Overview of Ambient Air Monitoring Programs in Durham Region

Ministry of the Environment, Conservation and Parks

Technical Memorandum Update
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Memorandum Completion Date: January 2022

Ontario

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EXECUTIVE SUMMARY

The ministry analyzed available air quality data for the Clarington area to observe possible trends, sources, or patterns and to provide a picture of the general ambient air quality throughout the Municipality of Clarington, Ontario.

In July 2018, a technical memorandum was produced summarizing the analysis of air quality data for the years 2013 to 2016. The report included a summary of data from air monitoring stations operating throughout Durham Region by various parties, including: the Ministry of the Environment, Conservation and Parks, Environment and Climate Change Canada, the Durham York Energy Centre, St. Marys Cement, 407 East Construction, and Gerdau Ameristeel.

This report provides an update of the original technical memorandum to include data from 2013 to 2020. A review of trends, sources and patterns was conducted on the most recent monitoring data. The monitoring data was compared against Ontario's *Ambient Air Quality Criteria* (AAQC) when AAQCs were available. For parameters that have Canadian Ambient Air Quality Standards (CAAQS), such as fine particulate matter ($PM_{2.5}$), the 2015 and 2020 CAAQS were used for comparison.

The ministry also undertook real time air monitoring in the Municipality of Clarington over five days on July 21, 22, 26, 28 and 30, 2021, using a mobile air monitoring vehicle. Concentrations of volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter were measured, along with meteorological conditions, at several locations. Concentrations of the measured pollutants did not exceed AAQC converted assessment values at any time during the 2021 mobile air monitoring survey (see Appendix A).

Analysis shows that air quality in Durham Region, with its range of urban and rural communities, are comparable to similar communities across southern Ontario. Air quality in Ontario has improved significantly over the last 10 years, including significant decreases in nitrogen dioxide, fine particulate matter, and sulphur dioxide.

A broad range of activities contribute to local air quality in Durham Region including industrial, construction, residential, commercial, agricultural, transportation, and transboundary sources from outside the region and province. The monitoring stations are influenced by all sources in the area and can vary from year to year. Though results are representative of local conditions, it is difficult to definitively determine the contribution of any individual sources to local air quality with accuracy using accepted methodologies.

Concentrations of the 2021 real time mobile air monitoring survey did not exceed AAQC converted assessment values, and while data from 2013 to 2020 showed that the pollutants monitored are generally below the CAAQS indicators and AAQC, there were a few exceedances which are discussed throughout the report. Air quality observed in this area were considered typical of similar communities across southern Ontario.

1.0 Introduction

The Ministry of the Environment, Conservation and Parks (MECP) received a request from the Municipality of Clarington to provide an overview of the air monitoring programs in Durham Region, with a focus on particulate matter (PM_{10} and $PM_{2.5}$). The original report of this memorandum was based on data considered from 2013 to 2016. This memorandum provides an update to the original report to include an additional four years of monitoring data; it summarizes air quality measurements from various monitoring programs located in Durham Region, including data collected from air monitoring stations operated by individual stakeholders.

The government-operated stations used to gather data include those operated by MECP and by Environment and Climate Change Canada as part of the National Air Pollution Surveillance (NAPS) network, and are as follows:

- Oshawa
- Newmarket
- Toronto West
- Hamilton Downtown
- Sarnia
- Simcoe

Data from Stakeholder-operated air monitoring stations was also used and includes stations located near:

- St. Marys Cement
- Durham York Energy Centre
- 407 East Construction Phase I & II
- Gerdau Ameristeel Company

The data presented in this memorandum represents numerous sources around the monitoring stations, and includes industrial, transportation, residential, commercial, agricultural, and construction activities. The data collected from the stations may also be influenced by transboundary sources outside Durham Region, including sources elsewhere in Ontario, Quebec and the United States. Based on the locations of the monitoring stations, the data considered here represents air quality in the south Clarington, Whitby and Oshawa areas, and is not assumed to be representative of general air quality for the entire Clarington area in Durham Region. Since each monitoring program was established for a unique purpose, and there are differences in the duration of sampling, parameters measured and equipment used, the resulting measurements may not be directly comparable. Furthermore, when considering these differences, together with high background variability, it is not possible to determine with any accuracy the percent contributions from any specific source.

Nevertheless, there is still value in summarizing the various air quality monitoring programs in Durham Region to assess any specific patterns; an increase or decrease in annual average concentrations between stations can potentially highlight patterns or trends which may not always be evident.

The air monitoring programs operated by stakeholders are used to measure specific contaminants based on the types of emissions associated with their specific activities. For example, some industries will monitor NO_2, SO_2 and $PM_{2.5}$ emissions that are by-products of combustion, whereas construction monitoring will sample mainly for PM_{10} and $PM_{2.5}$ that results from material handling activities and diesel construction equipment emissions. Government operated monitoring stations are designed to measure general outdoor air quality in the area. This kind of ambient air monitoring is not used for assessing compliance nor is it used for point source identification in this report. The ambient air quality readings collected are cumulative in nature, capturing all potential sources in the area.

1.1 Overview of Monitoring Programs in Durham Region

Monitoring stations in Durham Region are operated either by the MECP, as part of the Air Quality Health Index network, by Environment Canada and Climate Change (ECCC) as the National Air Pollution Surveillance (NAPS), or are operated by local stakeholders. Monitoring programs that are not operated by the MECP are reviewed and audited on a quarterly basis to ensure the data is valid, and to confirm that siting and performance criteria meet the *Operations Manual for Air Quality Monitoring in Ontario* (MECP, 2018). Stakeholder operated monitoring programs in Durham Region include programs designed to monitor ambient air quality around the Durham York Energy Centre (DYEC), St. Marys Cement, Gerdau Ameristeel Corporation (Gerdau Whitby) and the Highway 407 East construction activities.

In addition to providing data overviews from these stations, this memorandum also summarizes measurements from the MECP's Oshawa station for comparison purposes. Monitoring stations and parameters discussed are outlined in Table 1, along with a map of the monitoring stations provided in Figure 1.

DYEC has the most extensive monitoring network of all the stakeholder programs we considered, and for this reason the memorandum tends to focus heavily on the data from this program in comparison to the others. In addition, stakeholder operated stations were established for particular purposes associated with their specific activities. While it is possible to provide some general comparisons between these stations and the regional monitoring stations, the stakeholder operated monitoring programs were not designed to reflect the general air quality in south Clarington.

This memorandum focuses on monitoring data between 2013, when the 407 East Phase 1 construction and DYEC monitoring programs began, and 2020, which is the most recent annual data set available to the ministry. For some stations, annual statistics are included from 2014 to 2020, as monitoring at these stations only commenced mid-2013. The monitoring program for the 407 East construction project was operational for three months before construction and one year during construction for both Phase 1 and Phase 2. For this reason, annual statistics are only provided for the 2016 construction monitoring period.

Some parameters are monitored continuously while other parameters, such as metals, BaP, dioxins and furans, are measured on a 24-hour basis every 6, 12, or 24 day cycle which is referred to as non-continuous sampling.

Table 1. Air Monitoring Stations and Parameters

Stakeholder Monitoring Program	Station	Data Collection Frequency	Relevant Parameter(s)	Start/End Date
DYEC	Courtice and Rundle Stations [a]	Continuous	$PM_{2.5}$, NO_2, SO_2	May 1, 2013 - ongoing
		Every 6-days	TSP and metals	May 4, 2013 - ongoing
		Every 12- days	PAHs	May 4, 2013 - ongoing
		Every 24-days	Dioxins and Furans	May 16, 2013 - ongoing
		Continuous	Meteorological parameters	May 1, 2013 - ongoing
	Fenceline Station	Every 6-days	TSP and metals	February 18, 2016 – September 2018
MECP	Oshawa	Continuous	$PM_{2.5}$, NO_2, O_3	2005 [b] - ongoing
	Toronto West	Continuous	$PM_{2.5}$, NO_2, SO_2	January 2000 - ongoing
	Newmarket	Continuous	$PM_{2.5}$, NO_2	July 2001 - ongoing
	Sarnia	Continuous	NO_2, SO_2	June 1978 - ongoing
	Hamilton Downtown	Continuous	$PM_{2.5}$, NO_2, SO_2	March 1987 - ongoing
St. Marys Cement	SMC1 and SMC2	Continuous	PM_{10}	April 1, 2011 - ongoing
	Sites A[c], B and F[d]	Every 6-days	PM_{10}	November 2004 - ongoing
407 East – Phase One, Preconstruction and Construction	Cresser	Continuous	$PM_{2.5}$, PM_{10}, NO_2	April 15, 2012 – August 15, 2012 and February 1, 2013 – December 31, 2013

	Brooklin	Continuous	$PM_{2.5}$, PM_{10}, NO_2	May 16, 2012 – August 15, 2012 and February 1, 2013 – December 31, 2013
407 East – Phase Two, Preconstruction and Construction	Old Scugog	Continuous	$PM_{2.5}$, PM_{10}, NO_2	June 1, 2014 – August 31, 2014 and April 1, 2016 – April 30, 2017
	Highway 2	Continuous	$PM_{2.5}$, PM_{10}, NO_2	July 1, 2015 – September 30, 2015 and March 5, 2016 – March 31, 2017
Gerdau Ameristeel Corporation	Whitby	Every 6-days	TSP and metals	January 2015 – ongoing

[a] Note: DYEC non-continuous parameters were not monitored during the commissioning phase of the DYEC (between July 2014 and February 13, 2015).
[b] Previous to 2005 MECP Oshawa Station was situated at a different location. The Oshawa Station was further relocated in 2017.
[c] Site A was discontinued in January 2015.
[d] Site F was temporarily shut down in June 2016 due to construction activities on site.

Figure 1. Air Monitoring Stations in Durham Region

With the exception of $PM_{2.5}$, monitoring data is compared against Ontario's Ambient Air Quality Criteria (AAQC). $PM_{2.5}$ is compared against the Canadian Ambient Air Quality Standards (CAAQS). An AAQC is not a regulatory value, it is a concentration of a contaminant in air that is generated with a view to protecting human health and the environment. The term 'ambient' is used to reflect general air quality independent of location or source of a contaminant. AAQC are most commonly used in environmental assessments, special studies using ambient air monitoring data, assessment of general air quality in a community, and annual reporting on air quality across the province. (Ontario Air Quality in Ontario 2014 Report, MOECC).

While some of the stakeholder monitoring programs discussed here are designed around a specific source, the data can be used to compare against AAQCs as the stations are influenced by all sources in the area and as such, the results are representative of local conditions. Typically, in Ontario, sample collection is automated with samples being collected as regularly as every 5 minutes. These values are averaged on an hourly basis and reported to the ministry. The hourly information reported is compared to Ontario's AAQC for various averaging times. For example, the 24-hour concentrations are determined by averaging hourly measurements on each day of the year from midnight to midnight.

For parameters that have CAAQS, such as $PM_{2.5}$, either the 2015 or 2020 CAAQS are used for comparison purposes depending upon the year the data was collected. CAAQS are only applicable if the data reported is from a designated station and has followed the metrics as defined in the Canadian Council of Ministers of the Environment (CCME) guidelines. For example, at the ministry's Oshawa Station, the 24-hour average CAAQS for $PM_{2.5}$ is based on the average of the 98th percentile of three consecutive years of continuous hourly data. The CAAQS values for $PM_{2.5}$ in this report are provided as an indicator for relative comparison purposes only and are referenced herein as CAAQS indicators.

Further details on specific AAQCs for 2020 can be found at www.ontario.ca/page/ontarios-ambient-air-quality-criteria. It is important to note that the AAQCs and CAAQS for both SO_2 and NO_2 have been updated since the original memorandum to reflect the latest available science and harmonize with Health Canada's standards. The updated SO_2 AAQCs and air standards, as well as additional information pertaining to how the standards were developed, are published in the ministry's "Ontario Air Standards for Sulphur Dioxide (SO_2), March 2018".

A list of the relevant AAQC and CAAQS indicators are also provided in Appendix B.

2.0 Durham York Energy Centre Monitoring Program

The Durham York Energy Centre (DYEC) air monitoring program has been divided into three phases: pre-operation, a brief commissioning phase, and the operational period. The pre-operation phase captured baseline conditions before DYEC began operations (2013-2014). The commissioning phase occurred between June 28, 2014 and February 12, 2015 when equipment was tested. The operational phase consists of the day-to-day operations of the facility from February 13, 2015 to present. The DYEC air monitoring network is comprised of three monitoring stations, referred to as the Courtice, Rundle and Fenceline stations. Figure 1 provides a map of these locations. As outlined in the approved monitoring plan for the Fenceline station, data was only collected between 2016 and mid 2018.

Parameters are monitored at the stations both continuously and non-continuously. Continuous monitoring represents real-time data that has been collected on a regular and ongoing basis (e.g. hourly). Non-continuous monitoring represents data that has been collected over a period of time and on a set frequency (e.g. over a 24hr period every 6, 12, or 24 days) and is analysed by a certified laboratory. Non-continuous data represents a cumulative sample rather than discrete real-time measurements recorded with continuous monitoring data.

Continuously monitored pollutants at both the Courtice and Rundle stations includes fine particulate matter ($PM_{2.5}$), Oxides of Nitrogen (NO, NO_2 and NO_x), and Sulphur Dioxide (SO_2). Meteorological parameters including wind speed and direction, ambient temperature, relative humidity and barometric pressure are continuously monitored as well. Continuous parameters were monitored during the pre-operation and commissioning (May 1, 2013 to February 12, 2015) and the operational phases (February 13, 2015 to present) of the facility.

Non-continuously monitored pollutants at both the Courtice and Rundle stations includes total suspended particulate (TSP), metals, dioxins and furans (D/F) and polycyclic aromatic hydrocarbons (PAHs). The Fenceline station measured TSP and metals to capture process fugitive emissions. Non-continuous parameters were monitored during the pre-operation (May 1, 2013 to June 28, 2014) and operational phases (February 13, 2015 to present) of the facility, and not during the commissioning phase (June 29, 2014 to February 12, 2015), as per the environmental assessment conditions and the approved ambient monitoring plan.

Ambient air quality measurements at the DYEC monitoring stations are summarized in the sections below.

2.1 Continuous Parameters at DYEC

2.1.1 $PM_{2.5}$

$PM_{2.5}$ is either emitted directly into the atmosphere through fuel combustion (e.g. from vehicles, smelters, power plants, industrial facilities, residential fireplaces and wood stoves, agriculture and forest fires), or formed indirectly in the atmosphere through a series of complex chemical reactions. $PM_{2.5}$ is also found in the transboundary movement of pollutants from neighbouring States and Provinces, for example from wildfires (Air Quality in Ontario 2014 Report, MOECC).

$PM_{2.5}$ data collected pre-operation and during the operation of DYEC were compared. The following tables provide a statistical summary of $PM_{2.5}$ at both the Courtice and Rundle stations. All continuous parameters monitored were below the annual CAAQS for the appropriate years, as shown in Table 2. The 2014 annual $PM_{2.5}$ average reported in Table 2 includes both the construction and commissioning phases of the facility.

Table 2. Annual & Period Average $PM_{2.5}$ Concentrations at DYEC

	Pre-Operation (May 1, 2013 to Feb.12, 2015)			**Operation (Feb. 13, 2015 to Present)**					**Annual CAAQS (2015) [b]**	**Annual CAAQS (2020) [b]**
Station	**2013[a]**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**		
Courtice (ug/m³)	8.5	8.6	7.7	6.8	6.5	6.4	6.4	5.9	10	8.8
Rundle (ug/m3)	8.4	8.5	9.5	9.6	6.3	6.1	5.7	5.2	10	8.8

[a] There was insufficient data for a valid annual mean as the 2013 period captures 24-hour average concentrations only between May 1, 2013 and December 31, 2013.

[b] The CAAQS indicator of 10 ug/m³ (2015) and 8.8 ug/m³ (2020) are used as a reference and for comparison purposes only.

In general, $PM_{2.5}$ annual average concentrations were slightly higher during the pre-operation phase compared to the operational phase at both the Courtice and Rundle Stations. This decrease in concentrations was also highlighted in the ministry's AQHI 2018 Report (MECP, 2018), which showed an approximate 10% decrease over the last 10 years. While a small increase in $PM_{2.5}$ was noted at the Rundle station in 2015 and 2016. This was likely due to short-term impacts from local sources, such as road construction (construction of the highway 407 interchange), off-road mobile equipment and other combustion sources such as residential, commercial and industrial heating.

The maximum 24-hour average $PM_{2.5}$ concentrations at Courtice and Rundle Stations were also higher in 2015 and 2016 with lower concentrations over the past several years (Table 3a). This trend may be due to meteorological variability combined with changes in local construction and other activities. The frequency of 24-hour average elevated $PM_{2.5}$ events has also decreased from between 4 and 6 exceedances a year preconstruction, to only 1 or even no observed exceedances in 2020; suggesting that local sources (such as construction) are contributing less to the overall impacts.

Table 3a. Maximum 24-hour Average $PM_{2.5}$ Concentrations at DYEC

	Courtice	Rundle	CAAQS (2015) [c]	CAAQS (2020) [c]
	(µg/m³)			
Pre Operation of DYEC[a]	40.4	40.6	--	--
Operation of DYEC[b]	57.9	55.2	--	--
2017	43.4	29.6	28	--
2018	34.7	31.5	28	--
2019	28.1	24.9	28	--
2020	28.3	22.9	--	27

[a] Pre Operation of DYEC was between May 1, 2013 and February 12, 2015.
[b] Operation of DYEC between February 13, 2015 and December 31, 2016.
[c] In 2015 the 24-Hour CAAQS was 28 µg/m³. In 2020, the 24-Hour CAAQS was 27 µg/m³.

Table 3b. Number of 24-hour Average $PM_{2.5}$ Exceedances at DYEC

	Courtice	Rundle	CAAQS (2015) [c]	CAAQS (2020) [c]
	(µg/m³)			
Pre Operation of DYEC [a]	4	6	--	--
Operation of DYEC [b]	6	19	--	--
2017	2	3	28	--
2018	2	2	28	--
2019	1	0	28	--
2020	1	0	--	27

[a] Pre Operation of DYEC was between May 1, 2013 and February 12, 2015.
[b] Operation of DYEC between February 13, 2015 and December 31, 2016.
[c] In 2015, the 24-Hour CAAQS was 28 µg/m³. In 2020, the 24-Hour CAAQS was 27 µg/m³.

Pollution roses are tools used to illustrate the direction from which contaminants recorded at a station originate, as well as indicating the wind direction from which the elevated concentrations came from. These pollution roses do not include data from periods of calm winds as the anemometer does not accurately capture wind direction under calm conditions (ADMGO, 2016). Pollution roses were developed to assess the direction from which $PM_{2.5}$ concentrations recorded at the Courtice and Rundle stations originated.

In general, the hourly pollution roses illustrated that there are many different sources from all wind directions contributing to the overall $PM_{2.5}$ concentrations measured at the DYEC stations (see Appendix C). The predominant winds in the area around the DYEC monitoring stations were from the west/northwest during the winter months and from southwest during the summer months.

Hourly $PM_{2.5}$ pollution roses from 2013 to 2016 at the Courtice station are provided in Figure C1 (Appendix C). These graphs show $PM_{2.5}$ originated from the west, southwest, northwest, northeast and east directions. This suggests that Highway 401 traffic, construction emissions from ongoing work for the 407 East Phase 2 in 2016, and local industry, along with other potential local, regional, and transboundary sources, were captured.

