



Ekati Diamond Mine Air Quality Monitoring Program

Air Quality Monitoring Program

- Ekati Air Quality Monitoring 1998 – 2015
- 2014 AQMP
 - Components
 - Methods
 - Results



Air Quality Monitoring Program

Ekati Air Quality Monitoring 1998 – 2015



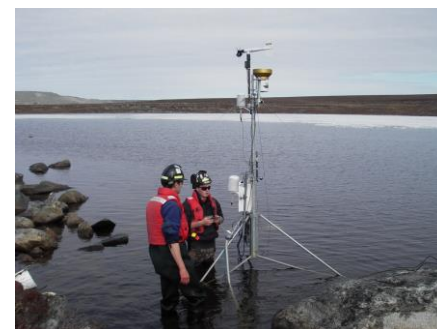
Ekati Air Quality Monitoring 1998 – 2015

1998: The Air Quality Monitoring Program (AQMP) was initiated (climate, HVAS-TSP, emission calculations, snow and vegetation studies every 3 years)

2002: AQMP report summarizing data collected 1998 to 2001

2006: AQMP report summarizing data collected 2002 to 2005 (climate, HVAS-TSP, emission calculations, snow and lichen sampling and vegetation distribution surveys)

2006: CALPUFF Air Dispersion Modelling Assessment and Review of the monitoring program



Ekati Air Quality Monitoring 1998 – 2015 (continued)

2008: Review of monitoring and changes made based on stakeholder comments (CAMB move, improvements with lichen monitoring)



2011: AQMP report summarizing data collected 2006 to 2008 (climate, HVAS-TSP, **CAM**, emission calculations, **dustfall monitoring**, snow and lichen sampling)



2011: AQMP report summarizing data collected 2009 to 2011 (climate, HVAS-TSP, CAM, emission calculations, dustfall monitoring, snow and lichen sampling)



2014: AQMP report summarizing data collected 2012 to 2014 (climate, HVAS-TSP, **Partisol**, emission calculations, snow and lichen sampling and vegetation distribution surveys)





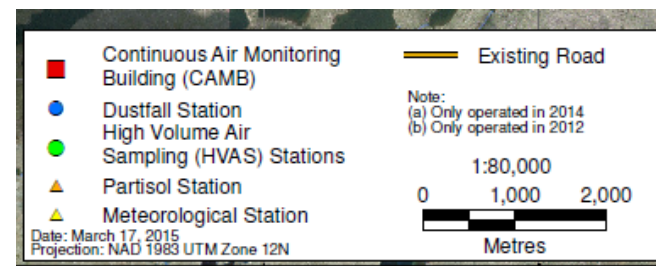
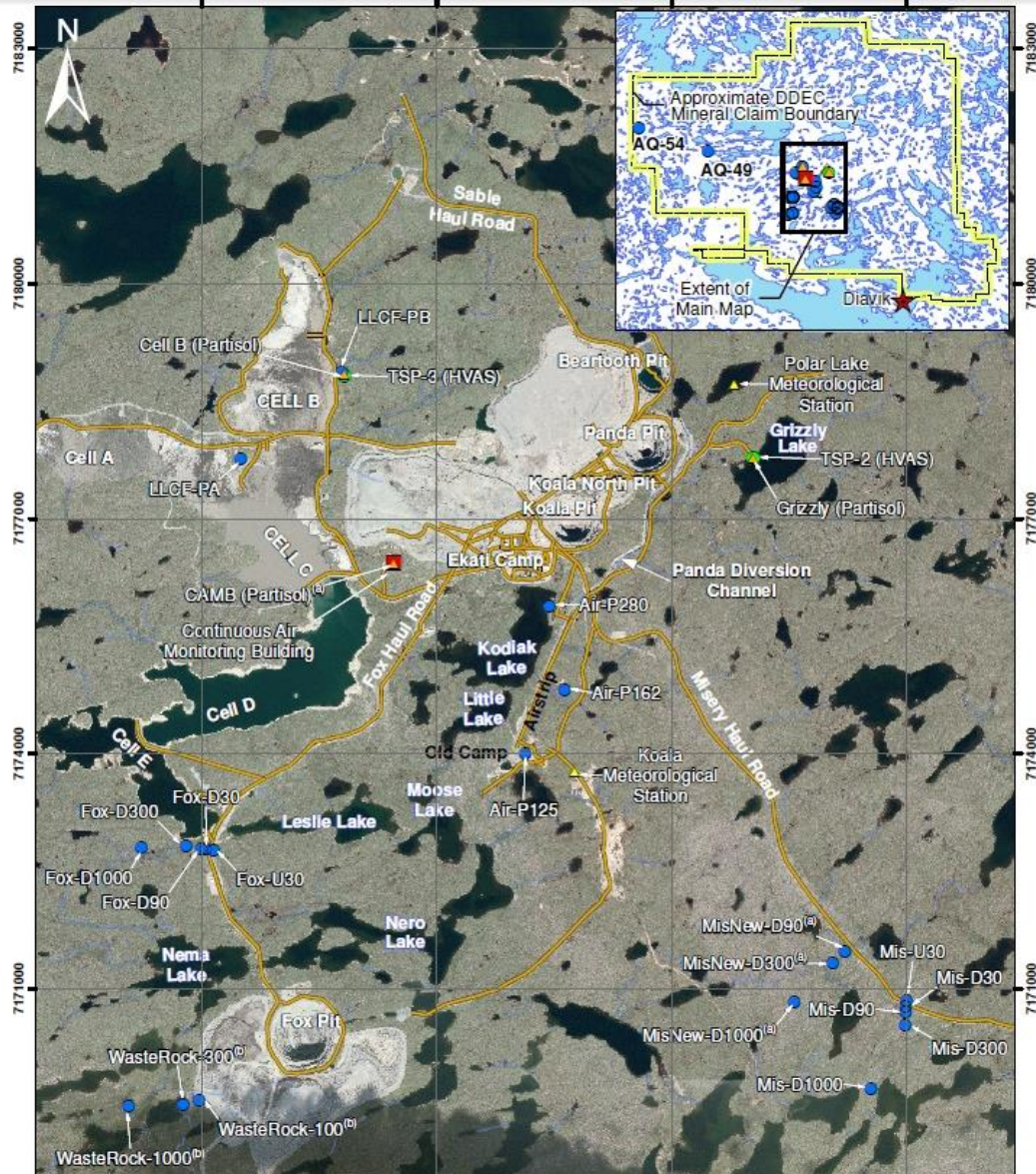
Air Quality Monitoring Program

2014 Air Quality Monitoring Program Report



2014 Air Quality Monitoring Program Report

- Summary of 2012-2014
- Compare to historical and 2006 CALPUFF
- Components:
 - Meteorological Monitoring
 - Air emissions and greenhouse gas (GHG) calculations
 - Ambient air quality monitoring (HVAS, Partisol, CAM)
 - Dustfall monitoring
 - Snow chemistry monitoring
 - Lichen tissue monitoring

