Appendix 0 – Air Dispersion Modelling Study 2015

Black Point Quarry Project
Guysborough County, NS
SLR Project No.: 210.05913.00000

Black Point Quarry Air Dispersion Modelling Study

Prepared for:

CJ Spainhour
Vulcan Materials Company
1200 Urban Center Drive
Birmingham, AL 35242

Prepared by:
Stantec Consulting Ltd.
40 Highfield Park Drive
Dartmouth, NS B3A 0A3

File: 121413420

February 6, 2015

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Vulcan Materials Company (Vulcan) retained Stantec Consulting Ltd. (Stantec) to conduct a dispersion modelling study of air contaminant emissions from the operation of the proposed development of a granite rock quarry and marine terminal at Black Point in Guysborough County, Nova Scotia (NS). This study was conducted to support the Environmental Impact Statement being prepared by Vulcan for the Project.

Dispersion modeling was completed Dispersion modeling was completed using AERMOD, developed by the American Meteorological Society (AMS) and United States Environmental Protection Agency (US EPA). AERMOD is the US EPA preferred model for regulatory air dispersion modelling of industrial sources and Nova Scotia Environment (NSE) has approved its use in various modelling projects to demonstrate compliance in Nova Scotia.

Air contaminants that are of most concern from project operations include total suspended particulate (TSP), particulate matter less than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$, respectively), nitrogen oxides (NO_x), carbon monoxide (CO) and sulphur dioxide (SO_2). Table 1.1 shows the air contaminants and averaging times modeled in this study. Also shown in Table 1.1 are the applicable regulatory thresholds for each contaminant and averaging time.

Contaminant	Averaging Period	Regulatory Threshold (µg/m³)	
		Federal[1]	Provincial[2]
Total Suspended Particulate (TSP)	24-hour	-	120
	Annual	-	70
Particulate Matter Less than 10 microns (PM_{10})	24-hour	-	-
Particulate Matter Less than 2.5 microns ($PM_{2.5}$)	24-hour	28 (2015) 27 (2020)	-
	Annual	10 (2015) 8.8 (2020)	-
Sulphur Dioxide (SO_2)	1-hour	-	900
	24-hour	-	300
	Annual	-	60
Nitrogen Dioxide (NO_2)	1-hour	-	400
	Annual	-	100
Carbon Monoxide (CO)	1-hour	-	34600
	8-hour	-	12700

[1]Canadian Council of Ministers of the Environment Canada-Wide Standards for $PM_{2.5}$
[2]Nova Scotia Air Quality Regulations (N.S. Reg. 179/2014)

This report is presented in five sections. General information and the dispersion modelling methodology are presented in Sections 1 and 2. The results of the dispersion modelling are presented and discussed in Section 3, and the conclusions of the study and closure are presented in Sections 4 and 5, respectively. References are provided in Section 6.

2.0 DISPERSION MODELLING

2.1 MODEL DESCRIPTION

The most recent version of the plume dispersion model AERMOD was used for this project (version 14134). AERMOD is the US EPA preferred model for regulatory air dispersion modelling of industrial sources and Nova Scotia Environment (NSE) has approved its use in various modelling projects to demonstrate compliance in Nova Scotia.

It is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources (including, point, area and volume sources). AERMOD currently contains algorithms for:

- dispersion in both the convective and stable boundary layers;
- plume rise and buoyancy;
- plume penetration into elevated inversions;
- treatment of elevated, near-surface, and surface level sources;
- computation of vertical profiles of wind, turbulence, and temperature; and
- the treatment of receptors on all types of terrain (from the surface up to and above the plume height).

Terrain handling is done with a simple approach while still considering the dividing streamline concept in stable-stratified conditions. Where appropriate, the plume is modelled as either impacting and/or following the terrain.

2.2 MODELLING METHODOLOGY

2.2.1 Overview of Project Interactions with Air Quality

This air dispersion modelling study has been conducted in support of the preparation of the Environmental Impact Statement for the proposed development, operation and decommissioning and abandonment of a granite quarry and marine terminal at Black Point in Guysborough County. It is common and accepted practice to use mathematical dispersion modeling techniques to simulate the transport of contaminants released from a proposed operation, and to compare the concentrations at significant points of reception (all of which are residences in this project) to the applicable limits. In order to do this, the project must be represented in the model in terms of activities which result in the emissions of air contaminants. In this project, activities responsible for such emissions are primarily internal combustion engine operation, mechanical abrasion, wind erosion, and blasting.

The proposed Project will involve the extraction and processing of granite rock using industry standard drilling, blasting, crushing, screening and washing procedures, stockpiling on site and loading into Panamax-sized bulk carrier ships via a deep water marine terminal. During peak production the anticipated annual production rate is 7.5 MT per year, which equates to roughly 5.0 MT per year of salable product.

To predict the potential effects that the operation of the proposed Project could have on air quality within and surrounding the proposed Project area air dispersion modelling was conducted. To capture the potential "worse case" operating scenario ground level concentrations were predicted for Phase 5 of the Project, which represents peak production and includes the greatest amount of mobile combustion equipment. Phase 3 of the project was also modeled due to the need for large diesel power generators on site.

2.2.2 Modeling Inputs

Input preparation for the dispersion modelling study consists of three main components:

1) Meteorological data acquisition and pre-processing;

2) Receptor grid and terrain data processing; and

3) Source and emissions characterization

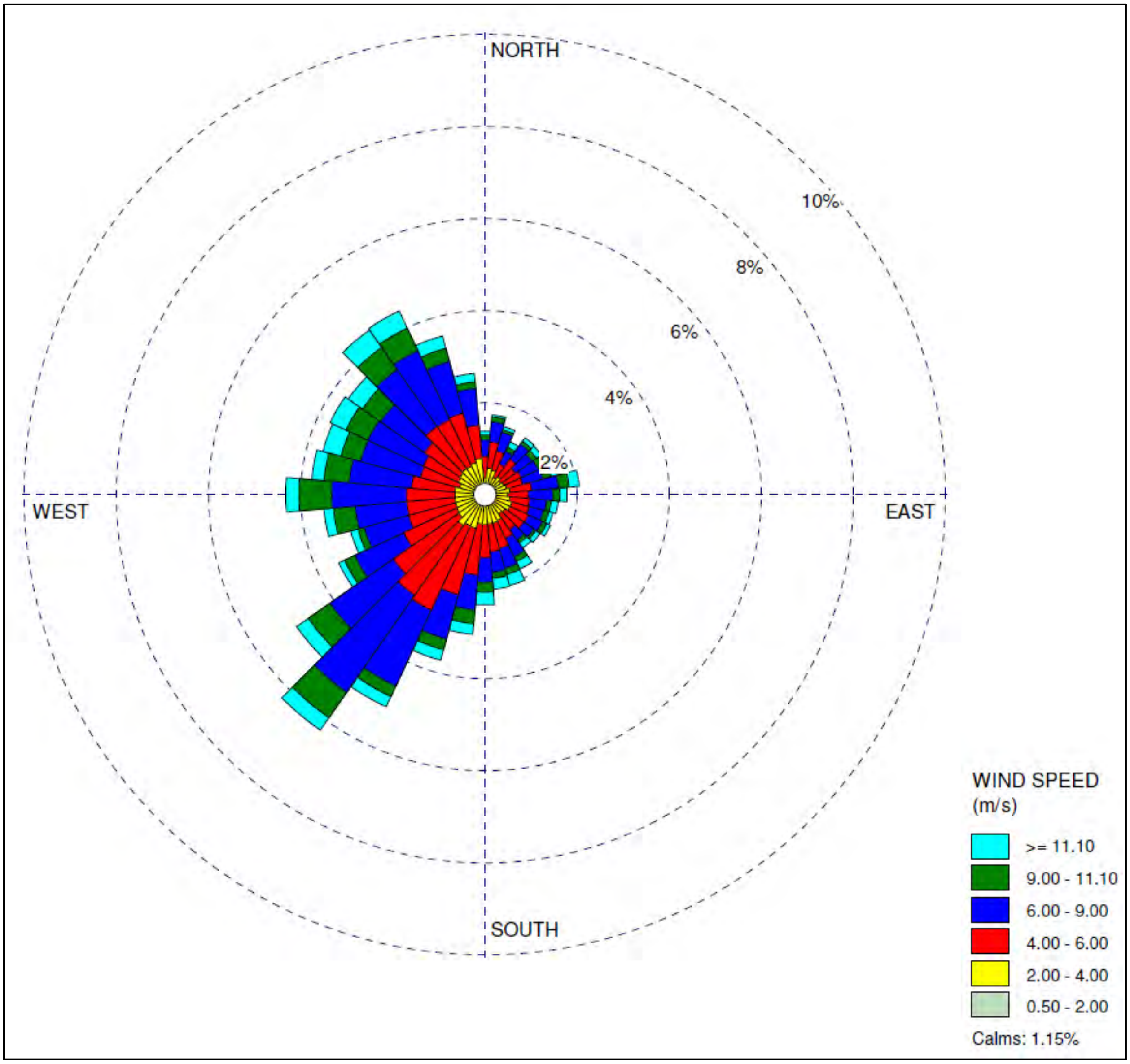
These components are described briefly in the following sections.

2.2.2.1 Meteorology Data

The accuracy of a dispersion model is dependent on the quality of meteorological data. For this dispersion modeling study, meteorological data preprocessed for use in AERMOD was acquired from Lakes Environmental for 2009 through 2013, inclusive. The data were generated using the MM5 meteorological model developed by the National Center for Atmospheric Research. The MM5 dataset comes ready to be immediately integrated into AERMET, the meteorological sub model for the AERMOD dispersion modeling system.

A joint wind direction and speed frequency diagram, or "wind rose", of these data is presented in Figure 2.1 (conventionally, wind roses show the direction from which the wind blows). Winds near the proposed quarry are dominated by north westerly winds hugging the coastline along the Atlantic Ocean, with appreciably frequent winds from the southwest. Winds are typically moderate to high with few calm periods, as expected from a coastal region.