Figure C2 (Appendix C) provides the hourly 2013 to 2016 $PM_{2.5}$ pollution roses for the Rundle station. These graphs show $PM_{2.5}$ originated from the west, southwest, northwest, north, northeast, and east-southeast directions, and captured emissions from various sources such as Highway 401 traffic emissions, 407 East Phase 2 construction activities and agricultural sources along with other potential local and regional sources. Since the Rundle station is situated close to the CN railway tracks (38 metres away), unlike the Courtice station (1383 metres away), the contribution from locomotive engines was likely measured when the winds were blowing from the south.

Based on field observations in 2016, the Rundle station was also impacted by the construction activities to the north and north-northwest of the station. The more frequent elevated $PM_{2.5}$ 24-hour average concentrations observed in 2016, compared to 2013, may have been a result of unusually dry summer conditions that year, which typically result in more dust impacts as a result of fewer rainfall events.

Figure C1 and C2 (Appendix C) also provides the hourly 2017 to 2020 pollution roses for both Courtice and Rundle stations. The 2017 to 2020 graphs showed similar trends to previous years.

2.1.2 NO_2

Nitrogen oxides (NOx) is a common name for the nitrogen oxides NO and NO_2, which are formed whenever combustion occurs in the presence of nitrogen (e.g. from vehicles, construction equipment and incomplete combustion from industrial, commercial or residential sources); but can also be produced naturally by lightning. Nitric oxide is not considered to be hazardous to health at typical ambient concentrations, but nitrogen dioxide can be.

NOx are measured continuously at the DYEC monitoring stations. This section focuses on NO_2 and recognizes the significance in atmospheric reactions that produce ground-level ozone, a component of smog, and contributes to the formation of $PM_{2.5}$.

Like $PM_{2.5}$, the annual NO_2 concentrations at both Courtice and Rundle stations showed a decrease in concentrations from 2013 to 2020 (Table 4). Overall, the concentrations of several common air pollutants, such as nitrogen dioxide associated with transportation and industry, generally decreased in 2020 since the provincial declaration of an emergency. However, by mid-April 2020, traffic volumes had gradually increased to near normal levels.

Table 4 below provides a statistical summary for NO_2 at the Courtice and Rundle Stations.

Table 4. Annual Average NO_2 Concentrations at DYEC

	Pre-Operation (May 1, 2013 to Feb.12, 2015)			Operation (Feb. 13, 2015 to Present)						
Station	**2013[a]**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Annual AAQC**	**Annual CAAQS**
Courtice (ppb)	6.4	8	6.8	6.3	6.4	6.1	5.8	4.6	n/a	17 (2020) 12 (2025)
Rundle (ppb)	6.5	6.1	6.6	5.3	5.5	4.9	4.3	3.9	n/a	17 (2020) 12 (2025)

Not Applicable (N/A) (there is only hourly or 24-hour average AAQC for NO_2)
[a] There was insufficient data for a valid annual mean as the 2013 period captures 24-hour average concentrations only between May 1, 2013 and December 31, 2013.
Note – the 2025 CAAQS are not currently in effect

While the annual NO_2 concentrations illustrate a general decrease in concentrations, there are no observable trends regarding the maximum hourly and daily values. Tables 5a and 5b below identify the maximum 24-hour and 1-hour NO_2 concentrations respectively. No exceedances have been identified when compared to their respective AAQCs. As there were no AAQC exceedances, a pollution rose assessment was not undertaken for this parameter.

Table 5a. Maximum 24-hour Average NO2 Concentrations at DYEC

	Courtice	**Rundle**	**24-Hour AAQC[c]**
	ppb		
Maximum 24-Hour Concentration			
Pre-Operation of DYEC[a]	31.2	24	100
Operation of DYEC[b]	23.1	19.6	100
2017	23.7	25.9	100
2018	21.1	20.5	100
2019	22.9	17.6	100
2020	23.8	16.9	100
No. of 24-Hour AAQC Exceedances			
Pre-Operation	0	0	100
Operation	0	0	100
2017	0	0	100
2018	0	0	100

2019	0	0	100
2020 [c]	0	0	100

[a] Pre Operation of DYEC was between May 1, 2013 and February 12, 2015.
[b] Operation of DYEC between February 13, 2015 and December 31, 2016.
[c] There is no 24-hour NO_2 CAAQS

Table 5b. Maximum 1-hour Average NO2 Concentrations at DYEC

	Courtice	**Rundle**	**1-Hour AAQC**
	ppb		
Maximum 1-Hour Concentration			
Pre -Operation of DYEC [a]	52.6	62	200
Operation of DYEC [b]	62.3	42.5	200
2017	43.0	43.0	200
2018	71.0	38.0	200
2019	41.3	57.2	200
2020 [c]	39.0	35.2	200
No. of 1-Hour AAQC Exceedances			
Pre-Operation	0	0	200
Operation	0	0	200
2017	0	0	200
2018	0	0	200
2019	0	0	200
2020 [c]	0	0	200

[a] Pre Operation of DYEC was between May 1, 2013 and February 12, 2015.
[b] Operation of DYEC between February 13, 2015 and December 31, 2016.
[c] In 2020, the 1-hour NO_2 CAAQS were phased in. In 2020 the 1-hour CAAQS is 60ppb.

2.1.3 SO_2

Sulphur dioxide (SO_2) is measured continuously at the DYEC monitoring stations. SO_2 is a precursor to sulphates, which is one of the main components of airborne secondary $PM_{2.5}$. Major sources of SO_2 include smelters, industrial processes, and electric utilities.

Provincial initiatives such as Ontario's emissions trading regulations on sulphur dioxide and nitrogen oxides *(O. Reg. 397/01 and O. Reg. 194/05)* and sulphur limits imposed on gasoline and diesel fuel, have helped reduce sulphur emissions regionally from direct sources.

Tables 6, 7a and 7b below provide statistical summaries for SO_2 at the Courtice and Rundle stations. Overall, SO_2 concentrations were similar among years, and below the annual AAQC (4ppb) during both the pre-operation and operation phases of the facility.

Table 6. Annual Average SO_2 Concentrations at DYEC

	Pre-Operation (May 1, 2013 to Feb.12, 2015)			Operation (Feb. 13, 2015 to Present)					
Station	**2013[a]**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Annual AAQC[b]**
Courtice (ppb)	1.63	1.45	0.94	1.73	1.73	2.70	1.95	1.37	4
Rundle (ppb)	0.43	0.66	0.73	0.77	0.57	0.69	0.49	0.39	4

[a] There was insufficient data for a valid annual mean as the 2013 period captures 24-hour average concentrations only between May 1, 2013 and December 31, 2013.
[b] In 2018, the annual AAQC was changed from 20 to 4 (ppb).

The maximum 24-hour average concentrations at Courtice station were higher than at the Rundle station (Table 7a), which were similar to the maximum 1-hour SO_2 trends in concentration. This was likely due to the proximity of the Courtice station to major highways and local roads.

Table 7a. Maximum 24-hour Average SO_2 Concentrations at DYEC

	Courtice	**Rundle**	**24-Hour AAQC[c]**
	(ppb)		
Maximum 24-Hour Concentration			
Pre-Operation of DYEC[a]	13.7	4.1	100
Operation of DYEC[b]	12.9	8.1	100
2017	15.1	5.3	100
2018	17.1	8.1	n/a
2019	18.2	5.5	n/a
2020	15.9	5.5	n/a
No. of 24-Hour AAQC Exceedances			
Pre- Operation of DYEC	0	0	100
Operation of DYEC	0	0	100
2017	0	0	100
2018	0	0	n/a
2019	0	0	n/a
2020	0	0	n/a

[a] Pre-Operation of DYEC was between May 1, 2013 and February 12, 2015.
[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.

[c] SO_2 levels were compared against the 24-hour average AAQC that were in effect through 2017. As of March 2018, there is no longer a 24-hour AAQC in effect.
n/a Not Applicable

Table 7b. Maximum 1-hour Average SO2 Concentrations at DYEC

	Courtice	**Rundle**	**1-Hour AAQC** [c]
	(ppb)		
Maximum 1-Hour Concentration			
Pre- Operation of DYEC [a]	56.3	34.1	250
Operation of DYEC [b]	57.1	30.7	250
2017	96.0	61.0	250
2018	96.0	66.0	40
2019	58.2	34.8	40
2020	67.2	59.7	40
No. of 1-Hour AAQC Exceedances			
Pre- Operation of DYEC	0	0	250
Operation of DYEC	0	0	250
2017	0	0	250
2018	27	3	40
2019	9	0	40
2020	16	3	40

[a] Pre-Operation of DYEC was between May 1, 2013 and February 12, 2015.
[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.
[c] The new 1-hour AAQC of 40ppb came into effect in March 2018.

There were no 1-hour SO_2 AAQC exceedances over 250 ppb reported prior to 2018. In 2018, the 1-hour SO_2 AAQC was updated to 40 ppb and, as a result, several exceedances at both Courtice and Rundle have been observed when concentrations were compared against the new AAQC. These exceedances were as a result of reporting against the more stringent standard rather than a deterioration in the overall air quality. When an exceedance of the 1-hour AAQC is observed a decision to undertake more in-depth reviews of potential health impacts are based on a number of factors, including but not limited to the frequency and magnitude of the exceedance(s). Consideration of the frequency and magnitude of any exceedances will help in understanding the potential risk for health impacts. When an hourly exceedance is noted, the 5-10 minute concentrations and maximum 1 hour concentration are considered. Of the exceedances observed (Table 7b), none of the 5-10 minute concentrations or 1 hour maxima exceeded the ministry's internal thresholds that would trigger a health impact review. For additional information please refer to the ministry's Decision Document: "Ontario Air Standards for Sulphur Dioxide (SO_2), March 2018".

Table 7b provides an overview of the frequency of 1-hour SO_2 exceedances at the Courtice and Rundle stations. Generally, SO_2 concentrations and associated exceedances were higher at the Courtice station, particularly in 2018. These observations may be due to a number of variables, including process changes, local and transboundary sources, and meteorological conditions.

2.2 Non-continuous Parameters at DYEC

2.2.1 PAHs

Polycyclic aromatic hydrocarbons (PAH) are a class of chemical compounds that occur naturally in coal, crude oil, and gasoline. They also are from incomplete combustion and decomposition (pyrolysis) of coal, oil, gas, wood, as well as agricultural and domestic sources. Typically, the predominant source for PAHs are motor vehicles and wood smoke (Ravindra K., et al., 2008).

At Courtice and Rundle stations, PAHs are measured every 12 days following the National Ambient Pollution Surveillance (NAPS) program schedule which meets the ministry's *Operations Manual for Air Quality Monitoring in Ontario* (2018) guidance document requirements.

Seventeen individual PAH compounds were measured at the Courtice and Rundle stations, of these, benzo(a)pyrene, referred to as BaP, is used as a surrogate of total PAHs as this represents the most prevalent PAH. The following section focuses on BaP annual and 24-hour measurements.

Tables 8, 9a and 9b provides a statistical summary for benzo(a)pyrene (BaP) at the Courtice and Rundle stations. It should be noted that data for BaP was unavailable during the commissioning phase, as non-continuous parameters were not being monitored at that time. The annual average concentrations remain consistent over the years as illustrated in Table 8. The maximum 24-hour average BaP concentrations generally are also similar over the years, however, as shown in Table 9a the elevated BaP levels are slightly higher at Rundle station compared to Courtice station.

A minimum number of consecutive samples are required in any given year in order to calculate an annual mean that can be compared to the AAQC. Insufficient data was collected during 2013, 2014 and 2015 to make any meaningful comparisons to the AAQC. The limited data collected between 2013 and 2015 was collectively considered to provide a period average rather than an annual mean for comparison purposes only.

Table 8. Annual & Period Average BaP Concentrations at DYEC

	Pre-Operation (May 1, 2013 to June 28, 2014)	Operation (Feb. 13, 2015 to Present)					Annual AAQC
Station	**2013 - 2014[a]**	**2016**	**2017**	**2018**	**2019**	**2020**	
Courtice (ng/m^3)	0.02	0.03	0.03	0.03	0.02	0.03	0.01
Rundle (ng/m^3)	0.04	0.04	0.04	0.03	0.02	0.04	0.01

[a] This value represents a period average and not an annual mean. 24-hour samples were collected periodically from 2013 to 2014 (there were no samples collected during the commissioning phase and until the facility was fully operational) therefore valid annual means could not be calculated.

Table 4a. Maximum 24-hour Average BaP Concentrations at DYEC

	Courtice	Rundle	24-hour AAQC
	(ng/m^3)		
Pre Operation of DYEC [a]	0.13	0.41	0.05
Operation of DYEC [b]	0.1	0.21	0.05
2017	0.09	0.16	0.05
2018	0.18	0.14	0.05
2019	0.10	0.11	0.05
2020	0.09	0.18	0.05

[a] Pre Operation of DYEC was between May 4, 2013 and June 28, 2014. No further samples were collected between June 29, 2014 and February 12, 2015

[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.

Table 9b. Number of 24-hour Average BaP Exceedances at DYEC

	Courtice	Rundle	24-hour AAQC (ng/m^3)
Pre Operation of DYEC [a]	3	5	0.05
Operation of DYEC [b]	5	7	0.05
2017	4	8	0.05
2018	5	5	0.05
2019	2	2	0.05
2020	4	5	0.05

[a] Pre Operation of DYEC was between May 4, 2013 and June 28, 2014. No further samples were collected between June 29, 2014 and February 12, 2015

[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.

As a result of residential wood burning, fires and other mobile combustion sources, exceedances of BaP can be found in background ambient air when compared against the AAQC. This is typical for most urban and rural areas in southern Ontario. To illustrate this, data from Environment and Climate Change Canada's (ECCC) urban Toronto West station and the more rural Simcoe station both showed trends of elevated BaPs (please refer to the following website for more information: www.canada.ca/en/environment-climate-change/services/air-pollution/monitoring-networks-data/national-air-pollution-program).

Due to high BaP background levels, the 24-hour average BaP concentrations were similar during pre-operation and operational periods at DYEC monitoring stations. Between 2017 and 2020, a total of 15 24-hour average BaP exceedances at the Courtice station and 20 at the Rundle station were observed (Table 9b).

Figures C3 and C4 (Appendix C) provide pollution roses for 24-hour average BaP concentrations measured at the Courtice and Rundle stations from 2013 to 2020. Similar to observations for $PM_{2.5}$, BaP emissions at both Courtice and Rundle stations originate from local, regional and transboundary sources. From 2013 to 2016, 24-hour average BaP exceedances at the Courtice station occurred mainly when winds were blowing from the west and northeast during pre-operation and from all quadrants during operation. At the Rundle station, 24-hour average BaP exceedances mainly occurred when the winds originated from the northwest, southeast, and occasionally the northeast quadrants. Potential sources from these wind directions included residential and commercial wood burning, agricultural equipment, locomotive engines, industrial, and local traffic.

From 2017 to 2020, the 24-hour average BaP exceedances during operation at the Courtice station did not appear to be strongly connected to any particular wind direction. At the Rundle Station, the 24-hour average BaP exceedances occurred mainly when winds were blowing from the southwest, northwest, and east. Potential sources from these wind directions included residential and commercial wood burning, agricultural equipment, locomotive engines, industrial, and local traffic.

Exceedances of the BaP AAQC at the Courtice and Rundle stations occurred most frequently when winds were blowing from the northwest quadrant, which is upwind of the DYEC facility. This trend was seen during both pre-operation and operational periods of the facility; implying that background BaP concentrations at the Courtice and Rundle stations were most likely due to Highway 401, Highway 407 East construction equipment, agricultural equipment, and potentially other local combustion sources, such as residential and or commercial wood burning. The frequency of BaP exceedances were slightly lower in 2019 and 2020, particularly at the Rundle station.

2.2.2 Dioxins and Furans

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, commonly known as dioxins and furans (D/F), are mainly released from waste incineration (municipal waste, hazardous waste, sewage sludge and medical waste), residential wood combustion, and industrial sources (CCME, 2001).

Table 10, Table 11a and 11b below provide a statistical summary for D/F concentrations that were detectable above the method detection limit (MDL) at the Courtice and Rundle stations. The MDL is the minimum concentration of a substance that can be measured by the analytical method.

The annual D/F trends, as shown in Table 10, were consistent throughout the years with lower annual concentrations in 2019 and 2020. It should be noted that D/F data was not available between June 28, 2014 and February 13, 2015, as non-continuous parameters had not been monitored during the commissioning phase.

Table 50. Annual & Period Average D/F Concentrations at DYEC

	Pre-Operation (May 1, 2013 to June 28, 2014)	Operation (Feb. 13, 2015 to Present)					Annual AAQC
Station	2013 - 2014[a]	2016	2017[b]	2018[b]	2019[c]	2020[c]	
Courtice ($pg\ TEQ/m^3$)	0.022	0.017	0.018	0.019	0.005	0.006	n/a
Rundle ($pg\ TEQ/m^3$)	0.022	0.016	0.020	0.019	0.006	0.007	n/a

[a] This value represents a period average and not an annual mean. 24-hour samples were collected periodically between 2013 to 2014 (there were no samples collected during the commissioning phase and until the facility was fully operational) therefore valid annual means could not be calculated.
[b] There were 16 samples at each monitoring locations in 2017 and 2018.
[c] There were 15 samples at each monitoring location in 2019 and 2020.

Table 11a. Maximum 24-hour Average D/F Concentrations at DYEC

Years/Periods	Courtice	Rundle	24-hour AAQC
	($pg\ TEQ/m^3$)		
Pre-Operation of DYEC [a]	0.04	0.07	0.1
Operation of DYEC [b]	0.04	0.03	0.1
2017	0.05	0.06	0.1
2018	0.10	0.09	0.1
2019	0.01	0.03	0.1
2020	0.03	0.03	0.1

[a] Pre-Operation of DYEC was between May 16, 2013 and June 28, 2014. No further samples were collected between June 29, 2014 and February 12, 2015
[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.

Table 11b. Number of 24-hour Average D/F Exceedances at DYEC

Years/Periods	Courtice	Rundle	24-hour AAQC ($pg\ TEQ/m^3$)
Pre-Operation of DYEC [a]	0	0	0.1
Operation of DYEC [b]	0	0	0.1
2017	0	0	0.1
2018	1	0	0.1
2019	0	0	0.1
2020	0	0	0.1

[a] Pre-Operation of DYEC was between May 16, 2013 and June 28, 2014. No further samples were collected between June 29, 2014 and February 12, 2015
[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.

With the exception of 2018, all maximum 24-hour D/F concentrations were below the AAQC and similar to pre-operation concentrations. An exceedance of the 24-hour average total equivalency toxic (TEQ) for Dioxins and Furans AAQCs (0.1 pg TEQ/m^3) was observed at the Courtice station in 2018. Following this occurrence, a detailed assessment was conducted, which placed the facility upwind. Pollution rose analysis and 48-hour backward trajectory were also conducted. The observed light wind speeds resulted in low mixing and dispersion conditions, and as such, a source could not be confirmed with any accuracy for this event. Toxicological assessment of the data, and the reported concentration of the exceedance suggested no adverse effect from this occurrence.

The pollution roses provided in Figures C5 and C6 (Appendix C) show the wind direction from which D/F were originating at the Courtice and Rundle stations. While the meteorological conditions vary from year to year, based on the 24-hour pollution rose, the contribution of D/F emissions at Rundle station were mainly from the west and northwest quadrants. In 2020 however, the highest D/F concentration was from the northeast. At Courtice station, D/F emissions originate from different quadrants depending on the year. These differences were not only due to meteorological conditions and influences from transboundary contributions at the specific monitors, but due to source variability in the Region.

