4-C: Addendum Air Quality Modelling Technical Summary

Appendix 4-C - Air Quality Modelling Technical Summary Addendum

Whale Tail Pit - Expansion Project

Submitted to:

Nunavut Impact Review Board

Submitted by:

Agnico Eagle Mines Limited – Meadowbank Division

Prepared by:

Golder Associates Ltd.

Appendix 4-C - Air Quality Modelling Technical Summary

1896037

December 2018

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TABLES

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4.C-1 INTRODUCTION

This document provides detailed technical information regarding the methods and results used to assess Project-related effects to air quality from the Expansion Project. The air quality modelling methods are identical to those used in the Approved Project in the following ways:

- Background concentrations of criteria air contaminants (CACs)
- Applicable ambient air quality standards
- Study area and modelling domain
- Meteorological data
- Terrain data
- Grid and discrete receptors
- NO_x to NO_2 conversion
- Gas deposition

The updates from the Approved Projects include:

- Updated source representations in the model
- Particulate matter deposition method

The haul road was modelled as a representative 1-km section of the road between the Whale Tail Pit and the Meadowbank Mine, identical to the Approved Project with updated emissions. The haul road section selected for modelling is aligned along a southwest to northeast direction, which is perpendicular to the dominant wind direction in the region.

4.C-2 AIR QUALITY MODELLING METHODS

Consistent with the Approved Project, the air quality modelling was completed using the AERMOD model, which is a plume dispersion model developed by the United States Environmental Protection Agency (US EPA 2004). The AERMOD model was selected for the air quality assessment because it has been accepted in many jurisdictions in Canada and the United States. In addition, this dispersion model is capable of local scale modelling of less than 50 km.

The air quality assessment is focused on predicting the change in air quality due to Project operations. Potential effects of the Project on air quality during the construction and decommissioning phases are not assessed as emissions during these periods are predicted to be well below emissions during the operations phase. Project air emissions for the year 2022 were selected as the basis for the air quality modelling. Year 2022 is predicted to have the highest ore production and therefore provides a conservative estimate of emissions for all years, including construction and operations phases of the Project. The air quality assessment for the Project includes the following steps:

1) establishing the existing background concentrations of criteria air contaminants in the region (see Approved Project FEIS Volume 4, Appendix 4-A; Agnico Eagle 2016);

2) creating an air emissions inventory for the Whale Tail mining area and the haul road to the Meadowbank Mine for year 2022 (see Volume 4, Appendix 4-B);

3) using the AERMOD model to predict ambient concentrations of criteria air contaminants and dust deposition as a result of the Expansion Project; and

4) comparing the ambient air quality and dust deposition predictions to existing federal, provincial and territorial air quality standards and/or guidelines.

The CACs considered in this assessment include the following:

- carbon monoxide (CO);
- nitrogen dioxide (NO_2);
- sulfur dioxide (SO_2);
- particulate matter, including:
  - total suspended particulate (TSP);
  - particulate matter with aerodynamic diameters less than 10 micrometers (µm) (PM_{10}); and
  - particulate matter with aerodynamic diameters less than 2.5 µm ($PM_{2.5}$).

4.C-2.1 Existing Air Quality Concentrations

Publicly available and Government of Nunavut Arctic air quality monitoring data were evaluated to estimate background concentrations of criteria air contaminants in the Kivalliq region of Nunavut (see Approved Project FEIS Volume 4, Appendix 4-A; Agnico Eagle 2016). For compounds with 1-hour, 8-hour, and 24-hour averaged periods, the 90th percentiles of historic air quality observations were used as the background regional concentrations for CAC's. For the annual averaged period, the 50th percentile values were used (Table 4-C-1). Because there are no existing TSP and PM_{10} data, TSP and PM_{10} background concentrations were assumed to be the same as the $PM_{2.5}$ background concentrations.

Table 4-C-1: Background Air Quality Concentrations

Compound	Averaging Period	Percentile	Background Concentration	
			µg/m³	ppbv
CO	1-hr	90th	389	0.3
	8-hr	90th	385	0.3
NO_2	1-hr	90th	12.6	5.0
	24-hr	90th	11.4	4.5
	Annual	50th	5.0	1.9
SO_2	1-hr	90th	2.7	1.0
	24-hr	90th	2.7	1.0
	Annual	50th	0.3	0.1
$PM_{2.5}$	24-hr	90th	6.6	—
	Annual	50th	3.6	—

4.C-2.2 Ambient Air Quality Standards

Consistent with the Approved Project, guidelines adopted by the Government of Nunavut are based on comparable standards established by the Federal Government and standards and/or guidelines in other Provinces and Territories. For the CACs that are not included in the Guideline, the Federal ambient air quality criteria or ambient air quality standards from other Provinces and Territories were adopted (Table 4-C-2).

Table 4-C-2: Applicable Ambient Air Quality Criteria

Parameter	Nunavut Ambient Air Quality Standard[a]		Other Ambient Air Quality Standards, Objectives or Guidelines	
	µg/m³	ppbv	µg/m³	ppbv
SO_2				
1-hour	450	172	—	—
24-hour	150	48	—	—
Annual	30	8	—	—
NO_2				
1-hour	400	159	—	—
24-hour	200	106	—	—
Annual	60	24	—	—
CO				
1-hour	—	—	15,000b	13,000b
8-hour	—	—	6,000b	5,000b
TSP				
24-hour	120	—	—	—
Annual	60	—	—	—
PM_{10}				
24-hour	—	—	50c	—
$PM_{2.5}$				
24-hour	30	—	27d	—
Annual	—	—	8.8e	—
Dustfall				
1-month (mg/cm²/30-day)	—	—	0.53 to 1.58b	—
Annual (mg/cm²/30-day)	-	-	0.46c	

[a] Environmental Guideline for Ambient Air Quality (Government of Nunavut 2011).
[b] Alberta Ambient Air Quality Objectives and Guidelines Summary (Alberta Environment and Parks 2017)
[c] Ontario's Ambient Air Quality Criteria (Ontario Ministry of the Environment 2012)
[d] 2020 achievement is based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years (CCME 2013).
[e] 2020 achievement is based on 3-year average of the annual average concentrations (CCME 2013).
µg/m³: microgram per cubic metre

4.C-2.3 Meteorological Data

The use of the AERMOD model requires that an AERMET data set be created to simulate the meteorology in the region of the Project. This meteorology dictates the transport and dispersion of atmospheric emissions from the Project, as well as the resulting ground-level concentrations of CACs. The AERMET dataset was constructed using 2005 to 2009 hourly surface observations from the Environment Canada Baker Lake station, and upper air data from the Baker Lake station from the National Oceanic & Atmospheric Administration/Earth System Research Laboratory (NOAA/ESRL) Radiosonde Database.

Albedo, Bowen ratio, and surface roughness are AERMET preprocessor input parameters that are site-specific and dependent on the land use of the region around the facility to be modelled (e.g., urban area, farmland, woodlot, forest, swamp). The albedo is the fraction of total incident radiation reflected by the surface back to space without absorption. Typical values range from 0.1 for heavily forested areas (little solar radiation is reflected) to 0.9 for fresh snow (most radiation is reflected back to space). The daytime Bowen Ratio is the ratio of the sensible heat flux (transfer of heat upwards from the ground due to surface heating) to the latent heat flux (energy loss at the ground and gain aloft, due to evaporation and condensation of water). The surface roughness length is related to the height of obstacles that interfere with the wind flow. In general, trees and buildings have a high surface roughness, while sand and water have a low surface roughness. The AERMET component allows these surface parameters to be defined in all directions around the site being modelled. The surface parameters used in AERMET are listed in Table 4-C-3. The values of the surface parameters were based on a mixture of four land types (Swamp: 10%; Water: 25%; Grassland: 30%; Desert shrubland:35%) with values of each land type given in the Alberta air quality modelling guideline (Government of Alberta 2009).

Approved Project FEIS Volume 4, Appendix 4-A (Agnico Eagle 2016) includes comparisons of AERMET and baseline meteorology for air temperature, wind speed and direction, and precipitation. The following subsections document mixing heights and atmospheric stability classes, which are additional meteorological inputs required by the AERMOD model.

Table 4-C-3: Surface Parameters Used in AERMET

Month	Albedo	Bowen Ratio	Roughness Length (m)
January	0.418	3.075	0.058
February	0.418	3.075	0.058
March	0.201	1.205	0.140
April	0.201	1.205	0.140
May	0.201	1.205	0.140
June	0.191	1.675	0.155
July	0.191	1.675	0.155
August	0.191	1.675	0.155
September	0.209	2.435	0.128
October	0.209	2.435	0.128
November	0.209	2.435	0.128
December	0.418	3.075	0.058

m = meter

4.C-2.3.1 Mixing Height

Mixing height or boundary layer depth is the depth of the surface layer in which the majority of air dispersion will occur. The depth of this well-mixed layer is a function of surface (convective) heating and wind (mechanical) turbulence. Low boundary layer depths provide little vertical room for dispersion and can result in elevated concentrations at ground level. Convective and mechanical boundary layer depths were determined by AERMET from surface and upper level temperatures and winds, respectively.

Figure 4-C-1 provides a summary of the convective and mechanical boundary layer depths calculated by AERMET. Convective boundary layer depths were calculated only for daytime hours that have convective meteorological conditions (i.e., 31.7% of the time), while mechanical boundary layer depths were calculated for every hour, except for hours with missing meteorological data. AERMOD uses the mechanical boundary layer depth in the absence of a convective boundary layer depth.

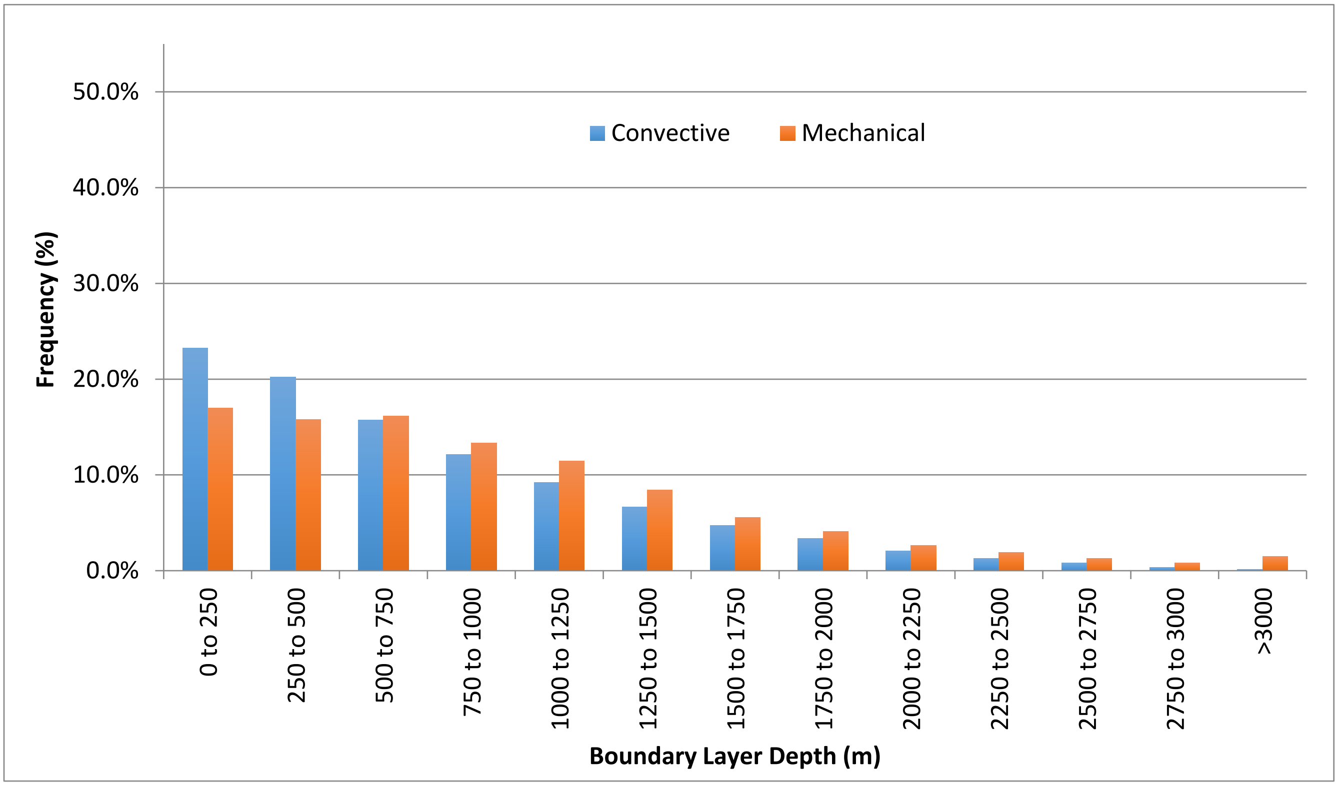


Figure 4-C-1: AERMET Derived Mixing Heights

4.C-2.3.2 Stability Class

Atmospheric stability can be viewed as a measure of the atmosphere's capability to disperse air pollutants. The amount of turbulence in the atmosphere plays an important role in the dilution of a plume as it is transported by the wind. Turbulence can be generated by either thermal or mechanical processes. Surface heating or cooling by radiation contributes to the generation or suppression of thermal turbulence, while high wind speeds contribute to the generation of mechanical turbulence.

The Pasquill-Gifford stability classification scheme is one classification of the atmosphere. The classification ranges from Unstable (Stability Classes A, B, and C) to Neutral (Stability Class D) to Stable (Stability Classes E and F). Unstable conditions are primarily associated with daytime heating conditions, which result in enhanced turbulence levels (enhanced dispersion). Stable conditions are associated primarily with nighttime cooling conditions, which result in suppressed turbulence levels (more limited dispersion). Neutral conditions are primarily associated with higher wind speeds or overcast conditions.

The stability conditions predicted for the Project site are presented in Figure 4-C-2 and summarized as follows:

- Unstable (A, B and C) conditions are predicted to occur 12.9% of the time.
- Neutral (D) conditions are predicted to occur 64.5% of the time.
- Stable (E and F) conditions are predicted to occur 22.5% of the time.