Figure 2.1 Joint Wind Speed and Frequency Wind Rose near Project Location

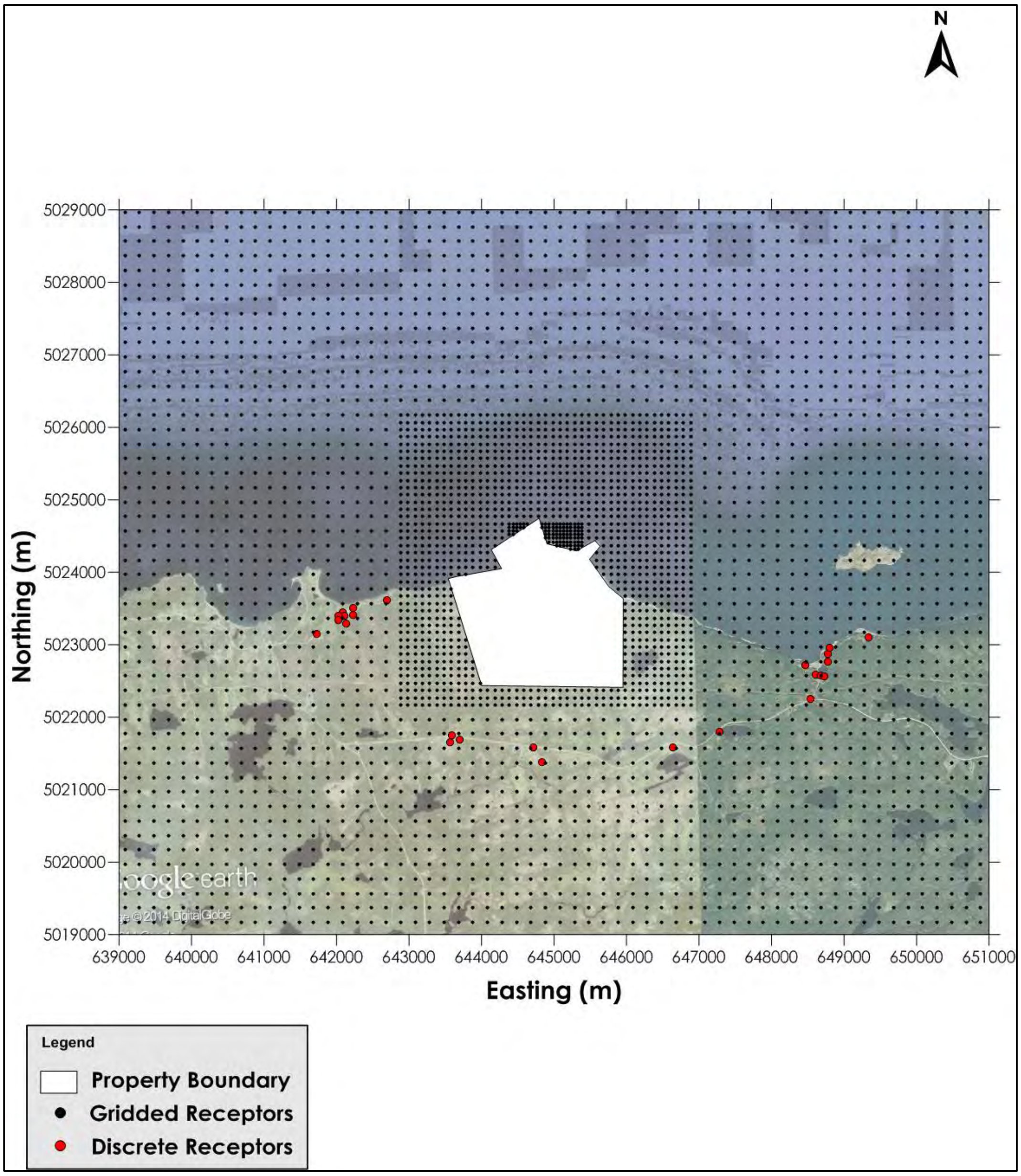


2.2.2.2 Receptor Grid and Terrain Data

AERMOD predicts ground-level concentrations at defined receptor locations. Straight-line plume transport is assumed to occur between the source and the downwind receptors. The Receptor Plan, which illustrates the locations of the receptors modelled, is presented in Figure 2.2.

A 10 km x 10 km nested Cartesian receptor grid was created with the quarry near the center. A grid spacing of 50 m was established from the property boundary to 500 m, 100 m spacing between 500 m and 1,500 m from the property line, and 200 m spacing from 1,500 m to 5,000 m. Twenty-five discrete receptors, representing the nearest residents to the Project site (based on well location information) were also included in each model. These locations are also presented in Figure 2.2.

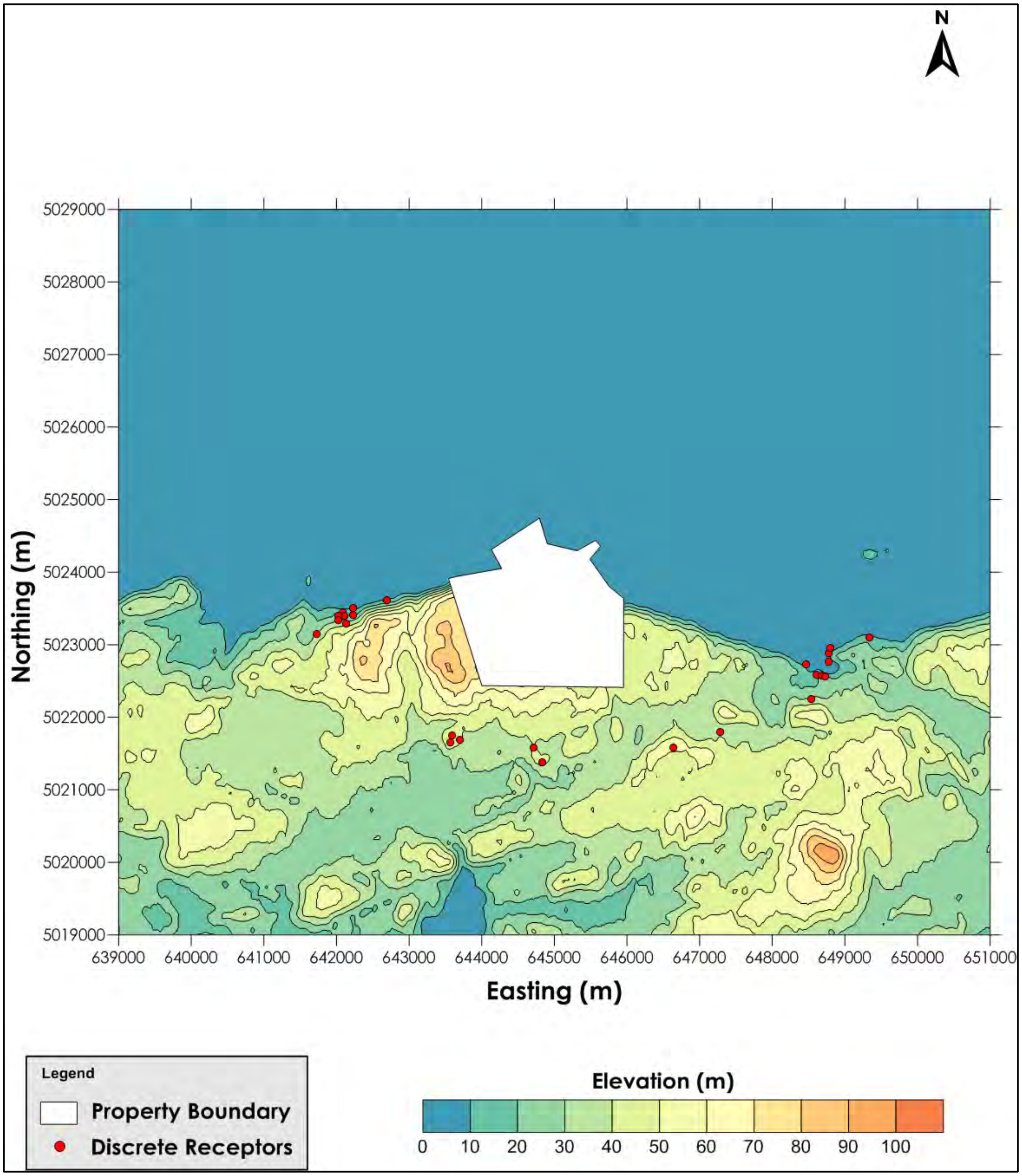
Figure 2.2 Receptor Locations for Dispersion Modeling



Terrain elevation data for sources and receptors were obtained from Natural Resources Canada's Canadian Digital Elevation Data (CDED) dataset using their Digital Elevation Model

(DEM) at a grid resolution range of 0.75 to 3 arc-seconds depending on latitude. Terrain contours based on the CDED DEM are illustrated in Figure 2.3.

Figure 2.3 Terrain Elevations for Dispersion Modeling



2.2.2.3 Source Characteristics

Source information data is required by AERMOD to characterize the release of air contaminants during Project operations. The operation of the proposed Project will involve the following activities:

- Rock quarrying (drilling and blasting);
- Rock haulage;
- Processing of the extracted rock (crushing, screening, washing, conveying, storage, reclaiming); and
- Ship loading.

The main sources of air emissions from the above activities are released through fuel combustion from drills, haul trucks, loaders and other earth-moving equipment, power generators, ship hotelling during product loading, blasting, and fugitive releases of dust from material handling and haul truck travel on unpaved roads.

As defined by the United States Environmental Protection Agency (US EPA 1995), fugitive dust is dust that is released to the atmosphere from open sources instead of being discharged to the atmosphere via a confined flow stream, and is created from the mechanical disturbance of granular material. Fugitive dust can remain suspended during airborne transport when less than 30 microns in diameter and this threshold is typically used to estimate emissions of TSP. Emissions of PM_{10} and $PM_{2.5}$ are further estimated as a source-dependent fraction of TSP.

Fugitive releases of dust will occur during Project operations through the following operational activities:

- Drilling and blasting;
- Material handling – through the loading and unloading of extracted rock, stockpiling, reclaiming, conveying and conveyor transfer points, and ship loading;
- Processing of the ore – crushing, screening and washing;
- Unpaved road travel –Haul truck travel on unpaved roads; and
- Wind erosion – rock stockpiles.

Several measures for mitigating particulate emissions during the operation of the Project are planned and include, but are not limited to, the following:

- Use of qualified blasting contractors with blast design plans that incorporate dust emission controls;
- Use of water suppression on unpaved roads and working areas;

- Construction of the haul roads using material with a low silt content;
- Use of a binder substance within the dust suppression application (e.g. calcium chloride) during drier periods of the year to aid in keeping the roads moist for longer periods of time;
- Dust collection systems and/or wet sprays on conveyor transfer points to reduce the fugitive releases of dust during the transfer of material; and
- Water sprays on the crushed rock stockpiles and transfer points.
- Dust suppression systems for secondary and tertiary crushing units, and
- Enclosures for screening towers

See Section 3.5 for additional information regarding on site mitigation.

The source information and emission rates required for the dispersion modelling study were obtained primarily from information provided to Stantec from Vulcan, with the exception of the emissions from the bulk carriers during product loading. Ship hotelling emissions were calculated using US EPA guidance as per the following document, "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories" (2009).

Emissions related to blasting within the quarry pit were not included in the dispersion model but were handled separately because the impact over longer time periods is very small.

As discussed above, stockpiles can also be a source of fugitive particulate emissions during quarry operations. The stockpiles planned for this Project will be equipped with rain birds and the water trucks used for dust suppression will be equipped with a canon to further provide wet suppression to these piles during times when needed. Further, most piles are prescreened and washed so that the fines that would generate airborne dust have been removed. As such emissions can be managed to the point where emissions of dust will be negligible they were not included as sources within the dispersion modelling.

2.2.2.3.1 Phase 3

Tables 2.1 and 2.2 present the point source parameters and emission factors used for dispersion modeling, respectively. Source parameters and emission rates for volume sources and pit sources can be found in Tables 2.3 and 2.4, respectively. Emission rates are prorated in the tables by duty cycles for the averaging periods specified.

Table 2.1 Phase 3 Point Source Exit Parameters

Source	Stack Height (m)	Stack Diameter (m)	Exhaust Gas Velocity (m/s)	Exhaust Gas Temperature (K)
Drill	4	0.3	30	373
Yard Loaders	4	0.3	30	373
Pit Loaders	4	0.3	30	373
Bobcats	4	0.3	30	373
Dozers	4	0.3	30	373
Excavators	4	0.3	30	373
Haul Trucks	7	0.3	30	373
Service Trucks	4	0.3	30	373
Ship Hotelling	25	2	15	673
Generators				
Station 1 LT160	3	0.127	28	737
Station 2 LT120	3	0.127	21	698
Station 3 LT300HP	3	0.127	25	696
Station 4 ST620	5	0.127	0	698
Station 5 LT300HP	3	0.127	25	696
Station 6 ST620	3	0.127	21	698
Station 7 LT300HP	3	0.127	25	696

Table 2.2 Phase 3 Emission Factors for Point Sources

Source	Emission Rate (g/s)											
	TSP		$PM_{2.5}$		PM_{10}	NO_x		CO		SO_2		
	24-hr	Annual	24-hr	Annual	24-hr	1-hr	Annual	1-hr	8-hr	1-hr	24-hr	Annual
Mobile Sources[1,2]												
Drill	0.002	0.000	0.002	0.000	0.002	0.005	0.001	0.008	0.008	0.00019	0.00013	0.00003
Yard Loaders	0.003	0.002	0.003	0.002	0.003	0.001	0.004	0.014	0.014	0.00033	0.00022	0.00013
Pit Loaders	0.012	0.008	0.012	0.008	0.012	0.120	0.055	0.191	0.191	0.00050	0.00033	0.00023
Bobcats	0.002	0.000	0.002	0.000	0.002	0.002	0.000	0.002	0.002	0.00006	0.00004	0.00001
Dozers	0.012	0.002	0.012	0.002	0.012	0.120	0.013	0.191	0.191	0.00050	0.00033	0.00006
Excavators	0.012	0.008	0.012	0.008	0.012	0.120	0.055	0.191	0.191	0.00050	0.00033	0.00023
Haul Trucks	0.025	0.017	0.025	0.017	0.025	0.262	0.119	0.418	0.418	0.00109	0.00073	0.00050
Service Trucks	0.005	0.001	0.005	0.001	0.005	0.014	0.002	0.019	0.019	0.00050	0.00033	0.00006
Ship Hotelling	0.156	0.015	0.156	0.015	0.170	0.194	0.018	0.381	0.381	0.147	0.147	0.014
Generators[2]												
Station 1 LT160	0.009	0.006	0.009	0.006	0.009	0.094	0.043	0.149	0.149	0.00039	0.00026	0.00018