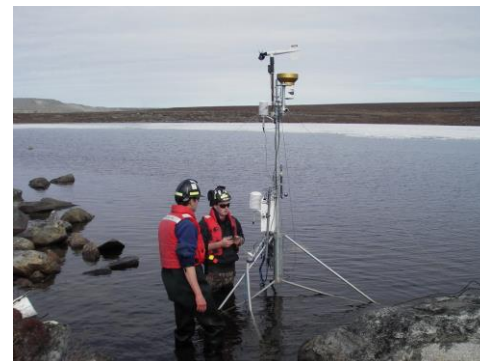


Meteorological Monitoring

Koala Automated
Meteorological Station



Ekati Airport Weather
Observations



**Three Data
Sources**

Polar Lake
Micrometeorological
Station



Meteorological Monitoring

- Results are summarized for
 - Temperature
 - Precipitation (snow water equivalent and rainfall)
 - Wind Speed

Air emissions and GHG Calculations

- Diesel Fuel Consumption
 - National Pollutant Release Inventory
 - Carbon monoxide, oxides of nitrogen, sulphur dioxide, volatile
 - Organic compounds (VOCs) and particulate matter (TSP, PM₁₀ and PM_{2.5})
 - GHG Reporting program
 - Carbon dioxide equivalent (CO_{2e})

Air emissions and GHG Calculations

Emission Sources and Resulting GHG Emissions at the Ekati Mine, 2012 to 2014

	Emission Sources				Resulting GHG Emissions			
Annual Total	Total Fuel ¹ (L)	ANFO + Emulsion (kgs)	Fugitive Emission s (tCO ₂ e)	Biomass (tCO ₂ e)	CO ₂ (tonnes)	CH ₄ (tCO ₂ e)	N ₂ O (tCO ₂ e)	Total GHG Emission s (tCO ₂ e)
2012	62,733,564	6,966,379	3	345	172,992	158	1,599	174,748
2013	69,871,165	9,284,526	0	331	192,996	175	1,778	194,949
2014	71,619,668	8,923,323	0	262	197,600	180	1,824	199,603

¹ Total fuel is comprised of diesel, Jet A-1, waste oil and gasoline

GHG Calculations completed according to NPRI and available online-

<http://ec.gc.ca/inrp-npri/>

<http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=040E378D-1>

Air emissions and GHG Calculations

- 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; and
 - formation of an Energy and GHG Steering Committee responsible for approving and overseeing energy and GHG reduction projects and tracking performance.

Ambient air quality monitoring (HVAS, Partisol, CAM)

- Total Suspended Solids (TSP)
 - HVAS (1997 to 2013)
 - Partisol Sampler (2012 to 2014)
 - Grizzly and Cell B
 - CAMB- PM_{2.5}

Advantages of Partisol Sampler:

- Sealed from environmental conditions
- Digital programmable timers
- Digital air volume data acquisition
- Easier sample handling
- Easier performance checks, and
- Certified laboratory analysis of samples



Ambient air quality monitoring (HVAS, Partisol, CAM)

- The Northwest Territories Ambient Air Quality Standard for 24 hour TSP concentration is $120 \mu\text{g}/\text{m}^3$

Year	Sample Station	Number of Samples	Maximum [TSP] 24 hour ($\mu\text{g}/\text{m}^3$)	Minimum [TSP] 24 hour ($\mu\text{g}/\text{m}^3$)	Arithmetic Mean [TSP] 24 hour ($\mu\text{g}/\text{m}^3$)	Windy Day - Fugitive Dust	Number of Days Exceeding Standard
2012	TSP-2	47 (12)	18.9	0.6	6.0	4.6	0
	TSP-3	44 (10)	145.6	0.9	11.8	6.1	1
	Grizzly	11 (5)	15.2	2.0	5.6	4.5	0
	Cell B	7 (8)	32.3	2.7	10.2	6.7	0
2013	TSP-2	20 (7)	33.5				
	TSP-3	22 (5)	51.8				
	Grizzly	47 (14)	52.1				
	Cell B	57 (3)	31.9			5.1	0
2014	Grizzly	55 (5)	183.6	1.4	15.2	9.5	2
	Cell B	54 (6)	93.7	2.2	13.5	7.8	0

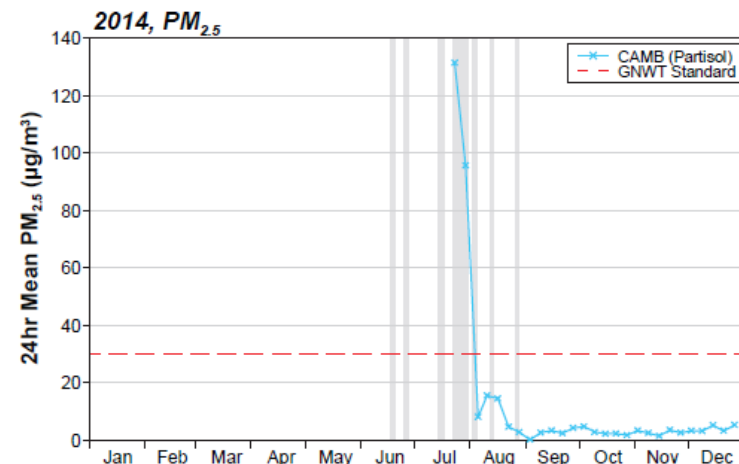
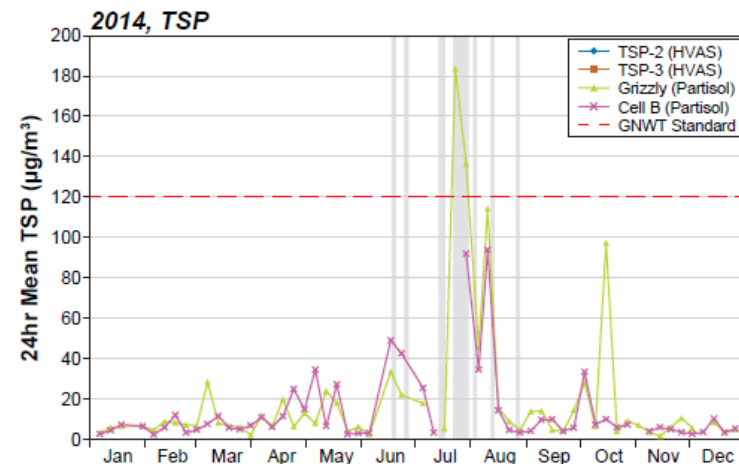


Windy Day -
Fugitive
Dust

Visible
Smoke
(Wildfires)

Ambient air quality monitoring (HVAS, Partisol, CAM)

