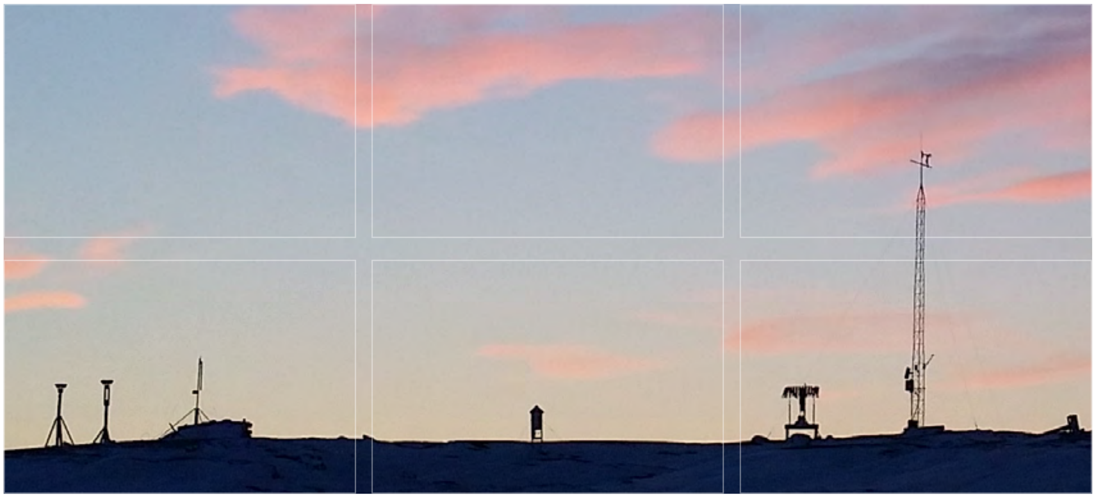
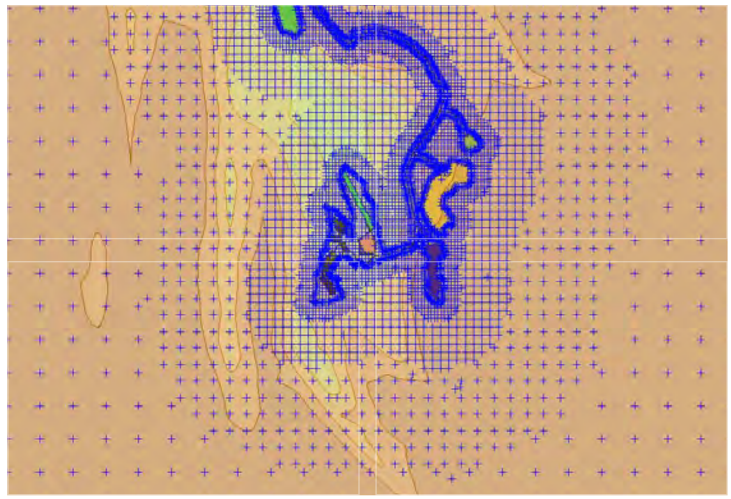
Appendix V4-2I

Phase 2 of the Hope Bay Project: Air Quality Modeling Study





Prepared for:

TMAC RESOURCES

PHASE 2 OF THE
HOPE BAY PROJECT

Air Quality Modeling Study

December 2016

ERM

The business of sustainability

TMAC Resources Inc.

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EXECUTIVE SUMMARY

An air quality modeling study (AQMS) was conducted in order to inform the assessment of air quality for the *Phase 2 of the Hope Bay Project Draft Environmental Impact Statement* (TMAC 2016).

The AQMS used the California Puff (CALPUFF) air dispersion model (version 7) to predict the resulting ambient air quality due to: existing permitted Hope Bay project activities, Hope Bay Phase 2 project activities, and the cumulative existing permitted activities along with Phase 2 activities.

The air contaminants modeled were nitrogen oxides (NO_X), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), total suspended particulate (TSP), particulate matter with diameter less than 10 micrometers (PM_{10}), particulate matter with diameter less than 2.5 micrometers ($PM_{2.5}$), dust deposition and acid deposition. Contaminants were compared against relevant ambient air quality standards, objectives and guidelines for Nunavut, other provinces, or Canada.

Baseline ambient air quality conditions were characterized from historical data collected from the Doris North Project Air Quality Monitoring Program from 2009 to 2014.

The CALPUFF model used appropriate terrain elevation and land use data for the Hope Bay Project area. The meteorological data inputs were from the on-site Doris and Boston meteorological stations along with an appropriate Weather Research and Forecasting model dataset. Model parameters were chosen using BC regulatory guidance, professional judgement and experience.

The AQMS used two spatial domains, one for Roberts Bay, Doris and Madrid, and the other for Boston. Both construction and operation periods were modeled for each domain. For each modeling domain and period, the ambient air quality was predicted for existing permitted activities only, Phase 2 activities only, and the cumulative existing permitted activities along with Phase 2 activities.

The emissions inventory was built using a number of information sources, calculations and assumptions. Some information sources and assumptions were informed by descriptions about proposed Phase 2 components and activities as well as existing information about the existing permitted activities. At the time of preparing the emissions inventory, the most up-to-date information was used as of November 7, 2016. Note that there may be changes to the Phase 2 design before construction as additional planning and detailed engineering design develops. Any changes to Phase 2 components and activities made after the emissions inventory was completed were not incorporated into the emissions inventory and therefore were not represented in the predicted ambient air quality results.

Where input data uncertainties existed, conservative assumptions were used following regulatory guidance, professional judgement and experience. The use of conservative assumptions can lead to conservative model predictions and therefore the model results of the model study are interpreted with the understanding that the predicted effects are likely overestimated.

There are no existing permitted activities that produce significant air emissions in the southern domain during the Phase 2 construction or operation periods. The existing permitted activities in the northern domain emit air contaminants that dilute and decrease to approaching baseline levels within the northern domain and any contaminants that reach the southern domain are negligible. Therefore the cumulative ambient air quality impact from existing permitted activities with Phase 2 activities in the southern domain is the same as the impact from just Phase 2 activities in the southern domain with baseline conditions.

The predicted ambient air quality results are compared against relevant guidelines, objectives and standards for each ambient air quality contaminant. The predicted maximum results show that SO_2, NO_2, CO, TSP, PM_{10}, $PM_{2.5}$ and dust deposition will exceed the relevant thresholds levels in limited areas surrounding the Phase 2 Project and the whole Hope Bay Development, during Phase 2 construction or operation periods. The frequency of exceedances is also limited, depending on the contaminant, averaging period and receptor location. There were no exceedances outside of the model domains, with the exception of limited maximum 24-hour PM_{10} exceedance events reaching the eastern boundary of the northern domain during Phase 2 operations (with existing permitted activities).

Ambient air quality modeling predictions were not completed for the reclamation and closure, post-closure, and temporary closure periods. Based on the Project Description (as of November 7, 2016), the air emissions during these three periods were identified to be much lower than the air emissions during construction and operation periods. The resulting ambient air quality is therefore expected to be better quality during the reclamation and closure, post-closure, and temporary closure periods compared to during the construction and operation periods.

The AQMS provided predictions of the ambient air quality resulting from Phase 2 components and activities; however, only appropriate on-site ambient air quality monitoring can verify the actual on-site ambient air quality resulting from Phase 2 components and activities.

Air Quality Modeling Report

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GLOSSARY AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

µg	Microgram
ANFO	Ammonium nitrate-fuel oil
AQMS	Air quality modeling study
ASTM	ASTM International
AWR	All-weather road
BC	British Columbia
BTU	British thermal units
CAAQS	Canadian Ambient Air Quality Standards
CALMET	The meteorological model component of the California Puff (CALPUFF) air dispersion model
CALPUFF	The California Puff air dispersion model
CCME	Canadian Council of Ministers of the Environment
CDED	Canadian Digital Elevation Data
cm	Centimetre
CO	Carbon monoxide
DEIS	Draft Environmental Impact Statement
dm^2	Square decimetre (equal to 100 square centimetres)
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Statement
ERM	ERM Consultants Canada Ltd.
GLCC	Global Land Cover Characterization
hr	Hour
km	Kilometre
LTO	Landing and take-off
m	Metre

m^2	Square metre
m^3	Cubic metre
mg	Milligram
MOE	Ministry of Environment
NIRB	Nunavut Impact Review Board
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
NSA	Nunavut Settlement Area
O_3	Ground level ozone
PDA	Project development area
PM	Particulate matter
PM_{10}	Particulate matter less than 10 µm in diameter
$PM_{2.5}$	Particulate matter less than 2.5 µm in diameter
ppb	Parts per billion
ppm	Parts per million
Rescan	Rescan Environmental Services Ltd.
SO_2	Sulphur dioxide
SOGs	Standards, Objectives and Guidelines
TIA	Tailings Impoundment Area (Doris)
TMA	Tailings Management Area (Boston)
TMAC	TMAC Resources Inc.
TSP	Total suspended particulate
US	United States
US EPA	United States Environmental Protection Agency
US FAA	United States Federal Aviation Administration
VOC	Volatile organic compounds
WRF	Weather Research and Forecasting (a mesoscale meteorological model)

1. INTRODUCTION

1.1 PROJECT BACKGROUND

The Hope Bay Project is located on the Hope Bay Belt, an 80 by 20 km property located along the south shore of Melville Sound in Nunavut. The property consists of a greenstone belt (the Hope Bay Belt) that contains three main gold deposits. The Doris and Madrid deposits are located in the northern portion of the belt and the Boston deposit is at the southern end. The Project is located approximately 125 km southwest of Cambridge Bay (Iqaluktuttiaq) on the southern shore of Melville Sound.

TMAC Resources Inc. (TMAC) acquired the Hope Bay Belt property from Newmont Corporation in March 2013. The acquisition included exploration and mineral rights over the Hope Bay Belt, including the Doris North Project and its permits, licences and authorizations for development received by previous owners.

Phase 1 of the Hope Bay Project involved the development of the Doris deposit and the proposed Phase 2 will involve the development of the Madrid and Boston deposits. High-level activities of Phase 2 will involve the construction, operation, closure and post-closure of the following components:

- expansion of the Doris Tailings Impoundment Area (TIA);
- expansion of the Roberts Bay Laydown and Dock;
- development of Madrid North, Madrid South and Boston sites; and
- development of an all-weather road (AWR) between Madrid and Boston.

TMAC contracted ERM Consultants Canada Ltd. (ERM) to prepare a Draft Environmental Impact Statement (DEIS) for the proposed Phase 2 development of the Hope Bay Project. Activities associated with Phase 2 will have the potential to generate air emissions and therefore air quality (specifically ambient air quality) is a valued ecosystem component that is assessed in the DEIS. ERM conducted an air quality modeling study (AQMS) in order to inform the air quality assessment. This report describes the methodology and results of the AQMS.

1.2 OBJECTIVES

The objectives of this report are to:

- present existing and baseline ambient air quality conditions used in the AQMS;
- describe the methodology used for the AQMS;
- identify the sources of air emissions associated with Phase 2 and present an emissions inventory;

- predict the change in ambient air quality due to the various emission sources using appropriate air dispersion modeling; and
- compare the results to relevant ambient air quality standards, objectives and guidelines (SOGs).

1.3 MODELING LIMITATIONS AND UNCERTAINTY

There is inherent uncertainty associated with the use of any model as real world processes are simplified and errors can be compounded throughout the modeling process resulting in inaccurate model results.

Air dispersion models can predict atmospheric concentrations and deposition levels to a reasonable degree of accuracy but the accuracy is highly dependent on the accuracy of the information being fed into the model (i.e., the model's inputs). Input data includes the overall modeling approach, model parameters, existing and baseline air quality data, meteorological data, terrain and land use data, and air emissions inventory data. Without accurate input data, the predicted results will also not be accurate. The input data with a high amount of uncertainty is commonly the air emissions inventory and this was the case for this AQMS.

The emissions inventory for the AQMS was built using a number of information sources, calculations and assumptions. Some information sources and assumptions were informed by descriptions about proposed Phase 2 components and activities as well as existing information about the Doris project. At the time of preparing the emissions inventory, the most up-to-date information was used as of November 7, 2016. Note that there may be changes to the Phase 2 design before construction as additional planning and detailed engineering design develops. Any changes to Phase 2 components and activities made after the emissions inventory was completed were not incorporated into the emissions inventory and therefore are not represented in the predicted ambient air quality results.

Where input data uncertainties existed, conservative assumptions were used following regulatory guidance, professional judgement and experience. The assumptions used in the AQMS to account for uncertainties are described throughout this report. The use of conservative assumptions can lead to conservative model predictions and therefore the model results of the AQMS are interpreted with the understanding that the predicted effects are likely overestimated.

The AQMS provided predictions of the ambient air quality resulting from Phase 2 components and activities; however, only appropriate on-site ambient air quality monitoring can verify the actual on-site ambient air quality resulting from a project's components and activities.

2. STUDY SCOPE OVERVIEW

2.1 Approach

Standard air dispersion modeling techniques were applied to predict the potential air quality effects associated with Phase 2. Air dispersion modeling is commonly used to assess air quality effects of a proposed source with respect to federal, territorial and provincial ambient air quality SOGs. The dispersion model allows an understanding of the interaction of existing and future emission sources and takes into account meteorological conditions, terrain elevation, land use and the existing ambient air quality.

This air dispersion modeling approach follows the Nunavut Impact Review Board (NIRB)'s EIS Guidelines for the Hope Bay Project Phase 2 (NIRB 2012).

2.2 Spatial Boundaries

Spatial boundaries of the AQMS were chosen in order to identify maximum air quality impacts due to the different scenarios as well as the spatial distribution of predicted air quality. The boundaries were also appropriately sized such that ambient air contaminant levels would approach baseline air contaminant levels within the boundaries.

To increase air quality modeling efficiency, two smaller spatial boundaries were used rather than one larger boundary. One boundary covers the northern area (Roberts Bay, Doris and Madrid) and the other boundary covers the southern area (Boston). The middle section of the AWR (spanning a length of approximately 20 km) and potential quarries along this road section are not included in the modeling study (i.e., emissions from these sources are not included). It is expected that the AWR's impact on ambient air quality will be approximately uniform along the entire length of the AWR and the results can be extrapolated and assessed over the entire AWR. This is further discussed in Section 5.2.

The northern and southern spatial boundaries are shown in Figure 2.2-1. Additional information about the spatial boundaries is included in Section 5.2.

2.3 Temporal Boundaries

Temporal boundaries of the AQMS were chosen in order to model the highest air emission sources during the Project Schedule, as described in the DEIS Project Description (as of November 7, 2016). Based on the Project Schedule, the Phase 2 construction and operation periods were determined to have the highest emissions compared to the closure, post-closure and care and maintenance periods. The resulting ambient air quality during the construction and operation periods are expected to be worse than during the closure, post-closure and care and maintenance periods. Therefore only the construction and operation periods were modeled in the AQMS in order to model the highest emission periods.

Because some of the different components of Phase 2 would be under construction and operation at different times, two temporal domains for each of the two spatial domains were needed to model the worst case emissions. For the northern domain, construction period (Project Year 1; calendar year 2019) and operation period (Project Year 12; calendar year 2030) components and activates were modeled. For the southern domain, construction period (Project Year 4; calendar year 2022) and operation period (Project Year 12; calendar year 2030) components and activities were modeled.

The Phase 2 DEIS air quality assessment assesses the resulting ambient air quality conditions due to Phase 2 components and activities against the existing air quality conditions before Phase 2. In addition, it also assesses the cumulative air quality effects of Phase 2 combined with the existing conditions. Air emissions from the Hope Bay Project existing permitted components and activities are used to represent the existing air quality conditions before Phase 2. Therefore the AQMS also models the ambient air quality resulting from the Hope Bay Project existing permitted components and activities during Phase 2 Project Year 1 (calendar year 2019) and Project Year 12 (calendar year 2030). Existing air quality conditions are further discussed in Section 4.

For each spatial and temporal domain, ambient air quality was modeled for a full year in order to account for seasonal meteorological conditions, seasonal air emissions, and compute the required averaging periods needed to compare against relevant ambient air quality SOGs.

Additional information about the temporal boundaries is included in Section 5.3.

2.4 AIR CONTAMINANTS

The AQMS predicted results for the following air contaminants:

- nitrogen oxides (NO_X);
- nitrogen dioxide (NO_2) resulting from emissions of NOx;
- sulphur dioxide (SO_2);
- carbon monoxide (CO);
- total suspended particulate matter (TSP);
- particulate matter with diameter less than 10 micrometers (PM_{10}; inhalable particulate);
- particulate matter with diameter less than 2.5 micrometers ($PM_{2.5}$; respirable particulate);
- dust deposition (dustfall); and
- acid deposition.

Ambient air quality contaminants are described in Table 2.4-1.

Figure 2.2-1
Spatial Boundaries for the Air Quality Modeling Study

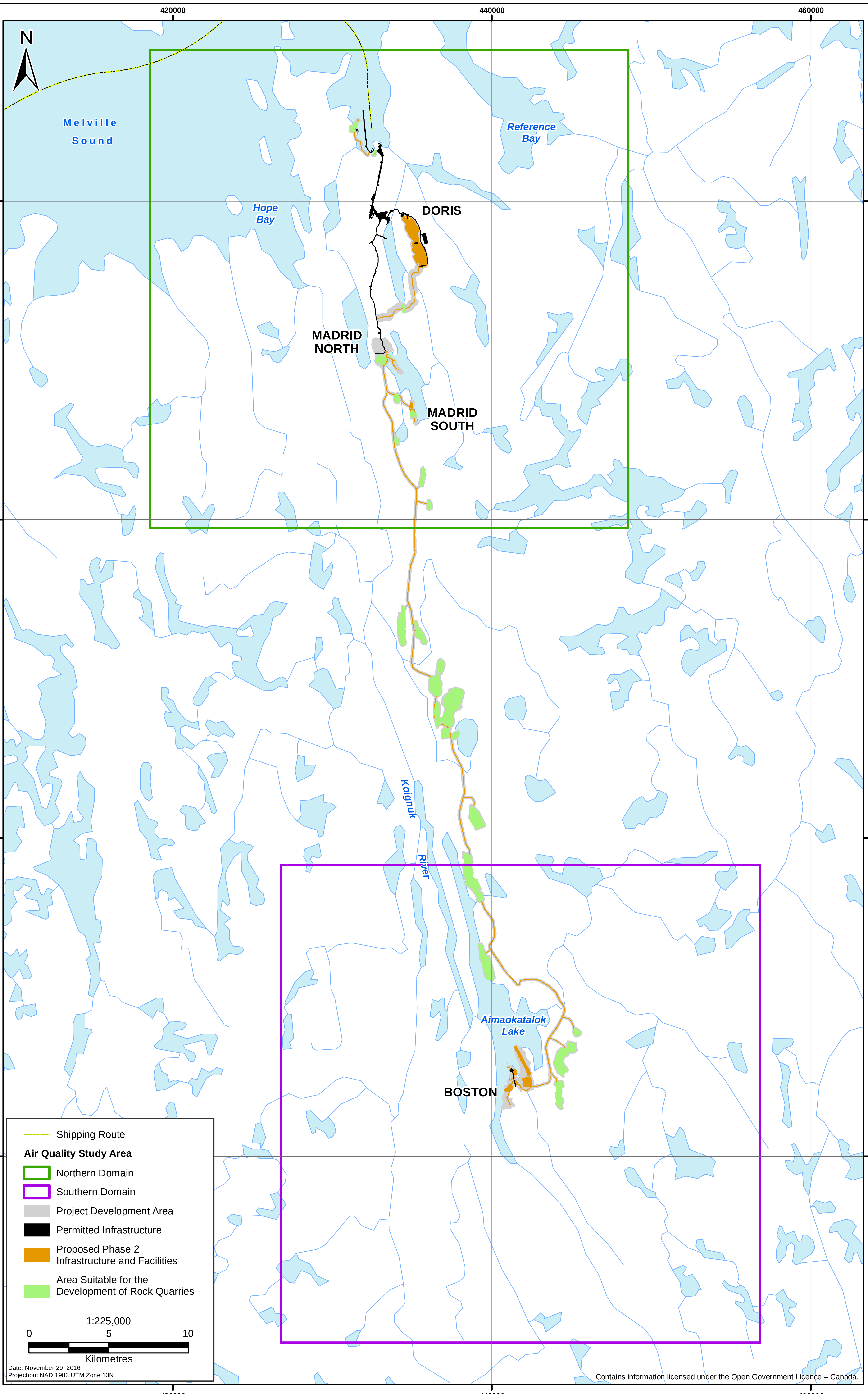


Table 2.4-1. Description of Air Contaminants Used as Ambient Air Quality Indicators

Air Contaminant Chemical Species	Description
SO_2	Fossil fuels contain a small amount of organic sulphur compounds. During fuel combustion, the sulphur is oxidized and emitted as SO_2 gas with the combustion exhaust. In the atmosphere, SO_2 can further oxidize to sulphate particles, which contribute to acid deposition. SO_2 can be harmful to humans at high concentrations.
NO_2	Nitrogen oxides (NO_X) gas is a product of fuel combustion and primarily consists of NO and NO_2. The gases are emitted with exhaust from combustion engines, power generation, and products from blasting operations. NO can be converted to NO_2 in the atmosphere. NO_X emissions can also be converted to nitric acid in the atmosphere, which contributes to acid deposition. NO_2 can be harmful to humans at high concentrations.
O_3	Ozone (O_3) exists naturally in the upper atmosphere (the Ozone Layer), and is also formed in the lower atmosphere and ground level due to photochemical reactions that result in ozone formation from precursor emissions (primarily NOx and VOCs). Ground level ozone is harmful to humans and vegetation at high concentrations.
CO	CO is formed as a result of incomplete combustion of fossil fuels and can be harmful to humans at high concentrations.
VOC	Volatile organic compounds (VOCs) are organic chemicals that have high vapor pressure resulting in high evaporation of the chemicals. There are a variety of common emission sources of VOCs such as some household product chemicals (e.g., paint) and the burning of some substances. VOCs are primary precursors to the formation of ground level ozone and particulate matter which leads to smog. VOCs, ground level ozone and particulate matter are harmful to humans at high concentrations.
TSP	TSP are airborne particulate matter that have diameters of approximately 100 µm or less. Sources of TSP include combustion processes (e.g., combustion engines) and fugitive dust. The smaller particles of airborne dust less than 10 µm are small enough to be inhaled and are harmful to humans at high concentrations. Depending on the source of TSP, other harmful chemicals such as heavy metals may also be transported as part of the airborne particulates.
PM_{10}	PM_{10} is particulate matter with a diameter of less than 10 µm. It is a subset of TSP. PM_{10} particles are small enough to be inhaled by humans and are harmful at high concentrations.
$PM_{2.5}$	$PM_{2.5}$ is particulate matter with a diameter of less than 2.5 µm. It is a subset of TSP and PM_{10}. $PM_{2.5}$ particles are small enough to be inhaled deep into the respiratory system by humans and are harmful at high concentrations.
Dust deposition (dustfall)	Dust deposition is airborne dust (TSP) that is deposited onto a surface (i.e., on top of soil, vegetation, etc.) by gravity, precipitation or wind. Depending on the source of dust, other harmful chemicals such as heavy metals may also be transported as part of the airborne particulates and deposited onto a surface.
Acid deposition	Acid deposition primarily occurs as a result of atmospheric oxidation of sulphur dioxide to sulphate (sulphuric acid) and oxidation of nitrogen dioxide to nitrate (nitric acid), which is then deposited on the ground. Acid deposition can be quantified as potential acid input, which is a measure of the combined input of sulphur and nitrogen derived acid species.

Volatile organic compounds (VOC) and ground level ozone (O_3) were not included in the AQMS as Phase 2 VOC and O_3 emissions were determined to be negligible based on the Project Description (as of November 7, 2016). O_3 is primarily produced from photochemically active nitrogen oxides (NO_X) and VOCs in the atmosphere. O_3 is primarily created downwind and away from NO_X and VOC emission sources as the chemical reaction takes place over time.

3. AIR QUALIY STANDARDS, OBJECTIVES AND GUIDELINES

Ambient air quality SOGs have been developed by the Canadian federal government and individual provinces and territories in order to assist or mandate the management of common air contaminants.

The AQMS incorporates the Nunavut *Environmental Guideline for Ambient Air Quality* (Government of Nunavut 2011). Nunavut does not have guidelines or standards for some of the air contaminants required to be included in the air quality assessment by the EIS guidelines (NIRB 2012). In these cases, guidelines, objectives or standards from the federal government (CCME 2016b, 2016a), British Columbia (BC) government (BC MOE 2016) and Alberta government (Alberta Environment and Parks 2016) have been used to inform the AQMS.

The ambient air quality SOGs that are used in the AQMS are summarized in Table 3-1. Canadian Ambient Air Quality Standards (CAAQS) for sulphur dioxide (SO_2), ground-level ozone (O_3) and particulate matter with diameter less than 2.5 µm ($PM_{2.5}$) have recently been revised and will come into effect in the years 2020 (for SO_2, O_3 and $PM_{2.5}$) and 2025 (for SO_2) (CCME 2016b, 2016a). For simplicity, the proposed activity timelines in the Project Schedule (as of November 7, 2016) are compared against the most stringent SO_2 and $PM_{2.5}$ standards.

Table 3-1. Ambient Air Quality Standards, Objectives and Guidelines

Contaminant	Units	Averaging Period	Nunavut Ambient Air Quality Guideline[a]	Guidelines or Standards from Other Government Agencies: Value	Guidelines or Standards from Other Government Agencies: Agency
Sulphur dioxide (SO_2)	µg/m³	1-hour	450	183 (70 ppb; Effective in 2020)[b] **<u>170 (65 ppb; Effective in 2025)[b]</u>**	CAAQS[g]
		24-hour (daily)	**<u>150</u>**	-	-
		Annual	30	13 (5 ppb; Effective in 2020)[c] **<u>10 (4 ppb; Effective in 2025)[c]</u>**	CAAQS[g]
Nitrogen dioxide (NO_2)	µg/m³	1-hour	**<u>400</u>**	-	
		24-hour (daily)	**<u>200</u>**	-	
		Annual	**<u>60</u>**	-	
Ground level ozone (O_3)	µg/m³	8-hour	126 (65 ppb)	123 (63 ppb)[d] **<u>121 (62 ppb; Effective in 2020)[d]</u>**	CAAQS[g]
Carbon monoxide (CO)	µg/m³	1-hour	-	**<u>14,300</u>**	BC Ambient Air Quality Objective[h]
		8-hour	-	**<u>5,500</u>**	BC Ambient Air Quality Objective[h]
Total suspended particulate (TSP)	µg/m³	24-hour (daily)	**<u>120</u>**	-	
		Annual (geometric mean)	**<u>60</u>**	-	
Particulate matter < 10 µm diameter (PM_{10})	µg/m³	24-hour (daily)	-	**<u>50</u>**	BC Ambient Air Quality Objective[h]
Particulate matter <2.5 µm diameter ($PM_{2.5}$)	µg/m³	24-hour (daily)	30	28[e] **<u>27 (Effective in 2020)[e]</u>**	CAAQS[g]
	µg/m³	Annual	-	10.0[f] **<u>8.8 (Effective in 2020)[f]</u>**	CAAQS[g]

Table 3-1. Ambient Air Quality Standards, Objectives and Guidelines (completed)

Contaminant	Units	Averaging Period	Nunavut Ambient Air Quality Guideline[a]	Guidelines or Standards from Other Government Agencies	
				Value	Agency
Dust deposition	mg/dm^2/ 30days	30-day	-	**<u>53 (residential and recreation areas)</u>** **<u>158 (commercial and industrial areas)</u>**	Alberta Ambient Air Quality Objectives and Guidelines[i]

Notes:

Bold underlined values indicate values that are used as reference values in the model study.

Dash (-) = not applicable

ppb = parts per billion

a: (Government of Nunavut 2011)

b: The 1-hour SO_2 value is calculated from the 3-year average of the 99^{th} percentile of the daily maximum 1-hour average concentrations.

c: The annual SO_2 value is calculated from the arithmetic average over a single calendar year of all 1-hour average concentrations.

d: The 8-hour O_3 value is calculated from the 3-year average of the annual 4^{th} highest daily maximum 8-hour average concentration.

e: The 24-hour $PM_{2.5}$ value is calculated from the 3-year average of the annual 98^{th} percentile of the daily 24-hour average concentration.

f: The annual $PM_{2.5}$ value is calculated from the 3-year average of the annual average concentrations.

g: Canadian Ambient Air Quality Standards for SO_2: (CCME 2016b). Canadian Ambient Air Quality Standards for O_3 and $PM_{2.5}$: (CCME 2016a)

h: (BC MOE 2016)

i: (Alberta Environment and Parks 2016)

4. EXISTING AND BASELINE AMBIENT AIR QUALITY

The AQMS uses distinct definitions when describing either baseline ambient air quality conditions or existing ambient air quality conditions for Phase 2.

- Baseline ambient air quality represents the ambient air quality conditions within the Hope Bay Project property area before any significant air emissions were released by any Hope Bay Project activity, i.e., before Phase 1, Phase 2 or Madrid Permitted activities. It is also used to describe the ambient air quality conditions within the Hope Bay Project property area when significant Phase 1 or Madrid Permitted construction or operation activities were temporarily stopped (e.g., during the winter in some years) or put under care and maintenance (e.g., in 2013 and 2014).
- Existing ambient air quality represents the ambient air quality conditions within the Hope Bay Project property area during Phase 1 operations and Madrid Permitted activities, but before Phase 2 construction or operation activities.

The distinct difference between baseline and existing ambient air quality is consistently and clearly used throughout this report.

4.1 DATA SOURCES AND APPLICATION

For characterizing Phase 2 baseline ambient air quality conditions, 2009 to 2014 (inclusive) data from the Doris North Project Air Quality Monitoring Program are used (Rescan 2009, 2010, 2011b, 2011a, 2012c, 2012a; ERM Rescan 2014a, 2014b). Emphasis is placed on the data collected during 2013 and 2014 as the Doris North Project was in care and maintenance at the time. The 2013 and 2014 data is therefore thought to be more representative of baseline ambient air quality conditions as there were less project air emissions in these years compared to years 2009 to 2012 when Doris North Project construction activities were taking place.

On-site ambient air quality monitoring data exists prior to 2009, but they are not incorporated into this ambient air quality setting section as these six years of monitoring data are sufficient to inform the baseline conditions for Phase 2.

For characterizing Phase 2 existing ambient air quality conditions, the predicted ambient air quality results from Hope Bay existing permitted activities are used (see Sections 7.1.1.1 and 7.2.1.1). These predicted results incorporate the baseline ambient air quality data sources described above.

4.2 CHARACTERIZATION OF BASELINE CONDITIONS

Table 4.2-1 summarizes the on-site 2009 to 2014 air quality monitoring results. The values that are bold and underlined are the baseline ambient air quality values used in the AQMS. These baseline values are assumed to be constant and applicable to entire modeling spatial and temporal domains.

Detailed air quality baseline data can be found in the 2009 to 2014 air quality baseline and compliance reports (Rescan 2009, 2010, 2011b, 2011a, 2012c, 2012a; ERM Rescan 2014a, 2014b).

There are no Hope Bay Project site-specific background concentrations available for CO, therefore the 2015 annual average CO concentrations at monitoring stations in Yellowknife, Norman Wells and Fort Smith were used to represent baseline conditions (GNWT 2016). The median of these three annual values is 261 $\mu g/m^3$.

Table 4.2-1. Air Quality Baseline Results Summary

Contaminant	Units	Normalized Sampling Period for Each Sample	2009 – 2014 Monitoring Data			2013 – 2014 Monitoring Data (during Care and Maintenance)		
			Median	Mean	Range	Median	Mean	Range
Sulphur dioxide (SO_2)	µg/m³	30 days	0.1	0.4	0.1 – 5.0	**<u>0.3</u>**	0.6	0.1 – 3.7
Nitrogen dioxide (NO_2)	µg/m³	30 days	1.2	1.9	0.1 – 9.6	**<u>1.1</u>**	1.9	0.1 – 7.0
Ground level ozone (O_3)	µg/m³	30 days	53.0	53.9	1.4 – 92.5	**<u>52.6</u>**	58.4	44.3 – 86.1
Total suspended particulate (TSP)	µg/m³	24 hours	4.4	5.4	0.1 – 45.0	**<u>5.8</u>**	6.7	1.1 – 17.5
Particulate matter < 10 µm diameter (PM_{10})	µg/m³	24 hours	4.7	6.3	0.5 – 46.0	**<u>5.4</u>**	6.1	1.2 – 17.1
Particulate matter <2.5 µm diameter ($PM_{2.5}$)	µg/m³	24 hours	2.6	3.0	0.1 – 20.0	**<u>3.1</u>**	3.5	1.2 – 13.3
Dust deposition (ASTM method)	mg/dm²/ 30 days	30 days	**<u>6.3</u>**	19.0	1.5 – 98.1	-	-	-
Dust deposition (Alberta Environment method)	mg/dm²/ 30 days	30 days	5.7	8.7	0.6 – 32.7			
Acid deposition	eq/ha/year	30 days	**<u>64.7</u>**	80.0	20.7 – 881.1	-	-	-

Notes:

Bold underlined values indicate values that are used as the baseline values in the assessment.

Dash (-) = not available

Data have been summarized from the 2009 – 2014 air quality compliance monitoring reports (Rescan 2009, 2010, 2011b, 2011a, 2012c, 2012a; ERM Rescan 2014a, 2014b).

There are no Hope Bay Project site-specific background concentrations available for CO, therefore the 2015 annual average CO concentrations at monitoring stations in Yellowknife, Norman Wells and Fort Smith were used to represent baseline conditions (GNWT 2016). The median of these three annual values is 261 µg/m³.

5. MODELING METHODOLOGY

5.1 MODEL SELECTION

The AQMS was completed using the California Puff (CALPUFF) air dispersion model (version 7) to simulate the resulting ambient air quality from Project emission sources. The CALPUFF model was chosen for the following reasons applicable to the Project:

- it is a non-steady state Lagrangian puff model suitable for local scale (within 10 km of emission source), regional scale (10 - 50 km from emission source) and long-range transport (50 – 200 km from emission source) applications;
- it is capable of modeling the interaction between source emissions where those emissions are transported for more than an hour, by keeping track of emissions on a time and space varying basis;
- it has the capability of modeling road sources with an algorithm specifically designed to account for the shape and elevation of each segment of the road;
- it can model meteorologically complex situations such as land and sea breezes, complex terrain effects, and recirculation; and
- it was previously used for completing the air quality assessment of 2005 Doris North Project Environmental Impact Statement (EIS) study (Golder 2005).

