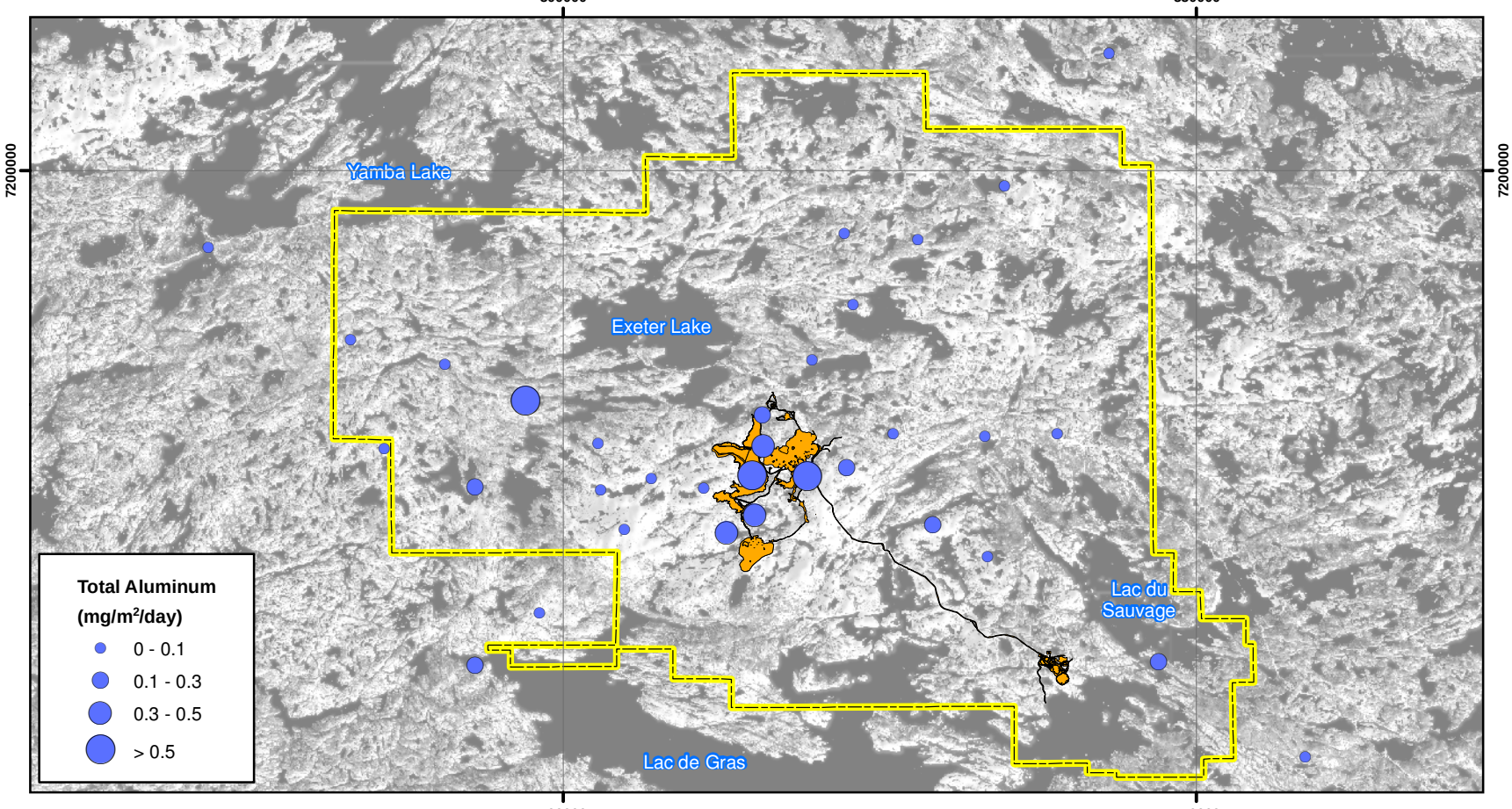
3.7 LICHEN TISSUE MONITORING

This section is a short text summary of the conclusions made in the *Lichen Monitoring at the Ekati Diamond Mine, NWT: 2014 Re-Measurement* (Enns 2015). The majority of the text below has been taken directly from the lichen report's conclusion section, with some edits to sentence structure and tense. The full lichen report is included in Appendix 13 and includes detailed text, informative maps, graphs and tables.

