Baffinland Iron Mines Corporation

AIR QUALITY AND NOISE ABATEMENT MANAGEMENT PLAN

BAF-PH1-830-P16-0002

Rev
Draft for Review

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1 INTRODUCTION

This document describes Baffinland Iron Mines Corporation's (Baffinland's) plans to manage its Mary River Project (the Project) operation to minimize effects on the atmospheric environment.

1.1 PURPOSE AND SCOPE

The purpose of this plan is to outline how potential Project impacts on air quality and noise will be managed throughout the lifecycle of the Project. Management processes and procedures include practices implemented at the Project to limit the potential for adverse impacts to local air quality, particulate and dust impacts, nuisance noise, and greenhouse gases. This document outlines the systems in place to mitigate and manage emission sources and activities that generate dust and noise at the Project. Applicable monitoring programs and roles and responsibilities are identified.

1.2 RELATIONSHIP TO OTHER MANAGEMENT PLANS

Project activities have the potential to affect the natural and human environment through air and noise emissions during construction, operations, and closure activities. Therefore, this Plan must be viewed in consideration with the Environmental Management and Monitoring Plans for the Project as listed and described in Table 1.1. The Document Reference Numbers in this table are currently under review and subject to change in future management plans.

TABLE 1-1 RELATIONSHIP TO OTHER MANAGEMENT PLANS

Referenced Management Plan	Document Reference Number	Information Provided by Referenced Plan
Adaptive Management Plan	TBD	Describes the generic approach to adaptive management on the Project, including management plans. Includes objectives, indicators, thresholds and indicators (OITRs) related to the Project.
Environmental Protection Plan	BAF-PH1-830-P16-0008	Provides relevant environmental protection measures
Roads Management Plan	BAF-PH1-830-P16-0023	Describes environmental protection measures related to road operation and maintenance
Terrestrial Environment Mitigation and Monitoring Plan	BAF-PH1-830-P16-0027	Describes mitigation and monitoring related to wildlife and vegetation.
Aquatic Effects Monitoring Plan	BAF-PH1-830-P16-0039	Describes mitigation and monitoring related to freshwater environment aquatic ecosystems.
Marine Monitoring Plan	TBD	Describes mitigation and monitoring related to marine environment aquatic ecosystems.
Interim Closure and Reclamation Plan	BAF-PH1-830-P16-0012	Outlines the goal, principles, objectives, criteria and activities associated with the final closure and reclamation of the Project
Waste Management Plan	BAF-PH1-830-P16-0028	Describes mitigation measures for waste to reduce interactions with wildlife.

1.3 CORPORATE POLICIES

Baffinland has two (2) corporate policies that apply to environmental management:

- **Sustainable Development (SD) Policy** - identifies Baffinland's commitment internally and to the public to operate in a manner that is environmentally responsible, safe, fiscally responsible and respectful of the cultural values and legal rights of Inuit.
- **Health, Safety and Environment (HSE) Policy** - describes the company's commitment to achieve a safe, healthy and environmentally responsible workplace.

All employees and contractors must comply with the contents of both above mentioned policies, which are included in Appendix A.

1.4 Regulatory Requirements

This Plan outlines the Project's policies and procedures to ensure compliance with the relevant terms, conditions and regulations outlined in the following Inuit agreements and regulatory instruments:

- Commercial Lease - Q13C301 (Commercial Lease) with the Qikiqtani Inuit Association (QIA)
- Inuit Impact Benefit Agreement with the QIA
- Project Certificate No. 005 issued by the Nunavut Impact Review Board (NIRB)

An Inuit Stewardship Plan (ISP) will be developed by the QIA pursuant to Commitment 19 referenced at Appendix B of the Project Certificate.

In addition to these Project-specific regulatory instruments, there are various regulations and guidelines pertaining to air quality, noise, vibration and greenhouse gas management which are applicable to the Project.

1.4.1 Applicable Legislation

Workplace air quality is protected in Nunavut by the Schedule O Contamination Limits provided in the *Nunavut Occupational Health and Safety Regulations* (Nunavut [NU] Reg 003-2016). The Project, however, presents an exception, whereby SO_2 and NO_2 monitoring data at the Milne Port and Mine Site are instead compared to the Nunavut Ambient Air Quality Guidelines in recognition of prolonged exposure at the accommodation facilities (beyond a typical 40 hour work week assumed for occupational guidelines).

1.4.1.1 Canadian Environmental Protection Act, 1999

Ambient air quality guidelines and objectives are non-statutory limits (i.e., not legally binding) used to assess ambient air quality and guide air management decisions. The Government of Nunavut (GN) has established ambient air quality guidelines for several criteria air contaminants (CACs): total suspended particulate matter (TSP), particulate matter with an aerodynamic diameter of <2.5 µm ($PM_{2.5}$), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) (GN, 2011). The Canadian Council for the Ministers of the Environment (CCME) developed Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$, ozone (O_3), SO_2 and NO_2. The CAAQS, which were established as objectives under sections 54 and 55 of the *Canadian Environmental Protection Act, 1999* (Government of Canada, 1999), are intended to manage air emissions and ambient air quality concentrations in a regional airshed and are used as a reference only for the Project. CAAQS are not intended to determine compliance at the fenceline for an industrial facility.

With respect to greenhouse gas emissions (GHGs), Environment and Climate Change Canada (ECCC) stipulate annual GHG reporting requirements for facilities that emit 10,000 tonnes of CO_2eq or more of in a calendar year. The legal basis for the GHG reporting program is the Notice published annually in the Canada Gazette, Part I, under the authority of subsection 46(1) of the *Canadian Environmental Protection Act, 1999 (*Government of Canada, 1999). In addition, the Nunavut Climate Change Strategy, which was outlined in October 2003 by the Department of Sustainable Development (GN, 2003) encourages "Nunavummiut, including government, non-government, industry, and the public to take action to control greenhouse gas emissions through energy management and alternative energy supply technology".

More information on how these regulatory instruments have influenced Project standards, monitoring frameworks and reporting requirements are presented in Section 5.

1.4.1.2 Nunavut Land Claims Agreement

The Nunavut Land Claims Agreement (NLCA) is a modern treaty that was signed in 1993 by representatives of the Government of Canada, Tunngavik Federation of Nunavut, and the government of the Northwest Territories (CIRNAC, 2020). The NLCA provides the Tunngavik Federation of Nunavut with aboriginal title to the Nunavut settlement area—a land area of approximately 350,000 square kilometres (Nunavut Tunngavik, 2019). The Tunngavik Federation of Nunavut also has ownership of waters and land-fast ice that fall within their area of traditional use. The NLCA consists of 42 chapters that focus on a range of aspects, such as: wildlife management; harvesting rights; lands, water and environmental management regimes; public sector employment and contracting; and heritage resources. Some of the identified rights of Indigenous Peoples include the right to harvest wildlife, the right to negotiate with industries for social and economic benefits from non-renewable resources, as well as the right to have equal representation of Inuit in decision-making processes related to resource management and land use (CIRNAC, 2020). The NLCA guarantees Inuit federal royalties from resource-extraction projects and allows for Inuit to self-govern. The goals of the NLCA are to provide Inuit with financial compensation and economic opportunities related to development; to provide clarity of land ownership and the use of land and resources; to provide harvesting rights; to provide the rights to participate in decision-making concerning the harvesting of wildlife; to encourage the cultural preservation of Inuit; and to encourage self-reliance (Nunavut Tunngavik, 2019). The Government of Nunavut Department of Environment (GNDoE) is the lead GN Agency in fulfilling Government obligations concerning wildlife in Nunavut. Section 5.2.1 (i) of the Nunavut Agreement states that the government retains the ultimate responsibility for wildlife management.

1.4.1.3 Nunavut Planning and Project Assessment Act (NuPPAA)

The Nunavut Planning and Project Assessment Act (NuPPAA) is a federal statute that was implemented in 2014 and adds to the environmental impact assessment regime outlined in Articles 11 and 12 of the NLCA (Dylan and Thompson, 2020). The NuPPAA contains provisions that regulators must follow during the environmental assessment process, including the incorporation of Inuit Qaujimajatuqangit (IQ). NuPPA allows for a single-window entry point, which means that all proposed projects must be submitted to the Nunavut Planning Commission (NPC) for review prior to any development (CIRNAC, 2015). As per the NuPPAA, the NPC must then determine whether the proposed developments conform with Nunavut land use plans (CIRNAC, 2015). If the NPC determines that the project plans conform with the land use plans, then a commercial production lease is granted and the project can begin compiling the necessary data to develop an environmental impact statement (EIS) (Dylan and Thompson, 2020).

1.4.1.4 Relevant Guidelines

DFO's *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters* (1998) apply to underwater blasting which may be required during the construction phase of the Project.

With respect to emissions from Project incinerators, the Canada-Wide Standards for Mercury (CCME, 2000) and Canada-Wide Standards for Dioxins and Furans (CCME, 2001) apply to incinerator stack testing.

The Government of Nunavut's *Environmental Guideline for Ambient Air Quality* establishes standards for common air contaminants in ambient air throughout Nunavut. Numeric standards for fine particulate matter, total suspended particulate, nitrogen dioxide, sulphur dioxide and ground level ozone are adopted under the Guideline. These standards should be applied as long term management goals for ambient air quality and are established at levels intended to protect human health, the environment and aesthetic properties of the environment.

There are no regulations or guidelines in Nunavut that address environmental noise levels. However, many projects in the Northwest Territories have adopted Alberta Energy Regulator Directive 038 Noise Control Guidelines (Alberta Energy Regulator, 2007) as indicative of what is generally considered acceptable with respect to noise levels from industrial activities in remote areas. Directive 038 Guidelines have been adopted for the Mary River Project.

2 PLANNING

2.1 OBJECTIVES

The goal of this Plan is to reduce or avoid adverse effects on the natural and human environment from Project-related air and noise emissions by meeting the following objectives:

- Meet air quality Project standards for SO_2, NO_2, and particulate matter ($PM_{2.5}$ and TSP)
- Control dust generation for the protection of cultural uses, vegetation and human health, and aesthetic impacts
- Control noise and vibration disturbance on seasonal human dwellings and regional wildlife use patterns

Baffinland and the QIA are implementing an adaptive management process into management plans developed for the Project (Section 2.3), and this includes the development of Inuit objectives and indicators in accordance with Commitment 18 of Appendix B of the Project Certificate, as noted in Table 2.1.

The above stated objectives will be achieved by:

- Listening to feedback from Inuit should they experience effects from dust that exceed culturally acceptable thresholds
- Ensuring appropriate mitigation measures are in place and followed to address community concerns and mitigate against adverse effects of air emissions (including greenhouse gas emissions), noise and vibration on the natural and human environment
- Compliance with Adaptive Management Plan objectives, thresholds, and response action requirements
- Meeting applicable Project standards for ambient air, dust, noise, vibration, and greenhouse gas emissions
- Implementing air quality, dustfall, and noise and vibration monitoring programs to confirm effectiveness of mitigations

2.2 CONSIDERATION OF INUIT QAUJIMAJATUQANGIT & LOCAL KNOWLEDGE

Baffinland views Inuit Qaujimajatuqangit (IQ) as central to the successful planning and operation of the Project. IQ is reflective of the Inuit knowledge transferred from generation to generation and captures knowledge of relationships and morality, core values and worldviews, as well as environmental knowledge. As identified in the Mary River Project Inuit Impact and Benefit Agreement (IIBA), IQ is beneficial for the Project and provides critical insights into the environmental, ecological, cultural and socioeconomic dimensions of the Project.

Given the importance of IQ, Baffinland developed an IQ Framework to guide its integration and use. The IQ Framework supports collaboration and decision-making throughout the life of the Project and accepts a broad definition of IQ that is not limited to that which is collected under a formal research license. The purpose of the IQ Framework is to identify procedures and provide guidance on the following;

- The processes through which IQ can be shared with Baffinland
- Schedule and timing for gathering and integration of IQ
- Roles and responsibilities of parties involved
- Processes and mechanisms through which IQ informs Project related decision-making

The IQ Framework also defines commonly used terms to support communication between parties and identifies the relationship between the IQ Framework and other management and monitoring plans, including the QIA's Inuit Stewardship Plan. For a greater understanding of the Projects general approach towards consideration of IQ, please refer to Baffinland's IQ Framework.

In addition to the general pathways that IQ has and will inform this Plan, there are several initiatives with specific relevance to this Plan worth noting here:

- Annual Dust Audit. The Annual Dust Audit, as required by Term and Condition 187 of the Project Certificate is supported by a Dust Audit Committee, comprised of representatives from each of the five (5) North Baffin communities. The Dust Audit Committee supports an annual audit of dust mitigation and monitoring across the Project, and drives recommendations that are submitted to Baffinland on an annual basis. These recommendations, as adopted have been and will be integrated into this Plan.
- North Baffin Hunters and Trappers Organizations membership in the Terrestrial Environment Working Group. Baffinland has agreed to resource the participation of 2 members of the MHTO and 1 member from each of the 4 remaining North Baffin HTO's in the Terrestrial Environment Working Group, where dust management is discussed as a standard agenda component.
- Project Certificate 005, Appendix B Commitments. Baffinland and QIA agreed to several commitments aimed at increasing the role of IQ in dust monitoring and mitigation. These include commitments by Baffinland to
    - resource and annual snowpack sampling and monitoring through the Inuit led dust monitoring program
    - resource the development of a snow quality metric, integrating traditional knowledge, as part of the development of Inuit OITRs related to dust.
    - Jointly approve with the QIA the adaptive management components of this Plan that relate to dust through a bilateral Adaptive Management Plan Working Group

2.3 Principles of Adaptive Management

Adaptive management is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. Adaptive management provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project.

Adaptive strategies are implemented when unanticipated adverse effects are observed, or if effects exceed identified thresholds. The management and mitigation of unanticipated adverse effects are most effective when there is collaboration between Baffinland, local stakeholders and regulators. If effects to the atmospheric environment exceed identified thresholds, Baffinland will implement a corresponding response as contained within the Trigger Action Response Plan (TARP; Section 5), or a reasonable alternative.

2.3.1 Defining the Adaptive Management Process

Baffinland has developed a draft Adaptive Management Plan (AMP) that provides the framework by which adaptive management is to be incorporated into Project operations (Baffinland, 2022b). The Project-wide adaptive management process begins with a planning phase, followed by iterative phases of implementing and monitoring the actions included in the plan(s), evaluating the effectiveness of actions included in the plans based on results of monitoring and other feedback mechanisms, and adjusting management strategies and actions and responses based on monitoring. The cycle begins anew with implementation and monitoring of a revised plan, which integrates the outcomes of the previous cycle. This cycle can occur, in real-time or over an extended period according to the nature of the situation or area of focus. In this way, a properly designed and well-implemented adaptive management process progressively diminishes uncertainty, as management strategies and processes are refined throughout a project's operational lifecycle.

Monitoring and responding to effects in the short-term is addressed in a Trigger Action Response Plan (TARP) described in Section 5. The TARP identifies the pre-defined actions to be taken should threshold levels be exceeded. A series of escalated actions to be implemented are detailed in Section 5. Longer term review of and response to monitoring data is addressed in an annual review of plan effectiveness in Section 6. The latter includes an annual comparison of project effects against impact predictions made in the Final Environmental Impact Statement (FEIS; Baffinland, 2012) and the addendums (Baffinland 2013, 2018, 2020, 2022a).

Implementation of the AMP will be informed by a Baffinland-QIA Adaptive Management Working Group. Ongoing inputs from the sources described in Section 2.2 above as well as Baffinland's ongoing project monitoring will also form the basis of amendments and refinements to the objectives, indicators, thresholds, and response requirements over time.

2.3.2 Adaptive Management Checklist for Environmental Management

Table 2.2 presents an adaptive management checklist developed for the Air Quality and Noise Abatement Management Plan, identifying how adaptive management has been incorporated into the current revision of the Plan."

TABLE 2-1 ADAPTIVE MANAGEMENT IN THE AQNAMP

Adaptive Management Phases	Components	Proposed Adaptive Management Mechanisms	Status of Management Plan
Plan	Objectives	Are objectives clear and key desired outcomes defined? Do they include Inuit objectives?	In Progress Objectives are stated in Section 2.1.
	Indicators	Are performance indicators adequately identified? Do they include Inuit defined indicators?	In Progress Indicators are tied to objectives in Section 2.1 and are presented in a TARP table in Section 5.
	Identification of Thresholds	Are thresholds for specific responses identified (e.g., early warning triggers, action levels, quantitative	In Progress Thresholds are presented in Section 3.1. Development of low, moderate and high action thresholds where practicable, through application of the TARP method in Section 5.

Adaptive Management Phases	Components	Proposed Adaptive Management Mechanisms	Status of Management Plan
		metrics or qualitative descriptions)?	
	IQ Integration / Influence	Are mechanisms for IQ integration/influence identified?	In Progress
Implement and Monitor	Management Strategies and Responses	Are management strategies and response options clearly identified?	In Progress Actions and management strategies are built into the TARP in updated Section 5.2 and Mitigation Toolkit in Section 5.3.
	Resourcing	Are all phases of the adaptive management cycle properly resourced (in accordance with Inuit Agreements) to be fully implemented?	In Progress
	Monitoring	Does the monitoring program provide the information needed to determine the effectiveness of management strategies and responses?	In Progress Section 5 presents Baffinland-led monitoring activities related to the AQNAMP.
Evaluate and Learn	Review Data and Feedback	Is the process for reviewing and evaluating management effectiveness (based on monitoring data and feedback) articulated?	The review process for plan effectiveness is outlined in Section 6
	Additional Mitigation	Are mechanisms for determining the need for additional mitigation described?	In Progress Section 5 identifies actions to be undertaken according to various triggers. Need for additional mitigation is determined based on results of monitoring programs described in Section 5.
	Input of IQ Holders	Are opportunities identified for IQ holders to review results and provide input into adaptive management responses / mitigations?	In Progress To be discussed with Inuit Committee

Adaptive Management Phases	Components	Proposed Adaptive Management Mechanisms	Status of Management Plan
Adjust	Unanticipated Adverse Effects or Issues	Is it apparent how unanticipated adverse effects or issues will be actioned and resolved?	In Progress Section 6 (Figure 6.1) describes the process for incorporating repeat non-compliance and unanticipated effects into future plan updates.
	Reporting	Are reporting mechanisms for new / revised strategies and response actions established?	In Progress Section 6 describes the process for reporting mechanisms for new / revised strategies.
	Scheduled Updates	Is the frequency of scheduled updates to the management plan identified?	A review of the plan is provided in Table 6.1.

2.4 Project Design Considerations

Baffinland has incorporated various mitigation measures in Project planning and design which will reduce Project-related air and noise emissions, many of which will be implemented for the life of the Project. Examples of mitigation by design are described below.

2.4.1 Reduction of Dust, Air Contaminants, and Greenhouse Gas Emissions

- **Procurement Policy** - Baffinland`s procurement procedures will incorporate air emissions and noise standards for the purchase of all equipment and machinery used at the Project. Emission and noise standards will be based on Nunavut or Canadian regulatory guidelines, or best available technologies. Where new equipment is required, this includes purchase of the highest available tier engines for mobile equipment and power generation, where practicable.
- **LED Diesel-powered Lighting** - In 2018, Baffinland replaced all diesel-powered lighting systems at the crusher with high efficiency LED lights. This efficiency has reduced annual diesel fuel consumption by 30,000 L.
- **Fuel Supply** - Throughout the life of the project, Baffinland will endeavour to secure sources of fuel low in contaminants (low-sulphur fuel).
- **Improvements to Crushing and Stockpiling Operations** – The following Project design changes will contribute to dust control during crushing operations:
    - Installation of shrouding and other engineered controls on conveyors and the shiploader
    - Minimizing drop distances (i.e., using adjustable stackers) for stockpiling activities

- **Power Supply** - Baffinland will investigate opportunities to use renewable energy sources and conventional power generators with higher emissions standards to reduce criteria air contaminants (CAC) emissions. Baffinland installed new GE low speed generators.
- **Heat Recovery Systems** - Baffinland is also currently investigating using thermo-electric or fluid heat exchange heat recovery systems from diesel generator exhaust and incinerator capture, however the feasibility of this is yet to be confirmed.
- **Exhaust Stack Design** - Exhaust stacks for power generators will be clustered within one to two stack diameters of each other to enhance plume rise, thereby reducing ground-level concentration of air contaminants.
- **Road Transportation Measures**– Coarse granular material will be used for road construction and well-defined haul routes will be used to reduce surface disturbance and reduce dust emissions during transportation. Note that aggregate calibre is a function of tire size and truck payload. Having too coarse aggregate for a certain size of equipment may cause damage and should be considered in final aggregate size selection.
- **Marine Vessel Operations** - Baffinland will continue to investigate and implement mitigation measures to reduce CAC emissions from large vessels, including use of alternative fuel and higher emission standards, but there is a limited ability to control the types of vessels and fuels used in shipping to and from the site. Baffinland contracts market vessels that comply with all international and domestic standard regulations which would include the choice of fuel of its carriers. Baffinland will discuss with our shipping partners whether feasible opportunities exist to reduce these sources of emissions. In 2020, a new sulphur cap was introduced to marine fuels; and vessels now either burn diesel or a fuel oil product that meets the sulphur cap requirements.

2.4.2 Reduction of Noise Emissions

The following mitigation will be incorporated into Project design to reduce noise emissions:

- Confirm that all internal combustion engines are fitted with appropriate muffler systems.
- Utilize acoustical screening from existing on-site buildings to shield dwellings from construction equipment noise.
- Discuss option of re-locating the Hunter and Trapper Organization (HTO) cabin outside the area of disturbance with community members and Mittimatalik HTO.

3 IMPLEMENTATION

This section describes the mitigation measures to be implemented in the event of the exceedance of an air quality, noise and vibration, or greenhouse gas threshold.

3.1 Thresholds

Thresholds are an important element of adaptive management (Section 2.3) and the establishment of TARPs (Section 5). Standards have been developed for air quality, noise and vibration in consideration of application federal, provincial and/or territorial legislation and guidelines. These standards are described below in the context of applicable regulatory frameworks.

3.1.1 Ambient Air Quality

Ambient air quality guidelines and objectives are non-statutory limits (i.e., not legally binding) used to assess ambient air quality and guide air management decisions. Ambient air is defined as the air outside (beyond) an industrial property fenceline (also referred to as the Potential Development Area or PDA) where public access is restricted. The air quality inside of the fenceline is considered an occupational workplace and is assessed using different standards. In Nunavut, workplace air quality is protected by the Schedule O Contamination Limits provided in the Nunavut Occupational Health and Safety Regulations (NU Reg 003-2016, http://canlii.ca/t/52qsb). The exception to this situation is the comparison of the SO_2 and NO_2 monitoring data at the Milne Port and Mine Site accommodation buildings that is being compared to the Nunavut Ambient Air Quality Guidelines.

The Government of Nunavut has established ambient air quality guidelines for several criteria air contaminants (CACs): total suspended particulate matter (TSP), particulate matter with an aerodynamic diameter of <2.5 µm ($PM_{2.5}$), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) (Government of Nunavut, 2011). Table 3.1 presents the air quality guidelines and objectives adopted by the Project for the CACs, which are consistent with those applied in the air quality assessment completed as part of the Addendum to the Final Environmental Impact Statement (FEIS) for the Phase 2 Proposal (RWDI, 2018a, 2018b; Knight Piésold, 2018). An updated air quality assessment and modelling was completed for 6 Mtpa and is included as Appendix G.

Canadian Ambient Air Quality Standards (CAAQS) were established as objectives under Sections 54 and 55 of the *Canadian Environmental Protection Act*, 1999 on May 25, 2013. The 2020 CAAQS are presented in Table 3.2 (ECCC, 2018). The 2020 CAAQS are not facility-level regulatory standards that are to be enforced at a property fenceline (also referred to as the Potential Development Area (PDA) boundary). The 2020 CAAQS are included in Table 3.2 for comparison purposes, although the adopted Project Standard for each CAC is based on the Nunavut standards or a provincial or Health Canada surrogate.

CAAQS were developed by the Canadian Council for the Ministers of the Environment (CCME) to manage air emissions and ambient air quality concentrations in a regional airshed; CAAQS are not intended to determine compliance at the fenceline for an industrial facility. Fenceline standards for ambient air quality are typically specified in the Project Certificate or the waste discharge (air) permit authorization – different jurisdictions use different regulatory instruments to identify the conditions that need to be met in order to maintain regulatory compliance with respect to ambient air quality. CAAQS are best suited as a tool to manage air emissions in regional airsheds that have multiple industrial sources. Regional airsheds typically have larger groups of sensitive receptors (i.e. vulnerable populations such infants, elderly and those with respiratory ailments), major industrial air emissions and opportunities for achievable emission reductions. These airsheds often have multi-pollutant management needs. Regional airsheds differ based on the unique characteristics of local geography, meteorological conditions, and composition of human activity, including industrial activity.

TABLE 3-1 STANDARDS AND OBJECTIVES FOR AMBIENT AIR QUALITY

Criteria Air Contaminant	Averaging Time	Units	Nunavut Ambient Air Quality Standards[1]	Northwest Territories Ambient Air Quality Standards[2]	2020 CAAQS[3]	Project Standard[5]
SO_2	1 hr	µg/m³	450	-	183.35[4]	450
	24 hr	µg/m³	150	-		150
	Annual	µg/m³	30	-	13.10[4]	30
NO_2	1 hr	µg/m³	400	-	112.85[4]	400
	24 hr	µg/m³	200	-		200
	Annual	µg/m³	60	-	31.97[4]	60
CO	1 hr	µg/m³	-	-	-	15,000
	8 hr	µg/m³	-	-	-	6,000
TSP	24 hr	µg/m³	120	-	-	120
	Annual	µg/m³	60	-	-	60
$PM_{2,5}$	24 hr	µg/m³	30	-	27	30
	Annual	µg/m³	-	10	8.8	10

Notes:

1. Government of Nunavut (2011).
2. Northwest Territories (GNWT, 2014).
3. 2020 Canadian Ambient Air Quality Standards (2020 CAAQS) provided for context, not intended for use at facility fenceline for compliance (CCME, 2014).
4. CAAQS for these parameters are provided in parts per billion (ppb); these have been converted to µg/m3 by the equation: Concentration (µg/m3) = 0.0409 x Concentration (ppb) x molecular weight (Boguski, 2006).
5. Project Standards are from Nunavut Standards where available, or otherwise the most stringent available from a Provincial or Territorial Government.

Baffinland has committed to advancing an ambient air quality monitoring framework in consultation with the Government of Nunavut and ECCC. The potential applicability of the 2020 CAAQS to the Project was considered as part of the monitoring framework and it was determined that the 2020 CAAQS would be used for comparison purposes only with the objective to “keep clean areas clean” with respect to ambient air quality. Health Canada has requested to be kept apprised of the discussions with ECCC on the application of the CAAQS and any updated air quality monitoring.

3.1.2 Source Emissions

The Government of Nunavut (2012) Guideline for the Burning and Incineration of Solid Waste has adopted the Canada-wide standards for mercury and dioxins and furans applicable to emissions from incinerators (CCME, 2000, 2001). These are applicable to stack testing conducted on the Project’s incinerators (Section 5.4.5). The standards for incinerator emissions are presented in Table 3.2.

TABLE 3-2 INCINERATOR STACK EMISSIONS STANDARD

Air Contaminant	Standard[1]	Explanation
Mercury	20 µg / Rm^3 @ 11% v/v O_2	Unit of measure is picograms of International Toxicity Equivalents per cubic metre of air
Dioxins and furans	0.08 ng TEQ / Rm^3 @ 11% v/v O_2	Unit of measure is micrograms per Reference cubic metre (the volume of gas adjusted to 25° C and 101.3 kilopascals)

Notes:
1. CCME, 2000; CCME, 2001.

3.1.3 Dust Thresholds

3.1.3.1 Inuit Thresholds

Inuit thresholds related to dust will be proposed by the QIA through the development of Inuit Stewardship Plan. Once made available and agreed to, they will be included in this Plan as appropriate. Relevant Project Certificate, Appendix B commitments are summarized below for reference.

TABLE 3-3 PROJECT CERTIFICATE APPENDIX B COMMITMENTS

ID	Commitment
026	Baffinland agrees to resource Inuit-led monitoring, updated Early Warning Indicator, Inuit Objectives, Thresholds, Responses consistent with Condition No. 8.
028	Baffinland agrees to resource QIA to establish an Inuit-led monitoring program on dustfall as an Inuit Stewardship Pilot program to establish the mechanisms needed to allow Inuit observations to influence mitigation measures and test appropriate Adaptive Management Plan structures, which are demonstrably responsive to Inuit Objectives Indicators Thresholds and Responses, with the budget and work plan agreed upon by Baffinland and QIA consistent with Condition No. 8.
043	Baffinland to resource annual snowpack sampling and monitoring through the Inuit led dust monitoring program (see related commitment in the global list related to Inuit led monitoring). Note – Baffinland accepts a funding role but wants to ensure it does not duplicate efforts already agreed to in relation to the Inuit led dust monitoring program.

3.1.3.2 Effects to Vegetation

There are no known dust deposition thresholds specific to effects on vegetation. Health Canada and Environment and Climate Change Canada's (ECCC) national ambient air quality objectives for particulate matter (CEPA/FPAC Working Group, 1998) state that for the lack of quantitative dose-effect information, it is not possible to define a reference level for vegetation and dust deposition. Impacts to vegetation/soil base metals are assessed as a component of the Terrestrial Environment Mitigation and Monitoring Plan (Baffinland, 2023a).

3.1.3.3 Human Health

Dustfall monitoring is not specifically relevant to human health. In June 2020, BC Ministry of Environment and Climate Change Strategy (BC ENV) published a technical guidance document on dustfall monitoring (*Dustfall Monitoring and Pollution Control Objectives).* In it, BC ENV states it no longer supports dustfall monitoring or the use of dustfall objectives, partly because their "effectiveness for determining impacts on human or environmental health (soil, water, vegetation) is extremely limited." Overall, dustfall monitoring results are poor indicators for metals effects monitoring. Instead, if the objective is to protect human health, BC ENV recommends that monitoring of fine particulate matter (e.g., $PM_{2.5}$) is more appropriate, including "compliance with associated Ambient Air Quality Objectives." In addition, if the objective is to monitor the accumulation of metals in the environment, including traditional foods, sampling of the relevant media is considered more appropriate.

As there are no health-based dustfall guidelines available for dust and because the recommended approach for assessing the potential impacts on human health is to monitor other contaminants in air and the constituents of dust (i.e., metals) in other environmental media, project standards for the protection of human health are not provided for dustfall monitoring.

3.1.3.4 Noise

There are no regulations or guidelines in Nunavut that address environmental noise levels. However, noise has been addressed in recent EISs developed for other mining projects in Nunavut (i.e., Meadowbank Gold Project, Doris North Gold Project, High Lake Project). These projects and other projects in the NWT have adopted Directive 038 Guidelines (Alberta Energy Regulator, 2007) as indicative of what is generally considered acceptable with respect to noise levels from industrial activities in remote areas. Directive 038 guidelines have been adopted for the Mary River Project. For an overview of Directive 038, see Table 3.4.

TABLE 3-4 ENERGY RESOURCES CONSERVATION BOARD DIRECTIVE 038 GUIDELINES

General Format of Directive 038	Directive 038 sets out permissible sound levels (PSLs), which must be met at all dwellings surrounding the Project development. These limits apply to operational noise only. The cumulative sound level from all energy-related (in this case Baffinland-related) development in the area is measured or predicted. This is called the comprehensive sound level (CSL) and is compared against the PSL. The CSL includes background ambient sound levels. The base PSL value is 40 dBA, which is based on a typical rural or remote ambient sound level (ASL) of 35 dBA, plus 5 dBA allowance for the industrial activity (Alberta Environment research showed that in general, people tolerate sound from energy facilities of up to 5 dBA above the ambient sound environment). The PSL can be increased to account for the presence of other industrial or transportation noise sources, such as road and rail traffic, and for the population density of developed areas. In remote pristine areas, an ASL adjustment, based on measured existing sound levels, can be applied, which might reduce PSL at these locations. For areas where there are no dwellings, a sound level limit of 40 dBA 1.5 Km from the facility fence is applied.
Dwellings	A dwelling is defined in Directive 038 as a permanently or seasonally occupied residence, including trailer parks and campgrounds in regular consistent use. For assessment, the only dwelling near Baffinland-related activities is a seasonally occupied hunt camp at Milne Inlet. Worker residences, dormitories, and construction camps are specifically excluded as dwellings under Directive 038.

Noise Limit for Remote Area	Where no noise-sensitive receptors are located within 1.5 Km of the facility, the CSL from the facility (facility noise plus ambient) must meet a PSL of 40 dBA Leq (night) measured at 1.5 Km from the facility fenceline.

3.1.3.5 Noise Limit at Fenceline

The fence line is not defined for facilities such as those at the Baffinland sites, where there is no fence or other fixed facility boundary. For this management plan, the Potential Development Area (PDA) was used as a proxy for the fence line. Thus, the PSL for the Mine Site is 40 dBA at 1.5 Km from the PDA.

3.1.3.6 Noise Limit for Work Camps

Work camps such as those associated with the Project are specifically excluded from the requirements of Directive 038. These camps were considered, however, as it is important for worker health to maintain an adequate sleep environment. In the original assessment for the project, an interior maximum noise limit of 75 dBa was identified by NIRB. This limit has been adopted from a Health Canada guideline *"Guidance for Evaluating Human Health Impacts in Environmental Assessment: NOISE – Health Canada"*, and is based on a nationally recognized noise limit over a 24-hour period where noise exceeding this level results in sleep disturbance and noise complaints. This is also a level that falls well below an occupational exposure over a theoretical 24-hour work shift. Therefore a noise limit of 75dBa at the accommodations has been adopted for the ProjectVibration

Vibration impacts can be broken down into two zones: terrestrial (above ground, on land) and underwater.

3.1.3.7 Terrestrial

Human perception of ground-borne vibration can be ranked as follows (Bender, 1996):

- Barely to distinctly perceptible - 0.5 to 2.5 mm/s ppv
- Distinctly to strongly perceptible - 2.5 to 6.25 mm/s ppv
- Strongly perceptible to mildly unpleasant – 6.25 to 25.4 mm/s ppv
- Increased potential for structural damage - 12.5 to 25.4 mm/s ppv.

The potential for structural damage increases for airborne vibration overpressure in excess of 120 dB (MOE, 1997).

3.1.3.8 Underwater

Fisheries and Oceans Canada (DFO) has produced *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters* to protect marine wildlife, including fish and marine mammals from underwater vibrations (DFO, 1998). Highlights of the guideline include the following:

- No explosive is to be knowingly detonated within 500 m of any marine mammal (or no visual contact from an observer using 7 x 35 power binocular).
- No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa in the swim bladder of a fish.

- No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during the period of egg incubation.

The guideline also presents tables of weight of explosive change versus distance and other estimation methods are provided to determine the potential impacts. This guideline is relevant mostly for the construction phase of the Project (construction of docking facilities, creek/river crossings).

3.1.4 Greenhouse Gas Emissions

There are currently no thresholds for Greenhouse Gas (GHG) emissions for the Mary River Project, as there are no regulatory guidelines or standards currently available. Baffinland will continue to implement the Climate Change Strategy for the reduction of GHGs and will evaluate the need for numerical standards through the life cycle of the Project, should best practice or regulatory guidance evolve to develop these values.

Environment and Climate Change Canada current GHG reporting requirements stipulate that all persons who operate a facility that emits 10,000 tonnes of CO_2eq or more of GHGs in a calendar year are subject to the reporting requirements and must report their emissions information to Environment and Climate Change Canada (ECCC, 2019). The legal basis for the GHG reporting program is the Notice published annually in the Canada Gazette, Part I, under the authority of subsection 46(1) of the *Canadian Environmental Protection Act*, 1999.

In addition, the Nunavut Climate Change Strategy was outlined in 2003 (Government of Nunavut, 2003). One of the objectives of this strategy is to "encourage Nunavummiut, including government, non-government, industry, and the public to take action to control greenhouse gas emissions through energy management and alternative energy supply technology."

3.2 Life of Project Mitigation Measures

Mitigation measures that will be implemented over the life of the Project to minimize identified or potential adverse impacts on air quality, noise, and vibration are outlined in this section. In addition to the Project design measures (see Section 2.4), Baffinland has initiated several mitigation strategies around mobile and stationary equipment to reduce fuel consumption and associated emissions including CACs and GHGs.

3.2.1 Idling Policy

Baffinland implemented an idling policy at the Project Site in 2017, to reduce unnecessary vehicle and equipment idling (Baffinland, 2017). Employees are required to follow the Idling Policy where manufacturer guidelines for warm-up periods are readily available. Where specific manufacturing guidelines are not provided, idling times are restricted to a maximum of 10 minutes for light vehicles and 20 minutes for heavy vehicles and equipment in -20°C or below, and a maximum of 5 minutes for light vehicles and 10 minutes for heavy vehicles and equipment when the ambient temperature is between 0 to -20°C.

3.2.2 Scheduled Maintenance Program

Mobile equipment and stationary combustion equipment (e.g., generators, boilers, and waste incinerators) will be subjected to a routine maintenance schedule to ensure that emissions are in line with emission criteria and vendor`s specifications on emissions.

3.2.3 Occupational Health and Safety

At all times, workplace conditions will be in compliance with OSHA standards for workplace ambient air quality and noise. When and where necessary, employees will be provided with hearing protection and respiratory masks for work in dusty environments. Health and safety procedures and standards will be strictly enforced throughout the life of the Project.

3.2.4 Waste Segregation for Incinerator Operation

Diversion of waste streams such as paper, glass, and plastic recyclables will be assessed for feasibility. Open-air burning will be limited and will only involve paper and chemical (e.g., glue, paint) free, untreated wood products. Refer to the Waste Management Plan for further details on waste segregation protocols (Baffinland, 2020).

3.2.5 Vehicle Traffic

Vehicle traffic at the Mine Site and the Tote Road to Milne Port is the major contributor to dust generation. Dust generation is more pronounced through the summer months. To minimize dust generated by vehicular traffic, Baffinland will:

- Limit speed of vehicles on all roads, and
- Use dust suppressant as required.

An additional 13 water sources are proposed for dust suppression along the Tote Road with an increase in the daily allowable water withdrawal for dust suppression from 1,500 to 2,600 m^3/day.

Baffinland uses calcium chloride (CaCl) as a dust suppressant on roads, and is continually evaluating alternatives to CaCl, including a polymer with the trade name DUST/BLOKR®. A non-corrosive alternative to CaCl called EK-35 is used on the airstrip. Refer to the Roads Management Plan for further details on mitigation measures and protocols associated with vehicle traffic (Baffinland, 2023b).

3.3 Construction and Closure Phase Mitigation Measures

3.3.1 Air Emissions and Dust Control

For the construction and closure phases, emissions sources include mobile equipment used for construction and the earthwork activities involved in preparing sites for Project infrastructure, roads, borrow pits, and quarry operations.

Activity-specific mitigation measures are outlined in the following management plans:

- Environmental Protection Plan (EPP)
- Borrow Pit and Quarry Management Plan
- Roads Management Plan

Best management practices for dust control to be implemented throughout the construction and closure phases include:

- Watering roads, as necessary, to reduce visible plumes when it is practical to do so (e.g., when temperatures are above freezing)

- Using other dust suppressants (i.e., $CaCl_2$ and other environmentally friendly products) as appropriate
- Limiting traffic to essential use over construction areas
- Limiting speed over construction areas

Principal contingencies for dust control are increased frequency of water spraying, and selection of a more effective dust suppressant in the case of road dust.

3.4 Operation Phase Mitigation

3.4.1 Milne Port

Specific actions that have been implemented, or could be further implemented by Baffinland for dust management at Milne Port have included:

- proper positioning of the conveyors to minimize ore drop distances when stockpiling
- installation of rubber bellows at the end of each stacker to minimize dispersion of dust generated during the fall
- installation of chutes on the shiploader to prevent windblown dust during loading operations
- installation of shrouding at the discharge end of the ore stackers to reduce the effect of windblown dust during stacking activities
- optimization of ore handling dust controls to minimize fugitive emissions at transfer points
- removal of dust impacted snow at strategic locations at the project.

Baffinland also has explored the application of a non-toxic substance to coat the outside of stockpiles and acts as a sealant to prevent lift-off of dust from the stockpiles. Various products have been considered by Baffinland although some were dismissed as unsuitable for trial because they either impacted the moisture content or altered the chemistry of the ore which would impact the final ore product and make it unsuitable for shipment to customers.

In 2020, Baffinland conducted a trial application of a specialized crusting agent (DusTreat®) to the ore stockpile to reduce wind erosion and mobilization of fine iron ore particles. This type of application had been shown to be effective at reducing dust from stockpiles at other sites, is known to last for months, and is rain resistant and non-toxic. The product is mixed with water and distributed onto stockpile surfaces using a manually-controlled sprayer. The fluid product then hardens to form a protective crust after it is applied to stockpile surfaces.

Product performance is being currently being evaluated using data obtained from existing dustfall monitoring programs and remote sensing of dust deposition using available satellite imagery to determine suitability for long term use. Should monitoring indicate mitigation measures have not been effective in reducing dust around Milne Port, Baffinland will work with QIA to investigate and agree to additional mitigation measures.

3.4.2 Northern Transportation Corridor Operations

3.4.2.1 Tote Road

Ore haul traffic is expected to be the main source of dust generated along the Tote Road. Mitigation measures to minimize dust emissions include regulating speed limits and utilizing water and dust suppressants during snow free months.

Based on feedback received from communities, the QIA and other regulators, Baffinland actioned an implementation plan for testing new dust suppression products with increased durability and longevity for site infrastructure and approved for use in Nunavut on unpaved roads. The use of DUST/BLOKR®, produced by Cypher Environmental, was first trialed in August of 2019 over a 4 Km stretch (from KM 103.5 to KM 97) of the Tote Road and subsequently applied along the entire Tote Road in 2020. Product performance is currently being reviewed and evaluated to determine suitability for long term use. DUST/BLOKR®, calcium chloride, and water only dust suppression trials were initiated along the entire length of the Tote Road and qualitative performance was assessed in 2022. Trials will continue with more quantitative performance indicators being assessed in 2023. Should these trials indicate DUST/BLOKR® is not a feasible product for its intended purpose along the Tote Road, Baffinland will continue to investigate the use of other alternative dust suppressants and report on their effectiveness accordingly.

3.4.3 Aircraft Operation

Although aircraft will be a source of air emissions, dust, and noise, given the intermittent nature of this source and the short aircraft operation times in the Project area, air quality and noise impacts of aircraft use are expected to be minimal. Dust suppressant will be used on the airstrips as required. No other specific air quality or noise mitigation measures are provided for aircraft operation.

3.4.4 Marine Vessel Operation

During the open water season, Panamax and Capesize ore carriers will dock at Milne Port. In addition to ore carrier operation, tugs will be operating to assist the ships and resupply barges in navigation at the port.

In addition to Project design considerations (see Section 2.4), including Baffinland's commitment to continue to investigate and implement mitigation measures to reduce CAC emissions from large vessels, including use of alternative fuel and higher emission standards, the following mitigation measures will be implemented to control noise during marine vessel operations:

- Minimize vessel traffic at Milne Port to the extent best practicable.
- Reduce vessel speeds when transiting along the established shipping corridor and operating in Milne Port.

3.5 Greenhouse Gas Emissions Reduction Program

Baffinland will continue to develop its Climate Change Strategy and benchmark its operation against other similar mining operations.

4 ROLES AND RESPONSIBILITIES

Resourcing is an important element of environmental management. This section outlines the roles and responsibilities of Baffinland staff, as well as QIA staff with a role in environmental management.

4.1 Construction

The personnel responsible for implementing this plan and their respective roles during the construction phase of the Project are described in Table 4.1. Professional Engineers and/or Professionals Geoscientists and Traditional knowledge holders shall fill roles as appropriate.

TABLE 4-1 CONSTRUCTION PHASE ROLES AND RESPONSIBILITIES FOR AIR QUALITY AND NOISE ABATEMENT MANAGEMENT

Position	Responsibilities
General Manager - Owner	• Reports to the Chief Executive Officer • Responsible for providing oversight for construction in support of the ongoing operation and allocating the necessary resources for construction management
Construction Manager – Contractor	• Reports to the General Manager • Responsible for providing oversight for all Project construction and allocation of Contractor resources
QIA Regulatory Manager (IIBA)	• Directs QIA's onsite environmental resources • Liaise with Baffinland's Permitting and Compliance Manager and/or Environmental Superintendents • Reviews regulatory submissions on behalf of the QIA • Member of the QIA-Baffinland Adaptive Management Working Group
QIA Environmental Monitor (IIBA)	• Monitors implementation of commitments, environmental compliance, and QIA interests • Participate in routine compliance inspections and monitoring alongside Baffinland staff • Participate follow-up corrective action undertaken regarding non-compliance events including spills • Weekly reporting to the QIA Regulatory Manager • Presents annual monitoring data to communities • The core responsibilities of this position are described completely in the IIBA
Departmental Manager / Superintendent - Owner and Contractor	• Reports to the General Manager • Responsible for providing departmental oversight for all Project construction
Environment Department	• Report incidents to senior management and the appropriate regulatory agencies and stakeholders • Conduct inspections and monitoring to ensure compliance with applicable regulations and commitments • Provide training sessions to departments on the appropriate mitigation measures and strategies for managing air and noise emissions at the Project
All Departmental Supervisors	• Reports to the Departmental Manager / Superintendent

Position	Responsibilities
	• Responsible for reading and understanding applicable sections of this Plan and directing departmental personnel on the appropriate mitigation measures and strategies for managing air and noise emissions in their Project area
All Project Personnel	• All Project personnel will be responsible to comply with the requirements of the Plan in the management of air and noise emissions of the Project

4.2 OPERATIONS

The personnel responsible for implementing this plan and their respective roles during the operations phase of the Project are described in Table 4.2. Professional Engineers and/or Professionals Geoscientists shall be used as appropriate.

TABLE 4-2 OPERATIONS PHASE ROLES AND RESPONSIBILITIES FOR AIR QUALITY AND NOISE ABATEMENT MANAGEMENT

Position	Responsibilities
Chief Operations Officer (COO)/General Manager	• Reports to the Chief Executive Officer • Responsible for providing oversight for all Project operations and allocating the necessary resources for the operation, maintenance and management of Project infrastructure
Mine Operations Manager/Superintendent	• Reports to the COO / General Manager • Provides oversight for all Deposit No. 1 mining operations, including the operation, construction and maintenance of surface water management infrastructure at Deposit No. 1 mining areas, Waste Rock Facility and along the Mine Haul Road, • In communication with the Environment Department, develop response plans to possible air and noise emission issues
Crushing Manager/Superintendent	• Reports to the COO / General Manager • Provides oversight for all ore crushing operations, including the operation, construction and maintenance of surface water management infrastructure at Mine Site Crusher Facility • In communication with the Environment Department, develop response plans to possible air and noise emission issues
Site Services Manager/Superintendent	• Reports to the COO / General Manager • Provides oversight for all Site Services operations, including the operation, construction and maintenance of Project service roads at the Mine Site and Milne Port • In communication with the Environment Department, develop response plans to possible air and noise emission issues
Road Maintenance Manager/Superintendent	• Reports to the COO / General Manager • Provides oversight for all Road Maintenance operations, including the operation, construction and maintenance of the Tote Road that runs between Milne Port and the Mine Site • In communication with the Environment Department, develop response plans to possible air and noise emission issues

Position	Responsibilities
Environmental Manager/Superintendent	• Support the management of the Project surface water management infrastructure by advising on-site environment staff and obtaining the appropriate regulatory approvals for necessary changes and modifications • Advise the Environmental Coordinator and/or Technician on the implementation of the appropriate controls to manage air and noise emissions from the Project • Manage all on-site air quality (including dustfall) and noise monitoring programs at the Project, discussed in Section 5 of this Plan • Conduct inspections and monitoring to ensure compliance with applicable regulations and commitments • Report incidents to senior management and the appropriate regulatory agencies and stakeholders • Provide training sessions to operational departments on the appropriate mitigation measures and strategies for managing air and noise emissions at the Project • The on-site Environmental Superintendent in concert with the corporate Sustainable Development team is responsible for data management and reporting related to air and noise management and monitoring
QIA Regulatory Manager (IIBA)	• Directs QIA's onsite environmental resources • Liaise with Baffinland's Permitting and Compliance Manager and/or Environmental Superintendents • Reviews regulatory submissions on behalf of the QIA • Member of the QIA-Baffinland Adaptive Management Working Group
QIA Environmental Monitor (IIBA)	• Monitors implementation of commitments, environmental compliance, and QIA interests • Participate in routine compliance inspections and monitoring alongside Baffinland staff • Participate follow-up corrective action undertaken regarding non-compliance events including spills • Weekly reporting to the QIA Regulatory Manager • Presents annual monitoring data to communities • The core responsibilities of this position are described completely in the IIBA
All Departmental Supervisors	• Reports to the Departmental Manager / Superintendent • Responsible for reading and understanding applicable sections of this Plan and directing departmental personnel on the appropriate mitigation measures and strategies for managing air and noise emissions in their Project area • Report any visual observations, or reports, of dust control issues to the Environment Department • Assist in implementing appropriate dust control measures
All Project Personnel	• All Project personnel will be responsible to comply with the requirements of the Plan in the management of air and noise emissions at the Project • Report any visual observations of dust accumulation, erosion and sediment issues to their respective supervisors • Report any visual observations, or reports, of dust control issues to their supervisors • Assist in implementing appropriate air and noise abatement measures

5 MONITORING

5.1 Data Assessment and Response Framework

Monitoring data collected through the AQNAMP requires a systematic data evaluation process, as well as management responses that would be taken, in response to certain data evaluation outcomes. A common assessment (data evaluation) and management response framework will be implemented. This multi-step process includes the following:

Step 1 - Data Management and Evaluation

This step includes the QA/QC; comparisons to the thresholds and to reference and/or baseline; and review of the data using various tools such as Exploratory Data Analysis (EDA) and Statistical Data Analysis (SDA), to determine if change is occurring. A change may be detected statistically or qualitatively, relative to benchmarks, baseline values and/or spatial or temporal trends. A change may be statistically significant, but professional judgement may also be applied using the various evaluation tools to detect a change qualitatively.

If Step 1 does not detect change, then no action is required. If a change is observed, then further evaluation of the data for that/those indicator(s) will be carried out under Step 2.

Step 2 - Determining Whether the Observed Change is Project-Related

Step 2 involves determining if the changes in the indicator(s) of concern are due to the Project or due to natural variability or other causes. This will include, as needed, an evaluation of both Project-related and non-Project related activities to assess potential influences of these factors in the observed change. This question can be addressed using EDA and subsequently using SDA. EDA will be completed to visualize overall data trends, and could include evaluating spatial patterns, to examine the spatial extent and pattern of observed changes.

Exploratory data analyses could include comparisons of data from reference and potential impact areas and from baseline and operational monitoring for BACI programs. This can further assist with determining whether the observed changes were due to natural variability, other anthropogenic activities in the vicinity of the Project, or the Project.

If the Step 2 analysis concludes that the changes in monitoring parameters of concern are, or are likely, due to the Project, the assessment will proceed to Step 3. If it is concluded the observed differences relative to baseline conditions are not due to the Project, no management response will be required.

Step 3 - Determine Action Level

If the evaluation conducted in Step 2 has indicated with some certainly that the measured change is Project-related, Step 3 involves determination of the action level associated with the observed monitoring results through comparisons to the benchmark. Three (3) levels of action have been identified: low, moderate, and high; and the response actions range from increased monitoring and data analysis (e.g., trend analysis); identification of possible sources; to risk assessment and/or mitigation. The Trigger Action Response Plan (TARP) presented in Table 5.1 outlines the thresholds and responses for each action level. Where actions cannot be specified based on factors such as the number of potential sources, evaluation of project contribution, and severity of the action, the moderate and high level of action refer to the Mitigation Toolkit presented in Section 5.3.

5.2 Trigger Action Response Plan

TABLE 5-1 AQNAMP TRIGGER ACTION RESPONSE PLAN

Project Activity	Objectives	Performance Indicators	Monitoring Program / Plan	Condition Status / Threshold			Pre-defined Response(s)		
				Low Risk	**Moderate Risk**	**High Risk**	**Low Risk**	**Moderate Risk**	**High Risk**
Life of Project	Meeting SO_2 and NO_2 air quality Project standards	SO_2 and NO_2 monitoring data Project Standard(s); • 30 µg/m³ averaged annually for SO_2, and • 60 µg/m³ averaged annually for NO_2	Continuous ambient air quality monitoring of SO_2 and NO_2 at Milne Port camp and the Mine Site camp	Measured annual average SO_2 and NO_2 concentrations are greater than 90% of the annual ambient air quality Project standards	Measured annual average SO_2 and NO_2 concentrations are above the annual ambient air quality Project standards	Measured annual average SO_2 and NO_2 concentrations are above the annual ambient air quality Project standards for two (2) or more successive years	Env't Dept: Review Project sources that may be attributable for the increase. Continue monitoring to determine if elevated levels are sustained or continuing to increase. Review compliance with relevant policies and procedures (i.e. idling policy). Operations Dept: Review schedule and procedures for ongoing maintenance for stationary and mobile diesel-powered equipment	Env't Dept: Identify the Project sources and/or root cause for exceedances of standards. Continue monitoring to assess effectiveness of mitigation measures, and determine if elevated concentrations are sustained Operations Dept: Implement responses from the Mitigation Toolkit (or new mitigation developed through investigation) Identify high risk mitigation measures for future implementation if needed.	Env't Dept: Identify the Project sources and/or root cause for exceedances of standards. Continue monitoring to assess effectiveness of mitigation measures, and determine if elevated concentrations are sustained Operations Dept: Implement responses from the Mitigation Toolkit (or new mitigation developed through investigation).

Project Activity	Objectives	Performance Indicators	Monitoring Program / Plan	Condition Status / Threshold			Pre-defined Response(s)		
				Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk
Life of Project	Meeting particulate matter ($PM_{2.5}$ and TSP) air quality Project standards	Particulate matter ($PM_{2.5}$ and TSP) monitoring data • Project Standard(s); 60 µg/m^3 averaged annually for TSP, and 10 µg/m^3 averaged annually for $PM_{2.5}$	Temporary (seasonal, during summer months) continuous ambient air quality monitoring for TSP and $PM_{2.5}$ upwind and downwind of the major sources of emissions at the boundary of the Project Development Area (PDA) at Milne Port and the Mine Site.	Measured $PM_{2.5}$ and/or TSP concentrations are greater than 90% of the annual ambient air quality Project standards	Measured $PM_{2.5}$ and/or TSP concentrations are above the annual ambient air quality Project standards	Measured $PM_{2.5}$ and/or TSP concentrations are above the annual ambient air quality Project standards for two (2) or more successive years	<u>Env't Dept:</u> Review whether increase is attributed to the Project. Continue monitoring to determine if elevated levels are sustained or continuing to increase. Review the level of compliance for mitigation measures that are associated with managing the amount of fuel burned (e.g., idling policy, speed limits, etc.). <u>Operations:</u> Review schedule and procedures for ongoing maintenance for stationary and mobile diesel-powered equipment. Review the effectiveness of the dust mitigation at potential source locations. Review schedule, procedures, and make improvements to the dust suppression program.	<u>Env't Dept:</u> Verify increase can be attributed to the Project. Identify the root cause for the measured concentrations. Continue monitoring to determine if elevated concentrations are sustained or continuing to increase. <u>Operations</u>: Implement responses from the Mitigation Toolkit (or new mitigation developed through investigation). Identify high risk mitigation measures for future implementation if needed	<u>Env't Dept:</u> Verify increase can be attributed to the Project. Identify the root cause for the measured concentrations. Identify impacts to the receiving environment and/or human health. Conduct a risk evaluation to determine if levels pose an immediate health risk. <u>Operations:</u> Implement responses from the Mitigation Toolkit (or new mitigation developed through investigation).
Life of Project	Controlling dust deposition for the protection of vegetation health	Dustfall deposition at co-located vegetation plots. Project Standard(s); • There are no dustfall standards identified that are protective of vegetation health	Dustfall monitoring at Milne Port, the Mine Site and along the Northern Transportation Corridor	Refer to the Terrestrial Environment Monitoring and Mitigation Plan for evaluation of impacts to vegetation.					
Life of Project	Minimize fugitive dust emissions associated with the Northern Transportation Corridor	Airborne Dust	Visual Monitoring	Refer to Roads Management Plan for relevant thresholds and responses.					

Project Activity	Objectives	Performance Indicators	Monitoring Program / Plan	Condition Status / Threshold			Pre-defined Response(s)		
				Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk
Life of Project	Occupational noise levels for the protection of employees at the Project	Noise level at Accommodations Project Standard(s); • 75 dBA	Noise and Vibration Monitoring at Accommodations	Concerns raised by employees	Noise monitoring greater than Project Standard at one (1) or more locations during single monitoring event	Noise monitoring greater than Project Standard at one (1) or more locations in consecutive monitoring events	Env't Dept: Implement additional monitoring events based on nature and location of noise concern. Continue regular monitoring program.	Env't Dept: Additional monitoring to determine if noise is consistently above Project Standard. Assess additional locations to determine extent of noise impacts. Operations: Review the feasibility of additional engineering controls to reduce noise from the process or equipment that is the source of the elevated noise levels. Implement responses from the Mitigation Toolkit (or new mitigation developed through investigation).	Env't Dept: Additional monitoring to determine if noise is consistently above Project Standard. Assess additional locations to determine extent of noise impacts. Operations: Implement responses from the Mitigation Toolkit (or new mitigation developed through investigation).
Life of Project	Meeting emissions standards for incinerator facilities	In stack concentrations Project Standard(s); • Dioxins and furans: 0.08 ng TEQ/Rm^3 at 11% v/v O_2 • Mercury: 20 ug/Rm^3 at 11% v/v O_2	Stack emissions testing program annually for the incinerator facilities	Measured emissions are between 80 and 90% of the Project Standards	Measures emissions concentrations are above the Project Standards for one or more parameters.	The incinerator emissions test results for two (2) consecutive years are greater than the Project standards for one or more parameters.	Env't Dept: Continue monitoring on regular interval to determine if elevated levels are sustained or continuing to increase. Operations: Review schedule and procedures for ongoing maintenance for the incinerators. Review the standard operating procedures for the incinerators to determine if non-compatible materials are in the waste stream.	Env't Dept: Increase monitoring frequency, re-sample in following year. Return to every five (5) years if monitoring determines levels below Project Standards. Operations: Investigate root cause of elevated concentrations. Determine if the incinerators are being operated within their design specifications. Determine the feasibility of possible design modifications or waste gas treatment. Review the standard operating procedures for the incinerators to determine if non-compatible materials are in the waste stream.	Env't Dept: Increase monitoring frequency to annually. Operations: Implement responses from the Mitigation Toolkit (or new mitigation developed through investigation).
Life of Project	Inuit Objectives	Inuit Indicators	TBD	TBD	TBD	TBD	TBD	TBD	TBD

5.3 Mitigation Toolkit

The preliminary Moderate and High Action Pre-Defined Responses to be implemented in the event of an exceedance of a moderate risk or high risk threshold are outlined in Table 5.2 for the Atmospheric Environment. These responses should not be considered exhaustive and may be supplemented pending the results of adaptive management investigations and subsequent QIA approval.

Note: These Moderate and High Action Pre-Defined Responses are preliminary and subject to further review. Even when finalized these responses should not be considered exhaustive and may be supplemented pending the results of adaptive management investigations and subsequent QIA approval.

TABLE 5-2 ATMOSPHERIC ENVIRONMENT – MODERATE AND HIGH ACTION PRE-DEFINED RESPONSES

Atmospheric Environment
Controls for Criteria Air Contaminant (SO_2, NO_2): • Reduce or suspend activity identified as root cause for elevated concentrations • Review maintenance/repair log for suspect equipment • Conduct emissions testing on equipment to compare to vendor specifications
Dust and Particulate Emission Controls: • Spray (or respray piles) with approved dust suppressant • Research and implement alternate dust suppression methods and products • Surface watering and sprinkler system options via mister trucks or trailers • Increase surface watering and dust suppressant application frequency • Where applicable, install or redesign conveyor shrouding for fugitive dust • Review of new technology and engineering solutions available on the market for dust control • Enclosure of facilities or operations Reduction or cessation of activity: • Adapt production rate to environmental conditions • Modify timing or frequency of operational activities (e.g., blasting frequency)
Controls for Noise Impacts: • Reduce or suspend activity identified as root cause for elevated concentrations • Modify the timing or frequency of operational activities (e.g., blasting frequency) • Review maintenance/repair log for suspect equipment • Conduct emissions testing on equipment to compare to vendor specifications
Assessment and/or Monitoring (General) • Increase frequency of inspection and audits • Increase frequency of incinerator emission testing • Increase frequency of noise and vibration monitoring • Revisit number, locations and type of dustfall monitoring stations • Update country food risk assessment if the metals levels determined by the environmental monitoring program are trending upwards • Development of site specific risk based guidelines
Negotiation of compensation

5.4 Monitoring Programs

5.4.1 Meteorology

Six (6) meteorological stations have been established at the Project. Four (4) stations which collect a suite of measurements and are equipped with dataloggers are located at:

- Mine Site exploration camp
- Mine Site Deposit No. 1
- Milne Port
- Steensby Port

These stations record air temperature, relative humidity, precipitation, barometric pressure, wind direction, and wind speed. Data collected from the meteorological stations are establishing a climatic record in key project areas. Details are presented in Appendix D.

In addition, basic weather stations are located at the Port Site and Mine Site complexes. These stations provide real-time weather data for operations. Data is saved to a datalogger and precipitation is measured in units of mm/hr.

Tide gauges are installed at Milne Port to monitor relative sea level and storm surge (Refer to Appendix B, Table 11 – Project Certificate commitments) and salinity.

5.4.2 Air Quality Monitoring

Air quality monitoring consists of the following programs:

- Inspections to verify compliance with the mitigation measures described in this plan
- Continuous ambient air quality monitoring of SO_2 and NO_2 at Milne Port and the Mine Site
- Continuous ambient air quality monitoring for TSP and $PM_{2.5}$ at Milne Port and the Mine Site
- Temporary (seasonal, during summer months) ambient air quality monitoring for TSP and $PM_{2.5}$ offsite near Milne Port and the Mine Site both upwind and downwind of the major sources of emissions
- Passive dustfall monitoring at Milne Port, the Mine Site, and along the Northern Transportation Corridor
- Incinerator emissions testing on commissioning and every five (5) years thereafter

5.4.2.1 Compliance Inspections

Potential sources of project-related effects on air quality include exhaust emissions from vehicles, mining activities, aircraft, generators and other equipment, emissions from camp incinerators, and fugitive dust emissions from road traffic during snow-free periods. Inspection of facilities will ensure compliance with this Air Quality and Noise Abatement Management Plan.

Scheduled maintenance on mobile equipment and stationary equipment will ensure that emissions are in line with vendors` specifications and emission criteria.

Dust Management procedures for applying dust-suppressants are outlined in the Terrestrial Environment Mitigation and Monitoring Plan. Training/instruction on the use of dust suppressants will be provided to all employees and Contractors, as required.

5.4.2.2 Gaseous Criteria Air Contaminant Monitoring

Continuous monitoring of gaseous CACs SO_2 and NO_2 is undertaken at Milne Port and the Mine Site, in accordance with Project Certificate Conditions No. 7 and No. 8 (Appendix B). No monitoring is undertaken at Steensby Port as that component of the Project has not yet been constructed. As previously discussed in Section 3.1.1 the continuous ambient air quality monitoring for SO_2 and NO_2 would normally be done at the PDA boundary, however there are no power sources available along the PDA boundary therefore the SO_2 and NO_2 monitors are located in an active area of the facility (e.g., at the accommodation facilities). The results of this monitoring are presented in the annual report to the NIRB. Table 5.1 presents an overview of the gaseous CAC Project Standards, management action trigger levels and corrective actions. Exceedance of the management action trigger levels will initiate a stepwise approach to air quality management which will include:

1. Identifying the cause of trigger exceedance (e.g., identification of sources; spatial / temporal aspects of exceedance);
2. Implementing the source mitigation, based on source identification;
3. Determining need for, and focus of, additional monitoring; and
4. Conducting a supplemental risk assessment based on the triggered exceedances, if necessary.

5.4.2.3 Particulate Matter Monitoring

Continuous monitoring of Total Suspended Particulate (TSP) and Particulate Matter less than 2.5 microns ($PM_{2.5}$) is undertaken at the Milne Port and Mine Site at the same location as the continuous monitoring stations for SO_2 and NO_2 (i.e., at the accommodations buildings). Continuous monitors for TSP and $PM_{2.5}$ require a continuous source of power and the sample inlets must meet the site selection recommendations provided in the National Air Pollution Surveillance (NAPS) Network Quality Assurance and Quality Control Guidelines (Environment Canada, 2004). The location of the continuous monitoring stations for TSP and $PM_{2.5}$ also considered logistical constraints such as whether the existing infrastructure at the Milne Inlet and Mine Site continuous air quality monitoring stations could support the additional TSP and $PM_{2.5}$ analyzers and sample inlets. The $PM_{2.5}$ continuous samplers at Milne Port and the Mine Site are consistent with the acceptable NAPS reference methods described in the Ambient Air Monitoring Protocol for $PM_{2.5}$ (CCME, 2011). The continuous monitors selected for the Mine and Milne Port Sites are manufactured by Met One Instruments, and are the Bata Attenuation Monitor (BAM) 1020 model with either TSP or $PM_{2.5}$ cut off inlets. The BAM 1020 monitors record ambient particulate mass concentration levels using the principle of beta ray attenuation. This method provides a simple determination of the ambient concentration of particulate matter in mg/m^3 or $\mu g/m^3$. Table 5.1 presents an overview of the Project standards, proposed management action trigger levels and corrective actions for TSP and $PM_{2.5}$.

According to EDI (2019), the predominant wind direction at the Milne Port is from the north-northwest (NNW), and the predominant wind direction at the Mine Site is from the south-southeast (SSE). The primary continuous sources of particulate emissions at the Mine Site are the haul roads. The particulate emissions from roads depend on the activity levels based on annual tonnages, equipment sizes, and/or anticipated utilization rates and equipment type. The locations for the seasonal particulate monitoring stations for TSP and $PM_{2.5}$ at the Mine Site and Milne Port are upwind and downwind along the PDA boundary and near one of the preliminary dustfall monitoring stations. A site reconnaissance was conducted in September 2020 to assess the potential locations for the new temporary/seasonal

TSP and $PM_{2.5}$ monitoring stations considering the study objectives, safe access for the staff and compliance with published regulatory siting standards.

5.4.3 Dustfall Monitoring

5.4.3.1 Monitoring Locations

Passive sampling of dustfall is undertaken at a total of 47 sampling sites across Milne Port, the Mine Site and along the Tote Road. This program forms part of the Terrestrial Environment Mitigation and Monitoring Plan because of its linkage to monitoring of metals concentrations in soil and vegetation, and monitoring of vegetation abundance and diversity programs also presented in the TEMMP (Baffinland, 2023a). Table 5.3 summarizes the monitoring locations. Dustfall monitoring locations are presented Figures in Appendix E.

TABLE 5-3 SUMMARY OF DUSTFALL MONITORING SITES

Project Site	Number of Dustfall Samplers	Notes on Distribution of Monitoring Sites
Mine Site	9	• 3 sites within the Mine Site • 4 sites outside the mine footprint, but within low to moderate isopleth areas • 2 reference sites - one to the northeast, and one to the south
Milne Port	10	• 4 sites in the Port footprint • 5 sites outside the port footprint, but within low to moderate isopleth areas 1 reference site located northeast of the Port site
Tote Road	24	• 16 sites divided between two locations along the Tote Road • 8 samplers on the North site and 8 samplers on the South site, each organized into transects perpendicular to the Tote Road centerline at 30 m, 100 m, 1,000 m, and 5,000 m on either side of the road • 6 sites at 1 km distant from either side of the centerline of the road at three different locations spread along the Tote Road • 2 reference sites located 14 km southwest of the Tote Road

5.4.3.2 Monitoring Methods

Each dustfall sampler comprises one (1) sampling apparatus including a hollow post (~ 2 m long) and terminal bowl-shaped holder for the dust collection vessel (a standard following ASTM 2004)). The terminal bowl is topped with bird spikes to prevent contamination by bird fecal matter. The sampling apparatus was installed by pounding 5-foot rebar into the ground, placing the post over the rebar, and then stabilizing with guy wires. Dust collection vessels are placed in the holder, pre-charged with 250 mL of algaecide in summer and 250 mL of alcohol in winter. Collection vessels are changed out every month (28–31 days), as close together as possible (within one 24-hr period to avoid confounding weather events), and shipped to an approved laboratory, under chain-of-custody documentation for analysis of TSP (units of $mg/dm^2 \cdot day$). In addition to the analysis of TSP, the dustfall samples are analyzed for total metal concentrations (including iron) to help inform potential trends in soil and vegetation tissues, collected as part of the vegetation health monitoring program.

Monthly passive dustfall sampling is conducted year-round at 34 of the 47 monitoring locations in 2022; these sites are all distributed within 1,000 m of the PDA and tend to experience higher dustfall levels. The remaining 16 monitoring stations are situated at, or greater than, 1,000 m from the PDA. For these 16 sites monthly seasonal sampling was conducted from mid-May through mid-September but paused during winter (e.g., September to May) due to their remote locations and inaccessibility without helicopter support. Winter monitoring activities are restricted by safety considerations associated with accessing the more remote reference sites.

5.4.3.2.1 Sampling Height Pilot Study

Through previous engagements at the TEWG and in comments on Baffinland's annual reports, the QIA questioned the utility of the standard 2.0 m height of dustfall monitors and suggested that ground-level dustfall deposition could be underestimated. To investigate potential sampling variability at 2.0 m height versus ground level, paired dustfall monitors (standard 2.0 m height and 'ground-level' 0.5 m height) were installed at six (6) sites in October 2021. Sites close to Project infrastructure were selected: DF-M-01, DF-RS-03, DF-RS-06, DF-RN-03, DF-RN-06, and DF-P-08. Data collection at these sites began in September 2021.

The shorter dustfall height was chosen based on discussions in the TEWG beginning in 2018, culminating in a request by NIRB during the Phase 2 hearing, and Baffinland acquiescing and installing six (6) 0.5 m dustfall collectors in the fall of 2021 to address the repeated requests and interests in non-standard dustfall sampling.

The 0.5 m was selected to be as close to ground level as possible while avoiding ground contamination (ground level sampling at other northern sites has been contaminated by small rodents, who have been found in the sample containers).

5.4.4 Incinerator Emission Testing

Non-hazardous combustible camp waste is disposed of in camp incinerators. Camp incinerators are currently installed at Milne Port and the Mine Site. Each incinerator uses dual-chamber, variable-airflow design technology and is specifically designed for remote camp operations. Incinerated waste is typically generated from the kitchen and personnel accommodations (domestic waste). All waste sent to the incinerator is sorted as per the Waste Sorting Guidelines (BAF-PH1-830-P25-0001) described in the Waste Management Plan (Baffinland, 2020). The incinerators are operated as required, using the Incinerator Operation Procedure (BAF-PH1-320-PRO-0002) which has been developed in accordance with the manufacturers' recommendations. All incinerator operators receive training by experienced supervisory personnel.

Incinerators onsite are capable of complying with the Government of Nunavut's waste incinerator standards (GN, 2012), which are based on the Canada-wide Standards for mercury emissions, and dioxins and furans (CCME, 2000, 2001). Initial stack tests were conducted upon commissioning all camp incinerators as required by Project Certificate Condition No. 12, to confirm conformance with the Government of Nunavut standards.

Baffinland has agreed to an ECCC recommendation to conduct stack testing of its incinerators annually. Stack testing will be conducted in accordance with the sampling methods identified in the Canada-wide Standards (CCME, 2000, 2001) and industry standard US EPA methodology.

Sampling of bottom ash is described in the Waste Management Plan (Baffinland, 2020).

5.4.5 Noise and Vibration

The purpose of the monitoring program is to assess the magnitude of noise impacts from Project activities. The main activities expected to cause noise impacts include mining, crushing, generators, aircraft activities and transportation activities related to ore, overburden, and waste rock.