Table 2.2 Phase 3 Emission Factors for Point Sources

Source	Emission Rate (g/s)											
	TSP		$PM_{2.5}$		PM_{10}	NO_x		CO		SO_2		
	24-hr	Annual	24-hr	Annual	24-hr	1-hr	Annual	1-hr	8-hr	1-hr	24-hr	Annual
Station 2 LT120	0.005	0.004	0.005	0.004	0.005	0.055	0.025	0.088	0.088	0.00023	0.00015	0.00011
Station 3 LT300HP	0.007	0.005	0.007	0.005	0.007	0.072	0.033	0.115	0.115	0.00030	0.00020	0.00014
Station 4 ST620	0.002	0.001	0.002	0.001	0.002	0.017	0.008	0.028	0.028	0.00007	0.00005	0.00003
Station 5 LT300HP	0.007	0.005	0.007	0.005	0.007	0.072	0.033	0.115	0.115	0.00030	0.00020	0.00014
Station 6 ST620	0.002	0.001	0.002	0.001	0.002	0.017	0.008	0.028	0.028	0.00007	0.00005	0.00003
Station 7 LT300HP	0.007	0.005	0.007	0.005	0.007	0.072	0.033	0.115	0.115	0.00030	0.00020	0.00014

[1]Exhaust and Crankcase Emission Factors for Non-road Engine Modeling - Compression-Ignition." US EPA.

[2]Information Provided by Vulcan

Table 2.3 Phase 3 Volume Source Information

Source[1]	Release Height (m)	Sigma Y (m)	Sigma Z (m)	Emission Rate (g/s)[2]				
				TSP		PM_{10}	$PM_{2.5}$	
				24-hr	Annual	24-hr	24-hr	Annual
Grizzly Feeder	8.4	0.93	0.93	0.173	0.128	0.058	0.004	0.003
Jaw Crusher	8.4	1.16	1.16	0.094	0.070	0.043	0.008	0.006
Feed to Conveyor C1	6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Discharge from C1 to Grizzly	6.6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Jaw Crusher	5	1.16	1.16	0.173	0.128	0.058	0.004	0.003
Grizzly Feeder	5	0.93	0.93	0.094	0.070	0.043	0.008	0.006
Oversize Feed to C3	3	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Discharge to C3	3	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Discharge to C2	5	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Feed to Grizzly from C2	6.6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Feed to Grizzly from C3	6.6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Grizzly Feeder	5	0.93	0.93	0.173	0.128	0.058	0.004	0.003
Cone Crusher	5	1.16	1.16	0.094	0.070	0.043	0.008	0.006
By-Pass Conveyor Feed	2.75	0.93	0.93	0.011	0.008	0.004	0.001	0.001
By-Pass Conveyor Discharge	8.8	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Cone Crusher Discharge Conveyor to Next Stage	4	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Feed to Screen Transfer Point	6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Screen	2.5	0.93	0.93	0.173	0.128	0.058	0.004	0.003
Screen Discharge To Dust	8.77	0.93	1.86	0.011	0.008	0.004	0.001	0.001

Table 2.3 Phase 3 Volume Source Information

Source[1]	Release Height (m)	Sigma Y (m)	Sigma Z (m)	Emission Rate (g/s)[2]				
				TSP		PM_{10}	$PM_{2.5}$	
				24-hr	Annual	24-hr	24-hr	Annual
Pile								
Screen Discharge to 57s Pile	8.77	0.93	1.86	0.011	0.008	0.004	0.001	0.001
Product Conveyance to Next Stage	3	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Feed to feed conveyor	6.6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Cone Crusher	5	1.16	1.16	0.094	0.070	0.043	0.008	0.006
Discharge to C11	6.6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Recycle to C11	8.77	0.93	0.93	0.011	0.008	0.004	0.001	0.001
C11 Discharge to Feed Conveyor	8.77	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Screen	6	0.93	0.93	0.173	0.128	0.058	0.004	0.003
Screen Discharge to C12	3	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Screen Discharge to C4	3	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Screen Discharge to C14	3	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Screen Discharge to C15	3	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Transfer Conveyors to C12 and C4	6.6	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Cone Crusher	5	1.16	1.16	0.094	0.070	0.043	0.008	0.006
Transfer to 78s Stockpile	8.77	0.93	1.86	0.018	0.014	0.009	0.001	0.001
Transfer to Dust Stockpile	8.77	0.93	1.86	0.018	0.014	0.009	0.001	0.001
Dump to Hopper	3	0.93	0.93	0.018	0.014	0.009	0.001	0.001
Conveyor Transfer Points	16	0.93	0.93	0.011	0.008	0.004	0.001	0.001
Overburden Removal	2	2.09	2.09	0.382	0.061	0.079	0.040	0.006

[1]C refers to a conveyor
[2]calculated using Information provided by Vulcan and US EPA AP-42 Chapter 11.19.2

Table 2.4 Phase 3 Pit Source Information

Source	Release Height (m)	Volume of Pit (m^3)	Area of Pit (m^2)	Emission Factor (g/s)[1,2]				
				TSP		PM_{10}	$PM_{2.5}$	
				24-hr	Annual	24-hr	24-hr	Annual
Pit	4.5	6,863,400	381,300	0.461	0.215	0.171	0.098	0.006

[1]Emissions include: (1) fugitive emissions from travel on unpaved haul roads and drilling; (2) 90% control applied to haul roads to account for wet suppression;
[2]Calculated from US EPA AP-42 Chapter 13.2.2, and information provided by Vulcan

2.2.2.3.2 Phase 5

Tables 2.5 and 2.6 present the point source parameters and emission factors used for dispersion modeling, respectively. Source parameters and emission rates for volume sources and pit sources can be found in Tables 2.7 and 2.8, respectively.

Table 2.5 Phase 5 Point Source Exit Parameters

Source	Stack Height (m)	Stack Diameter (m)	Exhaust Gas Velocity (m/s)	Exhaust Gas Temperature (K)
Drill	4	0.3	30	373
Yard Loaders	4	0.3	30	373
Pit Loaders	4	0.3	30	373
Bobcats	4	0.3	30	373
Dozers	4	0.3	30	373
Excavators	4	0.3	30	373
Haul Trucks	7	0.3	30	373
Service Trucks	4	0.3	30	373
Long Reach Excavators	4	0.3	30	373
Ship Hotelling	25	2	15	673

Table 2.6 Phase 5 Emission Factors for Point Sources

Source	Emission Factor (g/s)[1]											
	TSP		$PM_{2.5}$		PM_{10}	NO_x		CO		SO_2		
	24-hr	Annual	24-hr	Annual	24-hr	1-hr	Annual	1-hr	8-hr	1-hr	24-hr	Annual
Drill	0.002	0.001	0.002	0.001	0.002	0.005	0.002	0.008	0.008	0.000	0.000	0.000
Yard Loaders	0.006	0.004	0.006	0.004	0.006	0.018	0.008	0.028	0.028	0.001	0.000	0.000
Pit Loaders	0.023	0.017	0.023	0.017	0.023	0.239	0.118	0.382	0.382	0.001	0.001	0.000
Bobcats	0.002	0.000	0.002	0.000	0.002	0.002	0.000	0.002	0.002	0.000	0.000	0.000
Dozers	0.012	0.002	0.012	0.002	0.012	0.120	0.014	0.191	0.191	0.001	0.000	0.000
Excavators	0.012	0.009	0.012	0.009	0.012	0.120	0.059	0.191	0.191	0.001	0.000	0.000
Haul Trucks	0.063	0.047	0.063	0.047	0.063	0.654	0.323	1.046	1.046	0.003	0.002	0.001
Service Trucks	0.008	0.003	0.008	0.003	0.008	0.023	0.006	0.031	0.031	0.001	0.001	0.000
Long Reach Excavators	0.012	0.002	0.012	0.002	0.012	0.120	0.016	0.191	0.191	0.001	0.000	0.000
Ship	0.170	0.021	0.156	0.020	0.170	0.192	0.024	0.381	0.381	0.147	0.147	0.018

[1]Emission factors calculated using "Exhaust and Crankcase Emission Factors for Non-road Engine Modeling - Compression-Ignition" from the US EPA and information provided by Vulcan.

Table 2.7 Phase 5 Volume Source Information

Source	Release Height (m)	Sigma Y (m)	Sigma Z (m)	Emission Factor (g/s)[1]				
				TSP		PM_{10}	$PM_{2.5}$	
				24-hr	Annual	24-hr	24-hr	Annual
Primary Crusher	52	1.16	1.16	0.282	0.209	0.127	0.024	0.017
Feed to Conveyor (CNV001)	2	0.93	0.93	0.035	0.026	0.013	0.003	0.002
Discharge from Conveyor (CNV001) to Conveyor (CNV002)	10	0.93	0.93	0.035	0.026	0.013	0.003	0.002
Discharge from Conveyor (CNV002) to Surge Pile	29	0.93	1.86	0.059	0.044	0.028	0.003	0.002
Scalping Screen (SCR01)	22	0.93	0.93	0.554	0.410	0.186	0.013	0.009
Discharge to Conveyor (CNV005) from Scalping Screen Tower (SCR001)	3	0.93	0.93	0.007	0.005	0.003	0.001	0.000
Discharge from Conveyor (CNV005) to Crusher Run Stockpile	8	0.93	1.86	0.012	0.009	0.006	0.001	0.001
Secondary Crusher (CRS002)	7	1.16	1.16	0.228	0.169	0.103	0.019	0.014
Screen Discharge to Conveyor (CNV004)	2	0.93	0.93	0.008	0.006	0.003	0.001	0.001
Discharge from Conveyor (CNV004) to Secondary Surge Pile	29	0.93	1.86	0.055	0.041	0.026	0.004	0.003
Discharge from Conveyor (CNV006) to Hopper/bin	27	0.93	0.93	0.035	0.026	0.013	0.003	0.002
Feed to Belt Feeder #1	3	0.93	0.93	0.277	0.205	0.093	0.006	0.005
Feed to Belt Feeder #2	3	0.93	0.93	0.277	0.205	0.093	0.006	0.005
Screen 1 of 2	22	0.93	0.93	0.259	0.191	0.087	0.006	0.004
Screen 2 of 2	22	0.93	0.93	0.259	0.191	0.087	0.006	0.004
Screen Discharge to Conveyor (CNV007)	2	0.93	0.93	0.003	0.002	0.001	0.000	0.000
Conveyor (CNV007) transfer to Conveyor (CNV008)	2	0.93	0.93	0.003	0.002	0.001	0.000	0.000
Conveyor (CNV008) Feed to Stockpile	8	0.93	1.16	0.005	0.004	0.003	0.000	0.000
Screens (SCR02A and SCR02B) Feed to Bins	15	0.93	0.93	0.061	0.045	0.021	0.005	0.003
Crushers (CRS03A and CRS03B)	9	1.16	1.16	0.119	0.088	0.054	0.010	0.007
Transfers from Conveyors (CNV09A and CNV09B) to Conveyors (CNV10A,B,C,D)	8	0.93	0.93	0.047	0.035	0.017	0.004	0.003
Diester Screen Transfer to	5	0.93	0.93	0.001	0.001	0.000	0.000	0.000