Figure 3.6-1

Surface Loading Rates for TSS, Aluminum and Chromium from 2014 Snow Chemistry Data





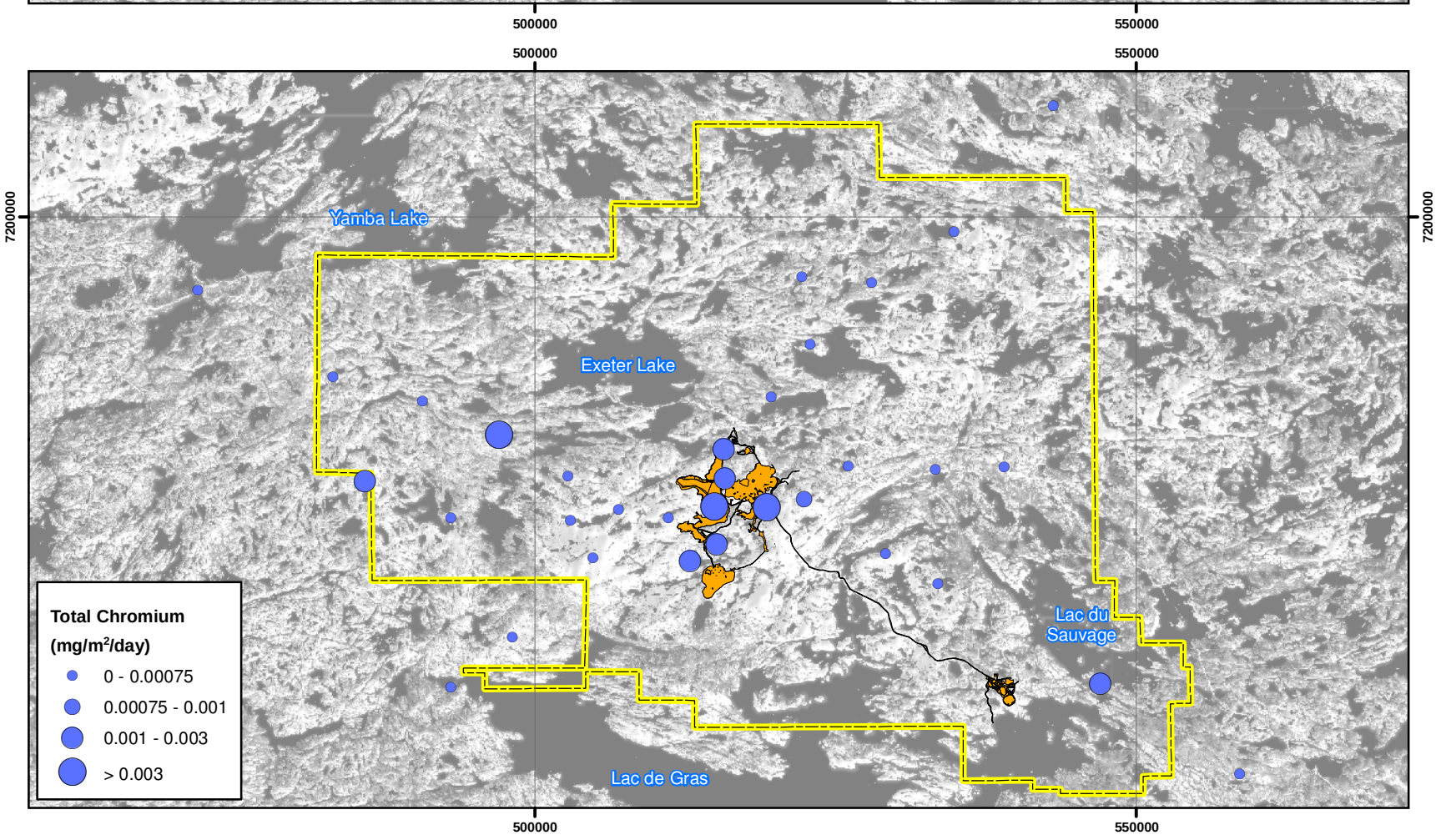
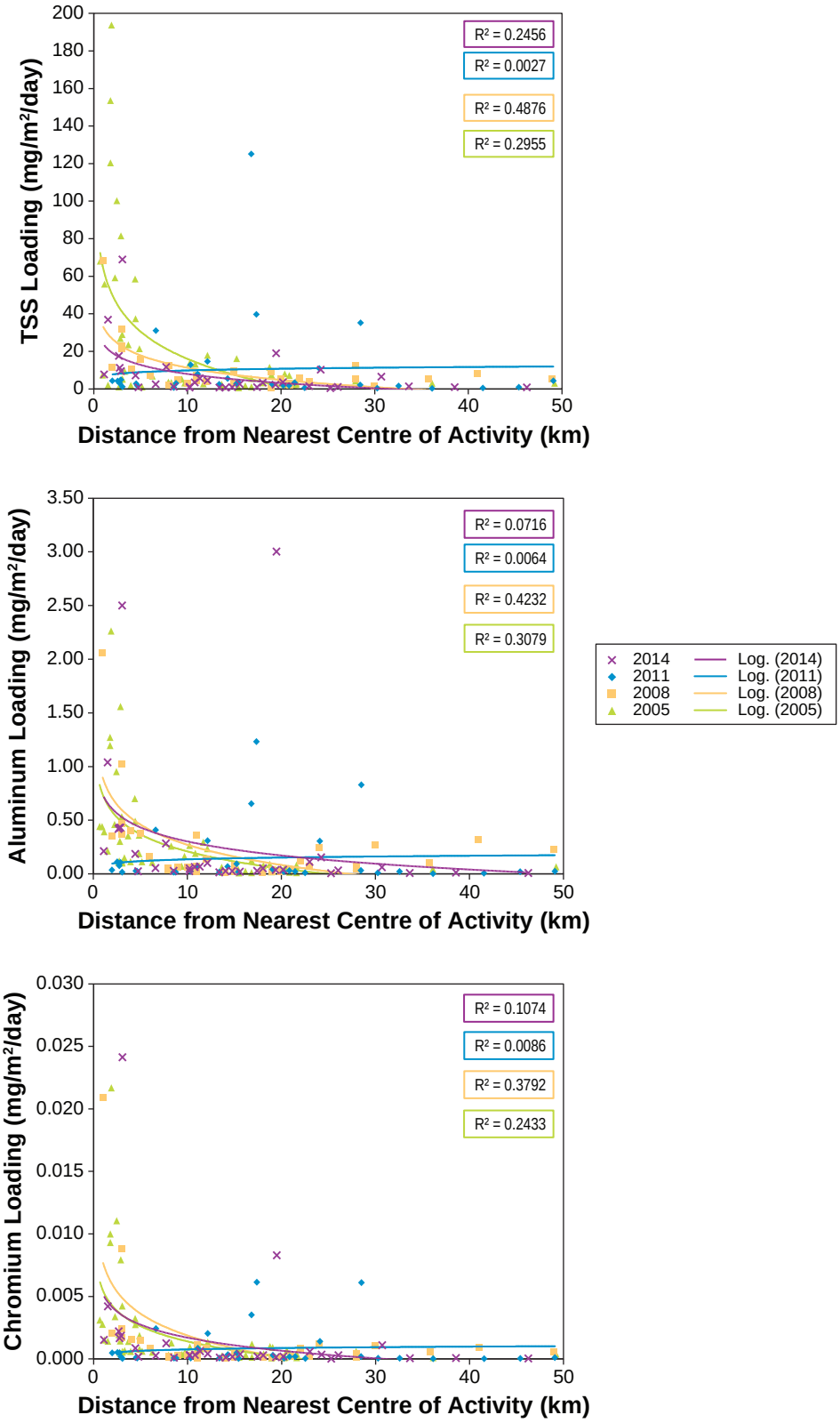


