Marathon Palladium Project Air Quality Updated Baseline Report

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Prepared for:

Generation PGM Inc. (GenPGM)

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Abbreviations

AAQC	ambient air quality criteria
ADMGO	Air Dispersion Modelling Guideline for Ontario
AP-42	U.S. Environmental Protection Agency Compilation of Air Pollution Emission Estimation Factors Document
AQMMP	Air Quality Management and Monitoring Plan
AQSA	Air Quality Study Area
CAAQS	Canadian Ambient Air Quality Standards
CAC	criteria air contaminants
CAS	Chemical Abstracts Service
CCME	Canadian Council of Ministers of the Environment
CEAA, 2012	*Canadian Environmental Assessment Act*
CIAR	Canadian Impact Assessment Review
CoPC	Contaminant of Potential Concern
CPR	Canadian Pacific Railway
CWS	Canada Wide Standards
EA	environmental assessment
EBMP	Explosives and Blasting Management Plan
ECCC	Environment and Climate Change Canada
EcoMetrix	EcoMetrix Incorporated
EIS/EA	Environmental Impact Statement/Environmental Assessment
EPA	*Environmental Protection Act*
GenPGM	Generation PGM Inc.
GHG	greenhouse gas
GWP	Global Warming Potential
HAP	hazardous air pollutants
HHERA	human health and ecological risk assessment
IR	Information Request

JSL	Jurisdictional Screening Level
LSA	local study area
Max	maximum
MECP	Ontario Ministry of the Environment, Conservation and Parks
Min	minimum
MRSA	Mine Rock Storage Area
N/A	not applicable
NAAQO	National Ambient Air Quality Objectives
NAG	Non-acid generating
NAPS	National Air Pollution Surveillance
O. Reg.	Ontario Regulation
PAG	Potentially acid generating
PAH	polycyclic aromatic hydrocarbons
PDA	Project development area
PGMs	Platinum group metals
PM	particulate matter (also referred to as TSP)
PM_{10}	particulate matter smaller than 10 microns
$PM_{2.5}$	particulate matter smaller than 2.5 microns
POI	point of impingement
PSMF	Process Solids Management Facility
RSA	regional study area
SCI	Stillwater Canada Inc.
SSA	Site Study Area
Stantec	Stantec Consulting Ltd.
SWC	Stillwater Mining Company
TGCL	True Grit Consulting Ltd.
TSP	total suspended particulate matter
UNFCCC	United Nations Framework Convention on Climate Change
URT	upper risk threshold

US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VEC	Valued Environmental Component
VOC	volatile organic compounds
WRSA	waste rock storage area

UNITS OF MEASUREMENT

cm	centimetre	
km	kilometre	
m	metre	
mm	millimetre	
Area		
ha	hectares	
Mass/Weight		
Re. Orders of Magnitude: x 10^2 = x 100, x10^3 = x 1000, etc.		
g	gram	
mg	milligrams	1 x 10^{-3} grams
µg	Microgram	1 x 10^{-6} grams
ng	nanogram	1 x 10^{-9} grams
pg	picogram	1 x 10^{-12} grams
kg	kilogram	1 x 10^3 g
Mg	Megagram	1 x 10^6 g
t	metric tonne	1 x 10^3 kg
kt	kilotonne	1 x 10^6 kg
lb	pound	1 lb = 453.592 grams

Concentration		
ppb	parts per billion	
ppmvd	parts per million by volume on a dry basis	
µg/m^3	micrograms per cubic metre	
Deposition		
g/m^2	grams per square metre	
Power		
W	watt	
kW	kilowatt	1 x 10^3 W
MW	megawatt	1 x 10^6 W
MWth	megawatts of thermal output	
Speed		
km/h	kilometres per hour	
Volume		
m^3	cubic metre	1 m^3 = 1 x 10^3 L
Time		
s	second	
hr	hour	
y	year	
Elements		
Cd	cadmium	
Hg	mercury	
Pb	lead	
Al	aluminum	
As	arsenic	
Be	beryllium	
Cr	chromium	
Cu	copper	
Mn	manganese	
Ni	nickel	
Ag	silver	
Tl	thallium	
Sn	tin	
V	vanadium	

Zn	zinc
Compounds	
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
HC	hydrocarbons
H_2O	water
NMHC	non-methane hydrocarbons
NO_x	nitrogen oxides
N_2O	nitrous oxide
O_3	ozone
SO_2	sulphur dioxide
VEC	Valued Ecosystem Component
VOC	volatile organic compounds

1.0 INTRODUCTION

Generation PGM Inc. (GenPGM) proposes to develop the Marathon Palladium Project (the "Project"), which is a platinum group metals (PGM) and copper (Cu) open pit mine and milling operation near the Town of Marathon, Ontario. The Project is being assessed in accordance with the *Canadian Environmental Assessment Act* (CEAA, 2012) and Ontario's *Environmental Assessment Act* (EA Act) through a Joint Review Panel (the Panel) pursuant to the *Canada-Ontario Agreement on Environmental Assessment Cooperation* (2004).

Stantec Consulting Ltd. (Stantec) has been retained by GenPGM to conduct an updated assessment of air quality baseline conditions for the Project. This report provides an update to the baseline conditions as described in the information currently on the record, including:

- Supporting Information Document #12: Baseline Technical Report – Air – Marathon PGM-Cu Project prepared by True Grit Consulting Ltd. (July 5, 2012) (CIAR # 227)
- Responses to IR10.5, 10.7, 10.15, Atmospheric Environment (CIAR # 373)
- Response to IR10.10.1 and IR10.14, Atmospheric Environment (CIAR # 401)
- Response to IR10.9, Atmospheric Environment (CIAR # 434)

This supplemental air quality baseline study has been completed to inform the Addendum to the Marathon PGM-Cu Environmental Impact Statement (EIS Addendum) as input to the Joint Review Panel process. It has been prepared pursuant to the *Canadian Environmental Assessment Act, 2012* and in consideration of the *Guidelines for the Preparation of an Environmental Impact Statement – Marathon Platinum Group Metals and Copper Mine Project* (EIS Guidelines) (Canadian Environmental Assessment Agency and Ontario Ministry of the Environment, Conservation and Parks (MOE 2011).

The information presented in this report is intended to summarize and document any changes to the existing environmental conditions relating to air quality monitoring data and air quality regulations, relative to those conditions considered in the previous assessment, in order to support the updated assessment of potential environmental effects provided in the EIS Addendum.

The information presented herein was obtained from a review of historical information and the updated design plans for the Project provided by GenPGM.

This document should be read in conjunction with the EIS Addendum.

1.1 PROJECT LOCATION AND SETTING

The Project is located approximately 10 km north of the Town of Marathon, Ontario (Appendix A, Figure 1). Marathon is a community of approximately 3,300 people (Statistics Canada, 2017) located adjacent to the Trans-Canada Highway (Highway 17) on the northeast shore of Lake Superior, approximately 300 km east of Thunder Bay and 400 km northwest of Sault Ste. Marie. The centre of the Project footprint sits at approximately 48° 47’ N latitude, 86° 19’ W longitude (UTM NAD83 N16 Easting 550197 and Northing 5403595). The footprint of the proposed mine location is roughly bounded by Highway 17 and the Marathon Airport to the south, the Pic River and Camp 19 Road to the east, Hare Lake to the west, and Bamoos Lake to the north (Appendix A, Figure 1). Access is currently gained through Camp 19 Road.

The Project is proposed within an area characterized by relatively dense vegetation, comprised largely of a birch and spruce-dominated mixed wood forest. The terrain is moderate to steep, with frequent bedrock outcrops and prominent east-west oriented valleys. Several watercourses and lakes traverse the area, with drainage flowing either eastward to the Pic River or westward to Lake Superior. The climate of this area is typical of northern areas within the Canadian Shield, with long winters and short, warm summers.

The Project is proposed on Crown Land, with GenPGM holding surface and/or mineral rights for the area. Regional land use activities in the area include hunting, fishing, trapping, and snowmobiling, as well as mineral exploration (and mining) and forestry. Other localized land uses in the area include several licensed aggregate pits, the Marathon Municipal Airport, the Marathon Landfill, a municipal works yard and several commercial and residential properties.

The primary industries in the area have historically been forestry, pulp and paper, mining, and tourism. Exploration for copper and nickel deposits in the area extend as far back as the 1920s. A large copper-PGM deposit was discovered in 1963. Advanced exploration programs have continued across the site since then. These programs have been supported by various feasibility studies to confirm the economic viability of extracting the deposits.

Several First Nation and Métis groups were originally identified as having a potential interest in the Project based on Treaty Rights, asserted traditional territory, and proximity to the Project. Traditional uses which they have identified as occurring in the area include hunting, trapping, fishing, and plant harvesting, with activities generally focused on the larger waterways, such as the Pic River, Bamoos Lake and Hare Lake.

Sources of airborne contaminants currently present on site include several permitted gravel pits, the Town of Marathon landfill site, and the Town of Marathon wastewater lagoons. Regional influences on air quality include residential/commercial/institutional heating, fugitive emissions from Highway 17 traffic, fugitive emissions from airport traffic, and other nearby industrial sources, such as the Hemlo gold mine, located approximately 30 km east of the Project site.

1.2 PROJECT OVERVIEW

The Project is based on the development of an open pit mining and milling operation for copper and platinum group metals. Ore will be mined from the pits and processed (crushed, ground, concentrated) at an on-site processing facility. Final concentrates containing copper and platinum group metals will be transported off-site via existing roadways and/or rail to a smelter and refinery for subsequent metal extraction and separation. Iron sulfide, magnetite and vanadium concentrates may also be produced, depending upon the results of further metallurgical testing and market conditions at that time.

The construction workforce will average approximately 450-550 people, with a peak workforce of an estimated 900 people, and will be required for between 18 and 24 months. During operations, the workforce will comprise an estimated 350 workers. The mine workforce will reside in local and surrounding communities, as well as in an accommodations complex that will be constructed off-site.

Most of the mine rock[1] produced through mining activities is non-acid generating (NAG) and will be permanently stored in a purposefully built Mine Rock Storage Area (MRSA). The NAG (also referred to as Type 1 mine rock) will also be used in the construction of access roads, dams and other site infrastructure, as needed. Drainage from the MRSA will be collected in a series of collection basins and treated, as necessary, to meet applicable water quality criteria prior to discharge to the Pic River. The remaining small portion of the mine rock is considered to be potentially acid generating (PAG) (also referred to as Type 2 mine rock) and will be stored in the open pits or the Process Solids Management Facility (PSMF). This will ensure that drainage from the Type 2 mine rock will be contained during operations. Following closure, the Type 2 mine rock will be permanently stored below water by flooding the open pits and maintaining saturated conditions in the PSMF to prevent acid generation in the future.

Most of the process solids[2] produced at the site will be NAG (Type 1 process solids) with the minority being PAG (Type 2 process solids). Both the Type 1 and Type 2 process solids will be stored in the PSMF and potentially within the open pits. In both cases, the Type 2 process solids will be managed to prevent acid generation during both the operation and closure phases of the Project. Water collected within the PSMF as well as water collected around the mine site (other than the MRSA), such as water pumped from the pits or run-off collected from the plant site, will be managed within the PSMF. Excess water not needed for processing ore will be discharged, following treatment as necessary, to Hare Lake.

Access to the Project is currently provided by the Camp 19 Road, opposite Peninsula Road at Highway 17. The existing road will be upgraded and utilized from its junction with Highway 17 to a new road running north that will be constructed to access the Project site. The Project will also require the

[1] Mine rock: rock that has been excavated from active mining areas but does not have sufficient ore grades to process for mineral extraction.
[2] Process solids: solids generated during the ore milling process following extraction of the ore (minerals) from the host material.

construction of a new 115 kV transmission line that will connect to the Terrace Bay-Manitouwadge transmission line (M2W Line). The width of the transmission corridor will be approximately 30 m.

Disturbed areas of the Project footprint will be reclaimed in a progressive manner during all Project phases. Natural drainage patterns will be restored as much as possible. The ultimate goal of mine decommissioning will be to reclaim land within the Project footprint to permit future use by resident biota and as determined through consultation with the public, Indigenous people and government. A certified Closure Plan for the Project will be prepared as required by Ontario Regulation (O. Reg.) 240/00 as amended by O. Reg. 194/06 "*Mine Development and Closure under Part VII of the Mining Act*" and "Mine Rehabilitation Code of Ontario".

A further description of the Project and associated activities and phases will be provided under separate cover in the EIS Addendum.

1.3 STUDY OBJECTIVES

This updated air quality baseline study provides information to inform the EIS Addendum for the Project. The objectives of this update were to describe and present available information and to characterize changes to the baseline conditions of air contaminants relative to regulatory criteria in the study area. The scope of the updated air quality baseline study includes the following:

- summary of findings of the existing baseline studies (Section 2.0)
- identification of regulatory guidance for the collection of baseline data (Section 3.0)
- confirmation of spatial boundaries (Section 4.0)
- description of the data collection methods and a review of available background information and data, including any additional and/or on-going data collection efforts (Section 5.0)
- analysis of information to characterize existing baseline conditions for air quality and to determine changes that have occurred since 2012 (Section 6.0)
- provide an updated summary of baseline conditions in the SSA, LSA and RSA specific to conditions relevant to the effects being assessed in the EIS Addendum (Section 7.0)

2.0 PREVIOUS CHARACTERIZATION OF EXISTING CONDITIONS

Baseline air quality and climate was characterized in *Stillwater Canada Inc. Marathon PGM-Cu Project, Supporting Information Document No. 12 – Baseline Technical Report – Air – Marathon PGM – Cu Project (July 5, 2012).* (TGCL, 2012). The report provided a summary of ambient measurements of PM_{10} at three locations in the vicinity of the Project from July to November 2011 and dustfall measurements from August to October 2011 at five locations. A summary of these measurements is provided in Table 2.1. Laboratory analysis of metals, sulphate and nitrate concentrations in the measured dustfall was also conducted and presented in the report.

Table 2.1: Summary of 2011 Ambient Monitoring Data

Contaminant	Averaging Period	Marathon Project Site
PM_{10} (ug/m^3)	24 hr	12.8 – 14.6
Dustfall (g/m^2)	30 day	0.33 – 1.44

The 2012 Baseline report also presented background data for a limited number of other contaminants derived from published air quality data for Thunder Bay and Sault Ste. Marie, which are presented in Table 2.2.

Table 2.2: Summary of 2012 Baseline Report Data for Non-Measured Contaminants

Contaminant	Averaging Period	Marathon Project Site
TSP (ug/m^3)	24 hr	22 – 48
$PM_{2.5}$ (ug/m^3)	24 hr	1 - 5
NO_x (ppb)	24 hr	33.2
SO_2 (ppb)	24 hr	3.25
CO (ppb)	24 hr	0.83

The 2012 baseline report utilized local meteorological data from a variety of stations with varying measured parameters, measurement times, and historical monitoring periods. Long-term climate data (1971-2000) for four stations (Manitouwadge, Terrace Bay, Sudbury Airport and Thunder Bay Airport) were examined.

During the Information Request (IR) process, data on expected background ambient concentrations of metals were presented in the response to IR 10.10.1. These data were, developed from three rural MECP monitoring sites (Burnt Island, Egbert and Point Petre) that are distant to the south of the Marathon site.

3.0 REGULATORY SETTING

Since the preparation of the original baseline report and completion of the EIS, some regulatory changes or updates have been implemented by federal and provincial authorities. The following sections describe the regulatory setting relative to contaminants of potential concern (CoPCs) and greenhouse gases (GHGs) in the province of Ontario.

3.1 ASSESSMENT CRITERIA

3.1.1 Ontario Criteria

The following point of impingement (POI) criteria published by the Ministry of the Environment, Conservation and Parks (MECP) have been applied as part of this review to characterize existing conditions:

- Ambient Air Quality Criteria (AAQC)
- Ontario Regulation 419/05 standards and guidelines
- Jurisdictional Screening Levels (JSLs)
- Upper Risk Thresholds (URTs)

The Project will be considered a new facility under O. Reg. 419/05 and, as such, the Schedule 3 standards apply. Where no O. Reg. 419/05 Schedule 3 standards are available for a particular CoPC, guidelines, Ontario AAQCs, and JSLs will be considered. Ontario's AAQC criteria are desirable effects-based concentrations in air with variable averaging periods. The type of effect that a chemical may have varies but may be based on health, odour, vegetation, soiling, visibility, or corrosion, amongst others. JSLs are screening criteria used in the province of Ontario to evaluate the significance of contaminant emissions for chemicals that do not have O. Reg. 419/05 or AAQC criteria. Similar to O. Reg. 419/05 criteria, JSL criteria are generally used for comparison at the property boundary. Modelled concentrations of chemicals that are below published JSLs are considered to be insignificant. Upper Risk Thresholds (URTs) are maximum concentrations which are not to be exceeded anywhere off-property. Similar to JSL values, URTs are compared to modelled concentrations at the claim boundary.

Criteria published in O. Reg. 419/05 are applied at a POI, most commonly a property boundary or, in the case of a mining property, the claim boundary. The exception is when a sensitive land use, such as a child-care facility, health care facility or educational facility, exists on site.

Summaries of the relevant provincial air quality objectives, guidelines, and standards are presented in Table 3.1 for total suspended particulate matter (TSP) and metals, Table 3.2 for Criteria Air Contaminants (CACs), Table 3.3 for volatile organic compounds (VOCs), and Table 3.4 for polycyclic aromatic hydrocarbons (PAHs). Changes in air quality criteria since the 2012 Baseline report (TGCL, 2012), as well as proposed future changes to criteria in O. Reg. 419/05 were also considered and included in the tables.

Table 3.1: Summary of Provincial Air Quality Criteria for TSP and Metals

Parameter	CAS #	O. Reg. 419/05 - Schedule 3 Standards, Guidelines, JSLs and URTs		Ontario AAQC	
		24 Hour (µg/m^3)	Other time period (µg/m^3)	24 Hour (µg/m^3)	Other time period (µg/m^3)
Total Particulate (TSP)	NA	120	-	-	-
Aluminum	7429-90-5	4.8(2)	-	-	-
Antimony	7440-36-0	25	-	25	-
Arsenic	7440-38-2	0.3(1)	-	0.3	-
Barium	7440-39-3	10(1)	-	10	-
Beryllium	7440-41-7	0.01	-	0.01	-
Bismuth	7440-69-9	-	-	-	-
Boron	7440-42-8	120	-	120	-
Cadmium	7440-43-9	0.025, 0.25(3)	-	0.025	0.005; annual
Calcium	7440-70-2	-	-	-	-
Chromium (total)	7440-47-3	0.5, 5(3)	-	0.5	-
Cobalt	7440-48-4	0.1(1)	-	0.1	-
Copper	7440-50-8	50	-	50	-
Iron	15438-31-0	4	-	4	-
Lead	7439-92-1	0.5, 2(3)	0.2; 30+ day	0.5	0.2(+) 30day
Lithium	7439-93-2	20	-	20	-
Magnesium	7439-95-4	0.2(2)	-	-	-
Manganese	7439-96-5	0.4	-	0.1 (Mn in PM2.5), 0.2 (Mn in PM10), 0.4 (Mn in TSP)	-
Mercury	7439-97-6	0.5	-	2 (Hg), 0.5 (Hg as alkyl compounds)	-
Molybdenum	7439-98-7	120(1)	-	120	-
Nickel	7440-02-0	2(3)	-	0.1 (Ni in PM10), 0.2 (Ni in TSP)	0.02 (Ni in PM10 - annual), 0.04 (Ni in TSP - annual)
Potassium	7440-09-7	8(2)	-	-	-
Selenium	7782-49-2	10(1)	-	10	-
Silver	7440-22-4	1	-	1	-

Table 3.1: Summary of Provincial Air Quality Criteria for TSP and Metals

Parameter	CAS #	O. Reg. 419/05 - Schedule 3 Standards, Guidelines, JSLs and URTs		Ontario AAQC	
		24 Hour (µg/m³)	Other time period (µg/m³)	24 Hour (µg/m³)	Other time period (µg/m³)
Sodium	7440-23-5	-	-	-	-
Strontium	7440-24-6	120(1)	-	120	-
Thallium	7440-28-0	0.24(2)	-	-	-
Tin	7440-31-5	10	-	10	-
Titanium	7440-32-6	120	-	120	-
Uranium	7440-61-1	1.5(3)	0.03; annual (after July 1, 2016)	0.15 (U in PM10), 0.3 (U in TSP)	0.03 (U in PM10 - annual), 0.06 (U in TSP - annual)
Vanadium	7440-62-2	2	-	2	-
Yttrium	7440-65-5	2.4(2)	-		-
Zinc	7440-66-6	120	-	120	-

Table 3.2: Summary of Provincial Air Quality Criteria for CACs

Parameter	CAS	O. Reg. 419/05 – Schedule 3 Standards and AAQC		
		1-Hour (µg/m³)	24-Hour (µg/m³)	Other time Period (µg/m³)
Sulphur dioxide	7446-09-5	690, 100 D	275, N/A D	55 A; 10 D annual
Nitrogen oxides B	10102-44-0	400	200	-
Ozone	10028-15-6	165	-	-
$PM_{2.5}$	N/A	-	30 A, C	-
PM_{10}	N/A	-	50 A, C	-
Carbon monoxide	630-08-0	36,200 A	-	6,000; ½-hour 15,700; 8-hour A

Notes:

A. Ontario Ambient Air Quality Criteria

B. The Schedule 3 standards for NO_X are based on health effects of NO_2, as NO_2 has adverse health effects at much lower concentrations than NO. Therefore, the standard was compared to NO_2 in this report.

