2017 Annual Ambient Air Quality Monitoring Report for the Durham York Energy Centre (Crago Road Station)

Durham York Energy Centre

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Sign-off Sheet

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Executive Summary

The Regional Municipalities of Durham and York operate the Durham York Energy Centre (DYEC) which is an Energy-from-Waste (EFW) Facility. The DYEC is intended to provide a long-term, sustainable solution to manage the remaining municipal solid waste after waste diversion from the Regions. The DYEC commenced commercial operation on February 1, 2016.

The Ambient Air Quality Monitoring Plan - Durham York Residual Waste Study (Stantec, 2012), was developed based on the Regional Council's mandate to provide ambient air quality monitoring in the area of the DYEC for a three-year period. An ambient air quality monitoring and reporting program was also a requirement laid out in the Provincial Minister's Notice of Approval to Proceed with the Undertaking, detailed in Condition 11 of the Notice of Approval (MOE, 2010). The air monitoring plan was also developed to satisfy the conditions of the Environmental Compliance Approval and the environmental mitigation and commitments set out in the Environmental Assessment (Jacques Whitford, 2009). The Ambient Monitoring Plan included two monitoring stations referred to as the Courtice Water Pollution Control Plant (WPCP) Station and the Rundle Road Station (as well as a temporary fence line monitor). Subsequently, the Regional Municipality of Durham decided to add a third ambient air monitoring station located near the corner of Crago and Osborne Roads (referred to as the Crago Road Station), which was installed in October/November 2014. The Crago Road Station is not part of the Ambient Monitoring Plan; however, it is operated following the same protocols as the other two stations. Since the Crago Road Station was not part of the Provincial Minister's Notice of Approval, results of the Crago Road Station are reported separately from the Courtice WPCP and Rundle Road Stations.

The Crago Road Station is equipped to measure concentrations of several air contaminants either continuously or at scheduled intervals (non-continuously) as outlined below.

- Contaminants monitored continuously:
  - Sulphur Dioxide (SO_2);
  - Nitrogen Oxides (NO_X); and,
  - Particulate Matter smaller than 2.5 microns ($PM_{2.5}$).
- Contaminants monitored non-continuously:
  - Metals in Total Suspended Particulate (TSP) matter;
  - Polycyclic Aromatic Hydrocarbons (PAHs); and,
  - Dioxins and Furans.

Meteorological variables were also measured at the station. The predominantly downwind Crago Road Station measures horizontal wind speed, wind direction, atmospheric temperature, relative humidity, and rainfall.

Monitoring of non-continuous air quality parameters commenced once the EFW facility became fully operational on February 1, 2016 with a first sample date of February 6, 2016. The monitoring has continued through 2017.

At the request of the Regional Municipality of Durham, dioxin and furan sampling that was outside the scope of the Ambient Monitoring Plan (Stantec, 2012) was conducted from July 18, 2017 to September 4, 2017. During this period the dioxin/furan sampling frequency was increased from once every 24 days to once every 12 days. The results of the additional sampling in 2017 have been included in the analysis provided in this report.

This annual report provides a summary of the ambient air quality data collected at the Crago Road Station for the period January to December 2017 and follows the same annual reporting requirements as for the Courtice WPCP and Rundle Road monitoring stations (Stantec, 2012).

The following observations and conclusions were made from a review of the measured ambient air quality monitoring data:

1. Measured concentrations of NO_2, SO_2 and $PM_{2.5}$ were below the applicable O. Reg. 419/05 Standards and/or human health risk assessment (HHRA) health-based criteria presented in **Table 2-1** of this report for hourly, 24-hour and annual averaging periods.

2. The 98th percentile of the measured daily average $PM_{2.5}$ levels during the 2017 monitoring period was 15.1 µg/m^3 at the Crago Road Station. The annual average $PM_{2.5}$ concentration measured at the Crago Road Station over the year was 5.6 µg/m^3. As detailed below, these values for the 2017 measurements should not be used for direct comparison against the Canadian Ambient Air Quality Standard.

3. The Canadian Ambient Air Quality Standards (CAAQS) require a three-calendar year average for comparison, with the data considered valid if an annual 98th percentile value is available for at least two of the three calendar years. Using the measured $PM_{2.5}$ data for calendar years 2015 to 2017, the average annual 98th percentile daily average and annual average $PM_{2.5}$ levels were below the CAAQS criteria.

4. The maximum measured concentrations of TSP and all metals with Ministry of the Environment and Climate Change (MOECC) air quality criteria were below their applicable criteria (presented in **Table 2-2** in this report).

5. The maximum measured concentrations of PAHs with MOECC Ambient Air Quality Criteria (AAQC) were almost all below their applicable 24-hour criteria (presented in **Table 2-3**) with the exception of six (6) benzo(a)pyrene (B(a)P) measurements. Out of thirty (30) PAH samples collected at the Crago Road Station, six (6) samples exceeded the Ontario 24-hour B(a)P AAQC of 0.05 ng/m^3 by 13% to 220%. However, all six (6) samples were well below the MOECC Schedule 6 Upper Risk Threshold, the MOECC O. Reg. 419/05 24-hour average guideline, and the HHRA health based criteria (as shown in **Table 2-3**).

Based on the air quality assessments completed during the Environmental Assessment Study and the Environmental Compliance Approval application for the DYEC, the facility will not be a significant contributor of B(a)P. Therefore, ambient B(a)P levels are not expected to be substantially impacted by the operation of the DYEC. Discussion of the meteorology and potential sources for these events, which is required by the MOECC to be included in each annual report, is provided in Section 4.4.

6. The maximum toxic equivalent dioxin and furan concentration measured over this period was below the applicable criteria presented in **Table 2-3**.

In summary, the measured concentrations of almost all measured air contaminants were below their applicable MOECC Standards during the 2017 monitoring period, except for benzo(a)pyrene as noted above. Further, the measured levels of monitored air contaminants were below their applicable HHRA health-based criteria.

Abbreviations

AAQC	Ambient Air Quality Criteria
ACB List	Air Contaminants Benchmark List: Standards, Guidelines and Screening Levels for Assessing Point of Impingement Concentrations of Air Contaminants
CAAQS	Canadian Ambient Air Quality Standard
CAC	Criteria Air Contaminants
CDD	Chlorinated Dibenzo-p-dioxins
CDF	Chlorinated Dibenzo-p-furans
DAS	Data acquisition system
D/Fs	Dioxins and Furans
DYEC	Durham York Energy Centre
EFW	Energy from Waste
HHRA	Human Health Risk Assessment
MOECC	Ontario Ministry of the Environment and Climate Change
SO_2	Sulphur Dioxide
NO_X	Nitrogen Oxides
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbons
Particulate	A particle of a solid or liquid that is suspended in air.
PCB	Polychlorinated biphenyl
PCDD/PCDF	Polychlorinated dibenzo-p-dioxins and dibenzofurans
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter smaller than 2.5 microns
TEQ	Toxic equivalent quotient
TEQs	Toxic Equivalents
TSP	Total Suspended Particulate
WPCP	Water Pollution Control Plant
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
Miscellaneous	
°C	Temperature in degrees Celsius
N/A	Not available
%	Percent
ppm	Part per million
ppb	Part per billion
ppbv	Parts per billion by volume
ppt	Part per trillion
min	Minimum
max	Maximum
mm	Millimetre
m	Metre
km/hr	Kilometre per hour
mg/m^3	Milligrams per cubic metre
$\mu g/m^3$	Microgram per cubic metre
ng/m^3	Nanograms per cubic metre
pg/m^3	Picograms per cubic metre
pg TEQ/m^3	Picograms toxic exposure equivalents per cubic metre

1.0 INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

The Regional Municipalities of Durham and York operate the Durham York Energy Centre (DYEC) which is an Energy-from-Waste (EFW) Facility intended to provide a long-term, sustainable solution to manage municipal solid waste remaining after diversion from the Regions. The facility commenced commercial operation on February 1, 2016. The site location of the DYEC is shown in **Figure 1-1**.

An Ambient Air Quality Monitoring Plan – Durham York Residual Waste Study (Ambient Monitoring Plan) was developed in 2011-2012 and included two monitoring stations referred to as the Courtice Water Pollution Control Plant (WPCP) Station and the Rundle Road Station (as well as a temporary Fence Line Station). The plan developed for these stations was based on the Regional Council's mandate to provide ambient air quality monitoring in the area of the DYEC for a three-year period.

The purposes of the ambient air quality monitoring program are to:

1. Quantify any measurable ground level concentrations resulting from emissions from the DYEC that may act cumulatively to influence local air quality, including validating the predicted concentrations from the dispersion modelling conducted in the Environmental Assessment (Jacques Whitford, 2009).
2. Monitor concentration levels of EFW-related air contaminants in nearby residential areas.
3. Quantify background ambient levels of air contaminants in the area.

At the request of the Regional Municipality of Durham (the Region), a third ambient air monitoring station located near the corner of Crago and Osborne Roads was installed in October/November 2014. This station, which is not part of the original Ambient Monitoring Plan, is operated following the same protocols as the other two stations (Courtice WPCP and Rundle Road Stations) already in operation.

The Crago Road Station is equipped to measure concentrations of several air contaminants either continuously or at scheduled intervals (non-continuously) as outlined below:

- Contaminants monitored continuously:
  - Sulphur Dioxide (SO_2);
  - Nitrogen Oxides (NO_X); and,
  - Particulate Matter smaller than 2.5 microns ($PM_{2.5}$).

- Contaminants monitored non-continuously:
  - Metals in Total Suspended Particulate (TSP) matter;
  - Polycyclic Aromatic Hydrocarbons (PAHs); and,
  - Dioxins and Furans.

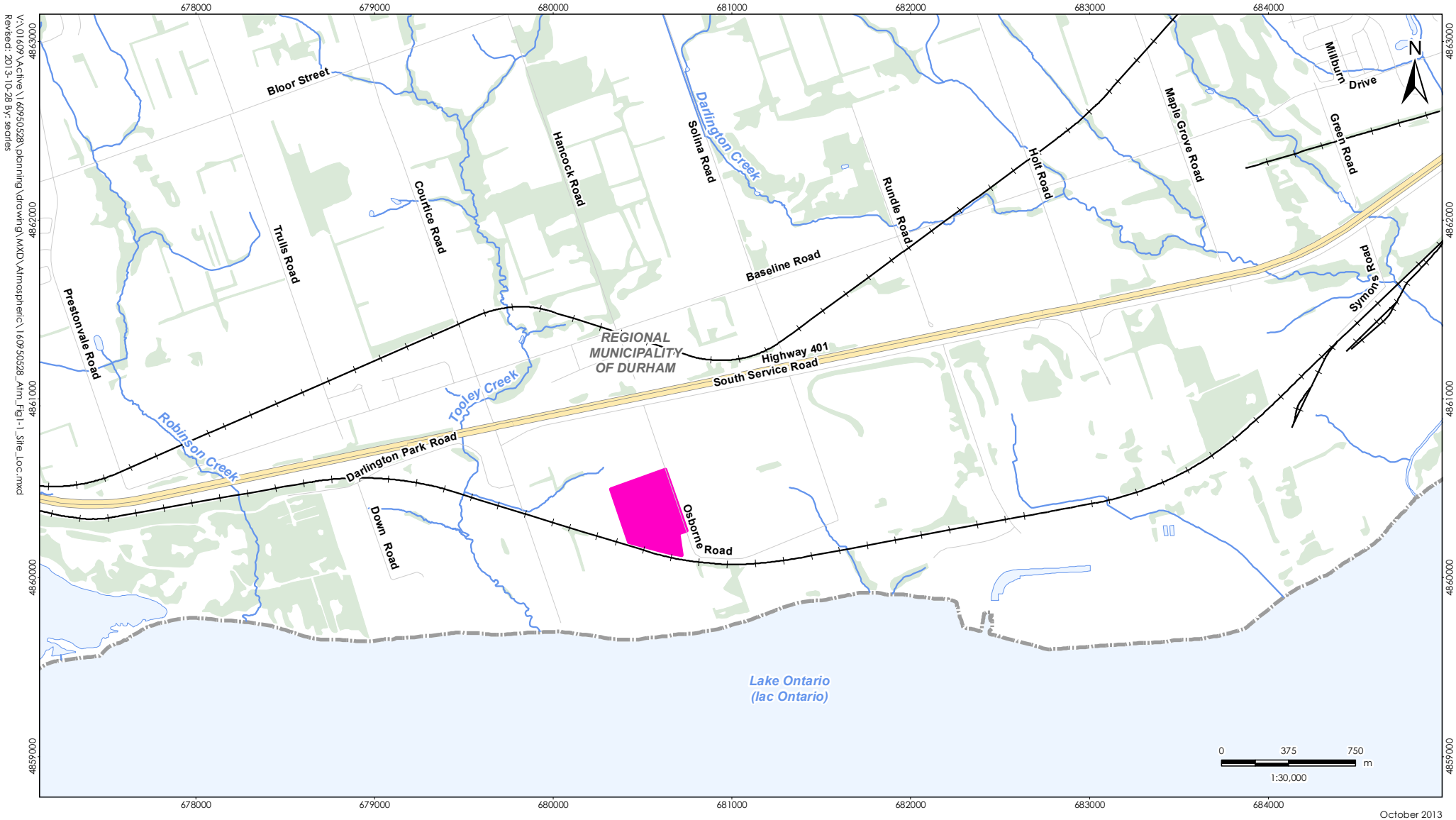
Quarterly reports presenting the ambient air quality data collected at this station for 2017 were prepared by Stantec and submitted to the Region. This Annual Report summarizes the results of the ambient air monitoring from January to December 2017.

At the request of the Region, dioxin and furan sampling that was outside the scope of the Ambient Monitoring Plan (Stantec, 2012) was conducted from July 18, 2017 to September 4, 2017. During this period the dioxin/furan sampling frequency was increased from once every 24 days to once every 12 days. The results of the additional sampling in 2017 have been included in the analysis provided in this report.

1.2 LOCATION OF THE AMBIENT AIR QUALITY MONITORING STATION

The selection of the site for the monitoring station was accomplished in consultation with Region representatives, with consideration of the location of the existing monitoring stations and general MOECC siting criteria. The final location of the monitoring station was influenced by the availability of electrical power, accessibility of each location, and security.

The Crago Road Station is sited east of the DYEC near the Darlington Hydro Upper and Lower Soccer Fields on the east side of Crago Road, north of Osborne Road. Its location is shown in **Figure 1-2** and **Figure 1-3**. The air contaminants listed in Section 1.1 and meteorological measurements are made at this monitoring station.



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October 2013
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Stantec

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.

Legend

- Durham York Energy Centre Site
- Railway
- Road
- Highway
- Watercourse
- Waterbody
- Wooded Area

Client/Project

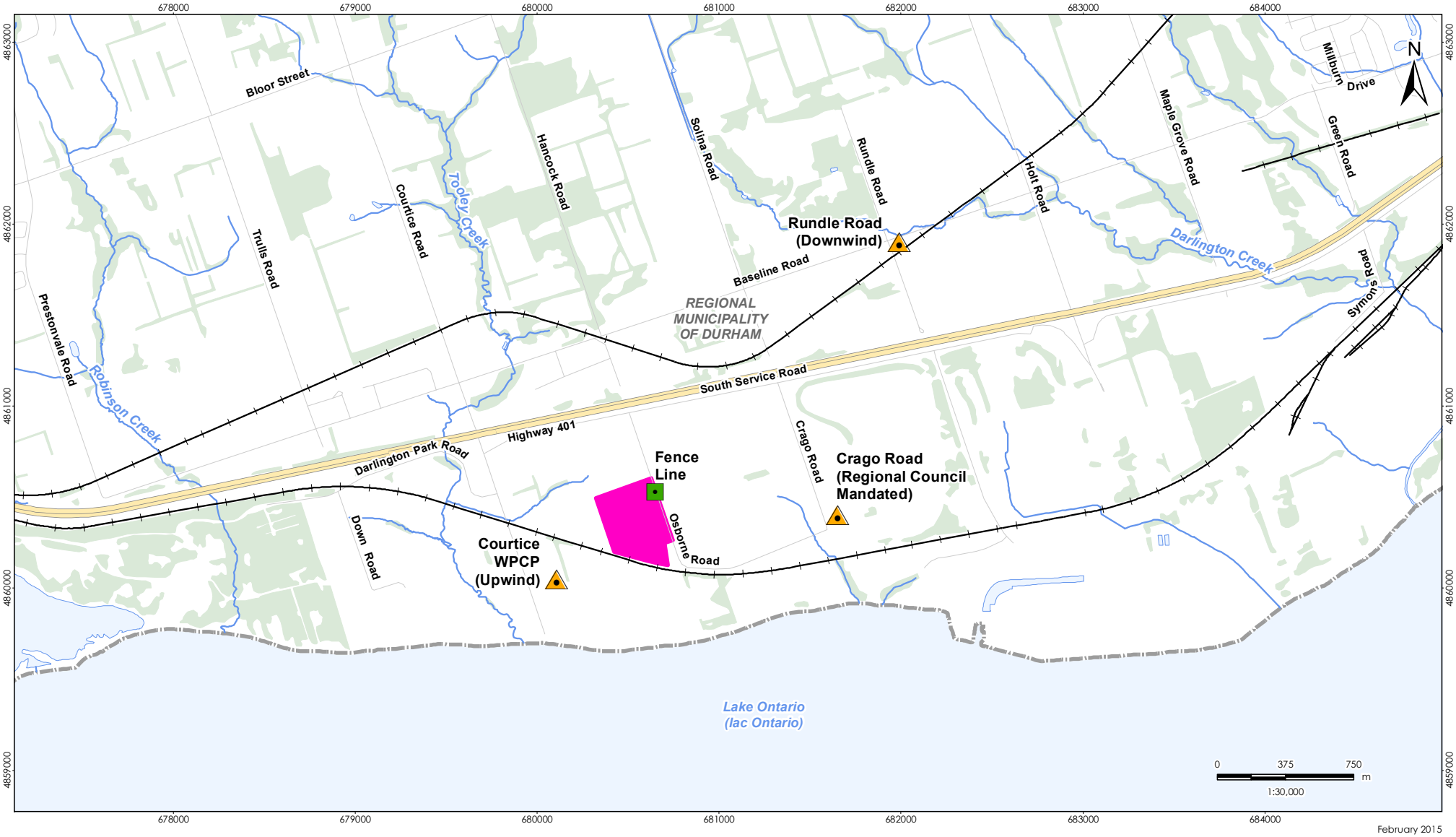
The Region of Durham
Durham York Energy Centre

Figure No.

1-1

Title

Site Location Plan



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Legend

- Station Location
- Fence Line Station Location (Monitoring to begin after DYEC commissioning period)
- Durham York Energy Centre Site
- Railway
- Road
- Highway
- Watercourse
- Waterbody
- Wooded Area

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.

Client/Project

The Region of Durham
Durham York Energy Centre

Figure No.

1-2

Title

Locations of Ambient Monitoring Stations

Figure 1-3 View of the Crago Road Ambient Air Quality Monitoring Station

2.0 KEY COMPONENTS ASSESSED

2.1 METEOROLOGY

The following meteorological variables are measured at the Crago Road monitoring station:

- Wind Speed and Direction at a height of 7.5 m;
- Ambient Temperature at a height of 2 m;
- Relative Humidity; and,
- Rainfall.

2.2 AIR QUALITY CONTAMINANTS OF CONCERN

The ambient air quality monitoring program for the Crago Road Station includes the following air contaminants specified in the Ambient Monitoring Plan (Stantec 2012):

- Continuously monitored criteria air contaminants (CACs)
  - Sulphur Dioxide (SO_2);
  - Nitrogen Oxides (NO_X); and,
  - Particulate Matter smaller than 2.5 microns ($PM_{2.5}$).

- Non-continuously monitored
  - Metals in Total Suspended Particulate (TSP) matter;
  - Polycyclic Aromatic Hydrocarbons (PAHs); and,
  - Dioxins and Furans.

Rationales for the choice of air contaminants being monitored are provided in the Ambient Monitoring Plan (Stantec, 2012).

2.2.1 Nitrogen Oxides (NO_X)

Nitrogen oxides (NO_X) are produced in most combustion processes, and are almost entirely made up of nitric oxide (NO) and nitrogen dioxide (NO_2). Together, they are often referred to as NO_X. NO_2 is an orange to reddish gas that is corrosive with an irritating odour. 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. NO is a colourless gas. The levels of NO and NO_2, and the ratio of the two gases, together with the presence of hydrocarbons and sunlight, are the most important factors in the formation of ground-level ozone (O_3). Further oxidation and mixing with water in the atmosphere forms what is known as "acid rain".

Nitrogen oxides are emitted from a variety of combustion sources including vehicles, industrial heaters and boilers, and residential gas-fired furnaces and hot water boilers. Generally, for combustion, 5 to 10% of the initial total emissions of NO_X are NO_2 with the remaining 90-95% being NO. The conversion of the majority of NO occurs after its release to the atmosphere. The rate of conversion depends on the oxidizing potential of the atmosphere at the time of release. For example, if the ambient concentration of O_3 is high at the time of release, the conversion might be expected to be higher than if the ambient concentration of O_3 was low at that time.