Noise and vibration monitoring is conducted in the Project accommodations in the summer and winter during all phases of the Project, in accordance with Project Certification Condition No. 14. Monitoring uses a sound meter with microphone and a vibration pad with meter set-up in different rooms and wings of accommodation buildings at both sites. Monitoring is conducted once per summer and once per winter season. Noise or vibration concerns brought forth by employees are taken seriously and addressed on an as-needed basis.

Field activities are conducted in accordance with the EPP to minimize potential effects on people and wildlife. More specifically, equipment is operated with modern mufflers, and subjected to regular maintenance. In remote areas, drilling and other site activities will be guided by the presence and response of wildlife. The only off-site receptors are the two HTO cabins located near to Milne Port and the Mine Site. As noted in Section 2.4.2, Baffinland is discussing the option of re-locating the HTO cabin outside the area of disturbance with community members and Mittimatalik HTO.

5.5 Reporting

5.5.1 Documentation and Data Control

Baffinland's Environmental Superintendent will oversee the preparation of data and reports required for regulatory purposes. Execution of some of the monitoring programs detailed in the Air Quality and Noise Abatement Management Plan will be conducted by or supported by consultants and contractors to Baffinland. Data and reports will be prepared and delivered to Baffinland by its consultants for internal and external distribution and use, as appropriate.

All formalized documents and reports will follow data-control procedures, with revision numbers and revision tracking. Documents and data that are to be issued and liable to change will be controlled to ensure they are approved before issue and that the current issue or revision is known to and available to those requiring them.

5.5.2 Internal and External Reporting

Implementation of monitoring under the Air Quality and Noise Abatement Management Plan results in collection of data and generation of various reports. Information collected on air quality and noise via the monitoring programs described in Section 5.4 will be reported annually to the NIRB as per the Terms and Conditions of the Project Certificate. GHGs will also be reported to Environment and Climate Change Canada as described below in Section 5.5.6.

Whereas there are regulatory requirements for formal monthly and annual reports, including disclosure of issues of non-conformance, internal reporting is used to provide direction to personnel and to provide operational updates to site and corporate management. Internal reporting mechanisms might include environment reports, operations reports, and routine inspection reports. Site-based toolbox and management meetings are also an important internal reporting tool commonly used.

5.5.3 Air Quality

Air quality monitoring results will be reported in the annual report to the NIRB as follows:

- Report on incinerator testing (as per requirements of Appendix B, Table 11 – T&C # 11 and 12)
- Results of active air quality measurements at the Mine Site and Milne Port (Appendix B, Table 12 commitment #61)
- Results of dust deposition monitoring at the Mine Site, along the Northern Transportation Corridor, and Milne Port (Appendix B, Table 12 commitment #60).
- Report on land-based monitoring stations.
- Report on results relative to FEIS and FEIS air quality predictions.

In accordance with T&C #8 (Appendix B, Table 11), in cases where exceedances are observed, Baffinland will provide an explanation for the exceedance, a description of planned mitigation, and shall conduct additional monitoring to evaluate the effectiveness of mitigative measures.

The air quality monitoring data will be presented to include at least, but not necessarily be limited to:

- Time series of data.
- Hourly, daily, and annual averages in graphical and/or tabulated form (if applicable to the air quality parameter).
- Comparison to the Ambient Air Quality Guidelines (Section 3.1.1) (and relevant statistical forms, if three years is not available, CAAQS can be calculated using one year).
- Graph and tables indicating seasonal variability.
- Comparisons to other years of data.
- Include any photos taken of dust on snow in the annual reports.
- Present the predicted concentrations in the annual reports as a range of absolute concentrations.

5.5.4 Dustfall

The Regional Study Area (RSA) was divided into four (4) areas for the purposes of reviewing dustfall data:

- The Mine Site;
- Milne Port;
- The Northern Transportation Corridor North crossing; and
- The Northern Transportation Corridor South crossing.

Extent and Magnitude of Dustfall at Various Sites — Dustfall deposition rates (as TSP) for each site were compiled and grouped according to the four study areas within the RSA. Data were reviewed to determine which sites in each sampling area were most affected by dustfall relative to reference sites.

Daily dustfall from summer sampling periods (June, July, August, and September) were used to evaluate the potential relationship between dustfall and distance from the road for the Mine Site, Milne Port, and the Tote Road. Mixed effects models are used to test for a relationship between distance from Project infrastructure and daily dustfall.

- Sites are treated as the random effect.

- Distance from the Mine was treated as a categorical variable with three classes – Near (within footprint), Far (1,000 m – 5,000 m), and Reference (>5,000 m).
- Distance from the road was treated as a categorical variable with four classes – 30 m, 100 m, 1,000 m, and 5,000 m.

Seasonal Variation in Dustfall — Daily dustfall at year-round sites in all Project areas (Mine Site, Milne Port, Tote Road) is assessed to determine for either discrete seasonal/monthly patterns or continuous temporal patterns. Generalized least squares regression is used to test for effects of season (summer and winter) or time (month time-series) and sample site on daily dustfall accumulation. Seasonal models are used to test the main effects of season and sample site, as well as the interaction between them. Time series models are used to test the main effects of sample site and cosinusoidal functions of month, as well as the interaction between them. Models included a first-order autocorrelation structure, based on sampling period within a site, to account for the possibility that dustfall in one sampling period was most similar to samples from the preceding period (Zuur et al., 2009). Fixed model weights based on the number of days in each sampling period were used to give more weight to dust samples collected over a longer period time (Zuur et al., 2009). Model selection procedures followed an information-theoretic approach using corrected Akaike's Information Criterion (AICc; Burnham and Anderson, 2002). Models with the lowest scores were identified as the best trade-off between parsimony and explained variance.

Models included a first-order autocorrelation structure, based on sampling period within a site, to account for the possibility that dustfall in one sampling period was more like samples from the preceding period than other samples from the same site (Zuur et al., 2009). Fixed model weights based on the number of days in each sampling period are used to give more weight to dust samples collected over a longer time (Zuur et al., 2009).

Annual Dustfall — Dustfall data is converted from units of $mg/dm^2 \cdot day$ to $g/m^2/year$ and compared with the Project Standard. Each month's data are converted to ($g/m^2/day$), and then summed to add up to one year.

Sites in the nil and low isopleth zones are not sampled during winter months, so annual accumulation is not calculated for those sites.

Inter-annual Trends — Linear mixed effects models are used to test for effects of year and season (summer and winter), month, or time (month time-series) on daily dustfall accumulation for each Project area (mine site, Milne Inlet port, north road and south road). Only sites that were sampled throughout the year are included in analyses. Monthly models are used to test the main effects of month and year, as well as the interaction between them. Time series models are used to test the main effects of year and sine/cosine functions of month, as well as the interaction between them. Sample site is included as a random effect to account for a lack of independence in samples collected from the same location over time. All dustfall data are log transformed before analysis and results are back transformed to the original scale. A constant variance structure for season is used to account for higher variation in summer dustfall relative to winter dust fall; the same structure was used for year effects in the time-series model.

If major dusting events are observed throughout the year, they will be photographed and included in the annual report. Also, satellite imagery available will be reviewed and included if considered relevant. Use of satellite imagery and other remote sensing applications will be evaluated on an ongoing basis to confirm whether it adds value or provides any relevant context to the dustfall evaluations.

5.5.5 Noise

Noise monitoring results will be reported in the annual report to the NIRB and will include any monitoring conducted at Project camp sites, as well as any monitoring for impacts at the boundary of the Potential Development Area.

5.5.6 Greenhouse Gases

As per the Notice with respect to reporting of greenhouse gases (GHGs) for 2018 (ECCC, 2019), if Baffinland meets or exceeds the 10,000 tonnes CO_2 eq threshold, it will be required to report emissions for each of the following gases or groups of gases:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Sulphur hexafluoride (SF_6)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)

Total quantity in tonnes of direct emissions of CO_2, CH_4, and N_2O must be reported for the following source categories:

- Stationary Fuel Combustion
- Venting
- Flaring
- Fugitive
- On-site Transportation
- Waste
- Wastewater

Baffinland will estimate its emissions according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). These guidelines describe the various approaches to estimate GHG emissions per category.

Additionally, the following will be reported annually to the NIRB as per the Terms and Conditions of the Project Certificate:

- Quantity of fuel consumed during the year
- Calculation of greenhouse gas emissions for the site (Appendix B, Table 11 T&C # 9)
- Provide interested parties with evidence of continued initiatives undertaken to reduce greenhouse gas emissions (Appendix B – Table 11 T&C # 3)
- And estimate of marine shipping vessels emissions (refer to Appendix B, Table 12 Commitment #62)
- Report on efforts made with shipping partners to reduce fuel consumption (refer to Appendix B, Table 12 Commitment #63).

5.5.7 Meteorological Data

In accordance with Project Certificate Terms and Conditions and other Baffinland commitments (refer to Appendix B), the following information will also be made available to regulatory agencies (Environment and Climate Change Canada, NRCan, others):

- Tidal information at Milne Port (Appendix B, Table 11 T&C #1).
- Weather related information (Appendix B, Table 11 T&C #5, Table 12 Commitments #58 and 59).

Data from the Mine Site and Milne Port stations are posted on the Baffinland website.

Specifically, meteorological monitoring data will be presented to include at least, but not necessarily limited to:

- Time series of data.
- Hourly, daily, and annual averages in graphical and/or tabulated form (if applicable to the meteorological parameter).
- Wind roses.
- Graph and tables indicating seasonal variability.
- Comparisons to other years of data.

6 REVIEW OF PLAN EFFECTIVENESS

An important element of Baffinland's management system is reviewing the continued suitability, adequacy and effectiveness of each management plan. This will occur through an annual review process as well as scheduled updates.

6.1 Annual Review of Compliance and Unanticipated Effects

Baffinland conducts internal inspections and audits throughout the year, with immediate corrective actions taken as appropriate to address instances of non-compliance, as well as unanticipated effects observed. Follow-up corrective actions may also be required. These immediate and follow-up corrective actions are documented in the annual report.

One follow-up corrective action may be to revise mitigation measures or monitoring programs described in the applicable management plans. During the annual reporting cycle, Baffinland staff will review instances of non-compliance as well as unanticipated effects and determine if a review of plan effectiveness is appropriate. Should there be a significant unanticipated effect, determined by the Inuit Committee and/or community observations, a review of plan effectiveness will be completed. This process is articulated on Figure 6.1.

Part of this annual review cycle is the incorporation of IQ, per Section 2.2. This process may occur annually whether repeat non-compliance and/or unanticipated effects are identified.

6.2 Scheduled Updates

The AQNAMP is a "living" document and will be revised regularly as new information becomes available, methods are further developed, refined or replaced, and/or to account for adaptive management measures. Further details will continually be developed following discussions with the Qikiqtani Inuit Association (QIA), community Hunters and Trappers Organizations (HTOs), the Terrestrial Environment Working Group (TEWG) and other involved parties. In addition to the annual review cycle described above, scheduled Plan reviews will occur according to the schedule presented in Table 6.1.

Plan updates will be recorded in the Document Revision Record located at the front of the Plan. Each plan update will be provided to the QIA for review and approval before being finalized for implementation.

TABLE 6-1 PLAN REVIEW SCHEDULE

Review Event	Description
Every 3 years during operation	Mandatory management review

Notes:
1. This is a generic term that applies to Project expansions or other major sustaining capital works.

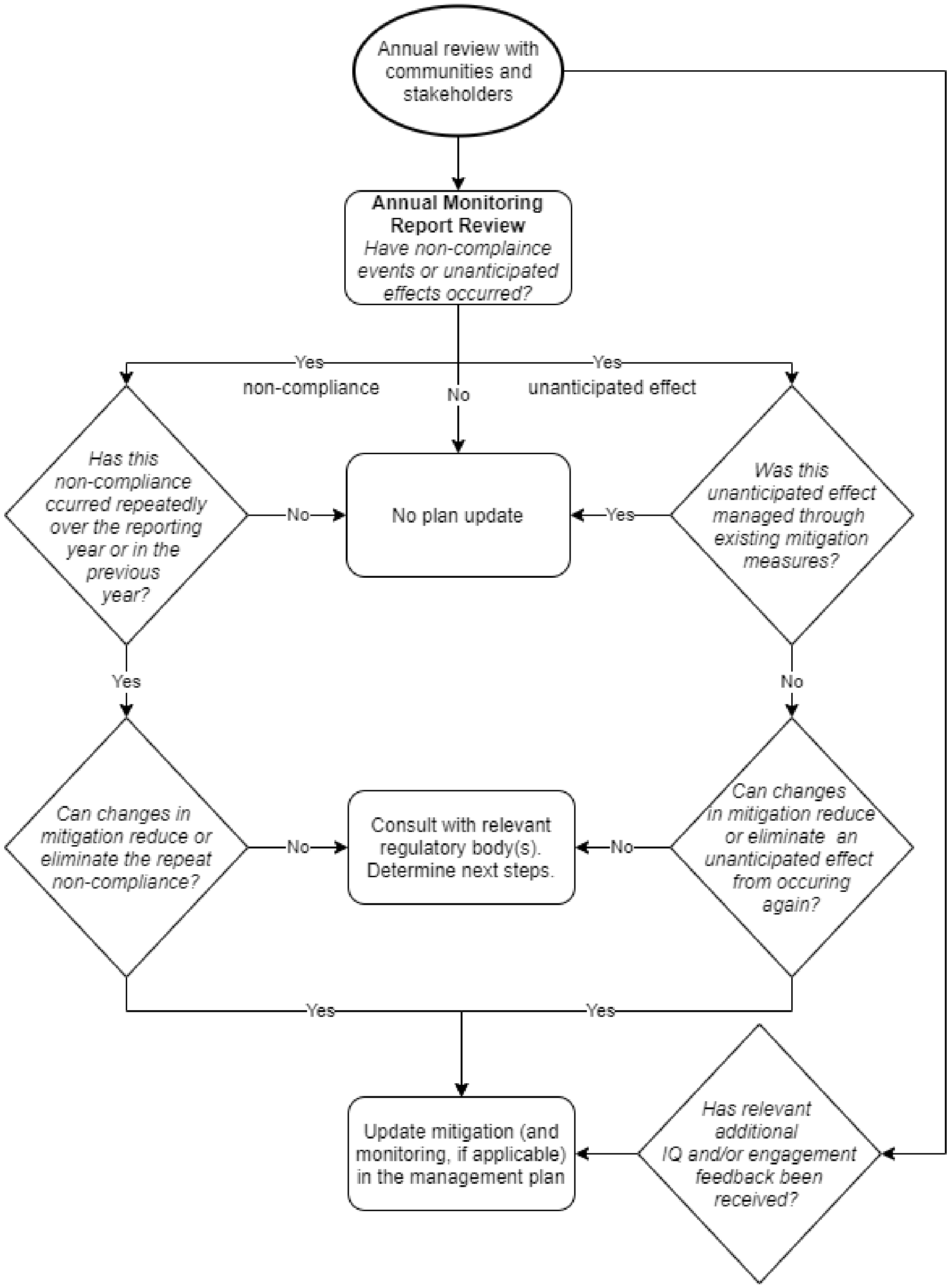

FIGURE 6.1 ANNUAL REVIEW OF PLAN EFFECTIVENESS

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Appendix A
Corporate Policies

Baffinland Iron Mines Corporation

Health, Safety and Environment Policy

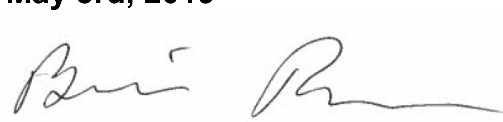
BAF-PH1-800-POL-0001

Rev 3

Approved by: **Brian Penney**

Title: **Chief Executive Officer**

Date: **May 3rd, 2019**

Signature: 

DOCUMENT REVISION RECORD

Issue Date MM/DD/YY	Revision	Prepared By	Approved By	Issue Purpose
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03/07/16	1	JS	BP	Minor edits
04/20/18	2	TS	SA/BP	Minor edits
05/03/19	3	TS	BP	Minor edits

This Baffinland Iron Mines Corporation Policy on Health, Safety and Environment is a statement of our commitment to achieving a safe, healthy and environmentally responsible workplace. We will not compromise this policy for the achievement of any other organizational goals.

We implement this Policy through the following commitments:

- Continual improvement of safety, occupational health and environmental performance
- Meeting or exceeding the requirements of regulations and company policies
- Integrating sustainable development principles into our decision-making processes
- Maintaining an effective Health, Safety and Environmental Management System
- Sharing and adopting improved technologies and best practices to prevent injuries, occupational illnesses and environmental impacts
- Engaging stakeholders through open and transparent communication.
- Efficiently using resources, and practicing responsible minimization, reuse, recycling and disposal of waste.
- Reclamation of lands to a condition acceptable to stakeholders.

Our commitment to provide the leadership and action necessary to accomplish this policy is exemplified by the following principles:

- As evidenced by our motto "Safety First, Always" and our actions Health and Safety of personnel and protection of the environment are values not priorities.
- All injuries, occupational illnesses and environmental impacts can be prevented.
- Employee involvement and active contribution through courageous leadership is essential for preventing injuries, occupational illnesses and environmental impacts.
- Working in a manner that is healthy, safe and environmentally sound is a condition of employment.
- All operating exposures can be safeguarded.
- Training employees to work in a manner that is healthy, safe and environmentally sound is essential.
- Prevention of personal injuries, occupational illnesses and environmental impacts is good business.
- Respect for the communities in which we operate is the basis for productive relationships.

We have a responsibility to provide a safe workplace and utilize systems of work to meet this goal. All employees must be clear in understanding the personal responsibilities and accountabilities in relation to the tasks we undertake.

The health and safety of all people working at our operation and responsible management of the environment are core values to Baffinland. In ensuring our overall profitability and business success every Baffinland and business partner employee working at our work sites is required to adhere to this Policy.

Brian Penney
Chief Executive Officer
May 2019

Sustainable Development Policy

At Baffinland Iron Mines Corporation (Baffinland), we are committed to conducting all aspects of our business in accordance with the principles of sustainable development & corporate responsibility and always with the needs of future generations in mind. Baffinland conducts its business in accordance with the Universal Declaration of Human Rights.

Everything we do is underpinned by our responsibility to protect the environment, to operate safely and fiscally responsibly and with utmost respect for the cultural values and legal rights of Inuit. We expect each and every employee, contractor, and visitor to demonstrate courageous leadership in personally committing to this policy through their actions. The four pillars of our corporate responsibility strategy are:

1. Health and Safety
2. Environment
3. Upholding Human Rights of Stakeholders
4. Transparent Governance

Health and Safety

- We strive to achieve the safest workplace for our employees and contractors; free from occupational injury and illness, where everyone goes home safe everyday of their working life. Why? Because our people are our greatest asset. Nothing is as important as their health and safety. Our motto is "Safety First, Always"
- We report, manage and learn from injuries, illnesses and high potential incidents to foster a workplace culture focused on safety and the prevention of incidents
- We foster and maintain a positive culture of shared responsibility based on participation, behaviour, awareness and promoting active courageous leadership. We allow our employees and contractors the right to stop any work if and when they see something that is not safe

Environment

- Baffinland employs a balance of the best scientific and traditional Inuit knowledge to safeguard the environment
- We apply the principles of pollution prevention, waste reduction and continuous improvement to minimize ecosystem impacts, and facilitate biodiversity conservation
- We continuously seek to use energy, raw materials and natural resources more efficiently and effectively. We strive to develop more sustainable practices. We strive to develop more sustainable practices
- Baffinland ensures that an effective closure strategy is in place at all stages of project development to ensure reclamation objectives are met

Upholding Human Rights of Stakeholders

- We respect human rights, the dignity of others and the diversity in our workforce. Baffinland honours and respects the unique cultural values and traditions of Inuit
- Baffinland does not tolerate discrimination against individuals on the basis of race, colour, gender, religion, political opinion, nationality or social origin, or harassment of individuals freely employed
- Baffinland contributes to the social, cultural and economic development of sustainable communities in the North Baffin Region

Sustainable Development Policy

- We honour our commitments by being sensitive to local needs and priorities through engagement with local communities, governments, employees and the public. We work in active partnership to create a shared understanding of relevant social, economic and environmental issues, and take their views into consideration when making decisions
- We expect our employees and contractors, as well as community members, to bring human rights concerns to our attention through our external grievance mechanism and internal human resources channels. Baffinland is committed to engaging with our communities of interest on our human rights impacts and to reporting on our performance

Transparent Governance

- Baffinland will take steps to understand, evaluate and manage risks on a continuing basis, including those that may impact the environment, employees, contractors, local communities, customers and shareholders.
- Baffinland endeavours to ensure that adequate resources are available and that systems are in place to implement risk-based management systems, including defined standards and objectives for continuous improvement.
- We measure and review performance with respect to our safety, health, environmental, socio-economic commitments and set annual targets and objectives.
- Baffinland conducts all activities in compliance with the highest applicable legal & regulatory requirements and internal standards.
- We strive to employ our shareholder's capital effectively and efficiently and demonstrate honesty and integrity by applying the highest standards of ethical conduct.

Brian Penney
Chief Executive Officer
March 2016

Appendix B
Amended Project Certificate Terms And Conditions

Below are Concordance Tables of this management plan with amended NIRB Project Certificate No. 005, October 2018 (main text) and Appendix A to NIRB Decision Report.

TABLE 1 CONCORDANCE TABLE WITH NIRB PROJECT CERTIFICATE NO. 005 TERMS AND CONDITIONS

No.	Term and Condition	Comments
Meteorology and Climate (including Climate Change)		
1	The Proponent shall use GPS monitoring or a similar means of monitoring at both Steensby Port and Milne Port, with tidal gauges to monitor the relative sea levels and storm surges at these sites.	A tide gauge was re-installed at Milne Port and resumed tidal monitoring during the 2017 and 2018 open-water seasons. Refer to Section 6.4 for Reporting.
2	The Proponent shall provide the results of any new or revised assessments and studies done to validate and update climate change impact predictions for the Project and the effects of the Project on climate change in the Local Study Area and Regional Study Area as defined in the Proponent's Final Environmental Impact Statement.	Ongoing
3	The Proponent shall provide interested parties with evidence of continued initiatives undertaken to reduce greenhouse gas emissions.	Section 3.5
4	The Proponent shall endeavour to include the participation of Inuit from affected communities and other communities in Nunavut when undertaking climate-change related studies and research.	Ongoing
5	The Proponent shall endeavour to explore and implement reasonable measures to ensure that weather-related information for the various Project sites is readily accessible to the public on a continual basis throughout the life of the Project.	Provided through The Weather Network; see Section 5.4.1
Air Quality		
6	The Proponent shall provide the results of any emissions calculations conducted to determine the level of sulphur dioxide (SO2) emissions, nitrogen oxide (NOX) emissions and greenhouse gases generated by the Project using fuel consumption or other relevant criteria as a basis.	Section 5.5
7	The Proponent shall update its Air Quality and Noise Abatement Management Plan to provide for continuous monitoring at land-based monitoring stations designed to capture operations phase ship-generated SO_2 and NO_2 emissions at Steensby Port and Milne Port. Continuous monitoring is to be carried out through several shipping seasons at each port as required to determine that emissions are at acceptable levels.	Refer to Sections 5.4 for Monitoring and Section 5.5 for Reporting
8	The Proponent shall demonstrate through monitoring of air quality at the mine site and at the Steensby Inlet and Milne Inlet port sites that SO_2 and NO_2 emissions remain within predicted levels and, where applicable, within limits established by all applicable guidelines and regulations. In cases where exceedances are manifested, the Proponent shall provide an explanation for the exceedance, a description of planned mitigation, and shall conduct additional monitoring to evaluate the effectiveness of mitigative measures.	Refer to Sections 5.4 for Monitoring and Section 5.5 for Reporting
9	The Proponent shall provide calculations of greenhouse gas emissions generated by activities at the Steensby Inlet and Milne Inlet port sites and other Project sources including aircraft associated with the Project. Calculations shall take into consideration, fuel consumption as measured by Baffinland's purchase and use as well as the fuel use of its contractors and sub-contractors.	Refer to Section 5.5 for Reporting.

No.	Term and Condition	Comments
10	7.1.1.1 The Proponent shall update its Dust Management and Monitoring Plan to address and/or include the following additional items: 7.1.1.2 a) Outline the specific plans for monitoring dust along the first few kilometres of the rail corridor leaving the Mary River mine site. 7.1.1.3 b) Identify the specific adaptive management measures to be considered should monitoring indicate that dust deposition from trains transporting along the rail route is greater than initially predicted. 7.1.1.4 c) Outline specific plans for monitoring dustfall at intervals along and in the vicinity of the Milne Inlet Tote Road to determine the amount and extent of dustfall. 7.1.1.5 d) Identify the specific adaptive management measures to be considered if monitoring indicates that dust deposition from traffic on the Milne Inlet Tote Road is greater than initially predicted. The Proponent shall implement its Dust Management and Monitoring Plan, report all monitoring data to the NIRB annually, and take all adaptive management measures described in its Dust Management and Monitoring Plan if monitoring indicates that dust in the ambient air or dust deposition from the increased traffic associated with the increased volume of ore being shipped is greater than initially predicted.	Section 5.3 presents Mitigation measures Section 5.4 presents Monitoring Section 5.5 presents Reporting
11	The Proponent shall develop and implement an Incineration Management Plan that takes into consideration the recommendations provided in Environment Canada's Technical Document for Batch Waste Incineration (2010).	Refer to Section 5
12	Prior to commencing any incineration of on-site Project wastes, the Proponent shall conduct at least one stack test immediately following the commissioning of each temporary and permanent incinerator.	Refer to Section 5
Noise and Vibration		
13	The Proponent is encouraged to work with Fisheries and Oceans Canada at the regulatory phase and to take a precautionary approach when selecting the overpressure threshold to be applied to explosives use for the protection of fish and aquatic life.	Refer to the Blasting Management Plan (Type A Water Licence). This plan was developed in consultation with the DFO. Refer to section 1.4.1
14	The Proponent shall conduct noise and vibration monitoring at project accommodations sites located at the Mary River Mine Site, Steensby Inlet Port Site and Milne Inlet Port Site. Sampling shall be undertaken during the summer and winter months during all phases of Project development.	Refer to Section 3.1.4
14(a)	The Proponent, through coordination with the MEWG as may be appropriate, shall demonstrate appropriate adaptive management for construction activities at Milne Inlet that have the potential to disrupt marine mammal species, including pile driving and ore dock construction, are undertaken.	Refer to the Shipping and Marine Wildlife Management Plan and Section 2.3.2
14(b)	The Proponent, through coordination with the TEWG as may be appropriate, shall demonstrate appropriate adaptive management for project activities during operations which have the potential to produce noise and sensory disturbance to wildlife and other users of project areas.	This condition is in progress in consultation with the Terrestrial Environment Working Group (TEWG). Refer to Section 6.2 for Schedule Updates.

No.	Term and Condition	Comments
15	The Proponent shall collaborate to the extent possible with the Qikiqtani Inuit Association and local Hamlet organizations when undertaking consultation with all affected communities regarding railway, tote road and marine shipping operations. During these consultations, it is recommended that the Proponent provide information including video, audio, and photographic representation as well as any other aids (i.e. models) that may enhance the general public's understanding of railway, tote road and marine shipping operations, as well as all safety considerations for members of the public who may be travelling around the project area.	Baffinland continues to work with Hamlet and QIA regarding safety considerations for travel and interaction with project for those travelling in the area. In support of this, Baffinland established the Pond Inlet Community Advisory Group (which includes HTO and Hamlet representation) and continues to work with the Marine and Terrestrial working groups, of which QIA is a member.

Appendix C
Baseline Project Ambient Air Quality Conditions

TABLE 1 MEASURED CRITERIA AIR CONTAMINANT CONCENTRATIONS FOR THE MARY RIVER PROJECT

Parameter	Baseline Concentration ($\mu g/m^3$)
24-hour TSP	7.0
24-hour PM_{10}	3.8
30-day SO_2	0.262
30-day NO_2	0.188
30-day O_3	52.8

TABLE 2 BASELINE DUSTFALL DEPOSITION RATES

Parameter	Baseline Deposition Rate ($mg/100cm^2/30$ days)
Total Dustfall	0.398

TABLE 3 BASELINE METAL DEPOSITION RATES FOR SELECTED METALS

Parameter	Baseline Deposition Rate ($\mu g/100cm^2/30$ days)
Al	26.9
Co	0.5
Cr	0.3
Fe	30.6
Mg	23.9
Mn	1.7

Data obtained from the 2007 sampling program were compared with federal and other provincial air quality criteria (see Section 1.2) and with data from other air quality monitoring stations in the Canadian Arctic. Results are shown in Table 4 Baseline Ambient Air Quality Monitoring Results, and indicate that concentrations of both TSP and PM10 were well below applicable indicator thresholds.

TABLE 4 BASELINE AMBIENT AIR QUALITY MONITORING RESULTS

Air Quality Parameter	24-h Project Standard	Mary River Sampling Locations			
		1A	1B	2A	2B
Maximum TSP (µg/m^3)$_1$	120	3.5	3.0	**7.0**	5.5
Maximum 24-h PM_{10}, (µg/m^3)$_2$	50	3.0	1.5	1.8	**3.8**
SO_2 (30-day average) (µg/m^3)$_3$	450 (1-h) 150 (24-h) 30 (annual)				
NO_2 (30-day average) (µg/m^3)$_3$	400 (1-h) 200 (24-h) 60 (annual)				
O_3 (30-day average) (µg/m^3)$_3$	100 (1-h) 127 (8-h) 30 (24-h) 30 (annual)				

NOTES:
1 – based on 15 samples
2 – based on 12 days of sampling
3 – based on 50 days of sampling.
Bold values indicate maximum values selected as baseline concentrations.

TABLE 5: BASELINE AMBIENT NOISE MONITORING RESULTS

Site	Leq (24 h) (dBA)	Leq (Day, 15 h) (dBA)	Leq (Night, 9 h) (dBA)	Minimum Leq (1 h) (dBA)	Maximum Leq (1 h)(dBA)
Mary River	25	25	26	20	34
Milne Inlet	30	31	29	21	35
Steensby Inlet	29	31	26	23	35

Appendix D
Met Station Monitoring And Maintenance
(Campbell Scientific, 2015)

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

CANADA

Baffinland Iron Mines Corporation Annual Report

2015 Met Station Monitoring and Maintenance

Presented to:

Trevor Meyer
Baffinland Iron Mines Corporation
December 10, 2015

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Overview

New meteorological stations were installed at Mary River, Milne and Steensby locations on Baffin Island, NU in August 2013 by Campbell Scientific Canada (CSC). These met stations were intended to replace existing Symboticware met stations that were previously installed and had become non-functional. The CSC stations contain new, calibrated rugged sensors and dataloggers in order to provide consistent, accurate and reliable data. These features are particularly important given the remote locations of these stations, where access is a challenge. Some existing hardware, such as enclosures, towers, and power supplies have been repurposed for use with these stations.

Campbell Scientific is also providing both Field and Data Services for all three stations, which include active network and data management.

Field Services includes an annual maintenance trip by a CSC technician. This trip involves field calibrating or swapping of sensors to minimize station downtime, general station maintenance and inspection, and addressing any hardware and/or troubleshooting concerns.

Data Services includes the remote collection of data once a week using each of the stations iridium satellite communications hardware. The data is collected to a CSC server and synced to an FTP site which is accessible by Baffinland Iron Mine Inc. Basic QA/QC is performed on the data in order to monitor station health and identify any abnormalities with a specific parameter/sensor.

This report includes an outline of the work completed by CSC Technician, Travis Holder, during the September 2015 maintenance trip. A summary is also included of the station health and data overview from each station since completion of the 2014 maintenance trip until the date of the maintenance trip in September 2015.

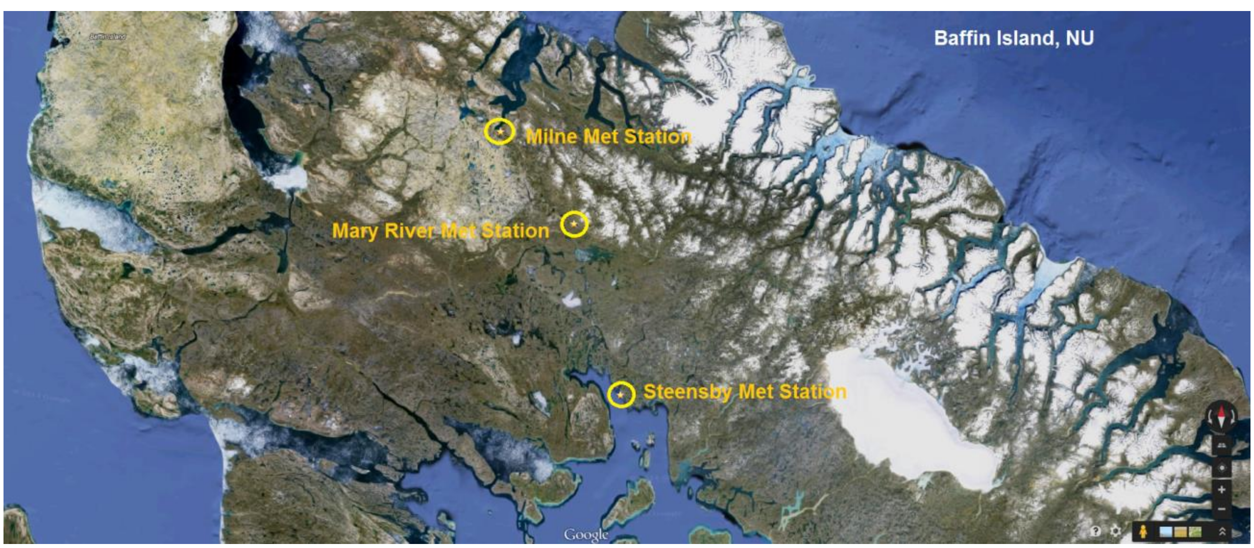


Figure 1: Map of Baffinland met stations installed on Baffin Island, NU as of August 2013

Station Health

Campbell Scientific Canada has been collecting data from the Milne, Mary River and Steensby met stations starting as of late August 2013. The data is collected remotely to a CSC server on a weekly schedule via iridium communication hardware. Once data is collected, it is then synced in near real time to a password protected, secure FTP site accessible by Baffinland end users.

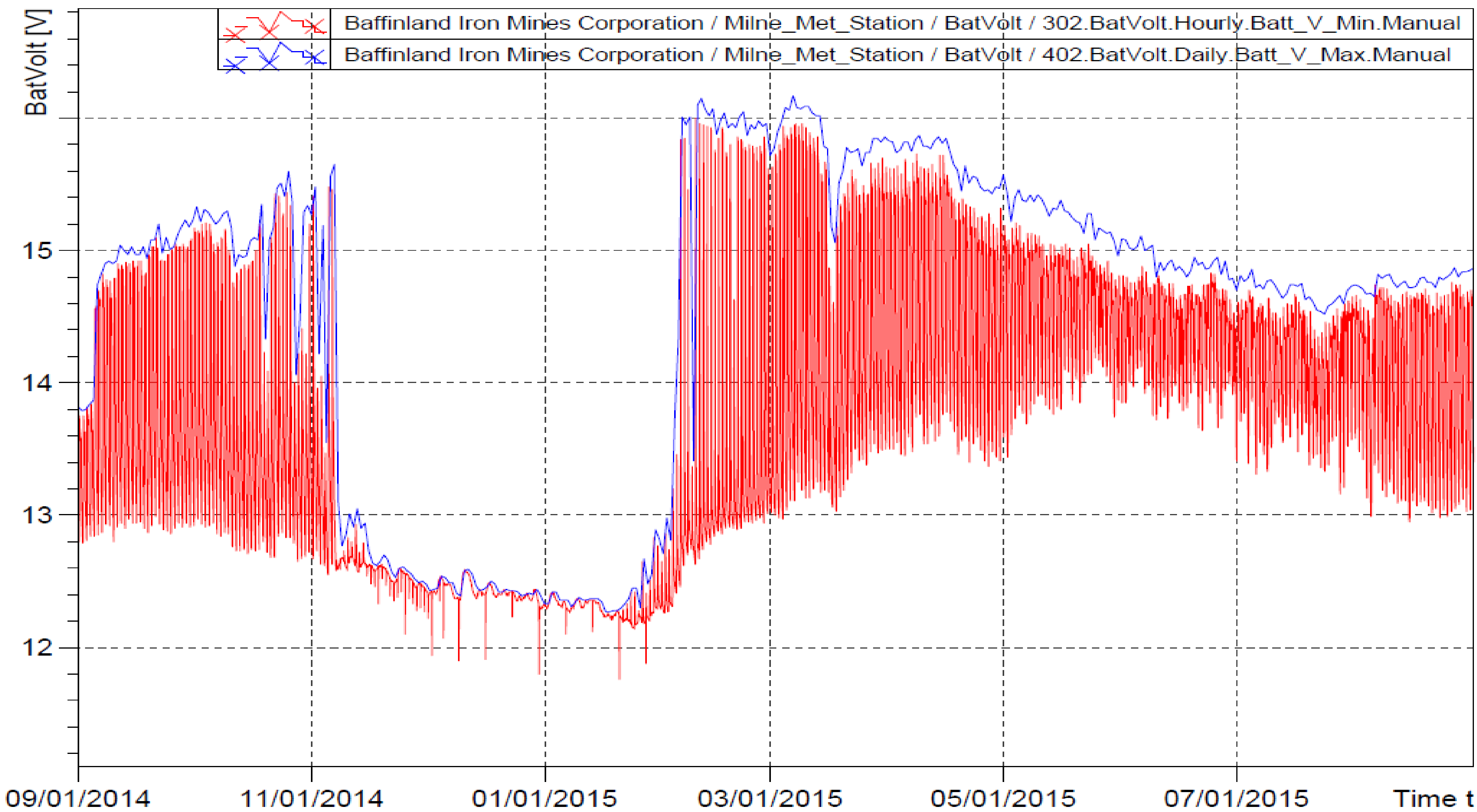
Data QA/QC

A basic QA/QC check of all data is performed in order to monitor station health and flag any suspect or invalid data. All data from each station is being imported into our WISKI database which provides automated data QA/QC and validation. The automated QA/QC occurs within several minutes after data is collected from each station and imported into the WISKI database. Below are events that occurred and were flagged during the past year:

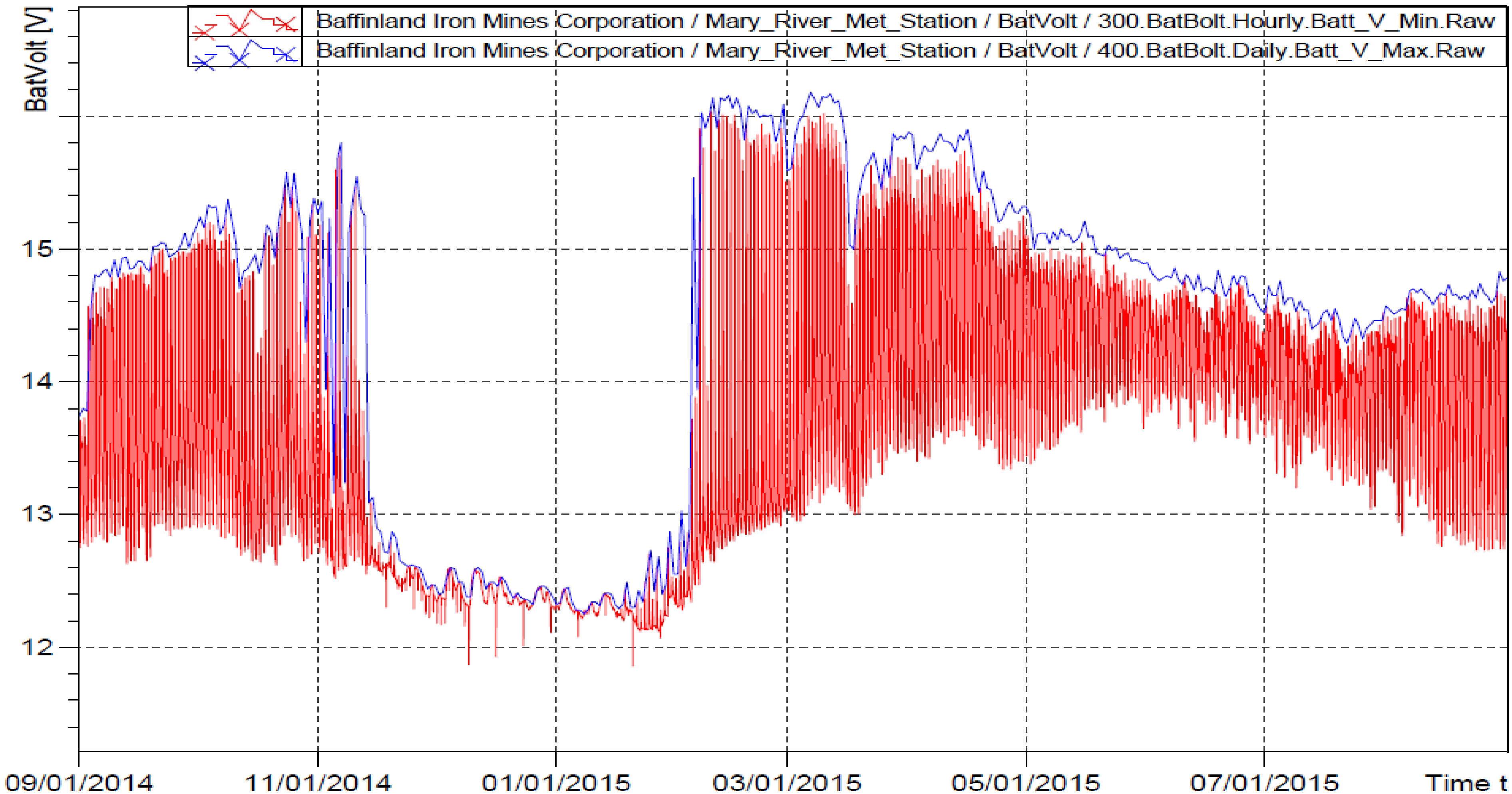
The removed HC-S3-XT Temp/RH probe heads (previously installed during 2014 maintenance trip) from the Milne, Mary River and Steensby met stations were returned to CSC facility and evaluated by a CSC repair technician. Upon evaluation it was determined that all three probe head temperature sensors were out of specification and could not be properly calibrated. We cannot determine at what point the temperature readings went out of spec over 2014, but can confirm the temperature readings may have been inaccurate by 0.4 or 0.5 degrees during all or a portion of the year, from September 2014 when the sensors were installed to September 2015 when these probe heads were removed. These returned sensors have been replaced under warranty and the replacement sensors were returned to CSC exchange inventory.

Data Retrieval

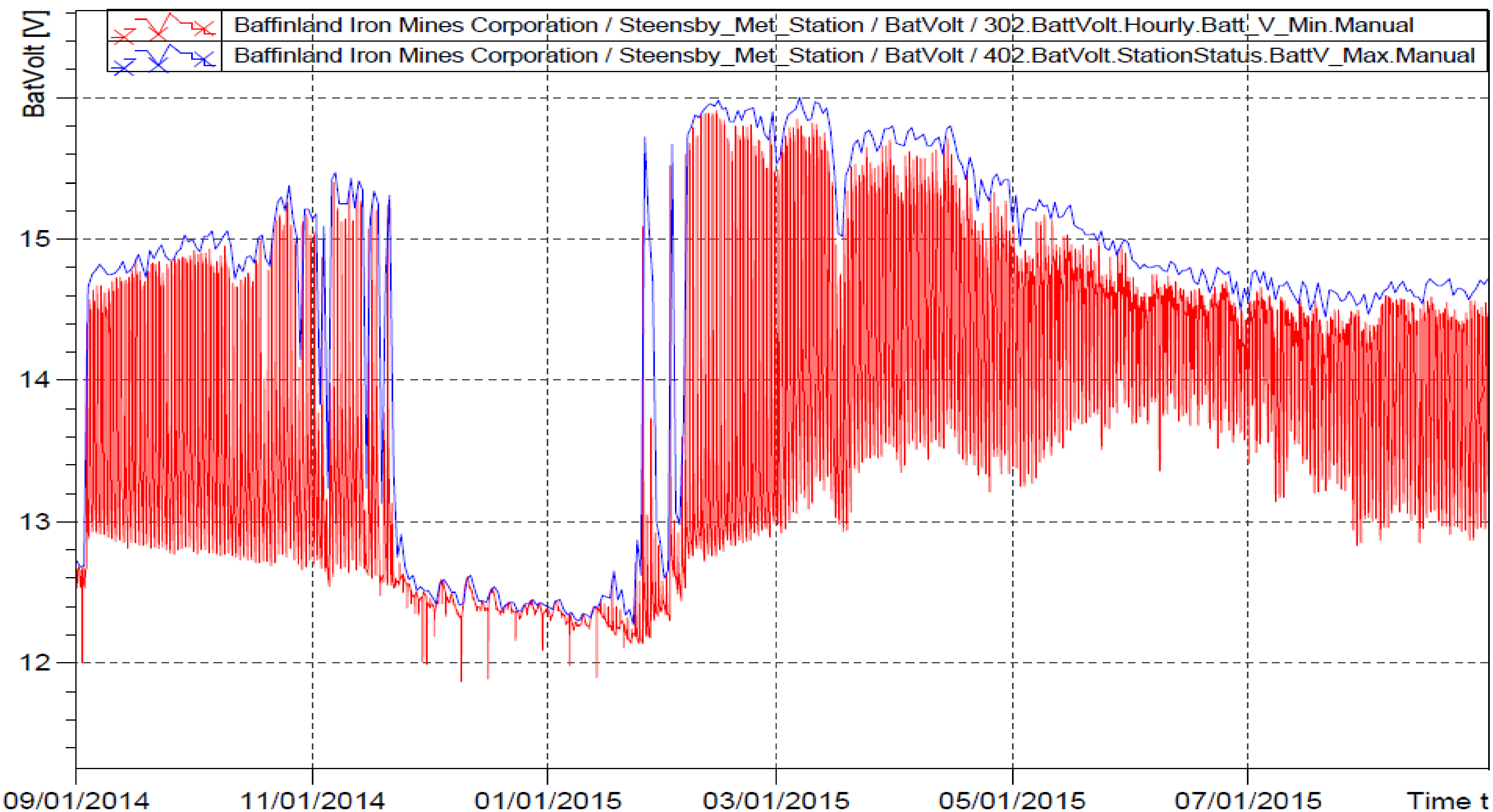
The extra modem power-on windows programmed for each station were turned off remotely by CSC over winter months to conserve battery power. The extra windows were then turned on again remotely in spring. All three stations remained operational over the entire year. A complete set of data files for all station tables has been collected and is stored on the CSC server as well as synced to the FTP folders for each station. Aside from minor station down time which occurred during the 2015 maintenance trip performed by CSC in September 2015, there were no other recorded data gaps over the year from the three met stations.



Graph 1: Milne station power – Sept 2014 to Sept 2015



Graph 2: Mary River station power – Sept 2014 to Sept 2015



Graph 3: Steensby station power – Sept 2014 to Sept 2015

Station Details and Maintenance Summaries

Milne Met Station

71°52'38.9"N 80°49'55.4"W

The Milne weather station equipment was installed by CSC Technician, Mike Ryder, in August 2013. This station is using an existing power supply from the Symboticware met station previously installed at this location. Below is the list of equipment currently installed at this station:

Datalogger:

CR1000 -55 - s/n 56192

Power Supply:

2 X 85 W solar panels

12V 115 AHr Battery

CH100 charger/regulator

Communications:

9522B Iridium satellite modem - s/n 300025010034330

COM9522B Satellite modem interface – s/n 1031

SC932A CS I/O to 9 Pin RS-232 DCE Interface (with L10873 and SC12 cables)

Sensors:

HC-S3-XT Rotronics Temp/RH probe – s/n 61468632

05108 RM Young Wind Monitor – s/n 1278320

SP Lite2 Kipp&Zonen Solar radiation sensor – s/n140745

TE525M Texas Electronics Tipping Bucket Rain Gauge – s/n 56724-8013

Housing:

ENC 16/18 fiberglass waterproof enclosure (datalogger, iridium modem hardware, and charger/regulator)

ENC BATT (12V 115 AHr battery)

Mounting Structure:

UT30 Universal Towers 10M tower with guy wire kit

Milne Maintenance Summary

Site Visit Date – Sept 21, 2015   CSC Technician: Travis Holder

Datalogger:

Prior to any maintenance performed at this station, all existing data stored on the datalogger was downloaded. Due to the age of this CR1000 datalogger calibration was not required. The datalogger lithium battery was recorded at 3.37 Volts, which indicates an acceptable voltage. The lithium battery requires replacement when reading 2.9 Volts or lower.

Chicken wire had been installed at this station during the 2014 maintenance trip to help prevent animals chewing on and damaging exposed cables; however only a small amount of chicken wire had remained at the station over time. During this trip additional chicken wire supplied by CSC was added and wrapped around the bottom of the tower base at this station.

A revised program was uploaded to the station datalogger which included updated modem registration code and included the specified sensitivity value (69.5) for the replacement solar radiation sensor.

Enclosure desiccant and humidity indicator card were replaced and the enclosure port was re-sealed with the existing putty prior to leaving site.

Power Supply:

The station power supply remained healthy over the past year as shown in graph 1 on page 4. Voltage issues look to have been resolved with replacement of charger/regulator at this station during the 2014 maintenance trip. The SunSaver20 regulator remains installed at this station. The battery voltage was recorded at 14.81 Volts while on-site.

Sensors:

A functional test and visual inspection were performed on each sensor. Most real time data values were verified using an on-site handheld unit. The station public table was also collected to verify proper functionality of all sensors. Below is a breakdown of maintenance performed on each sensor:

Temp/RH - The existing HC-S3-XT Temp/RH probe head from this station was exchanged for a refurbished, calibrated replacement HC-S3-XT Temp/RH probe head (s/n 61468632) through the CSC exchange program. The existing station HC-S3-XT probe head was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory.

Precipitation - The existing TE525M tipping bucket rain gauge from this station was exchanged for a refurbished, calibrated replacement TE525M (s/n 56724-8013) through the CSC exchange program. The existing station TE525M rain gauge was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory. The funnel screen was missing and replaced as well.

A new mounting bracket was also included with the replacement TE525M. The broken bracket was removed along with the existing TE525M. The funnel of the replacement TE525M was secured to the bucket using electrical tape once installed.

The existing TBRG cable has bare wires, and wraps around screws on the internal terminal strip of bucket. The bare leads were stripped back and doubled over a few times so thick enough to secure under screw on replacement bucket terminal strip. The funnel of the replacement TE525M was secured to the bucket using electrical tape once installed.

Wind Speed/Direction - The 05108-10 wind monitor contains long lasting ceramic bearings to reduce maintenance requirements of this sensor. Therefore calibration/maintenance was not required for this sensor during this site visit. The wind monitor housing and cable were visually inspected and confirmed to be in excellent condition.

Solar Radiation – The 015 mounting arm was removed and the existing SPLite2 solar radiation sensor from this station was exchanged for a refurbished, calibrated replacement SPLite2 solar radiation sensor (s/n140745) through the CSC exchange program. The existing station SPLite2 sensor was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory. The replacement SP Lite2 sensor level was not specifically confirmed due safety concerns accessing this sensor once the mounting arm was re-installed.

Communications:

A successful remote iridium communications test was performed by CSC Data Services representative once station maintenance was completed prior to leaving site. The communications remains on the existing power control schedule, turning on once a week.

Figure 2: Milne met station (photo taken during 2014 trip -looking towards the West)

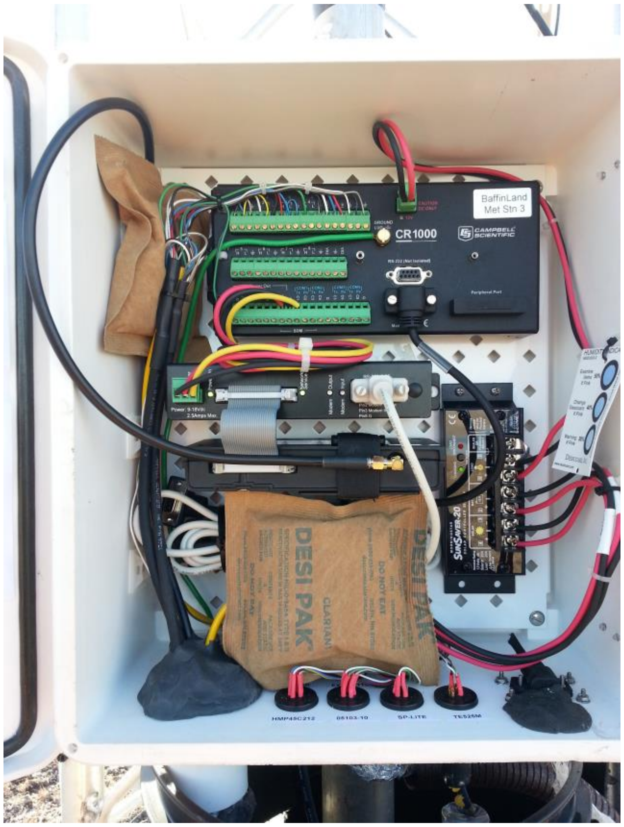


Figure 3: Inside Milne station enclosure (photo taken during 2014 trip)

Figure 4: Supplementary chicken wire added to base of Milne station during 2015 maintenance trip

Mary River Met Station

71°19'27.4"N 79°22'27.5"W

The Mary River weather station equipment was installed by Campbell Scientific Canada Technician, Mike Ryder, in August 2013. This station is using an existing power supply from the Symboticware met station previously installed at this location. Below is the list of equipment currently installed at this station:

Datalogger:

CR1000 -55 - s/n 56190

Power Supply:

2 X 85 W solar panels

12V 115 AHr Battery

CH100 charger/regulator

Communications:

9522B Iridium satellite modem - s/n 300025010334310

COM9522B Satellite modem interface – s/n 1029

SC932A CS I/O interface (with L10873 and SC12 cables)

Sensors:

HC-S3-XT Rotronics Temp/RH probe – s/n 61468628

05108 RM Young Wind Monitor – s/n 1278318

SP Lite2 Kipp&Zonen Solar radiation sensor – s/n 140746

TE525M Texas Electronics Tipping Bucket Rain Gauge – s/n 41626-207

Housing:

ENC 16/18 fiberglass waterproof enclosure (datalogger, iridium modem hardware, and charger/regulator)

ENC BATT (12V 115 AHr battery)

Mounting Structure:

UT30 Universal Towers 10M tower with guy wire kit

Mary River Maintenance Summary

Site Visit Date – Sept 19, 2015   CSC Technician: Travis Holder

Datalogger:

Prior to any maintenance performed at this station, all existing data stored on the datalogger was downloaded. Due to the age of this CR1000 datalogger calibration was not required. The datalogger lithium battery was recorded at 3.36 Volts, which indicates an acceptable voltage. The lithium battery requires replacement when reading 2.9 Volts or lower.

A revised program was uploaded to the station datalogger which included updated modem registration code and included the specified sensitivity value (67.9) for the replacement solar radiation sensor.

Enclosure desiccant was replaced and the enclosure port was re-sealed with the existing putty prior to leaving site.

Power Supply:

The station power supply remained healthy over the past year as shown in graph 2 on page 5. Voltage issues look to have been resolved with replacement of charger/regulator at this station during the 2014 maintenance trip. The SunSaver20 regulator remains installed at this station. The battery voltage was recorded at 14.69 Volts while on-site.

Sensors:

A functional test and visual inspection were performed on each sensor. Most real time data values were verified using an on-site handheld unit. The station public table was also collected to verify proper functionality of all sensors. Below is a breakdown of maintenance performed on each sensor:

Temp/RH - The existing HC-S3-XT Temp/RH probe head from this station was exchanged for a refurbished, calibrated replacement HC-S3-XT Temp/RH probe head (s/n 61468628) through the CSC exchange program. The existing station HC-S3-XT probe head was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory

Precipitation - The existing TE525M tipping bucket rain gauge from this station was exchanged for a refurbished, calibrated replacement TE525M (s/n 41626-207) through the CSC exchange program. The existing station TE525M rain gauge was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory.

Wind Speed/Direction - The 05108-10 wind monitor contains long lasting ceramic bearings to reduce maintenance requirements of this sensor. Therefore calibration/maintenance was not required for this sensor during this site visit. The wind monitor housing and cable were visually inspected and confirmed to be in excellent condition.

Solar Radiation – The 015 mounting arm was removed and the existing SPLite2 solar radiation sensor from this station was exchanged for a refurbished, calibrated replacement SPLite2 solar radiation sensor (s/n140746) through the CSC exchange program. The existing station SPLite2 sensor was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory. The replacement SP Lite2 sensor level was not specifically confirmed due safety concerns accessing this sensor once the mounting arm was re-installed.

While removing the 015 mount for replacing the solar sensors, the mount u-bolt was snapped off due to seizing of the nuts as a result of exposure to extreme elements. A spare compatible u-bolt was not available so a square shaped u-bolt was bent to accommodate re-installation of the 015 solar sensor mounting arm. Currently the top U-bolt for this mount is using 9/16″ size nuts and the bottom is using ½″ size nuts. The 015 mounting arm was installed and levelled as best as possible without the ability to use a proper levelling tool. The SP Lite2 sensor level was not specifically confirmed due safety concerns accessing this sensor once the mounting arm was re-installed.

Communications:

A successful remote iridium communications test was performed by CSC Data Services representative once station maintenance was completed prior to leaving site. The communications remains on the existing power control schedule, turning on once a week.

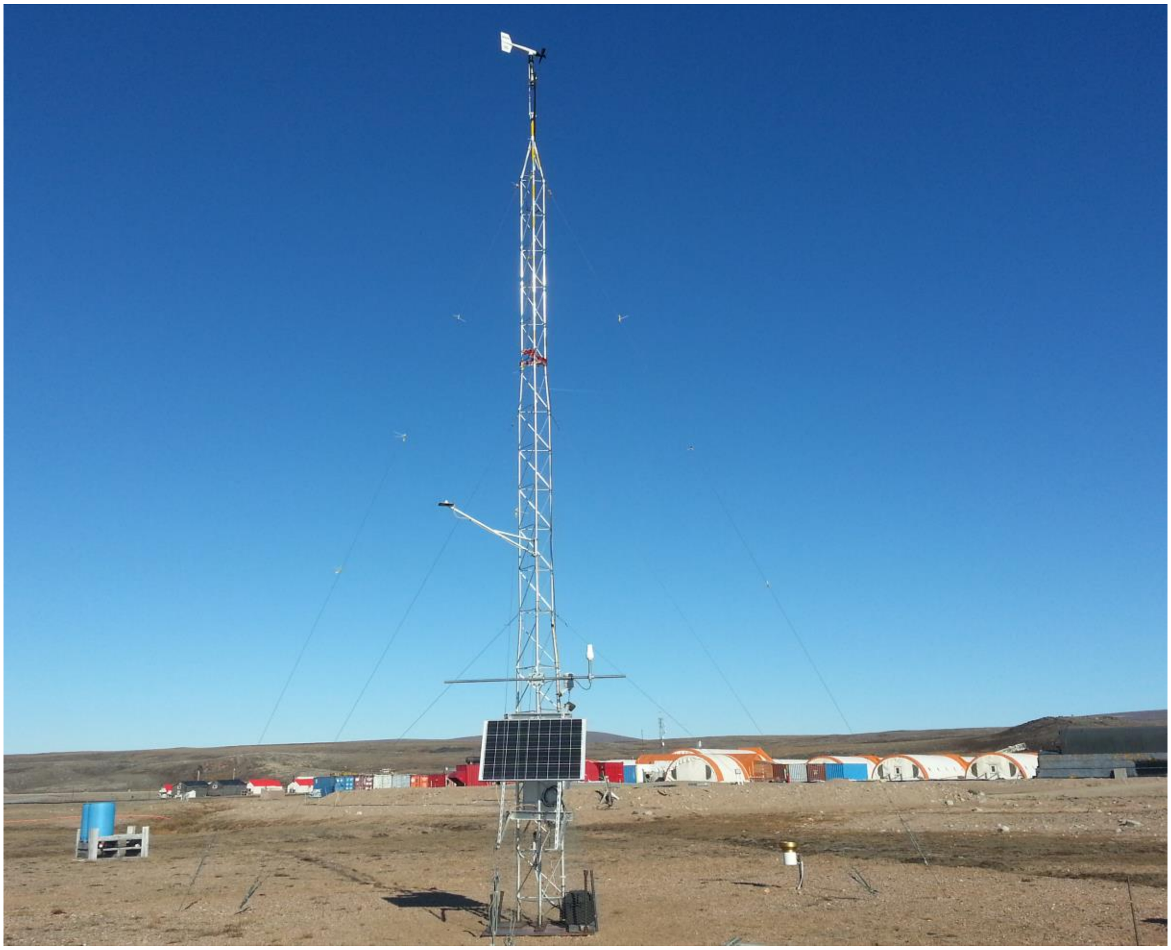


Figure 5: Mary River met station (photo taken during 2014 trip - looking towards the North)

Figure 6: Mary River met station (photo taken during 2015 trip - looking towards the South)

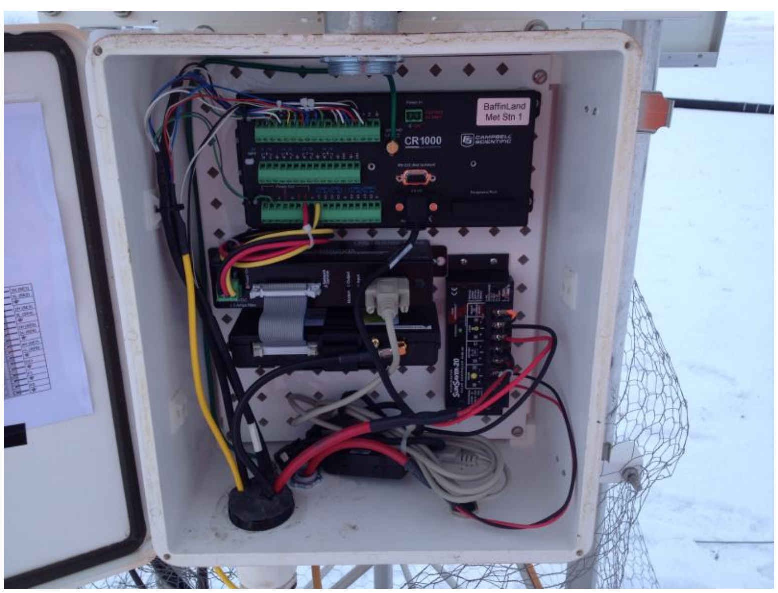


Figure 7: Inside Mary River datalogger enclosure during 2015 maintenance trip

Steensby Met Station

70°16'36.4"N 78°31'37.4"W

The Steensby weather station equipment was installed by Campbell Scientific Canada Technician, Mike Ryder, in August 2013. This station is using an existing power supply from the Symboticware met station previously installed at this location. Below is the list of equipment currently installed at this station:

Datalogger:

CR1000 -55 - s/n 56191

Power Supply:

2 X 85 W solar panels

12V 115 AHr Battery

CH100 charger/regulator

Communications:

9522B Iridium satellite modem - s/n 300025010037320

COM9522B Satellite modem interface – s/n 1030

SC932A CS I/O to 9 Pin RS-232 DCE Interface (with L10873 and SC12 cables)

Sensors:

HC-S3-XT Rotronics Temp/RH probe – s/n 61468626

05108 RM Young Wind Monitor – s/n 1278319

SP Lite2 Kipp&Zonen Solar radiation sensor – s/n 151088

TE525M Texas Electronics Tipping Bucket Rain Gauge – s/n 56721-813

Housing:

ENC 16/18 Fiberglass waterproof enclosure (datalogger, iridium modem hardware, and charger/regulator)

ENC BATT (12V 115 AHr battery)

Mounting Structure:

UT30 Universal Towers 10M tower with guy wire kit

Steensby Maintenance Summary

Site Visit Date – Sept 21, 2015 CSC Technician: Travis Holder

Datalogger:

Prior to any maintenance performed at this station, all existing data stored on the datalogger was downloaded. Due to the age of this CR1000 datalogger calibration was not required. The datalogger lithium battery was recorded at 3.35 Volts, which indicates an acceptable voltage. The lithium battery requires replacement when reading 2.9 Volts or lower.

A revised program was uploaded to the station datalogger which included updated modem registration code and included the specified sensitivity value (72.4) for the replacement solar radiation sensor.

Enclosure desiccant was replaced and the enclosure port was re-sealed the existing putty prior to leaving site.

Power Supply:

The station power supply remained healthy over the past year as shown in graph 3 on page 6. Voltage issues look to have been resolved with replacement of charger/regulator at this station during the 2014 maintenance trip. The SunSaver20 regulator remains installed at this station. The battery voltage was recorded at 14.56 Volts while on-site.

A new battery enclosure was installed to replace the existing cracked enclosure.

Sensors:

A functional test and visual inspection were performed on each sensor. Most real time data values were verified using an on-site handheld unit. The station public table was also collected to verify proper functionality of all sensors. Below is a breakdown of maintenance performed on each sensor:

Temp/RH - The existing HC-S3-XT Temp/RH probe head from this station was exchanged for a refurbished, calibrated replacement HC-S3-XT Temp/RH probe head (s/n 61468626) through the CSC exchange program. The existing station HC-S3-XT probe head was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory.

Precipitation - The existing TE525M tipping bucket rain gauge from this station was exchanged for a refurbished, calibrated replacement TE525M (s/n 56721-813) through the CSC exchange program. The existing station TE525M rain gauge was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory. The funnel of the replacement TE525M was secured to the bucket using electrical tape once installed.

Wind Speed/Direction - The 05108-10 wind monitor contains long lasting ceramic bearings to reduce maintenance requirements of this sensor. Therefore calibration/maintenance was not required for this sensor during this site visit. The wind monitor housing and cable were visually inspected and confirmed to be in excellent condition.

Solar Radiation – The 015 mounting arm was removed and the existing SPLite2 solar radiation sensor from this station was exchanged for a refurbished, calibrated replacement SPLite2 solar radiation sensor (s/n 151088) through the CSC exchange program. The existing station SPLite2 sensor was returned to CSC facility for standard maintenance and calibration and then placed into CSC exchange inventory. The replacement SP Lite2 sensor level was not specifically confirmed due safety concerns accessing this sensor once the mounting arm was re-installed.

Communications:

A successful remote iridium communications test was performed by CSC Data Services representative once station maintenance was completed prior to leaving site. The communications remains on the existing power control schedule, turning on once a week.

Figure 8: Steensby met station (picture taken during 2014 trip - looking towards the West)

Figure 9: Inside Steensby datalogger enclosure during 2015 maintenance trip

Figure 10: Previous Steensby cracked battery enclosure

Figure 11: New replacement battery enclosure

Milne Camp

The Milne Camp weather station equipment was installed by Campbell Scientific Canada Technician, Mike Ryder, in September 2014. Below is the list of equipment currently installed at this station:

Datalogger:

CR800

Power Supply:

PS100-8.5 Charger/regulator with rechargeable lead acid 12V battery

Z3749-ND – 120 to 24 VDC AC Adapter (Compatible for use with the WS600-UMB sensor)

Communications:

NL201-XT Ethernet interface – IP Address 10.40.2.17

Sensors:

WS600-UMB Lufft all-in-one smart weather sensor – includes Air Temp,RH, Barometric Pressure, Wind Speed/Direction and Precipitation.

Housing:

ENC 12/14 fiberglass waterproof enclosure (datalogger, Ethernet interface, and charger/regulator)

Mounting Structure:

Enclosure wall mounted inside on-site server room. WS600-UMB sensor mounted on top of user supplied pipe attached to outside of server room canister wall.

Milne Camp Station Maintenance Summary

Due to weather and other delays, CSC was not able to visit this station during this trip.

Figure 12: Milne camp WS600-UMB sensor installed on the outside wall of server room trailer (photo taken from 2014 trip)

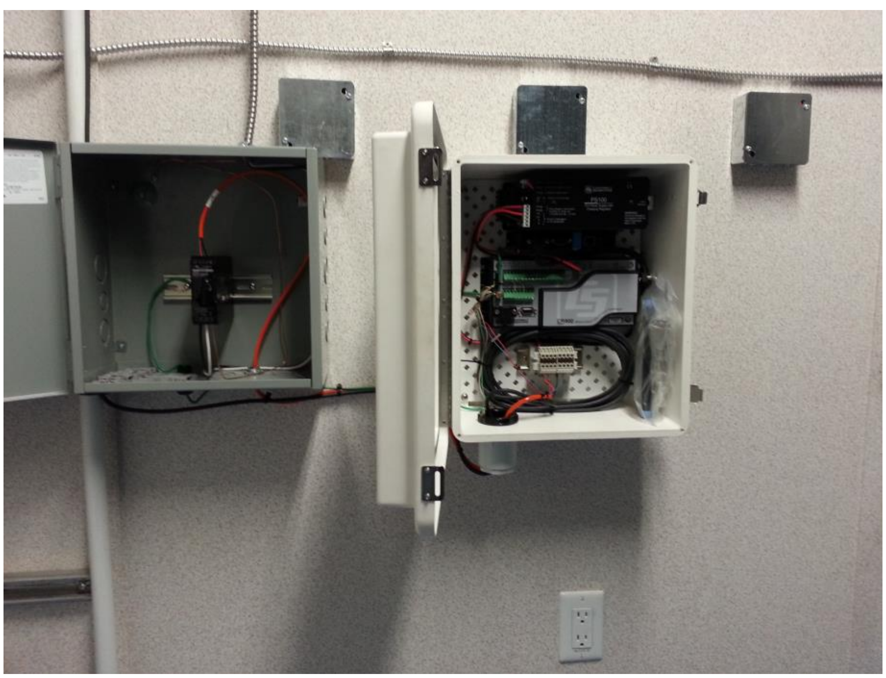


Figure 13: Inside Milne camp datalogger enclosure and sensor power supply enclosure (photo taken during 2014 trip)

Mary River Camp

The Milne Camp weather station equipment was installed by Campbell Scientific Canada Technician, Mike Ryder, in September 2014. Below is the list of equipment currently installed at this station:

Site Visit Date – Sept 18, 2015 CSC Technician: Travis Holder

Datalogger:

CR800

Power Supply:

PS100-8.5 Charger/regulator with rechargeable lead acid 12V battery

Z3749-ND – 120 to 24 VDC AC Adapter (Compatible for use with the WS600-UMB sensor)

Communications:

NL201-XT Ethernet interface – IP Address 10.20.2.17

Sensors:

WS600-UMB Lufft all-in-one smart weather sensor – includes Air Temp,RH, Barometric Pressure, Wind Speed/Direction and Precipitation.

Housing:

ENC 12/14 fiberglass waterproof enclosure (datalogger, Ethernet interface, and charger/regulator)

Mounting Structure:

Enclosure wall mounted inside on-site server room. WS600-UMB sensor mounted on top of user supplied pipe attached to outside of server room trailer wall.

Mary River Camp Station Maintenance Summary

The Lufft "all-in-one sensor" which remained installed at this station and was not exchanged with a replacement sensor. A functionality check and visual inspection was performed on the existing sensor.

The sensor was cleaned of dust built up and covering sensor. Please note that the red coloration on parts of this sensor is staining from this dust.