Table 2.7 Phase 5 Volume Source Information

Source	Release Height (m)	Sigma Y (m)	Sigma Z (m)	Emission Factor (g/s)[1]				
				TSP		PM_{10}	$PM_{2.5}$	
				24-hr	Annual	24-hr	24-hr	Annual
Conveyor (CNV013)								
Diester Screen Transfer to Conveyor (CNV015)	5	0.93	0.93	0.006	0.004	0.002	0.001	0.000
Diester Transfer Points to Conveyors (CNV17A,B,C,D)	3	0.93	0.93	0.028	0.021	0.010	0.003	0.002
Conveyors (CNV17A,B,C,D) Transfers to Conveyors (CNV18A,B,C,D,E,F)	10	0.93	0.93	0.028	0.021	0.010	0.003	0.002
Screens (SCR04A,C,D,F)	14	0.93	0.93	0.267	0.197	0.090	0.006	0.004
Screens (SCR04B,E)	14	0.93	0.93	0.131	0.097	0.044	0.003	0.002
Discharge to Conveyor (CNV024)	3	0.93	0.93	0.007	0.005	0.003	0.001	0.000
Conveyor (CNV024) Discharge to Conveyor (CNV025)	6	0.93	0.93	0.007	0.005	0.003	0.001	0.000
Conveyor (CNV025) Discharge to Crusher Run Pile	9	0.93	1.86	0.012	0.009	0.006	0.001	0.001
Screens Discharge to Conveyor (CNV021)	5	0.93	0.93	0.012	0.009	0.004	0.001	0.001
Conveyor (CNV021) to Conveyor (CNV022)	6	0.93	0.93	0.012	0.009	0.004	0.001	0.001
Conveyor (CNV022) Discharge to Product Stockpile	9	0.93	1.86	0.020	0.015	0.009	0.001	0.001
Screens Discharge to Conveyor (CNV015)	2	0.93	0.93	0.006	0.004	0.002	0.001	0.000
Conveyor (CNV015) to Conveyor (CNV016)	7	0.93	0.93	0.006	0.004	0.002	0.001	0.000
Conveyor (CNV016) Discharge to Product Stockpile	9	0.93	1.86	0.010	0.007	0.005	0.001	0.001
Screen Discharge to Conveyor (CNV013)	2	0.93	0.93	0.001	0.001	0.000	0.000	0.000
Conveyor (CNV013) to Conveyor (CNV014)	6	0.93	0.93	0.001	0.001	0.000	0.000	0.000
Conveyor (CNV014) to Product Stockpile	9	0.93	1.86	0.002	0.001	0.001	0.000	0.000
Screen to Conveyor (CNV019)	2	0.93	0.93	0.005	0.004	0.002	0.000	0.000
Conveyor (CNV019) to Conveyor (CNV020)	6	0.93	0.93	0.005	0.004	0.002	0.000	0.000
Conveyor (CNV020) to Product Stockpile	9	0.93	1.86	0.009	0.007	0.004	0.001	0.000
Conveyor (CNV026) to	12	0.93	0.93	0.035	0.026	0.013	0.003	0.002

Table 2.7 Phase 5 Volume Source Information

Source	Release Height (m)	Sigma Y (m)	Sigma Z (m)	Emission Factor (g/s)[1]				
				TSP		PM_{10}	$PM_{2.5}$	
				24-hr	Annual	24-hr	24-hr	Annual
Bins								
Bins to Conveyor (CNV028)	2	0.93	0.93	0.035	0.026	0.013	0.003	0.002
Conveyor (CNV027) to Bins	12	0.93	0.93	0.035	0.026	0.013	0.003	0.002
Transfer to Conveyor (CNV028)	2	0.93	0.93	0.035	0.026	0.013	0.003	0.002
Conveyor (CNV028) to Conveyor (CNV029A,B)	6	0.93	0.93	0.035	0.026	0.013	0.003	0.002
Dual Diester Screens	6	0.93	0.93	0.554	0.410	0.186	0.013	0.009
Transfer to Conveyors (CNV023A,B)	17.2	0.93	0.93	0.002	0.002	0.001	0.000	0.000
Transfer to Conveyors (CNV11A,B)	2	0.93	0.93	0.014	0.010	0.005	0.001	0.001
Conveyors (CNV11A,B) to Conveyors (CNV12A,B)	2	0.93	0.93	0.014	0.010	0.005	0.001	0.001
Conveyor (CNV12A,B) Dump to Feeders	4	0.93	0.93	0.199	0.147	0.067	0.005	0.003
Crushers (4)	18.5	1.16	1.16	0.108	0.080	0.049	0.009	0.007
Conveyor (CNV12) Dump to Feeders	18.5	0.93	0.93	0.199	0.147	0.067	0.005	0.003
Load-out Product Transfer to Conveyor (CNV038)	12	0.93	0.93	0.053	0.039	0.019	0.005	0.004
Load-out Product Transfer to Conveyor (CNV039)	18	0.93	0.93	0.053	0.039	0.019	0.005	0.004
Loading of Product Into Ship	20	0.93	1.86	0.354	0.262	0.169	0.025	0.019
Overburden Removal	2	2.09	2.09	0.382	0.164	0.079	0.040	0.017

[1]Calculated from information in US EPA AP-42 Chapter 11.19.2, and information provided by Vulcan.

Table 2.8 Phase 5 Pit Source Information

Source	Release Height (m)	Volume of Pit (m^3)	Area of Pit (m^2)	Emission Factor (g/s)[1,2]				
				TSP		PM_{10}	$PM_{2.5}$	
				24-hr	Annual	24-hr	24-hr	Annual
Pit	4.5	43,750,000	1,250,000	1.02	0.627	0.326	0.113	0.017

[1]Emissions include: (1) fugitive emissions from travel on unpaved haul roads and drilling; (2) 90% control applied to haul roads to account for wet suppression.
[2]Calculated from US EPA AP-42 Chapter 13.2.2, and information provided by Vulcan

2.2.2.4 Building Downwash

Downwash effects due to wind interaction of aerodynamic masses and emission sources can be modeled using AERMOD. Air contaminants released within the wake zone of buildings can be drawn down to the ground sooner than if release at higher elevations, and can change the ground-level concentration profile.

AERMOD implements downwash modeling using the Plume Rise Model Enhancements (PRIME) submodel. PRIME allows for streamline ascent/descent effects and enhanced dilution due to building induced turbulence. PRIME addresses the entire structure of the building wake, from the cavity immediately downwind of the building, to the far wake zone (US EPA 1997).

To model building downwash in AERMOD, wind direction dependent building information such as width and height were provided to Stantec by Vulcan. The Building Profile Input Program (BPIP) submodel in AERMOD was then used to generate dispersion parameters representing building downwash.

2.2.3 Existing Air Quality

Background air contaminant concentrations are typically added to the maximum predicted concentrations for comparison with the regulated ambient air quality objective or standard. Background concentrations are usually based on measured ambient air quality data from the nearest representative monitoring station. In this study, there is no ambient air quality monitoring station located near the Project site that could be reasonably used to characterize the existing air quality within the Project area. The closest monitoring station is located in Port Hawkesbury, approximately 30 km north of the Project, which is representative of an urban area containing industrial activity. As a result, based on its rural location, the background concentrations for this study are assumed to be negligible.

For a reference, the ambient concentrations (annual means) of SO_2, CO, $PM_{2.5}$ and NO_2 as measured in Port Hawkesbury are presented in Table 2.9.

Table 2.9 Summary of 2013 Annual Mean Ambient Air Quality Monitoring Data from Port Hawkesbury and Sydney, Nova Scotia

Contaminant	Annual Mean (µg/m^3)*	Station Location
$PM_{2.5}$	6	Port Hawkesbury
NO_2	9.4	Port Hawkesbury
CO	0.1**	Sydney
SO_2	2.6	Sydney

*Source: Environment Canada
**Data from 2012

2.2.4 NOx Conversion

Oxides of nitrogen (NO_X) comprise nitric oxide (NO) and nitrogen dioxide (NO_2). Most combustion sources emit primarily NO that can react with ambient ozone (O_3) to produce NO_2. The final quantity of NO_2 then becomes a function of the available O_3 in the atmosphere during the release.

Only ground-level concentrations of NO_2 are regulated in Nova Scotia. The US EPA three-tiered screening approach was used to consider conversion of NO to NO_2 (US EPA 2012). The tiered approach is as follows:

- **Tier 1 –** assume complete conversion of all emitted NO to NO_2;
- **Tier 2 –** multiply Tier 1 results by a representative equilibrium NO_2/NO_X ratio (*e.g.* ambient ratio method - ARM); and
- **Tier 3 –** perform detailed analysis on a case by case basis (*e.g.* ozone limiting method - OLM).

The Tier 2 approach was applied in the study. An NO_2/NO_x in stack ratio of 0.2 was applied to the NO_x emissions for all sources of diesel combustion for both operational phases.

3.0 DISPERSION MODELLING RESULTS

3.1 PHASE 3 OPERATIONS

3.1.1 Particulate Matter

The highest predicted 24-hour maximum and annual average ground-level concentrations (GLCs) for total suspended particulate matter (TSP) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) at each discrete receptor location for Phase 3 are presented in Table 3.1. The highest predicted 24-hour maximum for particulate matter less than 10 microns in diameter (PM_{10}) are also presented in this table. Background concentrations of particulate matter in the Project area are assumed to be negligible.

Table 3.1 Maximum Predicted Ground Level Concentrations of Particulate Matter at Discrete Receptor Locations - Phase 3

Receptor	UTM Coordinates		Maximum Predicted GLC				
	Easting (m)	Northing (m)	24-hr TSP (µg/m³)	Annual TSP (µg/m³)	24-hr PM_{10} (µg/m³)	24-hr $PM_{2.5}$ (µg/m³)	Annual $PM_{2.5}$ (µg/m³)
1	642692	5023616	58.6	0.75	21.5	7.79	0.049
2	642232	5023505	54.5	0.58	18.4	7.73	0.038

Table 3.1 Maximum Predicted Ground Level Concentrations of Particulate Matter at Discrete Receptor Locations - Phase 3

Receptor	UTM Coordinates		Maximum Predicted GLC				
	Easting (m)	Northing (m)	24-hr TSP (µg/m³)	Annual TSP (µg/m³)	24-hr PM_{10} (µg/m³)	24-hr $PM_{2.5}$ (µg/m³)	Annual $PM_{2.5}$ (µg/m³)
3	642231	5023406	52.8	0.65	18.7	5.96	0.042
4	642088	5023441	61.0	0.62	22.0	6.50	0.041
5	642106	5023396	53.3	0.54	19.2	5.78	0.036
6	642132	5023296	26.0	0.32	9.4	5.32	0.024
7	642030	5023399	53.2	0.50	19.3	5.87	0.034
8	642025	5023336	33.7	0.40	11.7	4.92	0.029
9	641731	5023150	30.6	0.35	9.5	4.15	0.025
10	643569	5021658	25.1	0.27	8.2	3.96	0.019
11	643589	5021745	27.9	0.27	8.8	4.23	0.019
12	643696	5021694	28.4	0.32	7.4	3.97	0.022
13	644835	5021376	25.0	0.33	9.1	5.17	0.023
14	644710	5021586	36.9	0.36	13.0	7.39	0.024
15	646643	5021585	24.2	0.55	9.0	5.21	0.037
16	647285	5021794	25.4	0.61	9.4	5.10	0.043
17	648538	5022253	21.0	0.54	7.7	2.87	0.041
18	648615	5022586	27.6	0.72	9.8	4.33	0.049
19	648680	5022576	27.0	0.71	9.1	4.26	0.048
20	648724	5022566	26.6	0.69	8.6	4.21	0.047
21	648781	5022762	25.7	0.62	9.7	4.27	0.043
22	648776	5022879	26.4	0.66	9.1	4.26	0.046
23	648805	5022959	34.9	0.66	11.4	4.33	0.045
24	648466	5022724	25.2	0.67	8.2	4.32	0.046
25	649335	5023096	25.7	0.64	9.2	2.48	0.044
Regulatory Limit	**-**	**-**	**120**	**70**	**-**	**28**	**10**

Isopleths of maximum predicted GLCs for 24-hour TSP can be found in Figure A.1 in Appendix A. GLCs for 24-hour TSP are highest on the shore on the northeastern corner of the property boundary. The highest 24-hour TSP GLC for the discrete receptors is 61 µg/m³ occurring at Receptor 1, approximately 50% of the provincial maximum permissible value of 120 µg/m³.

The highest predicted annual TSP GLC is 0.71 µg/m³ and occurs at Receptor 18. Annual TSP GLCs are predicted to be well below the maximum permissible value of 70 µg/m³.