2.2.2 Sulphur Dioxide (SO_2)

Sulphur dioxide (SO_2) is a colourless gas with a distinctive pungent sulphur odour. It is produced in combustion processes by the oxidation of sulphur in the fuel. The presence of SO_2 can, at high enough concentrations, cause damage to vegetation and health effects to animals through their respiratory system. The SO_2 can also be further oxidized and combines with water to form the sulphuric acid component of "acid rain."

Sulphur dioxide is emitted mainly from industrial sources utilizing coal, coke or oil-fired heaters and boilers.

2.2.3 Particulate Matter

Total suspended particulate matter (TSP) is a measure of the particles in the atmosphere that are too small to settle out quickly, but remain suspended for significant periods of time. Generally, this means particles with an aerodynamic diameter of less than 44 µm. TSP is produced by a variety of emissions sources including wind erosion of agricultural fields and other open areas, abrasion of vehicle tires on paved and unpaved roads, agricultural activities, and combustion processes (e.g., industrial boilers and heaters, power generation, and vehicle emissions).

Although total suspended particulate matter is an excellent measure of the loading of particulate matter in the air, it does not necessarily reflect the health risks of the particulate matter. The larger aerodynamic particles (PM_{10}) are trapped by the upper airways, and do not enter the lungs. Smaller diameter particles ($PM_{2.5}$) can make their way deep into the lungs, and may become lodged there. Over the past few years, greater concern regarding these fine particles has led to research resulting in new sampling methods and criteria.

2.2.4 Metals

Metals may exist in elemental form or in a variety of inorganic or organic compounds. Most environmental regulators do not make distinctions between metal species, and refer to them as metals and their compounds. Both natural (biogenic) and man-made (anthropogenic) processes and sources may emit metals and their compounds into the air. The processing of minerals, fuel combustion, and the wearing out of motor vehicle tires and brake pads result in the emission of metals associated with particulate matter. Metals occur naturally in soil and rock

- weathering of the rocks, mining/construction activities, etc. can release metals into air as particulate matter.

The following is a list of the specific metals being measured. The rationales for the choice of air contaminants being monitored are provided in the Ambient Air Quality Monitoring Plan (Stantec, 2012).

Metals:

- Aluminum (Al)
- Antimony (Sb)
- Arsenic (As)
- Barium (Ba)
- Beryllium (Be)
- Bismuth (Bi)
- Boron (B)
- Cadmium (Cd)
- Cobalt (Co)
- Copper (Cu)
- Chromium (Cr) (Total)
- Iron (Fe)
- Lead (Pb)
- Magnesium (Mg)
- Manganese (Mn)
- Mercury (Hg)
- Molybdenum (Mo)
- Nickel (Ni)
- Phosphorus (Ph)
- Selenium (Se)
- Silver (Ag)
- Strontium (Sr)
- Thallium (Tl)
- Tin (Sn)
- Titanium (Ti)
- Uranium (U)
- Vanadium (V)
- Zinc (Zn)
- Zirconium (Zr)

2.2.5 Polycyclic Aromatic Hydrocarbons (PAH)

Polycyclic aromatic hydrocarbons (PAHs) are a large group of organic compounds with two or more fused aromatic rings. The PAHs are formed mainly as a result of pyrolytic processes, especially the incomplete combustion of organic materials during industrial and other human activities, such as processing of coal and crude oil, combustion of natural gas, vehicle traffic, cooking and tobacco smoking.

The following is a list of PAHs being measured for the ambient air monitoring program. Rationales for the choice of contaminants being monitored are provided in the Ambient Air Quality Monitoring Plan (Stantec, 2012).

Polycyclic Aromatic Hydrocarbons:

- 1-Methylnaphthalene
- 2-Methylnaphthalene
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene
- Benzo(a)fluorene
- Benzo(a)pyrene
- Benzo(b)fluorene
- Benzo(b)fluoranthene
- Benzo(e)pyrene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Biphenol
- Chrysene
- Dibenz(a,h)anthracene
- Dibenz(a,c)anthracene
- Fluoranthene
- Indeno(1,2,3-cd)pyrene
- Naphthalene
- Perylene
- Phenanthrene
- Pyrene
- Tetralin
- o-Terphenyl
- Total PAH

2.2.6 Dioxins and Furans

Dioxins and furans refer to a family of toxic substances that share a similar chemical structure. Dioxins and furans contain chlorine and can occur in different configurations, called congeners. Most dioxins and furans are not produced intentionally, but are created when other chemicals or products are manufactured. Of all the dioxins and furans, one cogener 2,3,7,8-tetrachloro-p-dibenzo-dioxin (2,3,7,8 Tetra CDD) is considered the most toxic. International toxicity equivalency factors (I-TEFs) are applied to 17 dioxin and furan isomers to convert them into an equivalent 2,3,7,8 Tetra CDD concentration (I-TEQ) for comparison to ambient air quality criteria.

Concentrations of the following dioxins and furans are measured:

Dioxins and Furans:

- 2,3,7,8-Tetra CDD
- 1,2,3,7,8-Penta CDD
- 1,2,3,4,7,8-Hexa CDD
- 1,2,3,6,7,8-Hexa CDD
- 1,2,3,7,8,9-Hexa CDD
- 1,2,3,4,6,7,8-Hepta CDD
- Octa CDD
- Total Tetra CDD
- Total Penta CDD
- Total Hexa CDD
- Total Hepta CDD
- 2,3,7,8-Tetra CDF
- 1,2,3,7,8-Penta CDF
- 2,3,4,7,8-Penta CDF
- 1,2,3,4,7,8-Hexa CDF
- 1,2,3,6,7,8-Hexa CDF
- 2,3,4,6,7,8-Hexa CDF
- 1,2,3,7,8,9-Hexa CDF
- 1,2,3,4,6,7,8-Hepta CDF
- 1,2,3,4,7,8,9-Hepta CDF
- Octa CDF
- Total Tetra CDF
- Total Penta CDF
- Total Hexa CDF
- Total Hepta CDF
- Total toxic equivalency (I-TEQ)

2.3 AIR QUALITY CRITERIA

Two sets of criteria were used for comparison to the air quality data as specified in the Ambient Monitoring Plan (Stantec, 2012); one based on regulatory limits, and the second developed in the human health risk assessment (HHRA) completed as part of the Environmental Assessment of the DYEC. The regulatory criteria include:

- Schedule 3 Standards of O. Reg. 419/05;
- Schedule 6 Upper Risk Thresholds (URT) of O. Reg. 419/05;
- Ontario Ambient Air Quality Criteria (AAQC); and,
- Canadian Ambient Air Quality Standard (CAAQS).

In December 2016, O. Reg. 419/05 Standards, Guidelines, and Jurisdictional Screening Levels were consolidated into a new format known as the "Air Contaminants Benchmarks List: Standards, Guidelines, and Screening Levels for Assessing Point of Impingement Concentrations of Air Contaminants" (MOECC, 2016) (ACB List).

Not all chemicals have regulatory criteria, or in some instances updated health-based criteria were used in the human health risk assessment (HHRA) conducted in support of the Environmental Assessment (July 31, 2009 - December 10, 2009). These health-based values, which were reported in Table 7-2 (Summary of Inhalation TRVs and Inhalation Benchmarks Selected for CACs) and Table 7-3 (Inhalation TRVs and Inhalation Benchmarks for Selected COPCs) of the HHRA (Stantec, 2009) were used as the second set of criteria.

The previously applicable 24-hour Canada-Wide Standard (CWS) for $PM_{2.5}$ of 30 µg/m^3 (98th percentile averaged over three consecutive years) has been superseded by the new Canadian Ambient Air Quality Standard (CAAQS) of 28 µg/m^3 (98th percentile averaged over three consecutive years) and an annual objective of 10 µg/m^3, as noted in **Table 2-1**. The proposed CAAQS 24-hour objective for 2020 is 27 µg/m^3.

Summaries of the relevant ambient air quality criteria are presented in **Table 2-1** to **Table 2-3**.

Table 2-1 Summary of Air Quality Criteria for CACs

Contaminant	CAS	MOECC Criteria			HHRA Health-Based Criteria		
		1-Hour (ppb / µg/m^3)	24-Hour (ppb / µg/m^3)	Annual (µg/m^3)	1-Hour (µg/m^3)	1-Hour (ppb / µg/m^3)	24-Hour (ppb / µg/m^3)
Sulphur dioxide	7446095	250 /690	100 / 275	-	690	250 /690	100 / 275
Nitrogen dioxide	10102-44-0	200 /400	100 / 200	-	100	200 /400	100 / 200
Contaminant	**CAS**	**Canadian Ambient Air Quality Standards (CAAQS)**			**HHRA Health-Based Criteria**		
		1-Hour (µg/m^3)	24-Hour (µg/m^3)	Annual (µg/m^3)	1-Hour (µg/m^3)	1-Hour (µg/m^3)	24-Hour (µg/m^3)
$PM_{2.5}$	N/A	-	28 [A]	10 [B]	N/A	-	28 [C]

Notes:

A. Canadian Ambient Air Quality Standards (CAAQS) for Respirable Particulate Matter and Ozone, effective by 2015 (CCME, 2012). The Respirable Particulate Matter Objective is referenced to the 98th percentile daily average concentration averaged over 3 consecutive years.
B. Annual Canadian Ambient Air Quality Standard for Respirable Particulate Matter, effective by 2015. The Respirable Particulate Matter Objective is referenced to the 3-year average of the annual average concentrations.
C. HHRA Health-Based criterion for $PM_{2.5}$ was selected referencing CCME (2006).

Table 2-2 Summary of Air Quality Criteria for Metals

Contaminant	CAS	Regulatory Criteria			HHRA Health-Based Criteria		
		1-Hour (µg/m³)	24-Hour (µg/m³)	Other time Period (µg/m³)	1-Hour (µg/m³)	24-Hour (µg/m³)	Annual (µg/m³)
Total Particulate	NA	-	120	-	-	120	60
Aluminum	7429-90-5	-	4.8	-	-	-	-
Antimony	7440-36-0	-	25	-	5	25	0.2
Arsenic	7440-38-2	-	0.3	-	0.2	0.3	0.015 [A] 0.0043 [B]
Barium	7440-39-3	-	10	-	5	10	1
Beryllium	7440-41-7	-	0.01	-	0.02	0.01	0.007 [A] 0.0024 [B]
Bismuth	7440-69-9	-					
Boron	7440-42-8	-	120	-	50	-	5
Cadmium	7440-43-9	-	0.025	0.005; annual	0.1	0.025	0.005 [A] 0.0098 [B]
Chromium (Total)	7440-47-3	-	0.5	-	1	-	60
Cobalt	7440-48-4	-	0.1	-	0.2	0.1	0.1
Copper	8440-50-8	-	50	-	-	-	-
Iron	15438-31-0	-	4	-	-	-	-
Lead	7439-92-1	-	0.5	0.2; 30-day	1.5	0.5	0.5
Magnesium	7439-95-4	-					
Manganese	7439-96-5	-	0.4	-	-	-	-
Mercury	7439-97-6	-	2	-	0.6	2	0.3
Molybdenum	7439-87-7	-	120	-	-	-	-
Nickel	7440-02-0	-	0.2	0.04; annual	6	-	0.05
Phosphorus	7723-14-0	-	-	-	-	-	6.4×10^7
Selenium	7782-49-2	-	10	-	2	10	0.2
Silver	7440-22-4	-	1	-	0.1	1	0.01
Strontium	7440-24-6	-	120	-	-	-	-
Thallium	7440-28-0	-	-	-	1		0.1
Tin	7440-31-5	-	10	-	20	10	2
Titanium	7440-32-6	-	120	-	-	-	-

Table 2-2 Summary of Air Quality Criteria for Metals

Contaminant	CAS	Regulatory Criteria			HHRA Health-Based Criteria		
		1-Hour (µg/m³)	24-Hour (µg/m³)	Other time Period (µg/m³)	1-Hour (µg/m³)	24-Hour (µg/m³)	Annual (µg/m³)
Vanadium	7440-62-2	-	2	-	0.5	1	1
Uranium	7440-61-1	-	1.5	0.03; annual	-	-	-
Zinc	7440-66-6	-	120	-	50		5
Zirconium	7440-67-7	-	20	-	-	-	-

Notes:

A. Annual Average
B. Carcinogenic Annual Average

Table 2-3 Summary of Air Quality Criteria for PAHs and D/Fs

Contaminant	CAS	Regulatory Criteria			HHRA Health-Based Criteria			
		1-Hour (ng/m³)	24-Hour (ng/m³)	Other time Period (ng/m³)	1-Hour (ng/m³)	24-Hour (ng/m³)	Annual (ng/m³)	Toxic Equivalency Factor Annual [A, G] (ng/m³)⁻¹
1-Methylnaphthalene	90-12-0	-	12,000	-	-	-	3,000	-
2-Methylnaphthalene	91-57-6	-	10,000	-	-	-	3,000	-
Acenaphthene	83-32-9	-	-	-	1,000	-	-	1
Acenaphthylene	208-96-8	-	3,500	-	1,000	-	-	10
Anthracene	120-12-7	-	200	-	500	-	50	-
Benzo(a)anthracene	56-55-3	-	-	-	500	-	-	100
Benzo(b)fluoranthene	205-99-2	-	-	-	500	-	-	100
Benzo(k)fluoranthene	207 -08-9	-	-	-	500	-	-	100
Benzo(a)fluorene	238-84-6	-	-	-	500	-	50	-
Benzo(b)fluorene	243-17-4	-	-	-	500	-	50	-
Benzo (g,h,i) perylene	191-24-2	-	-	-	500	-	-	100
Benzo(a)pyrene	50-32-8	-	0.05 [B] 5 [C] 1.1 [D]	0.01; annual	-	1	87 [A]	-
Benzo(e)pyrene	192-97-2	-	-	-	500	-	-	10
Biphenyl	92-52-4	-	-	-	-	-	224,000	-
Chrysene	218-01-9	-						-
Dibenzo(a,c)anthracene	215-58-7	-	-	-	-	-	-	100

Table 2-3 Summary of Air Quality Criteria for PAHs and D/Fs

Contaminant	CAS	Regulatory Criteria			HHRA Health-Based Criteria			
		1-Hour (ng/m^3)	24-Hour (ng/m^3)	Other time Period (ng/m^3)	1-Hour (ng/m^3)	24-Hour (ng/m^3)	Annual (ng/m^3)	Toxic Equivalency Factor Annual [A, G] $(ng/m^3)^{-1}$
Dibenzo(a,h)anthracene	53-70-3	-	-	-	500	-	-	1,000
Fluoranthene	206-44-0	-	-	-	500	-	-	1
Indeno(1,2,3-cd)pyrene	193-39-5	-	-	-	500	-	-	100
Naphthalene	91-20-3	-	22,500	-	-	22,500	3,000	-
o-Terphenyl	84-15-1	-	-	-	50,000	-	5,000	-
Perylene	198-55-0	-	-	-	500	-	-	1
Phenanthrene	85-01-8	-	-	-	500	-	-	1
Pyrene	129-00-0	-	-	-	500	-	-	1
Tetralin	119-64-2	-						-
Dioxins and Furans Total Toxic Equivalency [E]	NA	-	0.1 (pg TEQ/m^3) [F] 1 (pg TEQ/m^3) [C]	-	-	-	-	-

Notes:

A. Carcinogenic Annual Average. Units in $(ng/m^3)^{-1}$.

B. Ontario Ambient Air Quality Criteria - The criteria for benzo(a)pyrene (B(a)P) is for B(a)P as a surrogate for PAHs.

C. O. Reg. 419/05 Schedule 6 Upper Risk Thresholds.

D. O. Reg. 419/05 24 Hour Guideline.

E. Application of the air standard for dioxins, furans, and dioxin-like PCBs requires the calculation of the total toxicity equivalent (TEQ) concentration contributed by all dioxin-like compounds in the mixture. TEQ is calculated using the methodology as per the current December 2016 version of the ACB List and the corresponding WHO2005 toxic equivalency factors (I-TEFs).

F. O. Reg. 419/05 Schedule 3 Standard phased in after July 1, 2016.

G. Toxic Equivalency Factors (TEFs) are shown as benzo(a)pyrene equivalents.

3.0 INSTRUMENTATION AND OPERATIONS SUMMARY

3.1 INSTRUMENTATION

The measurement program at the monitoring site includes both continuous and non-continuous monitors to sample and measure air contaminant concentrations. Monitoring for respirable particulate matter ($PM_{2.5}$), nitrogen oxides (NO_X) and sulphur dioxide (SO_2) are conducted on a continuous basis. A summary of the continuous monitors and a brief description of their principle of operation are provided in **Table 3-1** below.

Table 3-1 Summary of Continuous Ambient Air Quality Monitors

Contaminant	Monitor	Principle of Operation	Range	Time Interval
$PM_{2.5}$	Thermo Sharp 5030 Synchronized Hybrid Ambient Real-time Particulate Monitor	Light Scattering Photometry / Beta Attenuation - Consists of a carbon14 source, detector, and light scattering Nephelometer in a rack-mountable enclosure. The Thermo Sharp utilizes a continuous (non-step wise) hybrid mass measurement and a combination of beta attenuation and light scattering technology. The unit's filter tape is automatically advanced based upon a user defined frequency or particulate loading.	0 - 10 mg/m^3	1 minute
NO, NO_2, NO_X	Teledyne API Model 200E Chemiluminescence Analyzer	Chemiluminescence - Uses a chemiluminescence detection principle and microprocessor technology for ambient continuous emissions monitoring (CEM). Measurements are automatically compensated for temperature and pressure changes.	0 – 1000 ppb	1 second
SO_2	Teledyne API Model T100	Pulsed Florescence - SO_2 levels are measured based on the principle that SO_2 has a strong ultraviolet (UV) absorption at a wavelength between 200 and 240 nanometres (nm). The absorption of photons at these wavelengths results in the emission of fluorescence photons at a higher wavelength. The amount of fluorescence measured is directly proportional to the concentration of SO_2.	0 – 1000 ppb	1 second

Two manually operated, hi-volume air samplers are installed at the Crago Road Station to collect metals in total suspended particulate (TSP), polycyclic aromatic hydrocarbons (PAHs), and dioxins and furans. Sampling for these contaminants is conducted following the methodology and analyses described in the Ambient Monitoring Plan (Stantec, 2012), as presented in **Table 3-2**. The samples were submitted to Maxxam Analytics Inc., a Canadian Association for Laboratory Accreditation Inc. (CALA) / Standards Council of Canada (SCC) accredited laboratory, for analysis.

Table 3-2 Summary of Non-Continuous Ambient Air Quality Monitors

Contaminant	Sampler	Filter Media	Lab Analysis	Sampling Schedule
TSP and metals	Tisch Environmental TE-5170 mass-flow high volume sampler	Pre-weighed, conditioned Teflon coated glass fibre filters	Weighed for particulate loading and analysed using the Atomic Emission Spectroscopy / Inductively Coupled Plasma (AES/ICP) technique to determine metals content	24-hour sample taken every 6 days
PAHs	Tisch Environmental TE-1000 mass-flow high volume air sampler	Dual chambered sampling module with a Teflon-coated glass fibre filter and a Poly-Urethane Foam (PUF) cartridge	Gas Chromatography / Mass Spectrometry (GC/MS)	24-hour sample taken every 12 days
Dioxins and Furans				24-hour sample taken every 24 days. At the request of the Region this frequency was increased to once every 12 days from July 18 to September 4, 2017

Horizontal wind speed, wind direction, atmospheric temperature, relative humidity, and rainfall are measured at the predominantly downwind Crago Road Station. The meteorological sensors at the Crago Road Station are mounted on an external 7.5 m aluminum tower. The meteorological equipment at the Crago Road Station is summarized in **Table 3-3**.

Table 3-3 Summary of Meteorological Equipment

Parameter	Equipment
Wind Speed/Wind Direction	Met One Instruments Inc. Model 034B
Temperature / Relative Humidity	Campbell Scientific Model HMP 60
Rainfall	Texas Electronic TE525M

A Campbell Scientific CRX1000 station data acquisition system (DAS) is used to collect continuous instrument monitoring data and status codes from the ambient air quality monitors. Continuous station data are maintained in the data logger, and data is viewed locally using a laptop and the relevant DAS software applications. Remote data transmission is accomplished by the periodic transmission of collected station air quality data via cellular phone.

3.2 MONITORING STATION VISITS AND REGULAR MAINTENANCE ACTIVITIES

Visits to the monitoring stations were conducted by employees from Stantec, Valley Environmental Services (Valley Environmental) or Rotek Environmental Inc. (Rotek) for routine maintenance, setup of the non-continuous monitoring runs, and on an as-needed basis to verify the correct operation of the monitoring equipment as prescribed by the Ambient Monitoring Plan (Stantec, 2012). Rotek was retained by Stantec to replace Valley Environmental for maintenance and calibration of the monitoring stations in July 2017.

During the station visits, the integrity and proper operation of the monitoring equipment and the data acquisition systems were checked and verified. These checks were done to ensure the collection of valid and complete data, and to confirm the continued safe and secure environment at the station. Station visits in 2017 were documented in the site logbook, and visual checks of the equipment were documented during each site visit in an Ambient Pod Checklist. A list of the regular and major preventative maintenance activities performed by Stantec, Valley Environmental and/or Rotek during the station visits in 2017 is presented in **Table A-1** in **Appendix A**.

