Crown-Indigenous Relations and Northern Affairs Canada
Relations Couronne-Autochtones et Affaires du Nord Canada

Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

GIANT MINE REMEDIATION PROJECT

Dust Management and Monitoring Plan

June 2021

Version 2.1

LAND ACKNOWLEDGEMENT

The Giant Mine Remediation Project acknowledges the Indigenous Peoples and the importance of the land in and around the Giant Mine Site, which is located in Chief Drygeese Territory. From time immemorial, it has been and is the traditional land of the Yellowknives Dene First Nation. We acknowledge that the Giant Mine Site is also within the homeland of the North Slave Metis Alliance and the Tłı̨chǫ Mǫwhì Gogha Dè Nı̨ı̨tłèè boundary. The Giant Mine Remediation Project respects the histories, languages, and cultures of First Nations, Metis, Inuit, and all First Peoples of Canada, whose presence continues to enrich our vibrant community.

PLAIN LANGUAGE SUMMARY

This is a Giant Mine Remediation Project (GMRP) Dust Management and Monitoring Plan (Dust MMP) that explains how dust will be managed on Site. The focus of this version of the Dust MMP is on the remediation activities that will take place in the near term. This plan will be updated as necessary as remediation progresses.

This Dust MMP has been developed to meet applicable Water Licence conditions and Measures from the Environmental Assessment process. The approach of the Dust MMP is to list the best ways to mitigate and control dust, identify what to monitor and where to monitor, and when to act and what to do if dusty conditions occur. This plan outlines the sources of dust during remediation and how to stop them or reduce them.

This plan uses the forecast for winds so the GMRP can arrange in advance for controlling dust on days with anticipated high winds. The GMRP also watches for visible dust - this is when you can see dust with the eye. It is a concern to the community and the GMRP. This plans also uses continuous measurements of wind and measurements of dust to guide how to control dust on Site.

This Dust MMP gives the GMRP guidance on how to control dust. It gives ‘best management’ methods on how to water roads where trucks drive and what water to use or how to use a special product to stop dust from starting on the Tailings Containment Areas (tailings ponds) and on-site roads. It also discusses what to do during remediation, for example, when taking down buildings or blasting for rock to make the access pads needed to install the equipment required for the freeze program for the arsenic chambers.

The Dust MMP also describes when to act, what action is required, and when to report to the Mackenzie Valley Land and Water Board. This is called the ‘action level’. Action levels for visible dust and measured dust are proposed in this plan.

In accordance with the annual Water Licence reporting requirements, the GMRP will submit a summary of dust management and monitoring activities conducted during the previous calendar year. The GMRP will conduct an annual review of this plan and make any revisions necessary to reflect changes in operations, contact information, or other details.

As a note to the reader, this plan is related to the air quality monitoring program required as part of the Giant Mine Environmental Agreement with communities and governments. The Dust MMP describes how dust is controlled and checked on Site. The companion Air Quality Monitoring Plan (AQMP) describes how dust and other emissions are monitored around the perimeter of Site and near communities. Requirements for air quality monitoring are attached to this Dust MMP so it is easy for you to find the plan. However, note that the air quality monitoring and reporting about air quality results near and in communities is separate. The GMRP Engagement Plan outlines how air quality monitoring results will be communicated to Rights holders, stakeholders, and the public including through weekly reports and through the Emergency Communications Plan, and what actions are being taken.

VERSION HISTORY

Version	Date Issued	Description of Version
1.0	April 1, 2019	Submitted with Water Licence Application to Mackenzie Valley Land and Water Board
1.2	September 30, 2020	Circulated to Working Group for Pre-engagement prior to Submission to Mackenzie Valley Land and Water Board
2.0	March 12, 2021	Submitted to the Mackenzie Valley Land and Water Board as per Water Licence MV2007L8-0031, Part F, Condition 9. Changes to this Plan include an update to address the Board Directives included in the Water Licence, commitments made during the water licencing process and for consistency in format with other site wide management plans.
2.1	June 23, 2021	Submitted to the Mackenzie Valley Land and Water Board as per Water Licence MV2007L8-0031, Part F, Condition 9. Changes to this Plan include updates to address Board's direction dated June 4, 2021 and minor administrative updates. A summary of changes is appended to the cover letter submitted with this version.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AANDC	Aboriginal Affairs and Northern Development Canada
BMP	best management practice
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CRP	Closure and Reclamation Plan
CTP	Central Tailings Pond
EA	Environmental Assessment
ECCC	Environment and Climate Change Canada
EHSC	Environment, Health and Safety, and Community
ETP	effluent treatment plant
FOS	freeze optimization study
GMRP	Giant Mine Remediation Project
GNWT	Government of the Northwest Territories
GNWT-ENR	Government of the Northwest Territories – Environment and Natural Resources
MCM	Main Construction Manager
MMP	Management and Monitoring Plan
MOECC	Ontario Ministry of Environment and Climate Change
MVEIRB	Mackenzie Valley Environmental Impact Review Board
MVLWB	Mackenzie Valley Land and Water Board
NTP	North Tailings Pond
NO_2	nitrogen dioxide
NWT	Northwest Territories
OMOE	Ontario Ministry of the Environment
OMS manual	operational maintenance surveillance manual
Phase 2	Active remediation phase of GMRP
PM	particulate matter
PSPC	Public Services and Procurement Canada
RBAL	Risk-Based Action Level
RECP	Rolled Erosion Control Products
RWDI	RWDI AIR Inc.
Site	Giant Mine
STP	South Tailings Ponds
TCA	Tailings Containment Area
TRP	tailings retreatment plant
TSP	Total Suspended Particulates
U.S. EPA.	United States Environmental Protection Agency
YZF	Yellowknife Airport

LIST OF UNITS AND SYMBOLS

Unit/Symbol	Definition
%	percent
>	greater than
°C	degrees Celsius
µm	micrometre
µg	microgram
cm	centimetre
km	kilometre
km/h	kilometre per hour
m	metre
mm	millimetre
m/s	metre per second
m^3	cubic metre

1 INTRODUCTION

The Giant Mine (Site) is located within the City of Yellowknife boundary, approximately 1.5 kilometres (km) from the community of Ndilǫ and 9 km from the community of Dettah. The Site is situated on Commissioner's Land administered by the Government of the Northwest Territories (GNWT); Reserves (R622T and 85 J/8-257-2) have been established to allow for the implementation of the remediation of the Site. Ongoing care, maintenance and remediation of the Site is known as the Giant Mine Remediation Project (GMRP). Subsurface mineral rights are under federal jurisdiction and were withdrawn by Order in Council SI/2005-55 on 15 June 2005. For a history of the Giant Mine and planned remediation activities, please refer to the Closure and Reclamation Plan (CRP).

The Site consists of eight abandoned open pits; an underground mine with arsenic trioxide storage chambers; Tailings Containment Areas (TCAs) with associated rock fill dams; mine waste rock that buttresses Dams 11, 21B and 21D; a tailings re-treatment plant (out of service since 1990); an effluent treatment plant (ETP); a Mill Complex; several warehouses; and a townsite. Baker Creek flows through the Site seasonally with one ponded area. The Site features are outlined in Figure 1.1-1.

1.1 Plan Objectives and Linkages

This Dust Management and Monitoring Plan (Dust MMP) focuses on dust management on Site. It summarizes management and monitoring practices, actions and contingencies, and provides direction for additional management practices that will be required to manage upcoming remediation activities to continue to protect health, safety, and the environment. The Dust MMP provides an overview of the dust management strategy for the entire duration of active remediation and into post closure. However, the focus of this version of the Dust MMP is on the upcoming remediation activities that will take place in the near term over the next few years. It is required by the Water Licence that this management plan be reviewed annually. Should the annual review indicate that updates are required to the Plan to address upcoming activities, proposed updates will be submitted to the Mackenzie Valley Land and Water Board (MVLWB or Board). The Water Licence stipulates the Licensee may propose changes at any time by submitting revised plans to the Board, for approval, a minimum of 90-days prior to the implementation date of the desired change, as per Part B, condition 10.

This Dust MMP has been developed to satisfy applicable Water Licence conditions set forth in Water Licence MV2007L8-0031, Land Use Permit MV2019X0007, and Measures from the Environmental Assessment process. Updates to the Dust MMP will be ongoing through the life of the GMRP to provide more details on future management, as remediation moves forward.

Dust Management and Monitoring Plan Objectives

The objective of the Dust MMP is to reduce, to the extent possible, the amount of dust generated on-site and the movement of dust off-site such that there are no significant adverse impacts to people, the surrounding communities or environment. The Dust MMP focuses on the existing features that may generate dust and remediation activities that could generate dust over the next few years. Control of dust will be achieved through proactive implementation of best management practices, and active monitoring of the wind and dust conditions. This plan is intended as a guide for decision making with respect to dust management and monitoring.

634000 636000 638000

6936000 6934000 6932000

Trapper Lake
Shot Lake
DAM 22B
NORTHWEST POND NON-HAZARDOUS WASTE DISPOSAL SITE
DAM 22A
Gar Lake
NORTHWEST POND HAZARDOUS WASTE AREA
Yellowknife River
NORTHWEST POND
DAM 21D
Trapper Creek
SOLIDS RETENTION DYKE (SPLITTER DYKE)
CONTAINMENT BERM
DAM 21A
EFFLUENT TREATMENT PLANT (ETP)
DAM 21C
DAM 21B
DAM 3C
B4 PIT
DAM 3
SETTLING POND
DAM 3D
DAM 1
POLISHING POND
DAM 2
Baker Creek
B3 PIT
NORTH POND
M&M DAM
TAILING REPROCESSING PLANT
Pocket Lake
Baker Pond
DAM 6
4
DAM 10 (REMOVED)
CENTRAL POND
DAM 4
DAM 9
STORAGE DOME
MATERIAL STORAGE AREA
CALCINE POND
B1 PIT
B2 DAM
DAM 8
B2 PIT (UBC)
DAM 5
DAM 12
BROCK PIT
FORMER ROASTER AND STACK
SOUTH POND
MILL POND
MILL
DAM 11
C SHAFT
DAM 7
C1 CLAY BORROW DAM
Baker Creek
C1 PIT
FORESHORE TAILINGS AREA
A SHAFT
Yellowknife Bay
Handle Lake
A1 PIT
TOWNSITE
DWC DAM
A2 PIT
MARINA

634000 636000 638000

LEGEND

- BUILDING
- GIANT MINE PROJECT BOUNDARY
- HIGHWAY
- INDUSTRIAL WATERCOURSE
- INFRASTRUCTURE
- ROAD
- SPLITTER DYKE
- SURFACE WATER MANAGEMENT DAM/DYKE
- TAILINGS OR SLUDGE RETENTION DAM
- WATERCOURSE
- INDUSTRIAL WATERBODY
- PIT BOUNDARY
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCE(S)

HYDROLOGY AND TRANSPORTATION DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. 2018 ORTHOPHOTO PROVIDED BY AECOM.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

PROPONENT

Crown-Indigenous Relations and Northern Affairs Canada
Relations Couronne-Autochtones et Affaires du Nord Canada

Government of Northwest Territories / Gouvernement des Territoires du Nord-Ouest

YYYY-MM-DD	2021-03-18
DESIGNED	J. LACRAMPE
PREPARED	A. AUCOIN
REVIEWED	T. HALL
APPROVED	T. HALL

PROJECT

Giant Mine Remediation Project

TITLE

GIANT MINE SITE LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
20137939	02-74-0599	0	1.1-1

Closure Criteria Related to this Plan

There are closure objectives and criteria that will apply once remediation is complete. As required by Schedule 4, Condition 6f of the Water Licence, the closure objectives are included here. A summary of those relevant to this Dust MMP are provided below, with a full list presented in the CRP.

- SW1. Air quality is maintained at concentrations protective of human health and the environment
- P3. Pit fill material will not become a source of contamination to the environment
- T1. Contaminant loading from the tailings containment area to the environment is reduced

Linkage to Other Management and Monitoring Plans

The dust management strategies to meet the Dust MMP objectives are provided in Section 2. The Dust MMP will be implemented in conjunction with other site-wide management and monitoring plans to support the overall GMRP goals and closure objectives. Other GMRP management and monitoring plans that are relevant to this MMP are illustrated in Figure 1.1-2. An overview of Site-wide monitoring during Active Remediation and Adaptive Management (Phase 2) and during Post-Closure (Phase 3) is illustrated in Figure 1.1-3.

The environmental MMPs for the GMRP have been developed to complement each other while reducing repetition and overlap between plans. As a result, the environmental MMPs are cross-referenced within other plans to indicate where more information can be found. The linkage figures assist with the understanding of how these plans work together to manage and monitor site activities; this is a high-level figure representing overall relationships. Figure 1.1-2 is reflective of the current scope of the plans (i.e., the first few years), but includes major activities anticipated over the life of the Water Licence. As such, the post-construction plans (Arsenic Trioxide Frozen Shell and Tailings MMPs) are identified in the diagram but do not apply until those components are completed; they are listed to provide an understanding of how they fit within the project as a whole.

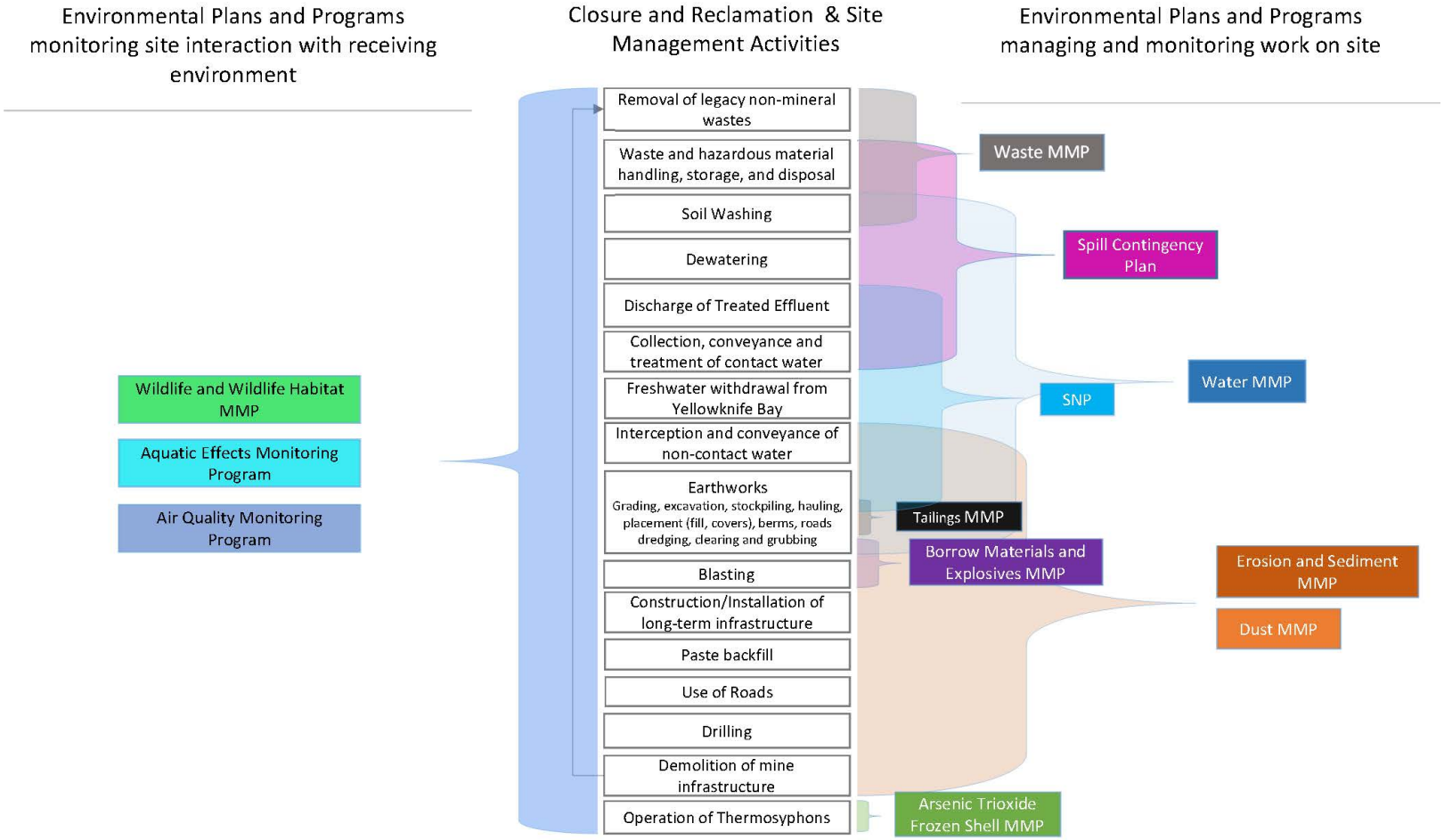
Linkage to Air Quality Monitoring Plan

The Air Quality Monitoring Plan (AQMP; Appendix D), which addresses Measure 25 from the Report of EA (MVEIRB 2013), is a requirement of the Environmental Agreement (CIRNAC and GNWT 2015) and is directly linked (and appended) to the Dust MMP as shown in Figure 1.1-4. The AQMP focuses on the monitoring of particulates and other emissions at the Site and within the surrounding communities of Yellowknife and Ndilǫ. The Site perimeter network consists of nine Site Perimeter Monitoring Stations placed on or near the Project Boundary. The Site Perimeter Monitoring Stations are described in Section 5.3.1 and shown in Figure 5.3-1. The community monitoring network consists of three stations shown in Figure 5.3-1: Ndilǫ(NDL Station), Great Slave Sailing Club marina area (YKB Station), and the Niven Lake subdivision (NVN Station). These Community Monitoring Stations provide continuous monitoring of target parameters (Section 5 of the AQMP). These community stations have been and will continue to be used to inform and verify the effectiveness of the Dust MMP in relation to dust from remediation activities on Site.

Should an exceedance of the monitoring criteria of one of the target parameters be detected at a community station, an investigation will be conducted immediately to determine whether the exceedance is from activities at Site, regional issues (e.g., forest fire), or a local community source such as road dust. If the source is determined to be the Site, the need for additional mitigation measures from the Dust MMP will be evaluated and implemented.

Note that air quality results are reported separately to various groups and communities as per the Environmental Agreement and are separate from the Water Licence reporting requirements (see discussion on Reporting in Section 7).

Figure 1.1-2: Linkages Between Management and Monitoring Plans for Giant Mine



Note: there is also an operational maintenance surveillance (OMS) manual for the existing tailings containment area and dam management relevant to the Canadian Dam Association guidelines; it is not for MVLWB approval but is available here for interested parties: https://giantminerp.ca/glance-giant-mine-remediation-project.

Figure 1.1-3: Linkages Between Environmental Management and Monitoring Plans, Construction and Design Plans for Giant Mine

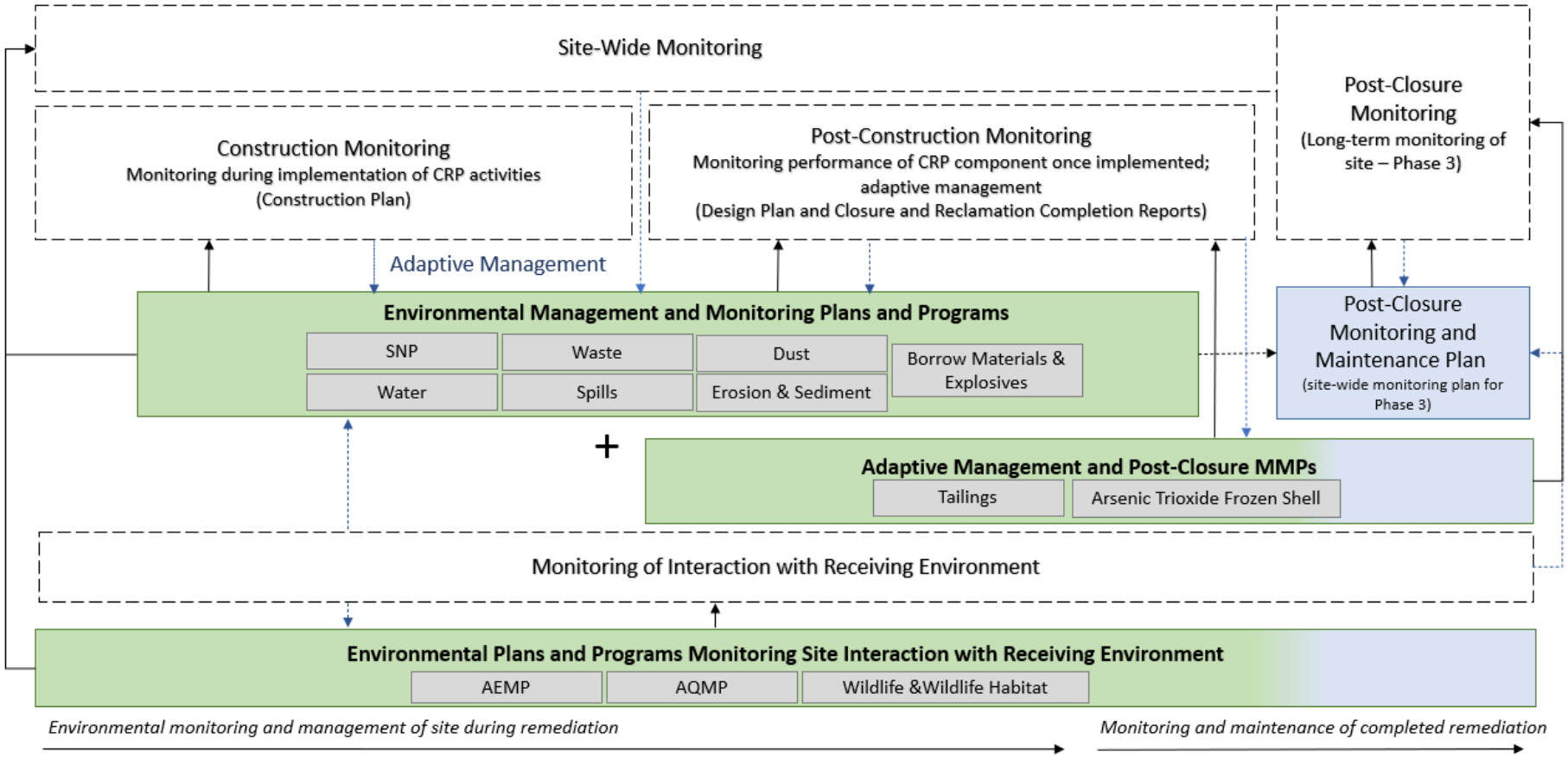
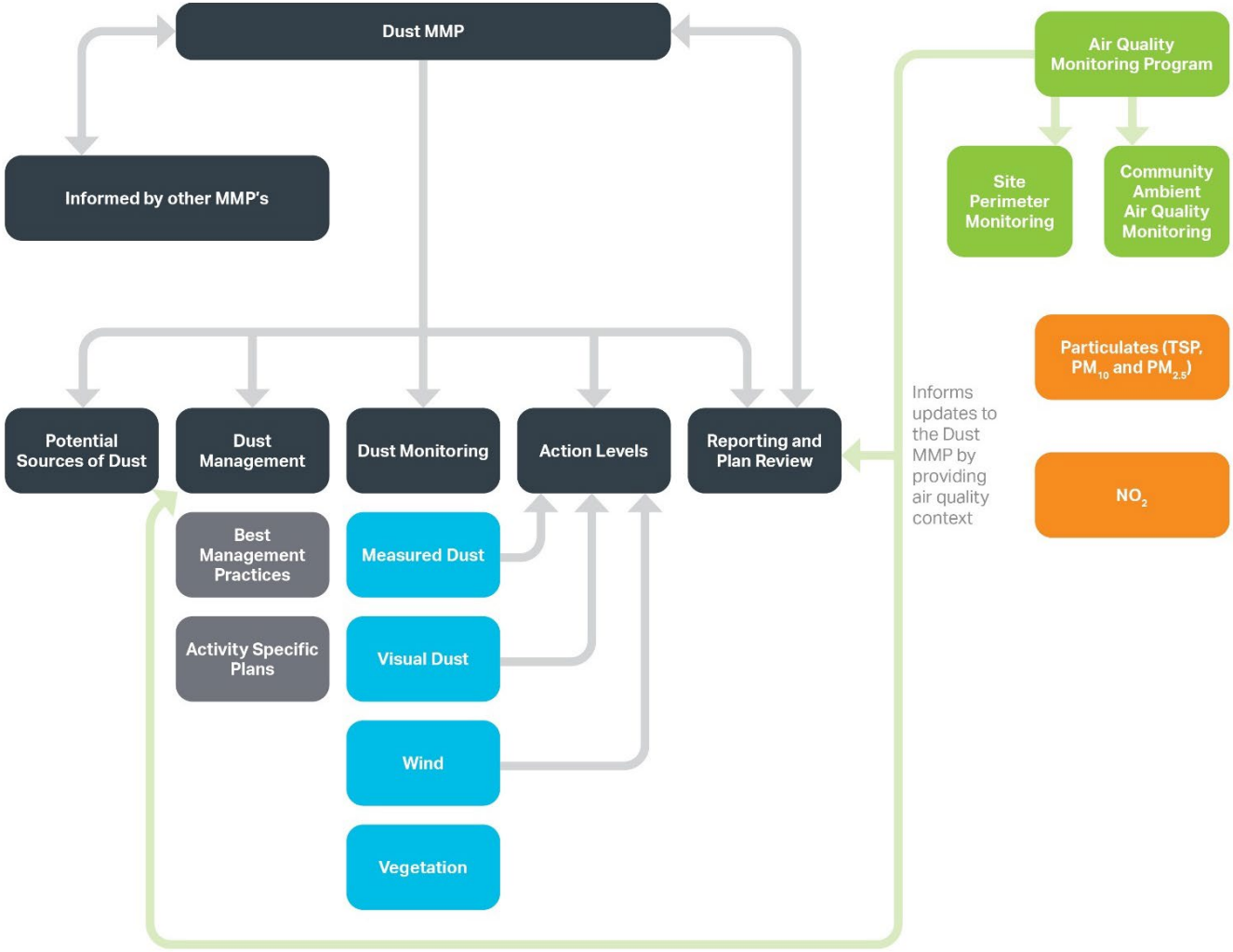


Figure 1.1-4: Linkages between the Air Quality Monitoring Program and the Dust Management and Monitoring Plan



1.2 Project Team

The GMRP is jointly managed through a Cooperation Agreement, with the Government of Canada and the Government of the Northwest Territories (GNWT). The GMRP Team consists of Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) and the Government of the Northwest Territories – Environment and Natural Resources (GNWT-ENR) acting as co-proponents with respect to the Environmental Assessment and other regulatory considerations. Public Services and Procurement Canada (PSPC) provides contracting services, contract management, and technical support services to CIRNAC. PSPC has awarded the Main Construction Manager (MCM) contract to Parsons Incorporated. This contract will be used to complete implementation activities for the GMRP. The MCM is responsible for overall Site construction activities management including emerging risks on Site and supporting planning efforts for closure and reclamation during active remediation.

For this Dust MMP, the GMRP is responsible for, and has retained the services of the MCM, to verify that required dust management monitoring and controls are in place and working properly. The MCM and their procured subcontractors will be required to adhere to management and monitoring details and best management practices outlined within the Dust MMP and the attached AQMP to confirm that dust is being minimized to the extent practicable. The MCM and each subcontractor will use the Dust MMP as both a framework within which it works, and the BMPs (Section 4.1) more specifically as a toolkit to select the best mitigation approaches to verify the objectives of this Dust MMP are met. It is the MCM's responsibility to verify that the requirement to minimize dust is met during implementation of the CRP and associated activities. Refer to Table 1.2-1- for staff responsible for management for the GMRP.

Table 1.2-1: Giant Mine Remediation Project Contacts

Company	Contact	Role	Information
CIRNAC	Natalie Plato	Deputy Director	Phone: 867-669-2823 Email: natalie.plato@canada.ca
	Candace DeCoste	Regulatory Manager	Phone: 867-444-9783 Email: candace.decoste@canada.ca
	Curtis Duffy	Senior Engineer	Phone: 867-444-9400 Email: curtis.duffy@canada.ca
PSPC	Brad Thompson	Senior Project Manager	Phone: 780-918-6277 Email: brad.thompson@pwgsc-tpsgc.gc.ca
Parsons	Doug Hayes	Mine Manager	Phone: 867-669-3715 Email: doug.hayes@parsons.com
	Norlito Cezar	Environment Manager	Phone: 867-669-3725 Email: Norlito.cezar@parsons.com
	Lex Lovatt	Senior Safety Specialist	Phone: 867-669-3719 Email: lex.lovatt@parsons.com
		Security	

1.3 Environment, Health and Safety, and Community Policy

Within the GMRP, the health and safety of employees and protection of the environment are an over-riding priority. Management is committed to doing everything possible to prevent injuries and to maintain a healthy environment.

The overall goals of the GMRP are:

- minimize public and worker health and safety risks
- minimize the release of contaminants from the Site into the environment
- remediate the Site in a way that inspires public trust
- implement an approach that is cost-effective and robust over the long term.

In keeping with these overall goals for the Project, the specific objectives of this policy are:

- protecting the environment and the health and safety of its employees, contractors, and the general public
- engaging meaningfully with stakeholders and rights holders
- recognizing the important contributions of Elders and community members, and incorporating Traditional Knowledge and community knowledge across Project
- delivering local social and economic benefits
- recognizing GMRP is an opportunity to advance reconciliation
- continuing to look for opportunities to further reduce greenhouse gas emissions and incorporate climate change adaptation into the Project
- being a recognized leader in Environment, Health and Safety, and Community (EHSC) management among public environmental remediation projects.

The full GMRP EHSC Policy is available upon request.

1.4 Regulatory Framework

This plan was developed in consideration of regulatory requirements including legislation, guidance documents, Water Licence requirements, and GMRP commitments and conditions. A full list of Water Licence requirements relevant to this plan can be found in Appendix A. There are Environmental Assessment Measures from the Report of EA (MVEIRB 2013) that pertain directly to the Dust MMP; Measure 20 and Suggestion 12 are discussed in Section 1.4.1.

Relevant federal and territorial legislation and permits/licences that apply to the Site include:

- *Mackenzie Valley Resource Management Act*
- Type A Water Licence (MV2007L8-0031)
- Type A Land Use Permit (MV2019X0007)
- *Northwest Territories Mine Health and Safety Act and Regulations*

Further, in adherence to the EHSC Policy, GMRP will comply with relevant federal and territorial legislation and guidelines when dealing with specific issues related to dust management and the environment. The following guidance/policy documents were used to support this Dust MMP:

- Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories prepared by the Mackenzie Valley Land and Water Board (MVLWB) and Aboriginal Affairs and Northern Development Canada (AANDC) (MVLWB and AANDC 2013)
- *Waters Act*
- *Fisheries Act*
- NWT *Environmental Protection Act*
- *Canadian Environmental Protection Act*
- Guideline for Ambient Air Quality Standards in the Northwest territories (GNWT 2014)
- Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities (ECCC 2005)
- Guidance Document on Air Zone Management (CCME 2019)
- Guideline for the Hazardous Waste Management (GNWT 2017)
- Guideline for Dust Suppression (GNWT 2013)
- Guideline for Asbestos Removal and Disposal (GNWT 2010)
- Guideline for the Management of Waste Asbestos (GNWT 2004)
- Achievement Determination Canadian Ambient Ait Quality Standards (CCME 2012)
- Standard Outline for Management Plans (MVLWB 2013)
- Contaminated Sites Environmental, Health and Safety Policy (AANDC 2006)
- Ontario’s Ambient Air Quality Criteria (OMOE 2019)

1.4.1 Environmental Assessment Measures

Measure 20 requires that the GMRP conduct all major demolition and construction activities with the potential to release large amounts of dust or contaminants into the air when wind directions will minimize the chances of dust and contaminants blowing into the City of Yellowknife, Dettah, and Ndilǫ. Similarly, Suggestion 12 indicates that, to prevent impacts on people from potentially harmful contaminant releases from deconstruction of buildings or other structures at the Site, the MVLWB should specify allowable wind directions and wind speeds in degrees, to ensure that contaminated structures are not demolished during blustery multi-directional winds at ground level. Measure 20 and Suggestion 12 have been incorporated into this plan. Wind direction and wind speed are measured in real time on-site (Section 5) and are considered as constraints on activity (Section 6).

Measure 21 requires that the GMRP collect dust and contaminant level data from soil and vegetation in the vicinity of major reclamation activities before and after major demolition or construction activities to serve as a baseline for any related adaptive management activities that may follow. Similarly, Schedule 4, Condition 6f (ii) of the Water Licence requires that the GMRP details dust monitoring, including vegetation monitoring pre- and post- demolition of major structures. Measure 21 (and corresponding Schedule 4, Condition 6f (ii) of the Water Licence) is discussed in Section 5.4.

1.5 Engagement

Version 1.0 of this Dust MMP was submitted to the MVLWB as part of the Water Licence Application Package in April 2019 and was part of the Water Licence proceedings. It was given interim approval for Phase 1 by the MVLWB on September 18, 2020 (Part F, Condition 8). As the GMRP committed to during the Water Licence Process, the Dust MMP underwent a pre-engagement process prior to Phase 2: Active Remediation and Adaptive Management. A draft version of the Dust MMP was provided to the GMRP Working Group, a pre-engagement meeting was held on October 13, 2020, and written comments were collected approximately four weeks after the draft version was distributed. General feedback provided included: plan should include more prescriptive language in best management practices and mitigation sections, request for inclusion of wind forecasting and additional detail on stockpile management and demonstrate how actions are proactive to prevent issues. The GMRP considered this input in Version 2.0 of the Dust MMP and acknowledges that this process has been helpful in improving this Dust MMP as well as understanding reviewer concerns with respect to management and monitoring of dust at the Site. For further detail on the general engagement that has occurred and will continue to occur for the GMRP please refer to the CRP and Engagement Plan.

1.6 Traditional and Community Knowledge

The consideration of Traditional and Community Knowledge has been integrated into project planning, wherever relevant and available. The CRP outlined how this knowledge influenced project decisions. The Engagement Plan, specifically Appendix C of that plan, summarizes the Traditional and Community Knowledge provided to date. The GMRP Team is committed to continuing to incorporate Traditional and Community Knowledge into the implementation of remediation and future versions of this plan, where information is available and appropriate. Recommendations from community members and rights holders have been incorporated into aspects of the Dust MMP including knowledge from Elders on seasonality of wind speed and direction.

1.7 Project Activities Relevant to the Plan

As noted in Section 1.1, this Dust MMP is focused on activities in the first few years of Phase 2: Active Remediation and Adaptive Management. The activities later in remediation will be captured in future versions of the Dust MMP. Remediation will take more than ten years to complete. After that time, the GMRP will commence 'adaptive management' to determine if the work completed is performing as designed. Once closure activities are complete, the GMRP will enter the post-closure phase. It is understood that post-closure activities are not in scope in the Water Licence, or this MMP, but some post-closure concepts are discussed herein so the reader can understand the transition from early remediation to post-closure for dust management.

With the receipt of the approved Water Licence, the GMRP is transitioning from care and maintenance to Active Remediation (Phase 2). The main work to be done in the first few years of remediation is:

- Underground stabilization
- Non-Hazardous waste landfill construction
- Develop AR-1 Freeze Pad
- Deconstruction of the Townsite buildings
- Continued care and maintenance and site investigation activities

Key activities that are described in this plan include both maintenance of existing conditions prior to remediation and activities associated with the main work (as listed above) in the first few years of remediation, which include:

- **Exposed Tailings** - Management of existing tailings containment areas.
- **Roads and Roadworks** – Widening, grading and contouring of existing roads, use and maintenance of existing roads, and placement of temporary access roads to support investigations, remediation and monitoring activities.
- **Earthworks** - Excavation and loading of mineral materials, transport of mineral materials, contaminated soil excavation, hauling, stockpiling, and placement of levelling course, construction of drill pads, and drain rock from off-site.
- **Drilling** – Drilling for investigations, equipment placement, borehole placement, thermosyphon installation, to support underground stabilization and backfilling of slopes, and for blasting.
- **Blasting** – Blasting for construction activities e.g., AR-1 Freeze Pad.
- **Infrastructure Demolition** - Decommission and demolition of Site infrastructure, equipment and facilities with no future use. This consists of structures, debris stockpiles, equipment, road network, utilities, and fencing.

2 DUST MANAGEMENT STRATEGY

The strategy to mitigate dust on Site is to:

- Control dust at the source with proactive implementation of dust control management practices (Section 4).
- Respond to measured dust in real time using Risk-Based Action Levels (RBALs) (Section 6.1 and Table 6.5-1).
- Continually improve based on reviews of results and past events (Section 7.3).