2.2.3 Total Suspended Particulates (TSP) and Metals

Total suspended particulates (TSP) and metals were measured at the Courtice, Rundle and Fenceline stations every 6 days, following the NAPS schedule. The Fenceline station at the DYEC facility monitored fugitive emissions from material handling activities. This section summarizes TSP and metal concentrations from pre-operation to 2020.

TSP emissions in the area are typically attributed to localized sources such as fugitive and process emissions from industrial or commercial sources (e.g. waste incineration, wood burning, and other processes), construction activities, agricultural activities, and re-suspension of dust from paved and unpaved roads.

Table 12, Table 13a and 13b below provides a statistical summary of TSP at the Courtice, Rundle and Fenceline stations. There were no annual TSP exceedances between 2013 and 2020 as shown in Table 12.

Table 62. Annual & Period Average TSP Concentrations at DYEC

	Pre-Operation (May 1, 2013 to June 28, 2014)		Operation (Feb. 13, 2015 to Present)					Annual AAQC (ug/m^3)
Station	**2013[a]**	**2014[b]**	**2016**	**2017**	**2018**	**2019**	**2020**	60
Courtice (µg/m^3)	18	24	27	26	24	24	22	
Rundle (µg/m^3)	21	25	32	38	52	25	24	
Fenceline[c] (µg/m^3)	---	---	33	35	-	---	---	

[a] There was insufficient data for a valid annual mean as the 2013 period captures samples between May 4, 2013 and December 31, 2013. This value represents a period average and not an annual mean.

[b] There was insufficient data for a valid annual mean as the 2014 period captures samples between January and June 28, 2014. This value represents a period average and not an annual mean. There was no data collected for 2015.
[c] The Fenceline Station began monitoring in February 18, 2016 and was not in operation during pre-operation of the DYEC. For 2018 there is insufficient data to calculate a valid annual average
--- Station not in operation.

Table 13a. Maximum 24-hour Average TSP Concentrations at DYEC

	Courtice (µg/m³)	Rundle (µg/m³)	Fenceline (µg/m³)	24-hour AAQC (µg/m³)
Pre-Operation of DYEC[a]	57	63	---	120
Operation of DYEC[b]	95	97	80	120
2017	60	232	86	120
2018	85	204	94 [c]	120
2019	146	82	---	120
2020	70	102	---	120

[a] Pre-Operation of DYEC was between May 4, 2013 and June 28, 2014. No further samples were collected between June 29, 2014 and February 12, 2015
[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.
[c] Data was collected between January 2, 2018 and September 29, 2018.
--- Station not in operation

Table 13b. Number of 24-hour Average TSP Exceedances at DYEC

	Courtice (µg/m³)	Rundle (µg/m³)	Fenceline (µg/m³)	24-hour AAQC (µg/m³)
Pre-Operation of DYEC [a]	0	0	0	120
Operation of DYEC [b]	0	0	0	120
2017	0	2	0	120
2018	0	4	0 [c]	120
2019	1	0	---	120
2020	0	0	---	120

[a] Pre-Operation of DYEC was between May 4, 2013 and June 28, 2014. No further samples were collected between June 29, 2014 and February 12, 2015
[b] Operation of DYEC was between February 13, 2015 and December 31, 2016.
[c] Data was collected between January 2, 2018 and September 29, 2018.
--- Station not in operation

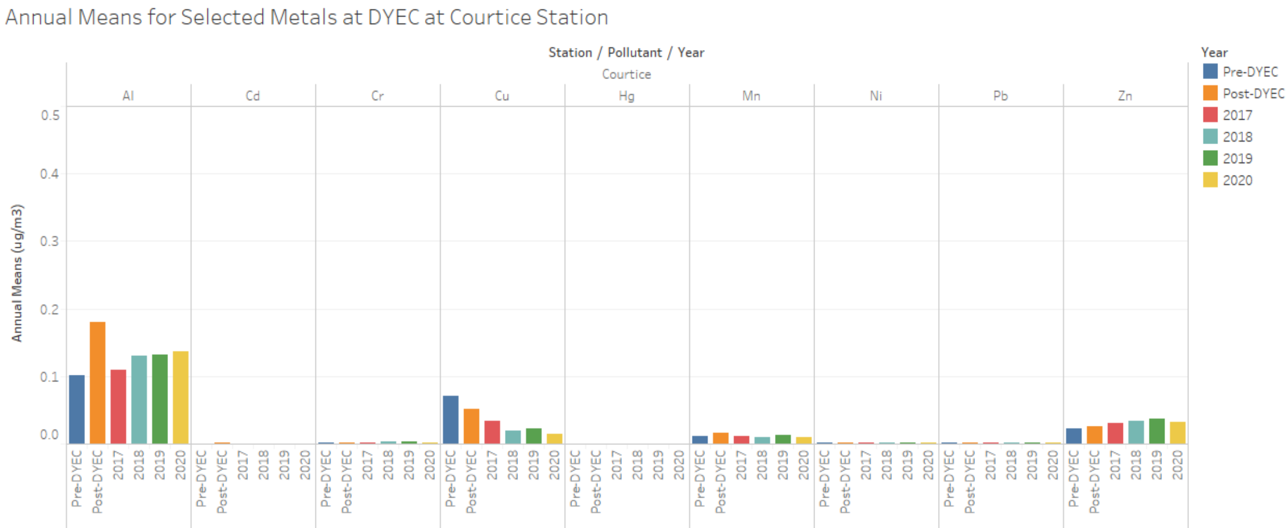
Maximum 24-hour TSP concentrations generally increased from 2013 (Table 13a). This increase was likely due to ongoing construction activities and fugitive dust sources in the area, including the highway interchange construction. Field observations verified these fugitive emissions. Between 2018 and 2019, there was one 24-hour TSP exceedance of the 24-hour AAQC at Courtice station and 4 exceedances at the Rundle station.

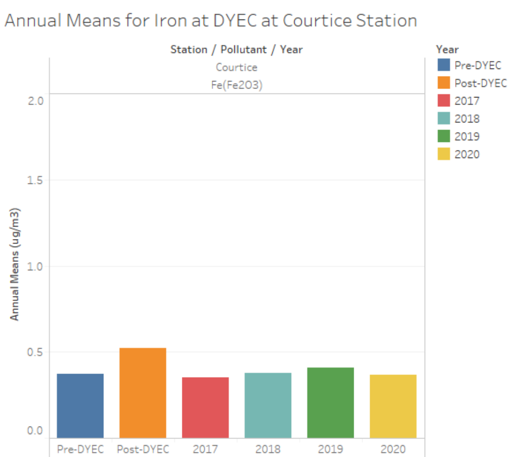
Concentrations of metals observed at the three monitoring stations from 2013 to 2020 are outlined individually in the figures below. All annual average metal measurements were lower than their respective 24-hour AAQC. A total of 29 metals were analyzed from the particulate filters. Nineteen of the metals are below the method detection limit (MDL). The MDL is the minimum concentration of a substance that can be measured by the analytical method. The remaining 10 metals are summarized in Figure 2 to Figure 4 for each of the DYEC monitoring stations.

With the exception of aluminum and iron at the Courtice station, the annual average metal concentrations at the Courtice and Rundle Stations were similar during the pre-operation and operation phases. Both aluminum and iron annual mean concentrations were higher in the operational phase compared to pre-operation, however both metals are still below the corresponding 24-hour AAQC (Figures 2 & 3).

At the Fenceline station, metal concentrations on average were similar to the Courtice and Rundle stations, however, as per the approved monitoring plan, metals were not collected at this station during the pre-operation phase. The maximum annual average metal concentrations are slightly lower for some of the metals detected at the Fenceline station when compared to that of the Courtice and Rundle stations.

Figure 2 Comparison of Selected Metal Concentrations at Courtice Station

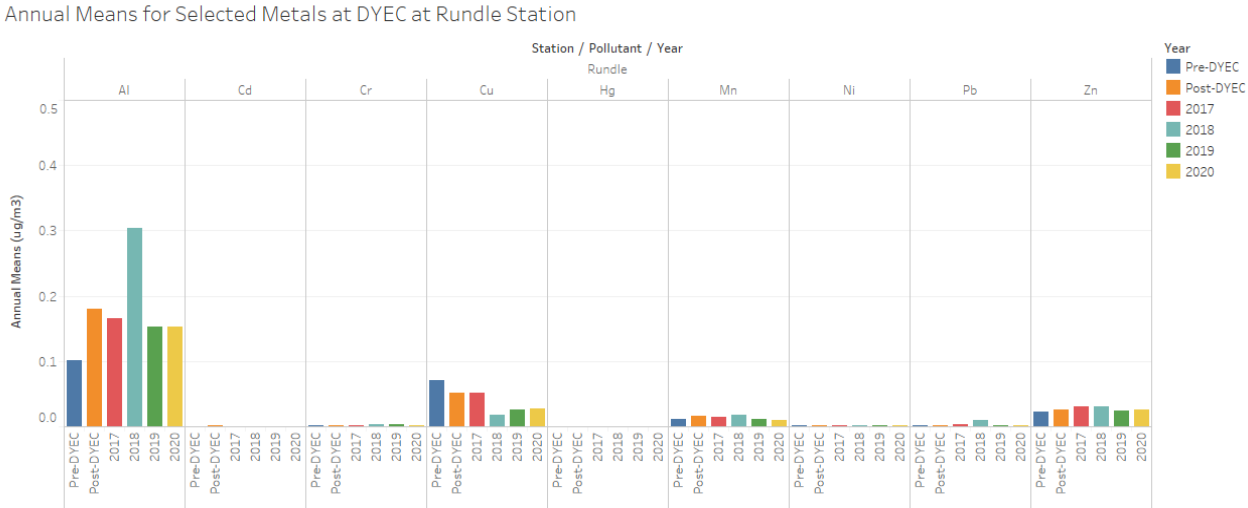


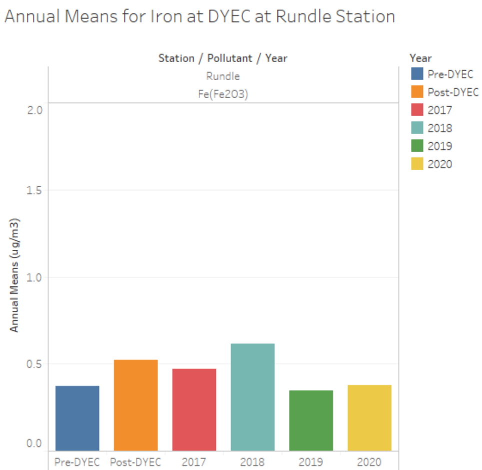


Notes – These figures represent an average of the daily samples over the course of each calendar year (frequency of samples was every 6 days).

-There is no annual AAQC except for nickel which has an annual AAQC of 0.04 ug/m3. For other AAQC averaging times, please refer to Appendix B.

Figure 3 Comparison of Selected Metal Concentrations at Rundle Station

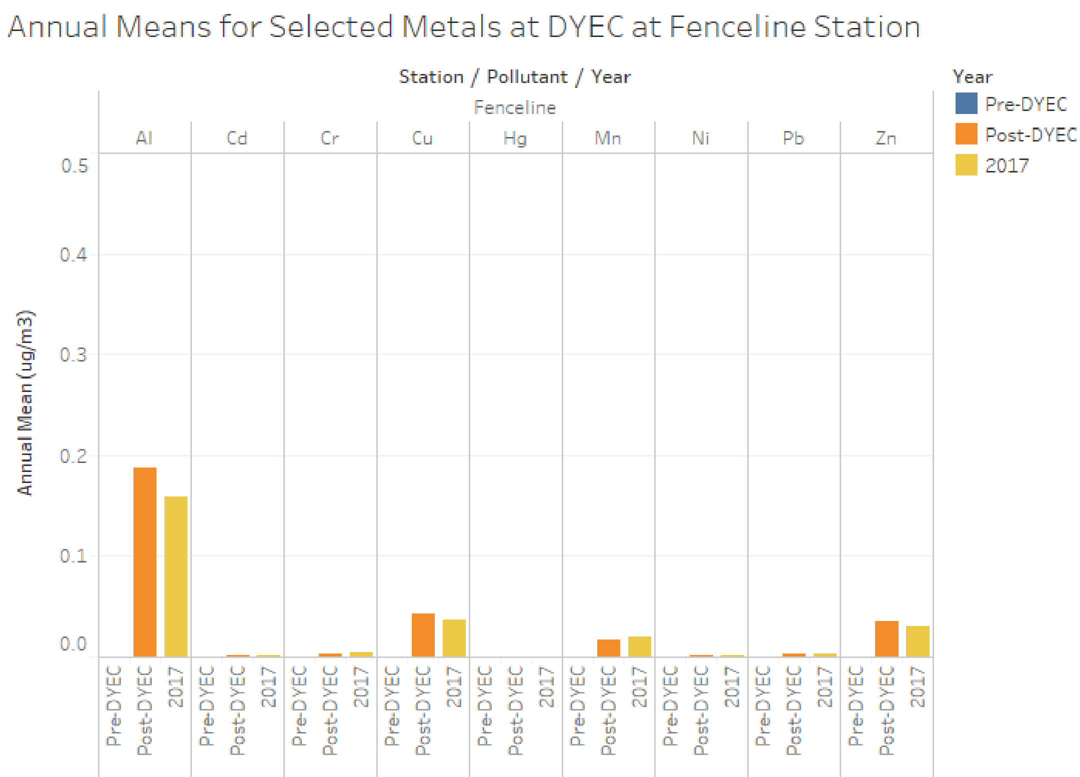


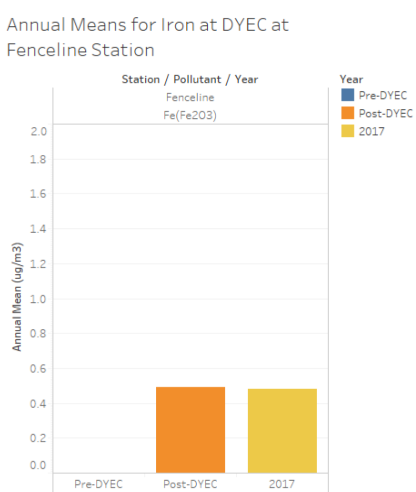


Notes – These figures represent an average of the daily samples over the course of each calendar year (frequency of samples was every 6 days).

-There is no annual AAQC except for nickel which has an annual AAQC of 0.04 ug/m3. For other AAQC averaging times, please refer to Appendix B.

Figure 4 Comparison of Selected Metal Concentrations at Fenceline Station





Notes – These figures represent an average of the daily samples over the course of each calendar year (frequency of samples was every 6 days).
-There is no annual AAQC except for nickel which has an annual AAQC of 0.04 ug/m3. For other AAQC averaging times, please refer to Appendix B.
-There is insufficient data in 2018 to calculate a valid annual average.

3.0 St. Marys Cement Monitoring Program

St. Marys Cement (SMC) monitoring stations are situated both upwind (SMC1, 45052) and downwind (SMC2, 45053) of the company's facility in Bowmanville, Ontario (see Figure 1).

The monitoring program measures dustfall and PM_{10}, which is the size of particulate most attributable to SMC quarry operations and fugitive emissions. PM_{10} is a measure of airborne coarse particulates comprised of aerodynamic particle sizes approximately 10 microns (µm) or less in diameter. These particles can include dust, pollen and mold spores, but also include industrial fugitive emissions and other local sources such as agricultural and construction activities, and re-suspension of dust from unpaved and paved roads.

Dustfall is comprised of larger coarse particle sizes that settles out closer to the facility's operations. As dustfall is not measured in any of the other monitoring programs that were reviewed in this memorandum, dustfall statistics have not been included.

Tables 14, 15a and 15b below provide statistical summaries of PM_{10} at SMC from 2013 to 2020. The hourly PM_{10} concentrations reported are compared to Ontario's AAQC as a 24-hour average. SMC1 and SMC2 stations collect continuous real-time data, whereas Site B and Site F stations collect 24-hour samples every six days which are sent to a certified lab for analysis.

The annual PM_{10} average concentrations were similar from 2013 to 2020, with no observable trend (Table 14). Calculation of 24-hour maximum PM_{10} concentrations help illustrate variability among the years (Table 15a). Table 15b indicates the number of exceedances of PM_{10} between 2013 to 2020.

Table 14. Annual Average PM_{10} Concentrations at SMC

Year	PM_{10}- Continuous (µg/m³)		PM_{10} - Non-Continuous (µg/m³)		Annual AAQC (µg/m³)
	SMC1	SMC2	Site B	Site F	n/a
2013	15.2	12.3	18.7	18.5	
2014	15.3	14.1	17.1	15.7	
2015	17.8	13.4	19.8	18.2	
2016	12.4	9.4	17.5	15.1	
2017	13.5	9.9	15.1	14.1	
2018	14.9	10.5	17.7	17.9	
2019	14.5	10.1	12.3	10.9	
2020	13.0	9.8	12.4	11.3	

Table 15a. Maximum 24-hour Average PM_{10} Concentrations at SMC

Year	PM_{10}-Continuous (µg/m³)		PM_{10} -Non-Continuous (µg/m³)		24-Hour Average AAQC (µg/m³)
	SMC1	SMC2	Site B	Site F	
2013	82	49	61	58	50
2014	86	77	57	29	
2015	54	72	43	49	
2016	87	52	47	52	
2017	89	39	39	42	
2018	43	62	74	72	
2019	45	33	33	26	
2020	95	41	45	43	

Table 15b. Number of 24-hour Average PM_{10} Exceedances at SMC

Year	PM_{10}-Continuous		PM_{10} -Non-Continuous		24-Hour Average AAQC (µg/m³)
	SMC1	SMC2	Site B	Site F	
June 2013 to Feb. 2015	4	5	1	2	50
March 2015 to Dec. 2016	5	1	0	1	
2017	2	0	0	0	
2018	0	2	1	1	
2019	0	0	0	0	
2020	2	0	0	0	

Pollution roses for continuously monitored PM_{10} are shown in Figures C7 and C8 (Appendix C). Based on hourly pollution roses, and elevated PM_{10} levels compared to wind direction, the data suggests that PM_{10} concentrations originate from all directions which implies that there are multiple sources contributing to PM_{10} levels.

Typically, PM_{10} concentrations in the area were from local fugitive sources including the operation of SMC. Fluctuations in concentrations from year to year may be attributed to operations at the SMC facility, along with other local sources, such as mobile and agricultural sources, and different meteorological conditions from year to year.

4.0 Highway 407 East Construction Monitoring Program

As outlined in condition 15 of its Environmental Assessment (EA) approval, the Ministry of Transportation (MTO) monitored for PM_{10}, $PM_{2.5}$, NO_x (NO & NO_2) and CO during the Highway 407 East Phase 1 and 2 construction (407 East construction). The locations of MTO's monitoring stations were selected based on proximity to residential areas that could potentially be impacted by the 407 East construction activities. Meteorological conditions were also considered when selecting monitoring station locations. *As the monitoring stations were only operational up to 2016, there is no additional data presented in the 2018 technical memorandum.*

The highway construction project included the extension of Highway 407 from Brock Road to Highway 35/115 along with construction of two north-south connectors to Highway 401 – the West Link in Whitby and the East Link in Oshawa. The first phase of the construction included the extension of Hwy 407 from Brock Road to Simcoe Street North, and the construction of the West Link, along with a number of interchanges. The second phase of the construction included the extension of Highway 407 from Simcoe Street North to Highway 35/115 and the construction of the East Link.

The ambient air monitoring conditions required monitoring baseline air quality before construction, as well as the local air quality during construction, for a predetermined amount of time.