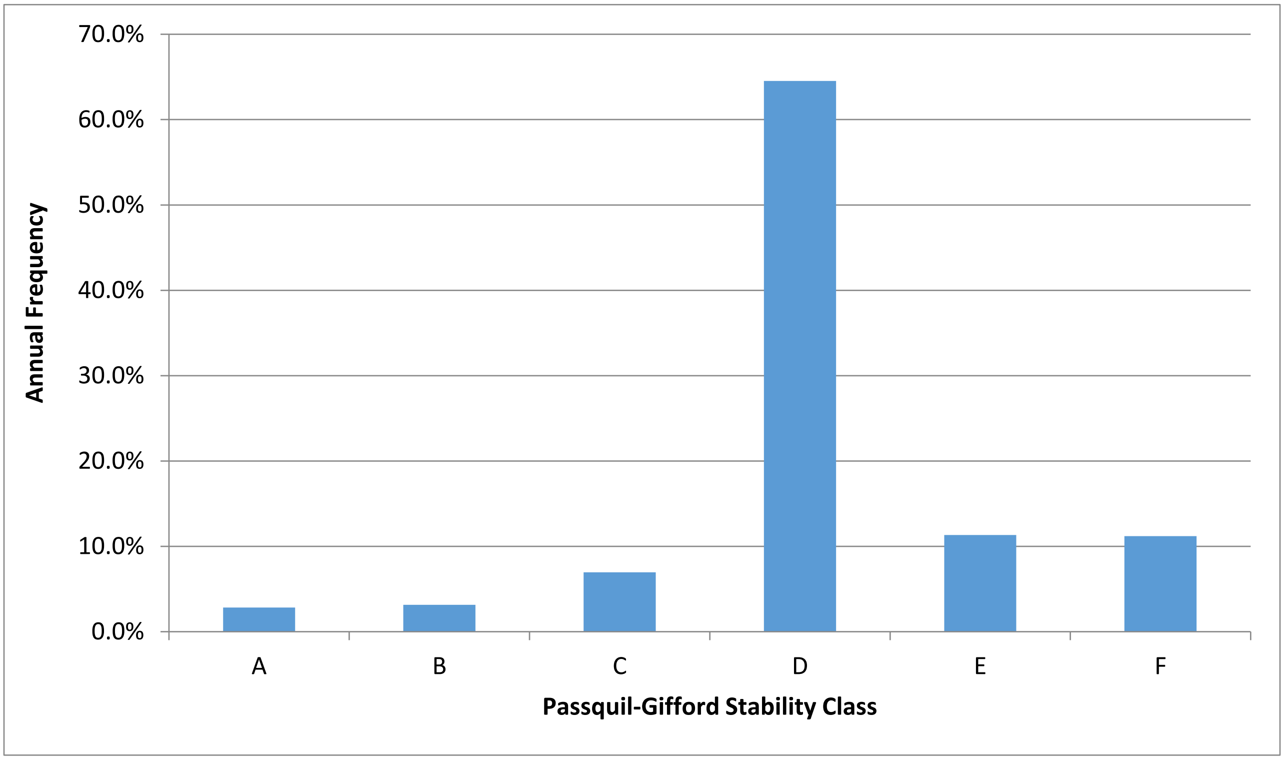
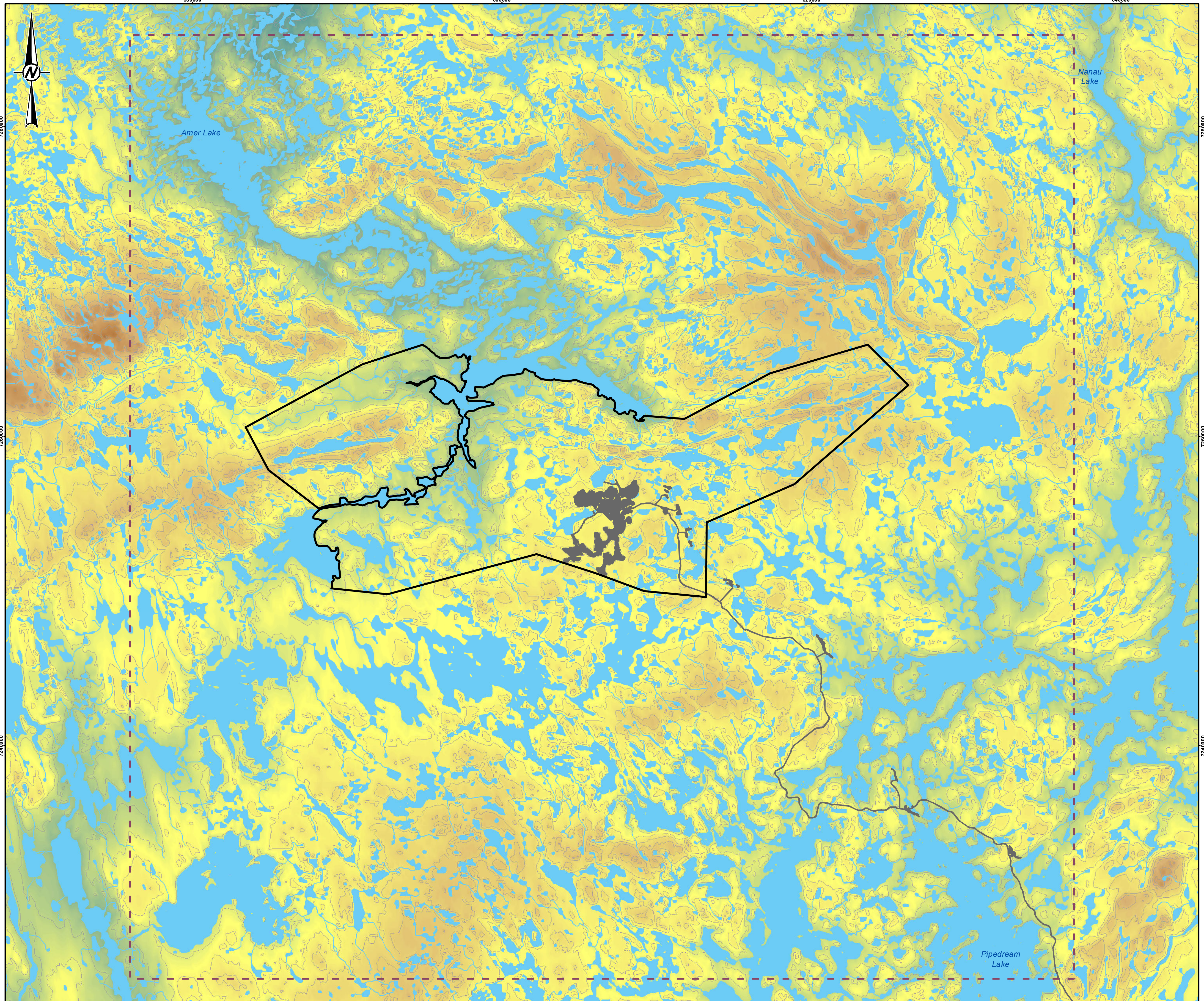


Figure 4-C-2: AERMET Derived Stability Classes

4.C-3 TERRAIN DATA

The terrain information required by the AERMOD dispersion model is generated by the AERMAP pre-processor. An AERMAP file was developed based on 1:250,000 Digital Elevation Model (DEM) data for the Project study area obtained from Geobase (Geobase 2015). The terrain in the effects study area is relatively flat with elevations ranging from approximately 315 to 544 metres above sea level (masl). The topography in the effects study area is shown in Figure 4-C-3.



LEGEND

- ELEVATION CONTOUR (20 m INTERVAL)
- WATERCOURSE
- WATERBODY
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

ELEVATION (mASL)

361
282
203
124
45

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

TOPOGRAPHY WITHIN THE STUDY AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

4.C-4 NO_X TO NO_2 CONVERSION

The oxides of nitrogen (NO_x) emissions from the Project are a mixture of nitrogen oxide (NO) and nitrogen dioxide (NO_2). However, NO is an unstable molecule and reacts quickly in the atmosphere to form NO_2. Since ambient air quality criteria are based on NO_2 concentrations, estimating the fraction of NO that has transformed into NO_2 is necessary. The AERMOD model's Ozone Limiting Method (OLM) was used to convert NO_x to NO_2. Background monthly ozone (O_3) concentrations are needed as input to the OLM calculations. Monthly average O_3 concentrations were calculated from National Air Pollution Station (NAPS) data for the Kivalliq region of Nunavut (see also Section 4.A-3.2 of the Approved Project FEIS Volume 4, Appendix 4-A; Agnico Eagle 2016). The background monthly O_3 concentrations used in the model are summarized in Table 4-C-4.

Table 4-C-4: Background Monthly Ozone Concentrations

Month	O_3 (ppbv)
January	24.0
February	25.5
March	25.5
April	30.6
May	30.4
June	25.7
July	20.0
August	17.7
September	17.3
October	19.1
November	22.7
December	22.8

O_3 = ozone; ppbv = parts per billion in volume

4.C-5 PARTICULATE MATTER DEPOSITION

The AERMOD model includes two methods for predicting dry and/or wet deposition of particulate matter emissions. Method 1 is used when the particle size distribution is known or when a significant fraction (greater than about 10%) of the total particulate mass has an aerodynamic diameter of 10 micrometers (µm) or larger. Method 2 is used when the particle size distribution is not well known and when a small fraction (less than 10% of the mass) has a diameter of 10 µm or larger (US EPA, 2004). Different from the method used in Approved Project (i.e., Method 2), Method 1 was used in this assessment to model the deposition of TSP, PM_{10}, $PM_{2.5}$. The Method 1 parameters used in the Expansion Project assessment are listed in Table 4-C-5.

Table 4-C-5: Particulate Matter Deposition Method 1 Parameters

Parameter	TSP			PM_{10}		$PM_{2.5}$
Size range	<2.5 µm	2.5 to 10 µm	>10 µm	<2.5 µm	2.5 to 10 µm	<2.5 µm
Mean diameter	0.5	5	20	0.5	5	0.5
Mass fraction	Calculated from emission rates of $PM_{2.5}$, $PM_{2.5\text{-}10}$, and $PM_{>10}$			Calculated from emission rates of $PM_{2.5}$ and $PM_{2.5\text{-}10}$		1
Density	1	1	1	1	1	1

TSP = total suspended particulate; PM_{10} = particulate matter smaller than 10 micrometers in aerodynamic diameter; $PM_{2.5}$ = particulate matter smaller than 2.5 micrometers in aerodynamic diameter; $PM_{2.5\text{-}10}$ = particulate matter smaller than 10 micrometers and larger than 2.5 micrometers in aerodynamic diameter; $PM_{>10}$ = particulate matter larger than 10 micrometers in aerodynamic diameter; µm = micrometer; <= less than; >= larger than

4.C-6 GAS DEPOSITION

The gas deposition algorithms incorporated into AERMOD are based on the draft Argonne National Laboratory (ANL) report (Wesely et al. 2002). The general gas deposition parameters specified for SO_2 and NO_x are as follows:

- pollutant reactivity factor: 0.1;
- fraction of maximum green LAI (Autumn): 0.5; and
- fraction of maximum green LAI (Transition Spring): 0.25.

The gas deposition algorithms of AERMOD include gas deposition resistance terms based on seasons and land use type (US EPA, 2004). Months of the year were separated into seasonal categories based on the Baker Lake climate normal data. The separation of months into seasons are as follows:

- Midsummer: July and August;
- Late Autumn: September and October;
- Winter: November, December, January, February, March, April, and May; and
- Transitional Spring: June.

The land use category of the region was classified as '8 – Barren land, mostly desert'. This determination is consistent with the Northern Arctic ecozone of Canada being classified as a 'Polar Desert' (see Section 4.A-2 of the Approved Project FEIS Volume 4, Appendix 4-A; Agnico Eagle 2016). Specific gas deposition parameters for SO_2 and NO_x are listed in Table 4-C-6 (Carbonell et al. 2010).

Table 4-C-6: AERMOD Gas Deposition Parameters for SO_2 and NO_x

Parameters	SO_2	NO_x
Diffusivity in air, cm^2/s	0.1509	0.1656
Diffusivity in water, cm^2/s	1.83×10^{-5}	1.4×10^{-5}
Cuticular resistance, s/cm	80	200
Henry's Law constant ($Pa\text{-}m^3/mol$)	72.37	8.443×10^{3}

SO_2 = sulfur dioxide; NO_x = oxides of nitrogen; cm^2/s = centimeters squared per second; s/cm = seconds per centimeter; $Pa\text{-}m^3/mol$ = Pascal meters cubed per mol

4.C-7 AIR QUALITY MODELLING FOR THE WHALE TAIL OPEN PIT

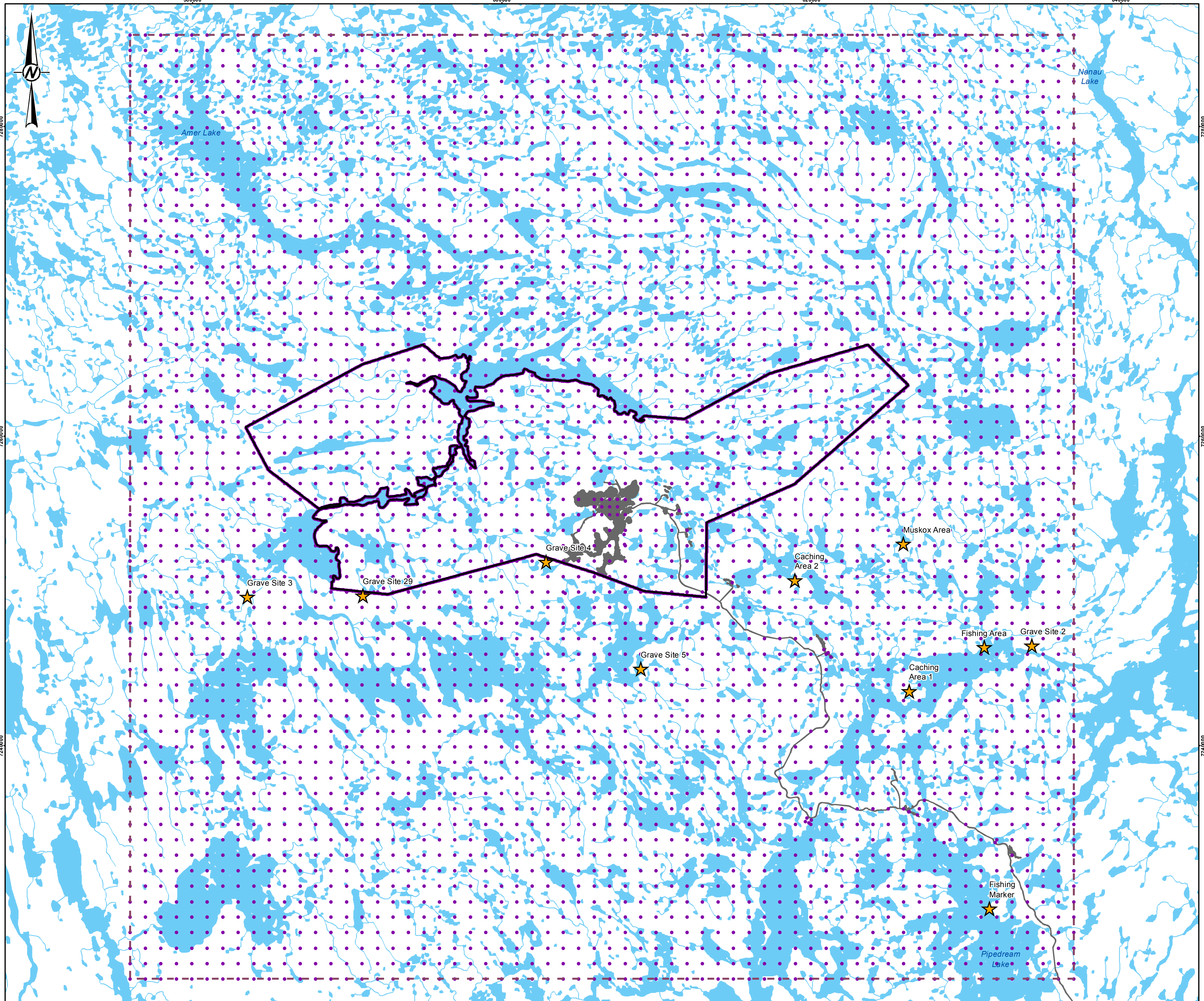
4.C-7.1 Study Area and Air Quality Receptors

A 60 km x 60 km study area centered at the Whale Tail Pit was created to assess the effects of the Project on air quality. Receptors with 100 m spacing were placed along the Project boundary and a receptor grid with 1000 m spacing was used in the remainder of the domain. To minimize the effects of the haul road, which will be assessed separately from the mining area, the Project boundary receptors that are within a buffer of 200 m from the haul road were removed. The boundary of the property owned by Agnico Eagle was used as the Project boundary where model-predicted concentrations of CACs are compared to the applicable ambient air quality guidelines or standards. Ground-level concentrations are also modelled at selected other locations (i.e., receptors) in the air quality study area. These discrete potential receptors include sites of historical and cultural significance to local Inuit including grave sites and locations representing traditional fishing and food caching areas located outside of the Project boundary. These receptors were identified based on Inuit Qaujimajatuqangit (IQ) workshops. These additional discrete receptors are listed in the Table 4-C-7 and plotted along with the other receptors in Figure 4-C-4.

Table 4-C-7: Selected Discrete Potential Receptors

Name	UTM Easting, m	UTM Northing, m
Grave site 2	634234	7246485
Grave site 3	583533	7249634
Grave site 4	602839	7251874
Grave site 5	608952	7244984
Grave site 29	590991	7249714
Fishing marker	631472	7229489
Muskox area	625924	7253042
Fishing area	631153	7246367
Caching area 1	626295	7243523
Caching area 2	618910	7250697

UTM = Universal Transverse Mercator; m = meter



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MODEL GRID RECEPTOR
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

STUDY AREA, GRID RECEPTORS, AND SELECTED DISCRETE RECEPTORS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-4

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25mm

PATH: G:_Clients\AgnicoEagle\WhaleTailPit\99_PROJECTS\1896037_WhaleTail\Phase2\02_PRODUCTION\MXD\Fig4C-4_1896037_Receptors.mxd

4.C-7.2 Emission Sources Modelled for the Mining Area

The primary sources of air emissions from the Expansion Project operations include the following:

- Whale Tail Pit, IVR Pit, and Underground Mine, including:
  - in-pit drilling and blasting;
  - in-pit material handling;
  - un-paved road dust; and
  - exhaust from off-road equipment operating in the pits and underground mine.
- ore pad material handling and ore crushing;
- wind erosion from ore pad and waste storage piles;
- power plant and camp heaters;
- incinerator; and
- un-paved road dust and vehicle exhaust from the section of haul road within the Project boundary.

Detailed methods associated with the Project's air emissions inventory are summarized in Volume 4, Appendix 4-B. The emission rates of the primary sources associated with the operation of the Expansion Project are summarized in Table 4-C-8.

Snow cover and frozen ground during winter months provides natural mitigation of windblown fugitive dust and fugitive road dust from un-paved roads. Therefore, monthly variable emission rates of particulate matters for the Whale Tail Pit, IVR Pit, haul roads, ore pad, and waste rock storage piles were used in the air quality model. The months classified as unfrozen season are June to October; months classified as the frozen season are November to May.