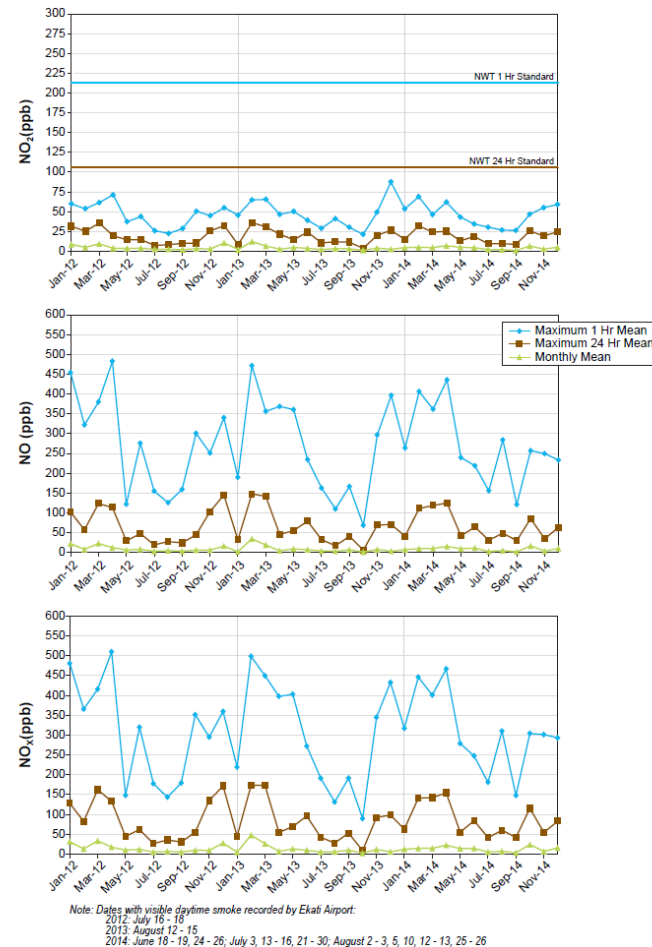
- 2014 TSP and PM_{2.5}
 - Shaded date ranges indicate consecutive days with visible daytime smoke recorded by Ekati Airport.



Ambient air quality monitoring (HVAS, Partisol, CAM)

CAM Results

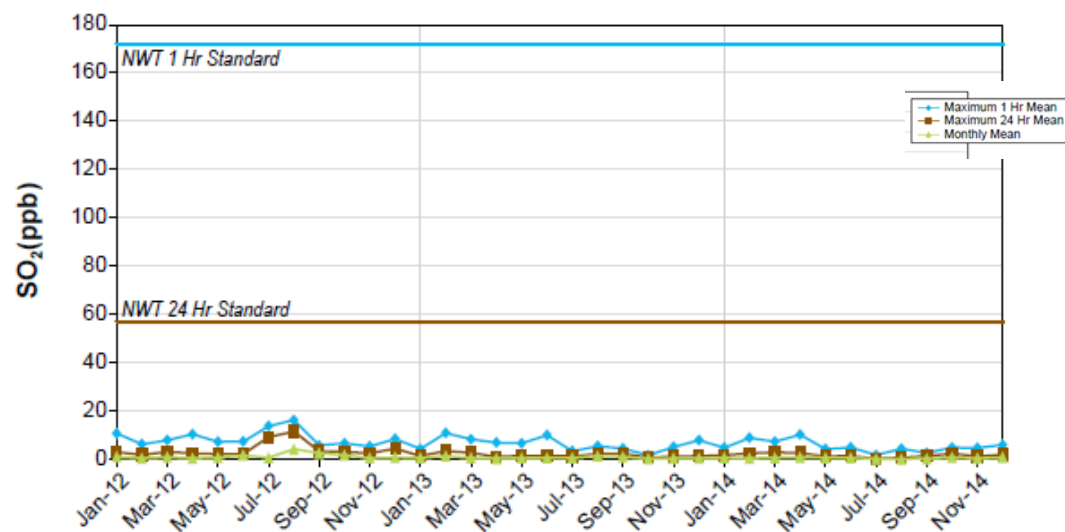
- Monthly maximum values for hourly and daily mean concentrations of NO_2 , NO , NO_x ,



Ambient air quality monitoring (HVAS, Partisol, CAM)

CAM Results

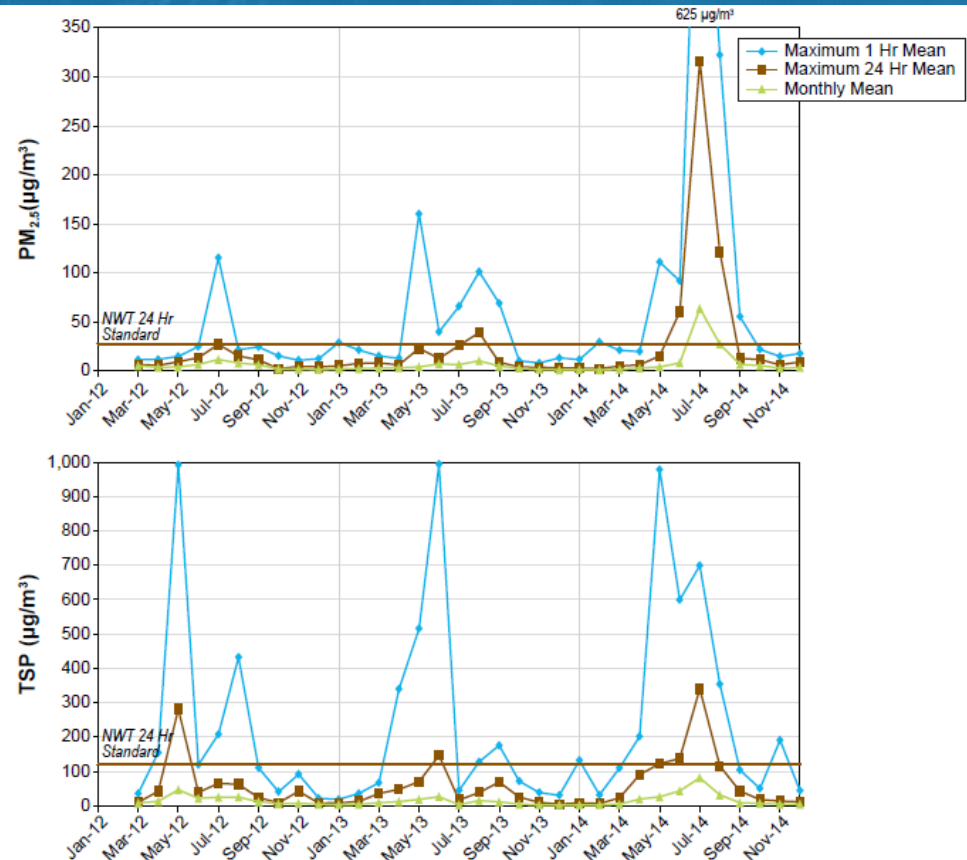
- Monthly maximum values for hourly and daily mean concentrations of SO_2



Ambient air quality monitoring (HVAS, Partisol, CAM)

CAM Results

- Monthly maximum values for hourly and daily mean concentrations of TSP and $PM_{2.5}$



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

Ambient air quality monitoring (HVAS, Partisol, CAM)