Data at this station was reviewed and no concerns with readings were noted. Confirmed functionality of the web page created during last year's trip which is still accessible at the following Baffinland internal network IP address: 10.20.2.17

Figure 14: Mary River camp WS600-UMB sensor installed on outside wall of server room trailer (photo taken during 2014 trip)

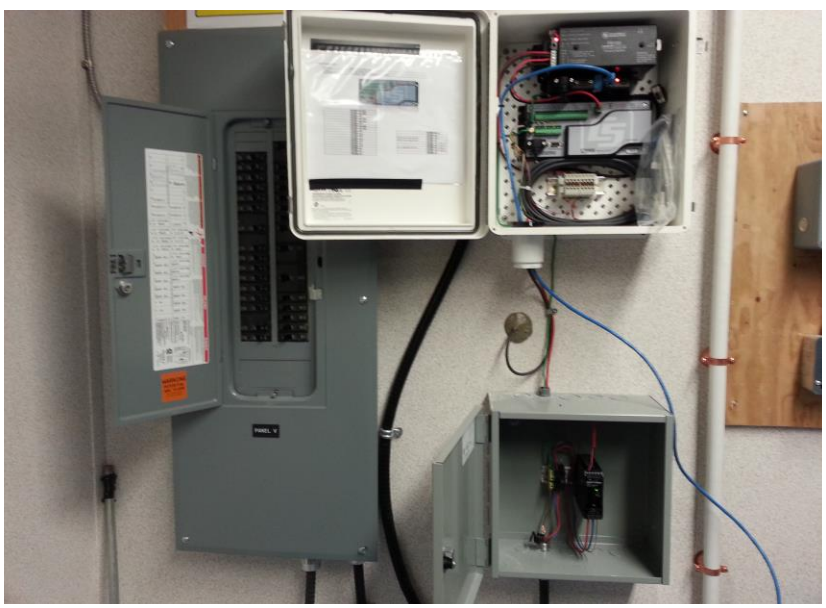


Figure 15: Inside Mary River camp datalogger enclosure and sensor power supply enclosure

Figure 16: Current condition of WS600-UMB Lufft sensor at Mary River Camp

Deposit No.1

The Deposit No.1 weather station equipment was installed by Campbell Scientific Canada Technician, Mike Ryder, in September 2014. Below is the list of equipment currently installed at this station:

Site Visit Date – Sept 22, 2015   CSC Technician: Mike Ryder

Datalogger:

CR1000

CFM100 Compact Flash Module with SD card

Power Supply:

BP 100 – 12V 100 AHr lead acid battery

Sensors:

05103-10 RM Young Wind Monitor

HC-S3 Rotronic Temp/RH Probe

Housing:

Existing Symboticware enclosure

Mounting Structure:

Existing communications repeater tower installed on top of on-site canister

Deposit No.1 Station Maintenance Summary

Datalogger:

This station does not currently have any remote communications installed so data can only be access directly from the datalogger upon a site visit to this station. Prior to any maintenance performed, all existing data was collected from the datalogger

Data for the last year was retrieved, reviewed and provided to the client. Upon review of the data, sections of 0 wind speed and wind direction for several days at a time were noted. The wind monitor at this station is prone to freeze up (as shown in the pictures below) which may explain values of zero for both wind speed and direction.

The datalogger lithium battery was recorded at 3.38 Volts, which indicates an acceptable voltage. The lithium battery requires replacement when reading 2.9 Volts or lower.

Due to time constraints, the enclosure desiccant was not replaced inside the datalogger enclosure at this station.

Power Supply:

The replacement PS150 battery was confiscated by airport authorities prior to arrival on-site. Therefore this battery and AC adapter were not installed as planned at this station.

The BP100 battery is not being charged at this station so voltage was recorded at 11.7 V. It is expected that the battery voltage will drop over time at this station.

Sensors:

A site lift was not available to access the sensors at this station. Due to safety concerns and regulations, maintenance was not performed on the sensors at this station.

Temp/RH: The HC-S3-XT sensor head could not be exchanged as the planned. The sensor radiation shield was partially covered in ice. While this may affect sensor air temperature and RH readings, the sensor remained functional as confirmed with review of collected data.

Wind Speed/Direction: The 05103-10 wind monitor speed bearings were not replaced as planned. This sensor was almost completely iced up, which will affect both wind speed and direction readings from this sensor.

Figure 17: Deposit No. 1 station installed on outside of existing site canister (picture taken during 2014 trip)

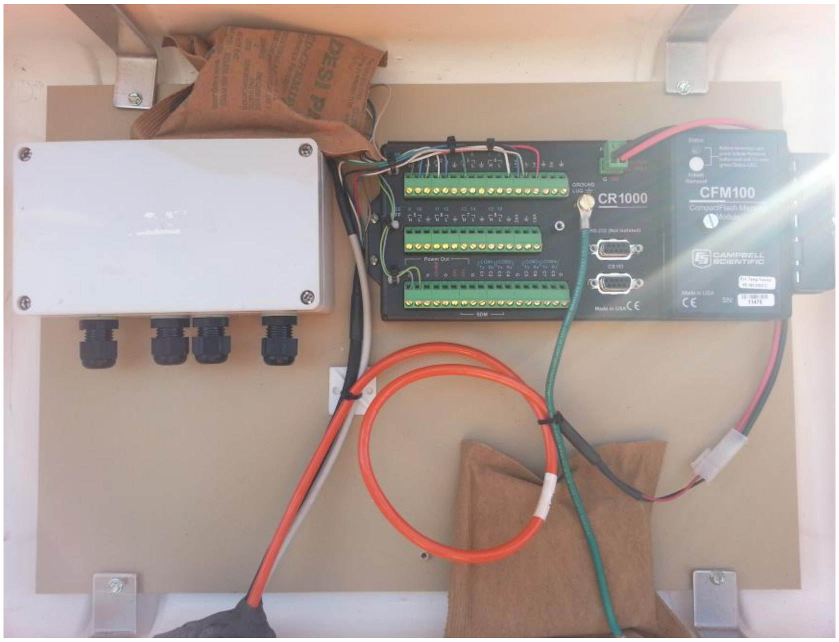


Figure 18: Inside Deposit No. 1 datalogger enclosure (picture taken during 2014 trip)

Figure 19: Ice cover on Deposit No. 1 station during 2015 trip

Figure 20: close up of Ice cover on Deposit No.1 sensors during 2015 trip

Action Items/Recommendations

General:

The next recommended field maintenance/calibration site visit for all stations is summer/fall 2016.

CSC will continue to monitor sensor data and battery voltage levels at the Milne, Mary River and Steensby remote met stations. CSC will notify the client if any issues arise.

Milne:

The current old generation cable entry port causes difficulty with running the current number of sensor cables into the station enclosure. Upgrading the enclosure port to the new larger version is recommended, but not absolutely necessary. This task was not performed during this year's maintenance trip. Extra time on site will need to be planned to replace this enclosure port as this will require drilling a larger port hole in the bottom the enclosure as well as re-wiring all sensor cable to the station datalogger.

Steensby:

The current old generation cable entry port causes difficulty with running the current number of sensor cables into the station enclosure. Upgrading the enclosure port to the new larger version is recommended, but not absolutely necessary. This task was not performed during this year's maintenance trip. Extra time on site will need to be planned to replace this enclosure port as this will require drilling a larger port hole in the bottom the enclosure and as well as re-wiring all sensor cable to the station datalogger.

Mary River and Milne Camp:

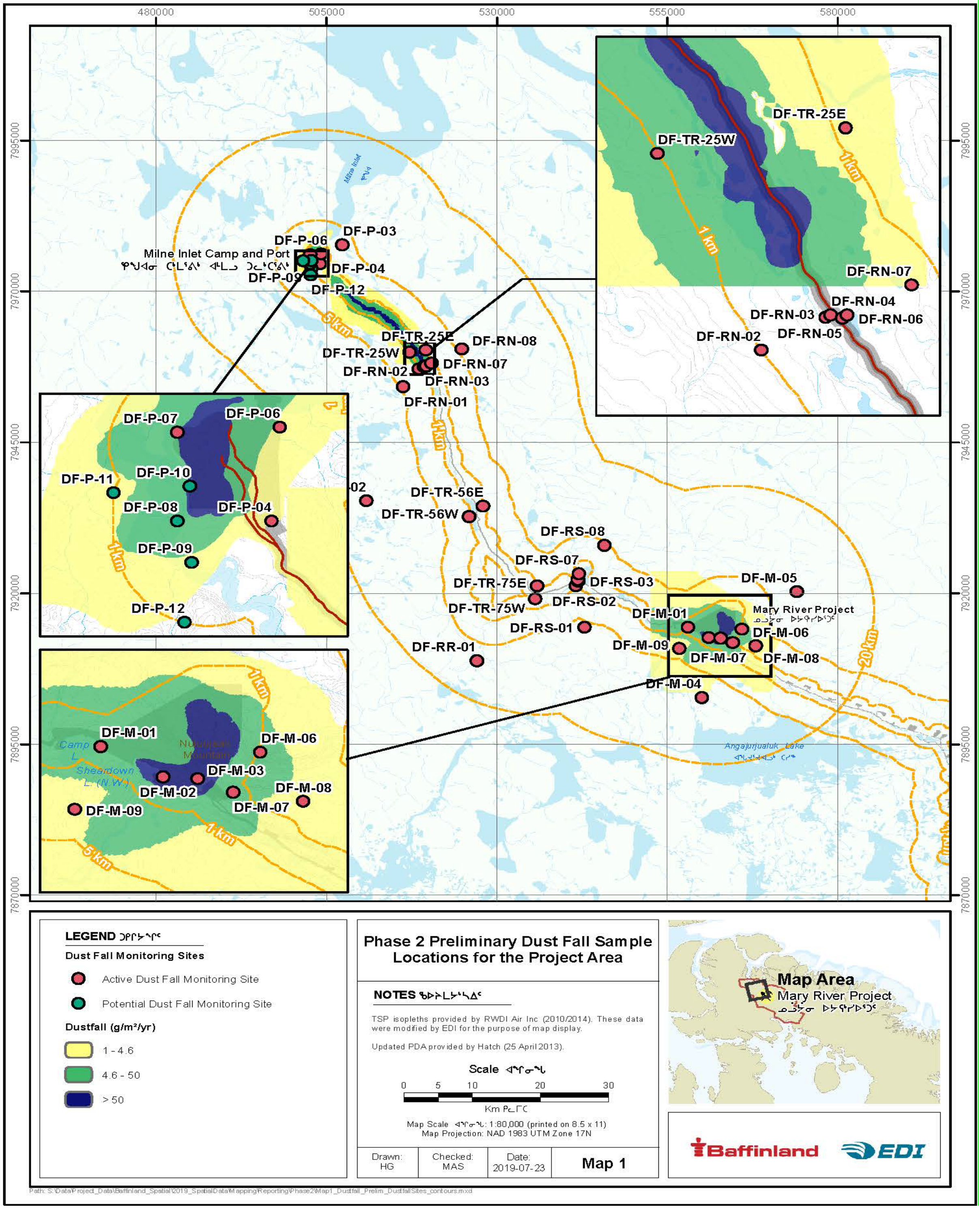
In order to prevent station down time and multiple site trips, a replacement calibrated sensor is recommended to be installed while the existing sensor is removed for recommended calibration or if sensor requires repair. The WS600-UMB sensor is not currently available through the CSC exchange program. In this case, the client will be responsible for purchase and management of a replacement sensor for these two stations.

Deposit No. 1:

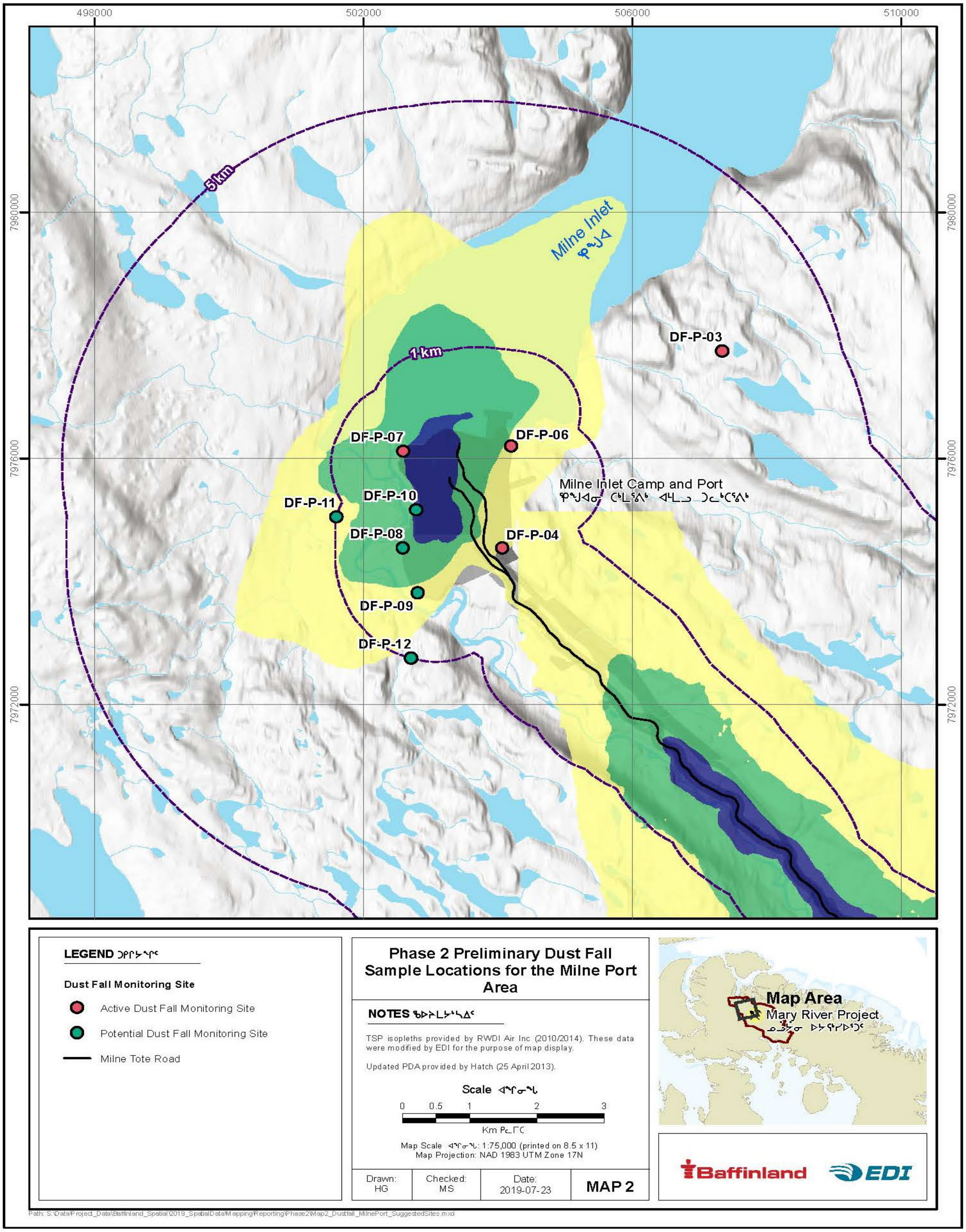
This station is currently being powered only by the BP100 battery with no solar panel. The battery voltage has dropped as expected at this station. Recommend a site visit by the client to recharge the battery within the next 1-2 months, and then periodically over the year to maintain healthy voltage levels. Also recommend client to download data during site visits to avoid any loss of data as this station is not actively being monitored remotely.

Prior to proposed 2016 maintenance trip, discuss possibility of adding communications to this station and potential for data services provided by CSC similar to other three met stations.

Appendix E
Dustfall Monitoring Sites

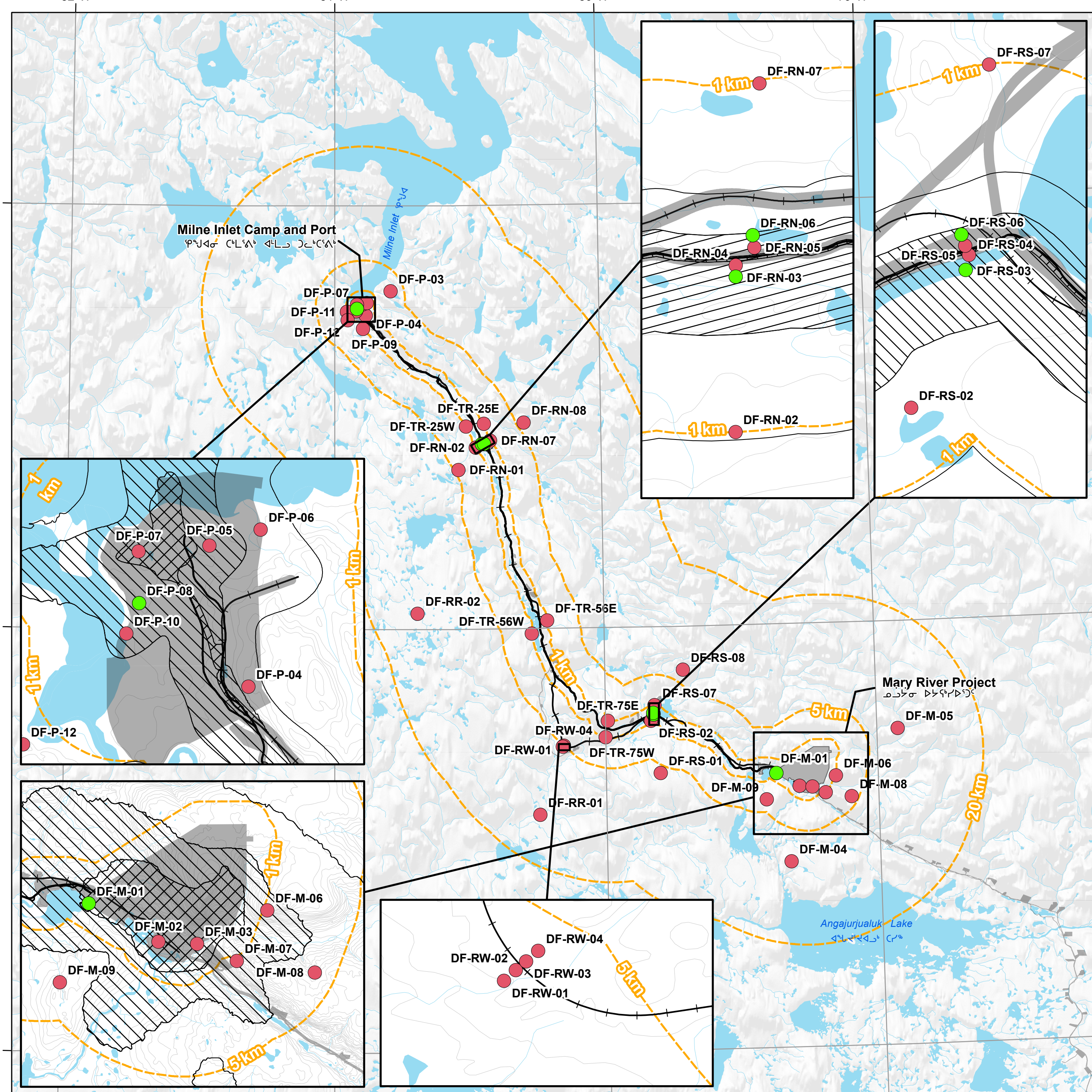


480000
505000
530000
555000
580000
7995000
7970000
7945000
7920000
7895000
7870000
Milne Inlet Camp and Port
DF-P-03
DF-P-04
DF-P-06
DF-P-07
DF-P-08
DF-P-09
DF-P-10
DF-P-11
DF-P-12
DF-TR-25E
DF-TR-25W
DF-RN-01
DF-RN-02
DF-RN-03
DF-RN-04
DF-RN-05
DF-RN-06
DF-RN-07
DF-RN-08
DF-TR-56E
DF-TR-56W
DF-RS-01
DF-RS-02
DF-RS-03
DF-RS-07
DF-RS-08
DF-TR-75E
DF-TR-75W
DF-RR-01
DF-M-01
DF-M-02
DF-M-03
DF-M-04
DF-M-05
DF-M-06
DF-M-07
DF-M-08
DF-M-09
Mary River Project
1 km
5 km
20 km
Angajurjualuk Lake
LEGEND
Dust Fall Monitoring Sites
Active Dust Fall Monitoring Site
Potential Dust Fall Monitoring Site
Dustfall (g/m²/yr)
1 - 4.6
4.6 - 50
> 50
Phase 2 Preliminary Dust Fall Sample Locations for the Project Area
NOTES
TSP isopleths provided by RWDI Air Inc (2010/2014). These data were modified by EDI for the purpose of map display.
Updated PDA provided by Hatch (25 April 2013).
Scale
0 5 10 20 30
Km
Map Scale: 1:80,000 (printed on 8.5 x 11)
Map Projection: NAD 1983 UTM Zone 17N
Drawn: HG
Checked: MAS
Date: 2019-07-23
Map 1
Map Area
Mary River Project
Baffinland
EDI



498000
502000
506000
510000
7980000
7976000
7972000
5 km
1 km
Milne Inlet
DF-P-03
DF-P-06
DF-P-07
DF-P-10
DF-P-11
DF-P-08
DF-P-04
DF-P-09
DF-P-12
Milne Inlet Camp and Port
LEGEND
Dust Fall Monitoring Site
Active Dust Fall Monitoring Site
Potential Dust Fall Monitoring Site
Milne Tote Road
Phase 2 Preliminary Dust Fall Sample Locations for the Milne Port Area
NOTES
TSP isopleths provided by RWDI Air Inc (2010/2014). These data were modified by EDI for the purpose of map display.
Updated PDA provided by Hatch (25 April 2013).
Scale
0 0.5 1 2 3
Km
Map Scale: 1:75,000 (printed on 8.5 x 11)
Map Projection: NAD 1983 UTM Zone 17N
Drawn: HG
Checked: MS
Date: 2019-07-23
MAP 2
Map Area
Mary River Project
Baffinland
EDI

Appendix F
Human Health Risk Evaluation



LEGEND ᑐᑭᓯᒋᐊᕐᑦ

Passive Dustfall Monitoring Sites

- Dustfall Monitoring Location
- Paired Height Monitoring (2 m & 0.5 m)
- Milne Inlet Tote Road
- Proposed North Railway - Route 3
- Potential Development Area

Total Suspended Particles

High | Moderate | Low

Dustfall monitoring sites

NOTES

Potential Development Area provided by BIM (2019).

TSP isopleths provided by RWDI Air Inc (2010/2014). These data were modified by EDI for the purpose of map display.

This document is not an official land survey and the spatial data presented is subject to change without notice.

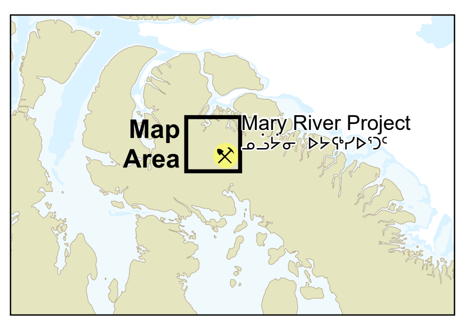
Scale

0 5 10 15 20 25

Km

Map Scale: 1:750,000 (printed on 8.5 x 11)
Map Projection: NAD 1983 UTM Zone 17N

Drawn:	Checked:	Appendix Map	Date: 2023-01-11
CT	LD	F-1	



Baffinland Iron Mines Corporation   EDI

Path: L:\PROJECTS\Baffinland_Spatial\2022_SpatialData\22Y0273_Baffinland_Mapping.aprx Layout: Map_DustfallSites_20230111

Appendix G
Mary River Project – 6 Mtpa, Air Quality Assessment

Mary River Project – 6 Mtpa

Air Quality Assessment

Final Report

July 2023

Prepared for:
Baffinland Iron Mines Corporation
Toronto, Ontario

Prepared by:
Nunami Stantec Limited
Calgary, Alberta

Project Number: 121417395

NUNAMI STANTEC

NUNAMI STANTEC

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Abbreviations

AAQC. Ambient Air Quality Criteria
AEP. Alberta Environment and Parks
Am³/h. actual cubic metres per hour
CDEM. Canadian Digital Elevation Model
CO carbon monoxide
COPC contaminants of potential concern
DPM diesel particulate matter
DPM_{10} diesel particulate matter with an aerodynamic diameter less than 10 µm
$DPM_{2.5}$ diesel particulate matter with an aerodynamic diameter less than 2.5 µm
DTSP diesel total suspended particulate
ECCC Environment and Climate Change Canada
ERP Early Revenue Phase
FEIS Final Environmental Impact Study
FLA Foreshore Lease Boundary
FPM_{10} fugitive particulate matter with an aerodynamic diameter less than 10 µm
$FPM_{2.5}$ fugitive particulate matter with an aerodynamic diameter less than 2.5 µm
FTSP fugitive total suspended particulate
GVWR gross vehicle weight rating
hp horsepower
HTO Hunter Trapper Organization
IMO International Maritime Organization
LAA. Local Assessment Area
µg/m³ microgram per cubic metre
mg/Am³ milligram per actual cubic metre
MOECP Ontario Ministry of the Environment, Conservation and Parks
Mtpa million tonnes per annum (year)
NIRB Nunavut Impact Review Board
NO_2 nitrogen dioxide
PDA Project Development Area
PIP Production Increase Proposal
PM particulate matter
PM_{10} particulate matter with an aerodynamic diameter less than 10 µm
$PM_{2.5}$ particulate matter with an aerodynamic diameter less than 2.5 µm
ROM run-of-mine
SO_2 sulphur dioxide
TEAMR Terrestrial Environment Annual Monitoring Report
TSP total suspended particulate
US EPA United States Environmental Protection Agency
WRAP Western Regional Air Partnership

1 INTRODUCTION

The Mary River Project (the Project) is an operating open pit iron ore mine located on northern Baffin Island, in the Qikiqtani Region of Nunavut, approximately 150 km southwest of the nearest community of Pond Inlet (Mittimatalik). The Mine Site is connected to a port at Milne Inlet (Milne Port) via the 100 km long Milne Inlet Tote Road (the Tote Road). Baffinland Iron Mines Corporation (Baffinland) operates the Project under Project Certificate No. 005 issued by the Nunavut Impact Review Board (NIRB) on December 28, 2012.

1.1 Background

Baffinland's initial Approved Project consisted of mining iron ore from the reserve at Deposit No. 1 at a production rate of 18 million tonnes per year (Mtpa) and constructing a railway to transport the ore to a port at Steensby Inlet, with year-round shipping through Foxe Basin and Davis Strait. In 2014, Baffinland received an approval for an amendment to the Project, the Early Revenue Phase (ERP), which included the mining and transportation by truck of an additional 4.2 Mtpa of ore along the existing Tote Road north from Deposit No. 1 to a port at Milne Inlet and shipping the iron ore during the open water season (between July and October) through Milne Inlet and Eclipse Sound. Hence, the total approved iron ore production was increased to 22.2 Mtpa (4.2 Mtpa transported by road to Milne Port, and 18 Mtpa transported by rail to Steensby Port). The 18 Mtpa Steensby rail project has not yet been constructed.

In October 2018, Baffinland submitted Phase 2 Development Proposal to increase the amount of ore mined, transported and shipped through Milne Port from 4.2 Mtpa to 12 Mtpa, via the construction of a new railway running parallel to the existing Tote Road (called the North Railway). In 2018, concurrent with the Phase 2 Proposal application, Baffinland applied for an amendment to the Project Certificate to allow an increase of up to 6 Mtpa in ore production and transportation along the Northern Transportation Corridor (the Production Increase Proposal (PIP)), which was approved on October 30, 2018. An amended Project Certificate was issued in 2020 (the PIP Extension) and 2022 (the PIP Renewal) to allow for an extension of the PIP to continue to produce and transport up to 6 Mtpa via truck along the Tote Road to Milne Port and ship ore through the Northern Transportation Corridor to the end of 2022.

1.2 Project Overview

Baffinland is proposing to continue to haul iron ore along the Tote Road with the intent to deliver a nominal rate of 6 Mtpa of iron ore to Milne Port each year, and to ship ore between July and October on up to 84 ore carriers.

1.3 Assessment Objective

Nunami Stantec Limited (Nunami Stantec) was retained to complete an air quality assessment to evaluate the air quality effects of the Project at 6 Mtpa mine production and ore transport along the Tote Road to Milne Port and ore sipping during the open water season (July to October). The objective of the air quality assessment is to characterize the Project emission sources to represent mining operation activities for the period the Project has operated (2018-2022) and to incorporate, to the extent possible, dust mitigation measures that have been implemented for the Project. Many dust control measures and natural dust mitigation effects cannot be explicitly accounted for in the air dispersion model, these include installation of dust hoods and shrouds on stackers and conveyors, reduced conveyor ore drop distances when stockpiling, installation of rubber chutes on stackers, installation of chutes on the ship loader to prevent windblown dust during loading operations, installation of downwind fencing, natural crust formation on undisturbed stockpiles, and reduced road dust emissions due to natural precipitation. Additionally, the use of US EPA emission factors for estimating fugitive dust emissions for the Project is a conservative assumption. The US EPA fugitive dust emission factors are known to be overly conservative and air dispersion models relying on the application of the US EPA fugitive dust emission factors overpredict fugitive dust concentrations by as much as an order of magnitude (Pace 2005).

The air quality assessment estimates the air emissions associated with the Project activities and uses an atmospheric dispersion model to predict the potential changes in ambient air quality associated with the Project emissions at the Mine Site and Milne Port, in addition to baseline ambient air quality levels. Air emissions associated with the Project were estimated based on information provided by Baffinland for the 6 Mtpa mine production and ore transport via truck along the Tote Road, and the type and number of mining off-road equipment and vehicles operating on site.

Key components of the air quality assessment include:

- Review of applicable regulatory criteria (Section 2)
- Review of baseline ambient air quality levels (Section 3)
- Estimated Project air emissions at Mine Site and Milne Port (Section 4.1 and Section 4.2, respectively)
- Dispersion modelling approach (Section 5)
- Dispersion modelling results and comparison of model-predicted concentrations to applicable ambient air quality criteria (Section 6)
- Comparison of model-predicted dustfall to measured dustfall levels at monitoring stations at the Mine Site, Milne Port and along Tote Road (Section7)
- Summary of fundings of the air quality assessment (Section 8)

The air dispersion modelling methodology followed the Newfoundland Guidelines for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012), consistent with the air quality assessments for the FEIS (RWDI 2012) and the Phase 2 Development Proposal (RWDI 2018).

1.4 Air Contaminants of Potential Concern

The Project is a source of particulate matter (PM) emissions resulting from the mining operations in the open pit, ore loading/unloading, crushing, screening and stockpiling and mechanically generated dust emissions from haul trucks transporting ore along haul roads and the Tote Road. The air quality assessment considers substances emitted to the atmosphere by the Project, for which there are applicable ambient air quality criteria and standards adopted by either territorial (Nunavut), provincial (Ontario, Alberta) or federal regulatory agencies (Environment and Climate Change Canada; ECCC).

The air quality assessment includes the following air contaminants of potential concern (COPC) associated with the operation of the Project:

- Total suspended particulate matter (TSP) with an aerodynamic diameter less than 30 µm.
- Respirable particulate matter (PM_{10}) with an aerodynamic diameter less than 10 µm.
- Fine particulate matter ($PM_{2.5}$) with an aerodynamic diameter less than 2.5 µm.
- Total particulate matter deposition (dustfall).

The applicable ambient air quality criteria for the air COPC are described in Section 2.

1.5 Spatial Boundaries

The air quality assessment includes two spatial domains (local assessment areas (LAA)) established to evaluate the potential air quality effects from the Project emissions with a reasonable degree of accuracy and confidence, generally accepted to extend from the Project Development Areas (PDAs) to locations where predicted concentrations decrease to near baseline levels.

The two spatial domains are defined as follows:

- **Mine Site LAA**: This spatial domain includes the area around the Mine Site and a section of Tote Road extending approximately 20 km from the Mine Site. This domain is a 30 km by 30 km square area centered at the Mine Site.
- **Milne Port LAA**: This spatial domain includes the area around Milne Port and a section of Tote Road extending approximately 30 km from Milne Port. This domain is a 35 km by 35 km square area centered at Milne Port and extended 5 km to the southeast to include the dustfall monitoring stations at the northern section of Tote Road.

To increase air quality modeling efficiency, the middle section of Tote Road between the Mine Site and Milne Port LAAs (spanning a length of approximately 40 km) was not included in the modelling assessment. It is expected that the air quality effects of the traffic emissions along Tote Road will be approximately uniform along the entire length of Tote Road. The regional topography, land use and meteorological conditions are generally uniform along the whole length of Tote Road. Therefore, the ambient air quality effects of the sections of Tote Road modeled within the Mine Site and the Milne Port LAAs can be extrapolated over the entire length of Tote Road.

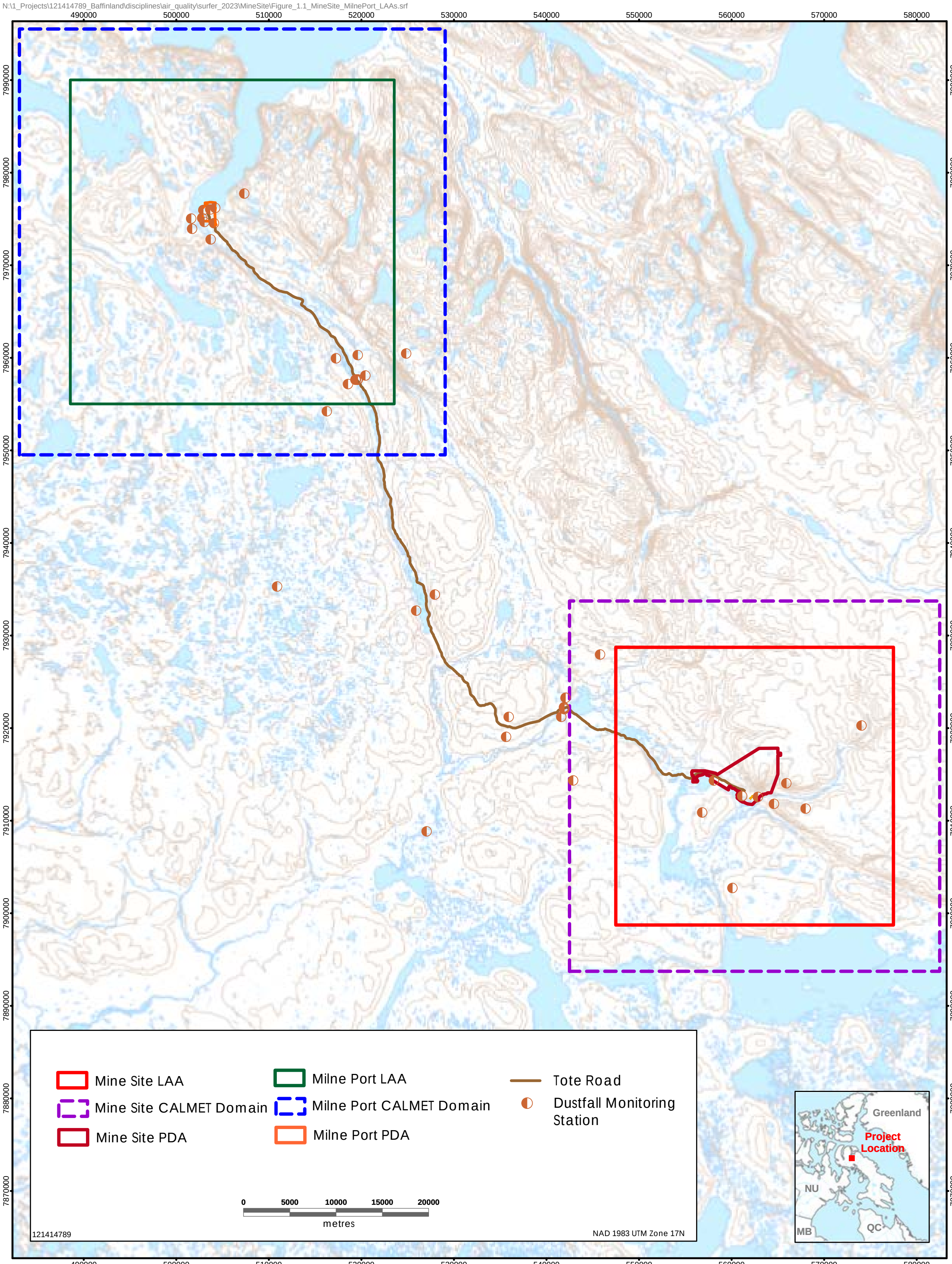
The ocean shipping route from Milne Port is partially included in the Milne Port LAA, with a shipping route length of approximately 3 km within Milne Inlet. It is expected that the air emissions along the entire shipping route (including the route within Eclipse Sound) will be relatively uniform and therefore, the ambient air quality effects of the shipping route modelled within the Milne Port LAA can be extrapolated to the entire shipping route.

The Mine Site and the Milne Port LAAs are presented in Figure 1.1. Additional information about the spatial boundaries is included in Section 5.4.

1.6 Temporal Boundaries

Baffinland has been operating at the current production levels since 2018. The air quality assessment evaluates the potential air quality effects of the Project at the currently approved 6 Mtpa ore production and transport via truck along the Tote Road to Milne Port and shipping ore during the open water season (July to October).

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\MineSite\Figure_1.1_MineSite_MilnePort_LAAs.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Local Assessment Areas for the Air Quality Assessment

Stantec

BAFFINLAND MARY RIVER PROJECT - AIR QUALITY ASSESSMENT

Figure 1.1

2 AMBIENT AIR QUALITY CRITERIA

Ambient air quality standards, objectives and guidelines have been developed by the Canadian federal government and individual provinces and territories to protect public health and the environment.

The air quality assessment incorporates the Nunavut Environmental Guideline for Ambient Air Quality (Government of Nunavut 2011), which establishes ambient air quality standards for common ambient air COPCs throughout Nunavut. These standards are used to assess the effects of emissions from proposed and existing industrial facilities on ambient air quality. For COPC and averaging periods, for which there are no ambient air quality standards established by the Government of Nunavut, standards, objectives and guidelines from other provinces (e.g., Ontario, Alberta) were used in the air quality assessment.

The ambient air quality criteria that are used in the air quality assessment are summarized in Table 2.1. The most stringent of the available territorial and provincial ambient air quality standards, objectives and guidelines were used in the air quality assessment. Henceforth, these are collectively referred to as the applicable ambient air quality criteria (AAQC).

The AAQC are applicable in areas accessible to the public or areas beyond the Project's property line. For this assessment, the PDAs (and the Foreshore Lease Boundary at Milne Port), which also approximate the current Commercial Lease boundaries, are used as the property lines for the Mine Site and Milne Port. The predicted ambient concentrations along and outside the PDA boundaries are compared to the AAQC to assess the Project's effect on ambient air quality. Air quality effects are also evaluated at two Hunter Trapper Organization (HTO) cabins located near the Mine Site and Milne Port, outside of the PDAs.

Table 2.1 Applicable Ambient Air Quality Criteria for the Project

Contaminant	Units	Averaging Period	Nunavut Ambient Air Quality Standard [a]	Ambient Air Quality Standards, Objectives and Guidelines from Other Government Agencies	
				Objective	Agency
Total suspended particulates (TSP)	µg/m³	24-hour	**<u>120</u>**	-	-
		Annual	**<u>60</u>**	-	-
Particulate matter < 10 µm diameter (PM_{10})	µg/m³	24-hour	-	**<u>50</u>**	Ontario Ambient Air Quality Criteria [c]
Particulate matter <2.5 µm diameter ($PM_{2.5}$)	µg/m³	24-hour	**<u>30</u>** [b]	-	-
Particulate Deposition (Dustfall)	g/m²/30-day	30-day	-	**<u>5.3</u> (residential and recreation areas)**	Alberta Ambient Air Quality Objectives and Guidelines [d]
	g/m²/year	Annual	-	**<u>55</u> (12 x 4.6 g/m²/30-day)**	Ontario Ambient Air Quality Criteria [c]

NOTES:
Bold underlined values indicate the ambient air quality criteria that are used in the air quality assessment.
"-" not applicable
[a] Nunavut Ambient Air Quality Standards (Government of Nunavut 2011)
[b] The 24-hour $PM_{2.5}$ ambient air quality standard is referenced to the annual 98th percentile of daily 24-hour average concentrations, averaged over three years.
[c] Ontario Ambient Air Quality Criteria (MOECP 2020)
[d] Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)

3 BASELINE AMBIENT AIR QUALITY

The Mary River Project is in a remote location with the Project activities the only existing local source of air pollutants, introducing air contaminants such as particulate matter (TSP, PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO) to the LAAs.

Baseline air quality conditions prior to the Mary River Project development were determined based on the short-term ambient air quality monitoring program within the Mine Site PDA in July 2007 (RWDI 2012). The monitoring program included the following contaminants: TSP, PM_{10}, dustfall, SO_2, NO_2, ozone and metals deposition. $PM_{2.5}$ and CO were excluded from the ambient air quality monitoring program because the levels were expected to be too low to be measurable. The ambient air quality monitoring indicated that measured baseline concentrations of air contaminants and metal deposition rates are extremely low.

The baseline ambient PM concentrations and dustfall (RWDI 2012) are summarized in Table 3.1. Baseline concentrations were added to the model-predicted ambient concentrations for the Mine Site and Milne Port to account for other more distant natural or anthropogenic emissions sources outside of the air quality LAAs.

Table 3.1 Baseline Ambient Air Quality

Contaminant	Units	Averaging Period	Baseline Concentration [a] (µg/m³)
Total suspended particulates (TSP)	µg/m³	24-hour	7.0
		Annual	7.0 [b]
Particulate matter < 10 µm diameter (PM_{10})	µg/m³	24-hour	3.8
Particulate matter <2.5 µm diameter ($PM_{2.5}$)	µg/m³	24-hour	0 [c]
Particulate Deposition (Dustfall)	g/m²/30-day	30-day	0.0398
	g/m²/year	Annual	0.478 [d]

NOTES:
[a] Baseline concentrations based on the ambient air quality monitoring program conducted at the Mine Site in July 2007 (FEIS, Volume 5)
[b] Assumed that the annual TSP baseline concentration is the same as the 24-hour baseline concentration
[c] Assumed $PM_{2.5}$ baseline concentration = 0 because the $PM_{2.5}$ ambient levels are expected to be too low to be measurable
[d] Estimated the annual baseline dustfall as 12 x the 30-day baseline dustfall
(12 x 0.0398 g/m²/30-day = 0.478 g/m²/year)

4 EMISSIONS

4.1 Mine Site Emissions

The emission sources at the Mine Site are typical for an open pit mine and ore processing. PM emissions during Mine Site operation result from the following emission source types:

- Fugitive dust emissions from mining activities such as drilling and blasting, surface disturbance activities, crushing operations, material transfer, unpaved haul roads, wind erosion of stockpiles, and ore haul trucks and other vehicle traffic along Tote Road.
- Diesel combustion exhaust (tailpipe) emissions from mining off-road equipment, including drills, excavators, loaders, bulldozers, graders and haul trucks. Diesel particulate matter (DPM) is a by-product of diesel fuel combustion. DPM is respirable particulate matter that has an aerodynamic diameter less than 10 µm (PM_{10}). It is assumed that 97% of DPM is fine particulate matter that has an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), based on the US EPA NONROAD model (US EPA 2010a).

Emissions from Mine Site operation were estimated based on information provided by Baffinland for the 6 Mtpa mine production and the type and number of mining off-road equipment operating at the Mine Site. The list of off-road diesel equipment at the Mine Site is presented in Table 4.1. The daily traffic volume along Tote Road is presented in Table 4.2.

The PM emission sources associated with the Mine Site operation include:

- Fugitive dust emissions from drilling and blasting
- Fugitive dust emissions from bulldozing and grading
- Fugitive dust emissions from truck loading/unloading
- Mechanically generated dust by mining off-road equipment movement
- Fugitive dust emissions from ore crushing and screening
- Mechanically generated fugitive dust by truck traffic along mine haul roads
- Mechanically generated fugitive dust by ore haul trucks and vehicles along Tote Road
- Fugitive dust emissions from wind erosion of stockpiles
- Diesel combustion exhaust emissions from mining off-road equipment and haul trucks
- Diesel combustion exhaust emissions from ore haul trucks and vehicles along Tote Road
- Diesel combustion exhaust emissions from stationary power generators at the Mine Site
- Diesel combustion exhaust emissions from waste incinerators at the Mine Site

Fugitive dust emissions from mining activities and wind erosion of stockpiles were estimated using emission factors from various chapters of the US EPA AP-42 Fifth Edition Compilation of Air Pollutant Emission Factors (US EPA 1995).

Diesel exhaust emissions from mining off-road equipment were based on the Canadian off-road diesel engine emission standards (ECCC 2005). Emissions were estimated based on the emission standards for off-road diesel engines corresponding to the equipment manufacturing year (e.g., Tier 3, Tier 4) provided by Baffinland. Most of the mining fleet is Tier 3 equipment. Tier 4 emission standards are the most stringent emission standards for new manufactured off-road diesel equipment that came into effect in 2014. The estimated emissions for the Tier 3 equipment are therefore higher compared to newer, Tier 4 equipment.

Diesel exhaust emissions from trucks and vehicles travelling along Tote Road were estimated using emission factors [in grams per vehicle mile travelled or g/VMT] for each truck/vehicle type derived from the US EPA Motor Vehicle Emission Simulator Model version 2014a (MOVES2014a; US EPA 2015), the number of vehicles round-trips per day and the length of the Tote Road segment within the Mine Site LAA. The MOVES2014a model was originally developed for the United States and therefore, a surrogate US county and state (Hill County, Montana) was selected to represent the Mine Site in terms of meteorological conditions and vehicles population. The model was run for a rural unrestricted road type that best represents Tote Road, for 2018 to represent current vehicle populations and emission standards, for winter to represent maximum exhaust emissions, and with fuel formulations specific to Canada.

Two 3.5 megawatt (MW) and six 1.32 MW stationary diesel power generators and two waste incinerators operate at the Mine Site. Emissions for the stationary diesel power generators were estimated based on manufacturer specifications for generator model GE 16V250 (3.5 MW) and Cummins QSK50-G5 NR2 (1.32 MW). The emission rates for the diesel power generators and waste incinerators were taken from the air quality assessment (RWDI 2018) for the Phase 2 FEIS Addendum (Baffinland 2018a).

A summary of the maximum annual emission rates (t/a; tonnes per annum) during the Mine Site operation is provided in Table 4.3. Table 4.3 shows that most of the fugitive TSP, PM_{10} and $PM_{2.5}$ emissions from the Mine Site operation are associated with ore haul trucks and other truck and vehicle traffic on the Tote Road (TSP = 3,894 t/a) and the crushing facility (TSP = 2,422 t/a), followed by the haul roads (TSP = 561 t/a) and mining in the open pit (TSP = 453 t/a). Total DPM emissions at the Mine Site (31.4 t/a) are much less compared to total fugitive dust emissions (7,359 t/a).

Additional assumptions specific to each emission source and detailed emission tables are included in Appendix A.

Table 4.1 Diesel Off-Road Equipment at the Mine Site

Mining Equipment	Manufacturer/ Model [a]	Emission Standard	Number of Units [a]	Engine Power [b]	Operating Hours	Operating Days	Running Load Factor [c]	Operating Weight/ GVWR [b]	Payload Capacity [b]
				(hp)	(h/d)	(d/a)	(%)	(tonne)	(tonne)
Primary Mining Equipment									
Production Blasthole Drill	Atlas Copco Pit Vipers	Tier 4	2	1,150	20	360	43%	-	-
Support Drills	Atlas Copco D65	Tier 3	2	403	20	360	43%	-	-
Hydraulic Shovel	CAT 6060 FS	Tier 4	1	3,000	20	360	53%	570	-
Wheel Front End Loader	CAT 994K	Tier 4	1	1,847	20	360	48%	240	-
Wheel Front End Loader	CAT 992K	Tier 3	2	900	20	360	48%	100	-
Wheel Front End Loader	CAT 950K	Tier 3	1	211	20	360	48%	19.4	-
Track Dozer	CAT D10	Tier 4	3	600	20	360	58%	66.5	-
Track Dozer	CAT D9	Tier 3	3	452	20	360	58%	50	-
Haul Roads									
Grader	CAT 16H	Tier 3	1	285	20	360	59%	24.7	-
Grader	CAT 16M	Tier 3	2	290	20	360	59%	30.6	-
Hydraulic Excavator	CAT 374F	Tier 4	2	485	20	360	53%	73.0	-
Ore Haul Truck	CAT 793	Tier 3	7	2,650	20	360	59%	386	231
Crushing Facility									
Wheel Front End Loader	CAT 988H	Tier 3	4	580	20	360	48%	51	-
Wheel Front End Loader	CAT 950H	Tier 3	1	200	20	360	48%	20	-
Wheel Front End Loader	CAT 930H	Tier 3	1	149	20	360	48%	13	-
Wheel Front End Loader	CAT 992K	Tier 3	2	900	20	360	48%	101	-
Wheel Front End Loader	CAT 908	Tier 3	1	74	20	360	48%	7	-
Hydraulic Excavator	CAT 345	Tier 3	1	345	20	360	53%	49	-
Track Dozer	CAT D9	Tier 3	1	452	20	360	58%	50	-

Table 4.1 Diesel Off-Road Equipment at the Mine Site

Mining Equipment	Manufacturer/ Model [a]	Emission Standard	Number of Units [a]	Engine Power [b] (hp)	Operating Hours (h/d)	Operating Days (d/a)	Running Load Factor [c] (%)	Operating Weight/ GVWR [b] (tonne)	Payload Capacity [b] (tonne)
Skid Steer	CAT 289D	Tier 3	4	74	20	360	59%	4.8	-
Supporting Equipment									
Water truck (15,000 L)	Western Star 4700SB	-	1	350	12	360	-	25	-
Maintenance, Fuel/Lube, Mechanics, Service Trucks	Peterbilt 357	-	16	335	20	360	-	30	-
Container Handler - Rough Terrain	Kalmar RT240	Tier 3	1	400	12	360	59%	53.8	-
Grader	CAT 14M	Tier 3	1	259	12	360	59%	21	-
Telehandler	CAT TL1055D	Tier 3	4	142	12	360	59%	14	-
Wheel Front End Loader	CAT 950K	Tier 3	1	211	12	360	48%	19.4	-
Wheel Front End Loader	CAT 930H	Tier 3	2	149	12	360	48%	13.0	-
Wheel Front End Loader	CAT 988H	Tier 3	1	580	12	360	48%	51	-
Articulated Truck	CAT 740B	Tier 3	3	489	12	360	59%	74	39.5
Hydraulic Excavator	CAT 345	Tier 3	1	345	12	360	53%	49	-
Frost Fighters	Frost Fighter DX1500	Tier 3	100	1	12	180	43%	-	-

NOTES:
[a] Manufacturer model and number of units provided by Baffinland.
[b] Engine power (hp), operating weight/GVWR (tonne) and payload capacity (tonne) based on manufacturer specifications for the equipment manufacturer and model.
[c] Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of off-road diesel equipment.
GVWR – gross vehicle weight rating
"-" – not applicable

Table 4.2 Daily Traffic Volume along Tote Road

Trucks and Vehicles	Manufacturer/ Model	Number of Units	Engine Power [b]	Operating Hours	Operating Days	Operating Weight/ GVWR [b]	Payload Capacity [b]	Traffic Volume
			(hp)	(h/d)	(d/a)	(tonne)	(tonne)	(round-trips/day)
Trucks and Vehicles								
Ore Haul Truck	Western Star 6900 XD	57	600	20	360	200	135	123 [c]
Diesel Fuel Tanker Truck (42,000 L) - Seasonal, August to September	Western Star 4900 SA	10	560	20	60	52	36	20 [d]
Diesel Fuel Tanker Truck (42,000 L) - Continuous	Western Star 4900 SA	1	560	20	360	52	36	2 [e]
Maintenance, Fuel/Lube, Mechanics, Service Trucks	Peterbilt 357 [a]	16	335	20	360	30	-	35.7 [f]
Passenger Transfer Bus (48 passengers)	Blue Bird BBCV2311 [a]	3	260	20	360	15	-	3 [g]
Passenger Vans	Ford E450 [a]	24	350	20	360	7	-	24 [g]
Pickup Trucks 3/4 ton	Ford F250 [a]	10	385	20	360	6	-	30 [g]
Supporting and Maintenance Equipment								
Grader	CAT 14M	5	259	11	360	21.2	-	50 [h]
Track Dozer	CAT D6	3	215	6	360	23	-	120 [h]
Hydraulic Excavator	CAT 345	2	345	2	360	49	-	50 [h]
Wheel Excavator	CAT M320	1	174	2	360	21	-	50 [h]
Wheel Front End Loader	CAT 950H	2	200	2	360	20	-	50 [h]

Table 4.2 Daily Traffic Volume along Tote Road

Trucks and Vehicles	Manufacturer/ Model	Number of Units	Engine Power [b]	Operating Hours	Operating Days	Operating Weight/ GVWR [b]	Payload Capacity [b]	Traffic Volume
			(hp)	(h/d)	(d/a)	(tonne)	(tonne)	(round-trips/day)
Wheel Front End Loader	CAT 988H	2	580	2	360	51	-	50 [h]
Articulated Truck	CAT 740B	3	489	2	360	74	39.5	150 [h]

NOTES:
[a] Assumed representative manufacturer/model for the type of truck/vehicle.
[b] Engine power (hp), GVWR (tonne) and payload capacity (tonne) based on manufacturer specifications for the equipment manufacturer and model.
[c] Ore haul trucks round trips per day based on 6 Mtpa ore transported along Tote Road to Milne Port and the average payload capacity of the haul truck.
[d] Seasonal fuel tanker trucks traffic volume based on 50 mega-litres (ML) fuel delivered to the Mine Site during August to September (60 days).
[e] Continuous fuel tanker trucks traffic volume based on 25 mega-litres (ML) fuel delivered to the Mine Site year-round (270 days).
[f] Service vehicle traffic based on 250 trips/week from the Phase 2 Key Facts Table (Baffinland 2018b).
[g] Number of round trips per day provided by Baffinland.
[h] Approximate kilometers travelled per day provided by Baffinland.
GVWR – gross vehicle weight rating
"-" – not applicable

Table 4.3 Annual Emissions at the Mine Site Associated with 6 Mtpa Mine Production

Emission Source	Operation Annual Emission Rates (t/a)					
	FTSP	**FPM_{10}**	**$FPM_{2.5}$**	**DTSP**	**DPM_{10}**	**$DPM_{2.5}$**
Blasting in the Open Pit	2.06	2.03	0.12	-	-	-
Mining in the Open Pit [a]	453	230	33.6	2.25	2.25	2.18
Waste Rock Pile [b]	16	4.9	1.44	0.425	0.425	0.412
Run of Mine (ROM) Ore Stockpile [b]	8.6	1.3	0.89	0.425	0.425	0.412
Crushing Facility [c]	2,422	680	73.4	4.95	4.95	4.80
Haul Roads [d]	561	147	14.8	12.4	12.4	12.1
Tote Road [e]	3,894	1,011	102	1.28	1.28	1.09
Wind Erosion [f]	1.11	0.56	0.083	-	-	-
Power Generation [g]	-	-	-	9.65	9.65	9.65
Waste Incinerators [g]	-	-	-	1.52	1.52	1.52
Total Emissions	**7,359**	**2,077**	**226**	**31.4**	**31.4**	**30.6**

NOTES:

[a] Emissions include fugitive dust emissions from mining off-road equipment movement, drilling, truck loading, bulldozing and diesel combustion exhaust emissions from mining off-road equipment.

[b] Emissions include fugitive dust emissions from truck unloading, bulldozing and diesel combustion exhaust emissions from bulldozers.

[c] Emissions include fugitive dust emissions from truck unloading/loading, ore crushing and screening, bulldozing and front-end loaders movement.

[d] Emissions include mechanically generated fugitive dust and diesel combustion exhaust emissions from haul trucks travelling along the mine haul roads.

[e] Emissions include mechanically generated fugitive dust and diesel combustion exhaust emissions from ore haul trucks and other trucks and vehicle traffic along the Tote Road.

[f] Wind erosion emissions represent emissions at mean hourly wind speed greater than the threshold wind speed (16.4 m/s for the waste rock pile). At wind speeds less than the threshold wind speed, no wind erosion emissions are generated (US EPA 1995, § 13.2.5).

[g] Emissions for the diesel power generators and waste incinerators are based on the 2018 air quality assessment (RWDI 2018) for the Phase 2 FEIS Addendum (Baffinland 2018a).

FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges

DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges

“-“ not applicable

4.2 Milne Port Emissions

The emission sources at Milne Port are associated with transporting 6 Mtpa of ore via truck from the Mine Site to Milne Port along the Tote Road, ore handling and stockpiling, ship loading and ocean shipping during the open water season (July to October). PM emissions during Milne Port operation result from the following emission source types:

- Fugitive dust emissions from ore handling and stockpiling, ship loading, unpaved haul roads, wind erosion of ore stockpiles and ore haul trucks and other vehicle traffic along Tote Road.
- Diesel combustion exhaust (tailpipe) emissions from off-road diesel equipment, including front-end loaders, bulldozers, graders and haul trucks.

Emissions from Milne Port operation were estimated based on information provided by Baffinland for the 6 Mtpa ore transport, handling, stockpiling and ship loading and the type and number of off-road equipment operating at the site. The list of diesel off-road equipment operating at Milne Port is presented in Table 4.4. The daily traffic volume along Tote Road is presented in Table 4.2.

The PM emission sources associated with Milne Port operation include:

- Fugitive dust emissions from lump ore handling, stockpiling and ship loading
- Fugitive dust emissions from fine ore handling, stockpiling and ship loading
- Fugitive dust emissions from bulldozing and grading
- Mechanically generated fugitive dust by front-end loaders movement
- Mechanically generated fugitive dust by truck traffic along haul roads
- Mechanically generated fugitive dust by ore haul trucks and vehicles along Tote Road
- Fugitive dust emissions from wind erosion of lump and fine ore stockpiles
- Diesel combustion exhaust emissions from off-road equipment and haul trucks
- Diesel combustion exhaust emissions from ore haul trucks and vehicles along Tote Road
- Diesel combustion exhaust emissions from stationary power generators at Milne Port
- Diesel combustion exhaust emissions from a waste incinerator at the Milne Port
- Diesel combustion exhaust emissions from ore carrier ships and tugboats at Milne Inlet

Fugitive dust emissions from ore handling and stockpiling, ship loading, haul roads and wind erosion of ore stockpiles were estimated using emission factors from various chapters of the US EPA AP-42 Fifth Edition Compilation of Air Pollutant Emission Factors (US EPA 1995).

Diesel exhaust emissions from the off-road diesel equipment were based on the Canadian off-road diesel engine emission standards (ECCC 2005). Emissions were estimated based on the emission standards for off-road diesel engines corresponding to the equipment manufacture year (e.g., Tier 3, Tier 4) provided by Baffinland. Most of the diesel off-road equipment operating at Milne Port is Tier 3.

Diesel exhaust emissions from trucks and vehicles travelling along Tote Road were estimated using emission factors [g/VMT] for each truck/vehicle type derived from the US EPA MOVES2014a model (US EPA 2015), the number of vehicle round-trips per day and the length of the Tote Road segment within the Milne Port LAA.

Seven 1.32 MW stationary diesel power generators and one waste incinerator operate at Milne Port. Emissions for the stationary diesel power generators were estimated based on manufacturer specifications for generator model Cummins QSK50-G5 NR2 (1.32 MW). The emission rates for the diesel generators, waste incinerator, the ore carrier ship and tug boats were taken from the air quality assessment (RWDI 2018) for the Phase 2 FEIS Addendum (Baffinland 2018a).

A summary of the maximum annual emission rates (t/a) during Milne Port operation is provided in Table 4.3. Table 4.3 shows that most of the fugitive TSP, PM_{10} and $PM_{2.5}$ emissions from Milne Port operation are associated with fugitive dust emissions from ore haul trucks and other truck and vehicle traffic on Tote Road (TSP = 6,342 t/a), followed by ore handling and stockpiling (TSP = 501 t/a) and ore ship loading (TSP = 476 t/a). Total DPM emissions at Milne Port (65.6 t/a) are much less compared to total fugitive dust emissions (7,389 t/a).

Additional assumptions specific to each emission source and detailed emission tables are included in Appendix A.

Table 4.4 Diesel Off-Road Equipment at Milne Port

Off-Road Diesel Equipment	Manufacturer/ Model [a]	Emission Standard	Number of Units [a]	Engine Power [b]	Operating Hours	Operating Days	Running Load Factor [c]	Operating Weight/ GVWR [b]	Payload Capacity [b]
				(hp)	(h/d)	(d/a)	(%)	(tonne)	(tonne)
Primary Equipment									
Wheel Front End Loader	CAT 988K	Tier 3	4	580	20	120	48%	51	-
Wheel Front End Loader	CAT 950H	Tier 3	1	200	20	360	48%	20	-
Wheel Front End Loader	CAT 930H	Tier 3	1	149	20	360	48%	13	-
Track Dozer	CAT D9	Tier 3	1	452	20	360	58%	50	-
Skid Steer	CAT 289D	Tier 3	2	74	20	360	59%	4.8	-
Hydraulic Excavator	CAT 374F	Tier 4	1	485	20	360	53%	73	-
Hydraulic Excavator	CAT 320GC	Tier 3	1	164	20	360	53%	22.5	-
Articulated Truck	CAT 740B	Tier 3	20	489	20	360	59%	74	39.5
Supporting Equipment									
Water Truck (15,000 L)	Western Star 4700SB	-	2	350	8	360	-	25	15
Maintenance, Fuel/Lube, Mechanics, Service Trucks	Peterbilt 357	-	5	335	20	360	-	30	-
Container Handler – Rough Terrain	Kalmar RT240	Tier 3	1	400	12	360	59%	53.8	-
Telehandler	CAT TL1055D	Tier 3	2	142	12	360	59%	14	-
Skid Steer	CAT 289D	Tier 3	2	74	12	360	59%	4.8	-
Wheel Front End Loader	CAT 930H	Tier 3	1	149	12	360	48%	13	-

Table 4.4 Diesel Off-Road Equipment at Milne Port

Off-Road Diesel Equipment	Manufacturer/ Model [a]	Emission Standard	Number of Units [a]	Engine Power [b]	Operating Hours	Operating Days	Running Load Factor [c]	Operating Weight/ GVWR [b]	Payload Capacity [b]
				(hp)	(h/d)	(d/a)	(%)	(tonne)	(tonne)
Articulated Truck	CAT 740B	Tier 3	1	489	12	360	59%	74	39.5
Frost Fighters	Frost Fighter DX1500	Tier 3	100	1	12	180	43%	-	-

NOTES:
[a] Manufacturer/model and number of units provided by Baffinland.
[b] Engine power (hp), operating weight/GVWR (tonne) and payload capacity (tonne) based on manufacturer specifications for the equipment manufacturer and model.
[c] Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of off-road diesel equipment.
GVWR – gross vehicle weight rating
"-" – not applicable

Table 4.5 Annual Emissions at Milne Port Associated with Transport and Handling of 6 Mtpa Ore

Emission Source	Operation Annual Emission Rates (t/a)					
	FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
Ore Handling and Stockpiling [a]	501	139	15.2	0.975	0.975	0.964
Ore Loading to Ore Carrier Ship [b]	476	127	13.4	0.975	0.975	0.946
Haul Road [c]	69.5	18.0	1.80	6.24	6.24	6.05
Tote Road [d]	6,342	1,645	165	1.60	1.60	1.30
Wind Erosion [e]	0.006	0.003	0.0004	-	-	-
Power Generation [f]	-	-	-	7.63	7.63	7.63
Waste Incinerator [f]	-	-	-	0.683	0.683	0.683
Ore Carrier Ships [f]	-	-	-	18.7	18.7	16.9
Tugboats [f]	-	-	-	28.7	28.7	25.9
Total Emissions	**7,389**	**1,929**	**195**	**65.6**	**65.6**	**60.3**

NOTES:

[a] Emissions include fugitive dust emissions from trucks unloading ore, front-end loaders loading ore to stacker feeders, stacking ore to stockpiles, front-end loaders movement and bulldozing, and diesel combustion exhaust emissions from the front-end loaders' operation.

[b] Emissions include fugitive dust emissions from front-end loader loading ore to ship loading conveyor, ship loader conveyor discharge chute to Panamax ship and front-end loaders movement.

[c] Emissions include mechanically generated fugitive dust and diesel combustion exhaust emissions from haul trucks travelling along the haul road.

[d] Emissions include mechanically generated fugitive dust and diesel combustion exhaust emissions from ore haul trucks and other truck and vehicle traffic along Tote Road.

[e] Wind erosion emissions represent emissions at mean hourly wind speed greater than the threshold wind speed (16.4 m/s for the lump ore stockpile, and 13.5 m/s for the fine ore stockpile). At wind speeds less than the threshold wind speed, no wind erosion emissions are generated (US EPA 1995, § 13.2.5).

[f] Emissions based on the 2018 air quality assessment (RWDI 2018) for the Phase 2 FEIS Addendum (Baffinland 2018a).

FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges

DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges

"-" not applicable

4.3 Dust Mitigation Incorporated in the Dispersion Model

Dust suppression applied along the haul roads and the Tote Road and dust control of ore stockpiles at Milne Port were incorporated directly into the emission factors used for the air dispersion model. As discussed in Section 1.3, some dust control measures applied at the Project sites and natural dust mitigation effects cannot be explicitly accounted for in the dispersion model, either because a control efficiency has not been estimated or the process cannot be represented with a constant control efficiency.

4.3.1 Haul Roads and Tote Road

Dust mitigation along the haul roads and the Tote Road was explicitly included in the emission factors used for the air dispersion model. Dust emissions from the haul roads and the Tote Road are controlled by a combination of watering and application of calcium chloride, generally applied from mid-May to mid-September. The application of chemical dust suppressant has a higher dust control efficiency, estimated to be 84% based on the WRAP Fugitive Dust Handbook (WRAP 2006), while the dust control efficiency associated with road watering is estimated to be 75%, corresponding to increasing two times the moisture content of the road surface (WRAP 2006).

To be conservative, a 75% dust control efficiency was assumed along the haul roads at the Mine Site and Milne Port, corresponding to road watering (WRAP 2006) during summer and the shoulder season (6 months, May to October) and a 90% natural mitigation efficiency was assumed during winter (6 months, November to April) due to snow cover and frozen ground (Golder Associated 2012). The more conservative (lower) dust mitigation efficiency of 75% was assumed during the shoulder season because during the shoulder season there is incomplete snow cover, while at the same time the dust mitigation options are limited because of low ambient air temperatures. The assumption of a lower dust control efficiency during the shoulder season (spring and fall) was confirmed by the dustfall monitoring program conducted for the Project since 2014. The dustfall monitoring program investigated the seasonal variations in dustfall at Project areas and observed elevated dustfall in early spring (March/April) and early fall (September/October) (EDI 2021).

Application of chemical dust suppressant for dust suppression along the Tote Road started in 2020 (Dust Stop®) and continued in 2021 and 2022 (DustBlockr®). The initial application was done typically in mid-June with re-applications as needed until mid-July. When ambient temperatures drop, the application of water to control dust resumes because the application of chemical dust suppressant is only recommended when the ambient air temperatures are at or above 5 degrees Celsius.

A 50% dust control efficiency was assumed along the Tote Road during summer and the shoulder season (6 months, May to October) based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2021) and a 90% natural mitigation efficiency was assumed during winter (6 months, November to April) due to snow cover and frozen ground (Golder Associated 2012). The 2020 dustfall monitoring data measured at dustfall monitoring stations along the Tote Road (Tote Road North Crossing at km 28 and Tote Road South Crossing at km 78) located within 1,000 m from the road was analyzed to determine the ratio of dust control efficiency in summer and winter. For the comparison, winter was assumed 6 months (November to April), summer was assumed 3 months (July to September) and the shoulder season was assumed 3 months (May, June and October). An average ratio of 5 was estimated between the measured dustfall in summer and measured dustfall in winter. Assuming a 90% natural mitigation efficiency in winter (Golder Associated 2012), the summer dust control efficiency was estimated to be 50% (100% - 5 x (100% – 90%)). As noted earlier, the lower dust control efficiency (50%) was assumed during the shoulder season based on the measured elevated dustfall in early spring (March/April) and early fall (September/October) during the dustfall monitoring program (EDI 2021).

4.3.2 Ore Stockpiles at Milne Port

A chemical dust suppressant (DusTreat®) was applied to the ore stockpiles at Milne Port starting in November 2020. DusTreat® is a non-toxic substance that coats the outside of the stockpiles and acts as a sealant to prevent the lift-off of dust from stockpiles. Application of the product to the ore stockpiles was carried out regularly from January through April 2021 and in late June 2021.

The dust control associated with the application of DusTreat® on the ore stockpiles at Milne Port was accounted for in the emission factors for the air dispersion model by assuming that no wind erosion emissions occur at the finished stockpiles which are not actively being stacked.

5 MODELLING METHODOLOGY

The effects of Project emissions on ambient air quality were evaluated by using a numerical atmospheric dispersion model. Atmospheric dispersion models simulate the transport, dispersion, transformation, and deposition of emissions in the atmosphere. Dispersion models are used to predict ambient concentrations for a wide range of meteorological conditions and accounting for terrain influences. Due to the many uncertainties associated with the application of dispersion models, the model results can be viewed as “best estimates” relative to the decision-making process when standardized model approaches are adopted (US EPA 2005).

5.1 Model Selection

The air quality assessment for the Project emissions was completed using the CALMET/CALPUFF® model system (Scire et al. 2000a; 2000b; 2011). The most recent model versions available at the time of the assessment were used:

- CALMET® version 6.5.0 (level 150223) – a diagnostic three-dimensional meteorological model.
- CALPUFF® version 7.2.1 (level 150618) – a numerical atmospheric dispersion model.

The CALPUFF® model is a multi-layer, multi-species, non-steady state puff dispersion model that can simulate the effects of time and space-varying meteorological conditions on substance transport, transformation, and removal. CALPUFF® contains algorithms for near-source effects such as building downwash, transitional plume rise, partial plume penetration, as well as longer-range effects such as chemical transformation, and pollutant removal (dry deposition and wet scavenging). The model can simulate temporary varying emissions. CALPUFF® uses a time-varying three-dimensional meteorological data field that is generated with the meteorological model CALMET®.

Two CALPUFF® model domains were created for the air quality assessment, coinciding with the Mine Site LAA and the Milne Port LAA. The extents of the CALPUFF® domains are sufficient to capture the overall maximum predicted concentrations of air COPC for the operation emission scenarios.

The Nunavut government does not have any published guidelines regarding air dispersion modelling and therefore, guidelines from the Newfoundland and Labrador government was used for the modelling assessment. The modelling system was applied in accordance with the Newfoundland and Labrador Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012) to be consistent with the dispersion modelling methodology used for the air quality assessments for the FEIS (RWDI 2012) and the Phase 2 Development Proposal (RWDI 2018).

The list of model options used to run the CALPUFF® model are included in Appendix C. The options were chosen based on guidance from the Newfoundland and Labrador Guideline for Plume Dispersion Modelling, guidelines from other provincial jurisdictions and the CALPUFF user manual (Scire et al. 2000b).

5.2 Meteorological Data

The CALMET® model (Scire et al. 2000a) was used to generate site specific, hourly three-dimensional meteorological fields (winds, air temperatures and turbulence) with spatial resolution of 400 m for input to the CALPUFF® model.

Meteorological data from the Weather Research and Forecasting (WRF) mesoscale prognostic model with 12 km grid resolution for a three-year period (2018-2020) was used to provide spatially and temporally varying wind and temperature fields for CALMET®. Two CALMET® model domains were created for the air quality assessment, containing the Mine Site LAA and the Milne Port LAA with a buffer of 5 km on each side to reduce potential boundary effects around the perimeter of the LAAs and to allow air emissions to exit and re-enter the LAAs if the wind directions are shifting. The CALMET® model domains are shown on Figure B.1 and Figure B.2 in Appendix B.

The meteorological model followed the guidance from the Newfoundland and Labrador Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012).

The details of the CALMET® modelling approach and the model-predicted meteorological fields are provided in Appendix B. The list of options used to run CALMET® are included in Appendix B. Key findings of the CALMET® model results include:

- The wind rose of the CALMET® predicted winds for the Mine Site indicates dominant winds from northeast and east.
- The wind rose of the CALMET® predicted winds for Milne Port indicates dominant winds from southeast.
- Wind speed increases with increasing height above ground.

The meteorological data that is used to evaluate air quality changes associated with Project emissions account for the seasonal and diurnal variations over a three-year period, and for the spatial terrain and land-cover variations across the CALMET® domains. The three-year data is viewed as being representative of the wide range of weather conditions that could occur in the LAAs.

5.3 Modelled Emission Sources

Emission sources were modelled in CALPUFF® as one of the following types depending on the nature of the source and the emission release to the atmosphere. Source-specific input parameters were used to represent the different source types:

- **Point source**: an industrial stack; parameters required for each stack include stack height, stack diameter, stack gas exit temperature and stack gas exit velocity.