C. AAQC for $PM_{2.5}$ references CAAQS. AAQC for PM_{10} is an interim AAQC provided as a guide for decision making.

D. New Schedule 3 standards for SO_2 effective July 1, 2023.

Table 3.3: Summary of Air Quality Criteria for VOCs

Parameter	CAS #	O. Reg. 419/05 - Schedule 3 Standards, Guidelines, and JSLs		Ontario AAQC	
		24 Hour (µg/m³)	Other (µg/m³)	24 Hour (µg/m³)	Other time period (µg/m³)
1,1,1-Trichloroethane	71-55-6	115,000	-	115,000	-
1,1,2,2-Tetrachloroethane	76-34-5	-	-	-	-
1,1,2-Trichloroethane	79-00-5	-	-	-	-
1,1-Dichloroethane	75-34-3	165	600 (1/2 hr) [2]	165	-
1,1-Dichloroethylene	75-35-4	10	-	10	-
1,2,4-Trichlorobenzene	120-82-1	400 [2]	-	400	-
1,2,4-Trimethylbenzene	95-63-6	220	-	220	-
1,2-Dichlorobenzene	95-50-1	-	30,500 (1 hr) [2] 37,000 (1/2 hr) [2]	-	30,500 (1 hr)
1,2-Dichloroethane	107-06-2	2	-	2	-
1,2-Dichloropropane	78-87-5	2,400 [2]	-	2,400	-
1,2-Dichlorotetrafluoroethane	76-14-2	700,000 [2]	-	700,000	-
1,3,5-Trimethylbenzene	108-67-8	220	-	220	-
1,3-Butadiene	106-99-0	-	-	-	-
1,3-Dichlorobenzene	541-73-1	-	-	-	-
1,4-Dichlorobenzene	106-46-7	95	-	95	-
1,4-Dioxane	123-91-1	3,500	-	3,500	-
2,2,4-Trimethylpentane	540-84-1	-	-	-	-
2-propanol	67-63-0	7,300	-	7,300	-
2-Propanone	67-64-1	11,880	-	-	-
4-ethyltoluene	622-96-8	500 [1]	-	-	-
Acrylonitrile	107-13-1	0.6	-	0.6	-
Benzene	71-43-2	-	0.45 (Annual)	-	-
Benzyl chloride	100-44-7	-	-	-	-
Bromodichloromethane	75-27-4	-	-	-	-
Bromoform	75-25-2	55 [2]	-	55	-
Bromomethane	74-83-9	1,350 [2]	-	1,350	-
Carbon Disulfide	75-15-0	330 [2]	-	330	-
Carbon tetrachloride	56-23-5	2.4	-	2.4	-

Table 3.3: Summary of Air Quality Criteria for VOCs

Parameter	CAS #	O. Reg. 419/05 - Schedule 3 Standards, Guidelines, and JSLs		Ontario AAQC	
		24 Hour (µg/m³)	Other (µg/m³)	24 Hour (µg/m³)	Other time period (µg/m³)
Chlorobenzene	108-90-7		3,500 (1 hr); 4,500 (10 min) [2]		3,500 (1 hr); 4500 (10 min)
Chloroethane	75-00-3	5,600	-	5,600	-
Chloroform	67-66-3	1	-	1	-
Chloromethane	74-87-3	320	-	320	-
cis-1,2-Dichloroethylene	156-59-2	105 [2]	-	105	-
cis-1,3-Dichloropropene	542-75-6	1.25 [1]	-	-	-
Cyclohexane	110-82-7	6,100	-	6,100	-
Dibromochloromethane	124-48-1	0.2 [1]	-	-	-
Dichlorodifluoromethane (FREON 12)	75-71-8	500,000 [2]	-	500,000	-
Ethanol	64-17-5	-	19,000 (1 hr) [2]	-	19,000 (1 hr)
Ethyl Acetate	141-78-6	-	19,000 (1 hr) [2]	-	19,000 (1 hr)
Ethylbenzene	100-41-4	1,000	1,900 (10 min) [2]	1000	1,900 (10 min)
Ethylene Dibromide	106-93-4	3 [2]	-	3	-
Heptane	142-82-5	11,000	-	11,000	-
Hexachlorobutadiene	87-68-3	0.227	-	-	-
Hexane	110-54-3	2,500 (mixture); 7,500 (n-Hexane and Hexane isomers only)	-	2,500 (mixture); 7,500 (n-Hexane and Hexane isomers only)	-
m / p-Xylene	108-38-3 / 106-42-3	100 [1, 3] 730 (total) [3]	3,000 (10min - total) [3]	-	730 (total) 3,000 (10min - total) [4]
Methanol	67-56-1	4,000	-	4,000	-
Methyl Butyl Ketone (2-Hexanone)	591-78-6	16 [1]	-	-	-
Methyl Ethyl Ketone (2-Butanone)	78-93-3	1,000	-	1,000	-
Methyl Isobutyl Ketone	108-10-1	1,200 [2]	-	1,200	-
Methyl t-butyl ether (MTBE)	1634-04-4	7,000 [2]	-	7,000	-
Methylene Chloride (Dichloromethane)	75-09-2	220	-	220	-

Table 3.3: Summary of Air Quality Criteria for VOCs

Parameter	CAS #	O. Reg. 419/05 - Schedule 3 Standards, Guidelines, and JSLs		Ontario AAQC	
		24 Hour (µg/m³)	Other (µg/m³)	24 Hour (µg/m³)	Other time period (µg/m³)
Naphthalene	91-20-3	22.5 [2]	50 (10 min) [2]	22.5	50 (10 min)
n-Butane	106-97-8	7,600 [1]	-	-	-
o-Xylene	95-47-6	100 [1, 3] 730 (total) [3]	3,000 (10min - total) [3]	-	730 (total) 3,000 (10min - total) [4]
Propene	115-07-1	4,000	-	4,000	-
Propionaldehyde (Propanal)	123-38-6	-	10 (10 min) [2]	-	10 (10 min)
Styrene	100-42-5	400	-	400	-
Tetrachloroethylene	127-18-4	360	-	360	-
Tetrahydrofuran	109-99-9	93,000 [2]	-	93,000	-
Toluene	108-88-3	2,000 [2]	-	2,000	-
trans-1,2-Dichloroethylene	156-60-5	105 [2]	-	105	-
trans-1,3-Dichloropropene	542-75-6	1.25 [1]	-	-	-
Trichloroethylene	79-01-6	12	-	12	-
Trichlorofluoromethane (FREON 11)	75-69-4	6,000 [2]	-	6,000	-
Trichlorotrifluoroethane	76-13-1	800,000	-	800,000	-
Vinyl Bromide	593-60-2	7 [1]	-	-	-
Vinyl Chloride	75-01-4	1	-	1	-
Vinyl Acetate	108-05-4	140 [1]	-		-

Notes:

1 – JSL

2 – Guideline

3 – JSL is 100 ug/m³ for each of m, p, and o-xylene. 24-hour Schedule 3 criteria for xylenes is 730 ug/m³. 10-minute guideline for xylenes is 3,000 ug/m³.

4 – 24-hour AAQC for xylenes is 730 ug/m³. 10-minute guideline for xylenes is 3,000 ug/m³.

Table 3.4: Summary of Applicable Provincial Air Quality Standards for Selected PAHs

CoPC	Chemicals Abstracts Services Number (CAS No.)	O. Reg. 419/05 – Schedule 3 Standards and JSLs		Ontario AAQC	
		24-Hour (µg/m^3)	Other time Period (µg/m^3)	24-Hour (µg/m^3)	Other time Period (µg/m^3)
Acenaphthene	83-32-9	-	-	-	-
Acenaphthylene	208-96-8	3.5 [A]	10.5; ½ hour [A]	-	-
Anthracene	120-12-7	0.2 [A]	0.6; ½ hour [A]	-	-
Benzo(a)anthracene	56-55-3	-	-	-	-
Chrysene	218-01-9	-	-	-	-
Fluoranthene	206-44-0	140 [A]	420; ½ hour [A]	-	-
Fluorene	86-73-7	-	-	-	-
Phenanthrene	85-01-8	-	-	-	-
Pyrene	129-00-0	0.2 [A]	0.6; ½ hour [A]	-	-
Benzo(a)pyrene	50-32-8	0.00005	0.00001	0.00005	0.00001
Benzo(b+k) fluoranthene	205-99-2	-	-	-	-
Benzo(g,h,i)perylene	191-24-2	1.2 [A]	3.6; ½ hour [A]	-	-

3.1.2 Federal Criteria

Federal air quality criteria published in the National Ambient Air Quality Objectives (NAAQO) and the Canada Wide Standards (CWS) (and discussed in the 2012 baseline report) have been replaced by Canadian Ambient Air Quality Standards (CAAQS). The CAAQS were developed through a collaborative process involving the federal, provincial, and territorial governments and stakeholders, as directed by the CCME (CCME 2012).

New or updated CAAQS for sulphur dioxide (SO_2) and particulate matter with diameter less than 2.5 µm ($PM_{2.5}$) came into effect in 2020 and 2025 (for SO_2) (CCME 2016b, 2016a). CAAQS for nitrogen dioxide (NO_2) were released on November 3, 2017 and come into effect in 2020 and 2025 (CCME 2017).

The applicable federal criteria are summarized in below.

Table 3.5: Summary of Federal Air Quality Standards

Air Contaminant	Averaging Time	2020 CAAQS ($\mu g/m^3$)	2025 CAAQS ($\mu g/m^3$)
NO_2	1 hour	113 [a]	79 [b]
	24 hours	-	-
	Annual	32 [a]	23 [b]
$PM_{2.5}$	24 hours	27 [c]	-
	Annual	8.8 [c]	-
SO_2	1 hour	183 [d]	170 [e]
	24 hours	-	-
	Annual	13 [d]	10.5 [e]
O_3	8 hours	124	-

Notes:

a. 1 Hour and Annual CAAQS for NO_2, effective by 2020 (CCME, 2020). The 1-hour CAAQS is referenced to the 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations. The annual CAAQS is the average over a single calendar year of all 1-hour average concentrations. The criteria were converted from ppb to $\mu g/m^3$ based on standard temperature of 25 ^oC and pressure of 1 atm as per (Health Canada, 2016).

b. 1 Hour and Annual CAAQS for NO_2, effective by 2025 (CCME, 2018). The 1-hour CAAQS is referenced to the 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations. The annual CAAQS is the average over a single calendar year of all 1-hour average concentrations. The criteria were converted from ppb to $\mu g/m^3$ based on a standard temperature of 25 ^oC and pressure of 1 atm as per (Health Canada, 2016).

c. 24 Hour and Annual CAAQS for Respirable Particulate Matter, effective by 2020 (CCME, 2012). The 24-hour CAAQS is referenced to the 98th percentile daily average concentration averaged over 3 consecutive years. The annual CAAQS is referenced to the 3-year average of the annual average concentrations.

d. 1 Hour and Annual CAAQS for SO_2, effective by 2020 (CCME, 2018). The 1-hour CAAQS is the 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations. The annual CAAQS is referenced to the average over a single calendar year of all 1-hour average concentrations. The criteria were converted from ppb to $\mu g/m^3$ based on a standard temperature of 25 ^oC and pressure of 1 atm as per (Health Canada, 2016).

e. 1 Hour and Annual CAAQS for SO_2, effective by 2025 (CCME, 2018). The 1 Hour CAAQS is the 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations. The annual CAAQS is the average over a single calendar year of all 1-hour average concentrations. The criteria were converted from ppb to $\mu g/m^3$ based on a standard temperature of 25 ^oC and pressure of 1 atm as per (Health Canada, 2016).

3.1.3 Greenhouse Gases (GHGs)

Environment and Climate Change Canada's document *Strategic Assessment of Climate Change* is the primary source of guidance for the incorporation of GHG and Climate Change Impact considerations into an EA in Canada (ECCC, July 2020).

Policy initiatives have been implemented to address GHG emissions at the federal level. The Paris Agreement enacted by the United Nations Framework Convention on Climate Change (UNFCCC) is in place to strengthen the global response to climate change by keeping a global temperature rise to 1.5 to 2.0 degrees Celsius above pre-industrial levels (UNFCCC, 2015). The Government of Canada ratified the Paris Agreement in 2016 and it forms the basis for Canada's federal climate change policy and GHG reduction targets.

Under the federal Greenhouse Gas Reporting Program, facilities that emit greater than 10,000 tonnes of carbon dioxide equivalent (tCO_2e) must report their emissions to ECCC in accordance with the Canada Gazette Notice published on an annual basis (Government of Canada, 2020(a)). Furthermore, facilities that emit greater than 50,000 tCO_2e must comply with the requirements of the federal Output-Based Pricing System Regulations made under the *Greenhouse Gas Pollution Pricing Act* which require such facilities to provide compensation for the GHG emissions that are over a prescribed amount or to obtain credit for GHG emissions that are under the prescribed amount (Government of Canada, 2020(b)).

Ontario Regulation 390/18 (Greenhouse Gas Emissions: Quantification, Reporting and Verification, O. Reg. 390/18) made under the *Environmental Protection Act* requires that facilities subject to the regulation calculate and report GHG emissions annually if the minimum reporting threshold limit of 50,000 tCO_2e is exceeded. Although there is an Ontario provincial regulatory compliance program similar to the federal Output-Based Pricing System Regulations, as described in Ontario Regulation 241/19 (Greenhouse Gas Emissions Performance Standards O. Reg. 241/19), this regulation has been put on hold until the federal government approves the basis and the requirements of the provincial regulation.

4.0 STUDY AREA

For the purpose of this assessment, the spatial boundaries considered include the direct and indirect effects related to site preparation, construction, operation, and decommissioning/closure of the Project. These areas are generally consistent with the spatial boundaries used in the EIS (2012) and associated supporting information documents, with appropriate revisions/refinements and rationale provided below.

4.1 SITE STUDY AREA (SSA)

The Site Study Area (SSA) is the direct footprint of the Project. Based on refinements to the Project footprint, and in recognition of project components originally located outside of the SSA, a revised SSA has been developed that encompasses the immediate area in which Project activities and components may occur and, as such, represents the area within which direct physical disturbance may occur as a result of the Project, whether temporary or permanent. The SSA is consistent for all Valued Ecosystem Components (VECs) as depicted on Figure 1 (Appendix A).

4.2 LOCAL STUDY AREA (LSA)

The Local Study Area (LSA) is the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the SSA and adjacent areas where Project-related environmental effects are reasonably expected to occur based on available information and professional judgment. The LSA for air quality is depicted on Figure 2 (Appendix A).

The LSA for air quality is considered to be an area extending 10 km from the Site surface claim boundary, which encompasses the Town of Marathon and the Pic River First Nation. The LSA was sized based on guidelines provided by the MECP to capture the maximum predicted ground level concentrations due to the Project in the dispersion modelling (MECP, 2016). This LSA has been updated relative to that defined in the 2012 AQ Baseline report (TGCL, 2012). The 2012 Baseline report defined the LSA as 10 km from all GenPGM claim areas (surface and subsurface), which also encompassed the Town of Marathon and the Pic River First Nation. This update report utilizes solely the surface claim area boundary, which defines the maximum surface extent of the mine site, as the basis for defining the 10-km zone around the site.

4.3 REGIONAL STUDY AREA (RSA)

The Regional Study Area (RSA) is the area within which cumulative environmental effects for atmospheric environment may occur, depending on physical and meteorological conditions and the type and location of other past, present, and reasonably foreseeable projects. The RSA (Figure 2, Appendix A) has been updated relative to the 2012 baseline report (TGCL, 2012) to be defined specific to the effect being considered:

- For air quality, the RSA is an area extending 50 km from the Site claim boundary. This distance defines the extent that other projects within this area may have a measurable effect on air quality in this study's LSA based on the types of emission sources anticipated for this Project.
- For a change in greenhouse gas (GHG) emissions, since GHG releases act cumulatively in the atmosphere globally, the environmental effect of GHG on the environment is a global concern. The spatial boundary is provincial and national in geographic extent.

5.0 METHODOLOGY

5.1 DESKTOP REVIEW AND DATA SOURCES

5.1.1 Climatology and Meteorology

For this update to the 2012 baseline report, climate normal data from the Thunder Bay Airport station was used. This is the nearest climate normal station with a comprehensive set of measurement parameters and with a similar setting to Marathon (i.e., located on the shore of Lake Superior). The climate normals for Thunder Bay Airport have not been updated since the 2012 baseline report; therefore, this report utilizes the same data set (1971-2000) for this station. Other climate normal stations included in the 2012 baseline report have limited measurement data or are not expected to be as representative of the site as the Thunder Bay station and, therefore, were not included in this update. The location of the Thunder Bay Airport station is provided in Table 5.1.

Table 5.1: Climate Normal Weather Station Information

Station ID	Station Name	Elevation (m)	Latitude	Longitude
6048261	Thunder Bay A	199.0	48°22’	89°19’

The 2012 baseline report utilized local meteorological data from a variety of stations with varying measured parameters, measurement times, and historical monitoring periods. This included a station at Marathon Airport which measured a full suite of meteorological parameters, but only during daytime hours. In 2014, Nav Canada established an automated meteorological station at Marathon Airport which measures data on a 24-hour basis. The most recent 5 full years of data from this station (2015-2019) were utilized in this updated baseline report for all parameters except for precipitation (data for which is not available for this station). Precipitation data from the Pukaskwa Park station, which is located approximately 15 km south of the Marathon Airport, and expected to be representative of the Marathon area, was utilized. A summary of the meteorological station location information is provided in Table 5.2 below.

Table 5.2: Meteorological Station Information

Station ID	Station Name	Elevation (m)	Latitude	Longitude
6044967	Marathon Airport (established 2014)	314.6	48°45’ 26”	86°20’ 45”
6046770	Pukaskwa National Park	192.0	48°36’	86°18’

Evaporation data was obtained from available mapping published by the Hydrological Atlas of Canada. Map Plate 17, depicting mean annual lake evaporation for the 10-year period spanning 1957 to 1966, was used to obtain data regarding the mean annual evaporation rate for the Marathon area.

Local meteorological conditions were also measured between September and November 2011 in conjunction with PM_{10} and dustfall monitoring. A Davis Vantage Pro2 weather station was established on the Project site to provide hourly measurements of wind speed, wind direction, temperature, relative humidity, and precipitation. The weather station was erected in accordance with the Environment Canada guideline entitled *MSC Guidelines for Co-operative Climatological Autostations, Version 3.0*, Meteorological Service of Canada, dated September 2004. The co-ordinates of the weather station were as follows:

Northing N 48.8°

Easting W 86.3°

Local data was compared to existing ECCC station data to assess data compatibility and to supplement data obtained from the Marathon Airport station.

5.1.2 Background Ambient Air Quality

Ambient monitoring data from two sources were assessed for this baseline report, as detailed in the following sub-sections.

5.1.2.1 National Air Pollution Surveillance Program

Ambient air quality monitoring is conducted by the National Air Pollution Surveillance (NAPS) Program operated by ECCC in populated regions of Canada. The NAPS program continuously measures sulphur dioxide, nitrogen dioxide, ozone, fine particulate matter, and carbon monoxide. Measurements of metals and volatile organic compounds (VOCs) from NAPS stations are also conducted at selected monitoring locations. In this baseline assessment, NAPS network data was assessed for the above pollutants at the monitoring sites nearest the Project. Available NAPS data was assessed for the most recent five years of available data (2014-2018) for all assessed contaminants (with the exception of metals) at the NAPS sites located closest to the Project site. These NAPS stations are listed in Table 5.3. For metals, the most recent NAPS data (2009-2013) were assessed.

The closest monitoring stations to the Project site are in Thunder Bay, approximately 300 km west of the subject property, and in Sault Ste. Marie, approximately 300 km east of the Project site. The Marathon Project site is located on the north side of Highway 17 in a remote area of northwestern Ontario, approximately 10 km north of the nearest community of Marathon. As a result, baseline ambient air quality is expected to be good and adequately represented by rural air quality. Data from more developed municipalities, such as Winnipeg, Thunder Bay and Sault Ste. Marie, are expected to provide conservative (i.e., over-estimate) estimates of air quality levels in the LSA.

Table 5.3: NAPS Locations Assessed in This Study

NAPS ID	City	Location		Elevation	Type
		Latitude	Longitude	(m)	
60709	Sault Ste. Marie (443 Northern College)	46.53319	-84.30992	252	Industrial
60809	Thunder Bay (415 James St.)	48.37939	-89.29017	207	Residential
62001	North Bay (Chippewa St.)	46.32323	-79.44928	223	Residential
70118	Winnipeg (299 Scotia St.)	49.93207	-97.11317	227	Residential
70119	Winnipeg (65 Ellen St.)	49.89809	-97.14652	229	Commercial

5.1.2.2 Baseline Local Ambient Air Quality

The methodology and results presented in this report are unchanged from those in the 2012 Baseline report. No additional baseline air quality sampling was conducted for this report update, which is consistent with the desk-top baseline air quality methodology used for the Nextbridge East-West Transmission Project EA (Nextbridge, 2017), whose study area included the Marathon area. For the Nextbridge study, use of existing air quality data sources (NAPS data) was deemed sufficient to characterize baseline air quality in the study area.

Baseline concentrations of PM_{10}, dustfall, metals, and nutrients were measured at up to five locations on and around the Project site in 2011. In addition, Project site meteorology was measured for some of the sampling period in 2011.

PM_{10}

Baseline concentrations of inhalable particulate matter (PM_{10}) were measured at three locations on the Project site using PQ100 portable PM_{10} air sampling equipment. Sampling was completed between June and November 2011 and was conducted in general accordance with methodology described in the MECP document *Operations Manual for Air Quality Monitoring in Ontario*, dated March 2008 (MECP, 2008).

The PQ100 sampling equipment consisted of calibrated low volume particulate air samplers mounted on a tripod equipped with new, pre-weighed 47 mm Teflon filters. Each sampling station was operated on a dedicated wet cell battery. Sampling equipment was operated on a six-day sampling schedule where one 24-hour sample was collected every six days over the sampling period. Sample locations are provided in Table 5.4, below.

Table 5.4: PM_{10} Monitoring Station Locations

Station No.	1	2	3
Location	Pic River	North of May's Gifts	Hare Lake
Easting (m)	551637	547152	545694
Northing (m)	5402371	5401222	5403864

The PM_{10} sampling equipment was sited to meet the requirements of the MECP air quality monitoring manual. To the extent possible, sampling equipment was placed in locations where the distance between the nearest obstacle and the sampling equipment was at least twice the height of the obstacle. Placement of sampling equipment near unpaved roadways was avoided to the extent possible. Sampler inlets were placed at least 2.5 m above ground surface.

Prior to sampling, the sample flow rate was calibrated using either a Gilian Gilabrator or a Delta Cal primary calibrator and the flow rate recorded. Ambient temperature and pressure were also recorded. A new pre-weighed 47 mm Teflon filter was placed in the sample holder and the equipment was programmed to sample for the specified date.

Upon completion of sampling, filters were collected, placed in labelled petri dish containers, and shipped under Chain of Custody to Galson Laboratories, an ISO accredited laboratory, for gravimetric analysis of PM_{10}.

Dustfall

Dustfall is a measure of total deposition of particulate, including wet deposition (material removed from the environment by precipitation) and dry deposition (material that settles naturally). Baseline dustfall was measured at five locations for the months of August, September, and October 2011: four locations on or around the Project site (Locations 1 through 4) and one within the Town of Marathon (Location 5).

Sampling locations were strategically selected to evaluate dustfall near identified sensitive receptors or areas that would be affected by dustfall once the Project site is developed. Site selection for the dustfall monitors was completed in general accordance with the MECP document *Operations Manual for Air Quality Monitoring in Ontario*, dated March 2008 and *ASTM Method D1739-98* (2004). Monitoring sites were selected based on an analysis of prevailing meteorological conditions, proximity to existing dust-generating sources (i.e., Highway 17, Marathon airport, existing gravel pits) and suitability of sampling locations to meet siting criteria.

Each dustfall monitoring station consisted of a laboratory-supplied collection jar mounted onto a fabricated metal stand. The metal stand extended 2.0 metres above ground and had a mesh wind screen surrounding the sample jar. In addition, bird-deterring spikes were mounted on top of the wind screen to minimize the potential for birds to perch on the stand and skew the results. A summary of dustfall stations is provided below in Table 5.5.

Table 5.5: Dustfall Monitoring Station Locations

Station No.	1	2	3	4	5
Location	Pic River	May's Gifts	Hare Lake	Airport	Field Office
Easting (m)	0551643	0547147	0545694	0549180	0545863
Northing (m)	5402374	5401216	5403873	5399815	5397092

Sample jars were deployed to the site at the beginning of each sampling month and left in place for the entire month (30 +/- 2 days). Following completion of sampling, jars were collected and transported under Chain of Custody to ALS Laboratory Group for analysis of total dustfall, total, soluble and insoluble anions and total metals.