Be Proactive - Control dust at source The Dust MMP proposes best management practices and activity-specific dust controls with monitoring, and response to monitoring, to implement this strategy. The GMRP requires that dust management be proactive for both site management and in implementation of remediation. Management to minimize dust relies on a series of interconnected MMPs as well as the implementation of BMPs. BMPs (Section 4) will be implemented prior to and during approved site activities and are evaluated through monitoring. BMPs will be selected to ensure Part F, Condition 1 of the Water Licence and the objectives of the applicable MMPs are satisfied. Flexibility in selection of BMPs is required to ensure impacts to the receiving environment are minimized; the selection of which BMP(s) to implement for each GMRP activity will be dependent upon the location of the activity on-site, the conditions at the time of work (weather, time of year), the type of equipment being used, and other site-and timing-specific considerations. The BMPs included in this MMP are a compilation of those most applicable to use at the Site for mitigation of dust. The specific BMPs to be utilized for a given activity will be selected prior to commencement of work to ensure use of what is most appropriate. Further, should conditions change, the GMRP must be able to adapt the mitigation as needed, to continue to satisfy Part F, Condition 1 and the objectives of the applicable MMPs.

Protect people and environment As noted in Section 1, the overall objective is to protect people and the environment by controlling dust at the source. Note that air quality on-site for workers is covered under separate legislation and personal protective equipment, associated reporting requirements, etc. are not captured in the Dust MMP. People and the environment encompass the valued components for the GMRP. As discussed in the CRP, valued components were developed to identify the values that surround a project, and what is of utmost importance to rights holders, affected parties and from an environmental standpoint, based on the existing project and receiving environment. The GMRP's valued components are listed in the CRP and the Updated Project Description. Most relevant to the Dust MMP are the following:

- Baker Creek and Yellowknife Bay.
- Surface water and ground water quality, soil and sediment quality, aquatic and terrestrial habitat, and air quality.
- Indigenous interests, including Indigenous community well-being, traditional harvesting and subsistence, and Indigenous heritage sites.
- Additional community interests including land use which might include areas the public visit such as the boat launch and sailing club area, Yellowknife Historical Society building, and Vee Lake Road.

Learn lessons from the past ('Continuously improve') Lessons have been learned from past dust events in relation to wind events and direction (Table 2.0-1). The lessons learned are used to improve upon management actions (Table 2.0-1).

Table 2.0-1: Lessons Learned from Past Dust Events Incorporated into the Management and Monitoring Plan

Observation	Source of Observation	How incorporated into Dust MMP
Dust released from infrastructure demolition not easily controlled.	Observation during Roaster demolition	Asbestos and arsenic abatement processes may be completed under negative air. Included in BMPs.
Localized dust generation from vehicles on Site roads increases with increased speeds.	MCM observation	Limiting vehicles speeds on Site as a BMP.
Some dust suppressants more effective than others on tailings and roads.	MCM observation	Continual improvement in application techniques and types of dust suppressant as a BMP.
Difficulty in managing dust from tailings pond surface in strong winds (as recently as October 2020)	Community and Site observations	Addition of water spray to tailings pond BMPs as a proactive and reactive measure. Water cannons obtained for use on Site to increase capacity to reach harder to access areas of the TCAs. Addition of helicopter water application in extreme cases to reactive BMPs.
Historic wind patterns	Traditional Knowledge	Timing considerations, such as was used for the A Shaft deconstruction, added to BMP. Added into BMP for scheduling and staging overall.
Three exceedances of the RBAL were observed in May 2014, 2015, and 2016, and were attributed to wind-blown dust from the South Pond, a Tailings Containment Area.	Documented in AECOM 2019	Addition of water sprays and other approaches to Site BMPs.
Require monitoring that reflects differences among remediation activities.	Documented in AECOM 2019	Revised criteria for activity-based monitoring in 2021.
Meteorological data collection on the Site was systematically biased - few North winds measured, perhaps due to initial installation issue.	Documented in AECOM 2019	New on-site Meteorological Station installed in 2020.
Higher wind speeds and gusts are often intuitively associated with higher concentrations of particulate matter; however, relatively small impact was observed in the analyzed data.	Documented in AECOM 2019	Revised action levels in 2021 which include wind speed.
Planned mitigation activities not always well communicated on site.	MCM observation	Every day during morning meetings a field level dust-risk assessment is conducted taking into consideration site conditions, forecasts, and planned activities. Assessment outcomes, and mitigation plans, are communicated to all contractors.
Need for stockpiles can be reduced or eliminated by employing just-in-time delivery approaches.	MCM observation	"Avoidance" of stockpiles to the extent practicable incorporated into BMPs.

MMP = Management and Monitoring Plan; TCAs = Tailings Containment Areas; MCM = Main Construction Manager; RBAL = Risk-Based Action Levels; BMPs = Best Management Practices.

3 POTENTIAL SOURCES OF DUST

The focus of this Dust MMP is “fugitive dust”, which refers to dust that arises from the mechanical disturbance of granular material exposed to the air. The two main causes of fugitive dust generation/emission at the Site are wind erosion of surfaces and physical disturbance:

- Wind erosion is the process by which loose particles are picked up by the wind as it blows over an erodible surface. Winds move across the area, generating dust.
- Physical disturbance is the process by which materials are disturbed because of remediation activities, generating dust.

The following factors determine the extent to which fugitive dust will be created at the Site:

- Size of the exposed area.
- Moisture content and particle size distribution of the surface material. The moisture content is influenced by precipitation and the presence of snow cover. Frozen water within material inhibits dust generation.
- Wind speed: Wind erosion events are highly dependent on wind speed. Very minimal erosion, if any, occurs below a wind speed threshold of about 20 km/h. Total Suspended Particulate (TSP) can become airborne at higher wind speeds on rougher surfaces like a gravelled road. Also, at higher wind speeds, larger particles comprising of visible dust can become airborne. There is typically a limited amount of material on the surface available to be eroded. As a result, there is typically a puff of dust emitted when the threshold speed is reached; after that, the amount of material released decreases rapidly with time (in U.S. EPA terms, the half life is a few minutes) (U.S. EPA 1995).
- The extent of dust generation from on-site activities is highly dependent on the form of disturbance, e.g., size and speed of haul trucks, number of haul truck trips made, road conditions (e.g., rough roads, dry roads, type of road construction material), height and shape of stockpiles, the volume of material handled, and the intensity of excavating and placement.

Two sizes of fugitive dust are *measured* on site. At these sizes, the dust is not generally visible and is size selected by accepted particulate monitoring equipment inlet systems.

- TSP is about 30 micrometres (µm) in diameter or smaller
- Particulate Matter - PM_{10} particles are 10 µm or less in diameter

Fugitive dust is also *observed* on site by GMRP staff and contractors. This “visible” dust is largely comprised of larger sized particles, but a dust plume will also include TSP and PM_{10}. The largest particles are kicked up from the surface, transported in the strongest winds, and are the first to be deposited back to the surface when strong winds decrease.

This section describes the key project elements affected by wind erosion and summarizes the key remediation activities (physical disturbances) which may generate dust.

3.1 Characteristics of the Material

The erodibility (potential to create dust) of the various soil types is generally high when the soil surface is made up of fine particles (e.g., silty soils have the highest erodibility classification while well-graded gravel has the lowest erosion potential) and moisture content is low. Erodibility is a key factor in determining emissions of windblown dust (refer to the Site Features that Influence Erosion section in the Erosion and Sediment MMP). Erodibility is one consideration when determining the application type and rate of dust suppressants for remediation activities (Section 4.2).

The arsenic content in dust is not uniformly distributed across the Site and has been accounted for by considering the maximum measured levels in surface material on Site. The 95th percentile levels of those measured values informed the development of the Risk-Based Action Levels (RBALs) for TSP and PM10 for air quality monitoring on Site (see Section 6.1 for a brief explanation and the AQMP for further details). Thus, the RBAL responses to measured dust in Section 6.2 assume the highest measured arsenic levels could be anywhere on ite and are therefore conservative. The soil chemistry maps (Figure 5.3-3) should be consulted for spatial variations in arsenic content.

3.2 Tailings Containment Areas

Tailings produced during mine operations were typically a slurry of fine particles in water pumped to a Tailings Containment Area (TCA). Four TCAs remain on-site (Figure 1.1-1): The Northwest Pond TCA; the North Pond TCA; the Central Pond TCA and the South Pond TCA. When the water drains off and the slurry dries, or when areas – even those covered with dust suppressant - are exposed to high winds, these fine particles can become a source of fugitive dust, as was experienced most recently in October 2020 (Table 2.0-1).

The spatial extent of the wet area (surface moisture content >5%) of each of these TCA's changes seasonally and on a year over year basis. The wet area is also expected to change during on-site activities where the TCA surface is disturbed. The wind generation dust source from each of the TCA's is summarized below in Table 3.2-1.

Table 3.2-1: Tailings Containment Area Dust Sources

Wind Generation Dust Source	Location	Description	Dust Generation Potential
Northwest Pond TCA	Northwest corner of property - west of Highway No. 4.	A large, dry erodible area that sits 10-15m higher than the surrounding terrain. Dust generation potential is high due to: (i) Lowering of the water levels due to seasonal effluent treatment and associated reduction of wet area results in a greater likelihood for dust to be emitted during high wind events, (ii) lack of protective terrain exposes the TCA to winds from multiple directions.	High
North Pond TCA	Northeast corner of the property - south of Dam 2 and 3 and north of the tailings reprocessing plant	The surrounding terrain features (e.g., Dam 2 and 3) of the TCA shelter this TCA from winds coming from the northeast and southwest	Moderate
Central Pond TCA	Between the North and South Pond TCAs - south of the tailings reprocessing plant and Dam 6 and north of Dams 4 and 5	Sits at a depression relative to the North Pond TCA and the South Pond TCA due to previous usage as the extraction site for tailings used in paste fill for site stabilization activities.	High

Table 3.2-1: Tailings Containment Area Dust Sources

Wind Generation Dust Source	Location	Description	Dust Generation Potential
South Pond TCA	South of Dams 4 and 5 and North of Dam 11	Sits 30 m above Great Slave Lake. The South Pond is the closest source of wind-blown dust emissions to Yellowknife, Ndilǫ and Dettah. The TCA is exposed to winds generally from the north with no obstructions between the TCA and Ndilǫ that lies across Back Bay 2.5 km to the south.	High

3.3 Roads

Most activities at the Site will involve the use of roads and parking lots which will generate dust as summarized in Table 3.3-1.

Table 3.3-1: Road Dust Sources

Construction Activity Dust Source	Description of Dust Generation Activities	Key Dust Generating Equipment	Dust Generation Potential
Roads and Roadworks	• Trafficking and maintenance of existing roads to support remediation and monitoring activities e.g., unpaved roads • Grading and contouring of existing roads • Widening of existing roads • Wind erosion of (dry) unpaved roads	Light vehicles, haul trucks, excavators, dozers, graders	Moderate
Parking Lot	• Traffic of parking lot south of C-Dry • Wind erosion of (dry) crushed rock parking lot	Exposed surface on an open lot (wind)	Low

3.4 Earthworks

Planned activities during the first few years of remediation involve earthworks, such as excavation for construction of the non-hazardous waste landfill. The activity generation dust source from earthworks is summarized in Table 3.4-1.

Table 3.4-1: Earthworks Dust Sources

Construction Activity Dust Source	Description of Dust Generation Activities	Key Dust Generating Equipment	Dust Generation Potential
Earthworks	Handling of mineral materials (a) materials for construction and (b) mineral wastes[(a)] for disposal • Movement of materials, general earthworks • Earthworks for investigations e.g., test pits • Construction and maintenance of infrastructure e.g., pad construction, temporary access roads, site grading, placing covers, building berms, and ponds • Demolition of infrastructure e.g., road removal • Underground stabilization works, e.g., batching paste, excavation, and processing of tailings • Storage of mineral materials e.g., erosion of exposed in-situ or stockpiled materials	Haul trucks, excavators, dozers, graders	High

(a) Mineral wastes include heavily arsenic-impacted wastes, contaminated soils and sediments, tailings, drill wastes, vegetation, and overburden as described in the CRP and Waste MMP.

3.5 Drilling

Activities during the first few years of remediation involve drilling for a variety of purposes including blast holes, underground stabilization and investigation. The activities generating dust from drilling are summarized below in Table 3.5-1.

Table 3.5-1: Drilling Dust Sources

Construction Activity Dust Source	Description of Dust Generation Activities	Key Dust Generating Equipment	Dust Generation Potential
Drilling	Handling of mineral materials (a) materials for construction and (b) mineral wastes[(a)] for disposal • Drilling for investigations e.g., geotechnical drilling, geophysical investigations • Boreholes for equipment placement e.g., for thermosyphons • Drilling to support underground stabilization and backfilling of slopes e.g., concrete delivery underground, placement of waste • Drilling for blast holes	Drill rig and support equipment	Low-Moderate

(a) Mineral wastes include heavily arsenic-impacted wastes, contaminated soils and sediments, tailings, drill wastes, vegetation, and overburden as described in the CRP and Waste MMP.

3.6 Blasting

One of the activities anticipated as part of remediation during the first few years is a limited amount of blasting. The activities generating dust from blasting are summarized in Table 3.6-1.

Table 3.6-1: Blasting Dust Sources

Construction Activity Dust Source	Description of Dust Generation Activities	Key Dust Generating Equipment	Dust Generation Potential
Blasting	• Blasting for construction e.g., AR-1 Freeze Pad • Construction of new long-term[(a)] portal to the underground	Rock trucks, excavators, dozer, explosives	Moderate

(a) Long-term defined as a period greater than 5 years.

3.7 Infrastructure Demolition

One of the activities during the first few years of remediation involves the demolition of some infrastructure (e.g., demolition of the Townsite). The infrastructure demolition dust source is summarized below in Table 3.7-1.

Table 3.7-1: Infrastructure Demolition Dust Sources

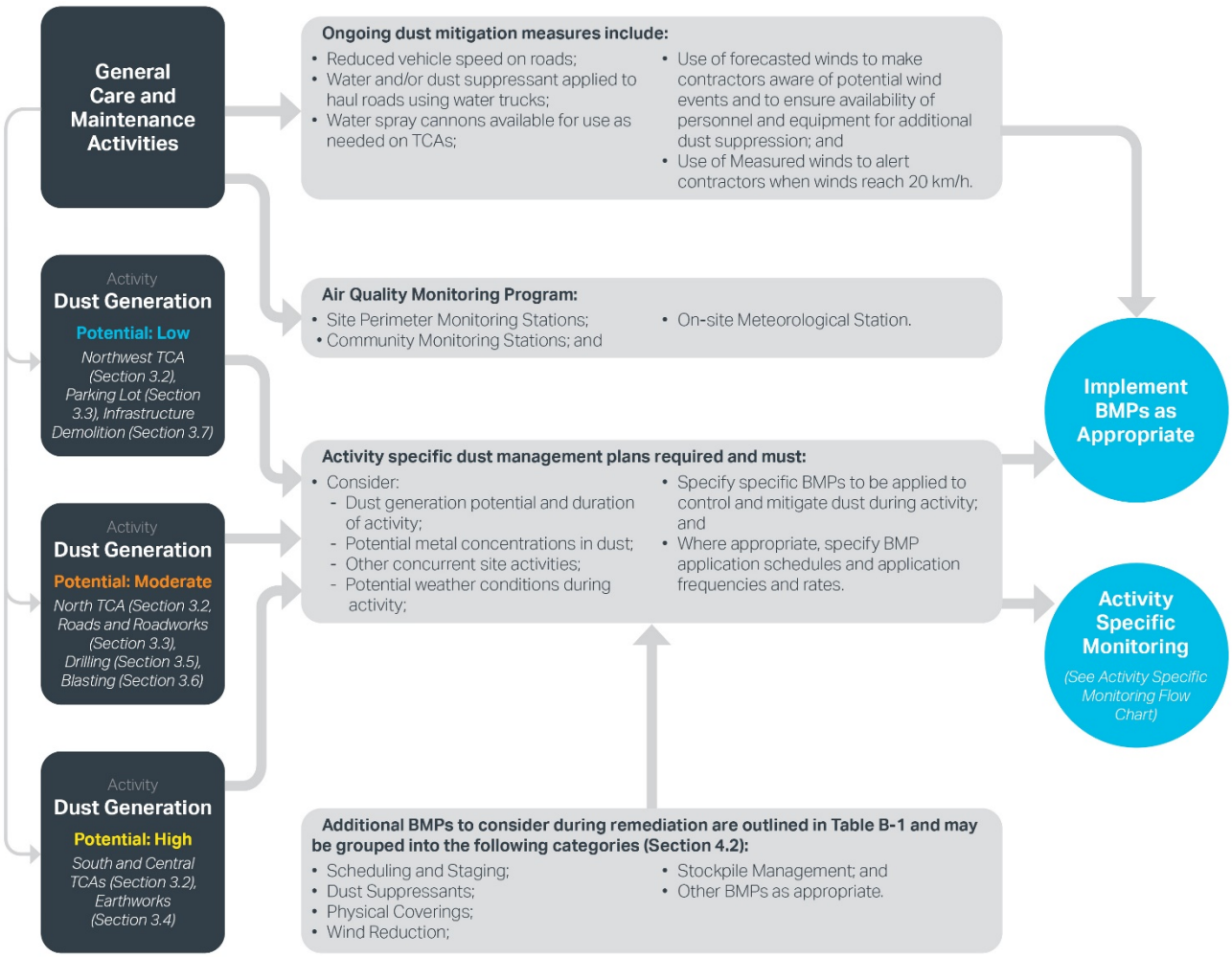
Construction Activity Dust Source	Description of Dust Generation Activities	Key Dust Generating Equipment	Dust Generation Potential
Infrastructure Demolition	Handling of non-mineral non-hazardous[(a)] and non-mineral hazardous wastes[(a)] • Deconstruction of buildings and structures e.g., grinding, cutting or breaking of non-friable and other materials, removal of hazardous materials from buildings, including disturbance of friable materials such as asbestos • Deconstruction of equipment e.g., the deconstruction of the freeze optimization study (FOS) • Collection, handling, and disposal of debris e.g., wastes stockpiled from previous deconstruction activities	Excavator, dozer, and haul trucks	Low

(a) Non-mineral non-hazardous wastes and non-mineral hazardous wastes (arsenic impacted infrastructure wastes, asbestos, leachable lead paint, cyanide containing waste, and miscellaneous hazardous materials) as described in the CRP and Waste MMP.

4 DUST MANAGEMENT

Section 3 identified the activities that have the potential to generate dust on the Site. In this section each of these activities have been assigned associated best management practices (BMP's) designed to manage fugitive dust. The best management practices include the application of dust suppressants, physical coverings, and wind speed reduction measures that can be applied during active remediation. They also reflect operational constraints such as vehicle speed control. This section identifies best management practices to limit fugitive dust, grouped as those implemented at a site management level (hereafter called standard operational mitigation/management) and those specific to remediation activities. The standard operational BMPs are those that are currently being implemented, as needed, and will continue to be implemented throughout remediation. These are the minimum level of BMPs that will be employed by the MCM. Additional BMPs will be employed as dust generation activities are initiated and progress with remediation. Figure 4.0-1 summarizes this and illustrates the GMRP approach to proactively managing dust.

Figure 4.0-1: Proactive Approach to Managing Dust



4.1 Standard Operational Best Management Practices

Standard operational BMPs are those that are being implemented currently on-site, as needed, during general care and maintenance activities. These will continue to be implemented during remediation activities to meet the objectives of this MMP, and other requirements including Part F, Condition 1 of the Water Licence pertaining to managing waste and water with the objective of minimizing impacts in the receiving environment.

4.1.1 Proactive Planning and Risk Assessment

The GMRP currently examines two wind forecasts to aid in planning:

- A 7-day forecast (including wind speed and direction) is used for operational planning to determine if modified mitigation are required to control fugitive dust at its source and prevent it from leaving Site, particularly towards Yellowknife, Ndilǫ and Dettah. This planning includes confirming appropriate application of dust suppressant and additional available suppressant, scheduling of activities including any planned maintenance, assessing site conditions, and confirming availability of additional support if required, if wind speeds above 25 km/h [1] (Low Action Level as described in Section 6.5) are forecast.
- The forecast for the next 24 hours is consulted each morning. The MCM conducts a dust risk-assessment of forecasted winds (speed and direction), site conditions and planned site activities to determine if modified mitigation are required to control fugitive dust and if there is a risk of approaching an action level, as outlined in Section 6.5.

Wind speed and direction are measured at the on-site Meteorological Station. This station provides the MCM with real-time access to meteorological data including wind speeds and direction to inform ongoing management decisions, including adaptive management. When measured 1-hour winds reach 80% of the 25 km/h threshold (i.e., 20 km/h) of the Low Action Level (Section 6.5), an email alert is provided to the MCM in order to assess whether additional operational mitigation are required.

4.1.2 Operational Mitigation

Current maintenance operations employ mitigation as and when needed, based on a dust-risk assessment (as outlined in Section 4.1.1) conducted by the MCM each morning. This daily risk assessment allows planning for the implementation of proactive measures to mitigate dust, such as:

- Reduce vehicle speed on roads.
- Water or use of approved dust suppressant on haul roads and TCAs.
- Water spray cannons are now available to use on the tailings containment areas. This increases the area of potential dust-generating surfaces that can be wetted.
- In extreme situations, use helicopters to apply water to the TCAs.

[1] The 25 km/h threshold is based on a U.S. EPA (2006) threshold for fine coal dust on a concrete surface of 11 m/s (40 km/h), similar to the fine dust on the surface of the TCA, with a gust factor of 1.6 (40/25) to account for gustiness within the 1-hour average wind speed.

- Strong winds could be forecast to occur at night after remediation activities cease and staff have left the Site. In this event, pre-water roads or other surfaces the evening before scheduled work, as site conditions require.
- When hauling is scheduled to occur on portions of the road network on-site, pre-moisten the affected areas, as needed. As the road portions dry during the day, re-moisten as needed to prevent fugitive dust. As the haul roads become more heavily used during the day, apply water more actively (either increase frequency or use greater volumes) to prevent the occurrence of visible dust and before RBALs are reached at the Site Perimeter Monitoring Stations and/or Activity-Specific Monitoring Stations, if active.
- Considerations for Watering of routine dust generators, such as haul roads and access roads or TCAs, is to occur in advance of any activity planned on the roads or TCAs. The risk assessment (see Section 4.1.1) incorporates information such as recent or expected rainfall and the recent application of other dust suppressants. The MCM uses this information to assess the timing and amount of dust suppression operations.
- On days when the wind gusts are forecast to exceed the 25 km/h threshold (i.e., Low Action Level as per Section 6.5) and/or winds are forecast to blow towards Yellowknife, Ndilǫ and Dettah, use water sprays to moisten the surface of the TCAs and roads, if needed. As the ponds dry during the day, re-moisten as required. Continue to moisten as wind speeds increase and drying occurs, as required.
- When the wind gusts are forecast to exceed the 25 km/h threshold and/or winds are forecast to blow towards Yellowknife, Ndilǫ and Dettah, remind subcontractors of the requirement to be observant for fugitive dust and communicate observed dust to the MCM. Reaching the 25 km/h threshold would trigger the Low Action Level as per Section 6.5, requiring action, including increased frequency of visible dust monitoring in all active work areas. (See Table 6.5-1 for further actions and contingencies.)

4.2 Additional Best Management Practices

In addition to the standard BMPs, additional BMPs related to dust control are available to employ during remediation planning and implementation. Five categories of additional BMPs are provided:

1) Scheduling and staging of activities – including considerations of season including typical wind speeds and direction, access, and responding to environmental conditions.
2) Use of approved dust suppressants, including water – both proactive and reactive use.
3) Physical covers – physical covers may be used during remediation, and permanent physical covers are a significant part of the approved closure activities. (Permanent physical covers are not included in this MMP)
4) Wind control – limited options may be employed in some circumstances to increase surface roughness.
5) Stockpile management.

Table B-1 in Appendix B identifies the dust generation activities that must be managed, summarizes the BMP options that could be used to achieve the dust management goals, and identifies the dust monitoring associated with the activities. Site activities must be scheduled and staged with dust management in mind. Physical covers

and wind control will be considered on an as-needed basis. The BMPs identify approaches that limit emissions and the circumstances during which the BMPs are implemented are described in Section 5.

4.2.1 Scheduling and Staging

Scheduling and staging BMPs (Table 4.2-1) are important factors to be considered early in planning for all activities. These will guide decisions regarding timing and sequence of operations and highlight important factors to consider such as seasonal wind patterns and any potentially conflicting work activities. These factors may include limiting unnecessary traffic or disturbance and or protocols for responding to high wind events.

Table 4.2-1: Best Management Practices for Reducing Dust - Scheduling and Staging

Scheduling and Staging of Activities							
Name	**TCA Maintenance**	**Roads**	**Earthworks**	**Drilling**	**Blasting**	**Infrastructure Demolition**	**Considerations**
Optimize Construction Sequence	✓	✓	✓	✓	✓	✓	The sequence of construction should be developed with consideration of site management and scheduling BMPs. The construction sequence should be compatible with plans for progressive reclamation, instream works, and stockpile operation. The construction sequence should also be compatible with the advice from Elders on the seasonality of wind speed and direction and the timing of snow cover and precipitation.
Install/Employ Best Management Practices Early	✓	✓	✓	✓	✓	✓	Erosion and dust potential can be reduced by installing/employing BMPs as soon as practical and always before soil is exposed. Early installation/deployment may require Site access or traffic control considerations.
Contaminant Map	✓	✓	✓	✓	✓	✓	Highly contaminated areas (Figure 5.3-3) should be identified so the contractor is aware of the contaminant content in the potentially generated dust and prepares for adequate control measures as needed.
Site Access Management	✓	✓	✓	✓	✓	✓	The sites should be accessible from a limited number of points. Frequently- used access roads should be gravelled to minimize the tracking of material off-site. Enforcing reduced vehicle speeds on unpaved roads. Vehicle wash station(s) will be used in accordance with the Waste MMP to minimize off-site tracking.
Minimize Unfavourable Winds	✓	✓	✓	✓	✓	✓	Dust producing activities should be reduced or avoided during times of forecast high winds or wind directions that may carry dust towards communities, where possible. Sequencing of these activities should be compatible with the advice from Elders on the seasonality of wind speed and direction.
Minimize Exposed Soils	✓	N/A	✓	N/A	N/A	N/A	By minimizing the total disturbed soil area and the disturbed soil area at any time, the wind erosion potential is reduced, and the quantity of sediment control measures required is reduced. Stripping of new areas should be delayed as long as possible and restoration of constructed areas should be done as soon as possible.
Stockpile Management	✓	N/A	✓	N/A	N/A	✓	See Section 4.2.5 for additional stockpile management details.
Restore Early	✓	✓	✓	N/A	N/A	✓	Erosion and dust potential can be minimized by restoring or reclaiming constructed areas as soon as possible..

TCA = Tailings Containment Area; BMPs = Best Management Practices; N/A = not applicable.

4.2.2 Dust Suppressants

The use of additional dust suppressants (Table 4.2-2) may be needed during remediation. As the simplest form of mitigation, dust suppression can be achieved through use of approved chemicals or water. Timing, type, and frequency of application will be determined by factors such season, winds, and materials being handled. The effectiveness of dust suppressants is continually evaluated.

Chemicals approved for use as dust suppressants at the Site are identified in the Spill Contingency Plan. The use of chemicals not captured in the Spill Contingency Plan will require prior approval from the MVLWB and Inspector.

As per the Reasons for Decisions for MV2007L8-0031 and MV2019X0007, untreated wastewater may be used for dust suppressant within the TCAs. Outside of the TCAs, water used for dust suppressant must meet the Effluent Quality Criteria (Part C, Condition 2 of the Water Licence), including that from the Polishing Pond. In accordance with the Water MMP, a notification will be provided to the MVLWB and the Inspector confirming the water quality from the Polishing Pond before use as a dust suppressant.

Table 4.2-2: Best Management Practices – Dust Suppressants

Dust Suppressants							
Name	**TCA Maintenance**	**Roads**	**Earthworks**	**Drilling Activities**	**Blasting**	**Infrastructure Demolition**	**Considerations**
Wet Suppression	✓	✓	✓	✓	N/A	✓	Application of water increases soil/material cohesion. Care must be taken to prevent mud tracking and runoff if this is done. Watering should be avoided when freezing occurs, especially on haul roads or where safety is a concern. Where water is used, the Water MMP needs to be followed.
Chemical Stabilization	✓	✓	✓	N/A	N/A	N/A	Approved chemical treatments can be applied to increase soil/material cohesion. It may be applied in conjunction with hydro-treatments. Chemical treatments must be assessed for site-specific conditions. Note that care must be taken to prevent mud tracking and runoff if this is done. Effectiveness of dust suppressants are continually evaluated.
Snow and Ice Cover	✓	✓	✓	✓	N/A	N/A	Freezing of pore water in soils or tailings reduces likelihood of wind erosion. Additional snow can be used and compacted to prevent drifting. The additional snow cover also increases moisture content of surface material in spring which inhibits windblown dust.

TCA = Tailing Containment Area; N/A = not applicable; MMP = Management and Monitoring Plan.

4.2.3 Physical Coverings

Physical coverings (Table 4.2-3) will be considered where activities must be carried out in areas of mineral wastes e.g., arsenic-containing soils, including during the transport of contaminated materials. When handling wastes, one of the considerations is the cleaning for re-use or disposal of the physical covering (the management of mineral wastes is addressed in the Waste MMP). Physical coverings may also be considered during blasting activities and for mineral materials in-situ or in transit when winds are high or other factors dictate an increased level of control. This may include simple measures like the use of tarps to secure loads or stockpiles.

The placement of physical coverings is typically determined either based on daily wind forecasts or as part of scheduling and staging considerations during activity-specific planning. The objective, if coverings are deployed, is to have them in place before windblown dust is generated.

Table 4.2-3: Best Management Practices – Physical Coverings

Physical Coverings							
Name	**TCA Maintenance**	**Roads**	**Earthworks**	**Drilling**	**Blasting**	**Infrastructure Demolition**	**Considerations**
Plastic Sheeting	N/A	N/A	✓	N/A	N/A	✓	Plastic sheeting or tarps can be used to secure loads, or on slopes of limited size to prevent dust. It is relatively easy to install/employ.
Blast Mats	N/A	N/A	N/A	N/A	✓	N/A	The use of blast mats for blasting activities is to be considered as a mitigation measure for dust/particle control.
Rolled Erosion Control Products (RECP)	✓	N/A	✓	N/A	N/A	N/A	Although typically used to control erosion by water, RECP provide a high degree of uniform and long-lasting wind erosion protection. Care should be taken to verify the product is suitable for the intended application and that it is applied in accord with the manufacturer's specifications. Permeable RECP's are used in conjunction with vegetation. Impermeable RECP's may be used for protection of stockpiles.
Aggregate Cover	✓	N/A	✓	N/A	N/A	N/A	Highly effective solution for inactive piles. Gravel and rock blankets can stabilize soil surfaces and can be used in combination with other types of cover. Little to no maintenance. Aggregate and rock covers should be designed by a qualified engineer.
Complete or Partial Covering and/or Negative Air Pressure	N/A	N/A	N/A	N/A	N/A	✓	Some abatement processes will be completed under negative air such that the buildings are securely enclosed so that dust cannot enter the environment.

TCA = Tailings Containment Area; N/A = not applicable; RECP = Rolled Erosion Control Products.

4.2.4 Wind Reduction

Wind reduction (Table 4.2-4) mitigation strategies may be required where higher dust generating activities must be carried out, and where suppression activities are not sufficient.

Table 4.2-4: Best Management Practices – Wind Reduction

Wind Reduction							
Name	**TCA Maintenance**	**Roads**	**Earthworks**	**Drilling**	**Blasting**	**Infrastructure Demolition**	**Considerations**
Non-Erodible Roughness Elements	✓	✓	✓	N/A	N/A	N/A	A wide variety of non-erodible elements have been used at mine sites, including tires, straw bales, mulch and rocks. This method can provide >90% control but is highly dependent on the size of the non-erodible elements and density of placement over the erodible surface. The element used is typically dependent upon local availability (e.g., aggregate for roads).
Vegetated Wind Breaks	✓	✓	N/A	N/A	N/A	N/A	In theory, trees, grasses, and shrubs planted over a sufficient extent are effective in reducing wind speeds within the planted area. This practice is suitable only for permanent features on a landscape. While revegetation is not included in this version of the document, it is recognized that existing vegetated areas act as a wind break.

TCA = Tailings Containment Area; N/A = not applicable.

4.2.5 Stockpile Management

Site personnel will handle material in a controlled and steady manner consistent with industry best practice. Dust mitigation techniques associated with stockpile management are largely associated with reducing the impact of high wind speeds on the stockpile through design of the stockpile (Table 4.2-5). The approaches in this table are not intended to apply to stockpiles that would not emit dust (e.g., stockpiles of metal debris).

Table 4.2-5: Best Management Practices – Stockpiles

Stockpile Management							
Stockpile Feature	**TCA Maintenance**	**Roads**	**Earthworks**	**Drilling**	**Blasting**	**Infrastructure Demolition**	**Considerations**
Avoidance	N/A	✓	✓	N/A	N/A	✓	The need for stockpiles can be reduced or eliminated by employing just-in-time delivery approaches where possible (e.g., for aggregate which is sourced off-site), or by reducing the size of stockpiles.
Location of Stockpiles	N/A	✓	✓	N/A	✓	✓	Stockpiles should be located away from site boundaries, in designated areas with wind breaks and as far away from receptors as practical. Prior to establishing stockpile locations within 100m of the Ordinary High Water Mark, authorization from the Inspector is required.
Shape and Size of Stockpiles	N/A	✓	✓	N/A	✓	N/A	Stockpiles can be shaped and oriented to minimize erosion. Stockpiles should be aligned with the longitudinal axis parallel to the direction corresponding to the strongest (seasonal) winds. Height of stockpiles should be limited to below any wind breaks, where they exist, and maintained as flat as possible (i.e., a flat shallow stockpile will be less prone to wind turbulence than on with tall conical top). Stockpiles of erodible material may be covered with other material to prevent drying. The number of stockpiles should be kept to a minimum to minimize the erodible surface area. The creation of or addition of material to stockpiles also generates dust, including the dispersion of granular material from the loader dropping material onto the stockpile. Dust generation is dependent on the drop height from the loader to the stockpile and is reduced by lowering the drop height.
Covers on Piles	N/A	✓	✓	N/A	✓	✓	Covering stockpiles with durable materials such as tarpaulins or plastic. It is appropriate for temporary storage of small piles of potentially hazardous materials.
Barriers and Shelters	N/A	✓	✓	N/A	✓	✓	Where feasible, stockpiles should be situated to take advantage of natural terrain features that may act as wind breaks. Distance from the stockpile to the wind break should be maintained at no more than twice the height of the pile.
Stockpile Constituents	N/A	✓	✓	N/A	✓	✓	This section relates to the handling of mineral materials at the Site, further details can also be found in the Borrow Materials and Explosives MMP. For handling of wastes (non-mineral hazardous wastes and mineral wastes) refer to the Waste MMP.

TCA = Tailings Containment Area; N/A = not applicable; MMP = Management and Monitoring Plan.

5 MONITORING

This section includes details for monitoring that are ongoing with respect to dust generated from the Site. These details include locations for monitoring, parameters monitored, monitoring rationale, and where data will be reported.

Monitoring serves several purposes for the GMRP:

- It provides the MCM with measured values at which reactive BMPs must be implemented and may also be used to modify or stop some work activities (e.g., wind speed).
- It provides a means by which the MCM can gauge the effectiveness of the BMPs that are implemented and may also be used to stop work (e.g., visual dust and measured dust).
- It can be used to demonstrate that the goals of the program have been met (e.g., that dust is not moving off-site).

As such, monitoring is a key link in dust management. Monitoring of visible dust and measured dust to confirm the effectiveness of the BMPs is in place and will continue for the GMRP as described in this section.

5.1 Wind

5.1.1 Wind Forecasts

In addition to the real-time information from the on-site Meteorological Station, wind forecasts from the Environment Canada and Climate Change website (or other online resources) are consulted each morning and throughout the day to help inform site activities. These wind forecasts are reviewed periodically or on an activity-specific basis by the MCM; the forecasts are used to inform the planning of activities likely to result in dust emissions so that proactive mitigation measures are implemented.

Location: The forecast is for the Yellowknife area.

Target Parameters: Forecasts of wind speed and wind direction and precipitation during the day are assessed as they are provided.

Data Handling and Response: Forecasts are accessed to assist with daily planning. Forecasts of wind speed are noted for their impact on generation of wind-blown dust and generally for planning dust control activities using BMPs (Section 4.1). Wind direction forecasts are consulted to plan activities, review BMPs and to implement additional BMPs as needed, when winds are blowing toward communities. Forecasts of precipitation are noted for their impact (need for) on dust suppression.

5.1.2 Wind Measurements on Site

Wind speeds and direction are continuously measured at the on-site Meteorological Station, so that mitigation activities can respond in real time to changes in wind speed and direction. Wind speed and direction information is monitored by the MCM and applicable subcontractors. This provides a timely relay of information on measured winds and allows for a prompt response by the MCM for effective implementation of dust mitigation responses.