Table 4-C-8: Daily Emission Rates Associated with Operation of the Expansion Project

Source ID	Total Emission Rate in Unfrozen Season (kg/day)						Total Emission Rate in Frozen Season, (kg/day)					
	TSP	PM_{10}	$PM_{2.5}$	NO_x	CO	SO_2	TSP	PM_{10}	$PM_{2.5}$	NO_x	CO	SO_2
WT_PIT	3434.4	1003.9	187.2	1273.7	1126.0	22.9	761.0	289.1	115.7	1273.7	1126.0	761.0
IVR_PIT	401.5	140.9	52.8	382.7	806.5	21.8	158.7	76.0	46.3	382.7	806.5	158.7
UG	93.4	44.6	29.6	369.4	854.3	21.9	93.4	44.6	29.6	369.4	854.3	93.4
OP	170.1	85.0	18.1	104.4	33.8	0.1	77.5	38.8	11.2	104.4	33.8	77.5
WT_WRSF	600.0	298.1	44.8	0.0	0.0	0.0	69.7	32.9	5.0	0.0	0.0	69.7
IVR_WRSF	124.4	61.8	9.3	0.0	0.0	0.0	12.7	6.0	0.9	0.0	0.0	12.7
UG_WREP	19.1	9.5	1.4	0.0	0.0	0.0	1.6	0.7	0.1	0.0	0.0	1.6
RD_WT_OP	1516.0	407.8	43.7	62.3	19.7	0.1	255.5	70.8	10.0	62.3	19.7	255.5
RD_WT_WRSF	2818.6	775.8	103.9	554.8	175.1	0.6	495.0	154.5	41.8	554.8	175.1	495.0
RD_IVR_OP	111.5	30.5	3.8	16.7	5.3	0.0	19.4	5.8	1.4	16.7	5.3	19.4
RD_IVR_WRSF	58.7	19.8	6.8	101.3	32.0	0.1	14.4	7.9	5.6	101.3	32.0	14.4
RD_UG_OP	45.5	14.1	3.7	25.8	20.3	0.0	9.8	4.6	2.8	25.8	20.3	9.8
RD_UG_WREP	18.1	6.1	2.2	17.0	13.4	0.0	4.5	2.5	1.8	17.0	13.4	4.5
HAUL_ROAD	3432.9	922.4	97.7	62.1	33.9	0.1	577.3	158.9	21.3	62.1	33.9	0.1
GEN1_CPP	4.3	4.3	4.2	148.8	34.1	0.8	4.3	4.3	4.2	148.8	34.1	4.3
GEN2_CPP	4.3	4.3	4.2	148.8	34.1	0.8	4.3	4.3	4.2	148.8	34.1	4.3
GEN3_CPP	4.3	4.3	4.2	148.8	34.1	0.8	4.3	4.3	4.2	148.8	34.1	4.3
GEN4_CPP	4.3	4.3	4.2	148.8	34.1	0.8	4.3	4.3	4.2	148.8	34.1	4.3

Table 4-C-8: Daily Emission Rates Associated with Operation of the Expansion Project

Source ID	Total Emission Rate in Unfrozen Season (kg/day)						Total Emission Rate in Frozen Season, (kg/day)					
	TSP	PM_{10}	$PM_{2.5}$	NO_x	CO	SO_2	TSP	PM_{10}	$PM_{2.5}$	NO_x	CO	SO_2
GEN5_CPP	4.3	4.3	4.2	148.8	34.1	0.8	4.3	4.3	4.2	148.8	34.1	4.3
GEN6_CPP	4.3	4.3	4.2	148.8	34.1	0.8	4.3	4.3	4.2	148.8	34.1	4.3
GEN7_CPP	4.3	4.3	4.2	148.8	34.1	0.8	4.3	4.3	4.2	148.8	34.1	4.3
GEN1_UG	16.3	16.3	15.8	558.1	127.9	2.8	16.3	16.3	15.8	558.1	127.9	16.3
GEN2_UG	16.3	16.3	15.8	558.1	127.9	2.8	16.3	16.3	15.8	558.1	127.9	16.3
GEN3_UG	16.3	16.3	15.8	558.1	127.9	2.8	16.3	16.3	15.8	558.1	127.9	16.3
HEATER1	0.2	0.0	0.0	2.2	0.5	0.2	0.2	0.0	0.0	2.2	0.5	0.2
HEATER2	0.2	0.0	0.0	2.2	0.5	0.2	0.2	0.0	0.0	2.2	0.5	0.2
INC	2.8	2.8	2.8	6.1	0.3	0.0	2.8	2.8	2.8	6.1	0.3	2.8

kg/day = kilograms per day; TSP = total suspended particulate; PM_{10} = particulate matter smaller than 10 micrometers in aerodynamic diameter; $PM_{2.5}$ = particulate matter smaller than 2.5 micrometers in aerodynamic diameter; NO_x = oxides of nitrogen; SO_2 = sulfur dioxide; CO = carbon monoxide

Figure 4-C-5 illustrates the locations of the emission sources associated with the operation of the Expansion Project. Within the AERMOD model, emissions from the Whale Tail Pit and IVR Pit are modelled as “open pit”. The depth of the open pit in 2020 is planned at 50 m. The total volume of the open pit is 25,235,546 m^3. As AERMOD can only model a rectangular open pit, the Whale Tail Pit was modelled as a rectangle (1320 m x 540 m). The model pit’s rectangle was then rotated 30 degrees to enclose and better represent the actual Whale Tail Pit. By conserving the overall volume of the pit, the effective depth of the modelled pit is 35.4 m. Since the actual pit will be approximately 50 m, not 35.4 m, emissions from the Whale Tail Pit are modelled relatively conservatively (i.e., less emissions are expected to leave the pit than those predicted in the assessment). The open pit parameters modelled in AERMOD were listed in Table 4-C-9.

Table 4-C-9: Modelled Open Pit Parameters

Open Pit	Actual Area (m^2)	Depth (m)	Volume (m^3)	Modelled Area (m^2)	Orientation Angle from North (º)	X Length (m)	Y Length (m)	Effective Pit Depth (m)
WT	568,123	119	67,606,637	712,800	-30.0	1,320	540	94.85
IVR	228,533	21	4,799,193	276,000	36.5	400	690	17.39

m^2 = square meters; m = meter; m^3 = cubic meters; º = degree

The Whale Tail Pit haul road (15 m wide) inside the Project boundary and the site haul roads (9.5 m wide) to transport ore and waste were modelled as a series of volume sources. The volume sources parameters were calculated from the vehicle height (5.1 m) and road width (US EPA 2012). The volume source parameters are as follows:

- emissions release height: 4.33 m;
- initial vertical dimension: 4.03 m; and
- initial lateral dimension: 19.5 m and 6.98 m for haul road and roads to transport ore and waste, respectively.

The ore pad and waste storage piles were modelled as area polygon sources. It was assumed that the emissions release from 4.33 m from the ground level and the initial vertical dimension is 4.03 m.

The power plant and camp heater emissions were modelled as point sources. The stack parameters for these sources are as follows:

- Vertical release height: 5.0 m for generators and 1.88 m for heaters;
- Gas exit temperature: 588.71 K for generators and 430.15 K for heaters;
- Stack inside diameter: 0.3 m for generators and 0.25 m for heaters; and
- Gas exit velocity: 17.00 m/s for generators and 4.38 m/s for heaters.

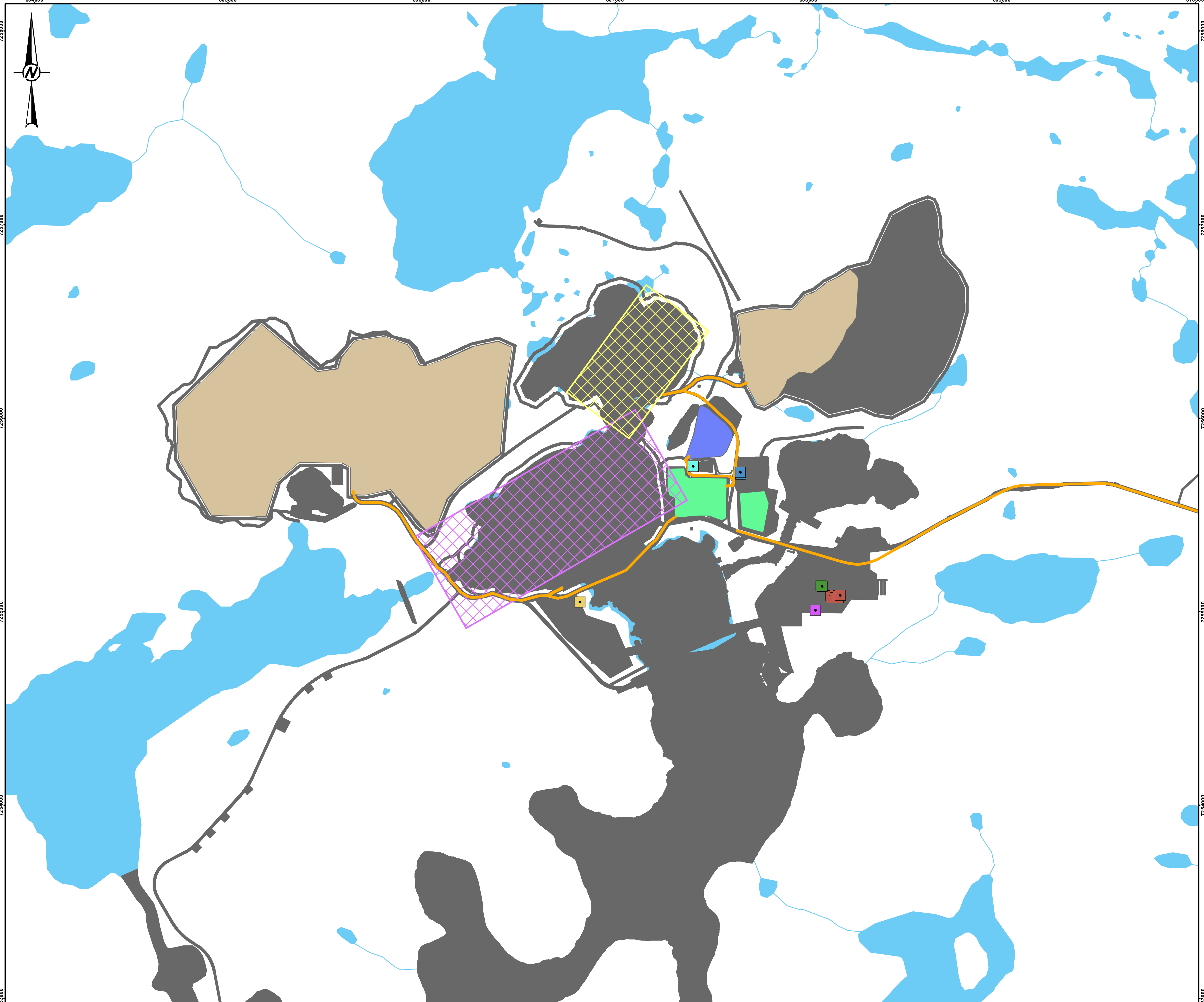
The emissions of incinerator were also modelled as a point source. The incinerator stack parameters found in the incinerator specifications are as follows:

- Vertical release height: 11.79 m;
- Gas exit temperature: 1000.15 K;

- Stack inside diameter: 0.97 m; and
- Gas exit velocity: 7.8 m/s.

The emissions rates from underground mine were exhausted from the underground vent and ramp portal and were modelled as point sources. The point source parameters are as followed:

- The ramp portal with dimension of 5.3 m x 5.3 m was modelled as horizontal point source;
- Release height: 0 m;
- Gas exit temperature was assumed to be 293.15 K;
- Stack inside diameter: 6.7 m for vent and 5.98 m for ramp portal; and
- Gas exit velocity: 2.59 m/s for vent and 4.87 m/s for ramp portal.



LEGEND

- WATERCOURSE
- WATERBODY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

EMISSION SOURCES

- HEATER
- INCINERATOR
- POWER PLANT GENERATOR
- UNDERGROUND MINE GENERATOR
- UNDERGROUND MINE RAMP PORTAL
- UNDERGROUND MINE VENT RAISE
- HAUL ROAD
- IVR OPEN PIT
- ORE PAD
- WASTE ROCK EXPLORATION PAD
- WASTE ROCK STORAGE FACILITY
- WHALE TAIL OPEN PIT

0 400 800

1:20,000 METRES

REFERENCE(S)

1. CANVEC BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

EMISSION SOURCES FOR THE AIR QUALITY MODELLING OF THE EXPANSION PROJECT

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

4.C-7.3 Air Quality Model Results for the Whale Tail Mining Area

To aid in interpretation of the air quality dispersion modelling results, the results are presented in tabular format. The summary tables include model predictions, model predictions plus background concentrations of the relevant CAC's, and the ambient air quality criteria for the CAC. In addition, isopleth maps showing the 1-hour, 8-hour, 24-hour, or annual maximum predictions are included in the assessment. For clarity, the isopleth maps for most compounds present contour levels for 100%, 50%, and 25% of the applicable air quality guideline or standard. For those compounds that have low model predicted concentrations compared to air quality standards, contour levels that best represent the spatial patterns of the model results were used.

The following sections present the predicted CO, NO_2, SO_2, $PM_{2.5}$, PM_{10}, and TSP concentrations from the AERMOD model. For each compound, the peak model predicted concentration refers to the highest 1-hour, 8-hour, and 24-hour concentration over the 5-year simulation. The maximum model predicted concentration refers to the following:

- For 1-hour predictions, the maximum concentrations represent the maximum 9th highest concentration over the 5-year simulation.
- For 8-hour predictions, the maximum concentrations represent the maximum 5th highest concentration over the 5-year simulation.
- For the 24-hour (daily) predictions of $PM_{2.5}$, the maximum concentrations represent the maximum 98th percentile of model predicted concentration averaged over 3 consecutive years' simulation.
- For the 24-hour (daily) predictions of all other pollutants, the maximum concentrations represent the maximum 2nd highest concentration over 5-year simulation.
- For averaging times longer than 24-hours, no modelled concentrations are eliminated from the maximum predicted value. The maximum concentrations represent the maximum 1st highest concentration over the 5-year simulation.

The maximum modelled predicted concentrations outside the Project boundary for each averaging period were then compared with the applicable ambient air standards outlined in Table 4-C-2. This means of expressing the maximum predicted concentrations is consistent with reporting requirements from other jurisdictions within Canada, for example the Alberta and Saskatchewan Air Quality Modelling Guidelines.

4.C-7.3.1 Carbon Monoxide (CO) Predictions

The model predicted 1-hour and 8-hour CO concentrations from the Expansion Project are summarized in Table 4-C-10 and shown in Figures 4-C-6 and 4-C-7. The maximum CO concentrations outside the Project boundary are lower than the ambient air standards. The 1-hour and 8-hour CO concentrations at the selected receptors (Table 4-C-11) are all lower than the respective air quality standards. The predicted 1-hour and 8-hour maximum CO concentrations from the Expansion Project are higher than those of the Approved Project because the worst case 1-hour CO emissions with the blasting activity were used in the Expansion Project.

Table 4-C-10: Summary Table of Model Predicted CO Concentrations Outside Project Boundary

Results	Approved Project[a]		Expansion Project	
	1-hr	8-hr	1-hr	8-hr
Peak CO Concentration (µg/m³)	18,839	3,324	40,334	8,341
Maximum CO Concentration (µg/m³)	6,172	1,482	11,330	2,762
Project Contribution Combined with Background Concentration				
Peak CO Concentration (µg/m³)	19,228	3,728	40,723	8,726
Maximum CO Concentration (µg/m³)	6,561	1,867	11,718	3,147
Number of occurrences above criteria	0	0	0	0
Distance (km)	3.8	3.8	3.8	4.3
Direction	S	S	S	SSE
Ambient Air Quality Standards (µg/m³)	**15,000**	**6,000**	**15,000**	**6,000**

[a]: uses the re-modelled worst-case concentrations for Approved Project

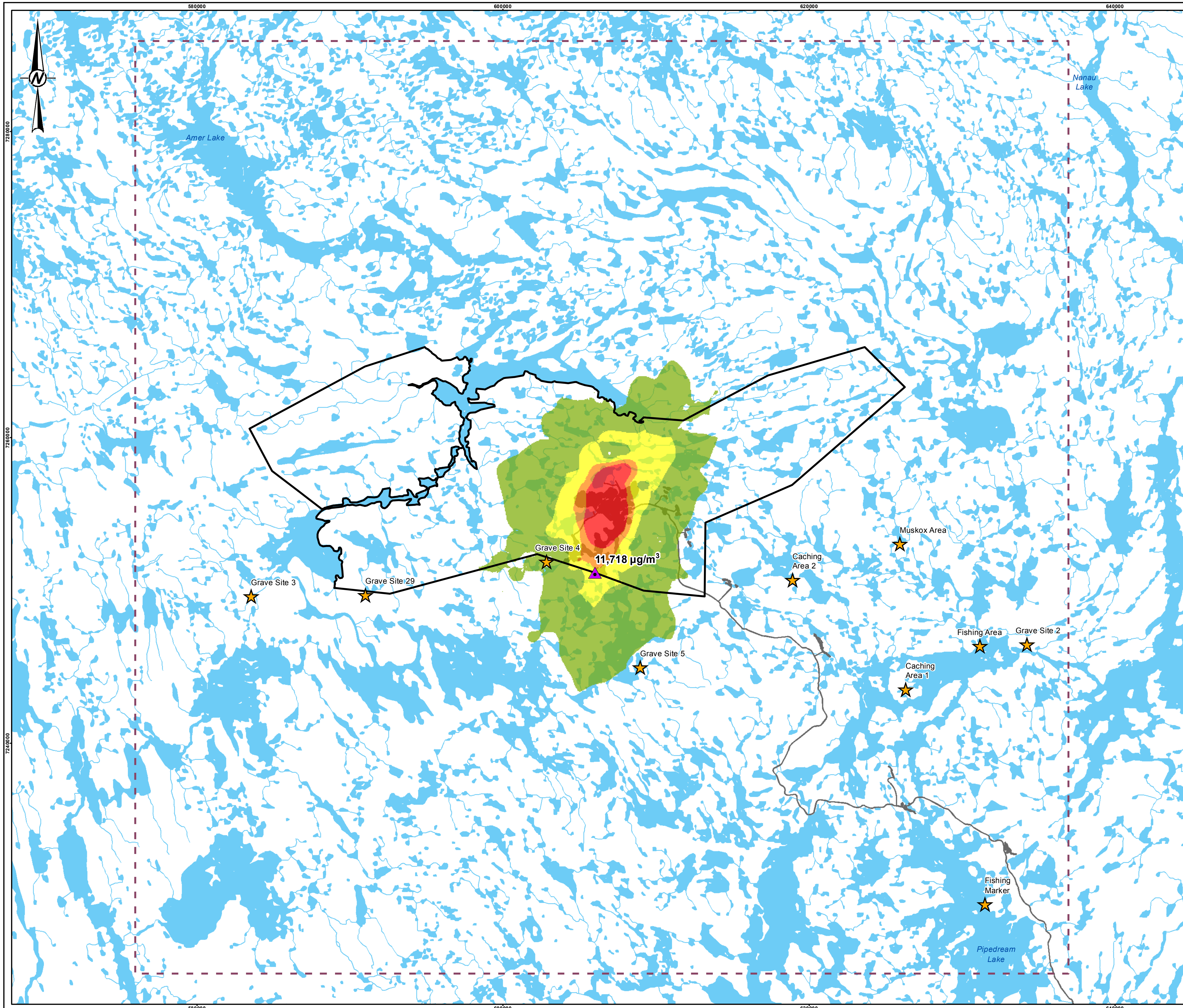
CO = carbon monoxide; hr = hour; µg/m³ = micrograms per cubic metre; km = kilometer; S = South; SSE = south-southeast