Improvements in 2014

- 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

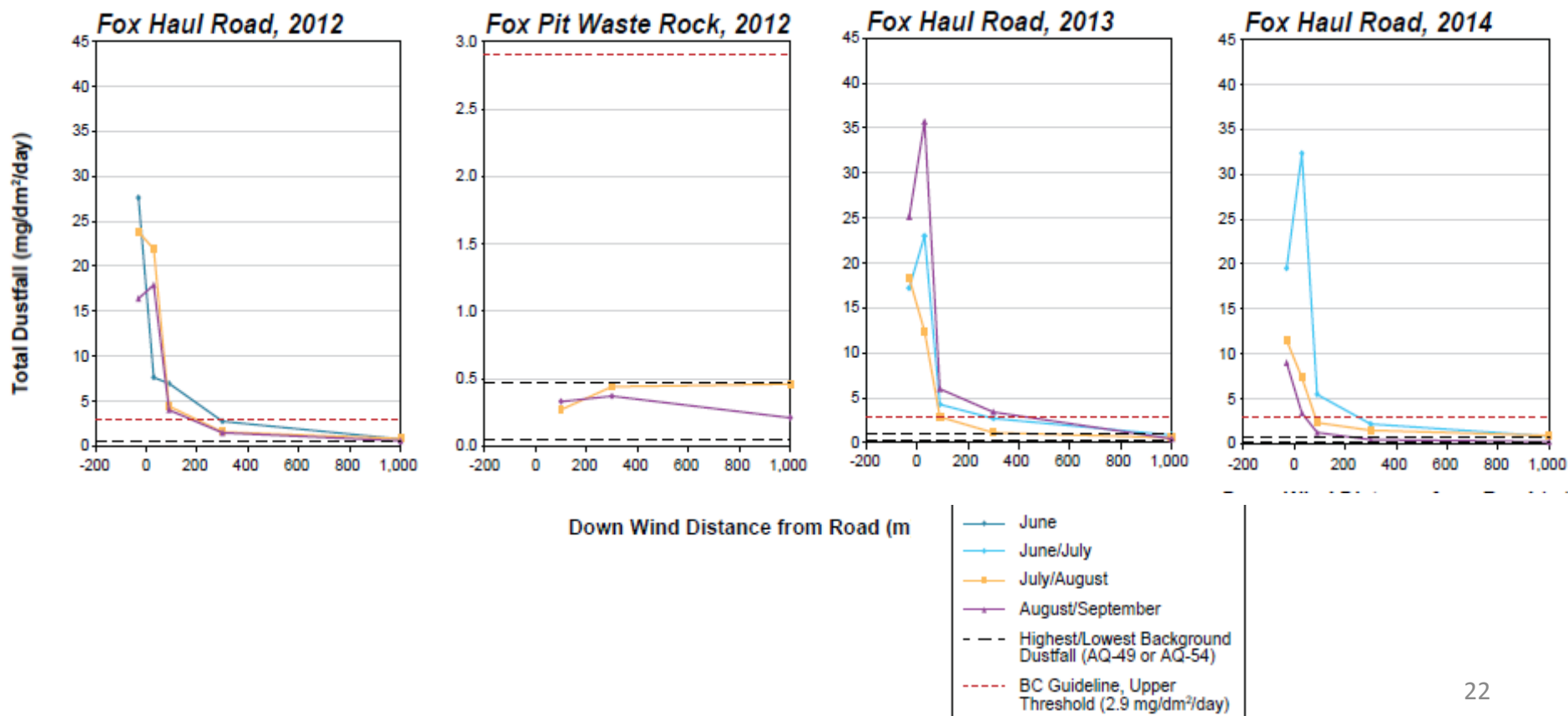
Dustfall monitoring

- 2012- Fox WRSA stations
- 2014- Misery Haul Road
- Samples analyzed for soluble and insoluble particulate, ammonia, chloride, nitrate, sulphate, and total metals
- Calculate acid deposition