Location: The on-site Meteorological Station is located just southwest of the South Pond TCA on a rocky outcrop.

Measured Parameters: The on-site Meteorological Station continuously collects the following meteorological information:

- Temperature at 2 m and 10 m elevation
- Delta T (temperature at 10 m minus the temperature at 2 m)
- Relative humidity
- Barometric pressure
- Wind speed at 10 m elevation
- Wind direction at 10 m elevation
- Solar radiation
- Precipitation

Data Handling and Response: Meteorological station data is captured by the measuring instrument's internal data logging system. Data is backed up to central data servers on a regular basis with a minimum backup frequency of once every 15-minutes. Data are available to the MCM and GMRP in real-time to support dust management operations. Wind action level thresholds and associated responses are outlined in Section 6 below.

5.2 Visible Dust

Location/Frequency: Visible dust monitoring takes place on Site during daylight hours. Although subjective, this type of data collection can be effective at documenting large-sized visible dust plumes that may or may not be captured by the Site Perimeter Monitoring Stations. To capture and document these visible plumes, regular visible dust checks are performed by on-site personnel (e.g., security personnel, on-site workers, and/or supervisors) in areas including active work sites, TCAs, and roads. The routine visual inspections occur at minimum twice daily. In addition to these daily checks, visible dust checks are performed in response to measured dust action levels (Section 6) and a log of these inspections is maintained on-site. Visible dust is reported to the MCM at any time it is observed.

Target Parameters: A visible dust check will entail inspecting a point downwind (at the time of inspection) of a TCA, road, or active work area and noting observations related to visible dust. At minimum the visible dust observation log should include the location where the dust observation was made, the presence or absence of visible dust and whether or not dust is observed to be travelling off-site.

Data Handling and Response: Routine visible dust checks are logged and the GMRP will take corrective action when visible dust exceeds action levels (Section 6). A record of all visible dust events is to be maintained by GMRP and reported annually (Section 7).

5.3 Measured Dust

Monitoring of measured dust enables the quantification of on-site dust and allows for a quantitative assessment of the effectiveness of ongoing dust management practices. Continuous monitoring of particulate at the Site Perimeter Monitoring Stations enables real-time tracking of dust concentrations for comparison to RBALs and incorporation into the determination of Action Levels (Section 6.1). For the rationale behind the RBALs used and their derivation refer to Appendix B (Action Level Derivation Memo) of the Air Quality Monitoring Plan (appended to this Dust MMP in Appendix D). Real-time tracking of particulate is supplemented by filter collection to enable longer term tracking of metal concentrations. To achieve this goal, a network of air quality monitoring stations is maintained by the GRMP as described in Section 5.3.1 below.

Where site activities are anticipated to generate large amounts of dust or dust that has the potential to entrain heavily contaminated materials, additional temporary Activity-Specific Monitoring Stations may also be established. The need for activity-specific monitoring is assessed by the MCM prior to each major site activity. These Activity-Specific Monitoring Stations are set up in a manner that allows for activity-specific emissions to be monitored in real time. Dust mitigation and management practices will be reviewed or altered, where deemed necessary, before action levels as outlined in Section 6.5 are triggered.

5.3.1 Site Perimeter Monitoring Stations

Location: The site perimeter network consists of nine Site Perimeter Monitoring Stations strategically placed on or near the Project Boundary (Figure 5.3-1). The Site Perimeter Monitoring Stations were formerly referred to as fence-line stations.

Target Parameters: Real-time TSP and PM_{10} mass concentrations. Gravimetric filter analysis of PM_{10} and TSP along with gravimetric analysis of antimony, arsenic (PM_{10} and TSP filters), lead, nickel and iron fractions from TSP filters.

Frequency: Continuous real-time monitoring of TSP and PM_{10} mass concentrations with a maximum averaging time of 15-minutes (for comparison to action levels – see Section 6.1). Continuous real-time data collection will operate year-round 24 hours a day. 24-hour integrated sampling of TSP and PM_{10} filters will take place alongside continuous real-time monitoring.

Gravimetric and metals laboratory analysis of filter samples are performed as follows:

- 24-hour integrated filter samples collected every 3-days between May and November are analyzed for PM_{10} / arsenic analyses and TSP / trace elements (antimony, arsenic, iron, lead, and nickel) analyses.
- 24-hour integrated filter samples are analyzed for PM_{10} / arsenic analyses and TSP / trace elements (antimony, arsenic, iron, lead, and nickel) analyses for all days where real-time measurements higher than the RBALs are recorded. During periods of limited Site activity (i.e. generally December to April), only those filters collected on days where RBAL exceedances are measured are submitted for analysis.

At all times of the year, RBAL exceedances are investigated and if they are found to be clearly related to fog or inclement weather, the filters are not analyzed. Unanalyzed filters are archived for the remainder of the reporting period in which they were collected (i.e. up to one calendar year).

Data Handling and Response: Continuous monitoring data is to be captured by the instrument's internal data logging system. Monitoring data is to be backed up to central data servers on regular basis with a minimum backup frequency of once every 15-minutes. Data loggers are to store 15-minute average concentrations along with instrument logged auxiliary parameters (i.e., flow, temperature, pressure, flags, etc.), and where possible, calibration sequences (zero/span checks). Any exceedances of the RBALs are communicated to the MCM and investigated further.

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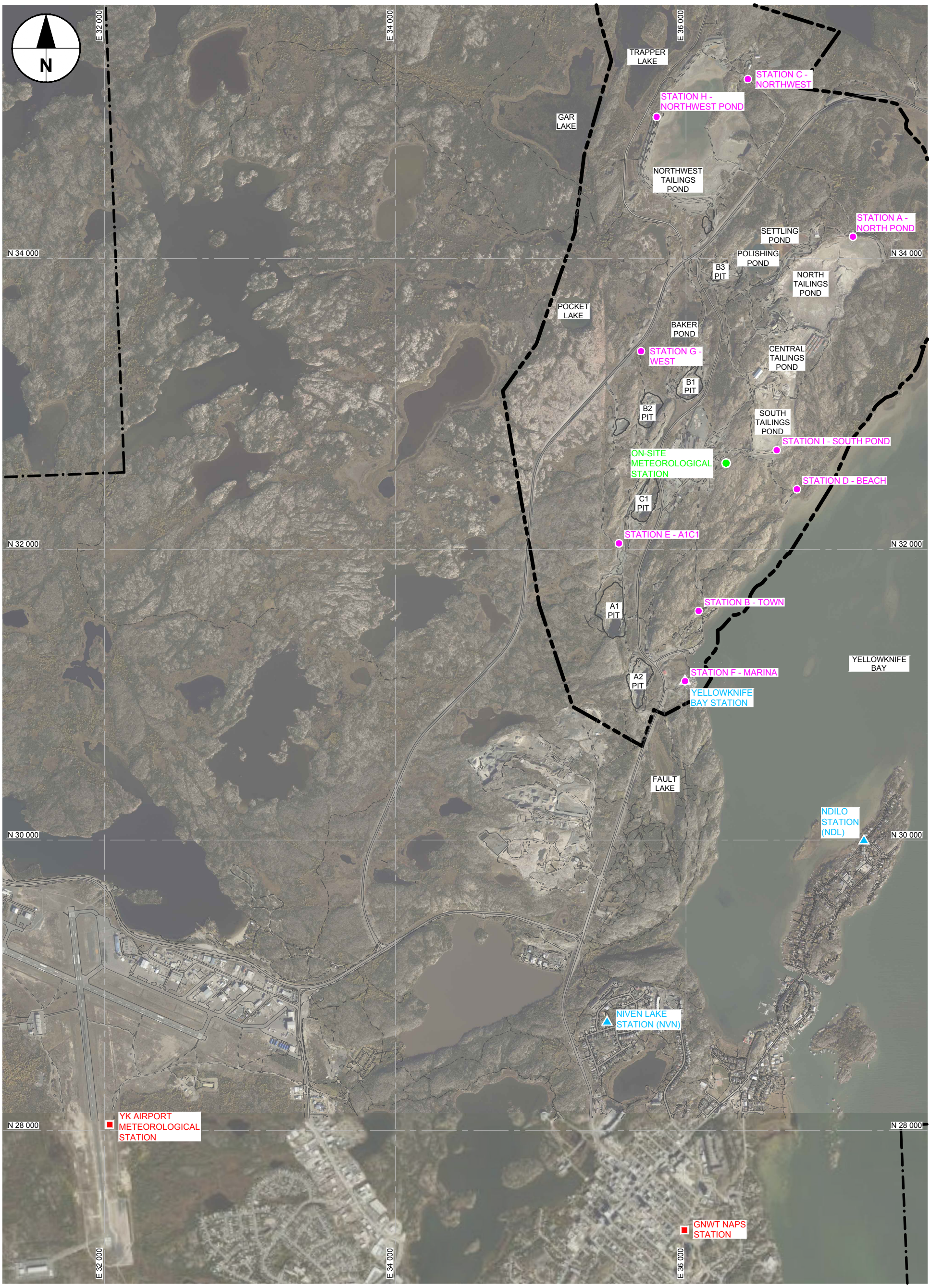

LEGEND:

- GIANT MINE PROJECT BOUNDARY
- CITY OF YELLOWKNIFE MUNICIPAL BOUNDARY
- GMRP SITE PERIMETER MONITORING STATION
- GMRP COMMUNITY MONITORING STATION
- GMRP ON-SITE METEOROLOGICAL STATION
- OTHER MONITORING STATIONS

0 625 1 250 m

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PROPONENT

Crown-Indigenous Relations and Northern Affairs Canada
Relations Couronne-Autochtones et Affaires du Nord Canada

Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

YYYY-MM-DD	2021-06-22
DESIGNED	L.Kootenay
PREPARED	L.Dowhaluk
REVIEWED	G. Woollett
APPROVED	R. Schmidtke

PROJECT

Giant Mine Remediation Project

TITLE

GMRP AIR QUALITY MONITORING STATION LOCATIONS

REV.	FIGURE
3	5.3-1

5.3.2 Activity-Specific Monitoring Stations

Location: During remediation, stations will be deployed, as required, to allow for the quantification of dust emissions from the specific activity being monitored. This is expected to allow mitigation strategies to be implemented before an Action Level exceedance occurs at the Site perimeter. Typically, these Activity-Specific Monitoring Stations are placed to allow them to, in combination with permanent Site Perimeter Monitoring Stations, measure dust upwind and downwind of a major site activity such as major construction or major excavation.

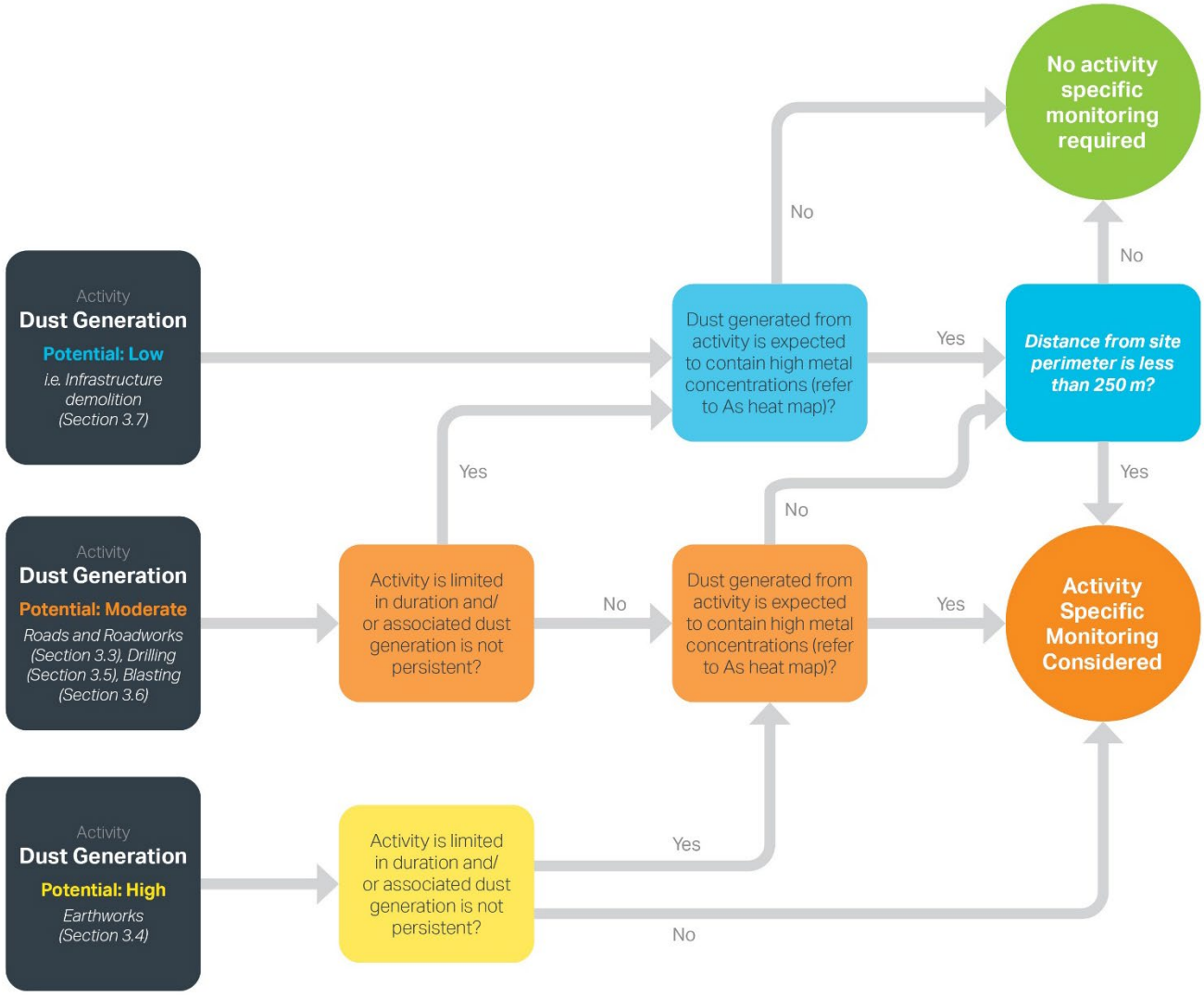
Target Parameters: Activity-Specific Monitoring Stations measure PM_{10}.

Frequency: Activity-Specific Monitoring Stations collect data at the same frequency as the Site Perimeter Monitoring Stations (i.e., continuous measurements).

Data Handling and Response: Data handling follows the same guidance outlined for the Site Perimeter Monitoring Stations. Real-time data will be used to direct dust mitigation responses like those outlined in Section 4.

Criteria: Not all remediation activities on-site warrant activity-specific monitoring. The key criteria for determining the need for this form of monitoring are dust generation potential (including metal composition of material), duration of activity, proximity to other activities, proximity to site perimeter monitoring stations, and proximity to the site boundary or sensitive environmental features (refer to Section 2) as determined by the MCM.
Figure 5.3-2 illustrates the process for determining if activity-specific monitoring is warranted. The process references dust generation potential discussed in Section 3 of this document and arsenic concentrations in soil which are mapped for convenience of site operations in Figure 5.3-3, which is also referred to in Figure 5.3-2 as the “Arsenic heat map”.

Figure 5.3-2: Criteria for Activity-Specific Monitoring



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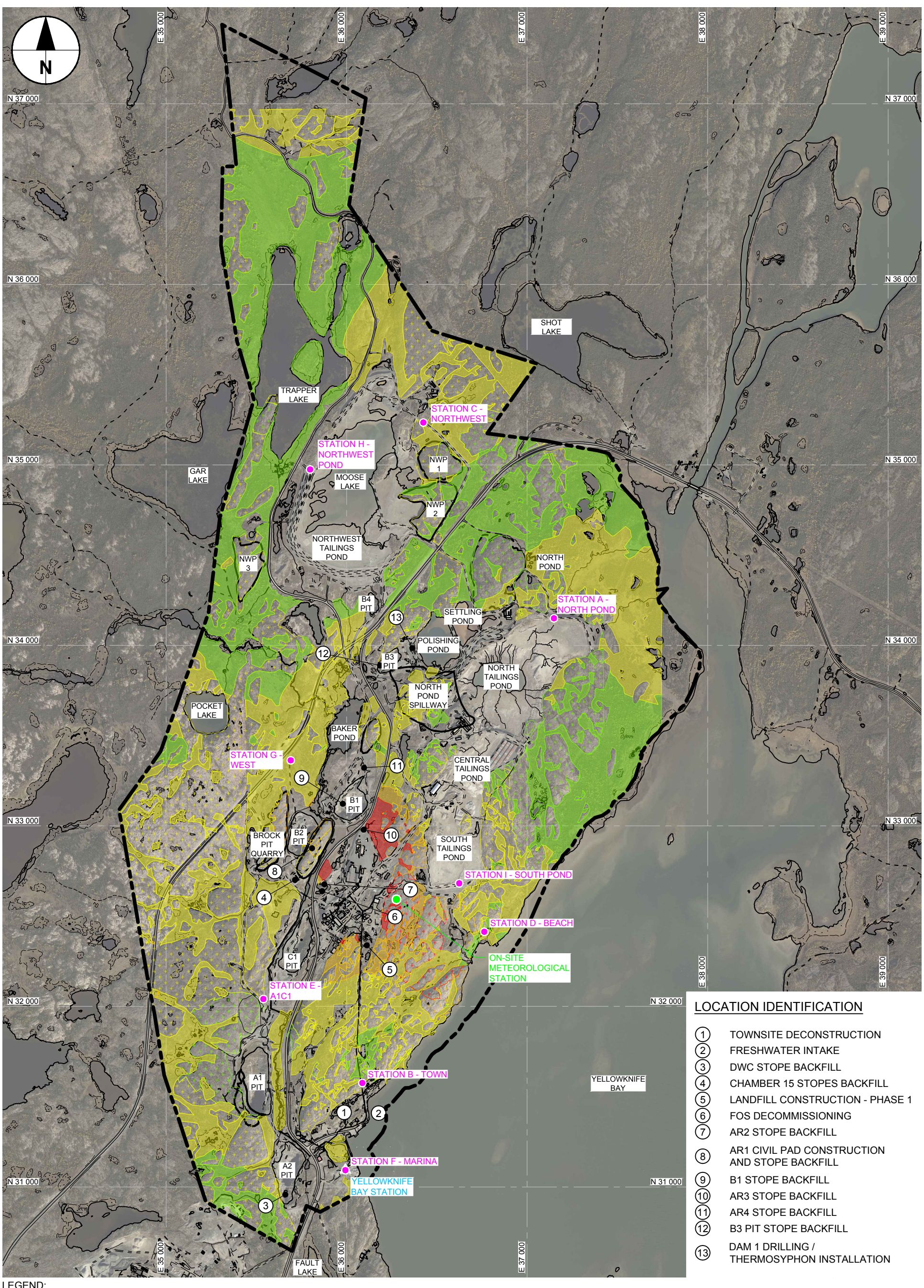

LOCATION IDENTIFICATION

1. TOWNSITE DECONSTRUCTION
2. FRESHWATER INTAKE
3. DWC STOPE BACKFILL
4. CHAMBER 15 STOPES BACKFILL
5. LANDFILL CONSTRUCTION - PHASE 1
6. FOS DECOMMISSIONING
7. AR2 STOPE BACKFILL
8. AR1 CIVIL PAD CONSTRUCTION AND STOPE BACKFILL
9. B1 STOPE BACKFILL
10. AR3 STOPE BACKFILL
11. AR4 STOPE BACKFILL
12. B3 PIT STOPE BACKFILL
13. DAM 1 DRILLING / THERMOSYPHON INSTALLATION

LEGEND:

- GIANT MINE PROJECT BOUNDARY
- GMRP SITE PERIMETER MONITORING STATION
- GMRP COMMUNITY MONITORING STATION
- GMRP ON-SITE METEOROLOGICAL STATION

BEDROCK CREVASSE ARSENIC CONCENTRATION (mg/kg)	FOREST / WETLAND ARSENIC CONCENTRATION (mg/kg)
0 - 340	0 - 340
340 - 3000	340 - 3000
3000 - 4500	3000 - 4500
4500 +	4500 +

0 500 1,000 m

1:20,000

PROPONENT

Crown-Indigenous Relations and Northern Affairs Canada
Relations Couronne-Autochtones et Affaires du Nord Canada

Government of Northwest Territories / Gouvernement des Territoires du Nord-Ouest

YYYY-MM-DD	2021-06-22
DESIGNED	L.Kootenay
PREPARED	L.Dowhaluk
REVIEWED	G. Woollett
APPROVED	R. Schmidtke

PROJECT

Giant Mine Remediation Project

TITLE

EXISTING SITE CONDITIONS - BEDROCK / FOREST / WETLAND SOIL CHEMISTRY (ARSENIC HEAT MAP) AND GMRP SITE PERIMETER LOCATIONS

REV. 2

FIGURE 5.3-3

5.4 Vegetation Monitoring Associated with the Demolition of Major Structures

As per Measure 21 (see Section 1.4.1) and Schedule 4, Condition 6f (ii) of the Water Licence, vegetation monitoring pre- and post- demolition of major structures (i.e., the Mill, the tailings retreatment plant (TRP), and C-Dry) is required. There is currently little or no vegetation in the area around the Mill or C-Dry. In addition, the contaminated soil that forms the top half metre or so of these areas is scheduled to be excavated for soil-washing or disposal in a TCA. All vegetation will be removed or destroyed during this process. Furthermore, there is a limited amount of vegetation around the TRP, as it is situated on a rocky outcrop that does not support a significant amount of vegetation. The TCAs do not support vegetation and are scheduled to be capped with rock to discourage vegetation growth.

Vegetation monitoring will be evaluated in future revision(s) of the Dust MMP closer to the timing of the demolition of these major structures. The details of dust monitoring will take into consideration the timing of demolition relative to each building, the contaminants of potential concern, the size of the building and the amount of dust expected.

5.5 Related Air Quality Monitoring

The following subsections relate to Schedule 4, Condition 7 of the Water Licence.

5.5.1 PM2.5 and Nitrogen Dioxide (NO_2)

Community Monitoring Station locations are shown in Figure 5.3-1. Monitoring for NO_2 (Niven Lake Community Monitoring Station only) and $PM_{2.5}$ is completed at the Community Monitoring Stations, in addition to PM_{10}. Monitoring activities related to the community monitoring network are described in the AQMP (Appendix D). Note that should the GMRP experience issues with the passive freeze program for the underground arsenic chambers, consideration of the use of an active freeze may be given as a contingency. If this occurred, review of existing NO_2 monitoring (at the Niven Lake Community Monitoring Station) would be made.

$PM_{2.5}$ and NO_2 are emitted by combustion sources like vehicle exhaust and forest fires. These two emissions are reviewed on an ongoing basis, along with the other target parameters as described in the AQMP. Measurements are also reviewed annually by the GMRP. Should $PM_{2.5}$ or NO_2 concentrations be elevated, a review would be conducted to determine if is it linked to remediation activities. This would include an examination of the timing of remediation activities and the corresponding measured dust at the Site Perimeter Monitoring Stations and in the community. If the source is determined to be from the Site, corrective actions will be implemented to improve control of dust on Site (Section 4).

Data collected at the Community Monitoring Stations will also be reviewed annually for patterns in exceedances or near exceedances. This will be used to help improve the types and duration of dust mitigation strategies. Based on previous data reviews, often spring road cleaning, vehicles parked near the stations, and/or forest fires are responsible for elevated values at Community Monitoring Stations. Mitigation for these sources is outside the role of the GMRP.

5.5.2 Metals

Reviews of data (including metals data) against applicable criteria is conducted as data is received by the GMRP. In addition to this regular ongoing review, an annual review of metals data collected on filters will be conducted. Trends in metal concentrations will be noted and will help inform monitoring and dust mitigation efforts and ongoing improvements. The current approach for antimony, arsenic, iron, lead, and nickel concentrations in particulate is as follows:

- Metal concentrations are logged and compared to Ontario Ambient Air Quality Criteria (OMOE 2019).
- Trends in metal concentrations are to be noted during annual air quality reporting and are to inform future updates the Dust MMP. Weekly and annual data reports will be reviewed for longer term trends in measured mass concentrations. Trends are used to assess the efficacy of ongoing dust management and mitigation efforts, aid in continuing to understand dust generation on-site and inform the dust management strategy and future updates to the Dust MMP.

Based on a review of metal measurements on filters collected on-site from 2017-2019, the highest number of times metal in TSP exceedances were recorded in a year was five times for iron, three times for nickel, and once for each of arsenic and lead. Contingency planning would be implemented if these frequencies were exceeded in any subsequent year and would entail a closer examination of the 24-hour filter metal exceedances events using the following approach:

1. Examine the meteorology associated with the events.
2. Identify source region for each event and any potentially contributing site activities.
    - Are additional mitigation efforts warranted?
3. Were 24-hour filter metal exceedances associated with 15-minute RBAL exceedances at the station that collected the exceeding filter? At other perimeter stations?
4. Did Community Monitoring Stations also measure exceedances of the same metal? Were CAAQS exceeded?
5. Examine filter data and quantify metal filter loading (i.e., µg of metal / g collected on filters)
    - Is the data consistent with what is to be expected?
6. Report on metal exceedance investigation in annual report.
7. If persistent, consider re-examination of metal contribution to health risk.

6 ACTION LEVELS

6.1 Approach

In general, should dust monitoring or inspection indicate that dust management is not performing as anticipated, a series of actions would be initiated. An adaptive management approach is used to link monitoring results to actions with the purpose of maintaining dust management as required. This provides a systematic approach to responding to the results of the monitoring. This includes:

- a description of how the results will link to those actions necessary to verify that changes remain within an acceptable range
- definitions, with rationale, for tiered action levels
- a description of the rationale for each action level
- a description of how exceedances of action levels will be assessed
- a description of potential actions that may be taken if an action level is exceeded

Briefly, the process involves:

- Action levels are evaluated based on monitoring findings averaged over periods of 15 minutes to one hour.
- When an action level is exceeded, the response actions associated with the action level exceedance should be completed, as appropriate.
- Report exceedance(s) to MVLWB annually in the Annual Water Licence Report.

Table 6.5-1 defines action levels for Measured Dust (TSP and PM_{10} particulate), Visible Dust (observed dust), and Wind (measured wind speed) and includes the following information:

- **Location/Item**: name or title of relevant location or topic for action level
- **Risk**: list the key item of concern around which actions levels relate
- **Key information:** summarizes which measurement endpoints are assessed for each assessment endpoint.
- **Low (Action Level):** the conditions under which the Low Action Level would be reached. The Action Level is defined by the frequency of exceedance of RBAL values, the location of observed dust, and the measured wind speed. Each Action Level is defined by a unique combination of these three elements.
- **Moderate (Action Level):** the conditions under which the Moderate Action Level would be reached.
- **High (Action Level):** the conditions under which the High Action Level would be reached.

If an exceedance occurs for any action level, the event will be logged noting meteorological and other relevant parameters, mitigation/management efforts performed in response including success level of efforts. The Annual Water Licence Report (Section 7) will include a summary of Action Level exceedances and a description of responses taken.

6.2 Measured Dust

RBALs are presented in the AQMP (Appendix D) for particulate based on maximum expected arsenic levels in soil. These RBALs were developed based on Health Canada toxicological reference values for arsenic, an inhalation unit risk factor of 1×10^{-5}, arsenic measured in the soils at Site along with long-term community exposure, dilution and wind frequency factors; for details, refer to Appendix B (Action Level Derivation Memo) of the Air Quality Monitoring Plan (appended to this Dust MMP in Appendix D). To be conservative, PM_{10} and TSP measured at the Site Perimeter Monitoring Stations are compared to the RBALs regardless of whether or not arsenic is a suspected component of sampled particulates.

Furthermore, based on a review of the Human Health and Ecological Risk Assessment (HHERA) conducted by CanNorth (2018)[1] at the Site, it was inferred that the RBALs are also protective of ecological health beyond the site boundary and that the BMPs in Section 4 will be effective at preventing adverse effects on ecological health due to the transport of dust off-site[2].

6.3 Visible Dust

Action levels were developed to manage dust events associated with visible dust particles, which are generally larger than those detected by particulate monitors (Section 6.2). It is understood that these visible dust cues are more subjective than dust measurements and are intended to supplement the measured dust. Nonetheless, it is recognized that visible dust can be observed on-site at source which can lead to more proactive mitigation. Dust can also be observed by the community and therefore remains a vital component of action levels.

6.4 Wind

Measured wind speed is a surrogate for dust generation potential. The wind speed threshold (the speed at which TSP-sized mine tailings materials will begin to drift) is typically in the range of 40 km/h measured 10 m above a relatively flat surface (U.S. EPA 2006). Because shorter duration gusts can also generate dust, an operational threshold of 25 km/h has been developed (see Section 4.1.1 for a brief derivation) as the Low Action Level. Larger particles, or particles on uneven surfaces or porous surfaces such as gravelled roads, become airborne at higher speeds. Wind that is laden with soil particles becomes more abrasive and therefore increases the impact that wind friction can have on exposed soils and tailings (OMOT 2015).

Wind speed is an integral component of the action levels.

6.5 Combined Action Levels

Combined Action Levels relating to wind, visible dust, and measured dust are summarized in Table 6.5-1. As Action Levels increase from Low through Moderate, it is expected that the application of BMPs and dust management and mitigation practices escalate/adapt as appropriate. Actions must be taken to reduce dust levels. This includes increasing the frequency of dust management activities (e.g., watering roads), adding new BMPs that were not in place for a certain activity or modifying or stopping the activity.

[1] A toxicological risk assessment for the GMRP indicated that animals that consume insects are at greater risk, but that effects to terrestrial wildlife are generally limited to small mammals that live in a small portion of the Site (CanNorth 2018).
[2] In humans, the cancer risk associated with arsenic in dust is much lower than that from ingestion (Carex Canada 2021). Under the assumption that this is similar for animals, inhalation risk to animals is expected to be effectively managed with RBALs.

Table 6.5-1: Combined Action Levels

Location (Wind)	On-site Meteorological Station 62.499267° N, 114.354259° W
Location (Visible Dust)	Site Wide
Location (Measured Dust)	Station A, B, C, D, E, F, G, H, I (see Figure 5.3-1)
Identified risks related to dust management	Winds blowing on, or visible or measured dust from an activity or group of activities present on Site that could blow or deposit dust toward nearby waterbodies or communities. Dust risk is proactively established by MCM during daily morning risk review.
Key Information	**Wind** (Continuous Measurements) **Visible Dust** (Based on daily observations during daylight hours by on-site personnel) **Measured Dust** (Based on 15-minute average PM_{10} and TSP mass concentrations that are continuously measured at the Site Perimeter Monitoring Stations)

Action Level		Types of Actions and Contingencies

Low	PM10 > 159 ug m^3 or TSP > 333 ug/m^3 (RBAL) (Measured as one 15-minute average concentration exceedance at any Site Perimeter Monitoring Station)
	OR
	Dust is observed travelling well beyond the feature producing windblown dust
	OR
	Sustained (1 hour) winds above 25 km/h or two or more wind gusts above 40 km/h in the hour.
		• Confirm measured value is not due to instrument error, interference from fog/ice or due to regional dust events (e.g., forest fires). These interferences are recorded but are not a GMRP Action Level trigger.
		• Confirm source of dust based on the examination of wind speed data and visible dust observations.
		• Increase frequency of visible dust monitoring in all active work areas and in high dust generating potential areas.
		• Employ dust mitigation / implement additional best management practices as required increasing from mitigation already implemented, e.g.,
		  • additional dust management and mitigation measures,
		  • reduce disturbances of surfaces (where practical)
		  • apply approved dust suppressant e.g., water
		  • add temporary physical covers (where practical), for example, rather than simply wetting a stockpile or exposed area, the area could be physically covered.
		  • consider increasing frequency of road watering or the application rate of water to haul roads (or both).
		  • vehicle speeds on haul roads could be decreased, for example, from 30 km/h to 20 km/h.

Moderate	PM10 > 159 ug m^3 or TSP > 333 ug/m^3 (RBAL) Measured as four consecutive 15-minute average concentrations exceeding the RBAL at any Site Perimeter Monitoring Station) *OR* Visible dust is observed travelling beyond the GMRP project boundary *OR* Sustained (1 hour) winds above 40 km/h or two or more wind gusts above 60 km/h in the hour.	• The specific activity causing dust stops if visible dust and/or measured dust action level criteria are reached. • Implement Low Action Level mitigation strategies and/or BMP practices • Alter dust management and mitigation practices as appropriate based on the BMPs. • Implement alternative operations strategy as appropriate. • Notify the MVLWB and CIRNAC Inspector within 24 hours.
High	Measured as four consecutive 15-minute average concentrations exceeding the RBAL at any Site Perimeter Monitoring Station: PM10 > 159 ug m^3 or TSP > 333 ug/m^3 (RBAL) *AND* Visible dust is observed travelling beyond the GMRP project boundary AND Sustained (1 hour) winds above 40 km/h or two or more wind gusts above 60 km/h in the hour.	• All dust generating remediation work on-site suspended when High Action Level exceeded • Implement Low and Moderate Action Level mitigation strategies and/or BMP practices. • Notify the MVLWB and CIRNAC Inspector within 24 hours.

PM = particulate matter; > = greater than; TSP = Total Suspended Particulate; RBAL = Risk-Based Action Level.

7 REPORTING AND PLAN REVIEW

7.1 Annual Water Licence Report

Reporting requirements for monitoring required by the MVLWB are set out in Water Licence MV2007L8-0031. An Annual Water Licence Report must be submitted to the MVLWB no later than 30 April of the year following the calendar year reported. This report provides a summary of activities and monitoring data from the GMRP and is also intended to help with the early identification of any emerging issues. The report should include response actions and contingency scenarios, since these are particularly useful in helping MVLWB staff and stakeholders to identify whether any issues have arisen over the past year.

The Annual Water Licence Report will include the following information related to dust management and monitoring activities conducted during the previous calendar year (Schedule 1, Condition 2.d):

i. A summary of updates or changes to the methodologies or Standard Operating Procedures required for the management of dust;

ii. A comparison of predictions made through the meteorological information presented and any modelling of dust dispersion to any monitoring or observations made during the year and an explanation of any significant difference between predictions and actual measurements;

iii. A summary of activity-specific monitoring updates to the Dust Management and Monitoring Plan;

iv. A summary of relevant findings from the Air Quality Monitoring Plan as they relate to dust deposition at site;

v. A summary and interpretation of monitoring results, including: the location(s), number of wind thresholds events, along with the actions taken and an assessment of these mitigation; and an assessment of road/work site wetting, including a review of the frequency and distribution;

vi. A summary and interpretation of vegetation monitoring results;

vii. A summary of Action Level exceedances and a description of actions taken in response to Action Level exceedances including any response or corrective action taken to verify Part F, condition 1 of this Licence is met; and

viii. A summary of lessons learned, and any changes made to minimize effects on the environment.

7.2 Related Reporting: Dust Communications Plan

The GMRP will develop a Dust Communications Plan for engagement with GMRP Working Group representatives in Fall/Winter 2021/2022. The final Dust Communications Plan will be included in the March 2022 revision to the GMRP Engagement Plan once engagement is complete. The GMRP recognizes this plan and engagement on it may result in updates required to the Dust MMP and/or Engagement Plan.

7.3 Related Reporting: Air Quality Monitoring Plan

Weekly air quality monitoring reports are sent via email to the GMRP Distribution List. Weekly and Annual Reports are also uploaded to the MVLWB Public Registry and GNWT's Ambient Air Quality Network Website.

7.4 Review and Evaluation of the Plan

The Dust MMP will be reviewed and updated when new dust generation activities emerge that require new BMPs, or when the GMRP becomes aware that current action levels and approaches to mitigation result in consistent exceedances of RBALs, or upon request of the MVLWB. In accordance with the Water Licence Part B, Condition 9, the GMRP will conduct an annual review of this Dust MMP and make any revisions necessary to reflect changes in operations, contact information, or other details. If no revisions are required to this plan, this plan will be listed as a document that has been reviewed and requires no revision in the notification letter sent for the GMRP to the MVLWB, no later than March 31 each year. If at any time, this plan is updated with proposed changes or additions, the GMRP will submit the revised plans to the MVLWB for approval, a minimum of 90 days prior to the proposed implementation date for the changes, as per Part B, Condition 10. No changes shall be implemented until approved by the MVLWB.

As the GMRP progresses, Design Plans for each project component and Construction Plans for engineered structures will be completed. Any relevant post-construction dust management and monitoring changes that are approved through the Design Plans will be incorporated into the Dust MMP as appropriate and submitted to the MVLWB.

Should any changes be required based on a review of the Ambient Air Quality Monitoring Program from the Environmental Agreement or from review of metals from on-site monitoring, these may also be incorporated into the Dust MMP.

7.5 Post-Closure Monitoring and Maintenance Plan

Remediation is anticipated to take more than 10 years to complete. A Post-Closure Monitoring and Maintenance Plan is required to be submitted prior to completion of remediation. This plan will provide a detailed description of management, anticipated maintenance, and monitoring that will continue post-closure and it is expected this will include dust management.