CALPUFF has been used to model other mining projects in Nunavut including the Back River Project, Mary River Project, Meadowbank Project, and Jericho Diamond Mine Project.

The latest version of the CALPUFF modeling system (version 7.2.1, Level 150618) was used as it aligns with the recommendations from the BC Ministry of Environment (BC MOE 2015) and Alberta Environment and Sustainable Resource Development (Alberta ESRD 2013). The Nunavut government does not have any published guidelines or regulations regarding air dispersion modeling and therefore guidelines from the BC and Alberta governments have been used instead.

There are many modular components that make up the CALPUFF modeling system (e.g., pre-processors, core models, post-processors, utilities, etc.), each with their own name and version number. For simplicity in this report, the overall CALPUFF modeling system will simply be referred to as "CALPUFF", rather than referring to specific individual modules. The exception is the CALMET processor (that is used to prepare meteorological inputs for CALPUFF) which is explicitly referenced.

The CALPUFF model uses a variety of input data and parameters, including terrain elevation, land use and meteorological (surface and upper air) datasets specific to the Hope Bay Project area. The model used air emissions inventories specific to Phase 1 operations, existing permitted activities, and Phase 2 construction and operation activities. These emissions inventories were calculated using the Project Description information available at the time (November 7, 2016), along with a variety of different published emission factors (see Section 6).

Emissions originate from three different types of sources: point (with a defined stack or vent), area (where emissions occur over an area, such as material handling and bulldozing on a storage pile, or wind erosion from storage piles), and road (emissions due to vehicle exhaust and dust entrained by vehicle motion) - source characterizations are described further in Section 6. To provide a better understanding of the major contributors to predicted impacts, each source was modeled individually and a post-processor was used that reads and combines the binary output files produced by CALPUFF to determine overall total model concentration/deposition for the various contaminants and averaging times. The post-processor identifies maximum concentration/ deposition values, identifies the specific source contributions to the total, and also identifies the maximum individual source impact. Each source was modeled with base (1-hour) emission rates for each contaminant, and the post-processor was used to scale the model output as necessary for longer averaging periods (i.e. 24-hour, annual). This approach provides an efficient and flexible methodology for processing CALPUFF output, and has been tested against the CALPUFF post-processors to ensure accuracy.

5.2 MODEL GRIDS

5.2.1 Meteorological Grid

The meteorological grid is used to define the three dimensional spatial area where meteorological conditions are modeled. The horizontal meteorological grid used for the AQMS was 100 km (north to south) by 100 km (east to west) and was centred approximately in the middle of the Hope Bay Project. The horizontal dimensional meteorological grid spacing was 1.0 km. There were 10 vertical layers above the surface used for the meteorological grid: 0, 20, 40, 80, 160, 320, 640, 1,000, 1,500, 2,000 and 3,000 m.

The grid size, spacing and vertical layers were chosen to be appropriate for the terrain characteristics and meteorological conditions of the Hope Bay Project regional area.

5.2.2 Computational Grid

The computational grid is used to define the three dimensional spatial area where simulated puffs are released and advected by the CALPUFF module. The AQMS used a 42 by 42 km computational grid for the northern and southern domains (see Section 5.3.1), centered over each domain.

5.2.3 Sampling Grid

The sampling grid is used to define the spatial area were receptors are placed for calculation of air contaminant concentrations. Both gridded and discrete sensitive receptors were used in the AQMS. Receptor spacing and development is discussed in Section 5.4.

5.3 MODEL SCENARIOS AND DOMAINS

Phase 2 periods and spatial domains were chosen for air quality modeling in order to represent the worst case air emissions. Based on the Project Description (as of November 7, 2016), the construction and operation periods were determined to have the highest emissions compared to the closure, post-closure and care and maintenance periods. Because some of the different components of the Phase 2 would be under construction and operation at different times, multiple temporal and spatial domains were needed to model the worst case scenarios.

Model temporal and spatial domains that were chosen and modeled separately are summarized in Table 5.3-1. The southern domain (Boston) Phase 2 construction and operation model scenarios in Table 5.3-1 do not include existing permitted activities (as was done for the northern domain) as it is expected that any air contaminants emitted from existing permitted activities (located at least 30 km away in the northern domain) would dilute and decrease to near background concentrations by the time it reached the southern domain.

Table 5.3-1. Model Scenarios, and Temporal and Spatial Domains

		Temporal Domain	
Model Scenario Description	Spatial Domain	Project Year[1]	Calendar Year
Existing Permitted Activities, During Phase 2 Construction	Northern Domain (Roberts Bay, Doris and Madrid)	1	2019
Existing Permitted Activities, During Phase 2 Operations	Northern Domain (Roberts Bay, Doris and Madrid)	12	2030
Phase 2 Construction: Northern Domain	Northern Domain (Roberts Bay, Doris and Madrid)	1	2019
Phase 2 Operations: Northern Domain	Northern Domain (Roberts Bay, Doris and Madrid)	12	2030
Existing Permitted Activities + Phase 2 Construction: Northern Domain	Northern Domain (Roberts Bay, Doris and Madrid)	1	2019
Existing Permitted Activities + Phase 2 Operations: Northern Domain	Northern Domain (Roberts Bay, Doris and Madrid)	12	2030
Phase 2 Construction: Southern Domain[2]	Southern Domain (Boston)	4	2022
Phase 2 Operations: Southern Domain[2]	Southern Domain (Boston)	12	2030

Notes:
1: This is the same as the "Operating Year" label used in the Phase 2 Project Schedule in the Project Description (as of November 7, 2016). "Project Year" is used instead to avoid potential confusion between years with construction and operation activities.
2: The southern domain model scenarios do not include existing permitted activities (as was done for the northern domain) as it is expected that any air contaminants emitted from existing permitted activities would dilute and decrease to background concentrations by the time it reached the southern domain.

5.3.1 Spatial Domains

The AQMS spatial domains (study areas) were established based on the "zone of influence" beyond which potential air contaminant concentrations from Phase 2 are expected to diminish to near baseline levels.

Two AQMS spatial domains were selected (Table 5.3-1 and Figure 5.3-1):

1. The northern domain includes the area around Roberts Bay, Doris, Madrid North, Madrid South and approximately 20 km of the AWR extending out to potential quarry M. This domain is a square area extending 30 km north to south, by 30 km east to west, and is centred approximately half way between Doris and Madrid North. This domain is shown in Figure 5.3-1.
2. The southern domain includes the area around Boston and approximately 20 km of the AWR extending from Boston to potential quarry T. This domain is a square area extending 30 km north to south, by 30 km east to west, and is centred approximately on the proposed Boston Mill. This domain is shown in Figure 5.3-2.

To increase air quality modeling efficiency, the middle section of the AWR (spanning a length of approximately 20 km) and potential quarries along this road section were not included in the modeling study (Figures 5.3-1 and 5.3-2), i.e., emissions from these sources are not included. It is expected that the AWR's impact on ambient air quality will be approximately uniform along the entire length of the AWR because:

- air contaminant emissions along the AWR (primarily vehicle tailpipe and fugitive unpaved road dust emissions) are expected to be uniform;
- the AWR alignment is generally a straight path; and
- regional topography, land use and meteorological conditions are generally uniform along the whole AWR length.

The ambient air quality impacts of the AWR sections modeled within the northern and southern domains can be extrapolated and assessed over the entire AWR.

The ocean shipping route within the Nunavut Settlement Area (NSA) is partially included in the northern domain, with a shipping route length of approximately 4 km within Roberts Bay. It is expected that the air emissions over the entire shipping route (including the entire route within the NSA) will be relatively uniform and the resulting ambient air quality impact from a moving ship will be generally consistent along the full shipping route. The ambient air quality impacts of the shipping route modeled within the northern domain can be extrapolated and assessed over the entire shipping route.

5.3.2 Temporal Domains

The temporal boundaries used for the AQMS include modeling air emissions and the resulting ambient air quality during Phase 2 Project Years 1, 4 and 12 for the following reasons:.

- Project Year 1 was chosen for modeling because it was determined to have the highest amount of construction air emissions in the northern domain due to the highest amount of overlapping construction activities in the proposed Phase 2 Project Schedule. Areas with Project Year 1 construction activities in the northern domain include Roberts Bay, Doris, Madrid North, Madrid South and the AWR.

Figure 5.3-1

CALPUFF Model Spatial Domains and Receptor Locations, Northern Domain (Roberts Bay, Doris and Madrid)

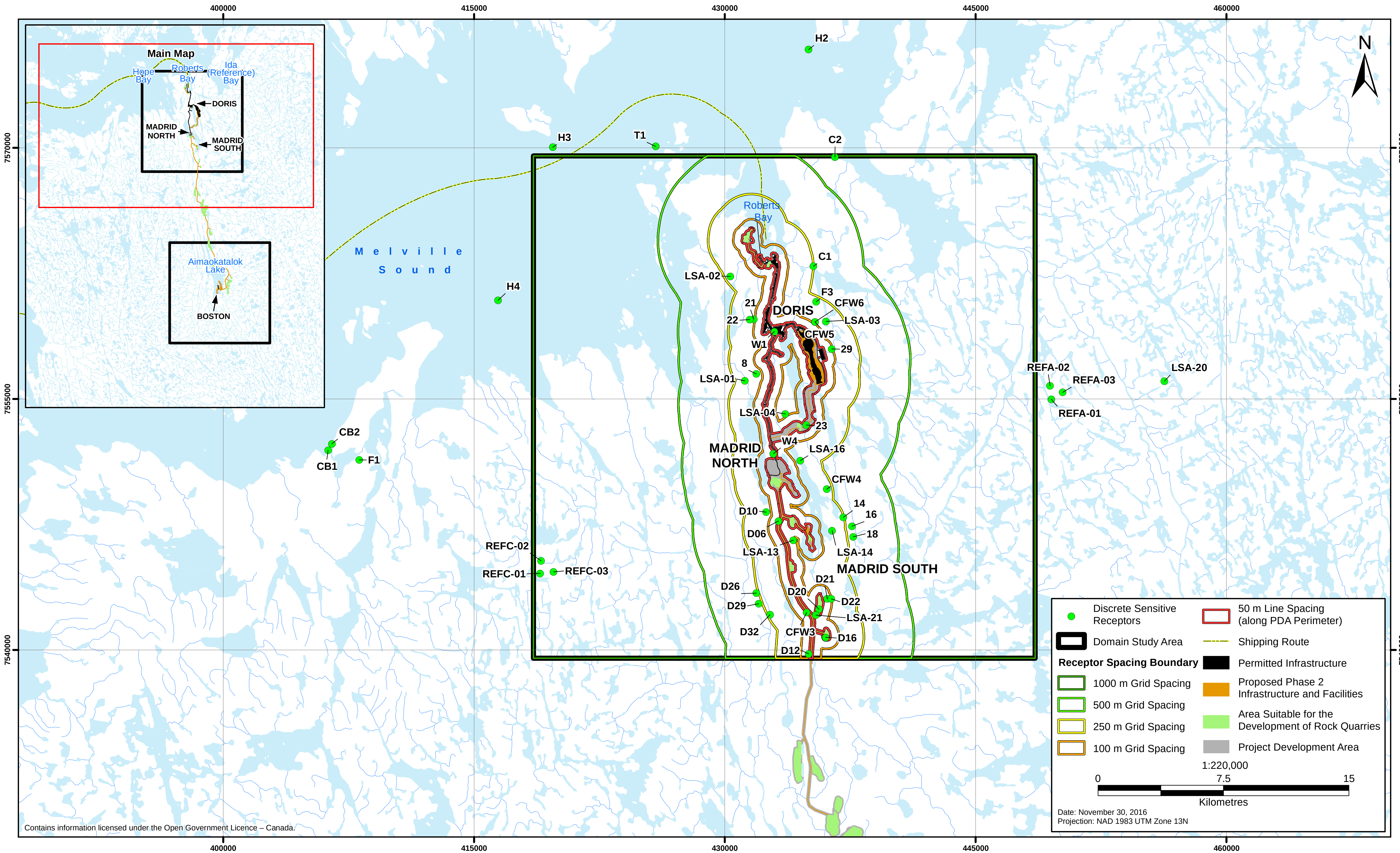
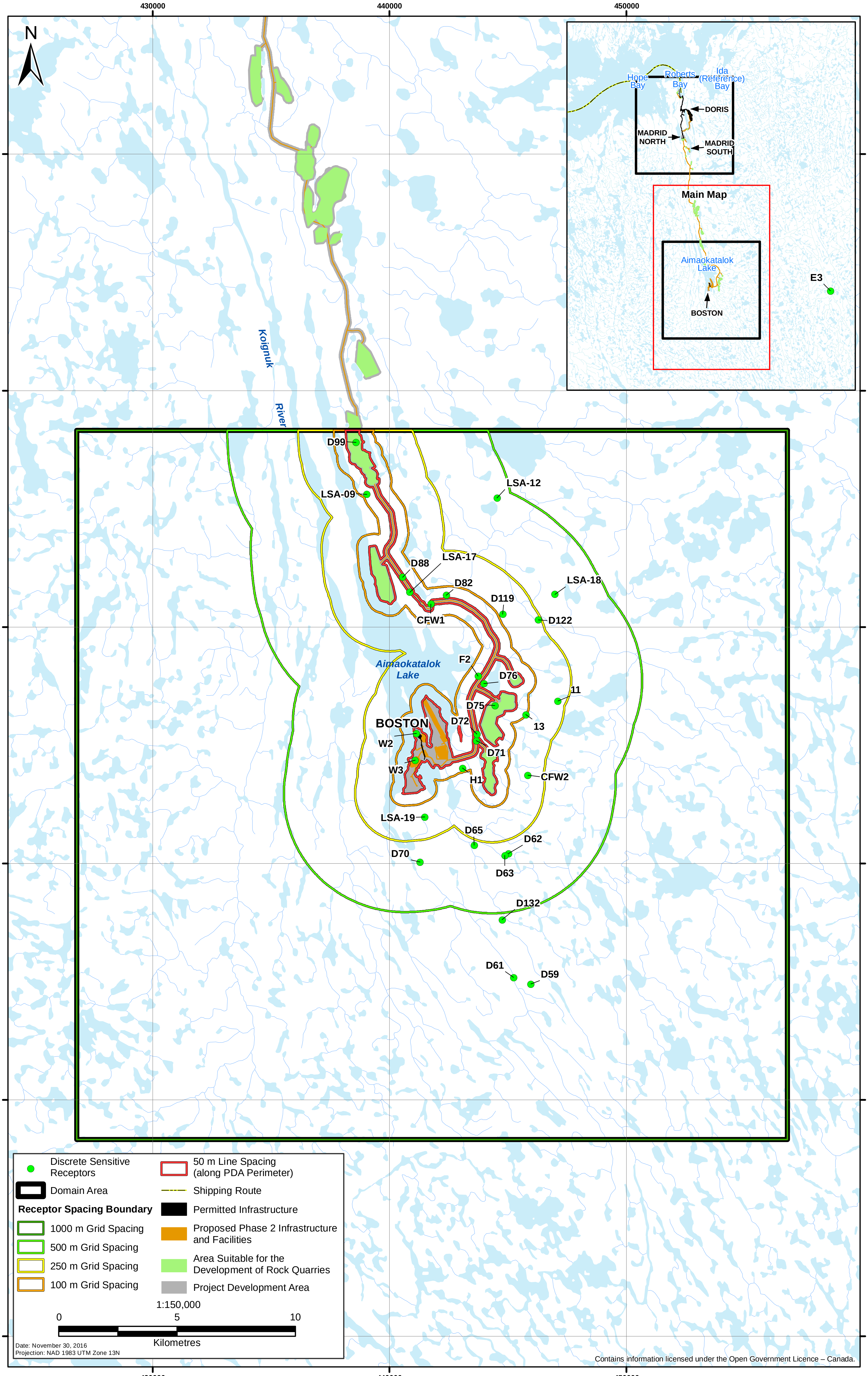


Figure 5.3-2
CALPUFF Model Spatial Domains and Receptor Locations, Southern Domain (Boston)



- Project Year 4 was chosen for modeling because it was determined to have the highest amount of construction air emissions in the southern domain due to the highest amount of overlapping construction activities in the proposed Phase 2 Project Schedule. Areas with Project Year 4 construction activities in the southern domain include Boston and it was assumed that AWR construction would also be included. The proposed Project Schedule (as of November 7, 2016) has AWR construction taking place in Phase 2 Project Years 1 to 3. The modeling study conservatively assumes that Boston and AWR construction activities overlap in Year 4 in the southern domain. This is a conservative assumption used to account for any delays in AWR construction that may cause AWR construction overlap into Year 4 with Boston construction. This assumption also helps to improve modeling efficiency.
- Project Year 12 was chosen for modeling because it was determined to have the highest amount of operational air emissions in both the northern and southern domains due to the highest amount of overlapping operational activity in the proposed Phase 2 Project Schedule.

Ambient air quality modeling predictions were not completed for the reclamation and closure, post-closure, and temporary closure periods. Based on the Project Description (as of November 7, 2016), the air emissions during these three periods were identified to be much lower than the air emissions during construction and operation periods. The resulting ambient air quality is therefore expected to be better quality during the reclamation and closure, post-closure, and temporary closure periods compared to during the construction and operation periods. Therefore, if the air quality effects assessment determines that Phase 2 does not have a significant impact on ambient air quality during construction and operations, then the same can be said about the reclamation and closure, post-closure, and temporary closure periods.

5.4 MODEL RECEPTORS

The air quality model used both grid receptors and discrete sensitive receptors.

5.4.1 Grid Receptors

Grid receptor spacing in each domain were informed by the BC and Alberta air quality model guidelines (Alberta ESRD 2013; BC MOE 2015):

- 50 m spacing along the Project Development Area (PDA) perimeter;
- 100 m spacing within 500 m of emission sources;
- 250 m spacing within 2 km of emission sources;
- 500 m spacing within 5 km of emission sources; and
- 1,000 m spacing beyond 5 km of emission sources.

The boundaries for each receptor grid are shown in Figures 5.3-1 and 5.3-2.

For modeling efficiency, a grid spacing of 50 m along the PDA and 100 m spacing within 500 m of emission sources were changed from the BC and Alberta guidelines (20 m spacing along facility fence line and 50 m spacing within 500 m of emission sources). This was an appropriate modification as it is very unlikely that the public will be within 500 m of emission sources due to the remote location of the Project. The 250 m, 500 m and 1,000 m spacing follow the BC and Alberta guidelines.

5.4.2 Discrete Sensitive Receptors

Discrete sensitive receptors were used to model the air quality at specific locations inside and outside of the northern and southern modeling domains. These sensitive receptor locations were informed by human health, soil and vegetation locations of interest. The results at these discrete sensitive receptors are specifically used for informing the DEIS assessment chapters: Human Health and Environmental Risk Assessment, Terrestrial Environment: Soils and Special Landforms, and Vegetation and Special Landscape Features.

Discrete sensitive receptor locations are shown in Figures 5.3-1 and 5.3-2 and are tabulated in Appendix A.

5.5 Model Input Data

5.5.1 Terrain Elevation Data

The terrain elevation dataset used in the model was the 15-minute Canadian Digital Elevation Data (CDED).

5.5.2 Land Use Data

Two land use datasets were used in the model: one for the snow covered period (October to May) and the other for the snow free period (June to September). Global Land Cover Characterization (GLCC) datasets did not do an appropriate job of representing the actual land use types for the domain; therefore, snow covered and snow free land use datasets were manually created for the meteorological grid using satellite imagery to identify land use types. The snow covered land use dataset assumed the entire domain was categorized as perennial snow and ice. The snow free land use dataset included tundra, lake and ocean categories.

5.5.3 Meteorological Data

The CALMET processor (Version 6.4.0 Level 121203) was used to create CALPUFF-ready inputs which consist of hourly values of surface parameters (e.g. stability category, mixing depth, temperature) and profiles of wind speed and direction at each grid cell throughout the modeling domain. CALMET used both measured on-site meteorological conditions and the output of a meteorological model as the primary inputs. On-site meteorological data for the year 2012 from the Doris and Boston meteorological stations (Rescan 2012b) were used as surface observational data in the model. The year 2012 was chosen as it was the most recent year with meteorological data available from both stations without significant data gaps. Data gaps were filled following the BC modeling guideline (BC MOE 2015) along with professional judgement and experience. This year of data was also determined to be a representative dataset of a “typical year” compared to historical years of data.

Meteorological data from the Weather Research and Forecasting mesoscale model (WRF) was also generated for the year 2012 and incorporated into the CALMET processing. The 2012 WRF dataset was a 100 km (north to south) by 100 km (east to west) horizontal domain with a horizontal resolution of 4 km. The domain was the same size and location as the CALPUFF meteorological grid (Section 5.2.1) and fully covered both AQMS northern and southern domains. Upper air data required by the model were also provided by the WRF dataset which incorporates the closest upper air observations from radiosondes launched from Cambridge Bay.

Preparation of the meteorological dataset was based on professional judgment and experience, and reference to the recommendations in the BC modeling guidelines (BC MOE 2015).

5.5.4 Existing and Baseline Ambient Air Quality

Existing and baseline ambient air quality data (see Section 4) were incorporated into the model results during post-processing so that results could be compared with and without the existing or baseline ambient air quality levels.

Baseline ambient air quality data were applied to model results by adding the baseline values to the entire domain. Baseline values were assumed to be constant over the entire spatial and temporal domain, as described in Section 4.2.

The ambient air quality model results of the existing permitted activity model scenarios (including baseline levels) were used as the existing ambient air quality data for the Phase 2 model scenarios, as described in Section 5.3. The model results from the existing permitted activates were incorporated into the Phase 2 model scenario results as described in Section 5.3 and Table 5.3-1.

5.5.5 Emission Sources

Emission sources used as part of the model input are discussed in Section 6.

5.5.6 Model Parameters

The list of parameters (or "switches") used to run both the air quality module (CALPUFF) and the meteorological module (CALMET) are included in Appendix B. Parameters were chosen based on professional judgement, experience and guidance from the *BC Air Quality Dispersion Modeling Guideline* (BC MOE 2015).

5.5.7 Nitrogen Oxides and Nitrogen Dioxide

NO_X emissions were included as model input in the emissions inventory and resulting ambient NO_X concentrations were predicted. Ambient NO_2 concentrations were calculated from the predicted ambient NO_X concentrations using the Ozone Limiting Method (BC MOE 2015). The Ozone Limiting Method normally uses the maximum hourly O_3 concentration measured from one-year of representative monitoring data. Hourly O_3 concentrations are not measured by the Hope Bay Project and there were suitable regional air quality monitoring stations with data representative of the Project area. As a substitute, the National Ambient Air Quality Objective maximum 1-hour O_3 objective of 160 $\mu g/m^3$ (82 ppb; BC MOE 2016) was used to perform the Ozone Limiting Method calculation.

6. EMISSIONS INVENTORY

An emissions inventory was prepared for the AQMS that was then used as an input for the air dispersion model. The objective of the emissions inventory was to estimate maximum air emissions of air contaminants from Project components and activities during both construction and operations.

The emissions inventory for the AQMS was built using a number of information sources, calculations and assumptions. Some information sources and assumptions were informed by descriptions about proposed Phase 2 components and activities as well as existing information about the existing permitted activities. At the time of preparing the emissions inventory, the most up-to-date information was used as of November 7, 2016. Note that there may be changes to the Phase 2 design before construction as additional planning and detailed engineering design develops. Any changes to Phase 2 components and activities made after the emissions inventory was completed were not incorporated into the emissions inventory and therefore were not represented in the predicted ambient air quality results.

The detailed emissions inventory is tabulated in Appendix C.

6.1 COMMON ASSUMPTIONS

Where input data uncertainties existed, conservative assumptions were used following regulatory guidance, professional judgement and experience. The use of conservative assumptions can lead to conservative model predictions and therefore the model results of the model study are interpreted with the understanding that the predicted effects are likely overestimated.

Common assumptions used to prepare the emissions inventory are listed below.

- The sulphur content in diesel was 15 ppm (0.0015%) for fuel used on-site, and 1,000 ppm (0.1%) for fuel used by marine shipping vessels. These sulphur contents conform to the Canadian *Sulphur in Diesel Fuel Regulations* (ECCC 2016b). The sulphur content in jet fuel used for aircraft was 680 ppm (0.068%; US FAA 2013).
- The running load factor for all on-land engines was 70%.
- The US EPA Motor Vehicle Emission Simulator version 2014a (MOVES2014a; US EPA 2014) was used to generated emission factors for all on-land mobile equipment. MOVES2014a was used with the assumption that all mobile equipment was manufactured in 2010.
- The moisture content of waste rock, ore, overburden, exposed tailings, road surfaces and pad surfaces was assumed to be 7.9%, the same as overburden moisture content (US EPA 1995, § 11.9) before any additional mitigation measures were used.
- The silt content of waste rock, ore, overburden, road surfaces and pad surfaces was assumed to be 6.9%, the same as overburden silt content (US EPA 1995, § 11.9). The silt content of tailings for both the Doris tailings impoundment area (TIA) and Boston tailings management areas (TMA) was assumed to be 51.2% (ERM 2016).

- For any emissions resulting from diesel fuel combustion that did not have specific TSP emission factors, it was assumed TSP emission factors were equal to PM_{10} emission factors.
- For any emissions resulting from diesel fuel combustion that did not have specific PM_{10} emission factors, it was assumed PM_{10} emission factors were equal to TSP emission factors multiplied by 0.976 (California Air Resource Board 2016).
- For any emissions resulting from diesel fuel combustion that did not have specific $PM_{2.5}$ emission factors, it was assumed $PM_{2.5}$ emission factors were equal to TSP emission factors multiplied by 0.967 (California Air Resource Board 2016).
- For any fugitive dust emissions that did not have specific $PM_{2.5}$ emission factors, it was conservatively assumed $PM_{2.5}$ emission factors were equal to PM_{10} emission factors.
- For CALPUFF area sources, the emission effective release height and initial sigma-z (vertical dispersion) for each area source were estimated using reasonable assumptions, and professional judgement and experience.

Additional assumptions specific to each emission source are described in Section 6.3 and included in the Appendix C emissions inventory.

6.2 EMISSION SCALING FACTORS

For the purpose of modeling the maximum 1-hour, 8-hour, daily, 30-day and annual average ambient air concentration and deposition rates used to compare against the relevant ambient air quality SOGs (see Section 3), emission scaling factors were used to adjust model output using the post-processor described in section 5.1.

For almost all emission sources, it was assumed that emissions would be generated continuously for the purpose of modeling the maximum 1-hour ambient air quality (i.e., the 1-hour emission scaling factor was 1.0). Some short duration (sub-hourly) emission activates such as blasting and aircraft takeoff and landing were calculated using emission rates that were adjusted to account for the sub-hourly emission duration. For these activities, the total amount of emissions calculated to be released within a one hour period were divided equally over the one hour period. In these cases the resulting adjusted emission rate already accounted for the sub-hourly emissions and therefore a 1-hour emission scaling factor of 1.0 was used. An exception to this was the shipping vessel movement in and out of Roberts Bay which was assumed to take 30 minutes and used a 1-hour emission scaling factor of 0.5.

It was assumed that the emission scaling factors for the 8-hour ambient air quality (used to compare CO concentrations against the 8-hour air quality objectives) were equal to the 1-hour scaling factors.

The daily emission scaling factor for each source was calculated by estimating the amount of emissions released from each source over the course of a day. For example, for most mobile equipment operating underground or in common general areas (see Section 6.3.2.1) it was assumed equipment would be operated throughout the whole day (daytime shift and nighttime shift) and the daily emission scaling factor of 1.0 was used. As another example, for specific vehicles that used the primary roads to travel to and from specific areas on a regular basis, the traffic rates (described in the November 7, 2016 Project Description) were used to calculate specific daily emission scaling factors based on the number of trips per day.

Similarly, the annual emission scaling factor for each source was calculated by estimating the amount of emissions released from each source over the course of a year. For example, for most mobile equipment operating underground or in common general areas (see Section 6.3.2.1) it was assumed equipment would be operated at the same rate over the whole year and the daily emission scaling factor of 1.0 was used. As another example, for the underground mine air heating facilities, it was assumed they would only be operated between October and May (8 out of 12 months of the year) and therefore an annual emission scaling factor of 0.67 was used. For these sources, scaling factors were used to "turn off" emissions between June and September.

Some of the area sources are potentially subject to wind erosion, i.e. emissions that occur due to the action of high wind speeds. The following sources are subject to wind erosion:

- overburden stockpiles;
- ore stockpiles;
- waste rock stockpiles;
- the TIA; and
- the TMA.

Wind erosion from these sources was modeled by developing an hourly emission rate file that calculated emissions as a function of wind speed. This was done to avoid calculating impacts under low wind speeds when wind erosion would not occur. The approach used to develop the hourly files is described in Section 6.3.2.7.

The specific emission scaling factors used for each emission source are included in the Appendix C emissions inventory.

6.3 EMISSION SOURCES

The air emissions associated with the Project within the modeling domains are outlined below. Sources were categorized and modeled as CALPUFF point, area or road sources. The CALPUFF road source type was first introduced in CALPUFF version 7.

6.3.1 Point Sources

Air emission sources that come out of a fixed stack are modeled as CALPUFF point sources.

6.3.1.1 *Genset Stacks*

Emissions from the gensets (a combination of diesel engine and electric generator) located at Doris, Madrid North, Madrid South, Boston and the Quarry D construction camp were calculated using the output power of each facility as described in the Project Description (as of November 7, 2016), and published emission factors for large stationary diesel engines (US EPA 1995, § 3.4; DieselNet 2016).

Assumptions used for the inventory include:

- the existing Doris power plant and Quarry D construction camp gensets were Tier 1 gensets and the gensets at Madrid North, Madrid South and Boston would be Tier 4; and
- stack locations, height, internal diameter, exit velocity and exit temperature were all assumed for each stack based on limited available information about the existing Doris genset stacks.

6.3.1.2 Processing Plant Stacks

Emissions from the Doris, Madrid North and Boston processing plants were calculated using the processing rate of each facility as described in the Project Description (as of November 7, 2016), and published emission factors for crushing and conveyor transfer points (US EPA 1995, § 11.24). The Doris processing plant emissions also incorporated emission factors for sludge drying (US EPA 1995, § 1.3) and smelting (Golder 2005).

Assumptions used for the inventory include:

- the sludge drying kiln was electric and had a 15 kW rating (Golder 2005); and
- stack locations, height, internal diameter, exit velocity and exit temperature were all assumed for each stack using reasonable assumptions.

6.3.1.3 Incinerator Stacks

Emissions from the Roberts Bay Laydown and Boston incinerators were calculated using the number of people in each camp as described in the Project Description (as of November 7, 2016), and published emission factors for multi-chamber industrial incinerators (US EPA 1995, § 2.1).

Assumptions used for the inventory include:

- the amount of waste burned was 2.5 kg/person/day; and
- stack locations, height, internal diameter, exit velocity and exit temperature were all assumed for each stack based on limited available information about the existing incinerators operated at Roberts Bay Laydown.

6.3.1.4 Mine Air Heating Facility Stacks

Emissions from the Doris, Madrid North, Madrid South and Boston mine air heating facilities were calculated using the 30 million British thermal unit per hour (BTU/hr) heating requirements described in the Project Description (as of November 7, 2016), and published emission factors for diesel fuel oil combustion (US EPA 1995, § 1.3).

Assumptions used for the inventory include:

- heating facilities are only used between October and May (inclusive); and

- stack locations, height, internal diameter, exit velocity and exit temperature were all assumed for each stack based on limited available information about the existing mine air heating facility operated at Doris.

6.3.1.5 *Mine Air Ventilation Exhaust Vents*

Emissions from the Doris, Madrid North, Madrid South and Boston mine air ventilation exhaust vents were calculated using the mine airflow ventilation rate, the mobile underground mine fleet inventory and underground blasting rates described in the Project Description (as of November 7, 2016). Emissions from the mobile underground mine fleet were calculated using emission factors from MOVES2014a (US EPA 2014). Emissions from underground blasting activities were calculated using published emission factors for ammonium nitrate-fuel oil (ANFO) detonation (US EPA 1995, § 13.3) and blasting particulate (US EPA 1995, § 11.9).

Assumptions used for the inventory include:

- the required total mine air ventilation exhaust rate for each mine is assumed to be equally distributed among the exhaust stack(s) for each mine; and
- stack locations, height, internal diameter, exit velocity and exit temperature were all assumed for each stack using reasonable assumptions.

6.3.1.6 *Docked Ship Stack*

Emissions from marine shipping vessels docked at Roberts Bay Dock were calculated using the shipping volumes and number of annual vessels described in the Project Description (as of November 7, 2016). Shipping emissions for a stationary docked ship were calculated using published emission factors and calculation methodology for marine vessels (EPA 2000).

Assumptions used for the inventory include:

- each shipping vessel would stay docked at the Dock for a period of seven days;
- only one shipping vessel would be docked at a time, spread out equally in the August to October shipping season; and
- stack locations, height, internal diameter, exit velocity and exit temperature were all assumed for each stack using reasonable assumptions.

6.3.2 Area Sources

Air emission sources that are mobile or that occur over a geographic area are modeled as CALPUFF area sources. A limitation in CALPUFF is that area sources can only be described with 4 vertices. The shape of each source was therefore approximated by using a number of 4-sided polygons. The resulting shapes were evaluated to ensure that the source was appropriately characterized, while keeping the number of polygons at a reasonable level given model run time considerations.

6.3.2.1 General Areas with Mobile Equipment

Emissions from mobile equipment operating in common general areas were calculated using the mobile surface equipment fleet described in the Project Description (as of November 7, 2016) and emission factors from MOVES2014a (US EPA 2014). The common general areas that were modeled were:

- Roberts Bay Dock;
- Roberts Bay Laydown;
- the area surrounding Doris camp, portal and stockpiles;
- the area surrounding Madrid North portal and stockpiles;
- the area surrounding Madrid South portal and stockpiles;
- the area surrounding Boston camp, portal and stockpiles;
- Quarry D construction camp;
- Quarry L (during quarry use);
- Quarry U (during quarry use); and
- Doris TIA west and south dams (during construction).

Assumptions used for the inventory include:

- all mobile equipment were operating continuously through the year except for equipment at Roberts Bay Dock which were only operational during the August to October shipping season and equipment at the Quarry D construction camp which were only operated for half of each day; and
- mobile crushers used at quarries used a dust suppression system to prevent fugitive dust emissions from rock crushing.