Isopleths of maximum predicted GLCs for 24-hour $PM_{2.5}$ can be found in Figure A.2 in Appendix A. GLCs for 24-hour $PM_{2.5}$ are highest near the western side of the property boundary. The highest 24-hour $PM_{2.5}$ GLC for the discrete receptors is 7.39 µg/m^3 and occurs at Receptor 14, or approximately 25% of the Canada-wide Standard of 28 µg/m^3. The maximum annual average GLC for $PM_{2.5}$ was predicted to be 0.049 µg/m^3, occurring at Receptor 18, well below the Canada-wide Standard of10 µg/m^3.

3.1.2 Combustion Gases

The highest predicted 1-hour and annual average ground-level concentrations for nitrogen dioxide (NO_2) at each discrete receptor for Phase 3 are presented in Table 3.2. Background concentrations of NO_2 in the Project area are assumed to be negligible.

Table 3.2 Maximum Predicted Ground Level Concentrations of Nitrogen Dioxide at Discrete Receptor Locations - Phase 3

Receptor	UTM Coordinates		Maximum Predicted GLC	
	Easting (m)	Northing (m)	1-hr NO_2 (µg/m^3)	Annual NO_2 (µg/m^3)
1	642692	5023616	34.9	0.057
2	642232	5023505	31.2	0.046
3	642231	5023406	39.2	0.050
4	642088	5023441	36.3	0.048
5	642106	5023396	35.4	0.047
6	642132	5023296	75.5	0.051
7	642030	5023399	36.3	0.046
8	642025	5023336	53.6	0.049
9	641731	5023150	43.0	0.046
10	643569	5021658	31.3	0.039
11	643589	5021745	29.8	0.039
12	643696	5021694	35.3	0.043
13	644835	5021376	21.5	0.047
14	644710	5021586	32.4	0.048
15	646643	5021585	26.7	0.073
16	647285	5021794	43.0	0.094
17	648538	5022253	61.6	0.092
18	648615	5022586	28.6	0.084
19	648680	5022576	29.0	0.083
20	648724	5022566	27.9	0.081
21	648781	5022762	22.8	0.078
22	648776	5022879	21.9	0.081
23	648805	5022959	22.0	0.080
24	648466	5022724	23.9	0.081
25	649335	5023096	23.0	0.075
Regulatory Limit	**-**	**-**	**400**	**100**

The predicted 1-hour maximum ground-level concentrations of NO_2 are presented in Figure A.3 in Appendix A. The highest ground-level concentrations are predicted to occur near the western side of the property boundary. The highest 1-hour NO_2 GLC for the discrete receptors is 75.6 µg/m^3 occurring at Receptor 6, approximately 20% of the provincial regulatory threshold of 400 µg/m^3. The maximum annual average GLC for NO_2 was predicted to be 0.094 µg/m^3, occurring at Receptor 16, well below the Provincial regulatory limit of100 µg/m^3.

Maximum predicted GLCs for CO and SO_2 can be found in Tables 3.3 and 3.4, respectively. GLCs for both contaminants were predicted to be well below regulatory thresholds for all averaging periods.

Table 3.3 Maximum Predicted Ground Level Concentrations of Carbon Monoxide at Discrete Receptor Locations - Phase 3

Receptor	UTM Coordinates		Maximum Predicted GLC	
	Easting (m)	Northing (m)	1-hr CO (µg/m^3)	8-hr CO (µg/m^3)
1	642692	5023616	55.3	16.9
2	642232	5023505	49.6	14.7
3	642231	5023406	62.6	21.6
4	642088	5023441	58.0	15.3
5	642106	5023396	56.8	18.4
6	642132	5023296	123	19.6
7	642030	5023399	58.4	14.6
8	642025	5023336	88.6	21.3
9	641731	5023150	70.9	18.6
10	643569	5021658	50.8	9.2
11	643589	5021745	48.3	8.7
12	643696	5021694	57.4	11.7
13	644835	5021376	35.0	10.8
14	644710	5021586	52.7	13.8
15	646643	5021585	43.0	15.0
16	647285	5021794	69.1	16.3
17	648538	5022253	101	16.7
18	648615	5022586	45.6	20.2
19	648680	5022576	46.2	20.4
20	648724	5022566	44.5	19.9
21	648781	5022762	36.4	15.8
22	648776	5022879	35.0	14.2
23	648805	5022959	35.2	13.5
24	648466	5022724	38.1	17.3
25	649335	5023096	36.8	16.1
Regulatory Limit	**-**	**-**	**34,600**	**12,700**

Table 3.4 Maximum Predicted Ground Level Concentrations of Sulphur Dioxide at Discrete Receptor Locations - Phase 3

Receptor	UTM Coordinates		Maximum Predicted GLC		
	Easting (m)	Northing (m)	1-hr SO_2 ($\mu g/m^3$)	24-hr SO_2 ($\mu g/m^3$)	Annual SO_2 ($\mu g/m^3$)
1	642692	5023616	0.29	0.04	0.0004
2	642232	5023505	0.37	0.05	0.0003
3	642231	5023406	0.32	0.04	0.0003
4	642088	5023441	0.38	0.05	0.0003
5	642106	5023396	0.36	0.05	0.0003
6	642132	5023296	0.37	0.05	0.0004
7	642030	5023399	0.38	0.05	0.0003
8	642025	5023336	0.34	0.04	0.0003
9	641731	5023150	0.30	0.04	0.0003
10	643569	5021658	0.66	0.15	0.0004
11	643589	5021745	0.84	0.19	0.0004
12	643696	5021694	0.45	0.10	0.0004
13	644835	5021376	0.61	0.15	0.0004
14	644710	5021586	0.40	0.07	0.0004
15	646643	5021585	1.66	0.20	0.0012
16	647285	5021794	0.46	0.07	0.0007
17	648538	5022253	0.43	0.04	0.0006
18	648615	5022586	0.28	0.03	0.0005
19	648680	5022576	0.26	0.03	0.0005
20	648724	5022566	0.25	0.03	0.0005
21	648781	5022762	0.21	0.05	0.0005
22	648776	5022879	0.22	0.06	0.0005
23	648805	5022959	0.23	0.07	0.0005
24	648466	5022724	0.26	0.03	0.0005
25	649335	5023096	0.33	0.05	0.0004
Regulatory Limit	**-**	**-**	**900**	**300**	**60**

3.2 PHASE 5 OPERATIONS

3.2.1 Particulate Matter

The highest predicted 24-hour maximum and annual average GLCs for TSP and $PM_{2.5}$ at each discrete receptor location for Phase 5 are presented in Table 3.5. The highest predicted 24-hour maximum GLCs for PM_{10} are also presented in this table for reference purposes only as there are no provincial or federal regulations associated with PM_{10}. Background concentrations of particulate matter in the Project area are assumed to be negligible.

Table 3.5 Maximum Predicted Ground Level Concentrations of Particulate Matter at Discrete Receptor Locations - Phase 5

Receptor	UTM Coordinates		Maximum Predicted GLC				
	Easting (m)	Northing (m)	24-hr TSP (μg/m³)	Annual TSP (μg/m³)	24-hr PM_{10} (μg/m³)	24-hr $PM_{2.5}$ (μg/m³)	Annual $PM_{2.5}$ (μg/m³)
1	642692	5023616	33.7	0.89	12.1	3.12	0.05
2	642232	5023505	30.3	0.67	10.1	3.04	0.04
3	642231	5023406	41.2	0.75	14.6	2.93	0.04
4	642088	5023441	30.9	0.73	11.2	3.07	0.04
5	642106	5023396	31.1	0.66	11.3	2.92	0.04
6	642132	5023296	42.4	0.59	14.8	2.88	0.03
7	642030	5023399	29.3	0.63	9.8	2.93	0.04
8	642025	5023336	29.7	0.57	10.6	2.80	0.03
9	641731	5023150	33.8	0.51	12.0	2.94	0.03
10	643569	5021658	47.8	0.71	13.7	4.78	0.05
11	643589	5021745	50.0	0.74	13.9	5.04	0.05
12	643696	5021694	58.1	0.84	15.8	5.74	0.05
13	644835	5021376	43.4	0.96	9.8	4.56	0.07
14	644710	5021586	40.7	1.27	11.5	4.12	0.08
15	646643	5021585	31.6	1.12	10.4	3.46	0.07
16	647285	5021794	36.0	1.44	12.8	2.85	0.07
17	648538	5022253	36.7	1.13	11.1	3.60	0.06
18	648615	5022586	27.8	1.23	10.2	2.37	0.07
19	648680	5022576	26.3	1.20	9.9	2.33	0.07
20	648724	5022566	26.5	1.18	10.0	2.31	0.07
21	648781	5022762	20.6	1.02	7.7	1.64	0.06
22	648776	5022879	22.9	1.03	8.4	1.47	0.06
23	648805	5022959	19.2	1.01	6.6	1.41	0.06
24	648466	5022724	24.9	1.15	8.6	2.13	0.06
25	649335	5023096	26.8	0.97	9.7	1.51	0.05
Regulatory Limit	**-**	**-**	**120**	**70**	**-**	**28**	**10**

Isopleths of maximum predicted GLCs for 24-hour TSP can be found in Figure B.1 in Appendix B. GLCs for 24-hour TSP for Phase 5 are predicted to continue to be highest on the shore on the northern edge of the property boundary. The highest 24-hour TSP GLC for the discrete receptors is 58.1 μg/m³ occurring at Receptor 12, approximately 50% of the provincial maximum permissible value of 120 μg/m³.

The highest predicted annual TSP GLC is 1.44 μg/m³ and occurs at Receptor 18. Annual TSP GLCs are predicted to be well below the maximum permissible value of 70 μg/m³.

Isopleths of maximum predicted GLCs for 24-hour $PM_{2.5}$ can be found in Figure B.2 in Appendix A. GLCs for 24-hour $PM_{2.5}$ are highest near the western side of the property boundary. The highest 24-hour $PM_{2.5}$ GLC for the discrete receptors is 5.74 μg/m³ occurring at Receptor 16, approximately 25% of the Canada-wide Standard of 28 μg/m³. The maximum annual average GLC for $PM_{2.5}$ was predicted to be 0.08 μg/m³, occurring at Receptor 14, well below the Canada-wide standard of 10 μg/m³.

3.2.2 Combustion Gases

The highest predicted 1-hour and annual average GLCs NO_2 at each discrete receptor for Phase 5 are presented in Table 3.6. Background concentrations of NO_2 in the Project area are assumed to be negligible.

Table 3.6 Maximum Predicted Ground Level Concentrations of Nitrogen Dioxide at Discrete Receptor Locations - Phase 5

Receptor	UTM Coordinates		Maximum Predicted GLC	
	Easting (m)	Northing (m)	1-hr NO_2 (μg/m³)	Annual NO_2 (μg/m³)
1	642692	5023616	15.9	0.042
2	642232	5023505	15.1	0.034
3	642231	5023406	15.4	0.035
4	642088	5023441	15.5	0.032
5	642106	5023396	15.4	0.033
6	642132	5023296	15.8	0.035
7	642030	5023399	15.4	0.032
8	642025	5023336	16.1	0.033
9	641731	5023150	13.4	0.029
10	643569	5021658	14.5	0.051
11	643589	5021745	14.0	0.055
12	643696	5021694	14.7	0.054
13	644835	5021376	16.3	0.071
14	644710	5021586	17.8	0.070
15	646643	5021585	11.9	0.101
16	647285	5021794	11.4	0.083
17	648538	5022253	9.8	0.071
18	648615	5022586	10.5	0.067
19	648680	5022576	10.4	0.067
20	648724	5022566	10.3	0.066
21	648781	5022762	10.0	0.059
22	648776	5022879	10.5	0.054

Table 3.6 Maximum Predicted Ground Level Concentrations of Nitrogen Dioxide at Discrete Receptor Locations - Phase 5

Receptor	UTM Coordinates		Maximum Predicted GLC	
	Easting (m)	Northing (m)	1-hr NO_2 (µg/m^3)	Annual NO_2 (µg/m^3)
23	648805	5022959	11.2	0.052
24	648466	5022724	11.8	0.065
25	649335	5023096	11.3	0.048
Regulatory Limit	**-**	**-**	**400**	**100**

The predicted 1-hour maximum GLCs of NO_2 are presented in Figure B.3 in Appendix B for Phase 5. The highest ground-level concentrations are predicted to occur near the western side of the property boundary. The highest 1-hour NO_2 GLC for the discrete receptors is 17.8 µg/m^3 occurring at Receptor 14, well below the provincial regulatory threshold of 400 µg/m^3. The maximum annual average GLC for NO_2 was predicted to be 0.101 µg/m^3, occurring at Receptor 15, also well below the Provincial regulatory threshold of 100 µg/m^3.