Should post-closure air quality monitoring demonstrate that air quality at the Site is similar to background levels, and dust monitoring confirms no significant dust sources remain at the Site, the air quality monitoring program may be scaled back or discontinued, based on a process to be determined and reasonable agreement with rights holders and stakeholders, including the City of Yellowknife. The Engagement Plan has been updated to include a trigger for engagement with rights holders and stakeholders prior to scaling back the dust management and monitoring post-remediation.

8 REFERENCES

8.1 Acts and Regulations

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APPENDIX A Conformity Table

Type A Water Licence

Conditions of the Type A Water Licence (MV2007L8-0031) are summarized in Table A-1 along with sections of the Dust MMP where each condition is addressed.

Table A-1: Water Licence Conditions

Condition	Corresponding Section in Management Plan
Part F, condition 9: A minimum of 90 days prior to the commencement of Active Remediation and Adaptive Management (Phase 2), the Licensee shall submit to the Board, for approval, a revised Dust Management and Monitoring Plan. The plan shall be in accordance with Schedule 4, condition 6, and Schedule 4, condition 7: Board Directives for the Dust Management and Monitoring Plan.	Purpose of this document
Schedule 4, Condition 6: The Dust Management and Monitoring Plan referred to in Part F, condition 8 and 9 of this Licence shall include, but not be limited to, the following:	-
a) Information regarding potential dust dispersion on site;	Section 3
b) A summary of meteorological information related to typical wind directions and speeds at the site;	Appendix C
c) A description of potential extreme meteorological events that could influence dust dispersion from the site with recommendations for wind conditions under which any dust-generating activities should be halted in order to minimize the chances of dust and contaminants blowing into the City of Yellowknife, Dettah and Ndilǫ;	Section 6
d) A description of any engagement activities undertaken to inform the Dust Management and Monitoring Plan;	Section 1.5
e) Information regarding dust control and mitigation methodologies:	-
i. A summary of the types of site activities that could generate dust;	Section 3
ii. For each of the activities identified above, a description of the best management practices or mitigations that may be employed minimize the generation of dust;	Section 4.1 and 4.2
iii. Details on the use of Wastewater/Effluent for dust suppressant activities; and	Section 4.2.2
iv. Any other information required to describe how the Licensee will minimize the release of dust and contaminants from any part of the site into the Receiving Environment.	Section 4, 5, and 6
f) Information about monitoring including:	-
i. Details for air quality monitoring, including the locations, parameters monitored, rationale, that will be undertaken with respect to dust generated from the site, and where data will be reported; a. Append the Air Quality Monitoring Plan.	Section 5 Appendix D: Air Quality Monitoring Plan
ii. Details of dust monitoring, including vegetation monitoring pre- and post- demolition of major structures, other parameters monitored at the site with rationale, and where data will be reported;	Section 5 and 5.4
iii. Linkages to other Site-Wide Management and Monitoring Plans, the Giant Mine Remediation Project Closure and Reclamation Plan, Design Plans, Construction Plans, and Closure and Reclamation Completion Reports required in this Licence;	Section 1.1 Throughout document
iv. Linkages to any Closure Objectives and Closure Criteria from the approved Giant Mine Remediation Project Closure and Reclamation Plan or Design Plan(s) that are satisfied in whole or in part by the management systems detailed in this Plan; and	Section 1.1
v. Any other information about monitoring that will be performed to meet the objectives in Part F, condition 1 of this Licence and approved EA0809-001 measure 20.	Section 4 and 5
g) A description of maintenance or contingency activities that will be undertaken if monitoring results show that dust management systems are not meeting *Guidelines for Ambient Air Quality Standards in the Northwest Territories*, or *Canadian Ambient Air Quality Standards*, or are not trending towards meeting Closure Criteria, guidelines or standards, or not meeting Part F, condition 1 of this Licence. The contingencies section of the Dust Management and Monitoring Plan will include:	-
i. Identified risks related to dust management;	Section 6

Table A-1: Water Licence Conditions

Condition	Corresponding Section in Management Plan
ii. A threshold or Action Level to define the point at which monitoring indicates a response is necessary; and	Section 6.5
iii Proposed response and possible contingency actions to be implemented if threshold is exceeded.	Section 6.5
Schedule 4, Condition 7: Board Directives for the Dust Management and Monitoring Plan referred to in Part F, condition 9 of this Licence:	-
a) Include a subsection which includes approved EA0809-001 measure 20 and suggestion 12, and reference to past dust events;	Section 1.4.1
b) Add information related to general best management practices for stockpile management that will be implemented onsite;	Section 4.2.5
c) Identify the need to reconsider NO_2 in the event of a change in the Freeze program in the contingencies section of the Air Quality Monitoring Plan;	Section 5.5
d) Include adaptive management thresholds for $PM_{2.5}$, NO_2 and metals (arsenic, antimony, lead, iron, and nickel);	Section 5.5
e) Define short-term, short-medium term, medium-term, and long-term;	Long term is defined in Table 3.6-1. The terms are no longer used in the Dust MMP
f) Further describe the wind threshold levels;	Section 6.4 and 6.5
g) Clarify the intention of the 'Values at Risk' section of Table 6.2-1 that is referring to the Valued Components as outlined in Section 1.4.2 of the Updated Project Description; and	Section 2 Previous Table 6.2-1 has been removed from the Dust MMP
h) Modify the text in Table 6.2-1 to provide numeric/further descriptions for the 'Values at Risk' column.	Section 2 Previous Table 6.2-1 has been removed from the Dust MMP

APPENDIX B Dust Management Summary Tables

Table B1: Dust Management Summary

Activity Category	Activities Requiring Dust Management	Description of Specific Mitigation and Management Options	Monitoring	Section References
Exposed Tailings	• Management of existing tailings containment areas (Northwest Pond TCA, North Pond TCA, Central Pond TCA, South Pond TCA).	• Approved soil stabilizer applied in the spring and as needed throughout the year. Coating reapplied if the tailings are disturbed. Spot treatment the following year if full application not required. • Tailings wetted, where possible, to prevent wind erosion and re-wetted as needed. • Closed / covered through the winter months (snow)	• Ongoing dust monitoring at Site Perimeter stations. • Visible dust observations • Wind measurement	• 4.2.1 Scheduling and Staging • 4.2.2 Dust Suppressants • 4.2.3 Physical Coverings • 4.2.4 Wind Reduction
Roads and Roadworks Parking Lot	• Trafficking and maintenance of existing roads to support remediation and monitoring activities e.g., unpaved roads. • Grading, widening, and contouring of existing roads. • Wind erosion of (dry) unpaved roads. • Trafficking of parking lots e.g., South of C-Dry. • Wind erosion of (dry) unpaved parking lots.	• Application of an approved dust suppressant in spring and summer and as needed. • Roads watered between applications of approved dust suppressant. • Road and surface disturbances minimized through proper road maintenance. Reducing disturbance except to monitor and stabilize roads. • Road maintenance (grading and repair) curtailed during high wind conditions. • Controlling vehicle/equipment speeds to 25 km/h or less on all roads with the exception of specific sections where speeds up to 40 km/h are permitted. Controlling vehicle/equipment speeds to 15 km/h around buildings and work sites. Refer to Traffic MP for GMRP speed limits. Restricting traffic to designated roads/corridors, as needed. • Washing of vehicles and equipment prior to leaving contaminated areas, refer Waste MMP.	• Dust monitoring at Site Perimeter stations. • Visible dust observations • Wind measurement • Potential for activity-specific particulate monitoring at upwind and downwind locations to supplement permanent monitoring.	• 4.2.1 Scheduling and Staging • 4.2.2 Dust Suppressants • 4.2.3 Physical Coverings • 4.2.4 Wind Reduction
Earthworks	Handling of mineral materials (a) materials for construction and (b) mineral wastes[(a)] for disposal • General movement of borrow materials, general earthworks e.g., overburden piles, handling and hauling of coarse and fine grained construction materials, storage/stockpiling of mineral materials, clearing and grubbing for surface preparation. • Earthworks for investigations e.g., testpits. • Maintenance of infrastructure e.g., site grading, road surface gravelling • Demolition of infrastructure e.g., Removal of up to 30 km of roads and utilities. • Earthworks associated with remediation and construction activities e.g., Construction of the on-site non-hazardous waste landfill, building berms and ponds, site grading, construction of freeze drill pads. • Development of temporary access roads, including upgrade to the A Shaft road and the road from the landfill footprint to the townsite. • Underground stabilisation works e.g., Backfilling of stopes. • Excavation and placement of arsenic-impacted materials in pits and tailings containment areas; e.g., Excavation, processing (soil washing), and placement of heavily arsenic-impacted materials in Chamber 15 and B1 Pit and contaminated fill in open pits. • Excavation and movement of tailings for paste production and remediation, backfilling stopes. • Construction of covers for TCAs, left in place arsenic-impacted materials, pits, and non-hazardous waste landfill. • Windblown erosion of exposed in-situ or stockpiled soils, borrow materials, and tailings.	• Consult Figure 5.3-3 to determine if work handles mineral wastes prior to earth moving, as action levels are linked to potential for higher arsenic emissions. • Minimize unnecessary disturbance. • Mineral materials (e.g., soils and tailings) are wetted (in above-freezing temperatures) or approved dust suppressant applied before or during activity. • Soil excavation to be managed per action levels (Section 6). • Manage stockpiles with Sections 4.2.5 BMPs, e.g., exposed stockpiles are watered to prevent wind erosion. • Machinery used for mineral materials disruption is to be appropriately sized for the level of effort, to minimize soil disruption as much as possible. • Respect relevant road dust mitigation measures while carrying out earthworks. • Tarps or a soil tackifier are used when transporting soils and tailings. • A temporary fabric building (approximately 2500 m^2) is set up near the Tailings Reprocessing Plant for paste production for protection from wind and to reduce tracking to other parts of the Site.	• Dust monitoring at Site Perimeter stations. • Visible dust observations • Wind measurement • Potential for activity-specific particulate monitoring at upwind and downwind locations to supplement permanent monitoring	• 4.2.1 Scheduling and Staging • 4.2.2 Dust Suppressants • 4.2.3 Physical Coverings • 6 Action Levels
Drilling	Handling of mineral materials (a) materials for construction and (b) mineral wastes[1] for disposal: • Drilling for investigations e.g., geotechnical drilling, geophysical investigations. • Boreholes for equipment placement e.g., for thermosyphons. • Drilling to support underground stabilization and backfilling of slopes e.g., concrete delivery underground, placement of waste. • Drilling for blast holes; e.g., AR-1 construction • Boreholes for placement of waste in chamber 15.	• Wet drilling to be employed where possible. Dry drilling avoided where possible, but when implemented will use dust control methods e.g., potential for wetting, use of a dust collector where the cutting may be wetted to reduce emissions, etc. Residuals managed through the Water MMP and Waste MMP. • Drilling during snow cover or frozen conditions where possible. • Avoid disturbing soils high in arsenic where possible; refer to the Waste MMP for mineral waste description.	• Dust monitoring at Site Perimeter stations. • Visible dust observations • Wind measurement • Potential for activity-specific particulate monitoring at upwind and downwind locations to supplement permanent monitoring	• 4.2.1 Scheduling and Staging • 4.2.2 Dust Suppressants
Blasting	• Blasting for civil works e.g., AR-1 freeze pad. • Construction of new long-term portal to the underground.	• Use blast mats where appropriate. • Timing: planned for periods when forecasted winds are light and blow away from communities. Confirm using measured winds on-site. • Refer to Borrow Materials and Explosives MMP for further details on blasting.	• Dust monitoring at Site Perimeter stations. • Visible dust observations • Wind measurement	• 4.2.1 Scheduling and Staging • 4.2.3 Physical Coverings

Table B1: Dust Management Summary

Activity Category	Activities Requiring Dust Management	Description of Specific Mitigation and Management Options	Monitoring	Section References
Infrastructure Demolition	Handling of non-hazardous non-mineral[(b)] and hazardous non-mineral[(b)] wastes for disposal: • Deconstruction of buildings and structures e.g., grinding, cutting or breaking of non-friable and other materials, removal of hazardous materials from buildings, including disturbance of friable materials such as asbestos. • Demolition of major structures (the Mill, the TRP and C-Dry) • Deconstruction of equipment e.g., the deconstruction of the FOS. • Collection, handling, and disposal of debris e.g., wastes stockpiled from previous deconstruction activities.	• Timing: planned for periods when temperatures are above freezing to allow for water use. • Timing: planned for periods when forecasted winds are light and blow away from communities. Confirm using measured winds on-site. • Reduce material drop heights to reduce dust emissions. • Approved dust suppressant or water spray will be applied to control dust emissions from loading, moving, or consolidation of debris stockpiles. Emissions from debris stockpiles will be managed (see Section 4.2.5 for options). • All structures assessed, and contaminated structures decontaminated using appropriate abatement procedures prior to demolition in accordance with the Waste MMP. If materials contain non-mineral hazardous wastes (e.g., asbestos) specific management is required in accordance with the Waste MMP. • Proactive removal of key structures to minimize unmanaged structural collapse that has the potential to produce hazardous dust.	• Dust monitoring at Site Perimeter stations. • Visible dust observations • Wind measurement • Potential for activity-specific particulate monitoring at upwind and downwind locations to supplement permanent monitoring • Vegetation monitoring pre- and post- demolition of major structures (the Mill, the TRP and C-Dry) – Specifics to be included in later version of plan	• 4.2.1 Scheduling and Staging • 4.2.2 Dust Suppressants • 4.2.3 Physical Coverings • 4.2.5 Stockpile Management
	• Collection and disposal of debris from previous deconstruction activities. • Relocation of debris and equipment e.g., laydown areas currently in the footprint of the landfill. • Removal of decommissioned electrical equipment (poles and wire).	• Wastes will be handled in accordance with the Waste MMP; e.g., appropriate handling and containerization in accordance with the identified waste stream. • Use tarps or tackifiers when transporting loads, refer to Section 4.2.3.	• Dust monitoring at Site Perimeter stations. • Visible dust observations • Wind measurement • Potential for activity-specific particulate monitoring at upwind and downwind locations to supplement permanent monitoring	• 4.2.3 Physical Coverings

(a) Mineral wastes include Heavily Arsenic-Impacted waste, Contaminated Soils and Sediments, Tailings, Drill Wastes, Vegetation and Overburden as described in the CRP and Waste MMP.
(b) Non-mineral non-hazardous wastes and non-mineral hazardous wastes (Arsenic Impacted Infrastructure Wastes, Asbestos, Leachable Lead Paint, Cyanide Containing Waste, and Miscellaneous Hazardous Materials) as described in the CRP and Waste MMP.
TCA = Tailings Containment Area; MMP = Management and Monitoring Plan; TRP = tailings retreatment plant; FOS = freeze optimization study.

APPENDIX C Existing Project Environment

Wind

Wind data has been analyzed in detail in Appendix C to the Air Quality Management Plan (Appendix D of this Dust MMP and in AECOM (2019). This section identifies the frequency of winds speeds that meet the Wind Thresholds and Action Alert Levels. Of importance is that the Yellowknife Airport (YZF) station measures winds 10 m above ground (Figure C-1). Note the data presented in this section (data collected from 2013 to 2017) was measured by the decommissioned (decommissioned in 2019) Site station with winds measured winds at 3 m. A 10-m tower was installed on-site in 2020 which allows for higher quality on-site meteorological data moving forward.

Figure C-1 Shows the wind class frequency distribution using the on-site meteorological station between 2013 to 2017. Winds above 30 km/h, measured at 3 m above ground, occur about 0.3% of the time (about 26 hours each year). Predominantly southerly winds in summer, when activities at the Site are most active, blow dust away from the community. Strong winds occur infrequently.

Figure C-1: Wind Class Frequency Distribution – Yellowknife Airport (November-March, 2013-2017)

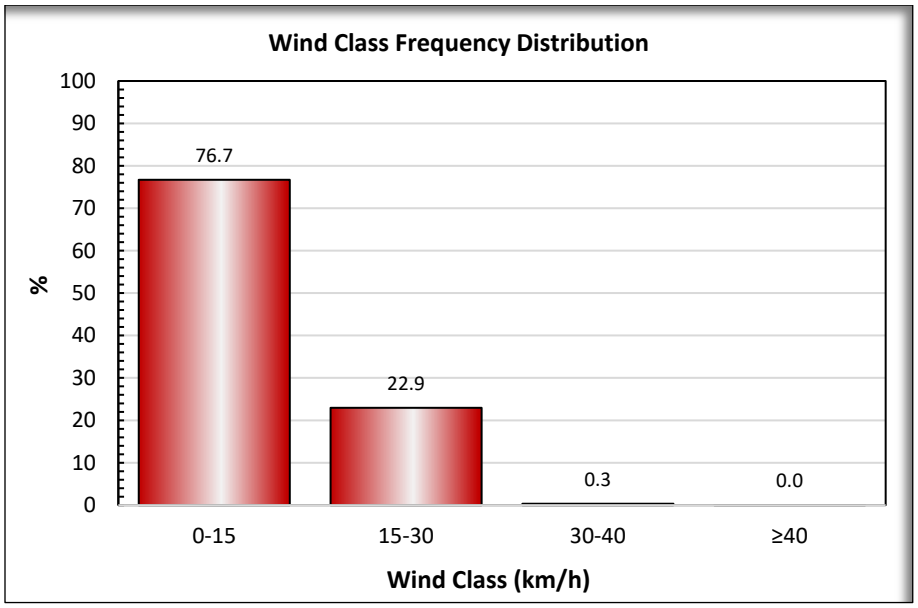

Figure C-2 shows Yellowknife Airport winds between 2013 and 2017. It shows winds blowing towards the community monitoring stations as follows; wind blowing from west and north (220-20°) blows from Site activities towards the Marina station, wind blowing from the northwest (290-10°) towards NDL, and wind blowing from the north (320-20°) towards NVN. Since fugitive dust is less of an issue during the snow-covered months, only April to November wind data are shown. Seasonal wind roses from the Yellowknife Airport, showing substantial variation, are shown in Figures C-3 and C-4.

Figure C-2: Wind Rose Generated from Yellowknife Airport Data (2013-2017)

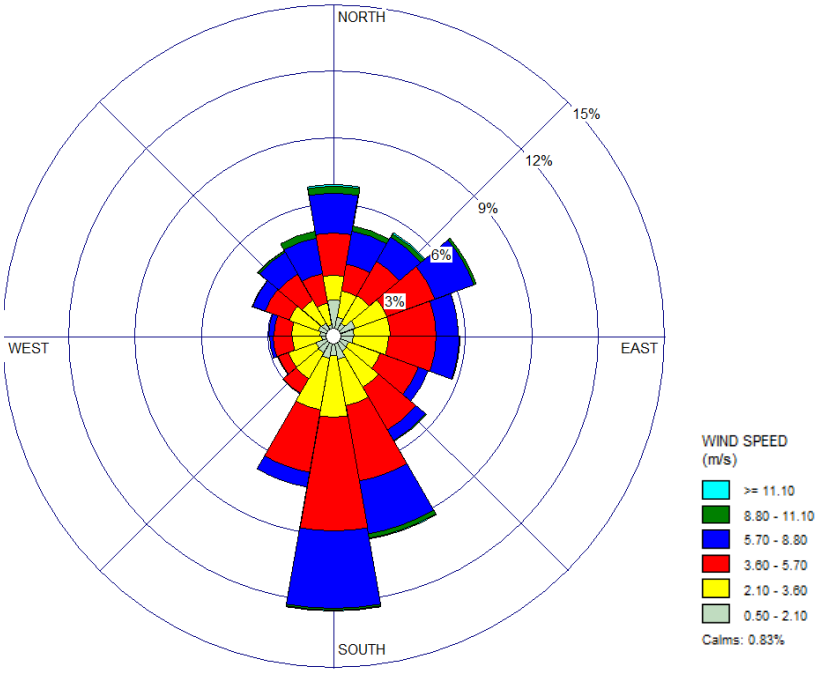

Figure C-3: Yellowknife Airport Wind Rose – (a) April-May, 2013-2017 (b) June-August, 2013-2017 (AECOM 2019)

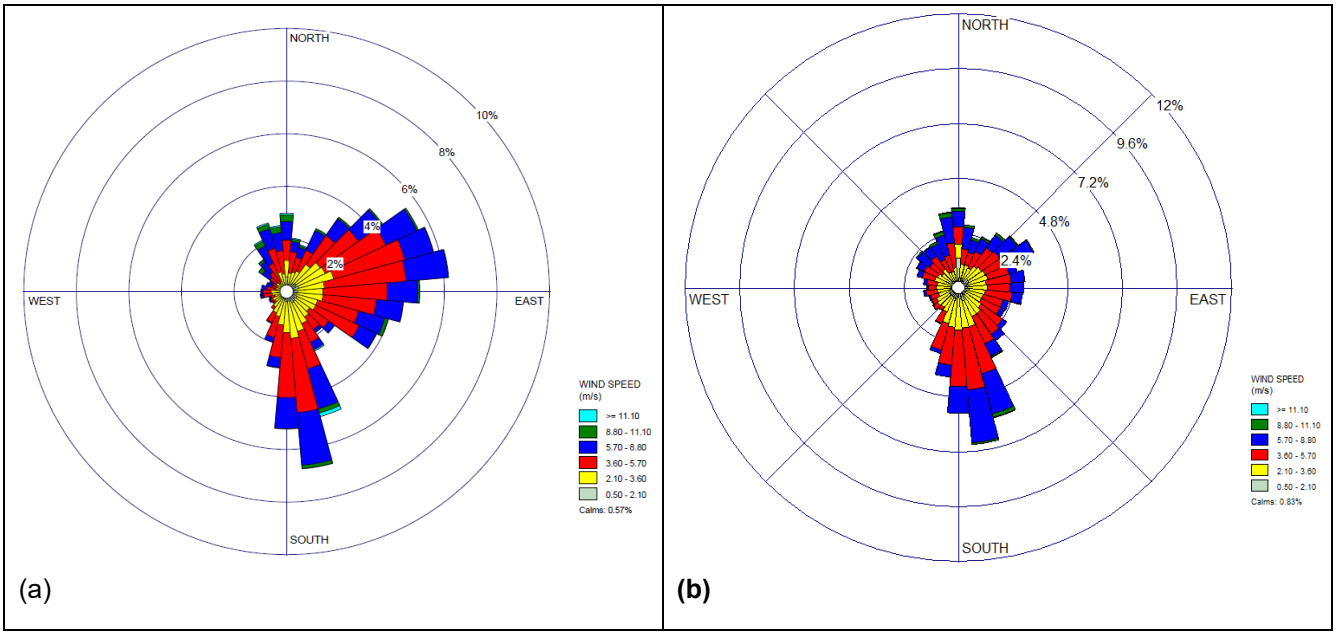

Figure C-4: Yellowknife Airport Wind Rose – (a) September-October, 2013-2017 (b) November-March, 2013-2017 (AECOM 2019)

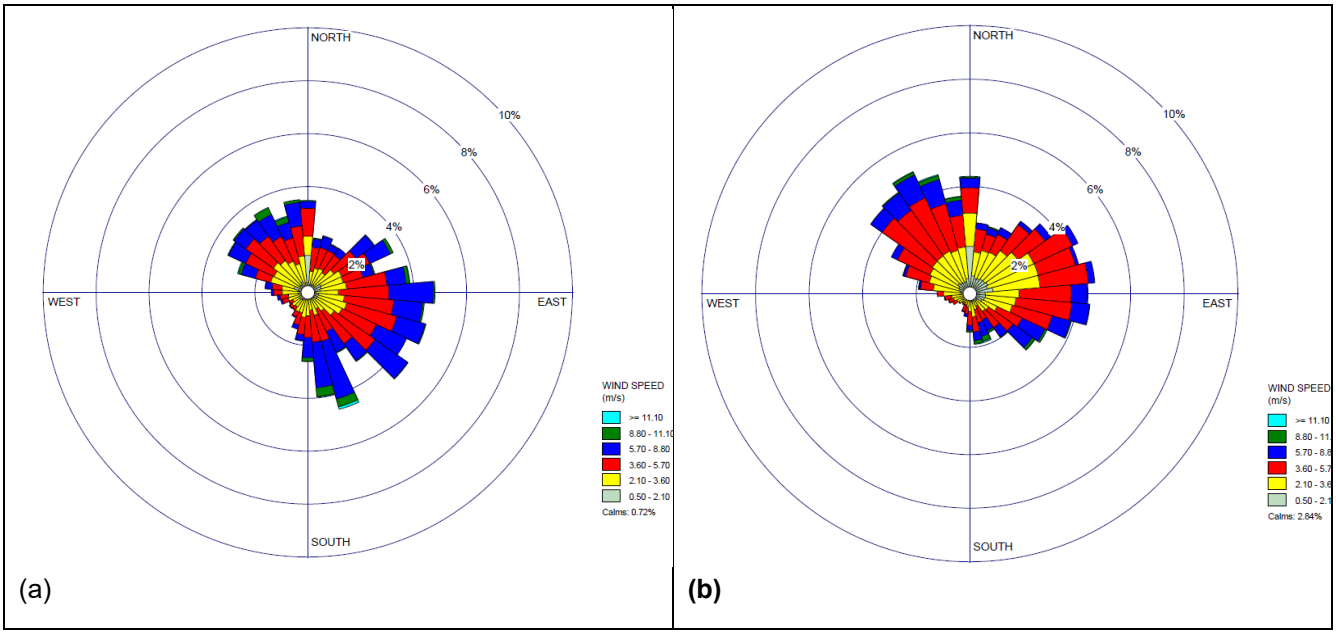

Table C-1 shows the percentage of time wind blows toward the three (3) community monitoring stations between April and November. The Marina station is most likely to be affected by activity at the Site.

Table C-1: Percent (%) of Time Wind Blows from the Site Towards Community Monitoring Stations during On-Site Activities[a]

	Yellowknife (220-20°[b])	Ndilo (290-10°)	Niven (320-20°)
Total (% of 2013-2017 data except winter)	30.8	18.4	11.5
0-15 (% of total)	21.5		7.1
15-30 (% of total)	9.1	6.5	4.3
30-40 (% of total)	0.2	0.1	0.1
40-50 (% of total)	0.0	0.0	0.0
≥50 (% of total)	0.0	0.0	0.0

(a) Note: Winter months (December-March) are excluded from the calculations.

(b) Wind sector blowing from the Site toward the station.

Precipitation and Evaporation

Table C-2 summarizes precipitation based on climate data from the Yellowknife airport meteorological station for 1943 to 2017 and 2007 to 2017. The 2007 to 2017 means are used to summarize recent conditions (within the last ten years), for comparison with the 1942 to 2017 long-term mean.

Rainfall has historically peaked in August but in more recent years has shifted to a September peak (Kokelj et al. 2012). There was an average of 51 and 79 days with rainfall ≥ 0.2 mm and snowfall ≥ 0.2 cm, respectively. Rainfall, a natural dust inhibitor, falls on about 25% of days during active work on-site.

Table C-2: Climate Annual Means for Yellowknife, NWT

Climate Variable	Long-Term Mean (1943–2017)	Recent Mean (2007–2017)
Air temperature (°C)	-4.8	-3.7
Total snowfall (cm)	140.5	155.2
Total rainfall (mm)	157.7	173.8
Total precipitation (mm)	270.5	283.0
Average number of days in a year with rainfall[a]	51.3 days with ≥ 0.2 mm	
Average number of days in a year with snowfall[a]	78.6 days with ≥ 0.2 cm	

(a) Days of rainfall and snow fall were available from 1981 to 2010 Canadian Climate Normals Yellowknife A Station Data (accessed 2017 and 2019).

°C = degrees Celsius; cm = centimetre; mm = millimetre.

APPENDIX D Air Quality Monitoring Plan

AECOM Imagine it. Delivered.

Giant Mine Remediation Project
Air Quality Monitoring Plan

Public Services and Procurement Canada

Project number: 60627248

June 23, 2021

Statement of Qualifications and Limitations

The attached Report (the “Report”) has been prepared by AECOM Canada Ltd. (“AECOM”) for the benefit of the Client (“Client”) in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the “Agreement”).

The information, data, recommendations and conclusions contained in the Report (collectively, the “Information”):

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- represents AECOM’s professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
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- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
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- was prepared for the specific purposes described in the Report and the Agreement; and
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AECOM: 2015-04-13

Quality information

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Revision History

Revision	Revision date	Name	Details
1	November 2, 2018	JL/PT	Revision of 2013 AWMP, Initial Draft
2	January 25, 2019	JL/MG	Draft with revisions
3	February 1, 2019	JL/PS/MG	Final
4	March 12, 2021	YT/RR	Final-Revision 1 – to be in line with Dust Management and Monitoring Plan
5	June 23, 2021	YT/EP	Updates to address Mackenzie Valley Land and Water Board direction dated June 4, 2021, received with submission of the Dust Management Plan.

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List of Abbreviations

Abbreviation	Full Text
AANDC	Aboriginal Affairs and Northern Development Canada
AAQC	Ambient Air Quality Criteria
AAQMP	Ambient Air Quality Monitoring Program
AQMP	Air Quality Monitoring Plan
AMD	Air Monitoring Directive
As	Arsenic
BAM	Beta Attenuation Monitor
CAAQS	Canadian Ambient Air Quality Standards
CEPA	Canadian Environmental Protection Act
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
cfm	Cubic Feet per Minute
COI	Constituents of Interest
CC	Construction Contractor
DAS	Data Acquisition System
DIAND	Department of Indian Affairs and Northern Development
Fe	Iron
GMRP	Giant Mine Remediation Project
GNWT	Government of the Northwest Territories
Hi-vol	High Volume, High Volume Sampler
INAC	Indian and Northern Affairs Canada/Indigenous and Northern Affairs
NAAQO	National Ambient Air Quality Objectives
NAPS	National Air Pollution Schedule
NDL	Ndilo Community Monitoring Station
Ni	Nickel
NIOSH	National Institute for Occupational Safety and Health
NO_2	Nitrogen Dioxide
NVN	Niven Community Monitoring Station
Pb	Lead
PCM	Phase Contrast Microscopy
PEI	Project Environment Inspector
PM_{10}	Particulate matter with a diameter of 10 microns or less
$PM_{2.5}$	Particulate matter with a diameter of 2.5 microns or less
PSPC	Public Services and Procurement Canada
PWGSC	Public Works and Government Services Canada
QA/QC	Quality Assurance/Quality Control
Sb	Antimony
SO_2	Sulphur Dioxide
TEM	Transmission Electron Microscopy
TSP	Total suspended particulate
US EPA	United States Environmental Protection Act
VFC	Volumetric Flow Controlled
YKB	Yellowknife Bay Community Monitoring Station

Executive Summary

The Giant Mine site (the Site) is located within the City of Yellowknife boundary, approximately 1.5 kilometres (km) from the community of Ndilǫ and 9 km from the community of Dettah. The Site produced gold from 1948 until 1999 and ore for off-Site processing from 2000 until 2004. In 1999, the owner of the Site went into receivership; care, custody, and control of the Site was transferred to Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) and the GNWT. Ongoing care and maintenance and the remediation of the Site is known as the Giant Mine Remediation Project (GMRP).

An Air Quality Monitoring Plan (AQMP) was developed in 2013 (AECOM 2013a) to provide a description of the air monitoring requirements during the GMRP. The air monitoring program was reviewed and updated in 2019 based on the information and data collected from 2013-2017 to produce a revised AQMP. The AQMP was also revised in 2021 to re-align with Dust Management and Monitoring Plan (Dust MMP Version 2.0) (this document). This AQMP outlines methods for measuring, documenting, and responding to potential airborne contaminants during the remedial activities. The AQMP is an integrated and tiered air quality monitoring approach starting with activity-specific monitoring on an as-and-when needed basis, moving to the site perimeter (Project Boundary) and extending into the communities of Ndilo and Yellowknife.

Ambient air quality monitoring at the Site was conducted seasonally from 2005-2012 and as part of the AQMP from 2013-2017 during earthworks, building demolition (including the roaster complex) and general care and maintenance, as per AECOM (2013a) and continued through 2018 and beyond. Results of the monitoring from 2013-2017 were analyzed and used to guide the 2019 revision to the AQMP. Analysis of the 2013-2017 data indicated an air monitoring system with excellent data availability from a coordinated network of monitors. The text in this version of the AQMP has been updated to reflect the current air quality monitoring at the Site along with updated air quality criteria but the basis of the air monitoring plan remains the same.

The Ambient Air Quality Monitoring Program (AAQMP) for the GMRP consists of three community monitoring stations located in the communities of Yellowknife and Ndilo. These locations were selected based on an analysis of the climatological data (including wind speeds and directions), existing air quality data, community input, location of sensitive receptors and topographic features. The program also consists of nine site perimeter monitoring locations strategically positioned along or near the Project Boundary. Activity-specific air quality monitoring is conducted as-and-when needed on site for higher risk activities as a dust management tool and is covered by the Dust MMP.

Previous studies served as a reference for the selection of parameters for the monitoring program during remediation. After review of the contaminants that were identified during investigations of the Site through historical studies, and following a review of measurements collected from 2013-2017, the target parameters for the AAQMP were originally identified and remain as arsenic (As), antimony (Sb), asbestos, iron (Fe), lead (Pb), nickel (Ni), total suspended particulate (TSP), particulate matter with a diameter of 10 microns or less (PM_{10}), and particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$).

The requirements for upper concentration limits for the AAQMP consist of two categories: action levels for the site perimeter (the Project Boundary) and the community air quality criteria requirements. The community requirements are based on the ambient air quality criteria (AAQC) set out by appropriate provincial/territorial or federal authorities. The action levels for the site perimeter monitors were established through a risk-based analysis from a site-specific surrogate method that is based on soil concentrations (AECOM 2013 b). These action levels were reviewed in 2019 based on monitoring data from 2013-2017 and were determined to be sufficiently protective. The site perimeter monitoring data is used as a construction and project management tool to ensure appropriate mitigation measures are implemented. If the action levels for the site perimeter monitoring locations are exceeded, appropriate measures are taken by the GMRP according to the directions outlined in this AQMP and the GMRP Dust MMP, such as the initiation of an investigation and undertaking of appropriate mitigation steps as necessary.

The AQMP includes quality assurance and quality control steps specifically focussed on the two aspects of the program (site perimeter and community air quality monitoring) to increase the quality of the measured parameters. Reporting requirements are also outlined in the AQMP and are broken down into real-time reports, weekly and annual reports.

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Appendices

1. Air Quality Monitoring Plan (AQMP) Introduction

The Giant Mine (the Site) is located within the municipal boundary of Yellowknife in the Northwest Territories, approximately five kilometres north of the city centre. The Site is situated on Commissioner's Land administered by the Government of the Northwest Territories (GNWT); Reserves (R622T and 85 J/8-257-2) have been established to allow for the implementation of the remediation of the Site. Ongoing care, maintenance and remediation of the Site is known as the Giant Mine Remediation Project (GMRP). Subsurface mineral rights are under federal jurisdiction and were withdrawn by Order in Council SI/2005-55 on 15 June 2005. The Site produced gold from 1948 until 1999 and ore for off-site processing from 2000 until 2004. In 1999, the owner of the Site went into receivership; care, custody, and control of the site was transferred to Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) and the GNWT.

The historic operation of Giant Mine resulted in widespread contamination of surface and subsurface soils. On-site ore processing generated arsenic trioxide dust which was discharged to the atmosphere in early years of mine operation and subsequently deposited on surface soils. A large portion of this by-product was collected and is stored in fourteen purpose-built chambers and mined-out stopes underground. Additionally, there are four tailings containment areas on site which contain a less-toxic species of arsenic (As(V)) as well as other trace metals.

The GMRP is intended to stabilize contaminated materials during remediation. However, some activities associated with the GMRP have the potential to generate dust which can be entrained in the ambient air either from the activity itself or assisted by unfavourable meteorological conditions. Mitigation measures are incorporated into remedial activities and management plans to substantially reduce the possibility of fugitive emissions from those activities.

An Air Quality Monitoring Plan (AQMP) was developed in 2013 (AECOM 2013a), revised in 2019 following a review of ambient air quality measurements collected from 2013-2017 and again updated in 2021 (this document). The AQMP provides a description of the air monitoring requirements during the GMRP and outlines methods for measuring, documenting, and responding to potential airborne contaminants during the remedial activities. It will be updated on a regular basis upon review of recommendations in annual air quality monitoring reports.

The framework used to design the remedial phase AQMP includes the following basic steps:

- Define program goals
- Specify target parameters
- Specify number and location of monitoring sites
- Specify duration and frequency of monitoring
- Specify monitoring methods
- Specify data quality objectives
- Specify Quality Assurance/Quality Control (QA/QC) program
- Specify data management and reporting systems
- Specify compliance criteria and site action levels

The AQMP forms the basis of the Ambient Air Quality Monitoring Program (AAQMP). The AAQMP consists of a community air quality monitoring component and a site perimeter air quality monitoring component. Additionally, activity-specific air quality monitoring is conducted as-and-when needed for higher risk activities such as the completed roaster complex demolition or major earthworks in heavily contaminated areas. **Appendix A** shows the location of the Site Perimeter and Community Monitoring Stations; activity-specific monitoring stations are not shown on the figure as their use and location are variable and depend on the location of a given activity.