6.3.2.2 Aircraft

Aircraft landing and take-off (LTO) emissions from aircraft activities were calculated for the Doris and Boston airstrips and helipads areas using the aircraft descriptions and flight schedule described in the Project Description (as of November 7, 2016), and emission factors from the US Federal Aviation Administration (FAA) Emissions and Dispersion Modeling System (EDMS) Version 5.1.4.1 (US FAA 2013).

Assumptions used for the inventory include:

- each aircraft would perform 1 LTO cycle per hour, 1 LTO per day and 208 LTOs per year (4 times per week) for modeling the maximum 1-hour, 24-hour and annual air contaminants, respectively.

6.3.2.3 Marine Shipping Vessels

Emissions from marine shipping vessels travelling to and from Roberts Bay Dock were calculated using the shipping volumes and number of annual vessels described in the Project Description (as of November 7, 2016). Shipping emissions for a manoeuvering and slow cruise speed ship were calculated using published emission factors and calculation methodology for marine vessels (EPA 2000). The modeled shipping route extended approximately 4 km long within Roberts Bay.

Assumptions used for the inventory include:

- a shipping vessel would take 30 minutes to manoeuver into or out of the Dock and take 30 minutes to travel at slow cruise speed out of Roberts Bay; and
- only one shipping vessel would be within the Project area at a time.

6.3.2.4 Material Handling and Transport

Fugitive dust emissions from bulldozing and material transfer drop activities for each stockpile, the Boston TMA and the AWR (during construction) were calculated using the area of each location, the material transfer rates described in the Project Description (as of November 7, 2016) and the published fugitive dust emission factors and calculation methods for bulldozing (US EPA 1995, § 11.9) and material transfer drops (US EPA 1995, § 13.2.4).

Assumptions used for the inventory include:

- only one bulldozer would be operating in each stockpile area and TMA at a time and it would operate continuously.

6.3.2.5 Drilling

Fugitive dust emissions from drilling in each underground mine and at the L and U quarries were calculated using the drilling activities described in the Project Description (as of November 7, 2016) and published fugitive dust emission factors for drilling (ECCC 2016a).

Assumptions used for the inventory include:

- drilling activity was wet drilling; and
- each blast used 5 holes and there were 35 holes drilled per day, at each drilling location.

6.3.2.6 Blasting

Emissions from blasting (including fugitive dust) in each underground mine and at the L and U quarries were calculated using the blasting activities and explosive consumption rates described in the Project Description (as of November 7, 2016) and published ANFO emission factors (US EPA 1995, § 13.3) and blasting particulate emission factors (US EPA 1995, § 11.9).

Assumptions used for the inventory include:

- there would be 7 blasts per day;
- the explosive used would be ANFO; and
- the area disturbed by each blast was 200 m^2 for each underground mine blast and 2,461 m^2 for each L and U quarries blast.

6.3.2.7 Material Pile Wind Erosion

Fugitive dust emissions resulting from wind erosion at each overburden, ore and waste rock stockpiles and the TIA and TMA were calculated using the descriptions of each stockpile, TIA and TMA from the Project Description (as of November 7, 2016), hourly 2012 wind data (10 m measurement height) from the Doris and Boston meteorological stations, and published wind erosion emission factors and calculation methodology (US EPA 1995, § 13.2). The hourly wind data were used to calculate hourly fugitive dust emissions and the resulting emissions were modeled in CALPUFF using an external file containing the emission rates and parameters for each hour and each individual source.

The wind erosion approach described in Section 13.2 of US EPA (1995) calculates emissions for a wind erosion event, which occurs when the wind exceeds a threshold that is defined based on the characteristics of the material subject to erosion. During each event, emissions calculations are based on the assumption that all erodible material is removed and that no emissions will occur until the area is disturbed (i.e. material is added to the storage area or material is moved to expose more erodible material). In order to create the hourly emissions files for wind erosion sources, a balanced approach was taken. Rather than making an assumption regarding the area disturbed in between hours with winds greater than the threshold, material and surface characteristics were defined as constant values for each area in a less conservative manner than suggested by particle size measurements, and emissions were then calculated for every hour with speeds greater than the threshold for the entire area source. This balanced approach results in predicted impacts that are reasonably conservative and representative of actual wind erosion emissions.

Assumptions used for the inventory include:

- The threshold friction velocity for all areas was assumed to be 0.73 m/s, the average of three data points contained in section 13.2 of US EPA (1995), namely the values for uncrusted coal pile, ground coal and fine coal dust on a concrete pad. This converts to a threshold wind velocity of 13.9 m/s at the reference anemometer height of 10 m.
- The roughness height for all areas was assumed to be 0.5 cm.
- Natural fugitive dust suppression in the form of snow cover was assumed to be applicable between October and April and the resulting wind erosion emissions were assumed to be zero during this period.
- No anthropogenic fugitive dust suppression was used (so that results would be more conservative).

6.3.3 Road Sources

Tailpipe and fugitive dust emissions from mobile equipment and vehicles travelling on unpaved roads were calculated using the traffic volumes and road dust mitigation measures described in the Project Description (as of November 7, 2016), tailpipe emission factors from MOVES2014a (US EPA 2014) and published fugitive dust emission factors from (US EPA 1995, § 13.2.2).

Assumptions used for the inventory include:

- an unpaved road dust suppressant would be used such that fugitive dust emissions would be reduced by 75%.

7. MODELING RESULTS

The predicted ambient air quality results are separated in the following subsections by construction and operation; northern domain and southern domain; and existing permitted activities, Phase 2 activities and cumulative existing permitted activities + Phase 2 activities.

There are no existing permitted activities that produce significant air emissions in the southern domain during the Phase 2 construction or operation periods. The existing permitted activities in the northern domain emit air contaminants that dilute and decrease to approaching baseline levels within the northern domain (Sections 7.1.1.1 and 7.2.1.1) and any contaminants that reach the southern domain are negligible. Therefore the cumulative ambient air quality impact from existing permitted activities with Phase 2 activities in the southern domain is the same as the impact from just Phase 2 activities in the southern domain with baseline conditions.

Results are presented by using the maximum predicted contaminant concentration or deposition rate for each applicable averaging period, along with the percentage of times that the contaminant exceeded the relevant ambient air quality SOGs. The results presented here only include gridded receptors that were on or outside of the PDA perimeter (see Section 5.4.1 and Figures 5.3-1 and 5.3-2).

The model represents the period of peak emissions for construction and operation periods and incorporates a number of conservative assumptions (see Section 6). The use of conservative assumptions can lead to conservative model predictions and therefore the model results of the model study are interpreted with the understanding that the predicted effects are likely overestimated.

Tabulated results for human health, and vegetation and soil discrete sensitive receptors are included in Appendix A.

Contour maps of the maximum predicted results are included in Appendices D to G:

- Appendix D: Construction, Northern Domain, Existing Permitted Activities + Phase 2
- Appendix E: Construction, Southern Domain, Phase 2
- Appendix F: Operation, Northern Domain, Existing Permitted Activities + Phase 2
- Appendix G: Operation, Southern Domain, Phase 2

To limit the number of contour maps included in this report, only the cumulative (Existing Permitted Activities + Phase 2) results are included for the northern domain. The cumulative results represent lower air quality compared to the resulting air quality from just Existing Permitted Activities or just Phase 2 activates.

The following air contaminants and averaging periods are presented in the result tables and contour maps but are not used to inform the air quality assessment:

- 8-hour CO;

- annual PM10;
- annual dust deposition; and
- annual acid deposition.

These contaminants and averaging periods are used by other assessment topics such as human health, terrestrial environment and wildlife. The contaminants and averaging periods are included in this report so that the results and this report can be referenced by these other assessment topics.

7.1 CONSTRUCTION

The predicted maximum ambient air contaminant concentrations or deposition rates for the Phase 2 construction period are summarized in Table 7.1-1. Construction period contour maps are included in Appendices D and E.

7.1.1 Northern Domain Construction (Roberts Bay, Doris and Madrid), Project Year 1

7.1.1.1 Existing Permitted Activities; Northern Domain; Construction

Existing permitted activities will generate air emissions in the northern domain during the Phase 2 construction period. Table 7.1-1 summarizes the predicted maximum air contaminants from northern domain existing permitted activities during the Phase 2 construction period (the “Existing Conditions” column), including baseline conditions. The highest (i.e. poorest ambient air quality) results were located within the PDA. Table 7.1-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included NO_2 (1-hour, 24-hour and annual), CO (8-hour), TSP (24-hour), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources.

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the northern domain. All exceedances were within the northern domain, close to emission sources. Ambient air quality approached baseline conditions within the northern domain, away from emission sources.

7.1.1.2 Phase 2; Northern Domain; Construction

Phase 2 activities will generate air emissions in the northern domain during the Phase 2 construction period. Phase 2 emissions were generally higher compared to existing permitted activity emissions. This was to be expected as there are more Phase 2 components and activities compared to the existing permitted activities. Table 7.1-1 summarizes the predicted maximum air contaminants from northern domain Phase 2 construction activities (the “Phase 2 Only” column), including baseline conditions. The poorest ambient air quality results were located within the PDA. Table 7.1-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included NO_2 (1-hour, 24-hour and annual), CO (1-hour and 8-hour), TSP (24-hour and annual), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources.

Table 7.1-1. Predicted Maximum Air Contaminants Resulting from Phase 2 Construction

					Northern Domain Construction (Operating Year 1; 2019)									Southern Domain Construction (Operating Year 4; 2022)		
					Existing Conditions (includes Baseline Conditions)			Phase 2 Only (includes Baseline Conditions)			Phase 2 + Existing Conditions			Phase 2 (includes Baseline Conditions)[a]		
Contaminant (Ambient Air Quality Indicator)	Averaging Period	Units	Relevant Guideline, Objective or Standard[b]	Baseline Conditions	Max. Value	Max. No. of Exceedances per Year	Location of Max. Value[c]	Max. Value	Max. No. of Exceedances per Year	Location of Max. Value[c]	Max. Value	Max. No. of Exceedances per Year	Location of Max. Value[c]	Max. Value	Max. No. of Exceedances per Year	Location of Max. Value[c]
SO_2	1-hour	µg/m³	170[d]	0.3	89	0 (of 8,760 hours)	PDA	210	0 (of 8,760 hours)	PDA	211	0 (of 8,760 hours)	PDA	201	0 (of 8,760 hours)	PDA
	24-hour (daily)	µg/m³	150	0.3	42	0 (of 365 days)	PDA	87	0 (of 365 days)	PDA	88	0 (of 365 days)	PDA	106	0 (of 365 days)	PDA
	Annual	µg/m³	10	0.3	9.9	0 (of 1 year)	PDA	7.4	0 (of 1 year)	PDA	10.2	1 (of 1 year)	PDA	16	1 (of 1 year)	PDA
NO_2	1-hour	µg/m³	400	1.1	869	616 (of 8,760 hours)	PDA	1,825	653 (of 8,760 hours)	PDA	1,828	827 (of 8,760 hours)	PDA	1,474	1052 (of 8,760 hours)	PDA
	24-hour (daily)	µg/m³	200	1.1	488	193 (of 365 days)	PDA	849	86 (of 365 days)	PDA	853	199 (of 365 days)	PDA	936	235 (of 365 days)	PDA
	Annual	µg/m³	60	1.1	196	1 (of 1 year)	PDA	161	1 (of 1 year)	PDA	201	1 (of 1 year)	PDA	259	1 (of 1 year)	PDA
CO	1-hour	µg/m³	14,300	261	9,508	0 (of 8,760 hours)	PDA	21,826	52 (of 8,760 hours)	PDA	21,831	52 (of 8,760 hours)	PDA	11,979	0 (of 8,760 hours)	PDA
	8-hour	µg/m³	5,500	261	6,318	4 (of 1,095 periods)	PDA	12,016	32 (of 1,095 periods)	PDA	12,044	32 (of 1,095 periods)	PDA	8,648	28 (of 1,095 periods)	PDA
TSP	24-hour (daily)	µg/m³	120	5.8	1,050	49 (of 365 days)	PDA	880	164 (of 365 days)	PDA	1,052	164 (of 365 days)	PDA	1,505	138 (of 365 days)	PDA
	Annual (geometric mean)	µg/m³	60	5.8	55	0 (of 1 year)	PDA	99	1 (of 1 year)	PDA	123	1 (of 1 year)	PDA	121	1 (of 1 year)	PDA
PM_{10}	24-hour (daily)	µg/m³	50[e]	5.4	532	148 (of 365 days)	PDA	454	270 (of 365 days)	PDA	533	270 (of 365 days)	PDA	762	232 (of 365 days)	PDA
	Annual	µg/m³	-	5.4	48.9	-	PDA	57.4	-	PDA	76.5	-	PDA	92.7	-	PDA
$PM_{2.5}$	24-hour (daily; 98th percentile)	µg/m³	27[f]	3.1	123	217 (of 365 days)	PDA	187	195 (of 365 days)	PDA	210	224 (of 365 days)	PDA	372	296 (of 365 days)	PDA
	Annual	µg/m³	8.8[g]	3.1	44	1 (of 1 year)	PDA	35	1 (of 1 year)	PDA	51	1 (of 1 year)	PDA	79	1 (of 1 year)	PDA
Dust Deposition	30-day	mg/dm²/30 days	53 (residential and recreation areas); 158 (commercial and industrial areas)[e]	6.3	177		PDA	156		PDA	181		PDA	90		PDA
	Annual	g/m²/year	-	7.6	32.9	-	PDA	52.4	-	PDA	63.9	-	PDA	71.6	-	PDA

Notes:
dash (-) = not applicable
a: Air contaminants from existing permitted activities (the Existing Conditions) are assumed to dilute to baseline levels before reaching the southern model domain and therefore it is assumed that the southern domain ambient air quality from Phase 2 activities is the same as the ambient air quality from Phase 2 + Existing Conditions.
b: See Section 2.2.1 for a description of the relevant guidelines, objectives and standards.
c: PDA = The maximum value is from a receptor located on the PDA perimeter; Domain = The maximum value is from a receptor located outside of the PDA and inside of the model domain.
d: The 1-hour SO_2 value is calculated from the 3-year average of the 99th percentile of the daily maximum 1-hour average concentrations.
e: There are no Nunavut or Canadian guidelines, objectives or standards for this contaminant. The contaminant is included in the assessment to satisfy the EIS Guidelines (NIRB 2012). An appropriate provincial objective threshold for this contaminant was included for comparison.
f: The 24-hour $PM_{2.5}$ value is calculated from the 3-year average of the annual 98th percentile of the daily 24-hour average concentration.
g: The annual $PM_{2.5}$ value is calculated from the 3-year average of the annual average concentrations.

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the northern domain. All exceedances were within the northern domain, close to emission sources. Ambient air quality approached baseline conditions within the northern domain, away from emission sources.

7.1.1.3 Existing Permitted Activities and Phase 2; Northern Domain; Construction

The cumulative air quality impact from existing permitted activity emissions combined with Phase 2 emissions, in the northern domain during the Phase 2 construction period, is higher than each individual component. Table 7.1-1 summarizes the predicted maximum air contaminants from northern domain existing permitted activities and Phase 2 construction activities (the "Phase 2 + Existing Conditions" column), including baseline conditions. Contour maps that show the geographic extent of these maximum predicted results are included in Appendix D. The poorest ambient air quality results were located within the PDA. Table 7.1-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included SO_2 (annual), NO_2 (1-hour, 24-hour and annual), CO (1-hour and 8-hour), TSP (24-hour and annual), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources (see Appendix D).

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the northern domain. All exceedances were within the northern domain, close to emission sources. Ambient air quality approached baseline conditions within the northern domain, away from emission sources.

7.1.2 Southern Domain Construction (Boston), Project Year 4

There are no existing permitted activities that produce significant air emissions in the southern domain during the Phase 2 construction period. The existing permitted activities in the northern domain emit air contaminants that dilute and decrease to approaching baseline levels within the northern domain (see Section 7.1.1.1) and any contaminants that reach the southern domain are negligible. Therefore the cumulative ambient air quality impact from existing permitted activities with Phase 2 activities is the same as the impact from just Phase 2 activities with baseline conditions.

Phase 2 activities will generate air emissions in the southern domain during the Phase 2 construction period. Table 7.1-1 summarizes the predicted maximum air contaminants from southern domain Phase 2 construction activities (the "Phase 2" column), including baseline conditions. Contour maps that show the geographic extent of these maximum predicted results are included in Appendix E. The poorest ambient air quality results were located within the PDA. Table 7.1-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included SO_2 (annual), NO_2 (1-hour, 24-hour and annual), CO (8-hour), TSP (24-hour and annual), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources (see Appendix E).

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the southern domain. All exceedances were within the southern domain, close to emission sources. Ambient air quality approached baseline conditions within the southern domain, away from emission sources.

7.2 OPERATION

The predicted maximum ambient air contaminant concentrations or deposition rates for the Phase 2 operation period are summarized in Table 7.2-1. Operation period contour maps are included in Appendices F and G.

7.2.1 Northern Domain Operation (Roberts Bay, Doris and Madrid), Project Year 12

7.2.1.1 Existing Permitted Activities; Northern Domain; Operation

Existing permitted activities will generate air emissions in the northern domain during the Phase 2 operation period. Table 7.2-1 summarizes the predicted maximum air contaminants from northern domain existing permitted activities during the Phase 2 operation period (the "Existing Conditions" column), including baseline conditions. The poorest ambient air quality results were located within the PDA. Table 7.2-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included NO_2 (1-hour, 24-hour and annual), TSP (24-hour), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources.

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the northern domain. All exceedances were within the northern domain, close to emission sources. Ambient air quality approached baseline conditions within the northern domain, away from emission sources.

7.2.1.2 Phase 2; Northern Domain; Operation

Phase 2 activities will generate air emissions in the northern domain during the Phase 2 operation period. Phase 2 emissions were generally higher compared to existing permitted activity emissions. This was to be expected as there are more Phase 2 components and activities compared to the existing permitted activities. Table 7.2-1 summarizes the predicted maximum air contaminants from northern domain Phase 2 operation activities (the "Phase 2 Only" column), including baseline conditions. The poorest ambient air quality results were located within the PDA. Table 7.2-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included SO_2 (annual), NO_2 (1-hour, 24-hour and annual), TSP (24-hour and annual), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources.

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the northern domain. All exceedances were within the northern domain, close to emission sources. Ambient air quality approached baseline conditions within the northern domain, away from emission sources.

Table 7.2-1. Predicted Maximum Air Contaminants Resulting from Phase 2 Operation

					Northern Domain Operation (Operating Year 12; 2030)									Southern Domain Operation (Operating Year 12; 2030)		
					Existing Conditions (includes Baseline Conditions)			Phase 2 Only (includes Baseline Conditions)			Phase 2 + Existing Conditions			Phase 2 (includes Baseline Conditions)[a]		
Contaminant (Ambient Air Quality Indicator)	Averaging Period	Units	Relevant Guideline, Objective or Standard[b]	Baseline Conditions	Max. Value	No. of Exceedances per Year	Location of Max. Value[c]	Max. Value	No. of Exceedances per Year	Location of Max. Value[c]	Max. Value	No. of Exceedances per Year	Location of Max. Value[c]	Max. Value	No. of Exceedances per Year	Location of Max. Value[c]
SO_2	1-hour	$\mu g/m^3$	170[d]	0.3	43	0 (of 8,760 hours)	PDA	161	0 (of 8,760 hours)	PDA	161	0 (of 8,760 hours)	PDA	201	0 (of 8,760 hours)	PDA
	24-hour (daily)	$\mu g/m^3$	150	0.3	19	0 (of 365 days)	PDA	79	0 (of 365 days)	PDA	79	0 (of 365 days)	PDA	65	0 (of 365 days)	PDA
	Annual	$\mu g/m^3$	10	0.3	2.9	0 (of 1 year)	PDA	17	1 (of 1 year)	PDA	17	1 (of 1 year)	PDA	9.9	0 (of 1 year)	PDA
NO_2	1-hour	$\mu g/m^3$	400	1.1	419	2 (of 8,760 hours)	PDA	1,271	1,374 (of 8,760 hours)	PDA	1,271	1,375 (of 8,760 hours)	PDA	1,405	605 (of 8,760 hours)	PDA
	24-hour (daily)	$\mu g/m^3$	200	1.1	278	26 (of 365 days)	PDA	706	250 (of 365 days)	PDA	706	250 (of 365 days)	PDA	608	157 (of 365 days)	PDA
	Annual	$\mu g/m^3$	60	1.1	102	1 (of 1 year)	PDA	240	1 (of 1 year)	PDA	240	1 (of 1 year)	PDA	205	1 (of 1 year)	PDA
CO	1-hour	$\mu g/m^3$	14,300	261	2,321	0 (of 8,760 hours)	Domain	5,474	0 (of 8,760 hours)	PDA	5,474	0 (of 8,760 hours)	PDA	9,189	0 (of 8,760 hours)	PDA
	8-hour	$\mu g/m^3$	5,500	261	1,463	0 (of 1,095 periods)	Domain	3,773	0 (of 1,095 periods)	PDA	3,773	0 (of 1,095 periods)	PDA	5,785	1 (of 1,095 periods)	PDA
TSP	24-hour (daily)	$\mu g/m^3$	120	5.8	1,050	48 (of 365 days)	PDA	2,711	220 (of 365 days)	PDA	3,579	220 (of 365 days)	PDA	1,881	87 (of 365 days)	PDA
	Annual (geometric mean)	$\mu g/m^3$	60	5.8	54	0 (of 1 year)	PDA	169	1 (of 1 year)	PDA	169	1 (of 1 year)	PDA	91	1 (of 1 year)	PDA
PM_{10}	24-hour (daily)	$\mu g/m^3$	50[e]	5.4	532	49 (of 365 days)	PDA	1,377	266 (of 365 days)	PDA	1,821	266 (of 365 days)	PDA	963	174 (of 365 days)	PDA
	Annual	$\mu g/m^3$	-	5.4	26.2	-	PDA	110.7	-	PDA	110.7	-	PDA	67.7	-	PDA
$PM_{2.5}$	24-hour (daily; 98th percentile)	$\mu g/m^3$	27[f]	3.1	80	67 (of 365 days)	PDA	271	300 (of 365 days)	PDA	271	300 (of 365 days)	PDA	246	249 (of 365 days)	PDA
	Annual	$\mu g/m^3$	8.8[g]	3.1	18	1 (of 1 year)	Domain	89	1 (of 1 year)	PDA	89	1 (of 1 year)	PDA	53	1 (of 1 year)	PDA
Dust Deposition	30-day	mg/dm^2/ 30 days	53 (residential and recreation areas); 158 (commercial and industrial areas)[e]	6.3	177		PDA	459		PDA	569		PDA	231		PDA
	Annual	g/m^2/year	-	7.6	32.2	-	PDA	62.5	-	PDA	77.3	-	PDA	53.7	-	PDA

Notes:
dash (-) = not applicable
a: Air contaminants from existing permitted activities (the Existing Conditions) are assumed to dilute to baseline levels before reaching the southern model domain and therefore it is assumed that the southern domain ambient air quality from Phase 2 activities is the same as the ambient air quality from Phase 2 + Existing Conditions.
b: See Section 2.2.1 for a description of the relevant guidelines, objectives and standards.
c: PDA = The maximum value is from a receptor located on the PDA perimeter; Domain = The maximum value is from a receptor located outside of the PDA and inside of the model domain.
d: The 1-hour SO_2 value is calculated from the 3-year average of the 99th percentile of the daily maximum 1-hour average concentrations.
e: There are no Nunavut or Canadian guidelines, objectives or standards for this contaminant. The contaminant is included in the assessment to satisfy the EIS Guidelines (NIRB 2012). An appropriate provincial objective threshold for this contaminant was included for comparison.
f: The 24-hour $PM_{2.5}$ value is calculated from the 3-year average of the annual 98th percentile of the daily 24-hour average concentration.
g: The annual $PM_{2.5}$ value is calculated from the 3-year average of the annual average concentrations.

7.2.1.3 Existing Permitted Activities and Phase 2; Northern Domain; Operation

The cumulative air quality impact from existing permitted activity emissions combined with Phase 2 emissions, in the northern domain during the Phase 2 operation period, is higher than each individual component. Table 7.2-1 summarizes the predicted maximum air contaminants from northern domain existing permitted activities and Phase 2 operation activities (the "Phase 2 + Existing Conditions" column), including baseline conditions. Contour maps that show the geographic extent of these maximum predicted results are included in Appendix F. The poorest ambient air quality results were located within the PDA. Table 7.2-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included SO_2 (annual), NO_2 (1-hour, 24-hour and annual), TSP (24-hour and annual), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources (see Appendix F), with the exception of the maximum 24-hour PM_{10} concentrations.

The maximum 24-hour PM_{10} concentrations had an exceedance that extended southeast of the TIA, to the eastern model receptor grid boundary (Appendix F). The highest 24-hour PM_{10} value along the eastern receptor grid boundary was 54 µg/m^3 (including baseline PM_{10}), just above the 24-hour PM_{10} threshold value of 50 µg/m^3. Based on the rate of PM_{10} dilution with distance away from the TIA, it is expected that the specific PM_{10} exceedance event would decrease below the threshold value in a short distance past the eastern model boundary (e.g., within approximately 1 km).

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the northern domain. All exceedances (except PM_{10}) were within the northern domain, close to emission sources. Ambient air quality approached baseline conditions within the northern domain, away from emission sources.

7.2.2 Southern Domain Operation (Boston), Project Year 12

There are no existing permitted activities that produce significant air emissions in the southern domain during the Phase 2 operation period. The existing permitted activities in the northern domain emit air contaminants that dilute and decrease to approaching baseline levels within the northern domain (see Section 7.2.1.1) and any contaminants that reach the southern domain are negligible. Therefore the cumulative ambient air quality impact from existing permitted activities with Phase 2 activities is the same as the impact from just Phase 2 activities with baseline conditions.

Phase 2 activities will generate air emissions in the southern domain during the Phase 2 operation period. Table 7.2-1 summarizes the predicted maximum air contaminants from southern domain Phase 2 operation activities (the "Phase 2" column), including baseline conditions. Contour maps that show the geographic extent of these maximum predicted results are included in Appendix G. The poorest ambient air quality results were located within the PDA. Table 7.2-1 tabulates the maximum air contaminants from along the PDA perimeter or outside of the PDA. Air contaminants with predicted exceedances included NO_2 (1-hour, 24-hour and annual), CO (8-hour), TSP (24-hour and annual), PM_{10} (24-hour), $PM_{2.5}$ (24-hour and annual) and dust deposition (monthly). Exceedances occurred for limited times and were confined to limited areas close to emission sources (see Appendix G).

Overall, the resulting ambient air quality was predicted to be generally below the relevant air quality SOGs in the majority of the southern domain. All exceedances were within the southern domain, close to emission sources. Ambient air quality approached baseline conditions within the southern domain, away from emission sources.

7.3 CLOSURE, POST-CLOSURE, AND CARE AND MAINTENANCE

Ambient air quality modeling predictions were not completed for the reclamation and closure, post-closure, and temporary closure periods. Based on the Project Description (as of November 7, 2016), the air emissions during these three periods were identified to be much lower than the air emissions during construction and operation periods. The resulting ambient air quality is therefore expected to be better quality during the reclamation and closure, post-closure, and temporary closure periods compared to during the construction and operation periods.

The purpose of this AQMS is to inform the *Hope Bay Project Phase 2 Draft Environmental Impact Statement* assessment of air quality. Therefore, if the air quality effects assessment determines that Phase 2 does not have a significant impact on ambient air quality during construction and operations, then the same can be said about the reclamation and closure, post-closure, and temporary closure periods.

8. SUMMARY

The AQMS used the CALPUFF air dispersion model (version 7) to predict the resulting ambient air quality due to: existing permitted Hope Bay project activities, Hope Bay Phase 2 project activities, and the cumulative existing permitted activities along with Phase 2 activities.

The air contaminants modeled were NO_X, NO_2, SO_2, CO, TSP, PM_{10}, $PM_{2.5}$, dust deposition and acid deposition. Contaminants were compared against relevant ambient air quality SOGs for Nunavut, other provinces, or Canada.

Baseline ambient air quality conditions were characterized from historical data collected from the Doris North Project Air Quality Monitoring Program from 2009 to 2014.

The CALPUFF model used appropriate terrain elevation and land use data for the Hope Bay Project area. The meteorological data inputs were from the on-site Doris and Boston meteorological stations along with an appropriate WRF dataset. Model parameters were chosen using BC regulatory guidance, professional judgement and experience.

The AQMS used two spatial domains, one for Roberts Bay, Doris and Madrid, and the other for Boston. Both construction and operation periods were modeled for each domain. For each modeling domain and period, the ambient air quality was predicted for existing permitted activities only, Phase 2 activities only, and the cumulative existing permitted activities along with Phase 2 activities.

The emissions inventory was built using a number of information sources, calculations and assumptions. Some information sources and assumptions were informed by descriptions about proposed Phase 2 components and activities as well as existing information about the existing permitted activities. At the time of preparing the emissions inventory, the most up-to-date information was used as of November 7, 2016. Note that there may be changes to the Phase 2 design before construction as additional planning and detailed engineering design develops. Any changes to Phase 2 components and activities made after the emissions inventory was completed were not incorporated into the emissions inventory and therefore are not represented in the predicted ambient air quality results.

Where input data uncertainties existed, conservative assumptions were used following regulatory guidance, professional judgement and experience. The use of conservative assumptions can lead to conservative model predictions and therefore the model results of the AQMS are interpreted with the understanding that the predicted effects are likely overestimated.

There are no existing permitted activities that produce significant air emissions in the southern domain during the Phase 2 construction or operation periods. The existing permitted activities in the northern domain emit air contaminants that dilute and decrease that approach baseline levels within the northern domain and any contaminants that reach the southern domain are negligible. Therefore the cumulative ambient air quality impact from existing permitted activities with Phase 2 activities in the southern domain is the same as the impact from just Phase 2 activities in the southern domain with baseline conditions.

The predicted ambient air quality results are compared against relevant guidelines, objectives and standards for each ambient air quality contaminant. The predicted maximum results show that SO_2, NO_2, CO, TSP, PM_{10}, $PM_{2.5}$ and dust deposition will exceed the relevant thresholds levels in limited areas surrounding the Phase 2 Project and the whole Hope Bay Development, during Phase 2 construction or operation periods. The frequency of exceedances is also limited, depending on the contaminant, averaging period and receptor location. There were no exceedances outside of the model domains, with the exception of limited maximum 24-hour PM_{10} exceedance event reaching the eastern boundary of the northern domain during Phase 2 operations (with existing permitted activities).

Ambient air quality modeling predictions were not completed for the reclamation and closure, post-closure, and temporary closure periods. Based on the Project Description (as of November 7, 2016), the air emissions during these three periods were identified to be much lower than the air emissions during construction and operation periods. The resulting ambient air quality is therefore expected to be better quality during the reclamation and closure, post-closure, and temporary closure periods compared to during the construction and operation periods.

The AQMS provided predictions of the ambient air quality resulting from Phase 2 components and activities; however, only appropriate on-site ambient air quality monitoring can verify the actual on-site ambient air quality resulting from Phase 2 components and activities.