Table 4-C-11: Model Predicted CO Concentration at Selected Potential Receptor Locations

Health Receptor	Approved Project[a]		Expansion Project	
	1-hr Maximum (µg/m³)	8-hr Maximum (µg/m³)	1-hr Maximum (µg/m³)	8-hr Maximum (µg/m³)
Grave site 2	611	426	803	785
Grave site 3	733	460	1131	860
Grave site 4	2,122	958	3,278	2,665
Grave site 5	2,067	825	3,278	2,665
Grave site 29	742	518	1,412	1,577
Fishing marker	618	432	961	553
Muskox	813	499	1,213	772
Fishing area	627	450	1,022	594
Caching area 1	627	450	1,021	924
Caching area 2	717	439	1,678	770

[a]: use the re-modelled worst-case concentrations for Approved Project

hr = hour; µg/m³ = micrograms per cubic metre



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 3,750
- 3,750 - 7,500
- 7,500 - 11,250
- 11,250 - 15,000
- > 15,000

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM 1-HOUR CO CONCENTRATIONS

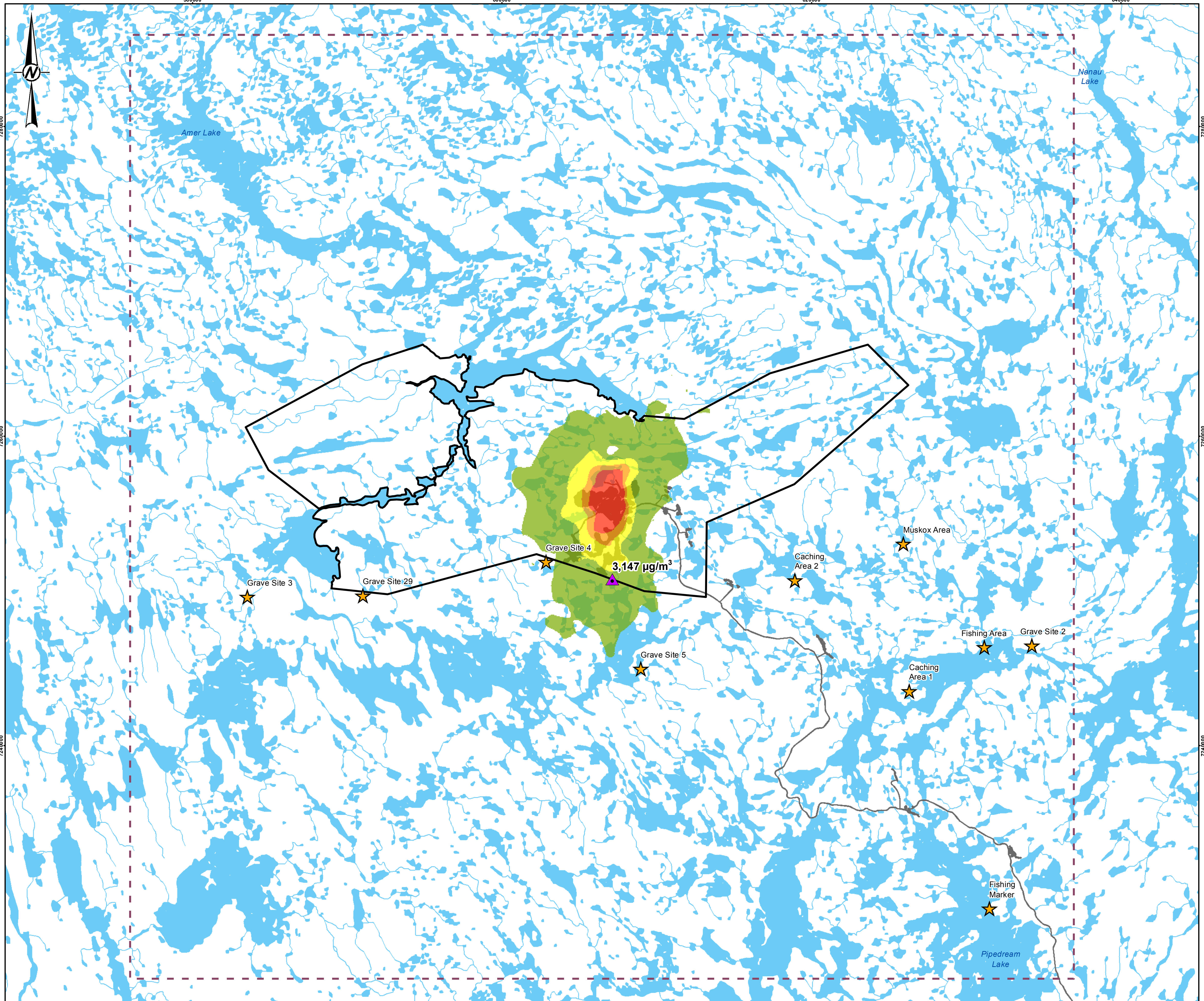
CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 1,500
- 1,500 - 3,000
- 3,000 - 4,500
- 4,500 - 6,000
- > 6,000

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM 8-HOUR CO CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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4.C-7.3.2 Nitrogen Oxide (NO_2) Predictions

The model predicted 1-hour, 24-hour, and annual NO_2 concentrations are summarized in Table 4-C-12 and shown in Figures 4-C-8 to 4-C-10. The maximum model predicted 1-hour, 24-hour, and annual NO_2 concentrations outside the Project boundary are 383, 122, and 13.6 µg/m^3, respectively. The maximum 1-hour, 24-hour, and annual NO_2 concentrations and the concentrations at the selected receptors (Table 4-C-13) are all lower than the respective air quality standards. The model predicted maximum NO_2 concentrations from the Expansion Project are much higher than those of Approved project due to increased NO_x emissions rates and using the worst case 1-hour NO_x emission in the modelling.

Table 4-C-12: Summary Table of Model Predicted NO_2 Concentrations

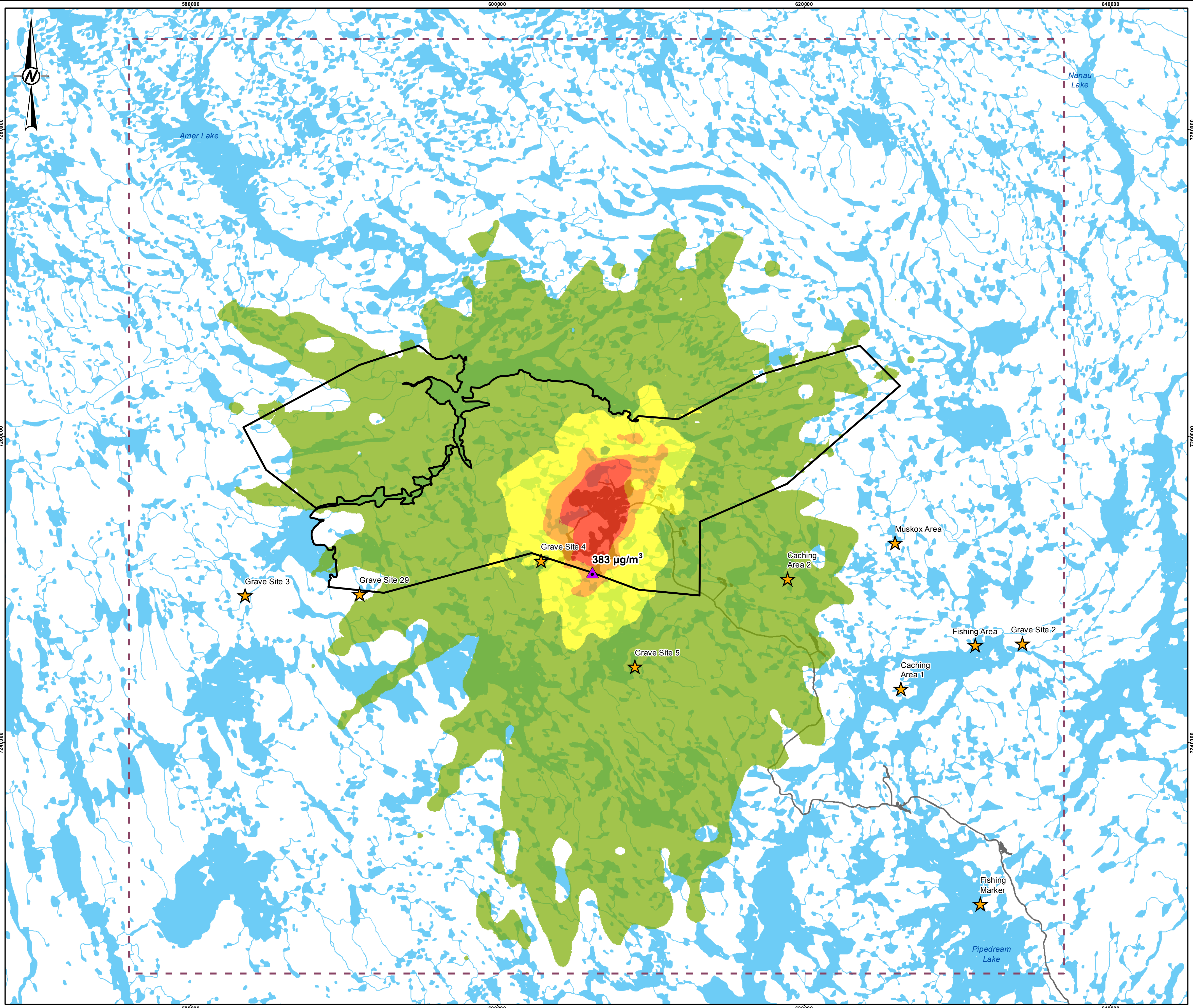
Results	Approved Project			Expansion Project		
	1-hr[a]	24-hr	Annual	1-hr	24-hr	Annual
Peak NO_2 Concentration (µg/m^3)	719	53.2	—	1,234	123	—
Maximum NO_2 Concentration (µg/m^3)	266	46.5	3.5	370	110	8.7
Project Contribution Combined with Background Concentration						
Peak NO_2 Concentration (µg/m^3)	732	64.6	—	1,246	134	—
Maximum NO_2 Concentration (µg/m^3)	278	57.9	8.5	383	122	13.6
Number of occurrences above criteria	0	0	0	0	0	0
Distance (km)	3.8	4.1	4.1	3.8	3.8	4.5
Direction	S	S	S	S	S	SSE
Ambient Air Quality Standards (µg/m^3)	**400**	**200**	**60**	**400**	**200**	**60**

NO_2 = nitrogen dioxide; hr = hour; µg/m^3 = micrograms per cubic metre; km = kilometer; S = south; SSE = south-southeast
[a]: use the re-modelled worst-case 1-hr concentrations for Approved Project

Table 4-C-13: Model Predicted NO_2 Concentrations at Selected Potential Receptor Locations

Health Receptor	Approved Project[a]			Expansion Project		
	1-hr Maximum ($\mu g/m^3$)[a]	24-hr Maximum ($\mu g/m^3$)	Annual ($\mu g/m^3$)	1-hr Maximum ($\mu g/m^3$)	24-hr Maximum ($\mu g/m^3$)	Annual ($\mu g/m^3$)
Grave site 2	61.8	15.0	5.1	76.1	21.9	20.4
Grave site 3	74.2	17.3	5.1	92.2	36.8	21.4
Grave site 4	126	24.0	5.6	173	51.5	44.4
Grave site 5	117	27.3	6.1	168	46.0	45.8
Grave site 29	70.3	17.3	5.2	89.7	29.6	29.6
Fishing marker	64.8	18.1	5.2	77.2	30.0	30.0
Muskox	73.4	15.8	5.2	92.5	21.6	20.5
Fishing area	67.8	14.9	5.1	83.6	22.7	19.1
Caching area 1	67.2	17.1	5.2	80.7	25.1	24.5
Caching area 2	91.6	17.6	5.4	114.9	31.6	24.9

$\mu g/m^3$ = micrograms per cubic metre; hr = hour
[a]: use the re-modelled worst-case 1-hour concentrations for Approved Project



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (μg/m³)

- < 100
- 100 - 200
- 200 - 300
- 300 - 400
- > 400

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

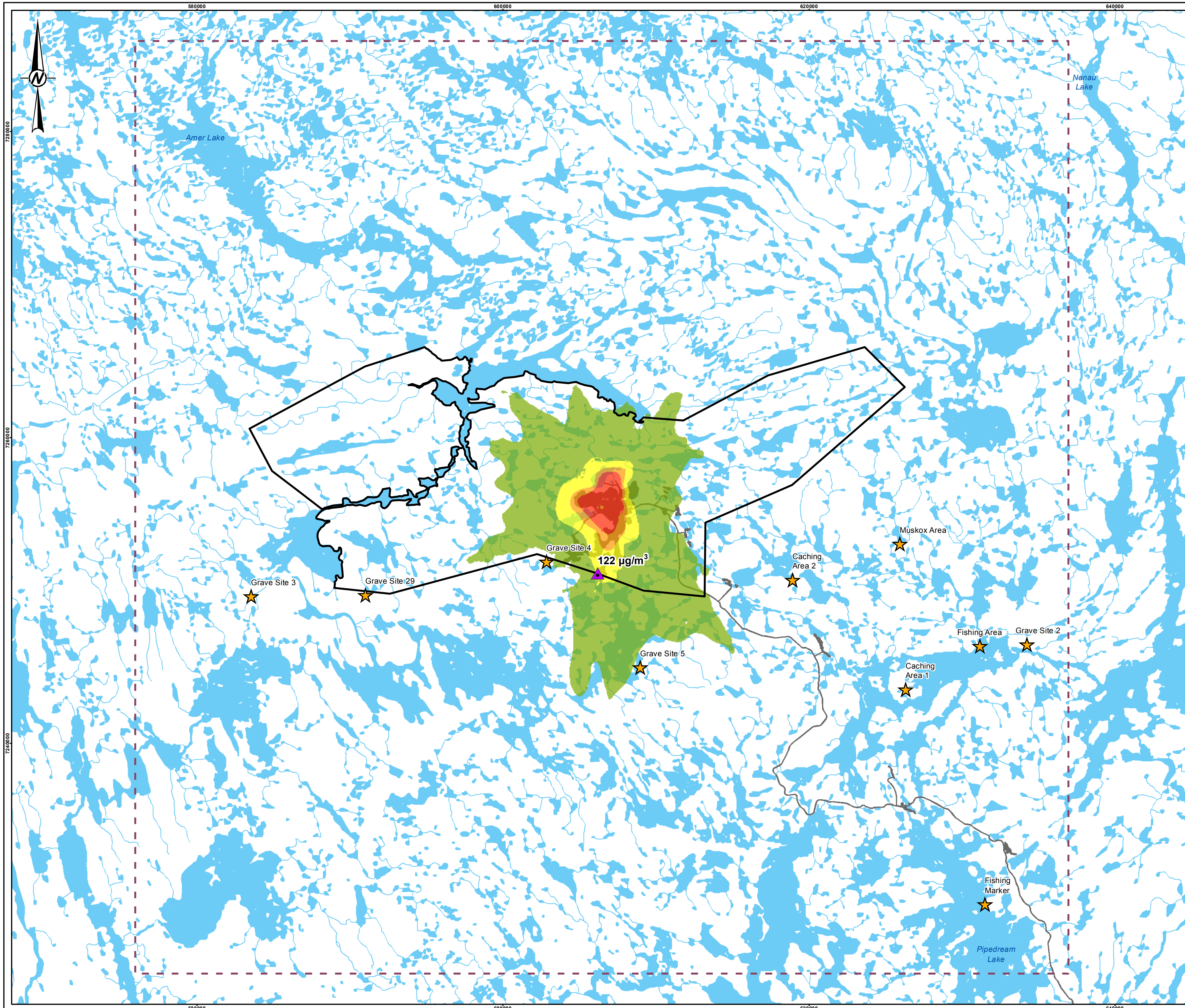
MODEL PREDICTED MAXIMUM 1-HOUR NO_2 CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-8



REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM 24-HOUR NO_2 CONCENTRATIONS

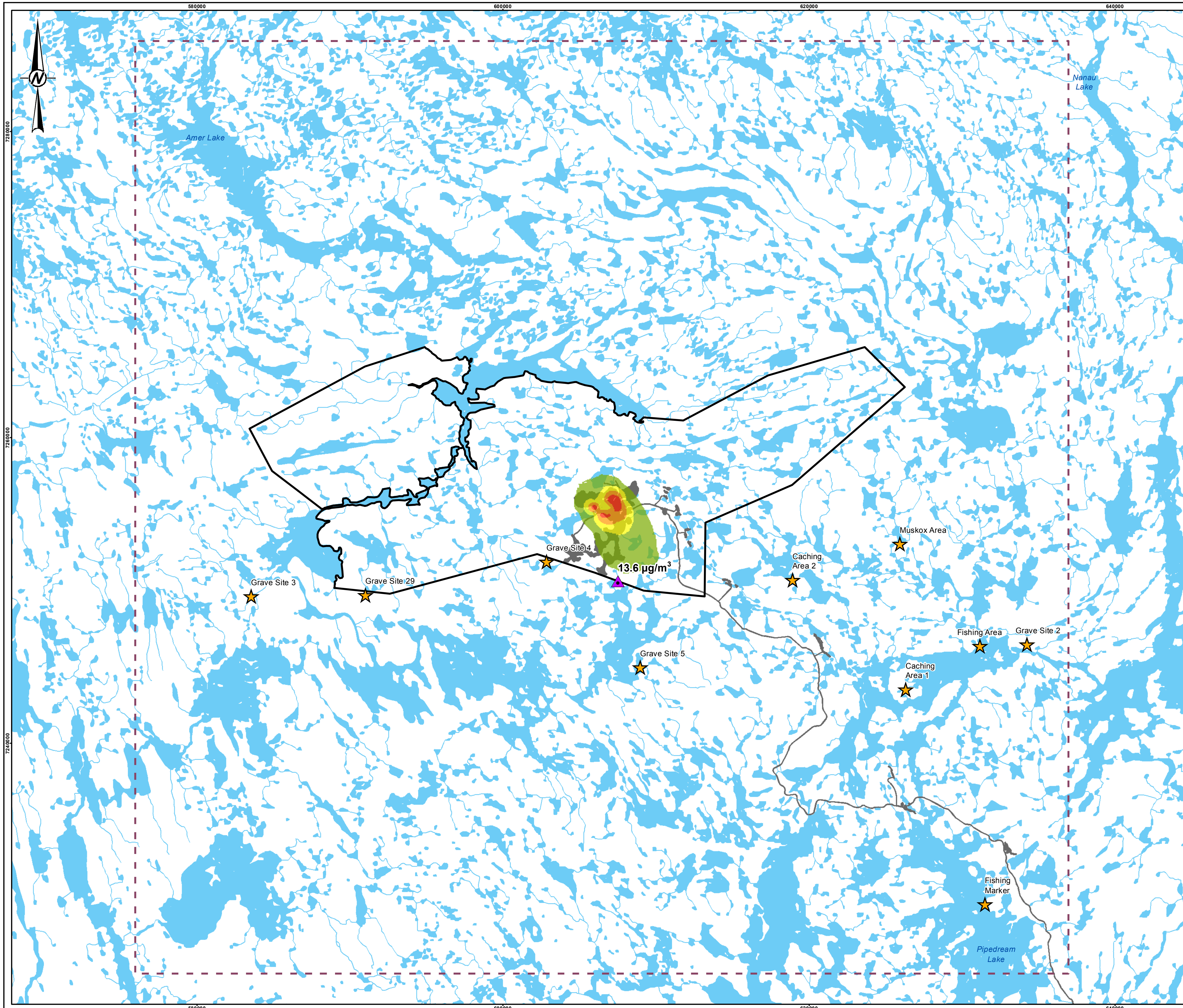
CONSULTANT

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	**4-C-9**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 15
- 15 - 30
- 30 - 45
- 45 - 60
- > 60

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM ANNUAL NO_2 CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

4.C-7.3.3 Sulfur Dioxide (SO_2) Predictions

The model predicted 1-hour, 24-hour, and annual SO_2 concentrations are summarized in Table 4-C-14 and shown in Figures 4-C-11 to 4-C-13. The maximum model predicted 1-hour, 24-hour, and annual SO_2 concentrations outside the Project boundary are 305, 88, and 2.3 µg/m^3, respectively. The maximum 1-hour, 24-hour, and annual SO_2 concentrations occur along the southern Project boundary. The maximum 1-hour, 24-hour, and annual SO_2 concentrations and the concentrations at the selected receptors (Table 4-C-15) are all lower than the respective air quality standards. The maximum SO_2 predictions from the Expansion Project are much higher than those of the Approved Project because of the higher emission rates and using the worst case 1-hour emission rates in the modelling.

Table 4-C-14: Summary Table of Model Predicted SO_2 Concentrations

Results	Approved Project			Expansion Project		
	1-hr[a]	24-hr	Annual	1-hr	24-hr	Annual
Peak SO_2 Concentration (µg/m^3)	538	3.7	—	1162	98	—
Maximum SO_2 Concentration (µg/m^3)	69.3	3.2	0.1	302	85	2.0
Project Contribution Combined with Background Concentration						
Peak SO_2 Concentration (µg/m^3)	540	6.3	—	1,165	101	—
Maximum SO_2 Concentration (µg/m^3)	172	5.8	0.4	305	88	2.3
Number of occurrences above criteria	0	0	0	0	0	0
Distance (km)	3.8	3.8	4.1	3.8	3.8	4.2
Direction	S	S	S	S	S	S
Current Ambient Air Quality Standards (µg/m^3)	**450**	**150**	**30**	**450**	**150**	**30**

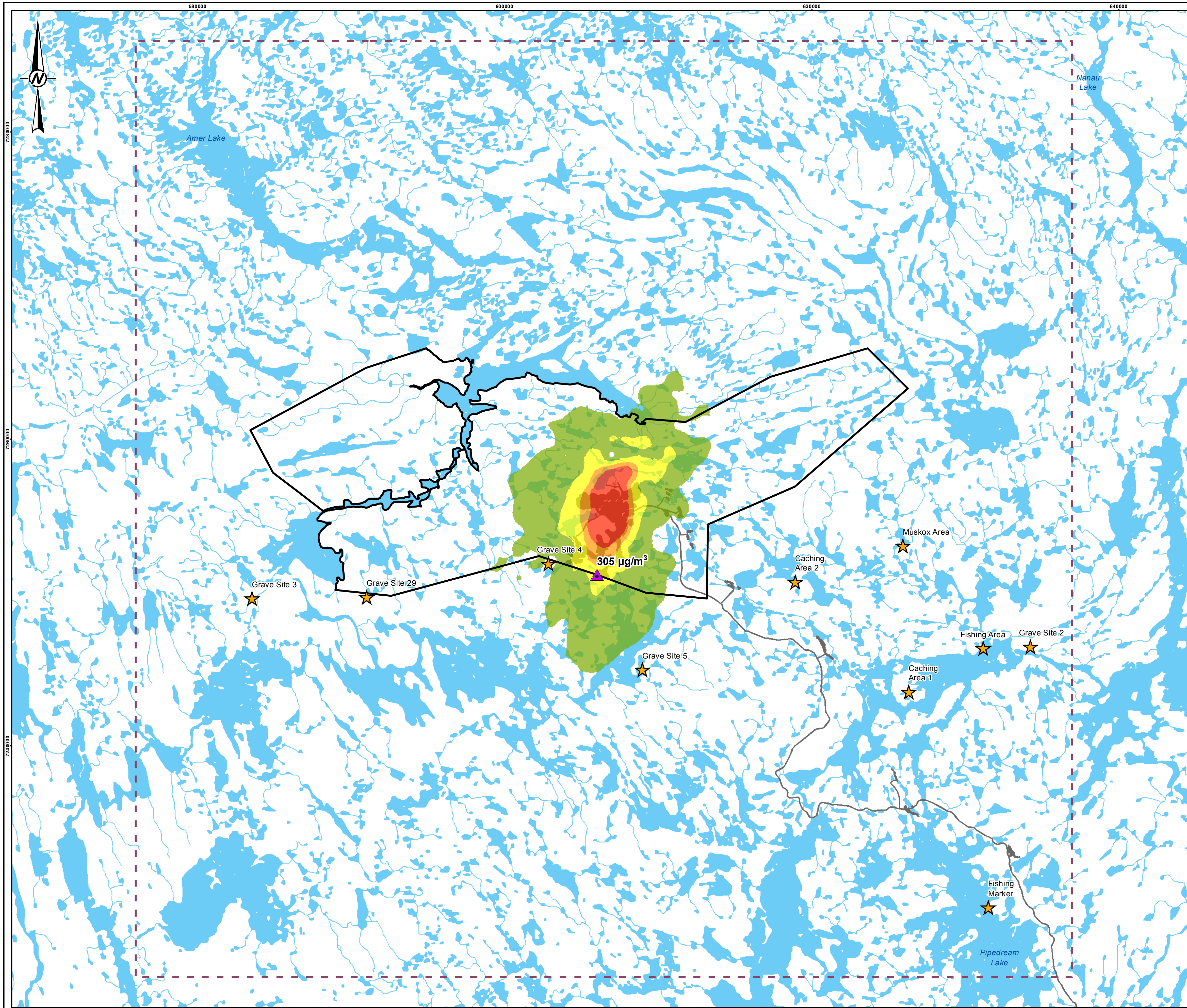
[a]: use the re-modelled worst-case 1-hour concentrations for Approved Project

SO_2 = sulphur dioxide; hr = hour; µg/m^3 = micrograms per cubic metre; km = kilometer; S = south

Table 4-C-15: Model Predicted SO_2 Concentrations at Selected Potential Receptor Locations

Health Receptor	Approved Project			Expansion Project		
	1-hr Maximum ($\mu g/m^3$)[a]	24-hr Maximum ($\mu g/m^3$)	Annual ($\mu g/m^3$)	1-hr Maximum ($\mu g/m^3$)	24-hr Maximum ($\mu g/m^3$)	Annual ($\mu g/m^3$)
Grave site 2	8.96	2.7	0.27	14.3	5.22	4.12
Grave site 3	12.4	2.9	0.27	23.3	11.2	5.81
Grave site 4	51.8	3.7	0.29	81.4	22.7	20.3
Grave site 5	50.4	3.4	0.30	83.3	22.3	22.3
Grave site 29	12.7	2.8	0.27	30.4	12.3	11.5
Fishing marker	9.15	2.8	0.27	18.1	5.41	5.28
Muskox	14.7	2.8	0.27	25.5	6.40	4.80
Fishing area	9.39	2.8	0.27	20.7	5.06	4.47
Caching area 1	12.0	2.8	0.27	20.9	7.81	5.26
Caching area 2	27.9	2.9	0.28	39.2	6.55	6.06

[a]: use the re-modelled worst-case 1-hour concentrations for Approved Project
hr = hour; $\mu g/m^3$ = micrograms per cubic metre;



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 112.5
- 112.5 - 225
- 225 - 337.5
- 337.5 - 450
- < 450

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

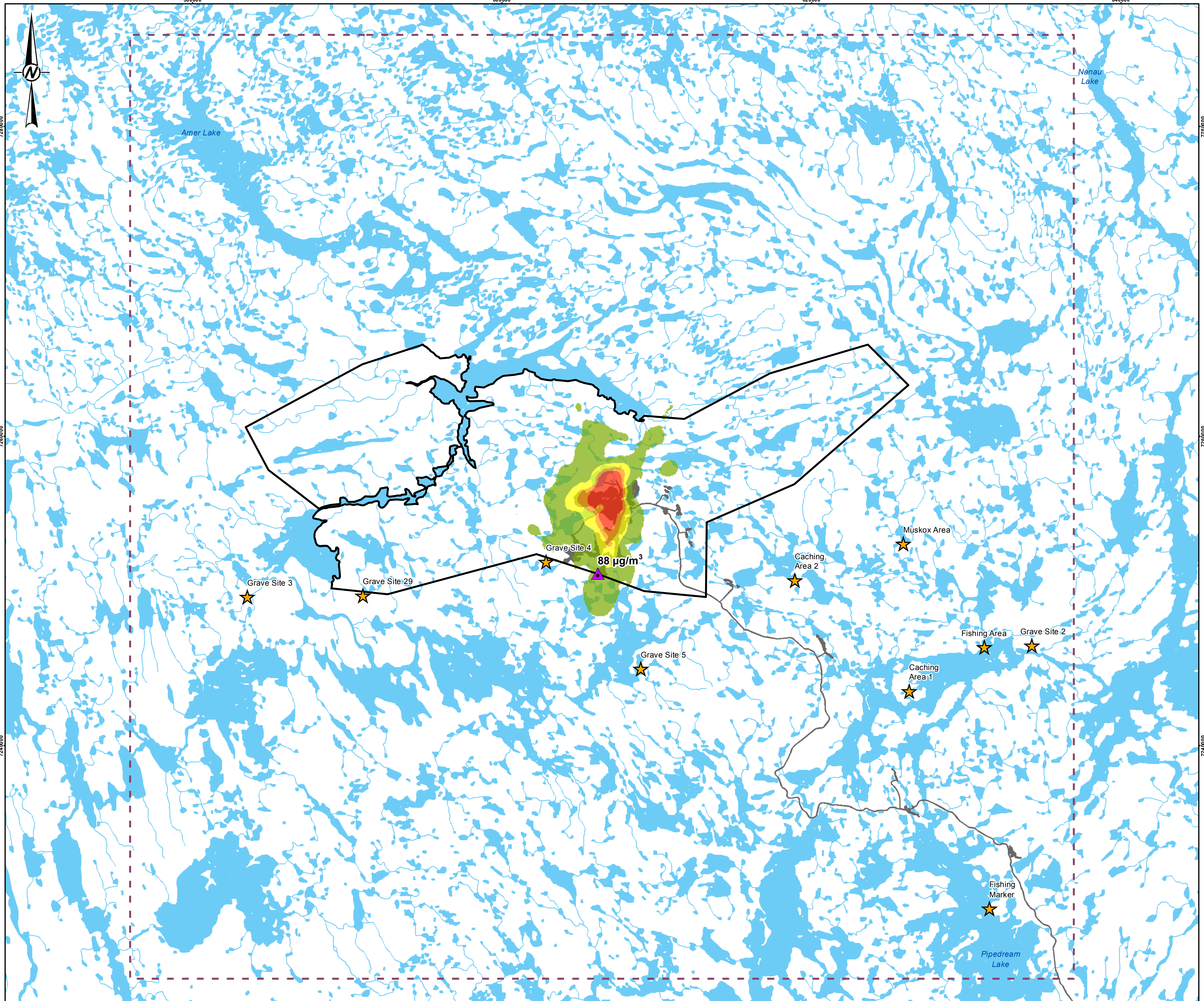
MODEL PREDICTED MAXIMUM 1-HOUR SO_2 CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-11



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 37.5
- 37.5 - 75
- 75 - 112.5
- 112.5 - 150
- > 150