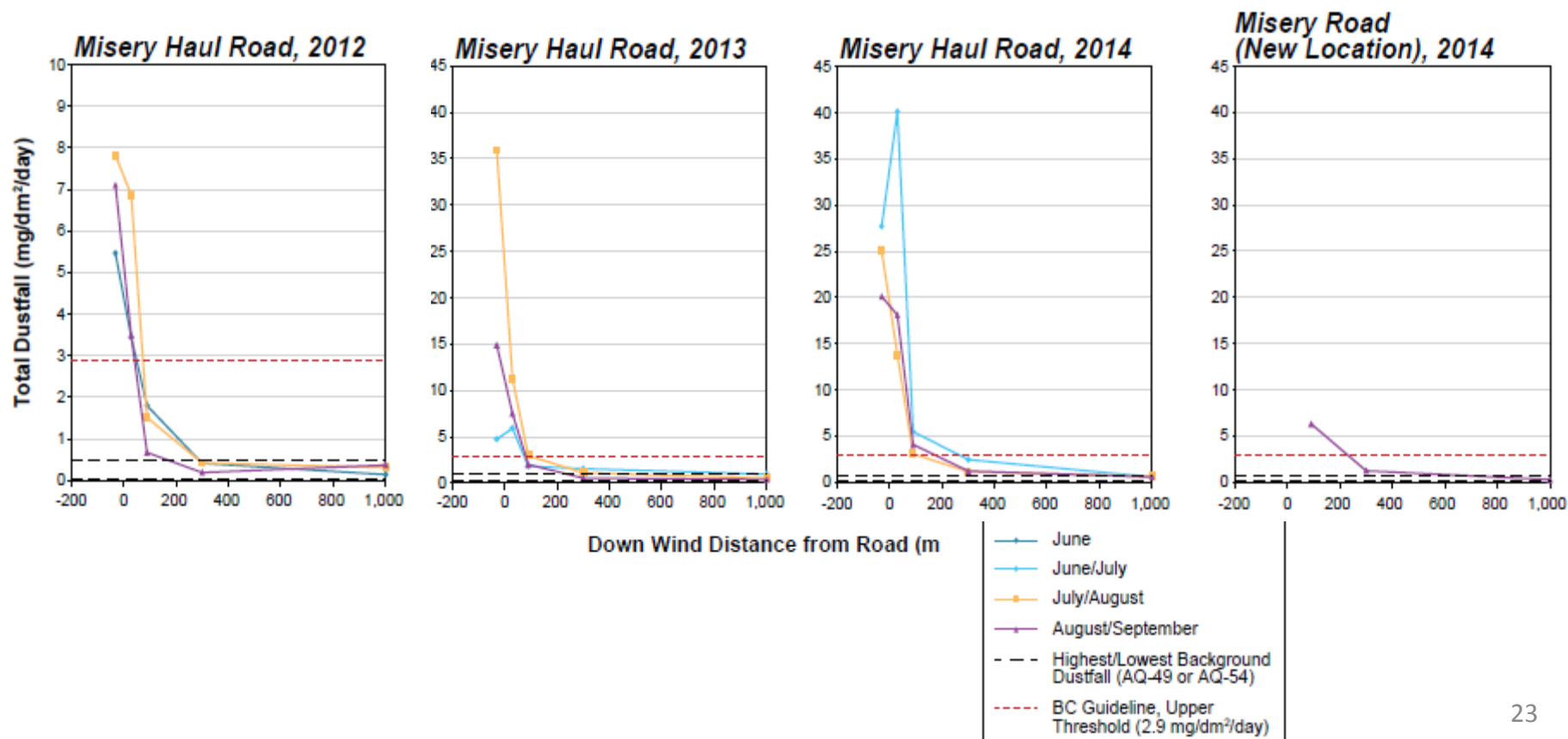
Dustfall monitoring

Fox Haul Road and Fox Pit Waste Rock



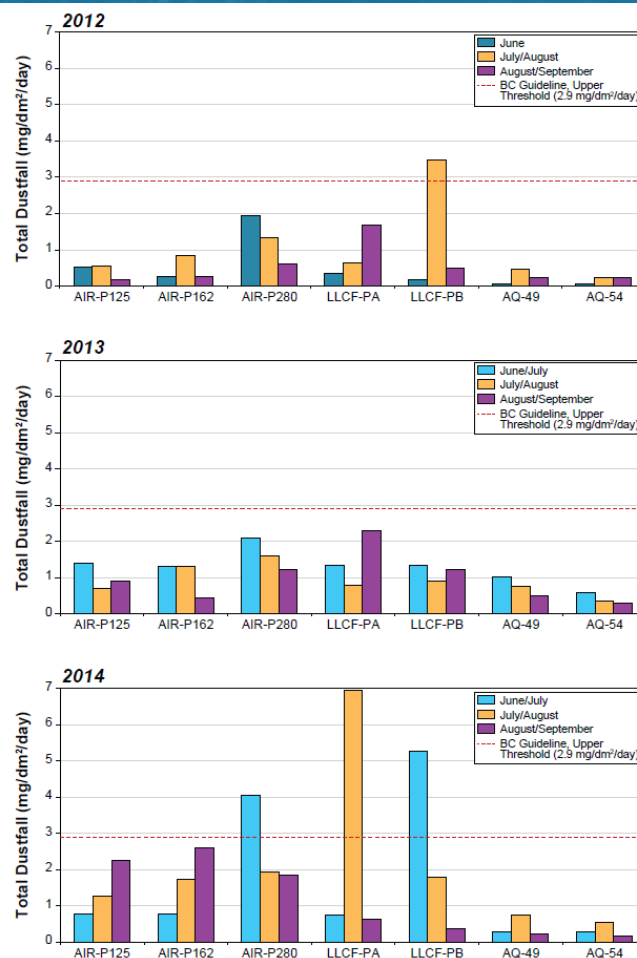
Dustfall monitoring

Misery Haul Road



Dustfall monitoring

Dustfall Measured at Airstrip, LLCF and Background Monitoring Stations



Dustfall monitoring

Acid Deposition

Maximums:

1. 836 eq/ha/yr, from LLCF-PA between mid-June and mid-September 2014
2. 392 eq/ha/yr from FOX-U30 between June and mid-September 2012

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	2,063	715
New Brunswick	1,169	559
Quebec	519	358
Ontario	548	388
Total	559	358

Alberta PAI load standard of 250 eq/ha/yr

Ekati non-background median: 173 eq/ha/yr

Ekati background ranged from 58 to 140 eq/ha/yr

Dustfall Monitoring

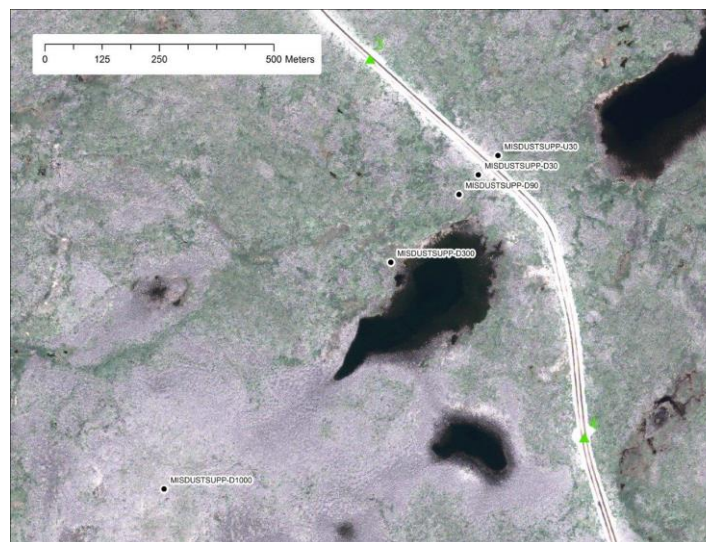
Dust Suppression 2012 to 2014

- Road watering
- DL-10
- EK-35 (airstrip only)
- Established Speed Limits



Dustfall Monitoring

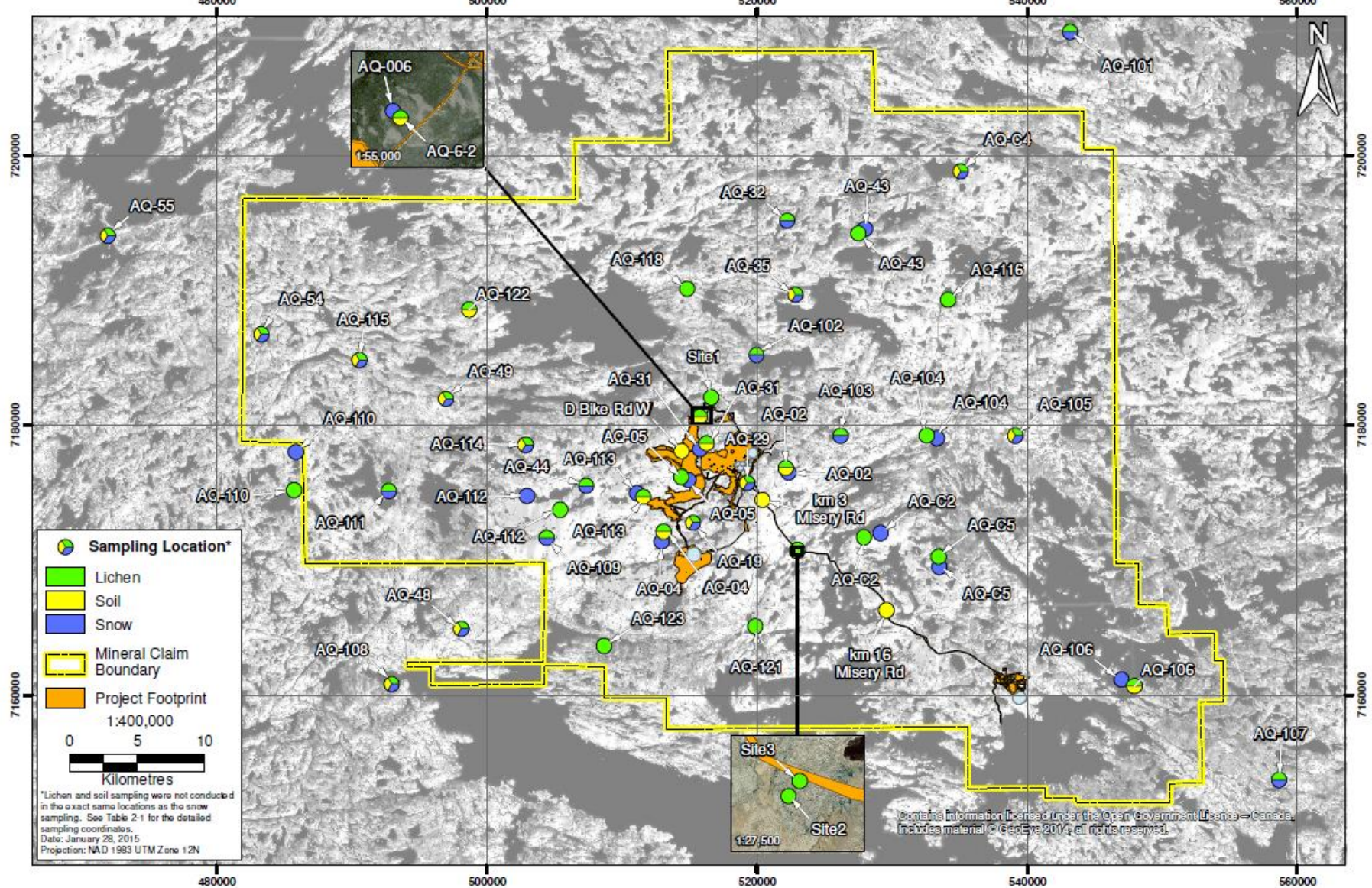
- 2015 Pilot Study: EnviroKleen® as an alternative dust suppressant on the Misery Road
 - 5 dustfall monitoring stations
 - Motion trigger cameras
- Results will be circulated
Fall 2015