Figure 3.6-2

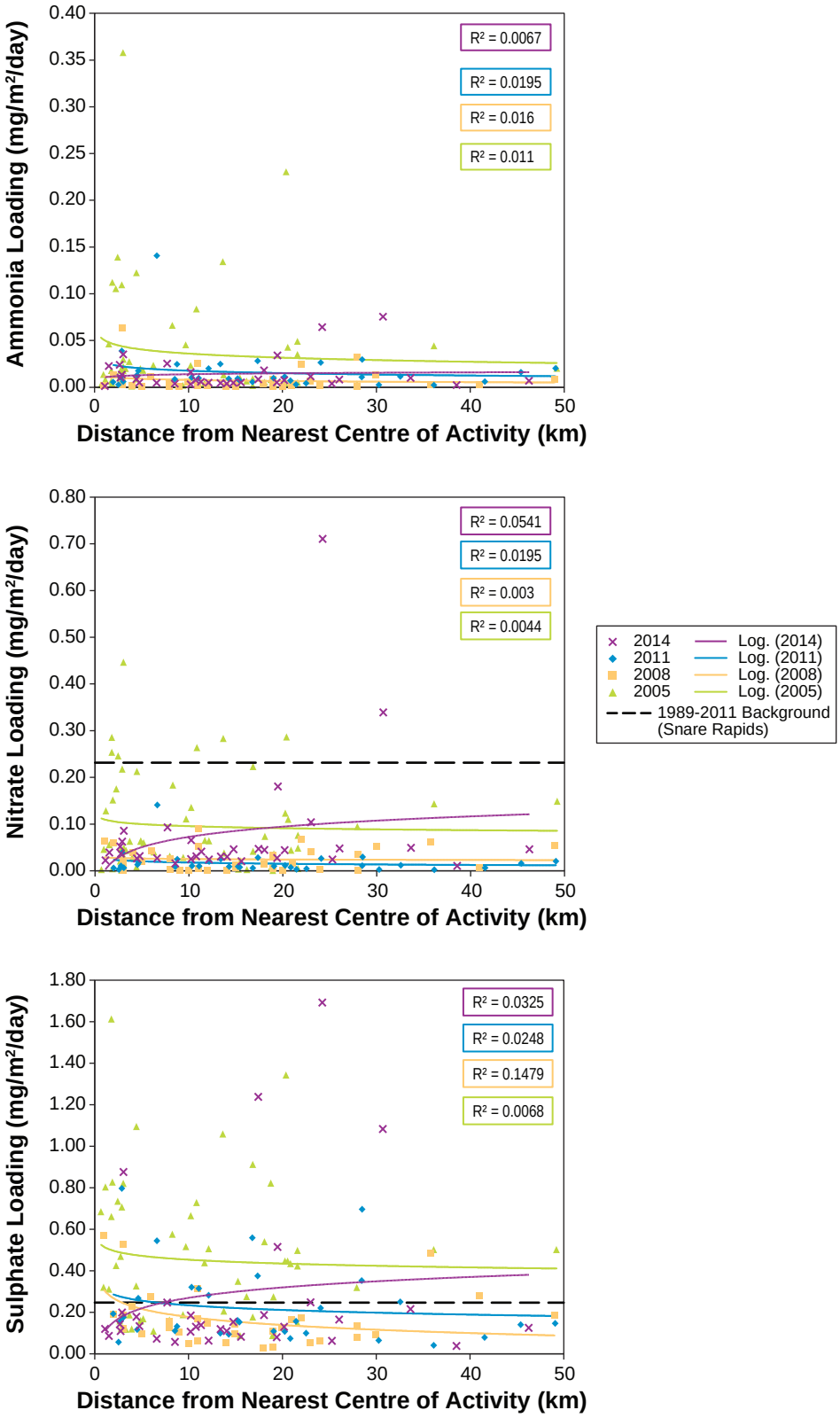
Winter Surface Loading Rates for Total Suspended Solids (TSS), Aluminum and Chromium Versus Distance from Mining Activity



Note: Historical background data are not available for these parameters.

Figure 3.6-3

Winter Surface Loading Rates for Nitrate, Ammonia and Sulphate Versus Distance from Mining Activity



Note: Historical background data are not available for these parameters.

3.7.1 Comparisons Over Distance

As part of the data analysis methodology, the question was asked: is there a relationship between distance from the mine site and the concentration of elements in *Flavocetraria cucullata*? The answer was determined to be yes for some of the elements known to originate from road dust which were above background levels, and less so for those elements that were potentially also influenced by long range transport (LRT).

Many elements from the various sampling locations were above background levels but most enhancements occurred within 10 to 30 km from the mine site. Many of the highest concentrations occurred within 1 km of roads.

Concentrations of basic rock elements and sulphur appeared to be mostly originating from mine operations. These included aluminum, barium, calcium, chromium, iron, lead, nickel, sodium and vanadium. The distribution and concentration gradients provided strong evidence that at least five trace/earth elements are possibly from a combination of LRT and mine operations: arsenic, cadmium, magnesium, mercury, nitrogen, sulphur and zinc.

Most elements in lichen tissue are significantly correlated with each other, as they tend to disperse and be absorbed evenly with distance from source. Elements that did not correlate with others usually did not originate from the same source or they had a different pattern in dispersal. These included arsenic, cadmium, mercury, nitrogen, sulphur and zinc.