  The power generators, waste incinerators and marine vessels (ore carrier and tugboats) exhaust stacks were modelled as point sources with their stack design parameters.

- **Volume source**: a single point of emission with initial vertical and horizontal dispersion; parameters required for each volume source include release height, and initial vertical (σ_z) and horizontal dimension (σ_y) which account for the initial vertical and horizontal dispersion of the plume.

  Truck loading/unloading, primary and secondary crushers, conveyor transfer points, material transfer to/from stockpiles, and ore loading into ore carrier ship were modelled as volume sources. Volume sources representing material transfer points were modelled with varying hourly emission rates depending on the wind speed.

- **Area source**: emission distributed over an area; parameters required for each area source include release height and initial vertical dimension (σ_z) which accounts for the initial vertical dispersion of the plume.

  The emission sources in the open pit, including fugitive dust emissions from drilling, blasting and mining operations and diesel exhaust emissions from the mining off-road equipment operating in the pit, were modelled as a surface area source representing the area (m^2) of the open pit. Pit retention fractions were applied to fugitive dust emissions from the pit. A 50% pit retention for fugitive TSP emissions and 5% pit retention for fugitive PM_{10} emissions was applied based on recommendation in the Australian Emission Manual for Mining (Australian Government 2012). A 2% pit retention was applied for fugitive $PM_{2.5}$ emissions based on the Winges equation (Winges 1981, 1986) corresponding to a pit depth of 192 m.

  Bulldozing, grading, front end loaders movement and trucks unloading at the stockpiles were modelled as area sources representing the surface of the stockpiles.

  Wind erosion PM emissions are generated when material is lifted from the surface of the stockpiles during a wind gust. The stockpiles were treated as area sources for wind erosion PM emissions. These area sources were modelled with varying hourly PM emission rates depending on the wind speed. An initial vertical dispersion of 1 m was assumed for the wind erosion area sources.

- **Road source**: emission distributed along a road; parameters required for each road source include release height, and initial vertical (σ_z) and horizontal dimensions (σ_y) which account for the initial vertical and horizontal dispersion of the plume. Emission rates are specified per meter of road length.

  Diesel exhaust (tailpipe) emissions and mechanically generated dust emissions from haul trucks travelling along the haul roads were modelled as road sources. Similarly, traffic emissions from trucks and vehicles travelling on the Tote Road were modelled as road sources.

For volume, area and road sources in CALPUFF®, the emission release height and initial vertical dispersion (σ_z) for each source were estimated based on the dimensions of the predominant off-road equipment (e.g., haul truck, bulldozer) operating on site and following US EPA guidance for calculating dispersion parameters for haul roads (US EPA 2012) and volume sources (US EPA 2021).

The detailed description of the modelled emission sources is provided in Appendix C. The modelled emission sources at the Mine Site during operation are shown on Figure 5.1. The modelled emission sources at Milne Port during operation are shown on Figure 5.2.

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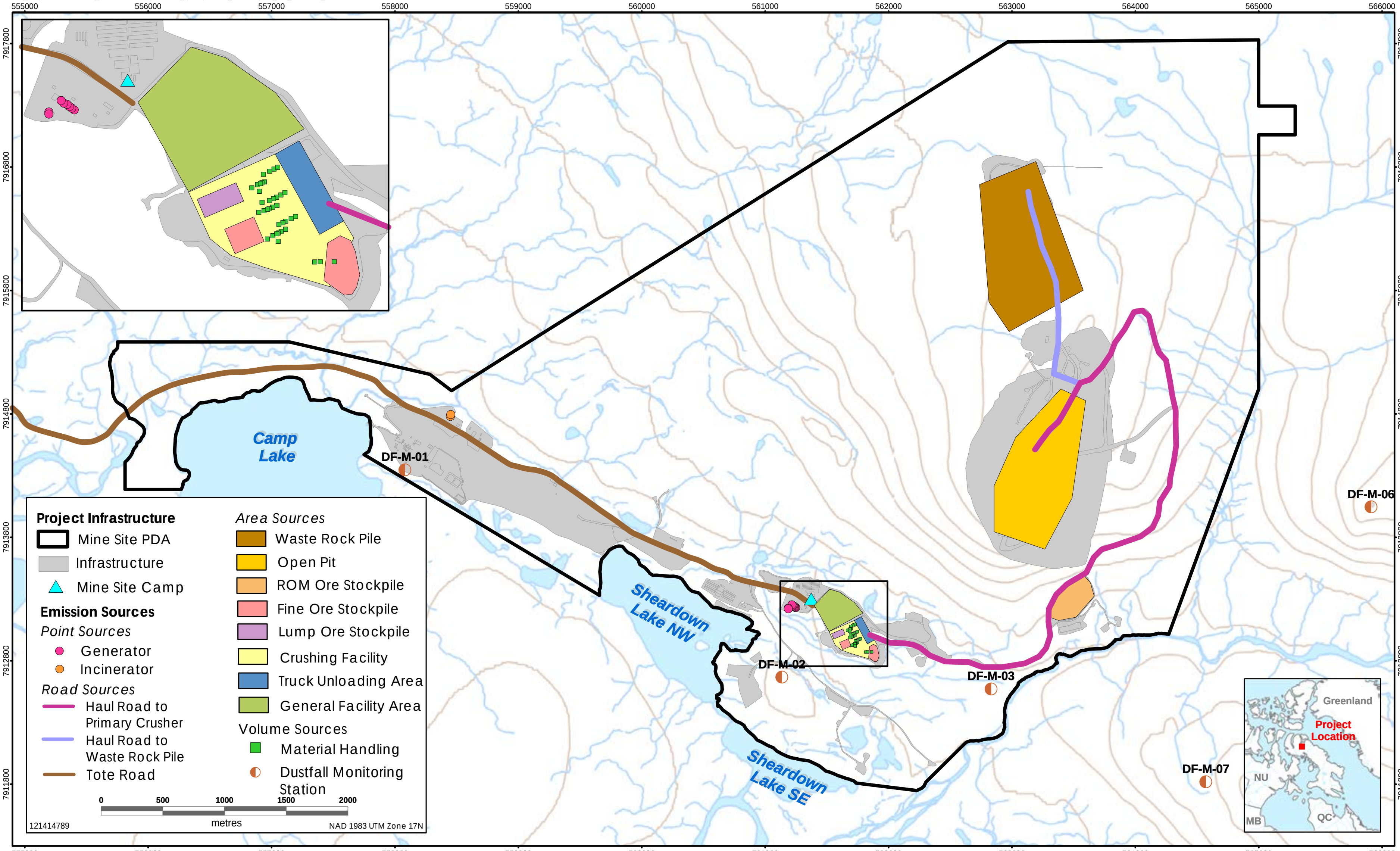


Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

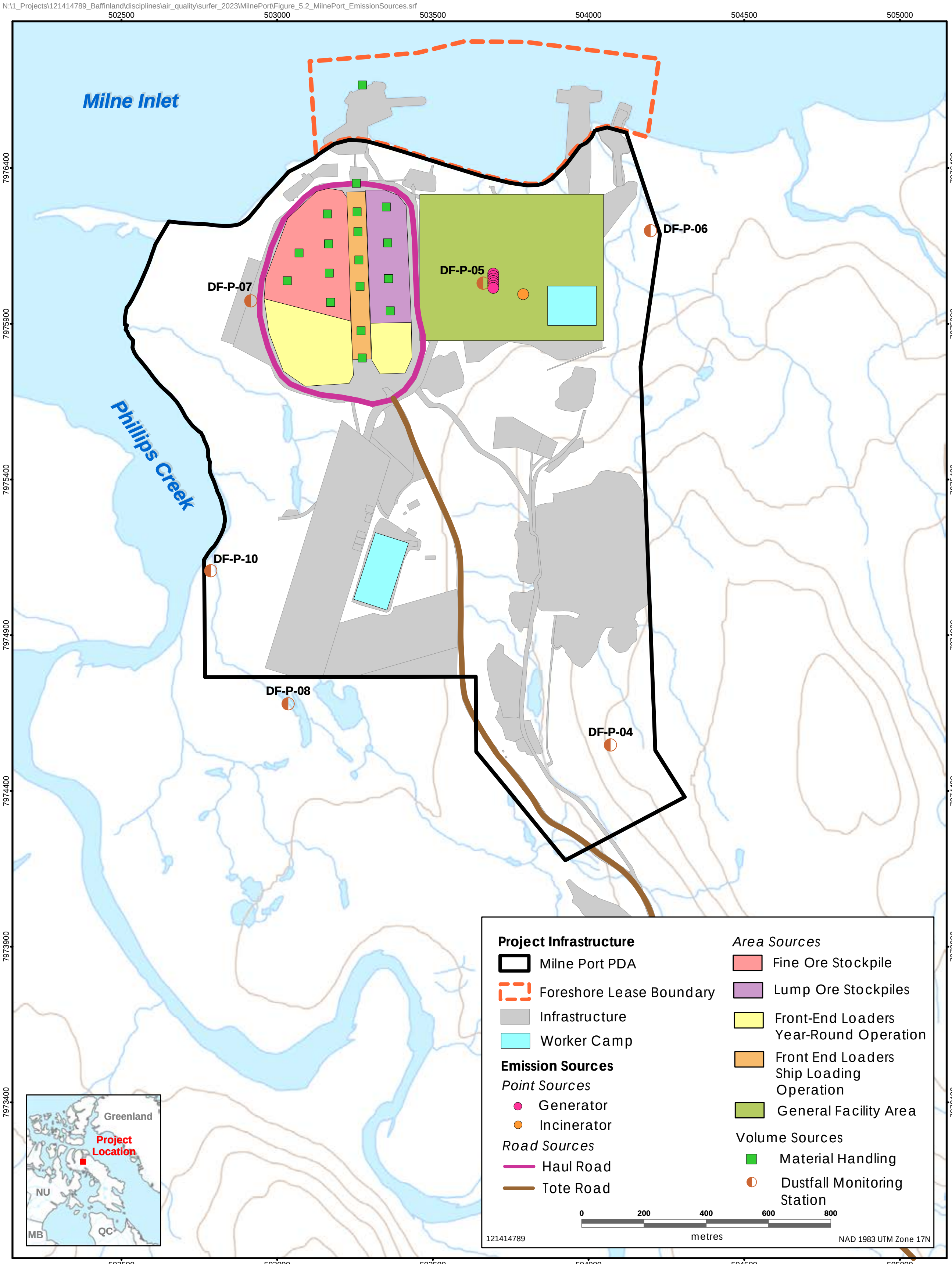
Modelled Emission Sources at the Mine Site

Stantec

BAFFINLAND MARY RIVER PROJECT - AIR QUALITY ASSESSMENT

Figure 5.1

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\MilnePort\Figure_5.2_MilnePort_EmissionSources.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Modelled Emission Sources at Milne Port

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BAFFINLAND MARY RIVER PROJECT - AIR QUALITY ASSESSMENT

Figure 5.2

5.4 Modelled Receptors

Maximum ground-level concentrations for the air COPC and dustfall were predicted at grid receptors and discrete sensitive receptors within the Mine Site LAA and Milne Port LAA. Terrain elevations were applied to all receptors using the Canadian Digital Elevation Model (CDEM; NRCan 2016) with spatial resolution of 0.75 arc seconds in south-north direction and 1.5 arc seconds in west-east direction, specific for the latitude of the Mary River Project.

5.4.1 Mine Site

5.4.1.1 Grid Receptors

A nested receptor grid with increased receptor density with proximity to the Mine Site PDA boundary was created in the Mine Site LAA following the spacing requirements in the Newfoundland and Labrador Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012), as follows:

- 200 m spacing inside the PDA boundary
- 20 m spacing along the PDA boundary
- 100 m spacing along the Tote Road with a 30 m buffer from the center of the road
- 200 m spacing from the Tote Road 30 m buffer out to 1,400 m
- 50 m spacing from the centroid of emission sources out to 2,000 m
- 100 m spacing from 2,000 m out to 2,500 m
- 200 m spacing from 2,500 m out to 3,500 m
- 500 m spacing from 3,500 m out to 7,500 m
- 1,000 m spacing from 7,500 m out to 15,000 m

The receptors along and outside the PDA boundary were used to compare the model-predicted concentrations and dustfall with the AAQC. The receptor grid in the Mine Site LAA is shown on Figure 5.3.

5.4.1.2 Discrete Receptors

Discrete receptors were used to predict air quality effects at specific locations inside and outside of the Mine Site LAA. A HTO cabin located at Camp Lake, approximately 400 m south of the southwest corner of the Mine Site PDA was identified as a human receptor outside of the PDA boundary. The work camp inside the PDA boundary was identified as a human receptor inside the PDA boundary.

Discrete receptor locations are shown on Figure 5.3. The maximum predicted ground-level concentrations and dustfall at the discrete receptors are provided in Section 6.1.

5.4.1.3 Dustfall Monitoring Stations

In 2021, dustfall was measured at 47 dustfall monitoring stations distributed across the Project area. Nine dustfall monitoring stations were located within the Mine Site LAA – three within the Mine Site PDA, four outside of the Mine Site PDA and two reference sites located further from the Project infrastructure. Monthly passive dustfall sampling was conducted year-round at three of the nine monitoring locations. At the remaining locations, monthly sampling was conducted in June, July, August and September. The nine dustfall monitoring stations were included as discrete receptors in the dispersion model. The model-predicted annual dustfall at the dustfall monitoring stations, at which dustfall sampling was conducted year-round, was compared with the measured dustfall during the 2018-2021 dustfall monitoring program and the comparison is presented in Section7. The dustfall monitoring stations included in the dispersion model for the Mine Site LAA are listed in Table 5.1 and shown on Figure 5.3.

Table 5.1 Dustfall Monitoring Sites at the Mine Site for the 2020 Dustfall Monitoring Program

Site ID	Location	Sample Period	Distance to PDA	Location (UTM 17, NAD83)	
			m	m E	m N
DF-M-01	Mine Site	year-round	Within PDA	558,080	7,914,347
DF-M-02	Mine Site	year-round	Within PDA	561,135	7,912,668
DF-M-03	Mine Site	year-round	Within PDA	562,830	7,912,572
DF-M-04	Mine Site	summer [a]	9,000	560,082	7,902,730
DF-M-05	Mine Site	summer [a]	9,000	574,030	7,920,281
DF-M-06	Mine Site	summer [a]	1,000	565,910	7,914,047
DF-M-07	Mine Site	summer [a]	1,000	564,571	7,911,820
DF-M-08	Mine Site	summer [a]	4,000	567,991	7,911,311
DF-M-09	Mine Site	summer [a]	2,500	556,813	7,910,888

NOTES:
[a] Summer sampling includes data collection from June, July, August and September

5.4.2 Milne Port

5.4.2.1 Grid Receptors

A nested receptor grid with increased receptor density with proximity to Milne Port PDA boundary was created in the Milne Port LAA following the spacing requirements in the Newfoundland and Labrador Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012), as follows:

- 200 m spacing inside the PDA boundary
- 50 m spacing inside the Foreshore Lease Boundary
- 20 m spacing along the PDA boundary
- 100 m spacing along the Tote Road 30 m buffer from the center of the road

- 250 m spacing from the Tote Road with a 30 m buffer out to 1,300 m
- 50 m spacing from the centroid of emission sources out to 1,000 m
- 100 m spacing from 1,000 m out to 1,500 m
- 200 m spacing from 1,500 m out to 2,600 m
- 500 m spacing from 2,600 m out to 6,700 m
- 1,000 m spacing from 6,700 m out to 15,000 m

The receptors along and outside the PDA boundary were used to compare the model-predicted concentrations and dustfall with the AAQC. The receptor grid in the Milne Port LAA is shown on Figure 5.4.

5.4.2.2 Discrete Receptors

Discrete receptors were used to predict air quality changes at specific locations inside and outside of the Milne Port LAA. A HTO cabin located at Milne Inlet, approximately 1,100 m east of the southeast corner of the Milne Port PDA was identified as a human receptor outside of the PDA boundary. Two work camps inside the PDA boundary – the Port Site Complex (PSC) Camp and the 380-Person Camp were identified as human receptors inside the PDA boundary.

Discrete receptor locations are shown on Figure 5.4. The maximum predicted ground-level concentrations and dustfall at the discrete receptors are provided in Section 6.2.

5.4.2.3 Dustfall Monitoring Stations

In 2021, dustfall was measured at 47 dustfall monitoring stations distributed across the Project area. Eighteen dustfall monitoring stations were located within the Milne Port LAA – ten at Milne Port and eight at Tote Road – north km 28. Out of the ten dustfall monitoring stations at Milne Port, four are located within the Milne Port PDA, five located at the PDA boundary and one reference site located outside of the Mine Site PDA. The eight dustfall monitoring stations at Tote Road – north km 28 are organized into transects distributed perpendicular to the Tote Road centerline at 30 m, 100 m and 1,000 m. Two additional stations are located 1,000 m distant from the Tote Road.

Monthly passive dustfall sampling was conducted year-round at 17 of the 18 monitoring locations. At one monitoring location, monthly sampling was conducted in June, July, August and September. The 18 dustfall monitoring stations were included as discrete receptors in the dispersion model for the Milne Port LAA. The model-predicted annual dustfall at the dustfall monitoring stations, at which dustfall sampling was conducted year-round, was compared with the measured dustfall during the 2018-2021 dustfall monitoring program and the comparison is presented in Section 7. The dustfall monitoring stations included in the dispersion model for the Milne Port LAA are listed in Table 5.2 and shown on Figure 5.4.

Table 5.2 Dustfall Monitoring Sites at Milne Port and Tote Road North km 27 for the 2020 Dustfall Monitoring Program

Site ID	Location	Sample Period	Distance to PDA	Location (UTM 17, NAD83)	
			m	m E	m N
DF-P-03	Milne Port	summer [a]	3,000	507,337	7,977,747
DF-P-04	Milne Port	year-round	Within PDA	504,070	7,974,548
DF-P-05	Milne Port	year-round	Within PDA	503,661	7,976,030
DF-P-06	Milne Port	year-round	Within PDA	504,199	7,976,199
DF-P-07	Milne Port	year-round	Within PDA	502,915	7,975,973
DF-P-08	Milne Port	year-round	1,000	503,035	7,974,680
DF-P-09	Milne Port	year-round [b]	1,000	503,710	7,972,794
DF-P-10	Milne Port	year-round [b]	1,000	502,787	7,975,107
DF-P-11	Milne Port	year-round [b]	1,000	501,600	7,975,043
DF-P-12	Milne Port	year-round [b]	1,000	501,700	7,973,940
DF-RN-02	Tote Road – north, km 28	year-round	1,000	518,546	7,957,169
DF-RN-03	Tote Road – north, km 28	year-round	Within PDA, 100 m from Tote Road	519,350	7,957,634
DF-RN-04	Tote Road – north, km 28	year-round	Within PDA, 30 m from Tote Road	519,410	7,957,668
DF-RN-05	Tote Road – north, km 28	year-round	Within PDA, 30 m from Tote Road	519,557	7,957,625
DF-RN-06	Tote Road – north, km 28	year-round	Within PDA, 100 m from Tote Road	519,616	7,957,670
DF-RN-07	Tote Road – north, km 28	year-round	1,000	520,424	7,958,090
DF-TR-25E	Tote Road	year-round	1,000	519,602	7,960,302
DF-TR-25W	Tote Road	year-round	1,000	517,248	7,959,947

NOTES:
[a] Summer sampling includes data collection from June, July, August and September
[b] Stations were installed in late summer 2021 and therefore do not have a complete 2021 annual dataset

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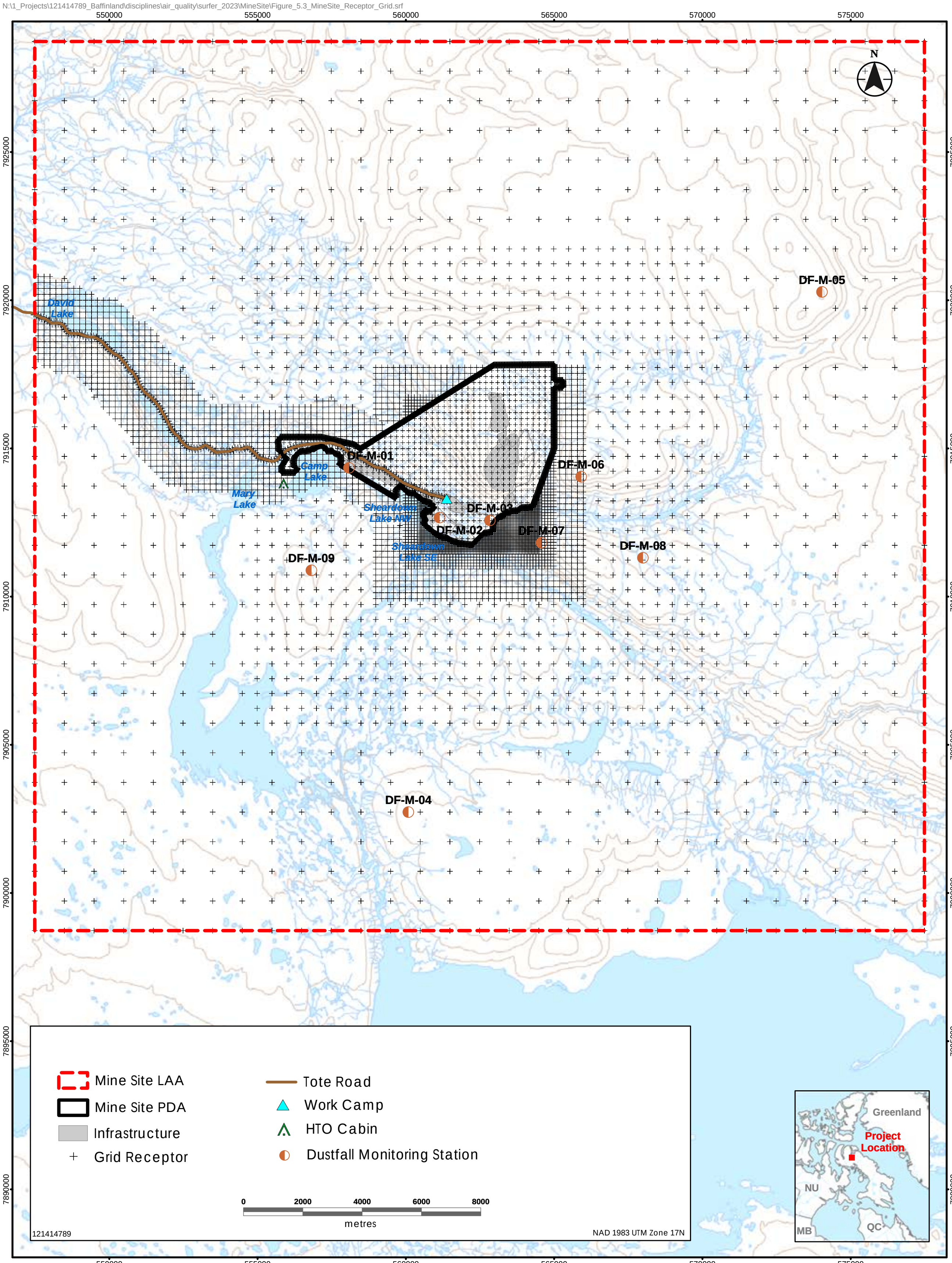

Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Mine Site LAA and Receptor Locations

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Figure 5.3

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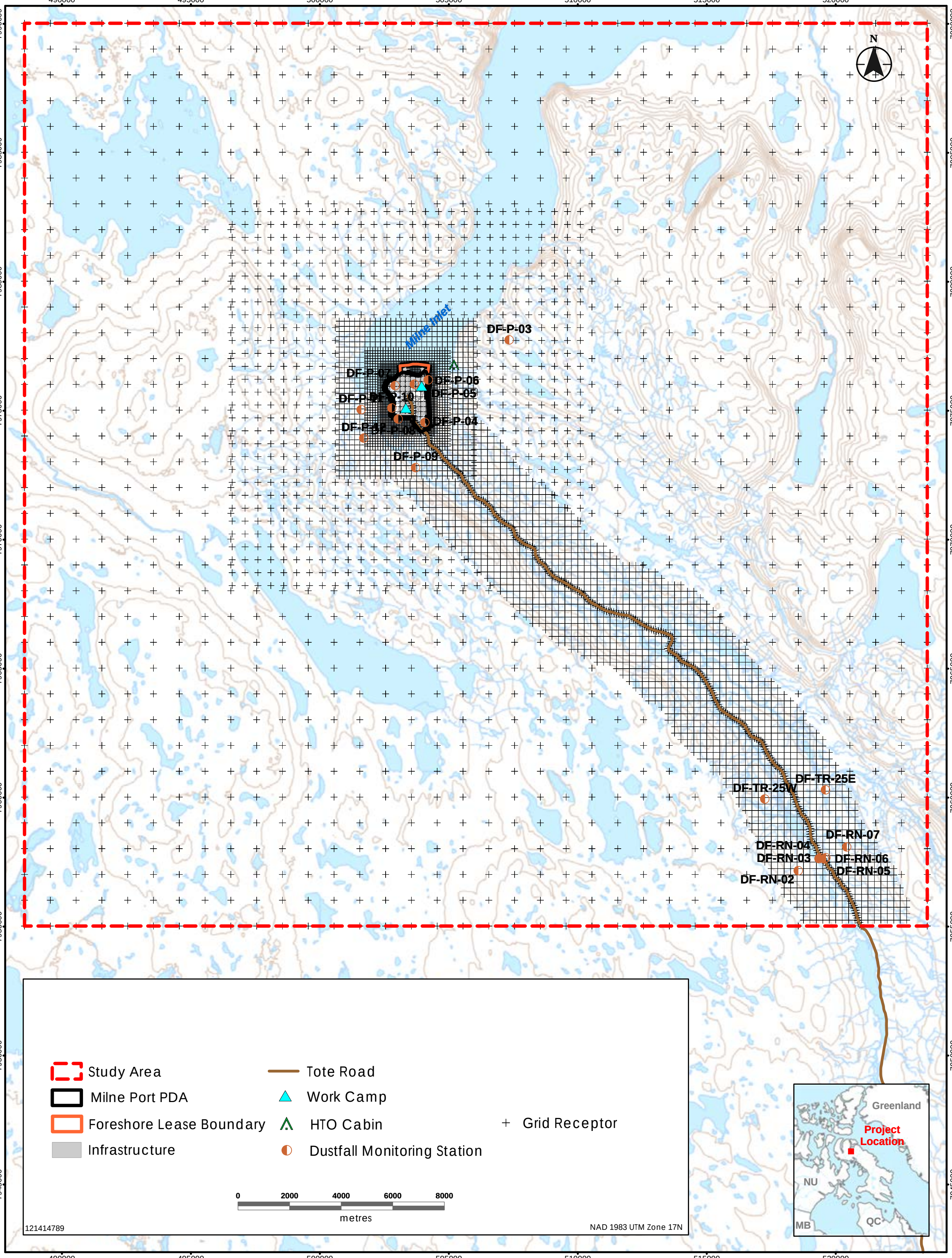


Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Milne Port LAA and Receptor Locations

Stantec

Figure 5.4

5.5 Particulate Matter Deposition

Dry deposition of PM is the process of settling of particles on the ground due to gravity and micro meteorological and atmospheric processes. Different physical processes govern the settling of PM of different sizes. For larger particles (greater than 20 μm), dry deposition is caused mainly by gravitational settling, while deposition of smaller particles is caused by micro meteorological and atmospheric processes.

Wet deposition is the depletion of particles from the atmosphere by rain or snow. Wet deposition is proportional to the precipitation rate and a scavenging coefficient which depends on the particle size and the type of precipitation – liquid or frozen.

Total PM deposition – the sum of dry and wet deposition, is also referred to as dustfall. Dry and wet deposition of total PM were modelled in CALPUFF®.

PM deposition in CALPUFF® was modelled by dividing PM into three particle size categories to account for the different deposition mechanism for particles of different size. The three particle size categories were defined in the model as follows:

- P1: Particles with aerodynamic diameter smaller than 2.5 μm.
- P2: Particles with aerodynamic diameter between 2.5 and 10 μm.
- P3: Particles with aerodynamic diameter between 10 and 30 μm.

The deposition algorithm in CALPUFF® requires specifying the mass-mean aerodynamic particle diameter (μm) and geometric standard deviation (μm) for each particle size category assuming a PM density of 1 g/cm³. The Newfoundland and Labrador Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012) suggests an adjustment to the mass-mean particle diameters for each particle size category to account for emissions of heavier PM such as iron, which has a density of 5 g/m³. The Guideline for Plume Dispersion Modelling provides adjusted mass-mean particle diameters for a range of PM density of 0.5 g/cm³ to 5 g/cm³. Based on the recommendations in the Guideline for Plume Dispersion Modelling, different mass-mean particle diameters were specified for PM deposition of fugitive dust emissions from ore, waste rock, the open pit (assuming a weighted average of ore and waste rock), haul roads and Tote Road, and DPM emissions from diesel combustion. The PM deposition parameters for the different emission sources are provided in Table 5.3.

Wet deposition fluxes due to precipitation scavenging were calculated in CALPUFF® using an empirical scavenging coefficient approach. The scavenging coefficients were specified as a function of the particle size and precipitation type (i.e., frozen vs. liquid precipitation). Total PM dustfall was estimated as the sum of modelled dry and wet deposition for each particle size category (P1 + P2 + P3).

Table 5.3 Particulate Matter Deposition Parameters for Emission Sources at the Mine Site and Milne Port

Emission Source	Particle Size Category	Particle Aerodynamic Diameter (µm)	Particle Density (g/cm³)	Geometric Mass-Mean Diameter (µm)	Geometric Standard Deviation (µm)
Ore	P1	0 µm to 2.5 µm	5	2.86	1.2418578
	P2	2.5 µm to 10 µm	5	11.25	1.2418578
	P3	10 µm to 30 µm	5	44.79	1.2418578
Waste Rock	P1	0 µm to 2.5 µm	3	2.20	1.2418578
	P2	2.5 µm to 10 µm	3	8.70	1.2418578
	P3	10 µm to 30 µm	3	34.68	1.2418578
Open Pit [a]	P1	0 µm to 2.5 µm	3.8	2.45	1.2418578
	P2	2.5 µm to 10 µm	3.8	9.68	1.2418578
	P3	10 µm to 30 µm	3.8	38.57	1.2418578
Haul Roads and Tote Road	P1	0 µm to 2.5 µm	2	1.79	1.2418578
	P2	2.5 µm to 10 µm	2	7.09	1.2418578
	P3	10 µm to 30 µm	2	28.31	1.2418578
Diesel Combustion	P1	0 µm to 2.5 µm	1	1.25	1.2418578
	P2	2.5 µm to 10 µm	1	5.00	1.2418578
	P3	10 µm to 30 µm	1	20.00	1.2418578

NOTES:
[a] Mass-mean particle diameters for fugitive dust emissions from the open pit were calculated as a weighted average of the adjusted diameters for ore and waste rock based on the annual production of ore (6 Mtpa) and waste rock (3.4 Mtpa).

SOURCE: Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012)

5.6 Pit Retention

CALPUFF® does not have an algorithm to model open pit sources and therefore, the open pit at the Mine Site was modelled as a surface area source with reduced fugitive PM emissions to account for the fraction of PM emissions retained in the open pit due to its depth, known as “pit retention”. Pit retention is the term used to describe the tendency for PM emissions released inside an open mine pit to remain inside the pit. The fraction of PM emissions that is retained in the open pit depends on the depth of the pit and the particle size (Winges 1981, 1986). A 50% pit retention for TSP emissions and 5% pit retention for PM_{10} emissions was applied based on recommendation in the Australian Emission Manual for Mining (Australian Government 2012). A 2% pit retention for $PM_{2.5}$ emissions was calculated based on the Winges equation (Winges 1981, 1986) and assuming an average pit depth of 192 m.

6 MODEL RESULTS

Summaries of the maximum predicted ground-level concentrations of TSP, PM_{10} and $PM_{2.5}$ and dustfall at the Mine Site during operation are presented in Table 6.1 and at Milne Port in Table 6.2. The results for the Mine Site and Milne Port include baseline ambient air concentrations or dustfall (Section 3) to account for other existing emission sources (natural and anthropogenic) that are not directly included in the model simulation. The maximum predicted concentrations and dustfall along and outside the PDA boundaries were compared with the AAQC (Section 2) to assess the air quality in areas accessible to the public.

The maximum model predicted ground-level concentrations and dustfall are presented in the tables separately for the following areas:

- along the PDA boundary
- along Tote Road 30 m buffer zone from the center of the road
- at the HTO cabins
- the overall maximum predicted concentration/dustfall in the LAA (along and outside the PDA boundary).

Additionally, the general location of the maximum model predicted concentration/dustfall is indicated by categorizing receptor locations into receptors along the PDA boundary, receptors along Tote Road 30 m buffer zone and receptors outside of the PDA boundary and within the LAA.

The tabulated number of exceedances per year represents the maximum number of exceedances at any receptor location between the PDA boundary and the LAA. The receptor that experiences the highest contaminant concentration or deposition rate is not necessarily the same receptor that experiences the highest number of exceedances.

The maximum model predicted concentrations and dustfall are discussed separately for the Mine Site and the Milne Port LAAs in the following sections. The corresponding contour plots showing the magnitude and spatial distribution of the maximum predicted concentrations and dustfall within the Mine Site and Milne Port LAAs are presented in Appendix D.

6.1 Mine Site

The maximum predicted ground-level concentrations and dustfall from Mine Site operation are summarized in Table 6.1. The associated concentration and dustfall contours in the Mine Site LAA are presented in Figure D.1 to Figure D.10 in Appendix D.1.

6.1.1 Maximum TSP Concentrations

The maximum predicted 24-hour and annual TSP concentrations in the Mine Site LAA, 3,250 µg/m³ and 606 µg/m³, are greater than the AAQC (120 µg/m³) and occur along Tote Road (Figure D.1 and Figure D.3). The maximum predicted 24-hour TSP concentration along the PDA boundary, 822 µg/m³, is greater than the 24-hour AAQC. The maximum predicted annual TSP concentration along the PDA boundary, 164 µg/m³, is greater than the annual AAQC (60 µg/m³). The predicted maximum 24-hour TSP concentrations greater than the AAQC extend up to approximately 2.2 km from the south PDA boundary. The predicted annual average TSP concentrations greater than the AAQC extend up to approximately 1 km from the south PDA boundary.

The maximum predicted 24-hour TSP concentration at the HTO cabin is greater than the 24-hour AAQC, while the annual average TSP concentration at the HTO cabin is less than the corresponding AAQC. The 24-hour TSP concentrations at the HTO cabin are predicted to exceed the AAQC for a maximum of 9 days in a year (Figure D.2).

The maximum 24-hour TSP concentrations along Tote Road are predicted to be greater than the AAQC. The predicted 24-hour TSP concentrations along Tote Road greater than the AAQC extend up to 2 km from the Tote Road centerline (Figure D.2).

6.1.2 Maximum PM_{10} Concentrations

The maximum predicted 24-hour PM_{10} concentration in the Mine Site LAA, 950 µg/m³, is greater than the 24-hour AAQC (50 µg/m³) and occurs along the Tote Road (Figure D.4). The maximum predicted 24-hour PM_{10} concentration along the PDA boundary, 441 µg/m³, is greater than the 24-hour AAQC. The maximum 24-hour PM_{10} concentrations greater than the AAQC extend up to approximately 3 km from the south PDA boundary.

The maximum predicted 24-hour PM_{10} concentration at the HTO cabin is greater than the 24-hour AAQC. The 24-hour PM_{10} concentrations at the HTO cabin are predicted to exceed the AAQC for a maximum of 16 days in a year (Figure D.5).

The maximum 24-hour PM_{10} concentrations along the Tote Road are predicted to be greater than the AAQC. The predicted 24-hour PM_{10} concentrations along the Tote Road greater than the AAQC extend up to approximately 3 km from Tote Road centerline (Figure D.4).

6.1.3 Maximum $PM_{2.5}$ Concentrations

The maximum predicted 24-hour $PM_{2.5}$ concentration in the Mine Site LAA, 61.7 µg/m³, is greater than the AAQC (30 µg/m³) and occurs along Tote Road (Figure D.6). The maximum predicted 24-hour $PM_{2.5}$ concentrations along the PDA boundary are less than the 24-hour AAQC. The maximum predicted 24-hour $PM_{2.5}$ concentration at the HTO cabin in the Mine Site LAA is less than the AAQC.

The maximum 24-hour $PM_{2.5}$ concentrations along the Tote Road are predicted to be greater than the AAQC. The 24-hour $PM_{2.5}$ concentrations along the Tote Road are predicted to exceed the AAQC for a maximum of 67 days in a year (Figure D.7). The predicted 24-hour $PM_{2.5}$ concentrations along the Tote Road greater than the AAQC extend up to approximately 240 m from Tote Road centerline (Figure D.6)

6.1.4 Maximum Dustfall

The maximum predicted 30-day and annual dustfall in the Mine Site LAA, 72.3 g/m²/30-day and 453 g/m²/year, are greater than the 30-day AAQC (5.3 g/m²/30-day) and the annual AAQC (55 g/m²/year), respectively, and occur along the Tote Road (Figure D.8 and Figure D.10). The maximum predicted 30-day dustfall long the PDA boundary, 27.9 g/m²/30-day, is greater than the 30-day AAQC. The maximum predicted annual dustfall along the PDA boundary, 207 g/m²/year, is greater than the annual AAQC. The predicted maximum 30-day dustfall greater than the AAQC extend up to approximately 1 km from the south PDA boundary (Figure D.8). The predicted annual average dustfall greater than the AAQC extend up to approximately 800 m from the south PDA boundary (Figure D.10). The maximum predicted 30-day and annual dustfall at the HTO cabin are less than the corresponding AAQC (Figures D.8 and D.10).

The maximum predicted 30-day and annual dustfall along the Tote Road is greater than the corresponding AAQC. The predicted 30-day dustfall along the Tote Road greater than the 30-day AAQC extends up to approximately 800 m from Tote Road centerline (Figure D.8). The predicted annual dustfall along the Tote Road greater than the annual AAQC extends up to approximately 400 m from Tote Road centerline (Figure D.10).

Table 6.1 Maximum Predicted Ground-Level Particulate Matter Concentrations and Dustfall at the Mine Site

Air Contaminant	Averaging Period	Units	Existing/ Baseline Conditions [a] (µg/m³)	Maximum Predicted Ground-level Concentrations/Dustfall (Including Baseline Conditions)						AAQC [d] (µg/m³)
				PDA Boundary	Tote Road	HTO Cabin	Max. Value in LAA	Location of Max. Value [b]	Max. No. of Exceed. Per Year [c]	
TSP	24-hour	µg/m³	7.0	**822**	**3,250**	**183**	**3,250**	TR	350 d/y	120
	Annual	µg/m³	7.0	**164**	**606**	31.4	**606**	TR	-	60
PM_{10}	24-hour	µg/m³	3.8	**441**	**950**	**114**	**950**	TR	331 d/y	50
$PM_{2.5}$	24-hour [e]	µg/m³	0	29.5	**61.7**	7.24	**61.7**	TR	67 d/y	30
Dustfall	30-day	g/m²/30-day	0.0398	**27.9**	**72.3**	2.64	**72.3**	TR	12 m/y	5.3
	Annual [f]	g/m²/year	0.478	**207**	**453**	13.3	**453**	TR	-	55

NOTES:
[a] Baseline ambient air quality conditions are described in Section 3.
[b] Location of the maximum value:
- PDA – receptor located on the PDA boundary.
- LAA – receptor located outside the PDA boundary and inside the LAA.
- TR – receptor located along Tote Road, on the 30 m buffer from the center of the road.

[c] Number of exceedances: d/y – days/year; m/y – months/year.
[d] The applicable AAQC for the air COPC are described in Section 2.
[e] The 24-hour $PM_{2.5}$ concentration is calculated as the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.
[f] The annual dustfall is calculated as the arithmetic mean of monthly average depositions.
Concentration/dustfall values in **bold** text font exceed the AAQC.

6.2 Milne Port

The maximum predicted ground-level concentrations and dustfall from Milne Port operation are summarized in Table 6.2. The associated concentration and dustfall contours in the Mine Site LAA are presented in Figure D.11 to Figure D.20 in Appendix D.2.

6.2.1 Maximum TSP Concentrations

The maximum predicted 24-hour and annual TSP concentrations in the Milne Port Site LAA, 3,473 μg/m³ and 648 μg/m³, are greater than the AAQC and occur at the crossing of Tote Road and the PDA boundary (Figure D.11 and Figure D.13). The maximum predicted 24-hour TSP concentration along the PDA boundary, 2,115 μg/m³, is greater than the 24-hour AAQC (120 μg/m³). The maximum predicted annual TSP concentration along the PDA boundary, 366 μg/m³, is greater than the annual AAQC (60 μg/m³). The predicted maximum 24-hour TSP concentrations greater than the AAQC extend up to approximately 2.7 km to the north from the Foreshore Lease Area (FLA) boundary and approximately 1.3 km to the west from the PDA boundary (Figure D.11). The predicted annual average TSP concentrations greater than the AAQC extend up to approximately 800 km north from the FLA boundary (Figure D.13).

The maximum predicted 24-hour TSP concentration at the HTO cabin is greater than the 24-hour AAQC, while the annual average TSP concentration at the HTO cabin is less than the annual AAQC. The 24-hour TSP concentrations at the HTO cabin are predicted to exceed the AAQC for a maximum of 1 day in a year (Figure D.12).

The maximum 24-hour TSP concentrations along Tote Road are predicted to be greater than the AAQC. The predicted 24-hour TSP concentrations along Tote Road greater than the AAQC extend up to 1 km from the Tote Road centerline (Figure D.11).

6.2.2 Maximum PM_{10} Concentrations

The maximum predicted 24-hour PM_{10} concentration in the Milne Port LAA, 1,038 μg/m³, is greater than the 24-hour AAQC (50 μg/m³) and occurs at the crossing of Tote Road and the PDA boundary (Figure D.14). The maximum predicted 24-hour PM_{10} concentration along the PDA boundary, 687 μg/m³, is greater than the 24-hour AAQC. The maximum 24-hour PM_{10} concentrations greater than the AAQC extend up to approximately 3 km to the north from the FLA boundary and approximately 1.8 km to the west from the PDA boundary.

The maximum predicted 24-hour PM_{10} concentration at the HTO cabin is greater than the 24-hour AAQC. The 24-hour PM_{10} concentrations at the HTO cabin are predicted to exceed the AAQC for a maximum of 7 days in a year (Figure D.15).

The maximum 24-hour PM_{10} concentrations along the Tote Road are predicted to be greater than the AAQC. The predicted 24-hour PM_{10} concentrations along the Tote Road greater than the AAQC extend up to approximately 1.5 km from Tote Road centerline (Figure D.14).

6.2.3 Maximum $PM_{2.5}$ Concentrations

The maximum predicted 24-hour $PM_{2.5}$ concentration in the Milne Port LAA, 67.4 µg/m³, is greater than the AAQC (30 µg/m³) and occurs at the crossing of Tote Road and the PDA boundary (Figure D.16). The maximum predicted 24-hour $PM_{2.5}$ concentration along the PDA boundary, 42.5 µg/m³, is greater than the 24-hour AAQC. The 24-hour $PM_{2.5}$ concentrations along the PDA boundary are predicted to exceed the AAQC for a maximum of 27 days in a year (Figure D.17). The maximum 24-hour $PM_{2.5}$ concentrations greater than the AAQC extend up to approximately 200 m to the northeast from PDA boundary and approximately 200 m to the west from the PDA boundary. The maximum predicted 24-hour $PM_{2.5}$ concentration at the HTO cabin in the Milne Port LAA is less than the AAQC.

The maximum 24-hour $PM_{2.5}$ concentrations along the Tote Road are predicted to be greater than the AAQC. The 24-hour $PM_{2.5}$ concentrations along the Tote Road are predicted to exceed the AAQC for a maximum of 71 days in a year (Figure D.17). The predicted 24-hour $PM_{2.5}$ concentrations along the Tote Road greater than the AAQC extend up to approximately 140 m from Tote Road centerline (Figure D.16).

6.2.4 Maximum Dustfall

The maximum predicted 30-day and annual dustfall in the Milne Port LAA, 84.1 g/m²/30-day and 490 g/m²/year, are greater than the 30-day AAQC (5.3 g/m²/30-day) and the annual AAQC (55 g/m²/year), respectively. The maximum predicted 30-day dustfall occurs at the crossing of Tote Road and the PDA boundary (Figure D.18). The maximum predicted annual dustfall occurs along Tote Road (Figure D.20). The maximum predicted 30-day dustfall along the PDA boundary, 46.3 g/m²/30-day, is greater than the 30-day AAQC. The maximum predicted annual dustfall along the PDA boundary, 257 g/m²/year, is greater than the annual AAQC. The predicted maximum 30-day dustfall greater than the AAQC extends up to approximately 800 m from the FLA boundary and up to approximately 300 m to the west from the PDA boundary (Figure D.18). The predicted annual average dustfall greater than the AAQC extends up to approximately 600 m from the north PDA boundary and up to approximately 160 m to the west from the PDA boundary (Figure D.20). The maximum predicted 30-day and annual dustfall at the HTO cabin are less than the corresponding AAQC.

The maximum predicted 30-day and annual dustfall along the Tote Road is greater than the corresponding AAQC. The predicted 30-day dustfall along the Tote Road greater than the 30-day AAQC extends up to approximately 400 m from Tote Road centerline (Figure D.18). The predicted annual dustfall along the Tote Road greater than the annual AAQC extends up to approximately 300 m from Tote Road centerline.

Table 6.2 Maximum Predicted Ground-Level Particulate Matter Concentrations and Dustfall at Milne Port

Air Contaminant	Averaging Period	Units	Existing/ Baseline Conditions [a] (µg/m³)	Maximum Predicted Ground-level Concentrations/Depositions (Including Baseline Conditions)						AAQC [d] (µg/m³)
				PDA Boundary	Tote Road	HTO Cabin	Max. Value in LAA	Location of Max. Value [b]	Max. No. of Exceedances per Year [c]	
TSP	24-hour	µg/m³	7.0	**2,115**	**3,473**	**127**	**3,473**	TR	356 d/y	120
	Annual	µg/m³	7.0	**366**	**648**	17.9	**648**	TR	-	60
PM_{10}	24-hour	µg/m³	3.8	**687**	**1,038**	**108**	**1,038**	TR	334 d/y	50
$PM_{2.5}$	24-hour [e]	µg/m³	0	**42.5**	**67.4**	8.50	**67.4**	TR	71 d/y	30
Dustfall	30-day	g/m²/30-day	0.0398	**46.3**	**84.1**	0.575	**84.1**	TR	12 m/y	5.3
	Annual [f]	g/m²/year	0.478	**257**	**490**	3.89	**490**	TR	-	55

NOTES:

[a] Baseline ambient air quality conditions are described in Section 3.

[b] Location of the maximum value:

- PDA – receptor located on the PDA boundary.
- LAA – located outside the PDA boundary and inside the LAA.
- TR – receptor located on the Tote Road 30 m buffer from the center of the road.

[c] Number of exceedances: d/y – days/year; m/y – months/year.

[d] The applicable AAQC for the air COPC are described in Section 2.

[e] The 24-hour $PM_{2.5}$ concentration is calculated as the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.

[f] The annual dustfall is calculated as the arithmetic mean of monthly average depositions.

Concentrations/depositions in **bold** text font exceed the AAQC.

6.3 Model Results Summary

The maximum predicted ground-level concentrations of TSP, PM_{10} and $PM_{2.5}$ and dustfall along and outside the Mine Site and Milne Port PDA boundaries were compared with the applicable AAQC for each relevant averaging period. The model results for the modelling scenarios indicate that:

Mine Site:

- The maximum predicted TSP, PM_{10} and $PM_{2.5}$ concentrations and the maximum predicted dustfall in the Mine Site LAA are greater than the corresponding AAQC and the maximum predicted values occur along the Tote Road.
- The maximum predicted TSP and PM_{10} concentrations and 30-day and annual dustfall at the Mine Site PDA boundary are greater than the corresponding AAQC and the predicted concentrations and dustfall greater than the AAQC extend up to a maximum of 3 km from the south PDA boundary.
- The maximum predicted 24-hour TSP and PM_{10} concentrations at the HTO cabin in the Mine Site LAA are greater than the AAQC, but the exceedances are infrequent (up to 9 days in a year for TSP and up to 16 days in a year for PM_{10}). The maximum predicted $PM_{2.5}$ concentrations and dustfall at the HTO cabin are less than the AAQC.
- The maximum predicted TSP, PM_{10} and $PM_{2.5}$ concentrations and the maximum predicted dustfall along the Tote Road are greater than the corresponding AAQC. The predicted TSP and PM_{10} concentrations greater than the AAQC extend up to 3 km from Tote Road centerline, and the predicted dustfall greater than the ACCC extends up to 800 m from Tote Road centerline.

Milne Port:

- The maximum predicted TSP, PM_{10} and $PM_{2.5}$ concentrations and the maximum predicted dustfall in the Milne Port LAA are greater than the corresponding AAQC and the maximum predicted values occur along the Tote Road.
- The maximum predicted TSP, PM_{10} and $PM_{2.5}$ concentrations and 30-day and annual dustfall at the Milne Port PDA boundary are greater than the corresponding AAQC and the predicted concentrations and dustfall greater than the AAQC extend up to a maximum of 3 km north from the FLA boundary and up to a maximum of 1.8 m west from the PDA boundary.
- The maximum predicted 24-hour TSP and PM_{10} concentrations at the HTO cabin in the Milne Port LAA are greater than the AAQC, but the exceedances are infrequent (up to 1 day in a year for TSP and up to 7 days in a year for PM_{10}). The maximum predicted $PM_{2.5}$ concentrations and dustfall at the HTO cabin are less than the AAQC.
- The maximum predicted TSP, PM_{10} and $PM_{2.5}$ concentrations and the maximum predicted dustfall along the Tote Road are greater than the corresponding AAQC. The predicted TSP and PM_{10} concentrations greater than the AAQC extend up to 1.5 km from Tote Road centerline, and the predicted dustfall greater than the ACCC extends up to 400 m from Tote Road centerline.

7 COMPARISON OF PREDICTED AND MEASURED DUSTFALL LEVELS AT DUSTFALL MONITORING STATIONS

The model-predicted total annual dustfall (g/m²/year) was compared with measured annual dustfall at dustfall monitoring stations at the Mine Site, Milne Port and the Tote Road – North Crossing at km 28. The annual dustfall monitoring data was sourced from the Terrestrial Environment Annual Monitoring Reports (TEAMR) for 2018-2021 (EDI 2019-2022) with an approximately constant mine production at 6 Mtpa. The dustfall monitoring stations at which dustfall sampling was conducted year-round were included in the comparison. The predicted and measured annual dustfall at dustfall monitoring stations for 2018-2021 are compared in Table 7.1 for the Mine Site, in Table 7.2 for Milne Port and in Table 7.3 for the Tote Road. The comparison of predicted and measured annual dustfall at dustfall monitoring stations is illustrated in Figure 7.1 for the Mine Site, in Figure 7.2 for Milne Port and in Figure 7.3 for Tote Road. The dustfall monitoring stations in Figure 7.1 and Figure 7.2 are grouped in two groups – stations within the PDA boundary and stations outside the PDA boundary. The dustfall monitoring stations in Figure 7.3 are grouped in three groups based on their distance from Tote Road – 30 m, 100 m and 1,000 m. The model-predicted annual dustfall was considered in a good agreement with the measured annual dustfall if the ratio of modelled and measured dustfall was within a factor of 2 (US EPA 1992).

The comparison of model-predicted and measured annual dustfall at dustfall monitoring stations at the Mine Site, Milne Port and Tote Road – North Crossing indicate that:

1. **Mine Site:**

- Within the Mine Site PDA boundary, the modelled annual dustfall was in a good agreement with the measured annual dustfall at one monitoring site (DF-M-01), under-predicted the measured annual dustfall at one monitoring site (DF-M-03), and over-predicted the measured annual dustfall at one monitoring site (DF-M-02).

2. **Milne Port:**

- Within the Milne Port PDA boundary, the modelled annual dustfall was in a good agreement with the measured annual dustfall at one monitoring site (DF-P-04) and over-predicted the measured annual dustfall at three monitoring sites (DF-P-05, DF-P-06 and DF-P-07). For the monitoring station located 1,000 m from the PDA boundary, the modelled dustfall was in a good agreement with the measured annual dustfall (DF-P-08).

3. **Tote Road – North Crossing at km 28:**

- At monitoring stations located 30 m and 100 m from Tote Road, the modelled annual dustfall was in a good agreement with the measured annual dustfall (DF-RN-04, DF-RN-05, DF-RN-03 and DF-RN-06). At monitoring stations located 1,000 m from Tote Road, the modelled annual dustfall was in a good agreement with the measured annual dustfall at two monitoring sites (DF-RN-02 and DF-TR-25W) and under-predicted the measured annual dustfall at two monitoring sites (DF-TR-25E and DF-RN-07).

Table 7.1 Comparison of Model-Predicted and Measured Annual Dustfall at Dustfall Monitoring Stations at the Mine Site

Site ID	Location	Distance from PDA (m)	Dustfall Monitoring Program Year			
			2018	2019	2020	2021
Model-Predicted Annual Dustfall (g/m²/year)						
DF-M-01 Model	Mine Site	Within PDA	38.6			
DF-M-02 Model	Mine Site	Within PDA	356.0			
DF-M-03 Model	Mine Site	Within PDA	19.5			
Measured Annual Dustfall (g/m²/year)						
DF-M-01	Mine Site	Within PDA	77.0	49.2	107.2	134.5
DF-M-02	Mine Site	Within PDA	91.2	66.5	68.4	82.4
DF-M-03	Mine Site	Within PDA	60.4	85.7	88.5	70.6
Ratio of Model-Predicted and Measured Dustfall						
DF-M-01	Mine Site	Within PDA	0.5	0.8	0.4	0.3
DF-M-02	Mine Site	Within PDA	3.9	5.4	5.2	4.3
DF-M-03	Mine Site	Within PDA	0.3	0.2	0.2	0.3

Table 7.2 Comparison of Model-Predicted and Measured Annual Dustfall at Dustfall Monitoring Stations at the Milne Port

Site ID	Location	Distance from PDA (m)	Dustfall Monitoring Program Year			
			2018	2019	2020	2021
Model-Predicted Annual Dustfall (g/m²/year)						
DF-P-04 Model	Milne Port	Within PDA	21.3			
DF-P-05 Model	Milne Port	Within PDA	524.0			
DF-P-06 Model	Milne Port	Within PDA	69.4			
DF-P-07 Model	Milne Port	Within PDA	497.5			
DF-P-08 Model	Milne Port	1,000	25.9			
Measured Annual Dustfall (g/m²/year)						
DF-P-04	Milne Port	Within PDA	21.5	17.7	23.9	11.6
DF-P-05	Milne Port	Within PDA	124.4	113.4	96.8	60.9
DF-P-06	Milne Port	Within PDA	21.2	12.1	14.6	7.3
DF-P-07	Milne Port	Within PDA	31.5	29.2	8.1	11.1
DF-P-08	Milne Port	1,000	-	78.1	35.6	36.4
Ratio of Model-Predicted and Measured Dustfall						
DF-P-04	Milne Port	Within PDA	1.0	1.2	0.9	1.8
DF-P-05	Milne Port	Within PDA	4.2	4.6	5.4	8.6
DF-P-06	Milne Port	Within PDA	3.3	5.7	4.8	9.5
DF-P-07	Milne Port	Within PDA	16	17	61	45
DF-P-08	Milne Port	1,000	-	0.3	0.7	0.7

Table 7.3 Comparison of Model-Predicted and Measured Annual Dustfall at Dustfall Monitoring Stations at Tote Road – North Crossing km 28

Site ID	Location	Distance from PDA (m)	Dustfall Monitoring Program Year			
			2018	2019	2020	2021
Model-Predicted Annual Dustfall (g/m²/year)						
DF-TR-25W Model	Tote Road – North, km 28	1,000	6.5			
DF-RN-02 Model	Tote Road – North, km 28	1,000	3.8			
DF-RN-03 Model	Tote Road – North, km 28	100	122.4			
DF-RN-04 Model	Tote Road – North, km 28	30	270.4			
DF-RN-05 Model	Tote Road – North, km 28	30	138.4			
DF-RN-06 Model	Tote Road – North, km 28	100	63.1			
DF-RN-07 Model	Tote Road – North, km 28	1,000	2.9			
DF-TR-25E Model	Tote Road – North, km 28	1,000	2.3			
Measured Annual Dustfall (g/m²/year)						
DF-TR-25W	Tote Road – North, km 28	1,000	-	5.9	10.0	7.8
DF-RN-02	Tote Road – North, km 28	1,000	-	5.2	6.1	5.2
DF-RN-03	Tote Road – North, km 28	100	45.7	62.2	77.6	58.2
DF-RN-04	Tote Road – North, km 28	30	225.0	390.6	133.4	149.4
DF-RN-05	Tote Road – North, km 28	30	116.6	480.4	228.8	188.2
DF-RN-06	Tote Road – North, km 28	100	63.8	74.6	97.1	72.2
DF-RN-07	Tote Road – North, km 28	1,000	-	7.7	9.6	6.5
DF-TR-25E	Tote Road – North, km 28	1,000	-	7.0	12.1	7.6
Ratio of Model-Predicted and Measured Dustfall						
DF-TR-25W	Tote Road – North, km 28	1,000	-	1.1	0.6	0.8
DF-RN-02	Tote Road – North, km 28	1,000	-	0.7	0.6	0.7
DF-RN-03	Tote Road – North, km 28	100	2.7	2.0	1.6	2.1

Table 7.3 Comparison of Model-Predicted and Measured Annual Dustfall at Dustfall Monitoring Stations at Tote Road – North Crossing km 28

Site ID	Location	Distance from PDA (m)	Dustfall Monitoring Program Year			
			2018	2019	2020	2021
DF-RN-04	Tote Road – North, km 28	30	1.2	0.7	2.0	1.8
DF-RN-05	Tote Road – North, km 28	30	1.2	0.3	0.6	0.7
DF-RN-06	Tote Road – North, km 28	100	1.0	0.8	0.7	0.9
DF-RN-07	Tote Road – North, km 28	1,000	-	0.4	0.3	0.4
DF-TR-25E	Tote Road – North, km 28	1,000	-	0.3	0.2	0.3

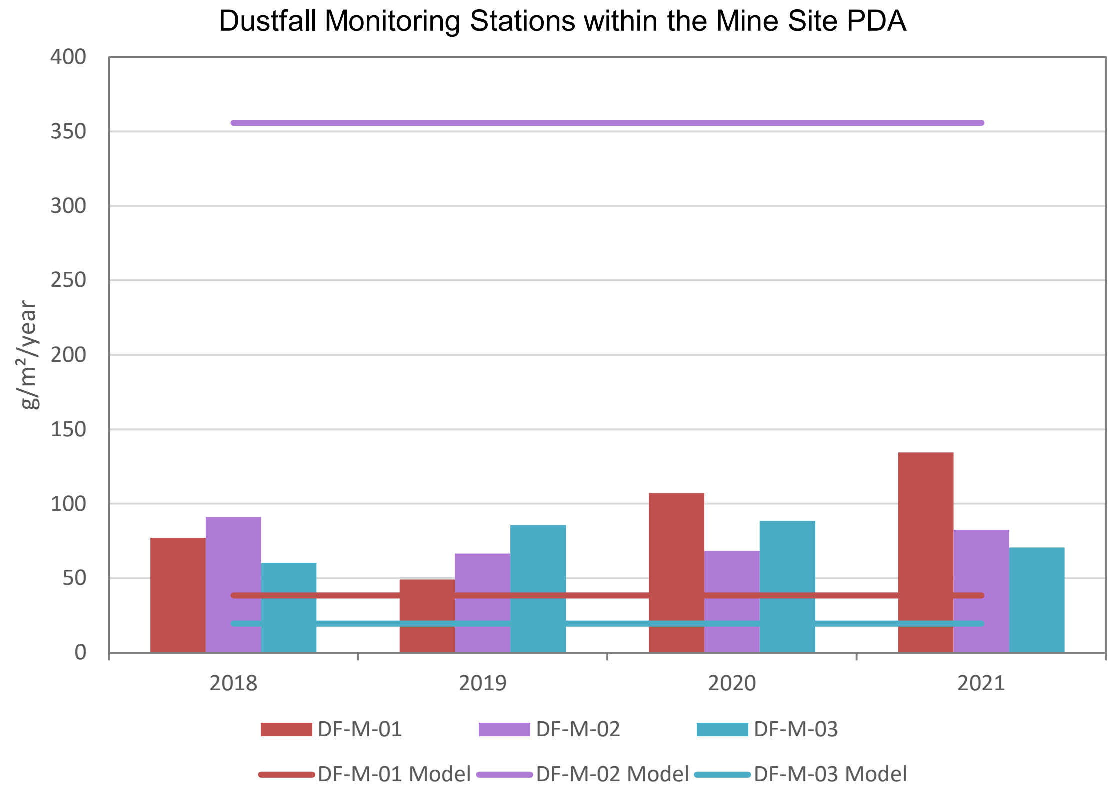
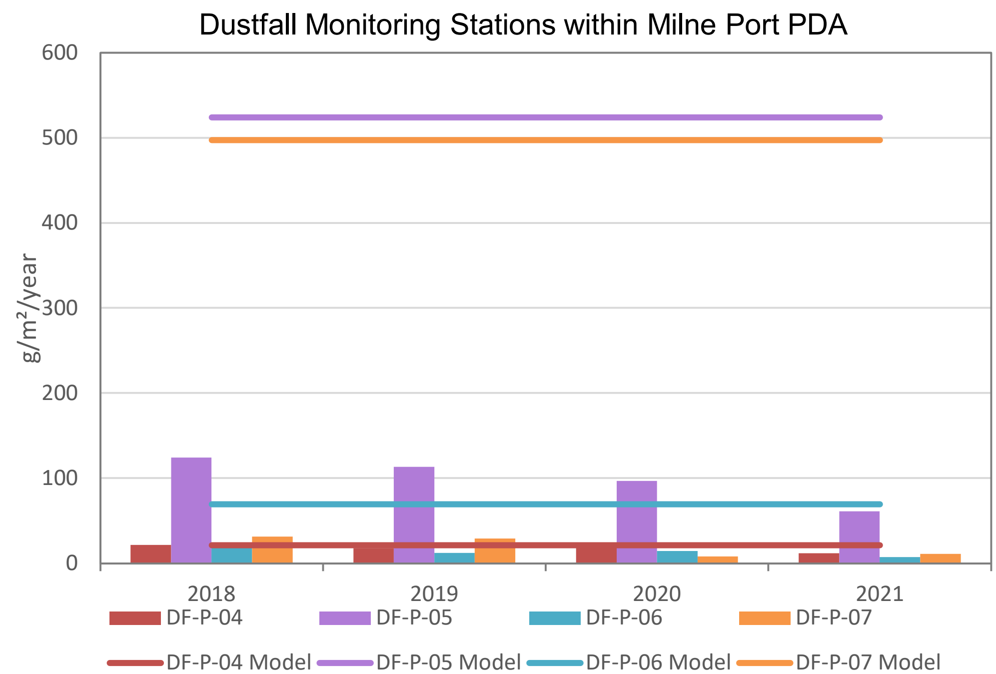


Figure 7.1 Comparison of Model-Predicted and Measured Annual Dustfall Accumulation at Dustfall Monitoring Stations at the Mine Site



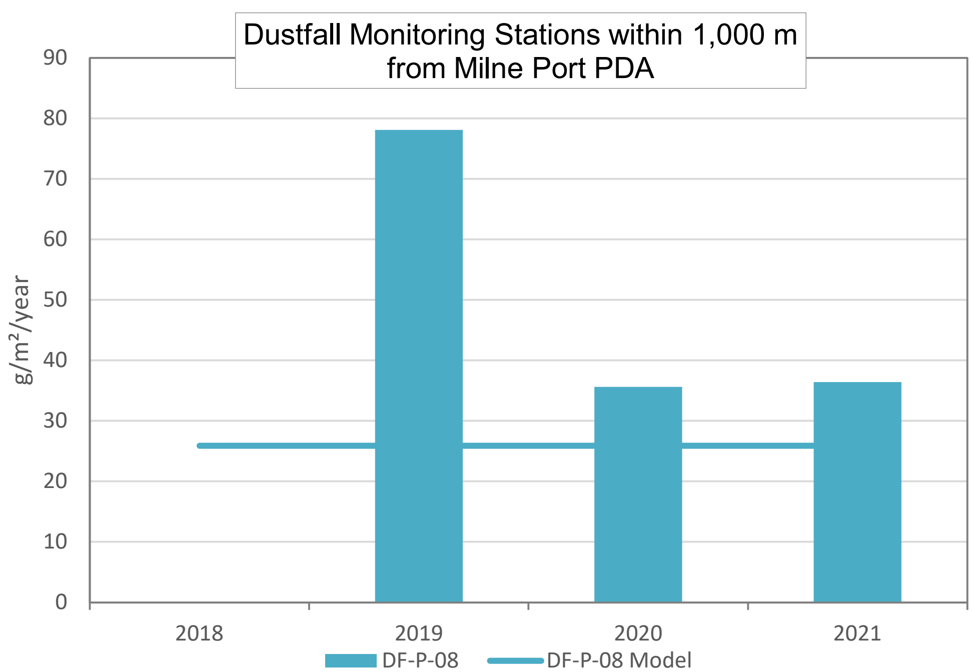
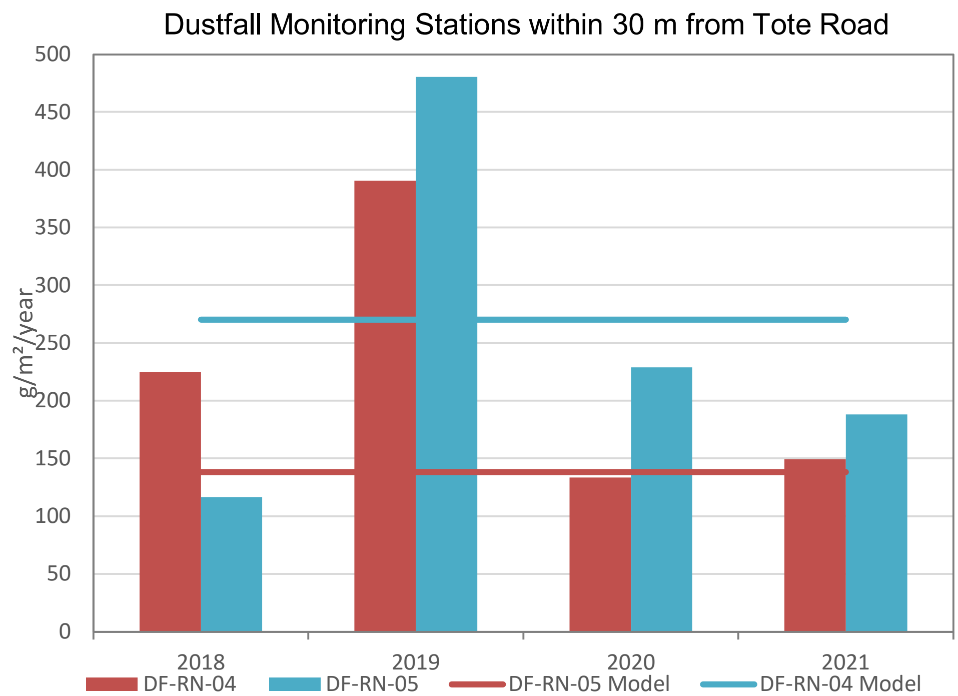


Figure 7.2 Comparison of Model-Predicted and Measured Annual Dustfall Accumulation at Dustfall Monitoring Stations at Milne Port



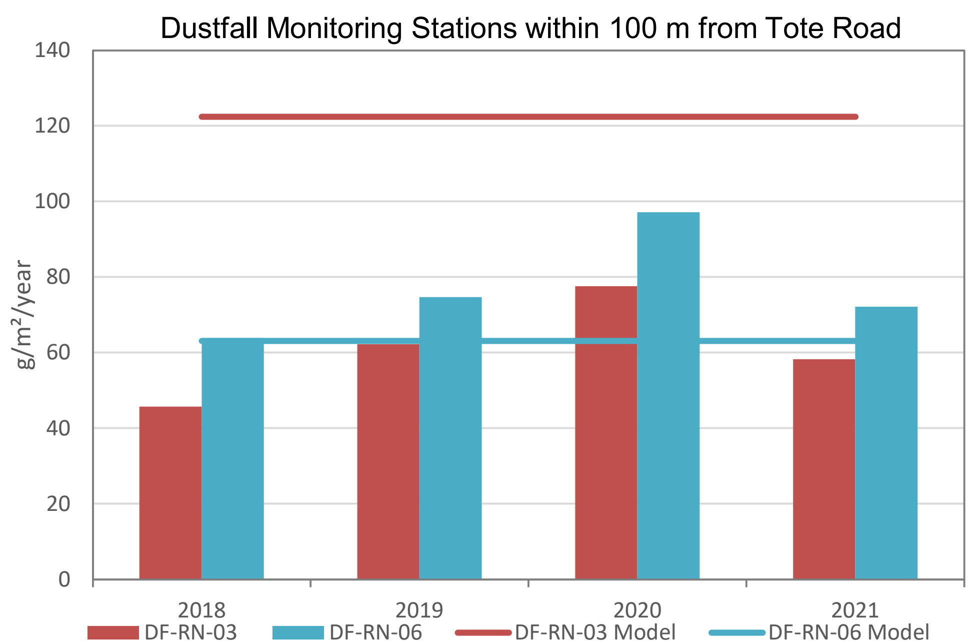


Figure 7.3 Comparison of Model-Predicted and Measured Annual Dustfall Accumulation at Dustfall Monitoring Stations at Tote Road – North Crossing km 28 (Part A)

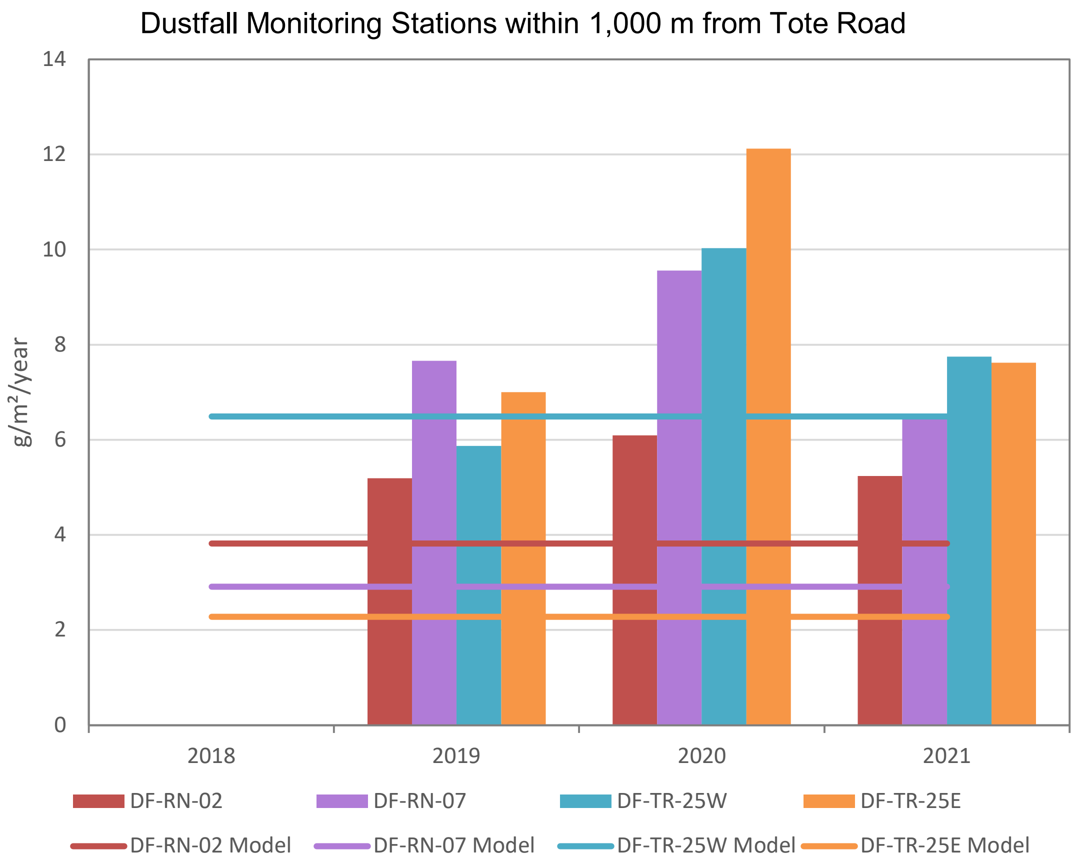


Figure 7.3 Comparison of Model-Predicted and Measured Annual Dustfall Accumulation at Dustfall Monitoring Stations at Tote Road – North Crossing km 28 (Part B)

8 SUMMARY AND CONCLUSIONS

The air quality assessment evaluated the air quality effects of the Project emissions for a 6 Mtpa mine production rate and ore transport along the Tote Road to Milne Port and ore sipping during the open water season (July to October). The assessment focused on emissions of PM of different aerodynamic particle sizes (TSP, PM_{10} and $PM_{2.5}$), which are the primary air COPCs associated with open pit mining and ore hauling. The air quality assessment characterized the Project emission sources to represent mining operations at the nominal ore production and transport levels approved from 2018 to 2022 and incorporated dust mitigation measures that have been implemented along the Tote Road and at the ore stockpiles at Milne Port.