Maximum predicted GLCs for CO and SO_2 for Phase 5 can be found in Tables 3.7 and 3.8, respectively. GLCs for both contaminants were predicted to be well below regulatory thresholds for all averaging periods.

Table 3.7 Maximum Predicted Ground Level Concentrations of Carbon Monoxide at Discrete Receptor Locations - Phase 5

Receptor	UTM Coordinates		Maximum Predicted GLC	
	Easting (m)	Northing (m)	1-hr CO (µg/m^3)	8-hr CO (µg/m^3)
1	642692	5023616	25.4	10.3
2	642232	5023505	24.0	11.5
3	642231	5023406	24.5	16.4
4	642088	5023441	24.7	13.8
5	642106	5023396	24.5	15.8
6	642132	5023296	25.2	14.6
7	642030	5023399	24.6	15.1
8	642025	5023336	25.7	15.7
9	641731	5023150	21.4	10.1
10	643569	5021658	23.0	10.2
11	643589	5021745	22.2	11.0
12	643696	5021694	23.3	11.8
13	644835	5021376	26.1	13.4
14	644710	5021586	28.4	21.6
15	646643	5021585	19.1	10.0
16	647285	5021794	18.2	8.4
17	648538	5022253	15.7	7.6

Table 3.7 Maximum Predicted Ground Level Concentrations of Carbon Monoxide at Discrete Receptor Locations - Phase 5

Receptor	UTM Coordinates		Maximum Predicted GLC	
	Easting (m)	Northing (m)	1-hr CO (μg/m³)	8-hr CO (μg/m³)
18	648615	5022586	16.8	8.8
19	648680	5022576	16.6	8.7
20	648724	5022566	16.5	8.6
21	648781	5022762	15.9	8.3
22	648776	5022879	16.7	10.8
23	648805	5022959	17.9	10.2
24	648466	5022724	18.8	8.2
25	649335	5023096	18.0	8.4
Regulatory Limit	-	-	**34,600**	**12,700**

Table 3.8 Maximum Predicted Ground Level Concentrations of Sulphur Dioxide at Discrete Receptor Locations - Phase 5

Receptor	UTM Coordinates		Maximum Predicted GLC		
	Easting (m)	Northing (m)	1-hr SO_2 (μg/m³)	24-hr SO_2 (μg/m³)	Annual SO_2 (μg/m³)
1	642692	5023616	0.27	0.04	0.0004
2	642232	5023505	0.34	0.05	0.0004
3	642231	5023406	0.28	0.04	0.0004
4	642088	5023441	0.35	0.05	0.0003
5	642106	5023396	0.32	0.04	0.0003
6	642132	5023296	0.26	0.05	0.0004
7	642030	5023399	0.34	0.05	0.0003
8	642025	5023336	0.30	0.04	0.0004
9	641731	5023150	0.27	0.04	0.0003
10	643569	5021658	0.65	0.15	0.0005
11	643589	5021745	0.83	0.18	0.0006
12	643696	5021694	0.44	0.09	0.0005
13	644835	5021376	0.56	0.15	0.0006
14	644710	5021586	0.35	0.08	0.0006
15	646643	5021585	1.65	0.20	0.0016
16	647285	5021794	0.44	0.07	0.0008
17	648538	5022253	0.42	0.04	0.0006
18	648615	5022586	0.28	0.03	0.0005
19	648680	5022576	0.26	0.03	0.0005
20	648724	5022566	0.25	0.03	0.0005

Table 3.8 Maximum Predicted Ground Level Concentrations of Sulphur Dioxide at Discrete Receptor Locations - Phase 5

Receptor	UTM Coordinates		Maximum Predicted GLC		
	Easting (m)	Northing (m)	1-hr SO_2 (µg/m^3)	24-hr SO_2 (µg/m^3)	Annual SO_2 (µg/m^3)
21	648781	5022762	0.21	0.05	0.0005
22	648776	5022879	0.22	0.06	0.0004
23	648805	5022959	0.22	0.07	0.0004
24	648466	5022724	0.26	0.03	0.0005
25	649335	5023096	0.32	0.05	0.0004
Regulatory Limit	-	-	900	300	60

3.3 BLASTING

Blasting is a short term event resulting in a near-instantaneous puff of air contaminants to be carried downwind. The emissions are dispersed horizontally and vertically, as in continuous plumes, and also are dispersed in the direction of the wind due to turbulence and wind shear. For this Project, the effects of a single blast were calculated on a worst-case basis, and used to derive the daily and annual impacts.

The basic puff model was derived by Turner (1994) and enhanced in the work by Schulze and Turner (1996). The period of maximum production used to calculate particulate concentrations downwind was based on a 50 hole-average blast. A low wind speed (low dilution) has been used, and temperature was assumed to be ambient to reduce thermal plume rise. Deposition is assumed to be negligible so that the estimates are a reasonable worst-case. Based on information provided by Vulcan, the estimated TSP and $PM_{2.5}$ generated by the blast is 9.7 kg and 0.3 kg, respectively.

The maximum 24 hour GLC of $PM_{2.5}$ at the nearest resident distance of 500 m was predicted to be 0.15 µg/m^3, well below the Canada-wide standard of 28 µg/m^3. Long term averages would be much lower due to wind direction and speed variability. AS shown by the wind rose in Figure 2.1, winds blow in the same direction less than 7% of the time toward any given receptor. At a maximum of 182 blasts per year, the annual average GLC would be well below the annual Canada-Wide Standard of10 µg/m^3. The results here are therefore expected to represent an over-estimate of the anticipated exposure levels to nearby residents.

3.4 SHIP TRANSIT

Ships approaching and berthing at the dock will have emissions from propulsion engines, while docked ships run onboard power requirements via "hotelling" emissions from the auxiliary power units. Although emissions from the propulsion engines are larger than the auxiliary units, propulsion unit are expected to operate for a much shorter duration and will be non-stationary; that is, the plume is only a temporary exposure due to ship motion. Virtually all of North America, including the project area, is within an Emission Control Area (ECA) protected by International Maritime Organization (IMO) regulations that reduce the acceptable levels of NOx and SO_2 from marine engines. In January 2016, Tier III limits replace those of Tier II, with a consequent reduction in NOx of about 74% in ECAs that include all of coastal Nova Scotia. With these reductions, model predictions for NOx indicate that hourly limits for NOx would be met on the order of 100 m from a steaming vessel. The expected exposure for hourly and annual averaging periods is therefore expected to be well below regulatory thresholds as vessels are expected to be of the order of 1 km offshore of any residences.

3.5 ADAPTIVE MANAGEMENT

In addition to mitigation measures identified in Section 2.2.2.3, additional controls will be implemented through adaptive management. Adaptive management is a systematic application of monitoring programs to learn optimum procedures for reducing exposure from air contaminants. For example, dust generation from haul roads is a function of several factors including moisture in the roadway and speed of the vehicle. Through adaptive management, the proponent may learn that immediate reductions are possible through speed reductions, while watering trucks may be deployed as a more long-term control that does not compromise productivity. Adaptive management therefore implies a willingness by quarry operators to continually monitor conditions on site and respond to changing environmental conditions to achieve predicted control efficiencies.

One contributing source to the overall impacts that can be controlled through adaptive management is the removal of overburden. This is an essential part of the development of the quarry, but is not an activity that needs to be continuous in order to sustain maximum production. It will be possible to incorporate in mitigation planning the suspension of activities such as overburden removal until such times that soil moisture conditions provide greater control on the emissions that will be generated, and the weather promotes adequate dispersion of any material that is released.

4.0 CONCLUSIONS

Air quality impacts of the quarry were estimated using a dispersion modelling approach to calculate ground level concentrations to be compared against applicable provincial and federal standards. The plume dispersion model AERMOD was used to predict the 1-hour and 24-hour maximum, and the annual average concentrations for nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and particulate matter (including TSP, PM_{10} and $PM_{2.5}$), as well as the 1-hour and the 8-hour maximum concentrations for carbon monoxide (CO).

The maximum ground-level concentrations predicted within the 10 km x 10 km model domain were compared with the applicable ambient standards described in Schedules A of the Nova Scotia *Air Quality Regulation* and the CCME Canada-Wide Standards.

The predicted ground-level concentrations of the air contaminants were found to be at least 50% below their respective objectives, standards and criteria at the nearest discrete receptors.

5.0 CLOSURE

This report has been prepared for the sole benefit of Vulcan Materials Company (Vulcan). The report may not be relied upon by any other person or entity without the express written consent of Stantec Consulting Ltd. (Stantec) and Vulcan.

Any use of this report by a third party, or any reliance on decisions made based upon this report, are the responsibility of the third party. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Stantec makes no representation or warranty with respect to this report other than the work was undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Any information or facts provided by others and referred to or utilized in the preparation of this report was assumed by Stantec to be accurate. This study was undertaken exclusively for the purpose outlined herein and was limited to those contaminants and sources specifically referenced in this report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations.

Due to the nature of the work, Stantec cannot warrant against undiscovered liabilities. Stantec's liability is limited to the lesser amount of Stantec's fees for undertaking this work or $100,000. Stantec disclaims liability for use by any other party and for any other purpose. The conclusions presented in this report should not be construed as legal advice.

This report was prepared by Gillian Hatcher, MASc, and Brian Bylhouwer, MRM, and was reviewed by John Walker, PhD. If you have any questions regarding the contents of this report, or require any additional information, please do not hesitate to contact the undersigned.

STANTEC CONSULTING LTD.

Gillian Hatcher, MASc
Atmospheric Scientist
Tel: (902) 468-7777

John Walker, PhD
Senior Associate
Tel: (902) 468-0442

6.0 REFERENCES

Environment Canada. 2013. National Air Pollutant Surveillance (NAPS) Monitoring Results, 2012 and 2013.

Shulze, R.H., and D. B. Turner. 1996. Practical Guide to Atmospheric Dispersion Modeling, Trinity Consultants, Incorporated.

Turner, D.B. 1994. *Workbook of atmospheric dispersion estimates: an introduction to dispersion modeling* (2nd ed.). CRC Press.