Figure 1 shows the locations of the four 407 East construction stations: Cresser, Brooklin, Old Scugog and Highway 2, which operated intermittently (seasonally) to capture construction activities and schedules. Of the four 407 East construction stations, two are situated in Clarington (Highway 2 and Old Scugog – Phase II) and the other two stations are situated in Whitby (Cresser and Brooklin – Phase I). The assessment primarily focused on particulate matter and nitrogen oxides, as these are the main contaminants of concern for construction activities.

4.1 Particulate Matter

PM_{10} and $PM_{2.5}$ were measured in the vicinity of the 407 East construction activities. Table 16 and Table below provide statistical summaries of the $PM_{2.5}$ concentrations before and during construction of the 407 East Extension.

Table 16. Seasonal Average $PM_{2.5}$ Concentrations at 407 East

Station	2013 (Phase 1 construction)	2014 [a] (Phase 2 pre-construction)	2015 [b] (Phase 2 pre-construction)	2016 [c] (Phase 2 construction)	Annual CAAQS Indicator [d]
Cresser (µg/m³)	6	---	---	---	10
Brooklin (µg/m³)	8	---	---	---	10
Old Scugog (µg/m³)	---	7	---	4	10
Highway 2 (µg/m³)	---	---	7	5	10

[a] Data collected between June and August, 2014.
[b] Data collected between July and September, 2015.

[c] One year of construction. Data collected between March/April 2016 to March/April/2017.
[d] Prior to the phased in CAAQS of 8.8 ug/m3, the CAAQS was 10 ug/m3
--- no data available due to sampling schedule as approved in the monitoring plan as per EA condition.

Table 17. Maximum 24-hour Average $PM_{2.5}$ Concentrations at 407 East

	Cresser ($\mu g/m^3$)	Brooklin ($\mu g/m^3$)	Old Scugog ($\mu g/m^3$)	Highway 2 ($\mu g/m^3$)
Maximum 24-Hour Concentration – Pre-Construction	36	22	20[a]	18[b]
Maximum 24-Hour Concentration - Construction	37	38	17	31
No. of 24-Hour Concentrations elevated above the 28 $\mu g/m^3$ CAAQS indicator (Pre-construction)	2	0	0	0
No. of 24-Hour Concentrations elevated above the 28 $\mu g/m^3$ CAAQS indicator (During construction)	1	2	0	1

[a] This was a seasonal average for the summer months of June to August, 2014.
[b] This was a seasonal average for the summer months of July to September, 2015.

$PM_{2.5}$ represents the fraction of particulate matter most associated with construction equipment and background fuel combustion sources as it pertains to highway construction activities. Based on an hourly $PM_{2.5}$ pollution rose assessment (Figures C9 and Figures C10 in Appendix C), $PM_{2.5}$ contributions to air quality were seen from all directions, but more frequently from the west and southwest quadrants during construction at Highway 2 station. Construction activities, including the construction of a large interchange and off ramps were all situated to the west of the monitoring locations. Cresser and Brooklin stations showed higher 24-hour average $PM_{2.5}$ measurements during the construction period (2013 and 2014) compared to the pre-construction period (2012).

The other particulate size measured at 407 East construction stations was PM_{10} since it represents the coarse fraction of particulate that related to construction activities, such as grading and material handling practices.
Table and Table provide statistical summaries for PM_{10} concentrations before and during construction of the 407 East Extension. Based on the construction monitoring stations, Highway 2 reported the highest number of measurements that exceeded the PM_{10} interim guideline of 50 $\mu g/m^3$. Between 2013 and 2016 there were 15 measurements across all stations which exceeded the 24-hour average PM_{10} concentrations.

Table 18. Period Average PM_{10} Concentrations at 407 East

Station	2013 (Phase 1 construction)	2014 [a] (Phase 2 pre-construction)	2015 [b] (Phase 2 pre-construction)	2016 (Phase 2 construction)	Annual AAQC
Cresser ($\mu g/m^3$)	12	---	---	---	n/a
Brooklin ($\mu g/m^3$)	15	---	---	---	n/a
Old Scugog ($\mu g/m^3$)	---	16	---	12	n/a
Highway 2 ($\mu g/m^3$)	---	---	14	17	n/a

[a] Data collected between June and August, 2014.
[b] Data collected between July and September, 2015.

--- Not in operation
n/a an Annual AAQC does not exist

Data showed that the 24-hour average maximum PM_{10} concentrations increased during construction activities when compared to the pre-construction period.

Table 19. Maximum 24-hour Average PM_{10} Concentrations at 407 East

	Cresser [c] (µg/m³)	Brooklin [d] (µg/m³)	Old Scugog [a] (µg/m³)	Highway 2 [b] (µg/m³)	24-Hour AAQC (µg/m³)
Maximum 24-Hour Concentration – Pre-Construction	45.8	45.7	28	35	50
Maximum 24-Hour Concentration - Construction	52	78	40	121	
No. of 24-Hour Exceedances	1	5	0	9	

[a] This was a period average for the spring & summer months of June to August, 2014.(background for Old Scugog –Phase II)
[b] This was a period average for the spring & summer months of July to September, 2015 (background for Highway 2 Phase II)
[c] This was a period average for the spring & summer months of April 15 to August 15, 2012 (background for Cresser -Phase I for Cresser).
[d] This was a period average for the spring & summer months of May 16 to August 15, 2012 (background for Brooklin- Phase I).

4.2 NO_2

NO_2 was measured at the 407 East Phase I and II construction stations, which used similar technology to the DYEC and Oshawa monitoring stations. Tables 20 and 21 provide statistical summaries for NO_2 at the 407 East stations. There were no exceedances of the hourly and 24-hour AAQC.

Table 20. Annual Average NO_2 Concentrations at 407 East

Station	2013 (Phase 1 construction)	2014 [a] (Phase 2 pre-construction)	2015 [b] (Phase 2 pre-construction)	2016 (Phase 2 construction)	Annual AAQC
Cresser (ppb)	10.3	---	---	---	---
Brooklin (ppb)	6.5	---	---	---	---
Old Scugog (ppb)	---	3.3	---	4.2	---
Highway 2 (ppb)	---	---	3.2	4.6	---

[a] This was a period average for the spring & summer months of June to August, 2014.
[b] This was a period average for the spring & summer months of July to September, 2015.
--- Station not operational

Based on the hourly pollution roses outlined in Figure C11 in Appendix C, NO_2 concentrations in 2016 (Phase II construction) originated from all directions at Highway 2. The highest NO_2 concentrations were most frequently seen from the west and southwest directions, which correspond to the upwind construction activities.

Table 21. Maximum 24-hour Average & Hourly NO_2 Concentrations at 407 East

	Cresser (ppb)	Brooklin (ppb)	Old Scugog (ppb)	Highway 2 (ppb)	24-Hour AAQC	1-Hour AAQC
Maximum 24-Hour Concentration – Pre-Construction	20[d]	27[d]	6 [a]	7 [b]	100	n/a
Maximum 24-Hour Concentration - Construction	68 [c]	29 [c]	20	22	100	n/a
Maximum 1-Hour Concentration – Pre-Construction	39	79	25[a]	23[b]	n/a	200
Maximum 1-Hour Concentration – Construction	93	40	57	35	n/a	200
No. of 24-Hour & 1- hour Exceedances (Pre- Construction & Construction)	0	0	0	0	n/a	n/a

[a] This was a period average for the spring & summer months of June to August, 2014.
[b] This was a period average for the summer months of July to September, 2015.
[c] This was a period average for construction months from February to December, 2013.
[d] This was a period average for background (pre-construction) from May/June to August, 2012.
n/a – Not applicable

5.0 Gerdau Particulate Monitoring Program

Gerdau Ameristeel Corporation in Whitby operates an industrial ambient air quality monitoring program, which began in January 2015 as a requirement of their Environmental Compliance Approval. The parameters of concern from Gerdau operations included particulates and metals.

Gerdau operates a meteorological tower and two monitoring stations that measure TSP and metals every 6 days following the NAPS schedule and the *Operations Manual for Air Quality Monitoring in Ontario* (MECP, 2018). During prevailing wind conditions, South Blair Station is upwind of Gerdau and Thickson Station is downwind, as illustrated in Figure 1.

Tables 22a and 22b represent annual TSP data from 2015 to 2020. There were no annual TSP exceedances recorded at the Gerdau monitoring stations, however there were 2 exceedances of the 24-hour TSP AAQC of 120 ug/m^3 (Table 22b). Overall, the annual TSP means at both stations were similar to each other, with no observed trends.

Table 22a Annual Average TSP Concentrations at Gerdau

Year	TSP Concentration (µg/m^3)		Annual AAQC (µg/m^3)
	South Blair	Thickson	
2015	36.3	INS	60
2016	28.7	23.7	
2017	33.4	23.8	
2018	41.6	29.4	
2019	32.6	23.4	
2020	33.3	19.0	

Notes: TSP measurements are based on 6-day frequency interval.
2015 – only 9 & 14 samples were collected at Blair & Thickson stations, respectively, due to technical errors
INS - Insufficient valid data in 2015 to calculate an annual average at Thickson station that can be compared to the AAQC

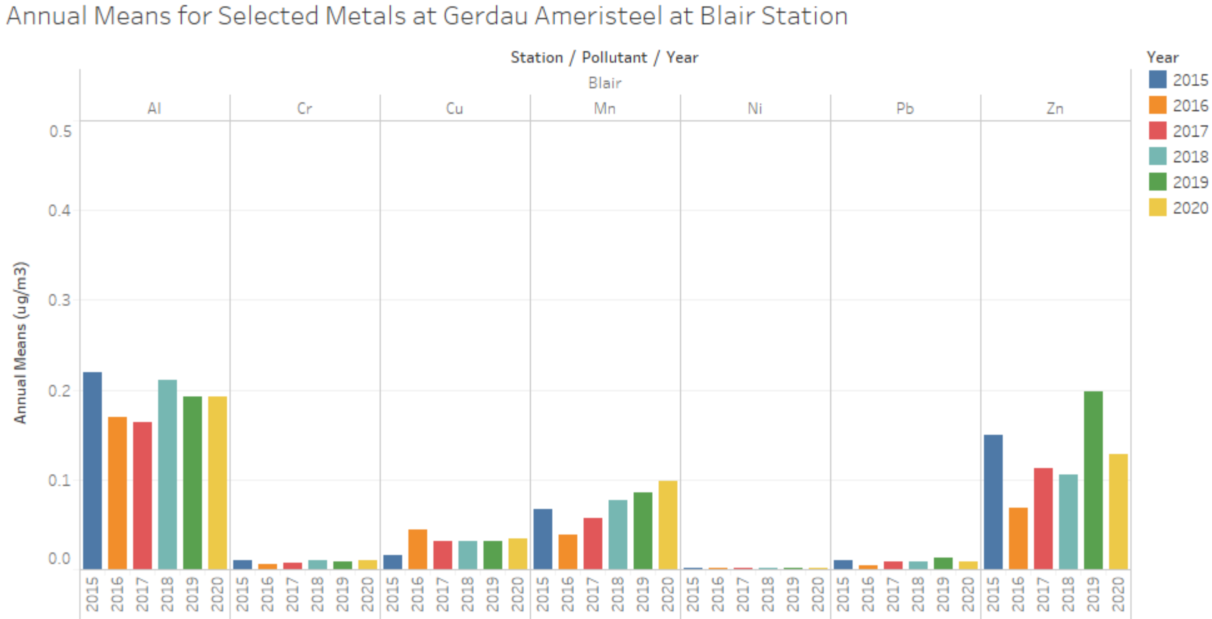
Table 22b Number of 24-hour Average TSP Exceedances at Gerdau

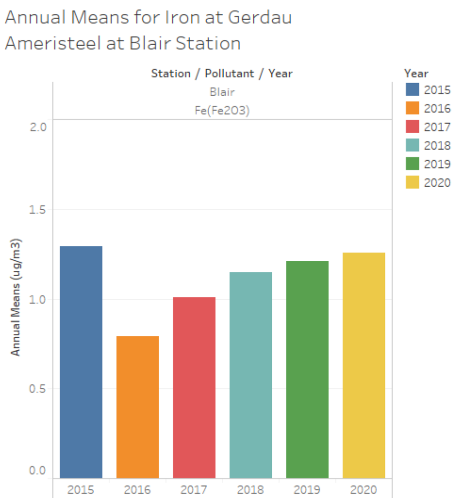
Year	TSP Exceedances	
	South Blair	Thickson
2015	0	0
2016	0	0
2017	0	0
2018	1	0
2019	0	0
2020	1	0

Annual TSP concentrations were generally higher at the South Blair Station compared to Thickson Station, with the highest annual average in 2018. Pollution roses for 24-hour average TSP concentrations are provided in Figure C12 (Appendix C). Based on the limited data set, the pollution rose showed TSP emissions coming from all directions. While background concentrations can be observed at the South Blair station, there are also elevated TSP levels coming from the east.

Of the 15 metals analyzed from TSP filters, 8 were above their respective method detection limits. As shown in Figures 5 through 7, the upwind Blair Station generally had higher metal concentrations compared to the downwind Thickson Station. These differences were most likely due to background sources from local activities that occurred in the vicinity of the South Blair station, such as local traffic and construction activities, and not just contributions from Gerdau's operation. Of the metals monitored, iron concentrations were the highest at both Thickson and Blair stations. With the exception of manganese, all metals analyzed were below their respective 24-hour average AAQCs at Blair station from 2015 to 2020. There were no metal 24-hour average AAQC exceedances at Thickson station from 2015 to 2020. While some metals such as copper and iron are found naturally in the environment, other sources in the area which may contribute to background levels include off-road mobile sources, railway and locomotive engines.

Figure 5 Comparison of Selected Metal Concentrations at Gerdau Ameristeel at Blair Station

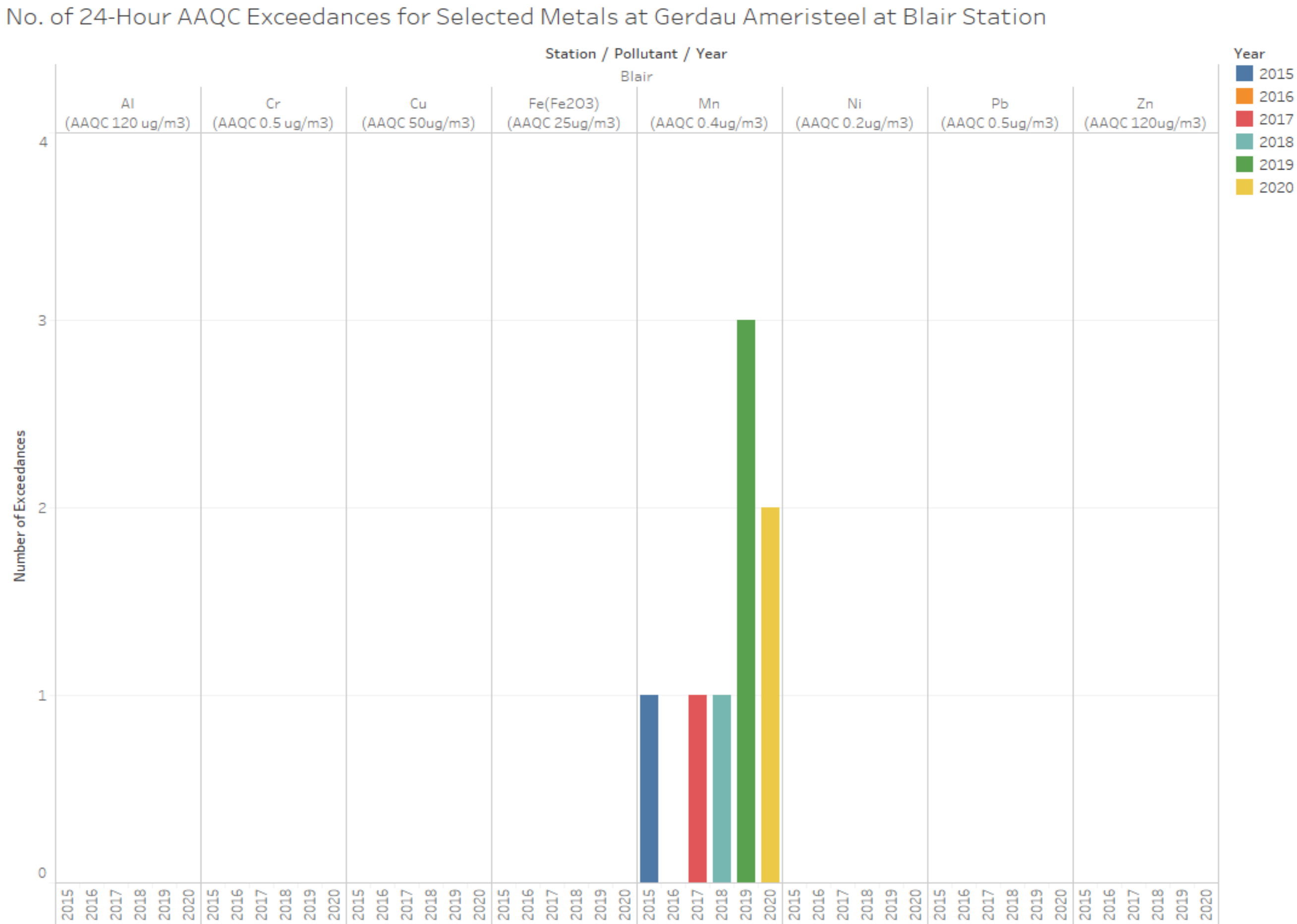




Notes – These figures represent an average of the daily samples over the course of each calendar year (frequency of samples was every 6 days).

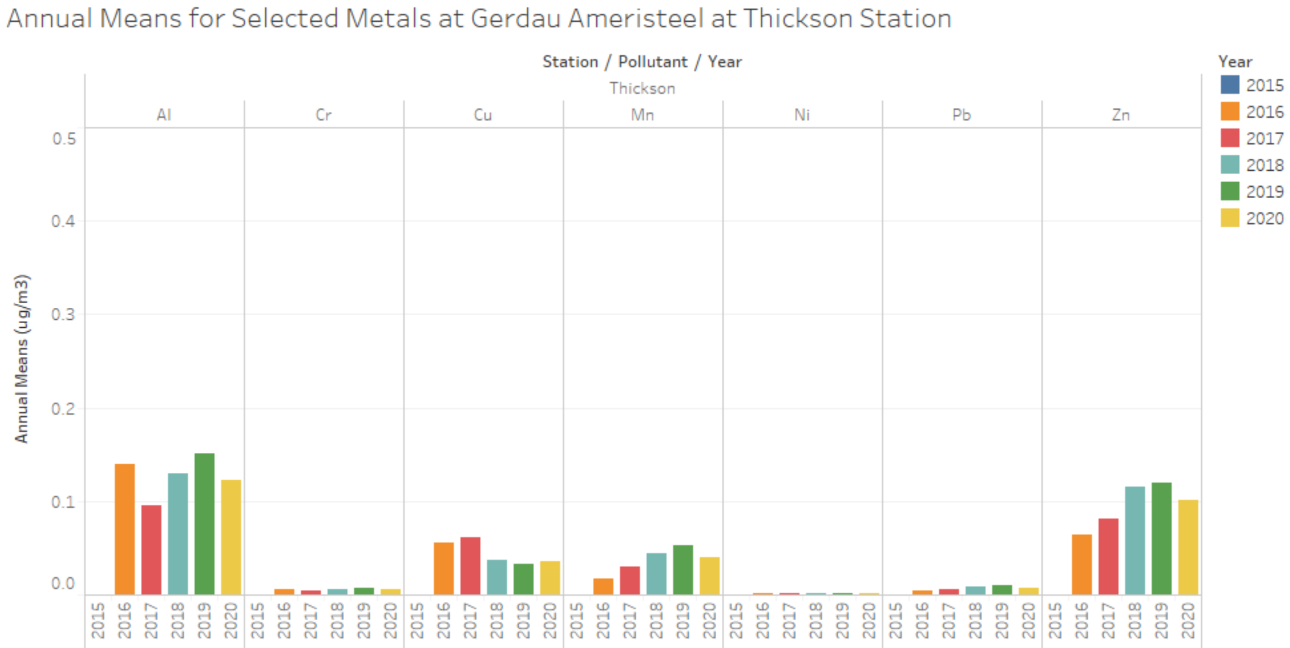
-There is no annual AAQC except for nickel which has an annual AAQC of 0.04 ug/m3. For other AAQC averaging times, please refer to Appendix B.