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Appendix A

Discrete Sensitive Receptor Locations and Ambient Air Quality Predictions

Table A-1. Maximum Ambient Air Quality Predictions for Discrete Sensitive Receptors for Phase 2 and Existing Permitted Activities, during Phase 2 Construction

		UTM Coordinate (Zone 13W)		NO_2 ($\mu g/m^3$)			SO_2 ($\mu g/m^3$)			TSP ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		PM_{25} ($\mu g/m^3$)		CO ($\mu g/m^3$)		TSP Deposition		Acid Deposition (eq/ha/year)
Receptor ID	Description	Easting (m)	Northing (m)	1 Hour Average	24 Hour Average	Annual Average	1 Hour Average	24 Hour Average	Annual Average	24 Hour Average	Annual Average	24 Hour Average	Annual Average	24 Hour Average (98^{th} percentile)	Annual Average	1 Hour Average	8 Hour Average	Monthly Average (mg/dm^2/30days)	Annual Average (g/m^2/year)	Annual Average
Baseline/Background Value Included in Results:				1.1	1.1	1.1	0.3	0.3	0.3	5.8	5.8	5.4	5.4	3.1	3.1	261	261	6.3	7.6	63.7
CB1	Cabin	406275	7551932	29.0	11.3	1.8	1.1	0.5	0.3	6.1	5.8	6.4	5.5	3.5	3.2	314	284	6.4	7.6	64.0
CB2	Cabin	406503	7552314	30.9	12.3	1.8	1.2	0.5	0.3	6.1	5.8	6.5	5.5	3.5	3.2	316	286	6.4	7.6	64.0
C1	Outpost Camp	435299	7562924	198.8	130.9	13.5	11.3	2.5	0.5	14.6	6.4	20.9	6.7	8.0	4.0	733	490	6.7	7.9	64.5
C2	Seasonal Camp (spring/summer)	436579	7569440	175.8	61.8	5.0	4.3	1.2	0.4	7.0	5.9	12.4	5.8	5.1	3.4	498	389	6.4	7.7	64.1
F1	Fishing Area	408133	7551357	29.1	13.1	1.9	1.4	0.5	0.3	6.1	5.8	6.6	5.5	3.6	3.2	319	287	6.4	7.6	64.0
F2	Fishing Area	443743	7507934	68.0	24.6	2.0	1.7	0.8	0.3	6.1	5.8	8.6	5.5	3.9	3.2	349	309	6.3	7.6	63.9
F3	Fishing Area	435464	7560803	195.5	122.2	15.6	9.7	2.1	0.5	17.8	6.7	20.7	7.1	10.3	4.2	730	558	7.8	8.1	64.5
H1	Hunting and Fishing	443076	7504032	59.0	18.9	1.8	1.4	0.7	0.3	6.0	5.8	7.8	5.5	3.9	3.2	326	302	6.3	7.6	63.9
H2	Hunting and Fishing	435004	7575863	144.7	26.6	3.2	3.3	0.8	0.3	6.7	5.8	9.7	5.6	4.2	3.3	447	337	6.4	7.7	64.0
H3	Hunting and Fishing	419714	7570035	107.4	45.3	4.4	2.8	0.9	0.3	7.4	5.9	10.0	5.8	4.7	3.4	385	333	6.6	7.7	64.3
H4	Hunting and Fishing	416437	7560887	66.1	22.6	3.2	1.6	0.6	0.3	7.1	5.9	7.7	5.7	4.1	3.3	349	314	6.5	7.7	64.3
T1	Travel Route	425864	7570078	173.2	76.5	5.8	4.8	1.4	0.4	7.4	6.0	12.7	5.9	5.5	3.4	452	377	6.6	7.8	64.2
E3	Queen Maude Gulf Migratory Bird Sanctuary	478687	7503125	43.3	13.5	1.8	1.2	0.6	0.3	5.9	5.8	7.1	5.5	3.6	3.2	317	288	6.3	7.6	63.9
W1	Doris Camp (active)	432965	7559019	248.9	189.9	67.9	18.8	5.2	1.5	429.3	42.5	157.6	22.3	28.3	10.6	1290	925	53.1	24.2	68.0
W2	Boston Exploration Camp	441137	7505488	60.8	17.2	1.8	1.4	0.7	0.3	6.0	5.8	7.6	5.5	3.8	3.2	325	302	6.3	7.6	63.9
W3	Boston Operation Camp	441091	7504366	58.2	16.3	1.8	1.3	0.6	0.3	6.0	5.8	7.5	5.5	3.7	3.2	322	300	6.3	7.6	63.9
W4	Quarry D Camp	432902	7551719	1271.7	331.1	171.3	144.2	23.9	5.9	463.0	103.4	242.6	55.0	93.6	29.7	28025	12258	45.8	38.8	86.3
8	Soil and Vegetation Site	431889	7556490	248.7	186.3	28.0	14.5	5.4	0.8	89.4	19.3	93.8	14.8	18.7	6.1	1215	904	9.9	10.6	65.1
11	Soil and Vegetation Site	447111	7506863	71.0	27.0	2.2	1.6	0.8	0.3	6.1	5.8	8.8	5.5	4.2	3.2	348	306	6.3	7.6	64.0
13	Soil and Vegetation Site	445764	7506296	64.9	25.2	2.1	1.6	0.8	0.3	6.1	5.8	8.6	5.5	4.1	3.2	341	306	6.3	7.6	63.9
14	Soil and Vegetation Site	437081	7547927	278.8	184.0	33.8	17.7	5.8	1.0	26.6	8.8	47.7	10.7	21.9	6.4	1663	976	7.8	8.6	65.4
16	Soil and Vegetation Site	437606	7547392	272.1	180.9	32.8	16.5	5.3	0.9	24.1	8.4	45.1	10.3	19.9	6.1	1564	1059	7.5	8.4	65.4
18	Soil and Vegetation Site	437685	7546759	282.6	185.6	33.8	17.7	5.4	0.9	27.4	8.3	45.3	10.2	20.1	6.1	1688	1023	7.5	8.5	65.3
21	Soil and Vegetation Site	431742	7559766	208.5	165.5	29.3	17.1	3.1	0.7	43.9	10.6	42.7	10.3	13.5	5.4	766	589	8.9	9.6	65.2
22	Soil and Vegetation Site	431495	7559736	200.4	151.9	24.0	11.9	2.5	0.6	30.2	9.2	32.9	9.1	11.0	4.9	674	532	8.4	9.1	65.0
23	Soil and Vegetation Site	434866	7553440	246.0	163.9	28.7	13.5	4.8	0.8	41.1	12.5	47.9	11.8	17.3	5.9	1223	899	8.2	9.4	65.1
29	Soil and Vegetation Site	436397	7557974	264.0	183.0	24.8	17.2	5.6	0.7	85.4	8.7	53.1	9.4	16.4	5.4	1591	1030	12.8	9.3	64.9
CFW1	Soil and Vegetation Site	441742	7510978	77.4	26.1	2.2	1.9	0.8	0.3	6.2	5.8	8.8	5.5	4.0	3.2	360	314	6.3	7.6	64.0
CFW2	Soil and Vegetation Site	445842	7503722	64.5	22.4	2.0	1.4	0.7	0.3	6.1	5.8	8.2	5.5	3.9	3.2	334	302	6.3	7.6	63.9
CFW3	Soil and Vegetation Site	434895	7542241	350.3	197.3	29.5	34.4	7.7	0.9	208.9	44.0	131.1	20.4	28.2	7.1	2984	1693	15.3	15.0	66.9
CFW4	Soil and Vegetation Site	436096	7549617	289.8	182.4	41.6	19.4	5.2	1.1	60.9	10.9	45.8	12.3	22.1	7.3	1617	1030	13.2	9.7	65.5
CFW5	Soil and Vegetation Site	435388	7559595	229.6	165.4	23.6	12.2	3.9	0.7	63.8	8.7	39.8	9.0	15.7	5.2	1206	918	18.3	10.1	64.8
CFW6	Soil and Vegetation Site	435400	7559600	228.8	164.6	23.4	12.1	3.9	0.7	63.2	8.6	39.3	9.0	15.7	5.1	1196	911	18.1	10.1	64.8
D06	Soil and Vegetation Site	433211	7547704	370.2	169.3	34.1	30.4	6.2	1.1	179.8	39.8	82.0	20.6	24.3	7.7	2264	1439	14.6	14.2	65.6
D10	Soil and Vegetation Site	432471	7548235	370.0	178.4	29.2	29.7	8.7	0.9	51.9	11.8	66.6	11.7	22.2	6.3	2266	1519	8.3	9.1	65.3
D12	Soil and Vegetation Site	435015	7539768	237.4	146.1	13.0	13.6	3.7	0.5	137.6	27.9	65.2	13.7	14.2	4.8	1363	974	12.0	11.8	64.8
D16	Soil and Vegetation Site	436028	7540759	295.4	190.1	16.3	23.5	7.6	0.7	59.1	15.0	87.3	11.3	19.4	5.1	2113	1344	8.7	9.4	65.0
D20	Soil and Vegetation Site	435631	7542445	664.8	342.6	197.9	126.4	27.8	6.7	721.5	43.9	470.8	39.3	116.9	30.8	8412	4102	26.1	27.1	98.3
D21	Soil and Vegetation Site	436121	7543060	428.3	300.5	65.6	47.8	20.9	2.3	144.0	16.0	196.5	17.4	51.1	11.8	4094	3054	12.0	11.7	73.1
D22	Soil and Vegetation Site	436364	7543053	398.5	258.4	50.4	42.8	15.0	1.6	80.5	12.7	139.5	14.3	38.5	9.1	3681	2381	9.9	10.1	69.4
D26	Soil and Vegetation Site	431884	7543400	193.7	120.0	14.3	5.6	2.4	0.5	22.0	7.4	26.6	7.5	8.8	4.1	711	560	7.1	8.0	64.7
D29	Soil and Vegetation Site	432032	7542768	198.7	126.9	14.5	6.4	2.7	0.5	22.2	7.4	30.4	7.6	8.9	4.2	768	560	7.1	8.0	64.7
D32	Soil and Vegetation Site	432709	7542115	192.6	125.2	13.5	7.1	2.2	0.5	27.3	7.6	30.5	7.5	8.5	4.1	796	540	7.1	8.0	64.7
D59	Soil and Vegetation Site	445959	7494897	54.0	15.6	1.7	1.2	0.6	0.3	6.0	5.8	7.1	5.5	3.7	3.2	317	291	6.3	7.6	63.9
D61	Soil and Vegetation Site	445242	7495180	52.3	14.8	1.7	1.1	0.6	0.3	5.9	5.8	7.0	5.5	3.7	3.2	316	291	6.3	7.6	63.9
D62	Soil and Vegetation Site	445021	7500407	61.4	18.0	1.8	1.3	0.6	0.3	6.0	5.8	7.6	5.5	3.8	3.2	325	298	6.3	7.6	63.9
D63	Soil and Vegetation Site	444873	7500331	60.9	17.7	1.8	1.3	0.6	0.3	6.0	5.8	7.6	5.5	3.8	3.2	324	298	6.3	7.6	63.9
D65	Soil and Vegetation Site	443575	7500774	57.2	16.4	1.8	1.2	0.6	0.3	6.0	5.8	7.5	5.5	3.8	3.2	322	298	6.3	7.6	63.9
D70	Soil and Vegetation Site	441289	7500063	47.1	13.1	1.7	1.2	0.6	0.3	5.9	5.8	7.1	5.5	3.7	3.2	312	294	6.3	7.6	63.9
D71	Soil and Vegetation Site	443663	7505185	61.8	21.1	1.9	1.5	0.7	0.3	6.1	5.8	8.1	5.5	3.9	3.2	333	304	6.3	7.6	63.9
D72	Soil and Vegetation Site	443686	7505467	62.5	21.5	1.9	1.5	0.7	0.3	6.1	5.8	8.1	5.5	3.9	3.2	335	305	6.3	7.6	63.9
D75	Soil and Vegetation Site	444448	7506676	64.4	24.1	2.1	1.6	0.8	0.3	6.1	5.8	8.5	5.5	3.9	3.2	343	307	6.3	7.6	63.9
D76	Soil and Vegetation Site	443985	7507620	67.1	24.7	2.1	1.7	0.8	0.3	6.1	5.8	8.6	5.5	3.9	3.2	348	308	6.3	7.6	63.9
D82	Soil and Vegetation Site	442400	7511352	77.6	27.9	2.2	2.0	0.8	0.3	6.2	5.8	9.1	5.5	4.0	3.2	367	315	6.3	7.6	64.0
D88	Soil and Vegetation Site	440559	7512115	81.0	25.4	2.1	1.8	0.8	0.3	6.1	5.8	8.8	5.5	4.0	3.2	356	316	6.3	7.6	64.0

Table A-1. Maximum Ambient Air Quality Predictions for Discrete Sensitive Receptors for Phase 2 and Existing Permitted Activities, during Phase 2 Construction

		UTM Coordinate (Zone 13W)		NO_2 (µg/m^3)			SO_2 (µg/m^3)			TSP (µg/m^3)		PM_{10} (µg/m^3)		PM_{25} (µg/m^3)		CO (µg/m^3)		TSP Deposition		Acid Deposition (eq/ha/year)
Receptor ID	Description	Easting (m)	Northing (m)	1 Hour Average	24 Hour Average	Annual Average	1 Hour Average	24 Hour Average	Annual Average	24 Hour Average	Annual Average	24 Hour Average	Annual Average	24 Hour Average (98th percentile)	Annual Average	1 Hour Average	8 Hour Average	Monthly Average (mg/dm^2/30days)	Annual Average (g/m^2/year)	Annual Average
Baseline/Background Value Included in Results:				1.1	1.1	1.1	0.3	0.3	0.3	5.8	5.8	5.4	5.4	3.1	3.1	261	261	6.3	7.6	63.7
D99	Soil and Vegetation Site	438580	7517814	99.6	30.3	2.4	2.1	0.9	0.3	6.2	5.8	9.5	5.5	4.1	3.2	375	330	6.3	7.6	64.0
D119	Soil and Vegetation Site	444785	7510544	70.7	29.9	2.3	1.9	0.9	0.3	6.2	5.8	9.3	5.5	4.2	3.2	368	313	6.3	7.6	64.0
D122	Soil and Vegetation Site	446280	7510305	75.2	30.5	2.3	1.8	0.9	0.3	6.2	5.8	9.4	5.5	4.3	3.2	365	311	6.3	7.6	64.0
D132	Soil and Vegetation Site	444763	7497620	55.6	15.7	1.7	1.2	0.6	0.3	6.0	5.8	7.3	5.5	3.7	3.2	320	294	6.3	7.6	63.9
LSA-01	Soil and Vegetation Site	431198	7556074	210.4	171.3	22.1	8.6	3.5	0.6	53.1	11.3	53.1	10.4	14.4	5.0	956	677	8.2	9.1	64.9
LSA-02	Soil and Vegetation Site	430333	7562313	259.8	142.5	16.2	25.0	2.4	0.5	16.1	7.1	27.8	7.6	9.8	4.3	1268	589	7.2	8.2	64.7
LSA-03	Soil and Vegetation Site	436054	7559625	197.5	131.7	18.4	7.9	2.6	0.6	38.3	7.4	26.7	7.7	10.9	4.5	901	625	13.5	9.1	64.6
LSA-04	Soil and Vegetation Site	433617	7554104	272.8	178.8	30.9	17.4	5.2	0.9	65.3	17.1	78.0	14.7	21.3	6.6	1772	1271	9.6	10.2	65.2
LSA-09	Soil and Vegetation Site	439040	7515619	91.7	27.4	2.2	1.9	0.8	0.3	6.1	5.8	9.1	5.5	4.1	3.2	360	324	6.3	7.6	64.0
LSA-12	Soil and Vegetation Site	444545	7515463	91.7	37.4	2.6	2.3	1.0	0.3	6.4	5.8	10.4	5.6	4.3	3.2	399	325	6.3	7.6	64.0
LSA-13	Soil and Vegetation Site	434097	7546554	365.5	195.2	39.4	28.3	7.9	1.2	125.7	26.6	78.2	17.5	27.8	7.9	2804	1407	11.1	11.8	66.4
LSA-14	Soil and Vegetation Site	436417	7547136	333.2	215.6	42.7	23.9	8.7	1.2	34.2	10.0	59.7	11.9	25.3	7.4	2466	1445	8.4	9.0	65.7
LSA-16	Soil and Vegetation Site	434510	7551315	358.4	188.2	38.4	29.0	6.4	1.1	74.1	15.9	61.9	14.2	24.6	7.3	2104	1162	11.8	10.5	65.4
LSA-17	Soil and Vegetation Site	440860	7511478	79.1	25.1	2.1	1.8	0.8	0.3	6.1	5.8	8.7	5.5	4.0	3.2	356	315	6.3	7.6	64.0
LSA-18	Soil and Vegetation Site	446981	7511393	83.7	32.2	2.5	1.9	0.9	0.3	6.2	5.8	9.6	5.6	4.3	3.2	371	314	6.3	7.6	64.0
LSA-19	Soil and Vegetation Site	441491	7501963	52.5	14.9	1.7	1.3	0.6	0.3	5.9	5.8	7.3	5.5	3.7	3.2	316	297	6.3	7.6	63.9
LSA-20	Soil and Vegetation Site	456292	7556061	133.9	48.7	4.9	3.2	1.0	0.4	9.4	5.9	10.4	5.9	5.0	3.4	425	360	6.8	7.7	64.3
LSA-21	Soil and Vegetation Site	435441	7542089	500.2	253.1	46.8	60.6	15.3	1.8	191.1	38.4	165.5	21.7	52.3	10.4	5083	3045	15.0	15.0	71.8
REFA-01	Soil and Vegetation Site	449538	7554968	177.4	66.5	7.5	5.1	1.2	0.4	10.6	6.0	12.6	6.2	6.0	3.6	496	379	7.1	7.8	64.4
REFA-02	Soil and Vegetation Site	449451	7555774	176.8	62.9	7.3	5.0	1.2	0.4	11.0	6.0	12.3	6.2	5.9	3.6	490	381	7.2	7.8	64.4
REFA-03	Soil and Vegetation Site	450209	7555394	176.3	63.7	7.2	4.9	1.2	0.4	9.6	6.0	12.3	6.1	5.8	3.6	485	381	7.1	7.8	64.4
REFC-01	Soil and Vegetation Site	418953	7544573	90.4	26.6	3.2	2.2	0.7	0.3	6.7	5.9	8.4	5.7	4.3	3.3	408	317	6.4	7.6	64.1
REFC-02	Soil and Vegetation Site	419009	7545325	97.2	23.0	3.2	2.3	0.7	0.3	6.8	5.9	8.2	5.7	4.4	3.3	418	317	6.4	7.6	64.1
REFC-03	Soil and Vegetation Site	419750	7544664	98.2	32.3	3.4	2.3	0.7	0.3	6.9	5.9	9.0	5.7	4.5	3.3	418	323	6.4	7.6	64.1

Table A-2. Maximum Ambient Air Quality Predictions for Discrete Sensitive Receptors for Phase 2 and Existing Permitted Activities, during Phase 2 Operation

Receptor ID	Description	UTM Coordinate (Zone 13W) Easting (m)	Northing (m)	NO_2 (µg/m^3) 1 Hour Average	24 Hour Average	Annual Average	SO_2 (µg/m^3) 1 Hour Average	24 Hour Average	Annual Average	TSP (µg/m^3) 24 Hour Average	Annual Average	PM_{10} (µg/m^3) 24 Hour Average	Annual Average	PM_{25} (µg/m^3) 24 Hour Average (98th percentile)	Annual Average	CO (µg/m^3) 1 Hour Average	8 Hour Average	TSP Deposition Monthly Average (mg/dm^2/30days)	Annual Average (g/m^2/year)	Acid Deposition (eq/ha/year) Annual Average
Baseline/Background Value Included in Results:				1.1	1.1	1.1	0.3	0.3	0.3	5.8	5.8	5.4	5.4	3.1	3.1	261	261	6.3	7.6	63.7
CB1	Cabin	406275	7551932	18.9	7.6	1.6	1.0	0.4	0.3	6.1	5.8	6.3	5.5	3.4	3.2	284	271	6.4	7.6	64.0
CB2	Cabin	406503	7552314	20.0	8.1	1.6	1.0	0.4	0.3	6.1	5.8	6.4	5.5	3.5	3.2	285	271	6.4	7.6	64.0
C1	Outpost Camp	435299	7562924	178.2	56.6	6.0	8.0	1.2	0.4	14.2	6.3	16.9	6.4	6.2	3.6	358	320	6.6	7.8	64.1
C2	Seasonal Camp (spring/summer)	436579	7569440	115.0	32.6	3.0	3.0	0.8	0.3	6.9	5.9	11.6	5.7	4.5	3.3	322	298	6.4	7.7	64.0
F1	Fishing Area	408133	7551357	22.1	9.0	1.7	1.2	0.4	0.3	6.1	5.8	6.5	5.5	3.5	3.2	287	271	6.4	7.6	64.0
F2	Fishing Area	443743	7507934	277.6	176.6	15.6	21.8	3.9	0.6	52.8	13.9	64.8	11.1	18.4	5.2	1080	514	9.3	9.2	64.4
F3	Fishing Area	435464	7560803	177.1	65.8	7.5	7.3	1.3	0.4	17.8	6.7	18.7	6.8	7.2	3.7	379	332	7.9	8.1	64.2
H1	Hunting and Fishing	443076	7504032	343.6	209.1	28.0	28.5	10.5	1.0	173.5	21.4	142.5	17.6	38.5	8.6	1447	981	23.7	14.6	64.8
H2	Hunting and Fishing	435004	7575863	68.6	15.0	2.2	2.7	0.6	0.3	6.7	5.8	9.1	5.6	3.9	3.2	299	280	6.4	7.7	63.9
H3	Hunting and Fishing	419714	7570035	65.2	21.2	3.0	2.1	0.6	0.3	7.6	6.0	9.2	5.8	4.3	3.3	306	283	6.6	7.7	64.1
H4	Hunting and Fishing	416437	7560887	42.7	13.5	2.4	1.3	0.5	0.3	7.1	5.9	7.4	5.7	3.8	3.2	290	276	6.5	7.7	64.1
T1	Travel Route	425864	7570078	87.0	32.1	3.1	3.6	0.8	0.3	7.5	6.0	11.5	5.8	4.6	3.3	312	295	6.5	7.7	64.0
E3	Queen Maude Gulf Migratory Bird Sanctuary	478687	7503125	33.1	11.5	2.2	1.2	0.5	0.3	8.9	5.8	9.8	5.6	3.9	3.2	285	276	6.6	7.6	63.9
W1	Doris Camp (active)	432965	7559019	243.9	168.5	53.5	17.1	4.1	1.2	502.3	45.1	178.3	22.3	23.7	9.4	1037	783	52.7	24.1	67.3
W2	Boston Exploration Camp	441137	7505488	345.8	236.7	51.8	27.9	13.0	1.9	233.6	35.5	155.4	22.8	51.7	12.8	1619	1321	18.8	16.0	66.3
W3	Boston Operation Camp	441091	7504366	958.0	589.9	214.3	115.0	62.2	10.9	737.2	135.0	422.2	82.3	252.5	60.6	4442	3318	72.3	59.7	105.8
W4	Quarry D Camp	432902	7551719	351.2	236.1	42.6	29.4	12.3	1.4	507.4	100.2	225.0	40.6	47.3	11.7	1396	964	28.2	26.4	65.5
8	Soil and Vegetation Site	431889	7556490	213.5	172.6	19.6	10.5	3.9	0.6	104.6	21.5	102.1	15.5	16.5	5.6	740	490	10.6	11.0	64.7
11	Soil and Vegetation Site	447111	7506863	198.1	94.0	11.2	7.3	1.9	0.5	15.6	6.6	27.3	7.4	10.3	4.2	551	393	6.9	7.9	64.3
13	Soil and Vegetation Site	445764	7506296	219.4	129.1	14.3	10.5	3.3	0.5	22.5	7.4	41.1	8.4	14.0	4.7	688	538	7.5	8.2	64.4
14	Soil and Vegetation Site	437081	7547927	300.3	172.5	27.4	21.4	5.7	0.9	31.3	9.6	54.3	11.3	23.8	6.7	963	598	8.1	8.8	65.0
16	Soil and Vegetation Site	437606	7547392	288.4	164.8	26.5	19.5	5.4	0.9	43.0	9.3	47.8	10.9	21.7	6.4	911	644	9.1	8.8	65.0
18	Soil and Vegetation Site	437685	7546759	278.5	167.3	28.0	18.6	5.4	0.9	64.1	9.4	46.2	10.9	22.8	6.4	887	627	10.4	9.1	65.0
21	Soil and Vegetation Site	431742	7559766	190.3	129.9	19.1	14.9	2.3	0.6	50.5	10.9	42.9	10.1	11.3	4.9	466	385	8.9	9.5	64.8
22	Soil and Vegetation Site	431495	7559736	179.1	105.0	14.3	9.6	1.9	0.5	34.4	9.5	32.8	8.9	9.0	4.4	392	355	8.4	9.1	64.6
23	Soil and Vegetation Site	434866	7553440	215.3	148.6	22.0	9.7	3.7	0.7	46.2	13.1	50.1	11.9	14.8	5.5	582	453	8.3	9.4	64.6
29	Soil and Vegetation Site	436397	7557974	184.2	113.8	13.6	8.1	2.2	0.5	851.9	13.9	464.9	11.5	12.5	4.9	498	402	111.2	20.0	64.4
CFW1	Soil and Vegetation Site	441742	7510978	250.4	126.9	12.7	16.5	2.2	0.5	57.4	17.9	44.0	11.2	11.7	4.7	910	470	8.8	10.2	64.3
CFW2	Soil and Vegetation Site	445842	7503722	223.2	136.6	15.6	11.3	3.3	0.5	47.5	7.6	34.4	8.3	11.3	4.8	723	482	11.8	8.8	64.4
CFW3	Soil and Vegetation Site	434895	7542241	209.9	125.3	10.8	8.7	3.0	0.5	60.6	14.6	50.9	9.6	12.0	4.4	550	454	8.3	9.3	64.6
CFW4	Soil and Vegetation Site	436096	7549617	288.7	176.0	35.0	19.9	6.4	1.1	60.5	12.0	49.8	13.1	25.4	7.6	899	582	13.3	9.9	65.1
CFW5	Soil and Vegetation Site	435388	7559595	189.5	113.4	14.3	10.4	2.2	0.5	63.8	8.7	37.2	8.6	11.2	4.5	477	416	18.6	10.0	64.4
CFW6	Soil and Vegetation Site	435400	7559600	188.9	112.7	14.1	10.3	2.2	0.5	63.2	8.7	36.7	8.5	11.1	4.4	474	413	18.4	10.0	64.4
D06	Soil and Vegetation Site	433211	7547704	292.1	151.7	29.8	20.6	5.2	1.0	83.5	19.8	63.5	14.5	23.6	7.3	1045	667	10.2	10.7	65.3
D10	Soil and Vegetation Site	432471	7548235	280.9	149.4	25.1	18.5	5.9	0.8	63.1	11.0	65.5	10.9	17.7	6.1	925	652	8.4	9.0	64.9
D12	Soil and Vegetation Site	435015	7539768	198.5	109.7	7.9	7.8	2.6	0.4	36.6	11.0	30.0	8.0	8.4	3.9	570	454	7.7	8.6	64.4
D16	Soil and Vegetation Site	436028	7540759	217.6	149.0	9.5	11.2	4.4	0.4	27.4	8.1	46.2	7.6	9.3	4.0	700	630	7.0	8.1	64.5
D20	Soil and Vegetation Site	435631	7542445	222.3	157.0	11.7	11.8	5.2	0.5	29.4	9.4	51.0	8.4	11.7	4.4	721	643	7.2	8.3	64.7
D21	Soil and Vegetation Site	436121	7543060	235.4	187.1	14.2	12.1	6.1	0.6	28.8	7.7	53.8	8.4	14.2	4.7	708	550	7.0	8.1	64.8
D22	Soil and Vegetation Site	436364	7543053	232.6	183.9	14.6	12.0	5.7	0.6	29.2	7.6	50.1	8.3	14.6	4.7	711	564	7.0	8.1	64.8
D26	Soil and Vegetation Site	431884	7543400	199.2	126.7	9.7	6.8	2.6	0.4	15.8	6.5	20.5	6.8	8.9	3.9	478	405	6.7	7.8	64.4
D29	Soil and Vegetation Site	432032	7542768	197.5	112.9	9.5	7.0	2.3	0.4	13.0	6.5	22.8	6.8	8.5	3.9	507	401	6.7	7.8	64.4
D32	Soil and Vegetation Site	432709	7542115	190.3	125.9	8.9	5.6	2.7	0.4	11.8	6.4	23.9	6.7	8.0	3.9	448	391	6.6	7.8	64.4
D59	Soil and Vegetation Site	445959	7494897	178.4	72.4	5.6	4.3	1.4	0.4	10.0	6.0	15.5	6.0	6.9	3.6	421	360	6.5	7.7	64.1
D61	Soil and Vegetation Site	445242	7495180	178.9	73.9	5.7	4.3	1.4	0.4	10.7	6.0	15.5	6.0	7.0	3.6	426	358	6.5	7.7	64.1
D62	Soil and Vegetation Site	445021	7500407	209.9	153.3	12.5	9.4	3.0	0.5	18.3	6.7	32.0	7.3	11.7	4.4	625	534	6.8	7.9	64.3
D63	Soil and Vegetation Site	444873	7500331	212.8	152.5	12.3	10.1	3.0	0.5	18.5	6.7	33.1	7.3	12.2	4.4	663	564	6.8	7.9	64.3
D65	Soil and Vegetation Site	443575	7500774	242.6	135.7	13.0	14.1	4.5	0.5	23.2	6.9	38.4	7.6	14.6	4.6	838	718	7.0	8.0	64.3
D70	Soil and Vegetation Site	441289	7500063	272.1	99.3	8.7	20.0	2.6	0.5	17.1	6.3	27.4	6.9	11.3	4.1	1028	561	6.7	7.8	64.4
D71	Soil and Vegetation Site	443663	7505185	311.0	196.5	21.4	24.7	7.2	0.8	173.7	21.6	138.8	16.5	33.6	7.3	1325	811	18.2	12.3	64.6
D72	Soil and Vegetation Site	443686	7505467	292.0	191.9	20.5	22.9	6.3	0.7	118.5	20.1	120.8	15.7	30.8	7.0	1160	749	15.6	11.7	64.6
D75	Soil and Vegetation Site	444448	7506676	271.2	162.9	16.1	20.0	4.0	0.6	29.7	8.9	59.3	10.0	18.1	5.3	1051	536	8.0	8.5	64.5
D76	Soil and Vegetation Site	443985	7507620	258.8	176.8	15.7	19.0	4.1	0.6	60.9	13.3	62.2	11.0	17.9	5.3	951	523	8.5	9.2	64.4
D82	Soil and Vegetation Site	442400	7511352	243.5	119.7	11.5	17.1	2.1	0.5	40.7	12.3	39.3	9.5	12.7	4.5	871	528	8.1	8.9	64.3
D88	Soil and Vegetation Site	440559	7512115	216.8	88.1	10.7	12.2	1.6	0.5	58.0	17.2	32.4	10.6	10.6	4.5	683	402	9.1	9.9	64.3

Table A-2. Maximum Ambient Air Quality Predictions for Discrete Sensitive Receptors for Phase 2 and Existing Permitted Activities, during Phase 2 Operation

Receptor ID	Description	UTM Coordinate (Zone 13W) Easting (m)	Northing (m)	NO_2 (µg/m^3) 1 Hour Average	24 Hour Average	Annual Average	SO_2 (µg/m^3) 1 Hour Average	24 Hour Average	Annual Average	TSP (µg/m^3) 24 Hour Average	Annual Average	PM_{10} (µg/m^3) 24 Hour Average	Annual Average	PM_{25} (µg/m^3) 24 Hour Average (98th percentile)	Annual Average	CO (µg/m^3) 1 Hour Average	8 Hour Average	TSP Deposition Monthly Average (mg/dm^2/30days)	Annual Average (g/m^2/year)	Acid Deposition (eq/ha/year) Annual Average
Baseline/Background Value Included in Results:				1.1	1.1	1.1	0.3	0.3	0.3	5.8	5.8	5.4	5.4	3.1	3.1	261	261	6.3	7.6	63.7
D99	Soil and Vegetation Site	438580	7517814	174.1	35.0	5.5	3.8	0.8	0.4	28.1	10.1	19.5	7.5	6.4	3.7	392	310	7.4	8.5	64.1
D119	Soil and Vegetation Site	444785	7510544	217.6	95.1	10.2	11.9	1.7	0.4	20.6	8.0	27.3	8.0	10.5	4.2	687	474	7.1	8.1	64.3
D122	Soil and Vegetation Site	446280	7510305	185.2	67.7	8.8	6.1	1.3	0.4	13.0	6.5	18.1	7.1	9.1	4.0	467	404	6.7	7.8	64.3
D132	Soil and Vegetation Site	444763	7497620	192.1	103.1	8.2	6.5	2.1	0.4	13.0	6.2	20.9	6.4	8.9	3.8	507	409	6.6	7.7	64.1
LSA-01	Soil and Vegetation Site	431198	7556074	190.6	144.5	15.2	7.3	2.6	0.5	61.1	12.2	55.9	10.7	12.4	4.7	481	396	8.7	9.3	64.5
LSA-02	Soil and Vegetation Site	430333	7562313	198.7	98.5	9.5	18.0	1.8	0.4	16.8	7.1	27.1	7.4	8.1	4.0	418	362	7.2	8.2	64.3
LSA-03	Soil and Vegetation Site	436054	7559625	177.9	88.7	10.0	6.1	1.7	0.4	48.8	7.4	29.6	7.4	8.0	4.0	411	357	14.1	9.1	64.3
LSA-04	Soil and Vegetation Site	433617	7554104	223.6	161.7	23.2	10.7	3.9	0.7	75.9	18.8	83.8	15.2	17.3	6.0	670	505	10.0	10.5	64.7
LSA-09	Soil and Vegetation Site	439040	7515619	178.3	45.1	6.6	4.6	1.0	0.4	16.5	8.1	16.9	7.2	6.9	3.8	420	328	6.8	8.1	64.2
LSA-12	Soil and Vegetation Site	444545	7515463	182.9	48.8	6.2	5.5	1.1	0.4	9.2	6.2	14.1	6.5	6.9	3.7	452	355	6.5	7.7	64.1
LSA-13	Soil and Vegetation Site	434097	7546554	447.9	215.4	35.9	42.5	12.0	1.3	94.3	16.8	79.2	15.0	41.4	8.9	1640	889	11.7	10.4	66.6
LSA-14	Soil and Vegetation Site	436417	7547136	393.3	217.9	38.7	35.1	10.2	1.4	161.9	13.9	95.2	14.6	37.6	9.2	1401	870	11.6	10.2	65.7
LSA-16	Soil and Vegetation Site	434510	7551315	284.7	180.0	30.0	19.6	4.8	0.9	83.7	17.4	63.8	14.6	22.0	6.9	944	598	11.8	10.6	64.9
LSA-17	Soil and Vegetation Site	440860	7511478	219.5	101.6	11.8	12.3	1.8	0.5	47.2	14.3	34.3	10.0	11.5	4.5	699	454	9.0	9.3	64.3
LSA-18	Soil and Vegetation Site	446981	7511393	182.3	68.3	8.1	5.2	1.2	0.4	11.2	6.3	16.5	6.8	8.2	3.9	446	381	6.6	7.8	64.2
LSA-19	Soil and Vegetation Site	441491	7501963	383.4	140.9	13.9	36.6	4.5	0.6	32.0	7.5	44.0	8.6	22.3	5.2	1712	788	7.3	8.2	64.6
LSA-20	Soil and Vegetation Site	456292	7556061	85.5	27.6	3.4	2.6	0.8	0.3	24.1	6.0	30.2	5.9	4.5	3.4	313	295	8.9	7.9	64.1
LSA-21	Soil and Vegetation Site	435441	7542089	213.8	145.4	10.9	10.3	4.3	0.5	36.8	12.7	47.2	9.1	11.5	4.4	660	571	7.9	8.9	64.6
REFA-01	Soil and Vegetation Site	449538	7554968	133.6	38.3	4.8	3.9	0.9	0.4	32.7	6.2	26.8	6.3	5.5	3.5	338	303	9.8	8.1	64.2
REFA-02	Soil and Vegetation Site	449451	7555774	130.4	36.6	4.6	3.9	0.9	0.4	29.7	6.2	31.7	6.3	5.5	3.5	336	301	10.5	8.2	64.1
REFA-03	Soil and Vegetation Site	450209	7555394	128.3	36.6	4.6	3.8	0.9	0.4	27.2	6.2	24.8	6.2	5.4	3.5	335	304	10.0	8.1	64.2
REFC-01	Soil and Vegetation Site	418953	7544573	79.2	22.8	2.8	2.0	0.6	0.3	7.3	5.9	8.4	5.7	4.3	3.3	335	288	6.4	7.7	64.1
REFC-02	Soil and Vegetation Site	419009	7545325	81.4	22.6	2.9	2.1	0.6	0.3	7.8	5.9	8.6	5.7	4.3	3.3	338	290	6.4	7.7	64.1
REFC-03	Soil and Vegetation Site	419750	7544664	86.2	26.1	3.0	2.2	0.7	0.3	7.2	5.9	9.0	5.7	4.4	3.3	340	291	6.4	7.7	64.1

Appendix B

Model Parameters

Table B-1. Example of CALMET Model Parameters

Parameter	Description	Value
GEODAT	Input file of geophysical data (GEO.DAT)	GEO_summer.DAT
SRFDAT	Input file of hourly surface meteorological data (SURF.DAT)	comb.csv.surf.DAT
METLST	Output file name of CALMET list file (CALMET.LST)	CALMET.LST
METDAT	Output file name of generated gridded met files (CALMET.DAT)	CALMET.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NUSTA	Number of upper air stations	0
NOWSTA	Number of overwater stations	0
NM3D	Number of prognostic meteorological data files (3D.DAT)	6
NIGF	Number of IGF-CALMET.DAT files used as initial guess	0
IBYR	Starting year	2012
IBMO	Starting month	5
IBDY	Starting day	1
IBHR	Starting hour	0
IBSEC	Starting second	0
IEYR	Ending year	2012
IEMO	Ending month	10
IEDY	Ending day	1
IEHR	Ending hour	0
IESEC	Ending second	0
ABTZ	Base time zone	UTC-0700
NSECDT	Length of modeling time-step (seconds)	3600
IRTYPE	Output run type (0 = wind fields only, 1 = CALPUFF/CALGRID)	1
LCALGRD	Compute CALGRID data fields (T = true, F = false)	F
ITEST	Flag to stop run after setup phase (1 = stop, 2 = run)	2
MREG	Regulatory checks (0 = no checks, 1 = US EPA LRT checks)	0
PMAP	Map projection system	UTM
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0
IUTMZN	UTM zone (1 to 60)	13
UTMHEM	Hemisphere of UTM projection (N = northern, S = southern)	N
RLAT0	Latitude of projection origin (decimal degrees)	0.00N
RLON0	Longitude of projection origin (decimal degrees)	0.00E
XLAT1	1st standard parallel latitude (decimal degrees)	30N
XLAT2	2nd standard parallel latitude (decimal degrees)	60N
DATUM	Datum-Region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	100
NY	Meteorological grid - number of Y grid cells	100
DGRIDKM	Meteorological grid spacing (km)	1
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	386.5470
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	7483.0840
NZ	Meteorological grid - number of vertical layers	10
ZFACE	Meteorological grid - vertical cell face heights (m)	0.00, 20.00, 40.00, 80.00, 160.00, 320.00, 640.00, 1000.00, 1500.00, 2000.00, 3000.00
LSAVE	Save met fields in unformatted output file (T = true, F = false)	T
IFORMO	Type of output file (1 = CALPUFF/CALGRID, 2 = MESOPUFF II)	1
LPRINT	Print met fields (F = false, T = true)	F

Note: The model parameters in this table were extracted from the snow-free period CALMET.inp file, one of three CALMET.inp files.