6.0 UPDATED BASELINE CONDITIONS

6.1 CLIMATOLOGY

The Project area lies in the sub-arctic region. The climate of the Project area is typical of northern areas within the Canadian Shield, with long winters and short warm summers.

6.1.1 Temperature

Mean monthly temperatures for the most recent 5 years of data (2015-2019) for the Marathon Airport station are shown below in Table 6.1 and compared to climate normal data for Thunder Bay. The Marathon Airport 2015-2019 temperature data is consistent with the Marathon Airport data presented in the 2012 Baseline Report.

Table 6.1: Summary of Average Temperature Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Marathon Airport (2015-2019)													
Daily Average (°C)	-13.3	-13.9	-6.6	-0.2	6.4	9.7	14.5	14.5	12.3	4.9	-2.6	-9.3	1.4
Thunder Bay (1971-2000)													
Daily Average (°C)	-14.8	-12.0	-5.5	2.9	9.5	14.0	17.6	16.6	11.0	5.0	-3.0	-11.6	2.5
Daily Maximum (°C)	-8.6	-5.6	0.3	9.0	16.4	20.6	24.2	23.1	17.1	10.4	1.7	-6.1	8.5
Daily Minimum (°C)	-21.1	-18.4	-11.2	-3.3	2.5	7.3	11.0	10.1	4.9	-0.5	-7.7	-17.0	-3.6

Temperatures for the Marathon area are characterized by warm summers and cold winters. Mean temperatures are relatively similar between the Marathon Airport data and the Thunder Bay Climate normal data, with the coldest temperatures occurring during the winter months of December to February and the warmest temperatures occurring in the summer months of July and August.

Extreme maximum and minimum temperatures for the Marathon Airport for the years 2015 to 2019 are summarized in Table 6.2 below.

Table 6.2: Summary of Measured Extreme Temperatures at Marathon Airport (2015-2019)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum (°C)	2.6	6.6	13.7	14.2	27.3	25.6	26.9	26.4	28.5	21.4	14.1	8.9
Minimum (°C)	-41.7	-39.3	-33	-22.6	-7.2	-0.8	2.1	1.1	-2.2	-11.1	-25	-36.3

Extreme minimum temperatures at the Marathon Airport ranged from -41.7°C to +2.1°C and maximum temperatures ranged from +2.6°C to +28.5°C.

6.1.2 Relative Humidity

Relative humidity is the gravimetric ratio of water vapour in a unit volume to the water vapour that would prevail under saturated conditions at a given temperature. Average monthly relative humidity (RH) levels at 6:00 AM and 3:00 PM local standard time (LST) for Marathon Airport (2015-2019) and from climate normal data for Thunder Bay Airport are presented in Table 6.3. Monthly average RH for Marathon Airport ranged from 79.9% - 94.8% at 6:00 AM and 53.8% - 80.5% at 3:00 PM. Measured RH levels at Marathon Airport for the 2015-2019 period were generally higher than the Thunder Bay climate normal data.

Table 6.3: Summary of Average Relative Humidity Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Marathon Airport (2015-2019)													
Average Relative Humidity – 0600 LST (%)	82.4	79.9	78.3	80.3	83.4	87.8	92.3	94.8	94.8	88.5	88.0	85.4	86.3
Average Relative Humidity – 1500 LST (%)	75.9	68.7	57.6	53.8	58.2	61.3	68.5	73.8	74.8	72.6	78.8	80.5	68.7
Thunder Bay (1971-2000)													
Average Relative Humidity – 0600 LST (%)	70.6	72.3	75.2	77.1	82.8	88.2	91.3	92.5	90	85.3	80.3	75.3	81.7
Average Relative Humidity – 1500 LST (%)	61.6	59.1	56.4	48.6	50.1	56.9	59	59.8	60.8	60.9	65.2	65.4	58.7

6.1.3 Evaporation

Based on the Hydrological Atlas of Canada (the same reference used in the 2012 Baseline Report), evaporation in the Marathon area is interpreted to be on the order of 510 mm. According to Environment Canada's Water Budget Values for the period 1959 to 1981, the mean annual evapotranspiration is approximately 488.2 mm (Golder, 2007).

An evaluation of Environment Canada lake evaporation data for Atikokan, Ontario between 1966 and 1988 shows a minimum value of -30 mm, a maximum of 3,910 mm and a 90th percentile value of 530 mm which compares well to the mapping value.

6.1.4 Precipitation

Mean monthly precipitation of the period 2015-2019 for the Pukaskwa station, which is approximately 15 km south of the Marathon Airport, is presented in Table 6.4. Climate normal data from Thunder Bay airport is also presented in this table.

Table 6.4: Mean Monthly Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pukaskwa (2015-2019)													
Precipitation (mm)	51.7	60.8	38.9	40.1	49.2	87.2	39.9	74.3	95.6	93.5	61.4	66.7	759.4
Average Snow Depth (cm)	29.9	41.8	44.9	18.0	0.1	0	0	0	0	0.7	2.4	12.8	12.6
Thunder Bay (1971-2000)													
Rainfall (mm)	2.5	2.8	17.5	29.5	65.0	85.7	89.0	87.5	87.5	57.0	31.5	3.6	559.0
Snowfall (cm)	41.2	26.9	26.8	12.4	1.7	0.0	0.0	0.0	0.5	6.1	27.8	44.1	187.6
Precipitation (mm)	31.3	24.9	41.6	41.5	66.5	85.7	89.0	87.5	88.0	62.6	55.6	37.5	711.6
Average Snow Depth (cm)	31	31	24	5	0	0	0	0	0	0	3	15	9

The average annual precipitation for the Pukaskwa Station is 759 mm, which compares well to the Thunder Bay climate normal value of 712 mm and the Marathon Airport data for 1988-1999 (840 mm) presented in the 2012 Baseline Report.

6.1.5 Wind Speed and Direction

Wind speed and direction climate normal data for Thunder Bay are presented in Table 6.5. The annual average windspeed is 11.7 km/hr with the most frequent wind direction being westerly.

Table 6.5: Monthly Average Wind Speed and Direction Data - Thunder Bay Climate Normals (1971-2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Speed (km/h)	12.2	11.5	12.4	12.7	12.5	11.3	10.3	9.8	11.1	11.9	12.2	11.9	11.7
Most Frequent Direction	W	SW	E	E	E	E	W	SW	SW	W	W	W	W

A wind rose of the Marathon Airport data from 2015-2019 is presented as Figure 3 (Appendix A). Wind roses are an efficient and convenient means of presenting wind data. The length of the radial barbs gives the total percent frequency of winds from the indicated direction, while portions of the barbs of different widths indicate the frequency associated with each wind speed category. The prevailing winds are from the northeast and southwest, with calm winds occurring less than 1% of the time. The average wind speed over the 5-year period was 13.9 km/hr which compares well with the climate normal data. The wind rose is reasonably consistent with that presented in the 2012 Baseline Report for Marathon Airport data from 2008-2010.

The frequency distribution of wind speeds is shown on Figure 4 (Appendix A). High wind speeds greater than 8.8 m/s occur infrequently, while wind speeds between 0.5 - 2.1 m/s occur the most frequently.

6.1.6 Atmospheric Pressure

Atmospheric pressure at the Marathon Airport between 2015 and 2019 ranged between 93.7 and 100.3 kPa, with an average pressure of 97.7 kPa, and is consistent with the 2012 Baseline Report data. Measured pressures at Marathon Airport are similar to the Climate Normal data for Thunder Bay as shown in Table 6.6.

Table 6.6: Atmospheric Pressure

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Marathon Airport (2015-2019)													
Average Station Pressure (kPa)	97.7	97.7	98.0	97.9	97.7	97.6	97.7	97.7	97.9	97.7	97.7	97.6	97.7
Thunder Bay (1971-2000)													
Average Station Pressure (kPa)	99.2	99.3	99.3	99.2	99.1	98.9	99	99.1	99.1	99.1	99.1	99.2	99.1

6.1.7 Weather Phenomena

Occurrences of weather phenomena, including extreme and rare meteorological phenomena, were reviewed from real-time data collected at the Marathon Airport and from published Environment Canada rare weather mapping.

6.1.7.1 Tornadoes

There are no reported occurrences of tornadoes in the Marathon area, based on ECCC mapping from the Canadian National Tornado Database for the period 1980 to 2009.

6.1.7.2 Lightning

According to Environment Canada records for the period 1999 to 2018, approximately 25 incidents of cloud to ground lightning are reported per year within 25 km of Geraldton - the closest city with data to the Project area. The incidence of lightning near the Project site is typical of northern Ontario and lower than the number of incidences observed in southern Ontario.

6.1.7.3 Fog

Visibility was not measured at the Marathon Airport Station for the 2015-2019 period. The average number of days per year that visibility is reduced to less than 1 km due to fog from the Thunder Bay climate normal data is approximately 127.

6.1.8 Other Extreme Weather Phenomena

Other extreme weather phenomena include ice storms, extreme rain or snow events, or hail.

Only one report of a potentially damaging hail occurrence was reported for the Marathon area between 1979 and 2009. Compared to southern Ontario where the range of incidences was from 1 to 50, the potential for damaging hail occurrences at the Project site is considered to be low.

The area is potentially susceptible to heavy snowfall events, with on average approximately five daily events per year of more than 10 cm of snowfall (based on the climate normal data for the Thunder Bay station between 1971 and 2000).

There were no reported damaging wind occurrences for the Marathon area between 1979 and 2009.

6.2 BASELINE AIR QUALITY CONDITIONS – NAPS DATA REVIEW

Baseline air quality was assessed through the review of historical air quality measurements from NAPS stations operated by Environment Canada. The following sections provide a review of available ambient monitoring data from the NAPS program at sites in northern Ontario and Manitoba. Available monitoring data for particulate matter less than 2.5 microns ($PM_{2.5}$), particulate matter less than 10 microns (PM_{10}), nitrogen dioxide (NO_2), nitrogen oxides (NOx), sulphur dioxide (SO_2), ozone (O_3), and carbon monoxide (CO) from 2014–2018 were obtained and reviewed from the NAPS locations identified in Section 5.1.2.1, Table 5.3 (Sault Ste. Marie, Thunder Bay, North Bay and two stations in Winnipeg). Metals are only measured at the Winnipeg Ellen Street monitoring station and the most recent 5 years of data available at this location (2009 to 2013) were used in the assessment. Likewise, monitoring data for CO for the period from 2017 to 2018 for the Winnipeg monitoring stations and PAHs from 2014 to 2018 for the Ellen Street Winnipeg monitoring station were not available, so the most recent 5 years of available data were reviewed. Total suspended particulate matter (TSP) was not measured at these stations during this time period.

Where applicable, concentrations are provided in this report in units of ppb and µg/m^3 (referenced to 1 atmosphere and 10˚C).

The historical long-term ambient air concentrations measured at the NAPS stations presented in this study are used as the basis to establish background ambient concentrations in the LSA. The Marathon Project site is located on the north side of Highway 17 in a remote area of northwestern Ontario with baseline ambient air quality expected to be typical for rural areas. Data from more developed municipalities, such as Winnipeg, Thunder Bay and Sault Ste. Marie, are expected to provide conservative (i.e., over-estimate) estimates of air quality levels in the LSA.

6.2.1 Particulate Matter

NAPS monitoring data for ambient particulate matter concentrations ($PM_{2.5}$ and PM_{10}) from 2014 to 2018, where available, were reviewed. Total suspended particulate matter (TSP) was not measured by NAPS during this period.

Particulate matter that is less than 2.5 microns in diameter ($PM_{2.5}$) is continuously monitored at all five stations listed in Section 5.1.2.1, including the Sault Ste. Marie station (an industrial location), Thunder Bay station (a residential location), North Bay station (a residential location), Scotia Street Winnipeg (a residential location), and Ellen Street Winnipeg station (a commercial location).

During the period from 2014-2018, annual mean $PM_{2.5}$ concentrations at the stations ranged from 4.6 µg/m^3 at North Bay in 2016 to 6.8 µg/m^3 in Winnipeg (65 Ellen St.) in 2018.

The maximum measured daily average $PM_{2.5}$ concentrations ranged from 13.3 µg/m^3 measured in 2016 at the Thunder Bay station to 112 µg/m^3 measured in 2018 at the Winnipeg (299 Scotia St.) station.

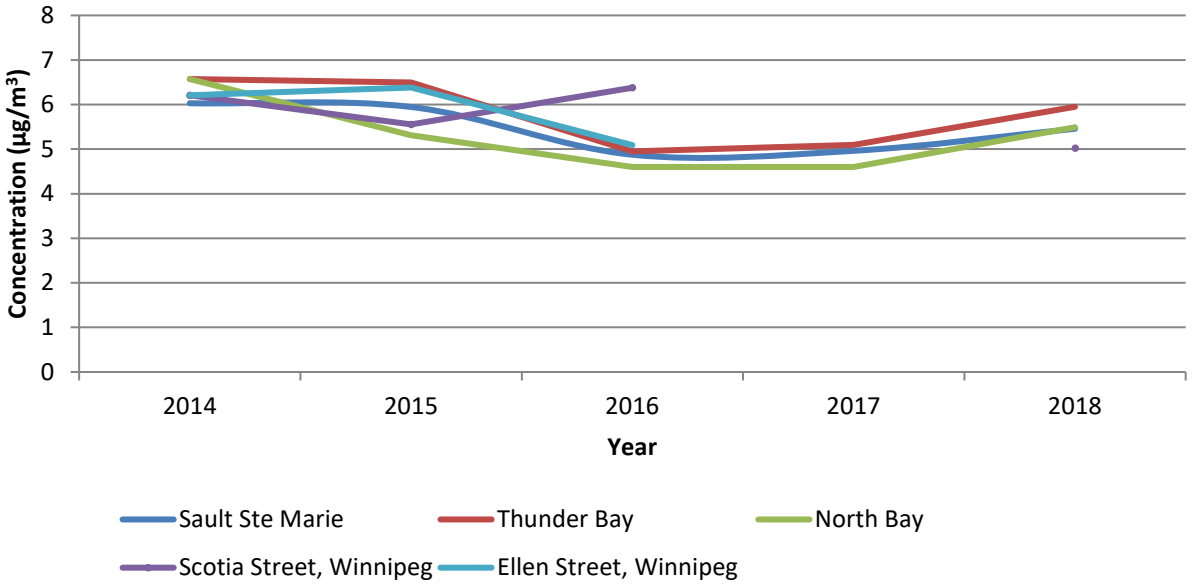
Compliance with the applicable CAAQS for $PM_{2.5}$ is based on meeting a daily average concentration of 27 µg/m^3 98% of the time, averaged over three consecutive years. The 98th percentile $PM_{2.5}$ concentrations (as shown in Table 6.7) did not exceed the 27 µg/m^3 level at any of the five stations. The annual average and maximum daily average concentrations of $PM_{2.5}$ at the five stations are provided graphically in Graph 6.1 and Graph 6.2.

Table 6.7: Summary of Ambient $PM_{2.5}$ Sampling Data

Year	$PM_{2.5}$ Concentration (µg/m^3)														
	Sault Ste. Marie			Thunder Bay			North Bay			Winnipeg (299 Scotia St.)			Winnipeg (65 Ellen St.)		
	Annual Mean	98th%ile of Daily Mean[2]	Daily Max	Annual Mean	98th%ile of Daily Mean[2]	Daily Max	Annual Mean	98th%ile of Daily Mean[2]	Daily Max	Annual Mean	98th%ile of Daily Mean[2]	Daily Max	Annual Mean	98th%ile of Daily Mean[2]	Daily Max
2014	6.0	15.0	19.2	6.6	15.3	23.5	6.6	15.3	23.5	6.2	21.6	29.3	6.2	15.8	29.3
2015	5.9	14.1	19.6	6.5	14.7	35.7	5.3	13.5	19.8	5.6	21.6	61.8	6.4	19.6	73.6
2016	4.9	12.3	20.8	4.9	10.1	13.3	4.6	11.6	16.8	6.4	17.5	28.4	5.1	11.4	24.8
2017	5.0	12.4	17.7	5.1	12.9	22.7	4.6	11.6	14.7	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
2018	5.5	12.4	21.2	6.0	12.9	28.3	5.5	18.6	60.3	5.0	26.7	112.0	6.8	24.5	68.0

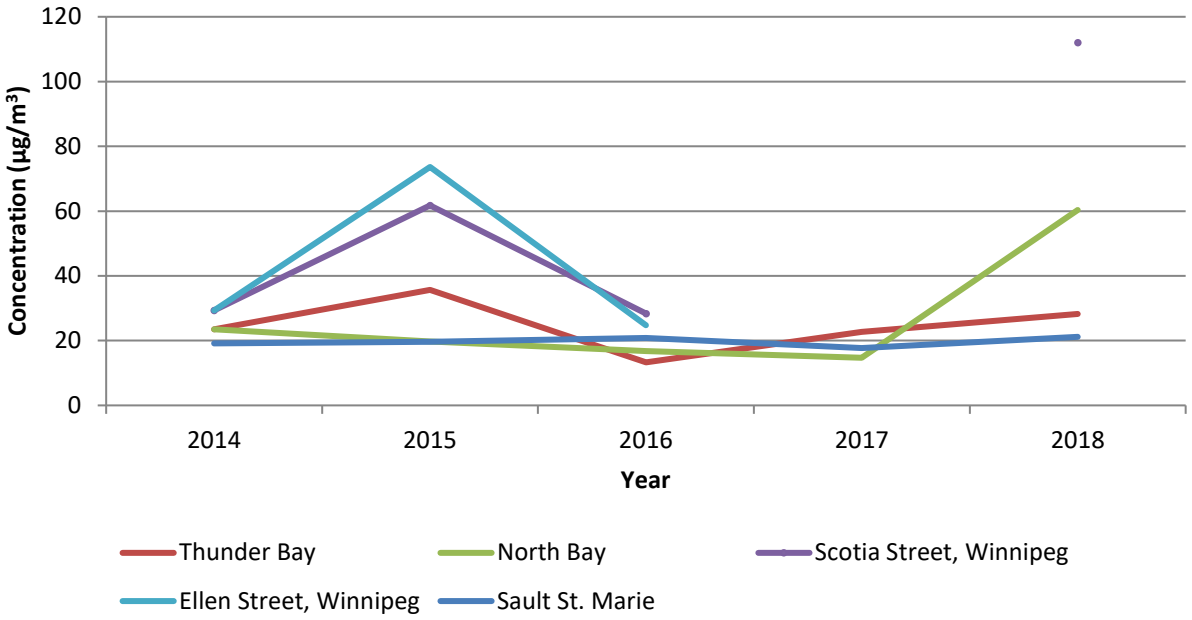
Notes:
1. The data sets for the Scotia Street and Ellen Street Winnipeg stations are not available for 2017. Data is shown as N/A for these years
2. The methodology to calculate the 98th percentile annual ambient measurement, averaged over 3 years CWS criteria requires at least 2 years of data.

Graph 6.1: Measured Annual Average $PM_{2.5}$ Concentrations (NAPS: 2014-2018)



Note: The data sets for Scotia Street and Ellen Street Winnipeg stations are not available for 2017 and are not presented.

Graph 6.2: Maximum Measured Daily Average $PM_{2.5}$ Concentrations (NAPS: 2014-2018)



Note: The data sets for Scotia Street and Ellen Street Winnipeg stations are not available for 2017 and are not presented.

Particulate matter less than 10 microns in diameter (PM_{10}) is measured at the Winnipeg (64 Ellen St.) station as 24-hour samples measured every 6 days. For the other NAPS stations examined, measured $PM_{2.5}$ concentrations were converted to equivalent PM_{10} concentrations using the empirical relationship that the mean ratio of ambient $PM_{2.5}/PM_{10}$ is 0.54 (Lall et al, 2004). Table 6.8 presents a summary of the data.

Annual mean PM_{10} concentrations ranged from 8.5 µg/m^3 in 2016 and 2017 at the North Bay station to 12.7 µg/m^3 in 2018 at the Winnipeg (Ellen Street) station. The maximum measured daily concentrations during this period ranged from 24.6 µg/m^3 in 2016 at the Thunder Bay station to 207 µg/m^3 in 2018 at the Winnipeg (Scotia Street) station.

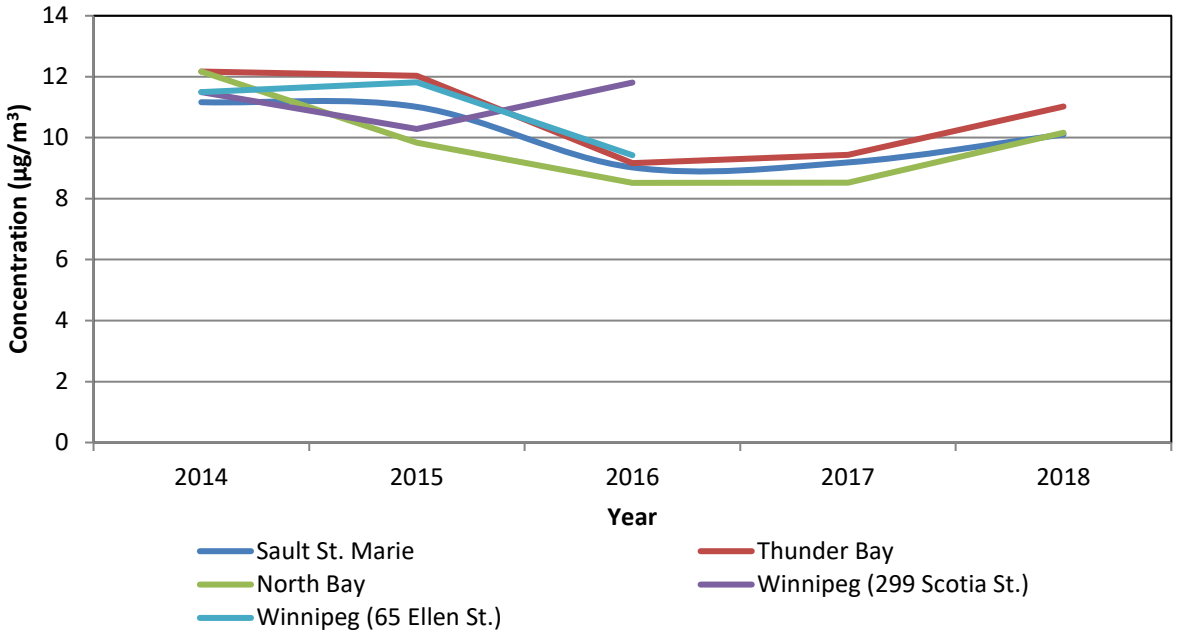
The measured annual average and maximum daily average PM_{10} concentrations for the 5-year period are presented graphically in Graph 6.3 and Graph 6.4.