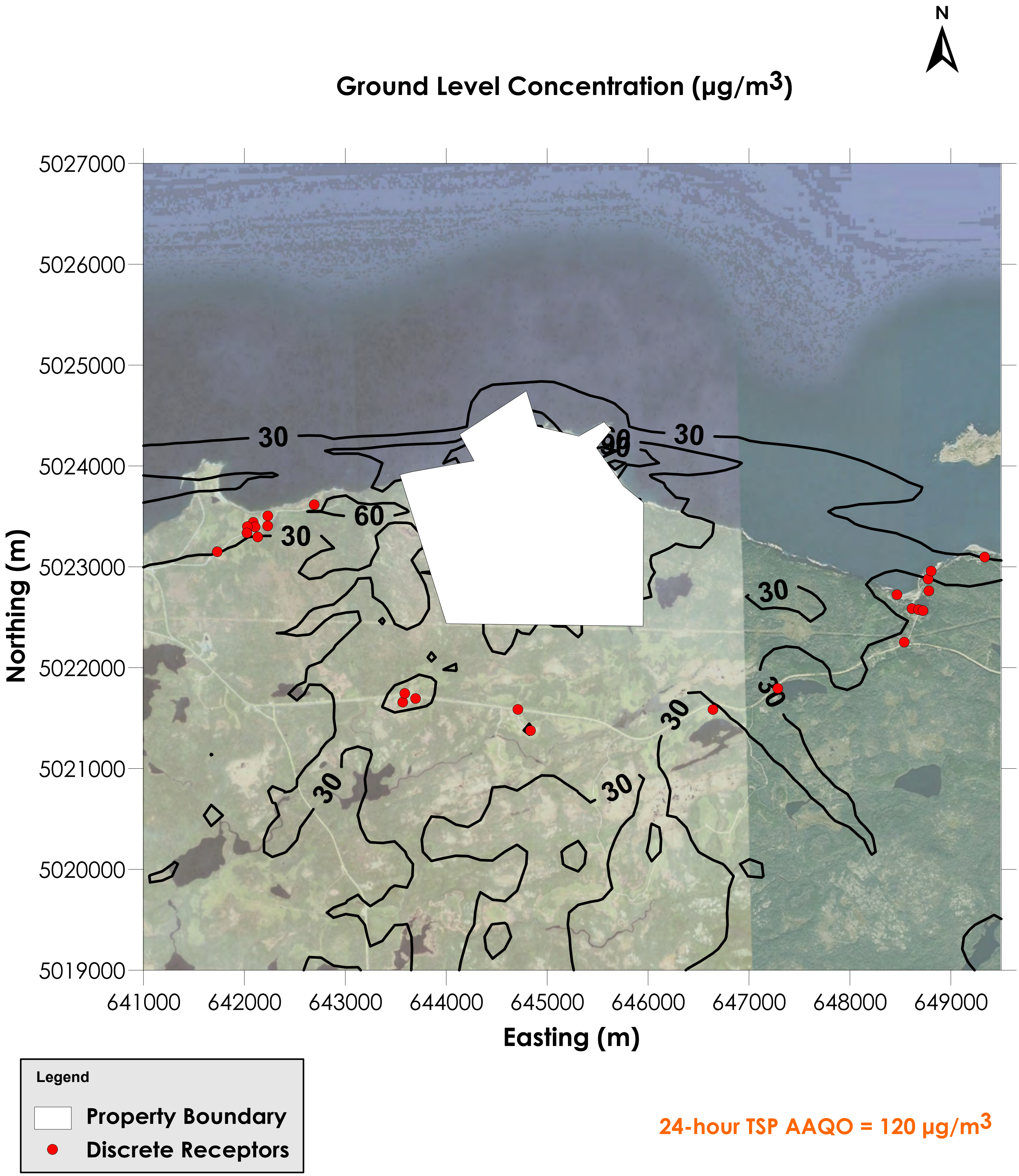
US EPA. 1995. Compliation of Air Pollutant Emission Factors, Section 13.2, Introduction to Fugitive Dust Sources.

US EPA. 1997. The Prime Plume Rise and Building Downwash Model, addendum to ISC3 user's guide, November 1997.

US EPA. 2009. Current Methodologies in preparing Mobile Source Port-Related Emission Inventories. Final Report.

APPENDIX A

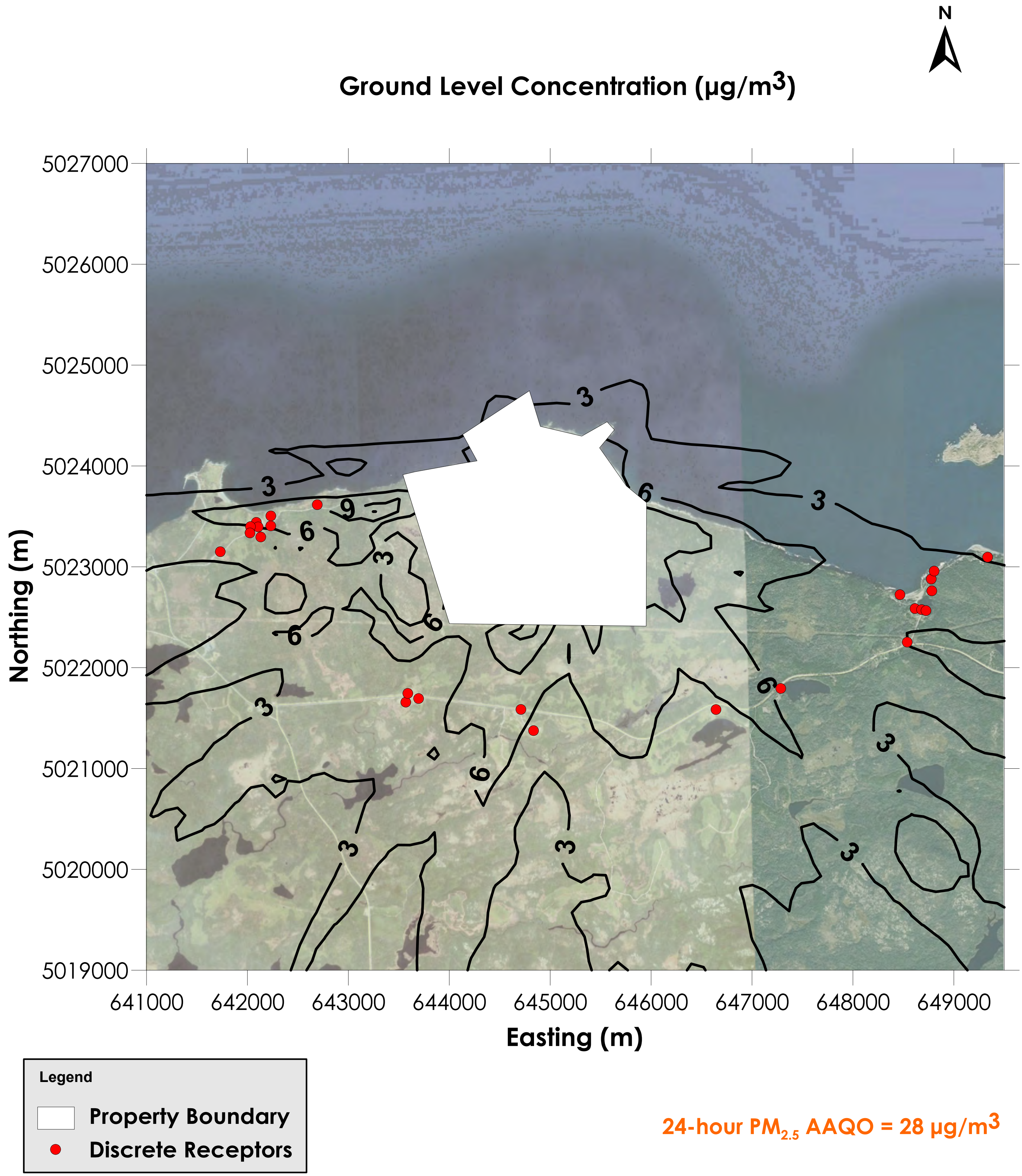
ISOPLETH CONTOURS OF GROUND LEVEL CONCENTRATIONS FROM PHASE 3 OPERATIONS



PROJECTION	UTM	DRAWN BY	BB
DATUM	NAD 83 - ZONE 20	CHECKED BY	JW
DATE	February 2, 2015	FIGURE NO.	Fig. A1

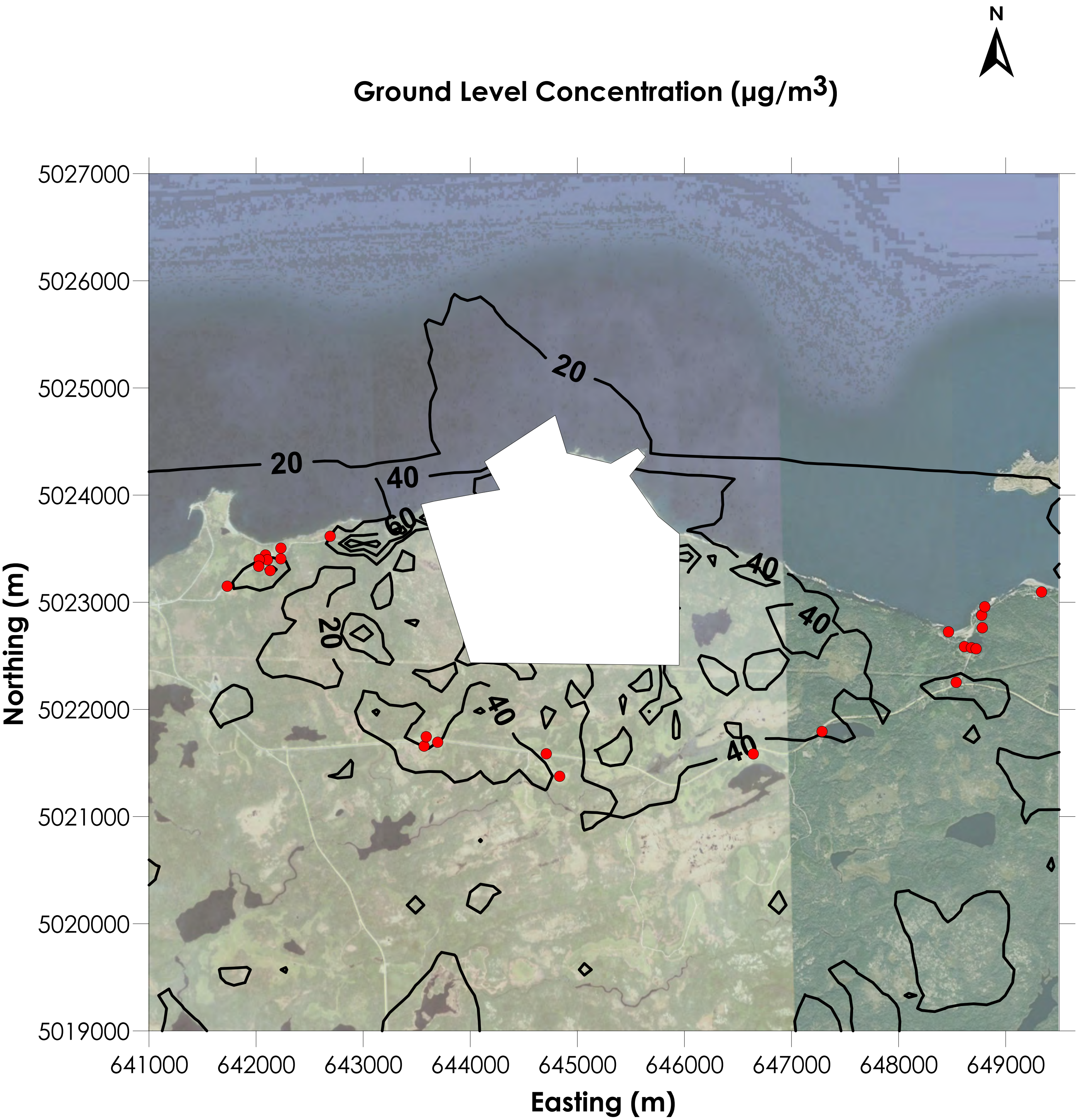
Stantec | Vulcan Materials Company

Maximum Predicted 24-hour Ground Level TSP Concentrations (µg/m³)



Stantec	Vulcan Materials Company	Maximum Predicted 24-hour Ground Level $PM_{2.5}$ Concentrations (µg/m^3)	PROJECTION UTM	DRAWN BY BB
			DATUM NAD 83 - ZONE 20	CHECKED BY JW
			DATE February 2, 2015	FIGURE NO. Fig. A2

Ground Level Concentration (µg/m³)