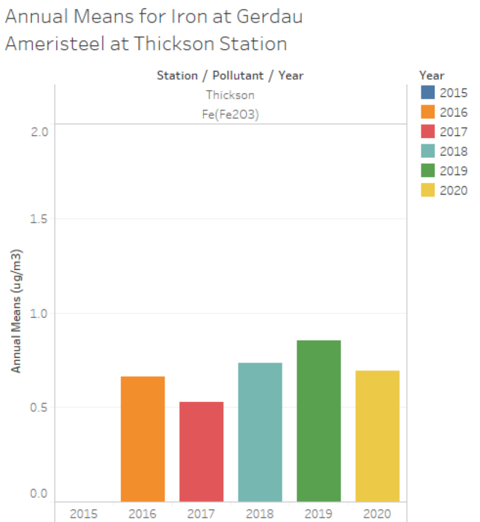
Figure 6 No. of 24-Hour AAQC Exceedances for Selected Metals at Gerdau Ameristeel at Blair Station



Note –The AAQC labelled in the graph are based on a 24-hour period.

Figure 7 Annual Means for Selected Metals at Gerdau Ameristeel at Thickson Station





Notes – These figures represent an average of the daily samples over the course of each calendar year (frequency of samples was every 6 days).
-There is no annual AAQC except for nickel which has an annual AAQC of 0.04 ug/m3. For other AAQC averaging times, please refer to Appendix B.

6.0 Oshawa Station

Ontario benefits from having one of the most comprehensive ambient air monitoring networks in North America, with 39 monitoring sites across the province providing data on the current state of air quality. One of these stations is located in Oshawa. Prior to 2017, the Oshawa ambient air monitoring station was located at 2000 Simcoe Street North, on the Durham College campus in Oshawa. This station was recently relocated to Britannia Avenue West.

The sections below summarize the Oshawa station monitoring data from 2013 to 2020, and is compared to data from the other programs discussed in this memorandum. The parameters currently monitored at the Oshawa station include ozone (O_3), $PM_{2.5}$, and NOx.

Table 23a provides the annual statistics for $PM_{2.5}$ and NO_2. Ozone is not discussed in this report as it was not measured at any of the other stations discussed here. Ozone is not generally emitted directly into the atmosphere, but it is formed through chemical reactions and strongly dependent on meteorological conditions (Air Quality in Ontario 2018 Report, MECP).

Table 23b provides the 24-hour maximum concentrations for $PM_{2.5}$ and NO_2 by year and the number of 24-hour exceedances.

Table 23a Annual $PM_{2.5}$ and NO_2 Statistics Reported at the Oshawa Station

Parameter	Annual Average Concentration [a]								
	2013	2014	2015	2016	2017	2018	2019	2020 [c]	Annual CAAQS [b]
$PM_{2.5}$ ($\mu g/m^3$) [b]	7.4	7.7	7.5	5.9	5.9	6.4	6.1	6.2	10 (2015) 8.8 (2020)
NO_2 (ppb) [b]	5.9	6.8	6.6	6.3	6.4	3.8	3.5	3.6	17 (2020) 12 (2025)
No. of PM2.5 Annual Exceedances	0	0	0	0	0	0	0	0	10 (2015) 8.8 (2020)
No. of NO2 Annual Exceedances	0	0	0	0	0	0	0	0	17 (2020) 12 (2025)

Notes:

[a] The annual average concentration is presented for each calendar year.

[b] CAAQS metrics varies for each parameter:

- $PM_{2.5}$ is based on a 3-year average of the 98th percentile for each year.
- NO_2 is based on the 1-hour average concentrations over a calendar year.

[c] All 2020 data quality is currently under ministry's review.

Table 23b 24 Hour $PM_{2.5}$ and NO_2 Statistics Reported at the Oshawa Station

Parameter	Maximum 24-Hour Concentration [a]								24Hr CAAQS [b]	24Hr AAQC
	2013	2014	2015	2016	2017	2018 [c]	2019	2020 [d]		
$PM_{2.5}$ (µg/m³)	41	27	26	22	23	28	28	21	27 (2020) 28 (2015)	27 (2020) 28 (2015)
NO_2 (ppb)	22	27	26	29	31	21	16	16	n/a	100
No. of PM2.5 24-Hr Exceedances	3	0	0	0	0	0	0	0	27 (2020) 28 (2015)	27 (2020) 28 (2015)
No. of NO2 24Hr Exceedances	0	0	0	0	0	0	0	0	n/a	100

Notes:

[a] The maximum 24-hour average concentration is presented for each calendar year.

[b] CAAQS metrics varies for each parameter:

- $PM_{2.5}$ is based on a 3-year average of the 98th percentile for each year.
- NO_2 is based on the 1-hour average concentrations over a calendar year.

[c] All 2020 data quality is currently under ministry's review.

[c] Data up to 2018 is from the Simcoe Street North location

[d] All 2020 data quality is currently under ministry's review

n/a - not available

The MECP Oshawa station is designated as a CAAQS reporting station, as per the CCME guidelines, since it includes communities with populations greater than 100,000 (as described in the *Air Quality in Ontario 2018 Report* (MECP, 2018)). Based on the ambient annual air quality report, which is published by the ministry, the 3-year average (98th percentile) of the 24hr $PM_{2.5}$ was 17µg/m³, which was lower than the 24hr CAAQS of 27µg/m³. The annual $PM_{2.5}$ 3-year average was 6.1µg/m³, which was also lower than the annual CAAQS of 8.8µg/m³.

Hourly $PM_{2.5}$ and NO_2 pollution roses for the Oshawa AQHI Station are included in Appendix C. Similar to the stakeholder stations, $PM_{2.5}$ and NO_2 emissions originate from all wind directions implying there are multiple sources in the area as illustrated in Figure C13 and C14.

As reported in the Air Quality in Ontario Report, NO_2 emissions have decreased due to more stringent standards in new vehicles and various initiatives to reduce industrial emissions of NO_2 and SO_2 (MECP, 2018).

7.0 Discussion: Common Pollutants across Networks

TSP, $PM_{2.5}$, PM_{10} and NO_2 are common parameters across the monitoring networks discussed in this memorandum, as such, were selected for further discussion. BaP will also be discussed as there have been exceedances of the AAQC.

An overview of how these parameters compared with other nearby stakeholder monitoring stations and or nearby MECP and Environment and Climate Change Canada NAPS stations was undertaken. The stations selected for further comparison include the ministry's Oshawa, Toronto West, Sarnia, Hamilton and Newmarket stations. For some of the non-continuous parameters, the Environment and Climate Change Canada stations at Downsview and Simcoe were selected.

The comparisons are based on limited data and consider various time periods (pre-operation and operation of the DYEC facility, background conditions and construction of the 407 East Extension), making it difficult to interpret or infer any trends or patterns. Based on the variability of the monitoring programs (i.e. different monitoring program schedules, purpose and equipment), and changes in background and transboundary sources, it was not possible to determine the percent contributions with accuracy from any particular source in the area. While this memorandum acknowledges these limitations, the results from this comparison are highlighted in section 7.2.

7.1 Data Limitations & Qualifiers

This section summarizes the limitations and qualifications that should be considered before data comparisons are made between stations.

1. <u>Purpose</u>
   The ministry's Air Quality Health Index monitoring stations are representative of ambient air quality, which reflects the contribution of all sources of air contaminants to air. These air monitoring stations are sited to be representative of general population exposure and thus do not necessarily reflect air quality at locations within a community that may be influenced by nearby local sources of air contaminants such as large industrial facilities or major transportation. Stakeholder stations were established to monitor general air quality in the vicinity of a particular facility or activity. Stakeholder ambient monitoring programs also often begin monitoring before activities in the area change to establish baseline concentrations for comparison with future monitoring results.

2. <u>Instrumentation</u>
   Monitoring equipment is selected based on project goals and constraints. Equipment size, program budgets, accessibility, service needs, shelter requirements, and electrical limitations are all considerations when selecting the appropriate equipment.

   The US EPA publishes a list of designated Federal Equivalent Method (FEM) and Federal Reference Method (FRM) equipment. Slight variations can be expected in the monitoring results from different equipment, however air monitoring equipment receiving US EPA designations have undergone rigorous testing and meet or exceed stringent air pollution monitoring standards for data quality and reliability.

The Highway 407 East monitoring program measures continuous PM_{10} and $PM_{2.5}$ using the BAM 1020 particulate monitor. SMC measures continuous PM_{10} using a BAM in addition to measuring PM_{10} on a 6-day NAPS schedule using Hi-Vol monitoring equipment. The DYEC and the ministry stations use a Synchronized Hybrid Ambient Real-time Particulate (SHARP) monitor to measure continuous $PM_{2.5}$ concentrations. These equipment are all designated by the US EPA as FEM or FRM.

3. Data Quality
   Only good quality data that has been through a quality assurance/quality control assessment, from proper operation of the equipment to sample analysis and data processing, should be used for interpretation and comparison between stations.

   The ministry is currently reviewing the 2020 data from ministry and stakeholder stations. Therefore, the 2020 statistics in this memo are considered preliminary and decisions should not be made based on the 2020 data presented in this memorandum. If any anomalies are discovered in the data, the ministry will update the data and prepare an addendum to this memorandum if required.

7.2 PM $_{2.5}$

$PM_{2.5}$ is either emitted directly into the atmosphere through fuel combustion (e.g. from vehicles, smelters, power plants, industrial facilities, residential fireplaces and wood stoves, agriculture and forest fires), or formed indirectly in the atmosphere through a series of complex chemical reactions. Ontario's air quality is also affected by transboundary movement of pollutants from neighbouring States and Provinces resulting, for example wildfires. (Air Quality in Ontario 2014 Report, MOECC).

When comparing the monitoring network at DYEC to that of 407 East, comparisons were performed for the same time period to ensure consistent meteorological conditions, even though the 407 East construction stations operated intermittently between 2013 and 2016. In addition, the construction monitoring time period also coincided with the highest particulate concentrations typically found in the spring and summer seasons.

Figure 8 illustrates 24-hour average $PM_{2.5}$ concentrations which are relatively similar when data from the 407 East Construction project is compared against other Durham Region stations or the nearest representative stations during the same time period.

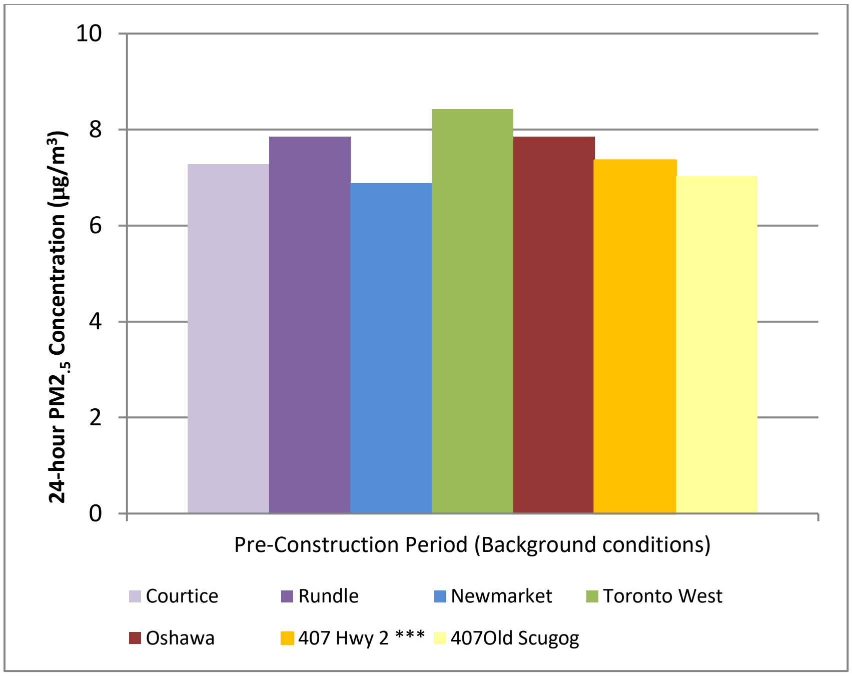
Based on this comparative assessment, the following observations were made:

- The Courtice station $PM_{2.5}$ measurements, which were representative of upwind conditions in relation to the DYEC facility, were similar to the 407 East stations. Comparison of the seasonal $PM_{2.5}$ average from the Courtice station to the Oshawa and Newmarket ministry stations showed that $PM_{2.5}$ was approximately 8% higher at Courtice station. This result was likely due to local activities occurring around the monitor, such as traffic from Highway 401 and construction.

- The Rundle station, which is situated downwind of the DYEC facility, is also downwind of other $PM_{2.5}$ sources such as Highway 401 and the CN Rail tracks. The $PM_{2.5}$ 24-hour average measurements at the Rundle Station were on average slightly lower (approximately 7%) than the Toronto West station during pre-operation. When compared with the Toronto West station during operation, the $PM_{2.5}$ 24-hour average concentrations were on average slightly higher (approximately 9%) as shown in Figure 9. This difference in $PM_{2.5}$ observations was relatively small, and likely due to changes in background concentrations and multiple sources of $PM_{2.5}$ in the Clarington area, such as the 407 East Construction Phase 2 activities. Toronto West station was used in this comparison since it is situated adjacent to the Highway 401 corridor similar to Rundle station.

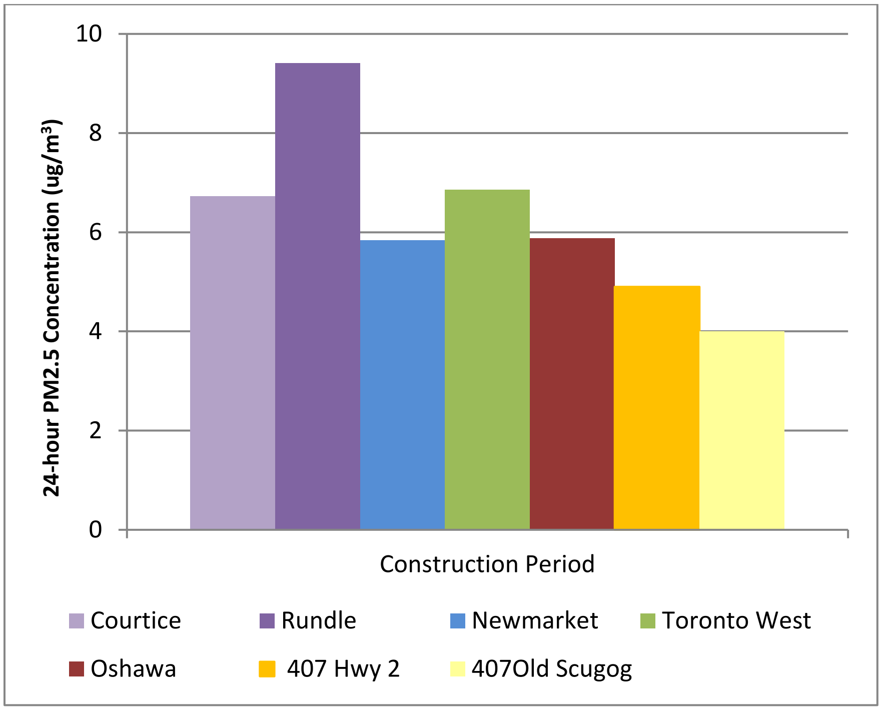
In 2016, the construction and the use of construction equipment for road realignment in the vicinity of Rundle station resulted in increased $PM_{2.5}$ measurements. There are likely other local sources, that due to seasonal variability, may have increased background $PM_{2.5}$ levels during the operation phase. These include residential and/or commercial wood burning or other utilities for comfort heating.

Figure 8 Period PM2.5 Average Concentrations during 407 East Phase II Pre-Construction Period



Notes:
This graph represents a 3-month period average which is the baseline monitoring conducted at the 407 East Phase II Construction.
*** Highway 2 station measurements are from July 1 to September 30, 2015
Old Scugog station measurements are from June 1 to August 31, 2014

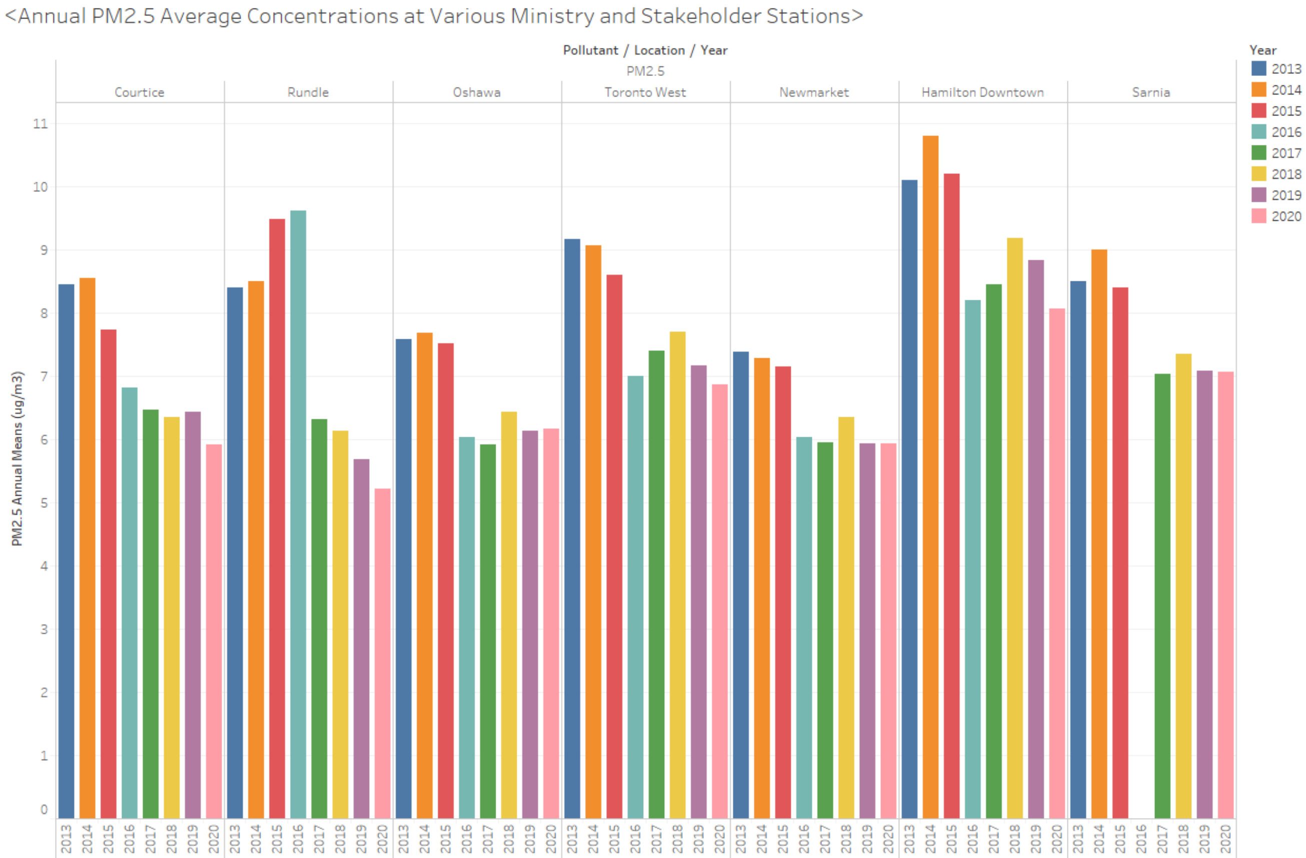
Figure 9 Period PM2.5 Average Concentrations during 407 East Phase II Construction Period



Notes:
This graph represents a 3-month period average which is the baseline monitoring conducted at the 407 East Phase II Construction.
*** Highway 2 station measurements are from March – December 2016
Old Scugog station measurements are from April – December 2016

While the previous figures focus specifically on $PM_{2.5}$ measurements from the Highway 407 construction project (with a focus on data from 2013 to 2016), annual average concentrations from a select number of ministry and stakeholder stations from 2013 to 2020 are presented in the figure below.