Table 6.8: Summary of NAPS Ambient PM_{10} Measurement Data

Year	PM_{10} Concentration (µg/m^3)									
	Sault Ste. Marie [2]		Thunder Bay [2]		North Bay [2]		Winnipeg (299 Scotia St.) [2]		Winnipeg (65 Ellen St.) [2]	
	Annual Mean	Daily Max	Annual Mean	Daily Max	Annual Mean	Daily Max	Annual Mean	Daily Max	Annual Mean	Daily Max
2014	11.2	35.5	12.2	43.5	12.2	43.5	11.5	54.3	11.5	54.3
2015	11.0	36.3	12.0	66.0	9.8	36.6	10.3	114.4	11.8	136.3
2016	9.0	38.5	9.2	24.6	8.5	31.1	11.8	52.5	9.4	45.8
2017	9.2	32.8	9.4	42.0	8.5	27.2	N/A[1]	N/A[1]	N/A[1]	N/A[1]
2018	10.1	39.2	11.0	52.3	10.2	111.7	9.3	207.4	12.7	125.8

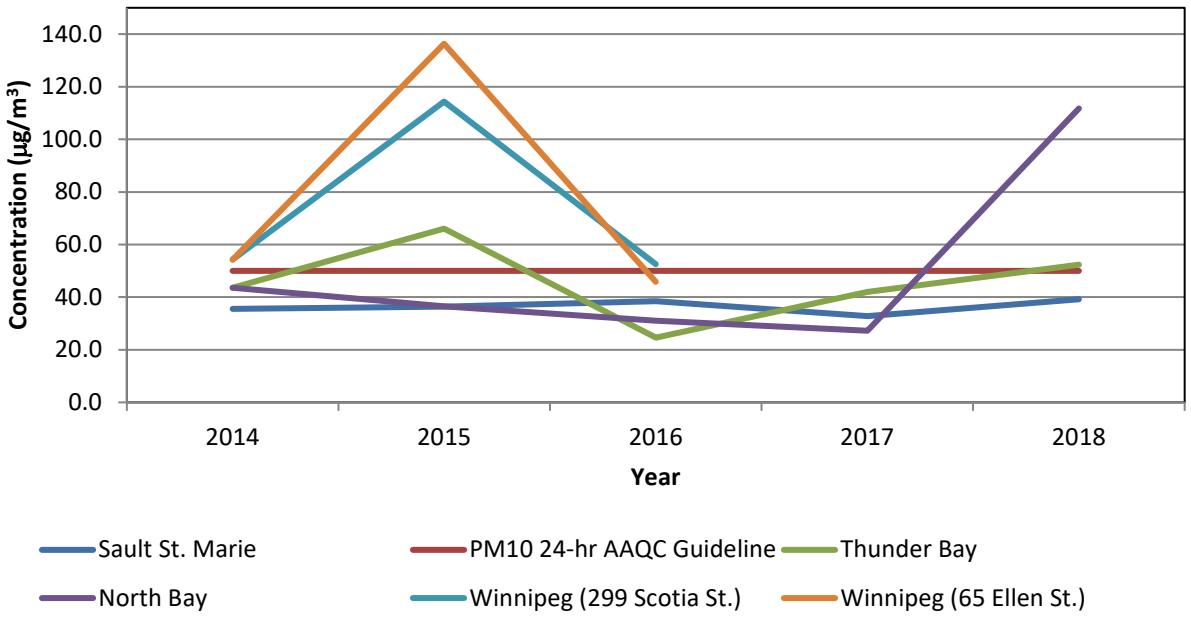
Note:
1. The data sets for the Scotia Street and Ellen Street Winnipeg stations are not available for 2017. Data is shown as N/A for these years
2. PM_{10} concentrations were converted from $PM_{2.5}$ concentrations using the Lall et. al, 2004 method.

Graph 6.3: Measured Annual Average PM_{10} Concentrations (NAPS: 2014-2018)



Note: The data sets for Scotia Street and Ellen Street Winnipeg stations are not available for 2017 and are not presented.

Graph 6.4: Maximum Measured Daily Average PM_{10} Concentrations (NAPS: 2014-2018)



Note: The data sets for Scotia Street and Ellen Street Winnipeg stations are not available for 2017 and are not presented.

6.2.2 Metals

Metals are measured at the NAPS Winnipeg (64 Ellen St.) station as 24-hour average samples taken once every 6 days. Data from the years 2009 to 2013, the most recent years with reported data, were reviewed. A summary of the measured annual average and maximum daily average metals concentrations are provided in Table 6.9 and Table 6.10, respectively. The data for 2009 and 2013 are not presented in Table 6.9 or Table 6.10 as the data sets had less than a 75% recovery rate and were, therefore, not considered valid.

Exceedances of the applicable O. Reg. 419/05 annual criterion of 0.00014 μg/m^3 for chromium occurred in 2010, 2011, and 2012 at this station; concentrations ranged from 0.00029 μg/m^3 in 2010 to 0.00068 μg/m^3 in 2012. The measured annual concentration for nickel and the measured 30-day average concentration for lead were all below their applicable criteria.

There were no exceedances of the applicable JSL 24-hour criteria for the measured metals between 2010 and 2012.

Table 6.9: Summary of Measured Annual Average Metals Concentrations – NAPS Winnipeg

Parameter	Annual Average Concentrations (μg/m^3)					Applicable AQ Criteria – Annual (μg/m^3)
	2009	2010	2011	2012	2013	
Aluminum	-	1.86E-01	2.70E-01	2.84E-01	-	-
Antimony	-	9.39E-03	6.57E-03	8.18E-03	-	-
Arsenic	-	N/A	N/A	N/A	-	-
Barium	-	1.92E-02	1.71E-02	1.79E-02	-	-
Beryllium	-	N/A	N/A	N/A	-	-
Bismuth	-	N/A	N/A	N/A	-	-
Boron	-	N/A	N/A	N/A	-	-
Cadmium	-	2.69E-03	1.53E-03	3.62E-03	-	-
Calcium	-	7.38E-01	7.62E-01	6.77E-01	-	-
Chromium	-	2.94E-04	5.69E-04	6.76E-04	-	0.00014
Cobalt	-	N/A	N/A	N/A	-	-
Copper	-	N/A	N/A	N/A	-	-
Iron	-	1.65E-01	1.91E-01	1.79E-01	-	-
Lead	-	1.42E-03	3.01E-03	1.85E-03	-	0.2 (30-day) [2]
Lithium	-	N/A	N/A	N/A	-	-
Magnesium	Note 1	N/A	N/A	N/A	Note 1	-
Manganese	-	6.46E-03	6.83E-03	7.71E-03	-	-
Mercury	-	N/A	N/A	N/A	-	-
Molybdenum	-	N/A	N/A	N/A	-	-
Nickel	-	3.49E-04	1.00E-03	8.79E-04	-	0.04
Potassium	-	1.12E-01	1.41E-01	1.49E-01	-	-

Table 6.9: Summary of Measured Annual Average Metals Concentrations – NAPS Winnipeg

Parameter	Annual Average Concentrations (µg/m³)					Applicable AQ Criteria – Annual (µg/m³)
	2009	2010	2011	2012	2013	
Selenium	-	5.88E-04	8.20E-04	9.63E-04	-	-
Silver	-	N/A	N/A	N/A	-	-
Sodium	-	N/A	N/A	N/A	-	-
Strontium	-	1.89E-03	6.02E-04	1.63E-03	-	-
Thallium	-	N/A	N/A	N/A	-	-
Tin	-	7.54E-04	1.98E-03	3.26E-03	-	-
Titanium	-	7.06E-03	8.93E-03	8.99E-03	-	-
Uranium	-	N/A	N/A	N/A	-	0.03
Vanadium	-	2.21E-04	2.75E-04	8.86E-04	-	-
Yttrium	-	N/A	N/A	N/A	-	-
Zinc	-	4.50E-03	1.55E-02	1.14E-02	-	-

Notes:
1. Data set had less than 75% data recovery and is not presented.
2. Criterion shown for lead is for a 30-day averaging period.

N/A – Data not analyzed/not available from NAPS.

Table 6.10: Summary of Maximum Measured 24-Hour Average Metals Concentrations – NAPS Winnipeg

Contaminant	Maximum 24-Hour Concentrations (µg/m³)					Applicable AQ Criteria – 24-Hour (µg/m³)
	2009	2010	2011	2012	2013	
Aluminum	-	9.89E-01	1.03E+00	3.17E+00	-	4.8
Antimony	-	3.60E-02	3.60E-02	3.26E-02	-	25.0
Arsenic	-	N/A	N/A	N/A	-	0.3
Barium	-	4.38E-02	6.21E-02	7.03E-02	-	10.0
Beryllium	-	N/A	N/A	N/A	-	0.01
Bismuth	-	N/A	N/A	N/A	-	N/A
Boron	-	N/A	N/A	N/A	-	120.0
Cadmium	-	1.02E-02	9.25E-03	1.75E-02	-	0.025
Calcium	-	2.61E+00	2.05E+00	5.83E+00	-	N/A
Chromium	-	4.38E-03	1.95E-03	2.56E-03	-	N/A
Cobalt	-	N/A	N/A	N/A	-	0.1
Copper	-	N/A	N/A	N/A	-	50.0
Iron	-	6.10E-01	5.41E-01	1.07E+00	-	4.0
Lead	-	8.28E-03	7.79E-03	1.52E-02	-	0.5
Lithium	-	N/A	N/A	N/A	-	20.0

Table 6.10: Summary of Maximum Measured 24-Hour Average Metals Concentrations – NAPS Winnipeg

Contaminant	Maximum 24-Hour Concentrations (µg/m³)					Applicable AQ Criteria – 24-Hour (µg/m³)
	2009	2010	2011	2012	2013	
Magnesium	Note 1	N/A	N/A	N/A	Note 1	0.2
Manganese	-	2.68E-02	3.02E-02	3.11E-02	-	0.4
Mercury	-	N/A	N/A	N/A	-	2.0
Molybdenum	-	N/A	N/A	N/A	-	120.0
Nickel	-	1.95E-03	2.69E-03	4.14E-03	-	N/A
Potassium	-	3.61E-01	6.64E-01	8.77E-01	-	8.0
Selenium	-	3.90E-03	3.90E-03	6.32E-03	-	10.0
Silver	-	N/A	N/A	N/A	-	1.0
Sodium	-	N/A	N/A	N/A	-	N/A
Strontium	-	7.79E-03	3.11E-03	1.16E-02	-	120.0
Thallium	-	N/A	N/A	N/A	-	0.2
Tin	-	5.84E-03	9.94E-03	2.09E-02	-	10.0
Titanium	-	4.19E-02	3.36E-02	4.86E-02	-	120.0
Uranium	-	N/A	N/A	N/A	-	N/A
Vanadium	-	1.46E-03	2.16E-03	9.28E-03	-	5.0
Yttrium	-	N/A	N/A	N/A	-	2.4
Zinc	-	2.48E-02	1.31E-01	6.03E-02	-	120.0

Notes:
1. Data set had less than 75% data recovery for the year and is not presented.
N/A – Data not analyzed/not available from NAPs.

6.2.3 Nitrogen Dioxide (NO_2)

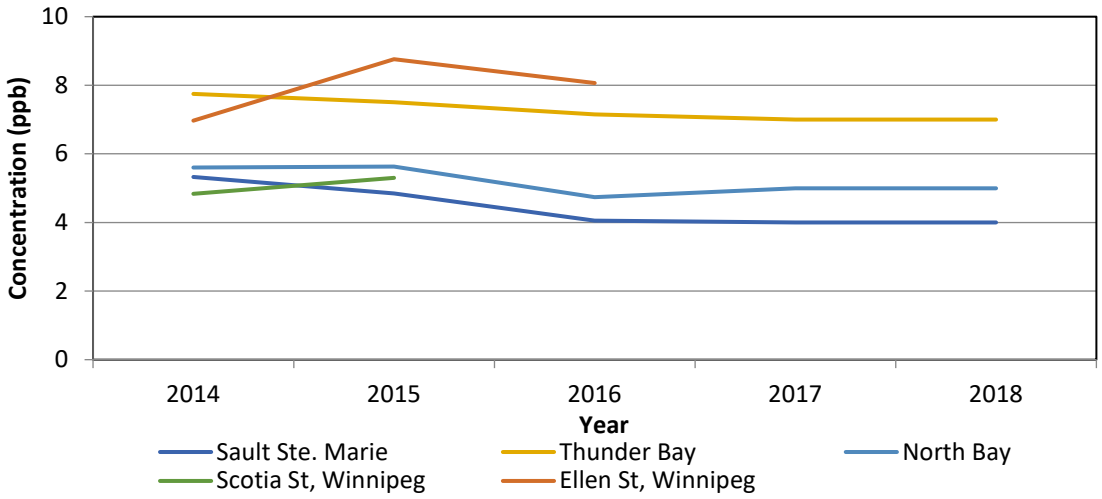
Nitrogen oxides (NO_X) are almost entirely made up of nitric oxide (NO) and nitrogen dioxide (NO_2). Together, they are often referred to as NO_X. Most NO_2 in the atmosphere is formed by the oxidation of NO, which is emitted directly by combustion processes, particularly those at high temperature and pressure. Exposure to both NO and NO_2 can result in adverse health effects to an exposed population. NO_2 is the regulated form of NO_X. Similar to other jurisdictions (e.g., Alberta Environment, World Health Organization), the O. Reg. 419/05 Schedule 3 standards for NO_X are based on health effects of NO_2, as health effects are seen at much lower concentrations of NO_2 than NO. In this report, because NO_2 is the regulated form of NO_X, the AAQC were compared to measured NO_2 concentrations (as per MECP, 2018). The monitored NO_X concentrations are also presented in the section below.

Nitrogen dioxide is continuously measured at all five of the NAPS stations including Sault Ste. Marie station, Thunder Bay station, North Bay station, Scotia Street Winnipeg, and Ellen Street Winnipeg station. The data set for the Scotia Street Winnipeg station is not available for 2016, 2017 and 2018. The data set for the Ellen Street Winnipeg station is not available for 2017 and 2018. Data is shown as "N/A" for these years.

NAPS ambient NO_2 monitoring data from 2014 to 2018 (where available) were reviewed. A summary of the variations in annual average, maximum 24-hour average, and hourly ambient NO_2 concentrations over the 5-year period are shown in Table 6.11 and Graph 6.5 to Graph 6.7 for these five stations and are compared to the applicable provincial criteria. The following observations are based on a review of the 5-year data set:

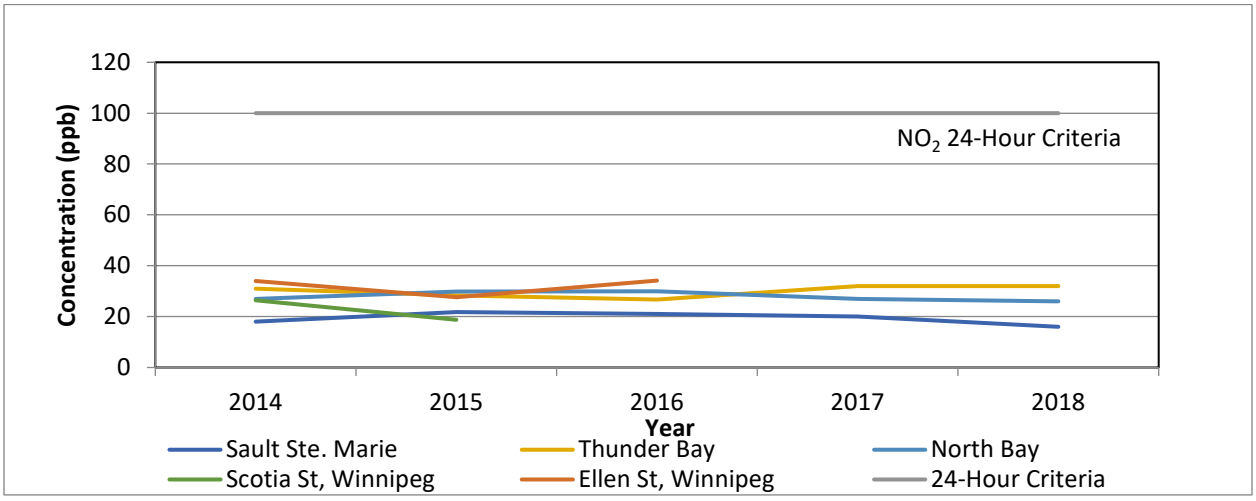
- The measured maximum hourly average and 24-hour average NO_2 concentrations at all five stations were below the applicable provincial 1-hour and 24-hour criteria of 200 ppb (400 µg/m^3) and 100 ppb (200 µg/m^3), respectively, for the five-year period between 2014 and 2018.
- From 2014 to 2018, the maximum measured hourly average NO_2 concentrations in the 5-year period ranged between 38 ppb (75 µg/m^3) (at Scotia Street Winnipeg in 2015) and 65 ppb (129 µg/m^3) (at Ellen Street Winnipeg in 2016), which were 19% and 33% of the MECP criterion of 200 ppb, respectively.
- The maximum measured 24-hour average NO_2 concentration in the 5-year period ranged between 16 ppb (32 µg/m^3) (at Sault Ste. Marie station in 2018) and 34 ppb (67 µg/m^3) (at Ellen Street Winnipeg in 2016), which were 16% and 34% of the of the applicable MECP criterion of 100 ppb (200 µg/m^3).

Graph 6.5: Measured Annual Average NO_2 Concentrations (NAPS: 2014 – 2018)



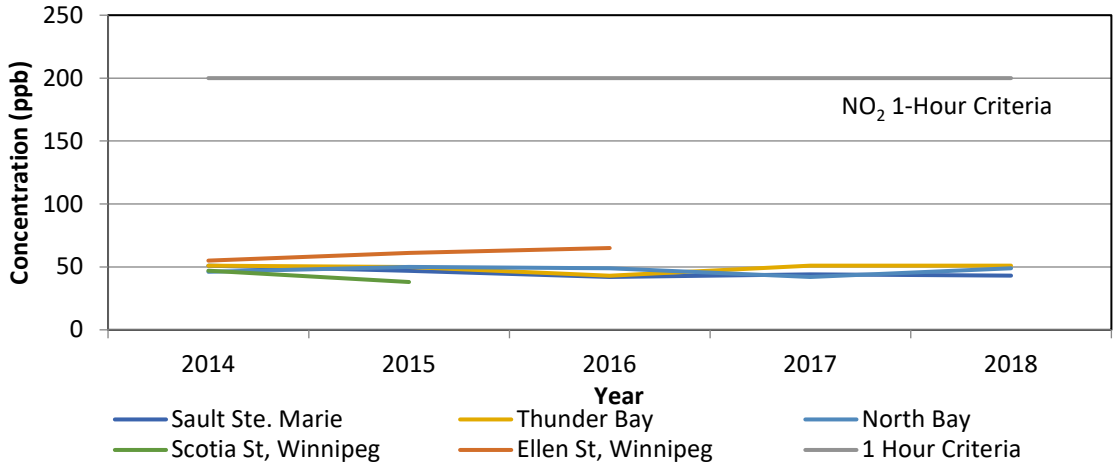
Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

Graph 6.6: Maximum Measured 24-Hour Average NO_2 Concentrations (NAPS: 2014 – 2018)



Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

Graph 6.7: Maximum Measured 1-Hour Average NO_2 Concentrations (NAPS: 2014 – 2018)



Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

Table 6.11: Summary of Measured Ambient NO_2 Concentrations

Monitoring Station	**Measured Maximum Hourly Nitrogen Dioxide Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	51	47	42	44	43
Thunder Bay	51	50	43	51	51
North Bay	46	50	49	42	49
Winnipeg (299 Scotia St.) *	47	38	N/A	N/A	N/A
Winnipeg (65 Ellen St.) *	55	61	65	N/A	N/A
Monitoring Station	**Measured Maximum 24-Hour Nitrogen Dioxide Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	18	22	21	20	16
Thunder Bay	31	28	27	32	32
North Bay	27	30	30	27	26
Winnipeg (299 Scotia St.) *	26	19	N/A	N/A	N/A
Winnipeg (65 Ellen St.) *	34	28	34	N/A	N/A
Monitoring Station	**Measured Annual Mean Nitrogen Dioxide Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	5	5	4	4	4
Thunder Bay	8	8	7	7	7

Table 6.11: Summary of Measured Ambient NO_2 Concentrations

Monitoring Station	Measured Maximum Hourly Nitrogen Dioxide Levels (ppb)				
	2014	2015	2016	2017	2018
North Bay	6	6	5	5	5
Winnipeg (299 Scotia St.) *	5	5	N/A	N/A	N/A
Winnipeg (65 Ellen St.) *	7	9	8	N/A	N/A

Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

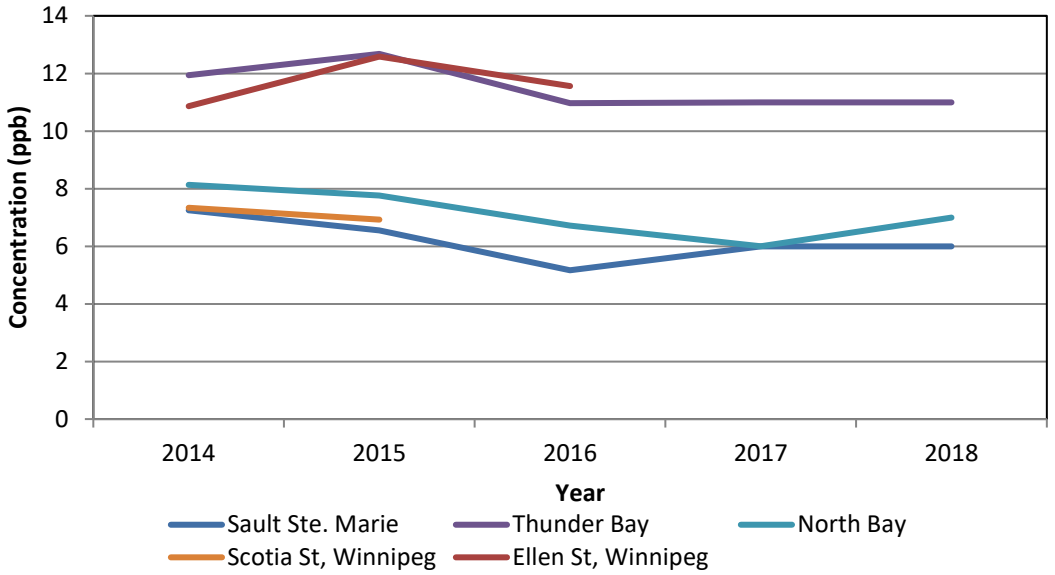
6.2.4 Nitrogen Oxides (NO_x)

Nitrogen oxide is continuously measured at all five of the NAPS stations listed in Section 3.4.2. The data set for the Scotia Street Winnipeg station is not available for 2016, 2017 and 2018. The data set for the Ellen Street Winnipeg station is not available for 2017 and 2018. Data is shown as “N/A” for these years.