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

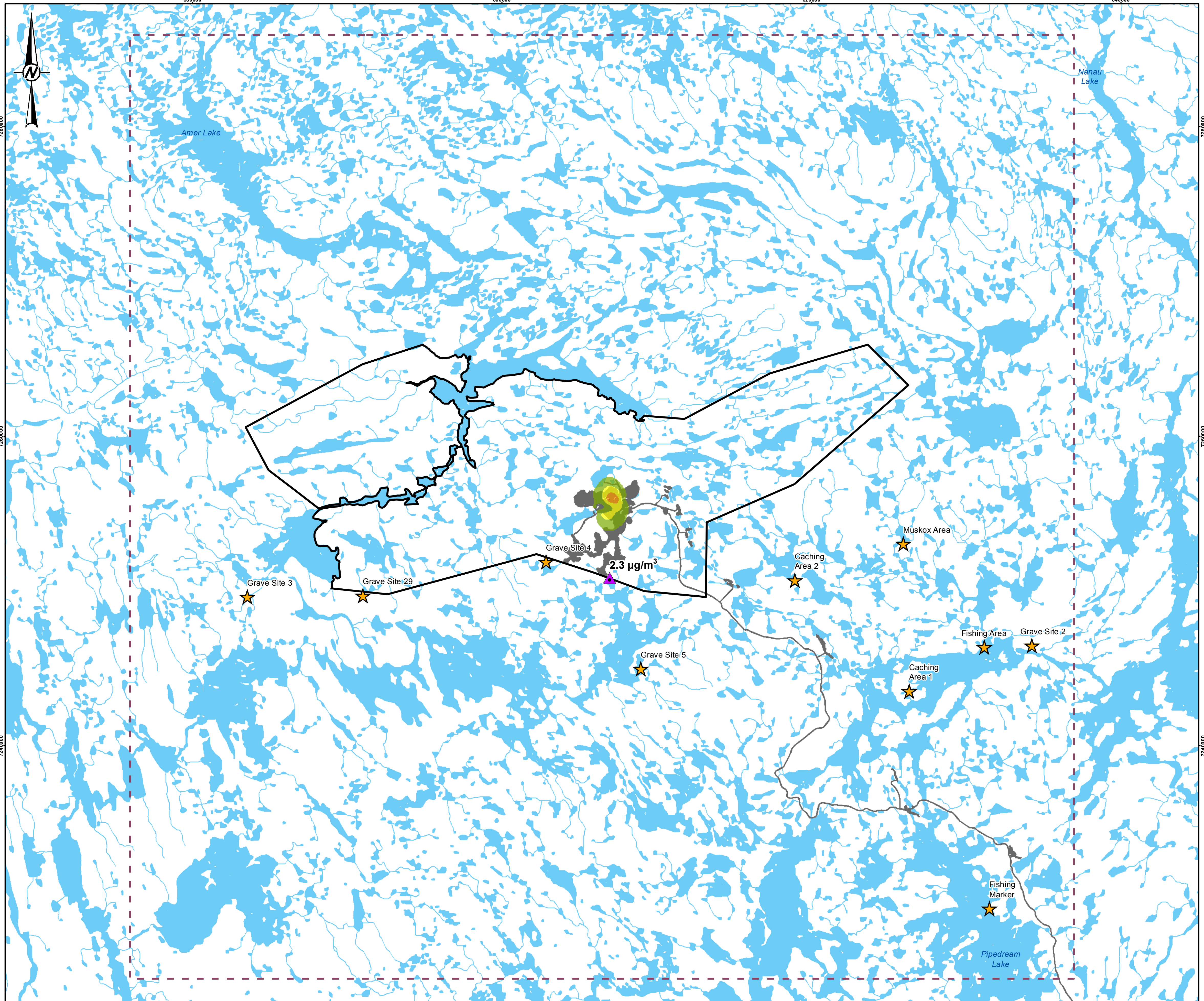
MODEL PREDICTED MAXIMUM 24-HOUR SO_2 CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-12



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 7.5
- 7.5 - 15
- 15 - 22.5
- 22.5 - 30
- > 30

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM ANNUAL SO_2 CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-13

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

4.C-7.3.4 Total Suspended Particulate Predictions

The model predicted 24-hour and annual TSP concentrations are summarized in Table 4-C-16 and shown in Figures 4-C-14 and 4-C-15. The maximum model predicted 24-hour and annual TSP concentrations outside the Project boundary are 158 and 19 µg/m³, respectively. The predicted maximum plus background 24-hour TSP concentrations exceed the ambient air quality standard of 120 µg/m³. The maximum annual TSP concentrations and the maximum 24-hr and annual average concentrations at the selected receptors (Table 4-C-17) are all lower than the respective air quality standards. The model predicted 24-hour TSP concentrations from the Expansion Project are lower than the Approved Project despite that the Expansion Project has higher TSP emission rate than the Approved Project. The use of Method 2 for particulate matter deposition have resulted in higher deposition and thus more depletion of airborne particulate matter. The model predicted annual concentrations are higher than the Approved Project because the conservative daily 24-hour emission rates were used in the modelling for annual average.

The maximum TSP concentration outside of the Project boundary occurs for meteorology observed in 2005 at a receptor 8.7 km southeast of the Whale Tail Pit (Figure 4-C-14). At this receptor, there is a total of one day that the TSP concentrations are predicted to exceed the air quality standard of 120 µg/m³. In other words, the results indicate potential for an exceedance of the 24-hr TSP air quality standard approximately once (i.e., one day) in every 5 years. The small area outside of the Project boundary that have TSP concentrations that exceed ambient air quality standards is near the southeast corner of the Project boundary near the location where the haul road to the Meadowbank Mine leave the Project boundary.

The small area outside the Project boundary that have concentrations that are predicted to exceed the 24-hour TSP air quality standard is not likely to present a risk to human health. There are no residences within the area predicted to have high TSP concentrations, nor is it likely that people will be present within this area for more than 24 consecutive hours.

Table 4-C-16: Summary Table of Model Predicted TSP Concentrations

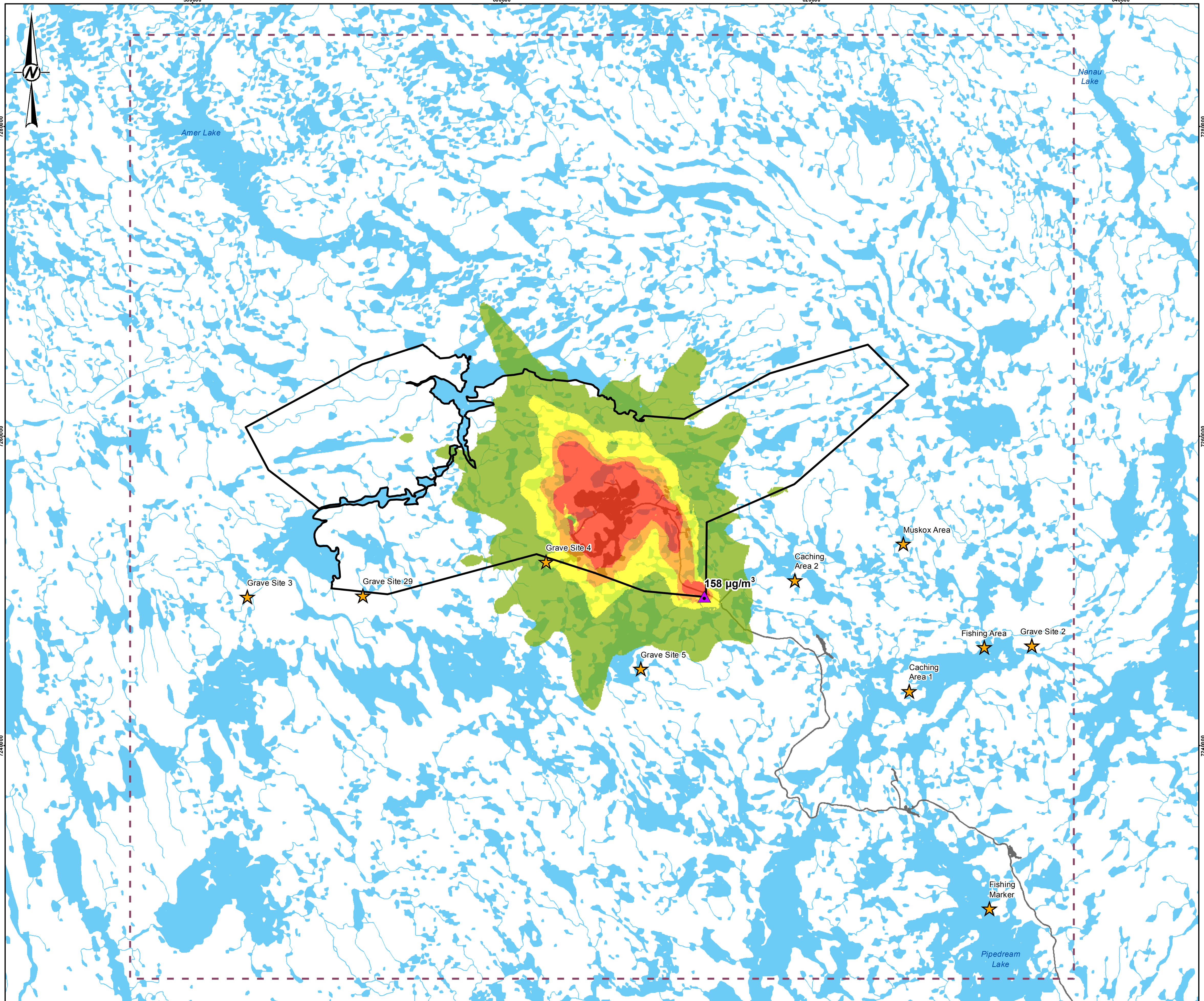
Results	Approved Project		Expansion Project	
	24-hr	Annual	24-hr	Annual
Peak TSP Concentration (µg/m³)	225	—	193	—
Maximum TSP Concentration (µg/m³)	167	13.3	152	15
Project Contribution Combined with Background Concentration				
Peak TSP Concentration (µg/m³)	231	—	200	—
Maximum TSP Concentration (µg/m³)	174	16.9	158	19
Number of occurrences above criteria	3	0	1	0
Distance (km)	8.5	8.2	8.7	8.6
Direction	SE	SE	SE	SE
Ambient Air Quality Standards(µg/m³)	**120**	**60**	**120**	**60**

TSP = total suspended particulate matter; hr = hour; µg/m³ = micrograms per cubic metre; km = kilometer; SE = southeast

Table 4-C-17: Model predicted TSP concentrations at Selected Potential Receptor Locations

Health Receptor	Approved Project		Expansion Project	
	24-hr Maximum ($\mu g/m^3$)	Annual ($\mu g/m^3$)	24-hr Maximum ($\mu g/m^3$)	Annual ($\mu g/m^3$)
Grave site 2	10	3.7	9.7	3.7
Grave site 3	10	3.7	9.7	3.7
Grave site 4	75	5.0	69	5.0
Grave site 5	28	5.2	24	5.1
Grave site 29	17	3.9	17	3.9
Fishing marker	9.8	3.8	9.4	3.8
Muskox	12	3.8	12	3.9
Fishing area	12	3.8	11	3.8
Caching area 1	15	3.9	13	3.9
Caching area 2	22	4.3	20	4.3

hr = hour; $\mu g/m^3$ = micrograms per cubic metre



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION ($\mu g/m^3$)

- < 30
- 30 - 60
- 60 - 90
- 90 - 120
- > 120

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM 24-HOUR TSP CONCENTRATIONS

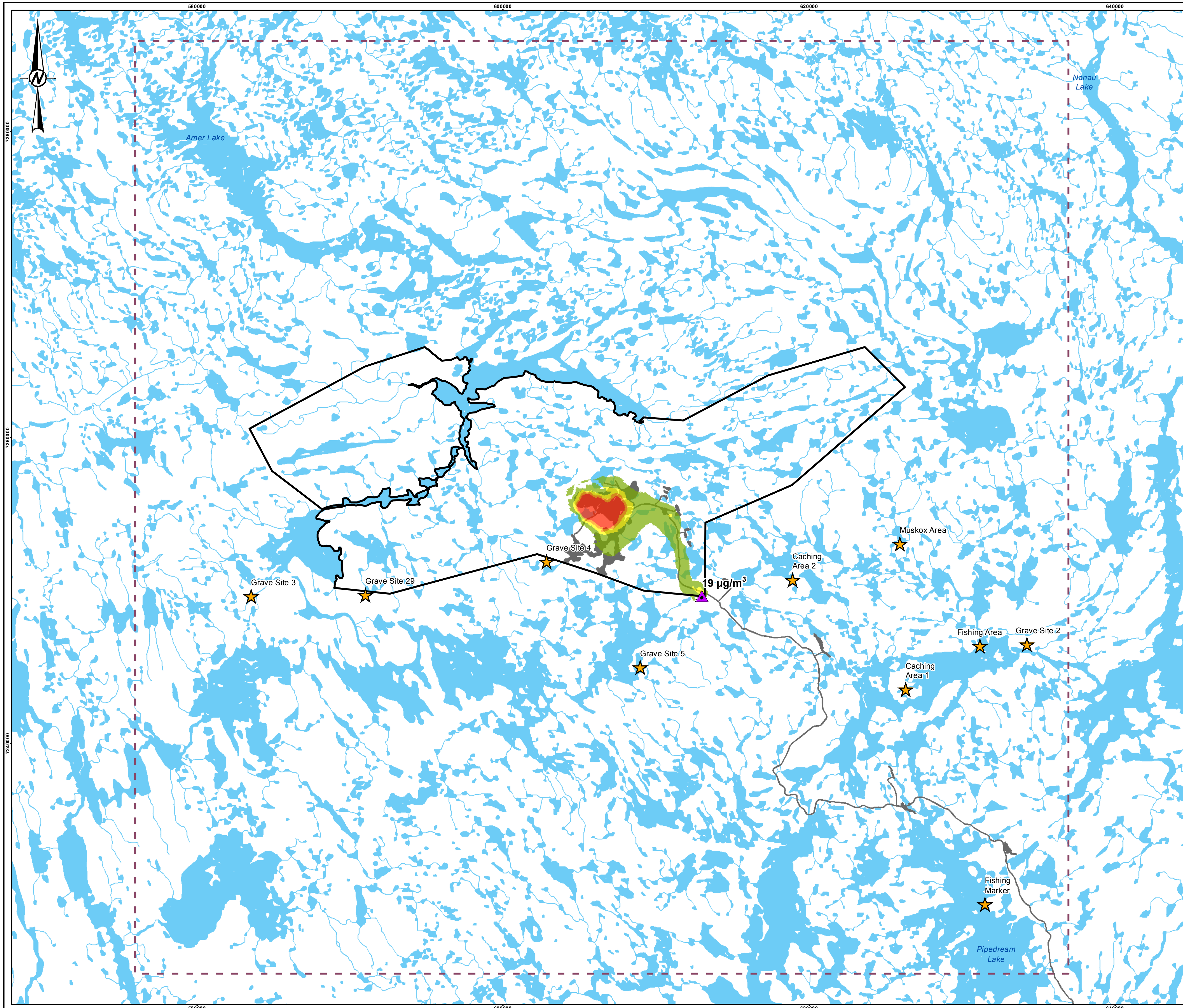
CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-14

25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 15
- 15 - 30
- 30 - 45
- 45 - 60
- > 60

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM ANNUAL TSP CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-15

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

4.C-7.3.5 PM_{10} Predictions

The model predicted 24-hour PM_{10} concentrations are summarized in Table 4-C-18 and shown in Figure 4.C-16. The maximum model predicted 24-hour outside the Project boundary is 107 µg/m^3. The maximum 24-hour PM_{10} concentrations occur along the southern Project boundary. The maximum PM_{10} concentration outside of the Project boundary occurs at a receptor 3.8 km south of the Whale Tail Pit and occurs in the modelling year of 2005. At this receptor, there are only 4 days that the PM_{10} concentrations are predicted to exceed the relevant ambient air quality standard (i.e., 50 µg/m^3). The area outside of the Project boundary that has a predicted PM_{10} exceedance is small and there are no residences or community receptors identified within this area.

The maximum 24-hour PM_{10} concentrations at the selected receptors (Table 4-C-19) are all lower than the respective air quality standard.