Occupational health monitoring is also conducted on the Site, as required, dependent on specific activities; this monitoring is not covered in the AQMP.

1.1 Project Background

1.1.1 Previous Environmental Assessments and Reports

The Giant Mine Environmental Assessment (EA) began in 2008 under the jurisdiction of the Mackenzie Valley Environmental Impact Review Board and was completed in 2014. The atmospheric environment (air quality) was identified in the EA and in the Developer's Assessment Report (DAR) (INAC and GNWT, 2010) as an environmental component that was and could be affected by past, present or future activities. The overall long-term goal of the GMRP is to prevent adverse effects that would result if no action was taken. Though the future effects of the project will benefit the environment and improve the current situation, site remediation activities may result in residual effects, notwithstanding extensive mitigation measures.

In 2013 AECOM developed the AQMP (AECOM, 2013a) to measure effects of the onsite activities on ambient air quality that may not be controlled by the mitigation measures. The monitoring program has collected a wealth of air quality information since 2013 from the locations along the site perimeter and in the communities of Yellowknife and Ndilo.

Some of the known and potential residual effects summarized in the DAR and the GMRP Closure and Reclamation Plan (GMRP, 2019) include:

- Increase in suspended solids (dust) during earthmoving activities
- Combustion emissions from equipment and vehicles during on-site activities
- Release of existing contaminants to air during remediation of contaminated areas
- Surface disturbances affecting terrestrial habitat and biota
- Asbestos containing material in the site buildings, identified as a hazard for building deconstruction

Based on the evaluation of the residual effects on the atmospheric criteria in the DAR (2010), it was concluded that with the proposed mitigation measures in place, residual adverse effects will be minor since most of the residual effects will be temporary and restricted to the remediation phase.

A screening level air dispersion modelling assessment was completed with the use of the United States Environmental Protection Agency's (US EPA) Industrial Source Complex Short-Term (ISCST3) modelling software (INAC and GNWT 2010). The screening level modelling assessment identified the following as Constituents of Interest (COI): Total Suspended Particulate (TSP), Particulate Matter with a diameter of 10 microns or less (PM_{10}), Particulate Matter with a diameter of 2.5 microns or less ($PM_{2.5}$), NO_2 and SO_2. The conclusion was that combustion emissions (NO_2 and SO_2) would exceed applicable 1-hour criteria in the immediate vicinity of heavy equipment operations. The primary source of particulate emissions was windblown dust. The off-site receptors were predicted to be within the allowable criteria for both particulates and combustion emissions. The mitigation measures to be implemented for emissions from vehicles and bulldozing activities were watering and the application of calcium chloride to reduce evaporative loss (INAC and GNWT 2010), (SENES 2012).

Refined air quality assessments using CALMET/CALPUFF were contracted in 2012 by CIRNAC to complete air contaminant dispersion analysis. The dispersion model evaluated Giant Mine remediation activities and assessed particulate emissions (TSP, PM_{10}, and $PM_{2.5}$) and combustion emissions (NO_2 and SO_2). Projected worst case operations of the Jackfish Power Plant were also included in the assessment, with the idea that an active freeze system would be built on site. (This is no longer the case, with a passive freeze system now planned.) The results of the screening level assessment were consistent with the CALPUFF results, in that with reasonable mitigation during remediation activities, wind-blown dust would be the primary emission source of TSP and arsenic (SENES, 2012).

However, the CALPUFF results predicted exceedances of on-site and off-site receptors. The minimum conservative assumption (power plant operating continuously at 18 MW) had a predicted exceedance of 1-hour NO_2 and 24-hour $PM_{2.5}$ at one receptor location. The worst-case maximum operation scenario for short term (power plant operating continuously at 27 MW for 1-hour) predicted significant exceedances of 1-hour NO_2 emissions at two off-site receptor locations closest to the plant. On-site receptor locations were predicted to have exceedances of applicable

criteria. The results also show that based on the operation of the freeze plant with 3 megawatts of incremental power from the Jackfish Power Plant, there would be no resultant NO_2 and SO_2 exceedances of applicable criteria at the sensitive receptor locations (SENES 2012).

1.1.2 Existing Human Health and Ecological Risk Assessments

Four risk assessments have been completed for the Site. In 2001-2002, an ecological and human health risk assessment was completed to assess the evaluation of alternative scenarios for the management of underground arsenic trioxide dust. In 2003 a screening level risk assessment for the Site was completed. Following the screening level risk assessment, a Tier 2 Risk assessment was completed for the surface remedial activities in 2006 (SENES, 2006). A Human Health and Ecological Risk Assessment was also completed by the GMRP in 2016/17 (CanNorth, 2018).

Risk assessments were carried out in support of assessing the potential adverse effects on human health, aquatic and terrestrial species in the vicinity of the Site. The 2003 screening level risk assessment examined existing conditions at the Site and used conservative assumption and literature transfer factors to assess effects from the surface conditions at the Site. The 2003 results indicated that in addition to arsenic (As); antimony (Sb), lead (Pb) and nickel (Ni) also present risks to humans due to existing surface conditions at the Site. Subsequent reviews of the 2003 findings resulted in hazard quotient values below 0.5 for Pb and Ni. Therefore, Pb and Ni were not found to be COIs at the Site. The primary source of Sb was found to be contaminated soils and that the proposed Remediation Plan of arsenic-contaminated soils will also lead to a substantial reduction in the Sb levels in the soils left on surface at the site. (SENES 2006).

A human health risk assessment was completed to determine the different levels of impacts on human receptors. The major pathways of exposure to background levels of arsenic were in the ingestion of water and food; air and soil inhalation pathways were considered insignificant contributors to overall arsenic exposure by Environment Canada (Environment Canada 1993). As outlined in the previous risk assessment, toxic arsenic has carcinogenic effects, and carcinogenic risk is evaluated by the incremental incidence of developing cancer in a lifetime of exposure. In the assessment study, the predicted cancer risk for the remediation study was 6.1 in 10,000. This is well below the lifetime incidence cancer rate of 3 in 10 for the Northwest Territories population. Based on these statistics, the risk of developing cancer from total arsenic exposure is up to 300 times lower than the overall cancer risk for the population. However, while the incremental lifetime risk levels are above the acceptable level of 1 in 100,000 from Health Canada, the predicted levels of cancer development from exposure to arsenic releases from the Site will not be distinguishable to the current levels of cancer development in the Yellowknife population (SENES 2006).

Overall, the human health risk assessment calculations found that arsenic intake by humans will be maintained within the estimated range for other Canadians and hence would have little risk of adverse health effects.

Previous reports outlined the requirement for restrictions on future activity at the Site until site monitoring programs prove that arsenic levels are within safe limits (Giant Mine Remediation Project 2010).

1.2 Ambient Air Quality Monitoring Program (AAQMP) Objectives

The objective of the AAQMP is to help protect the environment, workers on-site and the public from health impacts as a result of remediation activities. The main goals of the AAQMP are:

1. To measure air quality in the vicinity of remediation emissions to ensure overall compliance with established criteria. Real-time concentration averages will be continuously monitored on-site during remedial activity and the values will be compared to approved short-term action levels to assist site managers in assessing or modifying site activities to prevent exceedances of GMRP criteria. Whereas the monitoring associated with these short-term action levels is a component of the AAQMP and addressed in this AQMP, response associated with the action levels, beyond initial investigation and reporting, are a component of the Dust Management and Monitoring Plan (Dust MMP) and detailed therein.
2. To measure ambient air quality in the community surrounding the GMRP to confirm that there are no significant impacts to community air quality as a result of remediation activity.

2. Ambient Air Quality Monitoring Program

2.1 Overview

The overall commitment of the GMRP is to ensure that appropriate measures and precautions are taken for the GMRP to occur successfully in a manner that is protective of the environment and human health. The AAQMP is one measure that the GMRP implements to protect the local air quality during remediation activities.

Past air quality monitoring from 2005 to 2012 show that there were some recorded exceedances for TSP, PM_{10}, As, Fe, NO_2. Significant dust mitigation measures on-site, including the annual application of dust suppressant on the TCAs, has greatly reduced the amount of visible dust on site and the number of exceedances at Site Perimeter Monitoring Stations.

Monitoring results from 2013–2017 AQMP data show that overall, the Site Perimeter and Community Monitoring Stations have excellent data availability. The stations for these two program components responded similarly to large-scale events such as elevated particulate concentrations associated with wildfires over the monitoring period, and correlations between elevated readings between stations occur frequently, indicating that the system is functioning well as a coordinated network. Outside of wildfire events there were very few exceedances of the Risk Based Action Levels (RBALs) at Site Perimeter Monitoring Stations and no exceedances of the AAQC at the Community Monitoring Stations. There were no exceedances of the AAQC for arsenic at any of the Site Perimeter or Community Monitoring Stations during the 2013 – 2017 monitoring period. (AECOM 2019)

The AAQMP includes three Community Monitoring Stations located in the communities of Yellowknife (two stations) and Ndilo (one station). These locations were previously selected based on an analysis of the climatological data (including wind speeds and directions), existing air quality data, community input, location of sensitive receptors and topographic features. The program also includes nine Site Perimeter Monitoring Stations at or near the Project Boundary. Activity-specific Monitoring Stations are used as and when needed based on project activities.

Target parameters were identified as those COIs that have the potential to pose the most significant health risks during remediation activities. COIs were selected as target compounds based on the following criteria:

- Toxicity or unit risk factor of the particular COI
- Relative concentration of the COI present in the buried waste or soil
- The COI's emission rate into air
- Analysis of 2013-2017 monitoring results

After review of the contaminants that were identified during investigations of the Site through historical studies, and following a review of measurements collected from 2013-2017, the target parameters for the air monitoring program were identified and remain as arsenic (As), antimony (Sb), asbestos (Community Monitoring Stations only), iron (Fe), lead (Pb), nickel (Ni), total suspended particulate (TSP), particulate matter with a diameter of 10 microns or less (PM_{10}), particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$) ($PM_{2.5}$ at community stations only), and nitrogen dioxide (NO_2) (NO_2 is only measured at the Niven Community Monitoring Station). The above parameters are listed in **Table 2-1** as well.

Table 2-1. Target Parameters Measured at Site Perimeter and Community Monitoring Stations

Station Description	AAQMP Measured Parameters
Site Perimeter Monitoring Stations	Continuous basis reported as 15-minute averages: ▪ TSP, PM_{10} Discrete 24-hour samples: ▪ TSP plus Sb, Fe, Pb, Ni, As ▪ PM_{10} plus As
Community Monitoring Stations	Continuous basis recorded hourly, reported as 24-hour averages: • PM_{10}, $PM_{2.5}$ • NO_2 (Niven station only) Discrete 24-hour samples: • TSP plus Sb, Fe, Pb, Ni, As • PM_{10} plus As • Asbestos

Target parameter concentrations are assessed relative to two concentration limit categories. The community requirements are based on the AAQC set out by appropriate provincial/territorial or federal authorities. The RBALs for the Site Perimeter Monitoring Stations were established through a risk-based analysis based on arsenic concentrations in soil on Site (AECOM 2013b). The derivation of the RBALs is further detailed in **Appendix B.** The site perimeter monitoring data is used as a mitigation and management tool to ensure appropriate mitigation measures are implemented. If the RBALs are exceeded, appropriate measures are taken by the GMRP according to the guidance provided in the Dust MMP. RBALs were reviewed in 2019 against air quality monitoring data collected between 2013-2017.

In addition to the air monitoring stations, meteorological conditions including temperature, relative humidity, and wind speed and wind direction, are measured on-site. An on-site meteorological station (located at 62.499267,-114.354259) is used as the point of reference for obtaining ongoing meteorological parameters in 15-minute increments. This data is used to appropriately assess the potential for exceedances of the 15-minute RBAL and for the on-going assessment of wind speed and direction. Historical meteorological information can be found in **Appendix C**.

The AAQMP follows quality assurance and quality control procedures and methods, as outlined in this AQMP, to ensure target parameter data is of acceptable quality. Additionally, details associated with AAQMP related reporting, which takes place in real-time, weekly and annually, are outlined in this AQMP.

The remediation period is projected to be ten years (SRK Consulting and SENES 2007). Changes to the AQMP resulting in reduced air quality monitoring would be engaged upon with Rights Holders and stakeholders prior to implementation.

2.2 Ambient Air Quality Criteria

AAQC have been established to evaluate air monitoring results and to help protect local air quality (see **Table 2-2**). The GNWT Department of Environment and Natural Resources has developed a Guideline for Ambient Air Quality Standards based on the National Ambient Air Quality Objectives (NAAQO's) and Canada Wide Standards (CWS). This guideline was established under the GNWT's Environmental Protection Act and sets the standards for ambient air quality throughout the Northwest Territories (GNWT, 2014). In cases where there is no applicable GNWT standard, air monitoring results are compared to the Ontario Ambient Air Quality Criteria (Ontario Ministry of Environment 2020). Additionally, NO_2 and $PM_{2.5}$ measured at the Community Monitoring Stations are compared to their respective Canadian Ambient Air Quality Standards (CAAQS) (Alberta 2019).

In addition, the Health Canada Unit Risk factor for arsenic, as outlined in the Health Canada publication, "Federal Contaminated Site Risk Assessment in Canada. Part II: Health Canada Toxicological Reference Values" (Health Canada, 2004), was used to derive a 15-minute RBAL for use at the site perimeter. The RBAL derivation is further detailed in AECOM's letter dated April 12, 2013 titled "Real-time Fenceline Monitoring Risk-Based Action Level (RBAL) for PM_{10}" (AECOM 2013b; **Appendix B**). Briefly, the risk-based community air quality arsenic RBAL is calculated considering the following:

- Health Canada's arsenic risk factor $(0.011\ \mu g/m^3)^{-1}$
- Incremental lifetime cancer risk screening (1 in 100,000)
- A 10-year work plan exposure (10 years of 24hours/day, 365 days/year)

Using the Health Canada Unit Risk factor for arsenic of $0.0064\ (\mu g/m^3)^{-1}$ (Health Canada 2004), which corresponds to 70 years of exposure, the air quality concentration for arsenic corresponding to the GMRP, were it to last as long as ten years, is $0.011\ \mu g/m^3$ $[(1 \times 10^{-5} / 0.0064\ (\mu g/m^3)^{-1}) \times (70\ yr / 10\ yr)]$ (AECOM 2013b). For arsenic, consideration of carcinogenic effects for annual criteria results in more stringent annual criteria than when considering non-carcinogenic effects.

The above approach was used to establish the RBAL for PM_{10}. Assuming that arsenic is equally distributed among all particle sizes, the RBAL for TSP was scaled based on the ratio of AAQCs in the Northwest Territories for TSP ($120\ \mu g/m^3$) and PM_{10} ($50\ \mu g/m^3$).

Using the methodology outlined by section 17 of Ontario Regulation 419/05 for the conversion of averaging period, the 24-hour Ontario PM_{10} criterion of $50\ \mu g/m^3$ is equivalent to a 15-minute criterion of $179\ \mu g/m^3$. Similarly, using the same averaging period conversion the 24-hour Northwest Territories TSP criterion of $120\ \mu g/m^3$ is equivalent to a 15-minute criterion of $431\ \mu g/m^3$. For both PM_{10} and TSP the 15-minute RBALs are more stringent than their respective AAQC after conversion to a 15-minute equivalent.

Any exceedances of the AAQC at any Site Perimeter Monitoring Stations are immediately investigated, reviewed and acted upon following the approach detailed in the Dust MMP. Briefly, the approach detailed in the Dust MMP centers upon an investigation into the cause of the exceedance and the application of dust mitigation measures, as necessary, to reduce dust generation from contributing on-site activities.

Any exceedances of the AAQC at any of the Community Monitoring Stations leads to a follow up investigation that aims to identify potential causes of the measured exceedance. Site Perimeter Monitoring Station data is reviewed to assess potential contributions of on-site activities. Conditions during the exceedances, including measured meteorological parameters, are noted along with any potentially contributing regional events such as forest fires.

All exceedances measured at either Site Perimeter or Community Monitoring Stations are tabulated and reported on, weekly and annually, as outlined in section 7, in addition to immediate investigations. Long-term trends will be compared against relevant annual criteria and will be used as a benchmark to measure effects associated with the remediation project.

Table **2-2** summarizes the relevant AAQC for the GMRP.

Table 2-2. Ambient Air Quality Criteria

Parameter	Averaging Period	Source (Current as of 2021)	AAQC (µg/m^3)
TSP	24-hour	Guideline for Ambient Air Quality Standards in the Northwest Territories (February 2014)[c]	120
	Annual	Guideline for Ambient Air Quality Standards in the Northwest Territories (February 2014) [c]	60
PM_{10}	24-hour	Ontario Ambient Air Quality Criteria (2020) [d]	50
$PM_{2.5}$	24-hour	Guideline for Ambient Air Quality Standards in the Northwest Territories (February 2014) [c]	28
	Annual	Guideline for Ambient Air Quality Standards in the Northwest Territories (February 2014) [c]	10
	24-hour	CAAQS (Community Monitoring Stations only)	27
	Annual	CAAQS (Community Monitoring Stations only)	8.8
NO_2	24-hour	Guideline for Ambient Air Quality Standards in the Northwest Territories (February 2014) [c]	200
	1-hour	CAAQS (Community Monitoring Stations only)	60 (ppb)
	Annual	CAAQS (Community Monitoring Stations only)	17 (ppb)
As	Annual	Health Canada Toxicological Reference Values[a] (2004)	0.011
	24-hour	Ontario Ambient Air Quality Criteria (May 2020)[d]	0.3
Fe	24-hour	Ontario Ambient Air Quality Criteria (May 2020) [d]	25
Ni	24-hour	Ontario Ambient Air Quality Criteria (May 2020) [d]	0.2
Pb	24-hour	Ontario Ambient Air Quality Criteria (May 2020) [d]	0.5
Sb	24-hour	Ontario Ambient Air Quality Criteria (May 2020) [d]	25
Asbestos	24-hour	Ontario Ambient Air Quality Criteria (May 2020) [d]	0.04 (fibres/cm^3)
Site Perimeter - TSP Risk Based Action Level[b]	15-minute	-	333
Site Perimeter - PM_{10} Risk Based Action Level[b]	15-minute	-	159

[a] *Derivation calculated using Health Canada's Toxicological Reference Values in "Real-time Site Perimeter Monitoring Risk-Based Action Level (RBAL) for PM_{10}" (AECOM 2013b)*

[b] *Derived from toxicological references for the hypothetical on-site worker/trespasser, chronic criterion based on protection against both an incremental carcinogenic risk of 1 x 10^{-5} (Health Canada, 2004) using the Health Canada Inhalation Unit Risk Factor.*

[c] *Government of the Northwest Territories. 2014.*

[d] *Ontario Ministry of the Environment. 2020.*

2.3 Sampling Locations

To determine the siting of the Community Monitoring Stations (location map in **Appendix A**), several factors were reviewed and analyzed. Factors that were taken into consideration in establishing the monitoring locations included:

- The review of existing ambient air quality data within the study area; using historical ambient air quality data
- The location of project activities and sensitive receptors such as residential dwellings, health care facilities and education facilities
- Siting options review with community members (for Ndilo station location)

- The variability of local wind patterns by reviewing meteorological data collected at the on-site Meteorological Station and the Yellowknife Airport meteorological data. Meteorological data was analyzed for the period 2013-2017 with seasonal wind roses and frequency distributions for both the Site meteorological station and the Yellowknife Airport presented in **Appendix C**
- The location of topographic features that affect the dispersion of emissions

Based on these factors, monitoring sites were chosen that will be representative of the general group of sensitive receptors within the study area.

To achieve the goals for this AAQMP, three air monitoring locations were selected based on the meteorological data for wind directions, the location of receptors and the location of the remedial activities. The first station is the Yellowknife Bay Community Monitoring Station (YKB, previously named YCC), that is located in the Marina area closest to the Site. The second station (NDL) is located south of the Site on Latham Island in the Yellowknives Dene First Nation community of Ndilo. The third station is located in the Niven Lake area (NVN). During the review of 2013-2017 air quality monitoring data, the spatial distribution of station locations for the Site Perimeter Monitoring Stations were also reviewed. It was determined that the stations correspond similarly to large-scale events such as forest fires, as well as to local events at the site perimeter indicating the air monitoring network functions as a coordinated network.

In addition, there is an existing NAPS station (Environment Canada 2004) in Yellowknife run by the GNWT which is not part of the AAQMP. Data is retrieved and reviewed and used for comparison purposes with the three Community Monitoring Stations of the AAQMP.

Site Perimeter Monitoring Station locations were selected after considering the proposed work locations, public access, wind speeds, direction, frequency and the general layout of the site. Six of the Site Perimeter Monitoring Stations have been operating since 2013, and three more stations were installed in 2016.

See Table 2-3 and **Appendix A** for station locations.

Table 2-3. Site Perimeter and Community Monitoring Stations

Station ID	Station Description	Station Location
A-North	Site perimeter Station A	62.51291, -114.33609
B-Town	Site perimeter Station B	62.49022,-114.35873
C-Northwest	Site perimeter Station C	62.5229,-114.34926
D-Beach	Site perimeter Station D	62.49748,-114.34496
E-A1C1	Site perimeter Station E	62.49459,-114.36899
F-Marina	Site perimeter Station F	62.48592,-114.36093
G-West	Site perimeter Station G	62.50639,-114.365
H-Northwest Pond	Site perimeter Station H	62.52080, -114.36164
I-South Pond	Site perimeter Station I	62.49994,-114.34744
NDL	Ndilo Community Station	62.47562,-114.33795
YKB*	Yellowknife Bay Community Station	62.48593,-114.36094
NVN	Niven Community Station	62.46509,-114.37318
On-Site Met	On-site Meteorological Station	62.499267,-114.354259

**Note: The air quality monitoring station at the Great Slave Sailing Club (YKB) was formerly (erroneously) named YCC.*

2.4 Sampling Duration and Operating Frequency

2.4.1 Continuous Sampling

The AAQMP consists of continuous real-time monitoring of TSP, PM_{10}, $PM_{2.5}$ and NO_2. The Site Perimeter Monitoring Stations measure TSP and PM_{10} 15-minute average data which is used as a dust management tool (detailed in the Dust MMMP). The Community Monitoring Stations continuously monitor hourly average PM_{10}, $PM_{2.5}$ and NO_2 data (monitored at NVN only). As of April 1, 2021, continuous real-time monitoring takes place year-round (**Table 2-4**).

Meteorological parameters, including wind speed, wind direction and relative humidity are also continuously monitored by the on-site meteorological monitoring station.

2.4.2 Integrated Sampling

Integrated filter sampling at the Site Perimeter and Community Monitoring Stations relies upon the collection of 24-hour average filter samples. Filter samples are collected and sent to an accredited laboratory (ISO 17025:2017 certified or equivalent) for further analysis. Integrated sampling is scheduled over a 24-hour period (12AM to 12AM) in accordance with Environment and Climate Change Canada's NAPS cycle.

2.4.2.1 Site Perimeter

Integrated sampling at the Site Perimeter Monitoring Stations consists of 24-hour integrated sampling of TSP, PM_{10} and inorganic trace elements: As, Sb, Fe, Pb and Ni (**Table 2-1**). TSP filters are analyzed for inorganic trace element content of particulates while the PM_{10} filter is only analyzed for As content. Integrated 24-hour average filters for each of TSP and PM_{10} are collected daily basis between May and November. Filters are sent for gravimetric and inorganic trace element analysis on a 1 in 3-day rotation and whenever RBALs are exceeded on Site due to Site activities (i.e., not the result of fog or inclement weather).

2.4.2.2 Community

Integrated sampling at the Community Monitoring Stations consists of TSP, PM_{10}, inorganic trace element and asbestos sampling (**Table 2-1**). PM_{10} filters are solely analyzed for As while TSP filters are analyzed for all trace inorganics. Integrated sampling at the Community Monitoring Stations takes place on a 1 in 3 day rotation between May and November and on 1 in 6 day basis between December and April. Asbestos sampling follows the same sampling schedule as that of the TSP and PM_{10} particulate filters, as warranted by on-site activities.

Table 2-4. Site Perimeter and Community Monitoring Station Methodology, Specifications, and Frequency

Analyte	Averaging Period	Location	Current Monitoring Equipment (Method Specifications)	Operating Frequency
PM_{10}	15-minute	Site Perimeter	Met One E-Sampler w/ PM_{10} inlet	Continuous
TSP	15-minute	Site Perimeter	Met One E-Sampler w/ TSP inlet	Continuous
PM_{10}	24-hour	Site Perimeter	Met One E-Sampler, PM_{10} inlet	1 in 3 days (May through November) and whenever an RBAL is triggered at the Site Perimeter.
PM_{10} – Arsenic	24-hour	Site Perimeter	Met One E-Sampler, PM_{10} inlet (US EPA Method 6020C mod)	1 in 3 days (May through November) and whenever an RBAL is triggered at the Site Perimeter.
TSP	24-hour	Site Perimeter	Met One E-Sampler, TSP inlet	1 in 3 days (May through November) and whenever an RBAL is triggered at the Site Perimeter.
TSP-Metals (Sb, As, Pb, Ni, Fe)	24-hour	Site Perimeter	Met One E-Sampler, TSP inlet (US EPA Method 6010C mod)	1 in 3 days (May through November) and whenever an RBAL is triggered at the Site Perimeter.
$PM_{2.5}$	1-hour	Community	Met One Beta Attenuation Monitor (BAM) 1020, VSCC Inlet	Continuous
PM_{10}	1-hour	Community	Met One Beta Attenuation Monitor (BAM)1020, PM_{10} inlet	Continuous
TSP	24-hour	Community	Tisch Environmental Hi-Volume Sampler (Tisch 2013a)	1/3 day (May through November) or 1/6 day (December through April)
NO_2	1-hour	Community (NVN only)	Teledyne T200	Continuous
NO_2	24-hour	Community (NVN only)	Teledyne T200	Continuous
TSP-Metals (Sb, As, Pb, Ni, Fe)	24-hour	Community	Tisch Environmental Hi-Volume with Anderson TSP Inlet (US EPA Method 6010C mod) (Tisch 2013a)	1/3 day (May through November) or 1/6 day (December through April)
PM_{10}	24-hour	Community	Tisch Environmental Hi-Volume with Anderson PM_{10} Inlet (Tisch 2013b)	1/3 day (May through November) or 1/6 day (December through April)
PM_{10} – Arsenic	24-hour	Community	Tisch Environmental Hi-Volume with Anderson PM_{10} Inlet (US EPA Method 6010C mod) (Tisch 2013b)	1/3 day (May through November) or 1/6 day (December through April)
Asbestos	24-hour	Community	SKC Flite2 Pump (NIOSH Method 7400) (CDC 1994)	1/3 day (May through November) or 1/6 day (December through April) (as warranted by on-site activities)

3. Site Perimeter Monitoring

The site perimeter monitoring component of the AAQMP is critical to ensure that the remediation work is carried out in a manner that mitigates atmospheric emissions. The Site Perimeter Monitoring Stations (Table 2-3) operate year-round and are positioned near the perimeter of the Project Boundary. Real-time PM_{10} and TSP data are compared to 15-minute RBALs developed to manage dust emissions on site and to prevent exceedances of 24-hour ambient air quality criteria at the Community Monitoring Stations. Site Perimeter Monitoring Stations also consist of 24-hour integrated filter-based samples for PM_{10} and TSP, as well as trace metals (antimony, arsenic, lead, nickel, and iron).

3.1 Site Perimeter Monitoring Station Sampling

3.1.1 Total Suspended Particulate (TSP) and PM_{10}

The instrumentation selected for the Site Perimeter Monitoring Stations is portable and has the ability to provide quick/real-time results. Particulate monitoring is conducted at the site perimeter using portable optical particulate monitors equipped with either PM_{10} or TSP sampling cyclones, that continuously measure and record 15-minute average concentrations of PM_{10} or TSP. The 15-minute average particulate matter concentrations are transmitted to an off-site alert system computer that tracks and compares concentration data with RBALs. The monitor at each location is set up in a weather resistant environmental enclosure that sits on a tripod for continuous monitoring and operates on battery and/or solar power. The environmental enclosure protects the monitor from the elements and includes a sample inlet tube and pump for active air sampling.

The GMRP maintains an ongoing real-time log of concentrations for each 15-minute averaging period. Continuous monitoring data is captured by the instrument's internal data logging system. Monitoring data is backed up to central data servers on regular basis with a minimum backup frequency of once every 15-minutes. Data loggers are to store 15-minute average concentrations along with instrument logged auxiliary parameters (i.e., flow, temperature, pressure, flags, etc.), and where possible, calibration sequences (zero/span checks). Any exceedances of the RBALs are communicated to the MCM and investigated further (for clarity, the Monitoring Subcontractor is to notify the MCM within 30 minutes of the measurement of particulate concentrations which exceed the RBALs at any of the Site Perimeter Monitoring Stations). Data is to also be tabulated as hourly average data with each valid hourly average consisting of a minimum of three valid 15-minute readings.

3.1.2 TSP, PM_{10} and Inorganic Trace Elements

Twenty-four hour integrated filter sampling of inorganic trace elements is also conducted at Site Perimeter Monitoring Stations. Integrated sampling is achieved via active sampling, at a rate of 2 litres per minute, through 47-millimetre filters integrated into the real-time monitoring equipment. Samples are submitted for gravimetric analysis. In addition to the gravimetric analysis TSP filters are analyzed for Sb, As, Fe, Pb and Ni while PM_{10} filters are analyzed As. Filters are collected every day and analyzed on 1 in 3 day basis between May and November. Filters collected on days where an RBAL is exceeded at the site perimeter are also sent for analysis when related to Site activities (i.e. not the result of fog or inclement weather).

GMRP unanalyzed filter samples are archived for the reporting period in which they were collected (i.e. up to one calendar year).

4. Community Monitoring

The Community Monitoring Station component of the AAQMP consists of three stations that operate year-round, collecting continuous and discrete integrated ambient air quality data. **Table 4-1** summarizes the monitoring parameters for each Community Monitoring Station.

Table 4-1. Community Monitoring – Summary of Air Monitoring Parameters

	YKB Yellowknife Bay Marina	NDL Ndilo Community	NVN Niven Community
Asbestos as fibres > 5 um in length	✓	✓	✓
As	✓	✓	✓
Sb	✓	✓	✓
Fe	✓	✓	✓
Pb	✓	✓	✓
Ni (in TSP)	✓	✓	✓
TSP	✓	✓	✓
PM_{10}	✓	✓	✓
$PM_{2.5}$	✓	✓	✓
NO_2			✓

Daily and annual concentration data is compared to the AAQC for the appropriate time periods (**Table 2-2**) to monitor overall airshed quality during each phase of the remediation work. Any upward trends in average concentration for an individual or group of contaminants will be identified and evaluated in terms of project impact. In the event that these upward trends are determined to be project related, an evaluation of remedial procedures will be warranted .

4.1 Community Monitoring Station Sampling

4.1.1 Asbestos

Twenty-four-hour integrated sampling for asbestos is conducted using active sampling when on-site deconstruction activities warrant. This active sampling is conducted at sampling rate of approximately 5 litres per minute (L/min) and is verified by a flow standard before and after each sample collection period. Asbestos fibres are collected on a 47-millimetre mixed cellulose ester (MCE) filter media and post-exposure filters submitted to a certified laboratory for asbestos analysis in accordance with NIOSH method 7400 (CDC 1994). Chain of Custody forms are submitted with the asbestos samples and include documented sample start and stop times, pre and post sampling flow rates, average sampling flow rates, and sample volume. Results are provided in concentration units of counts of fibres of asbestos per cubic metre of air sampled.

4.1.2 TSP, PM_{10} and Inorganic Trace Elements

TSP and PM_{10} are collected with High-Volume (Hi-Vol) samplers in accordance with the US EPA methods and the Canadian standards. Hi-Vol samplers used are Volumetric Flow Controlled (VFC) type, equipped with a vacuum motor (pulling air through an 8”x10” filter supported by a wire mesh) or equivalent. Filter samples are submitted for gravimetric analysis and for subsequent analysis for PM_{10} (and arsenic) and TSP (for Sb, As, Fe, Pb and Ni) (EPA Reference Document 40CRF Part 50 **Appendix B**).

Historical air monitoring in the region has used similar methods allowing results to be directly compared and enabling longer term trend observation. The use of the Hi-Vol samplers also ensures data consistency throughout the remediation program and is consistent with Hi-Vol usage during the baseline study. Hi-Vol samplers with volumetric flow control is recommended by the EPA for measuring air quality standards since automatically maintaining constant flow during sampling periods reduces errors due to the method for calculating the particle concentration (weight per sampling flow rate) (EPA Reference Document 40CRF Part 50 Appendix B). The specific Hi-Vol instrument meet the sample-inlet collection efficiency required by the EPA Code of Federal Regulations (Appendix B, Part 50). Instrumentation employed additionally implement mechanical timers (instead of LCD) to stand up to more extreme cold weather application.

4.1.3 PM_{10} and $PM_{2.5}$

PM_{10} and $PM_{2.5}$ are continuously measured at the stations using separate Beta Attenuation Monitors (BAM) monitors. The BAM is controlled by an advanced microprocessor system that makes it fully automatic. The BAM devices uses the continuous tape method to detect airborne particles. A small 14C beta source (60 µCi) is coupled to a sensitive detector that counts the emitted beta particles. At the beginning of the sampling period, beta ray transmission is measured across a clean section of filter tape. This section of filter tape is then mechanically advanced to the sampling inlet. Particulate matter is then drawn into the sample inlet and deposited on the filter paper. At the completion of the sampling period, the filter tape is returned to its original location and the beta ray transmission is re-measured. The difference between the two measurements is used to determine particulate concentrations. Beta attenuation principles are then used to estimate particulate mass densities.

The samplers provide hourly averages of particulate concentrations in micrograms per cubic metre. A real-time data telemetry system, which has the capability of telemetering the collected data via satellite to a central computer, is employed. Data is ultimately archived and stored in a central database on a central data server.

The GRMP maintains an ongoing real-time log of concentrations for each hourly average period. Continuous monitoring data is captured by the instrument's internal data logging system. Monitoring data is backed up to the central data server regularly with a minimum backup frequency of once every hour.

4.1.4 Continuous Nitrogen Dioxide (NO_2) (Niven Station)

Ambient air monitoring for NO_2 is conducted at the NVN community station using a $NO/NO_2/NO_x$ analyzer. The current analyzer employs a Chemiluminescence detection scheme. Monitoring of NO_2 is measured on a continuous basis and recorded hourly and averaged over a 24-hour period.

Continuous monitoring data is captured by the instrument's internal data logging system. Monitoring data is backed up to central data servers on regular basis with a minimum backup frequency of once every hour. Data loggers are to store 15-minute average concentrations along with instrument logged auxiliary parameters (i.e., flow, temperature, pressure, flags, etc.), and where possible, calibration sequences (zero/span checks). Any exceedances of the AAQC are logged and reported to the MCM (see Section 7).

5. Meteorological Monitoring Station

Wind speeds and direction are continuously measured at the on-site Meteorological Station. The on-site Meteorological station is located just southwest of the South Pond TCA on a rocky outcrop (62.499267,-114.354259) and measures the following meteorological parameters:

- Temperature at 2 m and 10 m elevation
- Delta T
- Relative humidity
- Barometric pressure
- Wind speed at 10 m elevation
- Wind direction at 10 m elevation
- Solar radiation
- Precipitation

Meteorological station data is captured by the measuring instrument's internal data logging system. Data is backed up to central data servers on a regular basis with a minimum backup frequency of once every 15-minutes. Data are available to the MCM and GMRP in real-time to support dust management operations.

6. Quality Assurance/Quality Control

6.1 Data Collection and Management

The following sections describe the quality assurance and quality control (QA/QC) methods for the current AAQMP relating to the collection and recovery of valid air quality data and include: field and lab quality controls, field and lab quality assurance checks, routine data surveillance, data handling and reduction checks, and data validation for final reporting. In this section, where procedures for specific make and model of monitoring instrumentation are provided, similar procedures would be applicable to equivalent instrumentation.

6.1.1 Data Validation

Air monitoring data is reviewed routinely and screened using the recommended criteria from U.S. Environmental Protection Agency (EPA) and the AAQC in this AQMP. Site specific databases and spreadsheets are used to store and graphically review data collected by the GMRP. Monitoring locations are visually checked during routine site visits. After the completion of field work, documentation of the visit is entered into an electronic station logbook and/or field notes.