NAPS monitoring data for ambient NO_X concentrations from 2014 to 2018 (where available) were reviewed. A summary of the variation in annual average, maximum 24-hour average, and hourly ambient NO_X concentrations over the 5-year period is shown in Table 6.12 and Graph 6.8 to Graph 6.10 for these five stations. The following observations are based on a review of the 5-year data set:

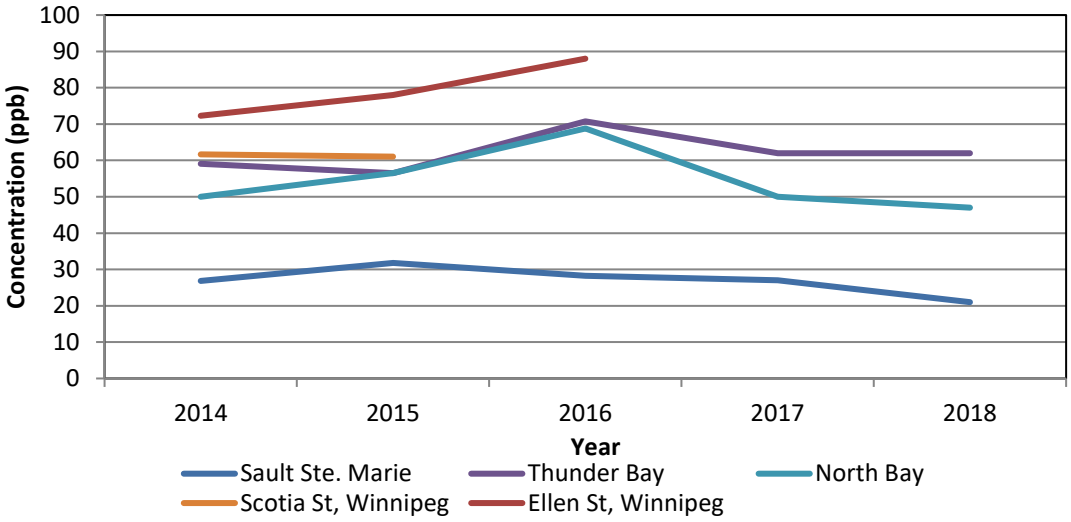
- From 2014 to 2018, the annual mean NO_X concentrations measured at the five stations ranged between 5 ppb (10 µg/m^3) (at Sault Ste. Marie station in 2016) and 13 ppb (16.25 µg/m^3) (at Thunder Bay station in 2015).
- From 2014 to 2018, the maximum measured hourly average NO_X concentrations in the 5-year period ranged between 68 ppb (135 µg/m^3) (at Sault Ste. Marie station in 2018) and 250 ppb (495 µg/m^3) (at Ellen Street Winnipeg station in 2016).
- The maximum measured 24-hour average NO_X concentration in the 5-year period ranged between 21 ppb (52 µg/m^3) (at Sault Ste. Marie station in 2018) and 88 ppb (174 µg/m^3) (at Ellen Street Winnipeg station in 2009).

Graph 6.8: Measured Annual Average NO_X Concentrations (NAPS: 2014 – 2018)



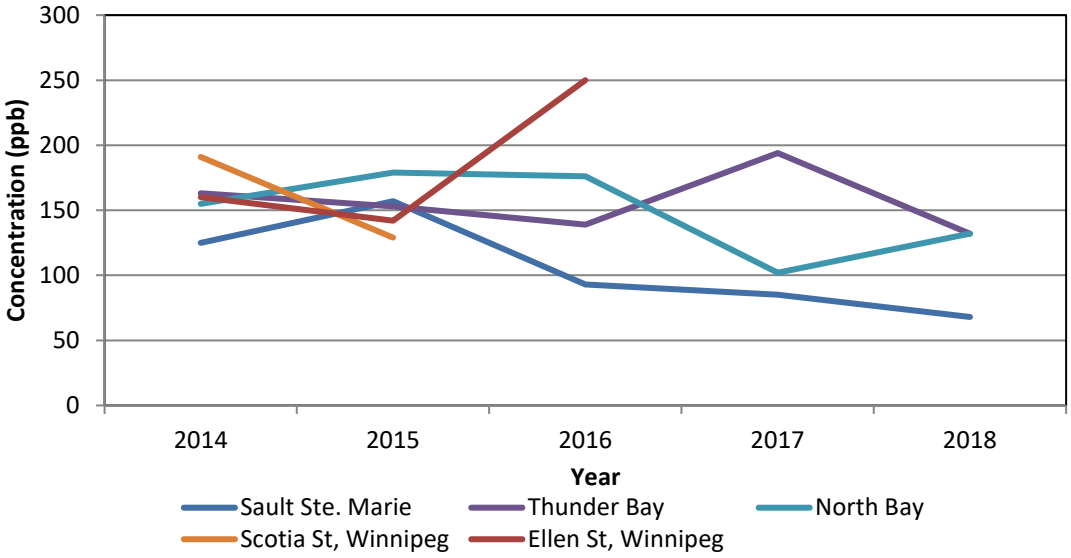
Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

Graph 6.9: Maximum Measured 24-Hour Average NO_X Concentrations (NAPS: 2014 – 2018)



Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

Graph 6.10: Maximum Measured 1-Hour Average NO_X Concentrations (NAPS: 2014 – 2018)



Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

Table 6.12 Summary of Measured Ambient NO_X Concentrations

Monitoring Station	Measured Maximum Hourly Nitrogen Oxides Levels (ppb)				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	125	157	93	85	68
Thunder Bay	163	153	139	194	132
North Bay	155	179	176	102	132
Winnipeg (299 Scotia St.) *	191	129	N/A	N/A	N/A
Winnipeg (65 Ellen St.) *	160	142	250	N/A	N/A
Monitoring Station	**Measured Maximum 24-Hour Nitrogen Oxides Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	27	32	28	27	21
Thunder Bay	59	57	71	62	62
North Bay	50	57	69	50	47
Winnipeg (299 Scotia St.) *	62	61	N/A	N/A	N/A
Winnipeg (65 Ellen St.) *	72	78	88	N/A	N/A
Monitoring Station	**Measured Annual Mean Nitrogen Oxides Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	7	7	5	6	6
Thunder Bay	12	13	11	11	11
North Bay	8	8	7	6	7
Winnipeg (299 Scotia St.) *	7	7	N/A	N/A	N/A
Winnipeg (65 Ellen St.) *	11	13	12	N/A	N/A

Notes:
* The data set for Scotia St, Winnipeg station is not available for 2016 to 2018. The data set for Ellen St, Winnipeg is not available for 2017 and 2018. Data is shown as N/A for these years.

6.2.5 Sulphur Dioxide (SO_2)

Sulphur dioxide is continuously measured at the NAPS Sault Ste. Marie station (an industrial location) and the Ellen Street Winnipeg station (a commercial location).

Ambient SO_2 concentrations measured at both sites from 2014 to 2018 (where available) were reviewed. Table 6.13 summarizes the variation in annual average, maximum hourly, and 24-hour average ambient SO_2 concentrations over the 5-year period at both stations.

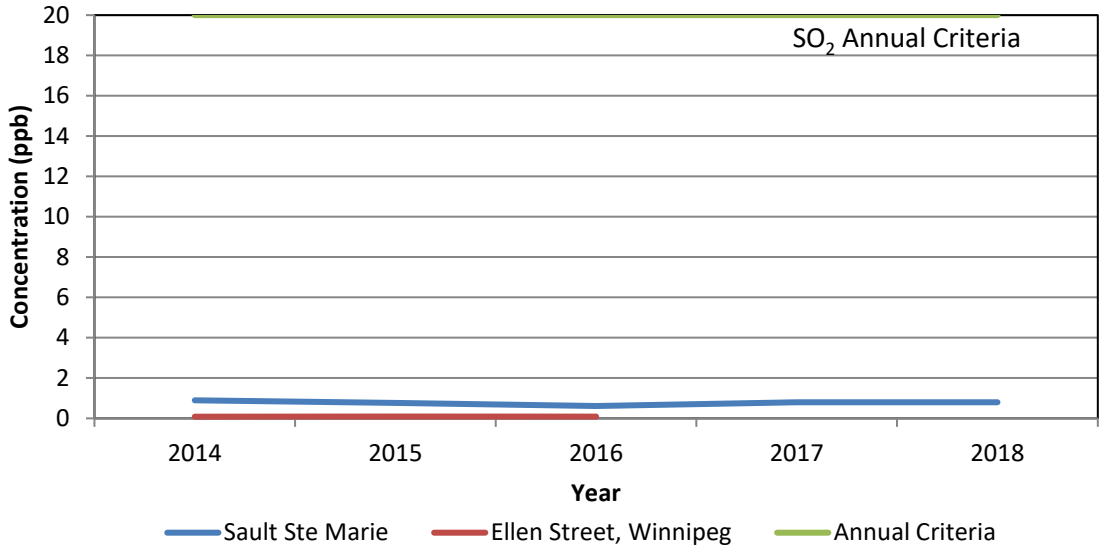
Graph 6.11 summarizes the measured annual average SO_2 concentrations at both stations for the last 5 years. The measured annual average SO_2 concentrations at both stations was less than 1 ppb (2.8 µg/m^3), which is less than 5% of the annual criterion (55 µg/m^3 or 20 ppb).

Graph 6.12 and Graph 6.13 summarize the maximum 24-hour and hourly average ambient SO_2 concentrations from 2014 to 2018. Maximum measured hourly and 24-hour average concentrations were below the 1-hour and 24-hour MECP criteria of 250 ppb (690 µg/m^3) and 100 ppb (275 µg/m^3), respectively.

The maximum measured hourly average SO_2 concentrations at the stations from 2014 to 2018 were 74 ppb (204 µg/m^3) at the Sault Ste. Marie station in 2015 and 10 ppb (28 µg/m^3) at the Ellen Street Winnipeg station in 2016, which are 30% and 4% of the MECP criterion of 250 ppb, respectively.

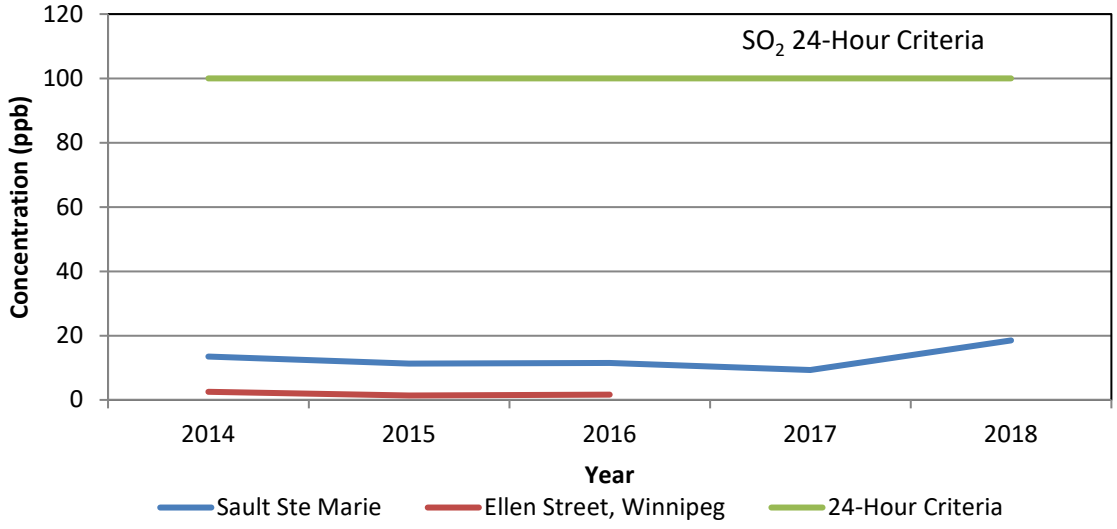
The maximum measured 24-hour average SO_2 concentration at the stations from 2014 to 2018 were 18.5 ppb (51 µg/m^3) at the Sault Ste. Marie station in 2018 and 1.4 ppb (3.9 µg/m^3) at the Ellen Street Winnipeg station in 2015. These maximums are 19% and 2% of the MECP criterion of 100 ppb (275 ug/m^3), respectively.

Graph 6.11: Measured Annual Average SO_2 Concentrations (NAPS: 2014 – 2018)



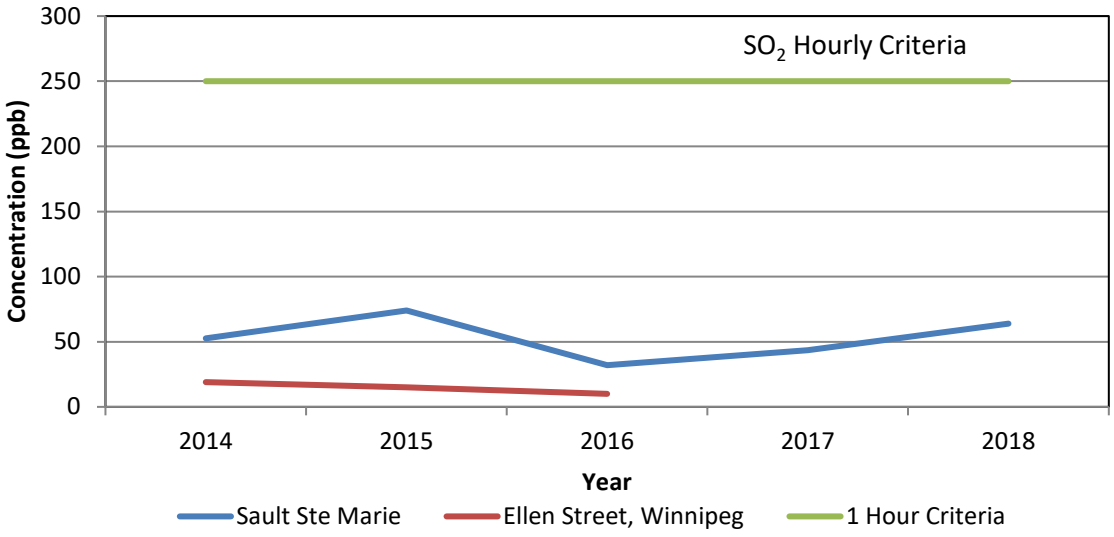
Notes:
* The data set for Ellen St, Winnipeg station is not available for 2017 and 2018. Data is shown as N/A for these years.

Graph 6.12: Maximum Measured 24-Hour Average SO_2 Concentrations (NAPS: 2014 – 2018)



Notes:
* The data set for Ellen St, Winnipeg station is not available for 2017 and 2018. Data is shown as N/A for these years.

Graph 6.13: Maximum Measured Hourly Average SO_2 Concentrations (NAPS: 2014 – 2018)



Notes:
* The data set for Ellen St, Winnipeg station is not available for 2017 and 2018. Data is shown as N/A for these years.

Table 6.13: Summary of Measured Ambient SO_2 Concentrations

Monitoring Station	**Measured Maximum Hourly Sulphur Dioxide Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	53	74	32	43	64
Winnipeg (65 Ellen St.) *	19	15	10	N/A	N/A
Monitoring Station	**Measured Maximum 24-Hour Sulphur Dioxide Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	13.5	11.3	11.5	9.3	18.5
Winnipeg (65 Ellen St.) *	2.5	1.4	1.6	N/A	N/A
Monitoring Station	**Measured Annual Mean Sulphur Dioxide Levels (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	0.9	0.8	0.6	0.8	0.8
Winnipeg (65 Ellen St.) *	0.1	0.1	0.1	N/A	N/A

Notes:
* The data set for Ellen St, Winnipeg station is not available for 2017 and 2018. Data is shown as N/A for these years.

6.2.6 Ozone

Ozone (O_3) is measured at all five NAPS stations. NAPS monitoring data for ambient O_3 concentrations from 2014 to 2018 (where available) were reviewed. A summary of the 2014-2018 data at the five stations is presented in Table 6.14.

Compliance with the ozone CAAQS standard is based on the assessment of three consecutive years of ozone data. For each year, rolling 8-hour average ozone concentrations are calculated from hourly average concentration data. For each day, the maximum 8-hour average concentrations are determined and are ranked from highest to lowest. From this ranking the 4th highest daily 8-hour average concentration is determined for each year. The 4th highest daily 8-hour average concentration from three consecutive years are then averaged together. The resultant concentration value is assessed against the 62 ppb (124 µg/m^3) standard. The 4th highest daily 8-hour average O_3 concentration averaged over 3 years (as shown in Table 6.14) was recorded to be higher than the applicable CAAQS criteria.

The maximum measured 8-hr average and hourly average O_3 concentrations at each station are shown in Graph 6.14 and Graph 6.15, respectively. The O. Reg. 419/05 1-hour criterion for O_3 is 80 ppb (165 µg/m^3). The maximum measured hourly average O_3 concentrations varied between 31 ppb (64 µg/m^3) and 80 ppb (165 µg/m^3), the latter of which occurred in 2016 at Sault Ste. Marie. Over the 5 years, no exceedances of the applicable MECP hourly objective were observed at Sault Ste. Marie, Thunder Bay, North Bay, or the Winnipeg (299 Scotia Street and 65 Ellen Street) monitoring stations.

Table 6.14: Summary of Ambient O_3 Monitoring Data (2014-2018)

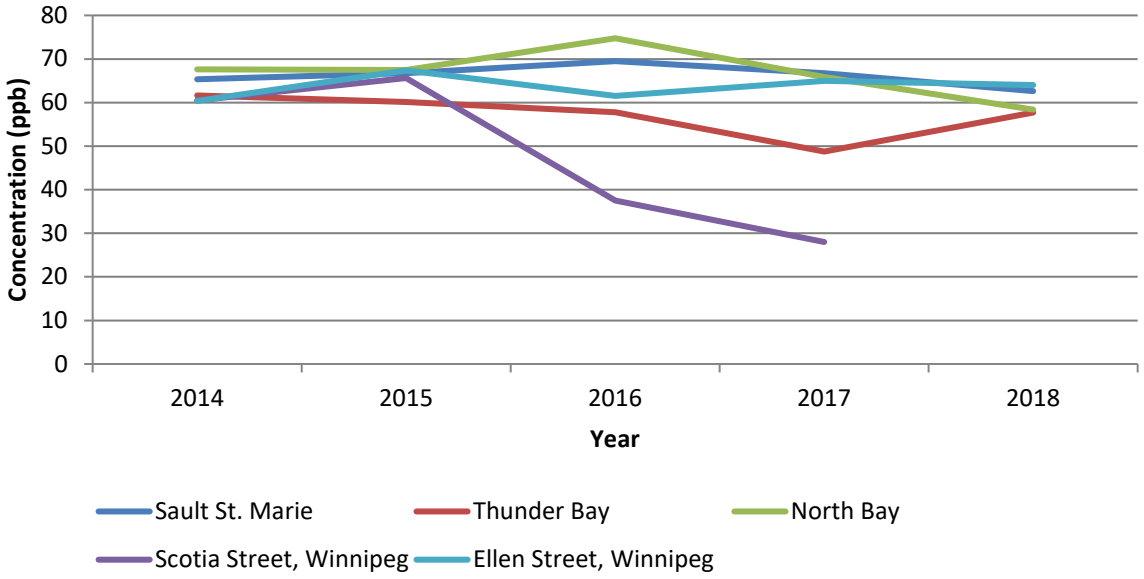
Monitoring Station	3-Year Average 98th Percentile Concentration using CCME Calculation Methodology[2,3] (ppb)				
	2014	2015	2016	2017	2018
Sault Ste. Marie	N/A	N/A	61	60	60
Thunder Bay	N/A	N/A	52	51	51
North Bay	N/A	N/A	62	62	59
Winnipeg (299 Scotia St.) [1]	58	57	56	N/A	N/A
Winnipeg (65 Ellen St.)	54	58	56	N/A	N/A
Monitoring Station	**Maximum 1-Hour Average Ozone Concentration (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	73	75	80	70	69
Thunder Bay	70	62	62	51	63
North Bay	71	70	78	69	63
Winnipeg (299 Scotia St.) [1]	64	68	39	31	N/A
Winnipeg (65 Ellen St.)	65	75	64	73	71

Table 6.14: Summary of Ambient O_3 Monitoring Data (2014-2018)

Monitoring Station	3-Year Average 98th Percentile Concentration using CCME Calculation Methodology[2,3] (ppb)				
	2014	2015	2016	2017	2018
Monitoring Station	**Maximum 8-Hour Average Ozone Concentration (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	65	67	70	67	63
Thunder Bay	62	60	58	49	58
North Bay	68	68	75	66	58
Winnipeg (299 Scotia St.) [1]	61	66	38	28	N/A
Winnipeg (65 Ellen St.)	60	67	62	65	64
Monitoring Station	**Maximum 24-Hour Average Ozone Concentration (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	57	56	58	55	57
Thunder Bay	49	52	48	46	46
North Bay	56	57	64	62	54
Winnipeg (299 Scotia St.) [1]	47	50	36	25	N/A
Winnipeg (65 Ellen St.)	48	52	54	52	47
Monitoring Station	**Average Annual Ozone Concentration (ppb)**				
	2014	**2015**	**2016**	**2017**	**2018**
Sault Ste. Marie	28	28	27	28	30
Thunder Bay	23	24	23	23	24
North Bay	27	27	26	26	26
Winnipeg (299 Scotia St.) [1]	23	20	15	25	N/A
Winnipeg (65 Ellen St.)	23	24	23	24	23

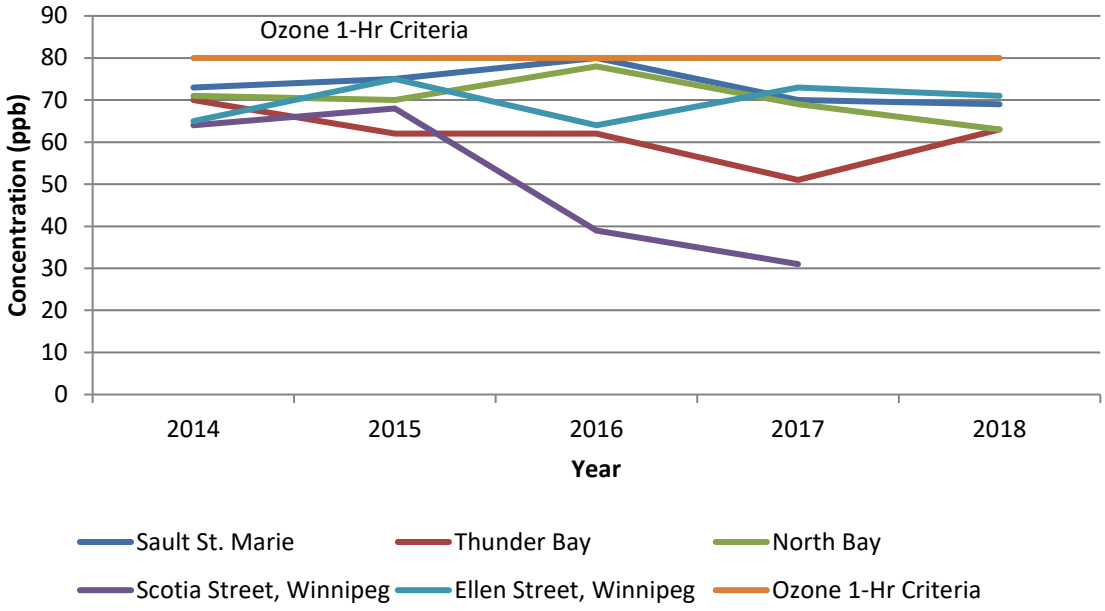
Notes:
1. Data set for Scotia St, Winnipeg had less than 75% data recovery in 2018 and is not presented.
2. For each year, rolling 8-hour average ozone concentrations were calculated from hourly average concentration data. For each day, the maximum 8-hour concentrations were determined and were ranked from highest to lowest and the 4th highest daily 8-hour average concentration was determined for each year. The 4th highest daily 8-hour average concentration from three consecutive years was then averaged together.
3. The 4th highest daily 8-hour average O_3 concentration averaged over 3 years requires three years of valid data to be available for comparison.