Daily diagnostic tests were performed remotely on the continuous monitoring equipment and station parameters to check for anomalous data and assess whether the equipment was functioning normally. Any issues identified were immediately assessed and rectified as soon as possible. If required, Valley Environmental or Rotek was notified to dispatch a trained technician to address the issue.

3.3 DATA ACQUISITION/ARCHIVING

Data from the continuous monitors at the station is maintained in the data logger. This data is viewed and collected via the automated data acquisition system and cell phone modem. The data review and storage schedule were as follows:

- On a daily basis during weekdays, the data logger was remotely accessed and the current data was reviewed to check the operational status of each monitor and for anomalous data;
- Data was downloaded and backed-up once a week (to a separate file location) to avoid any file overwriting or data loss; and,
- The full set of collected data was reviewed including manual verification of values, invalidating false / suspicious / calibration data where applicable. The protocols used to invalidate continuous data followed those provided in Table 5 of the MOECC Operations Manual (MOECC, 2008).

Details of the data editing are presented in the quarterly reports (Stantec, 2017a; Stantec, 2017b; Stantec, 2017c; Stantec, 2018).

3.4 INSTRUMENTATION CALIBRATION

Continuous Monitors

On-going performance checks and external calibrations of the continuous monitors were performed monthly. This meets the recommended calibration schedule listed in the MOECC Operations Manual (MOECC, 2008). The external calibrations for the NO_X and SO_2 monitors involved challenging each monitor with certified calibration gases (each referenced to a primary standard) for zero and span measurements.

Non-Continuous Monitors

The high volume air samplers were calibrated at a minimum monthly (or after any motor maintenance) during their sampling period in 2017. The calibration frequency exceeded the MOECC Operations Manual (MOECC, 2008) requirement of quarterly calibrations.

A summary of the calibration tasks that are required and have been performed for each sampler are provided in **Table A-2** in **Appendix A**.

3.5 ONTARIO MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE MONITOR PERFORMANCE AND SITE AUDIT

The Crago Road Station is not part of the ambient monitoring network required by MOECC as described in the Ambient Monitoring Plan (Stantec, 2012). Therefore, the MOECC does not conduct performance or site audits of the equipment.

3.6 INSTRUMENTATION ISSUES

A small number of instrumentation issues were encountered during 2017. These included issues with the internal power cable (repaired under manufacturer warranty), perm tube performance, and a Sharp monitor inlet malfunction. A summary of operational issues and the resolution for each measurement parameter during the 2017 monitoring period is presented in **Table A-3** in **Appendix A**.

3.7 DATA RECOVERY RATES

Data recovery rates for each continuous monitor at the station during the 2017 sampling period (January to December 2017) are presented in **Table 3-4**. The data recovery rates for the measured air contaminants met or exceeded MOECC requirements of 75% for data validity on an annual basis (MOECC, 2008).

Table 3-4 Summary of Data Recovery Rates for the Crago Road Station (Downwind) – 2017 Monitoring Period

Parameter	Valid Measurement Hours	Data Recovery Rate (%)
SO_2	8728	99.6% [A]
NO_X	8713	99.5% [A]
$PM_{2.5}$	8674	99.0% [A]
Temperature	8760	100% [A]
Rainfall	8760	100% [A]
Relative Humidity	8760	100% [A]
Wind Speed/Direction	8760	100% [A]
TSP/Metals	61 [B]	100%
PAHs	30 [B]	100%
Dioxins and Furans	16 [B,C]	100%

Notes:

A. Includes instrumentation issues summarized in Appendix Table A3 and monthly calibrations.
B. Number of filters/24-hour average samples.
C. Includes additional dioxins and furans sampling requested by the Regional Municipality of Durham.

3.8 FIELD CONDITION OBSERVATIONS

During 2017, activities near the Crago Road Station were observed that had the potential to affect ambient air quality. These observations were noted by Stantec, Valley Environmental and Rotek personnel during field visits and by Regional Municipality of Durham personnel located at the DYEC.

Construction of Highway 418, which will connect with Highway 401 between Courtice and Crago Roads has been ongoing since April 2016. Highway 418 will provide a north-south link between Highway 401 and the Phase 2 expansion of Highway 407. The Highway 401/418 interchange will be located almost directly north of the DYEC.

Throughout Q1 2017, hydro crews were observed working in a large area immediately north of the DYEC between Energy Drive and Highway 401 for the relocation/re-alignment of South Service Road. Excavator and dump truck crews were observed working in a large area immediately north of the DYEC between Energy Drive and Highway 401 for the relocation/ re-alignment of South Service Road from April to June as shown in **Figure 3-1**. The new road, called Megawatt Drive, was opened in August 2017 and is located immediately south of the previous South Service Road. Megawatt Drive runs between Courtice Road and Crago Road where it becomes Energy Drive West and connects to Holt Road. Construction activity in Q4 was dominated by excavator/dump truck crews working in a large area immediately north of the DYEC between Megawatt Drive and Highway 401. Major work observed included earthworks and Highway 401 overpass construction for on/off ramps connecting to Highway 418. Photographs of soil berms/ramps and overpass construction activities is provided in **Figure 3-2**.

Figure 3-1 Looking South from Existing South Service Road at South Service Road Realignment Construction (June 1, 2017)

Figure 3-2 Looking North from Megawatt Drive at the Highway 401 and Highway 418 Construction (November 28, 2017)

4.0 SUMMARY OF AMBIENT MEASUREMENTS

The following sections provide summaries of the validated data for each measured parameter.

4.1 METEOROLOGICAL DATA

A summary of the maximum, minimum, arithmetic mean, and standard deviation of the hourly average meteorological parameters measured at the monitoring station for January - December 2017 is presented in **Table 4-1**.

Table 4-1 Summary of Hourly Meteorological Measurements – 2017 Monitoring Period

Parameter [A]		Crago Road Station (Downwind)	Units
Temperature	Maximum	28.8	C
	Minimum	-24.3	C
	Mean	7.7	C
	Standard Deviation	9.8	C
Rainfall	Maximum	14.8	mm
	Minimum	0.0	mm
	Mean	0.10	mm
	Standard Deviation	0.58	mm
Relative Humidity	Maximum	98.3	%
	Minimum	24.9	%
	Mean	74.4	%
	Standard Deviation	14.8	%
Wind Speed [B]	Maximum	51.4	km/hr
	Minimum	0.0	km/hr
	Mean	11.9	km/hr
	Standard Deviation	7.6	km/hr

Notes:

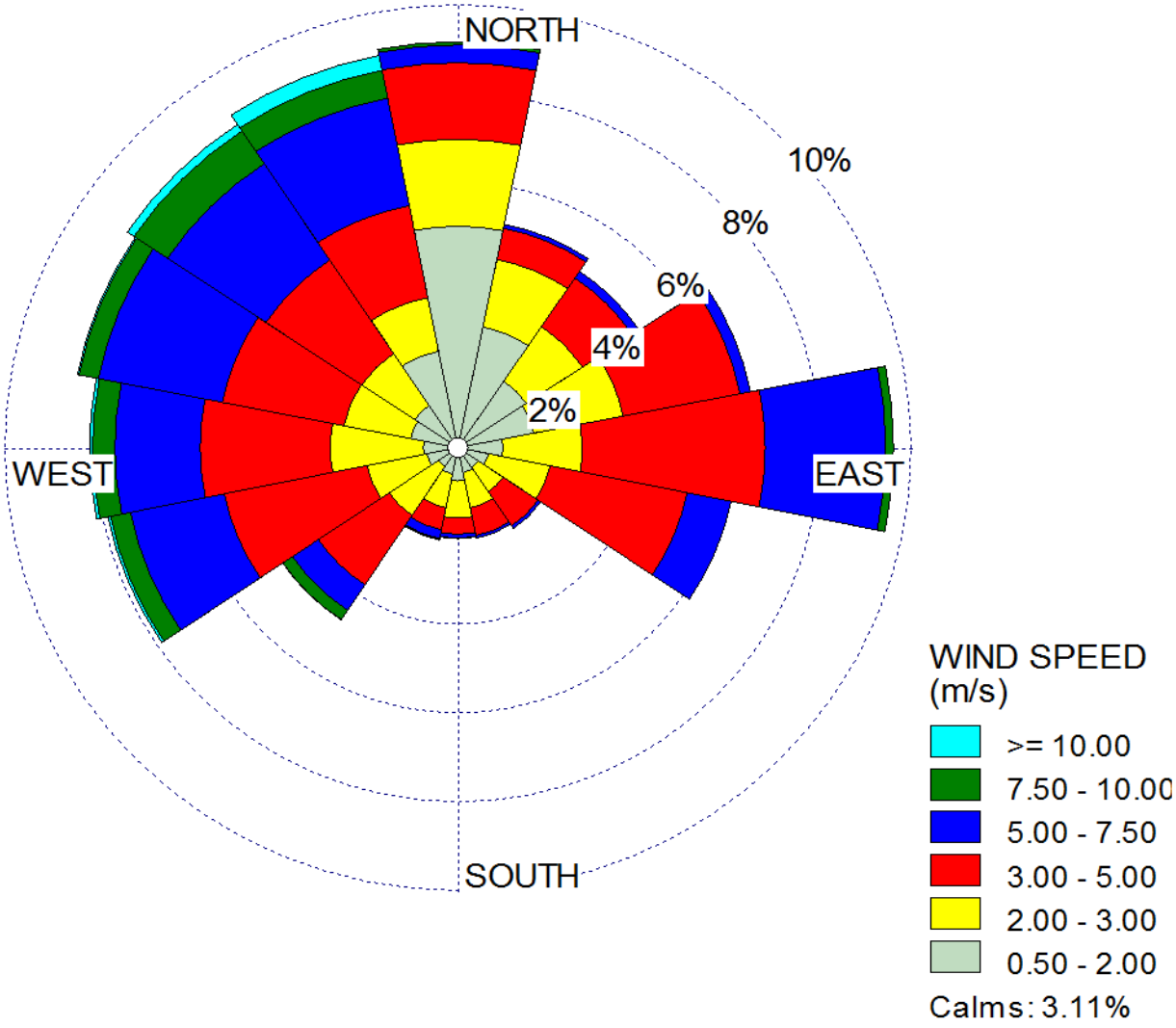
A. Pressure is not measured at the Crago Road Station.

B. Wind speed at the Crago Road Station is measured at a height of 7.5 m.

A wind rose showing the directionality and speed for 2017 at this location is presented in **Figure 4-1.** The length of the radial barbs gives the total percent frequency of winds blowing from the indicated direction, while portions of the barbs of different widths indicate the frequency associated with each wind speed category.

In 2017, winds at the Crago Road Station occurred predominantly from northerly to westerly directions, with some winds from easterly directions. Winds blew infrequently from the south.

Figure 4-1 Wind Rose for the 2017 Monitoring Period



4.2 CAC AMBIENT AIR QUALITY MEASUREMENTS

A summary of the maximum, minimum, arithmetic mean, and standard deviation of the Criteria Air Contaminants (CAC) pollutant concentrations measured at the station are presented in **Table 4-2**. Also presented in **Table 4-2** is the number of exceedances (if any) of the relevant Ontario Ambient Air Quality Criteria (AAQC) or health-based criteria for each contaminant.

The measured concentrations of the air contaminants monitored were all below their applicable hourly, 24-hour, and annual average criteria during 2017.

The concentration of Nitric oxide (NO) and Nitrogen oxides (NO_x) have no regulatory criteria as discussed in Section 4.2.2 below.

A comparison of the maximum measured data to their respective air quality criteria is presented graphically in **Figure 4-2.**

Table 4-2 Summary of Ambient CAC Monitoring Data - 2017 Monitoring Period

Pollutant	Averaging Period	Regulatory and HHRA Health-Based Criteria			Crago Road Station (Downwind)	
		ppb	µg/m³		Concentration (ppb)	Concentration (µg/m³)
SO_2	1	250	690	Maximum	66.1	182.1
				Minimum	0.0	0.0
				Mean	0.6	1.8
				Standard Deviation	1.8	5.1
				# of Exceedances	0	0
	24	100	275	Maximum	14.9	40.6
				Minimum	0.0	0.0
				Mean	0.6	1.8
				Standard Deviation	1.0	2.9
				# of Exceedances	0	0
	Annual	20 / 11 [A]	55 / 29 [A]	Mean (Period)	0.6	1.8
				# of Exceedances	0	0
$PM_{2.5}$	24	N/A	28 [B, G]	Maximum	-	30.4
				Minimum	-	0.0
				Mean	-	5.7
				98th Percentile [C]	-	15.1
				Standard Deviation	-	4.0
				# of Exceedances	-	N/A
	Annual	N/A	10 [D, H]	Mean (Period)	-	5.6
				# of Exceedances	-	N/A

Table 4-2 Summary of Ambient CAC Monitoring Data - 2017 Monitoring Period

Pollutant	Averaging Period	Regulatory and HHRA Health-Based Criteria			Crago Road Station (Downwind)	
		ppb	µg/m³		Concentration (ppb)	Concentration (µg/m³)
NO_2	1	200 [E]	400 [E]	Maximum	62.6	138.9
				Minimum	0.0	0.0
				Mean	5.2	10.4
				Standard Deviation	5.6	11.4
				# of Exceedances	0	0
	24	100 [E]	200 [E]	Maximum	27.9	59.2
				Minimum	0.0	0.0
				Mean	5.2	10.3
				Standard Deviation	3.7	7.5
				# of Exceedances	0	0
	Annual	30	60	Mean	5.2	10.4
				# of Exceedances	0	0
NO [F]	1	N/A	N/A	Maximum	57.4	77.3
				Minimum	0.0	0.0
				Mean	1.8	2.3
				Standard Deviation	4.0	5.3
				# of Exceedances	N/A	N/A
	24	N/A	N/A	Maximum	21.7	29.1
				Minimum	0.0	0.0
				Mean	1.8	2.3
				Standard Deviation	2.2	2.8
				# of Exceedances	N/A	N/A

Table 4-2 Summary of Ambient CAC Monitoring Data - 2017 Monitoring Period

Pollutant	Averaging Period	Regulatory and HHRA Health-Based Criteria			Crago Road Station (Downwind)	
		ppb	µg/m³		Concentration (ppb)	Concentration (µg/m³)
NO_X [F]	1	N/A	N/A	Maximum	77.9	158.6
				Minimum	0.0	0.0
				Mean	6.8	13.5
				Standard Deviation	8.5	17.2
				# of Exceedances	N/A	N/A
	24	N/A	N/A	Maximum	38.8	82.2
				Minimum	0.0	0.0
				Mean	6.8	13.5
				Standard Deviation	5.3	10.7
				# of Exceedances	0	0
	Annual	N/A	N/A	Mean	6.8	13.5
				# of Exceedances	N/A	N/A

Notes:

A. Annual AAQC / Annual HHRA.

B. Canadian Ambient Air Quality Standard for Respirable Particulate Matter, effective by 2015. The Respirable Particulate Matter Objective is referenced to the 98th percentile over three consecutive years.

C. The 98th percentile of the daily average $PM_{2.5}$ measurements in the period.

D. Annual Canadian Ambient Air Quality Standard for Respirable Particulate Matter, effective by 2015. The Respirable Particulate Matter Objective is referenced to a three-year average of the annual average concentrations.

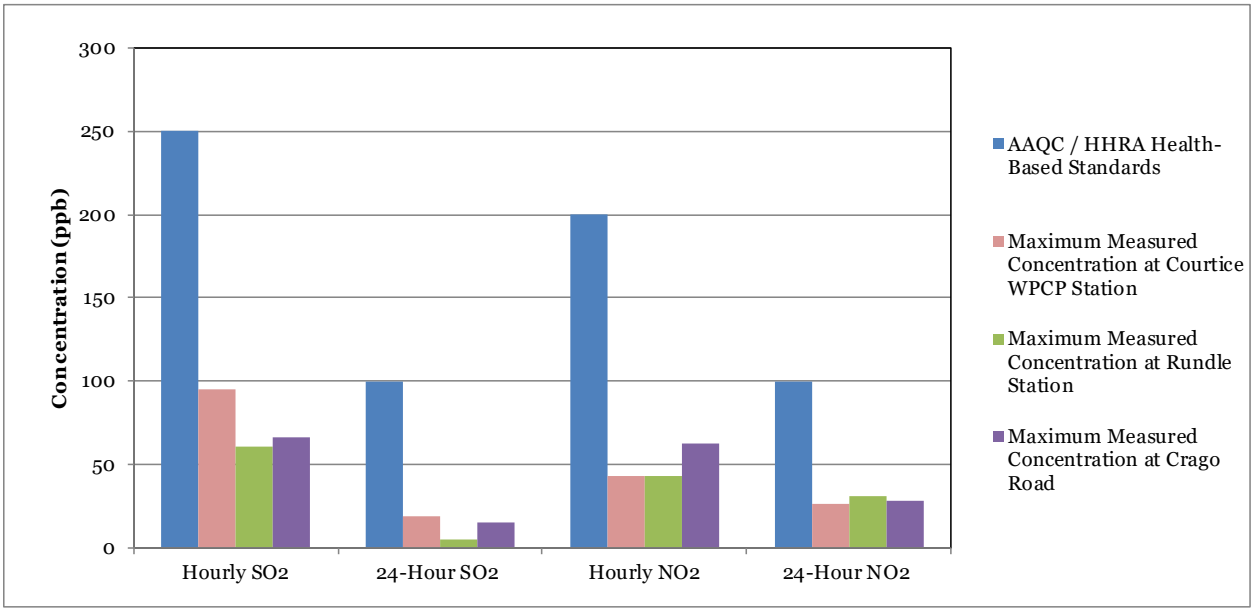
E. As per the current December 2016 version of the ACB List, the air Standard for NO_X is compared to a monitored NO_X concentration, although the Reg. 419/05 Schedule 3 Standard for NO_X is based on health effects of NO_2.

F. NO and NO_x has no regulatory criteria.

G. Daily $PM_{2.5}$ concentrations were not compared to the Canadian Ambient Air Quality Standard shown in this table, which requires averaging the 98th percentile concentrations over three consecutive years, as compared to the 12-month period covered by this report.

H. Annual $PM_{2.5}$ concentrations were not compared to the Canadian Ambient Air Quality Standard shown in this table, which requires a three-year average of the annual average concentrations over three consecutive years, as compared to the 12-month period covered by this report.

Figure 4-2 Comparison of NO_2 and SO_2 Ambient Monitoring Data to Applicable Criteria – 2017 Monitoring Period



Maximum measured hourly concentrations at the monitoring station in each quarter of 2017 along with other available local and regional air quality data, wind directionality, and potential emissions sources are presented in **Table 4-3**.

Additional details on the results for each measured contaminant are presented in the following sections.