In general, dust-borne elements and crustal elements declined with distance from the mine site, especially from active roads. These patterns are typical of silty gravel roads in Arctic environments where dust control systems have been put in place.

3.7.2 Comparisons Over Time

As part of the data analysis methodology, the question was asked: is there a difference in element concentrations in co-located *Flavocetraria cucullata* between years (2005, 2008, 2011 and 2014)? The answer was determined to be that four element concentrations have declined over time (aluminum, chromium, lead and sodium), nine have fluctuated (arsenic, cadmium, calcium, iron, magnesium, nickel, nitrogen, vanadium and zinc) and three have increased (barium, mercury and sulphur). Note that mercury occurred at very low concentrations compared to the other contaminants and remain close to Arctic background concentrations. Sulphur declined to below background levels within 70 km of the mine site. Barium may have increased due to its volatility from tailings, but it is not possible to confirm this from the data collected.

3.7.3 Comparisons of Elements in Lichens and Dustfall, Snow Chemistry and Soil

As part of the data analysis methodology, the question was asked: is there a relationship between dustfall, snow meltwater or soil measurements and the concentration of elements in *Flavocetraria cucullata*? The answer was determined to be that lichen element concentrations: seldom correlated to dustfall element concentrations, correlated better with snow meltwater element concentrations (as is typical), and did not always correlate with soil metal element concentrations.

Dustfall element concentrations seldom correlated to lichen element concentrations due to a high variance in 2014 dustfall samples. Distances from the two correlated features may be important and dustfall monitors were co-located with lichen samples in only 5 locations.

Soil concentrations reflected the long-term elemental status of the main vegetation and soil environment. Soils were often sampled from vegetated areas and therefore did not release enough local dust (due to lack of surface erosion) to influence lichen concentrations. Lichens are not as responsive to soil sources as they are to atmospheric sources of elements, and unless known to contribute to lichen concentrations through uptake from soil (e.g. nitrogen), soil metal concentrations did not always correlate with the lichen concentrations.

3.7.4 Conclusions

Despite severe wildfire smoke in 2014, the pattern of enhancement in lichens was similar to 2011 with some exceptions. Most elements were below Arctic background levels (from literature; Puckett and Finegan 1980) at distances from the mine. In general, dust control continues to be effective. With the exception of the high particulate matter episodes caused by wildfires, the overall air quality in 2014 near the mine has improved compared to previous lichen sampling years (Enns 2015).

4. CONCLUSIONS

A summary of the key findings associated with each component of the AQMP is provided below.

Air Emissions and Greenhouse Gases

- Fuel consumption levels in 2012 to 2014 were similar to those reported between 2006 and 2008, primarily due to an increase in motive diesel use as compared to the 2009-2011 reporting period as a result of material movement near Misery Pit and various construction activities.
- DDEC continues to implement programs that will minimize the amount of fuel used by utilizing:
  - the Energy Smart Program – initiated 2002;
  - the "No Idle" Campaign (including the onsite shuttle service), re-launched by DDEC in 2013;
  - testing the use of biodiesel as a fuel during a 2014 pilot project;
  - formation of an Energy and GHG Steering Committee responsible for approving and overseeing energy and GHG reduction projects and tracking performance;
  - ongoing shift from the use of surface mobile equipment to the development of underground operations; and
  - ongoing program burning waste oil to heat air for underground workings.
- A total of 200 kilotonnes of CO_2e emissions were calculated to be released in 2014. The average annual GHG emissions from 2012 to 2014 was 190 kilotonnes of CO_2e. This is 20% more than that estimated during the 2009 to 2011 AQMP (158 kilotonnes of CO_2e), due to the increase in fuel usage.
- In 2012, GHG emissions from the Ekati mine made up 12% of the total GHG emissions from the Northwest Territories, and 0.025% of the total national GHG emissions.