Legend
- Property Boundary
- Discrete Receptors

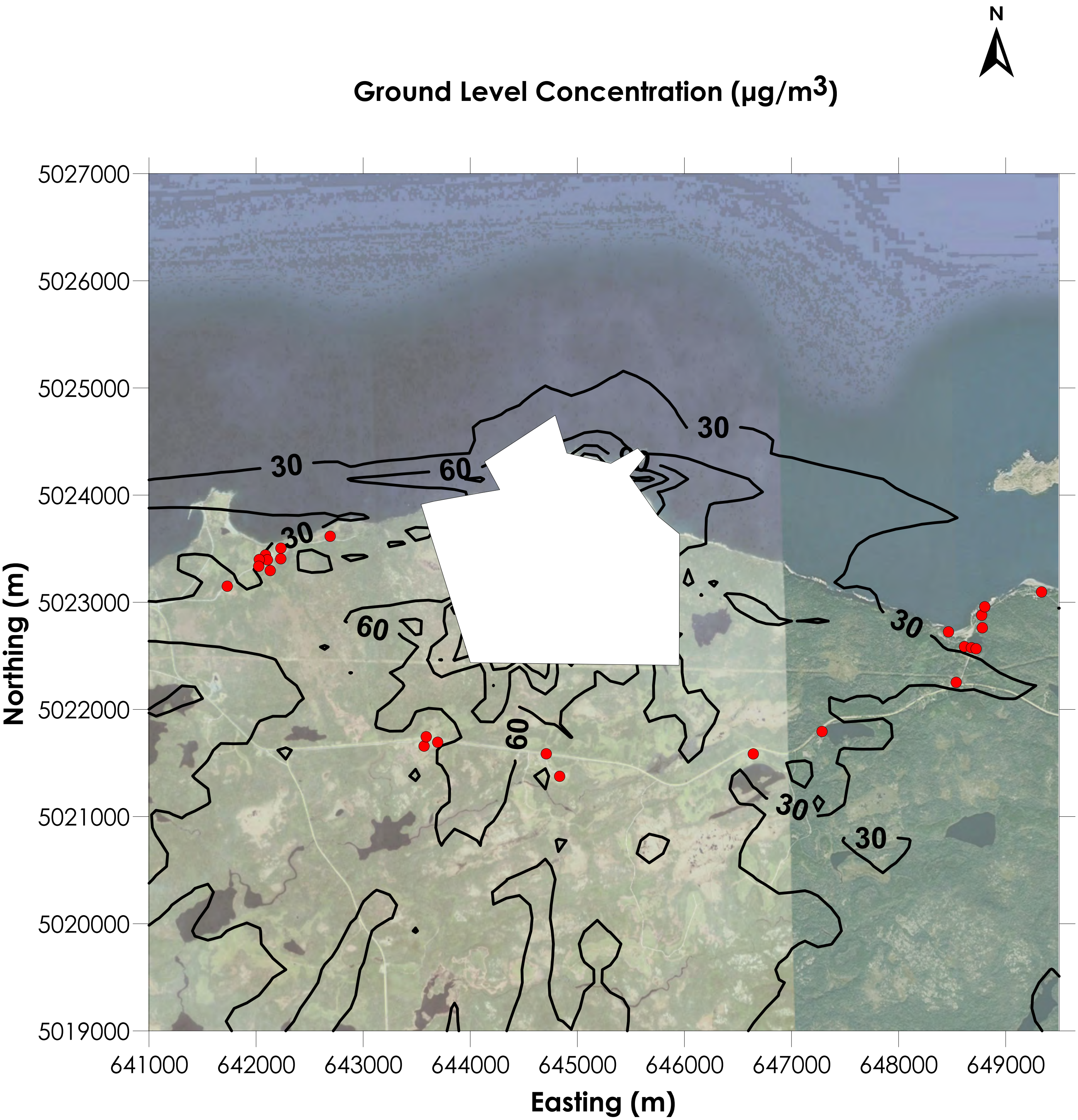
1-hour NO_2 AAQO = 400 µg/m³

Stantec	Vulcan Materials Company	Maximum Predicted 1-hour Ground Level NO_2 Concentrations (µg/m³)	PROJECTION: UTM	DRAWN BY: BB
			DATUM: NAD 83 - ZONE 20	CHECKED BY: JW
			DATE: February 2, 2015	FIGURE NO. Fig. A3

APPENDIX B

ISOPLETH CONTOURS OF GROUND LEVEL CONCENTRATIONS FROM PHASE 5 OPERATIONS

Ground Level Concentration (µg/m^3)

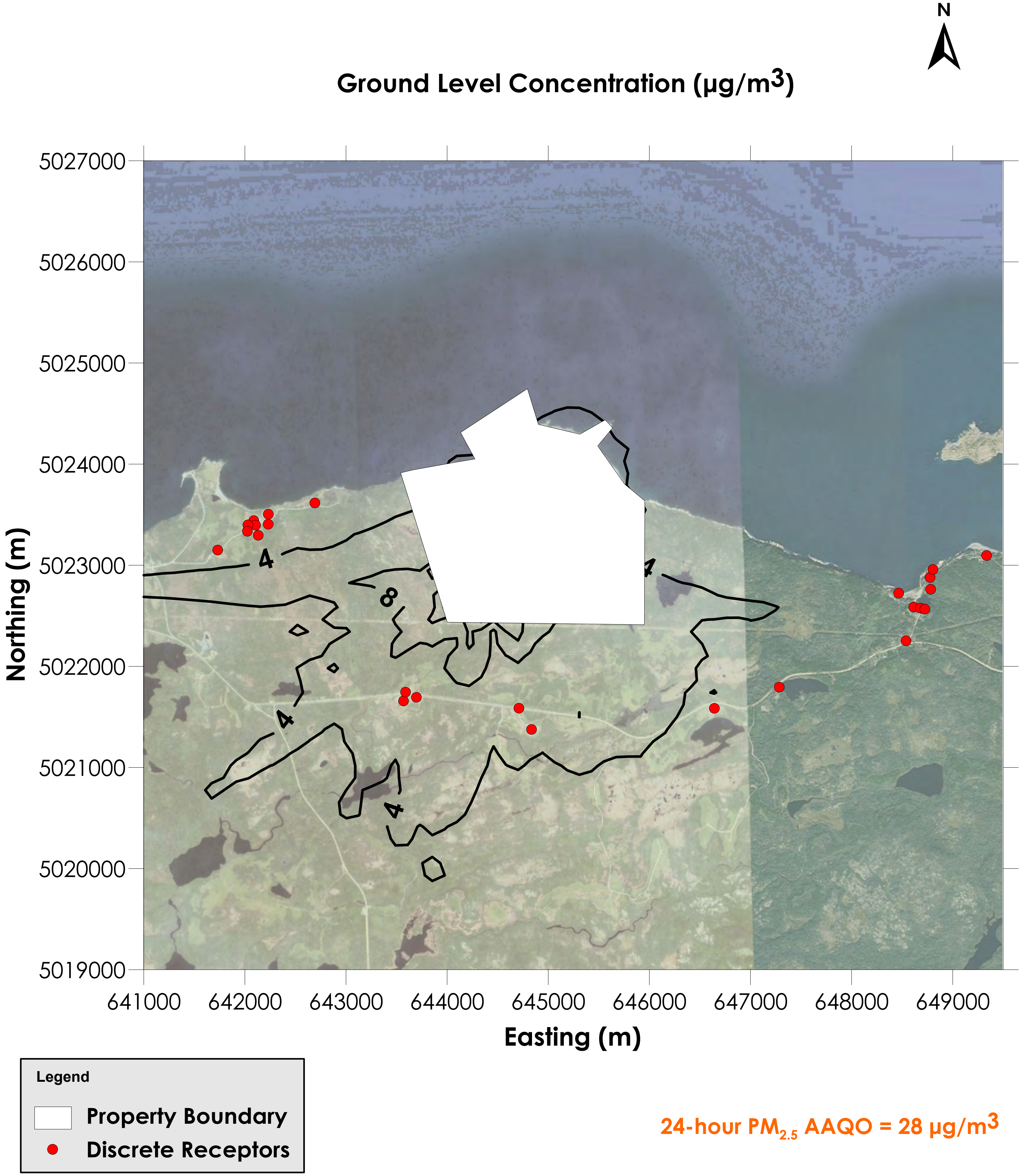


Legend

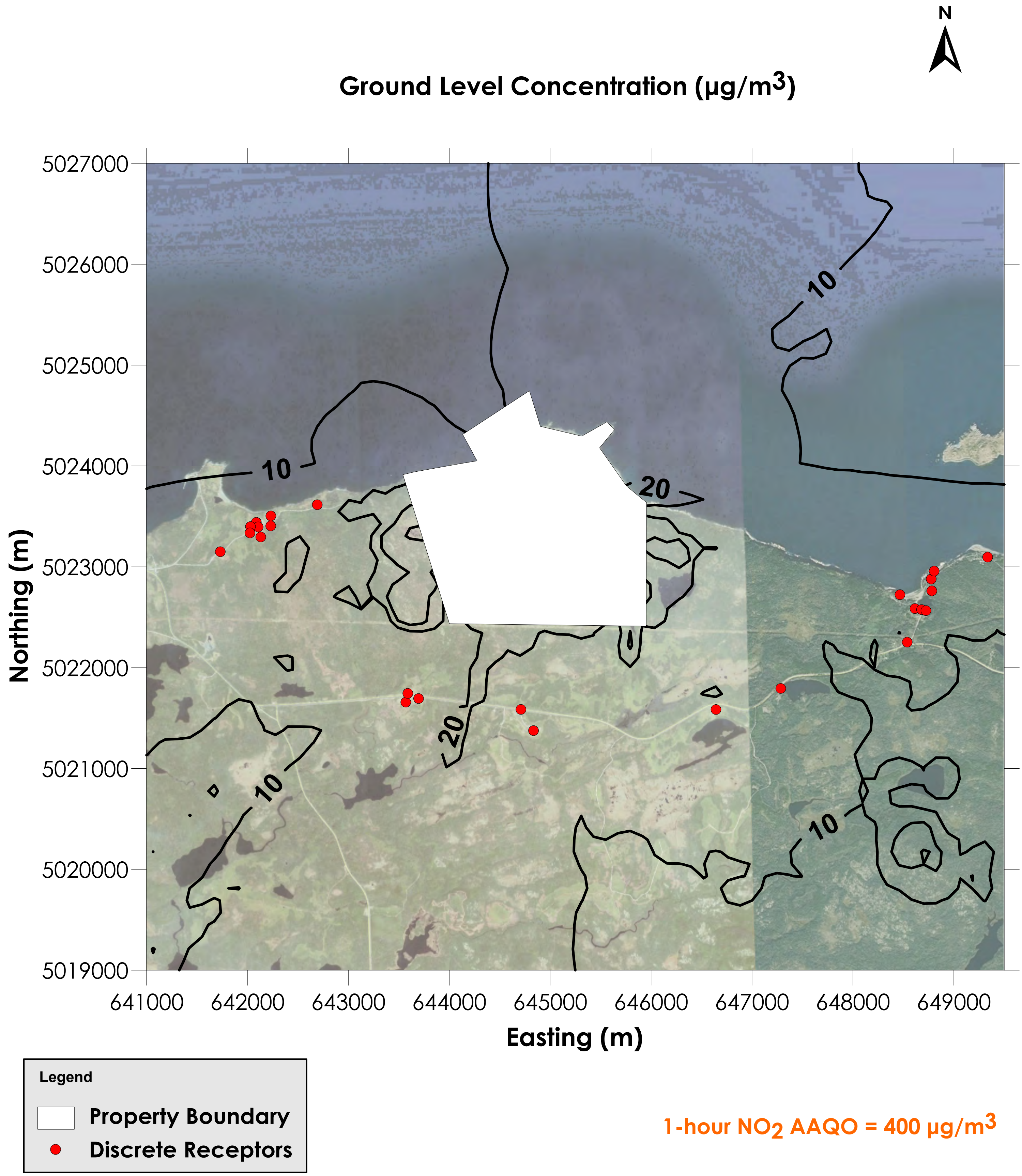
- Property Boundary
- Discrete Receptors

24-hour TSP AAQO = 120 µg/m^3

Stantec	Vulcan Materials Company	Maximum Predicted 24-hour Ground Level TSP Concentrations (µg/m^3)	PROJECTION UTM	DRAWN BY BB	
			DATUM NAD 83 - ZONE 20	CHECKED BY JW	
			DATE February 2, 2015	FIGURE NO. Fig. B1	



Stantec	Vulcan Materials Company	Maximum Predicted 24-hour Ground Level $PM_{2.5}$ Concentrations (µg/m^3)	PROJECTION UTM	DRAWN BY BB
			DATUM NAD 83 - ZONE 20	CHECKED BY JW
			DATE February 2, 2015	FIGURE NO. Fig. B2



Stantec	Vulcan Materials Company	Maximum Predicted 1-hour Ground Level NO_2 Concentrations (µg/m^3)	PROJECTION UTM	DRAWN BY BB
			DATUM NAD 83 - ZONE 20	CHECKED BY JW
			DATE February 2, 2015	FIGURE NO. Fig. B3