Table 4-3 Maximum Measured Concentrations by Quarter in 2017 – Crago Road Station

Pollutant	Averaging Period (hr)		Quarter 1	Quarter 2	Quarter 3	Quarter 4
SO_2	1	Maximum Concentration (ppb)	35.1	66.1	9.3	59.0
		Wind Direction	East	East	West	North
		Courtice WPCP / Rundle Road Station Concentrations During Same Period (ppb)	39.4 / 0.39	56.4 / 0.8	0.4 / 0.3	1.1 / 0.2
		Potential Emission Sources	St. Mary's Cement, CN Railroad, Darlington Nuclear Generating Station	St. Mary's Cement, CN Railroad, Darlington Nuclear Generating Station	DYEC and agricultural activities	Highway 401, agricultural activities, and Highway 418 construction
NO_2	1	Concentration (ppb)	30.2	36.2	38.6	62.6
		Wind Direction	North	North	North	North
		Courtice WPCP / Rundle Road Station Concentrations During Same Period (ppb)	38.6 / 10.4	33.9 / 6.8	31.3 / 8.8	18.8 / 16.9
		Oshawa MOECC Station Concentration During Same Period (ppb)	21	18	20	13
		Potential Emission Sources	Highway 401, agricultural activities, and Highway 418 construction	Highway 401, agricultural activities, and Highway 418 construction	Highway 401, agricultural activities, and Highway 418 construction	Highway 401, agricultural activities, and Highway 418 construction

Table 4-3 Maximum Measured Concentrations by Quarter in 2017 – Crago Road Station

Pollutant	Averaging Period (hr)		Quarter 1	Quarter 2	Quarter 3	Quarter 4
NOx	1	Concentration (ppb)	68.4	61.0	61.5	77.9
		Wind Direction	North	East	North	North
		Courtice WPCP / Rundle Road Station Concentrations During Same Period (ppb)	104.0 / 39.1	49.1 / 5.0	66.3 / 27.5	108.9 / 39.3
		Potential Emission Sources	Highway 401, agricultural activities, and Highway 418 construction	St. Mary's Cement, CN Railroad, Ontario Hydro	Highway 401, agricultural activities, and Highway 418 construction	Highway 401, agricultural activities, and Highway 418 construction
$PM_{2.5}$	24	Concentration (µg/m^3)	30.4	19.0	21.3	15.6
		Wind Direction	Northwest	West	Northwest	Northwest
		Courtice WPCP / Rundle Road Station Concentrations During Same Period (µg/m^3)	27.4 / 30.8	11.8 / 7.9	20.8 / 16.4	17.6 / 24.7
		Oshawa MOECC Station Concentration During Same Period (µg/m^3)	23.8	11.6	15.0	21.7
		Potential Emission Sources	Highway 401, agricultural activities, and Highway 418 construction	DYEC and agricultural activities	Highway 401, agricultural activities, and Highway 418 construction	Highway 401, agricultural activities, and Highway 418 construction

4.2.1 Sulphur Dioxide (SO_2)

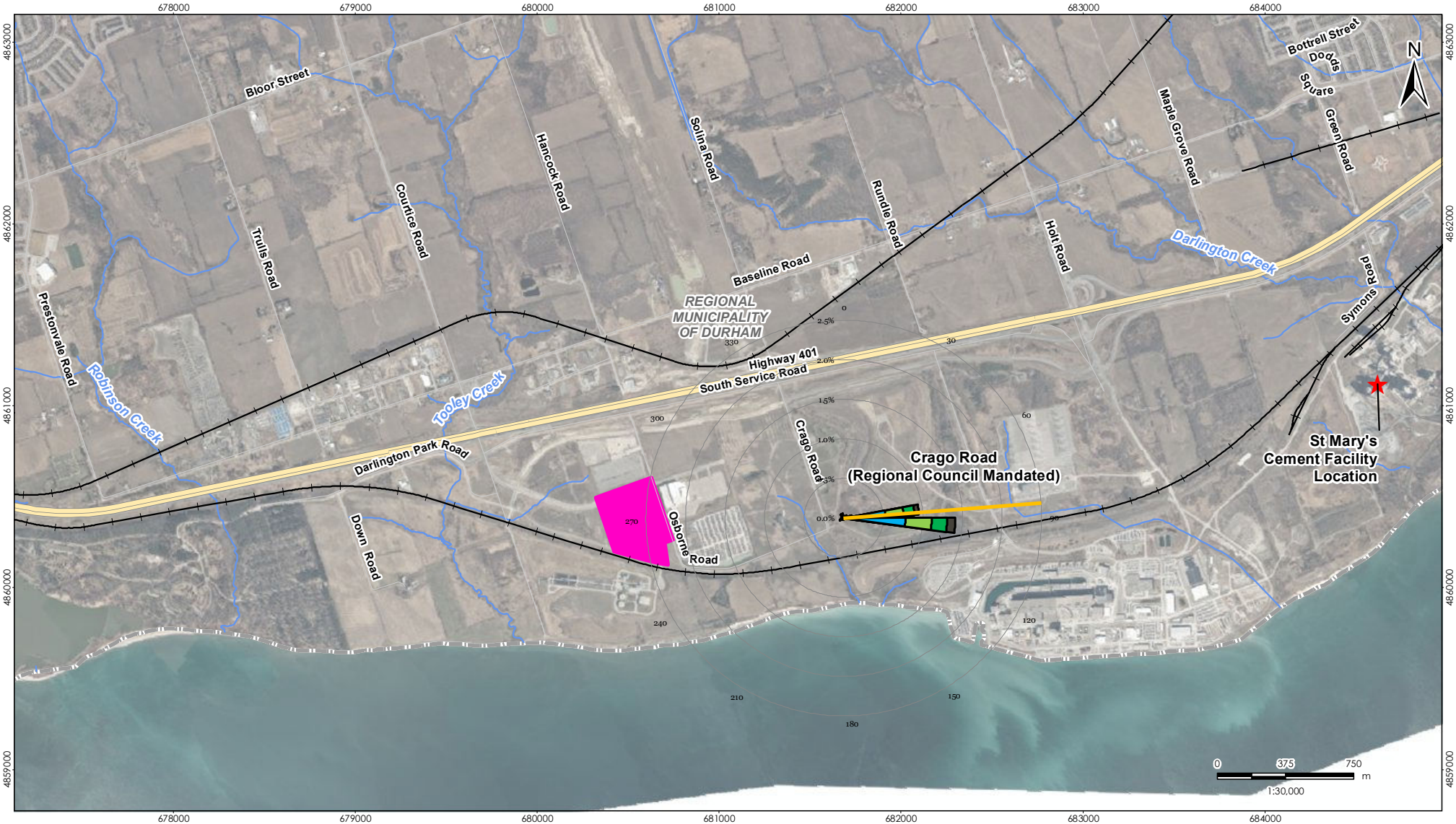
Time history plots of the hourly and 24-hour average SO_2 concentrations over the measurement period are presented in **Appendix B, Figure B1**. For hourly and 24-hour averages, the Ontario AAQCs of 250 ppb and 100 ppb (690 µg/m^3 and 275 µg/m^3) are shown with blue lines on the respective plot. The annual Ontario AAQC for SO_2 is 20 ppb (55 µg/m^3), and the annual HHRA criterion is 11 ppb (29 µg/m^3). As shown in these figures, measured ambient SO_2 concentrations were well below the Ontario AAQCs.

The maximum hourly, 24-hour and annual average concentrations measured at the Crago Road Station during the 2017 monitoring period were 66.1, 14.9, and 0.6 ppb (182.1, 40.6, and 1.8 µg/m^3), respectively, which are 26%, 15%, and 5.7% of the applicable 1-hour, 24-hour, and annual ambient air quality criteria.

A pollution rose of hourly average SO_2 concentrations measured at the Crago Road Station is presented in **Figure 4-3**. A pollution rose plot presents measured hourly average contaminant concentrations versus measured wind direction (over 10˚ wind sectors). In this figure, concentrations less than 2 ppb, which account for about 96% of the measurements at the station, were removed from the plot to allow the distribution of maximum levels to be more clearly visible in the figure. A plot of the measured hourly average SO_2 concentrations versus wind direction is presented in **Appendix B, Figure B2**.

For the Crago Road Station, higher measured concentrations occurred for winds blowing from easterly directions. The maximum measured concentration at this station occurred from the east – a direction in which the Darlington Nuclear Generating Station, CN railway and St. Mary's Cement are upwind of the monitoring station.

A summary of the maximum measured hourly concentrations in each quarter of 2017 at the monitoring station along with other available local and regional air quality data, wind directionality, and potential emissions sources are presented in **Table 4-3**.



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Revised: 2018-03-09 By: bcowper

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Notes

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4. Concentrations less than 2ppb, which account for 96% of the measurements, have been removed from the plot to allow the distribution of maximum levels to be more clearly shown in the figure.

Legend

- St Mary's Cement Facility Location
- Durham York Energy Centre Site
- Railway
- Road
- Highway
- Watercourse

Concentration (ppb)

- 20 - 100
- 10 - 20
- 5 - 10
- 2 -5
- Direction of Maximum Measured Concentration

Client/Project

The Region of Durham
Durham York Energy Centre

Figure No.

4-3

Title

Pollution Rose of Measured Hourly Average SO_2 Concentrations - 2017 Monitoring Period

4.2.2 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 species of NO_X, the AAQC were compared to measured NO_2 concentrations (MOECC, 2012).

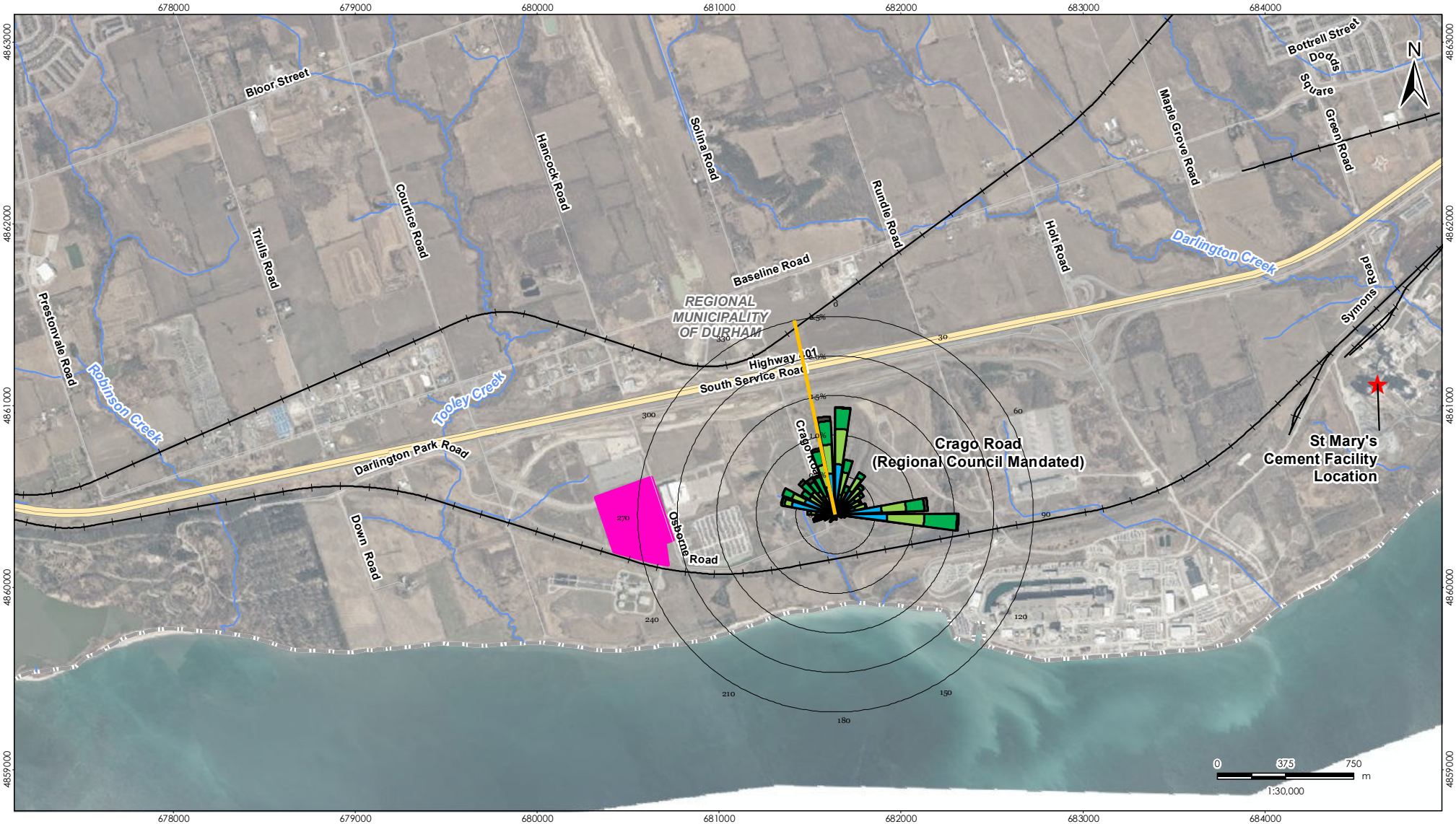
Time history plots of the hourly and 24-hour average NO_2 concentrations over the measurement period are presented in **Appendix C, Figure C1**. For hourly and 24-hour averages, the Ontario AAQCs of 200 ppb and 100 ppb (400 µg/m^3 and 200 µg/m^3) are shown as blue lines on their respective time history plots in **Appendix C**. Measured ambient NO_2 concentrations were well below the Ontario AAQCs.

The maximum hourly, 24-hour and annual average NO_2 concentrations measured at the Crago Road Station during 2017 were 62.6, 27.9, and 5.2 ppb (138.9, 59.2, and 10.4 µg/m^3), respectively, which are 31%, 28%, and 17% of the applicable ambient 1-hour, 24-hour, and annual air quality criteria.

A pollution rose of hourly NO_2 concentrations is presented in **Figure 4-4**. Concentrations less than 10 ppb which account for approximately 84% of the measurements were removed from the plot to allow higher concentrations to be more clearly visible. A plot of measured hourly average NO_2 concentrations versus measured wind direction is presented in **Appendix C, Figure C2**.

Higher measured hourly concentrations for the Crago Road Station occurred most frequently from northerly and easterly directions. The maximum measured hourly average NO_2 concentration for the Crago Road Station occurred for a north-northwesterly wind - a direction in which the CN railway, Highway 401, Highway 418, and the Darlington Hydro Upper and Lower Soccer Fields are upwind of the station.

A summary of the maximum measured hourly concentrations in each quarter of 2017 at the monitoring station along with other available local and regional air quality data, wind directionality, and potential emissions sources are presented in **Table 4-3.**



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March 2018
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4. Concentrations less than 10ppb, which account for 84% of the measurements, have been removed from the plot to allow the distribution of maximum levels to be more clearly shown in the figure.

Legend

- St Mary's Cement Facility Location
- Durham York Energy Centre Site
- Railway
- Road
- Highway
- Watercourse

Concentration (ppb)

- 30 - 80
- 20 - 30
- 15 - 20
- 10 - 15
- Direction of Maximum Measured Concentration

Client/Project

The Region of Durham
Durham York Energy Centre

Figure No.

4-4

Title

Pollution Rose of Measured Hourly Average NO_2 Concentrations - 2017 Monitoring Period

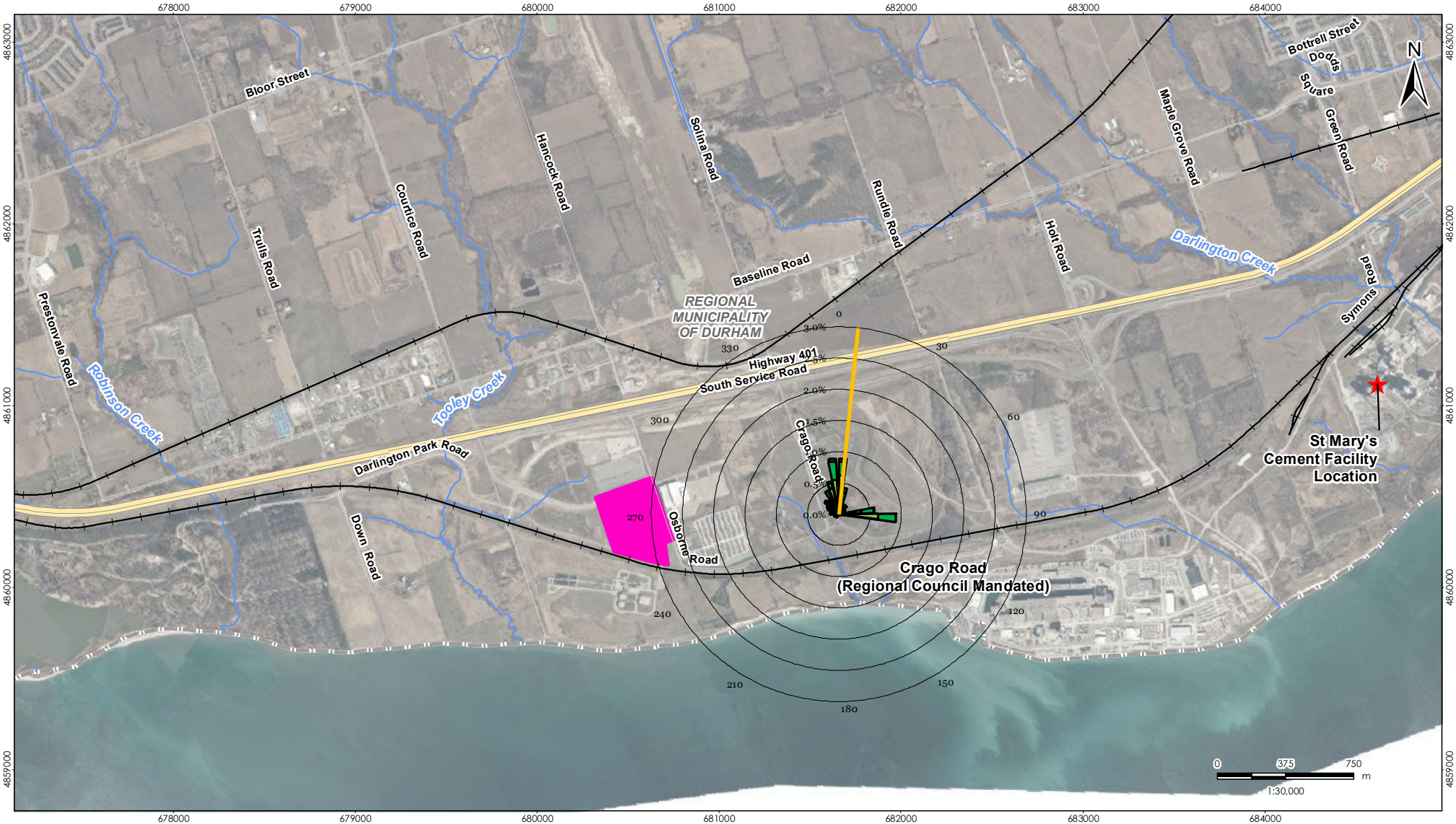
4.2.3 Nitrogen Oxides (NO_X)

Time history plots of hourly and 24-hour average NO_x concentrations over the measurement period are presented in **Appendix D, Figure D1**.

As presented in **Table 4-2**, the maximum hourly, 24-hour and annual average NO_X concentrations measured at the Crago Road Station during 2017 were 77.9, 38.8, and 6.8 ppb (158.6, 82.2, and 13.5 µg/m^3), respectively.

A pollution rose of hourly average NO_X concentrations for the Crago Road Station is presented in **Figure 4-5**. The pollution rose in this figure presents measured concentrations above 20 ppb to allow higher levels to be more easily visible (concentrations less than 20 ppb accounted for 92% of the NOx measurements). A plot of wind direction versus measured hourly average NO_X concentrations is presented in **Appendix D, Figure D2**. Higher measured hourly average NO_X concentrations for the Crago Road Station typically occurred for winds blowing from northerly and easterly directions. The maximum measured concentration was for a wind blowing from a northerly direction for which the CN railway, Highway 401, Highway 418, and the Darlington Hydro Upper and Lower Soccer Fields are upwind of the station.

A summary of the maximum measured hourly concentrations in each quarter of 2017 at the monitoring station along with other available local and regional air quality data, wind directionality, and potential emissions sources are presented in **Table 4-3**.



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3. Orthoimagery © First Base Solutions, 2013.
4. Concentrations less than 20ppb which account for 92% of the measurements, have been removed from the plot to allow the distribution of maximum levels to be more clearly shown in the figure.

Legend

- St Mary's Cement Facility Location
- Durham York Energy Centre Site
- Railway
- Road
- Highway
- Watercourse

Concentration (ppb)

- 60 - 110
- 35 - 60
- 25 - 35
- 20 - 25
- Direction of Maximum Measured Concentration

Client/Project

The Region of Durham
Durham York Energy Centre

Figure No.

4-5

Title

Pollution Rose of Measured Hourly Average NO_x Concentrations – 2017 Monitoring Period

4.2.4 Particulate Matter Smaller than 2.5 Microns ($PM_{2.5}$)

A time history plot of the measured 24-hour average $PM_{2.5}$ concentrations over the measurement period is presented in **Appendix E, Figure E1**.

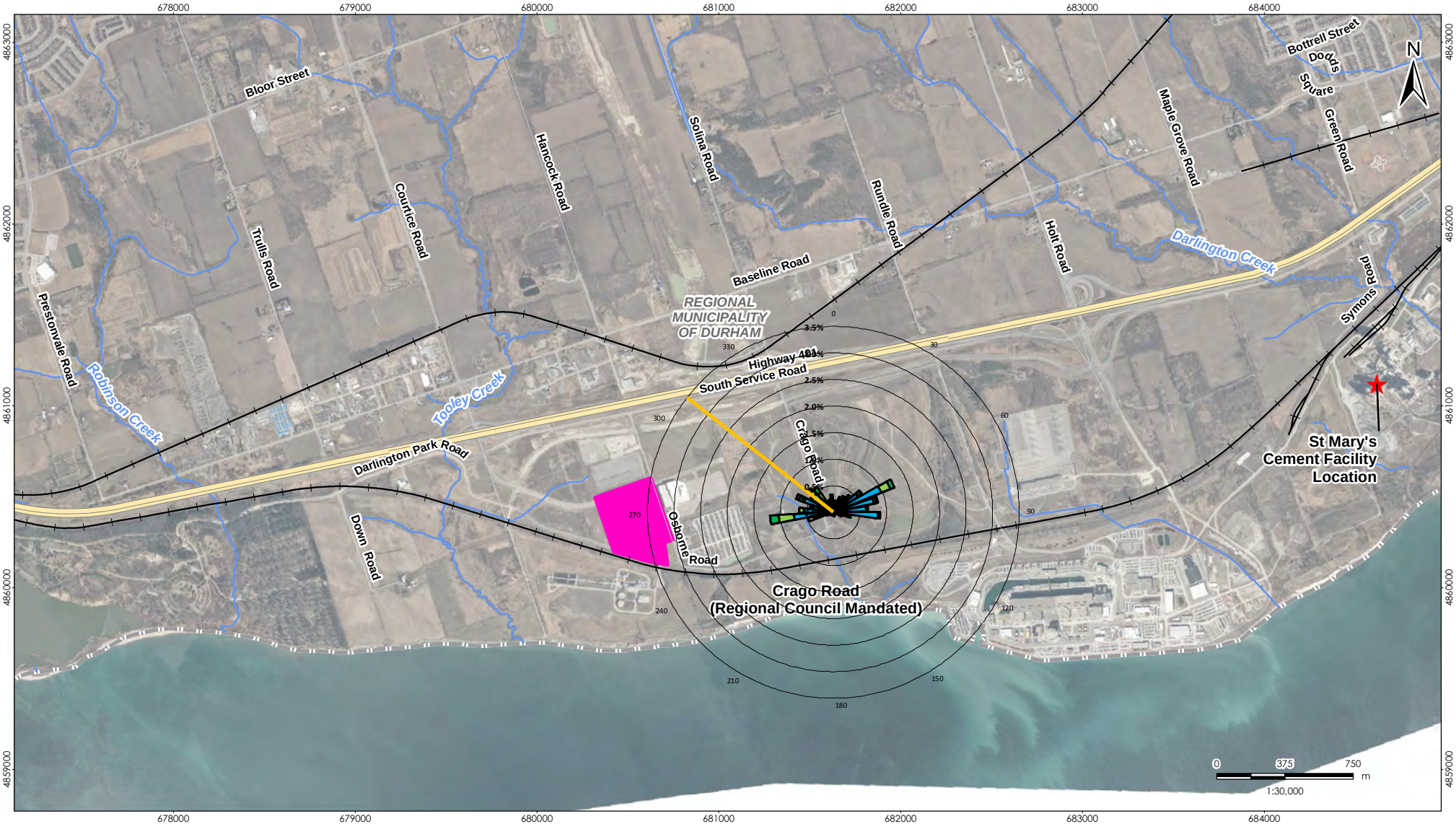
The maximum 24-hour average $PM_{2.5}$ concentration measured at the Crago Road Station over the monitoring period was 30.4 µg/m^3. In 2017, the 98th percentile of the measured daily average $PM_{2.5}$ concentration was 15.1 µg/m^3. The Crago 98th percentile daily value was lower than the 98th percentile daily average measurements at the Courtice WPCP and Rundle Road Stations (19.8 and 20.3 µg/m^3, respectively). As detailed below, this value for the 98th percentile should not be used for comparison against the Canadian Ambient Air Quality Standard.