Graph 6.14: Maximum Measured 8-Hour Average O_3 Concentrations (NAPS: 2014-2018)



Notes:
1. Data set for Scotia St, Winnipeg had less than 75% data recovery in 2018 and is not presented.

Graph 6.15: Maximum Measured Hourly Average O_3 Concentrations (NAPS: 2014-2018)



Notes:
1. Data set for Scotia St, Winnipeg had less than 75% data recovery in 2018 and is not presented.

6.2.7 Carbon Monoxide

Carbon monoxide (CO) is monitored at two NAPS stations, Winnipeg (299 Scotia Street) and Winnipeg (65 Ellen Street). Data from 2012 to 2016 were reviewed for these two stations. Annual average ambient CO concentrations for the 5-year period are shown on Figure 5-21 for both monitoring stations.

The applicable O. Reg. 419/05 criteria for CO are 5 ppm (6,000 µg/m^3) for a half-hour averaging period, 15,700 µg/m^3 (13 ppm) for an 8-hour averaging period, and 36,200 (30 ppm) for a 1-hour averaging period. In order to compare measured hourly average concentrations to the applicable half-hour standard, hourly average measurements were converted to a half-hour basis using the MECP recommended methodology described in Section 17 of O. Reg. 419/05.

Available half-hour, hourly, 8-hr, 24-hr, and annual average CO monitoring data from 2012 to 2016 for both stations were reviewed and summarized in Table 6.15.

The annual average CO concentrations measured at the two stations from 2012 to 2016 varied from 0.16 ppm (193 µg/m^3) to 0.49 ppm (590 µg/m^3), the latter of which occurred in 2012 at 65 Ellen Street. The maximum daily average CO concentration in the 5-year period was 0.98 ppm (1,181 µg/m^3) recorded at 65 Ellen Street in 2012.

The maximum 8-hour average CO concentration measured in the 5-year period was 1.95 ppm (2,350 µg/m^3) which is well below the provincial criterion of 13 ppm (15,700 µg/m^3). The maximum hourly average CO concentration measured in the 5-year period was 3.31 ppm (3,989 µg/m^3) at 65 Ellen Street in 2016 which is also well below the MECP criterion of 30 ppm (36,200 µg/m^3). The maximum half-hour average CO concentration measured in the 5-year period was 4.02 ppm (4,829 µg/m^3) at 65 Ellen Street in 2016 which is also below the applicable half-hour criterion of 5 ppm (6,000 µg/m^3).

Table 6.15: Summary of Ambient CO Monitoring Data (2012-2016)

Monitoring Station	Maximum Half-Hour Carbon Monoxide Concentration (ppm)				
	2012	**2013**	**2014**	**2015**	**2016**
Winnipeg (299 Scotia St.)	2.31	4.01	2.43	1.21	N/A
Winnipeg (65 Ellen St.)	2.19	1.94	2.43	1.54	4.02
Monitoring Station	**Maximum Hourly Carbon Monoxide Levels (ppm)**				
	2012	**2013**	**2014**	**2015**	**2016**
Winnipeg (299 Scotia St.)	1.90	3.30	2.00	1.00	N/A
Winnipeg (65 Ellen St.)	1.80	1.60	2.00	1.27	3.31
Monitoring Station	**Maximum 8-Hour Carbon Monoxide Levels (ppm)**				
	2012	**2013**	**2014**	**2015**	**2016**
Winnipeg (299 Scotia St.)	1.29	1.48	0.99	0.86	N/A
Winnipeg (65 Ellen St.)	1.10	0.96	0.99	0.98	1.95

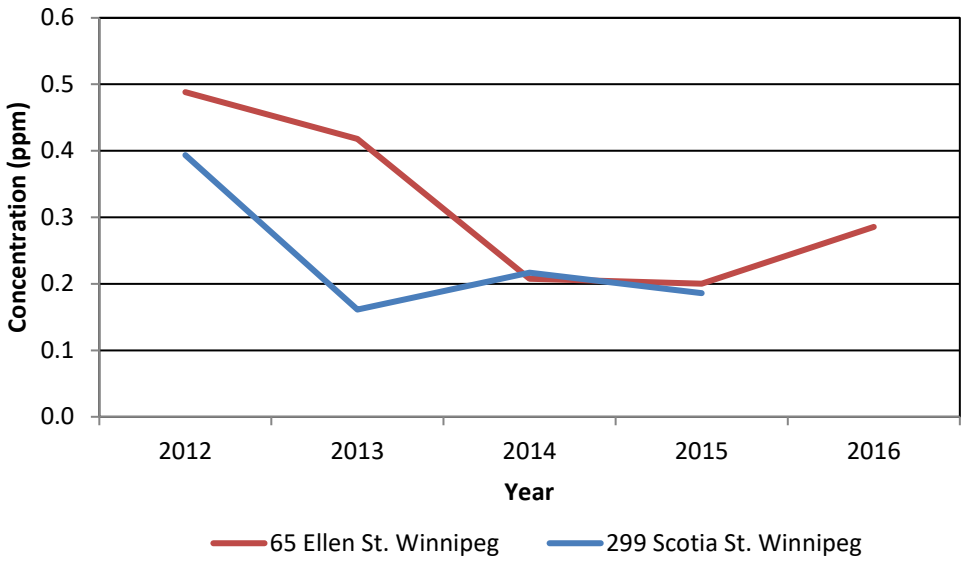
Table 6.15: Summary of Ambient CO Monitoring Data (2012-2016)

Monitoring Station	Maximum Half-Hour Carbon Monoxide Concentration (ppm)				
	2012	2013	2014	2015	2016
Monitoring Station	**Maximum 24-hr Carbon Monoxide Levels (ppm)**				
	2012	**2013**	**2014**	**2015**	**2016**
Winnipeg (299 Scotia St.)	0.88	0.66	0.86	0.64	N/A
Winnipeg (65 Ellen St.)	0.98	0.83	0.86	0.69	0.96
Monitoring Station	**Average Annual Carbon Monoxide Levels (ppm)**				
	2012	**2013**	**2014**	**2015**	**2016**
Winnipeg (299 Scotia St.)	0.39	0.16	0.22	0.19	N/A
Winnipeg (65 Ellen St.)	0.49	0.42	0.21	0.20	0.29

Notes:
1. 299 Scotia St: The year 2016 does not have 75% data recovery and is not presented.

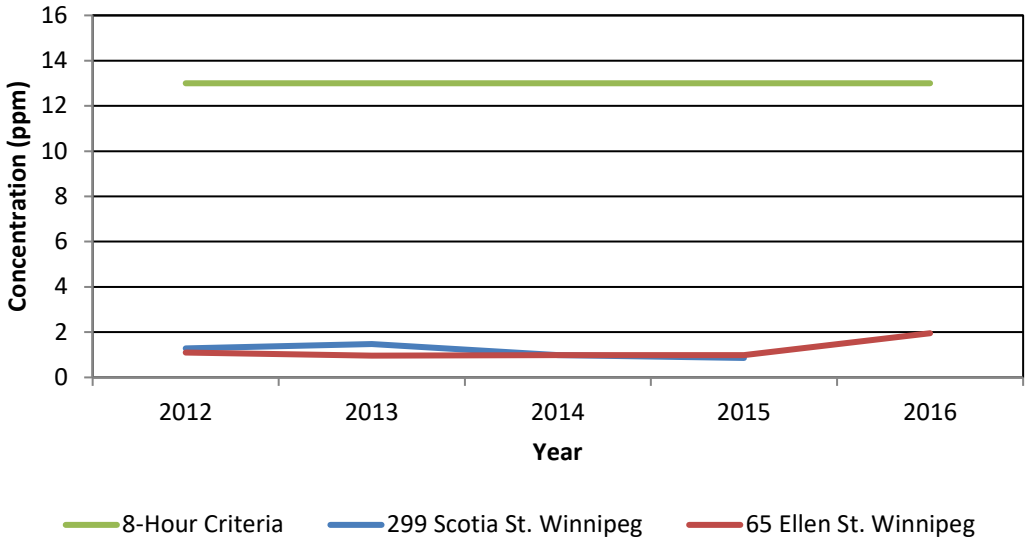
The maximum 8-hour, hourly, and half-hour average CO concentrations at both stations are shown in Graph 6.16 to Graph 6.19, respectively.

Graph 6.16: Measured Annual Average CO Concentrations (NAPS: 2012-2016)



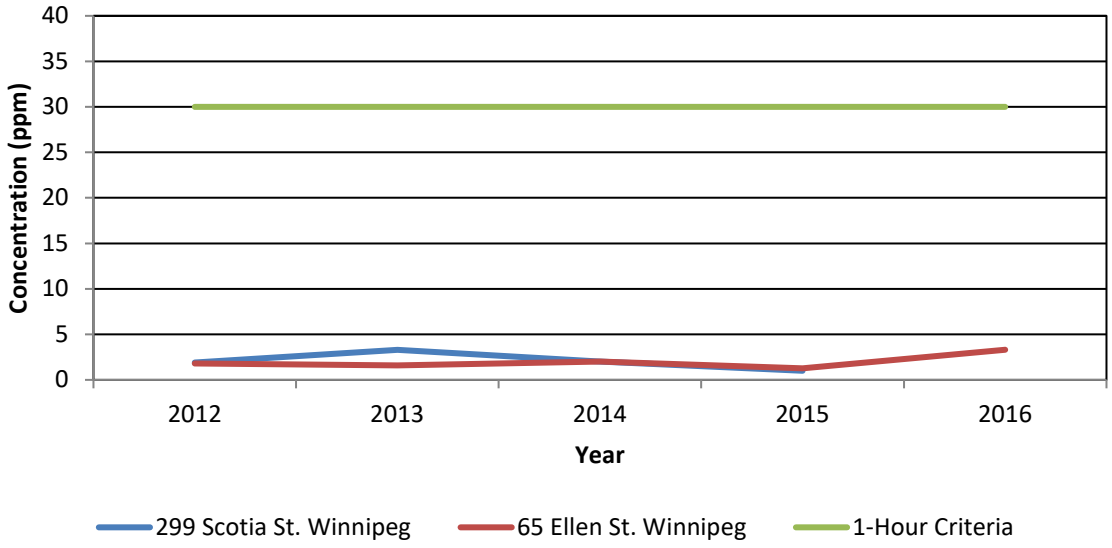
Notes: 299 Scotia St: The year 2016 did not have 75% data recovery and is not presented.

Graph 6.17: Maximum Measured 8-Hour Average CO Concentrations (NAPS: 2012-2016)



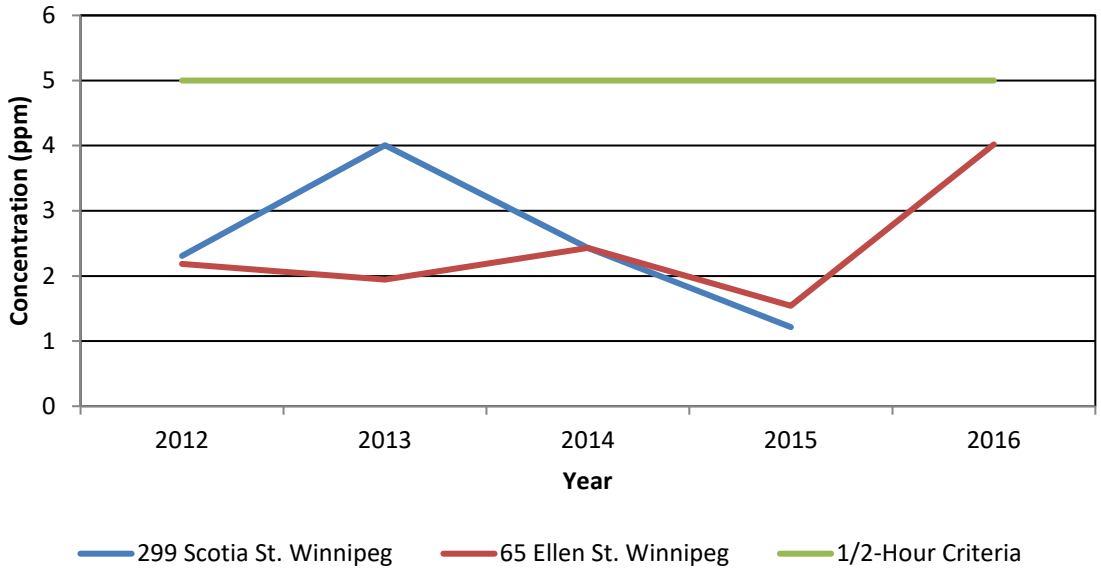
Notes:299 Scotia St: The year 2016 did not have 75% data recovery and is not presented.

Graph 6.18: Maximum Measured Hourly Average CO Concentrations (NAPS: 2012-2016)



Notes: 299 Scotia St: The year 2016 did not have 75% data recovery and is not presented.

Graph 6.19: Maximum Half-Hour Average CO Concentrations (NAPS: 2012-2016)



Notes: 299 Scotia St: The year 2016 did not have 75% data recovery and is not presented.

6.2.8 Volatile Organic Compounds (VOCs)

The following tables present sixty-eight (68) commonly measured VOC species. Of these sixty-eight (68) VOC species, fifty (50) were monitored at the NAPS Ellen Street, Winnipeg monitoring station from 2014 to 2018. Data for the other eighteen (18) contaminants was not available. The annual average and maximum 24-hour average concentrations measured at this NAPS station for these VOC species are presented in Graph 6.16 and Graph 6.17, respectively.

Exceedance of the applicable O. Reg. 419/05 annual criterion of 0.45 $\mu g/m^3$ for benzene occurred in 2014, 2015 and 2018. The measured annual average benzene concentration ranged from 0.42 to 0.90 $\mu g/m^3$. No other exceedances were measured for the other contaminants during this period.

Table 6.16: Summary of Measured Annual Average VOC Concentrations

VOC	Annual Average Concentrations (μg/m³)					Applicable AQ Criteria – Annual (μg/m³)
	2014	2015	2016	2017	2018	
1,1,1-Trichloroethane	2.36E-02	2.01E-02	1.65E-02	1.46E-02	1.36E-02	-
1,1,2,2-Tetrachloroethane	0.00E+00	1.43E-04	2.67E-04	2.43E-04	5.28E-04	-
1,1,2-Trichloroethane	N/A	3.13E-03	3.49E-03	3.77E-03	4.37E-03	-
1,1-Dichloroethane	N/A	6.23E-03	4.95E-03	4.82E-03	4.66E-03	-
1,1-Dichloroethylene	2.50E-04	2.60E-04	1.69E-04	0.00E+00	2.36E-04	-
1,2,4-Trichlorobenzene	5.02 E-03	3.78E-03	5.49E-03	3.51E-03	3.92E-03	-
1,2,4-Trimethylbenzene	2.75E-01	2.00E-01	1.77E-01	1.60E-01	1.82E-01	-
1,2-Dichlorobenzene	2.61E-03	2.13E-03	2.90E-03	2.16E-03	2.38E-03	-
1,2-Dichloroethane	6.48E-02	6.68E-02	5.68E-02	5.87E-02	7.36E-02	-
1,2-Dichloropropane	1.83E-02	1.94E-02	2.15E-02	2.03E-02	2.13E-02	-
1,2-Dichlorotetrafluoroethane [1]	N/A	N/A	N/A	N/A	N/A	-
1,3,5-Trimethylbenzene	8.06E-02	6.30E-02	5.67E-02	4.88E-02	5.38E-02	-
1,3-Butadiene	7.32E-02	5.11E-02	4.72E-02	4.02E-02	4.53E-02	-
1,3-Dichlorobenzene	2.32E-03	1.77E-03	2.21E-03	1.87E-03	1.85E-03	-
1,4-Dichlorobenzene	6.53E-02	4.50E-02	3.09E-02	2.94E-02	3.69E-02	-
1,4-Dioxane [1]	N/A	N/A	N/A	N/A	N/A	-
2,2,4-Trimethylpentane	2.14E-01	1.63E-01	1.80E-01	1.64E-01	1.62E-01	-
2-propanol [1]	N/A	N/A	N/A	N/A	N/A	-
2-Propanone [1]	N/A	N/A	N/A	N/A	N/A	-
4-ethyltoluene	9.14E-02	6.78E-02	5.93E-02	5.37E-02	5.78E-02	-
Acrylonitrile [1]	N/A	N/A	N/A	N/A	N/A	-
Acetaldehyde	0.8	0.7	0.6	0.8	1.6	-
Acrolein	0.02	0.02	0.02	0.01	0.02	-
Benzene	9.02E-01	4.87E-01	4.17E-01	4.30E-01	4.83E-01	0.45
Benzyl chloride	5.85E-03	3.92E-03	8.94E-04	2.53E-03	2.82E-03	-
Bromodichloromethane [2]	N/A	N/A	N/A	N/A	N/A	-
Bromoform	1.51E-02	1.42E-02	1.36E-02	1.47E-02	1.15E-02	-
Bromomethane	5.28E-02	4.44E-02	3.13E-02	3.00E-02	2.84E-02	-
Carbon Disulfide [1]	N/A	N/A	N/A	N/A	N/A	-
Carbon tetrachloride	5.05E-01	5.01E-01	4.69E-01	4.48E-01	3.97E-01	-
Chlorobenzene	7.84E-02	8.11E-03	7.97E-03	8.35E-03	8.19E-03	-
Chloroethane	8.90E-02	1.95E-02	1.46E-02	1.40E-02	1.30E-02	-

Table 6.16: Summary of Measured Annual Average VOC Concentrations

VOC	Annual Average Concentrations (μg/m³)					Applicable AQ Criteria – Annual (μg/m³)
	2014	2015	2016	2017	2018	
Chloroform	9.87E-02	1.07E-01	1.00E-01	1.08E-01	1.09E-01	-
Chloromethane	1.22E+00	1.16E+00	1.01E+00	9.27E-01	1.01E+00	-
cis-1,2-Dichloroethylene [2]	N/A	N/A	N/A	N/A	N/A	-
cis-1,3-Dichloropropene [2]	N/A	N/A	N/A	N/A	N/A	-
Cyclohexane	1.28E-01	1.15E-01	7.83E-02	8.32E-02	1.02E-01	-
Dibromochloromethane [2]	N/A	N/A	N/A	N/A	N/A	-
Dichlorodifluoromethane (FREON 12)	2.71E+00	2.63E+00	2.45E+00	2.46E+00	2.41E+00	-
Ethanol [1]	N/A	N/A	N/A	N/A	N/A	-
Ethyl Acetate [1]	N/A	N/A	N/A	N/A	N/A	-
Ethylbenzene	2.47E-01	2.08E-01	1.91E-01	1.65E-01	2.14E-01	-
Ethylene Dibromide [1]	N/A	N/A	N/A	N/A	N/A	-
Formaldehyde	1.5	1.3	0.9	0.8	1.9	-
Heptane	2.31E-01	1.56E-01	1.43E-01	1.34E-01	1.54E-01	-
Hexachlorobutadiene	3.00E-03	1.97E-03	1.94E-03	2.21E-03	4.10E-03	-
Hexane	3.67E-01	3.09E-01	2.32E-01	2.35E-01	2.71E-01	-
m / p-Xylene	7.97E-01	6.50E-01	5.65E-01	4.75E-01	6.24E-01	-
Methanol [1]	N/A	N/A	N/A	N/A	N/A	-
Methyl Butyl Ketone (2-Hexanone) [1]	N/A	N/A	N/A	N/A	N/A	-
Methyl Ethyl Ketone (2-Butanone) [1]	N/A	N/A	N/A	N/A	N/A	-
Methyl Isobutyl Ketone [1]	N/A	N/A	N/A	N/A	N/A	-
Methyl t-butyl ether (MTBE)	N/A	7.67E-04	1.77E-03	1.98E-03	4.02E-03	-
Methylene Chloride (Dichloromethane)	2.92E+00	4.45E-01	4.62E-01	4.72E-01	4.80E-01	-
Naphthalene	9.64E-02	4.73E-02	3.42E-02	2.97E-02	3.96E-02	-
n-Butane	2.29E+00	1.84E+00	1.61E+00	1.42E+00	1.86E+00	-
o-Xylene	2.81E-01	2.22E-01	1.99E-01	1.69E-01	2.09E-01	-
Propene [1]	N/A	N/A	N/A	N/A	N/A	-
Propionaldehyde (Propanal) [1]	N/A	N/A	N/A	N/A	N/A	-
Styrene	1.18E-01	3.65E-01	1.96E-01	3.50E-01	3.45E-01	-
Tetrachloroethylene	9.53E-02	1.50E-01	1.26E-01	1.00E-01	6.08E-02	-
Tetrahydrofuran [1]	N/A	N/A	N/A	N/A	N/A	-
Toluene	1.53E+00	1.22E+00	9.66E-01	9.65E-01	1.24E+00	-
trans-1,2-Dichloroethylene [2]	N/A	N/A	N/A	N/A	N/A	-

Table 6.16: Summary of Measured Annual Average VOC Concentrations

VOC	Annual Average Concentrations (μg/m³)					Applicable AQ Criteria – Annual (μg/m³)
	2014	2015	2016	2017	2018	
trans-1,3-Dichloropropene [2]	N/A	N/A	N/A	N/A	N/A	-
Trichloroethylene	2.73E-02	2.44E-02	2.56E-02	2.19E-02	3.61E-02	-
Trichlorofluoromethane (FREON 11)	1.54E+00	1.63E+00	1.46E+00	1.66E+00	1.48E+00	-
Trichlorotrifluoroethane [1]	N/A	N/A	N/A	N/A	N/A	-
Vinyl Bromide [1]	N/A	N/A	N/A	N/A	N/A	-
Vinyl Chloride	1.09E-03	2.23E-03	1.69E-03	1.33E-03	1.64E-03	-
Vinyl Acetate [1]	N/A	N/A	N/A	N/A	N/A	-

Notes:
1. These contaminants are not monitored at the NAPS Ellen Street, Winnipeg monitoring station.
2. Recovery rates for these contaminants for years 2014, 2015, 2016, 2017 and 2018 were below 75%, and data for these years are not presented here.