Snow chemistry monitoring

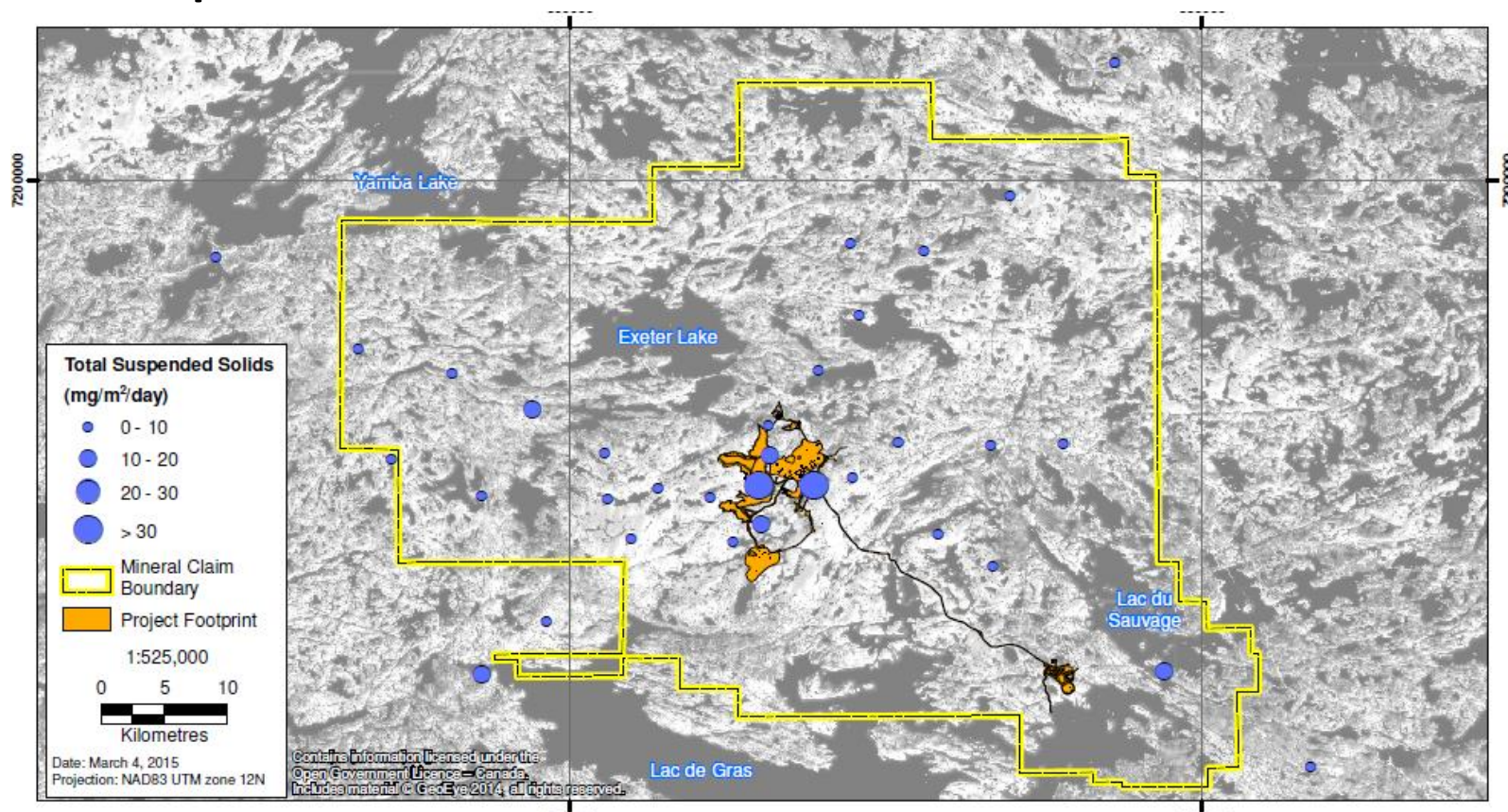
- Collected between March 25 and April 12
- Three separate snow samples were collected using a Mt. Rose sampler
- Three samples were then homogenised and analyzed- variable list same as the AEMP water quality list