A pollution rose showing measured 24-hour average ambient $PM_{2.5}$ concentrations versus wind direction is shown in **Figure 4-6**. Concentrations less than 10 µg/m^3, which accounted for approximately 86% of measurements, were not included in this figure to more clearly show the distribution of higher concentration levels. A plot of measured 24-hour average ambient $PM_{2.5}$ concentrations versus measured 24-hour average wind direction is presented in **Appendix E, Figure E-2**.

Higher measured $PM_{2.5}$ concentrations at the Crago Road Station occurred for westerly and easterly winds, with the maximum measured concentration occurring from the northwest on January 17. For westerly wind directions, the DYEC and agricultural fields are upwind. For northwesterly winds, Highway 401, Highway 418 construction and a CP railway are upwind of the monitoring station. For an easterly wind direction, the CN railway and St. Mary's Cement are located upwind.

The 24-hour and annual $PM_{2.5}$ CAAQS criteria both require a three-calendar year average for comparison, with the data considered valid if an annual 98th percentile value is available for at least two of the required three calendar years. A preliminary comparison of the calculated three-year average of the annual 98th percentile of the daily 24-hour average concentrations and the three-year average of the annual average concentrations to their respective CAAQS criteria using data for calendar years 2015 to 2017 is shown in **Table 4-4**. The measured ambient $PM_{2.5}$ levels were below their respective CAAQS.

A summary of the maximum measured 24-hour concentrations in each quarter of 2017 at the monitoring station along with other available local and regional air quality data, wind directionality and potential emissions sources are presented in **Table 4-3**.



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3. Orthoimagery © First Base Solutions, 2013.
4. Concentrations less than 10 µg/m³, which account for 86% of the measurements, have been removed from the plot to allow the distribution of maximum levels to be more clearly shown in the figure.

Legend

- St Mary's Cement Facility Location
- Durham York Energy Centre Site
- Railway
- Road
- Highway
- Watercourse

Concentration (µg/m³)

- 25 - 35
- 20 - 25
- 15 -20
- 10 - 15
- Direction of Maximum Measured Concentration

Client/Project

The Region of Durham
Durham York Energy Centre

Figure No.

4-6

Title

Pollution Rose of Measured 24-Hour Average $PM_{2.5}$ Concentrations – 2017 Monitoring Period

Table 4-4 Comparison of Ambient $PM_{2.5}$ Levels to the CAAQS Using 2015 to 2017 Measurement Data

Pollutant	Averaging Period	CAAQS (µg/m³)	Crago Road Station $PM_{2.5}$ Concentration (µg/m³) (Predominantly Downwind)
			2015 – 2017
$PM_{2.5}$	24-hour	28 [A]	20.1
	Annual	10 [B]	6.5

Notes:

A. Canadian Ambient Air Quality Standard for Respirable Particulate Matter. The Respirable Particulate Matter Objective is referenced to the average of the 98th percentile of the daily average over three consecutive years.

B. Annual Canadian Ambient Air Quality Standard for Respirable Particulate Matter, effective by 2015. The Respirable Particulate Matter Objective is referenced to the three-year average of the annual average concentrations.

4.3 AMBIENT TSP/METALS CONCENTRATIONS

A summary of the maximum, minimum, and mean measured ambient TSP and metals concentrations (for a daily averaging period) are presented in **Table 4-5**. The maximum measured concentrations of TSP and metals with MOECC air quality criteria during the 2017 monitoring period (January to December 2017) were below their applicable 24-hour criteria.

Table 4-5 Summary of Measured Ambient TSP/Metals Concentrations

Contaminant	Units	MOECC Standard	HHRA Health Based Criteria	Results			
				Maximum	Minimum	Period Arithmetic Mean	No. of Exceedances
Particulate	µg/m³	120	120	89.51	11.11	29.01/26.48 [B]	0
Total Mercury (Hg)	µg/m³	2	2	3.80E-5	6.13E-6 [A]	9.28E-06	0
Aluminum (Al)	µg/m³	4.8	-	5.97E-1	1.65E-2 [A]	1.25E-01	0
Antimony (Sb)	µg/m³	25	25	3.99E-3 [A]	3.06E-3 [A]	3.37E-03	0
Arsenic (As)	µg/m³	0.3	0.3	2.39E-3 [A]	1.84E-3 [A]	2.02E-03	0
Barium (Ba)	µg/m³	10	10	2.44E-2	3.44E-4	7.33E-03	0
Beryllium (Be)	µg/m³	0.01	0.01	3.99E-4 [A]	3.06E-4 [A]	3.37E-04	0
Bismuth (Bi)	µg/m³	-	-	2.39E-3 [A]	1.84E-3 [A]	2.02E-03	-
Boron (B)	µg/m³	120	-	4.82E-3	1.84E-3 [A]	2.18E-03	0
Cadmium (Cd)	µg/m³	0.025	0.025	7.98E-4 [A]	6.13E-4 [A]	6.75E-04	0
Chromium (Cr)	µg/m³	0.5	-	2.27E-2	1.53E-3 [A]	2.43E-03	0
Cobalt (Co)	µg/m³	0.1	0.1	2.01E-3 [A]	6.13E-4 [A]	6.96E-04	0

Table 4-5 Summary of Measured Ambient TSP/Metals Concentrations

Contaminant	Units	MOECC Standard	HHRA Health Based Criteria	Results			
				Maximum	Minimum	Period Arithmetic Mean	No. of Exceedances
Copper (Cu)	µg/m³	50	-	1.22E-1	1.72E-3	3.43E-02	0
Iron (Fe)	µg/m³	4	-	1.35E+0	1.72E-2	3.45E-01	0
Lead (Pb)	µg/m³	0.5	0.5	1.02E-2	9.19E-4 A	2.26E-03	0
Magnesium (Mg)	µg/m³	-	-	7.84E-1	1.72E-2	1.71E-01	-
Manganese (Mn)	µg/m³	0.4	-	5.46E-2	3.44E-4	1.10E-02	0
Molybdenum (Mo)	µg/m³	120	-	1.20E-3 A	9.19E-4 A	1.01E-03	0
Nickel (Ni)	µg/m³	0.2	-	5.39E-3 A	9.19E-4 A	1.13E-03	0
Phosphorus (P)	µg/m³	-	-	1.10E-1	8.18E-3 A	3.21E-02	-
Selenium (Se)	µg/m³	10	10	3.99E-3 A	3.06E-3 A	3.37E-03	0
Silver (Ag)	µg/m³	1	1	2.00E-3 A	1.53E-3 A	1.69E-03	0
Strontium (Sr)	µg/m³	120	-	1.60E-2	3.44E-4	4.39E-03	0
Thallium (Tl)	µg/m³	-	-	3.99E-3 A	3.06E-3 A	3.37E-03	-
Tin (Sn)	µg/m³	10	10	3.99E-3 A	3.06E-3 A	3.37E-03	0
Titanium (Ti)	µg/m³	120	-	3.01E-2	3.06E-3 A	7.06E-03	0
Vanadium (V)	µg/m³	2	1	2.00E-3 A	1.53E-3 A	1.69E-03	0
Zinc (Zn)	µg/m³	120	-	2.03E-1	1.72E-3	2.57E-02	0
Zirconium (Zr)	µg/m³	20	-	2.00E-3 A	1.53E-3 A	1.69E-03	0
Total Uranium (U)	µg/m³	1.5	-	1.80E-4 A	1.38E-4 A	1.52E-04	0

Notes:

A. Measured concentration was less than the laboratory method detection limit.
B. Period Arithmetic Mean/ Period geometric mean are presented for TSP.

4.4 AMBIENT PAH CONCENTRATIONS

A summary of the maximum and minimum and arithmetic mean daily average ambient PAH concentrations is presented in **Table 4-6**. In this summary, both individual PAHs as well as a total PAH concentration are reported. PAHs were monitored from January to December 2017.

The maximum measured concentrations of all PAHs with MOECC air quality criteria were well below their applicable 24-hour criteria, with the exception of six (6) measurements of benzo(a)pyrene (B(a)P) out of a total of 30 measurements.

B(a)P is a byproduct of a wide variety of natural and man-made combustion processes (including motor vehicles, natural gas, wood, refuse, oil, forest fires, etc.) and is widely present in the environment (including being present in soil and water).

The current Ontario 24-hour B(a)P AAQC was introduced in 2011 and levels above this AAQC are commonly measured throughout Ontario. B(a)P measurement data available from the National Air Pollutant Surveillance (NAPS) network for Ontario in 2013 (for Simcoe, Toronto, and Hamilton), all had maximum levels above the AAQC (varying between 136% -6,220% of the criteria). Available NAPS data for Ontario in 2012 (for Windsor, Toronto, and Hamilton) showed maximum B(a)P levels at these stations that varied between 716% -2,920% of the criteria. In 2011, NAPS data available for seven Ontario stations (Windsor, Toronto, Etobicoke, Hamilton, Simcoe, Pt. Petrie, and Burnt Island) showed exceedances at six of the seven stations, with only the remote Burnt Island Ontario station reporting a maximum level below the MOECC AAQC. In 2010, all of these stations, including the Burnt Island station, measured B(a)P levels above the AAQC.

The six (6) B(a)P samples collected on January 7, January 31, February 2, September 16, December 9 and December 21, 2017exceeded the Ontario AAQC of 0.05 ng/m^3 by 13% to 220%. The samples were, however, below the MOECC Schedule 6 Upper Risk Threshold, the MOECC O. Reg. 419/05 24-hour average guideline, and the HHRA health based criteria.

A summary of the wind directions and potential source contributions for these measurements (as required by the MOECC for inclusion in annual reports) is presented in **Table 4-7**.

Based on the air quality assessments completed during the Environmental Assessment Study and the Environmental Compliance Approval application for the DYEC, the facility is not a significant contributor of B(a)P. Therefore, ambient B(a)P levels are not expected to be substantially impacted by the operation of the DYEC.

Table 4-6 Summary of Measured Ambient PAH Concentrations

Contaminant	Units	Regulatory Criteria	HHRA Health Based Criteria	Results			
				Maximum	Minimum	Period Arithmetic Mean	No. of Exceedances
Benzo(a)pyrene	ng/m^3	0.05 [A]	1	0.16	0.008	0.0369	6
		5 [B]					0
		1.1 [C]					0
1-Methylnaphthalene	ng/m^3	12,000	-	9.42E+00	1.17E+00	4.23E+00	0
2-Methylnaphthalene	ng/m^3	10,000	-	1.48E+01	2.00E+00	6.89E+00	0
Acenaphthene	ng/m^3	-	-	9.41E+00	3.57E-01	2.34E+00	-
Acenaphthylene	ng/m^3	3500	-	4.24E-01	6.98E-02 [F]	1.39E-01	0
Anthracene	ng/m^3	200	-	3.07E+00 [F]	6.96E-02 [F]	2.10E-01	0

Table 4-6 Summary of Measured Ambient PAH Concentrations

Contaminant	Units	Regulatory Criteria	HHRA Health Based Criteria	Results			
				Maximum	Minimum	Period Arithmetic Mean	No. of Exceedances
Benzo(a)anthracene	ng/m³	-	-	1.16E-01 [A]	6.96E-02 [A]	9.17E-02	-
Benzo(a)fluorene	ng/m³	-	-	2.33E-01 [F]	1.39E-01 [F]	1.83E-01	-
Benzo(b)fluoranthene	ng/m³	-	-	1.16E-01 [F]	6.96E-02 [F]	9.17E-02	-
Benzo(b)fluorene	ng/m³	-	-	2.33E-01 [F]	1.39E-01 [F]	1.83E-01	-
Benzo(e)pyrene	ng/m³	-	-	2.33E-01 [F]	1.39E-01 [F]	1.83E-01	-
Benzo(g,h,i)perylene	ng/m³	-	-	1.16E-01 [F]	6.96E-02 [F]	9.17E-02	-
Benzo(k)fluoranthene	ng/m³	-	-	1.16E-01 [F]	6.96E-02 [F]	9.17E-02	-
Biphenyl	ng/m³	-	-	5.16E+00	2.31E-01	2.18E+00	-
Chrysene	ng/m³	-	-	1.16E-01 [F]	6.96E-02 [F]	9.17E-02	-
Dibenz(a,h)anthracene [D]	ng/m³	-	-	1.16E-01 [F]	6.96E-02 [F]	9.17E-02	-
Dibenzo(a,c)anthracene + Picene	ng/m³	-	-	2.33E-01 [F]	7.63E-02 [F]	1.76E-01	-
Fluoranthene	ng/m³	-	-	3.00E+00	1.15E-01	8.91E-01	-
Indeno (1,2,3-cd)pyrene	ng/m³	-	-	1.16E-01 [F]	6.96E-02 [F]	9.17E-02	-
Naphthalene	ng/m³	22,500	22,500	5.13E+01	4.71E+00	2.23E+01	0
o-Terphenyl	ng/m³	-	-	2.33E-01 [F]	1.39E-01 [F]	1.83E-01	-
Perylene	ng/m³	-	-	2.33E-01 [F]	1.39E-01 [F]	1.83E-01	-
Phenanthrene	ng/m³	-	-	1.31E+01	8.54E-01	3.64E+00	-
Pyrene	ng/m³	-	-	1.15E+00	7.08E-02 [F]	3.81E-01	-
Tetralin	ng/m³	-	-	3.57E+00	7.39E-01	1.83E+00	-
Total PAH [E]	ng/m³	-	-	1.01E+02	1.31E+01	4.68E+01	-

Notes:

A. Ontario Ambient Air Quality Criteria. The standard for benzo(a)pyrene (B(a)P) is for B(a)P as a surrogate for PAHs.

B. O. Reg. 419/05 Schedule 6 Upper Risk Thresholds.

C. O. Reg. 419/05 24 Hour Guideline.

D. Based on laboratory analyses, dibenzo(a,c)anthracene co-elutes with dibenz(a,h)anthracene. Picene elutes after dibenz(a,h)anthracene.

E. The reported total PAH is the sum of all analyzed PAH species.

F. Measured concentration was less than the laboratory method detection limit.

Table 4-7 Source Contribution Analysis – 2017 B(a)P Exceedances

Date	% above the MOECC B(a)P Criterion	Wind Direction	Potential Source Contributions
7-Jan-2017	220%	Northwest	Land use in this direction is primarily agricultural with Highway 401 also located to the north. Potential sources could be agricultural or transportation activities.
31-Jan-2017	32%	Northeast	Land use in this direction is primarily agricultural with Highway 401 also located to the north. Potential sources could be agricultural or transportation activities.
2-Feb-2017	112%	Northwest	Land use in this direction is primarily agricultural with Highway 401 also located to the north. Potential sources could be agricultural or transportation activities.
16-Sep-17	96%	North	Land use in this direction is primarily agricultural with Highway 401 and Highway 418 construction also located to the north. Potential sources could be agricultural, transportation, or construction activities.
9-Dec-17	41%	West	Land use in this direction is primarily agricultural, the DYEC and CN rail are also located upwind. Potential sources could be agricultural or transportation activities.
21-Dec-17	13%	Northeast	Land use in this direction is primarily agricultural with Highway 401 also located to the north. Potential sources could be agricultural or transportation activities.

4.5 AMBIENT DIOXIN AND FURAN CONCENTRATIONS

A summary of the maximum and minimum, and arithmetic mean daily average ambient dioxin and furan concentrations is presented in **Table 4-8** for the measurements collected in 2017. In this summary, both individual dioxin and furan concentrations (pg/m^3) as well as the total toxic equivalency concentration (TEQ) are reported.

The maximum measured toxic equivalent dioxin and furan concentration at the Crago Road Station was below the applicable 24-hour criteria AAQC of 0.1 pg TEQ/m^3 (as shown in **Table 4-8**) for the 2017 monitoring period (January to December 2017).

Table 4-8 Summary of Measured Ambient Dioxin and Furan Concentrations

Contaminant	Units	Regulatory Criteria	HHRA Health Based Criteria	Crago Road (Predominatly Downwind)			
				Maximum	Minimum	Arithmetic Mean	No. of Exceedances
2,3,7,8-Tetra CDD *	pg/m³	-	-	7.97E-03	3.99E-03 A	5.08E-03	N/A
1,2,3,7,8-Penta CDD	pg/m³			1.76E-02 A	4.27E-03	5.81E-03	
1,2,3,4,7,8-Hexa CDD	pg/m³			3.85E-02 A	4.52E-03	7.34E-03	
1,2,3,6,7,8-Hexa CDD	pg/m³			1.19E-01	4.38E-03	1.41E-02	
1,2,3,7,8,9-Hexa CDD	pg/m³			1.97E-01	3.96E-03	1.93E-02	
1,2,3,4,6,7,8-Hepta CDD	pg/m³			2.37E+00	4.48E-03	2.09E-01	
Octa CDD	pg/m³			7.67E+00	3.05E-02	6.80E-01	
Total Tetra CDD	pg/m³			1.25E-01 A	4.27E-03	1.71E-02	
Total Penta CDD	pg/m³			1.53E-01	4.27E-03	2.15E-02	
Total Hexa CDD	pg/m³			1.15E+00	4.62E-03	1.12E-01	
Total Hepta CDD	pg/m³			4.41E+00	4.48E-03	4.06E-01	
2,3,7,8-Tetra CDF **	pg/m³			1.29E-02	4.10E-03 A	6.46E-03	
1,2,3,7,8-Penta CDF	pg/m³			9.57E-03 A	3.39E-03	5.20E-03	
2,3,4,7,8-Penta CDF	pg/m³			8.90E-03 A	3.39E-03	5.17E-03	
1,2,3,4,7,8-Hexa CDF	pg/m³			1.58E-02	3.11E-03	5.10E-03	
1,2,3,6,7,8-Hexa CDF	pg/m³			4.96E-03 A	3.11E-03	4.32E-03	
2,3,4,6,7,8-Hexa CDF	pg/m³			1.09E-02	3.25E-03	5.18E-03	
1,2,3,7,8,9-Hexa CDF	pg/m³			7.06E-03 A	3.81E-03	5.15E-03	
1,2,3,4,6,7,8-Hepta CDF	pg/m³			6.62E-02	3.22E-03	1.67E-02	
1,2,3,4,7,8,9-Hepta CDF	pg/m³			1.21E-02	3.64E-03	5.73E-03	
Octa CDF	pg/m³			1.18E-01	4.10E-03	2.30E-02	

Table 4-8 Summary of Measured Ambient Dioxin and Furan Concentrations

Contaminant	Units	Regulatory Criteria	HHRA Health Based Criteria	Crago Road (Predominatly Downwind)			
				Maximum	Minimum	Arithmetic Mean	No. of Exceedances
Total Tetra CDF	pg/m^3			2.54E-02	4.10E-03	8.83E-03	
Total Penta CDF	pg/m^3			2.56E-02	3.39E-03	8.37E-03	
Total Hexa CDF	pg/m^3			5.05E-02	3.25E-03	1.05E-02	
Total Hepta CDF	pg/m^3			1.26E-01	3.36E-03	2.45E-02	
TOTAL TOXIC EQUIVALENCY [B]	pg TEQ/m^3	0.1 [C] 1 [D]	-	9.39E-02	1.33E-02	2.18E-02	0 0

Notes:

A. Measured concentration was less than the laboratory method detection limit.

B. Total Toxicity Equivalent (TEQ) concentration contributed by all dioxins, furans calculated as per O. Reg. 419/05methodology using corresponding WHO_{2005} toxic equivalency factors (I-TEFs) and a value of half the minimum detection limit (MDL) substituted for concentrations less than the MDL.