Table 6.17: Summary of Maximum Measured 24-Hour VOC Concentrations

VOC	Maximum 24-Hour Concentrations (μg/m³)					Applicable AQ Criteria – 24-Hour Average (μg/m³)
	2014	2015	2016	2017	2018	
1,1,1-Trichloroethane	3.20E-02	2.55E-02	4.05E-02	2.16E-02	7.02E-02	115,000
1,1,2,2-Tetrachloroethane	0.00E+00	1.69E-03	8.90E-03	5.22E-03	3.14E-03	-
1,1,2-Trichloroethane	N/A	5.73E-03	1.04E-02	6.66E-03	8.64E-03	-
1,1-Dichloroethane	N/A	3.76E-02	9.93E-03	8.41E-03	1.38E-02	165
1,1-Dichloroethylene	8.00E-03	1.29E-02	3.82E-03	0.00E+00	1.49E-03	10
1,2,4-Trichlorobenzene	1.20E-02	9.02E-03	3.22E-02	1.04E-02	1.66E-02	400
1,2,4-Trimethylbenzene	2.02E+00	6.01E-01	9.37E-01	6.69E-01	1.39E+00	220
1,2-Dichlorobenzene	4.00E-03	3.53E-03	1.25E-02	6.53E-03	1.06E-02	-
1,2-Dichloroethane	8.80E-02	9.31E-02	8.24E-02	1.19E-01	1.05E-01	2
1,2-Dichloropropane	2.60E-02	3.07E-02	3.91E-02	3.10E-02	3.39E-02	2400
1,2-Dichlorotetrafluoroethane [1]	N/A	N/A	N/A	N/A	N/A	700,000
1,3,5-Trimethylbenzene	5.84E-01	2.02E-01	2.98E-01	1.87E-01	3.95E-01	220
1,3-Butadiene	2.50E-01	1.51E-01	1.76E-01	9.20E-02	2.07E-01	-
1,3-Dichlorobenzene	6.00E-03	1.36E-02	1.02E-02	1.57E-02	6.03E-03	-
1,4-Dichlorobenzene	9.82E-01	1.63E-01	9.20E-02	1.07E-01	3.45E-01	95
1,4-Dioxane [1]	N/A	N/A	N/A	N/A	N/A	3,500
2,2,4-Trimethylpentane	6.46E-01	5.33E-01	5.60E-01	5.25E-01	1.41E+00	-
2-propanol [1]	N/A	N/A	N/A	N/A	N/A	7,300

Table 6.17: Summary of Maximum Measured 24-Hour VOC Concentrations

VOC	Maximum 24-Hour Concentrations (μg/m³)					Applicable AQ Criteria – 24-Hour Average (μg/m³)
	2014	2015	2016	2017	2018	
2-Propanone [1]	N/A	N/A	N/A	N/A	N/A	11,880
4-ethyltoluene	5.84E-01	1.95E-01	2.93E-01	2.08E-01	4.07E-01	500
Acrylonitrile [1]	N/A	N/A	N/A	N/A	N/A	1
Acetaldehyde	1.7	2.9	1.2	1.7	7.2	500
Acrolein	0.1	0.19	0.13	0.04	0.07	0.4
Benzene	4.38E+00	1.35E+00	9.77E-01	9.00E-01	1.74E+00	-
Benzyl chloride	1.00E-02	1.09E-01	6.26E-03	1.19E-02	2.16E-02	-
Bromodichloromethane [2]	N/A	N/A	N/A	N/A	N/A	-
Bromoform	3.80E-02	4.89E-02	2.42E-02	3.72E-02	2.15E-02	55
Bromomethane	7.20E-02	7.35E-02	6.49E-02	6.59E-02	4.39E-02	1,350
Carbon Disulfide [1]	N/A	N/A	N/A	N/A	N/A	330
Carbon tetrachloride	6.44E-01	6.26E-01	5.78E-01	5.81E-01	5.31E-01	2
Chlorobenzene	3.24E-01	1.32E-02	2.09E-02	2.97E-02	1.86E-02	-
Chloroethane	1.76E-01	5.47E-02	2.93E-02	2.68E-02	3.17E-02	5,600
Chloroform	1.98E-01	1.55E-01	1.52E-01	1.50E-01	3.16E-01	1
Chloromethane	1.46E+00	1.66E+00	1.26E+00	1.11E+00	1.17E+00	320
cis-1,2-Dichloroethylene [2]	N/A	N/A	N/A	N/A	N/A	105
cis-1,3-Dichloropropene [2]	N/A	N/A	N/A	N/A	N/A	1.25
Cyclohexane	7.22E-01	5.66E-01	3.23E-01	2.69E-01	3.34E-01	6,100
Dibromochloromethane [2]	N/A	N/A	N/A	N/A	N/A	0.2
Dichlorodifluoromethane (FREON 12)	7.12E+00	3.32E+00	2.91E+00	2.79E+00	2.69E+00	500,000
Ethanol [1]	N/A	N/A	N/A	N/A	N/A	-
Ethyl Acetate [1]	N/A	N/A	N/A	N/A	N/A	-
Ethylbenzene	1.03E+00	7.26E-01	5.60E-01	5.84E-01	1.36E+00	1,000
Ethylene Dibromide [1]	N/A	N/A	N/A	N/A	N/A	3
Formaldehyde	3.8	4.1	1.6	1.8	10.0	65
Heptane	1.10E+00	6.10E-01	5.45E-01	5.58E-01	8.34E-01	110,00
Hexachlorobutadiene	8.00E-03	4.67E-03	8.55E-03	5.61E-03	1.11E-02	0.227
Hexane	1.85E+00	1.01E+00	8.00E-01	1.00E+00	1.06E+00	7,500
m / p-Xylene	3.75E+00	3.29E+00	2.01E+00	1.95E+00	4.65E+00	100
Methanol [1]	N/A	N/A	N/A	N/A	N/A	4,000
Methyl Butyl Ketone (2-Hexanone) [1]	N/A	N/A	N/A	N/A	N/A	16
Methyl Ethyl Ketone (2-Butanone)[1]	N/A	N/A	N/A	N/A	N/A	1,000
Methyl Isobutyl Ketone [1]	N/A	N/A	N/A	N/A	N/A	1,200
Methyl t-butyl ether (MTBE)	N/A	7.90E-03	6.20E-02	1.12E-02	3.76E-02	7,000

Table 6.17: Summary of Maximum Measured 24-Hour VOC Concentrations

VOC	Maximum 24-Hour Concentrations (μg/m³)					Applicable AQ Criteria – 24-Hour Average (μg/m³)
	2014	2015	2016	2017	2018	
Methylene Chloride (Dichloromethane)	1.35E+02	8.62E-01	1.58E+00	1.58E+00	1.18E+00	220
Naphthalene	6.14E-01	1.30E-01	7.50E-02	1.90E-01	4.17E-01	22.5
n-Butane	1.58E+01	8.41E+00	6.49E+00	6.79E+00	9.23E+00	7,600
o-Xylene	1.23E+00	8.49E-01	5.85E-01	6.54E-01	1.39E+00	100
Propene [1]	N/A	N/A	N/A	N/A	N/A	4,000
Propionaldehyde (Propanal) [1]	N/A	N/A	N/A	N/A	N/A	-
Styrene	1.48E+00	1.32E+01	1.96E+00	1.19E+01	7.90E+01	400
Tetrachloroethylene	5.60E-01	1.07E+00	8.34E-01	7.59E-01	3.03E-01	360
Tetrahydrofuran [1]	N/A	N/A	N/A	N/A	N/A	93,000
Toluene	7.95E+00	3.84E+00	3.42E+00	4.21E+00	1.24E+01	2,000
trans-1,2-Dichloroethylene [2]	N/A	N/A	N/A	N/A	N/A	105
trans-1,3-Dichloropropene [2]	N/A	N/A	N/A	N/A	N/A	1.25
Trichloroethylene	9.60E-02	8.38E-02	1.63E-01	1.10E-01	5.67E-01	12
Trichlorofluoromethane (FREON 11)	2.58E+00	2.44E+00	1.68E+00	2.10E+00	1.87E+00	6,000
Trichlorotrifluoroethane [1]	N/A	N/A	N/A	N/A	N/A	800,000
Vinyl Bromide [1]	N/A	N/A	N/A	N/A	N/A	7
Vinyl Chloride	5.40E-03	7.99E-03	6.29E-03	5.15E-03	4.33E-03	1.0
Vinyl Acetate [1]	N/A	N/A	N/A	N/A	N/A	140

Notes:
1. These contaminants are not monitored at the NAPS Ellen Street, Winnipeg monitoring station.
2. Recovery rates for these contaminants for years 2014, 2015, 2016, 2017 and 2018 were below 75%, and data for these years are not presented here.

6.2.9 Polycyclic Aromatic Hydrocarbons (PAHs)

Data on PAHs from 2009 to 2011 from the NAPS Ellen Street, Winnipeg monitoring station were reviewed and used to conservatively characterize ambient PAH levels in the LSA. Thirty-one (31) PAHs are monitored at this station. A total of 13 PAHs were examined (those identified as CoPCs), with the following conclusions:

- For five assessed PAHs with applicable O. Reg. 419/05 half-hour and 24-hour averaging period JSLs, there were no exceedances of applicable screening levels.
- Exceedances of the applicable O. Reg. 419/05 annual average criterion of 0.00001 µg/m^3 for benzo(a)pyrene was measured for 2009 at this station. The measured annual average benzo(a)pyrene concentration in 2009 was 0.00008 µg/m^3.
- Exceedances of the applicable 24-hour Ontario AAQC of 0.00005 µg/m^3 for benzo(a)pyrene was also measured in 2009 at this station. The maximum 24-hour benzo(a)pyrene concentration measured in 2009 was 0.00039 µg/m^3.

Annual average PAH data is summarized in Table 6.18, and the maximum daily PAH data is provided in Table 6.19.

Table 6.18: Summary of Measured Annual Average PAH Concentrations

PAH	Annual Average Concentrations (µg/m^3)			Applicable AQ Criteria – Annual (µg/m^3)
	2009	2010	2011	
Acenaphthene	8.40E-04	8.40E-04	9.10E-04	-
Acenaphthylene	1.06E-03	1.06E-03	8.76E-04	-
Anthracene	2.51E-04	2.51E-04	1.88E-04	-
Benzo(a)anthracene	9.37E-05	9.37E-05	1.07E-04	-
Chrysene	1.57E-04	1.57E-04	1.51E-04	-
Fluoranthene	9.79E-04	9.79E-04	1.06E-03	-
Fluorene	1.62E-03	1.62E-03	1.49E-03	-
Phenanthrene	3.59E-03	3.59E-03	4.59E-03	-
Pyrene	8.01E-04	8.01E-04	7.37E-04	-
Benzo(a)pyrene [2]	7.79E-05	N/A	N/A	0.00001
Benzo(b+k)fluoranthene	2.68E-04	2.68E-04	2.07E-04	-
Benzo(g,h,i)perylene	1.32E-04	1.32E-04	9.51E-05	-

Notes:
1. Data from 2009 to 2011 was used for these contaminants. PAHs are not monitored at the NAPS Ellen Street, Winnipeg monitoring station after 2011.
2. Recovery rates for these contaminants for years 2010 and 2011 were below 75%, and data for these years are not presented here.

Table 6.19: Summary of Maximum Measured 24-hour Average PAH Concentrations

PAH	Maximum 24-Hour Concentrations (µg/m^3)			Applicable AQ Criteria – 24-Hour (µg/m^3)
	2009	2010	2011	
Acenaphthene	2.88E-03	1.69E-03	3.12E-03	-
Acenaphthylene	7.75E-03	5.62E-03	1.18E-02	3.5 [A]
Anthracene	7.72E-04	7.12E-04	5.79E-04	0.2 [A]
Benzo(a)anthracene	6.29E-04	4.74E-04	9.90E-04	-
Chrysene	9.35E-04	3.94E-04	1.28E-03	-
Fluoranthene	3.42E-03	2.27E-03	3.91E-03	140 A
Fluorene	3.60E-03	2.52E-03	4.06E-03	-
Phenanthrene	8.72E-03	1.02E-02	1.64E-02	-
Pyrene	3.32E-03	3.05E-03	3.12E-03	0.2 A
Benzo(a)pyrene [2]	3.89E-04	N/A	N/A	0.00005
Benzo(b+k)fluoranthene	1.51E-03	7.86E-04	1.59E-03	-
Benzo(g,h,i)perylene	7.24E-04	5.82E-04	6.15E-04	1.2 A

Notes:
1. Data from 2009 to 2011 was used for these contaminants. PAHs are not monitored at the NAPS Ellen Street, Winnipeg monitoring station after 2011.
2. Recovery rates for these contaminants for years 2010 and 2011 were below 75%, and data for these years are not presented here.

6.3 BASELINE AIR QUALITY CONDITIONS – PROJECT BASELINE MONITORING

6.3.1 PM_{10}

Measurements of on-site PM_{10} concentrations were made at three locations between July and October 2011. Results are summarized in Table 6.20, below.

Table 6.20: Summary of Measured Project Site (2011) PM_{10} Concentrations

Sample Date	24-hr PM_{10} Concentration (ug/m^3)		
	Pic River	**May's Gifts**	**Hare Lake**
7/24/11	7.1	5.6	6.3
7/30/11	12.5	12.1	12.7
8/5/11	16.4	16.4	16.9
8/11/11	6.4	4.8	5.2
8/17/11	10.41	10.46	11.61
8/23/11	15.55	12.96	12.64
8/29/11	7.09	6.27	6.27
9/4/11	4.59	4.15	4.18
9/10/11	6.69	6.19	5.83
9/16/11	4.14	4.21	4.17
9/22/11	4.14	4.26	4.20
9/28/11	9.52	6.82	8.32
10/4/11	9.10	8.07	7.90
10/10/11	14.05	12.66	13.36
10/16/11	< 4.18	4.14	4.19
10/22/11	4.99	4.95	6.28
10/28/11	< 4.16	4.16	7.12
Average	**8.3**	**7.5**	**8.1**
90th Percentile	**14.6**	**12.8**	**13.0**
Maximum	**16.4**	**16.4**	**16.9**

Average PM_{10} concentrations over the study period were fairly similar at all three stations, ranging from 7.5 ug/m^3 at May's Gifts to 8.3 ug/m^3 at the Pic River station. The 90th percentile results ranged from 12.8 ug/m^3 at May's Gifts to 14.6 ug/m^3 at the Pic River station. Days when elevated PM_{10} concentrations were detected were consistent across all three sampling stations, suggesting a regional and not local source. For comparison, the annual composite geometric mean for the province of Ontario between 1991 and 1996 ranged from about 18 to 22 ug/m^3, with peak values of up to 164 ug/m^3 measured near industrial sources. All results for the Marathon Project site were below the Ontario averages and well below the MECP AAQC criterion of 50 ug/m^3.

The measured annual mean PM_{10} concentrations for the Winnipeg Ellen St. Station from 2014-2018 ranged from 9.4 to 12.7 ug/m^3. The maximum 24-hour average measurement in each year over this period ranged from 45.8 to 136.3 ug/m^3. The annual mean PM_{10} concentrations for the Thunder Bay Station from 2014-2018 (estimated from the measured $PM_{2.5}$ data) ranged from 9.2 to 12.2 ug/m^3 with maximum 24-hour averages ranging from 24.5 to 66 ug/m^3. The NAPS PM_{10} data are generally higher than the on-site measurements as would be expected given the remote nature of the Marathon site and its significantly smaller population than Thunder Bay. The use of NAPS data to estimate background concentration levels is therefore expected to provide a conservative assessment.

6.3.2 Dustfall

Dustfall was measured at the Project site at five locations in August, September, and October 2011. No measurements were made in August at Location 5 (Field Office). A summary of the results is presented in Table 6.21, below.

Table 6.21: Project Site 2011 Ambient Monitoring Results for Total Dustfall

Sampling Date	Station ID				
	1	2	3	4	5
August	0.57	0.72	0.49	0.70	--
September	0.86	1.26	0.95	0.97	1.42
October	0.44	0.41	0.33	0.39	1.44
Mean	0.62	0.80	0.59	0.69	1.43

Notes: Results shown in g/m^2/30d.

All measured total dustfall concentrations were well below the MECP AAQC criterion of 7 g/m^2 for a 30-day averaging period. As expected, dustfall concentrations were highest at Station 5 (Field Office), located in the Town of Marathon for both sampling events.

The percentage of soluble dustfall in the collected samples ranged from 1.81% to 17.9%, with a mean of 9.9%. This result suggests that approximately 90% of the deposition is a result of dry deposition due to particle settling.

6.3.3 Metals in Particulate

Metals in dustfall were measured in August, September, and October 2011. There are no MECP or federal metals deposition criteria for comparison to the results. Results are summarized in Table 6.22.

Table 6.22: Summary of Measured Metals in Dustfall

Metal	Method Detection Limit (ug/m^2/day)	Range of Results (ug/m^2/day)	Regional Daily Average Background (ug/m^2/day)
Sb	0.332	BDL to 1.17	--
As	1.66	BDL	0.466
Ba	8.31	BDL to 27.1	--
Be	3.32	BDL	--
Cd	0.166	BDL	0.0822 to 0.465
Cr	1.66	BDL to 6.29	--
Co	0.332	BDL to 0.614	--
Cu	1.66	2.21 to 10.3	0.658 to 2.88
Pb	0.831	BDL to 3.2	1.07 to 3.3
Mn	0.831	BDL to 141	--
Ni	0.332	2.37 to 8.72	0.22 to 1.07
P	166	BDL to 209	--
Se	3.32	BDL	--
Ag	0.332	BDL	--
Tl	0.332	BDL	--
Zn	9.97	BDL to 63.5	3.8 to 14
Hg	0.0565	BDL to 0.33	--

Notes: BDL = below laboratory method detection limit.

Arsenic, beryllium, cadmium, selenium, silver and thallium were not detected in any of the dustfall samples collected. Measurable concentrations of antimony, barium, chromium, cobalt, copper, lead, manganese, nickel, phosphorus, zinc and mercury were detected in some of the collected samples.

Results were compared to estimated annual regional background total metal deposition compiled for the years 1989 to 1995 (Environment Canada/Health Canada, 1999). Background data for Geraldton, Ontario and the average of all 11 stations were referenced. For the metals with measurable concentrations, levels of copper, nickel and zinc were higher than regional background concentrations while concentrations of lead were similar to or lower than the background concentrations.

6.3.4 Nitrate and Sulphate

Nitrate and sulphate content in dustfall were measured on two occasions (September and October 2011) to determine the combined effects of wet and dry acidic deposition. Results are summarized in Table 6.23.

Table 6.23: Measured Nitrate and Sulphate Depositions

Station ID	Description	Results (mg/m^2/30d)	
		September	October
Nitrate			
1	Pic River	19.59	11.9
2	May's Gifts	21.48	8.5
3	Hare Lake	27.18	18.1
4	Former Airport	22.68	14.8
5	Field Office	17.22	19.0
Sulphate			
1	Pic River	110.1	115.0
2	May's Gifts	126.6	79.1
3	Hare Lake	161.4	105.3
4	Former Airport	129.0	84.2
5	Field Office	93.9	81.7

Nitrate deposition ranged from 8.5 to 27.18 mg/m^2/30d for the two sampling events. For all but the field office sample (Station 5), nitrate concentrations were lower in October than in September. Deposition levels were highest at the Hare Lake station in September but highest at the Field Office station in October.

Sulphate deposition at the Project site ranged from 79.1 to 161.4 mg/m^2/30d, with levels in October again generally lower than in September except for the Pic River Station (Station 1). Similar to the nitrate results, Hare Lake had the highest deposition values in September while the Pic River station was highest in October.

Results were converted to annual averaging periods and compared to estimated regional background concentrations (Health Canada/Environment Canada, 1999). The range of natural background sulphate deposition in the Algoma district (near Sudbury, Ontario) was reported as 3.6 to 5.6 kg/ha/year. Sulphate deposition considering all North American sources ranged from 13.9 to 22.9 kg/ha/year. Marathon Project site sulphate deposition results ranged from 9.6 to 19.6 kg/ha/year, higher than the predicted natural background deposition rates but within the range of deposition which included existing North American sources. This range is at the Eastern Canada Acid Rain Program target loading of 20 kg/ha/year. The results suggest that sulphate deposition at the project site is affected by existing sources of SO_2 emissions to the environment, which may originate locally, regionally, or even internationally (i.e., transboundary).

An evaluation of critical loads (CLs) for Ontario was carried out. Critical loads outline the amount of acidifying deposition that the environment (aquatic and terrestrial) can receive without anticipated adverse effects. The 5th percentile CL for Ontario is 126 eq/ha/year and the 50th percentile value is 832 eq/ha/year (ECCC/MSC, 2000). The highest baseline acidifying deposition for the Project site was calculated to be 440 eq/ha/year but does not take into account any neutralization from base cations (which were not measured). As a result, the calculated value is conservative, and the net acidifying deposition will be lower.

6.4 BACKGROUND AMBIENT CONCENTRATIONS FOR USE IN AIR QUALITY DISPERSION MODELLING

Background concentrations are used in dispersion modelling to represent the effect of other emissions sources in addition to the sources being included in the dispersion modelling. Sources of ambient air emissions in the LSA may include:

- Residential
- Commercial
- Industrial
- Transportation (traffic on local roads, railways, aircraft, etc.)
- Naturally occurring (wind erosion of open surfaces, forests, fires, etc.)
- Long-range transport from other sources outside the LSA

Background air quality levels due to these sources can be included in a dispersion modelling assessment in order to quantify the incremental change in local air quality with respect to the emissions source(s) being studied. Cumulative air quality levels due to the emissions sources being studied combined with background levels can then be compared to applicable air quality criteria to assess significance. Ambient monitoring is typically used to quantify air quality levels due to background emissions sources, as the emission rates of many of these sources are difficult to estimate accurately and their emission rates can vary considerably both temporally and spatially.

In previous Projects conducted by Stantec, the MECP has requested that 90th percentile ambient monitoring data be added to the dispersion model predictions to conservatively account for existing ambient concentrations. The MECP specifies the use of 90th percentile values for short-term averaging periods as it provides a conservative estimate of ambient levels, while at the same time providing some consideration for the fact that the location and time for the occurrence of maximum ground level concentrations from background sources varies from that for the source(s) being considered in the modelling assessment. For annual averages, an annual average value was used as the background level.

Background concentrations for the Project were conservatively determined by taking the highest 90th percentile concentration of each contaminant of concern from the following data sources previously discussed:

- The historical long-term ambient air concentrations measured by NAPS stations; or
- Generation PGM's baseline ambient monitoring presented in Section 4.3.

The following sections summarize 90th percentile (or maximum) concentrations for the contaminants assessed in this baseline air quality study and outline the background ambient concentrations to be used in the EA.

Baseline ambient concentrations established in this study are expected to be conservative and an over-estimation of actual ambient concentrations in the LSA. The Project will be located in a remote location of northern Ontario; air quality is primarily influenced by traffic on Highway 17. Baseline air concentrations established in this report are primarily based on NAPS stations which are located in large urban residential, commercial and industrial areas that are expected to have higher background concentrations relative to the LSA.

6.4.1 Background Particulate Matter Concentrations

A comparison of the historical ambient concentrations from the NAPS stations and on-site measurements of PM are presented in Table 6.24. The proposed background PM concentrations (TSP, PM_{10} and $PM_{2.5}$) to be used in the dispersion modelling assessment for the Project are based on the higher of these data sources and are listed in the right column of Table 6.24.

Table 6.24: Historical and Measured Ambient Particulate Matter 90th Percentile Concentrations and Background Concentrations to be Used in the Dispersion Modelling Assessment

Parameter	Historical 90th Percentile 24-Hour Average Concentration (µg/m³)[1]	Measured 90th Percentile 24-Hour Average Concentration (µg/m³)	Background Ambient 24-Hour Average Concentration to be used in AQ Assessment[3]
Total Suspended Particulate (TSP)	44.1 [4]	N/A	44.1
PM_{10}	22.8	14.6	22.8
$PM_{2.5}$	12.3 [2]	N/A	12.3

Notes:
1. Maximum data from all NAPS stations
2. $PM_{2.5}$ concentration is the 90th percentile of the 24-hour average concentrations.
3. The concentration identified in this column will be used as the background ambient concentration in the dispersion modelling assessment. It is equal to the higher of the 90th percentile historical or measured concentrations.
4. Estimated using approximate relationships from literature between $PM_{2.5}$ and TSP concentrations to provide additional background estimates.