The air quality assessment evaluated two LAAs – the Mine Site LAA and the Milne Port LAA as well as sections of the Tote Road located within the two LAAs. Emissions from Mine Site operation were estimated based on 6 Mtpa ore production and the type and number of mining off-road equipment operating at the Mine Site. Emissions from Milne Port operation were estimated based on 6 Mtpa ore transport, handling, stockpiling and ship loading, and the type and number of off-road equipment operating at the site. Fugitive dust emissions for the Project were estimated using emission factors from various chapters of the US EPA AP-42 Fifth Edition Compilation of Air Pollutant Emission Factors (US EPA 1995). DPM emissions from the mining off-road equipment, stationary diesel power generators, waste incinerators and marine vessels were estimated and included in the assessment for completeness; however, the Project DPM emissions are much less than the total fugitive dust emissions.

Potential effects on ambient air quality associated with Project operation were evaluated using the CALPUFF® atmospheric dispersion model. Three-dimensional meteorological fields for the CALPUFF® model were generated using the CALMET® meteorological model and WRF data with a 12 km grid resolution. The modelling assessment was completed in accordance with the Newfoundland and Labrador Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012) and guidelines from other provincial jurisdictions.

Baseline ambient air concentrations and dustfall were determined based on the short-term ambient air quality monitoring program within the Mine Site PDA in July 2007 (RWDI 2012). The ambient air quality monitoring indicated that measured baseline concentrations and dustfall are extremely low.

The model-predicted PM concentrations and dustfall along and outside the Mine Site and Milne Port PDA boundaries, with added baseline levels, were compared to relevant ambient air quality standards, objectives and guidelines from Nunavut and other jurisdictions (collectively referred to as the applicable AAQC).

The air dispersion modelling results show that the maximum predicted PM concentrations and dustfall in the Mine Site LAA and the Milne Port LAA are greater than the corresponding AAQC and the maximum predicted values occur along the Tote Road.

The maximum predicted PM concentrations and dustfall at the Mine Site and Milne Port PDA boundaries are greater than the corresponding AAQC and the predicted PM concentrations and dustfall greater than the AAQC extend up to a maximum of 3 km from the PDA boundaries.

The maximum predicted $PM_{2.5}$ concentrations and dustfall at the HTO cabins in the Mine Site LAA and Milne Port LAA are less than the AAQC. The maximum predicted 24-hour TSP and PM_{10} concentrations at the HTO cabins in the Mine Site LAA and Milne Port LAA are greater than the AAQC, but the exceedances are infrequent (up to 16 days for the Mine Site and up to 7 days for Milne Port).

The maximum predicted PM concentrations and the dustfall along the Tote Road are greater than the corresponding AAQC. The predicted TSP and PM_{10} concentrations greater than the AAQC extend up to 3 km from Tote Road centerline in the Mine Site LAA and up to 1.5 km from Tote Road centerline in the Milne Port LAA, and the predicted dustfall greater than the AAQC extends up to 800 m from Tote Road centerline in the Mine Site LAA and up to 400 m from Tote Road centerline in the Milne Port LAA.

The comparison of model-predicted and measured annual dustfall accumulation at dustfall monitoring sites at Tote Road – North Crossing at km 28 for 2018-2021 shows a good agreement (within a factor of two) with the measured annual dustfall at the monitoring stations located 30 m and 100 m from Tote Road and at two of the monitoring stations located 1,000 m from Tote Road. The modelled annual dustfall under-predicted the measured annual dustfall at two monitoring sites (DF-TR-25E and DF-RN-07) located 1,000 m from Tote Road. Most of the dustfall monitoring sites where dustfall sampling was conducted year-round are located within the Mine Site PDA and Milne Port PDA. The comparison of model-predicted and measured annual dustfall at these sites did not show a trend in under-prediction or over-prediction of the measured annual dustfall. For the monitoring station located 1,000 m from the Milne Port PDA boundary, the modelled dustfall was in a good agreement with the measured annual dustfall.

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10 CLOSURE

The conclusions in the Report titled "Mary River Project – 6 Mtpa– Air Quality Assessment" are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

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APPENDIX A Emission Inventory

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A.1 Mine Site Emissions

A.1.1 General Assumptions

The general assumptions used to estimate emissions at the Mine Site are listed below:

- Annual mine production and transport of 6 Mtpa ore via truck along the Tote Road to Milne Port.
- The Mine Site operates continuously 20 hours a day, 360 days a year.
- Average mine strip ratio of 0.57 resulting in 3.4 Mtpa of waste rock.
- Ore haul trucks along the Tote Road operate continuously 20 hours a day, 360 days a year.
- Ore transported to Milne Port is 63% fine ore (less than 6.3 mm) and 37% lump ore (6.3-32 mm).
- Open pit area of 583,729 m² and pit depth of 192 m as of 2022.
- The silt content of Run of Mine (ROM) ore and waste rock was assumed to be 1.2% based on bulk sampling conducted by RWDI (FEIS; Baffinland 2012).
- The silt content of haul roads, the Tote Road and the open pit was assumed to be 5.2% based on bulk sampling conducted by RWDI (FEIS; Baffinland 2012).
- The moisture content of ROM ore and waste rock was assumed to be 2% (FEIS; Baffinland 2012).
- The moisture content of haul roads and the Tote Road was assumed to be 1.3% (FEIS; Baffinland 2012).
- The moisture content of lump ore was assumed to be 1.5% and the moisture content of fine ore was assumed to be 4%, based on Baffinland's 2020 shipping specifications.
- The list of mining off-road diesel equipment operating at the Mine Site was provided by Baffinland. The power rating (hp) for the mining off-road equipment was based on manufacturer specifications for the equipment type and model.
- Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of off-road diesel equipment.
- Assumed a 50% pit retention for fugitive TSP emissions from the open pit and 5% pit retention for fugitive PM_{10} emissions from the open pit based on the Australian Emission Manual for Mining (Australian Government 2012). The fraction of fugitive $PM_{2.5}$ emissions retained in the open pit was estimated to be 2% based on the Winges equation (Winges 1981, 1986) and the pit depth of 192 m.
- Assumed a 75% dust control efficiency on haul roads, corresponding to road watering and application of calcium chloride (US EPA 2006) during summer and the shoulder season, assumed to be 6 months – May to October.
- Assumed a 50% dust control efficiency along the Tote Road during summer and the shoulder season (6 months, May to October) based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2021).

- Assumed a 90% natural mitigation efficiency for fugitive dust emissions on haul roads and the Tote Road during winter due to snow cover and frozen ground (Golder Associates 2012). Winter is assumed to be 6 months – November to April.
- Dust control was not applied to fugitive dust emissions from bulldozing and grading, mining equipment movement, including front-end loaders operation at the Mine Site crushing facility, truck loading and unloading and wind erosion of stockpiles.
- DPM from diesel combustion exhaust is assumed to have an aerodynamic diameter less than 10 µm (PM_{10}) and 97% to have an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), based on the US EPA NONROAD model (US EPA 2010a).

A.1.2 Emission Sources

A.1.2.1 Drilling and Blasting in the Pit

Blasting occurs once per week. Approximately 800 blast holes are used per blast with blasting area 27.56 m² per blast hole and an average blast area of 18,500 m² per blast.

Fugitive dust emissions from drilling and blasting in the pit were calculated using the blast area per blast and the published fugitive dust emission factors and calculation methods for drilling and blasting (US EPA 1995, § 11.9).

Assumptions used to estimate emissions include:

- Assumed that 4 production drills operate in the pit and each production drill drills one blast hole per hour, resulting in 4 blast holes drilled per hour.
- Pit retention fractions were applied to fugitive dust emissions from drilling and blasting in the pit: 50% for fugitive TSP emissions, 5% for fugitive PM_{10} emissions and 2% for $PM_{2.5}$.
- Fugitive dust control was not applied to PM emissions from drilling and blasting.

A.1.2.2 Mechanically Generated Dust from Mining Off-Road Equipment Movement

The mining off-road diesel equipment (Table 4.1) generates dust emissions from movement in the open pit, at the crushing facility and the general facilities area. Fugitive dust emissions from the mining off-road equipment movement were calculated using the average operating speed and operating weight of each equipment and the published fugitive dust emission factors and calculation methods for unpaved roads (US EPA 1995, § 13.2.2).

Assumptions used to estimate emissions include:

- The primary mining off-road equipment operates continuously 20 hours a day. The supporting diesel off-road equipment operates intermittently throughout the day, assumed an average of 12 hours a day.
- Average operating speed and operating weight for the mining off-road equipment were based on manufacturer specifications for the equipment manufacturer and model.

- Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of mining off-road equipment.
- Pit retention fractions were applied to fugitive dust emissions from mining off-road equipment movement in the pit: 50% for fugitive TSP emissions, 5% for fugitive PM_{10} emissions and 2% for $PM_{2.5}$.
- Fugitive dust control was not applied to PM emissions from mining off-road equipment movement.

A.1.2.3 Bulldozing and Grading

Three bulldozers are assumed to operate continuously in the open pit, three bulldozers at the waste rock pile and the ROM ore stockpile and one bulldozer at the crushing facility. Three bulldozers are assumed to operate intermittently, for a total of 6 hours a day, for maintenance of the Tote Road. Three graders are assumed to operate continuously along the mine haul roads, one grader is assumed to operate intermittently for 12 hours a day at the general facilities area and five graders are assumed to operate intermittently for 11 hours a day for maintenance of the Tote Road. Fugitive dust emissions from bulldozing and grading were calculated using the published fugitive dust emission factors and calculation methods for bulldozing and grading (US EPA 1995, § 11.9).

Assumptions used to estimate emissions include:

- A load/utilization factor of 58% from the US EPA NONROAD model (US EPA 2010b) was assumed for bulldozing and a load factor of 59% was assumed for grading.
- Assumed average grader speed of 11.4 km/h (as per US EPA 1995, § 11.9, Table 11.9-3)
- Pit retention fractions were applied to fugitive dust emissions from bulldozing and grading in the pit - 50% for fugitive TSP emissions, 5% for fugitive PM_{10} emissions and 2% for $PM_{2.5}$.
- Fugitive dust control was not applied to PM emissions from bulldozing in the open pit and at stockpiles.
- Dust control efficiency of 75% was assumed for grading along the haul roads, corresponding to road watering and application of calcium chloride (US EPA 2006) during summer and the shoulder season, assumed to be 6 months – May to October.
- Dust control efficiency of 50% was assumed for bulldozing and grading along the Tote Road during summer and the shoulder season (6 months, May to October) based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2020).
- Natural mitigation efficiency of 90% for fugitive dust emissions from bulldozing and grading along the haul roads and the Tote Road was assumed during winter (Golder Associates 2012). Winter is assumed to be 6 months – November to April.

A.1.2.4 Truck Loading/Unloading, Crusher Conveyors and Ore Handling

ROM ore in the open pit is loaded in the haul trucks and hauled to the crushing facility. Waste rock is loaded in the haul trucks and hauled to the waste rock pile. A small fraction of the ROM ore, assumed 3% equivalent to 0.18 Mtpa, is temporary stored at the ROM ore stockpile. Truck loading in the open pit is based on 6 Mtpa ore production and 3.4 Mtpa waste rock. ROM ore and waste rock are hauled using CAT 793 haul trucks with a payload capacity of 231 tonnes.

Ore haul trucks unload the ROM ore at the crushing facility, where the ore is loaded to crusher conveyors with front-end loaders. Three crusher conveyors operate continuously at the crushing facility. Crusher A has 9 conveyor transfer points and Crushers B and C each have 11 conveyor transfer points. Processed ore is loaded with front-end loaders to two temporary fine ore stockpiles and one temporary lump ore stockpile. The bigger fine ore stockpile is stacked with a radial stacker. The processed ore is loaded into ore haul trucks using front-end loaders and transported along the Tote Road to Milne Port. Fifty-seven Western Star 6900 XD ore haul trucks with a payload capacity of 135 tonnes are used to transport the processed ore to Milne Port.

Fugitive dust emissions from truck loading/unloading and ore handling were calculated using the mine production rate of 6 Mtpa and the published fugitive dust emission factors and calculation methods for material transfer (US EPA 1995, § 13.2.4).

Assumptions used to estimate emissions include:

- Seven CAT 793 haul trucks with a payload capacity of 231 tonnes operate continuously and load 6 Mtpa of ROM ore and 3.4 Mtpa waste rock in the open pit.
- Crusher A has 9 conveyor transfer points and Crushers B and C each have 11 conveyor transfer points.
- Fifty-seven Western Star 6900 XD ore haul trucks with a payload capacity of 135 tonnes operate continuously and transport 6 Mtpa ore along the Tote Road to Milne Port.
- Pit retention fractions were applied to fugitive dust emissions from truck loading in the pit - 50% for fugitive TSP emissions, 5% for fugitive PM_{10} emissions and 2% for $PM_{2.5}$.
- Fugitive dust emissions from truck loading/unloading, crusher conveyors and ore handling were modelled as varying emissions by wind speed.
- Fugitive dust control was not applied to PM emissions from truck loading/unloading, crusher conveyors and ore handling.

A.1.2.5 Ore Crushers

ROM ore is unloaded at the Mine Site crushing facility and processed using three crusher conveyors – Crushers A, B and C. Crusher A consists of a primary crusher, a screen and a conveyor system, while Crushers B and C consist of a primary crusher, a secondary crusher, a screen and a conveyor system.

Fugitive dust emissions from the crushers (primary and secondary) were calculated using the mine production rate of 6 Mtpa and the published fugitive dust emission factors and calculation methods for crushing (US EPA 1995, § 11.19.2).

Assumptions used to estimate emissions include:

- Three crusher conveyors (Crushers A, B and C) operate continuously and process 6 Mtpa ore.
- Fugitive dust control was not applied to PM emissions from primary and secondary crushers.

A.1.2.6 Haul Roads Dust Emissions

Seven CAT 793 haul trucks with a payload capacity of 231 tonnes are used to haul ROM ore and waste rock from the open pit to the Mine Site crushing facility and the waste rock pile. Fugitive dust emissions from haul trucks travelling on mine haul roads were calculated using the traffic volumes (number of truck round trips per day) and the published fugitive dust emission factors and calculation methods for unpaved roads (US EPA 1995, § 13.2.2). The number of truck round trips per day were calculated based on 6 Mtpa ROM ore and 3.4 Mtpa waste rock hauled and the truck payload capacity.

Assumptions used to estimate emissions include:

- Seven CAT 793 haul trucks operate continuously and haul 6 Mtpa of ROM ore and 3.4 Mtpa of waste rock.
- The traffic volume along the haul road to the crushing facility was estimated to be 72 round-trips per day, based on 6 Mtpa ROM ore hauled from the open pit to the Mine Site crushing facility and the payload capacity of the haul truck (231 tonne) and assuming 360 days of operation per year.
- The traffic volume along the haul road to the waste rock pile was estimated to be 41 round-trips per day, based on 3.4 Mtpa waste rock hauled from the open pit to the waste rock pile and the payload capacity of the haul truck (231 tonne) and assuming 360 days of operation per year.
- Dust control efficiency of 75% was assumed on the haul roads, corresponding to road watering and application of calcium chloride (US EPA 2006) during summer and the shoulder season, assumed to be 6 months – May to October.
- Natural mitigation efficiency of 90% for fugitive dust emissions was assumed on the haul roads during winter (Golder Associates 2012). Winter is assumed to be 6 months – November to April.

A.1.2.7 Tote Road Dust Emissions

The traffic along Tote Road includes ore haul trucks, seasonal (August and September) and year-round fuel tanker trucks, service vehicles, maintenance supporting equipment, passenger buses, passenger vans and pickup trucks (Table 4.2). Fugitive dust emissions from trucks and vehicles travelling on Tote Road were calculated using the traffic volumes (number of round trips per day) and the published fugitive dust emission factors and calculation methods for unpaved roads (US EPA 1995, § 13.2.2).

Assumptions used to estimate emissions include:

- Fifty-seven Western Star 6900 XD ore haul trucks with a payload capacity of 135 tonnes operate continuously and transport 6 Mtpa ore along the Tote Road to Milne Port.
- The ore haul trucks traffic volume along the Tote Road was estimated to be 123 round-trips per day, based on transporting 6 Mtpa ore and the payload capacity of the haul truck (135 tonne) and assuming 360 days of operation per year.
- Dust control efficiency of 50% was assumed along the Tote Road during summer and the shoulder season (6 months, May to October) based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2021).
- Natural mitigation efficiency of 90% for fugitive dust emissions was assumed on Tote Road during winter (Golder Associates 2012). Winter is assumed to be 6 months – November to April.

A.1.2.8 Wind Erosion of Stockpiles

Wind erosion emissions occur when the wind exceeds a threshold wind speed that is defined based on the characteristics of the material subject to erosion. Fugitive dust emissions resulting from wind erosion of the waste rock pile, ROM ore stockpile and the processed fine ore and lump ore stockpiles at the Mine Site crushing facility were calculated using the surface area of the pile and published wind erosion emission factors and calculation methodology (US EPA 1995, § 13.2.5).

The calculation methodology in Section 13.2.5 of US EPA (1995, § 13.2.5) assumes that wind erosion emissions occur only from a “disturbed” area of a stockpile which exposes fresh erodible material to the wind. Disturbance of the surface material can occur when material is added to the storage area or material is removed to expose more erodible material.

The disturbed area subject to wind erosion emissions of the waste rock pile was assumed to be 40,000 m² corresponding to an active truck unloading area of 200 m by 200 m. The disturbed area of the ROM was assumed to be 10,000 m² corresponding to an active truck unloading area of 100 m by 100 m. The disturbed area of the processed temporary ore stockpiles at the crushing facility was assumed to be 900 m² corresponding to an active loading/unloading area of 30 m by 30 m. The disturbed area of the bigger fine ore stockpile at the crushing facility was assumed to be approximately 9,000 m² corresponding to an active loading area of the radial stacker of 95 m by 95 m. It was assumed that there would be one disturbance per hour at the stockpiles.

Emissions were calculated for the mean wind speed of each of the 6 wind speed categories in the air dispersion model. This approach allowed wind erosion emissions to be modelled as variable emissions by wind speed category. In the calculation of emission factors for each of the wind speed categories, the hourly average wind speeds were corrected to “fastest mile wind” using a correction factor of 1.26 based on the Durst curves (Durst 1960).

Assumptions used to estimate emissions include:

- The threshold friction velocity for the waste rock pile and the ROM ore stockpile was assumed to be 1.02 m/s corresponding to overburden as per Section 13.2.5 of US EPA (1995, § 13.2.5), resulting in a wind erosion threshold mean wind speed of 16.4 m/s.
- The threshold friction velocity for the lump ore stockpile was assumed to be 1.02 m/s based on particle size distribution of lump ore provided by Baffinland and the methodology in Section 13.2.5 of US EPA (1995, § 13.2.5), resulting in a wind erosion threshold mean wind speed of 16.4 m/s.
- The threshold friction velocity for the fine ore stockpile was estimated to be of 0.76 m/s based on particle size distribution of fine ore provided by Baffinland and the methodology in Section 13.2.5 of US EPA (1995, § 13.2.5), resulting in a wind erosion threshold mean wind speed of 13.5 m/s.
- The roughness height for the ROM ore stockpile was assumed to be 0.30 cm corresponding to overburden as per Section 13.2.5 of US EPA (1995, § 13.2.5).
- The roughness height for the lump ore stockpile was assumed to be 0.30 cm corresponding to overburden as per Section 13.2.5 of US EPA (1995, § 13.2.5).
- The roughness height for the fine ore stockpile was assumed to be 0.133 cm corresponding to desert flat (Mansell et al. 2006).
- Fugitive dust control was not applied to PM emissions from wind erosion of stockpiles.

A.1.2.9 Diesel Combustion Exhaust Emissions from Mining Off-Road Diesel Equipment and Haul Trucks

Diesel exhaust emissions from mining off-road equipment and haul trucks were calculated using the power rating (hp) of the equipment and the Canadian off-road diesel engine emission standards (ECCC 2005). Emissions were calculated using the emission standard corresponding to the equipment manufacture year (Tier 3, Tier 4) as provided by Baffinland.

Assumptions used to estimate emissions include:

- The mining off-road diesel equipment and haul trucks operate continuously.
- Emissions for the mining off-road equipment and haul trucks were calculated using the emission standards corresponding to the equipment manufacture year (Tier 3, Tier 4) as provided by Baffinland.
- Power rating (hp) for the mining off-road equipment was based on manufacturer specifications using the equipment manufacturer and model.
- Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of mining off-road equipment.
- DPM from diesel combustion exhaust is assumed to have an aerodynamic diameter less than 10 µm (PM_{10}) and 97% to have an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), based on the US EPA NONROAD model (US EPA 2010a).

A.1.2.10 Diesel Combustion Exhaust from Trucks and Vehicles along Tote Road

The traffic along Tote Road includes ore haul trucks, seasonal (August and September) and year-round fuel tanker trucks, service vehicles, supporting maintenance equipment, passenger buses, passenger vans and pickup trucks (Table 4.2). Diesel exhaust emissions from on-road trucks and vehicles travelling along Tote Road were estimated using emission factors in g/VMT for each truck/vehicle type derived from the US EPA MOVES2014a model (US EPA 2015), the number of vehicle round-trips per day and the length of the Tote Road segment within the Mine Site LAA. MOVES2014a was run for a surrogate state and county in the US (Hill County, Montana) that experiences similar meteorological conditions, for a rural unrestricted road type that best represents Tote Road, for year 2018 to represent current vehicle populations and emission standards, for winter to represent maximum exhaust emissions and with fuel formulations specific to Canada.

Assumptions used to estimate emissions include:

- A representative manufacturer/model was assumed for each type of truck/vehicle.
- Engine power (hp), GVWR (tonne) and payload capacity (tonne) were based on manufacturer specifications using the equipment manufacturer and model.
- Fifty-seven Western Star 6900 XD ore haul trucks with a payload capacity of 135 tonnes operate continuously and transport 6 Mtpa ore along the Tote Road to Milne Port.
- The ore haul trucks traffic volume along the Tote Road was estimated to be 123 round-trips per day, based on transporting 6 Mtpa ore and the payload capacity of the haul truck (135 tonne) and assuming 360 days of operation per year.
- Service vehicle traffic is based on 250 trips/week from the Phase 2 Key Facts Table (Baffinland 2018b).
- DPM from diesel combustion exhaust is assumed to have an aerodynamic diameter less than 10 µm (PM_{10}) and 97% to have an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), based on the US EPA NONROAD model (US EPA 2010a).

A.1.2.11 Power Generation

Two 3.5 MW and six 1.32 MW stationary diesel power generators operate at the Mine Site. The PM emissions for the stationary diesel power generators were scaled from the emissions estimated for the Phase 2 FEIS Addendum (Baffinland 2018a) based on the ratio of engine power (hp). The emissions in the previous air quality assessment were calculated based on the power rating (hp) and the manufacturer specifications for generator model GE 16V250 (3.5 MW) and Cummins QSK50-G5 NR2 (1.32 MW).

Assumptions used to estimate emissions include:

- The Mine Site has two 3.5 MW and six 1.32 MW stationary diesel power generators.
- DPM emissions were calculated based on manufacturer emission specifications for generator model GE 16V250 (3.5 MW) and Cummins QSK50-G5 NR2 (1.32 MW).

- Stack parameters (height, diameter, exit velocity and temperature) were provided by Baffinland.
- DPM from the stationary diesel generators was assumed to be 100% $PM_{2.5}$.

A.2 Milne Port Emissions

A.2.1 General Assumptions

General assumptions used to estimate emissions for Milne Port operation are listed below:

- Milne Port operates continuously, 20 hours a day, 360 days a year.
- 6 Mtpa of ore is transported from the Mine Site via truck along the Tote Road to Milne Port.
- 6 Mtpa of ore is handled and stockpiled at Milne Port and loaded to ore carrier for ocean shipping during the open water season (July to October).
- Approximately 63% (63% x 6 Mtpa = 3.8 Mtpa) of the ore shipped to Milne Port is fine ore (less than 6.3 mm) and approximately 37% (37% x 6 Mtpa = 2.2 Mtpa) is lump ore (6.3-32 mm).
- The silt content of ore was assumed to be 1.2% based on bulk sampling conducted by RWDI (FEIS; Baffinland 2012).
- The silt content of haul roads and the Tote Road was assumed to be 5.2% based on bulk sampling conducted by RWDI (FEIS; Baffinland 2012).
- The moisture content of lump ore was assumed to be 1.5% and the moisture content of fine ore was assumed to be 4%, based on Baffinland's 2020 shipping specifications.
- The moisture content of haul roads and the Tote Road was assumed to be 1.3% (FEIS; Baffinland 2012).
- The list of diesel off-road equipment operating at Milne Port was provided by Baffinland. The power rating (hp) for the mining off-road equipment was based on manufacturer specifications for the equipment type and model.
- Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of off-road diesel equipment.
- Assumed a 75% dust control efficiency on the haul road around the ore stockpiles, corresponding to road watering and application of calcium chloride (US EPA 2006) during summer and the shoulder season, assumed to be 6 months – May to October.
- Assumed a 50% dust control efficiency along the Tote Road during summer and the shoulder season (6 months, May to October) based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2020).
- Assumed a 90% natural mitigation efficiency for fugitive dust emissions on the haul road around the ore stockpiles and on the Tote Road during winter due to snow cover and frozen ground (Golder Associates 2012). Winter is assumed to be 6 months – November to April.

- Assumed no wind erosion emissions occur at the finished ore stockpiles at Milne Port corresponding to the application of chemical dust suppressant (DusTreat®) on the finished ore stockpiles in preparation for the ship loading season.
- Assumed 80% dust control efficiency for using a telescopic chute for ore loading into the ship holds of the ore carriers.
- Dust control was not applied to fugitive dust emissions from bulldozing, mining equipment movement, including front-end loaders operation at the ore stockpiles at Milne Port, truck loading and unloading and wind erosion of ore stockpiles.
- DPM from diesel combustion exhaust is assumed to have an aerodynamic diameter less than 10 µm (PM_{10}) and 97% to have an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), based on the US EPA NONROAD model (US EPA 2010a).

A.2.2 Negligible Sources of PM Emissions

The following emission sources were considered to result in negligible PM emissions and were therefore not included in the emission inventory for Milne Port:

- Assumed no fugitive dust emissions from the ship loading conveyor transfer points because the transfer points are fully enclosed in the transfer tower, as per Baffinland.
- Aircraft emissions were not modelled, consistent with the FEIS (Baffinland 2012) and the Phase 2 FEIS Addendum (Baffinland 2018a), because aircraft flights are anticipated to be infrequent and short in duration.

A.2.3 Emission Sources

A.2.3.1 Ore Handling, Stockpiling and Ship Loading

Ore shipped from the Mine Site is unloaded at Milne Port and front-end loaders are used to feed fine and lump ore to the fine ore and lump ore stockpiles radial stackers. Approximately 63% (3.8 Mtpa) of the ore shipped to Milne Port is fine ore and approximately 37% (2.2 Mtpa) of the ore is lump ore. Ore stockpiling using radial stackers is continuous throughout the year. During the open water season (July to October), front-end loaders load ore from the fine ore and lump ore stockpiles to the ship loading conveyor and the ship loading conveyor discharge chute loads the ore into a Panamax ship carrier.

Fugitive dust emissions from ore handling, stockpiling and ship loading were calculated based on 6 Mtpa of ore handling, stockpiling and ship loading and the published fugitive dust emission factors and calculation methods for material transfer (US EPA 1995, § 13.2.4).

Assumptions used to estimate emissions include:

- Approximately 63% (63% x 6 Mtpa = 3.8 Mtpa) of the ore shipped to Milne Port is fine ore (less than 6.3 mm) and approximately 37% (37% x 6 Mtpa = 2.2 Mtpa) is lump ore (6.3-32 mm).

- Ship loading to Panamax ore carrier ships occurs during the open water season (4 months, July to October).
- Assumed 80% dust control efficiency for using telescopic chutes for ore loading into the ship holds of the ore carriers.
- Fugitive dust emissions from ore handling, stockpiling and ship loading were modelled as varying emissions by wind speed.
- Fugitive dust control was not applied to PM emissions from haul trucks unloading ore, front-end loaders feeding ore to the stockpiles radial stackers or loading ore to the ship loading conveyor, or ore stockpiling.

A.2.3.2 Bulldozing and Grading

One bulldozer is assumed to operate continuously at the ore stockpiles. Three bulldozers are assumed to operate intermittently, for a total of 6 hours a day, for maintenance of the Tote Road. Five graders are assumed to operate intermittently for 11 hours a day for maintenance of the Tote Road. Fugitive dust emissions from bulldozing and grading were calculated using the published fugitive dust emission factors and calculation methods for bulldozing and grading (US EPA 1995, § 11.9).

Assumptions used to estimate emissions include:

- A load/utilization factor of 58% from the US EPA NONROAD model (US EPA 2010b) was assumed for bulldozing and a load factor of 59% was assumed for grading.
- Assumed average grader speed of 11.4 km/h (as per US EPA 1995, § 11.9, Table 11.9-3)
- Fugitive dust control was not applied to PM emissions from bulldozing at the ore stockpiles.
- Dust control efficiency of 50% was assumed for bulldozing and grading along the Tote Road during summer and the shoulder season (6 months, May to October) based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2020).
- Natural mitigation efficiency of 90% for fugitive dust emissions from bulldozing and grading along the Tote Road was assumed during winter (Golder Associates 2012). Winter is assumed to be 6 months – November to April.

A.2.3.3 Mechanically Generated Dust by Diesel Off-Road Equipment Movement

The off-road diesel equipment (Table 4.4), primarily front-end loaders, generates dust emissions from movement at the ore stockpiles, at the ship loading conveyor and at the general facility area. The ore haul trucks unload ore at Milne Port and front-end loaders are used to feed ore to the fine ore and lump ore stockpiles radial stackers. Front-end loaders load ore from the fine ore and lump ore stockpiles to the ship loading conveyor during the open water season (July to October). Fugitive dust emissions from the front-end loaders' movement were calculated based on the average speed of the loaders while in operation and the published fugitive dust emission factors and calculation methods for unpaved roads (US EPA 1995, § 13.2.2).

Assumptions used to estimate emissions include:

- Six front-end loaders at the ore stockpiles are assumed to operate continuously 20 hours a day. The supporting diesel off-road equipment is assumed to operate intermittently throughout the day, assumed an average of 12 hours a day.
- Six front-end loaders are assumed to operate continuously (20 hours a day) loading ore to the ship loading conveyor during the open water season (4 months, July to October).
- Average operating speed and operating weight for the mining off-road equipment were based on manufacturer specifications for the equipment manufacturer and model.
- Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of mining off-road equipment.
- Fugitive dust control was not applied to PM emissions from mining off-road equipment movement.

A.2.3.4 Haul Road Dust Emissions

Twenty CAT 740B haul trucks with a payload capacity of 40 tonnes were assumed to haul 10% of the ore (10% x 6 Mtpa = 0.6 Mtpa) along the haul road around the ore stockpiles. Fugitive dust emissions from haul trucks travelling on the haul road were calculated using the traffic volume (number of truck round trips per day) and the published fugitive dust emission factors and calculation methods for unpaved roads (US EPA 1995, § 13.2.2).

Assumptions used to estimate emissions include:

- Twenty CAT 740B haul trucks are assumed to operate continuously and haul 0.6 Mtpa of ore along the haul road around the ore stockpiles.
- Dust control efficiency of 75% was assumed on the haul road, corresponding to road watering and application of calcium chloride (US EPA 2006) during summer and the shoulder season, assumed to be 6 months – May to October.
- Natural mitigation efficiency of 90% for fugitive dust emissions was assumed on the haul road during winter (Golder Associates 2012). Winter is assumed to be 6 months – November to April.

A.2.3.5 Tote Road Dust Emissions

The traffic along Tote Road includes ore haul trucks, seasonal (August and September) and year-round fuel tanker trucks, service vehicles, maintenance supporting equipment, passenger buses, passenger vans and pickup trucks (Table 4.2). Fugitive dust emissions from trucks and vehicles travelling on Tote Road were calculated using the traffic volumes (number of round trips per day) and the published fugitive dust emission factors and calculation methods for unpaved roads (US EPA 1995, § 13.2.2).

Assumptions used to estimate emissions include:

- Fifty-seven Western Star 6900 XD ore haul trucks with a payload capacity of 135 tonnes operate continuously and transport 6 Mtpa ore along the Tote Road to Milne Port.

- The ore haul trucks traffic volume along the Tote Road was estimated to be 123 round-trips per day, based on transporting 6 Mtpa ore and the payload capacity of the haul truck (135 tonne) and assuming 360 days of operation per year.
- Dust control efficiency of 50% was assumed along the Tote Road during summer and the shoulder season (6 months, May to October) based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2021).
- Natural mitigation efficiency of 90% for fugitive dust emissions was assumed on Tote Road during winter (Golder Associates 2012). Winter is assumed to be 6 months – November to April.

A.2.3.6 Wind Erosion of Ore Stockpiles

Fugitive dust emissions resulting from wind erosion of the fine ore and lump ore stockpiles were calculated using the surface area of the stockpiles and published wind erosion emission factors and calculation methodology (US EPA 1995, § 13.2.5).

The disturbed area of the fine ore and lump ore stockpiles was assumed to be approximately 10,000 m² corresponding to an active loading area of the radial stacker of 100 m by 100 m. It was assumed that there would be one disturbance per hour at the stockpiles.

Emissions were calculated for the mean wind speed of each of the 6 wind speed categories in the air dispersion model. This approach allowed wind erosion emissions to be modelled as variable emissions by wind speed category. In the calculation of emission factors for each of the wind speed categories, the hourly average wind speeds were corrected to “fastest mile wind” using a correction factor of 1.26 based on the Durst curves (Durst 1960).

Assumptions used to estimate emissions include:

- The threshold friction velocity for the lump ore stockpile was assumed to be 1.02 m/s based on the particle size distribution of lump ore provided by Baffinland and the methodology in Section 13.2.5 of US EPA (1995, § 13.2.5), resulting in a wind erosion threshold mean wind speed of 16.4 m/s.
- The threshold friction velocity for the fine ore stockpile was estimated to be 0.76 m/s based on the particle size distribution of fine ore provided by Baffinland and the methodology in Section 13.2.5 of US EPA (1995, § 13.2.5), resulting in a wind erosion threshold mean wind speed of 13.5 m/s.
- The roughness height for the lump ore stockpile was assumed to be 0.30 cm corresponding to overburden as per Section 13.2.5 of US EPA (1995, § 13.2.5).
- The roughness height for the fine ore stockpile was assumed to be 0.133 cm corresponding to desert flat (Mansell et al. 2006).
- Assumed no wind erosion emissions occur at the finished ore stockpiles because of an application of chemical dust suppressant (DusTreat®) on the finished ore stockpiles in preparation for the ship loading season.

A.2.3.7 Diesel Combustion Exhaust Emissions from Off-Road Equipment

Diesel exhaust (tailpipe) emissions from off-road equipment were calculated using the power rating (hp) of the equipment and the Canadian off-road diesel engine emission standards (ECCC 2005). Emissions were calculated using the emission standard corresponding to the equipment manufacture year (Tier 3, Tier 4) as provided by Baffinland.

Assumptions used to estimate emissions include:

- The off-road diesel equipment operates continuously.
- Emissions for the mining off-road equipment and haul trucks were calculated using the emission standards corresponding to the equipment manufacture year (Tier 3, Tier 4) as provided by Baffinland.
- Power rating (hp) for the off-road diesel equipment was based on manufacturer specifications using the equipment manufacturer and model.
- Running load factors from the US EPA NONROAD model (US EPA 2010b) were used for each type of off-road diesel equipment.
- DPM from diesel combustion exhaust is assumed to have an aerodynamic diameter less than 10 µm (PM_{10}) and 97% to have an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), based on the US EPA NONROAD model (US EPA 2010a).

A.2.3.8 Diesel Combustion Exhaust from Trucks and Vehicles along Tote Road

The traffic along Tote Road includes ore haul trucks, seasonal (August and September) and year-round fuel tanker trucks, service vehicles, supporting maintenance equipment, passenger buses, passenger vans and pickup trucks (Table 4.2). Diesel exhaust (tailpipe) emissions from on-road trucks and vehicles travelling along Tote Road were estimated using emission factors in g/VMT for each truck/vehicle type derived from the US EPA MOVES2014a model (US EPA 2015), the number of vehicle round-trips per day and the length of the Tote Road segment within the Mine Site LAA. MOVES2014a was run for a surrogate state and county in the US (Hill County, Montana) that experiences similar meteorological conditions, for a rural unrestricted road type that best represents Tote Road, for year 2018 to represent current vehicle populations and emission standards, for winter to represent maximum exhaust emissions and with fuel formulations specific to Canada.

Assumptions used to estimate emissions include:

- A representative manufacturer/model was assumed for each type of truck/vehicle.
- Engine power (hp), GVWR (tonne) and payload capacity (tonne) were based on manufacturer specifications using the equipment manufacturer and model.
- Fifty-seven Western Star 6900 XD ore haul trucks with a payload capacity of 135 tonnes operate continuously and transport 6 Mtpa ore along the Tote Road to Milne Port.

- The ore haul trucks traffic volume along the Tote Road was estimated to be 123 round-trips per day, based on transporting 6 Mtpa ore and the payload capacity of the haul truck (135 tonne) and assuming 360 days of operation per year.
- Service vehicle traffic is based on 250 trips/week from the Phase 2 Key Facts Table (Baffinland 2018b).
- DPM from diesel combustion exhaust is assumed to have an aerodynamic diameter less than 10 µm (PM_{10}) and 97% to have an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), based on the US EPA NONROAD model (US EPA 2010a).

A.2.3.9 Power Generation

Seven 1.32 MW stationary diesel power generators operate at Milne Port. The PM emissions for the stationary diesel power generators were scaled from the emissions estimated for the Phase 2 FEIS Addendum (Baffinland 2018a) based on the ratio of engine power (hp). The emissions in the previous air quality assessment were calculated based on the power rating (hp) and the manufacturer specifications for generator model Cummins QSK50-G5 NR2 (1.32 MW).

Assumptions used to estimate emissions include:

- Milne Port has seven 1.32 MW stationary diesel power generators.
- DPM emissions were calculated based on manufacturer emission specifications for generator model Cummins QSK50-G5 NR2 (1.32 MW).
- Stack parameters (height, diameter, exit velocity and temperature) were provided by Baffinland.
- DPM from the stationary diesel generators was assumed to be 100% $PM_{2.5}$.

A.2.3.10 Ore Carrier Ships

Shipment of 6 Mtpa ore from Milne Port will occur during the open water season (July to October). Diesel combustion exhaust emissions from the ore carriers were taken from the 2018 air quality assessment (RWDI 2018) for the Phase 2 FEIS Addendum (Baffinland 2018a). Diesel combustion exhaust emissions from the ships were calculated based on the International Maritime Organization (IMO) Tier 1 emission standards (IMO 1997).

Assumptions used to estimate emissions include:

- Panamax vessels with a capacity of 70,000 dry weight tonnes and Capesize vessels with a capacity of 230,000 dry weight tonnes will ship 6 Mtpa ore to market.
- Each ship is equipped with one 0.75 MW hoteling power generator.
- The Panamax ship has a 13 MW engine.
- Three ships can be anchored simultaneously while operating hoteling power generators.
- Each vessel will sail in open water at 13 knots.
- Ships in transit were modelled as a series of 20 points along the transit path.

- Stack parameters are approximate based on similar size equipment.
- Ships at port, at anchor and in transit operate only during the open water season (July to October).
- Ships at port and at anchor were assumed to operate continuously during the open water season, while ships in transit were assumed to operate for 8 hours per day within the Milne Port FLA.

A.2.3.11 Tugboats

Three tugboats are assumed to operate continuously during the open water season (July to October). Diesel combustion exhaust (tailpipe) emissions from the tugboats were taken from the 2018 air quality assessment (RWDI 2018) for the Phase 2 FEIS Addendum (Baffinland 2018a). Diesel combustion exhaust emissions from the tugboats were based on the IMO Tier 1 emission standards (IMO 1997).

Assumptions used to estimate emissions include:

- Three tugboats with a 3 MW engine operate continuously during the open water season (July to October).
- Tugboats were modelled as a grid of 4 by 4-point sources in the anticipated area of operation at Milne Inlet.
- Stack parameters are approximate based on similar size equipment.

Table A.1 Particulate Matter Emissions from Off-Road Diesel Equipment

Equipment Specifications											CAC Emission Factors			Daily Emission Rates (g/s)					
Activity and Equipment Description	Manufacturer	Model	Number of Units	Engine Power	Operating Hours per Day	Operating Days per year	BSFC	Fuel Consumption (Calculated)	Load Factor	Emission Standard Tier	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
			#	hp	h/d	d/y	lb fuel/hp-hr	L/h	%	Tier 3/4	g/hp-hr	g/hp-hr	g/hp-hr	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																			
Open Pit																			
Production Blasthole Drill	Atlas Copco	Pit Vipers	2	1,150	20	310	0.367	227	43%	Tier 4	0.03	0.03	0.03	0.0069	0.0069	0.0067	—	—	—
Support Drills	Atlas Copco	D65	2	403	20	360	0.367	79	43%	Tier 3	0.15	0.15	0.15	0.0120	0.0120	0.0117	—	—	—
Hydraulic Shovel	Caterpillar	CAT 6060 FS	1	3,000	20	360	0.367	591	53%	Tier 4	0.03	0.03	0.03	0.0110	0.0110	0.0107	—	—	—
Wheel Front End Loader	Caterpillar	CAT 994K	1	1,847	20	360	0.367	364	48%	Tier 4	0.03	0.03	0.03	0.0062	0.0062	0.0060	—	—	—
Wheel Front End Loader	Caterpillar	CAT 992K	2	900	20	360	0.367	177	48%	Tier 3	0.15	0.15	0.15	0.0300	0.0300	0.0291	—	—	—
Wheel Front End Loader	Caterpillar	CAT 950K	1	211	20	360	0.367	42	48%	Tier 3	0.15	0.15	0.15	0.0035	0.0035	0.0034	—	—	—
Track Dozer	Caterpillar	CAT D10	3	600	20	360	0.367	118	58%	Tier 4	0.02	0.02	0.01	0.0036	0.0036	0.0035	—	—	—
Waste and ROM Stockpiles																			
Track Dozer	Caterpillar	CAT D9	3	452	20	360	0.367	89	58%	Tier 3	0.15	0.15	0.15	0.0273	0.0273	0.0265	—	—	—
Haul Roads																			
Grader	Caterpillar	CAT 16H	1	285	20	360	0.367	56	59%	Tier 3	0.15	0.15	0.15	0.0058	0.0058	0.0057	—	—	—
Grader	Caterpillar	CAT 16M	2	290	20	360	0.367	57	59%	Tier 3	0.15	0.15	0.15	0.0119	0.0119	0.0115	—	—	—
Hydraulic Excavator	Caterpillar	CAT 374F	2	485	20	360	0.367	96	53%	Tier 4	0.02	0.02	0.01	0.0018	0.0018	0.0017	—	—	—
Ore Haul Truck	Caterpillar	CAT 793	7	2,650	20	360	0.367	522	59%	Tier 3	0.15	0.15	0.15	0.3800	0.3800	0.3686	—	—	—
Crushing Facility																			
Wheel Front End Loader	Caterpillar	CAT 988H	4	580	20	360	0.367	114	48%	Tier 3	0.15	0.15	0.15	0.0387	0.0387	0.0375	—	—	—
Wheel Front End Loader	Caterpillar	CAT 950H	1	200	20	360	0.367	39	48%	Tier 3	0.15	0.15	0.15	0.0033	0.0033	0.0032	—	—	—
Wheel Front End Loader	Caterpillar	CAT 930H	1	149	20	360	0.367	29	48%	Tier 3	0.22	0.22	0.21	0.0036	0.0036	0.0035	—	—	—
Wheel Front End Loader	Caterpillar	CAT 992K	2	900	20	360	0.367	177	48%	Tier 3	0.15	0.15	0.15	0.0300	0.0300	0.0291	—	—	—
Wheel Front End Loader	Caterpillar	CAT 908	1	74	20	360	0.408	16	48%	Tier 3	0.30	0.30	0.29	0.0025	0.0025	0.0024	—	—	—
Hydraulic Excavator	Caterpillar	CAT 345	1	345	20	360	0.367	68	53%	Tier 3	0.15	0.15	0.15	0.0063	0.0063	0.0062	—	—	—
Track Dozer	Caterpillar	CAT D9	1	452	20	360	0.367	89	58%	Tier 3	0.15	0.15	0.15	0.0091	0.0091	0.0088	—	—	—
Skid Steer	Caterpillar	CAT 289D	4	74	20	360	0.408	16	59%	Tier 3	0.30	0.30	0.29	0.0122	0.0122	0.0118	—	—	—
Supporting Equipment																			
Container Handler - Rough Terrain	Kalmar	RT240	1	400	12	360	0.367	79	59%	Tier 3	0.15	0.15	0.15	0.0049	0.0049	0.0048	—	—	—
Grader	Caterpillar	CAT 14M	1	259	12	360	0.367	51	59%	Tier 3	0.15	0.15	0.15	0.0032	0.0032	0.0031	—	—	—
Telehandler	Caterpillar	CAT TL1055D	4	142	12	360	0.367	28	59%	Tier 3	0.22	0.22	0.21	0.0102	0.0102	0.0099	—	—	—
Wheel Front End Loader	Caterpillar	CAT 950K	1	211	12	360	0.367	42	48%	Tier 3	0.15	0.15	0.15	0.0021	0.0021	0.0020	—	—	—
Wheel Front End Loader	Caterpillar	CAT 930H	2	149	12	360	0.367	29	48%	Tier 3	0.22	0.22	0.21	0.0044	0.0044	0.0042	—	—	—
Wheel Front End Loader	Caterpillar	CAT 988H	1	580	12	360	0.367	114	48%	Tier 3	0.15	0.15	0.15	0.0058	0.0058	0.0056	—	—	—
Articulated Truck	Caterpillar	CAT 740B	3	489	12	360	0.367	96	59%	Tier 3	0.15	0.15	0.15	0.0180	0.0180	0.0175	—	—	—
Hydraulic Excavator	Caterpillar	CAT 345	1	345	12	360	0.367	68	53%	Tier 3	0.15	0.15	0.15	0.0038	0.0038	0.0037	—	—	—
Frost Fighters	Frost Fighter	DX1500	100	1	12	180	0.408	0.219	43%	Tier 3	0.15	0.15	0.15	0.0009	0.0009	0.0009	—	—	—
Tote Road																			
Grader	Caterpillar	CAT 14M	5	259	11	360	0.367	51	59%	Tier 3	0.15	0.15	0.15	0.0146	0.0146	0.0142	—	—	—
Track Dozer	Caterpillar	CAT D6	3	215	6	360	0.367	42	58%	Tier 3	0.15	0.15	0.15	0.0039	0.0039	0.0038	—	—	—
Hydraulic Excavator	Caterpillar	CAT 345	2	345	2	360	0.367	68	53%	Tier 3	0.15	0.15	0.15	0.0013	0.0013	0.0012	—	—	—
Wheel Excavator	Caterpillar	CAT M320	1	174	2	360	0.367	34	53%	Tier 3	0.22	0.22	0.21	0.0005	0.0005	0.0005	—	—	—
Wheel Front End Loader	Caterpillar	CAT 950H	2	200	2	360	0.367	39	48%	Tier 3	0.15	0.15	0.15	0.0007	0.0007	0.0006	—	—	—
Wheel Front End Loader	Caterpillar	CAT 988H	2	580	2	360	0.367	114	48%	Tier 3	0.15	0.15	0.15	0.0019	0.0019	0.0019	—	—	—
Articulated Truck	Caterpillar	CAT 740B	3	489	2	360	0.367	96	59%	Tier 3	0.15	0.15	0.15	0.0034	0.0034	0.0033	—	—	—
Milne Port																			
Primary Equipment																			
Wheel Front End Loader	Caterpillar	CAT 988K	4	580	20	120	0.367	114	48%	Tier 3	0.15	0.15	0.15	0.0387	0.0387	0.0375	—	—	—
Wheel Front End Loader	Caterpillar	CAT 950H	1	200	20	360	0.367	39	48%	Tier 3	0.15	0.15	0.15	0.0033	0.0033	0.0032	—	—	—
Wheel Front End Loader	Caterpillar	CAT 930H	1	149	20	360	0.367	29	48%	Tier 3	0.22	0.22	0.21	0.0036	0.0036	0.0035	—	—	—
Track Dozer	Caterpillar	CAT D9	1	452	20	360	0.367	89	58%	Tier 3	0.15	0.15	0.15	0.0091	0.0091	0.0088	—	—	—
Skid Steer	Caterpillar	CAT 289D	2	74	20	360	0.408	16	59%	Tier 3	0.30	0.30	0.29	0.0061	0.0061	0.0059	—	—	—
Hydraulic Excavator	Caterpillar	CAT 374F	1	485	20	360	0.367	96	53%	Tier 4	0.02	0.02	0.01	0.0009	0.0009	0.0009	—	—	—
Hydraulic Excavator	Caterpillar	CAT 320GC	1	164	20	360	0.367	32	53%	Tier 3	0.22	0.22	0.21	0.0044	0.0044	0.0043	—	—	—
Haul Road																			
Articulated Truck	Caterpillar	CAT 740B	20	489	20	360	0.367	96	59%	Tier 3	0.15	0.15	0.15	0.2004	0.2004	0.1943	—	—	—
Supporting Equipment																			
Container Handler - Rough Terrain	Kalmar	RT240	1	400	12	360	0.367	79	59%	Tier 3	0.15	0.15	0.15	0.0049	0.0049	0.0048	—	—	—

Table A.1 Particulate Matter Emissions from Off-Road Diesel Equipment

Equipment Specifications											CAC Emission Factors			Daily Emission Rates (g/s)					
Activity and Equipment Description	**Manufacturer**	**Model**	**Number of Units**	**Engine Power**	**Operating Hours per Day**	**Operating Days per year**	**BSFC**	**Fuel Consumption (Calculated)**	**Load Factor**	**Emission Standard Tier**	**TSP**	**PM10**	**PM2.5**	**EPM30**	**EPM10**	**EPM2.5**	**FPM30**	**FPM10**	**FPM2.5**
			#	**hp**	**h/d**	**d/y**	**lb fuel/hp-hr**	**L/h**	**%**	**Tier 3/4**	g/hp-hr	g/hp-hr	g/hp-hr	g/s	g/s	g/s	g/s	g/s	g/s
Telehandler	Caterpillar	CAT TL1055D	2	142	12	360	0.367	28	59%	Tier 3	0.22	0.22	0.21	0.0051	0.0051	0.0050	—	—	—
Skid Steer	Caterpillar	CAT 289D	2	74	12	360	0.408	16	59%	Tier 3	0.30	0.30	0.29	0.0037	0.0037	0.0035	—	—	—
Wheel Front End Loader	Caterpillar	CAT 930H	1	149	12	360	0.367	29	48%	Tier 3	0.22	0.22	0.21	0.0022	0.0022	0.0021	—	—	—
Articulated Truck	Caterpillar	CAT 740B	1	489	12	360	0.367	96	59%	Tier 3	0.15	0.15	0.15	0.0060	0.0060	0.0058	—	—	—
Frost Fighters	Frost Fighter	DX1500	100	1	12	180	0.408	0	43%	Tier 3	0.15	0.15	0.15	0.0009	0.0009	0.0009	—	—	—
Tote Road																			
Grader	Caterpillar	CAT 14M	5	259	11	360	0.367	51	59%	Tier 3	0.15	0.15	0.15	0.0146	0.0146	0.0142	—	—	—
Track Dozer	Caterpillar	CAT D6	3	215	6	360	0.367	42	58%	Tier 3	0.15	0.15	0.15	0.0039	0.0039	0.0038	—	—	—
Hydraulic Excavator	Caterpillar	CAT 345	2	345	2	360	0.367	68	53%	Tier 3	0.15	0.15	0.15	0.0013	0.0013	0.0012	—	—	—
Wheel Excavator	Caterpillar	CAT M320	1	174	2	360	0.367	34	53%	Tier 3	0.22	0.22	0.21	0.0005	0.0005	0.0005	—	—	—
Wheel Front End Loader	Caterpillar	CAT 950H	2	200	2	360	0.367	39	48%	Tier 3	0.15	0.15	0.15	0.0007	0.0007	0.0006	—	—	—
Wheel Front End Loader	Caterpillar	CAT 988H	2	580	2	360	0.367	114	48%	Tier 3	0.15	0.15	0.15	0.0019	0.0019	0.0019	—	—	—
Articulated Truck	Caterpillar	CAT 740B	3	489	2	360	0.367	96	59%	Tier 3	0.15	0.15	0.15	0.0034	0.0034	0.0033	—	—	—
Total Emissions								**5,128**						**1.001**	**1.001**	**0.971**	**0.000**	**0.000**	**0.000**
Mine Site Emissions								**3,921**						**0.685**	**0.685**	**0.665**	**0.000**	**0.000**	**0.000**
Milne Port Emissions								**1,207**						**0.316**	**0.316**	**0.306**	**0.000**	**0.000**	**0.000**

Table A.2 Fugitive Dust Emissions from Mining Off-Road Equipment Movement

Equipment Specifications										Pit Retention/Dust Control			CAC Emission Factors			Daily Emission Rates (g/s)					
Activity and Equipment Description	Manufacturer	Model	Number of Equipment	Engine Power	Operating Hours per Day	Operating Days per year	Load Factor	Average Speed	Operating Weight	TSP	PM10	PM2.5	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
			#	hp	h/d	d/y	%	km/h	tonne	%	%	%	lb/VMT	lb/VMT	lb/VMT	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																					
Open Pit																					
Hydraulic Shovel	Caterpillar	CAT 6060 FS	1	3,000	20	360	53%	2.0	570	50%	5%	2%	30.23	7.83	0.78				1.046	0.514	0.053
Wheel Front End Loader	Caterpillar	CAT 994K	1	1,847	20	360	48%	12.9	240	50%	5%	2%	20.48	5.30	0.53				4.138	2.036	0.210
Wheel Front End Loader	Caterpillar	CAT 992K	2	900	20	360	48%	12.9	100	50%	5%	2%	13.81	3.58	0.36				5.581	2.746	0.283
Wheel Front End Loader	Caterpillar	CAT 950K	1	211	20	360	48%	12.9	19.4	50%	5%	2%	6.60	1.71	0.17				1.334	0.657	0.068
Waste and ROM Stockpiles																					
Haul Roads																					
Hydraulic Excavator	Caterpillar	CAT 374F	2	485	20	360	53%	4.1	73	75%	75%	75%	11.99	3.10	0.31				0.850	0.220	0.022
Crushing Facility																					
Wheel Front End Loader	Caterpillar	CAT 988H	4	580	20	360	48%	12.5	51	—	—	—	10.20	2.64	0.26				15.978	4.138	0.414
Wheel Front End Loader	Caterpillar	CAT 950H	1	200	20	360	48%	12.7	20	—	—	—	6.70	1.73	0.17				2.663	0.690	0.069
Wheel Front End Loader	Caterpillar	CAT 930H	1	149	20	360	48%	12.3	13.029	—	—	—	5.52	1.43	0.14				2.127	0.551	0.055
Wheel Front End Loader	Caterpillar	CAT 992K	2	900	20	360	48%	12.9	100.6	—	—	—	13.85	3.59	0.36				11.193	2.899	0.290
Wheel Front End Loader	Caterpillar	CAT 908	1	74	20	360	48%	20.0	7.3	—	—	—	4.25	1.10	0.11				2.665	0.690	0.069
Hydraulic Excavator	Caterpillar	CAT 345	1	345	20	360	53%	4.4	48.96	—	—	—	10.02	2.59	0.26				1.524	0.395	0.039
Skid Steer	Caterpillar	CAT 289D	4	74	20	360	59%	11.3	4.8	—	—	—	3.52	0.91	0.09				6.130	1.588	0.159
Supporting Equipment																					
Container Handler - Rough Terrain	Kalmar	RT240	1	400	12	360	59%	24.0	53.8	—	—	—	10.45	2.71	0.27				5.794	1.501	0.150
Telehandler	Caterpillar	CAT TL1055D	4	142	12	360	59%	20.0	14.46	—	—	—	5.79	1.50	0.15				10.693	2.769	0.277
Wheel Front End Loader	Caterpillar	CAT 950K	1	211	12	360	48%	12.9	19.4	—	—	—	6.60	1.71	0.17				1.601	0.415	0.041
Wheel Front End Loader	Caterpillar	CAT 930H	2	149	12	360	48%	12.3	13.029	—	—	—	5.52	1.43	0.14				2.552	0.661	0.066
Wheel Front End Loader	Caterpillar	CAT 988H	1	580	12	360	48%	12.5	51	—	—	—	10.20	2.64	0.26				2.397	0.621	0.062
Hydraulic Excavator	Caterpillar	CAT 345	1	345	12	360	53%	4.4	48.96	—	—	—	10.02	2.59	0.26				0.915	0.237	0.024
Tote Road																					
Hydraulic Excavator	Caterpillar	CAT 345	2	345	2	360	53%	4.4	48.96	50%	50%	50%	10.02	2.59	0.26				0.152	0.039	0.004
Wheel Excavator	Caterpillar	CAT M320	1	174	2	360	53%	30.0	21.2	50%	50%	50%	6.87	1.78	0.18				0.357	0.092	0.009
Wheel Front End Loader	Caterpillar	CAT 950H	2	200	2	360	48%	12.7	20	50%	50%	50%	6.70	1.73	0.17				0.266	0.069	0.007
Wheel Front End Loader	Caterpillar	CAT 988H	2	580	2	360	48%	12.5	51	50%	50%	50%	10.20	2.64	0.26				0.399	0.103	0.010
Milne Port																					
Primary Equipment																					
Wheel Front End Loader	Caterpillar	CAT 988K	4	580	20	120	48%	12.5	51	—	—	—	10.20	2.64	0.26				15.978	4.138	0.414
Wheel Front End Loader	Caterpillar	CAT 950H	1	200	20	360	48%	12.7	20	—	—	—	6.70	1.73	0.17				2.663	0.690	0.069
Wheel Front End Loader	Caterpillar	CAT 930H	1	149	20	360	48%	12.3	13.029	—	—	—	5.52	1.43	0.14				2.127	0.551	0.055
Skid Steer	Caterpillar	CAT 289D	2	74	20	360	59%	11.3	4.8	—	—	—	3.52	0.91	0.09				3.065	0.794	0.079
Hydraulic Excavator	Caterpillar	CAT 374F	1	485	20	360	53%	4.1	73	—	—	—	11.99	3.10	0.31				1.700	0.440	0.044
Hydraulic Excavator	Caterpillar	CAT 320GC	1	164	20	360	53%	5.7	22.5	—	—	—	7.06	1.83	0.18				1.392	0.360	0.036
Haul Road																					
Supporting Equipment																					
Container Handler - Rough Terrain	Kalmar	RT240	1	400	12	360	59%	24.0	53.8	—	—	—	10.45	2.71	0.27				5.794	1.501	0.150
Telehandler	Caterpillar	CAT TL1055D	2	142	12	360	59%	15.0	14.46	—	—	—	5.79	1.50	0.15				4.010	1.038	0.104
Skid Steer	Caterpillar	CAT 289D	2	74	12	360	59%	11.3	4.8	—	—	—	3.52	0.91	0.09				1.839	0.476	0.048
Wheel Front End Loader	Caterpillar	CAT 930H	1	149	12	360	48%	12.3	13.029	—	—	—	5.52	1.43	0.14				1.276	0.331	0.033
Tote Road																					
Hydraulic Excavator	Caterpillar	CAT 345	2	345	2	360	53%	4.4	48.96	50%	50%	50%	10.02	2.59	0.26				0.152	0.039	0.004
Wheel Excavator	Caterpillar	CAT M320	1	174	2	360	53%	30.0	21.2	50%	50%	50%	6.87	1.78	0.18				0.357	0.092	0.009
Wheel Front End Loader	Caterpillar	CAT 950H	2	200	2	360	48%	12.7	20	50%	50%	50%	6.70	1.73	0.17				0.266	0.069	0.007
Wheel Front End Loader	Caterpillar	CAT 988H	2	580	2	360	48%	12.5	51	50%	50%	50%	10.20	2.64	0.26				0.399	0.103	0.010
Total Emissions																**0.000**	**0.000**	**0.000**	**121.376**	**34.254**	**3.444**
Mine Site Emissions																**0.000**	**0.000**	**0.000**	**80.357**	**23.631**	**2.382**
Milne Port Emissions																**0.000**	**0.000**	**0.000**	**41.019**	**10.623**	**1.062**

Table A.3 Fugitive Dust Emissions from Bulldozing

Equipment Specifications								Pit Retention/Dust Control			CAC Emission Factors			Daily Emission Rates (g/s)					
Activity and Equipment Description	Manufacturer	Model	Number of Equipment	Engine Power	Operating Hours per Day	Operating Days per year	Load Factor	TSP	PM10	PM2.5	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
			#	hp	h/d	d/y	%	%	%	%	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																			
Open Pit																			
Track Dozer	Caterpillar	CAT D10	3	600	20	360	58%	50%	5%	2%	2.88	0.37	0.30				0.263	0.065	0.054
Waste and ROM Stockpiles																			
Track Dozer	Caterpillar	CAT D9	3	452	20	360	58%	—	—	—	2.88	0.37	0.30				0.526	0.068	0.055
Haul Roads																			
Crushing Facility																			
Track Dozer	Caterpillar	CAT D9	1	452	20	360	58%	—	—	—	2.88	0.37	0.30				0.175	0.023	0.018
Supporting Equipment																			
Tote Road																			
Track Dozer	Caterpillar	CAT D6	3	215	6	360	58%	50%	50%	50%	2.88	0.37	0.30				0.079	0.010	0.008
Milne Port																			
Primary Equipment																			
Track Dozer	Caterpillar	CAT D9	1	452	20	360	58%	—	—	—	2.88	0.37	0.30				0.175	0.023	0.018
Haul Road																			
Supporting Equipment																			
Tote Road																			
Track Dozer	Caterpillar	CAT D6	3	215	6	360	58%	50%	50%	50%	2.88	0.37	0.30				0.079	0.010	0.008
Total Emissions														**0.000**	**0.000**	**0.000**	**1.298**	**0.199**	**0.163**
Mine Site Emissions														**0.000**	**0.000**	**0.000**	**1.044**	**0.166**	**0.136**
Milne Port Emissions														**0.000**	**0.000**	**0.000**	**0.254**	**0.033**	**0.027**

Table A.4 Fugitive Dust Emissions from Grading

Equipment Specifications										Pit Retention/Dust Control			CAC Emission Factors			Daily Emission Rates (g/s)					
Activity and Equipment Description	Manufacturer	Model	Number of Equipment	Engine Power	Operating Hours per Day	Operating Days per year	Load Factor	Average Speed	Operating Weight	TSP	PM10	PM2.5	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
			#	hp	h/d	d/y	%	km/h	tonne	%	%	%	lb/VMT	lb/VMT	lb/VMT	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																					
Open Pit																					
Waste and ROM Stockpiles																					
Haul Roads																					
Grader	Caterpillar	CAT 16H	1	285	20	360	59%	11.4	24.7	75%	75%	75%	5.33	1.53	0.17				0.585	0.168	0.018
Grader	Caterpillar	CAT 16M	2	290	20	360	59%	11.4	30.6	75%	75%	75%	5.33	1.53	0.17				1.171	0.337	0.036
Crushing Facility																					
Supporting Equipment																					
Grader	Caterpillar	CAT 14M	1	259	12	360	59%	11.4	21.2	—	—	—	5.33	1.53	0.17				1.405	0.404	0.044
Tote Road																					
Grader	Caterpillar	CAT 14M	5	259	11	360	59%	11.4	21.2	50%	50%	50%	5.33	1.53	0.17				3.219	0.926	0.100
Milne Port																					
Primary Equipment																					
Haul Road																					
Supporting Equipment																					
Tote Road																					
Grader	Caterpillar	CAT 14M	5	259	11	360	59%	11.4	21.2	50%	50%	50%	5.33	1.53	0.17				3.219	0.926	0.100
Total Emissions																**0.000**	**0.000**	**0.000**	**9.598**	**2.760**	**0.298**
Mine Site Emissions																**0.000**	**0.000**	**0.000**	**6.379**	**1.834**	**0.198**
Milne Port Emissions																**0.000**	**0.000**	**0.000**	**3.219**	**0.926**	**0.100**

Table A.5 Fugitive Dust Emissions from Drilling and Blasting

Process Specifications							Pit Retention			CAC Emission Factors			Daily Emission Rates (g/s)					
Activity Description	Number of Holes		Blasted Area	ANFO Usage	Operating Hours per Day	Operating Days per Year	TSP	PM10	PM2.5	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
	per blast	per hour	m²	kg/hole	h/d	d/y	%	%	%	kg/hole (kg/blast)	kg/hole (kg/blast)	kg/hole (kg/blast)	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																		
Open Pit																		
Blasthole Drilling	800	4	—	—	20	360	50%	5%	2%	0.59	0.31	0.31				0.273	0.273	0.281
Blasting	—	—	18,500	—	0.143	52	50%	5%	2%	553.58	287.86	16.61				76.886	75.963	4.521
Total Emissions													**0.000**	**0.000**	**0.000**	**77.159**	**76.236**	**4.802**
Mine Site Emissions													**0.000**	**0.000**	**0.000**	**77.159**	**76.236**	**4.802**
Milne Port Emissions													**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Table A.6 Fugitive Dust Emissions from Primary and Secondary Crushers

Process Specifications						Dust Control			CAC Emission Factors			Daily Emission Rates (g/s)					
Activity Description	Operating Hours per Day	Operating Days per year	Material Transfer Rate			TSP	PM10	PM2.5	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
	h/d	d/y	Mtpa	t/d	t/h	%	%	%	kg/Mg	kg/Mg	kg/Mg	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																	
Primary Crushers																	
Primary Crusher A	20	360	2.2	6,167	308	—	—	—	0.0027	0.0012	0.00005				0.193	0.086	0.004
Primary Crusher B	20	360	1.9	5,250	263	—	—	—	0.0027	0.0012	0.00005				0.164	0.073	0.003
Primary Crusher C	20	360	1.9	5,250	263	—	—	—	0.0027	0.0012	0.00005				0.164	0.073	0.003
Secondary Crushers																	
Secondary Crusher B	20	360	1.9	5,250	263	—	—	—	0.0027	0.0012	0.00005				0.164	0.073	0.003
Secondary Crusher C	20	360	1.9	5,250	263	—	—	—	0.0027	0.0012	0.00005				0.164	0.073	0.003
Milne Port																	
Total Emissions												**0.000**	**0.000**	**0.000**	**0.849**	**0.377**	**0.016**
Mine Site Emissions												**0.000**	**0.000**	**0.000**	**0.849**	**0.377**	**0.016**
Milne Port Emissions												**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Table A.7 Fugitive Dust Emissions from Material Transfer

Process Specifications										Pit Retention/Dust Control			CAC Emission Factors			Daily Emission Rates (g/s)					
Activity Description	Truck Description	Manufacturer	Model	Number of Equipment	Operating Hours per Day	Operating Days per year	Material Transfer Rate			TSP	PM10	PM2.5	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
				#	h/d	d/y	Mtpa	t/d	t/h	%	%	%	kg/tonne	kg/tonne	kg/tonne	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																					
Open Pit																					
Truck Loading in Open Pit (ROM ore + Waste Rock)	Ore Haul Truck	Caterpillar	CAT 793	7	20	360	9.4	26,111	1,306	50%	5%	2%	2.39E-03	1.13E-03	1.71E-04				0.362	0.325	0.051
Waste Rock Stockpile																					
Truck Unloading at Waste Rock Stockpile	Ore Haul Truck	Caterpillar	CAT 793	2.1	20	360	3.4	9,444	472	—	—	—	2.39E-03	1.13E-03	1.71E-04				0.262	0.124	0.019
ROM Stockpile																					
Truck Unloading at ROM Stockpile	Ore Haul Truck	Caterpillar	CAT 793	0.15	20	360	0.2	500	25	—	—	—	2.39E-03	1.13E-03	1.71E-04				0.014	0.007	0.001
Crushing Facility																					
Truck Unloading at Crushing Facility	Ore Haul Truck	Caterpillar	CAT 793	4.9	20	360	6	16,667	833	—	—	—	2.39E-03	1.13E-03	1.71E-04				0.462	0.218	0.033
FEL Loading/Unloading Ore at Primary Crushers	—	—	—	—	20	360	12	33,333	1,667	—	—	—	2.39E-03	1.13E-03	1.71E-04				0.924	0.437	0.066
Crusher A (9 Transfer Points)	—	—	—	—	20	360	20	55,500	2,775	—	—	—	4.56E-03	2.15E-03	3.26E-04				2.926	1.384	0.210
Crusher B (11 Transfer Points)	—	—	—	—	20	360	21	57,750	2,888	—	—	—	1.15E-03	5.46E-04	8.26E-05				0.771	0.365	0.055
Crusher C (11 Transfer Points)	—	—	—	—	20	360	21	57,750	2,888	—	—	—	1.15E-03	5.46E-04	8.26E-05				0.771	0.365	0.055
Radial Stacker to Fine Ore Stockpile (3 Transfer Points)	—	—	—	—	20	360	10	28,350	1,418	—	—	—	1.15E-03	5.46E-04	8.26E-05				0.379	0.179	0.027
FEL Loading/Unloading Ore to Fine/Lump Ore Stockpiles	—	—	—	—	20	360	12	33,333	1,667	—	—	—	2.39E-03	1.13E-03	1.71E-04				0.924	0.437	0.066
Milne Port																					
Fine Ore Stockpile																					
Truck Unloading at Fine Ore Stockpile	Ore Haul Truck	Western Star 6900XD	6900 XD	36	20	360	3.8	10,500	525	—	—	—	7.12E-04	3.37E-04	5.10E-05				0.087	0.041	0.006
FEL Loading/Unloading Ore to Fine Ore Stockpile	—	—	—	—	20	360	7.6	21,000	1,050	—	—	—	7.12E-04	3.37E-04	5.10E-05				0.173	0.082	0.012
Radial Stacker to Fine Ore Stockpile (2 Transfer Points)	—	—	—	—	20	360	7.6	21,000	1,050	—	—	—	7.12E-04	3.37E-04	5.10E-05				0.173	0.082	0.012
Lump Ore Stockpile																					
Truck Unloading at Lump Ore Stockpile	Ore Haul Truck	Western Star 6900XD	6900 XD	21	20	360	2.2	6,167	308	—	—	—	2.81E-03	1.33E-03	2.01E-04				0.201	0.095	0.014
FEL Loading/Unloading Ore to Lump Ore Stockpile	—	—	—	—	20	360	4.4	12,333	617	—	—	—	2.81E-03	1.33E-03	2.01E-04				0.402	0.190	0.029
Radial Stacker to Lump Ore Stockpile (2 Transfer Points)	—	—	—	—	20	360	4.4	12,333	617	—	—	—	2.81E-03	1.33E-03	2.01E-04				0.402	0.190	0.029
Ore Shiploader Conveyor																					
FEL Loading/Unloading Ore to Shiploader Conveyor (2 Transfer Points)	—	—	—	—	20	120	12	100,000	5,000	—	—	—	1.48E-03	6.99E-04	1.06E-04				1.711	0.809	0.123
Shiploader discharge chute on Panamax ship	—	—	—	—	20	120	6	50,000	2,500	80%	80%	80%	1.48E-03	6.99E-04	1.06E-04				0.171	0.081	0.012
Total Emissions																**0.000**	**0.000**	**0.000**	**11.112**	**5.410**	**0.821**
Mine Site Emissions																**0.000**	**0.000**	**0.000**	**7.794**	**3.840**	**0.583**
Milne Port Emissions																**0.000**	**0.000**	**0.000**	**3.319**	**1.570**	**0.238**