C. Ontario Ambient Air Quality Criteria.

D. O. Reg. 419/05 Schedule 6 Upper Risk Thresholds.

* CDD - Chloro Dibenzo-p-Dioxin, ** CDF - Chloro Dibenzo-p-Furan

5.0 AMBIENT AIR QUALITY TRENDS

Ambient air quality measurements from the Crago Road Station have been collected since November 2014. The MOECC requires that a minimum of nine months of data out of the 12 months in a year (a minimum 75% data recovery rate) be available for calculation of annual averages. Since the length of the measurement period in 2014 was less than nine months, the 2014 period averages were not compared to available MOECC annual criteria, nor are they directly comparable to the 2015 to 2017 annual averages.

5.1 CRITERIA AIR CONTAMINANT (CAC) COMPARISONS

A summary of the maximum, minimum, and arithmetic mean CAC concentrations, along with the number of exceedances of the relevant Ontario Ambient Air Quality Criteria (AAQC) or health-based criteria for each contaminant (if any occurred) at the Crago Road Station from 2015 to 2017 are presented in **Table 5-1** below. Also presented is the percentage of the applicable criteria for the maximum measured value in each year.

Plots of annual variations in measured hourly, 24-hour and annual average SO_2, NO_2 and $PM_{2.5}$ concentrations are presented in **Figure 5-1** to **Figure 5-3**, respectively.

The following observations were made from comparing the 2015 and 2017 CAC data:

- The concentrations of the monitored CACs were below their applicable hourly, 24-hour and annual average criteria for 2015-2017;
- The 98th percentile daily average $PM_{2.5}$ concentration in 2017 decreased relative to 2015-2016 (22.7, 22.6, and 15.1 µg/m^3, respectively for years 2015, 2016, 2017). The 2017 value was similar to the measurement taken at MOECC's Oshawa Station, while previous years had been higher (20.5, 17.1 µg/m^3, and 14.3 µg/m^3, respectively);
- The maximum 24-hour average $PM_{2.5}$ concentration in 2017 was about 68% less than to the 2016 maximum concentration;
- The maximum measured hourly average NOx concentration decreased by 27% in 2017 relative to 2016 while the maximum measured 24-hour average NOx concentration increased by 9% relative to 2016;
- The maximum measured hourly and 24-hour average NO_2 concentrations increased in 2017 by 11% and 33%, respectively relative to 2016; and,
- The maximum measured hourly average SO_2 concentration increased in 2017 by 60% relative to 2016 while the maximum measured 24-hour average SO_2 concentration decreased in 2017 by 40% relative to 2016.

Table 5-1 Comparison of Measured Ambient CAC Concentrations (2015 - 2017)

Pollutant	Averaging Period	AAQC / HHRA Criteria	Units		Measurement			% of Criteria		
					2015	2016	2017	2015	2016	2017
SO_2	1	250	ppb	Maximum	120.5	41.3	66.1	48.2%	16.5%	26.4%
				Minimum	0.0	0.0	0.0			
				# of Exceedances	0	0	0			
	24	100	ppb	Maximum	19.9	24.7	14.9	19.9%	24.7%	14.9%
				Minimum	0.0	0.0	0.0			
				# of Exceedances	0	0	0			
	Annual	20 / 11 [A]	ppb	Mean (Period)	1.1	0.9	0.6	5.5%	4.5%	3.15%
				# of Exceedances	0	0	0			
$PM_{2.5}$	24	28 [B]	µg/m³	Maximum	45.8	96	30.4	-	-	-
				Minimum	0.4	0.2	0	-	-	-
				Mean	7.3	6.6	5.7	-	-	-
				98th Percentile [C]	22.7	22.6	15.1	-	-	-
				# of Exceedances	N/A [D]	N/A [D]	N/A [D]	-	-	-
	Annual	10 [E]	µg/m³	Mean (Period)	7.3	6.6	5.6			-
				# of Exceedances	N/A [F]	N/A [F]	N/A [F]			-
NO_2	1	200	ppb	Maximum	44	56.5	62.6	22.0%	28.3%	31.3%
				Minimum	0.0	0.0	0.0			
				# of Exceedances	0	0	0			
	24	100	ppb	Maximum	22.3	20.9	27.9	22.3%	20.9%	27.9%
				Minimum	0.0	0.0	0.0			
				# of Exceedances	0	0	0			
	Annual	30	ppb	Mean	4.7	5.5	5.2	15.7%	18.3%	17.2%
				# of Exceedances	0	0	0			

Table 5-1 Comparison of Measured Ambient CAC Concentrations (2015 - 2017)

Pollutant	Averaging Period	AAQC / HHRA Criteria	Units		Measurement			% of Criteria		
					2015	2016	2017	2015	2016	2017
NO [G]	1	NA	ppb	Maximum	75	78.4	57.4	-		
				Minimum	0	0.0	0.0			
				# of Exceedances	N/A	N/A	NA			
	24	NA	ppb	Maximum	15.1	16.9	21.7			
				Minimum	0	0.0	0.0			
				# of Exceedances	N/A	N/A	NA			
NO_X [G]	1	NA	ppb	Maximum	83.1	107.2	77.9			
				Minimum	0.0	0.0	0.0			
				# of Exceedances	0	0	0			
	24	NA	ppb	Maximum	35.8	35.7	38.8			
				Minimum	0.0	0.0	0.0			
				# of Exceedances	NA	NA	NA			
	Annual	30	ppb	Mean	6.2	7.0	6.8	20.7%	23.3%	22.5%
				# of Exceedances	0	0	0			

Notes:

A. Annual AAQC / Annual HHRA criteria.

B. 24-Hour Canadian Ambient Air Quality Standard for Respirable Particulate Matter. The Respirable Particulate Matter Objective is referenced to the average of the 98th percentile of the daily average over three consecutive years.

C. The 98th percentile of the daily average $PM_{2.5}$ measurements in the period.

D. Daily $PM_{2.5}$ concentrations were not compared to the Canadian Ambient Air Quality Standard shown in this table, which requires averaging the 98th percentile concentrations over three consecutive years from 2015-2017.

E. Annual Canadian Ambient Air Quality Standard for Respirable Particulate Matter, effective by 2015. The Respirable Particulate Matter Objective is referenced to the three-year average of the annual average concentrations.

F. Annual $PM_{2.5}$ concentrations were not compared to the Canadian Ambient Air Quality Standard shown in this table, which requires the three-year average of the annual average concentrations over three consecutive years from 2015-2017.

G. NO and NO_x have no regulatory criteria.

Figure 5-1 Maximum 1-hour, 24-hour, and Annual Average SO_2 Concentrations Measured at the Crago Road Station Between 2014-2017

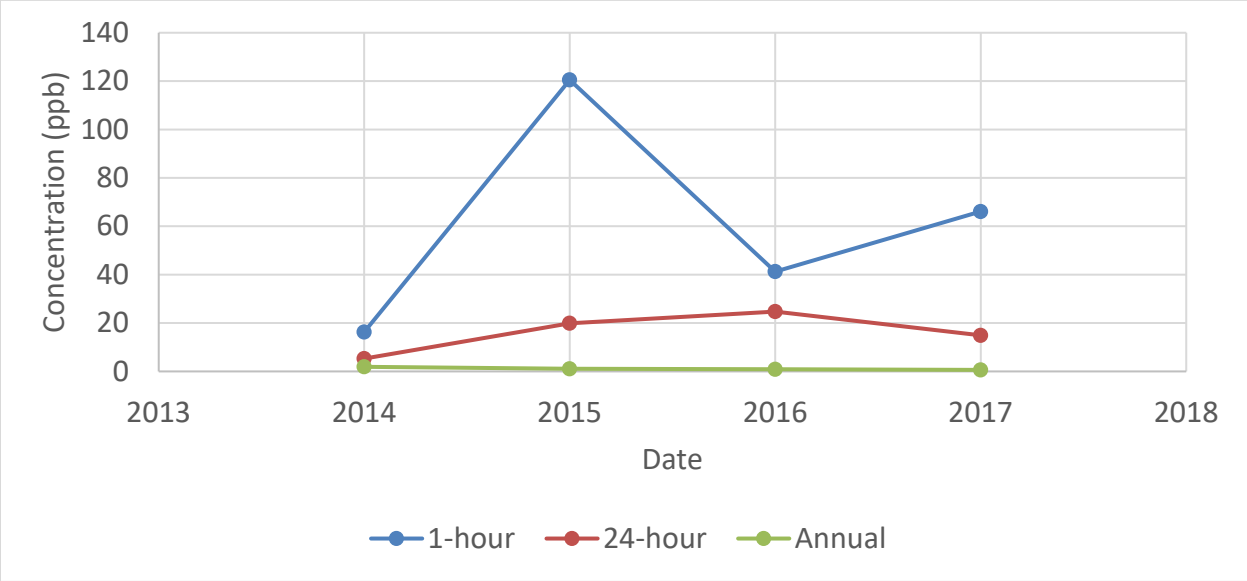


Figure 5-2 Maximum 1-hour, 24-hour, and Annual Average NO_2 Concentrations Measured at the Crago Road Station Between 2014-2017

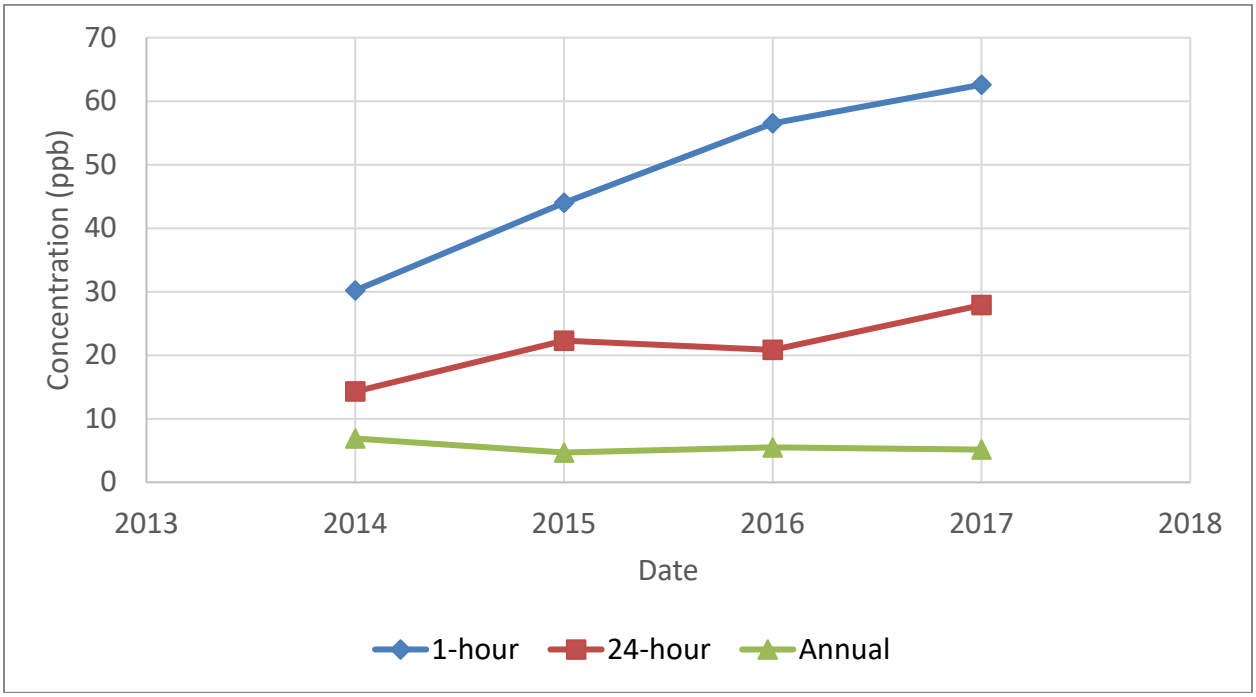
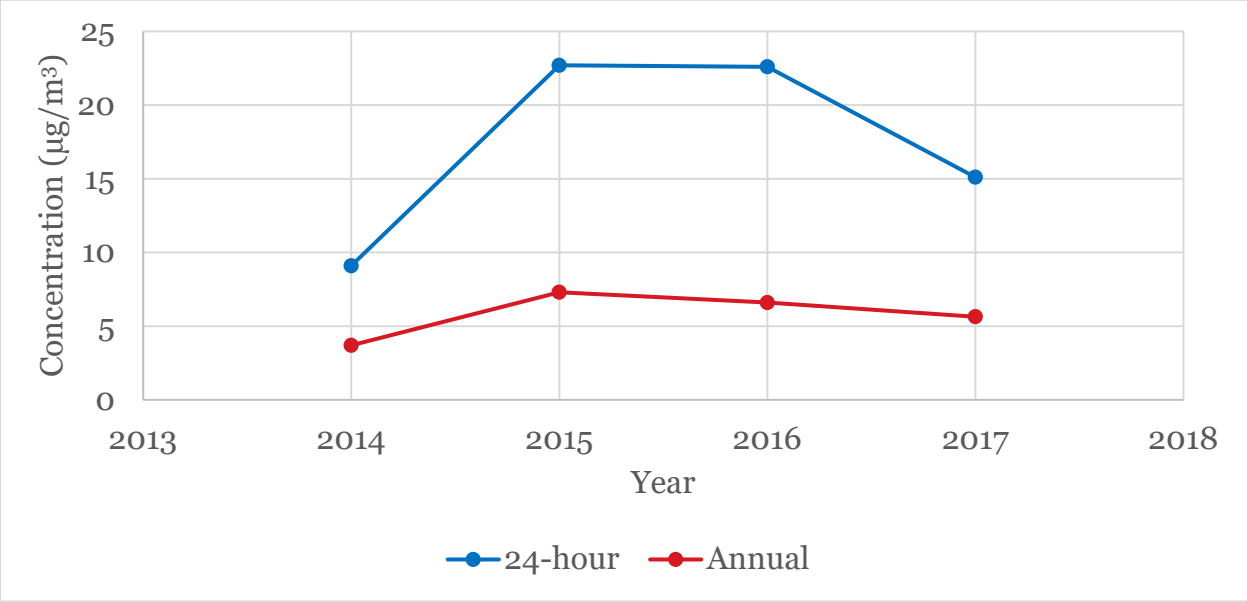


Figure 5-3 Maximum 98th Percentile 24-hour and Annual Average $PM_{2.5}$ Concentrations Measured at the Crago Road Station Between 2014-2017



5.2 DIOXIN AND FURAN COMPARISONS

A comparison of Dioxin and Furan measurements in 2017 relative to 2016 and 2015 are presented in **Table 5-2** below.

Table 5-2 Comparison of Maximum Measured Dioxin and Furan Measurements (2015-2017)

Year	Measurement Period in each Year	pg TEQ/m³
2015	October–December	0.034
2016	January-December	0.038
2017	January – December	0.094

The maximum measured toxic equivalent dioxin and furan concentration at the Crago Road Station was 94% the applicable 24-hour criteria of 0.1 pg TEQ/m³ in 2017. The total toxic equivalent dioxin and furan concentration increased by 147% in 2017 relative to 2016.

5.3 TSP AND METALS COMPARISONS

A comparison of TSP and metals measurements in 2017 relative to 2016 is presented in **Table 5-3.** The maximum measured concentrations of TSP and all metals with ambient criteria were below their Standards in both 2016 and 2017. The maximum measured TSP concentration in 2017 was about 12.4% less than that in 2016, while metals concentrations in 2017 varied between a

decrease of 52% to an increase of 286% (depending on the metal) relative to the maximum measured concentrations in 2016.

Table 5-3 Comparison of Maximum Measured TSP and Metals Measurements (2016-2017)

Contaminant	Units	2016	2017	Percent Change
Particulate	µg/m³	102.16	89.51	-12.4%
Total Mercury (Hg)	µg/m³	2.49E-05	3.80E-05	52.4%
Aluminum (Al)	µg/m³	7.79E-01	5.97E-01	-23.4%
Antimony (Sb)	µg/m³	3.52E-03	3.99E-03	13.2%
Arsenic (As)	µg/m³	3.71E-03	2.39E-03	-35.4%
Barium (Ba)	µg/m³	1.90E-02	2.44E-02	28.5%
Beryllium (Be)	µg/m³	3.52E-04	3.99E-04	13.2%
Bismuth (Bi)	µg/m³	2.11E-03	2.39E-03	13.2%
Boron (B)	µg/m³	6.71E-03	4.82E-03	-28.1%
Cadmium (Cd)	µg/m³	1.30E-03	7.98E-04	-38.5%
Chromium (Cr)	µg/m³	5.89E-03	2.27E-02	286.3%
Cobalt (Co)	µg/m³	7.05E-04	2.01E-03	185.7%
Copper (Cu)	µg/m³	6.58E-02	1.22E-01	84.6%
Iron (Fe)	µg/m³	1.58E+00	1.35E+00	-14.9%
Lead (Pb)	µg/m³	6.29E-03	1.02E-02	61.7%
Magnesium (Mg)	µg/m³	1.12E+00	7.84E-01	-30.1%
Manganese (Mn)	µg/m³	5.54E-02	5.46E-02	-1.5%
Molybdenum (Mo)	µg/m³	2.48E-03	1.20E-03	-51.7%
Nickel (Ni)	µg/m³	2.63E-03	5.39E-03	104.7%
Phosphorus (P)	µg/m³	1.24E-01	1.10E-01	-11.3%
Selenium (Se)	µg/m³	3.52E-03	3.99E-03	13.2%
Silver (Ag)	µg/m³	1.76E-03	2.00E-03	13.2%
Strontium (Sr)	µg/m³	1.74E-02	1.60E-02	-7.9%
Thallium (Tl)	µg/m³	3.52E-03	3.99E-03	13.2%
Tin (Sn)	µg/m³	3.52E-03	3.99E-03	13.2%
Titanium (Ti)	µg/m³	3.74E-02	3.01E-02	-19.6%
Vanadium (V)	µg/m³	1.76E-03	2.00E-03	13.2%
Zinc (Zn)	µg/m³	6.71E-02	2.03E-01	203.2%
Zirconium (Zr)	µg/m³	1.76E-03	2.00E-03	13.2%
Total Uranium (U)	µg/m³	1.59E-04	1.80E-04	13.2%

5.4 PAH COMPARISONS

A comparison of PAH measurements in 2017 relative to 2016 is presented in **Table 5-4.** The maximum measured concentrations of all PAH other than B(a)P with ambient criteria were below their Standards in both 2016 and 2017. In 2016 there were four exceedances in the B(a)P while in 2017 there were six. The maximum measured B(a)P concentration in 2017 was about 97.3% less than that in 2016. Maximum measured PAH concentrations changed within the range of -84% to +245% from 2016 to 2017. Anthracene had the greatest increase in the maximum measured concentration at 245%.

Table 5-4 Comparison of Maximum Measured PAH Measurements (2016-2017)

Contaminant	Units	2016	2017	Percent Change
Benzo(a)pyrene	ng/m^3	8.12E-02	0.1602	97.3%
1-Methylnaphthalene	ng/m^3	1.44E+01	9.42E+00	-34.7%
2-Methylnaphthalene	ng/m^3	2.77E+01	1.48E+01	-46.8%
Acenaphthene	ng/m^3	1.73E+01	9.41E+00	-45.5%
Acenaphthylene	ng/m^3	4.07E-01	4.24E-01	4.2%
Anthracene	ng/m^3	8.92E-01	3.07E+00	244.9%
Benzo(a)anthracene	ng/m^3	2.41E-01	1.16E-01	-51.7%
Benzo(a)fluorene	ng/m^3	2.22E-01	2.33E-01	4.6%
Benzo(b)fluoranthene	ng/m^3	5.89E-01	1.16E-01	-80.3%
Benzo(b)fluorene	ng/m^3	2.22E-01	2.33E-01	4.6%
Benzo(e)pyrene	ng/m^3	2.22E-01	2.33E-01	4.6%
Benzo(g,h,i)perylene	ng/m^3	6.78E-01	1.16E-01	-82.9%
Benzo(k)fluoranthene	ng/m^3	3.55E-01	1.16E-01	-67.3%
Biphenyl	ng/m^3	7.57E+00	5.16E+00	-31.9%
Chrysene	ng/m^3	4.56E-01	1.16E-01	-74.5%
Dibenz(a,h) anthracene	ng/m^3	7.03E-01	1.16E-01	-83.5%
Dibenzo(a,c) anthracene + Picene [A]	ng/m^3	7.54E-01	2.33E-01	-69.2%
Fluoranthene	ng/m^3	3.29E+00	3.00E+00	-8.8%
Indeno(1,2,3-cd)pyrene	ng/m^3	7.11E-01	1.16E-01	-83.6%
Naphthalene	ng/m^3	6.72E+01	5.13E+01	-23.7%
o-Terphenyl	ng/m^3	2.22E-01	2.33E-01	4.6%
Perylene	ng/m^3	2.22E-01	2.33E-01	4.6%
Phenanthrene	ng/m^3	1.96E+01	1.31E+01	-33.4%
Pyrene	ng/m^3	1.36E+00	1.15E+00	-15.4%
Tetralin	ng/m^3	4.95E+00	3.57E+00	-27.8%

Table 5-4 Comparison of Maximum Measured PAH Measurements (2016-2017)

Contaminant	Units	2016	2017	Percent Change
Total PAH [B]	ng/m^3	1.28E+02	1.01E+02	-20.7%

Notes:

A. Based on laboratory analyses, dibenzo(a,c)anthracene co-elutes with dibenz(a,h)anthracene. Picene elutes after dibenz(a,h)anthracene

B. The reported total PAH is the sum of all analysed PAH species

6.0 CONCLUSIONS

This report provides a summary of the ambient air quality data collected at the Crago Road Station for the 2017 monitoring period. The following observations and conclusions were made from a review of the measured ambient air quality monitoring data:

1. Measured concentrations of NO_2, SO_2 and $PM_{2.5}$ were below the applicable O. Reg. 419/05 Standards and/or human health risk assessment (HHRA) health-based criteria presented in **Table 2-1** of this report for hourly, 24-hour and annual averaging periods.