Logbook entries and/or field notes included the following:

- Time, date, and personnel at monitoring location
- Activities completed during the visit
- As-found and as-left observed conditions of monitoring equipment
- Any unusual ambient or meteorological conditions noted during visit

6.1.1.1 Integrated Sampling Data Handling, Validation and Recovery

The data handling for integrated sampling includes production and review of chain of custody (COC) records submitted to the laboratory for analysis. The original signed paper copies of the COCs are submitted along with filter media to the laboratory for analysis of TSP, PM_{10}, trace metals (TSP samples), and arsenic (PM_{10} samples). Data on the COC includes sample identification, sampling location, sampling date and time, average temperature and pressure, flow conditions, average flow volume corrected to standard temperature and pressure (25 degrees Celsius [°C] and 760 mmHg), and laboratory analysis requested.

Following laboratory analysis of filter media, the laboratory provides the results via email. Validation of the emailed analytical results includes verification for correct sample identification, sample dates, flow volumes, and concentration units. Analytical results are also checked for appropriate laboratory quality assurance parameters and any pertinent comments included in the laboratory analytical report remarks section that would invalidate or flag analytical results.

Provided that all filter media and chain of custody data received from the laboratory are found correct and accurate, laboratory analytical results are compared to available real-time site perimeter and community station data.

Final validation of integrated sampling results includes review and accounting of all samples submitted and analytical results received, valid weekly sensor verifications, correct association of sample dates and sample identification's, and qualitative review and comparison of meteorological, site perimeter and community station data for ensuring reasonably explainable sampler performance and analytical results.

Further comparisons and investigations are conducted in the event that concentration results are significantly different across community and fence line monitoring networks. Comparisons and investigations include review of available site perimeter and community monitoring data, station logbooks, field data sheets, calibration records, and on-site operational activity records. Final validation of integrated sampling results included review and accounting of all samples submitted and analytical results received, valid multi-point flow calibrations, correct association of sample dates and sample identification's, and qualitative review and comparison of meteorological and community station data for ensuring reasonably explainable sampler performance and analytical results.

GMRP unanalyzed filter samples are archived for the reporting period in which they were collected (i.e. up to one calendar year).

6.1.1.2 Laboratory QA/QC

Laboratory work is to be carried out by independent subcontracted analytical facilities that have QA/QC procedures in place in compliance with international standard ISO/IEC Guide 17025:2017. Analytical testing must be performed in accordance with the laboratory analysis methods outlined in that guide. Results of the analytical testing are to be reviewed in accordance with laboratory QA/QC procedures.

Samples are collected and analyzed in accordance with the following methods:

- US EPA National Primary and Secondary Ambient Air Quality Standards, Appendix B – Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method) (40 CFR Subchapter C Part 50)
- US EPA National Primary and Secondary Ambient Air Quality Standards, Appendix L – Reference Method for the Determination of Fine Particulate Matter as PM_{10} and $PM_{2.5}$ in the Atmosphere (BAM EQPM-0798-122 and EQPM-0308-170) (40 CFR Subchapter C Part 50)
- Ontario O.Reg 278/05 (Ontario 2011) and NIOSH 7400 (Asbestos and Other Fibers by PCM; CDC 1994)
- Alberta Environment and Parks Air Monitoring Directive (2016)

6.1.2 Data Handling

Continuously monitored data (i.e. TSP, PM_{10}, $PM_{2.5}$, NO_2 and Meteorological data) is captured by a data logger system. The data logger is the primary collection point for signal-based acquisition (analyzers) at all monitoring stations. The data logger is configured to collect and store analog signal data from analyzers and sensors operating at each monitoring station. The data logger also controls system functions like automatic calibration sequences (zero/span checks) and computes conditional averages. Data loggers record hourly or 15-minute average air contaminant data, zero/span check flags, and 15-min averages of meteorological data. Data collected by the data logger is then transmitted to a central data server via a satellite modem line. Data collected on the server is then disseminated to the project parties that have been provided authority to access the data.

The data acquisition system (DAS) polls data from the data loggers regularly and downloads raw data on to the central data server where the collection of programs resides that review air quality data for validating operations of monitoring stations in the network. The DAS allows high quality network operations and data by performing the following functions:

- Allows the operator to review current and recent past data, guides the operator through calibration, maintenance, operation and troubleshooting procedures and serves as the QA documentation archive
- Facilitates flagging of data to obtain rationale from the field technicians or site operations/functions
- Ensures that data is properly captured, managed and interfaced.

6.2 Site Perimeter QA/QC

The site perimeter monitoring program incorporates a number of field and data QA/QC procedures to demonstrate the acceptability and quality of air quality observations. Procedures to verify equipment function and measurement accuracy follow manufacturer recommendations and include:

- Daily site visits with visual inspection of sampling apparatus;
- Weekly flow, temperature, and pressure sensor verifications;
- Weekly sampling system leak checks;
- Communications system verification; and
- Daily battery charge verification.

Weekly sensor verifications are conducted to confirm E-Sampler instrument response to acceptability criteria for flow, temperature, and pressure. This ensures that any measurements of particulate matter concentrations near the instrument detection limits are accurate and reliable. This check ensures that the instrument is responsive to particulate matter passing through the instrument detection system.

Battery charge levels are checked regularly to ensure that sufficient electrical power is available to operate the instrument for the 24-hour sampling period. Similarly, communications systems are checked continuously during operational periods to ensure that each site perimeter monitor is remotely accessible and able to communicate sampler operational status and particulate matter concentrations to the remote computer data acquisition system.

As E-Sampler response to particulate matter concentrations are dependent on instrument air flow, the weekly single-point flow calibration verification is conducted to ensure that the sampler is operating within manufacturer operating specifications and that observed concentrations are accurate and defensible. To assess sampler flow, a certified flow transfer standard, of known and traceable accuracy is inserted on the sampler inlet system and the sampler was placed in normal operating mode. The weekly flow calibration verification assesses the sampler-controlled flows against performance specifications. E-Sampler instruments contain temperature and pressure sensors used to accurately report particulate matter concentrations at standard temperature and pressure. These sensors are also verified on a weekly basis using certified calibration standards.

6.3 Community Monitoring Station QA/QC

The current monitoring program incorporates a number of field and data quality assurance and control procedures to demonstrate the acceptability and quality of air quality observations. Procedures to verify equipment function and measurement accuracy follow manufacturer recommendations and include:

Continuous $PM_{2.5}$ and PM_{10} Monitors:

- Daily inter-measurement correlation ($PM_{2.5}$ vs. PM_{10} fractions)
- Monthly sensor verifications (barometric pressure, sample flow, and ambient temperature)
- Yearly three-day zero background check
- Yearly multipoint calibration of all sensors

Continuous NO_2 Monitor:

- Daily single point internal calibration
- Quarterly flow verifications
- Quarterly multipoint calibrations

Integrated High Volume Samplers:

- Pre-sampling and post-sampling flow calibration verification
- Timer verification
- Inter-measurement correlation (TSP vs. PM_{10} fractions for particulate and arsenic)
- Quarterly multi-point flow calibrations

6.3.1 Calibrations

Calibration are to be carried out routinely to ensure data collected is of acceptable quality. At minimum equipment are to be calibrated in the following instances:

- Prior to being put into service
- On a monthly basis, or more frequently if recommended by the manufacturer
- Prior to shutdown or removal from service (if operational)
- Prior to and following equipment adjustment or maintenance that may affect the response of the instrument

All calibrations must be recorded in the monitoring location logbook or equipment dedicated calibration record.

6.3.1.1 BAM

The Community Monitoring Station BAM 1020 particulate matter monitors for $PM_{2.5}$ and PM_{10} rely on calibration procedures to ensure the accuracy of measurements. An initial zero background calibration is performed on each monitor to account for local site conditions that could influence measurement accuracy near the instrument detection level. Zero background calibrations are performed annually by operating the instrument for a minimum of 72 hours with a filter on the inlet preventing any particulate matter from entering the measurement system.

An automated span verification check is performed every hour by the instrument to ensure that instrument response has not drifted due to external parameters such as temperature, barometric pressure, and relative humidity conditions. A film, representing a known instrument response, is mechanically inserted into the detector to assess instrument response. Results from the detector span verification check are captured and recorded with the hourly concentration measurement and if the verification exceeds required operating specifications data are flagged as invalid measurements.

Flow rate information is recorded by the instrument every hour for flow calibration verification. External verification of instrument flow is assessed monthly. To assess sampler flow, a certified flow transfer standard of known and traceable accuracy is inserted on the sampler inlet system when the sampler is in normal operating mode. Monthly flow calibration verification assesses the sampler-controlled flows against performance specifications.

Monthly leak verification checks are performed to ensure that the sampler inlet system integrity has not been compromised. Monthly leak verification involves placing the instrument inlet system under negative pressure (vacuum) conditions for a period of time and assessing whether the remaining pressure is maintained within specification. Monthly verification of the instrument's temperature and barometric pressure measurement system are performed to ensure flow rates are accurate.

6.3.1.2 Hi-Vol

The integrated high-volume samplers also require regular calibrations and data correlation. Multi-point flow calibrations are conducted on a quarterly basis for the PM_{10} and TSP high volume samplers. Flow calibrations are completed quarterly to ensure that sampler flow accuracy and precision was representative of seasonal conditions affecting sampler flow volumes and sampler inlet performance. An inter-measurement correlation check is done on all measurements when multiple fraction-size data are collected. PM_{10} concentrations are compared to $PM_{2.5}$ concentrations and if concentrations do not follow anticipated trends, data analysts perform additional investigations to determine the validity of the measurements.

Due to the large volume of air sampled by the 24-hour time integrated high-volume samplers, pre-sampling and post-sampling flow calibration assessment is required to assess sampler operation throughout the entire sample collection period. The potential exists for significant amounts of particulate matter "loading" on the sample media restricting airflow and thus the volume of air sampled would be reduced leading to inaccurate calculation of pollutant concentrations. Flows that are below calibration and operational specifications would result in overestimation of 24-hour particulate matter or asbestos concentrations. Flows above calibration and operational specifications would result in underestimation of 24-hour concentrations.

Pre-sampling flow calibration verifications on the asbestos, TSP, and PM_{10} samplers are conducted after installation of sample media to determine that the start-up flows of the sampler are within specification. A post-sampling flow verification calibration check for the asbestos, TSP, and PM_{10} samplers is conducted before removal of the sampling media following successful completion of a 24-hour sampling event. Like assessment of flow rates for

other samplers, a flow transfer standard of known accuracy is used to measure the sampler flow rate and compare them to acceptance criteria.

Timer function which controls when a sample is collected and for how long is verified when sample media are installed for initial sample collection. After completion of a sampling event, timer verification is performed to ensure that the actual sampling period was conducted at the right time (midnight-to-midnight) and for the proper duration (between 23 and 25 hours).

Due to the generally predictable relationship between TSP and PM_{10} the relative concentration observations are evaluated. The inter-measurement correlation check is done on all measurements when multiple fraction-size data are collected. In this case, TSP concentrations are compared to PM_{10} concentrations and TSP arsenic concentrations are compared to PM_{10} arsenic concentrations and if concentrations do not follow anticipated trends, data analysts perform additional investigations to determine the validity of the measurements.

6.4 Preventative and Corrective Maintenance

Performing regular system checks and calibrations will ensure that the sampling equipment is working according to specifications. Preventative maintenance also works to ensure that equipment remains in good operation order and that the minimum runtime/data capture of 90% is met. As the NWT does not specify data capture requirements the data capture requirement of 90% was chosen in accordance with the recommendations provided for continuous ambient air quality instrumentation in Alberta (AEP 2016), Saskatchewan (SME 2012) and Ontario (MECP, 2019). Preventative maintenance is an important tool in creating a proactive environment where QA and reliability are a top priority in providing fast responses and accurate results. The routine system checks will work towards providing this preventative maintenance step.

Preventative Maintenance will be done as per manufacturer specification for each instrument in the network. Repairs will be recorded and will help to determine if preventative measures are working and will assist in determining which instruments should be ear marked for replacement.

Corrective maintenance will be performed as required. Records will be kept of corrective maintenance and will also be recorded as part of our QA/QC program. Minor repairs will be conducted as part of the ongoing operation and maintenance program. Maintenance that occurs during the course of a routine calibration will be performed at that time.

6.5 Equipment Inventory

An inventory database is maintained to keep track of equipment parts that have been replaced, ordered, required to be ordered and in storage. This will ensure that the components and parts for the instruments are available when they are needed, minimizing delays in data collection and reporting, ensuring continuous, uninterrupted monitoring. By having consistent and reliable monitoring equipment and by extension data will be upheld with a high confidence level.

The equipment inventory will be implemented providing a complete record of manufacturer and supplier information, dates and locations of monitor usage, monitor performance, maintenance and or/cleaning events, calibration documentation and other pertinent information. Air monitoring stations are equipped with monitor manuals for reference. The manuals contain performance specifications, procedures and recommended maintenance.

A critical spare parts inventory supply containing consumables related to the operations of the air quality network is required. Consumables include inlet filters, tubing, fittings and scrubber materials. Certification, calibration or records verifying that the product used adheres to a specific assured quality or has been approved for use will be maintained.

7. Reporting

The GMRP has the potential to impact existing local air quality due to activities at the Site. The effectiveness of mitigation efforts on local air quality will be monitored on an ongoing basis and results will be reported on a regular basis, as outlined below.

The AQMP and associated protocols will be reviewed and revised periodically (at a minimum, every three years) during the GMRP to accommodate changes to regulations, guidance documents, or operations in the GMRP.

7.1 Real-Time Reports

The network of Site Perimeter and Community Monitoring Stations measuring PM_{10}, TSP and/or $PM_{2.5}$ is capable of logging minimum, maximum and average concentrations over predetermined time intervals via an external data logger. This network of monitors is capable of transmitting results directly to a central data server where real-time information from the monitors are converted quickly into practical information for rapid on-site decision-making requirements.

Alarms can then be acknowledged, detectors can be enabled and disabled, as well as event logs and event log history can be viewed. Any exceedances are to be immediately checked by the MCM to determine site conditions, equipment functionality, and any site activity that may be a contributing factor. Following this initial investigation, immediate phone/email notification for any exceedance or warning at a site perimeter or community station is required, with details of the investigation and probable cause, if known or suspected.

7.2 Weekly Reports

The contents of the Weekly Reports should contain at minimum the following information from Site Perimeter and Community Monitoring Stations.

- Site Perimeter Monitoring Stations:
  - Details on any 15-minute average PM_{10} concentrations above the established RBAL at each station, as applicable. This is to include the measured concentrations, actions taken to determine the cause, and the outcome. If the exceedance is determined to be weather related, this is to be stated. If no exceedances are measured this is also to be stated.
  - Details on any 15-minute average TSP concentrations above the established RBAL at each station, as applicable. This is to include the measured concentrations, actions taken to determine the cause, and the outcome. If the exceedance is determined to be weather related, this is to be stated. If no exceedances are measured this is also to be stated.
  - Laboratory results for TSP, PM_{10} and trace metals (including arsenic) analyses that were returned during the previous week, once validated. If all results were below detection limit and/or below the referenced standard, this is also to be stated.
- Community Monitoring Stations:
  - Details on any real time $PM_{2.5}$ or PM_{10} 24-hour average concentration above the referenced standards measured at any of the community stations that week.
  - Laboratory results for TSP, PM_{10} and trace metals (including arsenic) analyses that were returned during the previous week, once validated. Date of sampling event to be specified. If all results were below detection limit and/or below the referenced standard, this is also to be stated.
  - Laboratory results for asbestos analyses that were returned during the previous week, once validated. Date of sampling event to be specified. If all results were below detection limit and/or below the referenced standard, this is also to be stated.
  - Details on any NO_2 concentrations measured at the Niven Lake station above the NWT Ambient Air Quality 24-hour standard of 106 parts per billion (ppb) or the 1-Hour Standard of 213 ppb.

Table 7-1. Summary of Daily NO_2 Concentrations at Niven Lake Community Monitoring Station

Date	Maximum One-hour Average (ppb)	24-hour Average (ppb)
Date 1		
Date 2		
Date 3		
Date 4		
Date 5		
Date 6		
Date 7		

A general description of site activities and other potential offsite emission sources in terms of the monitoring events:

- General operation:
  - A data validation report, including data availability for site perimeter, community, and activity specific monitors (as applicable)
  - An equipment maintenance report (as applicable)
  - Meteorological summaries
  - Exceedances of AAQC
  - Discussion of exceedances with regard to environment and source of emission, and mitigation steps undertaken by the contractor
  - Discussion concerning geographic variation of results

7.2.1 Weekly Data Summary

A Weekly Data Summary is compiled for Site Perimeter, Community Monitoring Stations, and on-site Meteorological Monitoring Station in excel format for upload to the GNWT Air Quality Monitoring Network website (aqm.enr.gov.nt.ca).

7.3 Annual Reports

An Annual Report will be prepared for each calendar year. The report will include at a minimum the following for community, site perimeter and activity-specific monitoring:

- Executive summary
- Plain language summary
- Approach and methodology used
- A description of the data collection programs
- A summary of data quality issues
- A complete statistical evaluation and reporting of the data
- An analysis of trends and seasonal distinctions
- A discussion of any exceedances
- A comparison of the data to annual historical conditions
- A comparison of the data to the GNWT NAPS air quality monitoring station
- A summary of mass based ratios (I.e. µg/g particulate) data

- An overall air quality statement based on the air quality results
- Conclusions and recommendations
- Appendices:
  - Calibration and instrument certification records
  - Laboratory analytical reports

8. References

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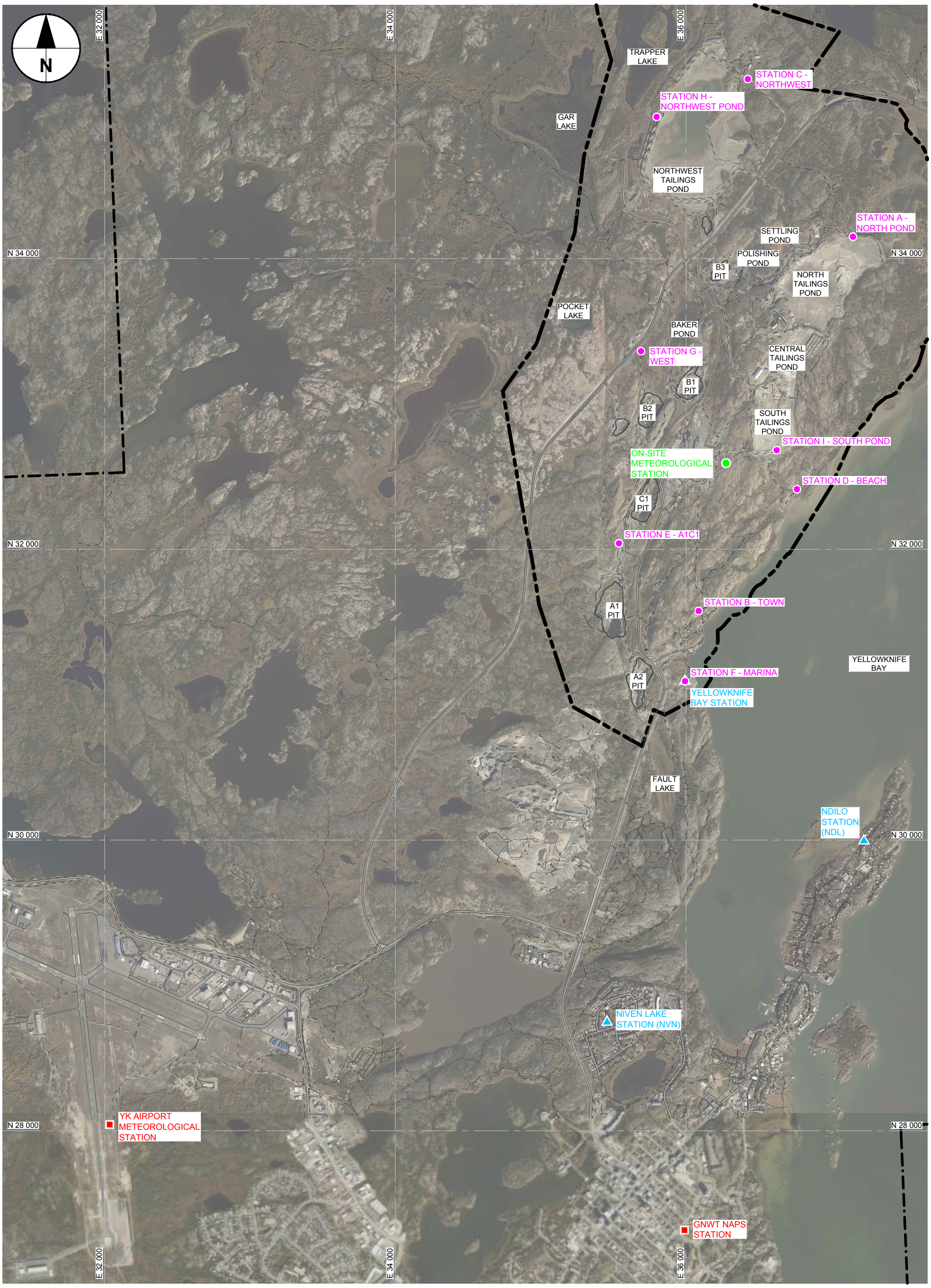
Appendix A

GMRP Air Quality Monitoring Station Locations

L:\Legacy\CAEDM1FP001\Prod\projects\60627248\900-CAD_GIS\910-CAD\30-FIGURES\B\00\60627248-FIG-00-0000-B-0003-A1.dwg



LEGEND:

- GIANT MINE PROJECT BOUNDARY
- CITY OF YELLOWKNIFE MUNICIPAL BOUNDARY
- GMRP SITE PERIMETER MONITORING STATION
- GMRP COMMUNITY MONITORING STATION
- GMRP ON-SITE METEOROLOGICAL STATION
- OTHER MONITORING STATIONS

0 625 1 250 m

1:25 000

PROPONENT

Crown-Indigenous Relations and Northern Affairs Canada

Relations Couronne-Autochtones et Affaires du Nord Canada

Government of Northwest Territories

Gouvernement des Territoires du Nord-Ouest

YYYY-MM-DD	2021-06-22
DESIGNED	L.Kootenay
PREPARED	L.Dowhaluk
REVIEWED	G. Woollett
APPROVED	R. Schmidtke

PROJECT

Giant Mine Remediation Project

TITLE

GMRP AIR QUALITY MONITORING STATION LOCATIONS

REV. 2

FIGURE A1

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Appendix B

Action Level Derivation Memo

AECOM
200 – 6807 Railway Street SE
Calgary, AB, Canada T2H 2V6
www.aecom.com

403 254 3301 tel
403 270 9196 fax

April 12, 2013

Via: Email

Belinda Campbell
Public Works and Government Services Canada

Dear Belinda Campbell:

Project No: 60284490

Regarding: Real-time Fenceline Monitoring Risk-Based Action Level (RBAL) for PM_{10}

AECOM has developed a Risk-Based Action Level (RBAL) for real-time fenceline monitoring of inhalable particulate matter (PM_{10}) for protection of the general public during remedial activities to be performed at the Giant Mine site. This memo provides the derivation of site-specific particulate action levels as an indication of when to initiate dust suppression activities and/or cease intrusive work for the protection of the general public. It is understood that the primary soil contaminant at the project site is arsenic. Therefore, the particulate action levels were developed based on this contaminant.

1. Risk-Based Particulate Exposure Concentration Associated with Arsenic

In order to develop an action level for particulates, it was first necessary to determine a risk-based, acceptable concentration in air (AAC) for arsenic. No Canada Wide Standard is available for arsenic. The Northwest Territories Department of Environment and Natural Resources has developed a Guideline for Ambient Air Quality Standards (January 2011) for carbon monoxide, fine particulate matter (as $PM_{2.5}$), ozone, nitrogen dioxide, sulphur dioxide and total suspended particulate. However, the guideline does not outline guidelines for arsenic. The primary health concern with exposure to long-term airborne emissions of arsenic is cancer risk. For the basis of developing a risk-based particulate exposure concentration, an incremental lifetime cancer risk screening level of one chance in 100,000 (1×10^{-5}) was used. This lifetime cancer risk is consistent with the risk goal used by Health Canada for site remediation. Using the Health Canada Unit Risk factor for arsenic of 0.0064 $(\mu g/m^3)^{-1}$ (Health Canada 2004), which corresponds to 70 years of exposure, the AAC for arsenic concentration corresponding to the Giant Mine site remediation, were it to last as long as ten years, is **0.011 µg/m^3** [$(1 \times 10^{-5} / 0.0064\ (\mu g/m^3)^{-1}) \times (70\ yr / 10\ yr)$]. This risk-based arsenic concentration is highly conservative considering that the planned excavation period is only two to three years and it assumes that exposures occur 24 hours/day, 365 days/year.

For arsenic, an AAC was calculated by using the annual average concentration of 0.011 µg/m^3 and then adjusting for the exposure duration and frequency based on the anticipated remediation

activities. It is expected that intrusive soil excavation activities which might generate site-related particulates in the air would occur 12 hours/day (an expected work day) and 245 days/year (7 days/week for 35 weeks/year). Note that the assumption of 12 hours/day accounts for potential dust-generating site activities that may at times extend beyond a standard 8 hour work day and that steps will be taken to help prevent wind-blown dust at other times when no remediation activities are taking place. The Health Canada risk based arsenic concentration of 0.011 µg/m^3 can then be modified to derive an AAC, as indicated below:

$$\text{Acceptable Air Concentration} = \frac{0.011 \mu g/m^3}{\frac{12hr}{24hr} \times \frac{245d}{365d}} = 0.0328 \mu g/m^3$$

In the next step, the PM_{10} action level was calculated by dividing the AAC by a soil concentration for arsenic. The PM_{10} action level was calculated by conservatively assuming that 100% of the arsenic in soil would become airborne. In other words, the concentrations of arsenic in particulates would mirror the concentrations in soil.

The particulate concentration was calculated using the following equation:

$$\text{Particulate Action Level} = \frac{(C)(AAC)}{SC}$$

Where:

- C = Conversion factor, 1 x 10^6 mg/kg
- AAC = Acceptable Air Concentration, 0.0328 µg/m^3
- SC = Soil Concentration, 6,120 mg/kg (95th percentile arsenic soil concentration)

The particulate concentration based on the AAC for arsenic of 0.033 µg/m^3 and a 95th percentile arsenic soil concentration of 6,120 mg/kg is **5.36 µg/m^3**. The 95th percentile was determined based on data for 515 soil samples obtained from the document "Distribution of Arsenic in Surficial Materials: Giant Mine" (Golder Associates, 2005). The location and material type sampled is outlined in **Table 1**. The statistical summary of all 515 samples is outlined in **Table 2** below.

Table 1 Summary of Sampling Locations and Associated Material Type

Investigated Areas	Material Type
Mill	Mixed Fill, and Clay with Silt and Sand
West of the Central Tailings Containment Area	Tailings
West of Tailing Retreatment Plant	Clay with Silt and Sand
West of Settling Pond	Tailings, Rock Fill, Mixed Fill, Refuse
Propane Tank Farm	Clay with Silt and Sand

Investigated Areas	Material Type
Townsite	Rock Fill, Mixed Fill, Clay with Silt and Sand, and Soil with Organic Matter
Townsite Road	Rock Fill, and Soil with Organic Matter
Dam 7 to Yellowknife Bay	Tailings, Mixed Fill, and Soil with Organic Matter
East of Dam 3	Mixed Fill, and Clay with Silt and Sand

Table 2 Statistical Summary of the Arsenic Soil Concentration Data Points (515)

Maximum (mg/kg)	87000
Minimum (mg/kg)	5
Average (mg/kg)	1687.27
95th Percentile (mg/kg)	6120

2. Adjustment Factors for Long-Term Community Exposure

As demonstrated above, a continuous PM_{10} risk-based exposure concentration of 5.4 µg/m^3 during every hour of remediation for 12 hours a day would correspond with the established annual health-based objective for arsenic. The exposure concentration will be used as a basis to establish an action level for 15-minute average real-time "fenceline" monitoring. Because the objective of the real-time monitoring is to make continuous short-term (15 minute average) measurements close to potential dust-generating remedial activities, it is unrealistic to assume that long-term average concentrations in nearby communities would be at the levels.

Figure 1 shows the location of three of the arsenic contaminated areas (areas 6, 7 and 8) with respect to three nearby population areas located to the north and northeast of Yellowknife. The closest distance between any of the three populated areas and the contaminated sites is 1.77 km, between Arsenic Area 6 and Resident Area A. The three arsenic areas are in the sector ranging from the west-northwest to north-north with respect to the three nearby populated areas.

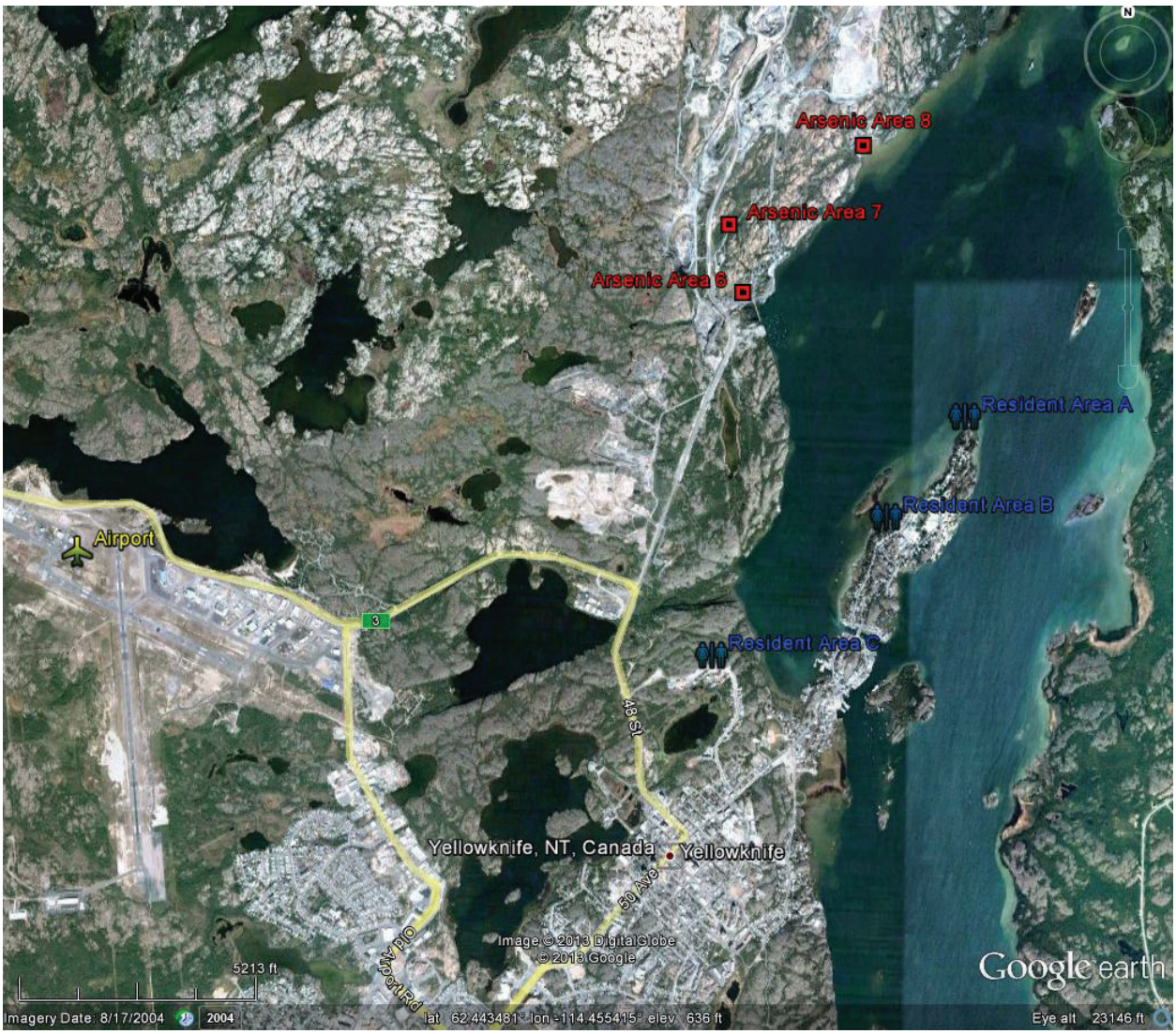
In establishing a conservative RBAL, (i.e., health-protective) adjustments are required to convert a peak 15-minute concentration at a fenceline to long-term average community exposure. The required adjustments include:

1. An averaging time adjustment factor (ATF) to relate peak 15-minute concentrations to work-day (12 hr) concentrations at the fenceline;
2. The dilution adjustment factor (DAF) addresses the degree to which dispersion will reduce the airborne fugitive dust concentrations by the time emissions reach nearby residential areas; and
3. The wind frequency factor (WFF) accounts for the long-term wind patterns for the time of day and time of year that remediation will take place in reference to the location of nearby populated areas.

Using these adjustment factors, the proposed action level will then be computed according to:

RBAL PM_{10} 15-minute real-time action level = 5.36 µg/m^3 x ATF x DAF x WFF (**Equation 1**)

Figure 1: Locations of Arsenic Contamination Closest to Residential Areas



Averaging Time Adjustment Factor (ATF)

Experience monitoring of PM_{10} near fugitive dust sources indicate that 15-minute average concentrations are highly variable. Given that the objective of the monitoring plan is to ensure that actions are taken to generally limit short-term concentrations at the fenceline below the RBAL, it has been conservatively assumed that the 12-hour work-day average concentration will not exceed 90% of the RBAL. This assumption results in an **ATF of 1.11** (1/0.90).

Dilution Adjustment Factor (DAF)

The DAF is defined as the relative degree of dilution from the fenceline monitor to the nearest residential area. DAF was based on the modeled 1-hour average downwind concentration associated with a ground level area source, representing a typical active excavation area. Model receptors were placed at two distances corresponding to the fenceline where monitoring is taking place and the closest residential area, where long-term exposure could occur. The DAF is then computed the ratio of the modeled concentration at the fencelince receptor and the residential receptor. For this calculation it is conservatively assumed that there is no deposition of PM_{10} that would further reduce airborne concentrations at the residential receptor. For a ground level source, the modeled concentration pollutant is directly proportional to the emission rate and inversely proportional to the wind speed. Thus, the selection of emission rate (1 g/sec) and wind wind speed (1 m/sec) do not affect the ratio of the modeled concentrations at the fenceline and residential receptors.

The model parameters that affect the DAF are the size of the area source, distance of the fenceline and residential receptors and the atmospheric stability class and dispersion environment (urban or rural), which affect the rate of dispersion. U.S. EPA SCREEN3 model was applied with a rural dispersion environment. In the rural mode SCREEN3 applies the standard Pasguill Gifford Taylor (PGT) dispersion coefficients. Given that remediation activities will take place during daylight hours SCREEN3 was applied using neutral atmospheric dispersion conditions (stability category D). During most of a typical day the atmosphere is unstable (categories A, B, and C) which would result in greater dilution. Stable conditions which occur at night result in a lesser dilution. Thus, the use of neutral stability is suitably conservative as it results in the least degree of atmospheric dispersion that would occur during daylight hours.

A 0.001 g/sec/m^2 emission rate and 1 m/sec wind speed was applied in SCREEN3. The screening model was used to estimate the degree of downwind dilution that would occur at the closest residential location (Resident Area A) associated with remediation taking place at Arsenic Area 6, 1.7 km to the west-northwest. For this calculation it is assumed that primary fugitive dust generating activities are taking place within a 300 m square area, corresponding to a portion of Arsenic Area 6, closest to community receptors. The fenceline monitor was assumed to be located 100 m from the downwind edge of the area source (i.e., 250 m from the center of the area source). The Dilution Adjustment Factor was computed as the ratio of the SCREEN3 modeled concentration at the fenceline receptor (2.61E+04 µg/m^3) to the modeled concentration at the receptor 1.7 km downwind (4.38E+03 µg/m^3). This ratio results in a **DAF of 5.96.**

This DAF (in Equation 1) can further be adjusted to incorporate people who may be present near the fenceline of an active excavation area for recreational purposes. The DAF for these recreational receptors will be smaller than the 5.96 and could be as small as 1 due to minimal distance

attenuation. The recreational areas considered include the Marina and Ingraham Trail. To address recreation that may occur close to the fenceline, the DAF would be replaced with the Daily Exposure Factor (DEF). The (DEF) in **Equation 1** and will reflect the number of hours per day spent at the location (assumed to be less than 12 hours).

$$\text{Daily Exposure Factor (DEF)} = \frac{12\text{hrs/day site activity}}{\text{H}}$$

Where:

- H = Hours per day a person is at the fenceline

A value of 2 hours per day for H would result in a DEF of 6, which is roughly equivalent to the currently modeled DAF value of 5.96.

Wind Frequency Factor (WFF)

To estimate the wind frequency factor a long-term wind rose was developed for non-winter meteorological seasons (April through November) during the hours of 7 AM to 7 PM, approximating the time of day and time of year that remedial activities are expected to occur. For this analysis five years of hourly meteorological data (2008-2012) was obtained from the nearby Yellowknife meteorological station. The resulting wind rose, shown in **Figure 2** was then used to estimate the fraction of the time during these periods that winds are likely to transport fugitive emissions in the wind direction of the nearby populated areas (WNW, NW, NNW and N). The wind rose indicates that winds from this sector are expected to occur about 22.3% of the time. This indicates that about 78% of the time the concentration measured at the downwind fenceline will not affect the annual average concentration at the residential areas because these areas are not downwind of any of the arsenic remediation sites. The WFF accounts for the contribution of activities to annual average concentrations by dividing the total frequency (100%) by the frequency of transport to the nearby populated areas (22.3%). Thus, the **WFF is 4.48** (100/22.3).