Table A.8 Fugitive Dust Emissions from Unpaved Roads

Equipment Specifications																Pit Retention			CAC Emission Factors			Daily Emission Rates (g/s) - with Summer Control Efficiency					
Haul Road	Road Length	Truck Description	Manufacturer	Model	Number of Equipment	Operating Hours per Day	Operating Days per year	GVWR	Payload Capacity	Hauled Material		Number of Round Trips		Summer Control Efficiency	Winter Natural Mitigation Efficiency	TSP	PM10	PM2.5	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
	km				#	h/d	d/y	tonne	tonne	Mtpa	t/d	trips/d	trips/h	%	%	%	%	%	lb/VMT	lb/VMT	lb/VMT	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																											
Haul Roads																											
Haul Road in Open Pit	1.000	Ore Haul Truck	Caterpillar	CAT 793	7	20	360	386	231	9.4	26,111	113	5.7	75%	90%	50%	5%	2%	21.62	5.60	0.56				1.993	0.981	0.101
Haul Road from Open Pit to Waste Rock Stockpile	2.382	Ore Haul Truck	Caterpillar	CAT 793	2	20	360	386	231	3.4	9,444	41	2.0	75%	90%	—	—	—	21.62	5.60	0.56				3.434	0.889	0.089
Haul Road from Open Pit to Crushing Facility	6.302	Ore Haul Truck	Caterpillar	CAT 793	5	20	360	386	231	6	16,667	72	3.6	75%	90%	—	—	—	21.62	5.60	0.56				16.034	4.152	0.415
Haul Road at Crushing Facility	0.200	Ore Haul Truck	Caterpillar	CAT 793	5	20	360	386	231	6	16,667	72	3.6	75%	90%	—	—	—	21.62	5.60	0.56				0.509	0.132	0.013
General Facility Area																											
Maintenance, Fuel/Lube, Mechanics, Service Trucks	2.000	Maintenance, Fuel/Lube, Mechanics, Service Trucks	Peterbilt 357 with CAT C11	357	16	20	360	30	—	—	—	32	1.6	75%	90%	—	—	—	8.04	2.08	0.21				0.839	0.217	0.022
Articulated Trucks	2.000	Articulated Truck	Caterpillar	CAT 740B	3	12	360	74	39.5	—	—	36	3.0	75%	90%	—	—	—	10.49	2.72	0.27				1.232	0.319	0.032
Tote Road																											
Tote Road - Seasonal Fuel Tankers	16.866	Diesel Fuel Tanker Truck (42,000 L) - S	Western Star with Detroit D	4900 SA	10	20	60	52	36	—	—	20	1.0	50%	90%	—	—	—	8.50	2.20	0.22				9.356	2.423	0.242
Tote Road - Continuous Traffic	16.866	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	50%	90%	—	—	—	15.68	4.06	0.41				106.512	27.584	2.758
	16.866	Diesel Fuel Tanker Truck (42,000 L) - C	Western Star with Detroit D	4900 SA	1	20	360	52	36	—	—	2	0.1	50%	90%	—	—	—	8.50	2.20	0.22				0.936	0.242	0.024
	16.866	Maintenance, Fuel/Lube, Mechanics,	Peterbilt 357 with CAT C11	357	16	20	360	30	—	—	—	35.7	1.8	50%	90%	—	—	—	8.04	2.08	0.21				15.792	4.090	0.409
	16.866	Passenger Transfer Bus (48 passenger	Diesel School Bus (Blue Bird	BBCV2311	3	20	360	15	—	—	—	3	0.2	50%	90%	—	—	—	5.88	1.52	0.15				0.971	0.251	0.025
	16.866	Passenger Vans	Ford E450 - Diesel	E450	24	20	360	7.0	—	—	—	24	1.2	50%	90%	—	—	—	4.17	1.08	0.11				5.513	1.428	0.143
	16.866	Pickup Trucks 3/4 ton	Ford F250 - Diesel	F250	10	20	360	6.0	—	—	—	30	1.5	50%	90%	—	—	—	3.89	1.01	0.10				6.429	1.665	0.167
	1.000	Articulated Truck	Caterpillar	CAT 740B	3	2	360	74	39.5	—	—	150	66.0	50%	90%	—	—	—	10.49	2.72	0.27				5.133	1.329	0.133
Tote Road - Section at Crushing Facility	0.250	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	75%	90%	—	—	—	15.68	4.06	0.41				0.789	0.204	0.020
Tote Road - Section at General Facility Area	0.250	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	75%	90%	—	—	—	15.68	4.06	0.41				0.789	0.204	0.020
Milne Port																											
Haul Road																											
Haul Road to Product Ore Stockpiles	2.039	Articulated Truck	Caterpillar	CAT 740B	20	20	360	74	39.5	0.6	1,667	42	2.1	75%	90%	—	—	—	10.49	2.72	0.27				1.472	0.381	0.038
General Facility Area																											
Maintenance, Fuel/Lube, Mechanics, Service Trucks	4.000	Maintenance, Fuel/Lube, Mechanics, Service Trucks	Peterbilt 357 with CAT C11	357	5	20	360	30	—	—	—	10	0.5	75%	90%	—	—	—	8.04	2.08	0.21				0.524	0.136	0.014
Articulated Trucks	4.000	Articulated Truck	Caterpillar	CAT 740B	1	12	360	74	39.5	—	—	12	1.0	75%	90%	—	—	—	10.49	2.72	0.27				0.821	0.213	0.021
Tote Road																											
Tote Road - Seasonal Fuel Tankers	28.551	Diesel Fuel Tanker Truck (42,000 L) - S	Western Star with Detroit D	4900 SA	10	20	60	52	36	—	—	20	1.0	50%	90%	—	—	—	8.50	2.20	0.22				15.838	4.102	0.410
Tote Road - Continuous Traffic	28.551	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	50%	90%	—	—	—	15.68	4.06	0.41				180.309	46.696	4.670
	28.551	Diesel Fuel Tanker Truck (42,000 L) - C	Western Star with Detroit D	4900 SA	1	20	360	52	36	—	—	2	0.1	50%	90%	—	—	—	8.50	2.20	0.22				1.584	0.410	0.041
	28.551	Maintenance, Fuel/Lube, Mechanics,	Peterbilt 357 with CAT C11	357	16	20	360	30	—	—	—	35.7	1.8	50%	90%	—	—	—	8.04	2.08	0.21				26.733	6.923	0.692
	28.551	Passenger Transfer Bus (48 passenger	Diesel School Bus (Blue Bird	BBCV2311	3	20	360	15	—	—	—	3	0.2	50%	90%	—	—	—	5.88	1.52	0.15				1.644	0.426	0.043
	28.551	Passenger Vans	Ford E450 - Diesel	E450	24	20	360	7.0	—	—	—	24	1.2	50%	90%	—	—	—	4.17	1.08	0.11				9.333	2.417	0.242
	28.551	Pickup Trucks 3/4 ton	Ford F250 - Diesel	F250	10	20	360	6.0	—	—	—	30	1.5	50%	90%	—	—	—	3.89	1.01	0.10				10.884	2.819	0.282
	1.000	Articulated Truck	Caterpillar	CAT 740B	3	2	360	74	39.5	—	—	150	66.0	50%	90%	—	—	—	10.49	2.72	0.27				5.133	1.329	0.133
Total Emissions																						**0.000**	**0.000**	**0.000**	**430.537**	**111.963**	**11.199**
Mine Site Emissions																						**0.000**	**0.000**	**0.000**	**176.262**	**46.112**	**4.614**
Milne Port Emissions																						**0.000**	**0.000**	**0.000**	**254.275**	**65.851**	**6.585**

Table A.9 Particulate Matter Emissions from On-Road Trucks and Vehicles

Equipment Specifications														CAC Emission Factors			Daily Emission Rates (g/s)					
Haul Road	Road Length	Truck Description	Manufacturer	Model	Number of Equipment	Operating Hours per Day	Operating Days per year	GVWR	Payload Capacity	Hauled Material		Number of Round Trips		TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
	km				#	h/d	d/y	tonne	tonne	Mtpa	t/d	trips/d	trips/h	g/VMT	g/VMT	g/VMT	g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																						
General Facility Area																						
Maintenance, Fuel/Lube, Mechanics, Service Trucks	2.000	Maintenance, Fuel/Lube, Mechanics, Service Trucks	Peterbilt 357 with CAT C1	357	16	20	360	30	—	—	—	32	1.6	0.213	0.213	0.124	1.96E-04	1.96E-04	1.14E-04	—	—	—
Tote Road																						
Tote Road - Seasonal Fuel Tankers	16.866	Diesel Fuel Tanker Truck (4	Western Star with Detroi	4900 SA	10	20	60	52	36	—	—	20	1.0	0.381	0.381	0.248	1.85E-03	1.85E-03	1.20E-03	—	—	—
Tote Road - Continuous Traffic	16.866	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	0.381	0.381	0.248	1.14E-02	1.14E-02	7.42E-03	—	—	—
	16.866	Diesel Fuel Tanker Truck (4	Western Star with Detroi	4900 SA	1	20	360	52	36	—	—	2	0.1	0.381	0.381	0.248	1.85E-04	1.85E-04	1.20E-04	—	—	—
	16.866	Maintenance, Fuel/Lube, N	Peterbilt 357 with CAT C1	357	16	20	360	30	—	—	—	35.7	1.8	0.213	0.213	0.124	1.85E-03	1.85E-03	1.08E-03	—	—	—
	16.866	Passenger Transfer Bus (48	Diesel School Bus (Blue B	BBCV2311	3	20	360	15	—	—	—	3	0.2	0.367	0.367	0.267	2.67E-04	2.67E-04	1.94E-04	—	—	—
	16.866	Passenger Vans	Ford E450 - Diesel	E450	24	20	360	7	—	—	—	24	1.2	0.066	0.066	0.040	3.85E-04	3.85E-04	2.34E-04	—	—	—
	16.866	Pickup Trucks 3/4 ton	Ford F250 - Diesel	F250	10	20	360	6	—	—	—	30	1.5	0.074	0.074	0.048	5.40E-04	5.40E-04	3.47E-04	—	—	—
Tote Road - Section at Crushing Facility	0.250	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	0.381	0.381	0.248	1.69E-04	1.69E-04	1.10E-04	—	—	—
Tote Road - Section at General Facility Area	0.250	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	0.381	0.381	0.248	1.69E-04	1.69E-04	1.10E-04	—	—	—
Milne Port																						
General Facility Area																						
Maintenance, Fuel/Lube, Mechanics, Service Trucks	4.000	Maintenance, Fuel/Lube, Mechanics, Service Trucks	Peterbilt 357 with CAT C1	357	5	20	360	30	—	—	—	10	0.5	0.213	0.213	0.124	1.23E-04	1.23E-04	7.14E-05	—	—	—
Tote Road																						
Tote Road - Seasonal Fuel Tankers	28.551	Diesel Fuel Tanker Truck (4	Western Star with Detroi	4900 SA	10	20	60	52.0	36	—	—	20	1.0	0.381	0.381	0.248	3.13E-03	3.13E-03	2.03E-03	—	—	—
Tote Road - Continuous Traffic	28.551	Ore Haul Truck	Western Star 6900XD	6900 XD	57	20	360	200	135	6	16,667	123	6.2	0.381	0.381	0.248	1.93E-02	1.93E-02	1.26E-02	—	—	—
	28.551	Diesel Fuel Tanker Truck (4	Western Star with Detroi	4900 SA	1	20	360	52	36	—	—	2	0.1	0.381	0.381	0.248	3.13E-04	3.13E-04	2.03E-04	—	—	—
	28.551	Maintenance, Fuel/Lube, N	Peterbilt 357 with CAT C1	357	16	20	360	30	—	—	—	35.7	1.8	0.213	0.213	0.124	3.13E-03	3.13E-03	1.82E-03	—	—	—
	28.551	Passenger Transfer Bus (48	Diesel School Bus (Blue B	BBCV2311	3	20	360	15	—	—	—	3	0.2	0.367	0.367	0.267	4.51E-04	4.51E-04	3.29E-04	—	—	—
	28.551	Passenger Vans	Ford E450 - Diesel	E450	24	20	360	7	—	—	—	24	1.2	0.066	0.066	0.040	6.52E-04	6.52E-04	3.96E-04	—	—	—
	28.551	Pickup Trucks 3/4 ton	Ford F250 - Diesel	F250	10	20	360	6.0	—	—	—	30	1.5	0.074	0.074	0.048	9.14E-04	9.14E-04	5.88E-04	—	—	—
Total Emissions																	**0.045**	**0.045**	**0.029**	**0.000**	**0.000**	**0.000**
Mine Site Emissions																	**0.017**	**0.017**	**0.011**	**0.000**	**0.000**	**0.000**
Milne Port Emissions																	**0.028**	**0.028**	**0.018**	**0.000**	**0.000**	**0.000**

Table A.10 Fugitive Dust Emissions from Wind Erosion

Process Specifications											CAC Emission Factors			Daily Emission Rates (g/s)					
Activity Description	Material Transfer Description	Operating Hours per Day	Operating Days per year	Number of Disturbances		Disturbed Area	Dust Control Efficiency	Wind Speed Category	Evaluated Wind Speed	Probability of Wind within Wind Speed Category	TSP	PM10	PM2.5	EPM30	EPM10	EPM2.5	FPM30	FPM10	FPM2.5
		h/d	d/y	per day	per hour	m²	%	(1-6)	(m/s)	%	(g/m²/disturbance)			g/s	g/s	g/s	g/s	g/s	g/s
Mine Site																			
Stockpiles																			
Waste Rock Stockpile	Ore Haul Truck	24	365	24	1	40,000	—	1	1.90	29.5%	0	0	0				0	0	0
		24	365		1	40,000	—	2	4.55	46.2%	0	0	0				0	0	0
		24	365		1	40,000	—	3	7.34	21.6%	0	0	0				0	0	0
		24	365		1	40,000	—	4	11.23	2.3%	0	0	0				0	0	0
		24	365		1	40,000	—	5	14.63	0.2%	0	0	0				0	0	0
		24	365		1	40,000	—	6	17.36	0.05%	1.673	0.836	0.125				18.584	9.292	1.394
ROM Stockpile	Ore Haul Truck	24	365	24	1	10,000	—	1	1.90	29.5%	0	0	0				0	0	0
		24	365		1	10,000	—	2	4.55	46.2%	0	0	0				0	0	0
		24	365		1	10,000	—	3	7.34	21.6%	0	0	0				0	0	0
		24	365		1	10,000	—	4	11.23	2.3%	0	0	0				0	0	0
		24	365		1	10,000	—	5	14.63	0.2%	0	0	0				0	0	0
		24	365		1	10,000	—	6	17.36	0.05%	1.673	0.836	0.125				4.646	2.323	0.348
Fine Ore Stockpile 1	Wheel Front End Loader	24	365	24	1	900	—	1	1.90	29.5%	0	0	0				0	0	0
		24	365		1	900	—	2	4.55	46.2%	0	0	0				0	0	0
		24	365		1	900	—	3	7.34	21.6%	0	0	0				0	0	0
		24	365		1	900	—	4	11.23	2.3%	0	0	0				0	0	0
		24	365		1	900	—	5	14.63	0.2%	1.914	0.957	0.144				0.478	0.239	0.036
		24	365		1	900	—	6	17.36	0.05%	8.334	4.167	0.625				2.084	1.042	0.156
Fine Ore Stockpile 2	Radial Stacker	24	365	24	1	8,860	—	1	1.90	29.5%	0	0	0				0	0	0
		24	365		1	8,860	—	2	4.55	46.2%	0	0	0				0	0	0
		24	365		1	8,860	—	3	7.34	21.6%	0	0	0				0	0	0
		24	365		1	8,860	—	4	11.23	2.3%	0	0	0				0	0	0
		24	365		1	8,860	—	5	14.63	0.2%	1.914	0.957	0.144				4.711	2.355	0.353
		24	365		1	8,860	—	6	17.36	0.05%	8.334	4.167	0.625				20.512	10.256	1.538
Lump Ore Stockpile	Wheel Front End Loader	24	365	24	1	900	—	1	1.90	29.5%	0	0	0				0	0	0
		24	365		1	900	—	2	4.55	46.2%	0	0	0				0	0	0
		24	365		1	900	—	3	7.34	21.6%	0	0	0				0	0	0
		24	365		1	900	—	4	11.23	2.3%	0	0	0				0	0	0
		24	365		1	900	—	5	14.63	0.2%	0	0	0				0	0	0
		24	365		1	900	—	6	17.36	0.05%	1.673	0.836	0.125				0.418	0.209	0.031
Milne Port																			
Stockpiles																			
Fine Ore Stockpile	Radial Stacker	24	365	24	1	10,000	—	1	1.37	36.2%	0	0	0				0	0	0
		24	365		1	10,000	—	2	3.14	34.5%	0	0	0				0	0	0
		24	365		1	10,000	—	3	5.24	28.8%	0	0	0				0	0	0
		24	365		1	10,000	—	4	10.66	0.5%	0	0	0				0	0	0
		24	365		1	10,000	—	5	13.85	0.01%	0.587	0.294	0.044				1.631	0.815	0.122
		24	365		1	10,000	—	6	18.00	0%	10.226	5.113	0.767				28.405	14.203	2.130
Lump Ore Stockpile	Radial Stacker	24	365	24	1	10,000	—	1	1.37	36.2%	0	0	0				0	0	0
		24	365		1	10,000	—	2	3.14	34.5%	0	0	0				0	0	0
		24	365		1	10,000	—	3	5.24	28.8%	0	0	0				0	0	0
		24	365		1	10,000	—	4	10.66	0.5%	0	0	0				0	0	0
		24	365		1	10,000	—	5	13.85	0.01%	0	0	0				0	0	0
		24	365		1	10,000	—	6	18.00	0%	3.021	1.510	0.227				8.391	4.196	0.629
Total Emissions														**0.000**	**0.000**	**0.000**	**89.860**	**44.930**	**6.740**
Mine Site Emissions														**0.000**	**0.000**	**0.000**	**51.433**	**25.716**	**3.857**
Milne Port Emissions														**0.000**	**0.000**	**0.000**	**38.427**	**19.214**	**2.882**

APPENDIX B Meteorological Data

APPENDIX C CALPUFF Model Source Parameters and Options

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B.1 Introduction

This appendix provides an overview of the meteorological information used for the dispersion modelling completed as part of the Baffinland Iron Mines Corporation (Baffinland) Mary River Project (the Project) 6 Mtpa air quality assessment. Also provided are the technical details and options that were used to apply the CALMET model for the assessment.

Meteorology determines the transport and dispersion of industrial emissions, and hence plays a significant role in determining air quality downwind of emission sources. For the air quality assessment, meteorological data for the three-year period from 2018 to 2020 are used to define transport and dispersion parameters. The selection of a three-year period is consistent with the Newfoundland Guidelines for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012).

Meteorological characteristics vary with time (e.g., season and time of day) and location (e.g., height above ground, terrain features, and land cover properties). Historically, meteorological data measured at one location have been used and extrapolated to reflect conditions across all model domains. For large model domains, this approach fails to recognize that meteorological conditions for any given hour can vary significantly across the domain due to terrain and geophysical differences. Curvilinear airflow can also result from mesoscale and synoptic-scale weather patterns.

Meteorological models are used to provide spatially and temporally varying wind and temperature fields across a model domain to overcome the limitations associated with the use of single station measurements. The CALMET meteorological pre-processing program is used to provide temporally, and spatially varying meteorological parameters required by the CALPUFF model.

The CALMET pre-processor is available from the web site of the model developer (i.e., Exponent Inc. - http://www.src.com/calpuff/calpuff1.htm). At the time of this assessment, the most recent CALMET version 6.5.0 was used.

B.2 MODEL DOMAINS

B.2.1 Boundaries

Two model domains are defined as follows:

- **Mine Site Model Domain**: This domain includes the area around the Mine Site and a section of Tote Road extending approximately 20 km from the Mine Site.

The model domain adopted for this assessment extends from 71.1427 degrees latitude to 71.4908 degrees latitude north (resulting in a north south extent of 40 km), and from 79.8222 degrees longitude to 78.6715 degrees longitude west (resulting in an east west extent of 40 km), as shown in Figure B.1. The study domain covers a 1,600 km^2 area, the extents of which are provided in Table B.1. A horizontal grid spacing of 400 m was selected for the CALMET simulation. The study area therefore corresponds to 100 rows by 100 columns. With this grid spacing, it was possible to maximize run time and file size efficiencies while still capturing terrain feature influences on wind flow patterns.

- **Milne Port Model Domain**: This spatial domain includes the area around Milne Port and a section of Tote Road extending approximately 20 km from Milne Port.

The model domain adopted for this assessment extends from 71.6461 degrees latitude to 72.0572 degrees latitude north (resulting in a north south extent of 46 km), and from 81.4823 degrees longitude to 80.1551 degrees longitude west (resulting in an east west extent of 46 km), as shown in Figure B.2. The study domain covers a 2,116 km^2 area, the extents of which are provided in Table B-2. A horizontal grid spacing of 400 m was selected for the CALMET simulation. The study area therefore corresponds to 115 rows by 115 columns. With this grid spacing, it was possible to maximize run time and file size efficiencies while still capturing terrain feature influences on wind flow patterns.

To simulate transport and dispersion processes, it is important to simulate the representative vertical profiles of wind direction, wind speed, temperature, and turbulence intensity within the atmospheric boundary layer (i.e., the layer within about 2,000 m above the Earth's surface). To capture this vertical structure, twelve vertical layers were selected. CALMET defines a vertical layer as the midpoint between two faces (i.e., thirteen faces correspond to twelve layers, with the lowest layer always being ground level or 10 m). The vertical faces used in this study are 0 m, 20 m, 40 m, 80 m, 120 m, 280 m, 520 m, 880 m, 1,320 m, 1,820 m, 2,380 m, 3,000 m, and 4,000 m.

Table B.1 Mine Site Model Domain (40 km by 40 km) Coordinates (UTM Zone 17; NAD 83)

Domain Corner	Easting (m)	Northing (m)
Southwest	542485	7893731
Northwest	542485	7933731
Northeast	582485	7933731
Southeast	582485	7893731

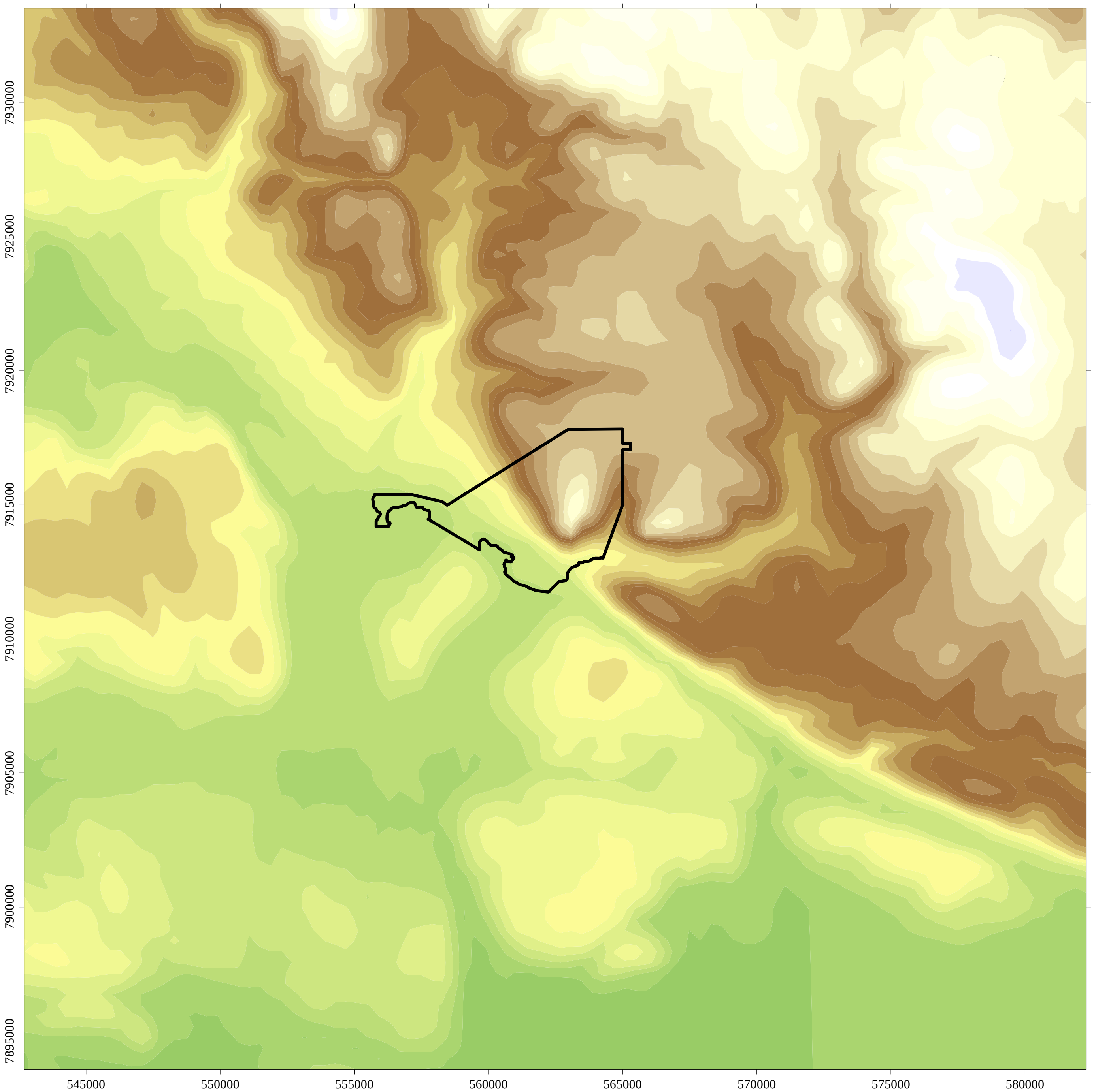
Table B.2 Mine Port Model Domain (46 km by 46 km) Coordinates (UTM Zone 17; NAD 83)

Domain Corner	Easting (m)	Northing (m)
Southwest	483049	7949521
Northwest	483049	7995521
Northeast	529049	7995521
Southeast	529049	7949521

B.2.2 Topography

Valleys and elevated terrain features influence surface wind flow patterns. Terrain data that are used to define these features were obtained from Canadian Digital Elevation Model (CDEM) (Natural Resources Canada, 2017). A CDEM mosaic can be obtained for a pre-defined or user-defined extent. The coverage and resolution of a mosaic varies according to latitude and to the extent of the requested area. Derived products such as slope, shaded relief and colour shaded relief maps can also be generated on demand. The pre-packaged GeoTif datasets are based on the National Topographic System of Canada (NTS) at the 1:250 000 scale. These data have a horizontal resolution of ~30 m, which is more than sufficient for air quality assessment purposes.

A general overview of the terrain in the model domain are presented in Figures B.1 and B.2. Broadly speaking, for Mine Site model domain, the higher elevations are towards the northeast of the domain, and the lowest elevations are near the south portion of the domain. While, for Mine Port model domain, the higher elevations are towards the east portion of the domain, and the lowest elevations are near the north and northwest portion of the domain.



Mine Site PDA

100 160 220 280 340 400 460 520 580 640 700 760

elevation (m)

Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

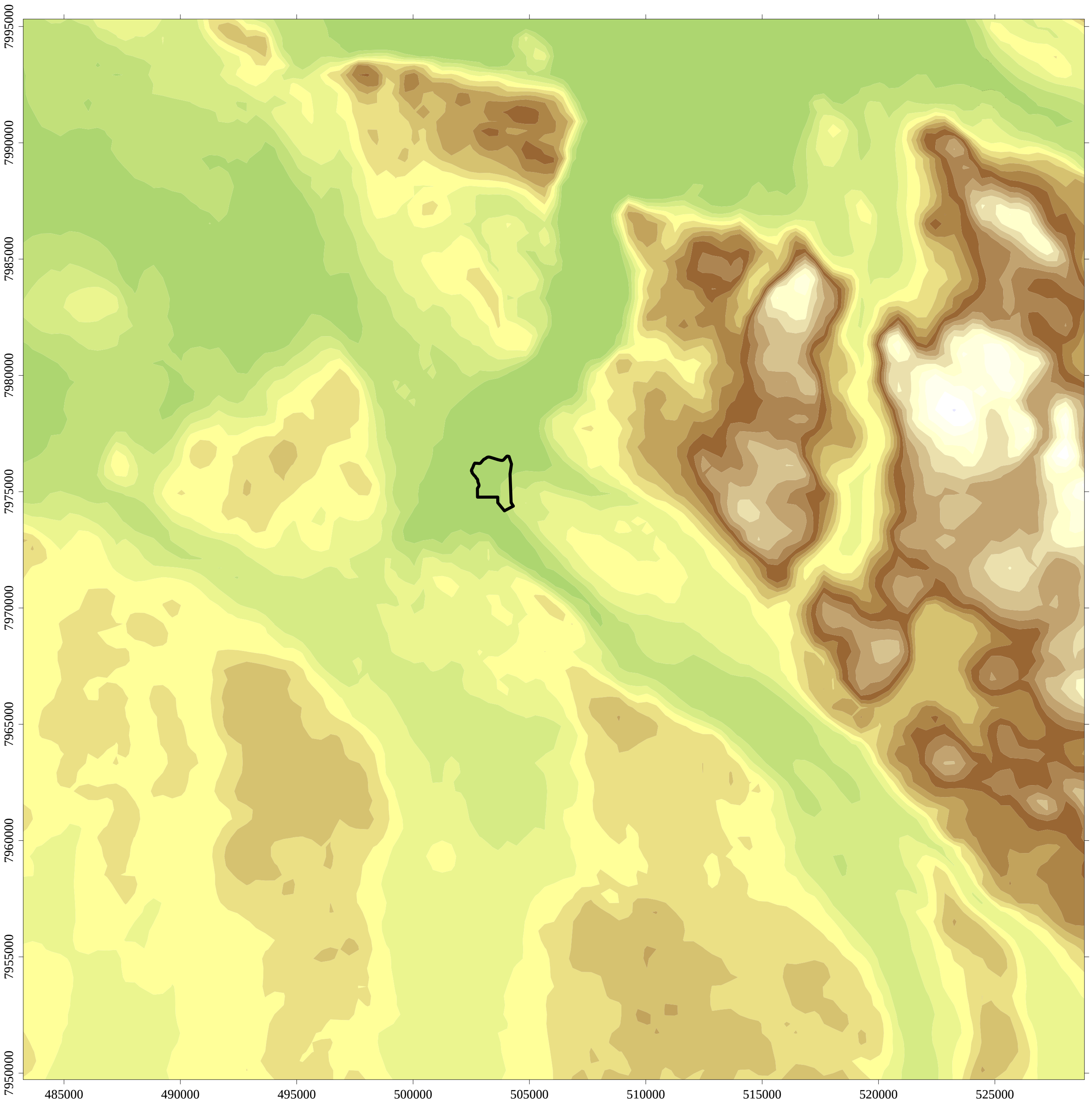
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

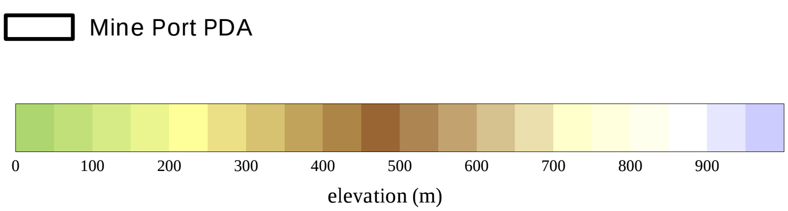
Terrain in Mine Site CALMET Model Domain

Stantec

BAFFINLAND MARY RIVER PROJECT

Figure B.1





Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Terrain in Mine Port CALMET Model Domain

Stantec

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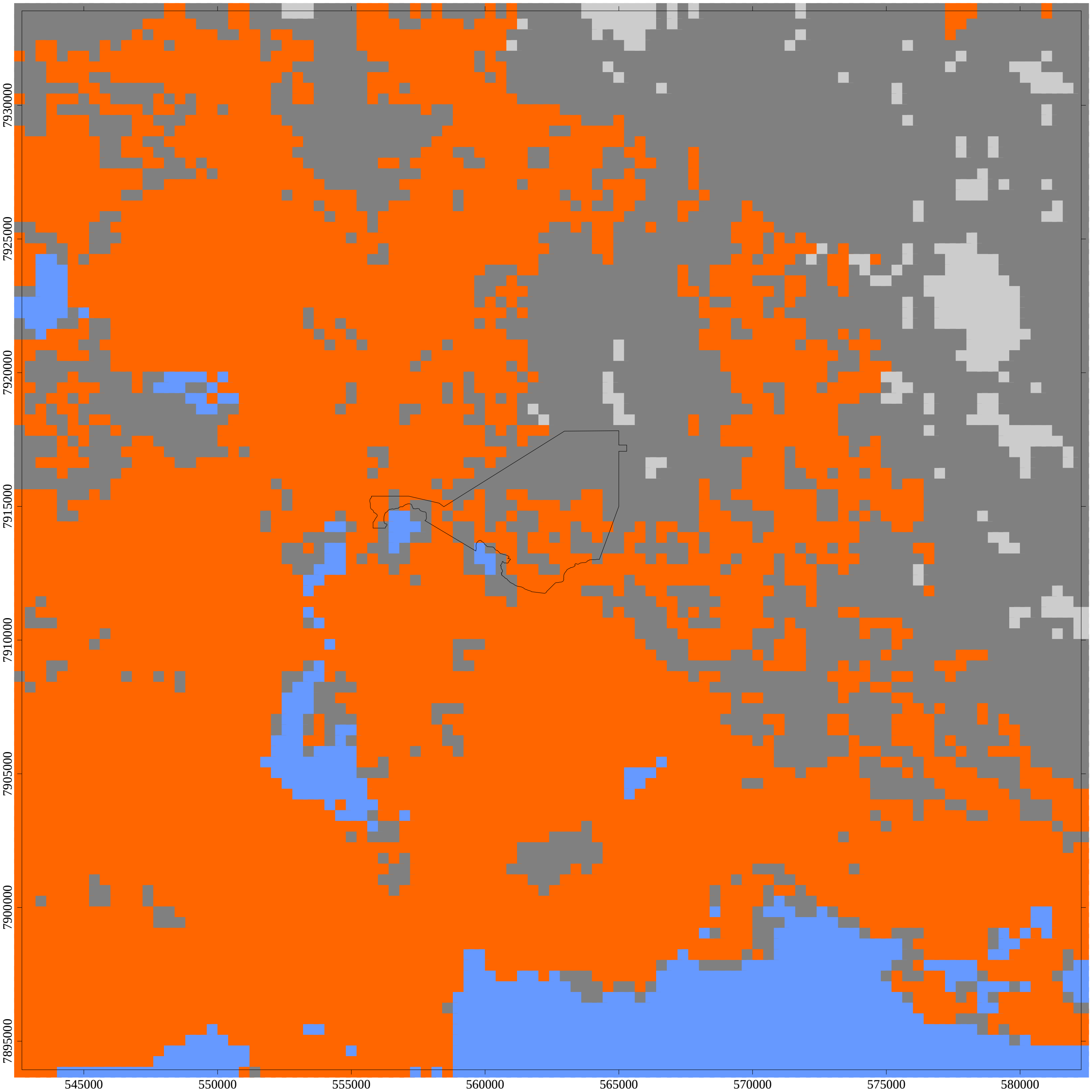
Figure B.2

B.2.3 Land-Cover Types

The North American land-cover data (Commission for Environmental Cooperation 2016) is used to initialize land-cover categories in the CALMET model. The 2005 North American land-cover dataset was produced as part of the North American Land Change Monitoring System (NALCMS), a trilateral effort between the Canada Centre for Remote Sensing, the United States Geological Survey, and three Mexican organizations including the National Institute of Statistics and Geography, National Commission for the Knowledge and Use of the Biodiversity, and the National Forestry Commission of Mexico. This dataset has a 250 m resolution.

For this assessment, the 2005 North American land-cover data were extracted and then converted into the fractional land-use format accepted by the CALMET MAKEGEO pre-processor. MAKEGEO creates the geophysical data file (GEO.DAT) for CALMET. The 250 m resolution data were grouped on a 400 m grid basis and the land-cover type assigned to the larger grid cell is based on the dominant land-cover type for that grid cell.

The mapping from the North American land-cover dataset to the CALMET land-use categories is contained in Table B.3. Tables B.4 and B.5 describe the seasonal values for surface roughness (z0), albedo, Bowen ratio, soil heat flux, anthropogenic heat flux, and leaf area index (LAI) defined according to the Newfoundland Guidelines for Plume Dispersion Modelling. Two seasons were specified: Non-winter (July to October) and Winter (November to June). The land-use in both CALMET domains is mainly barren land or tundra (see Figures B.3 and Figure B.4 for the land use classes on a 400 m resolution basis).



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Land-use Classes in Mine Site CALMET Model Domain

Stantec

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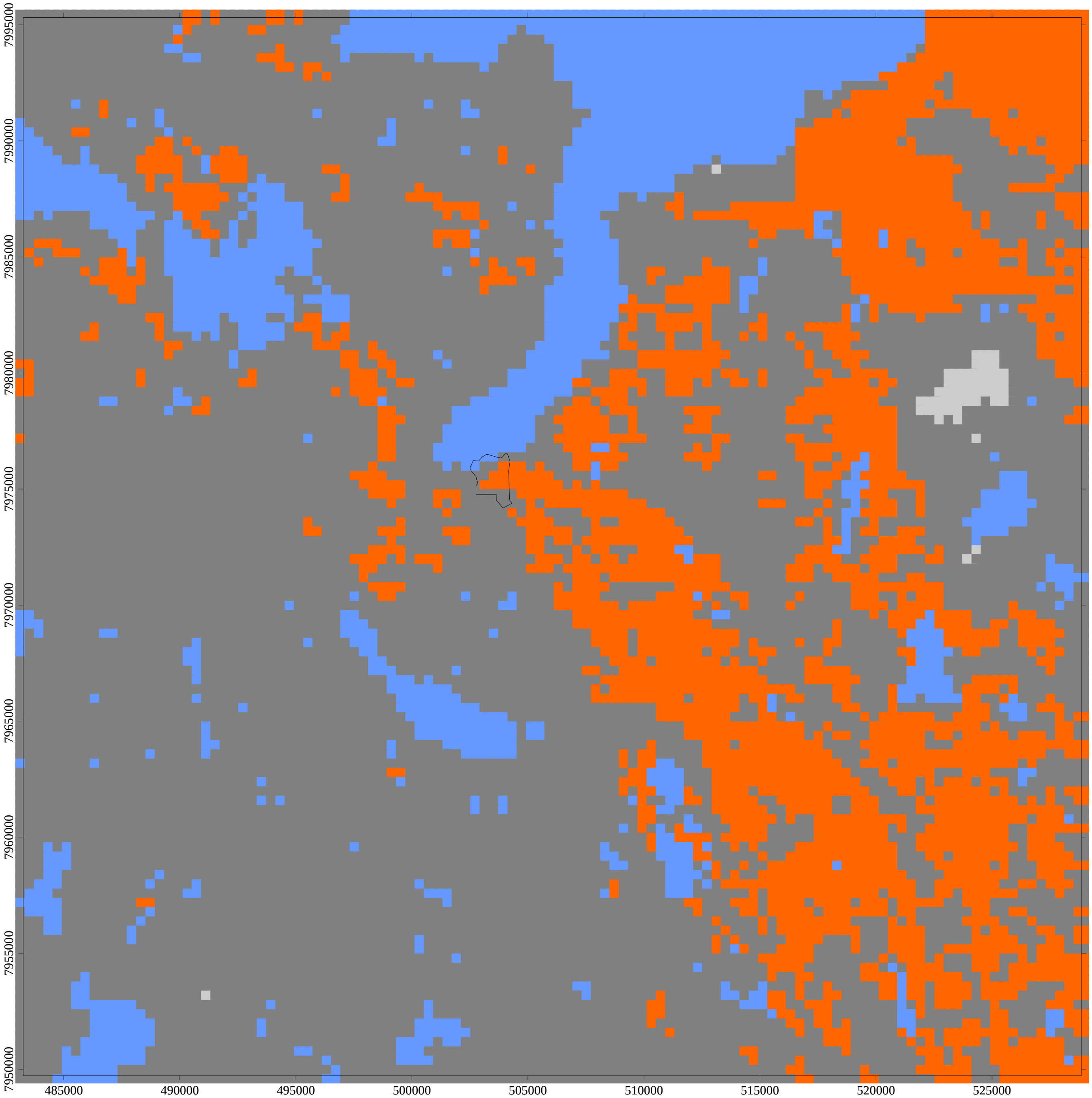
Figure B.3



Mine Port PDA

- Water
- Barren land
- Tundra
- Snow and Ice

Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Land-use Classes in Mine Port CALMET Model Domain

Stantec

BAFFINLAND MARY RIVER PROJECT

Figure B.4

Table B.3 Mapping from the North American Land-cover Data to CALMET Land-Use Categories

Land Cover Code	Land Cover Type	CALMET Code	CALMET Land Use Category
1	Temperate or sub-polar needleleaf forest	42	Evergreen Forest Land
2	Sub-polar taiga needleleaf forest	42	Evergreen Forest Land
3	Tropical or sub-tropical broadleaf evergreen forest	42	Evergreen Forest Land
4	Tropical or sub-tropical broadleaf deciduous forest	41	Deciduous Forest Land
5	Temperate or sub-polar broadleaf deciduous forest	41	Deciduous Forest Land
6	Mixed forest	43	Mixed Forest Land
7	Tropical or sub-tropical shrubland	32	Shrub Rangeland
8	Temperate or sub-polar shrubland	32	Shrub Rangeland
9	Tropical or sub-tropical grassland	30	Rangeland
10	Temperate or sub-polar grassland	30	Rangeland
11	Sub-polar or polar shrubland-lichen-moss	80	Tundra
12	Sub-polar or polar grassland-lichen-moss	80	Tundra
13	Sub-polar or polar barren-lichen-moss	80	Tundra
14	Wetland	60	Wet Land
15	Cropland	20	Agricultural Land
16	Barren lands	70	Barren Land
17	Urban	10	Urban or Build-up
18	Water	50	Water
19	Snow and Ice	90	Snow or Ice

Table B.4 Land-cover Characterization and Associated Geophysical Parameters for the Winter Season

NALCMS Code	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux (fraction)	Anthropogenic Heat Flux (W/m^2)	Leaf Area Index	CALMET Code	CALMET Land Cover Type
11	0.200	0.300	0.500	0.150	0.000	0.000	80	Tundra
12	0.200	0.300	0.500	0.150	0.000	0.000	80	
13	0.200	0.300	0.500	0.150	0.000	0.000	80	
16	0.150	0.450	6.000	0.150	0.000	0.050	70	Barren Land
18	0.001	0.750	0.000	1.000	0.000	0.000	50	Water
19	0.200	0.700	0.500	0.150	0.000	0.000	90	Snow and Ice

NOTES:
Winter = November to June
W/m^2 = watts per square metre

Table B.5 Land-cover Characterization and Associated Geophysical Parameters for the N\on-winter Season

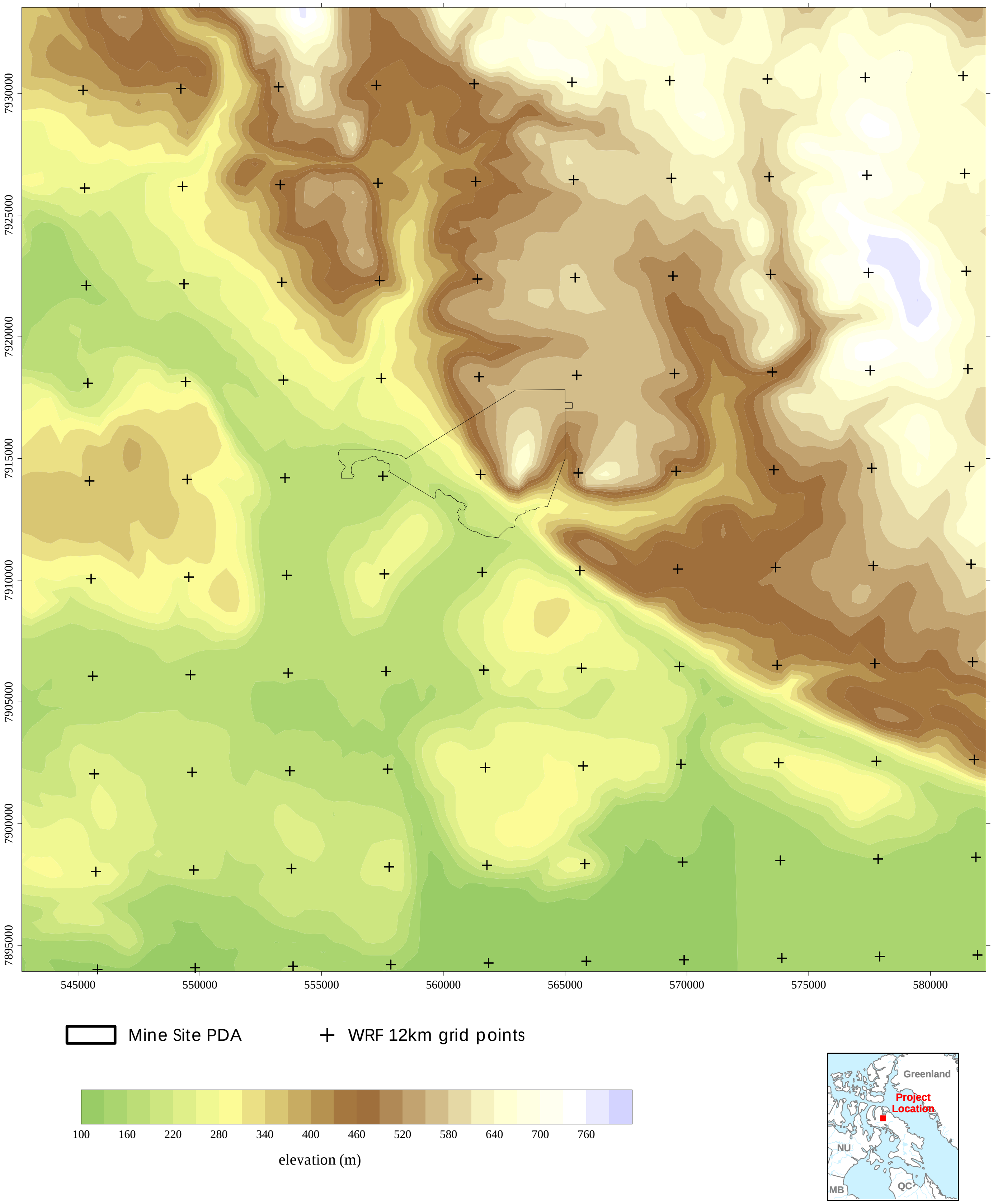
NALCMS Code	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux (fraction)	Anthropogenic Heat Flux (W/m^2)	Leaf Area Index	CALMET Code	CALMET Land Cover Type
11	0.200	0.300	0.500	0.150	0.000	0.000	80	Tundra
12	0.200	0.300	0.500	0.150	0.000	0.000	80	
13	0.200	0.300	0.500	0.150	0.000	0.000	80	
16	0.300	0.280	4.000	0.150	0.000	0.050	70	Barren Land
18	0.001	0.100	0.000	1.000	0.000	0.000	50	Water
19	0.200	0.700	0.500	0.150	0.000	0.000	90	Snow and Ice

NOTES:
Non-winter = July to October
W/m^2 = watts per square metre

B.3 CALMET INPUT DATA

The CALMET model requires the input of surface and upper air meteorological fields. For this application, CALMET model was run in no-obs mode by using WRF model output for the period of January 1, 2018 to December 31, 2020. There are no surface and upper air stations within or nearby the CALMET domain.

For this assessment, 12 km grid resolution WRF model data was generated by Lakes Environmental (Lakes Environmental 2021) for the years 2018 to 2020. The WRF model data were used to characterize the meteorology in the model as there is no surface and upper air meteorological station in the region. Figures B.5 and B.6 show the WRF grid point locations based on 12 km grid resolution within the two CALMET model domains.



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

WRF Grids in Mine Site CALMET Model Domain

Stantec

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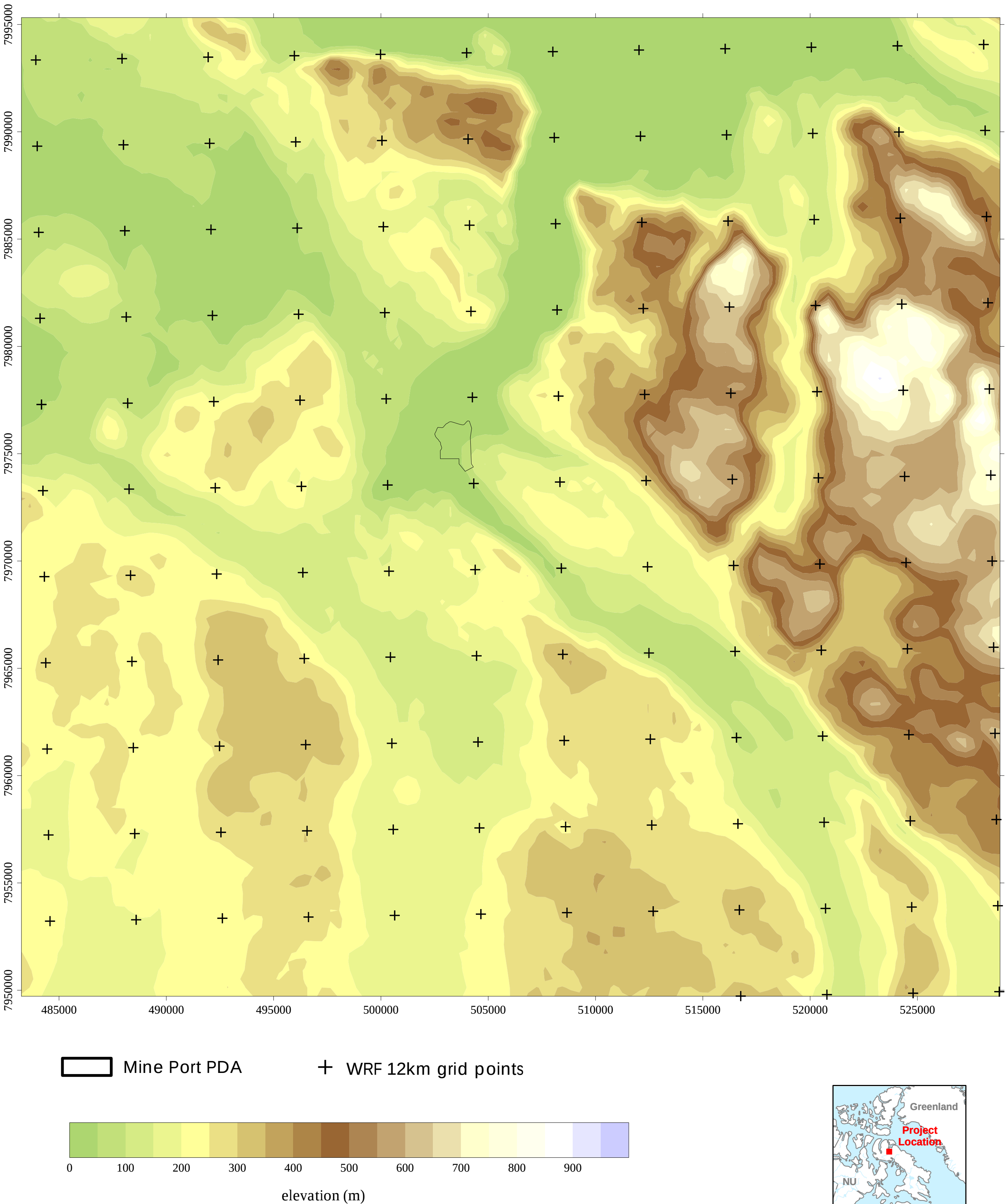
Figure B.5



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

WRF Grids in Mine Port CALMET Model Domain

Stantec

BAFFINLAND MARY RIVER PROJECT

Figure B.6

B.4 CALMET PREDICTIONS

To assess the value of the WRF-CALMET model approach for this assessment, the CALMET surface and elevated wind, surface temperature, mixing height, and Pasquill-Gifford (PG) stability class data were extracted for Mine Site and Mine Port Project Sites for analysis

B.4.1 Predicted Winds at Project Sites

Figures B.7 and B.8 show wind roses predicted by CALMET for the Mine Site and Mine Port Project Sites at various elevations above the ground (i.e., 10 m, 60 m, 100 m and 200 m). The results indicate:

- At Mine Site project site, winds at 10 m level are mainly from northeast and east. Winds at 60 m level are mainly from northeast, east and southeast. Winds at 100 m and 200 m levels are mainly from southeast. Wind speed increases with increasing height above the ground.
- At Mine Port project site, winds at all four levels are mainly from southeast. Wind speed increases with increasing height above the ground.

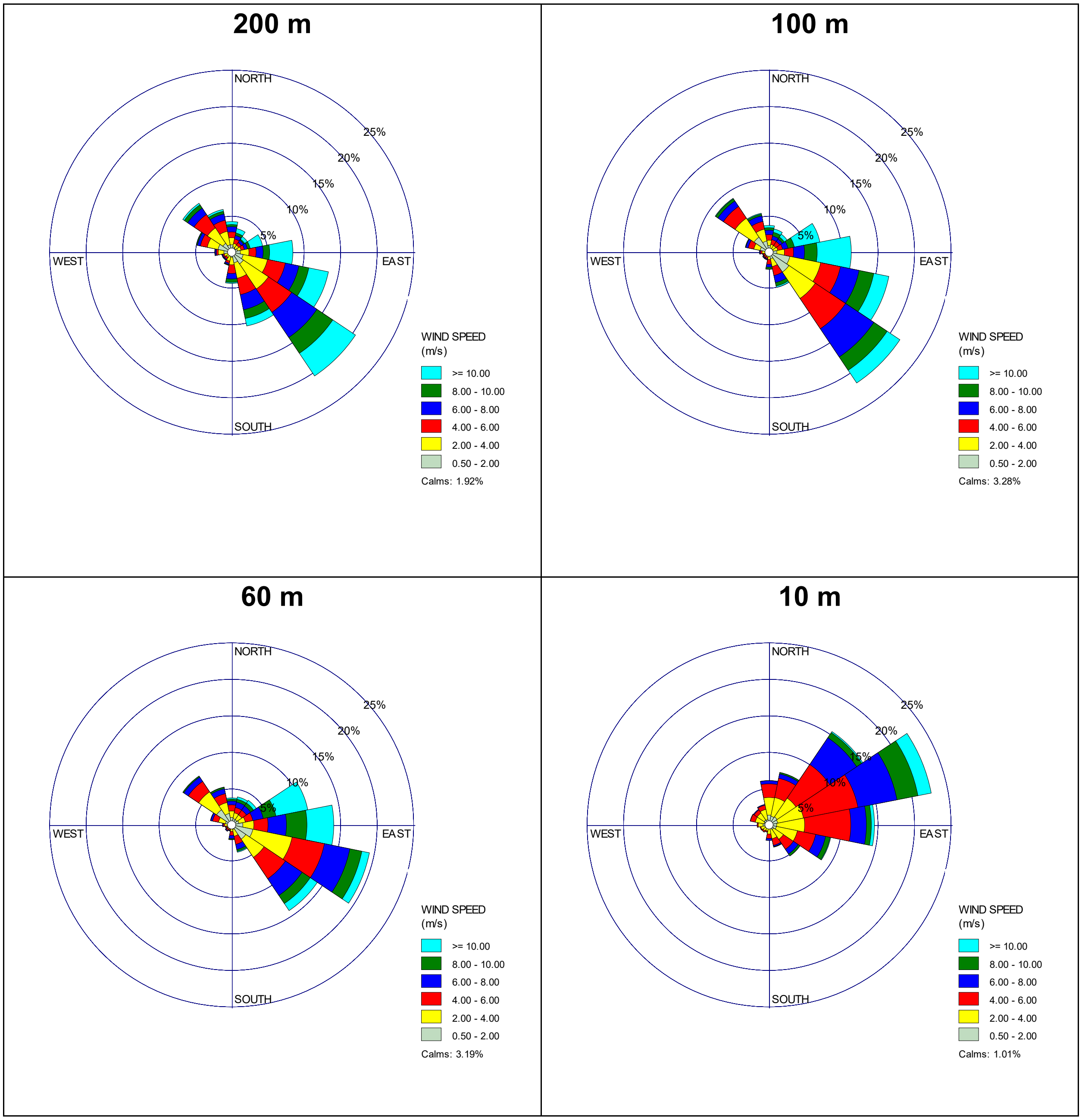


Figure B.7 Predicted Elevated Level Wind Roses for the Mine Site Project Site (2018 to 2020)

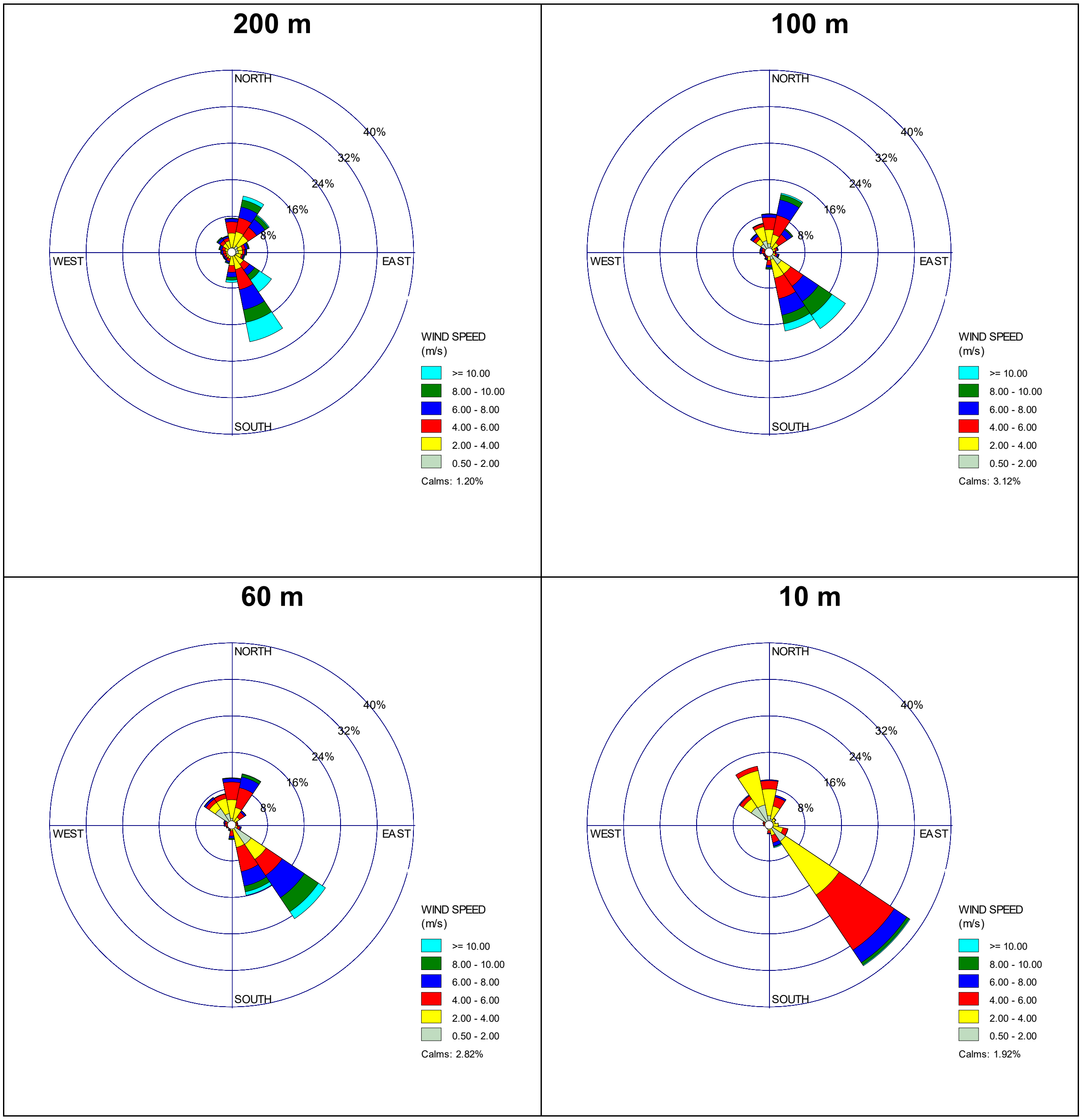


Figure B.8 Predicted Elevated Level Wind Roses for the Mine Port Project Site (2018 to 2020)

B.4.2 Predicted Surface Temperatures

Figures B.9 and B.10 show the monthly average surface temperatures predicted by CALMET for the Mine Site and Mine Port Project Sites, respectively. The predicted monthly temperatures indicate reasonable seasonal surface temperature variations.

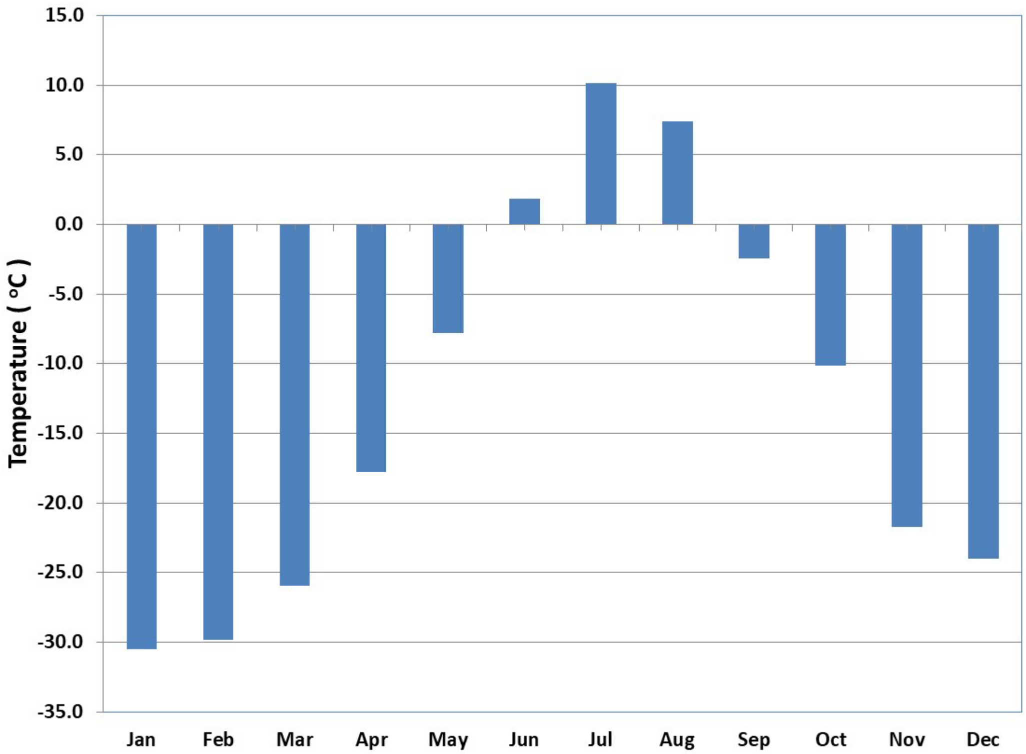


Figure B.9 Predicted Monthly Average Surface Temperatures for the Mine Site Project Site (2018 to 2020)

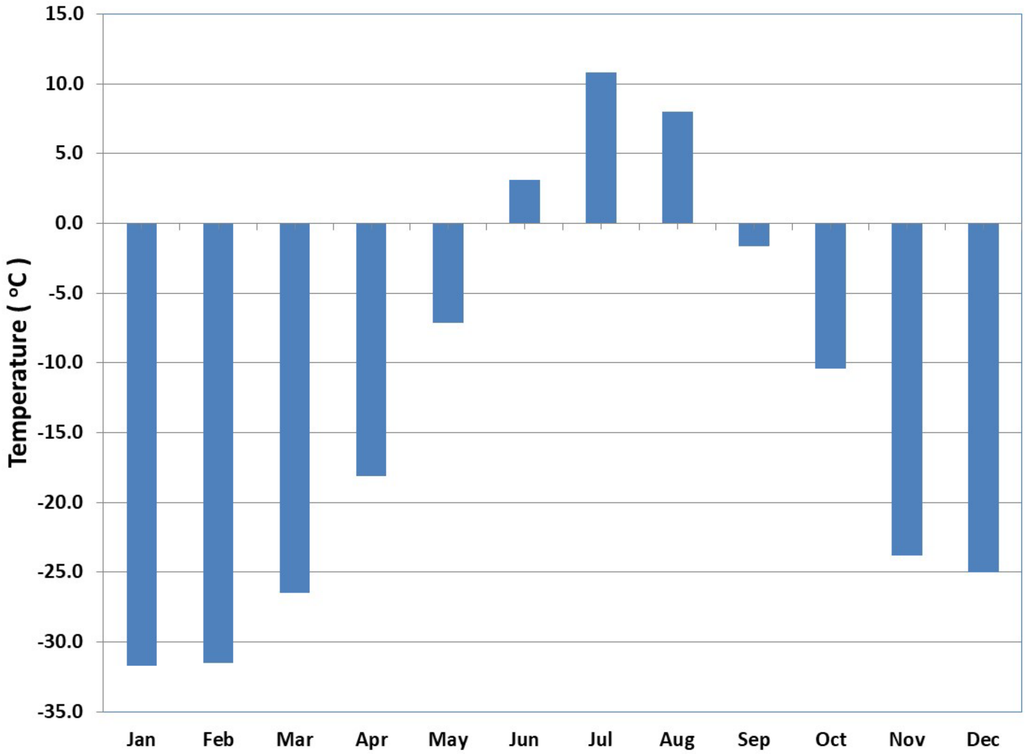


Figure B.10 Predicted Monthly Average Surface Temperatures for the Mine Port Project Site (2018 to 2020)

B.4.3 Predicted Mixing Heights

The presence of an elevated inversion can trap contaminants discharged into the atmosphere in the layer between the surface and the base of the inversion layer; this can increase ground-level ambient concentrations relative to the absence of an inversion layer. Mixing heights are usually the highest (i.e., in the 1,000 m to 2,000 m range) during daytime periods that are characterized by strong solar heating, and the lowest (i.e., about 100 m) during the night.

For this assessment, the CALMET post-processor was used to extract the mixing heights from CALMET output files, and the mixing height predictions for the Mine Site and Mine Port Project Sites are provided in Figures B.11 and B.12, respectively. The results show:

- Winter: The maximum median values are about 420 m and 430 m at the Mine Site and Mine Port Project Sites, respectively.
- Non-winter: The maximum median afternoon values are about 825 m and 835 m at the Mine Site and Mine Port Project Sites, respectively.

The minimum values for each season are predicted to occur during the night. During the night, the mixing height tends to be determined by mechanical mixing processes, with higher wind speeds resulting in a deeper mixed layer. The convective mixing process dominates during the day, leading to maximum mixed layer depths during the afternoon. The CALMET model, as applied, sets the minimum mixing height to 50 m.

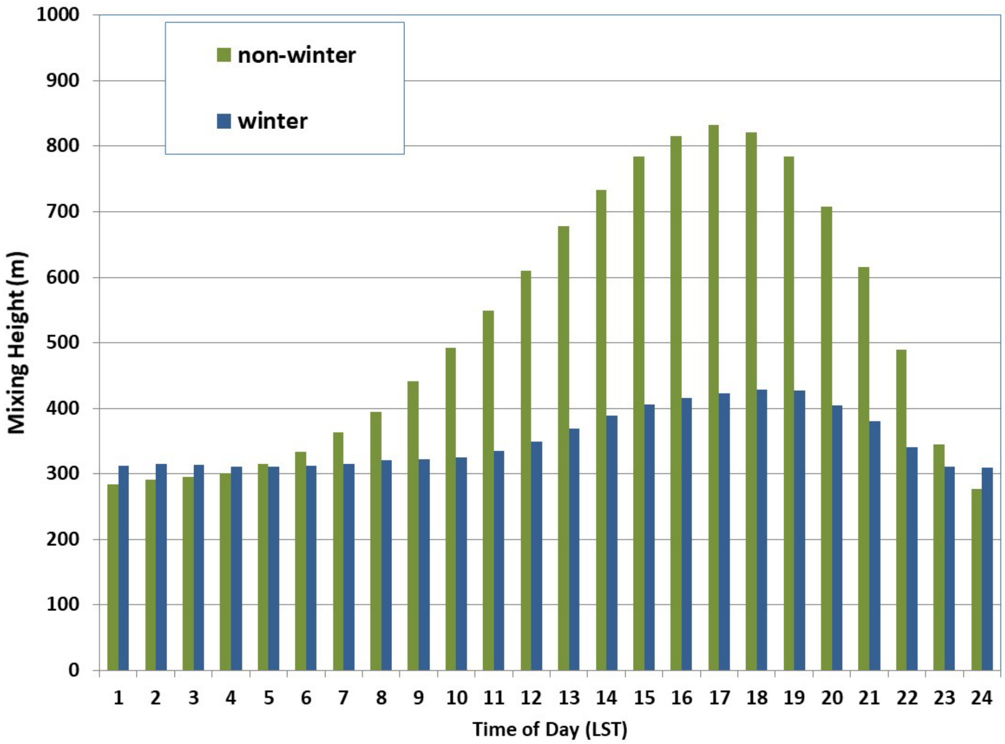


Figure B.11 Predicted Mixing Heights for Different Seasons and Times of Day for the Mine Site (2018 to 2020)

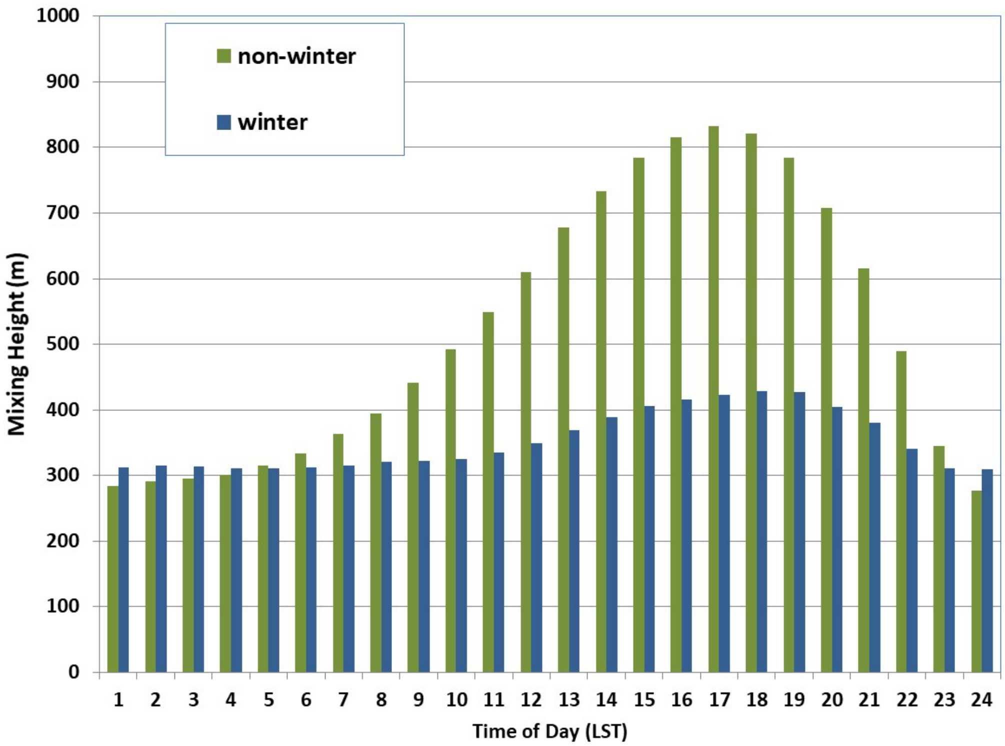


Figure B.12 Predicted Mixing Heights for Different Seasons and Times of Day for the Mine Port (2018 to 2020)

B.4.4 Predicted Atmospheric Stability Class

Atmospheric dispersion is caused by atmospheric turbulence, which can be related to atmospheric stability. Meteorologists define six stability classes (referred to as the Pasquill Gifford [PG] classes):

- Stability classes A, B and C occurs during the day, when solar radiation heats the ground. The air next to the ground is heated and tends to rise, enhancing vertical motions. This is referred to as an unstable atmosphere.