2. The 98th percentile of the measured daily average $PM_{2.5}$ levels during the 2017 monitoring period was 15.1 µg/m^3 at the Crago Road Station. The annual average $PM_{2.5}$ concentration measured at the Crago Road Station over the monitoring period was 5.6 µg/m^3. As detailed below, these values for the 2017 measurements should not be used for direct comparison against the Canadian Ambient Air Quality Standard.

3. The 24-hour and annual $PM_{2.5}$ Canadian Ambient Air Quality Standards (CAAQS) criteria both require a three-calendar year average for comparison, with the data considered valid if an annual 98th percentile value is available for at least two of the three calendar years. Using the measured $PM_{2.5}$ data for calendar years 2015 to 2017, the average annual 98th percentile daily average and annual average $PM_{2.5}$ levels were below the CAAQS criteria.

4. The maximum measured concentrations of TSP and all metals with MOECC air quality criteria were below their applicable criteria (presented in **Table 2-2** in this report).

5. The maximum measured concentrations of PAHs with MOECC Ambient Air Quality Criteria were almost all below their applicable 24-hour criteria (presented in **Table 2-3**) with the exception of six (6) benzo(a)pyrene (B(a)P) measurements. Out of thirty (30) PAH samples collected at the Crago Road Station, six (6) samples exceeded the Ontario 24-hour B(a)P AAQC of 0.05 ng/m^3 by 13% to 220%. However, all six (6) samples were well below the MOECC Schedule 6 Upper Risk Threshold, the MOECC O. Reg. 419/05 24-hour average guideline, and the HHRA health based criteria (as shown in **Table 2-3**).

   Based on the air quality assessments completed during the Environmental Assessment Study and the Environmental Compliance Approval application for the DYEC, the facility will not be a significant contributor of B(a)P. Therefore, ambient B(a)P levels are not expected to be substantially impacted by the operation of the DYEC. Discussion of the meteorology and potential sources for these events, which is required by the MOECC to be included in each annual report, is provided in Section 4.4.

6. The maximum toxic equivalent dioxin and furan concentration measured over this period was below the applicable criteria presented in **Table 2-3**.

Conclusions
May 8, 2018

In summary, the measured concentrations of almost all measured air contaminants were below their applicable Ministry of the Environment and Climate Change (MOECC) Standards during the 2017 monitoring period, except for benzo(a)pyrene as noted above. Further, the measured levels of monitored air contaminants were below their applicable HHRA health-based criteria.

7.0 REFERENCES

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Appendix A EQUIPMENT MAINTENANCE, CALIBRATION SCHEDULE AND SUMMARY OF EQUIPMENT ISSUES

Table A-1 Summary of Preventative Maintenance Crago Road Station

Parameter	Equipment Make/Model	Description of Maintenance Activities	Required Schedule (to meet MOE and Ambient Monitoring Plan requirements)	Target date	Schedule / Comments
SO_2	Teledyne Monitor Labs	Change particulate filter	Monthly	Every month	Done each month during calibrations
		Exchange chemical – external zero air scrubber	3 months	Every 3 months (Apr 2017)	Done July 26, 2017
		Replace perm tube	6 months	Oct-17	Done April 28, 2017
		Replace Pump diaphragm	8 months	Mar-17	To be completed in Q2/Q3 2018 during analyser overhaul
		Clean sample chamber, windows and filters	As required	Every year	To be completed in Q2/Q3 2018 during analyser overhaul
		Replace critical flow orifice and filters	As required	min. yearly	To be completed in Q2/Q3 2018 during analyser overhaul
		Yearly maintenance	Annual	Oct-17	To be completed in Q2 2018 during analyser overhaul
NOx	API Model 200E	Change particulate filter	Monthly	Every month	Done each month during calibrations
		Exchange chemical – external zero air scrubber	3 months	Every 3 months (Apr 2017)	October/November 2017
		Replace chemical – external dryer	3 months	Every 3 months (Apr 2017)	To be completed in Q2 2018 during analyser overhaul
		Chemical change – ozone filter	3 months	Every 3 months (Apr 2017)	To be completed in Q2 2018 during analyser overhaul
		Clean reaction cell window (annually or as necessary)	Annually	Oct-17	To be completed in Q2 2018 during analyser overhaul
		Change particulate DFU filter	Annually	Oct-17	To be completed in Q2 2018 during analyser overhaul
		Replace reaction cell O-rings & sintered filters	Annually or as required	Oct-17	To be completed in Q2 2018 during analyser overhaul
		Rebuild pump head	When RCEL pressures exceeds 10 in Hg	Oct-17	To be completed in Q2/Q3 2018 during analyser overhaul
		Replace inline exhaust scrubber	Annually	Oct-17	To be completed in Q2 2018 during analyser overhaul
		Replace perm tube	Annually	Apr-18	Done April 28, 2017
		Yearly maintenance	Annual	Oct-17	To be completed in Q2 2018 during analyser overhaul
		Replace NO2 converter	Every 3 years or if conversion < 96%		Done July 26, 2017
$PM_{2.5}$	Thermo Sharp 5030	Replace filter tape	Upon 10% remaining		Done July 26, 2017
		Replace SHARP zeroing filters	Monthly	Every month	Done each month
		Clean PM2.5 inlet	Monthly	Every month	Done each month during calibrations
		Clean cyclone	Monthly	Every month	Done each month during calibrations
		Clean air inlet system	Annually	Oct-17	To be completed in Q2 2018 during analyser overhaul
		Rebuild vacuum pump	12-18 months	Oct-17	Pump load at 40%
		Clean ambient temp/RH shield and assembly	Annually	Oct-17	To be completed in Q2 2018 during analyser overhaul
TSP/metals	TE-5170	Ensure all gaskets sealing properly	Weekly	Every Week	Completed during weekly site visits
		Power cord checks for damage/cracks	Weekly	Every Week	Completed during weekly site visits
		Inspect screen and remove foreign deposits	Weekly	Every Week	Completed during weekly site visits
		Inspect holder frame gasket	Every sample	Every Sample	Completed during weekly site visits
		Replace motor brushes	Every 500 hours	November-17	Done November 2017
		Check elapsed time meter	Weekly	Every Week	Completed during weekly site visits
		Check flow recorder pen/tubing	Weekly	Every Week	Completed during weekly site visits

Table A-1 Summary of Preventative Maintenance Crago Road Station

Parameter	Equipment Make/Model	Description of Maintenance Activities	Required Schedule (to meet MOE and Ambient Monitoring Plan requirements)	Target date	Schedule / Comments
		Ensure all gaskets sealing properly	Weekly	Every Week	Completed during weekly site visits
PAH and D/F	TE-1000	Ensure all gaskets sealing properly	Weekly	Every Week	Completed during weekly site visits
		Power cord checks for damage/cracks	Weekly	Every Week	Completed during weekly site visits
		Clean any dirt around module and filter holder	Weekly	Every Week	Completed during weekly site visits
		Inspect dual sampling module gaskets	Every sample	Every Sample	Completed during weekly site visits
		Inspect and replace motor flange gasket and motor cushion	Routinely, minimum annually	23-Oct-17	Replaced gasket and cushion on October 23, 2017
		Replace motor brushes	Every 400 hours	Dec-17	Completed December 2017
Wind Speed and Direction (Rundle Road Station only)	Met One 034B	Physical inspection of equipment for signs of damage/erratic behavior	Weekly	Every week	Done each month during calibrations
		Replace wind speed sensor bearings and calibrate	Annually	Sep-17	To be completed in Q2 2018 with warmer weather
		Replace wind vane potentiometer and bearings	24-months	Oct-17	To be completed in Q2 2018 during analyser overhaul
		Complete factory overhaul	24-36 months	Oct 2017 to Oct 2018	To be completed in Q2 2018 during analyser overhaul
Temperature	CS 107 (Rundle)/ HMP 60 (Courtice)	Check radiation shield free from debris	Weekly	Every week	Done each month during calibrations
Rainfall	TE525M	Inspect funnel and bucket mechanism for debris	Weekly	Every week	Done each month during calibrations
Relative Humidity	CS HMP60	Change INTERCAP® Sensor	On out of spec calibration	As required	To be completed in Q2/Q3 2018 during analyser overhaul
		Sensor cleaning	As required	As required	To be completed in Q2/Q3 2018 during analyser overhaul
		Inspect/replace filter if blocked	Monthly	Every month	Done each month during calibrations
Pod / others		Examine the external enclosure station conditions including the inlet probe for damage or blockage. Periodically review the station characteristics for any change or modification to the station	Weekly	Every week	Done each month during calibrations
		Examine the manifold, the transfer lines and the inlet filters for dirt buildup and replace or clean as required. Examine the seals in the sampling system, the scrubbing and drying agents and replace as required	Weekly	Every week	Done each month during calibrations
		Replace zero and span calibration cylinders when pressure is below 1,500 kPa (215 psig)			Replaced NO June 22, 2017
		Check data logger / equipment connection cables to ensure cables are not loose	Monthly	Monthly	Done each month during calibrations

Table A-1 Summary of Preventative Maintenance Crago Road Station

Parameter	Equipment Make/Model	Description of Maintenance Activities	Required Schedule (to meet MOE and Ambient Monitoring Plan requirements)	Target date	Schedule / Comments
		Ensure all debris and litter are cleaned up upon departure	Every site visit	Every site visit	Done each month during calibrations
		Ensure shelters and gates are locked upon departure	Every site visit	Every site visit	Done each month during calibrations
Datalogger		Send for calibration	Every 3 years	Sep-19	Logger failed March 30, 2017 and sent to Campbell for repairs. Spare installed same day. Logger reinstalled July 2077.
Other comments					See Notes 2 through 5

Table A-2 Summary of Equipment Calibration

Parameter	Equipment Make/Model	Description of Maintenance Activities	Required Schedule	Schedule / Comments	2017 Schedule Dates
SO_2	Teledyne API Model 1100	Verify test functions	Weekly	Checked weekly	Checked weekly
		Evaluate Zero/Span check	Weekly	Checked daily	Checked weekly
		Zero/span external check	Monthly	Checked monthly	See note 1
		Zero/span calibration	3 months	Calibrated monthly	See note 1
		Flow check	6 months	Checked monthly	See note 1
		Pneumatic leak check	Annually or after repairs	Done when flow drops or checked annually	N/A
		Calibrate UV lamp output	Prior to zero/span cal	Done prior to zero/span cal	See note 1
		PMT sensor hardware cal	On PMT/preamp changes or slope changes as specified	Done when instrument slope is outside of acceptable range	N/A
NOx	API Model 200E	Verify test functions	Weekly	Checked weekly	Checked weekly
		Evaluate Zero/Span check	Weekly	Checked daily	Checked weekly
		Zero/span external check	Monthly	Checked monthly	See Note 1
		Zero/span calibration	3 months	Calibrated monthly	See Note 1
		Pneumatic sub-system check	Annually or after repairs	Checked after repairs	See Note 1
		PMT sensor hardware cal	On PMT/preamp changes or slope changes as specified	Done when slope exceeds the acceptable range	See Note 1
$PM_{2.5}$	Thermo Sharp 5030	Ambient temperature	Audit monthly, calibrate annually	Audit monthly.	See Note 1
		Ambient pressure	Audit monthly, calibrate annually	Audit monthly.	See Note 1
		Flow	Audit monthly, calibrate annually	Audit monthly.	See Note 1
		Leak check	Monthly	See note 4	See note 3
		Analog output	Annually	Done annually	See note 1
		Proportional Counter	Audit annually	Done annually	See note 1
		Nephelometer zero	Audit quarterly	Done monthly	Checked at monthly calibrations. Adjusted when required.
TSP/metals	TE-5170	Flow calibration	Upon installation, monthly, or after any motor maintenance	Calibrated monthly and after motor maintenance.	Flows calibrated on the following dates: 05-Jan-1702-Feb-1727-Feb-1727-Apr-1730-May-1721-May-1729-July-1731-Aug-175-Sept-176-Oct-171-Nov-1723-Nov-1713-Nov-17
PAH and D/F	TE-1000	Flow calibration	Upon installation, monthly, or after any motor maintenance	Calibrated monthly and after motor maintenance.	Flows calibrated on the following dates: 05-Jan-17 02-Feb-17 27-Feb-17 27-Apr-17 3-May-17 1-June-17 4-July-17 28-Jul-17 31-Aug-17 14-Sep-17 23-Oct-17 23-Nov-17 18-Dec-17
Wind Speed and Direction	Met One 034B	Wind speed calibration	Annually	Annually	16-Sep
		Potentiometer calibration	Annually	Annually	16-Sep
Temperature	HMP 60	External calibration	Annually	Annually	16-Sep
Rainfall	TE525M	Field Calibration. Factory calibration if field calibration not passed.	Annually	Annually	16-Sep
Relative Humidity	CS HMP60	Calibration (annually)	Annually	Annually	16-Sep
Data Acquisition	CS CR1000	Calibration every three years	3- years	To be done at 3 years	See Note 4

Notes:

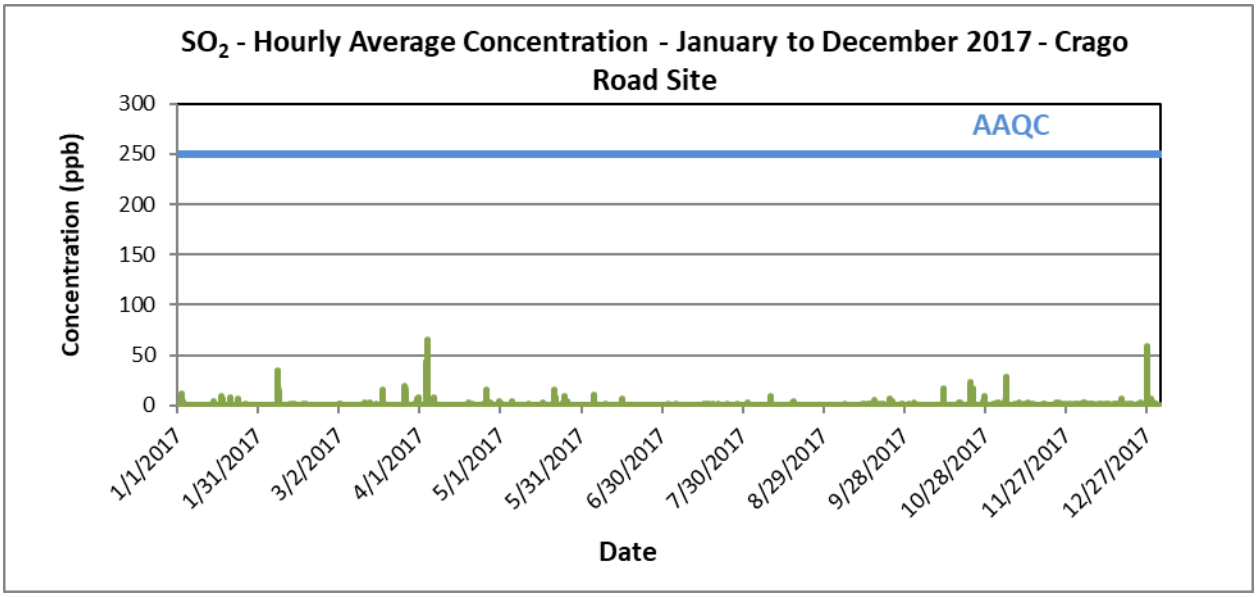
1. Monthly Calibrations Completed March 11, April 15, May 12, June 13, July 21, August 17, September 23, October 13, November 11, and December 12.
2. Although a leak check is not formally possible with this model, the MOECC introduced a methodology using a leak checker designed for the Sharp 5030i which has been implemented. The procedure is only performed when data is suspect.
3. Data logger failed Dec 21, replaced data logger with spare and sent data logger to manufacturer for repair and to download any data.

Table A-3 Summary of Instrument Issues at the Crago Road Station

Parameter	Issues	Timeframe	Remedial Action
SO_2	Equipment supplier identified potential internal power cable issue.	15-Mar-17	Supplier provided a new power cable under warranty, which was installed by Valley Environmental Services (VES). All data intact.
	Perm Tube performance degraded.	28-Apr-17 6:00	Perm Tube replaced.
NOx	Sudden, non-linear negative drift in NO_X measurements.	22-Feb-2017 8:00 - 14:00	Reviewed and invalidated 6 hours of data.
	Equipment supplier identified potential internal power cable issue.	15-Mar-17	Supplier provided a new power cable under warranty, which was installed by VES. All data intact.
	Measured concentration low due to off-specification calibration gas.	5-Apr-17 13:00 – 30-Jun-17 23:00	Conservatively applied a span correction of 13.3% to all data from 5-Apr-17 (the time of the MOECC audit of other stations previous to the June 20th audit).
	Faulty perm tube for instrument auto zeros.	28-Apr-17 8:00 – 30-Jun-17 23:00	Replacement perm tube ordered and installed as soon as received. All data intact.
	Monitor taken offline to diagnose perm tube performance issue.	28-Apr-17 6:00 – 8:00	Maintenance performed.
	Analyzer offline to diagnose auto zero performance.	10-May-17 9:00 - 14:00	Leak check performed.
$PM_{2.5}$	Sharp inlet pump malfunctioned, causing it to shut down.	30-May-17 7:00 – 31-May-17 14:00	Pump restarted. Data during the malfunction was invalidated.
	Crago Sharp moved to the Courtice WPCP Station after a pump issue at Courtice required the Courtice unit be sent for repair.	8-Jun-17 13:00 – 9-Jun-17 9:00	Once repair was completed, the Courtice Sharp was installed at Crago until the next monthly calibration, when both units were returned to their respective stations.
TSP/Metals Hi-Vol.	None	-	-
PAH/ D/F Hi-Vol	None	-	-
Other	None	-	-

Appendix B SO_2 PLOTS

Figure B-1 Time History Plots of Measured Hourly Average and 24-Hour Average SO_2 Concentrations – Crago Road Station