Table B-1. Example of CALMET Model Parameters

Parameter	Description	Value
IPRINF	Print interval for output wind fields (hours)	1
STABILITY	Print gridded PGT stability classes? (0 = no, 1 = yes)	0
USTAR	Print gridded friction velocities? (0 = no, 1 = yes)	0
MONIN	Print gridded Monin-Obukhov lengths? (0 = no, 1 = yes)	0
MIXHT	Print gridded mixing heights? (0 = no, 1 = yes)	0
WSTAR	Print gridded convective velocity scales? (0 = no, 1 = yes)	0
PRECIP	Print gridded hourly precipitation rates? (0 = no, 1 = yes)	0
SENSHEAT	Print gridded sensible heat fluxes? (0 = no, 1 = yes)	0
CONVZI	Print gridded convective mixing heights? (0 = no, 1 = yes)	0
LDB	Test/debug option: print input met data and internal variables (F = false, T = true)	F
NN1	Test/debug option: first time step to print	1
NN2	Test/debug option: last time step to print	1
LDBCST	Test/debug option: print distance to land internal variables (F = false, T = true)	F
IOUTD	Test/debug option: print control variables for writing winds? (0 = no, 1 = yes)	0
NZPRN2	Test/debug option: number of levels to print starting at the surface	1
IPR0	Test/debug option: print interpolated winds? (0 = no, 1 = yes)	0
IPR1	Test/debug option: print terrain adjusted surface wind? (0 = no, 1 = yes)	0
IPR2	Test/debug option: print smoothed wind and initial divergence fields? (0 = no, 1 = yes)	0
IPR3	Test/debug option: print final wind speed and direction? (0 = no, 1 = yes)	0
IPR4	Test/debug option: print final divergence fields? (0 = no, 1 = yes)	0
IPR5	Test/debug option: print winds after kinematic effects? (0 = no, 1 = yes)	0
IPR6	Test/debug option: print winds after Froude number adjustment? (0 = no, 1 = yes)	0
IPR7	Test/debug option: print winds after slope flow? (0 = no, 1 = yes)	0
IPR8	Test/debug option: print final winds? (0 = no, 1 = yes)	0
NOOBS	Observation mode (0 = stations only, 1 = surface/overwater stations with prognostic upper air, 2 = prognostic data only)	1
NSSTA	Number of surface stations	2
NPSTA	Number of precipitation stations	-1
ICLDOUT	Output the CLOUD.DAT file? (0 = no, 1 = yes)	0
MCLOUD	Method to compute cloud fields (1 = from surface obs, 2 = from CLOUD.DAT, 3 = from prognostic (Teixera), 4 = from prognostic (MM5toGrads)	3
IFORMS	Surface met data file format (1 = unformatted, 2 = formatted)	2
IFORMP	Precipitation data file format (1 = unformatted, 2 = formatted)	2
IFORMC	Cloud data file format (1 = unformatted, 2 = formatted)	2
IWFCOD	Wind field model option (1 = objective analysis, 2 = diagnostic)	1
IFRADJ	Adjust winds using Froude number effects? (0 = no, 1 = yes)	1
IKINE	Adjust winds using kinematic effects? (0 = no, 1 = yes)	0
IOBR	Adjust winds using O'Brien velocity procedure? (0 = no, 1 = yes)	0
ISLOPE	Compute slope flow effects? (0 = no, 1 = yes)	1

Note: The model parameters in this table were extracted from the snow-free period CALMET.inp file, one of three CALMET.inp files.

Table B-1. Example of CALMET Model Parameters

Parameter	Description	Value
IEXTRP	Extrapolation of surface winds to upper layers method (1 = none, 2 = power law, 3 = user input, 4 = similarity theory, - = same except layer 1 data at upper air stations are ignored)	-4
ICALM	Extrapolate surface winds even if calm? (0 = no, 1 = yes)	1
BIAS	Weighting factors for surface and upper air stations (NZ values)	-1,9*0
RMIN2	Minimum upper air station radius of influence for surface extrapolation exclusion (km)	-1
IPROG	Use prognostic winds as input to diagnostic wind model (0 = no, 13 = use winds from 3D.DAT as Step 1 field, 14 = use winds from 3D.DAT as initial guess field, 15 = use winds from 3D.DAT file as observations)	14
ISTEPPGS	Prognostic data time step (seconds)	3600
IGFMET	Use coarse CALMET fields as initial guess? (0 = no, 1 = yes)	0
LVARY	Use varying radius of influence (F = false, T = true)	T
RMAX1	Maximum radius of influence in the surface layer (km)	4
RMAX2	Maximum radius of influence over land aloft (km)	4
RMAX3	Maximum radius of influence over water (km)	4
RMIN	Minimum radius of influence used in wind field interpolation (km)	0.1
TERRAD	Radius of influence of terrain features (km)	4
R1	Relative weight at surface of step 1 fields and observations (km)	1.5
R2	Relative weight aloft of step 1 field and observations (km)	1.5
RPROG	Weighting factors of prognostic wind field data (km)	0
DIVLIM	Maximum acceptable divergence	5E-006
NITER	Maximum number of iterations in the divergence minimization procedure	50
NSMTH	Number of passes in the smoothing procedure (NZ values)	2,9*4
NINTR2	Maximum number of stations used in each layer for interpolation (NZ values)	10*99
CRITFN	Critical Froude number	1
ALPHA	Empirical factor triggering kinematic effects	0.1
FEXTR2	Multiplicative scaling factor for extrapolation of surface observations to upper layers (NZ values)	10*0
NBAR	Number of barriers to interpolation of the wind fields	0
KBAR	Barrier - level up to which barriers apply (1 to NZ)	10
IDIOPT1	Surface temperature (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	1
IDIOPT2	Temperature lapse rate used in the computation of terrain-induced circulations (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
IUPT	Upper air station to use for the domain-scale lapse rate (between 1 and NUSTA)	-1
ZUPT	Depth through which the domain-scale lapse rate is computed (m)	200
IDIOPT3	Initial guess field winds (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
IUPWND	Upper air station to use for domain-scale winds	-1
ZUPWND	Bottom and top of layer through which the domain-scale winds are computed (m)	1.0, 1000.00
IDIOPT4	Read observed surface wind components (0 = from SURF.DAT, 1 = from DIAG.DAT)	0

Note: The model parameters in this table were extracted from the snow-free period CALMET.inp file, one of three CALMET.inp files.

Table B-1. Example of CALMET Model Parameters

Parameter	Description	Value
IDIOPT5	Read observed upper wind components (0 = from UPn.DAT, 1 = from DIAG.DAT)	0
LLBREZE	Use Lake Breeze module (T = true, F = false)	F
NBOX	Lake Breeze - number of regions	0
CONSTB	Mixing height constant: neutral, mechanical equation	1.41
CONSTE	Mixing height constant: convective equation	0.15
CONSTN	Mixing height constant: stable equation	2400
CONSTW	Mixing height constant: overwater equation	0.16
FCORIOL	Absolute value of Coriolis parameter (1/s)	0.0001
IAVEZI	Spatial mixing height averaging? (0 = no, 1 = yes)	1
MNMDAV	Maximum search radius in averaging process (grid cells)	10
HAFANG	Half-angle of upwind looking cone for averaging (degrees)	30
ILEVZI	Layer of winds used in upwind averaging (between 1 and NZ)	1
IMIXH	Convective mixing height method (1 = Maul-Carson, 2 = Batchvarova-Gryning, - for land cells only, + for land and water cells)	1
THRESHL	Overland threshold boundary flux (W/m**3)	0
THRESHW	Overwater threshold boundary flux (W/m**3)	0.05
ITWPROG	Overwater lapse rate and deltaT options (0 = from SEA.DAT, 1 = use prognostic lapse rates and SEA.DAT deltaT, 2 = from prognostic)	0
ILUOC3D	Land use category in 3D.DAT	16
DPTMIN	Minimum potential temperature lapse rate (K/m)	0.001
DZZI	Depth of computing capping lapse rate (m)	200
ZIMIN	Minimum overland mixing height (m)	50
ZIMAX	Maximum overland mixing height (m)	2500
ZIMINW	Minimum overwater mixing height (m)	50
ZIMAXW	Maximum overwater mixing height (m)	2500
ICOARE	Overwater surface fluxes method	10
DSHELF	Coastal/shallow water length scale (km)	0
IWARM	COARE warm layer computation (0 = off, 1 = on)	0
ICOOL	COARE cool skin layer computation (0 = off, 1 = on)	0
IRHPROG	Relative humidity read option (0 = from SURF.DAT, 1 = from 3D.DAT)	0
ITPROG	3D temperature read option (0 = stations, 1 = surface from station and upper air from prognostic, 2 = prognostic)	1
IRAD	Temperature interpolation type (1 = 1/R, 2 = 1/R**2)	1
TRADKM	Temperature interpolation radius of influence (km)	20
NUMTS	Maximum number of stations to include in temperature interpolation	5
IAVET	Conduct spatial averaging of temperatures? (0 = no, 1 = yes)	1
TGDEFB	Default overwater mixed layer lapse rate (K/m)	-0.0098
TGDEFA	Default overwater capping lapse rate (K/m)	-0.0045
JWAT1	Beginning land use category for temperature interpolation over water	99
JWAT2	Ending land use category for temperature interpolation over water	99
NFLAGP	Precipitation interpolation method (1 = 1/R, 2 = 1/R**2, 3 = EXP/R**2)	2
SIGMAP	Precipitation interpolation radius of influence (km)	5
CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01

Note: The model parameters in this table were extracted from the snow-free period CALMET.inp file, one of three CALMET.inp files.

Table B-2. Example of CALPUFF Model Parameters for the Northern Domain

Parameter	Description	Value
METRUN	Run all periods in met data file? (0 = no, 1 = yes)	0
IBYR	Starting year	2012
IBMO	Starting month	1
IBDY	Starting day	1
IBHR	Starting hour	1
IBMIN	Starting minute	0
IBSEC	Starting second	0
IEYR	Ending year	2012
IEMO	Ending month	12
IEDY	Ending day	31
IEHR	Ending hour	23
IEMIN	Ending minute	0
IESEC	Ending second	0
ABTZ	Base time zone	UTC-0700
NSECDT	Length of modeling time-step (seconds)	3600
NSPEC	Number of chemical species modeled	9
NSE	Number of chemical species to be emitted	6
ITEST	Stop run after SETUP phase (1 = stop, 2 = run)	2
MRESTART	Control option to read and/or write model restart data	0
NRESPD	Number of periods in restart output cycle	0
METFM	Meteorological data format (1 = CALMET, 2 = ISC, 3 = AUSPLUME, 4 = CTDM, 5 = AERMET)	1
MPRFFM	Meteorological profile data format (1 = CTDM, 2 = AERMET)	1
AVET	Averaging time (minutes)	60
PGTIME	PG Averaging time (minutes)	60
IOUTU	Output units for binary output files (1 = mass, 2 = odour, 3 = radiation)	1
MGAUSS	Near field vertical distribution (0 = uniform, 1 = Gaussian)	1
MCTADJ	Terrain adjustment method (0 = none, 1 = ISC-type, 2 = CALPUFF-type, 3 = partial plume path)	3
MCTSG	Model subgrid-scale complex terrain? (0 = no, 1 = yes)	0
MSLUG	Near-field puffs modeled as elongated slugs? (0 = no, 1 = yes)	0
MTRANS	Model transitional plume rise? (0 = no, 1 = yes)	1
MTIP	Apply stack tip downwash to point sources? (0 = no, 1 = yes)	1
MRISE	Plume rise module for point sources (1 = Briggs, 2 = numerical)	1
MTIP_FL	Apply stack tip downwash to flare sources? (0 = no, 1 = yes)	0
MRISE_FL	Plume rise module for flare sources (1 = Briggs, 2 = numerical)	0
MBDW	Building downwash method (1 = ISC, 2 = PRIME)	1
MSHEAR	Treat vertical wind shear? (0 = no, 1 = yes)	0
MSPLIT	Puff splitting allowed? (0 = no, 1 = yes)	0
MCHEM	Chemical transformation method (0 = not modeled, 1 = MESOPUFF II, 2 = User-specified, 3 = RIVAD/ARM3, 4 = MESOPUFF II for OH, 5 = half-life, 6 = RIVAD w/ISORROPIA, 7 = RIVAD w/ISORROPIA CalTech SOA)	1
MAQCHEM	Model aqueous phase transformation? (0 = no, 1 = yes)	0
MLWC	Liquid water content flag	1
MWET	Model wet removal? (0 = no, 1 = yes)	1
MDRY	Model dry deposition? (0 = no, 1 = yes)	1
MTILT	Model gravitational settling (plume tilt)? (0 = no, 1 = yes)	0

Note: The model parameters in this table were extracted from one of the Northern Domain CALPUFF.inp files. Many CALPUFF.inp files were used for the Northern and Southern domain.

Table B-2. Example of CALPUFF Model Parameters for the Northern Domain

Parameter	Description	Value
MDISP	Dispersion coefficient calculation method (1= PROFILE.DAT, 2 = Internally, 3 = PG/MP, 4 = MESOPUFF II, 5 = CTDM)	2
MTURBVW	Turbulence characterization method (only if MDISP = 1 or 5)	1
MDISP2	Missing dispersion coefficients method (only if MDISP = 1 or 5)	3
MTAULY	Sigma-y Lagrangian timescale method	0
MTAUADV	Advective-decay timescale for turbulence (seconds)	0
MCTURB	Turbulence method (1 = CALPUFF, 2 = AERMOD)	1
MROUGH	PG sigma-y and sigma-z surface roughness adjustment? (0 = no, 1 = yes)	0
MPARTL	Model partial plume penetration for point sources? (0 = no, 1 = yes)	1
MPARTLBA	Model partial plume penetration for buoyant area sources? (0 = no, 1 = yes)	1
MTINV	Strength of temperature inversion provided in PROFILE.DAT? (0 = no - compute from default gradients, 1 = yes)	0
MPDF	PDF used for dispersion under convective conditions? (0 = no, 1 = yes)	1
MSGTIBL	Sub-grid TIBL module for shoreline? (0 = no, 1 = yes)	0
MBCON	Boundary conditions modeled? (0 = no, 1 = use BCON.DAT, 2 = use CONC.DAT)	0
MSOURCE	Save individual source contributions? (0 = no, 1 = yes)	0
MFOG	Enable FOG model output? (0 = no, 1 = yes - PLUME mode, 2 = yes - RECEPTOR mode)	0
MREG	Regulatory checks (0 = no checks, 1 = USE PA LRT checks)	0
CSPEC	Species included in model run	SO2
CSPEC	Species included in model run	SO4
CSPEC	Species included in model run	NOX
CSPEC	Species included in model run	HNO3
CSPEC	Species included in model run	NO3
CSPEC	Species included in model run	CO
CSPEC	Species included in model run	TSP
CSPEC	Species included in model run	PM10
CSPEC	Species included in model run	PM25
PMAP	Map projection system	UTM
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0
IUTMZN	UTM zone (1 to 60)	13
UTMHEM	Hemisphere (N = northern, S = southern)	N
RLAT0	Latitude of projection origin (decimal degrees)	0.00N
RLON0	Longitude of projection origin (decimal degrees)	0.00E
XLAT1	1st standard parallel latitude (decimal degrees)	30N
XLAT2	2nd standard parallel latitude (decimal degrees)	60N
DATUM	Datum-region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	100
NY	Meteorological grid - number of Y grid cells	100
NZ	Meteorological grid - number of vertical layers	10
DGRIDKM	Meteorological grid spacing (km)	1
ZFACE	Meteorological grid - vertical cell face heights (m)	0.0, 20.0, 40.0, 80.0, 160.0, 320.0, 640.0, 1000.0, 1500.0, 2000.0, 3000.0
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	386.5470

Note: The model parameters in this table were extracted from one of the Northern Domain CALPUFF.inp files. Many CALPUFF.inp files were used for the Northern and Southern domain.

Table B-2. Example of CALPUFF Model Parameters for the Northern Domain

Parameter	Description	Value
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	7483.0840
IBCOMP	Computational grid - X index of lower left corner	27
JBCOMP	Computational grid - Y index of lower left corner	51
IECOMP	Computational grid - X index of upper right corner	68
JECOMP	Computational grid - Y index of upper right corner	92
LSAMP	Use sampling grid (gridded receptors) (T = true, F = false)	F
IBSAMP	Sampling grid - X index of lower left corner	1
JBSAMP	Sampling grid - Y index of lower left corner	1
IESAMP	Sampling grid - X index of upper right corner	2
JESAMP	Sampling grid - Y index of upper right corner	2
MESHDN	Sampling grid - nesting factor	1
ICON	Output concentrations to CONC.DAT? (0 = no, 1 = yes)	1
IDRY	Output dry deposition fluxes to DFLX.DAT? (0 = no, 1 = yes)	1
IWET	Output wet deposition fluxes to WFLX.DAT? (0 = no, 1 = yes)	1
IT2D	Output 2D temperature data? (0 = no, 1 = yes)	0
IRHO	Output 2D density data? (0 = no, 1 = yes)	0
IVIS	Output relative humidity data? (0 = no, 1 = yes)	0
LCOMPRS	Use data compression in output file (T = true, F = false)	T
IQAPLOT	Create QA output files suitable for plotting? (0 = no, 1 = yes)	0
IPFTRAK	Output puff tracking data? (0 = no, 1 = yes use timestep, 2 = yes use sampling step)	0
IMFLX	Output mass flux across specific boundaries? (0 = no, 1 = yes)	0
IMBAL	Output mass balance for each species? (0 = no, 1 = yes)	0
INRISE	Output plume rise data? (0 = no, 1 = yes)	0
ICPRT	Print concentrations? (0 = no, 1 = yes)	0
IDPRT	Print dry deposition fluxes? (0 = no, 1 = yes)	0
IWPRT	Print wet deposition fluxes? (0 = no, 1 = yes)	0
ICFRQ	Concentration print interval (timesteps)	1
IDFRQ	Dry deposition flux print interval (timesteps)	1
IWFRQ	Wet deposition flux print interval (timesteps)	1
IPRTU	Units for line printer output (e.g., 3 = ug/m**3 - ug/m**2/s, 5 = odor units)	3
IMESG	Message tracking run progress on screen (0 = no, 1 and 2 = yes)	2
LDEBUG	Enable debug output? (0 = no, 1 = yes)	F
IPFDEB	First puff to track in debug output	1
NPFDEB	Number of puffs to track in debug output	1
NN1	Starting meteorological period in debug output	1
NN2	Ending meteorological period in debug output	10
NHILL	Number of terrain features	0
NCTREC	Number of special complex terrain receptors	0
MHILL	Terrain and CTSG receptor data format (1= CTDM, 2 = OPTHILL)	2
XHILL2M	Horizontal dimension conversion factor to meters	1.0
ZHILL2M	Vertical dimension conversion factor to meters	1.0
XCTDMKM	X origin of CTDM system relative to CALPUFF system (km)	0.0
YCTDMKM	Y origin of CTDM system relative to CALPUFF system (km)	0.0
RCUTR	Reference cuticle resistance (s/cm)	30
RGR	Reference ground resistance (s/cm)	10
REACTR	Reference pollutant reactivity	8

Note: The model parameters in this table were extracted from one of the Northern Domain CALPUFF.inp files. Many CALPUFF.inp files were used for the Northern and Southern domain.

Table B-2. Example of CALPUFF Model Parameters for the Northern Domain

Parameter	Description	Value
NINT	Number of particle size intervals for effective particle deposition velocity	5
IVEG	Vegetation state in unirrigated areas (1 = active and unstressed, 2 = active and stressed, 3 = inactive)	1
MOZ	Ozone background input option (0 = monthly, 1 = hourly from OZONE.DAT)	0
BCKO3	Monthly ozone concentrations (ppb)	40, 40, 40, 40, 40, 40, 40, 40, 40, 40, 40, 40
MNH3	Ammonia background input option (0 = monthly, 1 = from NH3Z.DAT)	0
MAVGNH3	Ammonia vertical averaging option (0 = no average, 1 = average over vertical extent of puff)	1
BCKNH3	Monthly ammonia concentrations (ppb)	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2
MH2O2	H2O2 background input option (0 = monthly, 1 = hourly from H2O2.DAT)	1
BCKH2O2	Monthly H2O2 concentrations (ppb)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
RH_ISRP	Minimum relative humidity for ISORROPIA	50.0
SO4_ISRP	Minimum SO4 for ISORROPIA	.4
BCKPMF	SOA background fine particulate (ug/m**3)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
OFRAC	SOA organic fine particulate fraction	0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15
VCNX	SOA VOC/NOX ratio	50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00
NDECAY	Half-life decay blocks	0
SYTDEP	Horizontal puff size for time-dependent sigma equations (m)	550
MHFTSZ	Use Heffter equation for sigma-z? (0 = no, 1 = yes)	0
JSUP	PG stability class above mixed layer	5
CONK1	Vertical dispersion constant - stable conditions	0.01
CONK2	Vertical dispersion constant - neutral/unstable conditions	0.1
TBD	Downwash scheme transition point option (<0 = Huber-Snyder, 1.5 = Schulman-Scire, 0.5 = ISC)	0.5
IURB1	Beginning land use category for which urban dispersion is assumed	10
IURB2	Ending land use category for which urban dispersion is assumed	19
ILANDUIN	Land use category for modeling domain	20
Z0IN	Roughness length for modeling domain (m)	.25
XLAIIN	Leaf area index for modeling domain	3.0
ELEVIN	Elevation above sea level (m)	.0
XLATIN	Meteorological station latitude (deg)	-999.0
XLONIN	Meteorological station longitude (deg)	-999.0
ANEMHT	Anemometer height (m)	10.0

Note: The model parameters in this table were extracted from one of the Northern Domain CALPUFF.inp files. Many CALPUFF.inp files were used for the Northern and Southern domain.

Table B-2. Example of CALPUFF Model Parameters for the Northern Domain

Parameter	Description	Value
ISIGMAV	Lateral turbulence format (0 = read sigma-theta, 1 = read sigma-v)	1
IMIXCTDM	Mixing heights read option (0 = predicted, 1 = observed)	0
XMXLEN	Slug length (met grid units)	1
XSAMLEN	Maximum travel distance of a puff/slug (met grid units)	1
MXNEW	Maximum number of slugs/puffs release from one source during one time step	10
MXSAM	Maximum number of sampling steps for one puff/slug during one time step	10
NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2
SYMIN	Minimum sigma-y for a new puff/slug (m)	1
SZMIN	Minimum sigma-z for a new puff/slug (m)	1
SZCAP_M	Maximum sigma-z allowed to avoid numerical problem in calculating virtual time or distance (m)	5000000
SVMIN	Minimum turbulence velocities sigma-v (m/s)	0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37, 0.37
SWMIN	Minimum turbulence velocities sigma-w (m/s)	0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06, 0.03, 0.016
CDIV	Divergence criterion for dw/dz across puff (1/s)	0, 0
NLUTIBL	TIBL module search radius (met grid cells)	4
WSCALM	Minimum wind speed allowed for non-calm conditions (m/s)	0.5
XMAXZI	Maximum mixing height (m)	3000
XMINZI	Minimum mixing height (m)	50
TKCAT	Emissions scale-factors temperature categories (K)	265., 270., 275., 280., 285., 290., 295., 300., 305., 310., 315.
PLX0	Wind speed profile exponent for stability classes 1 to 6	0.07, 0.07, 0.1, 0.15, 0.35, 0.55
PTG0	Potential temperature gradient for stable classes E and F (deg K/m)	0.02, 0.035
PPC	Plume path coefficient for stability classes 1 to 6	0.5, 0.5, 0.5, 0.5, 0.35, 0.35
SL2PF	Slug-to-puff transition criterion factor (sigma-y/slug length)	10
FCLIP	Hard-clipping factor for slugs (0.0 = no extrapolation)	0
NSPLIT	Number of puffs created from vertical splitting	3
IRESPLIT	Hour for puff re-split	0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0, 1,0,0,0,0,0,0
ZISPLIT	Minimum mixing height for splitting (m)	100
ROLDMAX	Mixing height ratio for splitting	0.25
NSPLITH	Number of puffs created from horizontal splitting	5
SYSPLITH	Minimum sigma-y (met grid cells)	1
SHSPLITH	Minimum puff elongation rate (SYSPLITH/hr)	2
CNSPLITH	Minimum concentration (g/m**3)	1E-007
EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	0.0001
EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-006
DSRISE	Trajectory step-length for numerical rise integration (m)	1.0
HTMINBC	Minimum boundary condition puff height (m)	500
RSAMPBC	Receptor search radius for boundary condition puffs (km)	10
MDEPBC	Near-surface depletion adjustment to concentration (0 = no, 1 = yes)	1

Note: The model parameters in this table were extracted from one of the Northern Domain CALPUFF.inp files. Many CALPUFF.inp files were used for the Northern and Southern domain.

Appendix C

Air Emissions Inventory

Table C-1. Genset Stack, Characteristics and Air Emissions

								UTM Coordinates Zone 13W							Emission Factor (g/kWh).						Emission Rates per Stack (g/s)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Emission Location	Facility Description	Generator Tier	Total Max Power Output, at Full Load for Each Facility (kW)	Assumed Running Load Factor (%)	Nominal Total Power Output (kW)	Nominal Total Power Output, "Per Stack" (kW)	Stack Description	Easting (m)	Northing (m)	Base Elevation (masl)	Emission Release Height (Stack Height) (m)	Stack Internal Diameter (m)	Stack Exit Velocity (m/s)	Stack Exit Temperature (k)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-Hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris Camp	8x 1.2 MW generators. 4 stacks	Assume Tier 1	9600	70	6720.0	1680.0	Stack #1	433016	7559168	68.4	30.0	0.6	54.2	800.0	1.5E+1	7.4E-3	3.3E+0	4.3E-1	4.1E-1	4.0E-1	6.8E+0	3.4E-3	1.6E+0	2.0E-1	1.9E-1	1.9E-1	1.0	1.0	1.0	1	1	0	0
Doris Camp						1680.0	Stack #2	433025	7559167	68.3	30.0	0.6	54.2	800.0	1.5E+1	7.4E-3	3.3E+0	4.3E-1	4.1E-1	4.0E-1	6.8E+0	3.4E-3	1.6E+0	2.0E-1	1.9E-1	1.9E-1	1.0	1.0	1.0	1	1	0	0
Doris Camp						1680.0	Stack #3	433034	7559167	68.3	30.0	0.6	54.2	800.0	1.5E+1	7.4E-3	3.3E+0	4.3E-1	4.1E-1	4.0E-1	6.8E+0	3.4E-3	1.6E+0	2.0E-1	1.9E-1	1.9E-1	1.0	1.0	1.0	1	1	0	0
Doris Camp						1680.0	Stack #4	433041	7559166	68.3	30.0	0.6	54.2	800.0	1.5E+1	7.4E-3	3.3E+0	4.3E-1	4.1E-1	4.0E-1	6.8E+0	3.4E-3	1.6E+0	2.0E-1	1.9E-1	1.9E-1	1.0	1.0	1.0	1	1	0	0
Madrid North	3x 1.2 MW generators. Assume 2 stacks	Assume Tier 4	3600	70	2520.0	1260.0	Stack #1	433155	7550027	51.8	30.0	0.6	54.2	800.0	6.7E-1	7.4E-3	3.5E+0	3.0E-2	2.9E-2	2.8E-2	2.3E-1	2.6E-3	1.2E+0	1.1E-2	1.0E-2	9.8E-3	1.0	1.0	1.0	0	1	0	0
Madrid North						1260.0	Stack #2	433155	7550003	52.3	30.0	0.6	54.2	800.0	6.7E-1	7.4E-3	3.5E+0	3.0E-2	2.9E-2	2.8E-2	2.3E-1	2.6E-3	1.2E+0	1.1E-2	1.0E-2	9.8E-3	1.0	1.0	1.0	0	1	0	0
Madrid South	2x 725 kW generators, N+1 configuration	Assume Tier 4	725	70	507.5	507.5	Stack #1	434968	7546916	40.2	6.0	0.6	54.2	800.0	6.7E-1	7.4E-3	3.5E+0	3.0E-2	2.9E-2	2.8E-2	9.4E-2	1.0E-3	4.9E-1	4.2E-3	4.1E-3	4.0E-3	1.0	1.0	1.0	0	1	0	0
Quarry D construction camp	Assume 1x 725 kW	Assume Tier 1	725	70	507.5	507.5	Stack #1	432874	7551687	48.3	6.0	0.6	54.2	800.0	1.5E+1	7.4E-3	3.3E+0	4.3E-1	4.1E-1	4.0E-1	2.1E+0	1.0E-3	4.7E-1	6.0E-2	5.8E-2	5.6E-2	1.0	1.0	1.0	1	0	0	0
Boston Ops Camp	8x 1.2 MW generators. Assume 4 stacks	Assume Tier 4	9600	70	6720.0	1680.0	Stack #1	441026	7504145	77.9	30.0	0.6	54.2	800.0	6.7E-1	7.4E-3	3.5E+0	3.0E-2	2.9E-2	2.8E-2	3.1E-1	3.4E-3	1.6E+0	1.4E-2	1.3E-2	1.3E-2	1.0	1.0	1.0	0	0	0	1
Boston Ops Camp						1680.0	Stack #2	441039	7504144	77.9	30.0	0.6	54.2	800.0	6.7E-1	7.4E-3	3.5E+0	3.0E-2	2.9E-2	2.8E-2	3.1E-1	3.4E-3	1.6E+0	1.4E-2	1.3E-2	1.3E-2	1.0	1.0	1.0	0	0	0	1
Boston Ops Camp						1680.0	Stack #3	441053	7504143	77.4	30.0	0.6	54.2	800.0	6.7E-1	7.4E-3	3.5E+0	3.0E-2	2.9E-2	2.8E-2	3.1E-1	3.4E-3	1.6E+0	1.4E-2	1.3E-2	1.3E-2	1.0	1.0	1.0	0	0	0	1
Boston Ops Camp						1680.0	Stack #4	441069	7504142	77.4	30.0	0.6	54.2	800.0	6.7E-1	7.4E-3	3.5E+0	3.0E-2	2.9E-2	2.8E-2	3.1E-1	3.4E-3	1.6E+0	1.4E-2	1.3E-2	1.3E-2	1.0	1.0	1.0	0	0	0	1
Boston Construction Camp	Assume 1x 725 kW	Assume Tier 1	725	70	507.5	507.5	Stack #1	441193	7505544	71.2	6.0	0.6	54.2	800.0	1.5E+1	7.4E-3	3.3E+0	4.3E-1	4.1E-1	4.0E-1	2.1E+0	1.0E-3	4.7E-1	6.0E-2	5.8E-2	5.6E-2	1.0	1.0	1.0	0	0	1	0

Table C-2. Processing Plant Stack, Characteristics and Air Emissions

					UTM Coordinates Zone 13W							Total Emission Rate (g/s)						Emission Rates per Stack (g/s)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Emission Location	Material Crushing Rate (tonnes/ day)	Sludge Drying Rate (tonnes/ day)	Diesel use for Sludge Drying (L/hr)	Smelting Rate (tonnes/ day)	Easting (m)	Northing (m)	Base Elevation (masl)	Emission Release Height (Stack Height) (m)	Stack Internal Diameter (m)	Stack Exit Velocity (m/s)	Stack Exit Temperature (k)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris Processing Plant	2400	0.0	1.4	0.2	433155	7559187	66.6	20.0	0.5	10.0	373.2	9.4E-4	1.0E-5	2.4E-4	1.3E+0	5.1E-1	5.1E-1	9.4E-4	1.0E-5	2.4E-4	1.3E+0	5.1E-1	5.1E-1	1.0	1.0	1.0	1	1	0	0
Boston Processing Plant	2400	0.0	0.0	0.0	441042	7504181	77.7	20.0	0.5	10.0	373.2	0.0E+0	0.0E+0	0.0E+0	1.3E+0	5.0E-1	5.0E-1	0.0E+0	0.0E+0	0.0E+0	1.3E+0	5.0E-1	5.0E-1	1.0	1.0	1.0	0	0	0	1
Madrid North Processing Plant	1200	0.0	0.0	0.0	433185	7550013	51.9	20.0	0.5	10.0	373.2	0.0E+0	0.0E+0	0.0E+0	6.3E-1	2.5E-1	2.5E-1	0.0E+0	0.0E+0	0.0E+0	6.3E-1	2.5E-1	2.5E-1	1.0	1.0	1.0	0	1	0	0