- Stability classes E and F occur during the night, when the ground cools due to long-wave radiation losses. The air next to the ground cools, suppressing vertical motions. This is referred to as a stable atmosphere.

- Stability class D is associated with completely overcast conditions (day or night) when there is no net heating or cooling of the ground, transitional periods between stable and unstable conditions, or during high wind speed periods (winds greater than 6 m/s [or 22 km/h]). This is referred to as a neutral atmosphere.

Stability classes undergo a significant daily variation, and they have a seasonal dependence. Stability classes can be determined from routine airport observations using the method devised by Turner (1963). A stability classification algorithm is also included in the CALMET model, this approach is based on the Turner approach using wind speed and cloud cover information for each grid point in the domain.

Table B.6 compares the stability class frequency distributions based on the CALMET model predictions for the Mine Site and Mine Port Project Sites. Neutral conditions (PG class D) are more frequent at Mine Site project site. While stable conditions (PG class E and F) are more frequent at Mine Port project site.

Table B.6 Predicted Stability Class Frequency Distributions (%) at the Project Sites (2018 to 2020)

PG Class	Mine Site	Mine Port
A	0.1	0.2
B	4.4	5.1
C	11.4	15.3
D	59.9	38.0
E	13.6	19.6
F	10.6	21.9
Total	100	100
NOTE: PG – Pasquill-Gifford.		

B.5 CALMET MODEL OPTIONS

The input parameters for the CALMET control file used for the assessment are provided in Tables B.7 to B.13. The Newfoundland Guidelines for Plume Dispersion Modelling indicates that default assumptions and switches are to be used. Although not specified in the Model Guideline, it is assumed that the default values are defined in the CALMET user manual (Scire et al. 2000). The default values and the values adopted for this assessment are identified in the tables.

Table B.7 Input Groups in the CALMET Control File

Input Group	Description	Applicable to Project
0	Input and output file names	Yes
1	General run control parameters	Yes
2	Grid control parameters	Yes
3	Output Options	Yes
4	Meteorological data options	Yes

Table B.7 Input Groups in the CALMET Control File

Input Group	Description	Applicable to Project
5	Wind Field Options and Parameters	Yes
6	Mixing Height, Temperature and Precipitation Parameters	Yes
7	Surface meteorological station parameters	No
8	Upper air meteorological station parameters	No
9	Precipitation parameters	No

Table B.8 CALMET Model Options Groups 0 and 1

Parameter	Default	Project	Comment
Input Group 0: Input and Output File Names			
NUSTA	-	0	Number of upper air stations
NOWSTA	-	0	Number of overwater meteorological stations
MM3D	-	36	Number of WRF.DAT files (one for each month)
NIGF	-	0	Number of IGF-CALMET.DAT files
Input Group 1: General Run Control Parameters			
IBYR	-	2018	Starting year
IBMO	-	1	Starting month
IBDY	-	1	Starting day
IBHR	-	0	Starting hour
IBSEC	-	0	Starting second
IEYR	-	2021	Ending year
IEMO	-	1	Ending month
IEDY	-	1	Ending day
IEHR	-	0	Ending hour
IESEC	-	0	Ending second
ABTZ	-	UTC-0400	UTC time zone
NSECDT	3,600	3,600	Length of modeling time-step (seconds)
IRTYPE	1	1	Run type = 1 computes wind fields and micro-meteorological fields. Run type = 1 required for CALPUFF.
LCALGRD	T	T	LCALGRD = 1 stores the special data fields required by CALPUFF.
ITEST	2	2	Flag to stop run after SETUP phase
MREG	-	0	Test options specified to see if they conform to regulatory values 0 = NO checks are made

Table B.9 CALMET Model Options Group 2: Grid control parameters

Parameter	Default	Project	Comment
PMAP	UTM	UTM	Map projection
IUTMZN	-	17	UTM Zone
UTMHEM	N	N	Hemisphere for UTM projection
DATUM	WGS-84	NAR-C	The NORTH AMERICAN 1983 GRS 80 Spheroid datum is used for output coordinates to be consistent with the applied CDED terrain data
NX	-	100 (Mine Site Domain) 115 (Mine Port Domain)	Number of X grid cells
NY	-	100 (Mine Site Domain) 115 (Mine Port Domain)	Number of Y grid cells
DGRIDKM	-	0.4	Horizontal grid spacing (km)
XORIGKM	-	542.485 (Mine Site Domain) 483.049 (Mine Port Domain)	Reference coordinate of SW corner of grid cell (1,1) -X coordinate (km)
YORIGKM	-	7893.731 (Mine Site Domain) 7949.521 (Mine Port Domain)	Reference coordinate of SW corner of grid cell (1,1) -Y coordinate (km)
NZ	-	12	Vertical grid definition: Number of vertical layers
ZFACE	-	0, 20, 40, 80, 120, 280, 520, 880, 1320, 1820, 3000 and 4000	Vertical grid definition: Cell face heights (m)

Table B.10 CALMET Model Options Group 3: Output Options

Parameter	Default	Project	Comment
Disk Output:			
LSAVE	T	T	Save meteorological fields in the unformatted output files
IFORMO	1	1	Unformatted output file suitable for input into CALPUFF is generated
Line Printer Output:			
LPRINT	F	F	LPRINT = F, do not print meteorological fields
IPRINF	1	1	Print intervals (h); used only if LPRINT = T.
IUVOUT (NZ)	NZ*0	12*0	Specify which layers of U, V wind component to print
IWOUT (NZ)	NZ*0	12*0	Specify which level of the w wind component to print
ITOUT (NZ)	NZ*0	12*0	Specify which levels of the 3-D temperature field to print
Meteorological fields to print:			
Variable		**0 = don't print 1 = print**	**Comment**
STABILITY		0	PGT stability; used only if LPRINT = T.
USTAR		0	Friction velocity; used only if LPRINT = T.
MONIN		0	Monin-Obukhov length; used only if LPRINT = T.
MIXHT		0	Mixing height; used only if LPRINT = T.
WSTAR		0	Convective velocity scale; used only if LPRINT = T.
PRECIP		0	Precipitation rate; used only if LPRINT = T.
SENSHEAT		0	Sensible heat flux; used only if LPRINT = T.
CONVZI		0	Convective mixing height; used only if LPRINT = T.
Testing and debug print options for micrometeorological module:			
LDB	F	F	Print input meteorological data and internal variables
NN1	1	1	First time step for which debug data are printed
NN2	1	1	Last time step for which debug data are printed
LDBCST	F	F	Print distance to land internal variables
Testing and debug print options for wind field module:			
Variable		**0 = don't write 1 = write**	**Comment**
IOUTD	0	0	Control variable for writing the test/debug wind fields to disk files
NZPRN2	1	1	Number of levels to print, starting at surface,
IPR0	0	0	Print the interpolated wind components
IPR1	0	0	Print the terrain adjusted surface wind components
IPR2	0	0	Print the smoothed wind components and the initial divergence fields
IPR3	0	0	Print the final wind speed and direction

Table B.10 CALMET Model Options Group 3: Output Options

Parameter	Default	Project	Comment
IPR4	0	0	Print the final divergence fields
IPR5	0	0	Print the winds after kinematic effects are added
IPR6	0	0	Print the winds after the Froude number adjustment is made
IPR7	0	0	Print the winds after slope flows are added
IPR8	0	0	Print the final wind field components

Table B.11 CALMET Model Options Group 4: Meteorological Data Options

Parameter	Default	Project	Comment
NOOBS	0 or 1 or 2	2	No surface, overwater stations and upper air observations Use WRF/3D for surface, overwater, and upper air data
Number of Surface & Precipitation Meteorological Stations:			
NSSTA	-	0	Number of surface stations used
NPSTA	-	-1	Precipitation stations not used
Cloud Data Options:			
ICLDOUT	-	Not applicable	output a CLOUD.DAT file (yes or no) 1=yes
MCLOUD	4	4	Use WRF gridded cloud data
File Formats:			
IFORMS	2	Not applicable	Used free-formatted surface meteorological data file
IFORMP	2	Not applicable	Precipitation data file format
IFORMC	2	Not applicable	Cloud data file format

Table B.12 CALMET Model Option Group 5: Wind Field Options and Parameters

Parameter	Default	Project	Comment
Wind Field Model Options:			
IWFCOD	1	1	Model selection variables
IFRADJ	1	1	Compute Froude number adjustment
IKINE	0	0	Compute kinematic effects
IOBR	0	0	Use O'Brien procedure for adjustment of the vertical velocity
ISLOPE	1	1	Compute slope flow effects
IEXTRP	-4	1	no extrapolation is done
ICALM	0	0	Extrapolate surface winds even if calm
BIAS	NZ*0	12*0	Layer-dependent biases modifying the weights of surface and upper air stations Zero BIAS leaves weights unchanged
RMIN2	4	Not applicable	Minimum distance from nearest upper air station to surface station for which extrapolation of surface winds at surface station will be allowed
IPROG	14	14	Use gridded prognostic wind field model output fields as input to the diagnostic wind field model. Set to 14 as WRF gridded model data was used as the main input to CALMET model for this assessment.
ISTEPPGs	3600	3600	Time step (seconds) of the prognostic model input data
IGFMET	0	0	Use coarse CALMET fields as initial guess fields
Radius of Influence Parameters:			
LVARY	F	F	Use varying radius of influence
RMAX1	-	Not Applicable	Maximum radius of influence over land in the surface layer (km)
RMAX2	-	Not Applicable	Maximum radius of influence over land aloft (km)
RMAX3	-	Not Applicable	Maximum radius of influence over water
Other Wind Field Input Parameters:			
RMIN	0.1	0.1	Minimum radius of influence used in the wind field interpolation (km)
TERRAD	-	5	Radius of influence of terrain features (km) based on local topographic conditions near the Project Site
R1	-	Not Applicable	Relative weighting of the first guess field and observations in the surface layer (km)
R2	-	Not Applicable	Relative weighting of the first guess field and observations in the layers aloft (km)
RPROG	-	0	Relative weighting parameter of the prognostic wind field data (km)
DIVLIM	5.0E-6	5.0E-6	Maximum acceptable divergence in the divergence minimization procedure

Table B.12 CALMET Model Option Group 5: Wind Field Options and Parameters

Parameter	Default	Project	Comment
NITER	50	50	Maximum number of iterations in the divergence minimization procedure
NSMTH (NZ)	2, (MXNZ-1)*4	2, 11*4	Number of passes in the smoothing procedure For NZ level 1, the CALMET default value 2 was used for the Project. For other levels, value 4 was used as CALMET input 12km WRF data already provided spatial wind fields
NINTR2	99	12*99	Maximum number of stations used in each layer for the interpolation of data to a grid point
CRITFN	1.0	1.0	Critical Froude number
ALPHA	0.1	0.1	Empirical factor controlling the influence of kinematic effects
FEXTR2(NZ)	NZ*0.0	12*0	Multiplicative scaling factor for extrapolation of surface observations to upper layers
Barrier Information:			
NBAR	0	0	Number of barriers to interpolation of the wind fields (The barrier option is not used)
KBAR	NZ	12	Level (1 to NZ) up to which barriers apply For this project, NZ=12
XBBAR	-	0	X coordinate of beginning of each barrier
YBBAR	-	0	Y coordinate of beginning of each barrier
XEBAR	-	0	X coordinate of ending of each barrier
YEBAR	-	0	Y coordinate of ending of each barrier
Diagnostic Module Data Input Options:			
IDIOPT1	0	0	Surface temperature (0 = compute internally from hourly surface observation)
ISURFT	-	-1	use 2-D spatially varying surface temperatures
IDIOPT2	0	0	Domain-averaged temperature lapse (0 = compute internally from hourly surface observation)
IUPT	-	Not Applicable	Not applicable since no upper air stations are used
ZUPT	200	200	Depth through which the domain-scale lapse rate is computed (m)
IDIOPT3	0	0	Domain-averaged wind components
IUPWND	-1	Not Applicable	Not applicable since no upper air stations are used
ZUPWND	1., 1000	Not Applicable	Bottom and top of layer through which domain-scale winds are computed (m). Not applicable since it is only used if IDIOPT3 = 0, NOOBS > 0 and IUPWND > 0
IDIOPT4	0	0	Observed surface wind components for wind field module
IDIOPT5	0	Not Applicable	Observed upper air wind components for wind field module
Lake Breeze Information:			
LLBREZE	F	F	Lake breeze module is not used

Table B.12 CALMET Model Option Group 5: Wind Field Options and Parameters

Parameter	Default	Project	Comment
NBOX	-	0	Number of lake breeze regions
XG1	-	0	X Grid line 1 defining the region of interest
XG2	-	0	X Grid line 2 defining the region of interest
YG1	-	0	Y Grid line 1 defining the region of interest
YG2	-	0	Y Grid line 2 defining the region of interest
XBCST	-	0	X Point defining the coastline in kilometres (Straight line)
YBCST	-	0	Y Point defining the coastline in kilometres (Straight line)
XECST	-	0	X Point defining the coastline in kilometres (Straight line)
YECST	-	0	Y Point defining the coastline in kilometres (Straight line)
NLB	-	0	Number of stations in the region
METBXID	-	0	Station ID's in the region

Table B.13 CALMET Model Option Group 6: Mixing Height, Temperature and Precipitation Parameters

Parameter	Default	Project	Comment
Empirical Mixing Height Constants:			
CONSTB	1.41	1.41	Neutral, mechanical equation
CONSTE	0.15	0.15	Convective mixing height equation
CONSTN	2400	2400	Stable mixing height equation
CONSTW	0.16	0.16	Over water mixing height equation
FCORIO	1.0E-4	1.0E-04	Absolute value of Coriolis parameter
Spatial Averaging of Mixing Heights:			
IAVEZI	1	1	Conduct spatial averaging
MNMDAV	1	1	Maximum search radius in averaging (grid cells)
HAFANG	30	30	Half-angle of upwind looking cone for averaging
ILEVZI	1	1	Layer of winds used in upwind averaging
Convective Mixing Heights Options:			
IMIXH	1	1	Method to compute the convective mixing height (Maul-Carson)
THRESHL	0.0	0.0	Threshold buoyancy flux required to sustain convective mixing height growth overland (W/m^3)
THRESHW	0.05	0.05	Threshold buoyancy flux required to sustain convective mixing height growth overwater (W/m^3)
IZICRLX	1	1	Flag to allow relaxation of convective mixing height to equilibrium value when 0<QH<THRESHL (overland) or 0<QH<THRESHW (overwater)

Table B.13 CALMET Model Option Group 6: Mixing Height, Temperature and Precipitation Parameters

Parameter	Default	Project	Comment
TZICRLX	800	800	Relaxation time of convective mixing height to equilibrium value Used only if IZICRLX = 1 and TZICRLX must be >= 1.
ITWPROG	0	0	Option for overwater lapse rates used in convective mixing height growth (1=use prognostic lapse rates)
ILUOC3D	16	16	Land use category ocean in 3D.DAT datasets
Other Mixing Height Variables:			
DPTMIN	0.001	0.001	Minimum potential temperature lapse rate in the stable layer above the current convective mixing height (K/m)
DZZI	200	200	Depth of layer above current convective mixing height through which lapse rate is computed (m)
ZIMIN	50	50	Minimum overland mixing height (m)
ZIMAX	3,000	3,000	Maximum overland mixing height (m)
ZIMINW	50	50	Minimum overwater mixing height (m)
ZIMAXW	3,000	3,000	Maximum overwater mixing height (m)
Overwater Surface Fluxes Method and Parameters:			
ICOARE	10	10	Overwater surface fluxes method Set to 10 means COARE with no wave parameterization
DSHELF	0	0	Coastal/Shallow water length scale (km)
IWARM	0	0	COARE warm layer computation
ICOOL	0	0	COARE cool skin layer computation
Relative Humidity Parameters:			
IRHPROG	1	1	Use the WRF gridded relative humidity data
Temperature Parameters:			
ITPROG	-	2	No surface or upper air observations Use the WRF gridded surface temperature data
IRAD	1	1	Interpolation type
TRADKM	-	Not Applicable	Radius of influence for temperature interpolation (km)
NUMTS	5	Not Applicable	Maximum number of stations to include in temperature interpolation
IAVET	1	1	Conduct spatial averaging of temperatures (1 = yes)
TGDEFB	-0.0098	-0.0098	Default temperature gradient below the mixing height over water (K/m)
TGDEFA	-0.0045	-0.0045	Default temperature gradient above the mixing height over water (K/m)

Table B.13 CALMET Model Option Group 6: Mixing Height, Temperature and Precipitation Parameters

Parameter	Default	Project	Comment
JWAT1	-	55	Beginning land use categories for temperature interpolation over water
JWAT2	-	55	Ending land use categories for temperature interpolation over water
Precipitation Interpolation Parameters:			
NFLAGP	2	Not Applicable	Method of interpolation
SIGMAP	100	Not Applicable	Radius of Influence (km) Not Applicable for this project as no precipitation station data were used
CUTP	0.01	Not Applicable	Minimum Precipitation rate cut-off (mm/h)

B.6 REFERENCES

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C.1 Modelled Emission Sources

C.1.1 Mine Site

Twenty-seven sources were created to model the Mine Site emissions during operation. The emission sources at the Mine Site and their dispersion modelling parameters are provided in Table C.1, Table C.2 and Table C.3 for volume, area and road sources, respectively. These sources include:

- Three volume sources representing the Mine Site primary crushers (PCA, PCB and PCC) at the crushing facility.
- Two volume sources representing the secondary crushers (SCB and SCC) at the crushing facility.
- Three groups of volume sources representing the three crusher conveyor systems and material transfer points (CRA, CRB and CRC) at the crushing facility.
- One volume source representing the radial stacker to the fine ore stockpile (ST2FOP) at the crushing facility.
- Two collocated open pit sources representing blasting (BLAST) and fugitive dust and diesel exhaust emissions from mining off-road equipment (PIT) in the open pit.
- Three collocated area sources representing trucks unloading at the waste rock pile (TUWASTE), bulldozing emissions at the waste rock pile (WASTE) and wind erosion of the waste rock pile (WEWASTE).
- Three collocated area sources representing trucks unloading at the ROM ore stockpile (TUROM), bulldozing emissions at the ROM ore stockpile (ROM) and wind erosion of the ROM ore stockpile (WEROM).
- Two collocated area sources representing trucks unloading at the crushing facility (TUCRUSHF) and bulldozing and front-end loader movement emissions at the crushing facility (CRUSHF).
- Three area sources representing wind erosion emissions at the fine ore stockpiles (WEFINE1 and WEFINE2) and the lump ore stockpile (WELUMP) at the crushing facility.
- One area source representing fugitive dust and diesel exhaust emissions from supporting equipment at the general facility area (GA).
- Two road sources (consisting of multiple line segments) representing mechanically generated dust emissions and diesel exhaust emissions from haul trucks along the haul roads from the open pit to the primary crusher (HRPC) and from the open pit to the waste rock pile (HRWR).
- Two road sources (consisting of multiple line segments) representing seasonal traffic emissions along Tote Road (TOTERDS) and continuous emissions from truck traffic and maintenance equipment along Tote Road (TOTERDC).

C.1.2 Milne Port

Fifteen sources were created to model Milne Port emissions during operation. The modelled emission sources at Milne Port and their dispersion modelling parameters are provided in Table C.4, Table C.5 and Table C.6 for volume, area and road sources, respectively. These sources include:

- One group of volume sources representing radial stacker transfer points to the fine ore stockpile (ST2FOS)
- One group of volume sources representing radial stacker transfer points to the lump ore stockpile (ST2LOS)
- One group of volume sources representing front-end loaders loading ore to ship loading conveyor (FEL2SL)
- One volume source representing ship loading conveyor discharge chute to Panamax ship (FOSL2PS).
- Two collocated area sources representing truck unloading at the fine ore stockpile (TUFINE) and emissions from bulldozing and the operation of the front-end loaders at the fine ore stockpile (FINE).
- Two collocated area sources representing truck unloading at the lump ore stockpile (TULUMP) and emissions from bulldozing and the operation of the front-end loaders at the lump ore stockpile (LUMP).
- Two area sources representing wind erosion emissions from the fine ore stockpile (WEFINE) and the lump ore stockpile (WELUMP).
- One area source representing the front-end loaders movement loading ore to the ship loading conveyor (FELLOAD).
- One area source representing fugitive dust and diesel exhaust emissions from supporting equipment at the general facility area (GAMP).
- One road source (consisting of multiple line segments) representing mechanically generated dust emissions and diesel exhaust emissions from haul trucks along the haul road around the ore stockpiles (HRFS).
- Two road sources (consisting of multiple line segments) representing seasonal traffic emissions along Tote Road (TOTERDS) and continuous emissions from truck traffic and maintenance equipment along Tote Road (TOTERDC).

Table C.1 Model Volume Sources and Emission Rates at the Mine Site

Source ID	Volume Source Description	Temporal Allocation	UTM Coordinates (UTM Zone 17N, NAD 83)		Base Elevation	Initial Plume Width [a]	Initial Plume Height [a]	Release Height [a]	Initial Sigma Y [a]	Initial Sigma Z [a]	Model Emission Rates					
			Easting	Northing							FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(m)	(m)	(m asl)	(m)	(m)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
PCA	Primary Crusher A	Continuous	561,720	7,913,091	214	5.00	5.00	2.50	1.16	2.33	0.193	0.086	0.004	-	-	-
CRA [b] (CRA_T1-CRA_T9)	Crusher Conveyor A	Continuous, varying by wind speed	561,729 561,710 561,695 561,697 561,691 561,681 561,688 561,667 561,685	7,913,095 7,913,086 7,913,079 7,913,061 7,913,058 7,913,054 7,913,057 7,913,047 7,913,038	212	3.00	5.00	2.50	0.70	2.33	2.93	1.38	0.210	-	-	-
PCB	Primary Crusher B	Continuous	561,736	7,913,030	212	5.00	5.00	2.50	1.16	2.33	0.164	0.073	0.003	-	-	-
SCB	Secondary Crusher B	Continuous	561,727	7,913,005	211	3.00	5.00	2.50	0.70	2.33	0.164	0.073	0.003	-	-	-
CRB [b] (CRB_T1-CRB_T11)	Crusher Conveyor B	Continuous, varying by wind speed	561,746 561,726 561,719 561,727 561,709 561,717 561,708 561,696 561,705 561,692 561,684	7,913,035 7,913,024 7,913,021 7,913,005 7,913,016 7,913,001 7,912,997 7,912,992 7,912,996 7,913,012 7,912,988	211	3.00	5.00	2.50	0.70	2.33	0.771	0.365	0.055	-	-	-
PCC	Primary Crusher C	Continuous	561,761	7,912,974	211	5.00	5.00	2.50	1.16	2.33	0.164	0.073	0.003	-	-	-
SCC	Secondary Crusher C	Continuous	561,747	7,912,948	210	3.00	5.00	2.50	0.70	2.33	0.164	0.073	0.003	-	-	-
CRC [b] (CRC_T1-CRC_T11)	Crusher Conveyor C	Continuous, varying by wind speed	561,771 561,748 561,741 561,747 561,732 561,737 561,730 561,717 561,726 561,730 561,704	7,912,979 7,912,968 7,912,964 7,912,948 7,912,960 7,912,943 7,912,940 7,912,933 7,912,938 7,912,920 7,912,925	210	3.00	5.00	2.50	0.70	2.33	0.771	0.365	0.055	-	-	-

Table C.1 Model Volume Sources and Emission Rates at the Mine Site

Source ID	Volume Source Description	Temporal Allocation	UTM Coordinates (UTM Zone 17N, NAD 83)		Base Elevation	Initial Plume Width [a]	Initial Plume Height [a]	Release Height [a]	Initial Sigma Y [a]	Initial Sigma Z [a]	Model Emission Rates					
			Easting	Northing							FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(m)	(m)	(m asl)	(m)	(m)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
ST2FOP [b] (ST2FOP_T1 ST2FOP_T3)	Radial Stacker to Fine Ore Stockpile	Continuous, varying by wind speed	561,816	7,912,871	211	3.90	4.20	2.10	0.91	1.95	0.379	0.179	0.027	-	-	-
			561,829	7,912,872	211	3.00	5.00	2.50	0.70	2.33						
			561,863	7,912,872	212	3.00	3.00	16.0	0.70	0.70						

NOTES:
[a] Dispersion modelling parameters were estimated based on the conveyor dimensions and drop distances and following US EPA guidance for defining dispersion parameters for volume sources (US EPA 2021).
[b] Emission rates correspond to the annual average wind speed (4.55 m/s) at the Mine Site. Material transfer emissions are modelled as varying emissions by wind speed.
FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges
DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges
"-" not applicable

Table C.2 Model Area Sources and Emission Rates at the Mine Site

Source ID	Area Source Description	Temporal Allocation	UTM Coordinates (UTM Zone 17N, NAD 83)		Base Elevation	Area	Initial Plume Height [a]	Release Height [a]	Initial Sigma Z [a]	Model Emission Rates					
			Easting	Northing						FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(m)	(m)	(m asl)	(m²)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
PIT	Mining activities and mining off-road equipment operating in the open pit	Continuous	563,030	7,914,610	600	615,435	11.90	5.95	5.53	15.0	7.60	1.10	0.073	0.073	0.071
BLAST	Blasting in the open pit	1 hour/week	563,030	7,914,610	600	615,435	10.00	5.00	5.00	76.9	76.0	4.52	-	-	-
WASTE	Bulldozing emissions at the waste rock pile	Continuous	562,737	7,916,658	600	741,515	6.80	33.40	3.16	0.263	0.034	0.028	0.014	0.014	0.013
TUWASTE [b]	Haul trucks unloading at the waste rock pile	Continuous, varying by wind speed	562,737	7,916,658	600	741,515	26.7	43.3	12.4	0.262	0.124	0.019	-	-	-
WEWASTE [c]	Wind erosion emissions of the waste rock pile	Only when wind speed > 16.4 m/s, varying by wind speed	562,737	7,916,658	600	741,515	2.0	30.0	1.0	18.6	9.29	1.39	-	-	-
ROM	Bulldozing emissions at the ROM ore stockpile	Continuous	563,636	7,913,431	314	79,426	6.80	3.40	3.16	0.263	0.034	0.028	0.014	0.014	0.013
TUROM [b]	Haul trucks unloading at the ROM ore stockpile	Continuous, varying by wind speed	563,636	7,913,431	314	79,426	26.7	13.35	12.4	0.014	0.007	0.001	-	-	-
WEROM [c]	Wind erosion emissions of the ROM ore stockpile	Only when wind speed > 16.4 m/s, varying by wind speed	563,636	7,913,431	314	79,426	2.0	15.00	1.0	4.65	2.32	0.348	-	-	-
CRUSHF	Crushing facility - bulldozing and front-end movement	Continuous	561,777	7,913,151	211	78,022	5.95	2.98	2.77	45.6	12.2	1.28	0.106	0.106	0.103
TUCRUSHF [b]	Haul trucks unloading at the crushing facility	Continuous, varying by wind speed	561,723	7,913,126	211	14,105	26.7	23.35	12.41	0.462	0.218	0.033	-	-	-
GA	General facilities area	Continuous	561,398	7,913,249	212	74,257	5.10	2.55	2.37	28.2	7.35	0.738	0.054	0.054	0.052
WEFINE1 [d]	Wind erosion of fine ore stockpile 1	Only when wind speed > 13.5 m/s, varying by wind speed	561,628	7,912,891	208	4,725	2.0	3.00	1.00	-	-	-	2.084	1.042	0.156
WEFINE2 [d]	Wind erosion of fine ore stockpile 2	Only when wind speed > 13.5 m/s, varying by wind speed	561,923	7,912,841	212	8,860	2.0	11.00	1.00	-	-	-	20.5	10.3	1.54

Table C.2 Model Area Sources and Emission Rates at the Mine Site

Source ID	Area Source Description	Temporal Allocation	UTM Coordinates (UTM Zone 17N, NAD 83)		Base Elevation	Area	Initial Plume Height [a]	Release Height [a]	Initial Sigma Z [a]	Model Emission Rates					
			Easting	Northing						FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(m)	(m)	(m asl)	(m^2)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
WELUMP [c]	Wind erosion of lump ore stockpile	Only when wind speed > 16.4 m/s, varying by wind speed	562,136	7,912,449	207	4,700	2.0	3.00	1.00	-	-	-	0.418	0.209	0.031

NOTES:
[a] Dispersion modelling parameters were estimated based on the dimensions of the predominant mining equipment (e.g., haul truck, bulldozer) operating on site and following US EPA guidance for defining dispersion parameters for haul roads (US EPA 2012) and volume sources (US EPA 2021).
[b] Emission rates correspond to the annual average wind speed (4.55 m/s) at the Mine Site. Material transfer emissions are modelled as varying emissions by wind speed.
[c] Wind erosion emissions are modelled as varying emission rates with wind speed. Wind erosion emissions are generated only when the wind speed is greater than 16.4 m/s.
[d] Wind erosion emissions are modelled as varying emission rates with wind speed. Wind erosion emissions are generated only when the wind speed is greater than 13.5 m/s.
FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges
DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges
"-" not applicable

Table C.3 Model Road Sources and Emission Rates at the Mine Site

Source ID	Road Source Description	Temporal Allocation	Road Length	Road Width	Initial Plume Height [a]	Release Height [a]	Initial Sigma Y [a]	Initial Sigma Z [a]	Model Emission Rates					
									FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(km)	(m)	(m)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
HRPC [b]	Haul road from the open pit to the crushing facility	Continuous, varying by season	6.30	40	11.90	5.95	21.40	5.53	17.9	4.66	0.469	0.318	0.318	0.308
HRWR [b]	Haul road from the open pit to the waste rock pile	Continuous, varying by season	2.40	40	11.90	5.95	21.40	5.53	4.22	1.11	0.112	0.082	0.082	0.079
TOTERDC [c]	Tote Road - continuous traffic	Continuous, varying by season	16.87	30	8.50	4.25	16.74	3.95	146	37.8	3.80	0.041	0.041	0.035
TOTERDS [c]	Tote Road - seasonal fuel tankers	August to September	16.87	30	8.50	4.25	16.74	3.95	9.36	2.42	0.242	0.002	0.002	0.001

NOTES:
[a] Dispersion modelling parameters were estimated based on the dimensions of the haul trucks and following US EPA guidance for defining dispersion parameters for haul roads (US EPA 2012) and volume sources (US EPA 2021).
[b] Fugitive dust emission rates from haul roads include 75% dust control efficiency due to road watering in summer. Summer is assumed 6 months – May to October.
[c] Fugitive dust emission rates from the Tote Road include 50% dust control efficiency in summer based on measured monthly dustfall along Tote Road during the 2020 dustfall monitoring program (EDI 2021). Summer is assumed 6 months – May to October.
FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges
DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges
"-" not applicable

Table C.4 Model Volume Sources at Milne Port

Source ID	Volume Source Description	Temporal Allocation	UTM Coordinates (UTM Zone 17N, NAD 83)		Base Elevation	Initial Plume Width [a]	Initial Plume Height [a]	Release Height [a]	Initial Sigma Y [a]	Initial Sigma Z [a]	Model Emission Rates					
			Easting	Northing							FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(m)	(m)	(m asl)	(m)	(m)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
ST2FOS [b] (ST2FOS1-ST2FOS6)	Radial stacker to fine ore stockpile	Continuous, varying by wind speed	503,172 503,167 503,165 503,161 503,033 503,070	7,975,969 7,976,063 7,976,157 7,976,253 7,976,038 7,976,127	16.0	3.00	3.00	15.0	0.70	0.70	0.173	0.082	0.012	-	-	-
ST2LOS [b] (ST2LOS1-ST2LOS4)	Radial stacker to lump ore stockpile	Continuous, varying by wind speed	503,363 503,358 503,355 503,350	7,975,942 7,976,045 7,976,160 7,976,275	15.0	3.00	3.00	15.0	0.70	0.70	0.402	0.190	0.029	-	-	-
FEL2SL [b] (FEL2SL1-FEL2SL7)	Front-end loaders loading ore from ore stockpiles to ship loading conveyor	July to October, varying by wind speed	503,273 503,269 503,266 503,262 503,259 503,257 503,254	7,975,790 7,975,877 7,976,020 7,976,105 7,976,196 7,976,259 7,976,351	16.0	3.00	3.00	4.0	0.70	0.70	1.71	0.809	0.123	-	-	-
SL2PS [b, d]	Ship loading conveyor discharge chute to Panamax ship	July to October, varying by wind speed	503,274	7,976,666	0.0	3.00	3.00	20.00	0.70	0.70	0.171	0.081	0.012	-	-	-

NOTES:
[a] Dispersion modelling parameters were estimated based on the dimensions of the predominant mining equipment (e.g., haul truck, front-end loader) operating on site and following US EPA guidance for defining dispersion parameters for haul roads (US EPA 2012) and volume sources (US EPA 2021).
[b] Emission rates correspond to the annual average wind speed (3.14 m/s) at Milne Port. Material transfer emissions are modelled as varying emissions by wind speed.
[d] Fugitive dust emission rates from ship loading include 80% dust control efficiency due to using telescopic chutes for ore loading into the ships.
FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges
DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges
"-" not applicable

Table C.5 Model Area Sources at Milne Port

Source ID	Area Source Description	Temporal Allocation	UTM Coordinates (UTM Zone 17N, NAD 83)		Base Elevation	Area	Initial Plume Height [a]	Release Height [a]	Initial Sigma Z [a]	Model Emission Rates					
			Easting	Northing						FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(m)	(m)	(m asl)	(m²)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
LUMP	Bulldozing and front-end loader movement at lump ore stockpile	Continuous	503,300	7,975,902	16.0	19,970	6.80	3.40	3.16	7.97	2.11	0.220	0.016	0.016	0.016
TULUMP [b]	Haul trucks unloading at the lump ore stockpile	Continuous, varying by wind speed	503,300	7,975,902	16.0	19,970	12.1	6.03	5.61	0.602	0.285	0.043	-	-	-
WELUMP [c, e]	Wind erosion emissions of the lump ore stockpile	Only when wind speed > 16.4 m/s, varying by wind speed	503,300	7,975,902	11.2	53,929	2.0	15.0	1.00	8.39	4.20	0.629	-	-	-
FINE	Bulldozing and front-end loader movement at fine ore stockpile	Continuous	503,236	7,975,909	15.6	58,062	6.80	3.40	3.16	13.3	3.51	0.367	0.027	0.027	0.026
TUFINE [b]	Haul trucks unloading at the fine ore stockpile	Continuous, varying by wind speed	503,236	7,975,909	15.6	58,062	12.1	6.03	5.61	0.260	0.123	0.019	-	-	-
WEFINE [d, e]	Wind erosion emissions of the fine ore stockpile	Only when wind speed > 13.5 m/s, varying by wind speed	503,236	7,975,909	13.8	85,557	2.0	15.0	1.00	28.4	14.2	2.13	-	-	-
FELLOAD	Front-end loaders operation at the ship loading conveyor	July to October	503,223	7,976,323	13.3	32,280	5.95	2.98	2.77	10.4	2.69	0.269	0.023	0.023	0.022
GAMP	General facility area	Continuous	503,458	7,975,846	14.1	277,300	5.10	2.55	2.37	14.4	3.71	0.381	0.023	0.023	0.022

NOTES:
[a] Dispersion modelling parameters were estimated based on the dimensions of the predominant mining equipment (e.g., haul truck, bulldozer) operating on site and following US EPA guidance for defining dispersion parameters for haul roads (US EPA 2012) and volume sources (US EPA 2021).
[b] Emission rates correspond to the annual average wind speed (3.14 m/s) at Milne Port. Material transfer emissions are modelled as varying emissions by wind speed.
[c] Wind erosion emissions are modelled as varying emission rates with wind speed. Wind erosion emissions are generated only when the wind speed is greater than 16.4 m/s.
[d] Wind erosion emissions are modelled as varying emission rates with wind speed. Wind erosion emissions are generated only when the wind speed is greater than 13.5 m/s.
[e] Only the actively loaded stockpile area was used to estimate wind erosion emissions. The finished stockpiles are treated with chemical dust suppressant (DusTreat®) and are not expected to generate wind erosion emissions.
FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges
DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges
"-" not applicable

Table C.6 Model Road Sources at Milne Port

Source ID	Road Source Description	Temporal Allocation	Road Length	Road Width	Initial Plume Height [a]	Release Height [a]	Initial Sigma Y [a]	Initial Sigma Z [a]	Model Emission Rates					
									FTSP	FPM_{10}	$FPM_{2.5}$	DTSP	DPM_{10}	$DPM_{2.5}$
			(km)	(m)	(m)	(m)	(m)	(m)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
HRFS [b]	Haul road around the ore stockpiles	Continuous, varying by season	2.04	30	5.51	2.75	16.74	2.56	1.47	0.381	0.038	0.200	0.200	0.194
TOTERDC [c]	Tote Road - continuous traffic	Continuous, varying by season	28.55	30	8.50	4.25	16.74	3.95	240	62.3	6.24	0.051	0.051	0.041
TOTERDS [c]	Tote Road - seasonal fuel tankers	August to September	28.55	30	8.50	4.25	16.74	3.95	15.8	4.10	0.410	0.003	0.003	0.002

NOTES:
[a] Dispersion modelling parameters were estimated based on the dimensions of the haul trucks and following US EPA guidance for defining dispersion parameters for haul roads (US EPA 2012) and volume sources (US EPA 2021).
[b] Fugitive dust emission rates from haul roads include 75% dust control efficiency due to road watering in summer. Summer is assumed 6 months – May to October.
[c] Fugitive dust emission rates from the Tote Road include 50% dust control efficiency due to road watering in summer. Summer is assumed 6 months – May to October.
FTSP, FPM_{10}, $FPM_{2.5}$ – fugitive particulate matter of different particle size ranges
DTSP, DPM_{10}, $DPM_{2.5}$ – diesel particulate matter of different particle size ranges
"-" not applicable

C.2 CALPUFF Model Options

The CALPUFF control file defines 20 input groups as identified in Table C.1. The input parameters for the CALPUFF control file used in this modelling assessment are provided in Tables C.2 to C.9. The Newfoundland and Labrador Guideline for Plume Dispersion Modelling (Government of Newfoundland and Labrador 2012) specifies required options/switches to be used in the model control file. The Guideline-required values are highlighted by orange shading in the tables. The default options/switches which are not explicitly specified in the Guideline are assumed to be those defined in the CALPUFF user manual (Scire et al. 2000). The default values and the values adopted for this assessment are identified in the tables.

Table C.1 Input Groups in the CALPUFF Control File

Input Group	Description	Applicable to Project?
0	Input and output file names	Yes
1	General run control parameters	Yes
2	Technical options	Yes
3	Species list	Yes
4	Map projection and grid control parameters	Yes
5	Output options	Yes
6	Sub grid scale complex terrain inputs	No
7	Dry deposition parameters for gases	Yes
8	Dry deposition parameters for particles	Yes
9	Miscellaneous dry deposition for parameters	Yes
10	Wet deposition parameters	Yes
11	Chemistry parameters	Yes
12	Misc. dispersion and computational parameters	Yes
13	Point source parameters	Yes
14	Area source parameters	Yes
15	Line source parameters	No
16	Volume source parameters	Yes
17	Flare source control parameters	No
18	Road emissions parameters	Yes
19	Emission rate scale-factor tables	Yes

Table C.2 CALPUFF Model Options Groups 1 and 2

Input Group 1: General Run Control Parameters

Parameter	Default	Project	Comments
METRUN	0	0	All model periods in met file(s) will be run
IBYR	-	2018	Starting year
IBMO	-	1	Starting month
IBDY	-	1	Starting day
IBHR	-	0	Starting hour
IEYR	-	2020	Ending year
IEMO	-	1	Ending month
IEDY	-	1	Ending day
IEHR	-	0	Ending hour
ABTZ		UTC-0400	Base time zone (4)
NSPEC	5	6	Number of chemical species
NSE	3	6	Number of chemical species to be emitted
ITEST	2	2	Program is executed after SETUP phase
MRESTART	0	0	Do not read or write a restart file during run
NRESPD	0	0	File written only at last period
METFM	1	1	CALMET binary file (CALMET.MET)
MPRFFM	1	1	CTDM plus tower file
AVET	60	60	Averaging time in minutes
PGTIME	60	60	PG Averaging time in minutes
IOUTU	1	1	Output units for binary concentration and flux files written in Dataset v2.2 or later formats. 1 = mass - g/m^3 (concentration) or $g/m^2/s$ (deposition)

Input Group 2: Technical Options

Parameter	Default	Project	Comments
MGAUSS	1	1	Gaussian distribution used in near field
MCTADJ	3	3	Partial plume path terrain adjustment
MCTSG	0	0	Scale-scale complex terrain not modelled
MSLUG	0	0	Near-field puffs not modelled as elongated
MTRANS	1	1	Transitional plume rise modelled
MTIP	1	1	Stack tip downwash used
MRISE	1	1	Method used to compute plume rise for point sources not subject to building downwash 1 = Briggs plume rise
MTIP_FL	0	0	No stack-tip downwash for flare sources
MRISE_FL	2	2	Plume rise module for flare sources; 2=Numerical plume rise

Table C.2 CALPUFF Model Options Groups 1 and 2

Input Group 2: Technical Options (cont'd)

Parameter	Default	Project	Comments
MBDW	2	2	PRIME Method is used to simulate building downwash
MSHEAR	0	0	Vertical wind shear is not modelled
MSPLIT	1	1	Puff splitting allowed
MCHEM	6	0	Chemical transformation not modelled
MAQCHEM	1	0	Aqueous phase transformation not modelled
MLWC	0	0	Liquid Water Content flag (Used only if MAQCHEM = 1)
MWET	1	1	Wet removal modelled
MDRY	1	1	Dry deposition modelled
MTILT	0	0	Gravitational settling (plume tilt) not modelled
MDISP	2	2	Dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables (u*, w*, L, etc.)
MTURBVW	3	3	Use both σ_v and σ_w from PROFILE.DAT to compute σ_y and σ_z (n/a)
MDISP2	3	3	PG dispersion coefficients for rural areas (computed using ISCST3 approximation) and MP coefficients in urban areas when measured turbulence data is missing
MTAULY	0	0	Draxler default 617.284 (s)
MTAUADV	0	0	No turbulence advection
MCTURB	1	1	Standard CALPUFF subroutines
MROUGH	0	0	PG σ_y and σ_z is not adjusted for roughness
MPARTL	1	1	Partial plume penetration of elevated inversion
MPARTLBA	1	1	Partial plume penetration of elevated inversion modelled for the buoyant area sources
MTINV	0	0	Strength of temperature inversion computed from default gradients
MPDF	1	1	The probability density function (PDF) to be used for dispersion under convective conditions
MSGTIBL	0	0	Sub-grid TIBL module not used for shoreline
MBCON	0	0	Boundary concentration conditions not modelled
MSOURCE	0	0	Individual source contributions not saved
MFOG	0	0	Do not configure for FOG model output
MREG	0	0	Do not test options specified to see if they conform to regulatory values

Table C.3 CALPUFF Model Options Groups 3 and 4

Input Group 3: Species List-Chemistry Options

CSPEC	Modelled[1]	Emitted[2]	Dry Deposition[3]	Output Group Number
$PM_{2.5}$ (Combustion product)	1	1	2	0
$PM_{2.5}$ to PM_{10} range (Combustion product)	1	1	2	0
PM_{10} to TSP (Combustion product)	1	1	2	0
$PM_{2.5}$ (Fugitive dust)	1	1	2	0
$PM_{2.5}$ to PM_{10} range (Fugitive dust)	1	1	2	0
PM_{10} to TSP (Fugitive dust)	1	1	2	0

NOTES:
[1] 0=no, 1=yes
[2] 0=no, 1=yes
[3] 0=none, 1=computed-gas, 2=computed particle, 3=user-specified

Input Group 4: Map Projection and Grid Control Parameters

Parameter	Default	Project	Comments
PMAP	UTM	UTM	Universal Transverse Mercator
FEAST	0	0	False Easting (km) at the projection origin
FNORTH	0	0	False Northing (km) at the projection origin
IUTMZN	-	17	UTM zone
UTMHEM	N	N	Northern Hemisphere for UTM projection
DATUM	WGS-84	NAR-C	North American 1983 GRS 80 Spheroid, Mean for Conus (NAD83)
NX	-	100	Number of X grid cells in meteorological grid
NY		100	Number of Y grid cells in meteorological grid
NZ	No default	12	Vertical grid definition: Number of vertical layers as per the AEP Model Guideline.
DGRIDKM	-	0.4	Grid spacing (km) to match CALMET (see Appendix B)
ZFACE	No default	0, 20, 40, 80, 120, 280, 520, 880, 1320, 1820, 2380, 3000 and 4000	Vertical grid definition: Cell face heights (m)

Table C.3 CALPUFF Model Options Groups 3 and 4

Input Group 4: Map Projection and Grid Control Parameters (cont'd)

Parameter	Default	Project	Comments
XORIGKM	-	542.485	Reference X coordinate for SW corner of grid cell (1,1) of meteorological grid (km)
YORIGKM	-	7893.731	Reference Y coordinate for SW corner of grid cell (1,1) of meteorological grid (km)
IBCOMP	-	1	X index of lower left corner of the computational grid
JBCOMP	-	1	Y index of lower left corner of the computational grids
IECOMP	-	100	X index of the upper right corner of the computational grid
JECOMP	-	100	Y index of the upper right corner of the computational grid
LSAMP	T	F	Sampling grid is not used
IBSAMP	-	1	X index of lower left corner of the sampling grid
JBSAMP	-	1	Y index of lower left corner of the sampling grid
IESAMP	-	100	X index of upper right corner of the sampling grid
JESAMP	-	100	Y index of upper right corner of the sampling grid
MESHDN	1	1	Nesting factor of the sampling grid

Table C.4 CALPUFF Model Option Group 5

Input Group 5: Output Option

Parameter	Default	Project	Comments
ICON	1	1	Output file CONC.DAT containing concentrations is created
IDRY	1	1	Output file DFLX.DAT containing dry fluxes is created
IWET	1	1	Output file WFLX.DAT containing wet fluxes is created
IT2D	0	0	2D Temperature
IRHO	0	0	Density
IVIS	1	0	Output file containing relative humidity data is not created
LCOMPRS	T	T	Do not perform data compression in output file
IQAPLOT	1	0	Create a standard series of output files (e.g., locations of sources, receptors, grids ...) suitable for plotting
IMFLX	0	0	Do not calculate mass fluxes across specific boundaries
IPFTRAK	0	0	Puff locations and properties reported to PFTRAK.DAT file for postprocessing
IMBAL	0	0	Mass balances for each species are not reported hourly
INRISE	0	0	Create a file with plume properties for each rise increment
ICPRT	0	1	print concentration fields to the output list file
IDPRT	0	0	Do not print dry flux fields to the output list file
IWPRT	0	0	Do not print wet flux fields to the output list file
ICFRQ	1	24	Concentration fields are printed to output list file every 24-hour
IDFRQ	1	24	Dry flux fields are printed to output list file every 24-hour
IWFRQ	1	24	Wet flux fields are printed to output list file every 24-hour
IPRTU	1	3	Units for line printer output are in μg/m^3 for concentration and μg/m^2/s for deposition
IMESG	2	2	Messages tracking the progress of run are written on screen
LDEBUG	F	F	Logical value for debug output
IPFDEB	1	1	First puff to track
NPFDEB	1	1	Number of puffs to track
NN1	1	1	Meteorological period to start output
NN2	10	10	Meteorological period to end output

Table C.4 CALPUFF Model Option Group 5

Input Group 5: Output Option (cont'd)

Species	Concentrations Printed (0= no, 1 = yes)		Dry Fluxes Printed (0 = no, 1 = yes)		Wet Fluxes Printed (0 = no, 1 = yes)		Mass Flux
	Printed	Saved to Disk	Printed	Saved to Disk	Printed	Saved to Disk	Saved to Disk
$PM_{2.5}$ (Combustion product)	1	1	0	1	0	1	0
$PM_{2.5}$ to PM_{10} range (Combustion product)	0	1	0	1	0	1	0
PM_{10} to TSP (Combustion product)	0	1	0	1	0	1	0
$PM_{2.5}$ (Fugitive dust)	0	1	0	1	0	1	0
$PM_{2.5}$ to PM_{10} range (Fugitive dust)	0	1	0	1	0	1	0
PM_{10} to TSP (Fugitive dust)	0	1	0	1	0	1	0

Table C.5 CALPUFF Model Option Groups 6 and 7

Input Group 6: Sub-Grid Scale Complex Terrain Inputs

Parameter	Default	Project	Comments
NHILL	0	0	Number of terrain features
NCTREC	0	0	Number of special complex terrain receptors
MHILL	-	2	Hill data created by OPTHILL & input below in Subgroup (6b); Receptor data in Subgroup (6c)
XHILL2M	1	1	Conversion factor for changing horizontal dimensions to metres
ZHILL2M	1	1	Conversion factor for changing vertical dimensions to metres
XCTDMKM	-	0	X origin of CTDM system relative to CALPUFF coordinate system (km)
YCTDMKM	-	0	Y origin of CTDM system relative to CALPUFF coordinate system (km)

Table C.6 CALPUFF Model Option Groups 8, 9, 10, and 11

Input Group 8: Dry Deposition Parameters for Particles

Species	Geometric mass mean diameter [µm]	Geometric standard deviation [µm]
$PM_{2.5}$ (Combustion product)	1.25	1.2418578
$PM_{2.5}$ to PM_{10} range (Combustion product)	5.00	1.2418578
PM_{10} to TSP (Combustion product)	21.5	1.2418578
$PM_{2.5}$ (Fugitive dust from ore)	20.00	1.2418578
$PM_{2.5}$ to PM_{10} range (Fugitive dust from ore)	11.25	1.2418578
PM_{10} to TSP (Fugitive dust from ore)	44.79	1.2418578
PM2.5 (Fugitive dust from waste rock)	2.20	1.2418578
$PM_{2.5}$ to PM_{10} range (Fugitive dust from waste rock)	8.70	1.2418578
PM_{10} to TSP (Fugitive dust from waste rock)	34.68	1.2418578
$PM_{2.5}$ (Fugitive dust from open pit)	2.45	1.2418578
$PM_{2.5}$ to PM_{10} range (Fugitive dust from open pit)	9.68	1.2418578
PM_{10} to TSP (Fugitive dust from open pit)	38.57	1.2418578
$PM_{2.5}$ (Fugitive dust from haul roads and Tote Road)	1.79	1.2418578
$PM_{2.5}$ to PM_{10} range (Fugitive dust from haul roads and Tote Road)	7.09	1.2418578
PM_{10} to TSP (Fugitive dust from haul roads and Tote Road)	28.31	1.2418578
NOTES: Geometric mass mean diameter and geometric standard deviation of different PM size fractions are derived from Government of Newfoundland and Labrador (2012)		

Table C.6 CALPUFF Model Option Groups 8, 9, 10, and 11

Input Group 9: Miscellaneous Dry Deposition Parameters

Parameters	Default	Project	Comments
RCUTR	30	30	Reference cuticle resistance (s/cm)
RGR	10	10	Reference ground resistance (s/cm)
REACTR	8	8	Reference pollutant reactivity
NINT	9	5	Number of particle size intervals for effective particle deposition velocity
IVEG	1	1	Vegetation in non-irrigated areas is active and unstressed

Input Group 10: Wet Deposition Parameters

Species	Scavenging coefficient for liquid precipitation [s-1]	Scavenging coefficient for frozen precipitation [s-1]
$PM_{2.5}$ (Combustion product)	6.0E-05	2.0E-05
$PM_{2.5}$ to PM_{10} range (Combustion product)	4.2E-04	1.4E-04
PM_{10} to TSP (Combustion product)	6.6E-04	2.2E-04
$PM_{2.5}$ (Fugitive dust)	6.0E-05	2.0E-05
$PM_{2.5}$ to PM_{10} range (Fugitive dust)	4.2E-04	1.4E-04
PM_{10} to TSP (Fugitive dust)	6.6E-04	2.2E-04
NOTES: PM size fractions scavenging coefficients are from US EPA (1995)		

Table C.6 CALPUFF Model Option Groups 8, 9, 10, and 11

Input Group 11: Chemistry Parameters

Parameters	Default	Project	Comments
MOZ	0	0	Use a monthly background ozone value
BCKO3	12*80	Not used	Background ozone concentration (ppb)
MNH3	0	0	Use monthly background ammonia values (Used only if MCHEM = 6 or 7)
MAVGNH3	1	1	Average ammonia values over vertical extent of puff (Used only if MCHEM = 6 or 7, and MNH3 = 1)
BCKNH3	12*10	Not used	Background ammonia concentration (ppb)
RNITE1	0.2	0.2	Night-time NO_2 loss rate in percent/hour
RNITE2	2	2	Night-time NO_X loss rate in percent/hour
RNITE3	2	2	Night-time HNO_3 loss rate in percent/hour
MH202	0	0	Use a monthly background H_2O_2 value (Used only if MCHEM = 6 or 7, and MAQCHEM = 1)
BCKH202	12*1	Not used	Monthly background H_2O_2 concentrations (Aqueous phase transformations modelled)
RH_ISRP	50	50	Minimum relative humidity used in ISORRPOIA computations (Used only if MCHEM = 6 or7)
SO4_ISRP	0.4	0.4	Minimum SO_4 used in ISORRPOIA computations (Used only if MCHEM = 6 or7)
BCKPMF	-	Not used	Fine particulate concentration for Secondary Organic Aerosol Option
OFRAC	-	Not used	Organic fraction of fine particulate for SOA Option
VCNX	-	Not used	VOC/NO_X ratio for SOA Option

Table C.7 CALPUFF Model Option Group 12

Input Group 12: Miscellaneous Dispersion and Computational Parameters

Parameters	Default	Project	Comments
SYTDEP	550	550	Horizontal size of a puff in metres beyond which the time dependent dispersion equation of Heffter (1965) is used
MHFTSZ	0	0	Do not use Heffter formulas for sigma z
JSUP	5	5	Stability class used to determine dispersion rates for puffs above boundary layer
CONK1	0.01	0.01	Vertical dispersion constant for stable conditions
CONK2	0.1	0.1	Vertical dispersion constant for neutral/stable conditions
TBD	0.5	0.5	Use ISC transition point for determining the transition point between the Schulman-Scire (Schulman et al., 1998) to Huber-Snyder Building Downwash scheme
IURB1	10	10	Range of land use categories for which urban dispersion is assumed
IURB2	19	19	Range of land use categories for which urban dispersion is assumed
ILANDUIN	20	20	Land use category for modeling domain
Z0IN	0.25	0.25	Roughness length (m) for modeling domain
XLAIIN	3.0	3.0	Leaf area index for modeling domain
ELEVIN	0.0	0.0	Elevation above sea level (m)
XLATIN	-999	-999	Latitude (degrees) for met location
XLONIN	-999	-999	Longitude (degrees) for met location
ANEMHT	10.0	10.0	Anemometer height (m) (Used only if METFM = 2,3)
ISIGMAV	1	1	Sigma-v is read for lateral turbulence data
IMIXCTDM	0	0	Predicted mixing heights are used
XMXLEN	1	1	Maximum length of emitted slug in meteorological grid units
XSAMLEN	1	1	Maximum travel distance of slug or puff in meteorological grid units during one sampling unit
MXNEW	99	99	Maximum number of puffs or slugs released from one source during one time step
MXSAM	99	99	Maximum number of sampling steps during one time step for a puff or slug
NCOUNT	2	2	Number of iterations used when computing the transport wind for a sampling step that includes transitional plume rise
SYMIN	1	1	Minimum sigma y in metres for a new puff or slug
SZMIN	1	1	Minimum sigma z in metres for a new puff or slug
SZCAP_M	5.0E06	5.0E06	Maximum sigma z in metres to avoid numerical problem in calculating time or distance
CDIV	0.0, 0.0	0.0, 0.0	Divergence criteria for dw/dz in met cells
NLUTBIL	4	4	Search radius for nearest land and water cells used in the subgrid TIBL module
WSCALM	0.5	0.5	Minimum wind speed allowed for non-calm conditions (m/s)
XMAXZI	3000	3000	Maximum mixing height in metres
XMINZI	50	50	Minimum mixing height in metres

Table C.7 CALPUFF Model Option Group 12

Input Group 12: Miscellaneous Dispersion and Computational Parameters (cont'd)

Parameters	Default	Project	Comments	
TKCAT	265	265	Temperature class 1	Temperatures (K) used for defining upper bound of categories for emissions scale-factors; 11 upper bounds (K) are entered; the 12th class has no upper limit.
	270	270	Temperature class 2	
	275	275	Temperature class 3	
	280	280	Temperature class 4	
	285	285	Temperature class 5	
	290	290	Temperature class 6	
	295	295	Temperature class 7	
	300	300	Temperature class 8	
	305	305	Temperature class 9	
	310	310	Temperature class 10	
	315	315	Temperature class 11	
WSCAT	1.54	3.06	wind speed category 1 [m/s]	Wind Speeds (m/s) used for defining upper bound of categories for emissions scale-factors; 5 upper bounds (m/s) are entered; the 6th class has no upper limit.
	3.09	6.00	wind speed category 2 [m/s]	
	5.14	10.00	wind speed category 3 [m/s]	
	8.23	13.46	wind speed category 4 [m/s]	
	10.80	16.42	wind speed category 5 [m/s]	

Stability Class	Parameter			
	SVMIN		SWMIN	
	Minimum turbulence (σ_v) (m/s)		Minimum turbulence (σ_v) (m/s)	
	Land	Water	Land	Water
A	0.5	0.37	0.2	0.2
B	0.5	0.37	0.12	0.12
C	0.5	0.37	0.08	0.08
D	0.5	0.37	0.06	0.06
E	0.5	0.37	0.03	0.03
F	0.5	0.37	0.016	0.016

Stability Class	Parameter	
	PLX0	PPC (see text)
	Wind speed profile exponent	Plume path coefficient
A	0.07	0.5
B	0.07	0.5
C	0.10	0.5
D	0.15	0.5
E	0.35	0.35
F	0.55	0.35

Table C.7 CALPUFF Model Option Group 12

Input Group 12: Miscellaneous Dispersion and Computational Parameters (cont'd)

Parameters	Default	Project	Comments
PTG0	0.020	0.020	Potential temperature gradient for E stability [K/m]
	0.035	0.035	Potential temperature gradient for F stability [K/m]
SL2PF	10	10	Slug-to-puff transition criterion factor equal to sigma y/length of slug
FCLIP	0.0	0.0	No extrapolation of receptor-specific puff/slug properties
NSPLIT	3	3	Number of puffs that result every time a puff is split
IRESPLIT	0,0,0,0,0,0,0,0,0,0,0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0	0,0,0,0,0,0,0,0,0,0,0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0	Time(s) of day when split puffs are eligible to be split once again
ZISPLIT	100	100	Minimum allowable last hour's mixing height for puff splitting
ROLDMAX	0.25	0.25	Maximum allowable ratio of last hour's mixing height and maximum mixing height experienced by the puff for puff splitting
NSPLITH	5	5	Number of puffs that result every time a puff is horizontally split
SYSPLITH	1	1	Minimum sigma-y of puff before it may be horizontally split
SHSPLITH	2	2	Minimum puff elongation rate due to wind shear before it may be horizontally split
CNSPLITH	1.0E-7	1.0E-7	Minimum concentration of each species in puff before it may be horizontally split
EPSSLUG	1.00E-04	1.00E-04	Fractional convergence criterion for numerical SLUG sampling iteration
EPSAREA	1.00E-06	1.00E-06	Fractional convergence criterion for numerical AREA sampling iteration
DRISE	1.0	1.0	Trajectory step length for numerical rise
HTMINBC	500	500	Minimum height (m) to which boundary condition puffs are mixed as they are emitted (MBCON=2 ONLY)
RSAMPBC	10	10	Search radius (km) about a receptor for sampling nearest boundary condition puff.
MDEPBC	1	1	Concentration is adjusted for depletion

Table C.8 CALPUFF Model Option Groups 13, 14, and 15

Input Group 13: Point Source Parameters

Parameters	Default	Project	Comments
NPT1	-	Varies by scenario	Number of point sources with constant stack parameters or variable emission rate scale factors
IPTU	1	1	Units for point source emission rates are g/s
NSPT1	0	0	Number of source-species combinations with variable emissions scaling factors
NPT2	-	0	Number of point sources with variable emission parameters provided in external file

Input Group 14: Area Source Parameters

Parameters	Default	Project	Comments
NAR1	-	Varies by scenario	Number of polygon area sources
IARU	1	1	Units for area source emission rates are $g/m^2/s$
NSAR1	0	Varies by scenario	Number of source species combinations with variable emissions scaling factors
NAR2	-	0	Number of buoyant polygon area sources with variable location and emission parameters

Input Group 15: Line Source Parameters

Parameters	Default	Project	Comments
NLN2	-	0	No line sources modelled
NLINES	-	0	Number of buoyant line sources
ILNU	1	1	Units for line source emission rates is g/s
NSLN1	0	0	Number of source-species combinations with variable emissions scaling factors
MXNSEG	7	7	Maximum number of segments used to model each line
NLRISE	6	6	Number of distance at which transitional rise is computed
XL	-	0.1	Average line source length (m)
HBL	-	0.1	Average height of line source height (m)
WBL	-	0.1	Average building width (m)
WML	-	25	Average line source width (m)
DXL	-	0.1	Average separation between buildings (m)
FPRIMEL	-	50	Average buoyancy parameter (m^4/s^3)

Table C.9 CALPUFF Model Option Groups 16, 17, 18, 19 and 20

Input Group 16: Volume Source Parameters

Parameter	Default	Project	Comments
NVL1	-	Varies by scenario	Number of volume sources
IVLU	1	1	Units for volume source emission rates is grams per second
NSVL1	0	Varies by scenario	Number of source-species combinations with variable emissions scaling factors
NVL2	0	Varies by scenario	No volume source with variable location and emissions

Input Group 17: Flare Source Parameters

Parameter	Default	Project	Comments
NFL2	-	0	Number of flare sources defined in FLEMARB.DAT

Input Group 18: Road Source Parameters

Parameter	Default	Project	Comments
NRD1	-	Varies by scenario	Number of road sources
NRD2	-	Varies by scenario	Number of road-links with arbitrarily time-varying emission parameters
NSFRDS	0	Varies by scenario	Number of road links and species combinations with variable emission-rate scale-factors

Input Group 19: Emission Rate Scale-factor Tables

Parameter	Default	Project	Comments
NSFTAB	-	Varies by scenario	Number of emission scale-factors

Input Group 20: Discrete Receptor Information

Parameter	Default	Project	Comments
NREC	-	7,492	Number of receptors in the Mine Site LAA
		5,251	Number of receptors in the Milne Port LAA

C.3 References

Government of Newfoundland and Labrador. 2012. Guideline for Plume Dispersion Modelling. September 18, 2012. Available at: https://www.gov.nl.ca/ecc/files/env-protection-science-gd-ppd-019-2.pdf. Accessed June 2022.

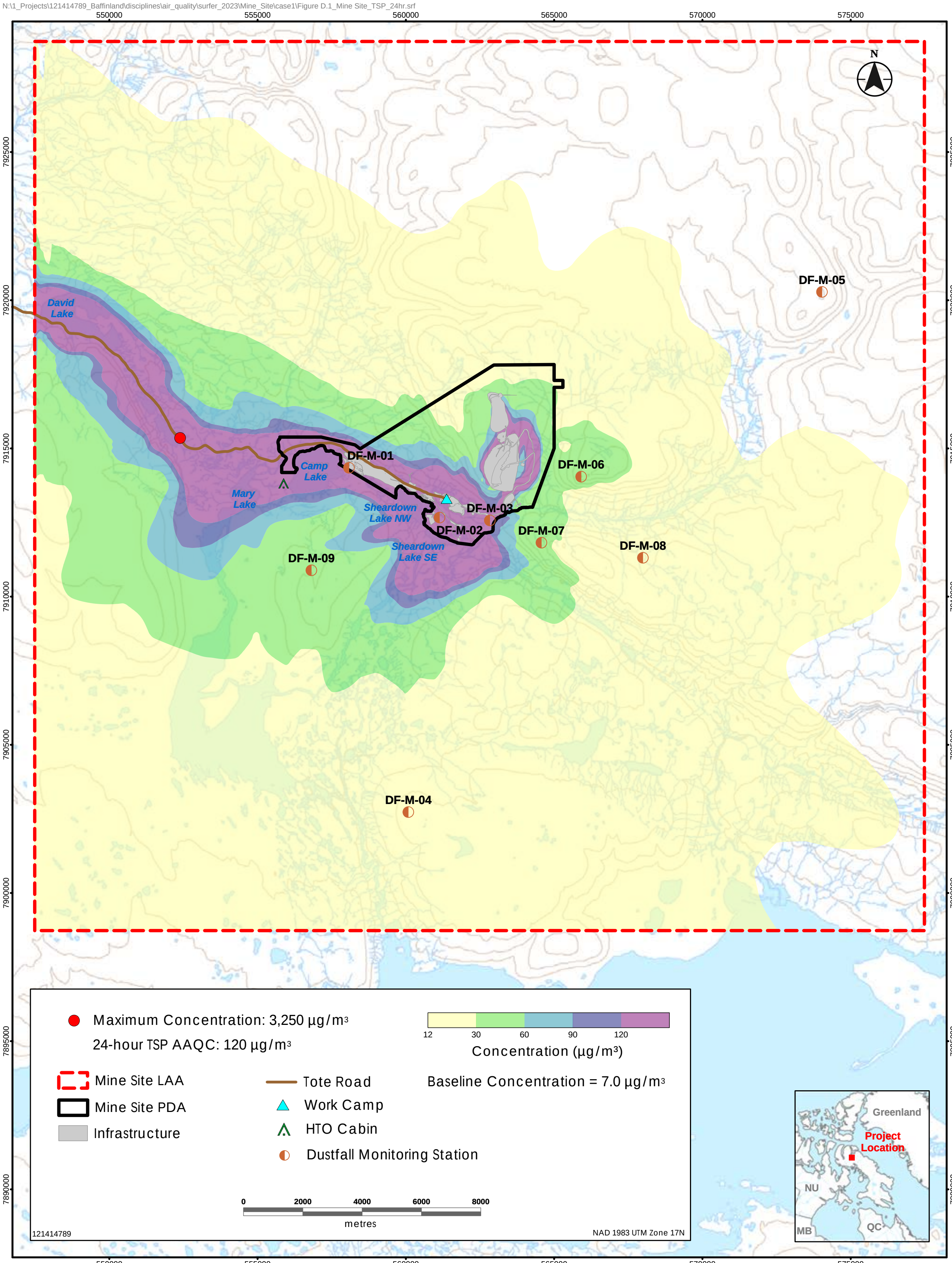
Schulman, L.L., D.G. Strimaitis and J.S. Scire. 1998. Development and Evaluation of the PRIME Plume Rise and Building Downwash Model. Submitted to Journal of the Air & Waste Management Association.

Scire, J.S., D.G. Strimaitis and R.J. Yamartino. 2000. A User's Guide for the CALPUFF Dispersion Model (Version 5). Earth Tech Inc. January 2000. Available at: http://www.src.com/calpuff/download/CALPUFF_UsersGuide.pdf. Accessed June 2022.

US EPA. 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models. Volume II – Description of Model Algorithms. EPA-454/B-95-003b. Research Triangle Park, NC.