Figure 10 Annual PM2.5 Average Concentrations at Various Ministry and Stakeholder Stations



Notes:

a. This graph illustrates the annual arithmetic averages at stakeholder and ministry's stations from 2013 to 2020.

b. In 2016, the annual PM2.5 average at Sarnia AQHI station reported as INS since this station was relocated and therefore did not meet the 75% data validity requirements

Figure 10 shows that annual $PM_{2.5}$ concentrations from 2016 to 2020 were generally lower than $PM_{2.5}$ concentrations from 2013 to 2015. The annual $PM_{2.5}$ concentrations at DYEC monitoring stations were similar to the Newmarket and Oshawa AQHI stations with the exception of data from 2015 and 2016. This exception was potentially due to construction activities (Highway 407 construction), and elevated local and regional $PM_{2.5}$ sources around Rundle station. In 2017, the annual $PM_{2.5}$ concentration at Rundle station returned to similar ambient background levels when compared to the Oshawa and Newmarket stations.

When comparing stations such as Courtice, Rundle, Newmarket and Oshawa, the annual $PM_{2.5}$ concentrations were relatively consistent from 2017 to 2020. Large urban areas such as Toronto and Hamilton tended to have higher $PM_{2.5}$ concentrations due to contributions from multiple sources.

$PM_{2.5}$ concentrations measured in Durham Region were from local sources, but were also influenced by emission sources outside of regional or provincial boundaries, referred to as transboundary sources. For example, the 2013 forest fires in Quebec resulted in $PM_{2.5}$ in visible impacts to southern Ontario monitoring stations (including the one in Durham).

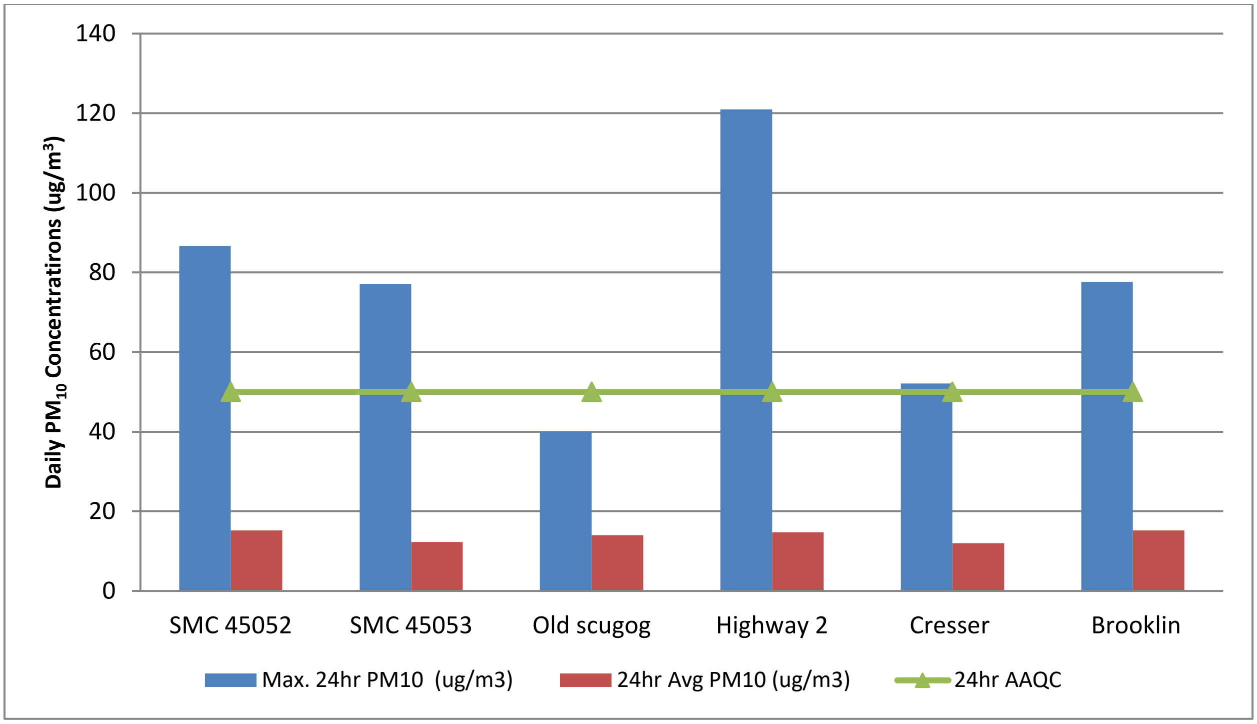
7.3 PM_{10}

Particulate matter smaller than 10 microns (PM_{10}) was monitored at both SMC and 407 East. Exceedances of the PM_{10} 24-hour average interim AAQC of 50 ug/m^3 were reported at both SMC and 407 East. PM_{10} is mostly from industrial fugitive emissions, re-suspension of dust from unpaved and paved roads, as well as other local sources such as agricultural and construction activities.

Comparisons between SMC and 407 East PM_{10} monitoring stations were made for the same time period to ensure consistent meteorological conditions even though the 407 East construction stations operated intermittently between 2013 and 2016. As noted in Section 4, the 407 monitoring stations was not operational after 2016.

PM_{10} 24-hour average concentrations were similar between SMC and 407 East construction stations (Figure 11). The maximum 24-hour PM_{10} concentrations reported were, however, significantly higher at Highway 2 station when compared to SMC stations and the remaining 407 East stations.

Figure 11 Annual and Maximum 24-hour Average PM10 Concentrations at SMC and 407 East Construction



Notes: Figure 11 represents data from 2013 to 2016. For 407 East Construction Stations, the average concentration is based on seasonal period

Even though the maximum 24-hour PM_{10} concentrations were elevated when compared to the AAQC, on average PM_{10} daily concentrations have been well below the AAQC of 50 µg/m^3 as shown in Figure 11. These types of elevated maximum values are typical when monitoring temporary construction activities.

7.4 TSP

Total suspended particulate (TSP) was another pollutant common to some of the stakeholder monitoring programs in Durham Region. When comparing TSP data across stations, local activities present at the time of monitoring need to be considered, along with potential sources and wind variability on sampling days. Further, TSP data is collected on a 6-day cycle and it is not monitored continuously like PM_{10} and $PM_{2.5}$. For these reasons, the percent contribution of TSP from different sources as discussed in previous sections can be difficult. In all cases however, the monitors captured transportation sources from major highways nearby, and also captured re-suspension of road dust from paved and unpaved roads surrounding the monitors.

Figure 12 below illustrates the annual average TSP concentrations reported from each of the stakeholder monitoring programs from 2013 to 2020.

Figure 12 TSP Annual Mean Concentrations at Gerdau and DYEC facilities

Notes:
This figure does not contain bars for specific years due to insufficient measurements for a valid annual mean.
The annual AAQC for TSP is 60 µg/m^3

The annual TSP average at the South Blair Station was slightly higher than at Thickson in 2015 (Figure 12). This may be due to local construction activities at the time, such as grade separation and material handling from a rail construction project which occurred northwest of the South Blair Street station. Although 24-hour average TSP levels occasionally exceeded the 24-hour TSP AAQC of 120 µg/m^3, there were no exceedances of the TSP annual AAQC of 60 ug/m^3.

When comparing Courtice and Rundle stations, 2019 and 2020 annual TSP averages were lower than previous years. Based on field observations, elevated TSP levels were observed during dry conditions and when multiple sources were in operation simultaneously.

7.5 NO_2

Nitrogen dioxides (NO_2) are released from multiple sources in Durham Region. These include: vehicle emissions, wood burning activities, and industrial combustion sources like the DYEC facility. Based on the current stakeholder monitoring stations in Durham Region and the ministry's Oshawa station, NO_2 was below the hourly and 24-hour average AAQC.

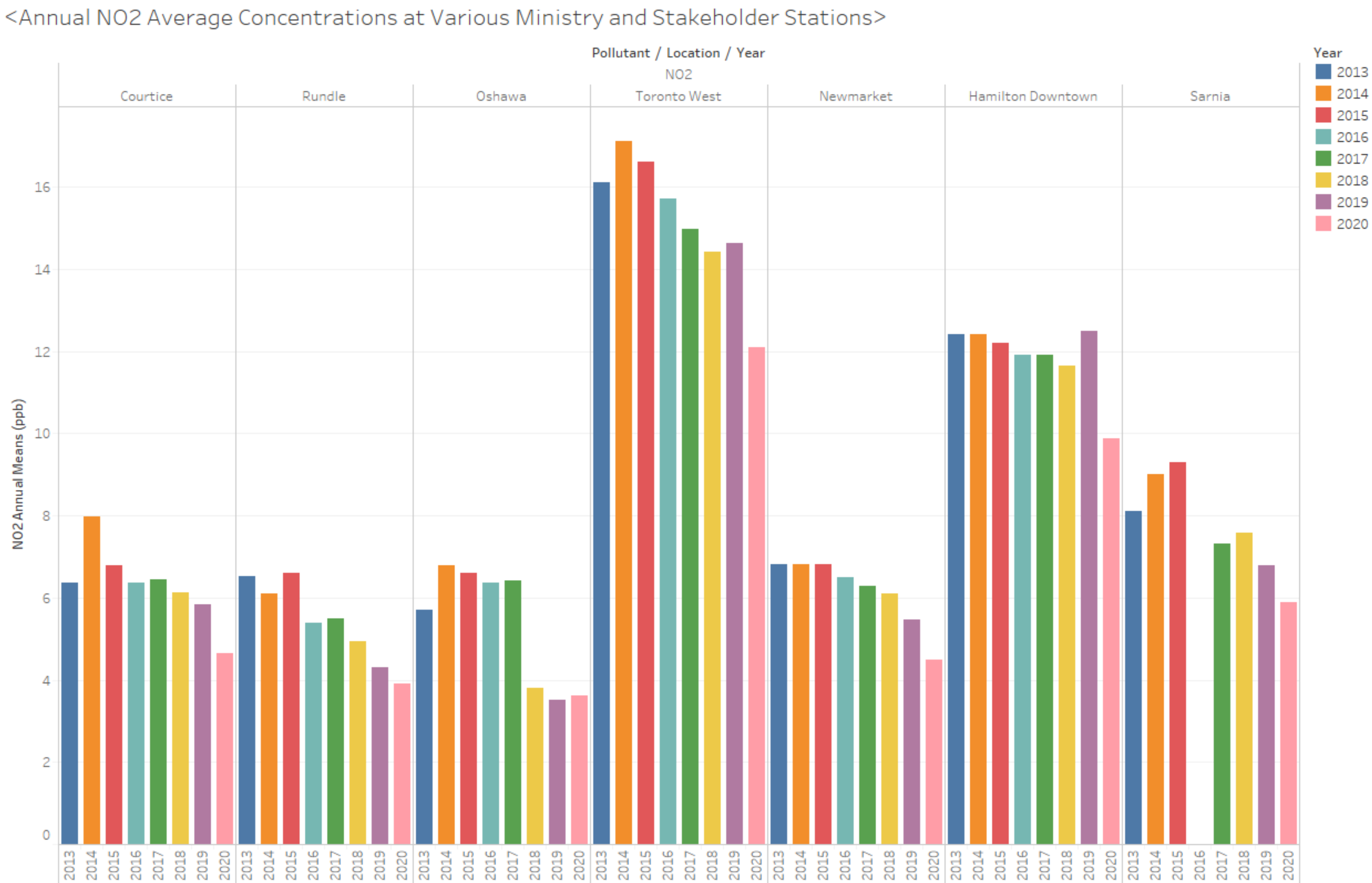
Figure 13 shows the annual NO_2 concentrations at stakeholder and various AQHI monitoring stations from 2013 to 2020. The annual NO_2 concentrations recorded at the stakeholder stations within Durham Region were similar to that of the Oshawa and Newmarket AQHI stations from 2013 to 2020. Based on the figure below, the annual NO_2 trends showed subtle variations which likely accounted for daily traffic, colder winters, warmer summers, meteorological conditions and introduction of any new local sources. All stakeholder and AQHI stations in Durham Region were below the annual NO_2 criteria.

With the exception of the Toronto West station, which was slightly higher when compared to other stations, annual NO_2 average concentrations were similar. The difference observed at the Toronto West station was likely due to traffic volumes as the station is situated directly adjacent to Highway 401.

Annual NO_2 concentrations have decreased from 2013 to 2020, which was also noted in the Air Quality in Ontario Report (MECP, 2018). Provincial initiatives from the emissions trading regulation, changes in Ontario's fuel formulation and the Ontario Drive Clean program have further reduced NO_2 emissions. (MECP, 2018) The introduction of hybrid and electric vehicles also reduce NO_2 emissions from transportation sources.

Finally, the ministry assessed the impacts of the COVID-19 pandemic on air quality in Ontario in 2020 by using data collected from a comprehensive network of air monitoring stations across the province. During the COVID-19 pandemic in 2020, concentrations of several common air pollutants associated with transportation and other major emissions sources generally decreased.

Figure 13 Annual NO2 Average Concentrations at Various Ministry and Stakeholder Stations



7.6 Benzo(a)pyrene

PAHs were only monitored at the DYEC stations in Durham Region. Based on the limited benz(a)pyrene (BaP) data and the pollution rose assessment, days that BaP exceeded the AAQC at the Courtice and Rundle stations were more frequent when the winds were blowing from the northwest quadrant, which is upwind of the DYEC facility. This trend was observed during both pre-operation and operation periods of the DYEC facility. From 2013 to 2020, BaP levels from the northwest, east and southeast directions were observed and varied from year to year. This assessment implies that the background BaP concentrations at the Courtice and Rundle stations were most likely due to Highway 401, Highway 407 East construction equipment, agricultural equipment, and potentially other local combustion sources, such as residential and or commercial wood burning.

BaP is commonly measured above the 24-hour average AAQC throughout Ontario, not only in urban settings but also at rural locations due to the contribution of combustion sources and diesel engines. For example, BaP measurements in 2018 for Simcoe and Toronto West had maximum levels above the AAQC (please refer to the following website for more information: www.canada.ca/en/environment-climate-change/services/air-pollution/monitoring-networks-data/national-air-pollution-program).

7.7 Metals

Metals were monitored at the DYEC and Gerdau Ameristeel stations in Durham Region. The data showed that metal concentrations were below the 24-hour average AAQC, with the exception of manganese at South Blair Station. The metal concentrations when compared to the nearest NAPS station were relatively similar with the exception of certain parameters like manganese and total chromium.

The metal concentrations reported were within the ministry's AAQC, with the exception of six 24-hour average manganese samples at Gerdau Ameristeel from 2015 to 2020. This implied that daily manganese AAQC exceedances were infrequent (2.2 % of the time).

8.0 Mobile Air Monitoring Survey of the Municipality of Clarington, Ontario, 2021

To further assess air quality in the Municipality of Clarington, the ministry undertook real time air monitoring over five days on July 21, 22, 26, 28 and 30, 2021, using a mobile air monitoring vehicle.

Precise real-time air monitoring was performed using a truck mounted mobile air monitoring lab. The vehicle was equipped with scientific analyzers capable of measuring volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter (PM), along with meteorological conditions. Measurements were focused on areas downwind of St. Marys Cement and DYEC.

Real-time mobile monitoring measurements were combined with concurrent GPS and meteorological data to produce spatial air pollutant maps (see Appendix A). VOC, SO_2 and PM concentrations were compared against AAQCs and other applicable standards, as further described in Appendix A. As some of the data is converted from half hour assessment values before it can be compared against the appropriate standards, this conversion only considers meteorological variation and does not account for other factors such as changes in facility operations. The calculated assessment values were used for screening purposes only, and cannot be used to determine non-compliance or to determine whether an adverse health effect has occurred or will occur.

The highest half-hour average air pollutant concentrations (in µg m3) observed during stationary measurements were benzene (1.3), toluene (3.5), styrene (1.0), xylenes (5.9), trimethylbenzenes (1.9), naphthalene (0.9), $PM_{2.5}$ (51) and PM_{10} (67). SO_2 concentrations up to 4.6 ppb were also observed during stationary measurements. Ambient concentrations of these pollutants did not exceed applicable air quality standards, guidelines, AAQC or converted assessment values at any time during the 2021 survey at any of the survey sites.

9.0 Summary

This memorandum summarizes air quality measurements from various monitoring programs situated in Durham Region between 2013 to 2020. It also highlights that there were numerous sources that contributed to $PM_{2.5}$, NO_2, TSP and BaP emissions.

Each monitoring program had been established for a particular purpose. While the stations discussed in this memorandum were not sited to obtain general air quality levels in the south Clarington area, there was value in assessing the data from the DYEC facility, St. Marys Cement, Gerdau Whitby, and the 407 East Extension construction monitoring locations to identify any trends or patterns over the years.

Subject to the data limitations and qualifications identified in section 7.1, the findings of this assessment were as follows:

1. $PM_{2.5}$, NO_2 and BaP concentrations across Durham Region were similar in comparison to other communities across southern Ontario.

2. Based on field observations and pollution rose assessments, background sources have changed from 2013 to 2016 in south Clarington, mainly due to the changes in local activities near the monitors, and the 407 East construction activities.

3. Analysis of the 2017 to 2020 air quality data shows that urban and rural communities in Durham Region were comparable to similar communities across southern Ontario. As supported in the findings of this report, decreases in nitrogen dioxide and fine particulate matter were observed over the past several years. This was further evident based on the findings in the *Air Quality in Ontario 2018 Report* (MECP, 2018) which recognized that air quality in Ontario has improved significantly over the last 10 years.

4. The ministry undertook real time air monitoring in the Municipality of Clarington over five days on July 21, 22, 26, 28 and 30, 2021, using a mobile air monitoring vehicle. Concentrations of volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter were measured, along with meteorological conditions, at several locations. Concentrations of the

measured pollutants did not exceed AAQC converted assessment values at any time during the 2021 mobile air monitoring survey.

5. In every monitoring network, there were multiple sources that contribute to the measurements observed at the station. Based on the data available, there was no reasonable method for deciphering contributions with accuracy from a particular source based on air measurement data.

6. Based on stakeholder monitoring stations and the hourly pollution rose assessments, industrial sources were not the only contributor to air quality issues. Other sources such as construction activities, residential and commercial, agricultural and transportation sources contributed significantly to the air quality measurements observed at the monitoring stations in Durham Region.