Table C-3. Incinerator Stack, Characteristics and Air Emissions

		UTM Coordinates Zone 13W												Emission Factor (kg/tonne)						Emission Rates (g/s)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Emission Location	Incinerator Description	Easting (m)	Northing (m)	Base Elevation (masl)	Emission Release Height (Stack Height) (m)	Stack Internal Diameter (m)	Stack Opening Area (m^2)	Actual Flow Rate (m^3/s)	Stack Exit Velocity (m/s)	Stack Exit Temperature (k)	Amount of Waste per Person per Day (kg)	Number of People per Incinerator (Divided Equally)	Total Amount of Waste per Year (tonne/year), Divided Equally	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Robert's Bay. Taking waste from Doris and Quarry D camps	CY100	432876	7563172	13.8	8.0	0.5	0.2	1.7	10.2	1322.2	2.5	166.7	152.1	1.5E+0	1.3E+0	5.0E+0	3.5E+0	3.4E+0	3.4E+0	7.2E-3	6.0E-3	2.4E-2	1.7E-2	1.6E-2	1.6E-2	1.0	1.0	1.0	1	1	0	0
Robert's Bay. Taking waste from Doris and Quarry D camps	CY-2050 Unit 1	432870	7563172	13.8	7.0	0.4	0.1	1.7	14.6	1322.2	2.5	166.7	152.1	1.5E+0	1.3E+0	5.0E+0	3.5E+0	3.4E+0	3.4E+0	7.2E-3	6.0E-3	2.4E-2	1.7E-2	1.6E-2	1.6E-2	1.0	1.0	1.0	1	1	0	0
Robert's Bay. Taking waste from Doris and Quarry D camps	CY-2050 Unit 2	432873	7563172	13.8	7.0	0.4	0.1	1.7	14.6	1322.2	2.5	166.7	152.1	1.5E+0	1.3E+0	5.0E+0	3.5E+0	3.4E+0	3.4E+0	7.2E-3	6.0E-3	2.4E-2	1.7E-2	1.6E-2	1.6E-2	1.0	1.0	1.0	1	1	0	0
Boston	Assume CY-2050	441198	7504262	76.7	7.0	0.4	0.1	1.7	14.6	1322.2	2.5	100.0	91.3	1.5E+0	1.3E+0	5.0E+0	3.5E+0	3.4E+0	3.4E+0	4.3E-3	3.6E-3	1.4E-2	1.0E-2	9.9E-3	9.8E-3	1.0	1.0	1.0	0	0	1	1
Boston	Assume CY-2050	441198	7504269	76.6	7.0	0.4	0.1	1.7	14.6	1322.2	2.5	100.0	91.3	1.5E+0	1.3E+0	5.0E+0	3.5E+0	3.4E+0	3.4E+0	4.3E-3	3.6E-3	1.4E-2	1.0E-2	9.9E-3	9.8E-3	1.0	1.0	1.0	0	0	1	1

Table C-4. Mine Air Heating Facility Stack, Characteristics and Air Emissions

						UTM Coordinates Zone 13W							Emission Factor (lb/1000 gallons)					
Emission Location	Facility Description	Annual Diesel Fuel Usage October to May (L/244 days)	Diesel Fuel Usage (L/s)	Diesel Fuel Usage (Per Stack) (L/s)	Stack Description	Easting (m)	Northing (m)	Base Elevation (masl)	Emission Release Height (Stack Height) (m)	Stack Internal Diameter (m)	Stack Exit Velocity (m/s)	Stack Exit Temperature (k)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Doris	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	500,000	0.024	0.0059	Stack #1	433687	7559416	50.9	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Doris				0.0059	Stack #2	433693	7559419	50.6	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Doris				0.0059	Stack #3	433699	7559408	50.6	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Doris				0.0059	Stack #4	433694	7559406	50.4	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid North	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	500,000	0.024	0.0059	Stack #1	433560	7550340	42.7	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid North				0.0059	Stack #2	433565	7550339	42.6	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid North				0.0059	Stack #3	433557	7550328	42.9	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid North				0.0059	Stack #4	433563	7550327	42.8	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid South	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	500,000	0.024	0.0059	Stack #1	435157	7546646	37.1	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid South				0.0059	Stack #2	435166	7546640	37.1	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid South				0.0059	Stack #3	435160	7546631	37.1	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Madrid South				0.0059	Stack #4	435151	7546637	37.1	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Boston	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	500,000	0.024	0.0059	Stack #1	441179	7505092	73.9	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Boston				0.0059	Stack #2	441189	7505092	73.9	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Boston				0.0059	Stack #3	441189	7505082	74.0	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0
Boston				0.0059	Stack #4	441179	7505082	74.0	6.0	0.5	10.0	473.2	2.0E+1	2.1E-1	5.0E+0	3.3E+0	2.3E+0	1.6E+0

Table C-4. Mine Air Heating Facility Stack, Characteristics and Air Emissions

		Emission Factor (g/L)						Emission Rates per Stack (g/s)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Emission Location	Facility Description	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	0	0	0
Doris		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	0	0	0
Doris		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	0	0	0
Doris		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	0	0	0
Madrid North	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	1	0	0
Madrid North		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	1	0	0
Madrid North		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	1	0	0
Madrid North		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	1	1	0	0
Madrid South	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	1	0	0
Madrid South		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	1	0	0
Madrid South		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	1	0	0
Madrid South		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	1	0	0
Boston	Air heater for underground; 30M BTU/hr diesel heater, air heated to -8 °C; est. 0.5 Ml/yr diesel fuel burned	2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	0	1	1
Boston		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	0	1	1
Boston		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	0	1	1
Boston		2.4E+0	2.6E-2	6.0E-1	4.0E-1	2.8E-1	1.9E-1	1.4E-2	1.5E-4	3.6E-3	2.3E-3	1.6E-3	1.1E-3	1.0	1.0	0.7	0	0	1	1

Table C-5. Mine Air Ventilation Exhaust Vent, Characteristics and Air Emissions

												Equipment Tailpipe Emissions											
					UTM Coordinates Zone 13W							Total Underground Tailpipe Emissions for Each Mine (g/s)						Tailpipe Emission Rates per Stack (g/s)					
Emission Location	Total Mine Air Ventilation Rate (Nm^3/m)	Total Mine Airflow Rate (Nm^3/m)	Airflow Rate per Vent. Assumes Equal Distribution	Stack Description	Easting (m)	Northing (m)	Base Elevation (masl)	Emission Release Height (Stack Height) (m)	Stack Internal Diameter (m)	Stack Exit Velocity (m/s)	Stack Exit Temperature (k)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Doris Mine	9600	160	80.0	Mine Vent #1	433385	7558558	45.0	2.0	3.6	7.9	265.2	1.7E+1	1.9E-1	5.8E+0	1.1E+0	1.1E+0	1.0E+0	8.5E+0	9.7E-2	2.9E+0	5.3E-1	5.3E-1	5.1E-1
Doris Mine			80.0	Mine Vent #2	433387	7557660	59.0	2.0	3.6	7.9	265.2							8.5E+0	9.7E-2	2.9E+0	5.3E-1	5.3E-1	5.1E-1
Madrid North Mine	17000	283	94.4	Mine Vent #1	433437	7550554	45.5	2.0	3.6	9.3	265.2	2.0E+1	2.3E-1	1.1E+1	1.3E+0	1.3E+0	1.3E+0	6.7E+0	7.6E-2	3.7E+0	4.5E-1	4.5E-1	4.3E-1
Madrid North Mine			94.4	Mine Vent #2	433850	7550006	43.8	2.0	3.6	9.3	265.2							6.7E+0	7.6E-2	3.7E+0	4.5E-1	4.5E-1	4.3E-1
Madrid North Mine			94.4	Mine Vent #3	434129	7549454	47.7	2.0	3.6	9.3	265.2							6.7E+0	7.6E-2	3.7E+0	4.5E-1	4.5E-1	4.3E-1
Madrid South Mine	6000	100	100.0	Mine Vent #1	435179	7546194	37.8	2.0	3.6	9.8	265.2	2.0E+1	2.3E-1	1.1E+1	1.3E+0	1.3E+0	1.3E+0	2.0E+1	2.3E-1	1.1E+1	1.3E+0	1.3E+0	1.3E+0
Boston Mine	9600	160	40.0	Mine Vent #1	441107	7504910	75.2	2.0	3.6	3.9	265.2	2.0E+1	2.3E-1	1.1E+1	1.3E+0	1.3E+0	1.3E+0	5.0E+0	5.7E-2	2.8E+0	3.4E-1	3.4E-1	3.3E-1
Boston Mine			40.0	Mine Vent #2	441252	7504857	75.1	2.0	3.6	3.9	265.2							5.0E+0	5.7E-2	2.8E+0	3.4E-1	3.4E-1	3.3E-1
Boston Mine			40.0	Mine Vent #3	440913	7503667	80.2	2.0	3.6	3.9	265.2							5.0E+0	5.7E-2	2.8E+0	3.4E-1	3.4E-1	3.3E-1
Boston Mine			40.0	Mine Vent #4	441149	7503280	81.1	2.0	3.6	3.9	265.2							5.0E+0	5.7E-2	2.8E+0	3.4E-1	3.4E-1	3.3E-1

Table C-5. Mine Air Ventilation Exhaust Vent, Characteristics and Air Emissions

	Equipment Tailpipe Emissions							Blasting Emissions																		
	Emission Scaling Factors for Hourly, Daily, Annual			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)				Total Underground Blasting Emissions for Each Mine (g/s)						Blasting Emission Rates per Stack (g/s)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Emission Location	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris Mine	1.0	1.0	1.0	1	0	0	0	7.9E-1	9.9E-2	3.4E+0	1.7E-1	9.0E-2	5.2E-3	4.0E-1	5.0E-2	1.7E+0	8.6E-2	4.5E-2	2.6E-3	1.0	0.3	0.0	1	0	0	0
Doris Mine	1.0	1.0	1.0	1	0	0	0							4.0E-1	5.0E-2	1.7E+0	8.6E-2	4.5E-2	2.6E-3	1.0	0.3	0.0	1	0	0	0
Madrid North Mine	1.0	1.0	1.0	1	1	0	0	1.5E+0	1.9E-1	6.3E+0	1.7E-1	9.0E-2	5.2E-3	4.9E-1	6.2E-2	2.1E+0	5.8E-2	3.0E-2	1.7E-3	1.0	0.3	0.0	1	1	0	0
Madrid North Mine	1.0	1.0	1.0	1	1	0	0							4.9E-1	6.2E-2	2.1E+0	5.8E-2	3.0E-2	1.7E-3	1.0	0.3	0.0	1	1	0	0
Madrid North Mine	1.0	1.0	1.0	1	1	0	0							4.9E-1	6.2E-2	2.1E+0	5.8E-2	3.0E-2	1.7E-3	1.0	0.3	0.0	1	1	0	0
Madrid South Mine	1.0	1.0	1.0	0	1	0	0	1.4E+0	1.8E-1	6.0E+0	1.7E-1	9.0E-2	5.2E-3	1.4E+0	1.8E-1	6.0E+0	1.7E-1	9.0E-2	5.2E-3	1.0	0.3	0.0	0	1	0	0
Boston Mine	1.0	1.0	1.0	0	0	1	1	8.8E-1	1.1E-1	3.7E+0	1.7E-1	9.0E-2	5.2E-3	2.2E-1	2.7E-2	9.3E-1	4.3E-2	2.2E-2	1.3E-3	1.0	0.3	0.0	0	0	1	1
Boston Mine	1.0	1.0	1.0	0	0	1	1							2.2E-1	2.7E-2	9.3E-1	4.3E-2	2.2E-2	1.3E-3	1.0	0.3	0.0	0	0	1	1
Boston Mine	1.0	1.0	1.0	0	0	1	1							2.2E-1	2.7E-2	9.3E-1	4.3E-2	2.2E-2	1.3E-3	1.0	0.3	0.0	0	0	1	1
Boston Mine	1.0	1.0	1.0	0	0	1	1							2.2E-1	2.7E-2	9.3E-1	4.3E-2	2.2E-2	1.3E-3	1.0	0.3	0.0	0	0	1	1

Table C-6. Marine Shipping Vessels, Characteristics and Air Emissions

Emission Location	Stack Description	Ship DWT (worst case)	Max Main Engine Power (kW)	Main Engine Power During Activity (kW)	Aux Engine Power During Activity (kW)	UTM Coordinates Zone 13W		Base Elevation (masl)	Emission Release Height (Stack Height) (m)	Stack Internal Diameter (m)	Stack Exit Velocity (m/s)	Stack Exit Temperature (k)	Main Engine Emission Factor (g/kW-hr)					
						Easting (m)	Northing (m)						NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Robert's Bay Dock	Docked ship, hoteling. Stack source	16640	10846.3	0.0	1000	431626	7565136	13.4	30.0	1.0	10.0	573.2	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0
Robert's Bay	Maneuvering ship, area source	16640	10846.3	2169.3	1250	n/a	n/a	n/a	30.0	n/a	n/a	n/a	1.2E+1	6.6E-1	4.2E+0	3.2E-1	3.1E-1	3.0E-1
Robert's Bay	Slow cruise ship, road source	16640	10846.3	4338.5	750	n/a	n/a	n/a	30.0	n/a	n/a	n/a	1.1E+1	5.7E-1	2.1E+0	2.8E-1	2.7E-1	2.6E-1

Table C-6. Marine Shipping Vessels, Characteristics and Air Emissions

	Aux. Engine Emission Factor (g/kW-hr)						Total Emission Rates (g/s)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Emission Location	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Robert's Bay Dock	1.1E+1	5.2E-1	8.4E-1	2.6E-1	2.5E-1	2.4E-1	2.9E+0	1.4E-1	2.3E-1	7.3E-2	7.0E-2	6.8E-2	1.0	1.0	0.1	1	1	0	0
Robert's Bay	1.1E+1	5.2E-1	8.4E-1	2.6E-1	2.5E-1	2.4E-1	1.1E+1	5.8E-1	2.8E+0	2.8E-1	2.7E-1	2.7E-1	0.5	0.0	0.0	1	1	0	0
Robert's Bay	1.1E+1	5.2E-1	8.4E-1	2.6E-1	2.5E-1	2.4E-1	1.5E+1	8.0E-1	2.7E+0	3.9E-1	3.7E-1	3.7E-1	0.5	0.0	0.0	1	1	0	0

Table C-7. General Areas with Mobile Equipment, Characteristics and Air Emissions

Emission Area Location	Equipment Description	Tailpipe Emission Rates (g/s)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
		NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris general area	General operation equipment.	8.3E+0	1.2E-1	7.8E+0	5.9E-1	5.9E-1	5.7E-1	1.0	1.0	1.0	1	1	0	0
Roberts Bay New Dock, construction	General construction equipment. Assume same emissions as Madrid North construction.	1.5E+1	1.9E-1	1.9E+1	8.2E-1	8.2E-1	7.9E-1	1.0	1.0	1.0	1	0	0	0
Roberts Bay New Dock, operations	Minimal operation equipment. Assume same emissions as Roberts Bay Laydown area.	1.2E+0	1.7E-2	5.5E-1	8.3E-2	8.3E-2	8.0E-2	1.0	1.0	0.3	0	1	0	0
Roberts Bay Laydown general area	General operation equipment.	1.2E+0	1.7E-2	5.5E-1	8.3E-2	8.3E-2	8.0E-2	1.0	1.0	1.0	1	1	0	0
Madrid North general area, construction equipment	General construction equipment	1.5E+1	1.9E-1	1.9E+1	8.2E-1	8.2E-1	7.9E-1	1.0	1.0	1.0	1	0	0	0
Madrid North general area, operations equipment	General operation equipment	2.1E+1	2.9E-1	9.5E+0	1.5E+0	1.5E+0	1.4E+0	1.0	1.0	1.0	1	1	0	0
Madrid South general area, construction equipment	General construction equipment	1.5E+1	1.9E-1	1.9E+1	8.2E-1	8.2E-1	7.9E-1	1.0	1.0	1.0	1	0	0	0
Madrid South general area, operations equipment	General operation equipment	2.1E+1	2.9E-1	9.5E+0	1.5E+0	1.5E+0	1.4E+0	1.0	1.0	1.0	0	1	0	0
Quarry L (northern)	General quarry equipment and crusher	1.5E+1	1.9E-1	1.9E+1	8.4E-1	8.4E-1	8.1E-1	1.0	1.0	1.0	1	0	0	0
Quarry U (southern)	General quarry equipment and crusher	1.5E+1	1.9E-1	1.9E+1	8.4E-1	8.4E-1	8.1E-1	1.0	1.0	1.0	0	0	1	0
Boston general area, construction equipment	General construction equipment	1.5E+1	1.9E-1	1.9E+1	8.2E-1	8.2E-1	7.9E-1	1.0	1.0	1.0	0	0	1	0
Boston general area, operations equipment	General operation equipment	2.0E+1	2.9E-1	9.4E+0	1.4E+0	1.4E+0	1.4E+0	1.0	1.0	1.0	0	0	1	1
Quarry D construction camp, construction	Small amount of mobile equipment for camp	6.5E+0	8.4E-2	1.6E+1	3.6E-1	3.6E-1	3.5E-1	1.0	0.5	0.5	1	0	0	0
Doris TIA, west dam construction	General construction equipment, shared between west and south dam	7.4E+0	9.3E-2	9.6E+0	4.1E-1	4.1E-1	3.9E-1	1.0	1.0	1.0	1	0	0	0
Doris TIA, south dam construction	General construction equipment, shared between west and south dam	7.4E+0	9.3E-2	9.6E+0	4.1E-1	4.1E-1	3.9E-1	1.0	1.0	1.0	1	0	0	0

Table C-8. Aircraft, Characteristics and Air Emissions

Location	Aircraft Type	Unit #	Time Adjustment for 1 LTO Event Over a 1h Period	Emissions (g/s) during 1 LTO Event. Emission Rate Adjusted Over a 1h Emission Period						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
				CO	NO_X	SO_X	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Boston Runway	737-200 Aircraft	1	3600	2.0E-1	1.1E+0	9.0E-2	2.7E-2	2.7E-2	2.7E-2	1.0	0.0	0.0	0	0	1	1
Boston Runway	Dash 8 aircraft	1	3600	8.9E-2	4.7E-2	9.2E-3	2.4E-3	2.4E-3	2.4E-3	1.0	0.0	0.0	0	0	1	1
Boston Runway	Hercules C130	1	3600	2.0E-1	2.2E-1	3.0E-2	5.0E-3	5.0E-3	5.0E-3	1.0	0.0	0.0	0	0	1	1
Boston Helicopter Pad	Bell 206 Long Ranger Helicopter	1	3600	4.3E-2	1.1E-3	5.8E-4	6.1E-4	6.1E-4	6.1E-4	1.0	0.0	0.0	0	0	1	1
Doris Runway	737-200 Aircraft	1	3600	2.0E-1	1.1E+0	9.0E-2	2.7E-2	2.7E-2	2.7E-2	1.0	0.0	0.0	1	1	0	0
Doris Runway	Dash 8 aircraft	1	3600	8.9E-2	4.7E-2	9.2E-3	2.4E-3	2.4E-3	2.4E-3	1.0	0.0	0.0	1	1	0	0
Doris Helicopter Pad	Bell 206 Long Ranger Helicopter	1	3600	4.3E-2	1.1E-3	5.8E-4	6.1E-4	6.1E-4	6.1E-4	1.0	0.0	0.0	1	1	0	0

Table C-9. Unpaved Roads and Travel Routes, Characteristics and Air Emissions

										Fugitive Dust Emissions								
					Number of One Way Transits			Total Equipment Weight (e.g., assume loaded if applicable)		Emissions Factors (g/VKT) Without Dust Controls.			Emissions Factors (g/VKT) with Watering to 75% Control Efficiency			Fugitive Dust Emission Rates for CALPUFF Road Source Type (g/s/m) with 75% Control Efficiency		
Road Portion	Equipment	Notes	Speed (km/hr)	Approx. Distance Travelled in Specific Road Portion, per One Way Trip (km)	Per Hour	Per Day	Per Year	Tonne	Ton (Imperial)	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Roberts Bay New Port to Roberts Bay Laydown	Light Vehicle, Ford F350		50	3.3	1.0	24.0	8760.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	7.7E-5	2.2E-5	2.2E-6
Roberts Bay New Port to Roberts Bay Laydown	Freightliner	For transferring cargo from ship to laydown area. Assume 14,000 tonnes of freight per year (Project Description). ~5000 tonnes per ship if 3 ships. 20 tonnes per container = 250 Freightliner round trips to the dock, per ship. = 36 trips per day if each ship unloaded over 7 days.	50	3.3	3.0	72.0	1500.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	6.7E-4	1.9E-4	1.9E-5
Roberts Bay Laydown to Doris	Light Vehicle, Ford F350		50	5.0	1.7	40.0	14600.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	1.3E-4	3.7E-5	3.7E-6
Roberts Bay Laydown to Doris	Freightliner	Going to Madrid North	50	5.0	1.0	2.0	730.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	2.2E-4	6.4E-5	6.4E-6
Roberts Bay Laydown to Doris	Freightliner	Going to Madrid South	50	5.0	1.0	2.0	730.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	2.2E-4	6.4E-5	6.4E-6
Roberts Bay Laydown to Doris	Freightliner	Going to Boston	50	5.0	1.0	4.0	1460.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	2.2E-4	6.4E-5	6.4E-6
Roberts Bay Laydown to Doris	Freightliner	Going to Doris	50	5.0	1.0	2.0	730.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	2.2E-4	6.4E-5	6.4E-6
Roberts Bay Laydown to Doris	Super B Train Fuel Truck (60,000 L capacity)	Going to Madrid North	50	5.0	1.0	1.0	365.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Roberts Bay Laydown to Doris	Super B Train Fuel Truck (60,000 L capacity)	Going to Madrid South	50	5.0	1.0	1.0	365.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Roberts Bay Laydown to Doris	Super B Train Fuel Truck (60,000 L capacity)	Going to Boston	50	5.0	1.0	1.0	243.3	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Roberts Bay Laydown to Doris	Super B Train Fuel Truck (60,000 L capacity)	Going to Doris	50	5.0	1.0	1.0	365.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Roberts Bay Laydown to Doris	INTERNATIONAL BUS	For airstrip, just assume whole road length	50	5.0	1.0	16.0	5840.0	15.0	16.5	2.3E+3	6.6E+2	6.6E+1	5.8E+2	1.7E+2	1.7E+1	1.6E-4	4.6E-5	4.6E-6
Doris to Doris TIA, access road	Light Vehicle,Ford F350		50	3.8	1.0	24.0	8760.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	7.7E-5	2.2E-5	2.2E-6
AWR to Doris TIA South Dam, access road	Light Vehicle,Ford F350		50	3.8	1.0	24.0	8760.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	7.7E-5	2.2E-5	2.2E-6
Doris Portal to Ore Stockpile	CAT 740B	Move 1500 tonnes per day	25	0.2	3.6	85.7	31285.7	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	1.2E-3	3.4E-4	3.4E-5
Doris Portal to Waste Rock Pile	CAT 740B	Move 1500 tonnes per day	25	0.2	3.6	85.7	31285.7	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	1.2E-3	3.4E-4	3.4E-5
Doris to Madrid North	Freightliner	Going to Madrid North	50	10.0	1.0	2.0	730.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	2.2E-4	6.4E-5	6.4E-6
Doris to Madrid North	Super B Train Fuel Truck (60,000 L capacity)	Going to Madrid North	50	10.0	1.0	1.0	365.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Doris to Madrid North	Crew Busses 16+ passenger	Going to Madrid North	50	10.0	1.0	16.0	5840.0	6.4	7.0	1.6E+3	4.5E+2	4.5E+1	3.9E+2	1.1E+2	1.1E+1	1.1E-4	3.1E-5	3.1E-6
Doris to Madrid North	Light Vehicle,Ford F350	Going to Madrid North	50	10.0	1.7	40.0	14600.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	1.3E-4	3.7E-5	3.7E-6
Doris to Madrid North	Super B Train Fuel Truck (60,000 L capacity)	Going to Madrid North; transport Ore, Concentrate and leach tailings. Assume same size truck. 40 t per load	50	10.0	5.4	130.0	47450.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	1.5E-3	4.4E-4	4.4E-5
Madrid North Portal to middle of Ore Stockpile	CAT 740B	Move 3200 tonnes per day	25	0.2	7.6	182.9	66742.9	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	2.5E-3	7.2E-4	7.2E-5

Table C-9. Unpaved Roads and Travel Routes, Characteristics and Air Emissions

	Tailpipe Emissions: Tailpipe Emission Rates for CALPUFF Road Source Type (g/s/m).						Fugitive + Tailpipe Emissions: Fugitive + Tailpipe Emission Rates for CALPUFF Road Source Type (g/s/m)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Road Portion	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Roberts Bay New Port to Roberts Bay Laydown	7.6E-5	1.2E-6	3.3E-5	4.8E-6	4.8E-6	4.6E-6	7.6E-5	1.2E-6	3.3E-5	8.2E-5	2.7E-5	6.8E-6	1.0	1.0	1.0	1	1	0	0
Roberts Bay New Port to Roberts Bay Laydown	2.2E-4	3.6E-6	9.8E-5	1.4E-5	1.4E-5	1.4E-5	2.2E-4	3.6E-6	9.8E-5	6.9E-4	2.1E-4	3.3E-5	1.0	1.0	0.1	1	1	0	0
Roberts Bay Laydown to Doris	8.4E-5	1.4E-6	3.6E-5	5.2E-6	5.2E-6	5.1E-6	8.4E-5	1.4E-6	3.6E-5	1.3E-4	4.2E-5	8.7E-6	1.0	1.0	1.0	1	1	0	0
Roberts Bay Laydown to Doris	4.9E-5	8.0E-7	2.1E-5	3.1E-6	3.1E-6	3.0E-6	4.9E-5	8.0E-7	2.1E-5	2.3E-4	6.7E-5	9.4E-6	1.0	0.1	0.1	1	1	0	0
Roberts Bay Laydown to Doris	4.9E-5	8.0E-7	2.1E-5	3.1E-6	3.1E-6	3.0E-6	4.9E-5	8.0E-7	2.1E-5	2.3E-4	6.7E-5	9.4E-6	1.0	0.1	0.1	1	1	0	0
Roberts Bay Laydown to Doris	4.9E-5	8.0E-7	2.1E-5	3.1E-6	3.1E-6	3.0E-6	4.9E-5	8.0E-7	2.1E-5	2.3E-4	6.7E-5	9.4E-6	1.0	0.2	0.2	1	1	0	0
Roberts Bay Laydown to Doris	4.9E-5	8.0E-7	2.1E-5	3.1E-6	3.1E-6	3.0E-6	4.9E-5	8.0E-7	2.1E-5	2.3E-4	6.7E-5	9.4E-6	1.0	0.1	0.1	1	1	0	0
Roberts Bay Laydown to Doris	4.7E-5	7.6E-7	2.0E-5	2.9E-6	2.9E-6	2.8E-6	4.7E-5	7.6E-7	2.0E-5	2.9E-4	8.4E-5	1.1E-5	1.0	0.0	0.0	1	1	0	0
Roberts Bay Laydown to Doris	4.7E-5	7.6E-7	2.0E-5	2.9E-6	2.9E-6	2.8E-6	4.7E-5	7.6E-7	2.0E-5	2.9E-4	8.4E-5	1.1E-5	1.0	0.0	0.0	1	1	0	0
Roberts Bay Laydown to Doris	4.7E-5	7.6E-7	2.0E-5	2.9E-6	2.9E-6	2.8E-6	4.7E-5	7.6E-7	2.0E-5	2.9E-4	8.4E-5	1.1E-5	1.0	0.0	0.0	1	1	0	0
Roberts Bay Laydown to Doris	4.7E-5	7.6E-7	2.0E-5	2.9E-6	2.9E-6	2.8E-6	4.7E-5	7.6E-7	2.0E-5	2.9E-4	8.4E-5	1.1E-5	1.0	0.0	0.0	1	1	0	0
Roberts Bay Laydown to Doris	3.3E-5	6.0E-7	1.4E-5	2.6E-6	2.6E-6	2.5E-6	3.3E-5	6.0E-7	1.4E-5	1.6E-4	4.8E-5	7.1E-6	1.0	0.7	0.7	1	1	0	0
Doris to Doris TIA, access road	6.6E-5	1.1E-6	2.9E-5	4.1E-6	4.1E-6	4.0E-6	6.6E-5	1.1E-6	2.9E-5	8.1E-5	2.6E-5	6.2E-6	1.0	1.0	1.0	1	1	0	0
AWR to Doris TIA South Dam, access road	6.6E-5	1.1E-6	2.9E-5	4.1E-6	4.1E-6	4.0E-6	6.6E-5	1.1E-6	2.9E-5	8.1E-5	2.6E-5	6.2E-6	1.0	1.0	1.0	1	1	0	0
Doris Portal to Ore Stockpile	5.7E-3	9.2E-5	2.5E-3	3.6E-4	3.6E-4	3.4E-4	5.7E-3	9.2E-5	2.5E-3	1.5E-3	6.9E-4	3.8E-4	1.0	1.0	1.0	1	1	0	0
Doris Portal to Waste Rock Pile	5.7E-3	9.2E-5	2.5E-3	3.6E-4	3.6E-4	3.4E-4	5.7E-3	9.2E-5	2.5E-3	1.5E-3	6.9E-4	3.8E-4	1.0	1.0	1.0	1	1	0	0
Doris to Madrid North	2.5E-5	4.0E-7	1.1E-5	1.5E-6	1.5E-6	1.5E-6	2.5E-5	4.0E-7	1.1E-5	2.3E-4	6.5E-5	7.9E-6	1.0	0.1	0.1	1	1	0	0
Doris to Madrid North	2.3E-5	3.8E-7	1.0E-5	1.5E-6	1.5E-6	1.4E-6	2.3E-5	3.8E-7	1.0E-5	2.9E-4	8.3E-5	9.6E-6	1.0	0.0	0.0	1	1	0	0
Doris to Madrid North	3.5E-5	1.8E-7	3.7E-4	3.5E-7	3.5E-7	3.2E-7	3.5E-5	1.8E-7	3.7E-4	1.1E-4	3.2E-5	3.4E-6	1.0	0.7	0.7	1	1	0	0
Doris to Madrid North	4.2E-5	6.8E-7	1.8E-5	2.6E-6	2.6E-6	2.5E-6	4.2E-5	6.8E-7	1.8E-5	1.3E-4	3.9E-5	6.2E-6	1.0	1.0	1.0	1	1	0	0
Doris to Madrid North	1.3E-4	2.1E-6	5.5E-5	7.9E-6	7.9E-6	7.7E-6	1.3E-4	2.1E-6	5.5E-5	1.6E-3	4.5E-4	5.2E-5	1.0	1.0	1.0	1	1	0	0
Madrid North Portal to middle of Ore Stockpile	1.2E-2	2.0E-4	5.3E-3	7.6E-4	7.6E-4	7.4E-4	1.2E-2	2.0E-4	5.3E-3	3.3E-3	1.5E-3	8.1E-4	1.0	1.0	1.0	1	1	0	0

Table C-9. Unpaved Roads and Travel Routes, Characteristics and Air Emissions

					Number of One Way Transits			Total Equipment Weight (e.g., assume loaded if applicable)		Fugitive Dust Emissions: Emissions Factors (g/VKT) Without Dust Controls.			Fugitive Dust Emissions: Emissions Factors (g/VKT) with Watering to 75% Control Efficiency			Fugitive Dust Emissions: Fugitive Dust Emission Rates for CALPUFF Road Source Type (g/s/m) with 75% Control Efficiency		
Road Portion	Equipment	Notes	Speed (km/hr)	Approx. Distance Travelled in Specific Road Portion, per One Way Trip (km)	Per Hour	Per Day	Per Year	Tonne	Ton (Imperial)	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Madrid North Portal to middle of Waste Rock Pile	CAT 740B	Move 690 tonnes per day	25	0.5	1.6	39.4	14391.4	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	5.4E-4	1.5E-4	1.5E-5
Doris to Madrid South	Freightliner	Going to Madrid South	50	14.0	1.0	1.0	300.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	2.2E-4	6.4E-5	6.4E-6
Doris to Madrid South	Super B Train Fuel Truck (60,000 L capacity)	Going to Madrid South	50	14.0	1.0	1.0	365.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Doris to Madrid South	Crew Busses 16+ passenger	Going to Madrid South	50	14.0	1.0	16.0	5840.0	6.4	7.0	1.6E+3	4.5E+2	4.5E+1	3.9E+2	1.1E+2	1.1E+1	1.1E-4	3.1E-5	3.1E-6
Doris to Madrid South	Light Vehicle,Ford F350	Going to Madrid South	50	14.0	1.7	40.0	14600.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	1.3E-4	3.7E-5	3.7E-6
Doris to Madrid South	Super B Train Fuel Truck (60,000 L capacity)	Move 2415 tonnes ore per day from Madrid North to Doris. Assume same size truck. 45 tonnes per load.	50	14.0	5.4	130.0	47450.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	1.5E-3	4.4E-4	4.4E-5
Madrid South Portal to middle of Ore Stockpile	CAT 740B	Move 2415 tonnes per day	25	0.3	5.8	138.0	50370.0	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	1.9E-3	5.4E-4	5.4E-5
Madrid South Portal to middle of Waste Rock Pile	CAT 740B	Move 1300 tonnes per day	25	0.4	3.1	74.3	27114.3	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	1.0E-3	2.9E-4	2.9E-5
Doris to Boston	Freightliner	Going to Boston	50	65.0	1.0	4.0	1460.0	31.3	34.5	3.2E+3	9.2E+2	9.2E+1	8.1E+2	2.3E+2	2.3E+1	2.2E-4	6.4E-5	6.4E-6
Doris to Boston	Super B Train Fuel Truck (60,000 L capacity)	Going to Boston. Fuel	50	65.0	1.0	1.0	243.3	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Doris to Boston	INTERNATIONAL BUS	Going to Boston	50	65.0	1.0	1.0	365.0	15.0	16.5	2.3E+3	6.6E+2	6.6E+1	5.8E+2	1.7E+2	1.7E+1	1.6E-4	4.6E-5	4.6E-6
Doris to Boston	Light Vehicle,Ford F350	Going to Boston	50	65.0	1.7	40.0	14600.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	1.3E-4	3.7E-5	3.7E-6
Doris to Boston	Super B Train Fuel Truck (60,000 L capacity)	Move ore from Boston to Doris, before Boston mill is built. 45 tonnes per load. Assume same size truck as super B Fuel truck.	50	65.0	3.5	84.0	30660.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	1.0E-3	2.8E-4	2.8E-5
Doris to Boston	Super B Train Fuel Truck (60,000 L capacity)	Move concentrate from Boston to Doris, after Boston mill is built. 45 tonnes per load. Assume same size truck as super B Fuel truck.	50	65.0	1.0	8.0	2920.0	53.5	59.0	4.1E+3	1.2E+3	1.2E+2	1.0E+3	2.9E+2	2.9E+1	2.9E-4	8.1E-5	8.1E-6
Boston Portal to middle of Ore Stockpile	CAT 740B	Move 1600 tonnes per day	25	1.5	3.8	91.4	33371.4	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	1.3E-3	3.6E-4	3.6E-5
Boston Portal to middle of Waste Rock pile	CAT 740B	Move 710 tonnes per day	25	0.2	1.7	40.6	14808.6	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	5.6E-4	1.6E-4	1.6E-5
Boston Mill to middle of Drystack Tailings	CAT 740B	Move 1600 tonnes per day	25	2.6	3.8	91.4	33371.4	74.0	81.6	4.8E+3	1.4E+3	1.4E+2	1.2E+3	3.4E+2	3.4E+1	1.3E-3	3.6E-4	3.6E-5
Boston camp to portal	Crew Busses 16+ passenger	Move crew to/from portal. Assume same rate as Madrid North crew Movements	25	1.3	1.0	16.0	5840.0	6.4	7.0	1.6E+3	4.5E+2	4.5E+1	3.9E+2	1.1E+2	1.1E+1	1.1E-4	3.1E-5	3.1E-6
Boston airstrip to camp	INTERNATIONAL BUS		25	3.0	1.0	2.0	416.0	15.0	16.5	2.3E+3	6.6E+2	6.6E+1	5.8E+2	1.7E+2	1.7E+1	1.6E-4	4.6E-5	4.6E-6
Boston airstrip to camp	Light Vehicle,Ford F350		25	3.0	1.0	2.0	730.0	2.9	3.2	1.1E+3	3.2E+2	3.2E+1	2.8E+2	7.9E+1	7.9E+0	7.7E-5	2.2E-5	2.2E-6