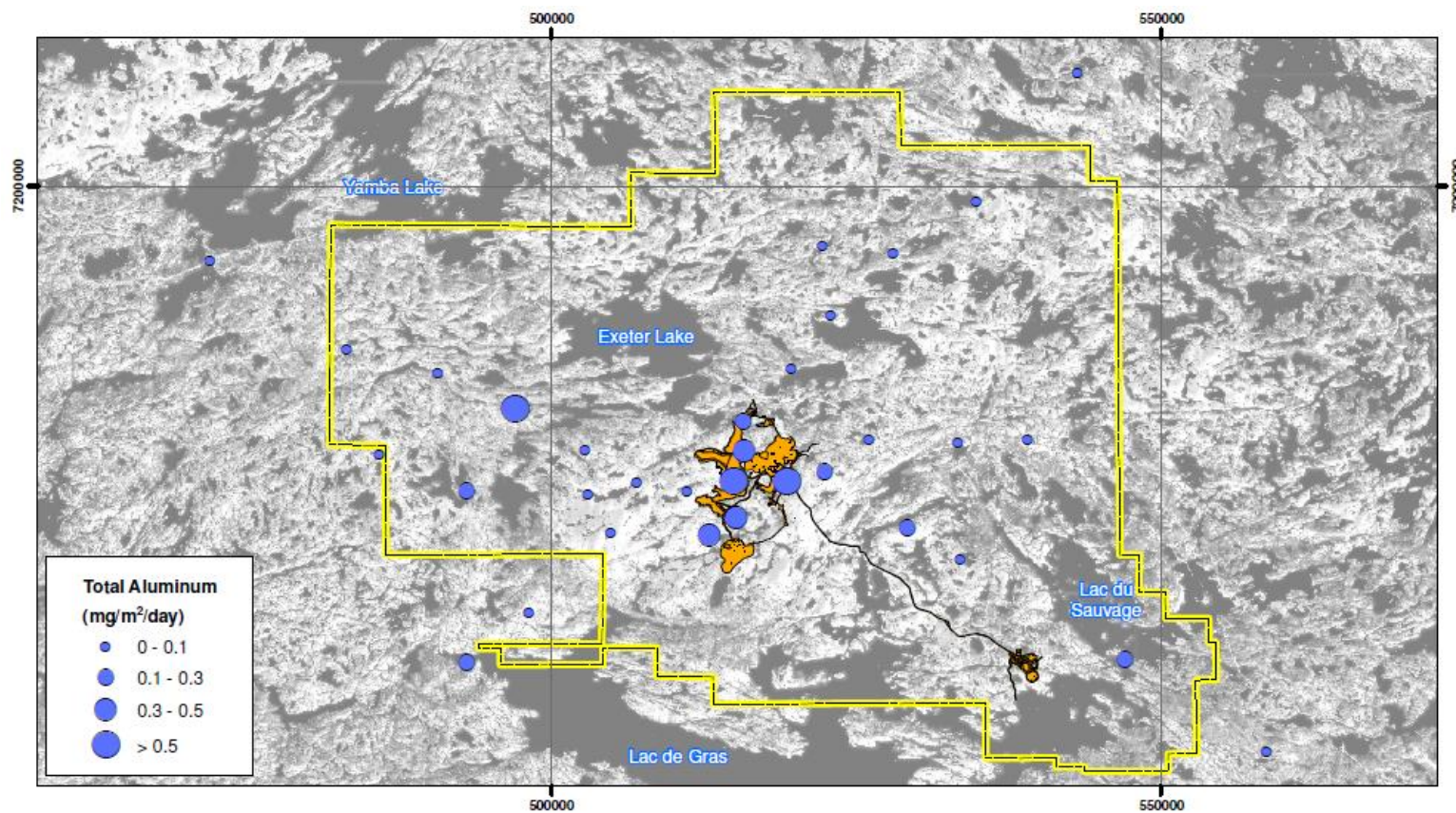
Snow chemistry monitoring

Total Suspended Solids



Snow chemistry monitoring

Total Aluminum





Snow chemistry monitoring

2014 Comparison to Historical

- TSS generally lower when compared to 2008 and 2011
- Metals generally similar between years (2008 and 2011)
- Nitrate, ammonia, and sulphate loadings similar between years (2008 and 2011)



Snow chemistry monitoring

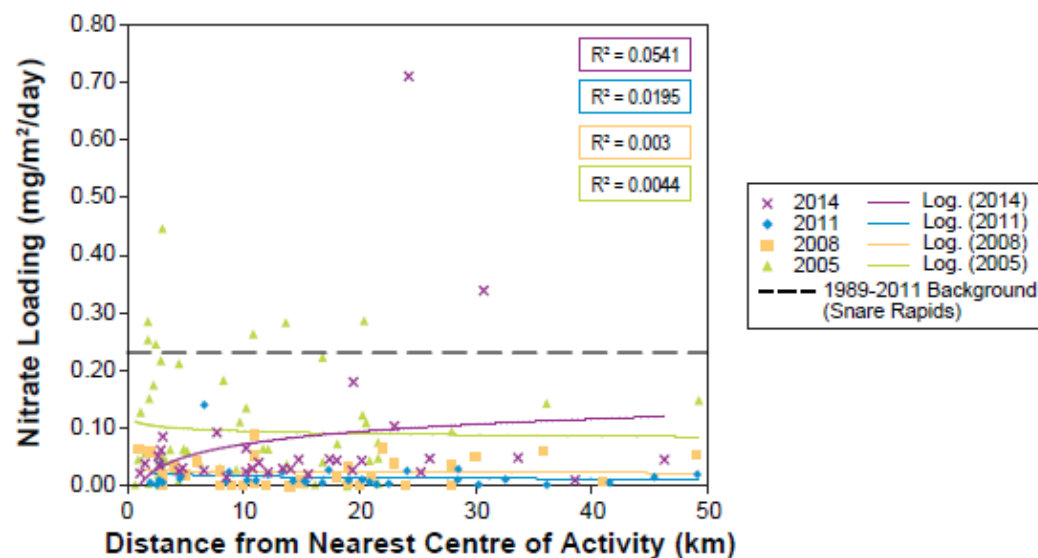
2014 Comparison to Historical

- TSS generally lower when compared to 2008 and 2011
- Metals generally similar between years (2008 and 2011)

Snow chemistry monitoring

Nitrate, ammonia, and sulphate loadings:

- Similar trends with elevated loadings at close proximity to mining activity
- Generally below Snare Rapids (background)
- In agreement with CALPUFF and similar results to 2008 and 2011 loadings



Lichen tissue monitoring

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 (2008, 2011 and 2014)?
3. Is there a relationship between dustfall and snow melt water with the lichen and soil sample collection areas?

Lichen tissue monitoring

- In conjunction with snow core sampling
- 39 Air Quality (AQ) lichen plots
- Soil samples were collected at 19 random AQ sites
- Road dust: two from the Misery Haul Road and one from the Dike B Road

Lichen Species Collected:

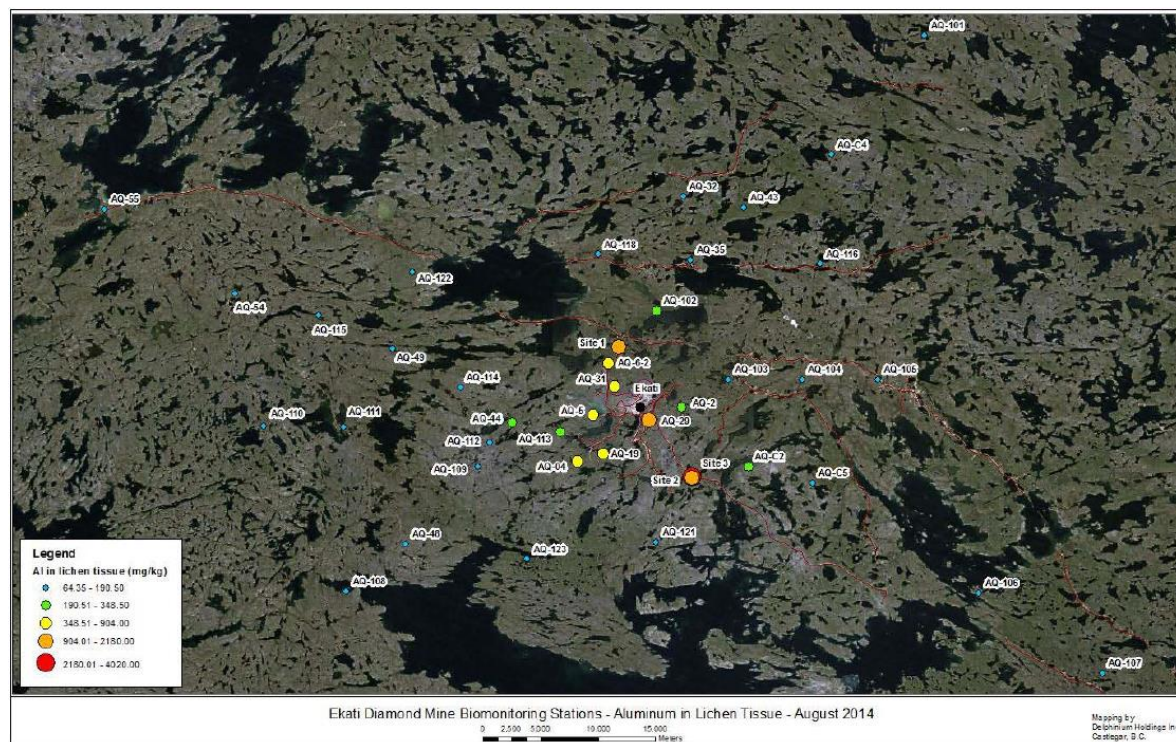
Flavocetraria cucullata
Peltigera (mainly) *rufescens*