Ambient Air Quality

- Available HVAS and Partisol results from 1994 to 2014 indicate that TSP values have been decreasing over time. For the 2012 to 2014 monitoring period, only three measured values, out of 364, exceeded the 24 hour standard of 120 µg/m^3; however, two of these exceedances (in 2014) occurred on days when smoke from distant wildfires was present at the mine site. The other exceedance occurred in 2012 (146 µg/m^3) and which was a very windy day (therefore likely contributing to the exceedance). All other values were generally well below the set standard.
- CAM results from 2012 to 2014 indicate that mean monthly NO_2, NO, NO_X and SO_2 have a slight decreasing trend, and concentrations are higher in the winter compared to the summer in response to seasonal fuel usage for heating. All NO_2 and SO_2 hourly, daily and annual average values were below the GNWT standards.
- The CAM $PM_{2.5}$ and TSP results indicated that concentrations for both particulates have increased over the 3 year period; however, this apparent increase was due to the numerous

days with wildfire smoke present at the mine site in 2014. As directed by the GNWT, particulate results were ignored on days when wildfire smoke was observed at the Ekati mine site. Thus the filtered observations indicated that there were no daily or annual $PM_{2.5}$ exceedances, however, there were six days with daily TSP exceedances when there was no wildfire smoke present. These exceedances were 2%, 15%, 19%, 22%, 50% and 134% over the GNWT standard of 120 µg/m^3. The annual mean TSP concentrations for each reporting year were below the GNWT standard.

- Due to the changes in data collection and reporting, the ambient air quality data reported data in this report is of better quality compared to the 2009 to 2011 data reported in the previous AQMP report (Rescan 2012). These changes include the replacement of the problematic HVAS units with more reliable Partisol air samplers, using an external certified laboratory to perform filter weighing, and correcting TSP and $PM_{2.5}$ data collected from the CAM station using procedures in the *Alberta Air Monitoring Directive Chapter 6: Ambient Data Quality* (Alberta Environment and Sustainable Resource Development 2014).

Dustfall

- In 2012, dustfall was higher near the Fox Haul Road compared to the Misery Haul Road. In 2013, the dustfall near the Misery Haul Road was much higher than in 2012, but still less than at Fox Haul Road. In 2014, the dustfall near the Misery Haul Road was generally higher than in the previous year and dustfall near the Fox Haul Road decreased. These trends reflect the amount of vehicle traffic present on each road.
- In all years, dustfall at 300 m downwind of the road decreased below the BC Pollution Objective goal of 2.9 mg/dm^2/d, except for the August/September 2013 measurement at Fox Haul Road. At 1,000 m downwind of the road, all dustfall concentrations were at background levels.
- Dustfall concentrations measured from the three airport stations and two LLCF stations showed that average dustfall was higher in 2013 and 2014 compared to 2012. The majority of measurements were below the BC Pollution Objective goal.
- The maximum acid deposition value was calculated to be 836 eq/ha/yr (LLCF-PA station), and the highest annual median value from all non-background sites was 173 eq/ha/yr (based on 3 months of data). This median value is below the established Canadian critical soil load for all provinces as well as the Alberta PAI load standard of 250 eq/ha/yr. The actual annual loading would likely be well below this prediction, due to neutralizing processes that were not accounted for.
- All metal deposition values were below 0.5 mg/dm^2/d. There are no guidelines to compare metal deposition values to; however, all metal deposition values at the two background monitoring stations were below 0.03 mg/dm^2/d.
- The use of DL-10 and water on roads to mitigate dust release was shown to be effective.

Snow Chemistry

- Spatial analysis of 2014 snow chemistry data suggests that winter loading of TSS and a number of metals likely associated with fugitive dust and fine particulates are elevated in an area directly surrounding the mine footprint and concentrations generally decrease with distance from mining activity. Variables associated with gaseous emissions, blasting and long range transport (e.g., ammonia, nitrate and sulphate) do not show strong trends with distance from mining activity. The 2014 results were generally lower than those for 2005, but slightly higher than those for 2008 and 2011.
- Most elemental concentrations, even for impacted areas near the Ekati mine site, are below established background concentrations observed (1998-2011) at the CAPMoN station Snare Rapids. The exceptions are for the sampling locations in close proximity to mining activity and occasional outliers; those areas with observed concentrations greater than background are less than those typically associated with industrial developments.

Lichen Indicator Species

- Elemental concentrations in the two indicator lichens collected in the study area show that mine influence of dust is confined to a relatively small area within 10 to 30 km from the mine, and tends to decline with distance from the mine site.
- The lichen tissue concentrations of most dust-borne metals and crustal elements have either decreased or fluctuated when compared over time (2005, 2008, 2011 and 2014) with the exception of barium, mercury and sulphur. However, all 2014 concentrations are low and most elements are below Arctic background levels at 30 km from the mine.
- The influence of wildfire smoke on elemental enhancement was difficult to describe due to the lack of isolated wood smoke inductively coupled plasma analysis data and unknown particulate distribution size.

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