7. Finally, it is also important to note that when comparing data, fluctuations in meteorological conditions must be considered. Meteorological variations from year to year influence the air quality measurements observed at each station. For example, particulate matter impacts were typically highest during dry summer conditions due to less rainfall events resulting in higher dust impacts if unpaved surface emissions were not mitigated. During cold winters, as a result of increased heating requirements, products of combustion result in higher emissions which was seen at the different monitoring stations across Durham Region. On the other hand, during very wet conditions or rainfall events, particulate matter typically was at its lowest. Thus, meteorology influences the activities that occur around a specific monitoring location which in turn influences the air quality measurements.

10 References

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APPENDIX A- 2021 Mobile Air Monitoring Survey of the Municipality of Clarington, Ontario

Ministry of the Environment, Conservation and Parks

Environmental Monitoring and Reporting Branch

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Ministère de l'Environnement, de la Protection de la nature et des Parcs

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November 18, 2021

To: Jeff Butchart, Issues Project Coordinator
Kristen Sones, Supervisor
Celeste Dugas, Manager
York Durham District Office, Central Region

From: Aaron Todd, Supervisor
Terrestrial Assessment and Field Services Unit
Environmental Monitoring and Reporting Branch

Re: 2021 Mobile Air Monitoring Survey of the Municipality of Clarington, Ontario

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In July 2021, at the request of the York Durham District Office, the Terrestrial Assessment and Field Services Unit of the Environmental Monitoring and Reporting Branch (EMRB) conducted a mobile air monitoring survey of the Municipality of Clarington. On behalf of the Unit, please find attached a Technical Memorandum summarizing the results of the survey.

For further information regarding this survey, please contact me at 416-314-5047 (Office) or 647-633-3351 (Mobile).

____
Aaron Todd

On behalf of Chris Charron, Manager
Air Monitoring and Modelling Section, EMRB

Cc: Chris Charron, Robert Healy, EMRB
Kim Lendvay, Philip Dunn, Paul Martin, Central Region

Technical Memorandum

2021 Mobile Air Monitoring Survey of the Municipality of Clarington, Ontario

Ontario Ministry of the Environment, Conservation and Parks

Report Prepared by:

Terrestrial Assessment and Field Services Unit
Air Monitoring and Modelling Section
Environmental Monitoring and Reporting Branch

Report Completion Date:
November 2021

Ontario

Executive Summary

- The Ontario Ministry of the Environment, Conservation and Parks conducted real time air monitoring in the Municipality of Clarington, Ontario over five days on July 21, 22, 26, 28 and 30, 2021 using a mobile air monitoring vehicle.

- Concentrations of volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter were measured, along with meteorological conditions, at several locations around the Municipality of Clarington, including locations directly downwind of the St. Marys Cement plant and the Durham York Energy Centre (DYEC).

- The highest half-hour average air pollutant concentrations observed during the survey were (concentrations in µg m^{-3}) benzene (1.3), toluene (3.5), styrene (1.0), xylenes (5.9), trimethylbenzenes (1.9), naphthalene (0.9), $PM_{2.5}$ (51), PM_{10} (67) and (concentration in ppb) SO_2 (4.6).

- Half-hour air pollutant concentrations were compared with Ontario's Ambient Air Quality Criteria (AAQC) using converted half-hour assessment values where necessary. Concentrations of the measured pollutants did not exceed AAQC converted assessment values at any time during the 2021 mobile air monitoring survey.

- Relatively high background concentrations of $PM_{2.5}$ were observed in the Municipality of Clarington (and throughout the Greater Toronto Area) on July 26 due to the influence of a regional wildfire smoke event.

Survey Background

At the request of Central Region, the Environmental Monitoring and Reporting Branch (EMRB) of the Ontario Ministry of the Environment, Conservation and Parks (MECP or Ministry) completed a mobile air monitoring survey in the Municipality of Clarington, Ontario in July 2021. The survey was requested in response to concerns around air quality related to local industrial sources. Ambient concentrations of volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter (PM) were measured and the results were compared with *Ontario Regulation 419/05 Air Pollution - Local Air Quality* (O. Reg. 419/05) air quality standards or guidelines and Ontario's Ambient Air Quality Criteria (AAQC) where applicable.

Measurements were focused primarily in the vicinity of the St. Marys Cement plant and quarry at 410 Bowmanville Avenue, Bowmanville and the Durham York Energy Centre (DYEC) at 1835 Energy Drive, Courtice. Similar surveys of DYEC were performed by EMRB in 2014, 2015 and 2016 ("*2014 and 2015 Mobile TAGA Survey of Durham York Energy Centre (Courtice, Ontario)", "2016 Mobile TAGA Survey of Durham York Energy Centre (Courtice)"*). The St. Marys site emits approximately 69 tonnes of volatile organic compounds (VOCs), 55 tonnes of particulate matter smaller than 2.5 µm ($PM_{2.5}$) and 142 tonnes of particulate matter smaller than 10 µm (PM_{10}) annually according to Environment and Climate Change Canada's National Pollutant Inventory (NPRI, 2019). DYEC emits approximately 0.5 tonnes of $PM_{2.5}$ and 0.7 tonnes of PM_{10} annually (NPRI, 2019).

Both the St. Marys Cement plant and DYEC are subject to O. Reg. 419/05 Schedule 3 standards or guidelines, which are based on annual or 24-hour averages. Ontario's AAQC are benchmarks used to assess general air quality resulting from all sources of a contaminant to air. They are based on effects on human health, vegetation, soil, visibility, odour detection and approaches taken by other jurisdictions. In general, these standards and benchmarks are set at protective levels and based on effects that occur after longterm exposure and therefore direct comparison of shorter-term measurements is not always appropriate. To give context to the mobile air monitoring results, O. Reg. 419/05 standards/guidelines/jurisdictional screening levels (found on the Ministry's Air Contaminants Benchmarks List) and AAQC were converted to half-hour assessment values as described in Section 17 of the regulation (Appendix A). Since this conversion only considers meteorological variation and does not account for other factors, such as changes in facility operations, the calculated assessment values are for screening purposes only and cannot be used to determine non-compliance or whether an adverse health effect has occurred or will occur. Additional information on the use of the O. Reg. 419/05 air standards, guideline values, and other screening levels to interpret air monitoring results is provided in Appendix A.

Survey Methodology

Real-time air monitoring of VOCs was performed using a truck equipped with a Proton Transfer Reaction Mass Spectrometer (PTR-MS, Ionicon). The PTR-MS is calibrated for the quantification of aromatic hydrocarbons and chlorinated VOCs. Mobile monitoring was conducted while the truck was in motion to acquire measurements in real time and to identify any VOC hotspots by combining the monitoring data with concurrent on-board Global Positioning System (GPS) data. The mass spectrometer used here cannot separate the contributions of xylenes and ethylbenzene, and instead measures the sum of these species. For clarity xylenes/ethylbenzene are simply referred to as “xylenes” throughout. SO_2 concentrations were measured using a Thermo Scientific 43i analyzer and $PM_{2.5}$/PM_{10} concentrations were measured using a Teledyne T640 PM Mass Monitor. VOCs and SO_2 were measured at five second resolution and $PM_{2.5}$ and PM_{10} were measured at ten second resolution. Concentrations of VOCs, SO_2, $PM_{2.5}$ and PM_{10} were also measured at eight sites around the Municipality of Clarington while the mobile unit was stationary.

Mobile Monitoring Results

Air monitoring in the Municipality of Clarington was performed over five days on July 21, 22, 26, 28 and 30, 2021. No odours were noted by the TAGA staff downwind of either the St. Marys Cement plant or DYEC. VOC concentrations remained at background levels downwind of both facilities throughout the mobile monitoring periods. Examples of benzene mobile monitoring data collected while driving around the St. Marys Cement plant on July 21 and 22 are shown in Figures 1 and 2, respectively. Benzene has been chosen for these examples because of its relatively low AAQC value. Benzene concentrations remained at background levels (<1 $\mu g\ m^{-3}$) both upwind and downwind of the facility except for brief periods when slightly elevated concentrations were observed, most likely a result of passing vehicles on the roadways. Similar results were observed for DYEC on July 26 as shown in Figure 3. A defined VOC plume was not detected downwind of either facility at any time during the study period. A north-south transect of Bowmanville, shown in Figure 4, demonstrates low levels of benzene throughout the area, with slightly elevated concentrations observed near the intersection of King Street West and Scugog Street associated with stop and go traffic.

The St. Marys Cement plant is also a source of particulate matter and TAGA staff observed visible dust within the facility and dust resuspended by passing trucks and other vehicles on the roadways surrounding the facility. PM_{10} mobile measurement data for July 21 and 22 are shown in Figures 5 and 6, respectively. While localized PM_{10} hotspots were observed while driving around the facility, with concentrations reaching > 200 µg m^{-3} at times, these elevated concentrations were not a result of direct emissions from the facility but instead were associated with resuspension of road dust by passing vehicles. On both days elevated PM_{10} was also observed at the perimeter of the Dufferin Concrete Bowmanville plant at the intersection of West Beach Road and East Shore Drive, caused both by trucks entering and exiting the property and direct fugitive dust emissions from activities on site.

Figure 1: Mobile monitoring of benzene in the vicinity of the St. Marys Cement plant, Municipality of Clarington, Ontario, July 21, 2021 09:47-10:06. The red arrow indicates the general location of the plant. The yellow arrow indicates the direction the wind was blowing during the measurement period.

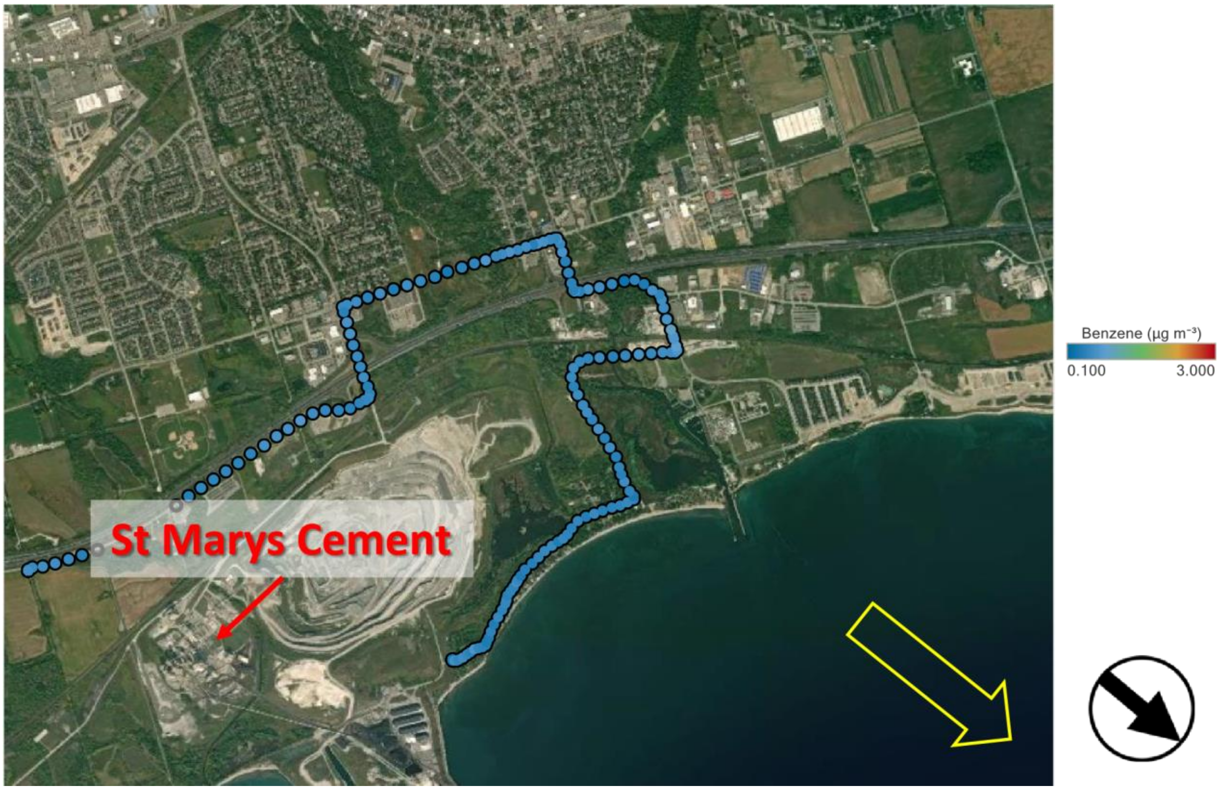


Figure 2: Mobile monitoring of benzene in the vicinity of the St. Marys Cement plant, Municipality of Clarington, Ontario, July 22, 2021 10:20-10:40. The red arrow indicates the general location of the facility. The yellow arrow indicates the direction the wind was blowing during the measurement period.

Figure 3: Mobile monitoring of benzene in the vicinity of DYEC, Municipality of Clarington, Ontario, July 26, 2021 11:01-11:12. The red arrow indicates the general location of the facility. The yellow arrow indicates the direction the wind was blowing during the measurement period.

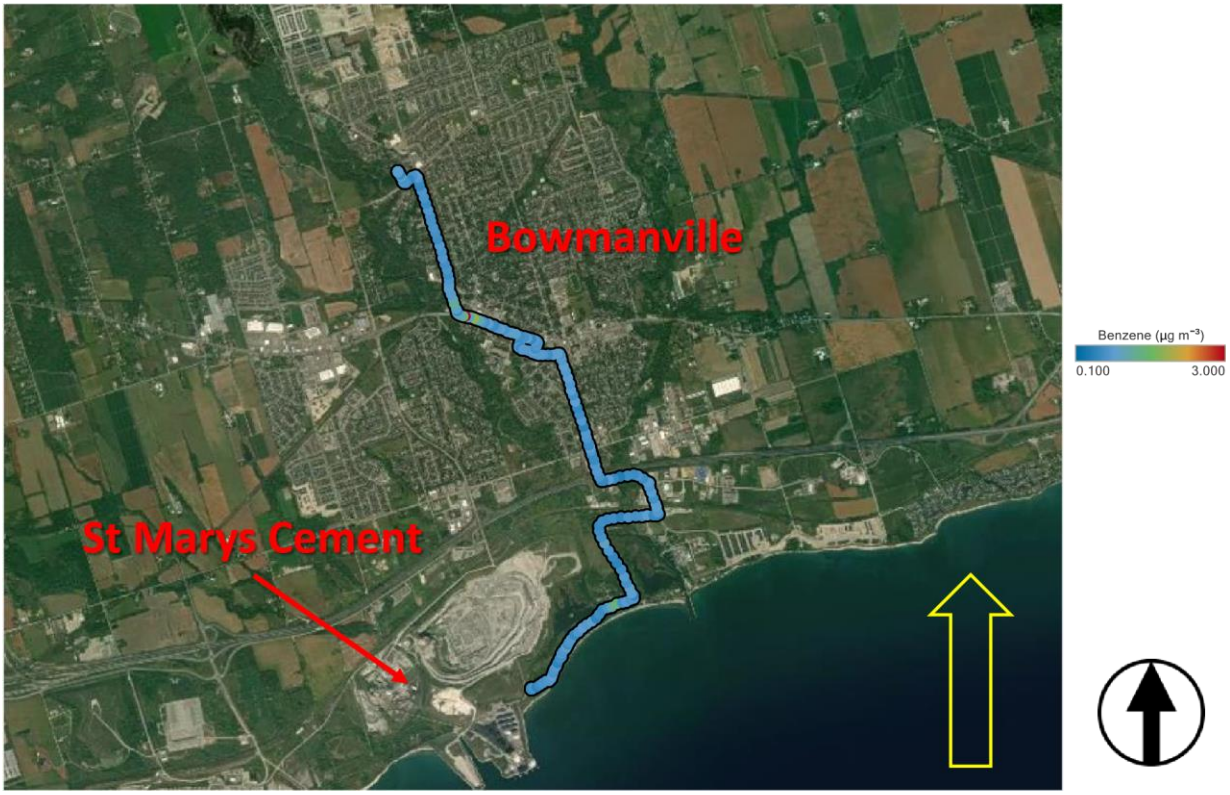


Figure 4: Mobile monitoring of benzene in the Municipality of Clarington, Ontario, July 28, 2021 11:00-12:00. The yellow arrow indicates the direction the wind was blowing during the measurement period.

Figure 5: Mobile monitoring of PM_{10} in the vicinity of the St. Marys Cement plant, Municipality of Clarington, Ontario, July 21, 2021 09:47-10:06. The red arrow indicates the general location of the facility. The yellow arrow indicates the direction the wind was blowing during the measurement period.

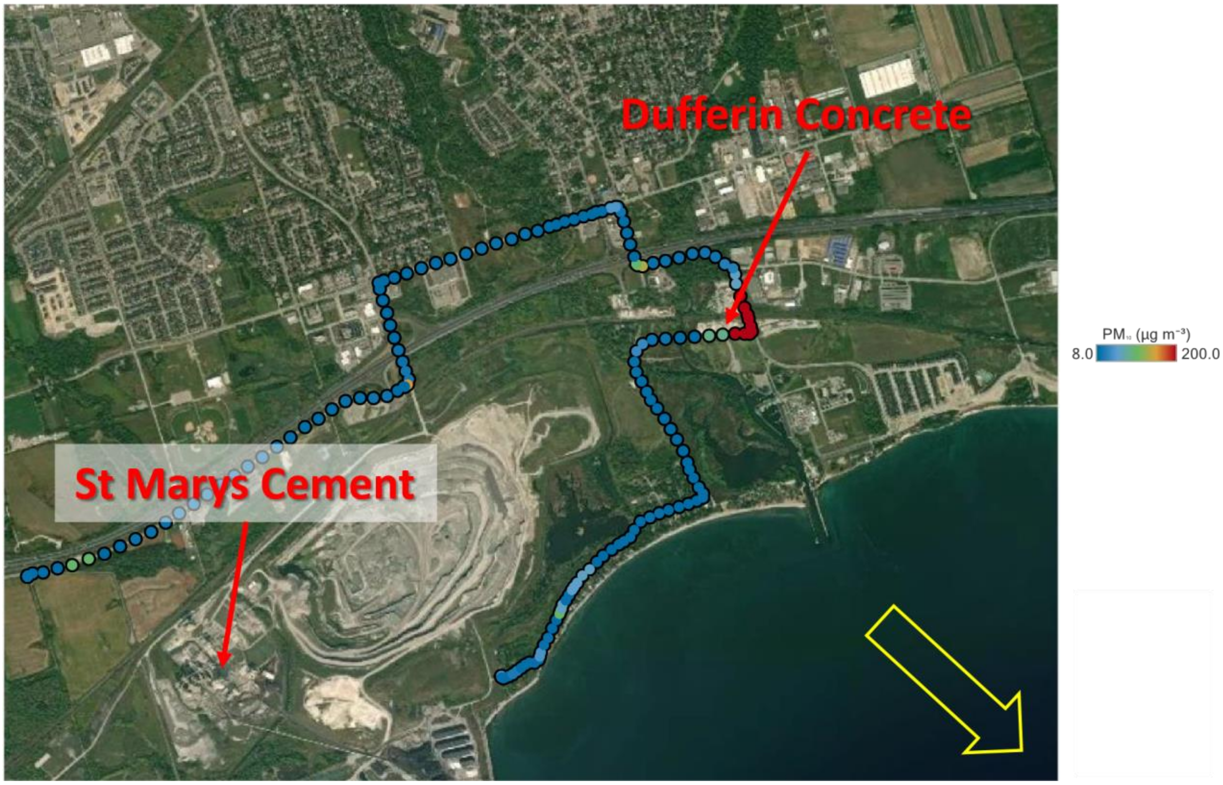


Figure 6: Mobile monitoring of PM_{10} in the vicinity of the St. Marys Cement plant, Municipality of Clarington, Ontario, July 22, 2021 10:20-10:40. The red arrow indicates the general location of the facility. The yellow arrow indicates the direction the wind was blowing during the measurement period.