Lichen tissue monitoring

1. Is there a relationship between distance from the mine site and the concentration of elements in *Flavocetraria cucullata*?

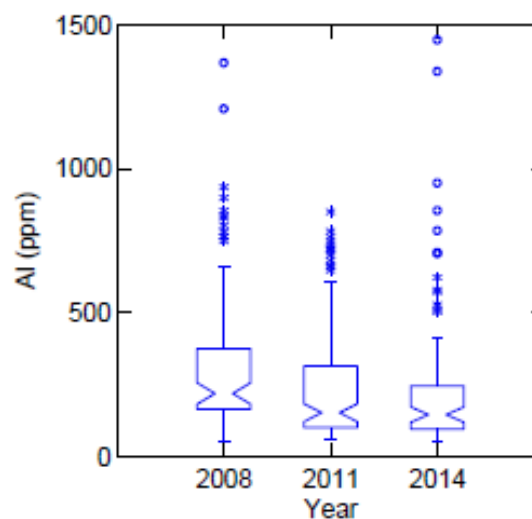
- Most enhancements occurred within 10 to 30 km from the mine site
- Tends to decline with distance from the mine site
- Highest concentrations generally occurred within 1 km of roads
- Example: Aluminum



Lichen tissue monitoring

2. Is there a difference in element concentrations in co-located *Flavocetraria cucullata* between years (2008, 2011 and 2014)?

- Al, Cr, Pb, and Na declined
- As, Cd, Ca, Fe, Mg, Ni, N, V, Zn fluctuated
- All 2014 concentrations were low
- Most elements are below Arctic background levels at 30 km from the mine.



Lichen tissue monitoring

- 3. Is there a relationship between dustfall and snow melt water with the lichen and soil sample collection areas?**
- No general relationship with dustfall or soil samples
 - Typically correlated well with snow core results

Air Quality Monitoring Program

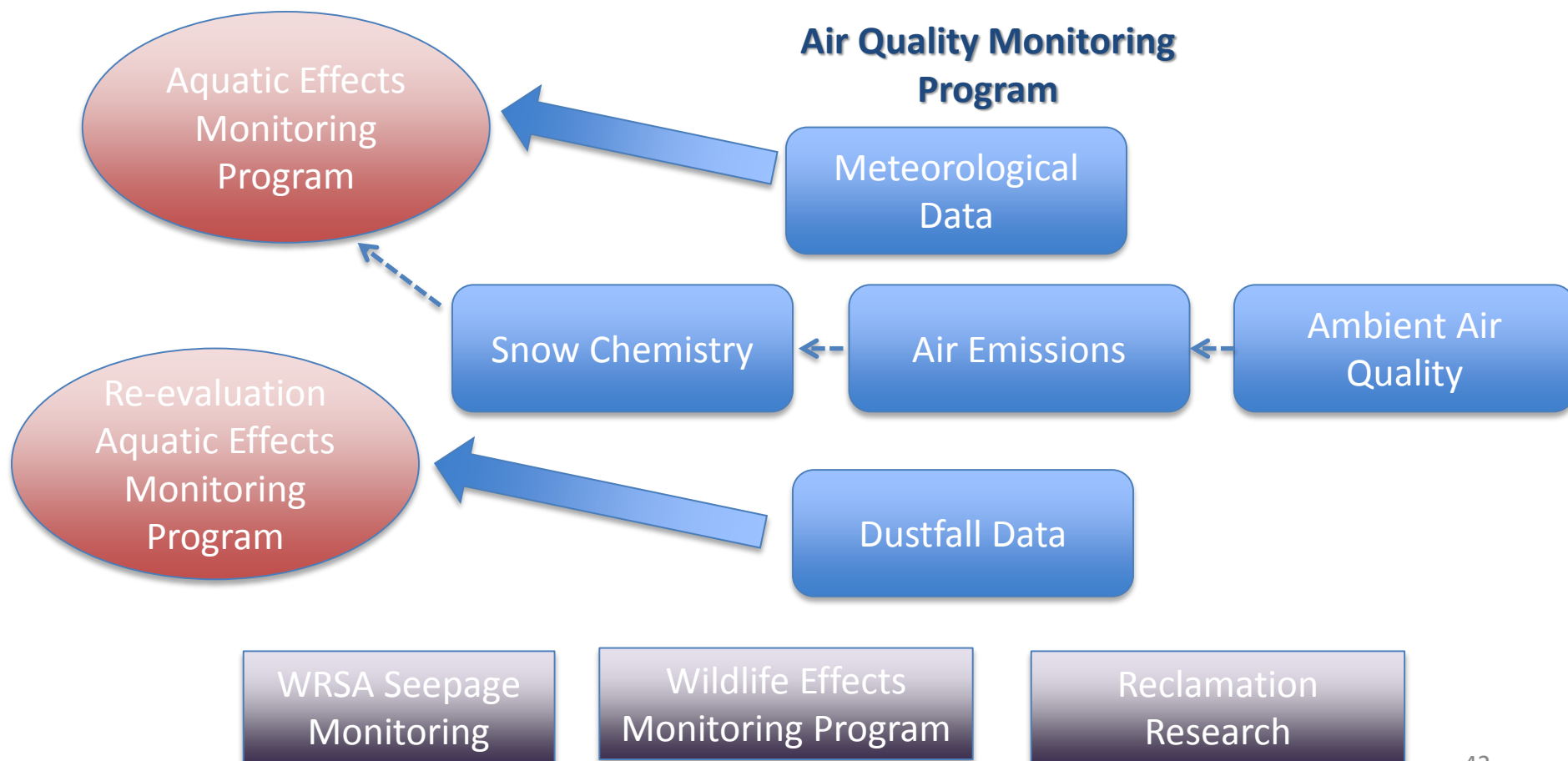
Questions?



Air Quality Monitoring Program

Linking Air Quality to Other Environmental Programs

Linking Air Quality to Other Environmental Programs





Thank -you