3. Risk-Based Action Level

The RBAL for PM_{10} is computed by applying **Equation 1**.

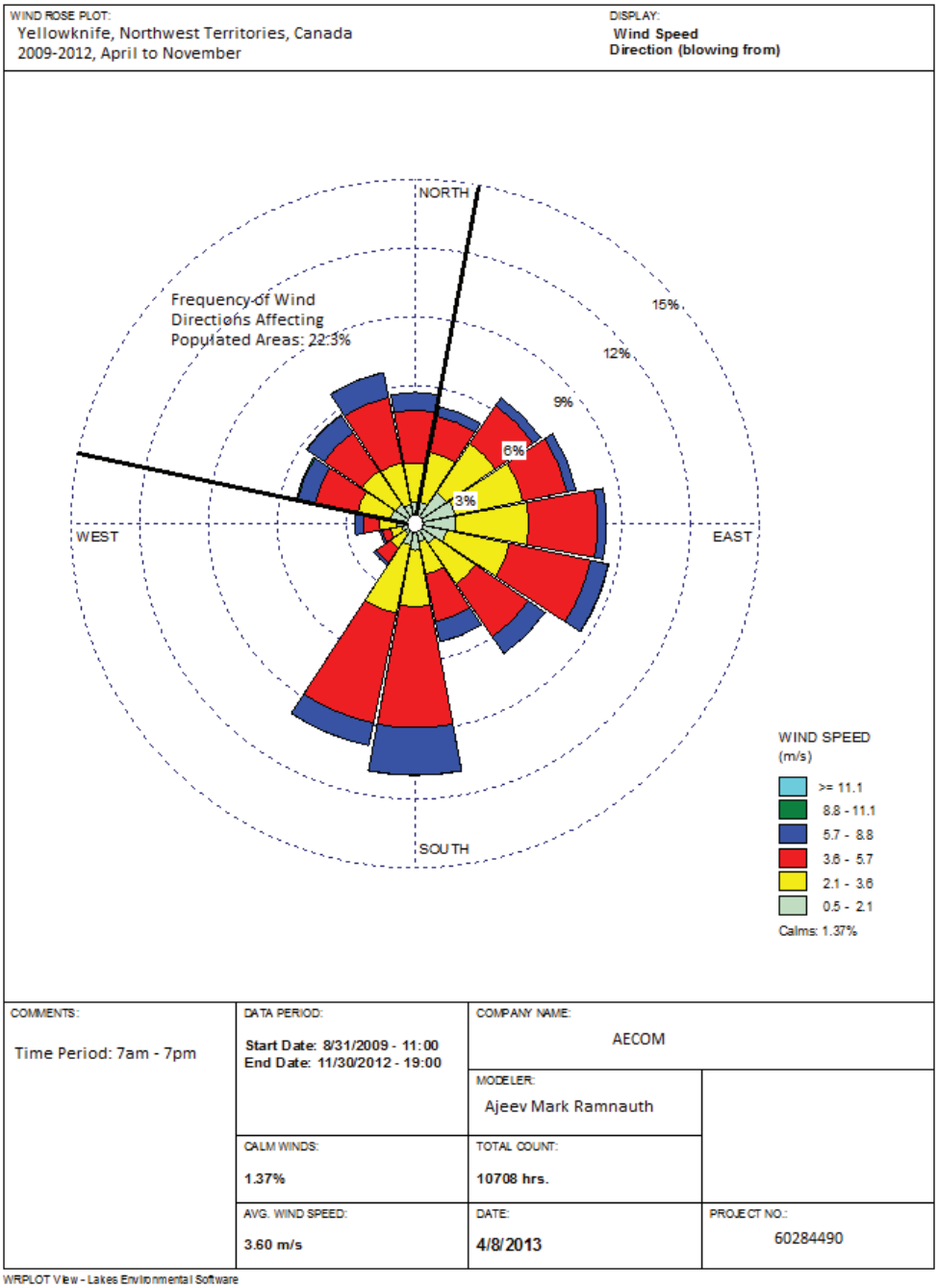
RBAL = 5.36 µg/m^3 x 1.11 x 5.96 x 4.48 **= 159 µg/m^3.**

This RBAL is also applicable to recreational users close to site activities when considering the same WFF outlined previously and 2 hours of exposure per day.

TSP represents particles with an aerodynamic diameter less than 30 µm. TSP is not directly associated with human health effects because particles between 10 and 30 µm in diameter are not inhaled into the lungs. Thus, a human health RBAL was developed only for inhalable PM_{10}. Fenceline criteria for TSP will be outlined in the site-wide air monitoring plan and will be based on nuisance effects.

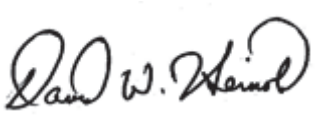
Appendix A and **Figure 2** provide the dispersion modeling and wind frequency information used to develop the DAF and WFF, respectively.

Figure 2: Wind Rose for Yellowknife Representative of Remediation Period



If you have any questions, please do not hesitate to contact the undersigned.

Sincerely,
AECOM Canada Ltd.



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4. References

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Memo Appendix A - Screen 3 Model Output and Input Used to Compute the Dilution Adjustment Factor

```
04/08/13

10:29:49
  ***  SCREEN3 MODEL RUN  ***
  *** VERSION DATED 95250 ***

 300 m area source

 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE                =          AREA
    EMISSION RATE (G/(S-M**2)) =      .100000E-02
    SOURCE HEIGHT (M)          =         .0000
    LENGTH OF LARGER SIDE (M)  =       300.0000
    LENGTH OF SMALLER SIDE (M) =       300.0000
    RECEPTOR HEIGHT (M)        =         .0000
    URBAN/RURAL OPTION         =         RURAL
    ANGLE RELATIVE TO LONG AXIS =        .0000

 BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

 *** STABILITY CLASS  4 ONLY ***
 *** 10-METER WIND SPEED OF   1.00 M/S ONLY ***

 **********************************
 *** SCREEN DISCRETE DISTANCES ***
 **********************************

 *** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING
DISTANCES ***

   DIST     CONC              U10M   USTK  MIX HT   PLUME  MAX DIR
    (M)   (UG/M**3)   STAB   (M/S)   (M/S)    (M)   HT (M)   (DEG)
 -------  ----------  ----  -----  -----  ------  ------  -------
    250. .2612E+05    4     1.0    1.0   320.0     .00      0.
   1700. 4384. 4     1.0    1.0   320.0     .00      0.

      ************************************
      *** SUMMARY OF SCREEN MODEL RESULTS ***
      ************************************

  CALCULATION      MAX CONC   DIST TO  TERRAIN
   PROCEDURE      (UG/M**3)   MAX (M)   HT (M)
 --------------  -----------  -------  -------
 SIMPLE TERRAIN    .2612E+05     250. 0.


 ************************************************
 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
 ************************************************
```

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Appendix C

Analysis of 2013-2017 Monitoring Data

C1.1 Summary of AECOM AQMP Re-Evaluation Technical Memorandum

A technical memorandum was written by AECOM to analyze the data collected from site perimeter and community stations from 2013-2017. The air quality monitoring was conducted according to the Air Quality Monitoring Plan (AQMP) (AECOM, May 2013) to measure any impacts of the onsite activities on ambient air quality. A summary of the key findings and recommendations can be found in **Table C-1** below:

Table C-1. Summary of Key Findings and Recommendations

Item	Current Status	Recommended Change	Document Reference
General Comments	Overall the site perimeter and community stations have excellent data availability. The stations for these two program components respond similarly to large-scale events such as during elevated particulate concentrations associated with wildfires, and correlations between elevated readings between stations occur frequently, indicating that the system is functioning well as a coordinated network. Considering the spatial distribution of the different stations across the air quality monitoring network, this level of commonality is remarkable and supports the conclusion of accuracy and repeatability from station to station. Outside of wildfire data there were very few exceedances of the RBAL on site perimeter stations and no exceedances of the RBAL on the community stations. Across all years, but most notably in 2014 and 2017, a large portion of the PM_{10} concentrations above baseline at the site perimeter monitors were measured while the wind was blowing predominantly from the south, toward the Site. This is indicative of offsite particulate matter blowing across the site from the south. There were no exceedances of the air quality criteria for arsenic at any of the site perimeter or community stations during the reviewed monitoring period (June, 2013 to December, 2017).	None	General

Item	Current Status	Recommended Change	Document Reference
AQMP Review and Revision	The AQMP (AECOM, 2013) does not specify requirements for periodic review and revision.	AECOM recommends that the AQMP be reviewed periodically and revised as required. A periodic review of the AQMP will allow the plan to be adapted for changes in the remedial activities and monitoring requirements. The timing of the AQMP re-evaluation should be coordinated with the requirements of other monitoring programs (e.g. Aquatic Effects Monitoring Program). AECOM recommends that a formal review period of 3 years be added to the next AQMP revision, or at an interval that aligns with the requirements of other monitoring programs.	General
AQMP Objectives	The AQMP (AECOM, 2013) identifies the goals of the remedial phase air monitoring program as: 1. To measure air quality in the vicinity of remediation emissions to confirm overall compliance with established criteria. Real-time concentration averages will be continuously monitored on-site during remedial activity and the values will be compared to approve short term action levels in order to assist site managers in assessing or modifying site activities to prevent exceedances of project criteria. 2. To measure ambient air quality in the community surrounding the remediation sites to confirm that there are no significant impacts to community air quality as a result of remediation activity.	No changes are recommended; AECOM believes that the AQMP objectives remain relevant to the planned activities associated with the GMRP going forward.	Technical Memorandum Section 3
Station Naming Change – YCC	One community station – YCC – was erroneously named when the monitoring program was established.	An opportunity exists in the revision of the AQMP to correct this naming error, and through discussion with PSPC and CIRNAC it has been decided that it be more appropriately named the Yellowknife Bay Community Station, abbreviated by YKB.	Technical Memorandum Section 2

Item	Current Status	Recommended Change	Document Reference
Station Naming Change – Perimeter Stations	The AQMP (AECOM, 2013) refers to the site perimeter stations as “fenceline” stations.	Through discussion with PSPC and CIRNAC, it was decided to refer to these as “site perimeter” stations to avoid confusion with planned fencing that is expected to enclose a smaller area within the site.	Technical Memorandum Section 3
Measured Parameters – Site Perimeter Stations	Continuous basis reported as 15-minute averages: TSP, PM_{10}	For future consideration, AECOM recommends removing TSP monitoring requirements from the site perimeter stations and maintaining only PM_{10} at these stations.	Technical Memorandum Section 3.1.1
Measured Parameters – Community Stations	Continuous basis reported as 15-minute averages: ▪ PM_{10}, $PM_{2.5}$ Discrete 24-hour samples: ▪ TSP plus Sb, Fe, Pb, Ni ▪ PM_{10} plus As ▪ Asbestos	For future consideration, AECOM recommends removing $PM_{2.5}$ monitoring requirements from the community stations and maintaining only PM_{10} at these stations. For future consideration, AECOM recommends removing trace metals monitoring requirements from the community monitoring stations. For future consideration, AECOM recommends only collecting asbestos samples at the community stations when site activities involve a known disturbance of asbestos-containing material, such as a building demolition. Since arsenic pollution is a primary concern for the GMRP and the community, AECOM recommends retaining the requirement for metals analysis from the AQMP.	Technical Memorandum Section 3.1.2
Laboratory Detection Limits	Laboratory detection limits were evaluated to determine if they were appropriate to allow for meaningful interpretation of measured concentrations.	No changes are recommended.	Technical Memorandum Section 3.1.3

Item	Current Status	Recommended Change	Document Reference
Air Quality Criteria	Some air quality criteria have been updated since the AQMP (AECOM, 2013) was finalized in 2013. The AQMP does not specify air quality criteria for Ni, Pb and Sb, which are monitored parameters. Additionally, the AQMP specifies an air quality criteria for metallic iron, which is a form of iron that is not expected to be produced from the GMRP activities.	AECOM recommends updating the air quality criteria for PM2.5, and adding criteria for Ni, Pb, and Sb, and changing the air quality criteria for iron from metallic iron to ferrous oxide. Additionally, AECOM recommends removing any air quality criteria for pollutants that are not being monitored and part of the AQMP.	Technical Memorandum Section 3.2
Review of RBAL	The Risk-Based Action Level (RBAL) was developed for the roaster deconstruction and considered potential public exposure associated with a roadway that crossed the Site.	AECOM does not recommend making such a change at this stage of the project. There is expected to be a reduced risk associated with the airborne concentration of metals resulting from planned remedial activities (as compared to the roaster deconstruction), as well as the elimination of an exposure pathway associated with re-routing the public-access roadway. However, there is value in maintaining an RBAL that is designed to protect human health and reduce ecological risk even during the highest risk activities of the project. Additionally, there is little advantage to relaxing the RBAL, since the RBAL has not been restrictive to site activities. Only a small number of concentrations were measured above the RBAL at the site perimeter, and none were measured above the RBAL at the community stations.	Technical Memorandum Section 3.3
Site Perimeter RBAL Exceedances	Three exceedances of the RBAL were observed that were not attributable to increased particulate matter from wildfires. Those exceedances were observed in May of 2014, 2015, and 2016, and were attributed by the air quality contractor to wind-blown dust from the south tailings pond.	Consider early-season mitigation measures to reduce wind-blown dust from the south tailings pond.	Technical Memorandum Section 3.3

Item	Current Status	Recommended Change	Document Reference
Site Perimeter and Community Stations: Monitoring program tailored to different remedial activities	The AQMP (AECOM, 2013) was developed for the roaster deconstruction, and recommends that monitoring occur consistently during remedial activities.	While this approach was appropriate for the roaster deconstruction, it may not be suited for the variety of planned activities throughout the remediation phase. As the project continues, differentiating between remedial activities and site conditions may be appropriate. AECOM suggests a tiered monitoring approach based on the characterization of the remedial activity occurring onsite, the level of contamination of material that may be disturbed, and environmental (seasonal) conditions at the time of the activity.	Technical Memorandum Section 3.4
On-Site Meteorological Station	Meteorological data collection on the Site appears to be systematically biased. This may lead to an incomplete understanding of wind speed and direction and how on site activities relate to measured concentrations of monitored contaminants.	AECOM recommends that the on-site meteorological station be inspected to determine the source of the bias, and whether repair or replacement of the station is required. Additionally, AECOM recommends that a comparison of on-site meteorological data with airport data be performed with regular reporting to identify any potential bias between the two stations.	Technical Memorandum Section 4.1
Site Perimeter Station Locations – Stations I & D	Site perimeter Stations I and D have a significant overlap in terms of the portion of the airshed they are measuring. Comparing measurements between the two stations shows that Station I (located at the top of the embankment) captured a large number of events with PM_{10} concentrations above baseline that were not measured by Station D (located at the bottom of the embankment). Conversely, very few events of PM_{10} concentrations above baseline that were measured by Station D did not coincide with an event of PM_{10} concentrations above baseline measured by Station I.	AECOM recommends considering the removal of Station D, provided that Station I can fulfil the intent of site perimeter monitoring (e.g. no remedial activities occur between the locations of Station I and Station D). AECOM notes that the station may need to be relocated when the South Pond is incorporated into the Central/North ponds.	Technical Memorandum Section 4.2.7.1

Item	Current Status	Recommended Change	Document Reference
Gust and Windspeed Analysis	Gusts and wind speed variation have a relatively small impact on observed concentrations at the site perimeter and community monitoring stations. Higher wind speeds and gusts are often associated with higher concentrations of particulate matter; however, this was not observed in the analyzed data.	AECOM recommends continuing the mitigation measures that have been applied to the project. The favourable monitoring results at higher wind speeds are likely a result of the increased application of dust suppression mitigation measures during periods of high wind speed, effectively preventing increased dust concentrations during those wind events.	Technical Memorandum Section 4.2.5 Technical Memorandum Section 5
Measurement Bias – Stations F & YKB	There appears to be a systematic bias between the co-located site perimeter (Station F) and community station (Station YKB, formerly YCC) where the community station consistently measures higher than the site perimeter station during periods of PM_{10} concentrations above baseline.	AECOM recommends an investigation into this bias by the air quality consultant to determine the cause of the bias (e.g. placement, technology difference, etc) and propose a plan to correct the bias. Alternately, AECOM recommends considering the removal of the site perimeter station provided that reporting from the community station can be adapted to fill the purpose of the site perimeter monitoring (e.g. reporting short-term concentration changes in real time)	Technical Memorandum Section 4.2.7.2
Mitigation Measures – Wind Speed	Windspeed threshold bins in the Dust Management Plan (Draft) (CIRNAC, 2018) were considered with respect to the observed wind speeds and associated measured dust concentrations.	No changes recommended to windspeed threshold bins. AECOM recommends specifying the required mitigation measures in further detail or referring to the Dust Suppression and Mitigation section of the DMP where appropriate when specifying responses to windspeed thresholds.	Technical Memorandum 4.2.6
Mitigation Measures – Visual Observations	Responses to visual dust observations are specified in the Dust Management Plan (Draft) (CIRNAC, 2018).	No changes are recommended to the visual dust monitoring requirements of the DMP.	Technical Memorandum 4.2.6

The following figures provide a summary of the key analyses of the previous air quality data as presented in the AECOM technical memorandum. Note that the figure numbers are those direct from the AECOM technical memorandum.

- AECOM recommended that there is little advantage to changing the RBAL, since only a small number of concentrations were measured above the RBAL at site perimeter locations outside of specified wildfire dates, as shown in Technical Memorandum Figure 2.

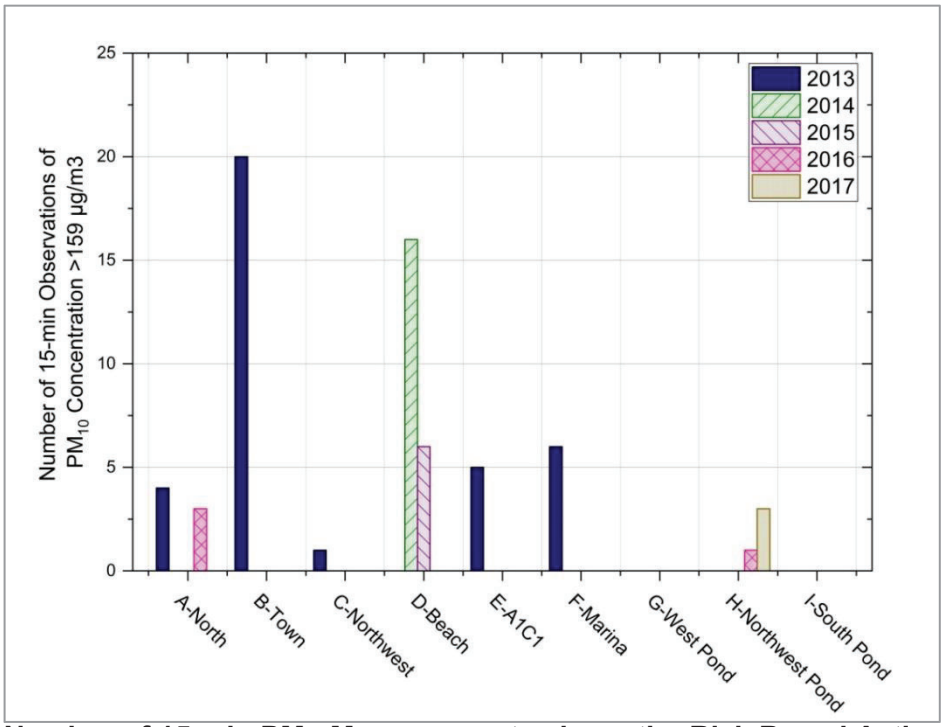


Figure 2. Number of 15-min PM_{10} Measurements above the Risk Based Action Level at Site Perimeter Stations

- AECOM recommends that a comparison of on-site measurements of wind speed and direction with the airport data be performed with regular reporting to identify any potential bias between the two stations. It was noticed that for winds blowing from the north, current data from the onsite met station show a consistent absence of measurements as shown in Technical Memorandum Figure 4.

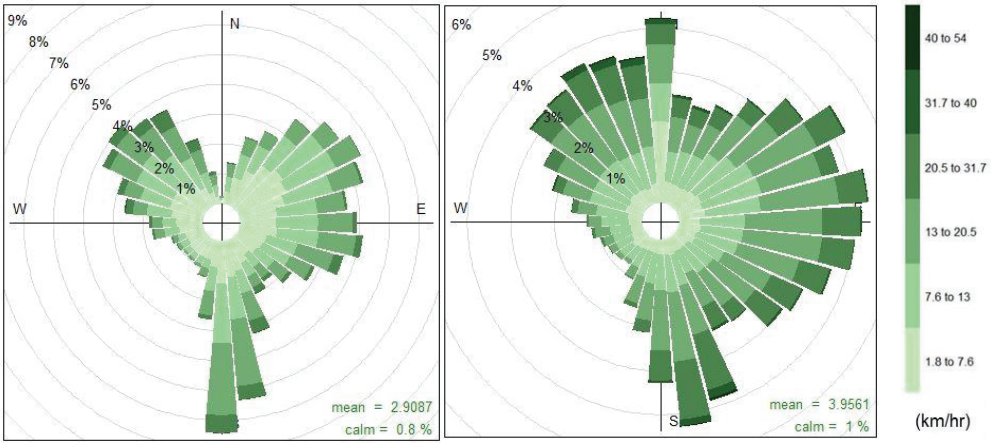


Figure 4. Wind Rose Plots from On-site (Left) and Yellowknife Airport (Right) Meteorological Stations (2013 – 2017)

- At the site perimeter locations, TSP and PM_{10} are measured concurrently, and data trends were observed to be consistent between the two fractions of particulate matter, as shown in Technical Memorandum Figure 7. AECOM recommends considering the removal of TSP monitors from the sire perimeter locations in the future. The TSP data collected at the site perimeter stations is not providing additional information about risks from project-based activities to human health or environmental health.

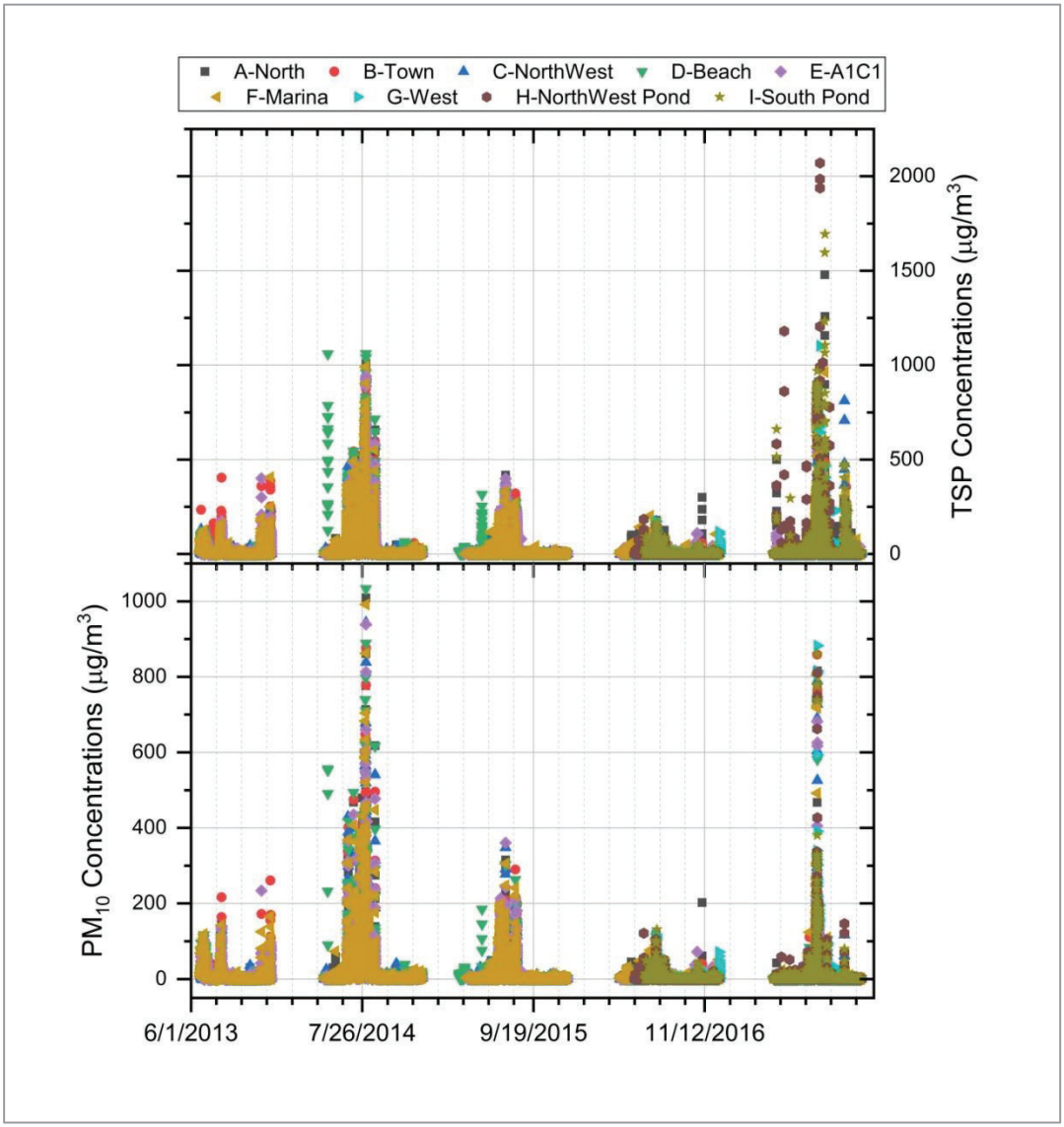


Figure 7. TSP and PM_{10} Concentrations Measured at Site Perimeter Stations

- AECOM recommends continuing with the dust suppression techniques that have previously been employed, as they appear to be effective in preventing elevated concentrations of PM_{10} at higher wind speeds. Since the site perimeter stations only measured a very small number of instances where concentrations were above the RBAL. Furthermore, since the community stations did not measure any such exceedances, extending dust suppression practices to lower wind speeds when there are no specific site activities going on, as outlined in the Dust Management Plan, is considered optional.

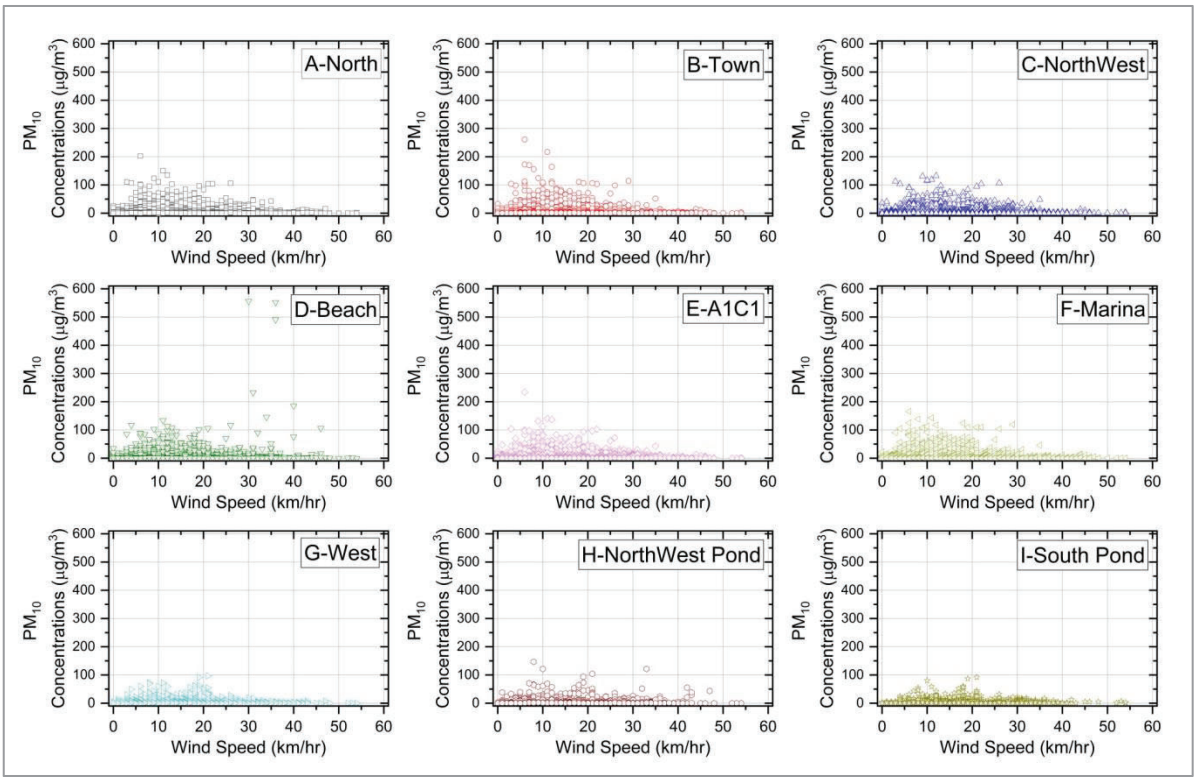


Figure 31. PM_{10} Concentrations at Different Wind Speed Measured at Site Perimeter Stations

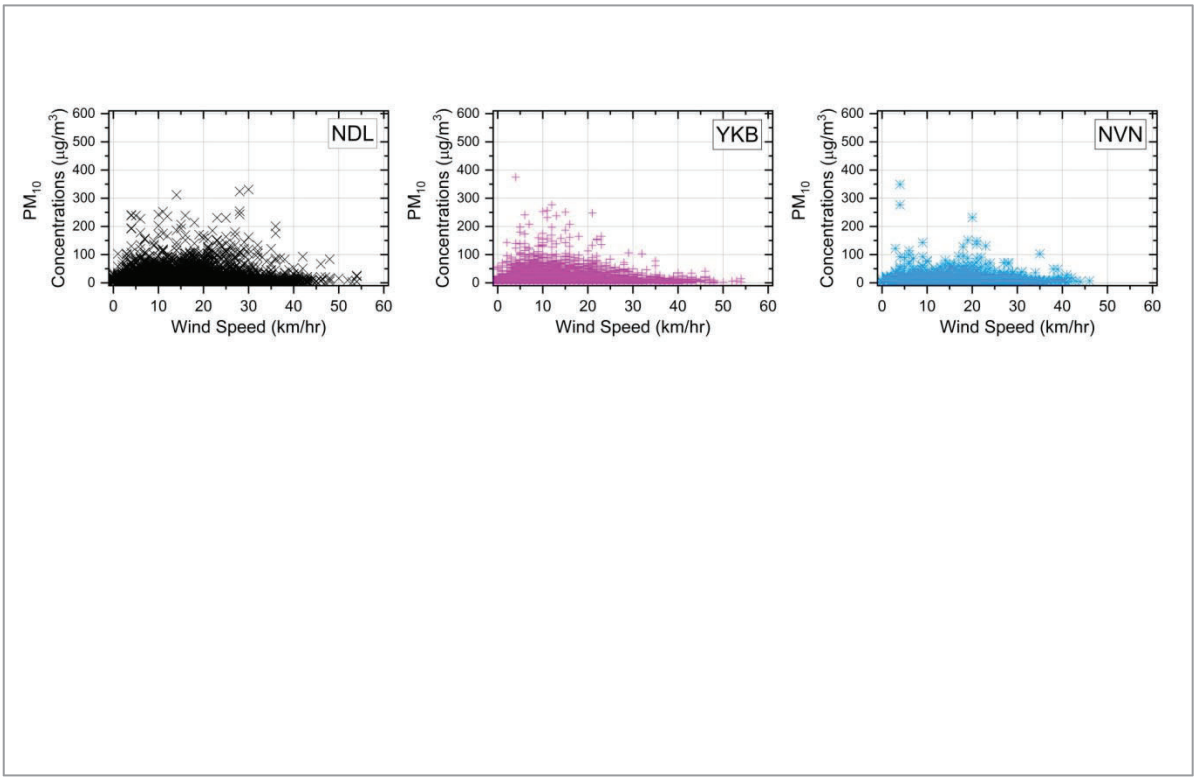


Figure 32. PM_{10} Concentrations at Different Wind Speed Measured at Community Stations

- No correlation was found between the arsenic and PM_{10} concentration. As such, AECOM recommends continuing to monitor for trace compounds including arsenic. This is a valuable method to confirm the RBAL and verify the potential for arsenic exposure throughout the varying Site activities and the disturbance of different areas of the Site. Additionally, during periods of elevated background levels due to wildfires, the arsenic analysis provides confidence that PM_{10} concentrations above baseline measurements are not related to activities on the Site.

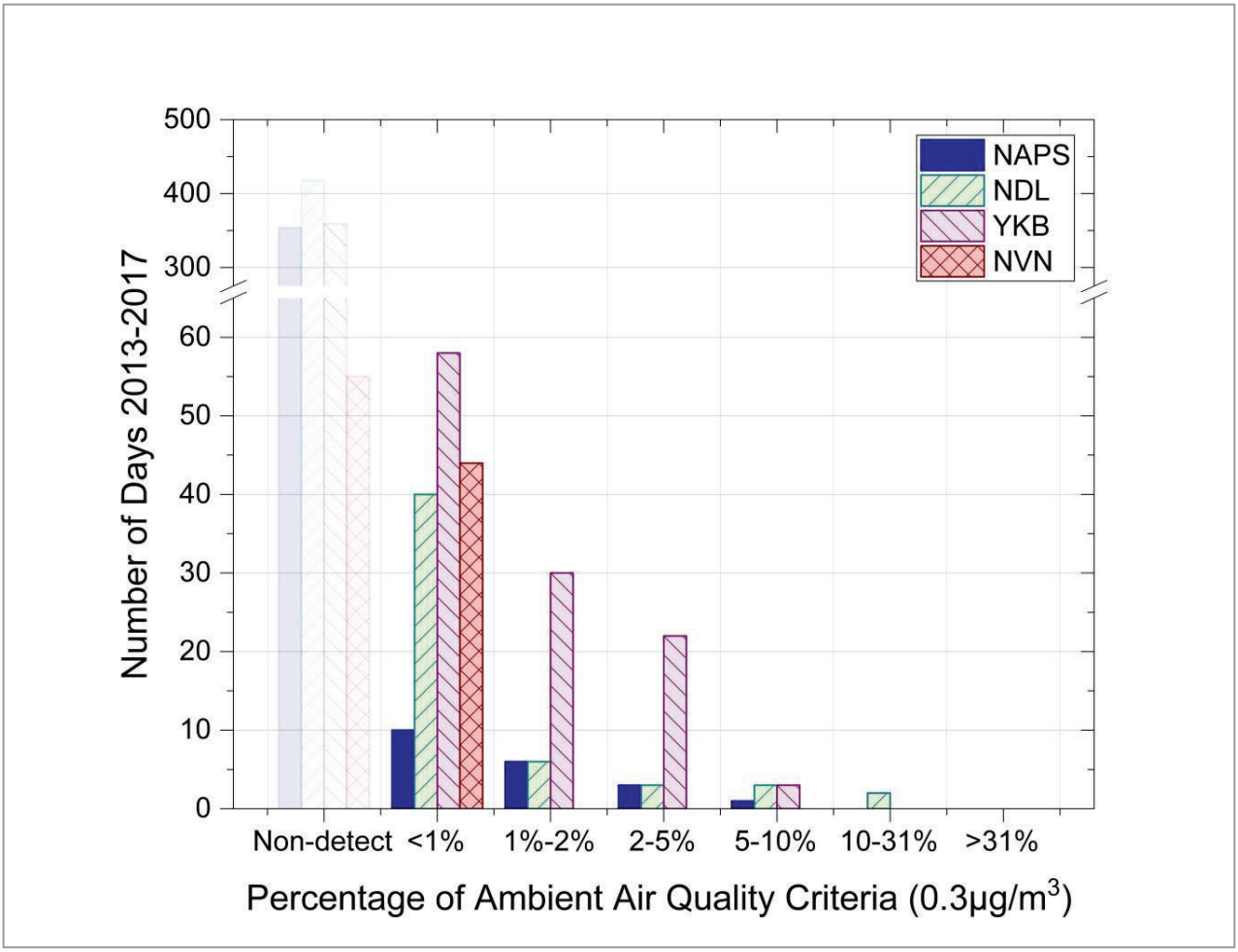


Figure 42. Arsenic Measurement Results Summary

- For the analysis of asbestos, all available data from the community stations was plotted with PM_{10} when wind was blowing from the site. All of the asbestos readings are well below the AAQC. Similar to the analysis of arsenic measurements, no correlation noted between asbestos and PM_{10} concentration.