Table C-9. Unpaved Roads and Travel Routes, Characteristics and Air Emissions

	Tailpipe Emissions						Fugitive + Tailpipe Emissions												
	Tailpipe Emission Rates for CALPUFF Road Source Type (g/s/m).						Fugitive + Tailpipe Emission Rates for CALPUFF Road Source Type (g/s/m)						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Road Portion	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Madrid North Portal to middle of Waste Rock Pile	1.0E-3	1.7E-5	4.5E-4	6.5E-5	6.5E-5	6.3E-5	1.0E-3	1.7E-5	4.5E-4	6.1E-4	2.2E-4	7.9E-5	1.0	1.0	1.0	1	1	0	0
Doris to Madrid South	1.8E-5	2.9E-7	7.7E-6	1.1E-6	1.1E-6	1.1E-6	1.8E-5	2.9E-7	7.7E-6	2.3E-4	6.5E-5	7.5E-6	1.0	0.0	0.0	1	1	0	0
Doris to Madrid South	1.7E-5	2.7E-7	7.3E-6	1.0E-6	1.0E-6	1.0E-6	1.7E-5	2.7E-7	7.3E-6	2.9E-4	8.2E-5	9.2E-6	1.0	0.0	0.0	1	1	0	0
Doris to Madrid South	2.5E-5	1.3E-7	2.6E-4	2.5E-7	2.5E-7	2.3E-7	2.5E-5	1.3E-7	2.6E-4	1.1E-4	3.1E-5	3.3E-6	1.0	0.7	0.7	1	1	0	0
Doris to Madrid South	3.0E-5	4.8E-7	1.3E-5	1.9E-6	1.9E-6	1.8E-6	3.0E-5	4.8E-7	1.3E-5	1.3E-4	3.9E-5	5.5E-6	1.0	1.0	1.0	1	1	0	0
Doris to Madrid South	9.1E-5	1.5E-6	3.9E-5	5.7E-6	5.7E-6	5.5E-6	9.1E-5	1.5E-6	3.9E-5	1.6E-3	4.5E-4	5.0E-5	1.0	1.0	1.0	0	1	0	0
Madrid South Portal to middle of Ore Stockpile	6.1E-3	9.9E-5	2.6E-3	3.8E-4	3.8E-4	3.7E-4	6.1E-3	9.9E-5	2.6E-3	2.3E-3	9.2E-4	4.2E-4	1.0	1.0	1.0	0	1	0	0
Madrid South Portal to middle of Waste Rock Pile	2.5E-3	4.0E-5	1.1E-3	1.5E-4	1.5E-4	1.5E-4	2.5E-3	4.0E-5	1.1E-3	1.2E-3	4.5E-4	1.8E-4	1.0	1.0	1.0	0	1	0	0
Doris to Boston	3.8E-6	6.2E-8	1.7E-6	2.4E-7	2.4E-7	2.3E-7	3.8E-6	6.2E-8	1.7E-6	2.2E-4	6.4E-5	6.6E-6	1.0	0.2	0.2	1	1	1	1
Doris to Boston	3.6E-6	5.8E-8	1.6E-6	2.3E-7	2.3E-7	2.2E-7	3.6E-6	5.8E-8	1.6E-6	2.9E-4	8.2E-5	8.4E-6	1.0	0.0	0.0	1	1	1	1
Doris to Boston	2.5E-6	4.6E-8	1.1E-6	2.0E-7	2.0E-7	2.0E-7	2.5E-6	4.6E-8	1.1E-6	1.6E-4	4.6E-5	4.8E-6	1.0	0.0	0.0	1	0	1	0
Doris to Boston	6.4E-6	1.0E-7	2.8E-6	4.0E-7	4.0E-7	3.9E-7	6.4E-6	1.0E-7	2.8E-6	1.3E-4	3.7E-5	4.1E-6	1.0	1.0	1.0	1	1	1	1
Doris to Boston	1.3E-5	2.0E-7	5.5E-6	7.9E-7	7.9E-7	7.7E-7	1.3E-5	2.0E-7	5.5E-6	1.0E-3	2.9E-4	2.9E-5	1.0	1.0	1.0	1	0	1	0
Doris to Boston	3.6E-6	5.8E-8	1.6E-6	2.3E-7	2.3E-7	2.2E-7	3.6E-6	5.8E-8	1.6E-6	2.9E-4	8.2E-5	8.4E-6	1.0	0.3	0.3	0	1	0	1
Boston Portal to middle of Ore Stockpile	8.1E-4	1.3E-5	3.5E-4	5.1E-5	5.1E-5	4.9E-5	8.1E-4	1.3E-5	3.5E-4	1.3E-3	4.1E-4	8.5E-5	1.0	1.0	1.0	0	0	1	1
Boston Portal to middle of Waste Rock pile	2.7E-3	4.4E-5	1.2E-3	1.7E-4	1.7E-4	1.6E-4	2.7E-3	4.4E-5	1.2E-3	7.3E-4	3.3E-4	1.8E-4	1.0	1.0	1.0	0	0	1	1
Boston Mill to middle of Drystack Tailings	4.7E-4	7.6E-6	2.0E-4	2.9E-5	2.9E-5	2.8E-5	4.7E-4	7.6E-6	2.0E-4	1.3E-3	3.9E-4	6.4E-5	1.0	1.0	1.0	0	0	0	1
Boston camp to portal	2.7E-4	1.4E-6	2.9E-3	2.7E-6	2.7E-6	2.5E-6	2.7E-4	1.4E-6	2.9E-3	1.1E-4	3.4E-5	5.6E-6	1.0	0.7	0.7	0	0	1	1
Boston airstrip to camp	5.5E-5	1.0E-6	2.3E-5	4.4E-6	4.4E-6	4.2E-6	5.5E-5	1.0E-6	2.3E-5	1.7E-4	5.0E-5	8.8E-6	1.0	0.1	0.0	0	0	1	1
Boston airstrip to camp	8.4E-5	1.4E-6	3.6E-5	5.2E-6	5.2E-6	5.1E-6	8.4E-5	1.4E-6	3.6E-5	8.2E-5	2.7E-5	7.3E-6	1.0	0.1	0.1	0	0	1	1

Table C-10. Bulldozing, Characteristics and Air Emissions

					Emission Factors (kg/hr)			Emission Rates (g/s)			Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Bulldozing Location	Approximate Area (m^2)	Material Type Assumption for Calcs.	Estimated Silt Content (%)	Estimated Moisture Content of Material (%)	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris Waste Rock Pile	21400	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	1	1	0	0
Doris Ore Pile	5000	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	1	1	0	0
Madrid North Waste Rock Pile	32888	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	1	0	0
Madrid North Ore Pile	2000	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	1	0	0
Madrid South Waste Rock Pile	45150	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	1	0	0
Madrid South Ore Pile	1162	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	1	0	0
Boston Waste Rock Pile	37500	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	0	0	1
Boston Ore Pile	1600	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	0	0	1
Boston Overburden	16600	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	0	1	0
Boston Tailings	197609	Tailings	51.2	7.9	2.0E+1	6.8E+0	2.1E+0	5.5E+0	1.9E+0	5.8E-1	1.0	1.0	1.0	0	0	0	1
Boston airstrip, construction	322752	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	0	1	0
Boston general camp area, construction	122000	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	0	1	0
Madrid North to Madrid South Road, construction	42900	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	1	0	0	0
Madrid South to Boston Road, construction	583000	Overburden	6.9	7.9	1.8E+0	3.4E-1	1.9E-1	5.0E-1	9.4E-2	5.2E-2	1.0	1.0	1.0	0	0	1	0

Table C-11. Material Transfer Drops, Characteristics and Air Emissions

									Emission Factors (kg/Mg)			Emission Rates (g/s)			Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
Material Drop Location	Approximate Area (m^2)	Material Type Assumption for Calcs.	Estimated Silt Content (%)	Estimated Moisture Content of Material (%)	Transfer Rate (tonnes/ day)	Max Pile Height Above Ground (m)	Median of Measured Hourly Wind Speed at Boston or Doris Met Stn., 2012 - 2014 (m/s), 10 m high anemometer	Estimated Wind speed at Mid Pile Height (m/s)	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris Waste Rock Pile	21400	Overburden	6.9	7.9	1500	25.0	5.2	5.4	5.6E-4	2.6E-4	4.0E-5	9.7E-3	4.6E-3	6.9E-4	1.0	1.0	1.0	1	1	0	0
Doris Ore Pile	5000	Overburden	6.9	7.9	1500	5.0	5.2	4.0	3.7E-4	1.8E-4	2.7E-5	6.4E-3	3.0E-3	4.6E-4	1.0	1.0	1.0	1	1	0	0
Madrid North Waste Rock Pile	32888	Overburden	6.9	7.9	690	20.0	5.2	5.2	5.3E-4	2.5E-4	3.8E-5	4.2E-3	2.0E-3	3.0E-4	1.0	1.0	1.0	0	1	0	0
Madrid North Ore Pile	2000	Overburden	6.9	7.9	3200	7.0	5.2	4.3	4.1E-4	1.9E-4	2.9E-5	1.5E-2	7.2E-3	1.1E-3	1.0	1.0	1.0	0	1	0	0
Madrid South Waste Rock Pile	45150	Overburden	6.9	7.9	2300	20.0	5.2	5.2	5.3E-4	2.5E-4	3.8E-5	1.4E-2	6.7E-3	1.0E-3	1.0	1.0	1.0	0	1	0	0
Madrid South Ore Pile	1162	Overburden	6.9	7.9	2415	5.0	5.2	4.0	3.7E-4	1.8E-4	2.7E-5	1.0E-2	4.9E-3	7.4E-4	1.0	1.0	1.0	0	1	0	0
Boston Waste Rock Pile	37500	Overburden	6.9	7.9	710	23.0	4.9	5.0	5.1E-4	2.4E-4	3.6E-5	4.2E-3	2.0E-3	3.0E-4	1.0	1.0	1.0	0	0	0	1
Boston Ore Pile	1600	Overburden	6.9	7.9	1600	5.0	4.9	3.7	3.4E-4	1.6E-4	2.5E-5	6.4E-3	3.0E-3	4.6E-4	1.0	1.0	1.0	0	0	0	1
Boston Overburden	16600	Overburden	6.9	7.9	1000	5.0	4.9	3.7	3.4E-4	1.6E-4	2.5E-5	4.0E-3	1.9E-3	2.8E-4	1.0	1.0	1.0	0	0	1	0
Boston Tailings	197609	Tailings	51.2	7.9	1600	26.0	4.9	5.1	5.2E-4	2.5E-4	3.7E-5	9.6E-3	4.5E-3	6.9E-4	1.0	1.0	1.0	0	0	0	1

Table C-12. Drilling, Characteristics and Air Emissions

Drilling Sources	Number of Holes per Blast	Number of Holes per Day	Emission Factors (kg/hole)			Emission Rate (g/s), Adjusted Over a 1 h Emission Period. Assumes 1 Set of Holes per Hour.			Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
			TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris, underground. Emissions out of mine vents	5	35	5.9E-1	3.1E-1	3.1E-1	8.2E-1	4.3E-1	4.3E-1	1.0	0.3	0.0	1	0	0	0
Madrid North, underground. Emissions out of mine vents	5	35	5.9E-1	3.1E-1	3.1E-1	8.2E-1	4.3E-1	4.3E-1	1.0	0.3	0.0	0	1	0	0
Madrid South, underground. Emissions out of mine vents	5	35	5.9E-1	3.1E-1	3.1E-1	8.2E-1	4.3E-1	4.3E-1	1.0	0.3	0.0	0	1	0	0
Boston, underground. Emissions out of mine vents	5	35	5.9E-1	3.1E-1	3.1E-1	8.2E-1	4.3E-1	4.3E-1	1.0	0.3	0.0	0	0	0	1
Quarry L, surface (Construction period only)	5	35	5.9E-1	3.1E-1	3.1E-1	8.2E-1	4.3E-1	4.3E-1	1.0	0.3	0.0	1	0	0	0
Quarry U, surface (Construction period only)	5	35	5.9E-1	3.1E-1	3.1E-1	8.2E-1	4.3E-1	4.3E-1	1.0	0.3	0.0	0	0	1	0
Exploration, surface	n/a	1	5.9E-1	3.1E-1	3.1E-1	1.6E-1	8.6E-2	8.6E-2	1.0	0.0	0.0	1	1	1	1

Table C-13. Blasting, Characteristics and Air Emissions

Blasting Sources	Number of Blasts per Day	Amount of ANFO per Day (kg/day)	Amount of ANFO per Blast (kg/blast)	Area Affected per Blast (m^2)	Explosives Used	Emission Factor (kg/tonne of explosive)			Dust Emission Factor (kg/blast)			Emission Rate (g/s), Adjusted Over a 1 h Emission Period. Assumes 1 Blast During the Hour.						Emission Scaling Factors for Averaging Periods			Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
						SO_2	NO_X	CO	TSP	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	TSP	PM_{10}	$PM_{2.5}$	Hourly and 8-hour	Daily	Annual	Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris, underground. Emissions out of mine vents	7	2500	357.1	200.0	ANFO	1.0E+0	8.0E+0	3.4E+1	6.2E-1	3.2E-1	1.9E-2	9.9E-2	7.9E-1	3.4E+0	1.7E-1	9.0E-2	5.2E-3	1.0	0.3	0.0	1	0	0	0
Madrid North, underground. Emissions out of mine vents	7	4670	667.1	200.0	ANFO	1.0E+0	8.0E+0	3.4E+1	6.2E-1	3.2E-1	1.9E-2	1.9E-1	1.5E+0	6.3E+0	1.7E-1	9.0E-2	5.2E-3	1.0	0.3	0.0	0	1	0	0
Madrid South, underground. Emissions out of mine vents	7	4470	638.6	200.0	ANFO	1.0E+0	8.0E+0	3.4E+1	6.2E-1	3.2E-1	1.9E-2	1.8E-1	1.4E+0	6.0E+0	1.7E-1	9.0E-2	5.2E-3	1.0	0.3	0.0	0	1	0	0
Boston, underground. Emissions out of mine vents	7	2770	395.7	200.0	ANFO	1.0E+0	8.0E+0	3.4E+1	6.2E-1	3.2E-1	1.9E-2	1.1E-1	8.8E-1	3.7E+0	1.7E-1	9.0E-2	5.2E-3	1.0	0.3	0.0	0	0	0	1
Quarry L, surface (Construction period only)	7	2000	285.7	2461.0	ANFO	1.0E+0	8.0E+0	3.4E+1	2.7E+1	1.4E+1	8.1E-1	7.9E-2	6.3E-1	2.7E+0	7.5E+0	3.9E+0	2.2E-1	1.0	0.3	0.0	1	0	0	0
Quarry U, surface (Construction period only)	7	2000	285.7	2462.0	ANFO	1.0E+0	8.0E+0	3.4E+1	2.7E+1	1.4E+1	8.1E-1	7.9E-2	6.3E-1	2.7E+0	7.5E+0	3.9E+0	2.2E-1	1.0	0.3	0.0	0	0	1	0

Table C-14. Material Pile Wind Erosion, Characteristics and Air Emissions

Location	Type of Feature	Description	Time Period of Use	Footprint Area (m^2)	Material Transfer Rate (tonne/day)	Threshold Friction Velocity (m/s)	Roughness Height (cm)	Emissions	Modelling Domain Area and Scenario to be Applied (1=yes, 0=no)			
									Northern, Construction	Northern, Operation	Southern, Construction	Southern, Operation
Doris	Waste Rock Pile	Doris Waste Rock Pile	Construction and operations	38,653	1500	0.73	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	1	1	0	0
Doris	Ore stockpile	Doris Ore stockpile	Construction and operations	5,043	1500	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	1	1	0	0
Doris	Overburden	Doris Overburden	Construction and operations	69,808	1500	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	1	1	0	0
Doris	Tailings Impoundment Area Phase 1	Doris Tailings Impoundment Area Phase 1	Construction and operations	273,715	3200	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	1	1	0	0
Doris	Tailings Impoundment Area Phase 2	Doris Tailings Impoundment Area Phase 2	Operations	1,463,419	3200	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	0	1	0	0
Madrid North	Waste Rock Pile	Madrid North Waste Rock Pile	Operations	31,317	690	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	1	1	0	0
Madrid North	Ore stockpile	Madrid North Ore stockpile	Operations	2,051	3200	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	1	1	0	0
Madrid South	Waste Rock Pile	Madrid South Waste Rock Pile	Operations	45,420	2300	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	0	1	0	0
Madrid South	Ore stockpile	Madrid South Ore stockpile	Operations	1,166	2415	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	0	1	0	0
Boston	Waste Rock Pile	Boston Waste Rock Pile	Operations	37,774	710	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	0	0	1	1
Boston	Ore stockpile	Boston Ore stockpile	Operations	1,601	1600	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	0	0	1	1
Boston	Overburden	Boston Overburden	Construction and operations	15,857	1000	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	0	0	1	1
Boston	Tailings (dry stack)	Boston Tailings (dry stack)	Operations	197,609	1600	0.7	0.50	Variable emission rate file used. October to April emissions are zero due to assumed snow-cover.	0	0	0	1

Table C-15. Mobile Surface Equipment, Characteristics and Air Emissions

						Operating Hours Per Day				Emission Factor (g/hp-hr)						Emission Rates (g/s) for All Equipment Qty					
Emission Location Description	Equipment Description	Qty	Fuel Type	Power (hp)	Weight kg	Day (7 am to 10 pm)	Night (10 pm to 7 am)	Operating Days per Year	Assumed Running Load Factor (%)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Boston, Operations	Cement Mixer, FORD LOUISVILLE	1	Diesel	305	27,216	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	2.9E-1	2.9E-1	2.8E-1	3.6E-1	3.2E-3	1.2E-1	1.7E-2	1.7E-2	1.7E-2
Boston, Operations	Compressor ,	1	Diesel	475	7,376	15	9	365	70	5.2E+0	5.4E-2	1.7E+0	2.6E-1	2.6E-1	2.5E-1	4.8E-1	4.9E-3	1.5E-1	2.4E-2	2.4E-2	2.3E-2
Boston, Operations	Dozer, Cat D6R	3	Diesel	198	18,325	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	4.1E-1	6.3E-3	1.4E-1	2.8E-2	2.8E-2	2.7E-2
Boston, Operations	Drill Rig, SANDVIK DX800	7	Diesel	225	15,200	15	9	365	70	5.9E+0	5.4E-2	1.8E+0	3.4E-1	3.4E-1	3.3E-1	1.8E+0	1.6E-2	5.4E-1	1.0E-1	1.0E-1	1.0E-1
Boston, Operations	Elevated Work Platform, JLG Manlift	11	Diesel	49	6,187	15	9	365	70	6.4E+0	7.0E-2	8.7E+0	1.2E+0	1.2E+0	1.2E+0	6.7E-1	7.3E-3	9.1E-1	1.3E-1	1.3E-1	1.2E-1
Boston, Operations	Excavator (30T+), Cat 325DL	3	Diesel	204	29,240	15	9	365	70	3.4E+0	5.4E-2	1.2E+0	2.3E-1	2.3E-1	2.2E-1	4.0E-1	6.5E-3	1.5E-1	2.7E-2	2.7E-2	2.7E-2
Boston, Operations	Grader ,	2	Diesel	259	24,375	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	3.6E-1	5.5E-3	1.2E-1	2.4E-2	2.4E-2	2.3E-2
Boston, Operations	Heavy Vehicle	5	Diesel	370	52,100	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	1.2E+0	2.0E-2	5.2E-1	7.5E-2	7.5E-2	7.3E-2
Boston, Operations	Light Vehicle,Ford F350	33	Diesel	385	2,926	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	8.3E+0	1.3E-1	3.6E+0	5.2E-1	5.2E-1	5.0E-1
Boston, Operations	Lighting Tower, WACKER LTC4	14	Diesel	11	815	15	9	365	70	5.6E+0	5.9E-2	4.6E+0	6.0E-1	6.0E-1	5.9E-1	1.7E-1	1.8E-3	1.4E-1	1.8E-2	1.8E-2	1.7E-2
Boston, Operations	Loader (Large), Cat 980H	3	Diesel	349	30,519	15	9	365	70	4.6E+0	5.4E-2	2.0E+0	2.7E-1	2.7E-1	2.6E-1	9.4E-1	1.1E-2	4.1E-1	5.5E-2	5.5E-2	5.3E-2
Boston, Operations	Loader (Small), Cat 930H	3	Diesel	150	13,029	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	3.6E-1	4.7E-3	1.3E-1	2.9E-2	2.9E-2	2.8E-2
Boston, Operations	Mobile Crane, Grove RT625	2	Diesel	156	24,548	15	9	365	70	4.3E+0	5.4E-2	1.0E+0	2.4E-1	2.4E-1	2.4E-1	2.6E-1	3.3E-3	6.2E-2	1.5E-2	1.5E-2	1.4E-2
Boston, Operations	Pump, ALLENTOWN ELITE 40	6	Diesel	96	2,720	15	9	365	70	5.8E+0	5.9E-2	3.2E+0	6.1E-1	6.1E-1	5.9E-1	6.5E-1	6.7E-3	3.6E-1	6.8E-2	6.8E-2	6.6E-2
Boston, Operations	Roller (Vibratory), CAT CS563	1	Diesel	145	11,130	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	1.2E-1	1.5E-3	4.3E-2	9.2E-3	9.2E-3	9.0E-3
Boston, Operations	Shredder, Shredall	1	Diesel	125	4,082	15	9	365	70	4.5E+0	5.4E-2	1.1E+0	2.5E-1	2.5E-1	2.4E-1	1.1E-1	1.3E-3	2.6E-2	6.1E-3	6.1E-3	5.9E-3
Boston, Operations	Snow Cat, Tucker	2	Diesel	173	5,443	15	9	365	70	4.5E+0	5.4E-2	1.1E+0	2.5E-1	2.5E-1	2.4E-1	3.0E-1	3.6E-3	7.2E-2	1.7E-2	1.7E-2	1.6E-2
Boston, Operations	Telehandler, Cat TL943	2	Diesel	99	11,814	15	9	365	70	4.7E+0	6.0E-2	4.0E+0	5.8E-1	5.8E-1	5.6E-1	1.8E-1	2.3E-3	1.6E-1	2.2E-2	2.2E-2	2.2E-2
Boston, Operations	Tracked Loader (Small), Cat 277B	4	Diesel	78	4,269	15	9	365	70	6.7E+0	7.0E-2	8.3E+0	1.3E+0	1.3E+0	1.2E+0	4.1E-1	4.2E-3	5.0E-1	7.8E-2	7.8E-2	7.6E-2
Boston, Operations	Truck, Kenworth - Fuel Truck	9	Diesel	330	25,855	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	1.9E+0	3.1E-2	8.4E-1	1.2E-1	1.2E-1	1.2E-1
Boston, Operations	Water Truck, PETERBUILT	1	Diesel	360	27,216	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.3E-1	3.8E-3	1.0E-1	1.5E-2	1.5E-2	1.4E-2
Boston, Operations	Tractor, KUBOTA	1	Diesel	128	6,598	15	9	365	70	3.8E+0	5.4E-2	1.5E+0	3.2E-1	3.2E-1	3.1E-1	9.4E-2	1.3E-3	3.6E-2	7.9E-3	7.9E-3	7.7E-3
Boston, Operations	Welder, LINCOLN WELDER 300-D	3	Diesel	36	599	15	9	365	70	6.1E+0	7.0E-2	7.5E+0	1.1E+0	1.1E+0	1.1E+0	1.3E-1	1.4E-3	1.6E-1	2.3E-2	2.3E-2	2.2E-2
Boston, Operations	Super B Train Fuel Truck (60,000 L capacity)	1	Diesel	360	53,500	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.3E-1	3.8E-3	1.0E-1	1.5E-2	1.5E-2	1.4E-2
Quarry	CAT D8 Dozer	3	Diesel	312	39,420	15	9	365	70	4.2E+0	5.4E-2	1.8E+0	2.3E-1	2.3E-1	2.2E-1	7.6E-1	9.9E-3	3.2E-1	4.2E-2	4.2E-2	4.1E-2
Quarry	CAT 345 Excavator	1	Diesel	380	45,375	15	9	365	70	3.9E+0	5.4E-2	1.6E+0	2.2E-1	2.2E-1	2.1E-1	2.9E-1	4.0E-3	1.2E-1	1.6E-2	1.6E-2	1.6E-2
Quarry	CAT 988 Loader	1	Diesel	501	50,144	15	9	365	70	4.6E+0	5.4E-2	2.0E+0	2.7E-1	2.7E-1	2.6E-1	4.5E-1	5.3E-3	2.0E-1	2.6E-2	2.6E-2	2.6E-2
Quarry	Air rotary drill	1	Diesel	385	21,772	15	9	365	70	6.1E+0	5.4E-2	2.0E+0	3.2E-1	3.2E-1	3.1E-1	4.6E-1	4.0E-3	1.5E-1	2.4E-2	2.4E-2	2.3E-2
Quarry	Mobile Crusher	1	Diesel	440	64,340	15	9	365	70	5.1E+0	5.4E-2	1.5E+0	2.2E-1	2.2E-1	2.2E-1	4.3E-1	4.6E-3	1.3E-1	1.9E-2	1.9E-2	1.9E-2
Quarry	930 Loader	3	Diesel	156	13,829	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	3.7E-1	4.9E-3	1.4E-1	3.0E-2	3.0E-2	2.9E-2
Quarry	988 Loader/ITC	3	Diesel	501	50,144	15	9	365	70	4.6E+0	5.4E-2	2.0E+0	2.7E-1	2.7E-1	2.6E-1	1.4E+0	1.6E-2	5.9E-1	7.9E-2	7.9E-2	7.7E-2
Quarry	730 Rock Truck	2	Diesel	370	52,100	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	4.8E-1	7.8E-3	2.1E-1	3.0E-2	3.0E-2	2.9E-2
Quarry	CAT 773 Rock Truck	1	Diesel	724	102,740	15	9	365	70	3.3E+0	5.4E-2	2.2E+0	2.2E-1	2.2E-1	2.1E-1	4.7E-1	7.6E-3	3.1E-1	3.0E-2	3.0E-2	2.9E-2
Quarry	D6 Dozer	1	Diesel	198	18,325	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	1.4E-1	2.1E-3	4.8E-2	9.2E-3	9.2E-3	8.9E-3
Quarry	14M grader	2	Diesel	259	24,375	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	3.6E-1	5.5E-3	1.2E-1	2.4E-2	2.4E-2	2.3E-2
Quarry	Snow Cat, Tucker	2	Diesel	173	5,443	15	9	365	70	4.5E+0	5.4E-2	1.1E+0	2.5E-1	2.5E-1	2.4E-1	3.0E-1	3.6E-3	7.2E-2	1.7E-2	1.7E-2	1.6E-2
Quarry	130T RT Crane	1	Diesel	300	60,651	15	9	365	70	4.1E+0	5.4E-2	8.8E-1	1.8E-1	1.8E-1	1.8E-1	2.4E-1	3.1E-3	5.1E-2	1.1E-2	1.1E-2	1.0E-2
Quarry	30T RT Crane	1	Diesel	139	24,450	15	9	365	70	4.3E+0	5.4E-2	1.0E+0	2.4E-1	2.4E-1	2.4E-1	1.2E-1	1.4E-3	2.8E-2	6.6E-3	6.6E-3	6.4E-3
Quarry	Telehandler - 10T	3	Diesel	142	16,267	15	9	365	70	4.3E+0	5.4E-2	1.6E+0	3.4E-1	3.4E-1	3.3E-1	3.6E-1	4.5E-3	1.4E-1	2.8E-2	2.8E-2	2.7E-2
Quarry	Aerial work Platforms (90; min)	2	Diesel	59	9,200	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	1.6E-1	1.6E-3	1.6E-1	2.5E-2	2.5E-2	2.4E-2
Quarry	Yard Forklift	1	Diesel	94	7,031	15	9	365	70	4.7E+0	6.0E-2	4.0E+0	5.8E-1	5.8E-1	5.6E-1	8.6E-2	1.1E-3	7.4E-2	1.1E-2	1.1E-2	1.0E-2
Quarry	Reimer batch truck	1	Diesel	330	25,000	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.1E-1	3.5E-3	9.3E-2	1.3E-2	1.3E-2	1.3E-2
Quarry	Concrete trans-mixer	3	Diesel	330	25,000	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	2.9E-1	2.9E-1	2.8E-1	1.2E+0	1.0E-2	3.7E-1	5.6E-2	5.6E-2	5.4E-2
Quarry	RIMPULL Tundra Hauler	1	Diesel	1,500	37,000	15	9	365	70	4.9E+0	5.4E-2	1.3E+0	2.0E-1	2.0E-1	2.0E-1	1.4E+0	1.6E-2	3.9E-1	5.9E-2	5.9E-2	5.7E-2
Quarry	Pickup trucks	12	Diesel	440	6,350	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	3.4E+0	5.6E-2	1.5E+0	2.2E-1	2.2E-1	2.1E-1
Quarry	Gator Utility Transports	3	Gasoline	62	648	15	9	365	70	7.1E+0	3.7E-2	7.5E+1	7.1E-2	7.1E-2	6.5E-2	2.6E-1	1.3E-3	2.7E+0	2.6E-3	2.6E-3	2.4E-3
Quarry	Crew Busses 16+ passenger	3	Gasoline	255	6,350	15	9	365	70	7.1E+0	3.7E-2	7.5E+1	7.1E-2	7.1E-2	6.5E-2	1.1E+0	5.5E-3	1.1E+1	1.1E-2	1.1E-2	9.7E-3
Quarry	Water truck	2	Diesel	360	27,216	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	4.7E-1	7.6E-3	2.0E-1	2.9E-2	2.9E-2	2.8E-2
Quarry	Vacuum Truck	1	Diesel	550	36,287	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	3.6E-1	5.8E-3	1.6E-1	2.2E-2	2.2E-2	2.2E-2