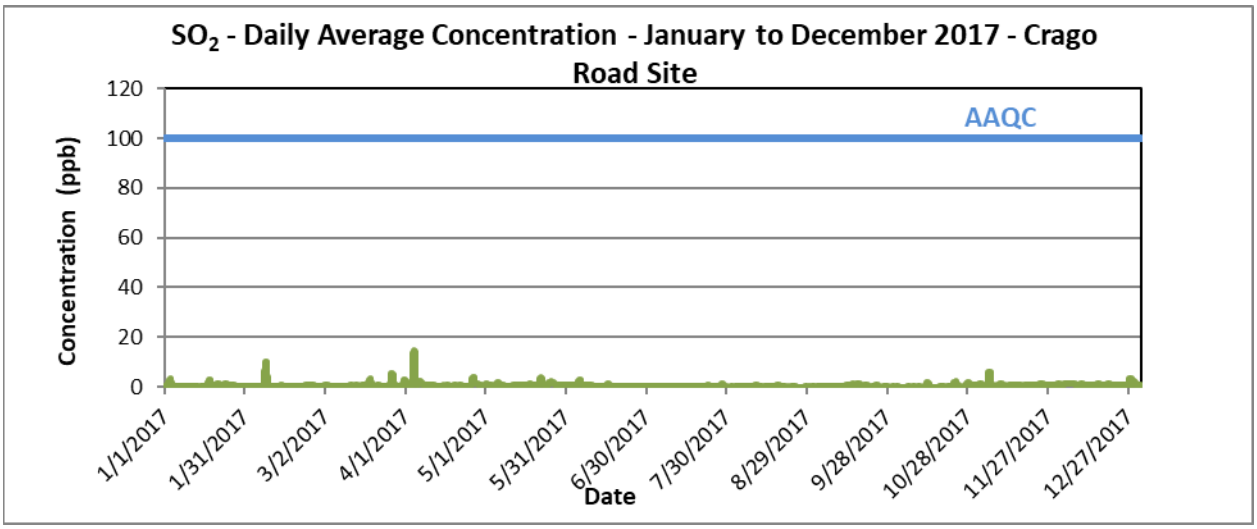
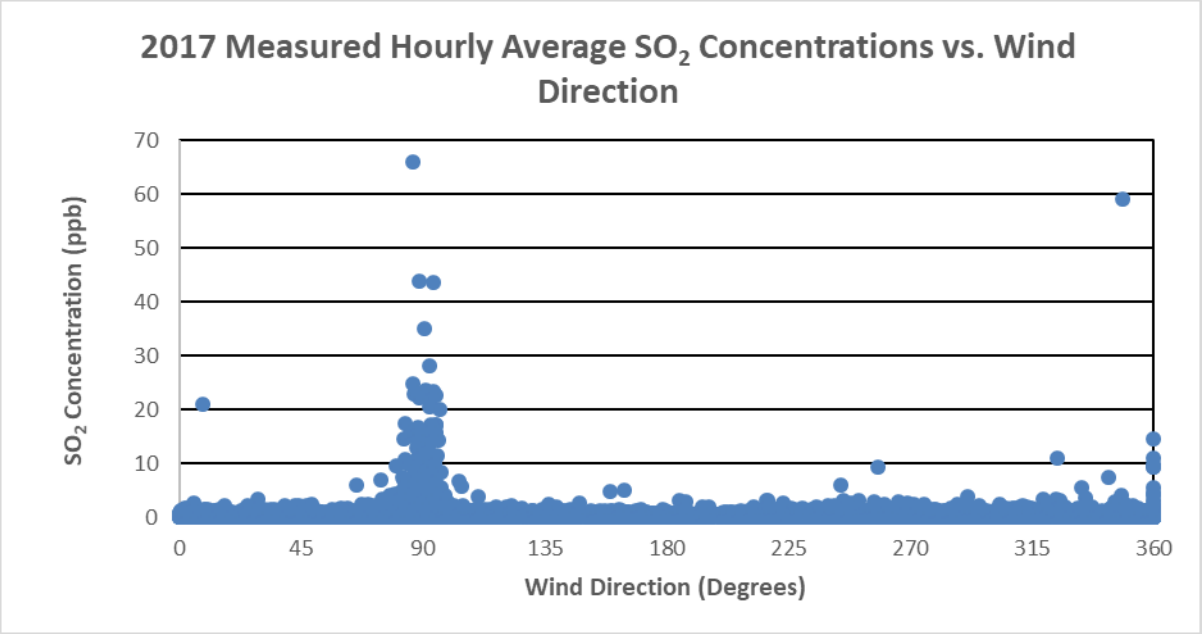
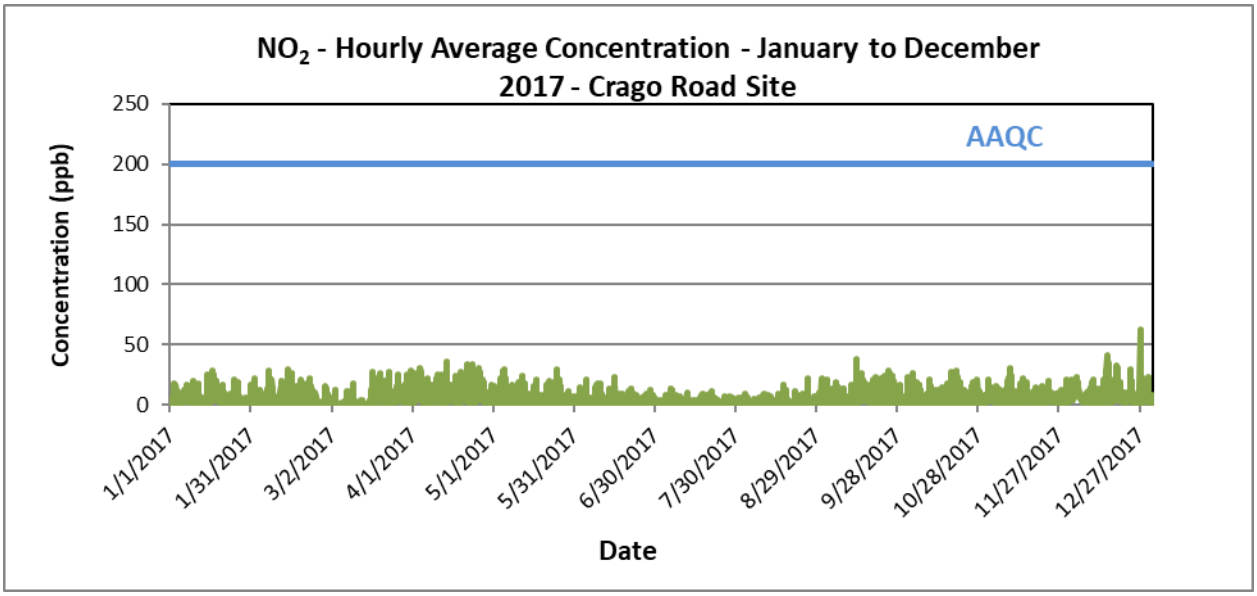


Figure B-2 Measured Hourly Average SO2 Concentrations vs. Wind Direction – Crago Road Station



Appendix C NO_2 PLOTS

Figure C-1 Time History Plots of Measured Hourly Average and 24-Hour Average NO2 Concentrations – Crago Road Station



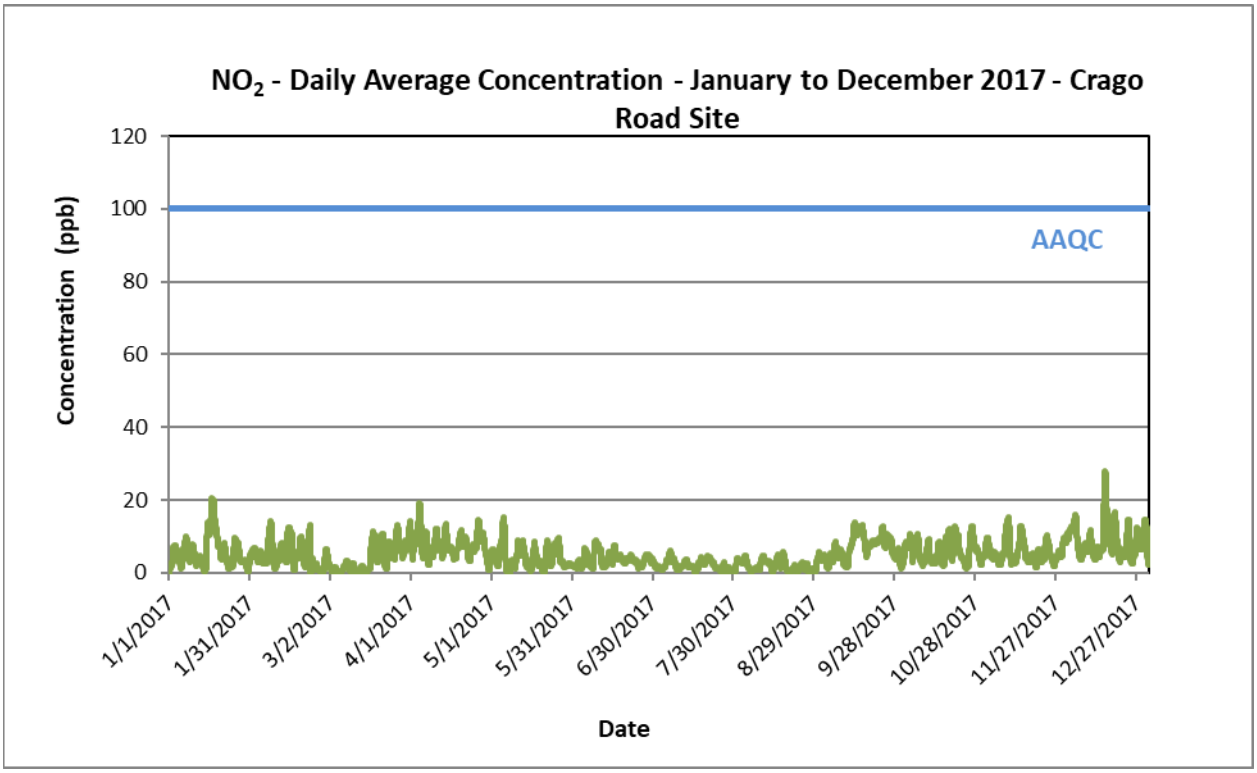
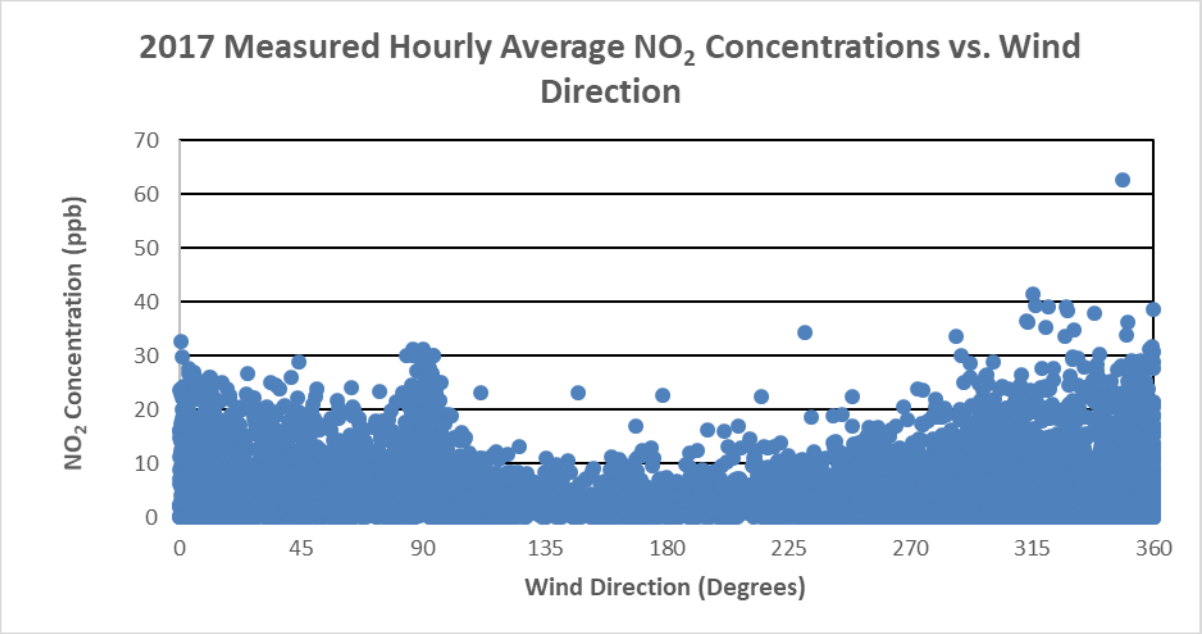
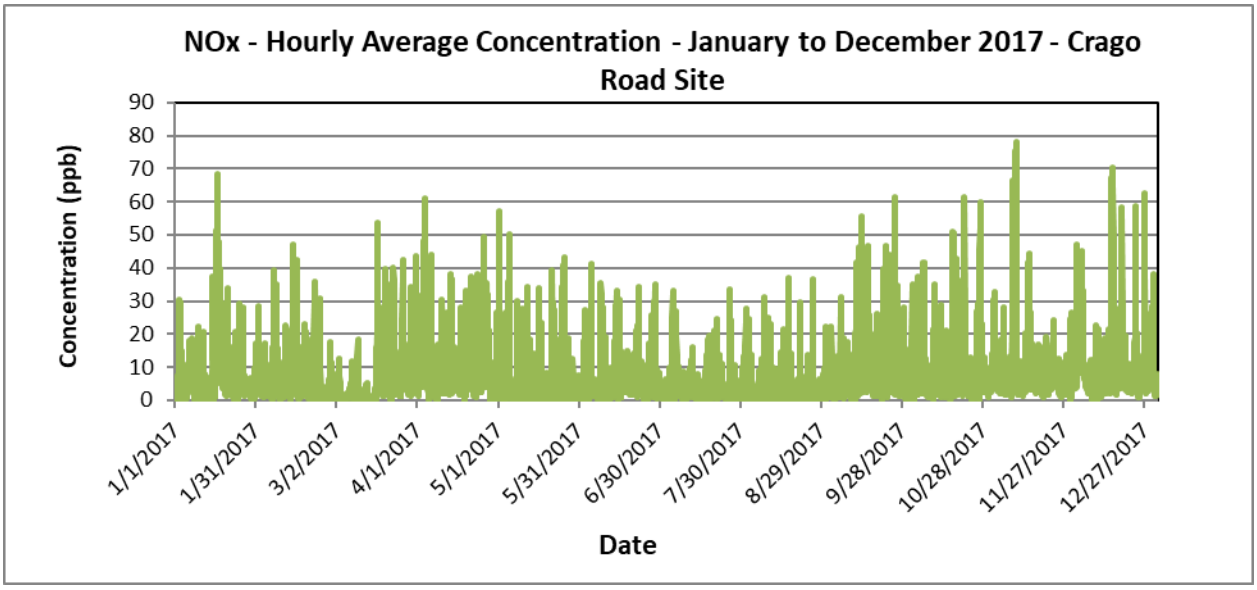


Figure C-2 Measured Hourly Average NO2 Concentrations vs. Wind Direction – Crago Road Station



Appendix D NO_X PLOTS

Figure D-1 Time History Plots of Measured Hourly Average and 24-Hour Average NOX Concentrations– Crago Road Station



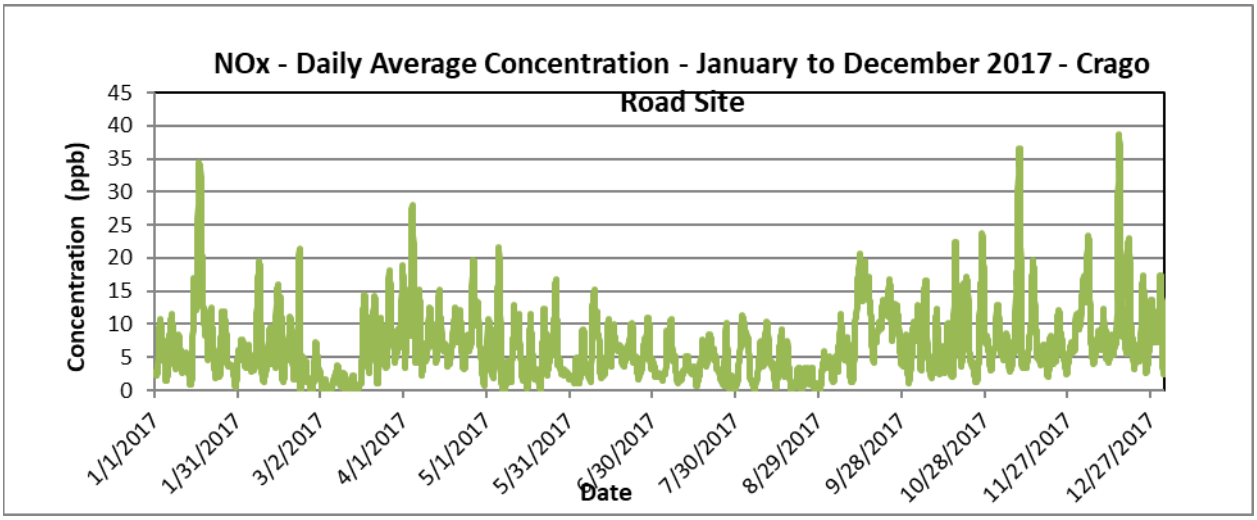
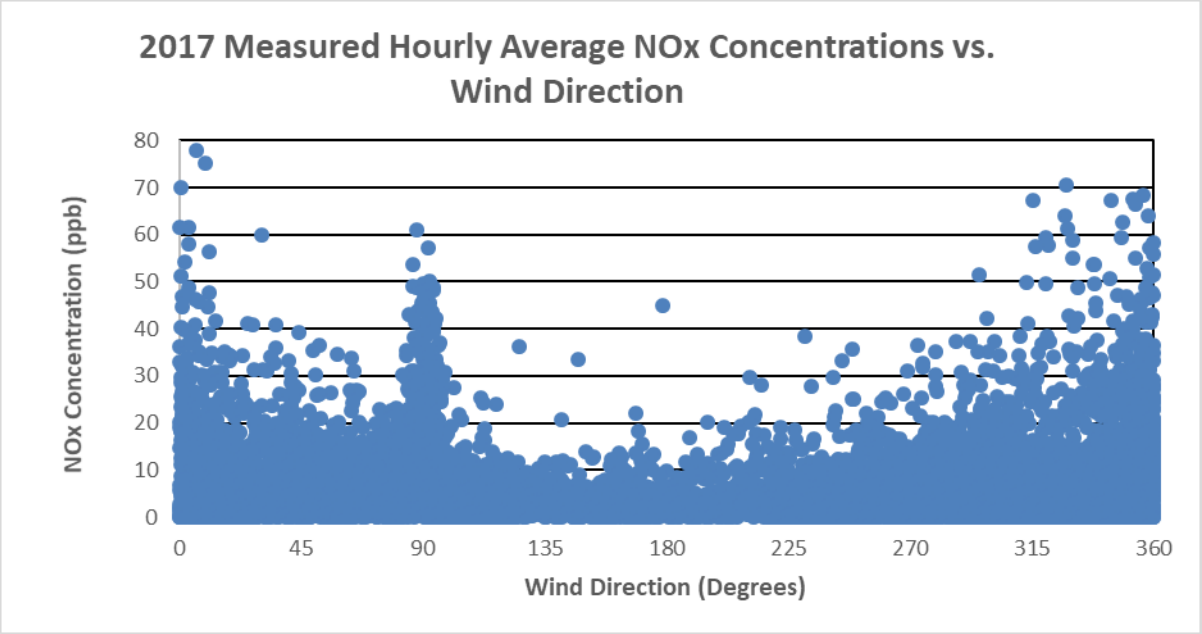


Figure D-2 Measured Hourly NOX Concentrations vs. Wind Direction – Crago Road Station



Appendix E $PM_{2.5}$ PLOTS

Figure E-1 Time History Plot of Measured 24-Hour Average PM2.5 Concentrations – Crago Road Station

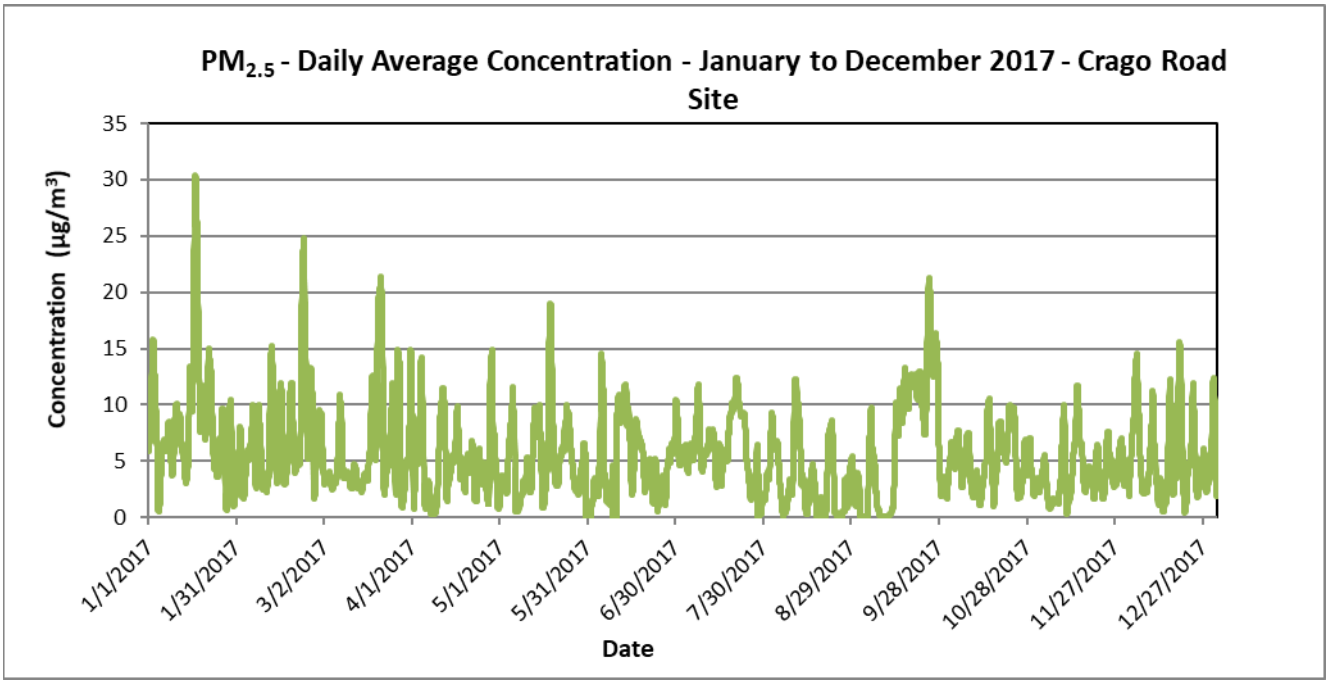


Figure E-2 Time History Plot of Measured 24-Hour Average PM2.5 Concentrations – Crago Road Station