6.4.2 Background Metal Concentrations

A summary of the background 24-hour and annual average metals concentrations to be used in the dispersion modelling assessment are presented in Table 6.25. The background metal concentrations for the Project are based on the highest 90th percentile 24-hour average concentration or the highest annual average concentration in any individual year over the 5-year monitoring period.

Table 6.25: Background Metals in TSP Concentrations to be Used in the Dispersion Modelling Assessment

Parameter	CAS #	90th Percentile 24-Hour Average Background Concentration (µg/m^3)	Annual Average Background Concentration (µg/m^3)
Aluminum	7429-90-5	5.88E-01	2.84E-01
Antimony	7440-36-0	2.71E-02	9.39E-03
Arsenic	7440-38-2	N/A	N/A
Barium	7440-39-3	3.99E-02	1.92E-02
Beryllium	7440-41-7	N/A	N/A
Bismuth	7440-69-9	N/A	N/A
Boron	7440-42-8	N/A	N/A
Cadmium	7440-43-9	1.20E-02	3.62E-03
Calcium	7440-70-2	1.74E+00	7.62E-01
Chromium (total)	7440-47-3	1.46E-03	6.76E-04
Cobalt	7440-48-4	N/A	N/A
Copper	7440-50-8	N/A	N/A
Iron	15438-31-0	3.85E-01	1.91E-01
Lead	7439-92-1	5.74E-03	3.01E-03
Lithium	7439-93-2	N/A	N/A
Magnesium	7439-95-4	N/A	N/A
Manganese	7439-96-5	1.42E-02	7.71E-03
Mercury	7439-97-6	N/A	N/A
Molybdenum	7439-98-7	N/A	N/A
Nickel	7440-02-0	2.60E-03	1.00E-03
Potassium	7440-09-7	2.79E-01	1.49E-01
Selenium	7782-49-2	2.44E-03	9.63E-04
Silver	7440-22-4	N/A	N/A
Sodium	7440-23-5	N/A	N/A
Strontium	7440-24-6	4.36E-03	1.89E-03
Thallium	7440-28-0	N/A	N/A
Tin	7440-31-5	1.50E-02	3.26E-03
Titanium	7440-32-6	1.89E-02	8.99E-03

Parameter	CAS #	90th Percentile 24-Hour Average Background Concentration (µg/m³)	Annual Average Background Concentration (µg/m³)
Uranium	7440-61-1	N/A	N/A
Vanadium	7440-62-2	3.14E-03	8.86E-04
Yttrium	7440-65-5	N/A	N/A
Zinc	7440-66-6	3.35E-02	1.55E-02

Note: N/A – Data not analyzed/not available from NAPS.

6.4.3 Background Criteria Air Contaminant Concentrations

Background Criteria Air Contaminant concentrations were determined from the NAPS station data for Sault Ste. Marie, Thunder Bay, North Bay and Winnipeg. The maximum 90th percentile concentration in each year over all five years of data and all stations was conservatively taken to be the background value for the Project. The background concentrations to be used in the dispersion modelling for the applicable averaging periods are listed below in Table 6.26.

Table 6.26: Background Criteria Air Contaminant (90th Percentile) Concentrations for Use in the Dispersion Modelling Assessment

Contaminant	Concentration units	Background 90th Percentile 1-Hour Concentration	Background 90th Percentile 24-Hour Concentration	Background 90th Percentile Other Time Period Concentration
NO_2	ppb	32	16	
SO_2	ppb	1.0	2.1	0.9 (Annual)[1]
O_3	ppb	46	42	43 (8-hour)
CO	ppm	0.80	0.80	0.97 (1/2-hour) 0.80 (8-hour)

Note:
1. Annual background concentration is the maximum of the annual means measured from the five NAPS stations.

6.4.4 Background Volatile Organic Compound Concentrations

Background VOC concentrations were conservatively assessed from the NAPS Winnipeg (65 Ellen St.) station. The maximum 90th percentile or annual average concentration in each year over all five years of data was conservatively taken to be the background value for the Project. The background 24-hour and annual average concentrations to be used in the dispersion modelling assessment are listed below in Table 6.27.

Table 6.27 Background Volatile Organic Compound Concentrations for Use in the Dispersion Modelling Assessment

Contaminant	90th Percentile 24-Hour Average Background Concentration (µg/m³)	Annual Average Background Concentration (µg/m³)
1,1,1-Trichloroethane	2.60E-02	2.36E-02
1,1,2,2-Tetrachloroethane	1.60E-03	5.28E-04
1,1,2-Trichloroethane	5.91E-03	4.37E-03
1,1-Dichloroethane	7.73E-03	6.23E-03
1,1-Dichloroethylene	7.55E-04	2.60E-04
1,2,4-Trichlorobenzene	9.68E-03	5.49E-03
1,2,4-Trimethylbenzene	5.24E-01	2.75E-01
1,2-Dichlorobenzene	4.91E-03	2.90E-03
1,2-Dichloroethane	9.81E-02	7.36E-02
1,2-Dichloropropane	3.25E-02	2.15E-02
1,2-Dichlorotetrafluoroethane	N/A	N/A
1,3,5-Trimethylbenzene	1.56E-01	8.06E-02
1,3-Butadiene	1.09E-01	7.32E-02
1,3-Dichlorobenzene	4.19E-03	2.32E-03
1,4-Dichlorobenzene	9.60E-02	6.53E-02
1,4-Dioxane [1]	N/A	N/A
2,2,4-Trimethylpentane	3.80E-01	2.14E-01
2-propanol [1]	N/A	N/A
2-Propanone [2]	N/A	N/A
4-ethyltoluene	1.71E-01	9.14E-02
Acrylonitrile [1]	N/A	N/A
Acetaldehyde	4.0	1.6
Acrolein	0.05	0.023
Benzene	1.44E+00	9.02E-01
Benzyl chloride	1.00E-02	5.85E-03
Bromodichloromethane [2]	N/A	N/A
Bromoform	2.26E-02	1.51E-02
Bromomethane	6.40E-02	5.28E-02
Carbon Disulfide [1]	N/A	N/A
Carbontetrachloride	5.61E-01	5.05E-01
Chlorobenzene	1.89E-01	7.84E-02
Chloroethane	1.48E-01	8.90E-02

Table 6.27 Background Volatile Organic Compound Concentrations for Use in the Dispersion Modelling Assessment

Contaminant	90th Percentile 24-Hour Average Background Concentration (µg/m³)	Annual Average Background Concentration (µg/m³)
Chloroform	1.29E-01	1.09E-01
Chloromethane	1.32E+00	1.22E+00
cis-1,2-Dichloroethylene [2]	N/A	N/A
cis-1,3-Dichloropropene [2]	N/A	N/A
Cyclohexane	2.73E-01	1.28E-01
Dibromochloromethane [2]	N/A	N/A
Dichlorodifluoromethane (FREON 12)	2.94E+00	2.71E+00
Ethanol [1]	N/A	N/A
Ethyl Acetate [1]	N/A	N/A
Ethylbenzene	4.47E-01	2.47E-01
Ethylene Dibromide	N/A	N/A
Formaldehyde	5.4	1.9
Heptane	3.43E-01	2.31E-01
Hexachlorobutadiene	6.30E-03	4.10E-03
Hexane	5.57E-01	3.67E-01
m / p-Xylene	1.53E+00	7.97E-01
Methanol [1]	N/A	N/A
Methyl Butyl Ketone (2-Hexanone) [1]	N/A	N/A
Methyl Ethyl Ketone (2-Butanone) [2]	N/A	N/A
Methyl Isobutyl Ketone [2]	N/A	N/A
Methyl t-butyl ether (MTBE)	6.50E-03	4.02E-02
Methylene Chloride (Dichloromethane)	8.22E-01	2.92E+00
Naphthalene	2.39E-01	9.64E-02
n-Butane	4.33E+00	2.29E+00
o-Xylene	5.29E-01	2.81E-01
Propene [1]	N/A	N/A
Propionaldehyde (Propanal) [1]	N/A	N/A
Styrene	6.01E-01	3.65E-01
Tetrachloroethylene	3.57E-01	1.50E-01
Tetrahydrofuran [1]	N/A	N/A
Toluene	2.81E+00	1.53E+00
trans-1,2-Dichloroethylene	N/A	N/A

Table 6.27 Background Volatile Organic Compound Concentrations for Use in the Dispersion Modelling Assessment

Contaminant	90th Percentile 24-Hour Average Background Concentration (µg/m3)	Annual Average Background Concentration (µg/m3)
trans-1,3-Dichloropropene	N/A	N/A
Trichloroethylene	5.50E-02	3.61E-02
Trichlorofluoromethane (FREON 11)	1.94E+00	1.66E+00
Trichlorotrifluoroethane	N/A	N/A
Vinyl Bromide [1]	N/A	N/A
Vinyl Chloride	4.48E-03	2.23E-03
Vinyl Acetate [1]	N/A	N/A

Notes:
1. No baseline ambient concentration data is available for these contaminants.
2. Recovery rates for year 2014, 2015, 2016, 2017 and 2018 were below 75% for these contaminants, and data for these years are not available.

6.4.5 Background PAH Concentrations

Background PAH concentrations were conservatively assessed from the NAPS Winnipeg (65 Ellen St.) station. The highest 90th percentile 24-hour average (and other averaging period) concentration in each year of the five-year period for each PAH were conservatively taken as the background concentrations, and are listed in Table 6.28.

Table 6.28: Summary of Background PAH Concentrations for Use in the Dispersion Modelling Assessment

Contaminant	Background 90th Percentile 24-Hour Concentration [1] (μg/m3)	Background 90th Percentile Other Time Period Concentration [2,3] (μg/m3)
Acenaphthene	1.81E-03	-
Acenaphthylene	1.79E-03	5.29E-03 (half-hour)
Anthracene	4.49E-04	-
Benzo(a)anthracene	2.14E-04	-
Benzo(a)pyrene	2.06E-04	1.03E-04 (annual)
Benzo(b+k)fluoranthene	5.13E-04	-
Benzo(g,h,i)perylene	2.8E-04	8.29E-04 (half-hour)
Chrysene	2.65E-04	-
Fluoranthene	1.91E-03	-
Fluorene	2.91E-03	-
Phenanthrene	7.86E-03	-
Pyrene	1.34E-03	5.65E-03 (half-hour)

Notes:

1 Background concentrations for 24-Hour averaging period are based on the maximum of the historical NAPS measurements.

2 Background concentrations for 30 day and annual averaging periods are based on historical NAPS measurements. Annual background concentration is the highest of the annual means measured from the NAPS station.

3. Half-hour concentrations calculated from the 24-hour data using the MECP recommended averaging time conversion equation.

4. No baseline ambient concentration data is available for these contaminants.

- Not applicable.

7.0 SUMMARY AND CONCLUSIONS

This renewed background air quality report provides updated meteorological and background ambient air quality concentration data relative to the 2012 Baseline Report. A comprehensive list of CoPCs, reflecting the expanded availability of air quality criteria for a variety of substances since 2012, are also assessed in this report.

Climate and meteorology in the Marathon Project site area is typical of northwestern Ontario. Marathon experiences cooler summers and warmer winters compared to other more remote northerly communities in northwestern Ontario due to its proximity to Lake Superior. The site does not experience a significant amount of adverse weather phenomena. Isolated events of hail, extreme rainfall or extreme snowfall are possible.

Baseline air quality levels at the Project site are low as the property is located in a relatively undeveloped area north of Highway 17. Sources of airborne contaminants currently present on site include several permitted gravel pits, the Town of Marathon landfill site, and the Town of Marathon wastewater lagoons. Regional influences on air quality include residential/commercial/institutional heating, fugitive emissions from Highway 17 traffic, fugitive emissions from airport traffic, and other nearby industrial sources, such as the Hemlo gold mine, located approximately 30 km east of the Project site.

Concentrations of CACs at the property were either confirmed to be low through measurement or were projected to be low, based on a review of NAPS measurements at nearby representative stations.

Background ambient concentrations established in this report are expected to be conservative and an over-estimation of actual ambient concentrations in the LSA. Background air concentrations are primarily based on NAPS stations which are located in large urban residential, commercial, and industrial areas that are expected to have higher background concentrations relative to the LSA.

8.0 REFERENCES

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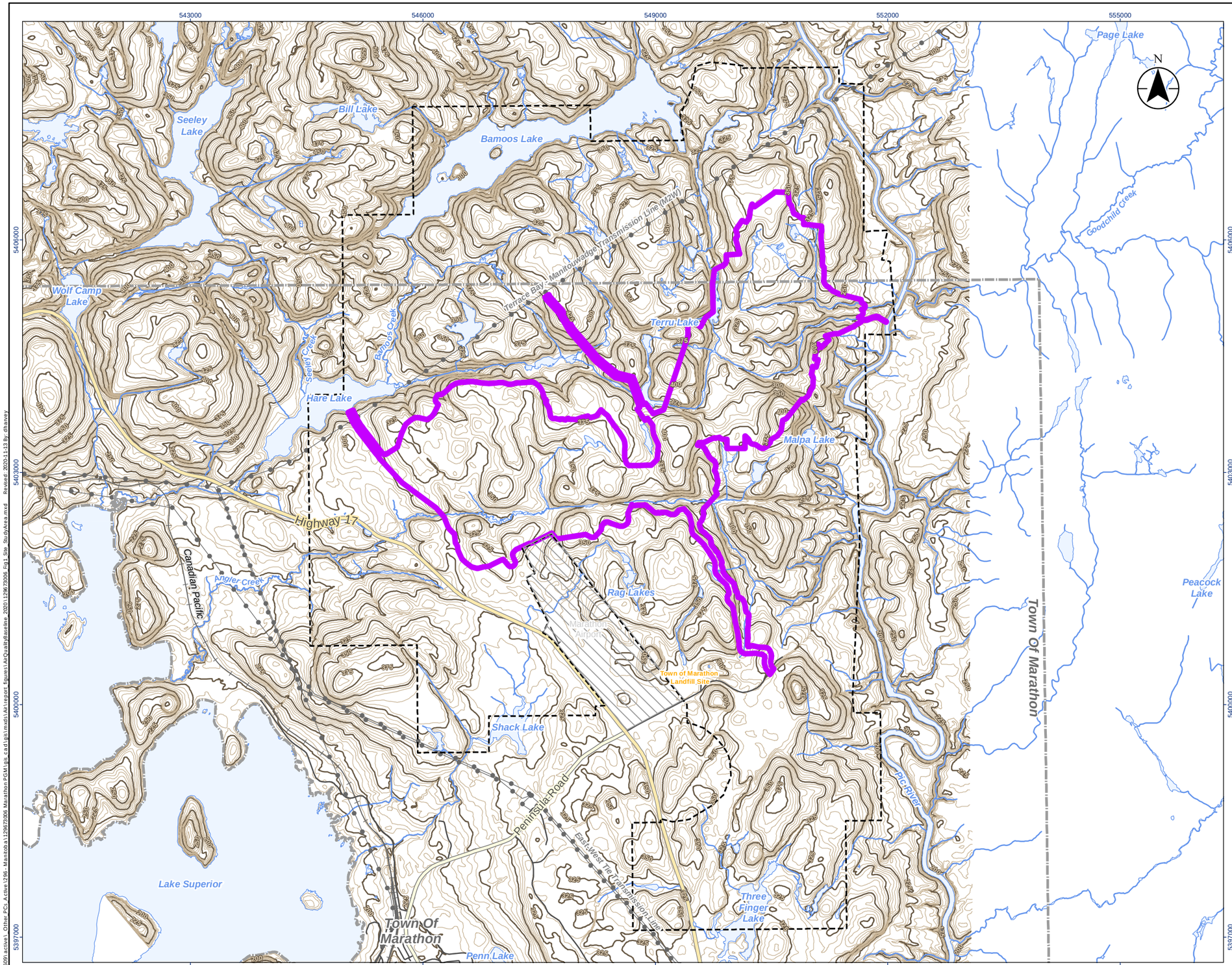
APPENDIX A
Figures



Stantec

Legend

- Project Boundary (MLAS, MENDM Changed 2017)
- Site Study Area Boundary
- Topographic Contour (5 m Intervals)
- Topographic Contour (25 m Intervals)
- Highway
- Major Road
- Minor Road
- Hydro Line
- Railway
- Watercourse
- Airport
- Municipal Boundary, Lower Tier
- Waterbody

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Notes

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018.

Project Location
Marathon

129673006 REVA
Prepared by DH on 2020-11-13
Technical Review by DH on 2020-09-21

Client/Project
GENERATION PGM INC.
MARATHON PALLADIUM PROJECT

Figure No.
1

Title
Site Study Area

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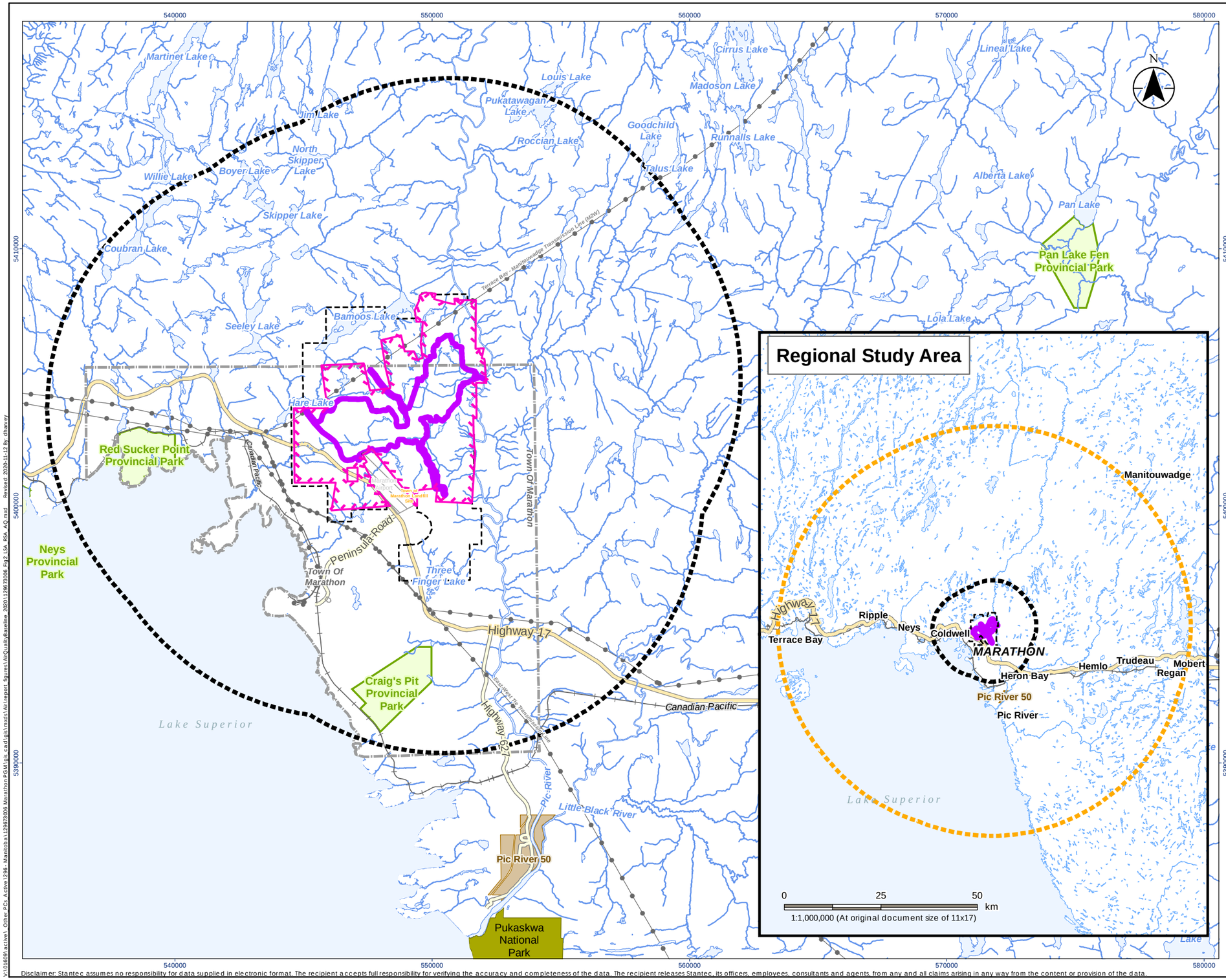

Stantec

Legend

- Project Boundary (MLAS, MENDM Changed 2017)
- Site Study Area Boundary
- Limit of Surface Rights Controled by Generation Mining (Current or Pending)
- Local Study Area
- Regional Study Area
- Highway
- Major Road
- Hydro Line
- Railway
- Watercourse
- Airport
- Municipal Boundary, Lower Tier
- National Park
- Provincial Park
- Waterbody

0 2.5 5 km

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Notes

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Project Location
Marathon

129673006 REVA
Prepared by SW on 2020-11-12
Technical Review by DH on 2020-09-17
Independent Review by ABC on yyyy-mm-dd

Client/Project
GENERATION PGM INC.
MARATHON PALLADIUM PROJECT

Figure No.
2

Title
Local and Regional Study Areas for AQ

Figure 3: Wind Rose for Marathon Airport – 2015-2019

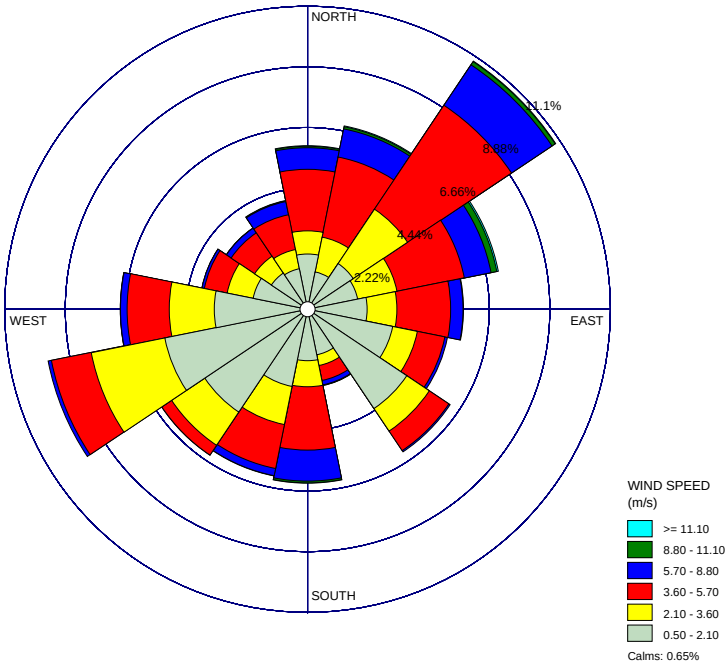

Figure 4: Wind Class Frequency Distribution (2015-2019)