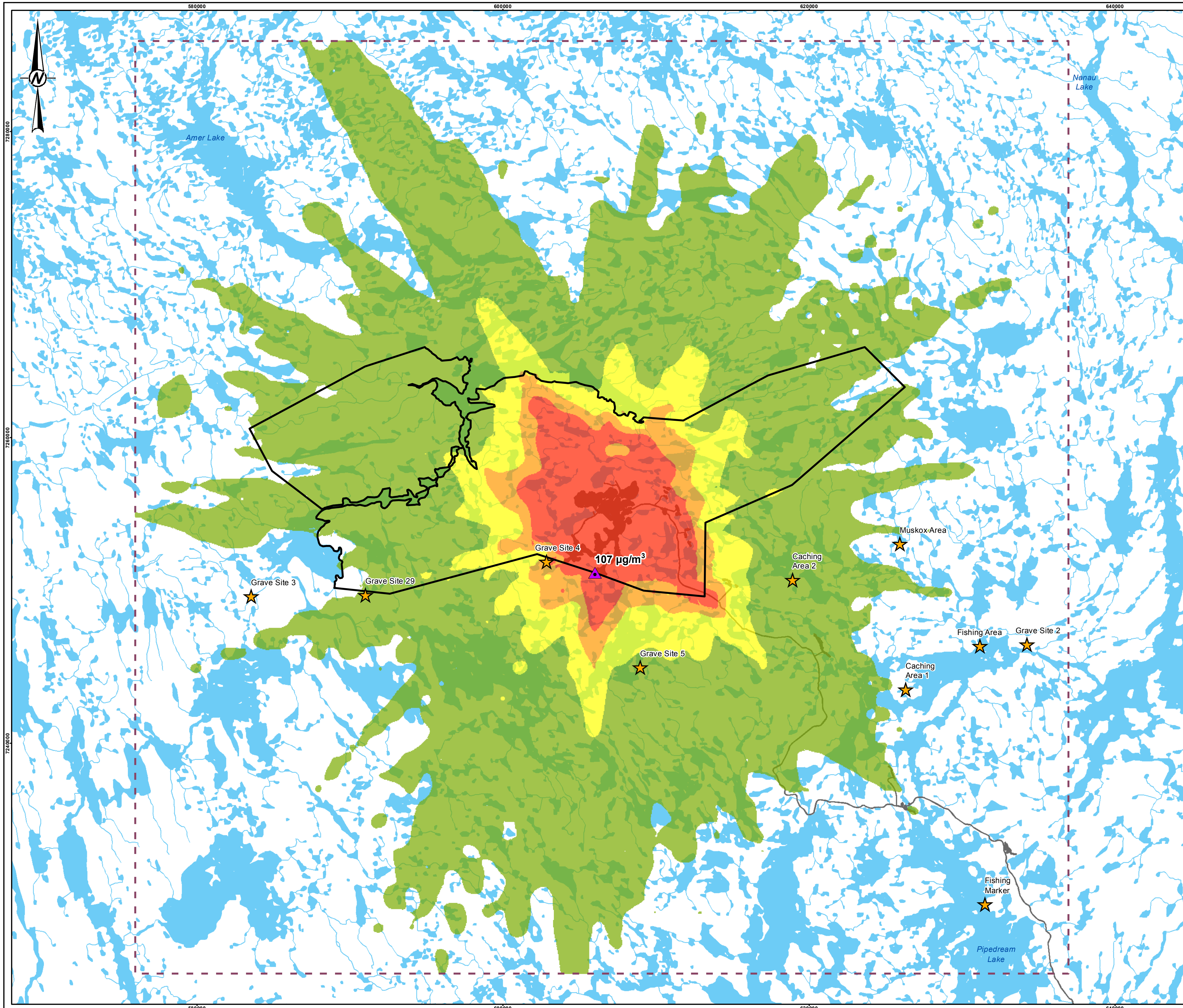
Table 4-C-18: Summary Table of Model Predicted 24-hour PM_{10} Concentrations

Results	Approved Project	Expansion Project
Peak PM_{10} Concentration (µg/m^3)	63	111
Maximum PM_{10} Concentration (µg/m^3)	46	101
Project Contribution Combined with Background Concentration		
Peak PM_{10} Concentration (µg/m^3)	70	118
Maximum PM_{10} Concentration (µg/m^3)	52	107
Number of occurrences above criteria	1	4
Distance (km)	3.8	3.8
Direction	S	S
Ambient Air Quality Standards (µg/m^3)	**50**	**50**

PM_{10} = particulate matter smaller than 10 micrometers in aerodynamic diameter; µg/m^3 = micrograms per cubic metre; km = kilometer; S = south

Table 4-C-19: Model predicted Maximum 24-hour PM_{10} concentrations at Selected Potential Receptor Locations

Health Receptor	Approved Project	Expansion Project
Grave site 2	7.9	9.1
Grave site 3	8.9	9.8
Grave site 4	29	46
Grave site 5	13	22
Grave site 29	10	17
Fishing marker	7.8	9.1
Muskox	8.4	11
Fishing area	8.6	10
Caching area 1	9.4	12
Caching area 2	12	18



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 12.5
- 12.5 - 25
- 25 - 37.5
- 37.5 - 50
- > 50

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

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PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM 24-HOUR PM_{10} CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-16

4.C-7.3.1 $PM_{2.5}$ Predictions

The model predicted 24-hour and annual $PM_{2.5}$ concentrations are summarized in Table 4-C-20 and shown in Figures 4-C-17 and 4-C-18. Compliance with territorial and national 24-hour ambient air quality standards is based on the 98th percentile value over three years. For the Project, this value is 17 µg/m³, which is below the air quality standard (i.e., 27 µg/m³). The annual (4.9 µg/m³) $PM_{2.5}$ concentration is also predicted to be below the 8.8 µg/m³ annual air quality standards.

The maximum 24-hour and annual $PM_{2.5}$ concentrations (Table 4-C-21) at the selected receptors are also all lower than their respective air quality standards.

Table 4-C-20: Summary Table of Model Predicted $PM_{2.5}$ Concentrations

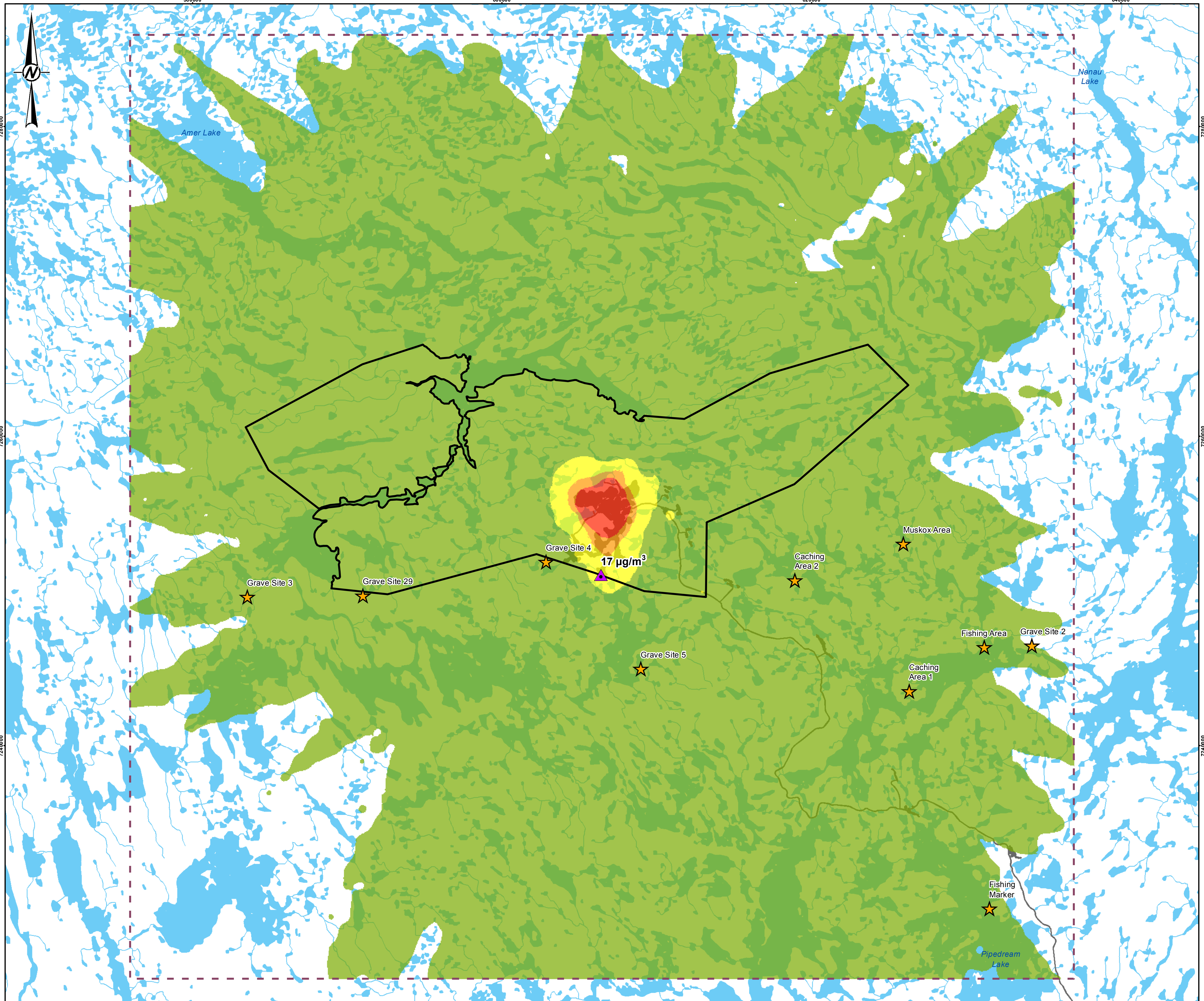
Results	Approved Project		Expansion Project	
	24-hr	Annual	24-hr	Annual
Peak $PM_{2.5}$ Concentration (µg/m³)	16	—	28	—
Maximum $PM_{2.5}$ Concentration (µg/m³)	13	0.7	21	1.3
98th percentile $PM_{2.5}$ Concentration (µg/m³)	6.8	—	11	—
Project Contribution Combined with Background Concentration				
Peak $PM_{2.5}$ Concentration (µg/m³)	22	—	35	—
Maximum $PM_{2.5}$ Concentration (µg/m³)	20	4.3	28	4.9
98th percentile $PM_{2.5}$ Concentration (µg/m³)	14	—	17	—
Number of occurrences above criteria	0	0	0	0
Distance (km)	3.9	4.0	4.0	4.1
Direction	S	S	S	S
Current Ambient Air Quality Standards (µg/m³)	**27**	**8.8**	**27**	**8.8**

$PM_{2.5}$ = particulate matter smaller than 2.5 micrometers in aerodynamic diameter;µg/m³ = micrograms per cubic metre; km = kilometer; S = south

Table 4-C-21: Model Predicted $PM_{2.5}$ Concentrations at Selected Potential Receptor Locations

Health Receptor	Approved Project		Expansion Project	
	24-hr Maximum (µg/m³)	Annual (µg/m³)	24-hr Maximum (µg/m³)	Annual (µg/m³)
Grave site 2	6.8	3.6	7.0	3.6
Grave site 3	6.9	3.6	7.1	3.6
Grave site 4	8.4	3.8	9.0	3.9
Grave site 5	8.6	3.8	9.5	4.0
Grave site 29	7.1	3.6	7.6	3.7
Fishing marker	6.9	3.6	7.1	3.6
Muskox	7.0	3.6	7.3	3.7
Fishing area	7.0	3.6	7.1	3.6
Caching area 1	7.0	3.6	7.2	3.7
Caching area 2	7.5	3.7	7.7	3.7

hr = hour; µg/m^3 = micrograms per cubic metre



LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 7
- 7 - 14
- 14 - 21
- 21 - 28
- > 28

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 14 DATUM: NAD 83

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM 24-HOUR $PM_{2.5}$ CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-17

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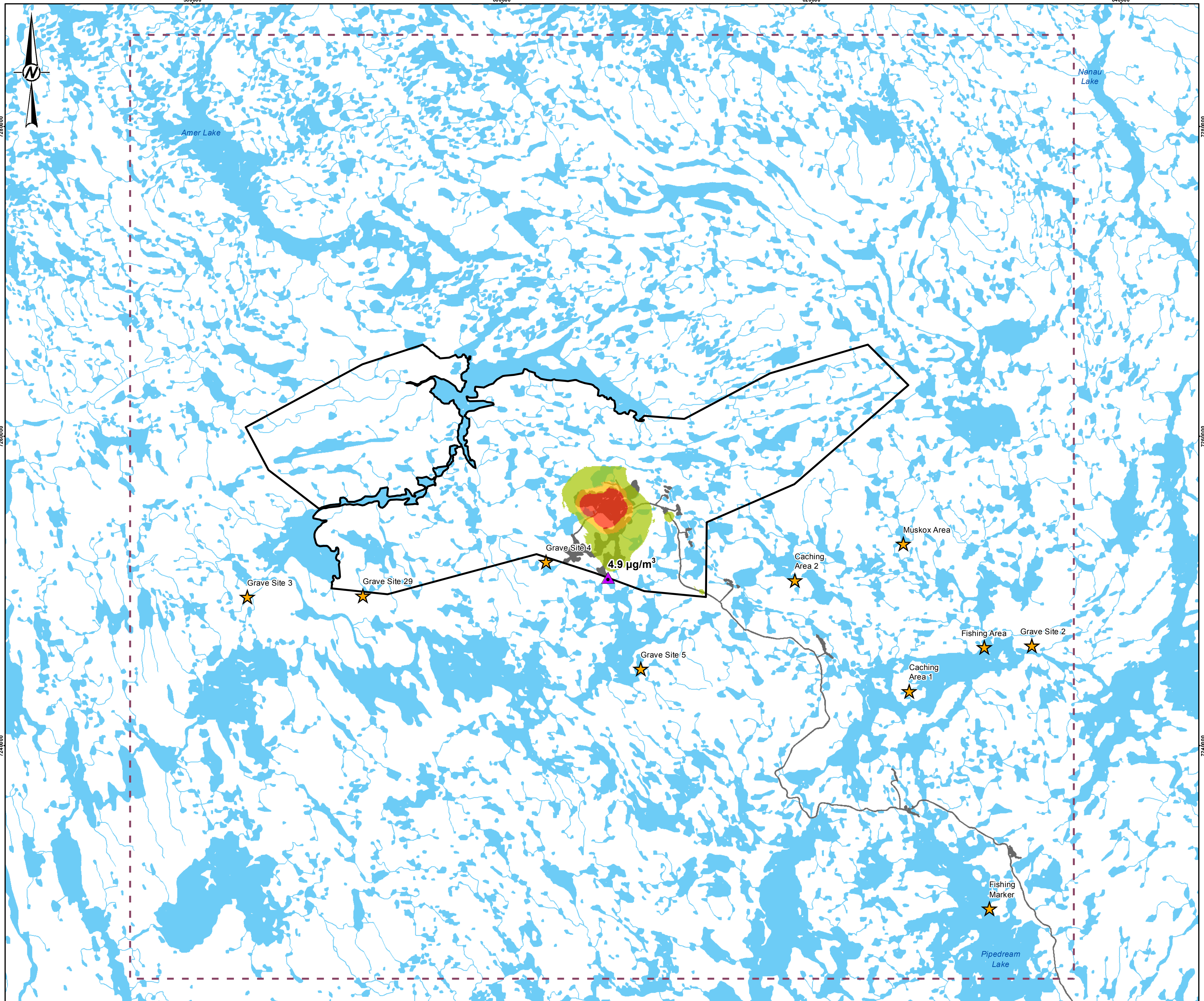

LEGEND

- WATERCOURSE
- WATERBODY
- DISCRETE RECEPTOR
- MAXIMUM POINT OF IMPINGEMENT
- MODEL BOUNDARY
- PROJECT FOOTPRINT - EXPANSION PROJECT
- PROPERTY BOUNDARY

CONCENTRATION (µg/m³)

- < 5
- 5 - 7.5
- 7.5 - 10
- > 10

0 5,000 10,000

1:250,000 METRES

REFERENCE(S)

1. NATIONAL TOPOGRAPHIC DATA BASE (NTDB) DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
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CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT

WHALE TAIL PIT - EXPANSION PROJECT

TITLE

MODEL PREDICTED MAXIMUM ANNUAL $PM_{2.5}$ CONCENTRATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-25
DESIGNED	ZY
PREPARED	LMS
REVIEWED	CMc
APPROVED	CM

PROJECT NO.	PHASE	REV.	FIGURE
1896037	4100	0	4-C-18

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

4.C-8 AIR QUALITY MODELLING FOR THE HAUL ROAD

The Whale Tail mining area is connected to the Meadowbank Mine by an un-paved, 64 km haul road. With the exception of $PM_{2.5}$, combustion related emissions (e.g., CO, NO_2, SO_2) from light and heavy-duty diesel vehicles travelling along the haul road have low potential to affect air quality because the amount of emissions is low. Fugitive road dust generated by these vehicles does have the potential to affect air quality adjacent to the road, and atmospheric deposition of fugitive road dust has the potential to affect soil and water quality adjacent to the road. This section of Appendix 4-C discusses the methods used to evaluate particulate matter concentrations and atmospheric deposition of particulate matter along the haul road, and the results of this analysis.

4.C-8.1 Methods

Air quality model predictions for the haul road were created to evaluate atmospheric concentrations and atmospheric deposition of particulate matter as a function of distance from the centre of the haul road. To evaluate potential Project related effects of the haul road on air quality, emissions along a representative 1 km long section of the haul road were simulated.

The representative section is aligned along a southwest to northeast transect, an orientation perpendicular to the prevailing winds. The emissions include particulate matter emissions from vehicle exhaust, and fugitive road dust from the un-paved road surface, which are summarized in Section 4.B-11 of Volume 4, Appendix 4-B. The simulation of the haul road is identical to the simulation of the portion of the haul road that resides within the Project boundary. However, the representative 1-km haul road simulation excludes the application of any dust mitigation measures (i.e., it excludes an assumed 70% reduction in fugitive dust due to road watering) and includes a natural 95% reduction in fugitive dust during winter months when the road bed is frozen.

Air quality modelling receptors with 20 m intervals were placed along the road in rows with distances of 25 m, 50 m, 75 m, 100 m, 300 m, 500 m, 750 m, 1,000 m, 1,500 m, and 2,000 m from the centre of the haul road. Using the maximum daily emission estimates for the unfrozen season, the ground level concentrations of all CACs were predicted for the receptors using the air quality model.

4.C-8.2 Results

Low level emissions of CO, NO_2, and SO_2 will be produced by vehicles using the haul road. The model predicted ground level concentrations of CO, NO_2, and SO_2 due to haul road vehicle emissions represent a very small increase compared to background concentrations, and are well below their relevant ambient air quality standards. Thus, only model predictions for particulate matter are considered in further detail.

Table 4-C-22 summarizes maximum predicted particulate matter (TSP, PM_{10}, $PM_{2.5}$) concentrations plus background concentrations as a function of distance from the haul road. All PM size classes will experience decreases in their concentration with distance due to atmospheric mixing (i.e., dilution). However, only PM_{10} and TSP have appreciable atmospheric deposition within a few 100 m from the haul road.