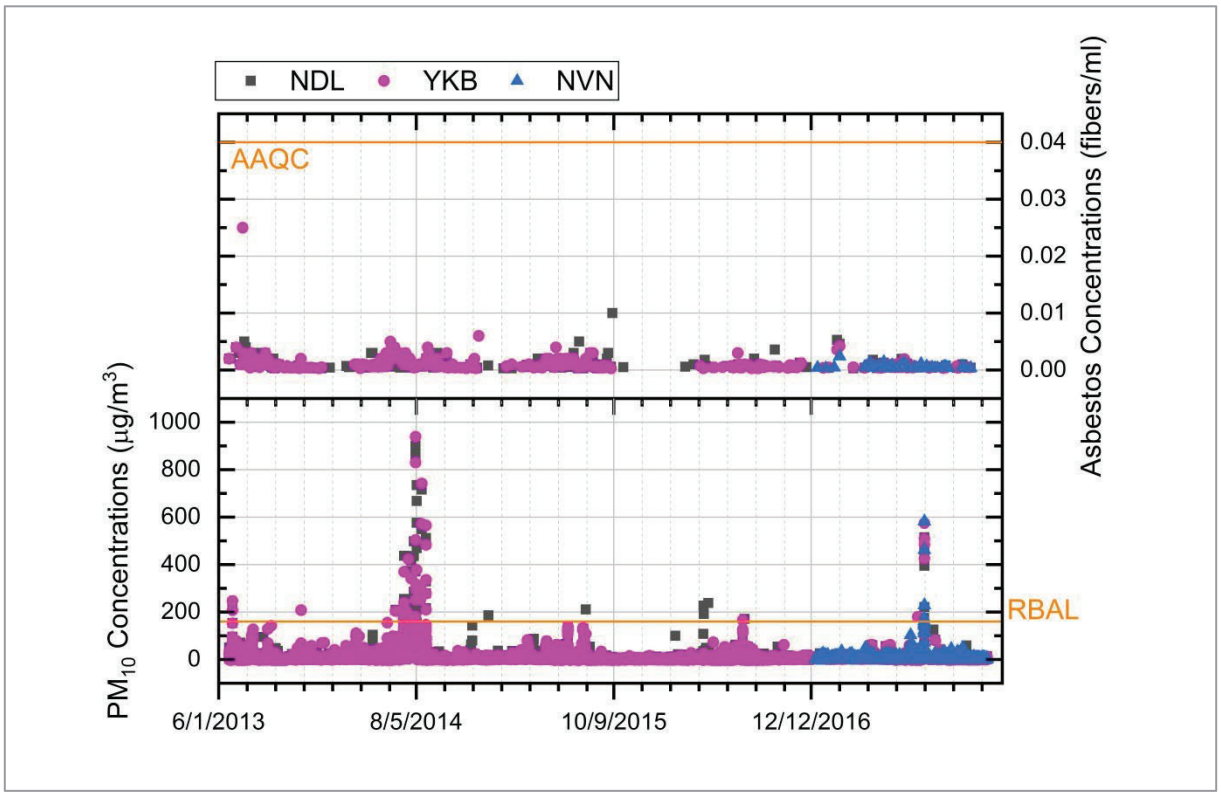


Figure 48. Measured Concentrations of Asbestos at Community Stations and PM_{10} Concentrations when Wind Blowing from the Site

- For the analysis of metals, all available data from the community stations was plotted with PM_{10} when wind was blowing from the site. Concentrations of all metals were well below the applicable AAQC. In the event that iron concentration was above AAQC, PM_{10} concentration was also found above the baseline.

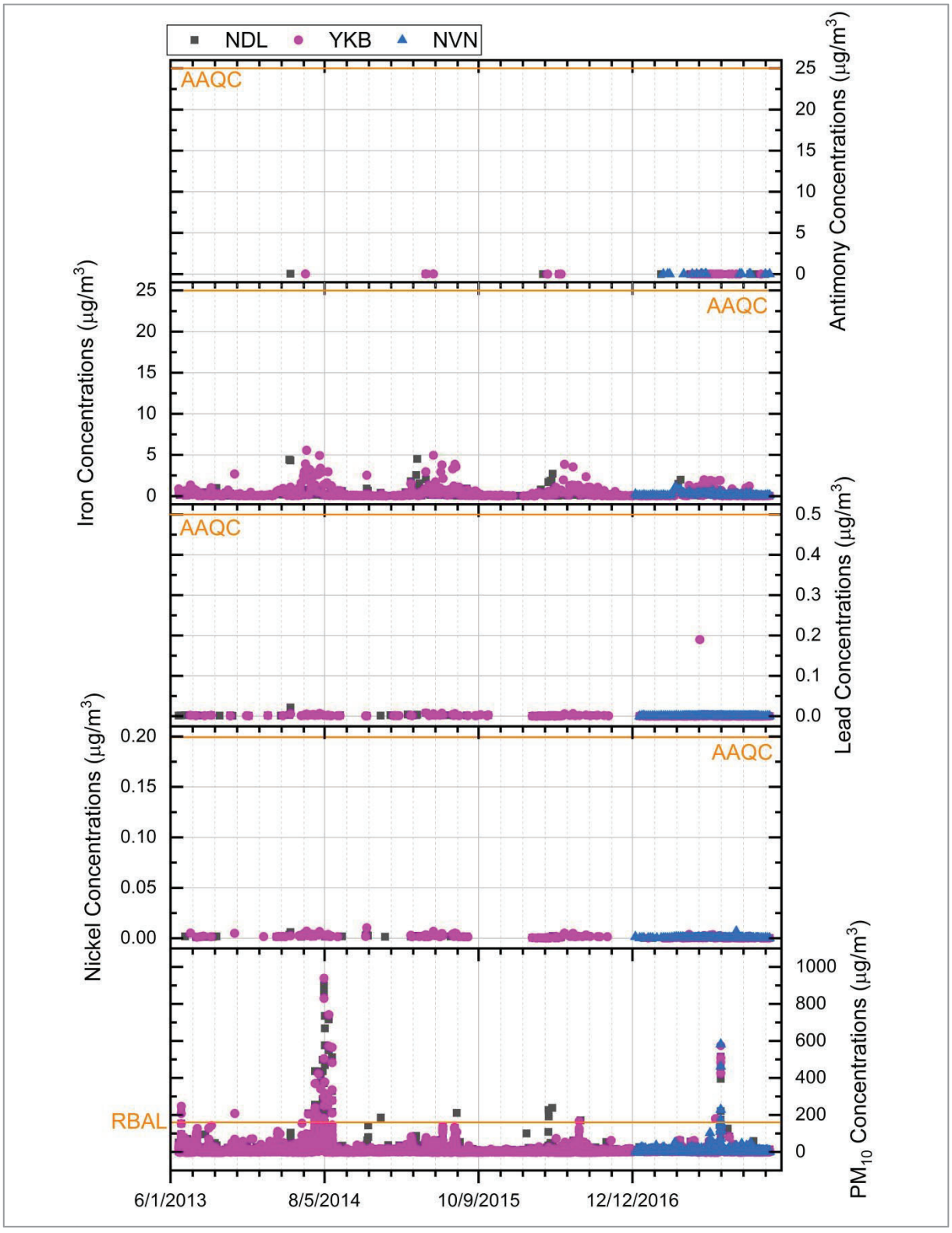


Figure 49. Measured Concentrations of Metals at Community Stations and PM_{10} Concentrations when Wind Blowing from the Site

C1.2 Summary of Wind Data

Wind contributes to the dispersion, re-suspension and surface drying through evaporation; all of which have the potential to release the dust particles. As such, wind conditions are very important in understanding the potential distribution of airborne contaminants throughout the Remediation Program.

Wind roses are a convenient and efficient method to present wind data. As such, wind roses are used to present the measured total wind speed, wind direction and wind class frequency data for local wind patterns. The wind roses in this section will aid in the analysis of the wind behaviour and lead to the determination of monitoring locations that are required for the AQMP.

The study area includes two monitoring stations that were used in this assessment:

- Yellowknife Airport (NavCanada), located southwest of the Giant Mine site
- Giant Mine Site (CIRNAC)

The meteorological station located at the Giant Mine Site showed a systemic bias throughout the monitoring period from 2013-2017, as noted in *Giant Mine Air Quality Monitoring Program Re-Evaluation* technical memorandum (AECOM, 2018). Meteorological measurements from this station do not include measurements of wind events blowing from the North. Wind roses from these stations are included below, but should be considered in this context.

Figure 3-1 and **Figure 3-2** depict the wind roses for the local study area. In the wind roses below, the length of radial barbs depict the total percent frequency of winds from the indicated direction, while portions of the barbs of different colours and widths illustrate the frequency of associated wind speed categories. The frequency distribution for wind speeds for the local study area is illustrated below each wind rose in **Figure C-1** and **Figure C-2**. **Figure C-1** illustrates the data from the Giant Mine site while **Figure C-2** represents Yellowknife airport data.

The seasonal wind roses allow for a more detailed look at the wind data through the seasons within the five-year period.

During the more active remediation period (April to November), the Giant Mine site shows that the most frequent wind strength is generally between 2.10 to 3.60 m/s. The prevailing wind originates from the south, but there is good distribution of winds from the north as well.

From the Yellowknife airport meteorological station, the most frequent wind strength is also between 2.10 to 3.60 m/s during construction period. Again, the prevailing wind originates from the south, with good distribution of winds from the north as well.

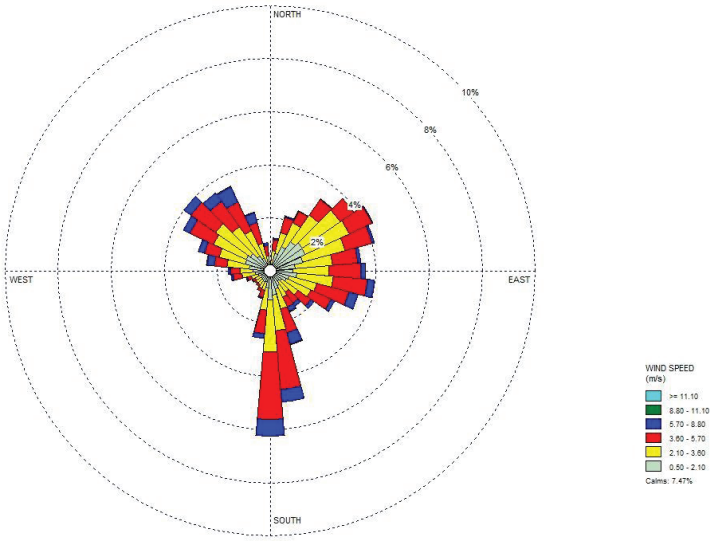
Detailed analysis is provided for the Giant Mine Site meteorological station through the rest of this section. The winter wind rose shows that the prevailing winds were from the northwest and the east, which also concurs with the 30-year climate normal for that period. The average winter wind speed is 2.35 m/s with 12.74% calms.

The fall data shows generally the same shape as the five-year wind rose with the exception that the highest wind speed seen through the seasons was encountered in the fall months from the west northwesterly direction, and is consistent with the historical assessment information. In the fall, the average wind speed is 3.25 m/s with 3.98% calms.

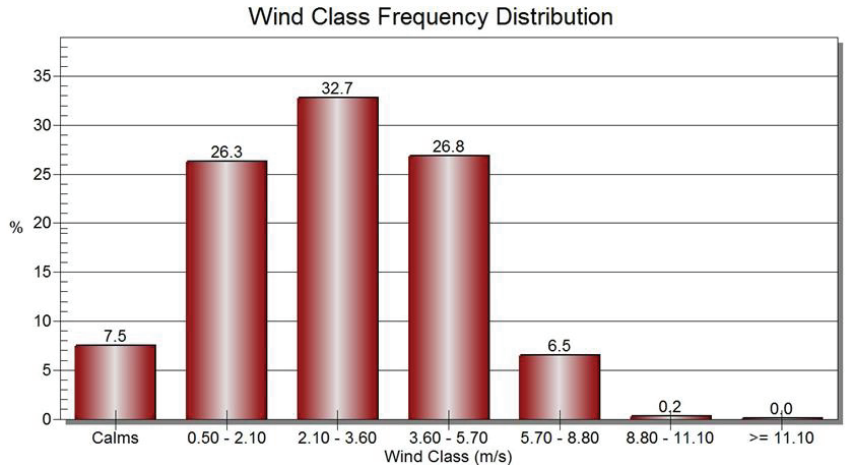
Spring data illustrates that the predominant winds were easterly with some northeast and some southwest winds. In the spring, the average wind speed is 3.26 m/s with 4.29% calms. The frequency distribution of wind speeds shows that spring and fall have the highest average wind speeds.

For the summer periods, the prevailing winds are from the south and south west followed by the constant easterly wind. The average wind speed is 3.21 m/s, the lowest average wind speed of all seasons. Calms occur 4.20% of the time.

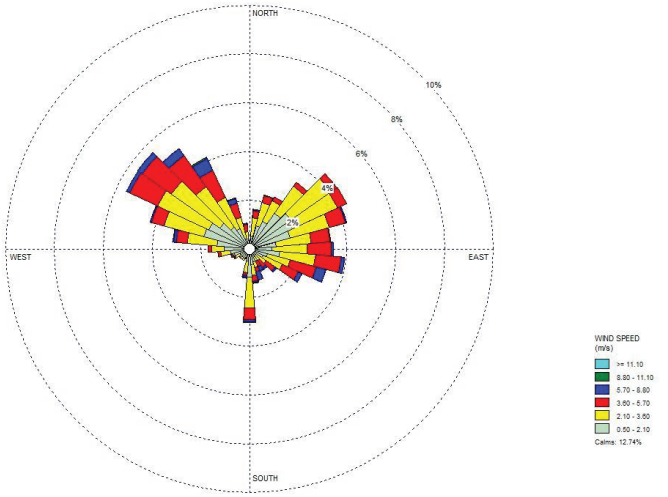
Figure C-1: Wind Roses for Giant Mine Site (2013-2017)



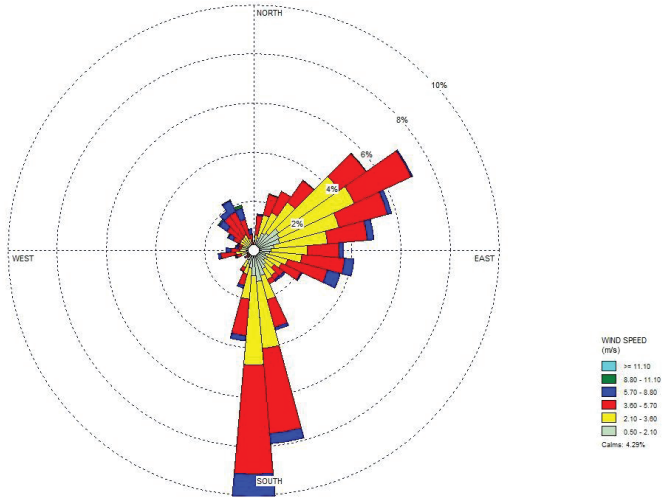
Giant Mine Site Total Wind Rose



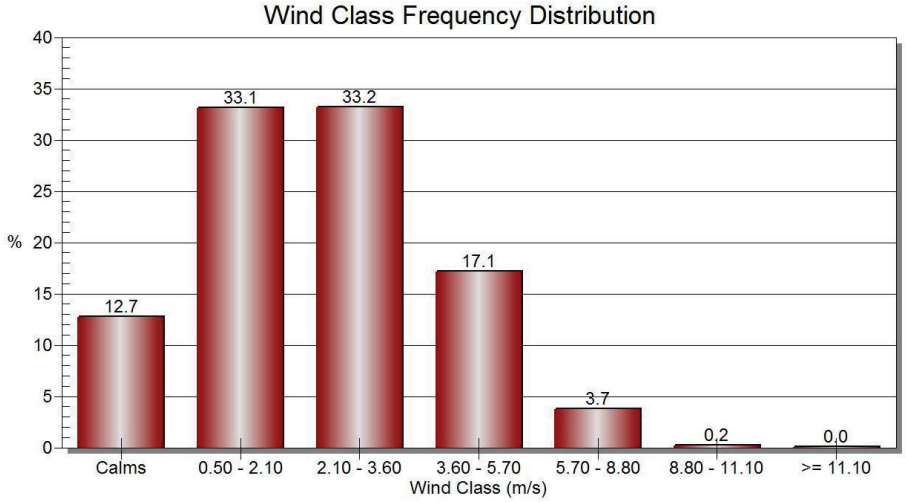
Frequency Distribution – Giant Mine Site



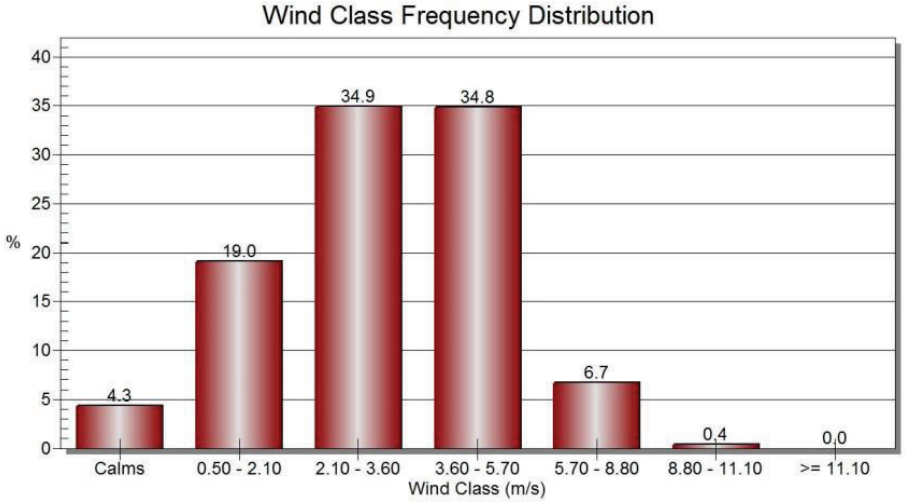
Wind Rose – Giant Mine Site Winter (November - March) (2013-2017)



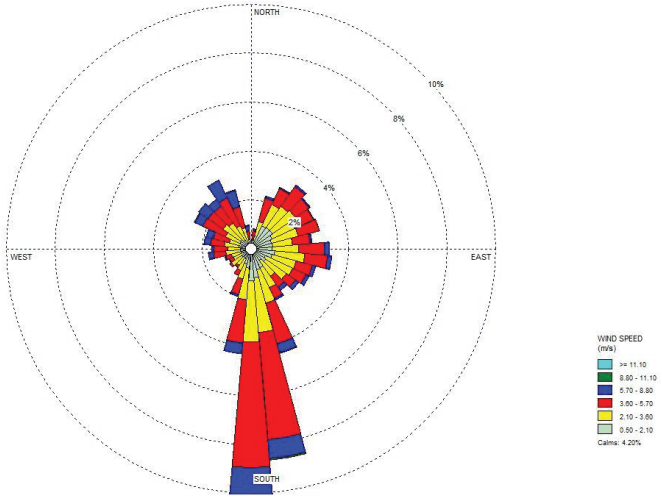
Wind Rose – Giant Mine Site Spring (April-May) (2013-2017)



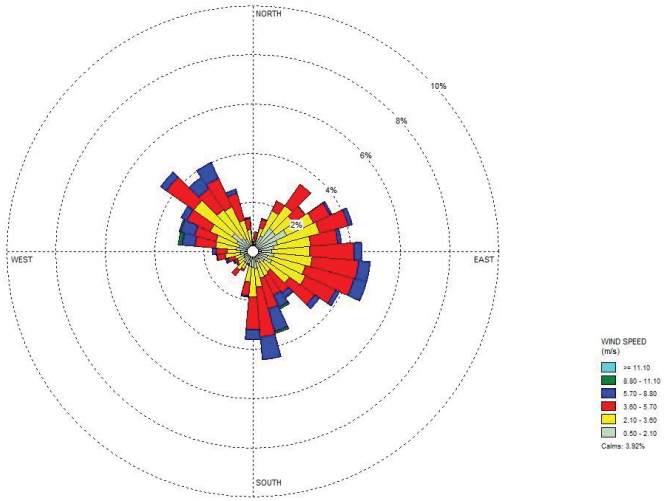
Frequency Distribution – Giant Mine Site Winter (November-March) (2013-2017)



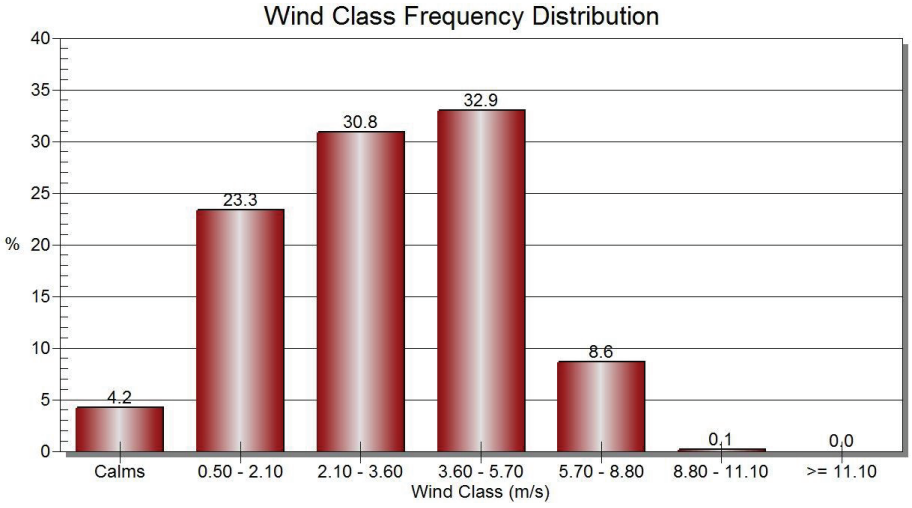
Frequency Distribution – Giant Mine Site Spring (April-May) (2013-2017)



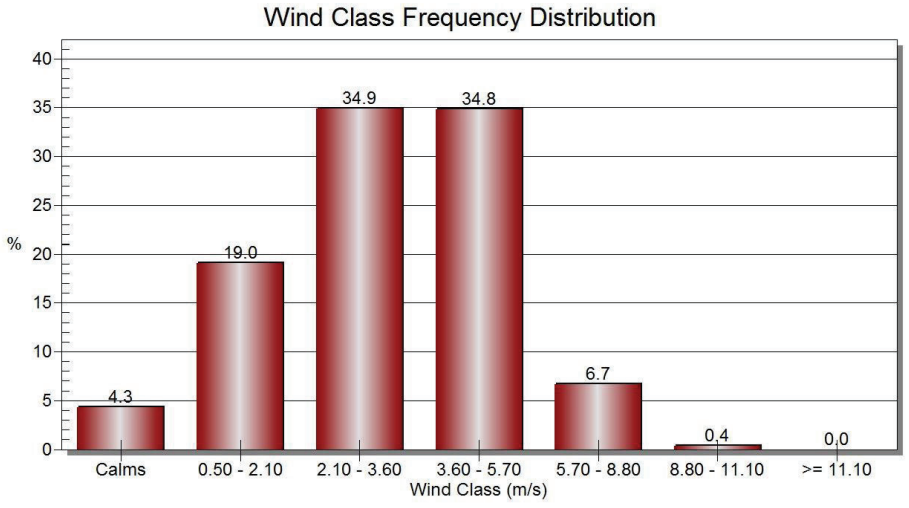
Wind Rose – Giant Mine Site Summer (June-August) (2013-2017)



Wind Rose – Giant Mine Site Fall (September-October) (2013-2017)

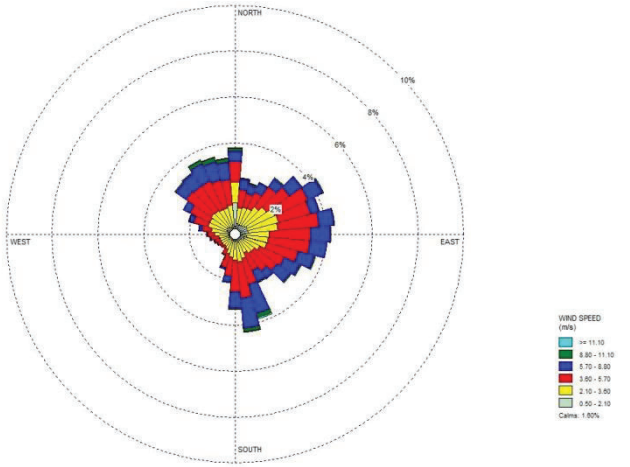


Frequency Distribution – Giant Mine Site Summer (June-August) (2013-2017)

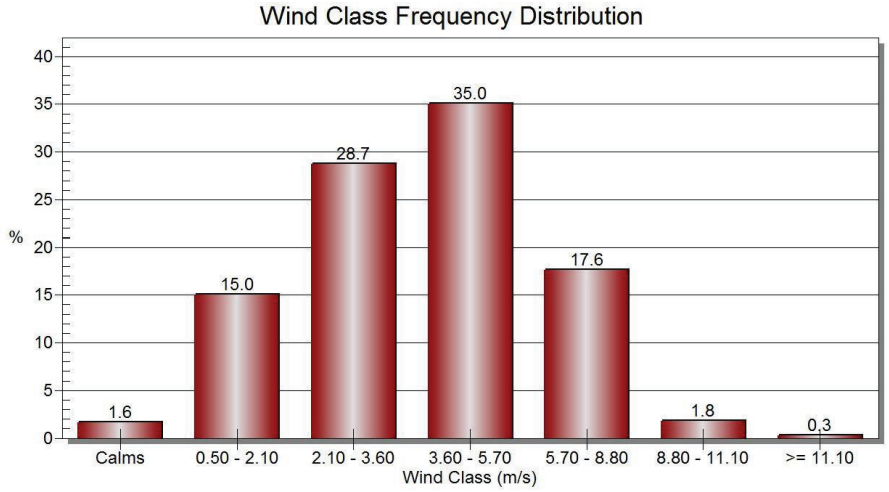


Frequency Distribution – Giant Mine Site Fall (September-October) (2013-2017)

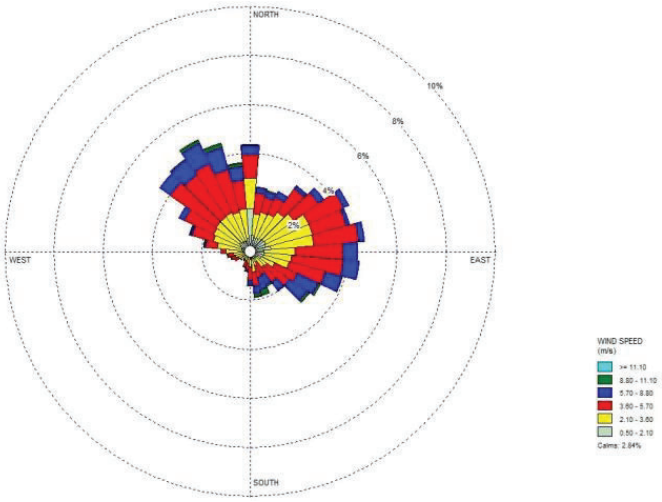
Figure C-2: Wind Roses for Yellowknife Airport (2008-2013)



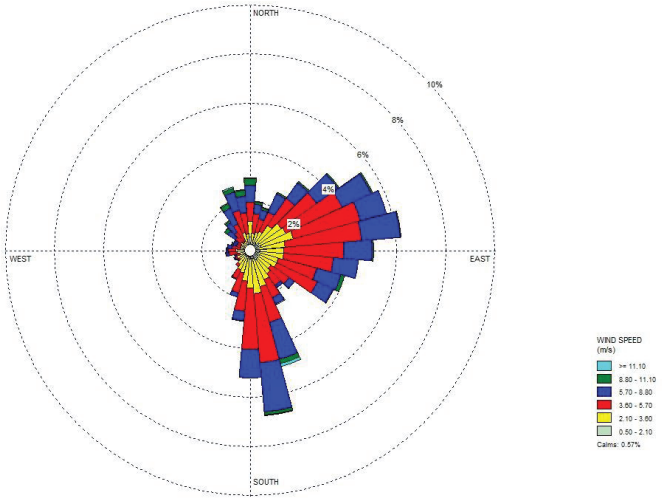
Yellowknife Airport Total Wind Rose



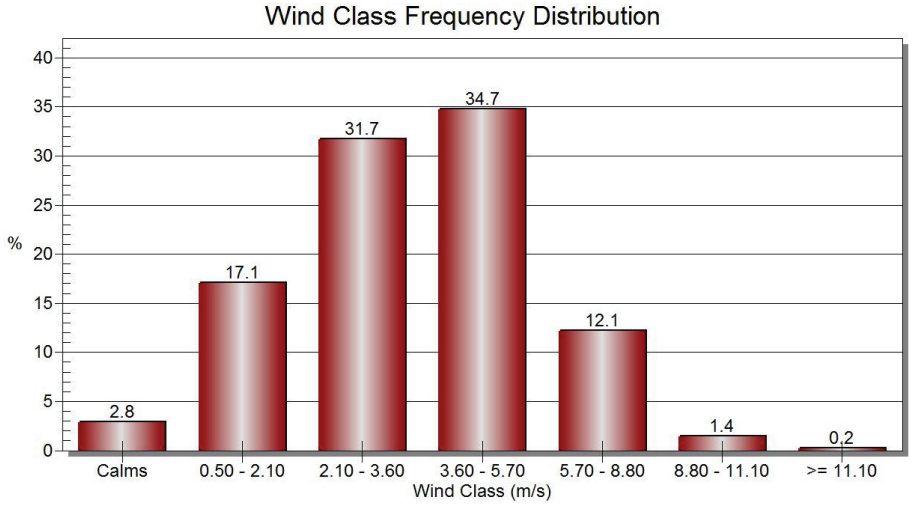
Yellowknife Airport Total Frequency Distribution



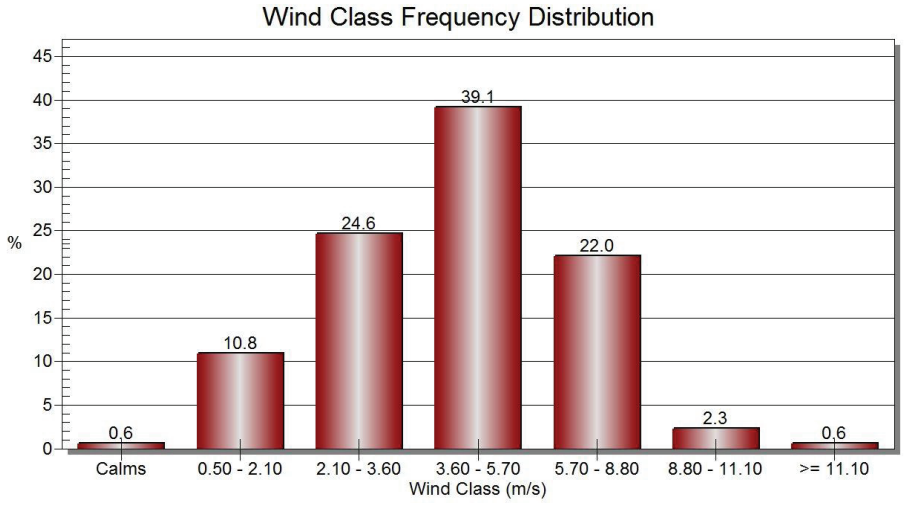
Wind Rose – Yellowknife Airport Winter (November - March) (2013-2017)



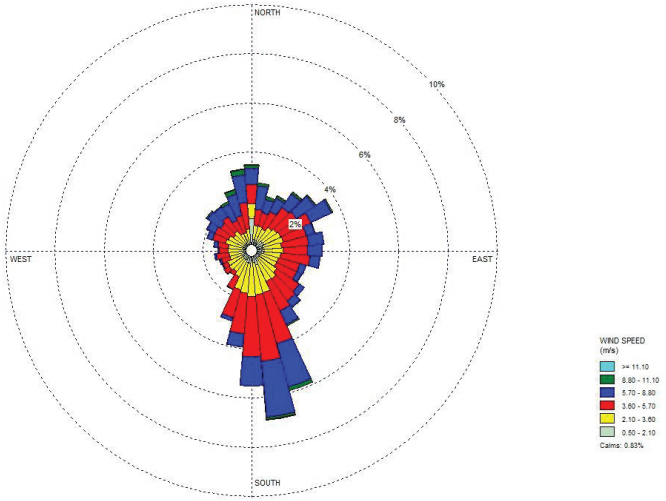
Wind Rose – Yellowknife Airport Spring (April-May) (2013-2017)



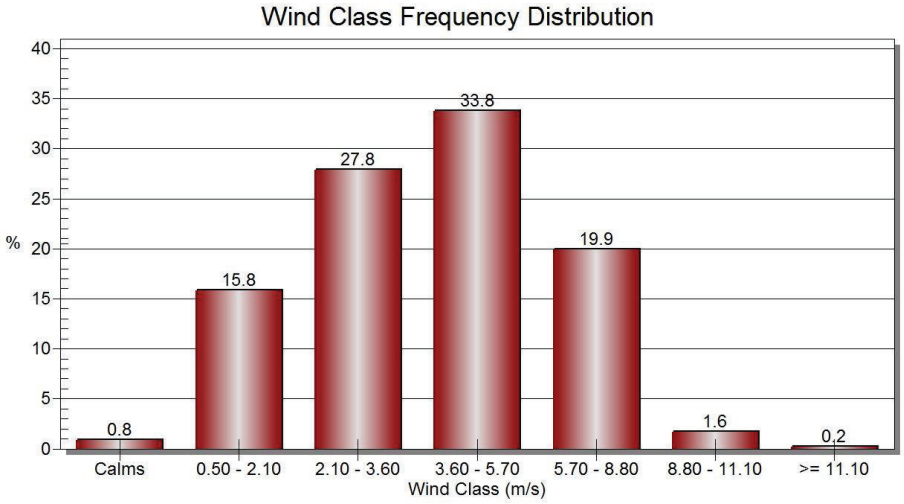
Frequency Distribution – Yellowknife Airport Winter (November - March) (2013-2017)



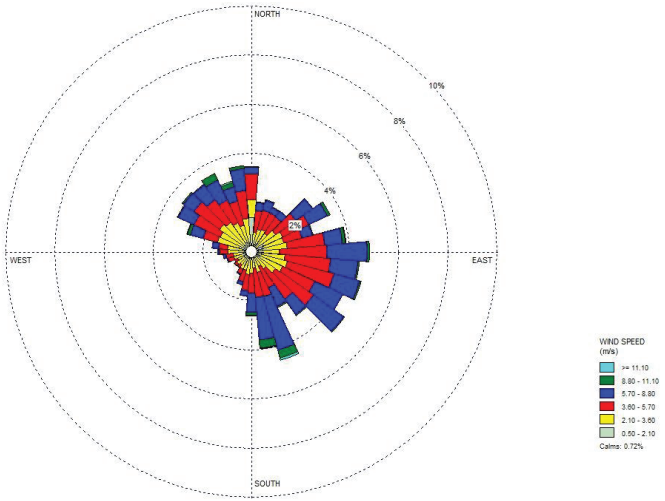
Frequency Distribution – Yellowknife Airport (April-May) (2013-2017)



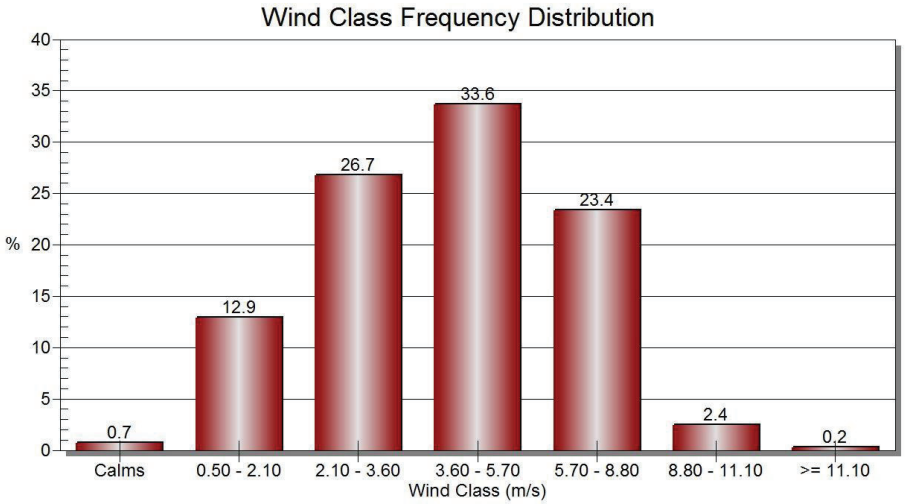
Wind Rose – Yellowknife Airport Summer (June-August) (2013-2017)



Frequency Distribution – Yellowknife Airport Summer (June-August) (2013-2017)



Wind Rose– Yellowknife Airport Fall (September-October) (2013-2017)



Frequency Distribution – Yellowknife Airport Fall (September) (2013-2017)

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