Table C-15. Mobile Surface Equipment, Characteristics and Air Emissions

						Operating Hours Per Day				Emission Factor (g/hp-hr)						Emission Rates (g/s) for All Equipment Qty					
Emission Location Description	Equipment Description	Qty	Fuel Type	Power (hp)	Weight kg	Day (7 am to 10 pm)	Night (10 pm to 7 am)	Operating Days per Year	Assumed Running Load Factor (%)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Madrid North and Madrid South, Operation	Cement Mixer, FORD LOUIVILLE	1	Diesel	305	27,216	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	2.9E-1	2.9E-1	2.8E-1	3.6E-1	3.2E-3	1.2E-1	1.7E-2	1.7E-2	1.7E-2
Madrid North and Madrid South, Operation	Compressor , 107 @ 0m, 107 LwA	3	Diesel	475	7,376	15	9	365	70	5.2E+0	5.4E-2	1.7E+0	2.6E-1	2.6E-1	2.5E-1	1.4E+0	1.5E-2	4.6E-1	7.1E-2	7.1E-2	6.9E-2
Madrid North and Madrid South, Operation	Dozer, Cat D6R	2	Diesel	198	18,325	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	2.8E-1	4.2E-3	9.5E-2	1.8E-2	1.8E-2	1.8E-2
Madrid North and Madrid South, Operation	Drill Rig, SANDVIK DX800	7	Diesel	225	15,200	15	9	365	70	5.9E+0	5.4E-2	1.8E+0	3.4E-1	3.4E-1	3.3E-1	1.8E+0	1.6E-2	5.4E-1	1.0E-1	1.0E-1	1.0E-1
Madrid North and Madrid South, Operation	Elevated Work Platform, JLG Manlift	11	Diesel	49	6,187	15	9	365	70	6.4E+0	7.0E-2	8.7E+0	1.2E+0	1.2E+0	1.2E+0	6.7E-1	7.3E-3	9.1E-1	1.3E-1	1.3E-1	1.2E-1
Madrid North and Madrid South, Operation	Excavator (30T+), Cat 325DL	3	Diesel	204	29,240	15	9	365	70	3.4E+0	5.4E-2	1.2E+0	2.3E-1	2.3E-1	2.2E-1	4.0E-1	6.5E-3	1.5E-1	2.7E-2	2.7E-2	2.7E-2
Madrid North and Madrid South, Operation	Grader, 83 dB @ 15m, 115 LwA	2	Diesel	259	24,375	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	3.6E-1	5.5E-3	1.2E-1	2.4E-2	2.4E-2	2.3E-2
Madrid North and Madrid South, Operation	Heavy Vehicle (idling, in use), 91 dB @ 7m, 116 LwA	5	Diesel	370	52,100	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	1.2E+0	2.0E-2	5.2E-1	7.5E-2	7.5E-2	7.3E-2
Madrid North and Madrid South, Operation	Light Vehicle (Idling), Ford F350	33	Diesel	385	2,926	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	8.3E+0	1.3E-1	3.6E+0	5.2E-1	5.2E-1	5.0E-1
Madrid North and Madrid South, Operation	Lighting Tower, WACKER LTC4	14	Diesel	11	815	15	9	365	70	5.6E+0	5.9E-2	4.6E+0	6.0E-1	6.0E-1	5.9E-1	1.7E-1	1.8E-3	1.4E-1	1.8E-2	1.8E-2	1.7E-2
Madrid North and Madrid South, Operation	Loader (Large), Cat 980H	3	Diesel	349	30,519	15	9	365	70	4.6E+0	5.4E-2	2.0E+0	2.7E-1	2.7E-1	2.6E-1	9.4E-1	1.1E-2	4.1E-1	5.5E-2	5.5E-2	5.3E-2
Madrid North and Madrid South, Operation	Loader (Small), Cat 930H	3	Diesel	150	13,029	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	3.6E-1	4.7E-3	1.3E-1	2.9E-2	2.9E-2	2.8E-2
Madrid North and Madrid South, Operation	Mobile Crane, Grove RT625	2	Diesel	156	24,548	15	9	365	70	4.3E+0	5.4E-2	1.0E+0	2.4E-1	2.4E-1	2.4E-1	2.6E-1	3.3E-3	6.2E-2	1.5E-2	1.5E-2	1.4E-2
Madrid North and Madrid South, Operation	Pump, ALLENTOWN ELITE 40	6	Diesel	96	2,720	15	9	365	70	5.8E+0	5.9E-2	3.2E+0	6.1E-1	6.1E-1	5.9E-1	6.5E-1	6.7E-3	3.6E-1	6.8E-2	6.8E-2	6.6E-2
Madrid North and Madrid South, Operation	Roller (Vibratory), CAT CS563	1	Diesel	145	11,130	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	1.2E-1	1.5E-3	4.3E-2	9.2E-3	9.2E-3	9.0E-3
Madrid North and Madrid South, Operation	Shredder, Shredall	1	Diesel	125	4,082	15	9	365	70	4.5E+0	5.4E-2	1.1E+0	2.5E-1	2.5E-1	2.4E-1	1.1E-1	1.3E-3	2.6E-2	6.1E-3	6.1E-3	5.9E-3
Madrid North and Madrid South, Operation	Snow Cat, Tucker	2	Diesel	173	5,443	15	9	365	70	4.5E+0	5.4E-2	1.1E+0	2.5E-1	2.5E-1	2.4E-1	3.0E-1	3.6E-3	7.2E-2	1.7E-2	1.7E-2	1.6E-2
Madrid North and Madrid South, Operation	Telehandler, Cat TL943	2	Diesel	99	11,814	15	9	365	70	4.7E+0	6.0E-2	4.0E+0	5.8E-1	5.8E-1	5.6E-1	1.8E-1	2.3E-3	1.6E-1	2.2E-2	2.2E-2	2.2E-2
Madrid North and Madrid South, Operation	Tracked Loader (Small), Cat 277B	4	Diesel	78	4,269	15	9	365	70	6.7E+0	7.0E-2	8.3E+0	1.3E+0	1.3E+0	1.2E+0	4.1E-1	4.2E-3	5.0E-1	7.8E-2	7.8E-2	7.6E-2
Madrid North and Madrid South, Operation	Truck, Kenworth - Fuel Truck	9	Diesel	330	25,855	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	1.9E+0	3.1E-2	8.4E-1	1.2E-1	1.2E-1	1.2E-1
Madrid North and Madrid South, Operation	Water Truck, PETERBUILT	1	Diesel	360	27,216	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.3E-1	3.8E-3	1.0E-1	1.5E-2	1.5E-2	1.4E-2
Madrid North and Madrid South, Operation	Tractor, KUBOTA	1	Diesel	128	6,598	15	9	365	70	3.8E+0	5.4E-2	1.5E+0	3.2E-1	3.2E-1	3.1E-1	9.4E-2	1.3E-3	3.6E-2	7.9E-3	7.9E-3	7.7E-3
Madrid North and Madrid South, Operation	Welder, LINCOLN WELDER 300-D	3	Diesel	36	599	15	9	365	70	6.1E+0	7.0E-2	7.5E+0	1.1E+0	1.1E+0	1.1E+0	1.3E-1	1.4E-3	1.6E-1	2.3E-2	2.3E-2	2.2E-2
Madrid North, Madrid South and Boston, Construction	Welder, LINCOLN WELDER 300-D	1	Diesel	36	599	15	9	365	70	6.1E+0	7.0E-2	7.5E+0	1.1E+0	1.1E+0	1.1E+0	4.2E-2	4.8E-4	5.2E-2	7.7E-3	7.7E-3	7.5E-3
Madrid North, Madrid South and Boston, Construction	Dozer ,CAT D8 Dozer	2	Diesel	312	39,420	15	9	365	70	4.2E+0	5.4E-2	1.8E+0	2.3E-1	2.3E-1	2.2E-1	5.1E-1	6.6E-3	2.1E-1	2.8E-2	2.8E-2	2.7E-2

Table C-15. Mobile Surface Equipment, Characteristics and Air Emissions

						Operating Hours Per Day				Emission Factor (g/hp-hr)						Emission Rates (g/s) for All Equipment Qty					
Emission Location Description	Equipment Description	Qty	Fuel Type	Power (hp)	Weight kg	Day (7 am to 10 pm)	Night (10 pm to 7 am)	Operating Days per Year	Assumed Running Load Factor (%)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Madrid North, Madrid South and Boston, Construction	Excavator (30T+) ,CAT 345 Excavator	1	Diesel	380	45,375	15	9	365	70	3.9E+0	5.4E-2	1.6E+0	2.2E-1	2.2E-1	2.1E-1	2.9E-1	4.0E-3	1.2E-1	1.6E-2	1.6E-2	1.6E-2
Madrid North, Madrid South and Boston, Construction	Loader (Large) ,CAT 988 Loader	1	Diesel	501	50,144	15	9	365	70	4.6E+0	5.4E-2	2.0E+0	2.7E-1	2.7E-1	2.6E-1	4.5E-1	5.3E-3	2.0E-1	2.6E-2	2.6E-2	2.6E-2
Madrid North, Madrid South and Boston, Construction	Drill (Blasting Prep) ,Air rotary drill	1	Diesel	385	21,772	15	9	365	70	6.1E+0	5.4E-2	2.0E+0	3.2E-1	3.2E-1	3.1E-1	4.6E-1	4.0E-3	1.5E-1	2.4E-2	2.4E-2	2.3E-2
Madrid North, Madrid South and Boston, Construction	Crusher ,Mobile Crusher	1	Diesel	440	64,340	15	9	365	70	5.1E+0	5.4E-2	1.5E+0	2.2E-1	2.2E-1	2.2E-1	4.3E-1	4.6E-3	1.3E-1	1.9E-2	1.9E-2	1.9E-2
Madrid North, Madrid South and Boston, Construction	930 Loader	3	Diesel	156	13,829	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	3.7E-1	4.9E-3	1.4E-1	3.0E-2	3.0E-2	2.9E-2
Madrid North, Madrid South and Boston, Construction	988 Loader/ITC	3	Diesel	501	50,144	15	9	365	70	4.6E+0	5.4E-2	2.0E+0	2.7E-1	2.7E-1	2.6E-1	1.4E+0	1.6E-2	5.9E-1	7.9E-2	7.9E-2	7.7E-2
Madrid North, Madrid South and Boston, Construction	730 Rock Truck	2	Diesel	370	52,100	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	4.8E-1	7.8E-3	2.1E-1	3.0E-2	3.0E-2	2.9E-2
Madrid North, Madrid South and Boston, Construction	CAT D8 Dozer	1	Diesel	312	39,420	15	9	365	70	4.2E+0	5.4E-2	1.8E+0	2.3E-1	2.3E-1	2.2E-1	2.5E-1	3.3E-3	1.1E-1	1.4E-2	1.4E-2	1.4E-2
Madrid North, Madrid South and Boston, Construction	D6 Dozer	1	Diesel	198	18,325	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	1.4E-1	2.1E-3	4.8E-2	9.2E-3	9.2E-3	8.9E-3
Madrid North, Madrid South and Boston, Construction	14M grader	2	Diesel	259	24,375	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	3.6E-1	5.5E-3	1.2E-1	2.4E-2	2.4E-2	2.3E-2
Madrid North, Madrid South and Boston, Construction	Snow cat	2	Diesel	173	5,443	15	9	365	70	4.5E+0	5.4E-2	1.1E+0	2.5E-1	2.5E-1	2.4E-1	3.0E-1	3.6E-3	7.2E-2	1.7E-2	1.7E-2	1.6E-2
Madrid North, Madrid South and Boston, Construction	130T RT Crane	1	Diesel	320	60,651	15	9	365	70	4.9E+0	5.4E-2	1.4E+0	2.1E-1	2.1E-1	2.1E-1	3.1E-1	3.3E-3	8.5E-2	1.3E-2	1.3E-2	1.3E-2
Madrid North, Madrid South and Boston, Construction	30T RT Crane	1	Diesel	139	24,450	15	9	365	70	4.3E+0	5.4E-2	1.0E+0	2.4E-1	2.4E-1	2.4E-1	1.2E-1	1.4E-3	2.8E-2	6.6E-3	6.6E-3	6.4E-3
Madrid North, Madrid South and Boston, Construction	Telehandler - 10T	3	Diesel	142	16,267	15	9	365	70	4.3E+0	5.4E-2	1.6E+0	3.4E-1	3.4E-1	3.3E-1	3.6E-1	4.5E-3	1.4E-1	2.8E-2	2.8E-2	2.7E-2
Madrid North, Madrid South and Boston, Construction	Aerial work Platforms (90; min)	2	Diesel	59	9,200	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	1.6E-1	1.6E-3	1.6E-1	2.5E-2	2.5E-2	2.4E-2
Madrid North, Madrid South and Boston, Construction	Yard Forklift	1	Diesel	94	7,031	15	9	365	70	4.7E+0	6.0E-2	4.0E+0	5.8E-1	5.8E-1	5.6E-1	8.6E-2	1.1E-3	7.4E-2	1.1E-2	1.1E-2	1.0E-2
Madrid North, Madrid South and Boston, Construction	Reimer batch truck	1	Diesel	330	25,000	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.1E-1	3.5E-3	9.3E-2	1.3E-2	1.3E-2	1.3E-2
Madrid North, Madrid South and Boston, Construction	Concrete trans-mixer	3	Diesel	330	25,000	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	2.9E-1	2.9E-1	2.8E-1	1.2E+0	1.0E-2	3.7E-1	5.6E-2	5.6E-2	5.4E-2
Madrid North, Madrid South and Boston, Construction	RIMPULL Tundra Hauler	1	Diesel	1,500	37,000	15	9	365	70	4.9E+0	5.4E-2	1.3E+0	2.0E-1	2.0E-1	2.0E-1	1.4E+0	1.6E-2	3.9E-1	5.9E-2	5.9E-2	5.7E-2
Madrid North, Madrid South and Boston, Construction	Pickup trucks	12	Diesel	440	6,350	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	3.4E+0	5.6E-2	1.5E+0	2.2E-1	2.2E-1	2.1E-1
Madrid North, Madrid South and Boston, Construction	Gator Utility Transports	3	Gasoline	62	648	15	9	365	70	7.1E+0	3.7E-2	7.5E+1	7.1E-2	7.1E-2	6.5E-2	2.6E-1	1.3E-3	2.7E+0	2.6E-3	2.6E-3	2.4E-3
Madrid North, Madrid South and Boston, Construction	Crew Busses 16+ passenger	3	Gasoline	255	6,350	15	9	365	70	7.1E+0	3.7E-2	7.5E+1	7.1E-2	7.1E-2	6.5E-2	1.1E+0	5.5E-3	1.1E+1	1.1E-2	1.1E-2	9.7E-3
Madrid North, Madrid South and Boston, Construction	Water truck	2	Diesel	360	27,216	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	4.7E-1	7.6E-3	2.0E-1	2.9E-2	2.9E-2	2.8E-2
Madrid North, Madrid South and Boston, Construction	Vacuum Truck	1	Diesel	550	36,287	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	3.6E-1	5.8E-3	1.6E-1	2.2E-2	2.2E-2	2.2E-2

Table C-15. Mobile Surface Equipment, Characteristics and Air Emissions

Emission Location Description	Equipment Description	Qty	Fuel Type	Power (hp)	Weight kg	Operating Hours Per Day: Day (7 am to 10 pm)	Operating Hours Per Day: Night (10 pm to 7 am)	Operating Days per Year	Assumed Running Load Factor (%)	Emission Factor (g/hp-hr): NO_X	Emission Factor (g/hp-hr): SO_2	Emission Factor (g/hp-hr): CO	Emission Factor (g/hp-hr): TSP	Emission Factor (g/hp-hr): PM_{10}	Emission Factor (g/hp-hr): $PM_{2.5}$	Emission Rates (g/s) for All Equipment Qty: NO_X	Emission Rates (g/s) for All Equipment Qty: SO_2	Emission Rates (g/s) for All Equipment Qty: CO	Emission Rates (g/s) for All Equipment Qty: TSP	Emission Rates (g/s) for All Equipment Qty: PM_{10}	Emission Rates (g/s) for All Equipment Qty: $PM_{2.5}$
Doris North	Light Vehicle, Ford F250	2	Diesel	440	2,721	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	5.7E-1	9.3E-3	2.5E-1	3.6E-2	3.6E-2	3.5E-2
Doris North	Ford F550	8	Diesel	330	8,845	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	1.7E+0	2.8E-2	7.5E-1	1.1E-1	1.1E-1	1.0E-1
Doris North	Ford E550	2	Diesel	288	8,845	15	9	365	70	3.0E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	3.3E-1	6.1E-3	1.4E-1	2.6E-2	2.6E-2	2.6E-2
Doris North	CAT TL1255	1	Diesel	142	16,267	15	9	365	70	4.3E+0	5.4E-2	1.6E+0	3.4E-1	3.4E-1	3.3E-1	1.2E-1	1.5E-3	4.5E-2	9.3E-3	9.3E-3	9.0E-3
Doris North	CAT 308CCR	1	Diesel	54	8,040	15	9	365	70	4.2E+0	6.0E-2	3.4E+0	4.0E-1	4.0E-1	3.9E-1	4.4E-2	6.3E-4	3.6E-2	4.2E-3	4.2E-3	4.0E-3
Doris North	CAT 725 (Articulated Truck)	1	Diesel	320	46,820	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.1E-1	3.4E-3	9.0E-2	1.3E-2	1.3E-2	1.3E-2
Doris North	CAT 140G	1	Diesel	150	12,620	15	9	365	70	3.7E+0	5.4E-2	1.4E+0	3.2E-1	3.2E-1	3.1E-1	1.1E-1	1.6E-3	4.2E-2	9.3E-3	9.3E-3	9.0E-3
Doris North	Freightliner	1	Diesel	380	31,298	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.5E-1	4.0E-3	1.1E-1	1.5E-2	1.5E-2	1.5E-2
Doris North	Manlift Geinie S-80	1	Diesel	74	16,106	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	1.0E-1	1.0E-3	9.9E-2	1.5E-2	1.5E-2	1.5E-2
Doris North	Manlift Geinie GS-5390	1	Diesel	48	9,190	15	9	365	70	6.4E+0	7.0E-2	8.7E+0	1.2E+0	1.2E+0	1.2E+0	5.9E-2	6.5E-4	8.1E-2	1.1E-2	1.1E-2	1.1E-2
Doris North	Manlift Geinie S-60	1	Diesel	74	9,408	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	1.0E-1	1.0E-3	9.9E-2	1.5E-2	1.5E-2	1.5E-2
Doris North	Manlift Geinie S-85	1	Diesel	74	17,237	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	1.0E-1	1.0E-3	9.9E-2	1.5E-2	1.5E-2	1.5E-2
Doris North	Manlift Geinie S-65	2	Diesel	74	10,102	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	2.1E-1	2.0E-3	2.0E-1	3.1E-2	3.1E-2	3.0E-2
Doris North	Manlift Geinie Z60-34	1	Diesel	51	10,215	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	7.1E-2	6.9E-4	6.8E-2	1.1E-2	1.1E-2	1.0E-2
Doris North	Manlift Geinie	1	Diesel	74	10,102	15	9	365	70	7.1E+0	7.0E-2	6.9E+0	1.1E+0	1.1E+0	1.0E+0	1.0E-1	1.0E-3	9.9E-2	1.5E-2	1.5E-2	1.5E-2
Doris North	Link Belt RTC 80130	1	Diesel	333	59,951	15	9	365	70	4.9E+0	5.4E-2	1.4E+0	2.1E-1	2.1E-1	2.1E-1	3.2E-1	3.5E-3	8.8E-2	1.4E-2	1.4E-2	1.3E-2
Doris North	TEREX REACH STACKER FC45	1	Diesel	345	7,258	15	9	365	70	4.9E+0	5.4E-2	2.4E+0	3.2E-1	3.2E-1	3.1E-1	3.3E-1	3.6E-3	1.6E-1	2.2E-2	2.2E-2	2.1E-2
Doris North	Truck, Sterling - Fuel Truck	1	Diesel	335	29,366	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.2E-1	3.5E-3	9.5E-2	1.4E-2	1.4E-2	1.3E-2
Doris North	Kenworth T170MEC	1	Diesel	325	8,845	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.1E-1	3.4E-3	9.2E-2	1.3E-2	1.3E-2	1.3E-2
Doris North	Kenworth T370 FUEL	1	Diesel	350	19,051	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	2.3E-1	3.7E-3	9.9E-2	1.4E-2	1.4E-2	1.4E-2
Doris North	Peterbuilt - Roll off	1	Diesel	260	11,793	15	9	365	70	3.0E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	1.5E-1	2.7E-3	6.3E-2	1.2E-2	1.2E-2	1.2E-2
Doris North	Magnum - Light tower	8	Diesel	13	848	15	9	365	70	5.2E+0	5.9E-2	2.9E+0	4.4E-1	4.4E-1	4.2E-1	1.1E-1	1.2E-3	5.9E-2	8.9E-3	8.9E-3	8.6E-3
Doris North	Snow Cat, BR350S	1	Diesel	350	18,542	15	9	365	70	5.4E+0	5.4E-2	1.5E+0	2.4E-1	2.4E-1	2.4E-1	3.6E-1	3.6E-3	1.0E-1	1.7E-2	1.7E-2	1.6E-2
Doris North	SULLAIR COMPRESSOR 1600	1	Diesel	475	7,376	15	9	365	70	5.2E+0	5.4E-2	1.7E+0	2.6E-1	2.6E-1	2.5E-1	4.8E-1	4.9E-3	1.5E-1	2.4E-2	2.4E-2	2.3E-2
Doris North	INGERSOLL COMPRESSOR 185 CFM	1	Diesel	48	968	15	9	365	70	4.8E+0	6.0E-2	1.8E+0	3.6E-1	3.6E-1	3.5E-1	4.5E-2	5.6E-4	1.7E-2	3.3E-3	3.3E-3	3.2E-3
Doris North	CAT 14Hr	1	Diesel	240	18,809	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	1.7E-1	2.5E-3	5.8E-2	1.1E-2	1.1E-2	1.1E-2
Doris North	CAT 740B	3	Diesel	489	73,990	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	9.5E-1	1.5E-2	4.1E-1	6.0E-2	6.0E-2	5.8E-2
Doris North	Geotech 3500	5	Gasoline	8	54	15	9	365	70	5.3E+0	5.1E-2	3.1E+2	1.1E-1	1.1E-1	1.1E-1	4.1E-2	4.0E-4	2.4E+0	8.9E-4	8.9E-4	8.2E-4
Doris North	Geotech 5500	1	Gasoline	12	87	15	9	365	70	5.3E+0	5.1E-2	3.1E+2	1.1E-1	1.1E-1	1.1E-1	1.2E-2	1.2E-4	7.2E-1	2.7E-4	2.7E-4	2.5E-4
Doris North	INTERNATIONAL BUS	1	Diesel	285	14,969	15	9	365	70	3.0E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	1.6E-1	3.0E-3	6.9E-2	1.3E-2	1.3E-2	1.3E-2
Doris North	John Deer Gator	1	Gasoline	62	648	15	9	365	70	7.1E+0	3.7E-2	7.5E+1	7.1E-2	7.1E-2	6.5E-2	8.6E-2	4.4E-4	9.0E-1	8.5E-4	8.5E-4	7.8E-4
Doris North	MERCEDES BUS	1	Diesel	225	11,680	15	9	365	70	3.0E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	1.3E-1	2.4E-3	5.4E-2	1.0E-2	1.0E-2	1.0E-2
Doris North	Zoom Boom 10-55	1	Diesel	110	14,700	15	9	365	70	4.3E+0	5.4E-2	1.6E+0	3.4E-1	3.4E-1	3.3E-1	9.2E-2	1.2E-3	3.5E-2	7.2E-3	7.2E-3	7.0E-3
Doris North	Zoom Boom 11-02	1	Diesel	110	14,700	15	9	365	70	4.3E+0	5.4E-2	1.6E+0	3.4E-1	3.4E-1	3.3E-1	9.2E-2	1.2E-3	3.5E-2	7.2E-3	7.2E-3	7.0E-3

Table C-16. Mobile Underground Equipment, Characteristics and Air Emissions

					Operating Hours Per Day				Emission Factor (g/hp-hr)						Emission Rates (g/s) for All Equipment Qty					
Emission Location Description	Equipment Description	Qty	Fuel Type	Power (hp)	Day (7 am to 10 pm)	Night (10 pm to 7 am)	Operating Days per Year	Assumed Running Load Factor (%)	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Boston Underground	Jumbo Drills 1 Boom	4	Diesel	225	15	9	365	70	5.9E+0	5.4E-2	1.8E+0	3.4E-1	3.4E-1	3.3E-1	1.0E+0	9.4E-3	3.1E-1	5.9E-2	5.9E-2	5.7E-2
Boston Underground	Jumbo Drills 2 Boom	2	Diesel	149	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	3.8E-1	3.8E-1	3.7E-1	3.5E-1	3.1E-3	1.1E-1	2.2E-2	2.2E-2	2.1E-2
Boston Underground	LHD CAT R1300	8	Diesel	165	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	1.0E+0	1.4E-2	4.0E-1	8.4E-2	8.4E-2	8.2E-2
Boston Underground	LHD CAT R1600	6	Diesel	279	15	9	365	70	3.9E+0	5.4E-2	1.3E+0	2.5E-1	2.5E-1	2.5E-1	1.3E+0	1.8E-2	4.3E-1	8.3E-2	8.3E-2	8.0E-2
Boston Underground	CAT AD30 30T	12	Diesel	409	15	9	365	70	5.4E+0	5.4E-2	1.5E+0	2.4E-1	2.4E-1	2.4E-1	5.1E+0	5.1E-2	1.4E+0	2.3E-1	2.3E-1	2.3E-1
Boston Underground	MacLean Rock bolter	4	Diesel	154	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	3.8E-1	3.8E-1	3.7E-1	7.3E-1	6.4E-3	2.3E-1	4.5E-2	4.5E-2	4.4E-2
Boston Underground	Production Drill	4	Diesel	149	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	3.8E-1	3.8E-1	3.7E-1	7.1E-1	6.2E-3	2.2E-1	4.4E-2	4.4E-2	4.2E-2
Boston Underground	Grader ,	2	Diesel	259	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	3.6E-1	5.5E-3	1.2E-1	2.4E-2	2.4E-2	2.3E-2
Boston Underground	Service Truck, flat deck	2	Diesel	350	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	4.6E-1	7.4E-3	2.0E-1	2.9E-2	2.9E-2	2.8E-2
Boston Underground	Lube Truck	2	Diesel	500	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	6.5E-1	1.1E-2	2.8E-1	4.1E-2	4.1E-2	4.0E-2
Boston Underground	Scissor Lift Truck	4	Diesel	173	15	9	365	70	7.3E+0	6.3E-2	4.3E+0	7.7E-1	7.7E-1	7.4E-1	9.8E-1	8.5E-3	5.8E-1	1.0E-1	1.0E-1	1.0E-1
Boston Underground	ANFO Loader Truck	2	Diesel	173	15	9	365	70	3.1E+0	5.4E-2	1.4E+0	3.3E-1	3.3E-1	3.2E-1	2.1E-1	3.6E-3	9.7E-2	2.2E-2	2.2E-2	2.2E-2
Boston Underground	Personnel Carrier	10	Diesel	173	15	9	365	70	3.1E+0	5.4E-2	1.4E+0	3.3E-1	3.3E-1	3.2E-1	1.1E+0	1.8E-2	4.8E-1	1.1E-1	1.1E-1	1.1E-1
Boston Underground	Crane Truck	2	Diesel	505	15	9	365	70	4.9E+0	5.4E-2	1.4E+0	2.1E-1	2.1E-1	2.1E-1	9.7E-1	1.1E-2	2.7E-1	4.2E-2	4.2E-2	4.1E-2
Boston Underground	Transmixers	2	Diesel	118	15	9	365	70	6.3E+0	5.4E-2	2.0E+0	3.7E-1	3.7E-1	3.6E-1	2.9E-1	2.5E-3	9.1E-2	1.7E-2	1.7E-2	1.6E-2
Boston Underground	Long Tom	4	Diesel	200	15	9	365	70	4.3E+0	5.4E-2	9.2E-1	1.9E-1	1.9E-1	1.9E-1	6.7E-1	8.3E-3	1.4E-1	3.0E-2	3.0E-2	2.9E-2
Boston Underground	Misc. Pumps	10	Diesel	9	15	9	365	70	6.4E+0	5.9E-2	4.7E+0	7.1E-1	7.1E-1	6.8E-1	1.1E-1	1.0E-3	8.3E-2	1.2E-2	1.2E-2	1.2E-2
Boston Underground	Compressors (1,500 cfm)	2	Diesel	475	15	9	365	70	5.2E+0	5.4E-2	1.7E+0	2.6E-1	2.6E-1	2.5E-1	9.7E-1	9.9E-3	3.1E-1	4.8E-2	4.8E-2	4.6E-2
Doris Madrid Underground	Jumbo Drills 1 Boom	4	Diesel	225	15	9	365	70	5.9E+0	5.4E-2	1.8E+0	3.4E-1	3.4E-1	3.3E-1	1.0E+0	9.4E-3	3.1E-1	5.9E-2	5.9E-2	5.7E-2
Doris Madrid Underground	Jumbo Drills 2 Boom	2	Diesel	149	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	3.8E-1	3.8E-1	3.7E-1	3.5E-1	3.1E-3	1.1E-1	2.2E-2	2.2E-2	2.1E-2
Doris Madrid Underground	LHD CAT R1300	8	Diesel	165	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	1.0E+0	1.4E-2	4.0E-1	8.4E-2	8.4E-2	8.2E-2
Doris Madrid Underground	LHD CAT R1600	6	Diesel	279	15	9	365	70	3.9E+0	5.4E-2	1.3E+0	2.5E-1	2.5E-1	2.5E-1	1.3E+0	1.8E-2	4.3E-1	8.3E-2	8.3E-2	8.0E-2
Doris Madrid Underground	CAT AD30 30T	12	Diesel	409	15	9	365	70	5.4E+0	5.4E-2	1.5E+0	2.4E-1	2.4E-1	2.4E-1	5.1E+0	5.1E-2	1.4E+0	2.3E-1	2.3E-1	2.3E-1
Doris Madrid Underground	MacLean Rock bolter	4	Diesel	154	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	3.8E-1	3.8E-1	3.7E-1	7.3E-1	6.4E-3	2.3E-1	4.5E-2	4.5E-2	4.4E-2
Doris Madrid Underground	Production Drill	4	Diesel	149	15	9	365	70	6.1E+0	5.4E-2	1.9E+0	3.8E-1	3.8E-1	3.7E-1	7.1E-1	6.2E-3	2.2E-1	4.4E-2	4.4E-2	4.2E-2
Doris Madrid Underground	Grader ,	2	Diesel	259	15	9	365	70	3.6E+0	5.4E-2	1.2E+0	2.4E-1	2.4E-1	2.3E-1	3.6E-1	5.5E-3	1.2E-1	2.4E-2	2.4E-2	2.3E-2
Doris Madrid Underground	Service Truck, flat deck	2	Diesel	350	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	4.6E-1	7.4E-3	2.0E-1	2.9E-2	2.9E-2	2.8E-2
Doris Madrid Underground	Lube Truck	2	Diesel	500	15	9	365	70	3.3E+0	5.4E-2	1.5E+0	2.1E-1	2.1E-1	2.0E-1	6.5E-1	1.1E-2	2.8E-1	4.1E-2	4.1E-2	4.0E-2
Doris Madrid Underground	Scissor Lift Truck	4	Diesel	173	15	9	365	70	7.3E+0	6.3E-2	4.3E+0	7.7E-1	7.7E-1	7.4E-1	9.8E-1	8.5E-3	5.8E-1	1.0E-1	1.0E-1	1.0E-1
Doris Madrid Underground	ANFO Loader Truck	2	Diesel	173	15	9	365	70	3.1E+0	5.4E-2	1.4E+0	3.3E-1	3.3E-1	3.2E-1	2.1E-1	3.6E-3	9.7E-2	2.2E-2	2.2E-2	2.2E-2
Doris Madrid Underground	Personnel Carrier	10	Diesel	173	15	9	365	70	3.1E+0	5.4E-2	1.4E+0	3.3E-1	3.3E-1	3.2E-1	1.1E+0	1.8E-2	4.8E-1	1.1E-1	1.1E-1	1.1E-1
Doris Madrid Underground	Crane Truck	2	Diesel	505	15	9	365	70	4.9E+0	5.4E-2	1.4E+0	2.1E-1	2.1E-1	2.1E-1	9.7E-1	1.1E-2	2.7E-1	4.2E-2	4.2E-2	4.1E-2
Doris Madrid Underground	Transmixers	2	Diesel	118	15	9	365	70	6.3E+0	5.4E-2	2.0E+0	3.7E-1	3.7E-1	3.6E-1	2.9E-1	2.5E-3	9.1E-2	1.7E-2	1.7E-2	1.6E-2
Doris Madrid Underground	Long Tom	4	Diesel	200	15	9	365	70	4.3E+0	5.4E-2	9.2E-1	1.9E-1	1.9E-1	1.9E-1	6.7E-1	8.3E-3	1.4E-1	3.0E-2	3.0E-2	2.9E-2
Doris Madrid Underground	Misc. Pumps	10	Diesel	9	15	9	365	70	6.4E+0	5.9E-2	4.7E+0	7.1E-1	7.1E-1	6.8E-1	1.1E-1	1.0E-3	8.3E-2	1.2E-2	1.2E-2	1.2E-2
Doris Madrid Underground	Compressors (1,500 cfm)	2	Diesel	475	15	9	365	70	5.2E+0	5.4E-2	1.7E+0	2.6E-1	2.6E-1	2.5E-1	9.7E-1	9.9E-3	3.1E-1	4.8E-2	4.8E-2	4.6E-2
Doris Madrid Underground	Atlas Copco 282 Boomer Jumbo	4	Diesel	78	15	9	365	70	6.1E+0	5.9E-2	3.2E+0	6.0E-1	6.0E-1	5.9E-1	3.7E-1	3.6E-3	1.9E-1	3.7E-2	3.7E-2	3.6E-2
Doris Madrid Underground	Atlas Copco H104 Boomer Jumbo	2	Diesel	57	15	9	365	70	6.1E+0	5.9E-2	3.2E+0	5.9E-1	5.9E-1	5.7E-1	1.3E-1	1.3E-3	7.1E-2	1.3E-2	1.3E-2	1.3E-2
Doris Madrid Underground	Getman A64 Boom Truck	2	Diesel	173	15	9	365	70	7.3E+0	6.3E-2	4.3E+0	7.7E-1	7.7E-1	7.4E-1	4.9E-1	4.2E-3	2.9E-1	5.1E-2	5.1E-2	5.0E-2
Doris Madrid Underground	Getman A64 Man Carrier	2	Diesel	173	15	9	365	70	7.3E+0	6.3E-2	4.3E+0	7.7E-1	7.7E-1	7.4E-1	4.9E-1	4.2E-3	2.9E-1	5.1E-2	5.1E-2	5.0E-2
Doris Madrid Underground	Getman A64 Scissor Lift	2	Diesel	173	15	9	365	70	7.3E+0	6.3E-2	4.3E+0	7.7E-1	7.7E-1	7.4E-1	4.9E-1	4.2E-3	2.9E-1	5.1E-2	5.1E-2	5.0E-2
Doris Madrid Underground	Kubota RTV	4	Gasoline	16	15	9	365	70	5.2E+0	5.1E-2	3.1E+2	1.4E-1	1.4E-1	1.3E-1	6.4E-2	6.3E-4	3.8E+0	1.7E-3	1.7E-3	1.5E-3
Doris Madrid Underground	R1300 Scoop	4	Diesel	165	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	5.2E-1	7.0E-3	2.0E-1	4.2E-2	4.2E-2	4.1E-2
Doris Madrid Underground	R1600 Scoop	2	Diesel	279	15	9	365	70	3.9E+0	5.4E-2	1.3E+0	2.5E-1	2.5E-1	2.5E-1	4.2E-1	5.9E-3	1.4E-1	2.8E-2	2.8E-2	2.7E-2
Doris Madrid Underground	ST2G scoop	2	Diesel	117	15	9	365	70	4.1E+0	5.4E-2	1.5E+0	3.3E-1	3.3E-1	3.2E-1	1.9E-1	2.5E-3	7.0E-2	1.5E-2	1.5E-2	1.4E-2

Appendix D

Contour Plots of Ambient Air Quality Predictions: Construction, Northern Domain, Existing Permitted Activities + Phase 2

Figure D-1

Maximum 1-hour SO_2 Concentration: Construction Period, Northern Domain, Existing Permitted Activities + Phase 2