APPENDIX D Concentration Contour Plots

D.1 Concentration Contour Plots for the Mine Site Operation



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

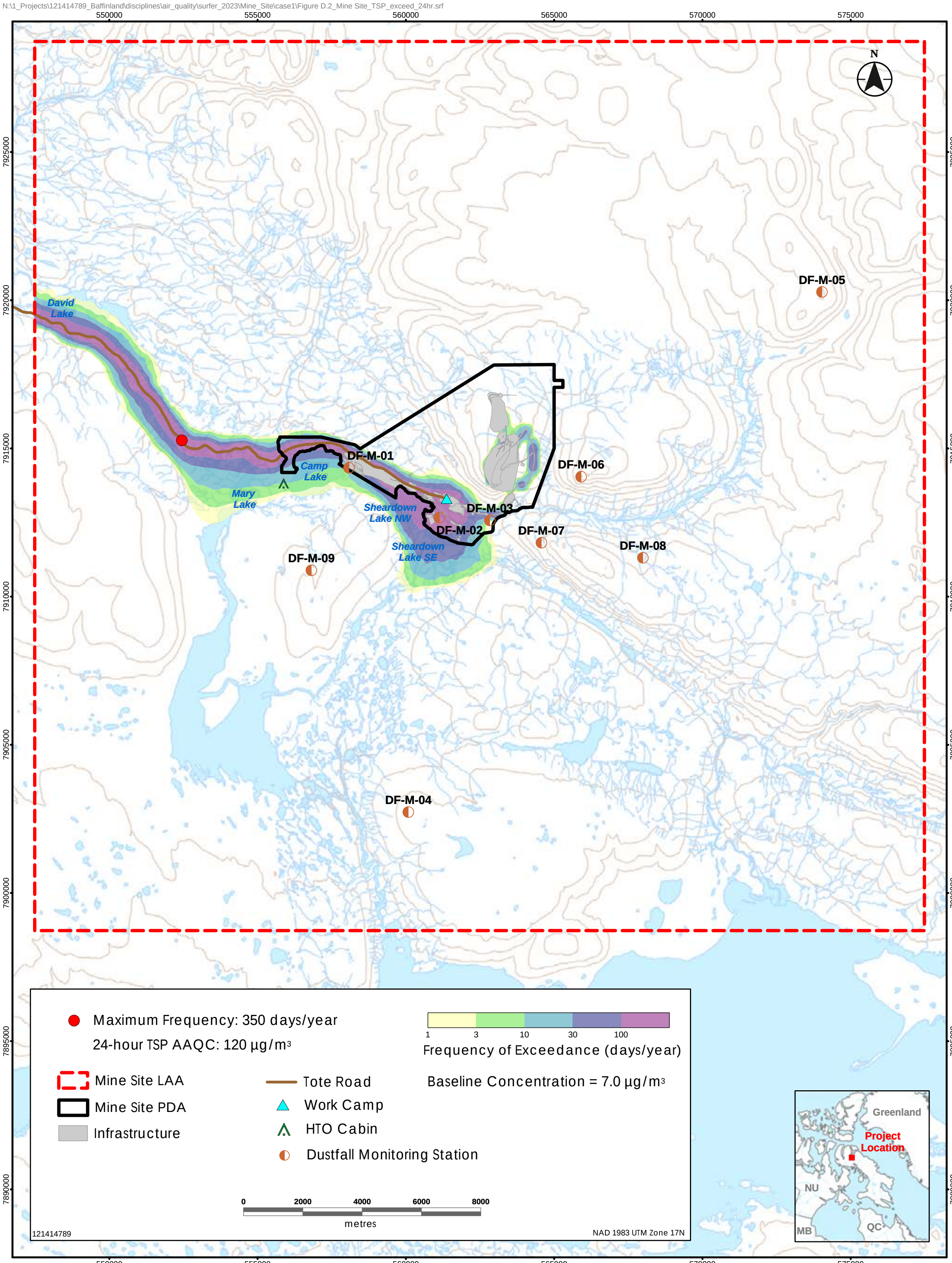
Maximum Predicted 24-hour Average TSP Ground-level Concentrations (Mine Site)

Stantec

BAFFINLAND MARY RIVER PROJECT - AIR QUALITY ASSESSMENT

Figure D.1

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Mine_Site\case1\Figure D.2_Mine Site_TSP_exceed_24hr.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

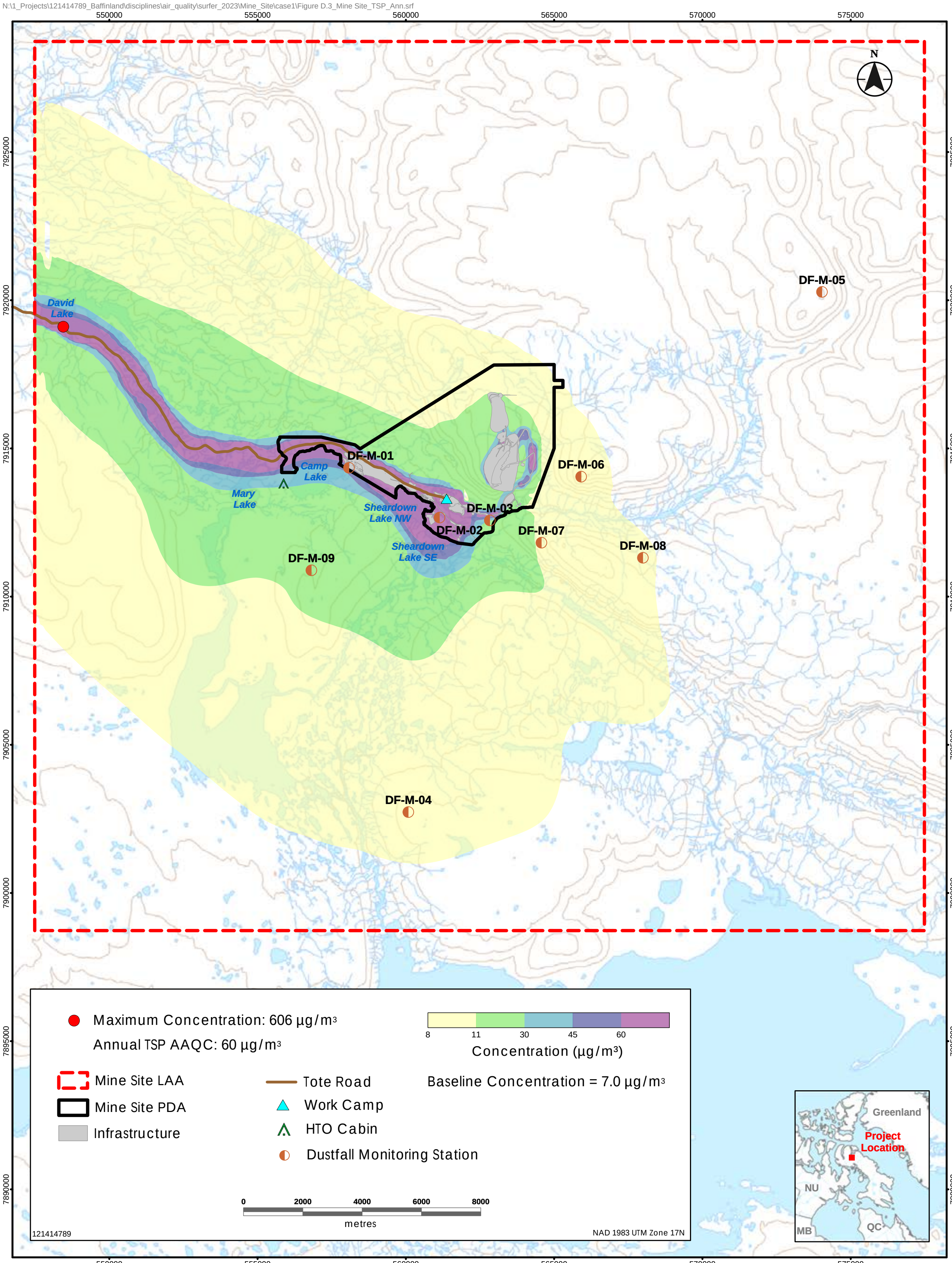
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 24-hour TSP AAQC (Mine Site)

Stantec

BAFFINLAND MARY RIVER PROJECT - AIR QUALITY ASSESSMENT

Figure D.2

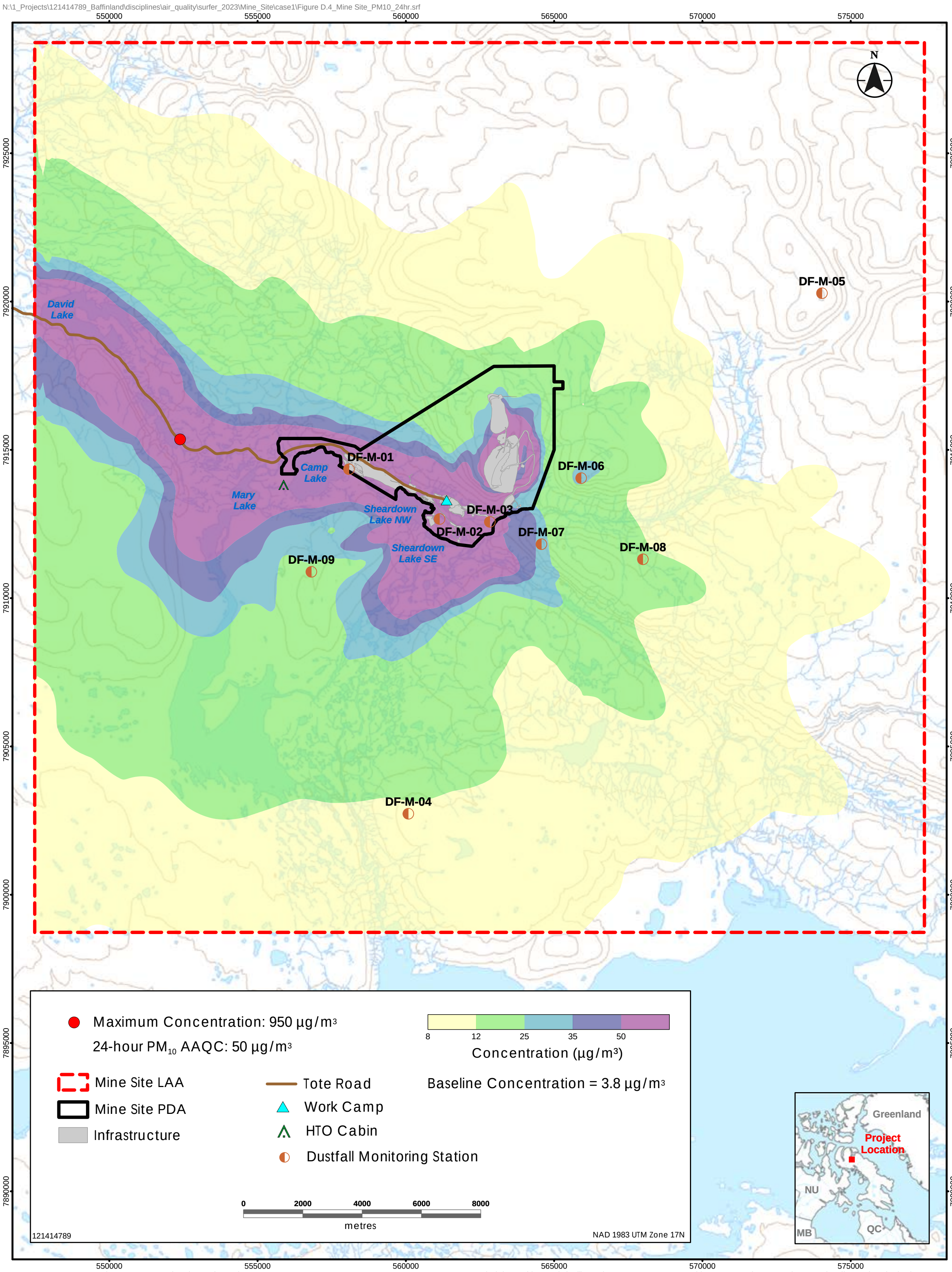


Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Predicted Annual Average TSP Ground-level Concentrations (Mine Site)

Stantec

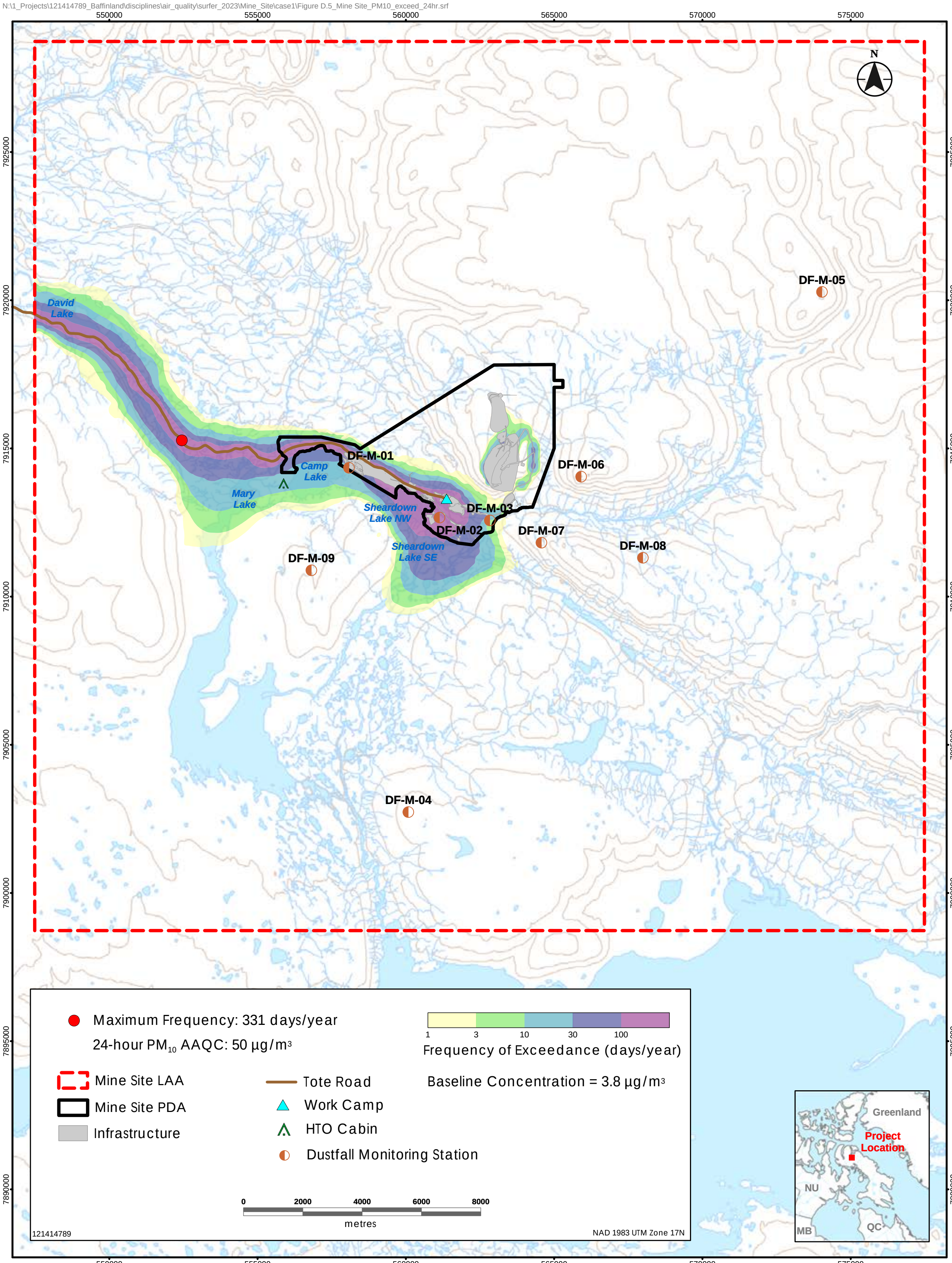


Maximum Predicted 24-hour Average PM_{10} Ground-level Concentrations (Mine Site)

Stantec

Figure D.4

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Mine_Site\case1\Figure D.5_Mine Site_PM10_exceed_24hr.srf

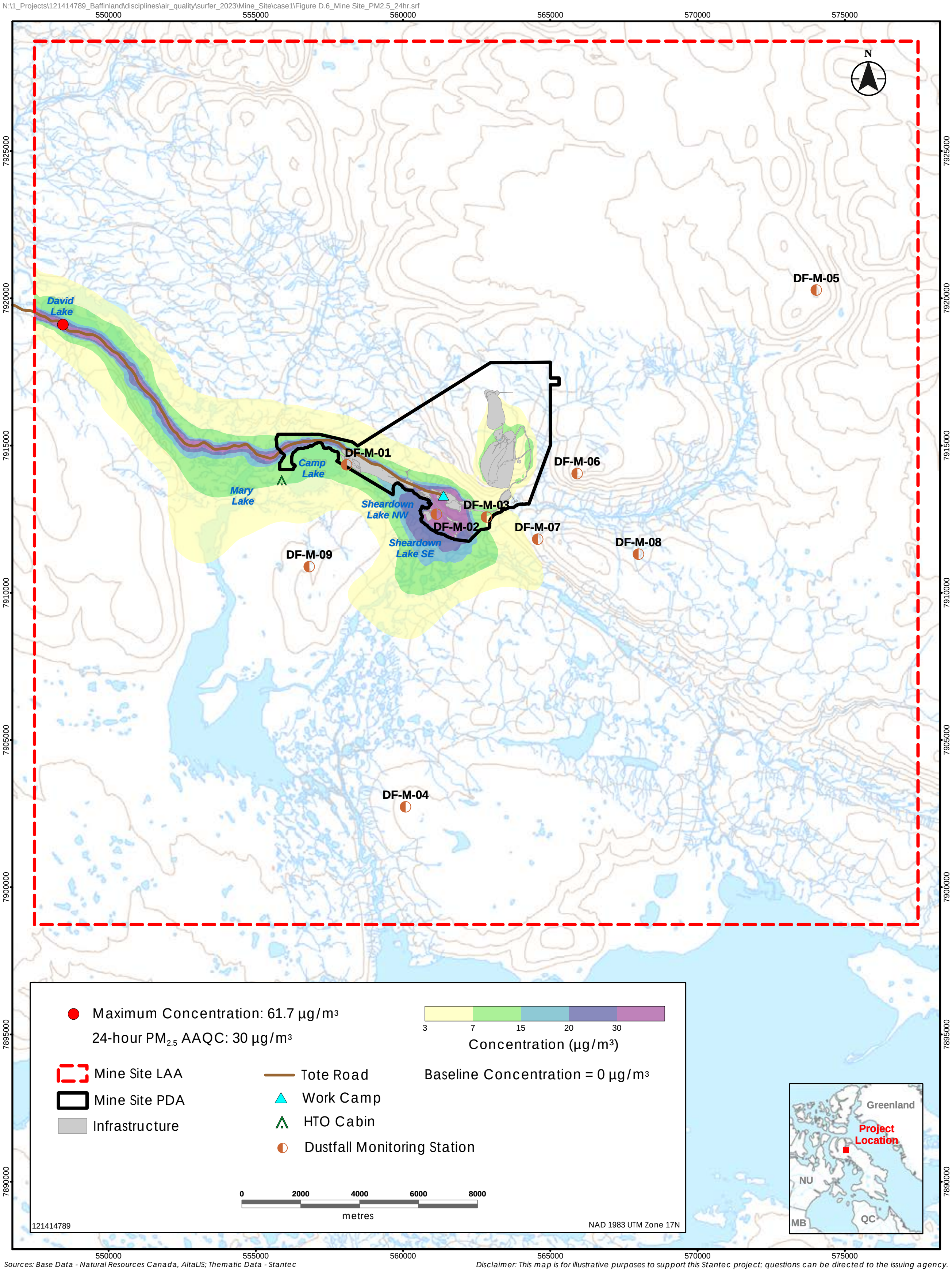


Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 24-hour PM_{10} AAQC (Mine Site)

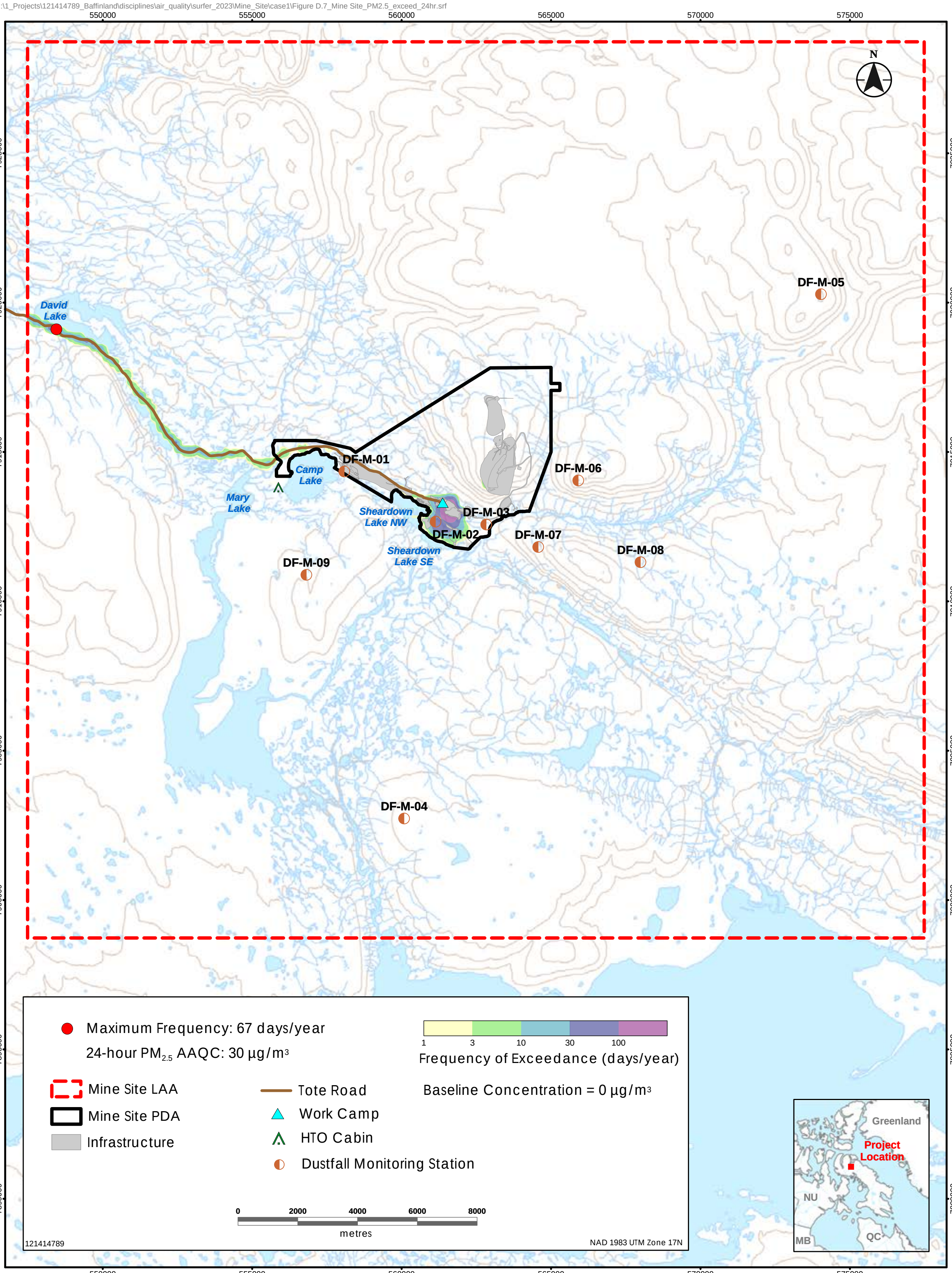
Stantec



Predicted 98th Percentile 24-hour Average $PM_{2.5}$ Ground-level Concentrations (Mine Site)

Stantec

Figure D.6



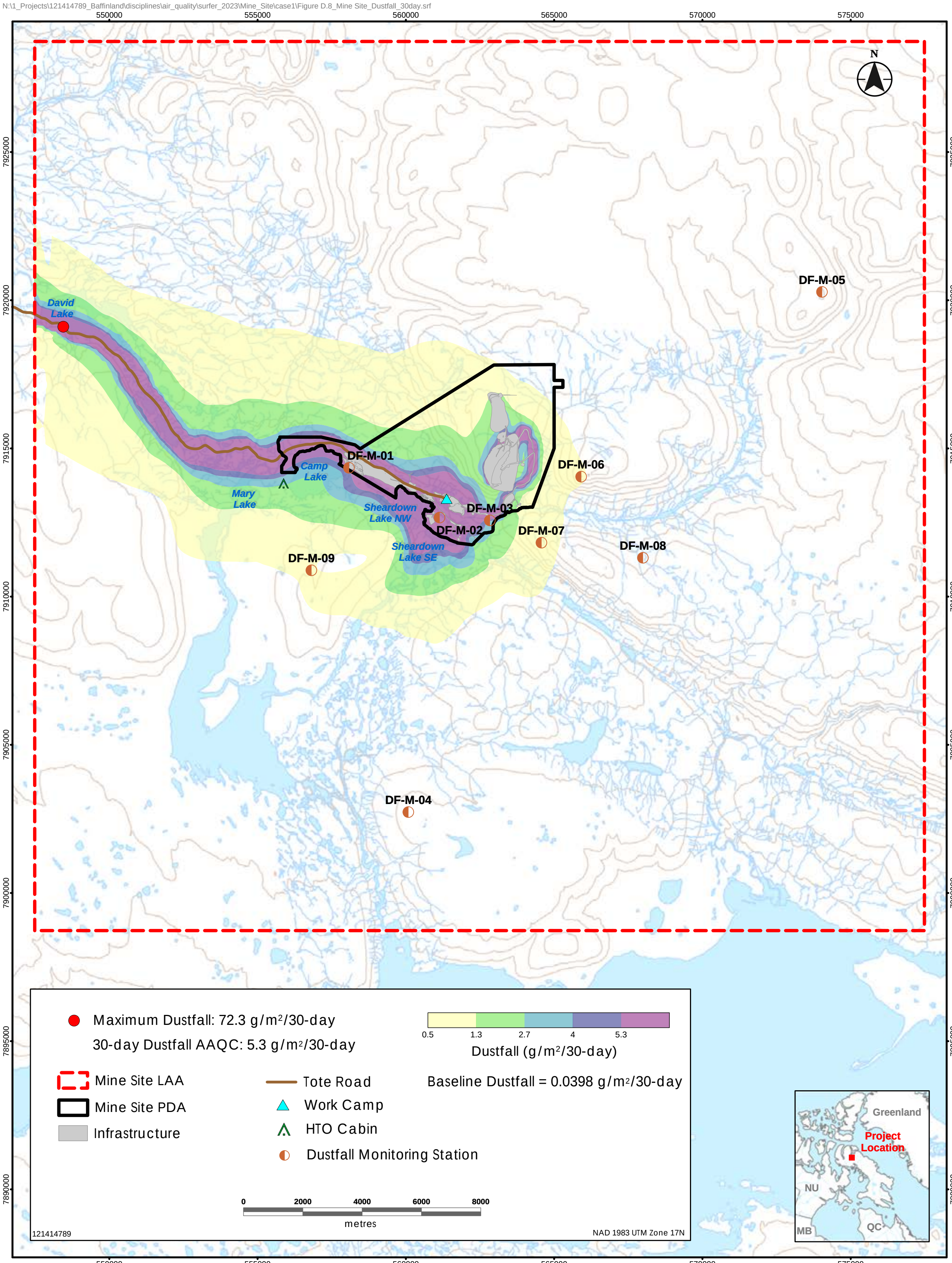
Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 24-hour $PM_{2.5}$ AAQC (Mine Site)

Stantec

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Mine_Site\case1\Figure D.8_Mine Site_Dustfall_30day.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

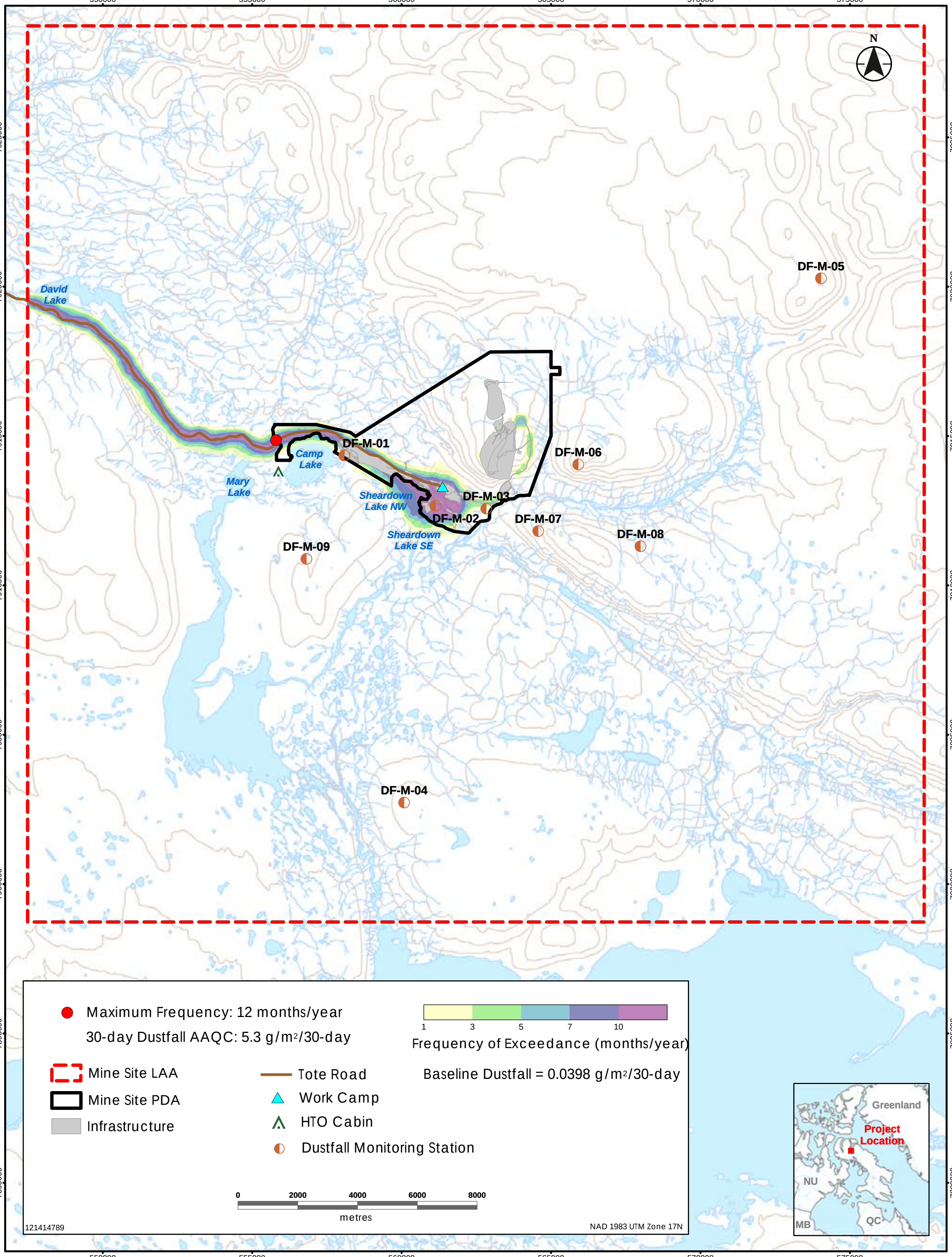
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Predicted 30-day Average Dustfall (Mine Site)

Stantec

Figure D.8

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Mine_Site\case1\Figure D.9_Mine Site_Dustfall_exceed_30day.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

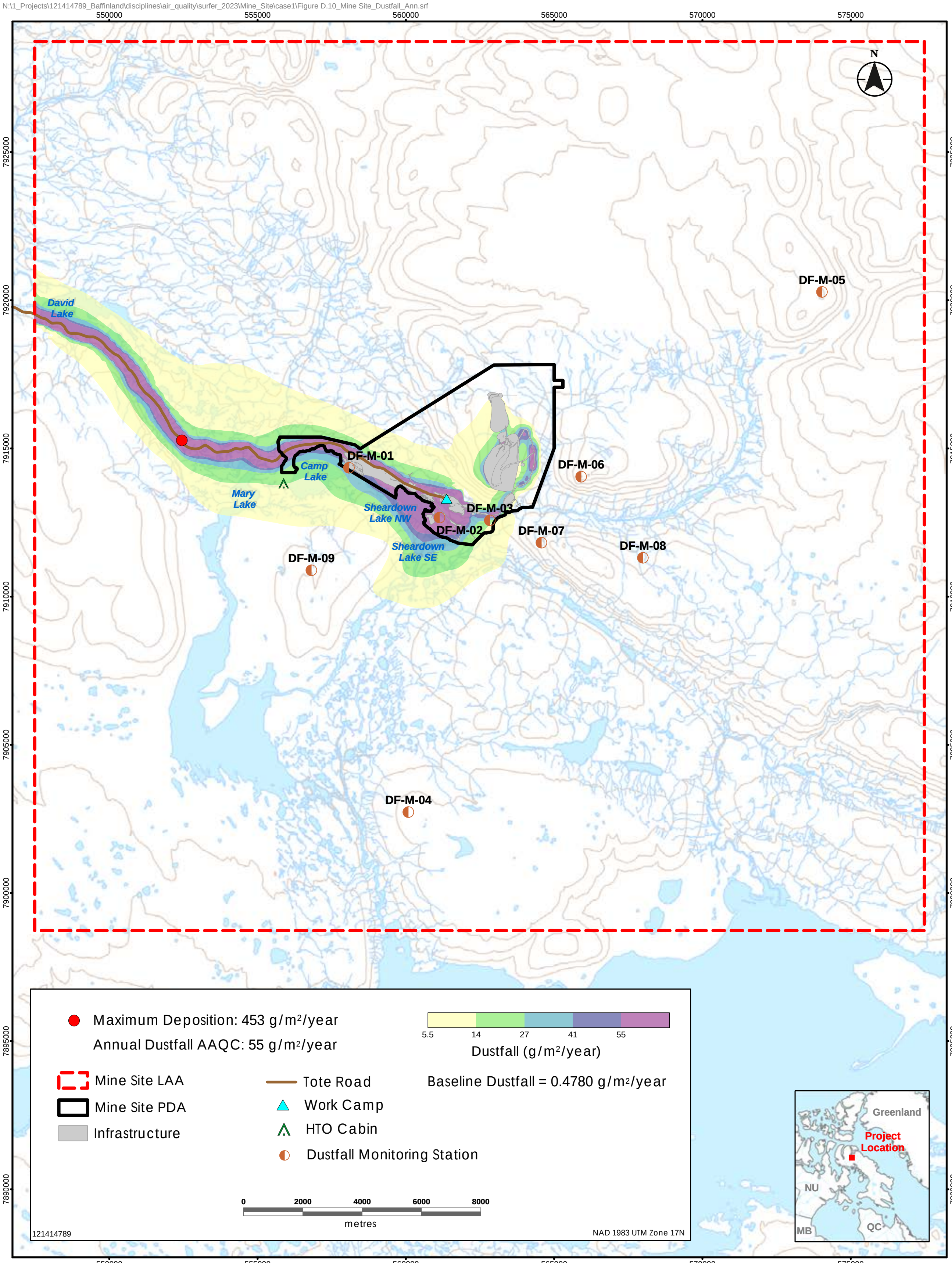
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 30-day Dustfall AAQC (Mine Site)

Stantec

Figure D.9

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Mine_Site\case1\Figure D.10_Mine Site_Dustfall_Ann.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Predicted Annual Average Dustfall (Mine Site)

Stantec

D.2 Concentration Contour Plots for Milne Port Operation

D.11 Maximum Predicted 24-hour Average TSP Ground-level Concentration (Milne Port)

D.12 Maximum Frequency of Exceedance of the 24-hour TSP AAQC (Milne Port)

D.13 Maximum Predicted Annual Average TSP Ground-level Concentration (Milne Port)

D.14 Maximum Predicted 24-hour Average PM_{10} Ground-level Concentration (Milne Port)

D.15 Maximum Frequency of Exceedance of the 24-hour PM_{10} AAQC (Milne Port)

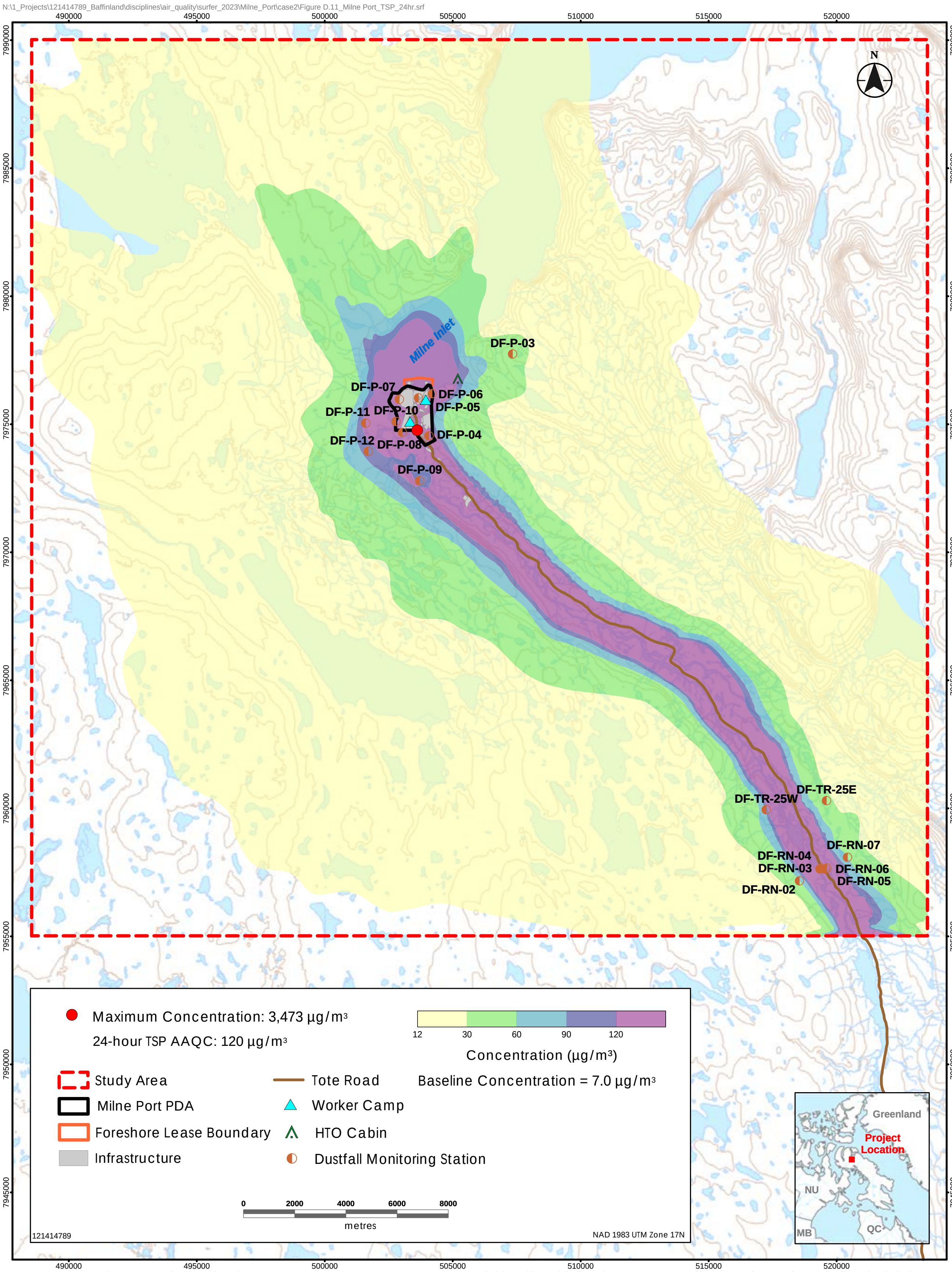
D.16 Predicted 98th Percentile 24-hour Average $PM_{2.5}$ Ground-level Concentration (Milne Port)

D.17 Maximum Frequency of Exceedance of the 24-hour $PM_{2.5}$ AAQC (Milne Port)

D.18 Maximum Predicted 30-day Average Dustfall (Milne Port)

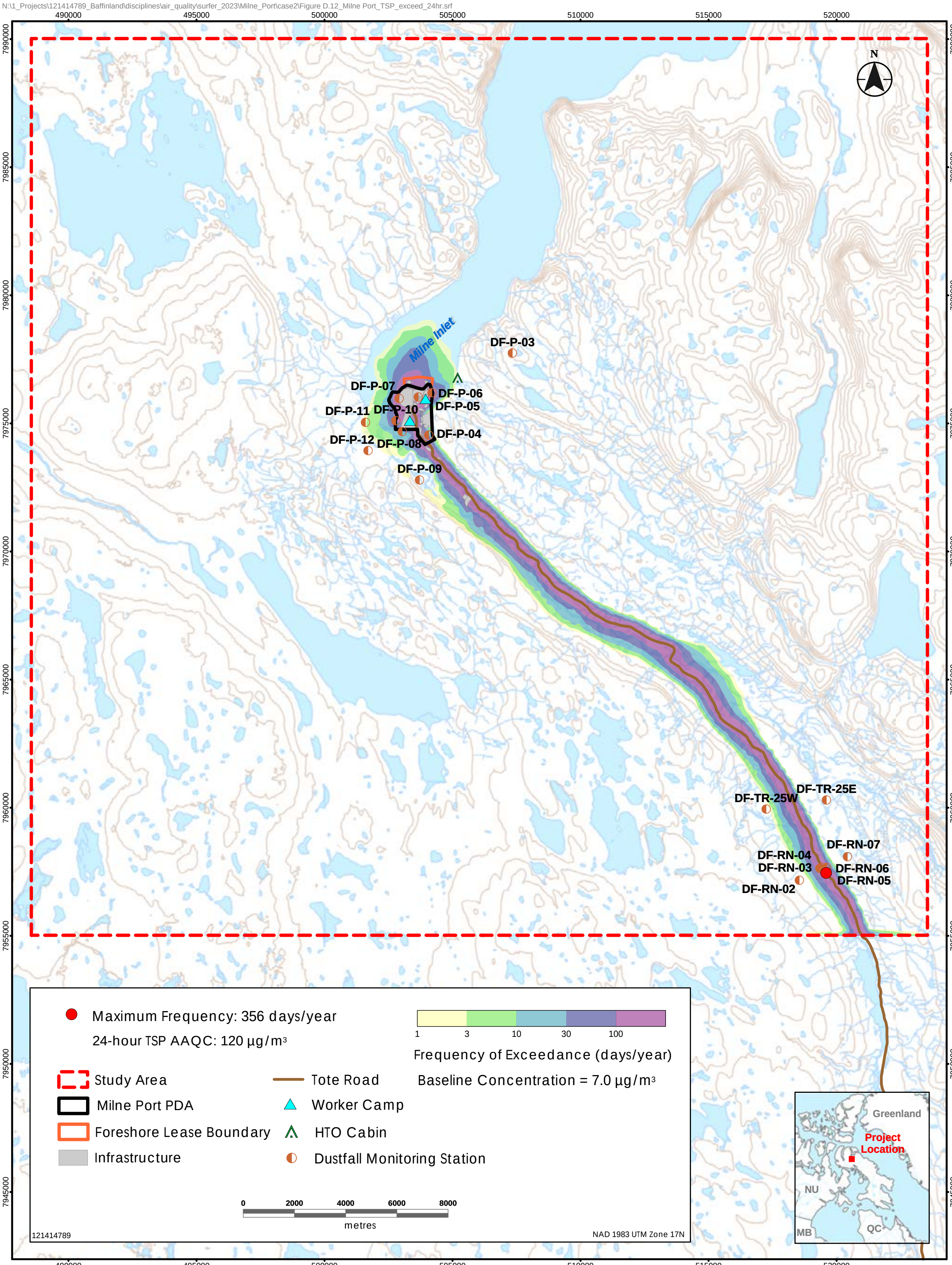
D.19 Maximum Frequency of Exceedance of the 30-day Dustfall AAQC (Milne Port)

D.20 Maximum Predicted Annual Average Dustfall (Milne Port)



Maximum Predicted 24-hour Average TSP Ground-level Concentrations (Milne Port)

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Milne_Port\case2\Figure D.12_Milne Port_TSP_exceed_24hr.srf



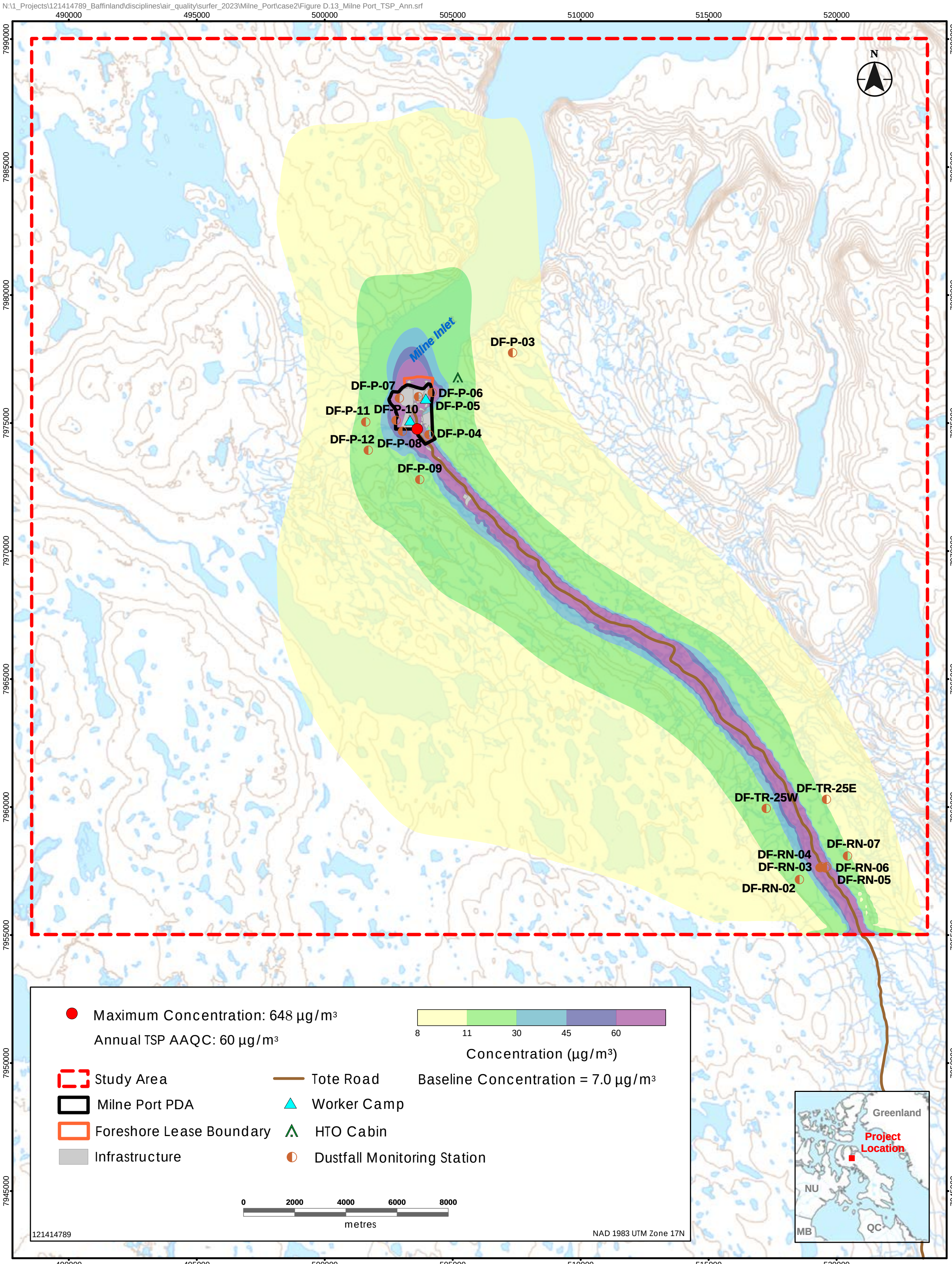
Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 24-hour TSP AAQC (Milne Port)

Stantec

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Milne_Port\case2\Figure D.13_Milne Port_TSP_Ann.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

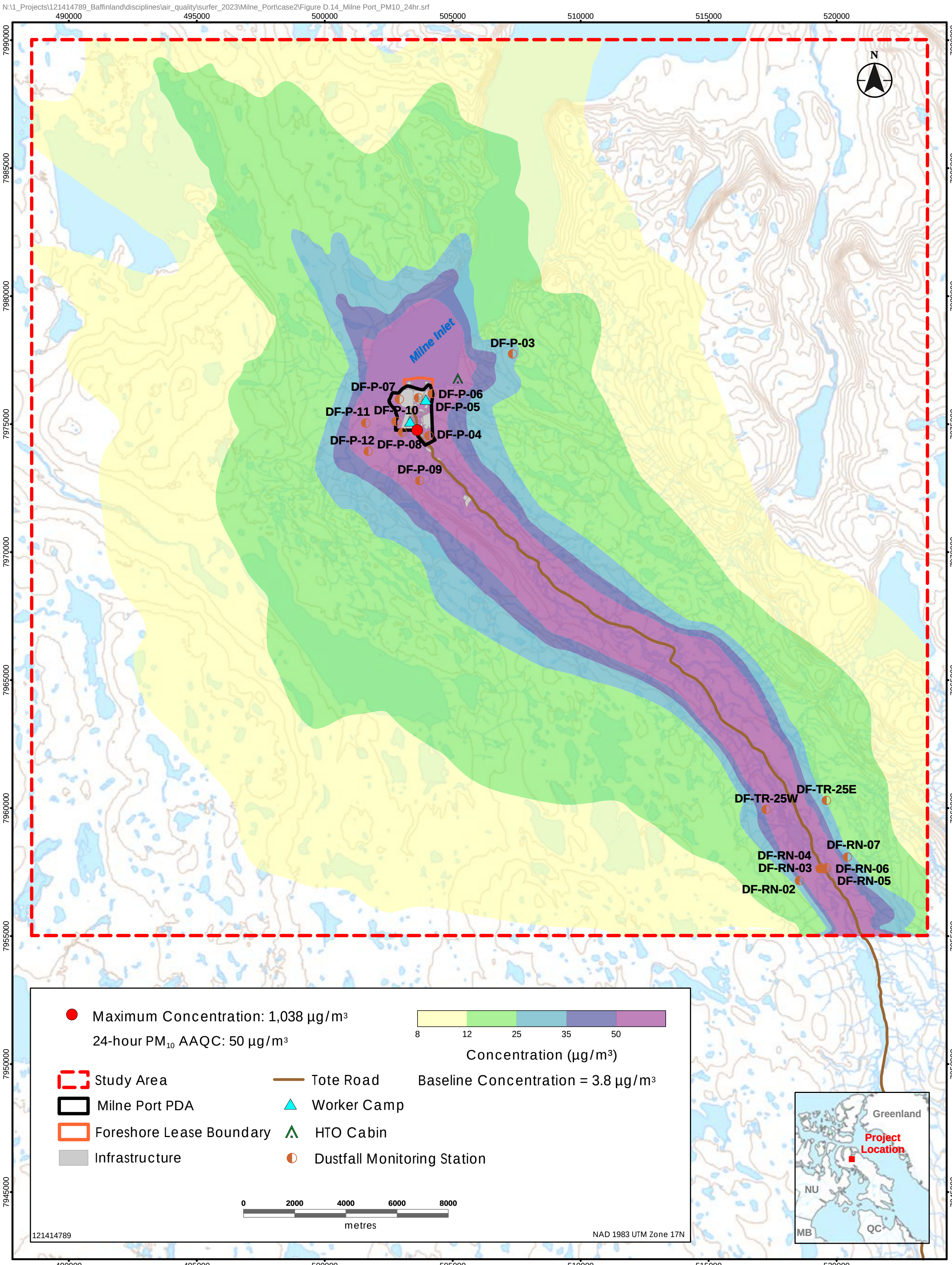
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Predicted Annual Average TSP Ground-level Concentrations (Milne Port)

Stantec

BAFFINLAND MARY RIVER PROJECT - AIR QUALITY ASSESSMENT

Figure D.13

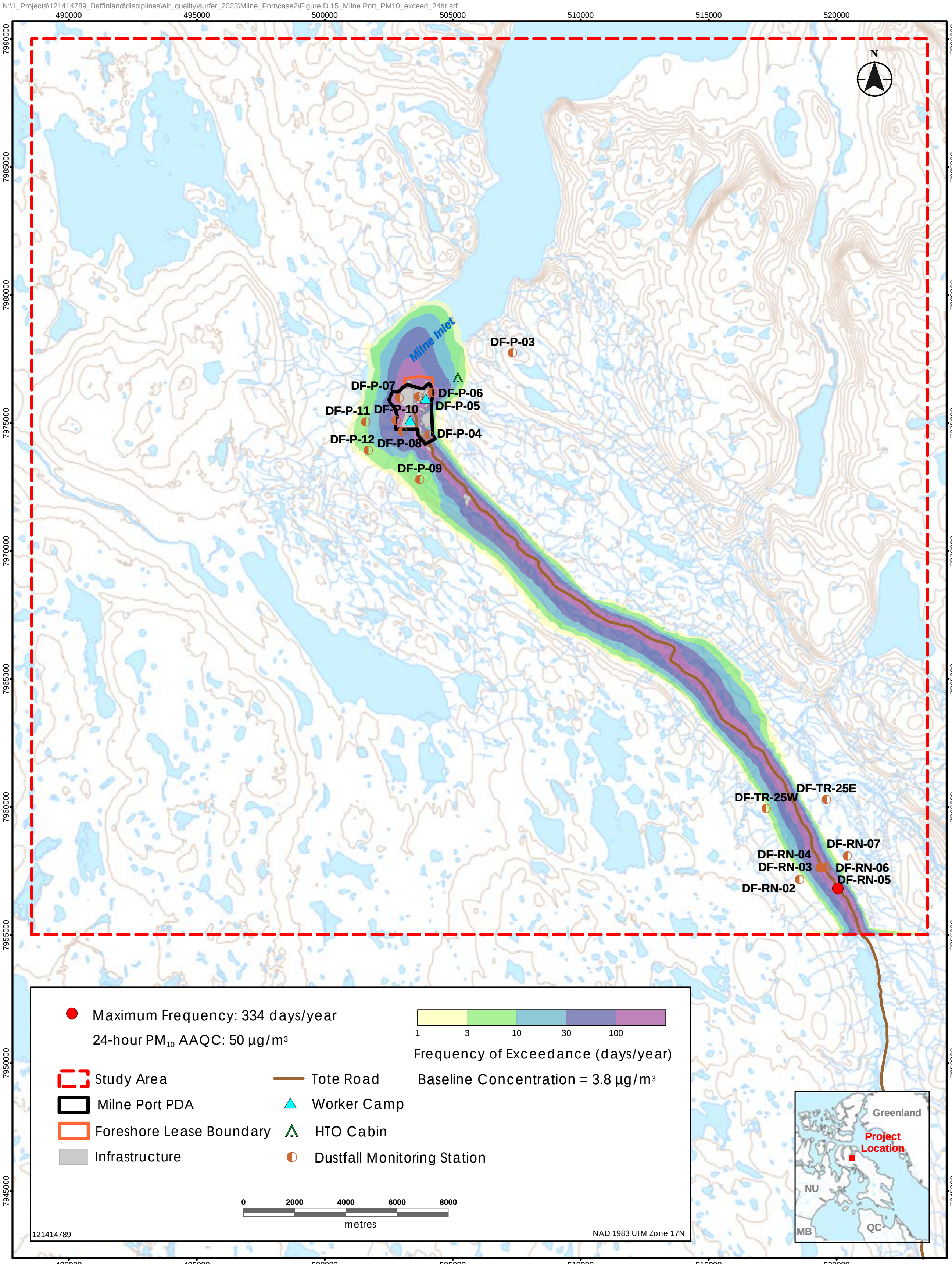


Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Predicted 24-hour Average PM_{10} Ground-level Concentrations (Milne Port)

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Milne_Port\case2\Figure D.15_Milne Port_PM10_exceed_24hr.srf



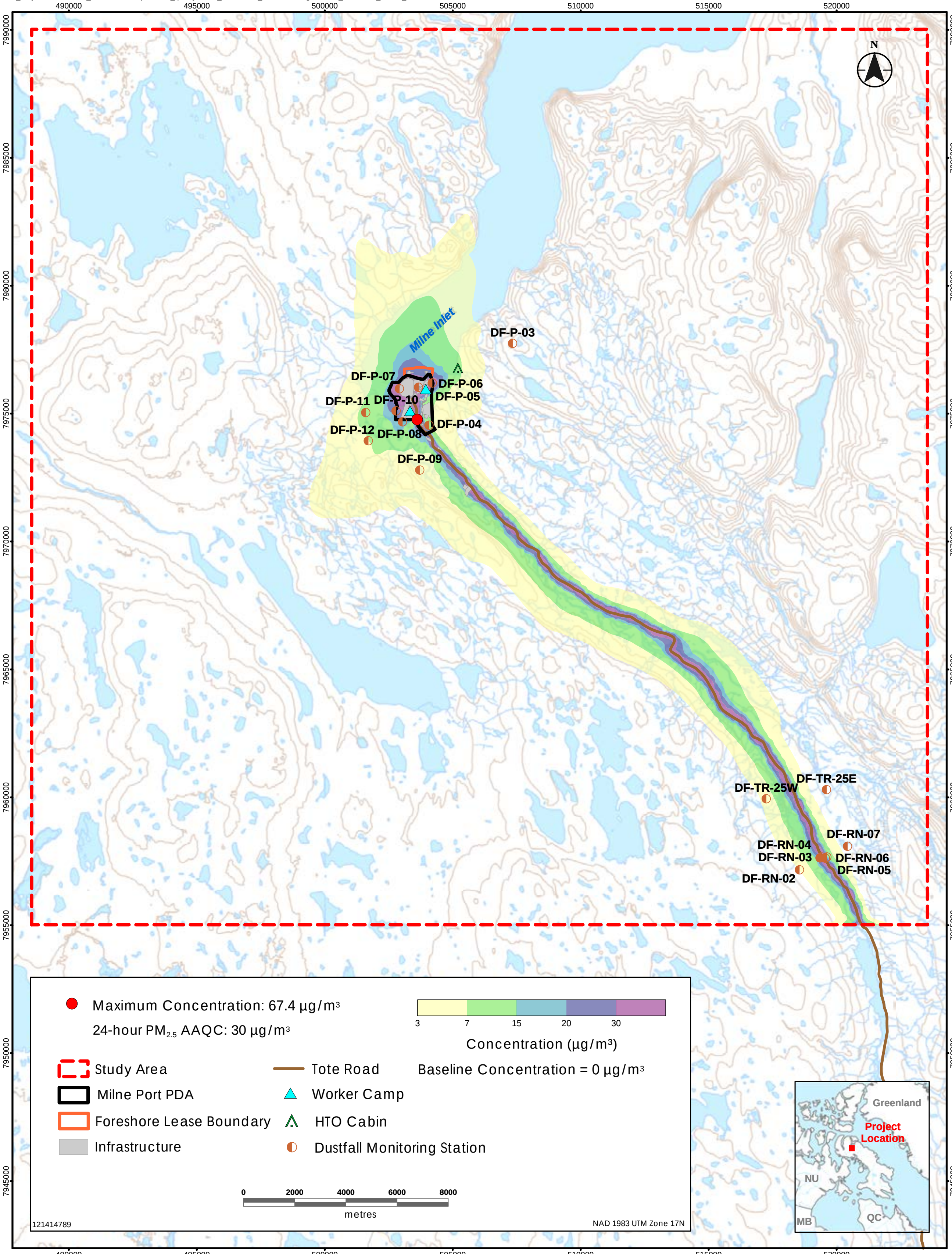
Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 24-hour PM_{10} AAQC (Milne Port)

Stantec

Figure D.15



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Predicted 98th Percentile 24-hour Average $PM_{2.5}$ Ground-level Concentrations (Milne Port)

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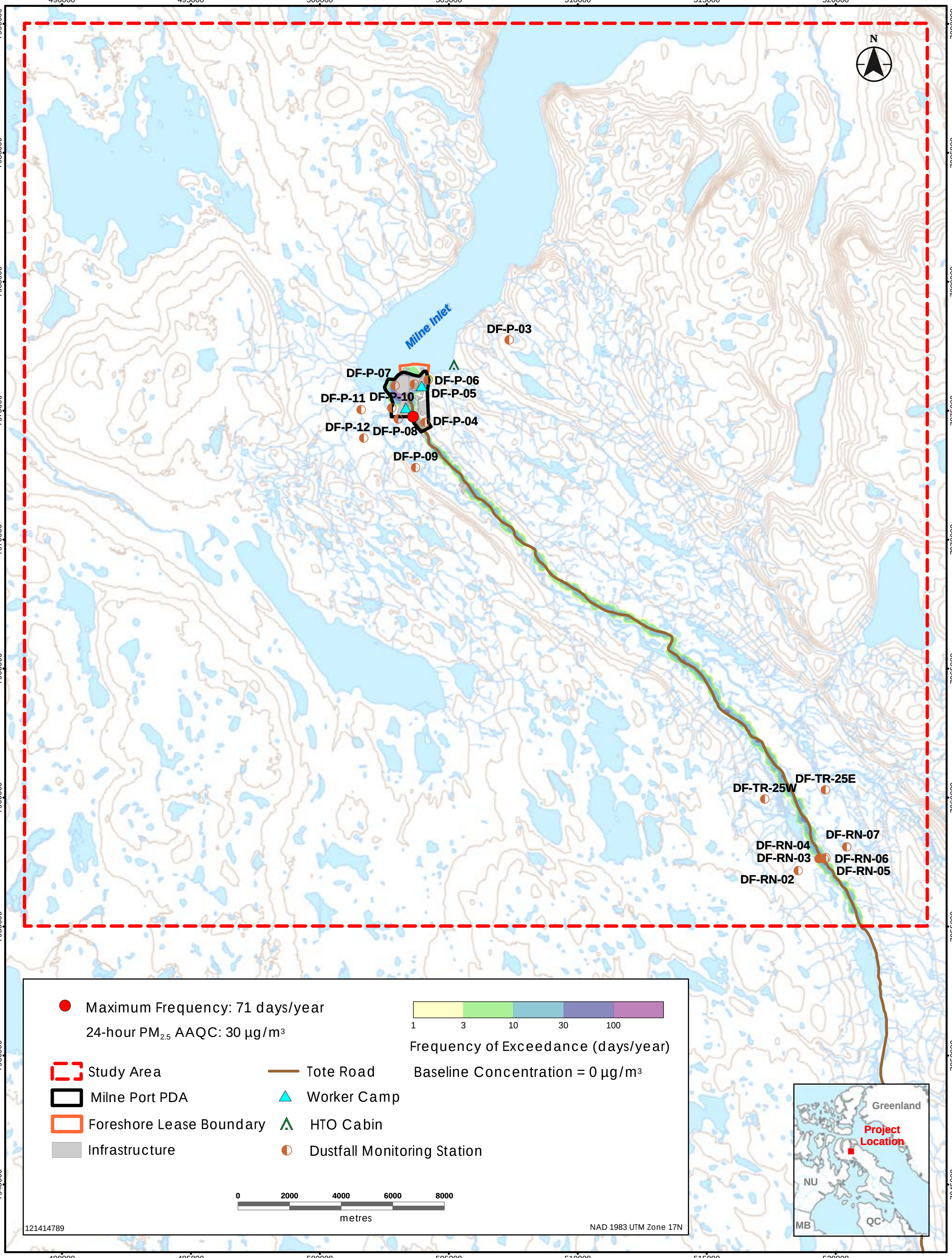


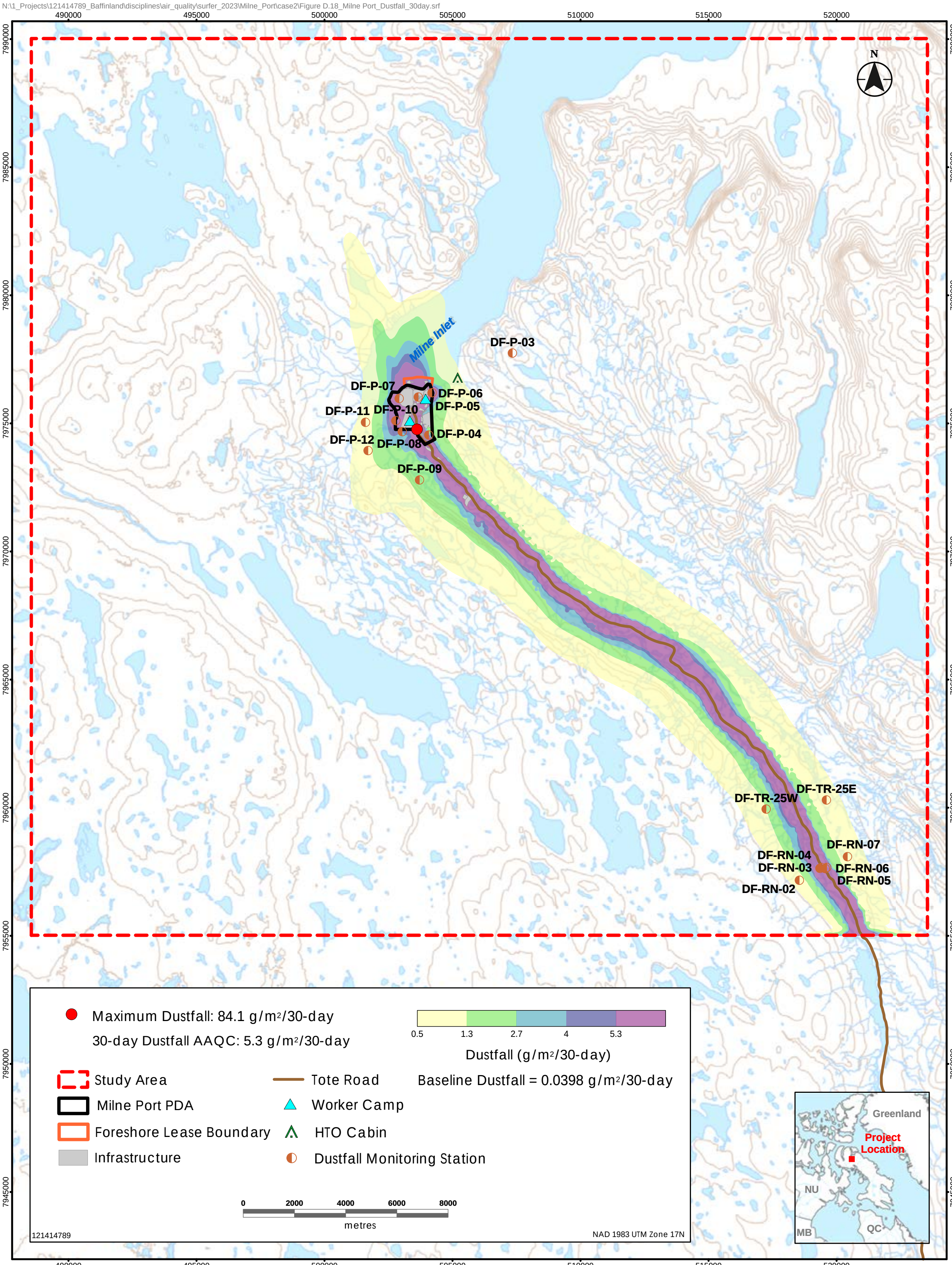
Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 24-hour $PM_{2.5}$ AAQC (Milne Port)

Stantec

Figure D.17



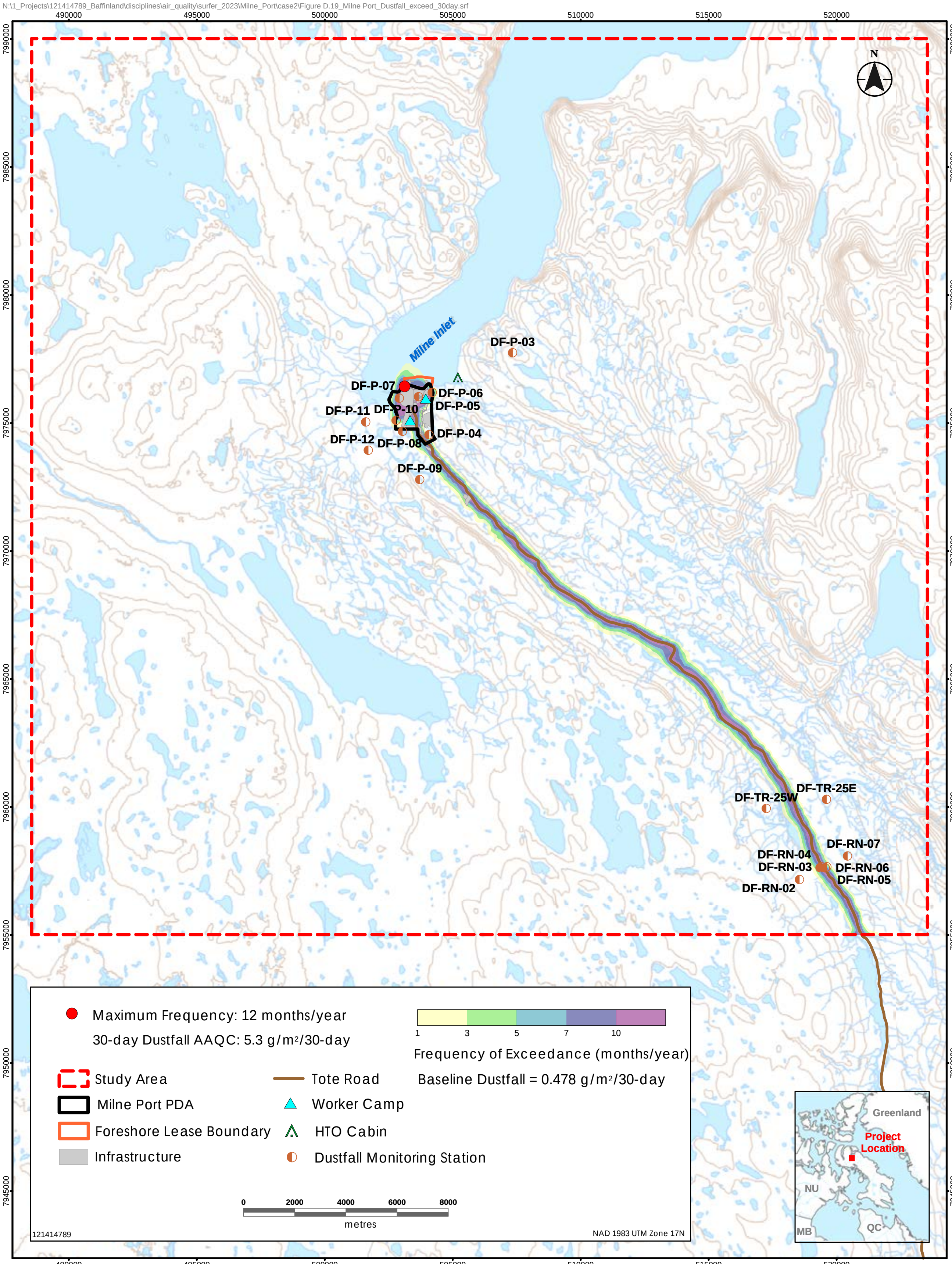
Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Predicted 30-day Average Dustfall (Milne Port)

Figure D.18

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Milne_Port\case2\Figure D.19_Milne Port_Dustfall_exceed_30day.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

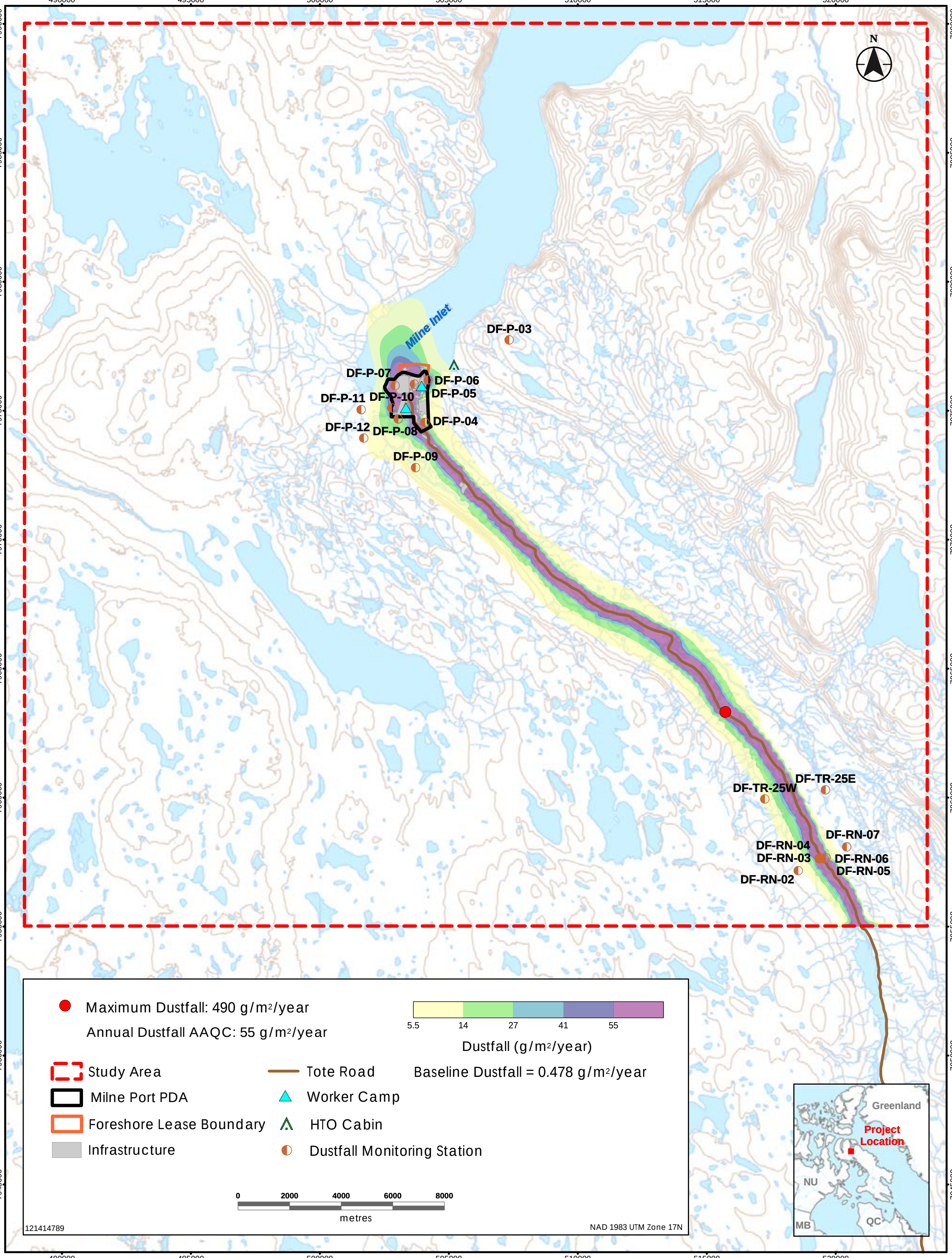
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Frequency of Exceedance of the 30-day Dustfall AAQC (Milne Port)

Stantec

Figure D.19

N:\1_Projects\121414789_Baffinland\disciplines\air_quality\surfer_2023\Milne_Port\case2\Figure D.20_Milne Port_Dustfall_Ann.srf



Sources: Base Data - Natural Resources Canada, AltaLIS; Thematic Data - Stantec

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Maximum Predicted Annual Average Dustfall (Milne Port)

Stantec