Figures 4-C-19 and 4-C-20 show the predicted decrease in maximum 24-hour and annual TSP concentrations plus background concentrations with increasing distance from the haul road. In the near field, maximum TSP concentrations adjacent to the road are predicted to exceed the 24-hour average ambient air quality standard (120 $\mu g/m^3$) at distances of up to 750 to 1,000 m from the road. Maximum predicted 24-hour PM_{10} concentrations are predicted to exceed the ambient air quality standard (50 $\mu g/m^3$) at distances of up to 1,000 to 1,500 m from the road. Maximum predicted 24-hour $PM_{2.5}$ concentrations are predicted to exceed the ambient air quality standard

(27 μg/m³) at distances up to 100 m from the road. Maximum annual TSP concentrations are predicted to exceed the ambient air quality standard (60 μg/m³) within approximately 100 to 300 m from the road. Maximum annual $PM_{2.5}$ concentrations are not predicted to exceed the ambient air quality standard (8.8 μg/m³) with distances greater than 50 m to the haul road.

Table 4-C-22: Maximum Predicted PM Concentrations with Distance from the Haul Road

Distance (m)	Maximum predicted PM concentrations (μg/m³)				
	24-hour TSP	Annual TSP	24-hour PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$
25	1240	94	370	44	10
50	1160	100	330	35	8.6
75	980	77	290	29	7.5
100	850	62	260	25	6.8
300	380	21	160	15	4.8
500	210	12	120	11	4.3
750	130	8.5	82	10	4.0
1000	93	6.7	62	9.4	3.8
1500	51	5.2	37	7.9	3.7
2000	32	4.5	24	7.6	3.7
Ambient Air Quality Standards	**120**	**60**	**50**	**27**	**8.8**

m = metres; PM = particulate matter; μg/m³ = micrograms per cubic metre; TSP = total suspended particulate; PM_{10} = particulate matter smaller than 10 micrometers in aerodynamic diameter; $PM_{2.5}$ = particulate matter smaller than 2.5 micrometers in aerodynamic diameter;

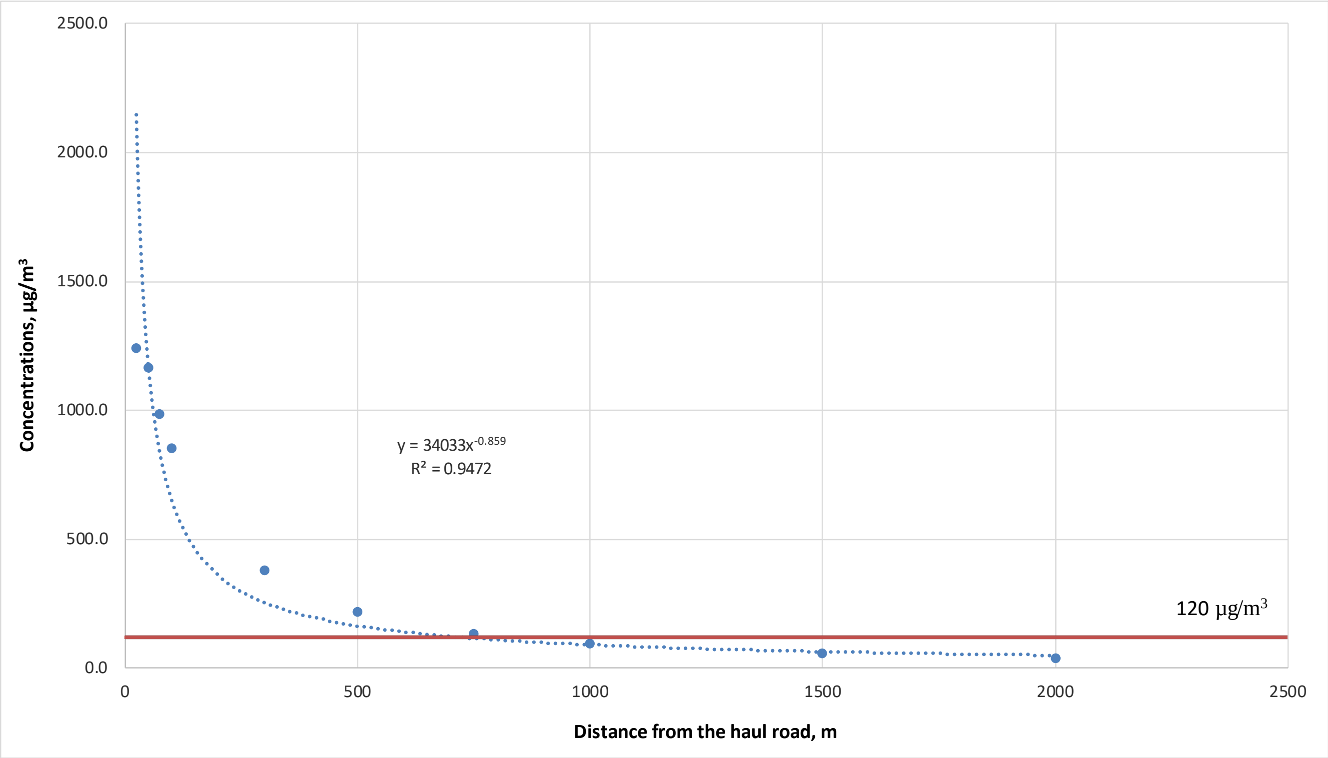

Figure 4-C-19: Maximum Predicted 24-Hour TSP Concentrations with Distance from the Haul Road

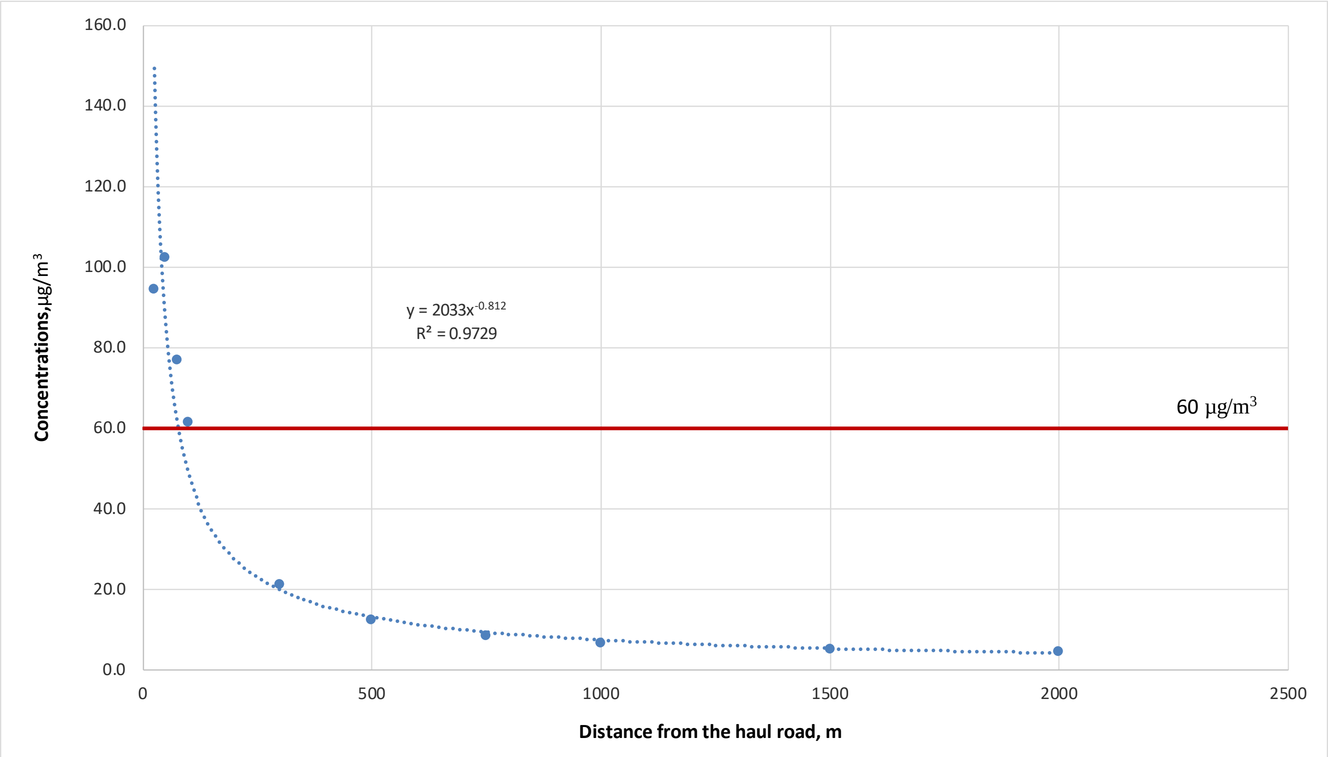

Figure 4-C-20: Maximum Predicted Annual TSP Concentrations with Distance from the Haul Road

There are no dust deposition rate standards for Nunavut Territory. The Alberta Environment Department's recreational/residential and industrial/commercial area dustfall guidelines of 0.53 mg/cm^2/30-days and 1.58 mg/cm^2/30-days are indicated for total dustfall (Alberta Environment and Parks 2017). The monthly and annual Ontario dust fall criteria are 0.7 mg/cm^2/30-days and 0.46 mg/cm^2/30-days, respectively (Ontario Ministry of the Environment 2012). As summarized in Table 4-C-23, the most stringent 30-day and annual dustfall criteria are the Alberta's guideline for recreational/residential area of 0.53 mg/cm^2/30-days and the Ontario annual deposition rate of 0.46 mg/cm^2/30-days.

Table 4-C-23: Dust fall criteria (mg/cm^2/30-days)

Averaging Time	Alberta Residential and Recreation Areas	Alberta Commercial and Industrial Areas	Ontario
30 days	**0.53**	1.58	0.7
Annual	—	—	**0.46**

Note: **Bold number** indicates applicable criteria

The maximum monthly and annual total deposition of TSP was modelled at the same receptors as those used to predict ambient concentrations of TSP with distance from the haul road. At the receptors closest to the haul road (i.e., 25 m), the maximum monthly and annual total TSP deposition rates are 3.4 mg/cm^2/30-days and 0.53 mg/cm^2/30-days, respectively.

The dust deposition modelling results are summarized in Table 4-C-24 and illustrated in Figures 4-C-21 and 4-C-22. The maximum predicted monthly dust deposition rates are predicted to be below the Alberta guideline for residential and recreation areas within 500 m of the haul road. Maximum predicted annual dust deposition rates at 75 m from the haul road are predicted to be less than the Ontario annual dust fall standard.

Table 4-C-24: Maximum Predicted TSP Total Deposition with Distance from the Haul Road

Distance (m)	Monthly (mg/cm^2/30-days)	Annual (mg/cm^2/30-days)
25	3.4	0.53
50	3.4	0.61
75	2.5	0.43
100	1.9	0.32
300	0.59	0.09
500	0.31	0.04
750	0.17	0.02
1000	0.11	0.02
1500	0.06	0.01
2000	0.03	0.01
Dust fall criteria	**0.53**	**0.46**

m = meter; mg/cm2/30-days = milligram per centimeters squared per 30 days

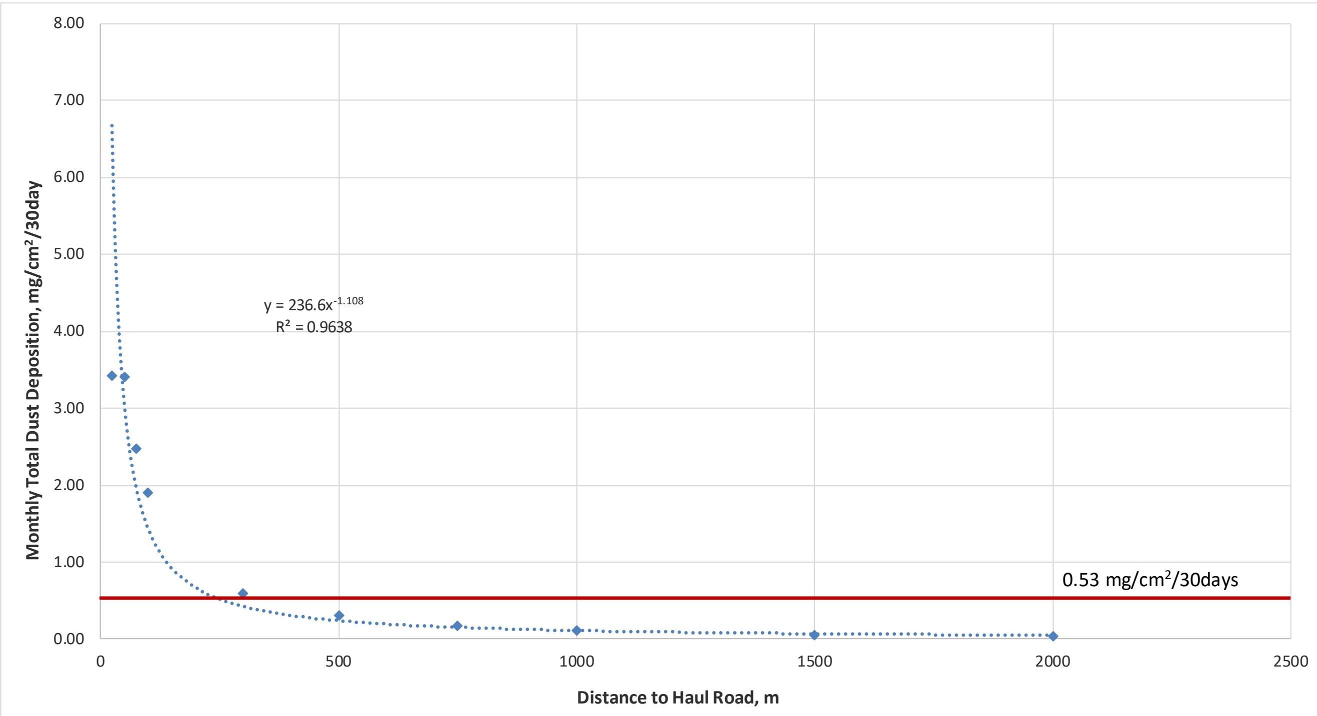

Figure 4-C-21: Maximum Predicted Monthly Dust Deposition with distance from the Haul Road

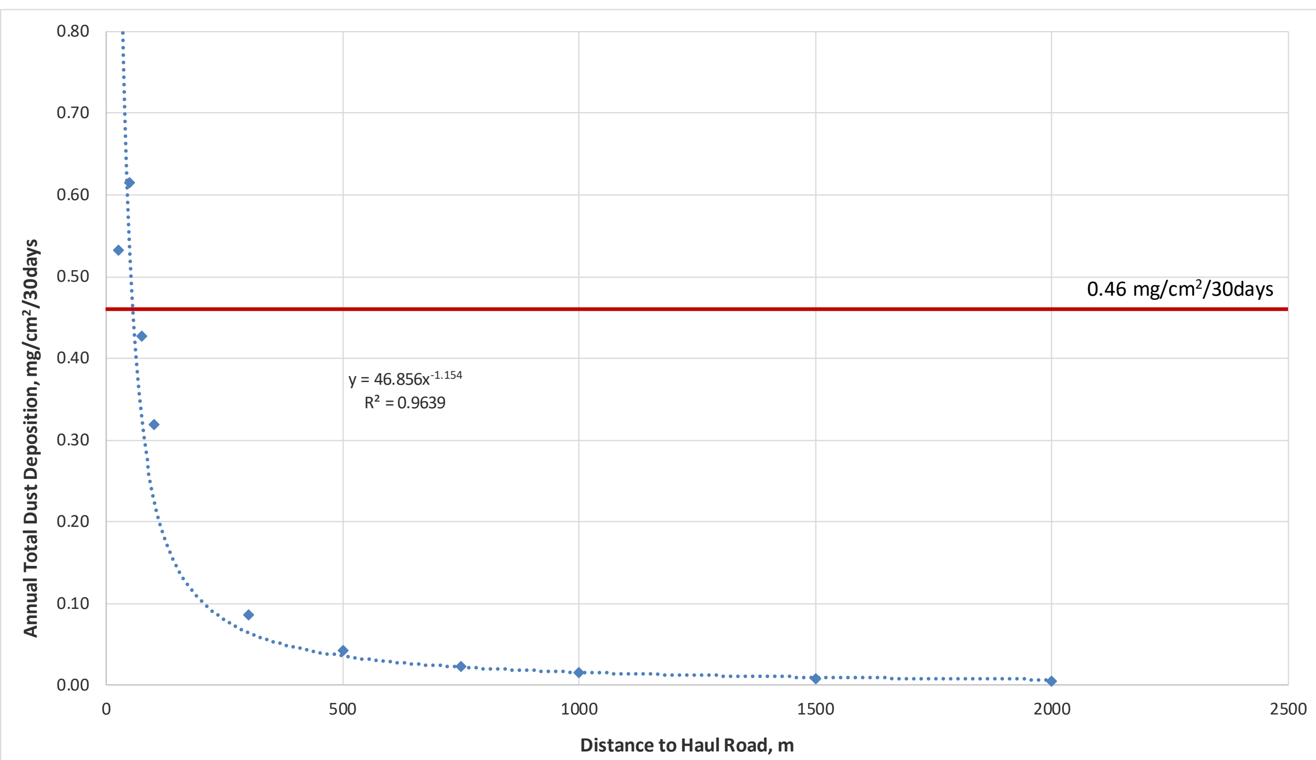

Figure 4-C-22: Maximum Predicted Annual Dust Deposition with distance from the Haul Road

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