Stationary Monitoring Results

Although the mobile monitoring measurements did not identify defined VOC or particulate matter plumes associated with either the St. Marys Cement plant or DYEC, stationary measurements were performed to assess air quality directly downwind of both facilities. Emissions from HWY401 and local roadways are also expected to contribute to ambient concentrations of VOCs and particulate matter in the area. Stationary locations as close as possible to the facilities were chosen based on wind direction measurements on each survey day. This does not guarantee that facility emissions will be intercepted at ground level. Residential areas located at different distances from local industrial sources were also selected to represent general ambient air quality in the community (Kelman Place and Brown Street). The stationary monitoring locations are shown in Figure 7. Table 1 summarizes the data collected during these stationary periods including sampling times, monitoring sites, meteorology and half-hour average air pollutant concentrations. Air pollutant concentrations measured downwind of both facilities were similar to their respective upwind concentrations on all five survey days and concentrations measured in residential areas were similar to those measured throughout the Municipality of Clarington area. Table 2 highlights the highest half-hour concentrations observed, converted half-hour assessment values, and respective standards/guidelines for each measured air pollutant. Ambient concentrations of these pollutants did not exceed applicable O. Reg. 419/05 air quality standards, guidelines, AAQC or converted assessment values at any time during the 2021 survey at any of the sites investigated.

Figure 7: Map of stationary monitoring sites used during the Municipality of Clarington survey, July 2021.

Table 1: Average stationary measurement concentrations of VOCs, SO_2, $PM_{2.5}$ and PM_{10} measured during the Municipality of Clarington survey, July 2021.

Date	Start Time	End Time	Site (1)	Wind direction from) (2)	Wind speed km h^{-1}) (2)	Benzene (3)	Toluene (3)	Styrene (3)	Xylenes (3)	Trimethyl - benzenes (3)	Naphthalene (3)	SO_2 (4)	$PM_{2.5}$ (3)	PM_{10} (3)
July 21	10:19	10:49	A	SW	9	0.5	1.4	0.7	2.4	1.3	0.6	0.2	10	20
	10:49	11:19	A	SSW	6	0.5	1.4	0.7	2.5	1.3	0.6	0.2	10	17
	11:19	11:49	A	WSW	10	0.5	1.3	0.7	2.5	1.3	0.6	0.2	10	14
	11:49	12:19	A	SSW	6	0.5	1.3	0.7	2.4	1.2	0.6	0.2	10	20
	12:19	12:49	A	SSW	8	0.5	1.2	0.7	2.5	1.2	0.6	0.2	11	17
	12:49	13:19	A	WSW	9	0.5	1.2	0.7	2.6	1.2	0.6	0.2	10	18
	13:19	13:49	A	S	10	0.5	1.2	0.7	2.7	1.2	0.6	0.2	9	19
	13:49	14:19	A	W	8	0.5	1.2	0.7	2.7	1.3	0.6	0.3	8	17
	14:19	14:49	A	WNW	13	0.4	1.2	0.7	2.7	1.2	0.6	0.2	7	14
	14:49	15:19	A	SW	9	0.4	1.2	0.7	2.6	1.2	0.6	0.2	7	25
July 22	10:09	10:19	B	NNW	9	0.5	1.7	0.7	2.6	1.3	0.6	0.3	7	12
	10:40	11:10	A	NW	7	0.5	1.6	0.7	2.4	1.2	0.6	0.2	9	29
	11:10	11:40	A	SW	7	0.5	1.4	0.7	2.5	1.2	0.6	0.3	8	26
	11:40	12:10	A	W	7	0.5	1.6	0.7	2.7	1.3	0.6	0.2	9	33
	12:10	12:40	A	SW	7	0.5	1.6	0.7	3.2	1.3	0.6	0.2	9	49
	12:40	13:10	A	WSW	6	0.5	1.6	0.7	2.5	1.2	0.6	0.2	8	29
	13:10	13:40	A	WSW	7	0.5	1.9	0.7	3.0	1.3	0.7	0.2	10	44
	13:40	14:10	A	SW	11	0.6	2.3	0.7	3.4	1.3	0.6	0.2	11	50
	14:10	14:40	A	WSW	10	0.6	2.0	0.7	3.2	1.2	0.6	0.2	12	67
July 26	11:13	11:23	C	WSW	10	1.3	3.5	1.0	4.6	1.9	0.9	0.4	51	63
	11:37	12:07	D	W	15	1.2	3.1	0.9	4.4	1.7	0.9	0.3	49	65
	12:07	12:37	D	WSW	15	1.1	2.5	0.8	3.7	1.6	0.8	0.8	46	62
	12:37	13:07	D	WSW	12	1.0	2.1	0.9	3.4	1.5	0.8	4.1	47	62
	13:07	13:37	D	WSW	11	1.0	1.9	0.8	4.2	1.4	0.8	4.6	45	56
	13:37	14:07	D	W	14	0.9	1.7	0.8	3.1	1.4	0.8	3.7	44	56
	14:07	14:37	D	W	15	0.9	1.7	0.8	3.0	1.4	0.8	1.5	36	45
	14:37	15:07	D	W	14	0.8	1.5	0.8	2.9	1.4	0.8	0.9	31	41
July 28	10:59	11:14	E	S	4	0.7	2.6	0.8	3.3	1.5	0.8	0.4	12	18
	11:26	11:41	F	S	5	0.8	1.9	0.8	5.9	1.7	0.7	0.3	12	18
	11:55	12:05	A	W	16	0.6	1.3	0.7	2.4	1.2	0.7	0.3	48	64
	12:37	13:07	B	SE	17	0.7	1.3	0.7	2.3	1.1	0.7	0.5	11	15
	13:07	13:37	B	SE	15	0.6	1.1	0.7	2.2	1.1	0.7	0.3	10	14

	13:38	14:08	B	SSE	14	0.6	1.1	0.7	2.3	1.1	0.7	0.2	9	13
	14:08	14:38	B	SSE	12	0.6	1.1	0.7	2.4	1.1	0.7	0.2	10	13
	14:38	15:08	B	SSE	12	0.6	1.1	0.7	2.4	1.1	0.6	0.2	9	13
July 30	10:40	10:50	G	SW	17	0.5	1.4	0.7	2.0	1.1	0.6	0.2	2	6
	11:04	11:34	H	W	14	0.5	1.5	0.7	2.1	1.2	0.7	0.2	3	8
	11:34	12:04	H	SSW	15	0.5	1.6	0.7	2.4	1.2	0.8	0.2	3	8
	12:04	12:34	H	NW	17	0.4	1.2	0.7	2.1	1.1	0.7	0.1	3	10
	12:34	13:04	H	WNW	18	0.4	1.2	0.7	2.3	1.1	0.8	0.1	3	13
	13:04	13:34	H	NW	19	0.4	1.1	0.7	2.2	1.1	0.7	0.1	3	14
	13:34	14:04	H	NNW	17	0.4	1.2	0.7	2.3	1.1	0.7	0.2	3	13
	14:35	14:50	E	W	7	0.4	1.3	0.7	2.5	1.2	0.6	0.2	3	11
	15:00	15:15	F	SE	8	0.5	1.3	0.7	2.6	1.2	0.6	0.2	3	12

Notes:
(1) Monitoring sites - see Figure 7.
(2) Weather conditions were recorded on-site by meteorological equipment on-board the mobile unit.
(3) Concentrations are in micrograms per cubic metre (μg m^{-3}).
(4) Concentrations are in parts per billion (ppb).

Table 2: Summary of maximum half-hour concentrations of VOCs, SO_2, $PM_{2.5}$ and PM_{10} measured in the Municipality of Clarington during the mobile air monitoring survey, July 2021. Converted assessment values are included for comparison purposes only.

Pollutant	Survey highest half-hour concentration	Half-hour Assessment Value (converted from O. Reg 419/05 Standard/AAQC) (3)
Benzene (1)	1.3	6.8
Toluene (1)	3.5	5913
Styrene (1)	1.0	1183
Xylenes (1)	5.9	2158
Trimethylbenzenes (1)	1.9	650
Naphthalene (1)	0.9	67
SO_2 (2)	4.6	67 (4)
$PM_{2.5}$ (1)	51	80
PM_{10} (1)	67	149

Notes:

(1) Concentrations are in micrograms per cubic metre (µg m^{-3}).
(2) Concentrations are in parts per billion (ppb)
(3) Converted as described in Appendix A
(4) This is the unconverted 10-minute AAQC for SO_2

Summary and Conclusions

The Ministry conducted real time air monitoring in the Municipality of Clarington, Ontario over five days in July 2021. Measurements were focused on areas downwind of the St. Marys Cement plant and DYEC, but residential areas were also investigated. Real-time mobile monitoring measurements were combined with concurrent GPS and meteorological data to produce spatial air pollutant maps. The highest half-hour average air pollutant concentrations (in $\mu g\ m^{-3}$) observed during stationary measurements were benzene (1.3), toluene (3.5), styrene (1.0), xylenes (5.9), trimethylbenzenes (1.9), naphthalene (0.9), $PM_{2.5}$ (51) and PM_{10} (67). SO_2 concentrations up to 4.6 ppb were observed during stationary measurements. Air pollutant concentrations, measured while stationary at eight sites around the Municipality of Clarington, were compared with Ontario Regulation 419/05 standards and AAQC using converted half-hour assessment values where applicable. The concentrations of the measured pollutants did not exceed their respective half-hour converted assessment values for applicable standards or AAQC at any time during the survey period.

Appendix A

Conversion of O. Reg 419/05 Standards/Guidelines/Jurisdictional Screening Levels and Ontario's Ambient Air Quality Criteria (AAQC) to Converted Assessment Values

To compare a short-term monitoring value to a benchmark with a longer averaging period a conversion factor was applied. Conversion factors were calculated using the method described in Section 17 of O. Reg. 419/05. This conversion only takes meteorological variation into account.

Calculation of a Conversion Factor for monitoring periods shorter than the averaging period specified by the standard/guideline/jurisdictional screening level or AAQC.

$(t_0 \div t_1)^n$

t_0 = the averaging period specified by the standard/guideline, expressed in hours t_1 = the averaging period used for monitoring, expressed in hours n = 0.28

The standard is multiplied by this calculated conversion factor to give a Converted Assessment Value

Use of the O. Reg. 419/05 air standards, guideline values, AAQC and other screening levels to interpret air monitoring results

Ontario regulates contaminants released to air by various sources, including local industrial and commercial facilities, to limit exposure to substances that can affect human health and the environment. The Ministry's *Ontario Regulation 419/05 – Local Air Quality* (O. Reg. 419/05) air standards, guideline values, and other screening levels are found on the Air Contaminants Benchmarks List. These standards and guidelines are used under the general provisions of the *Environmental Protection Act*, including compliance purposes under O. Reg. 419/05. These values are, however, sometimes used to interpret air quality outside of the purposes of O. Reg. 419/05. Ontario's AAQC are benchmarks used to assess general air quality resulting from all sources of a contaminant to air. They are based on effects on human health, vegetation, soil, visibility, odour detection and approaches taken by other jurisdictions. They are set at concentrations that are protective against adverse effects.

Many of the applicable standards or guidelines are based on annual or 24-hour averages. In general, they are set at protective levels and based on effects that occur following longterm exposure. Therefore, direct comparison of short-term measurements is not always appropriate. To give context to the short-term monitored results (i.e., half-hour TAGA survey measurements), applicable O. Reg. 419/05 standards or guidelines are converted to half-hour assessment values, as described in Section 17 of O. Reg. 419/05. Since this conversion only considers meteorological variation and not factors such as changes in facility operations, these calculated assessment values are for screening purposes only, and cannot be used to determine non-compliance or whether an adverse health effect has occurred or will occur. However, these calculated assessment value comparisons can be used to provide context to monitoring results. Short-term monitoring results that are elevated with respect to the assessment values may be used to flag potential issues worthy of further investigation.

In these situations, monitoring results that are elevated with respect to the half-hour assessment values do not necessarily indicate that an adverse effect has occurred or will occur. Rather, an air quality analyst or risk assessor should consider, on a case-specific basis, whether there is potential for adverse effects when using the converted O. Reg. 419/05 standards or guidelines to interpret air monitoring data. This could include considerations of the nature of the contaminant, how the air limits were developed, supplementary monitoring or air dispersion modelling, or other elements typical of a human health risk assessment (i.e., frequency, magnitude and duration of elevated values).

For additional details regarding the development of the Ministry's air standards, and the Ministry's framework for managing risk, please refer to the following document: *Guideline A-12: Guideline for the Implementation of Air Standards in Ontario* (GIASO). https://www.ontario.ca/page/guideline-12-guideline-implementation-air-standardsontario

Table A1: O. Reg. 419/05 standards and AAQC values used to produce the converted assessment values in Table 2.

Pollutant	O. Reg 419/05 Standard/AAQC (4)
Benzene (1)	0.45 (S, annual)
Toluene (1)	2000 (A, 24-hr)
Styrene (1)	400 (S, 24-hr)
Xylenes (1)	730 (S, 24-hr)
Trimethylbenzenes (1)	220 (S, 24-hr)
Naphthalene (1)	22.5 (A, 24-hr)
SO_2 (2)	67 (A, 10-min)
$PM_{2.5}$ (1)	27 (A, 24-hr)
PM_{10} (1)	50 (A, 24-hr)

APPENDIX B - AAQCs and CAAQS INDICATORS for Relevant Parameters

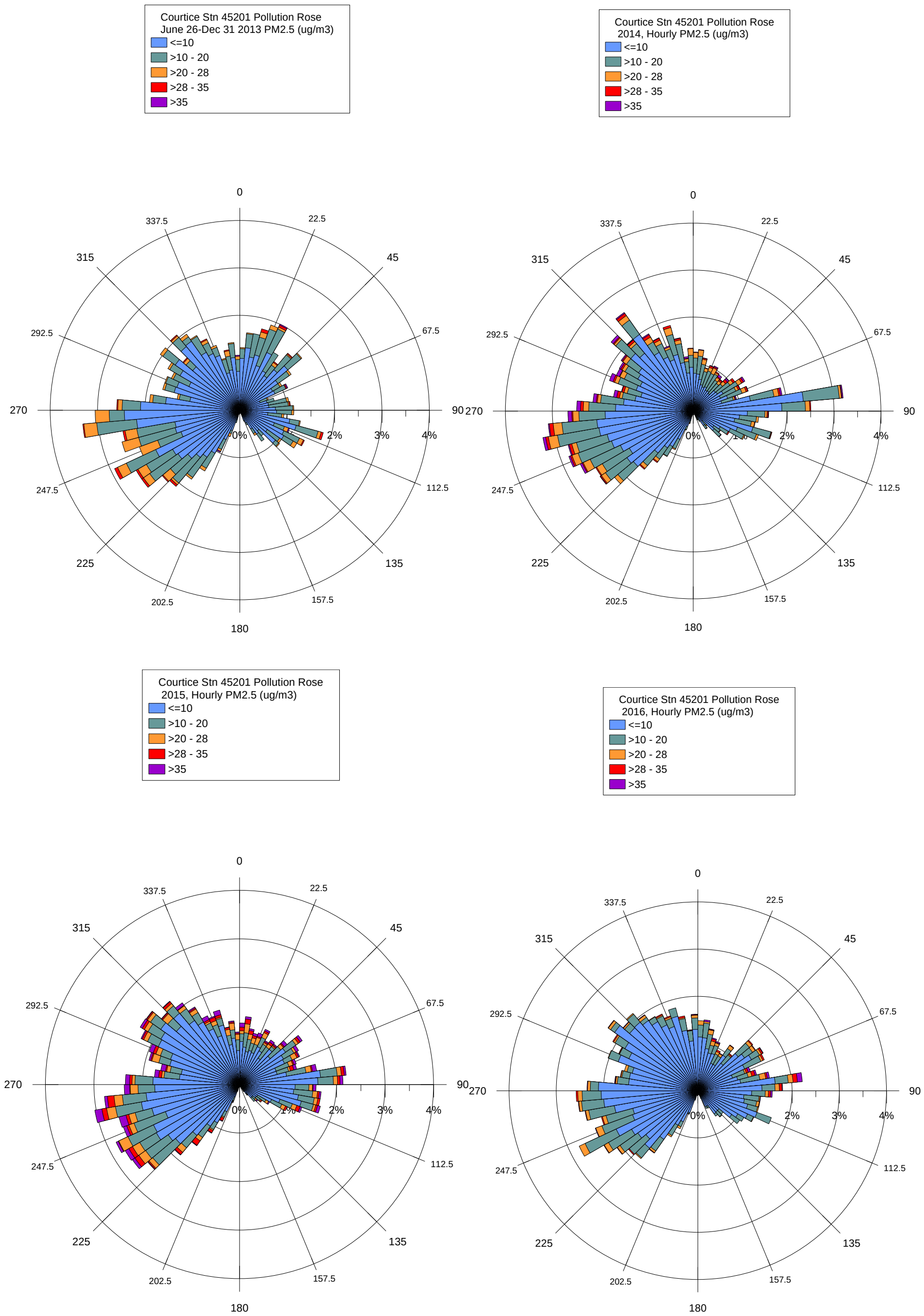
Contaminant	Unit	10min AAQC	1- Hour AAQC	1-Hour CAAQS INDICATOR	8-Hour AAQC	24-Hour AAQC	24-Hour CAAQS INDICATOR	30 Day AAQC	Annual AAQC	Annual CAAQS INDICATOR
NO_2	ppb		200	60 (2020)[d] 42 (2025)		100				17 (2020)[e] 12 (2025)
$PM_{2.5}$	ug/m3						27 (2020) [a] 28 (2015)			8.8(2020) [b] 10 (2015)
PM_{10}	ug/m3					50 [c]				
TSP	ug/m3					120			60	
Dustfall	g/m2							7	4.6	
SO_2	ppb	67	40	70 (2020) 65 (2025)					4	5 (2020) 4 (2025)
CO	ppm		30		13					
Total Mercury (Hg)	ug/m3					2				
Aluminum (Al)	ug/m3					120				
Cadmium (Cd)	ug/m3					0.025				
Total Chromium (Cr)	ug/m3					0.5				
Copper (Cu)	ug/m3					50				

Iron (Fe)	**ug/m3**					4 (Metallic) 25 (Ferric Oxide)				
Lead (Pb)	**ug/m3**					0.5		0.2		
Total Manganese (Mn)	**ug/m3**					0.4				
Total Nickel (Ni)	**ug/m3**					0.2			0.04	
Zinc (Zn)	**ug/m3**					120				
BaP	**ng/m3**					0.05			0.01	
Dioxins/ Furans	**pg TEQ/m3**					0.1				

[a] This value of 27 ug/m^3 is the 2020 *Canadian Ambient Air Quality Standard* (CAAQS) for $PM_{2.5}$ which is based on the 24-hour 98^{th} percentile ambient measurement annually, averaged over three consecutive years.
[b] This value of 8.8 ug/m^3 is the 2020 CAAQS for $PM_{2.5}$ which is based on the three year average of the annual average concentrations.
[c] This value of 50 ug/m^3 (24 hour) is an interim AAQC and is provided here as a guide for decision making (with no conversion to other averaging times).
[d] The 2020 and 2025 1-Hour NO2 CAAQS are based on the 3-year average of the annual 98^{th} percentile daily maximum 1-hour average concentrations
[e] The 2020 and 2025 annual NO2 CAAQS are based on the average over a single calendar year of all the 1-hour average concentrations

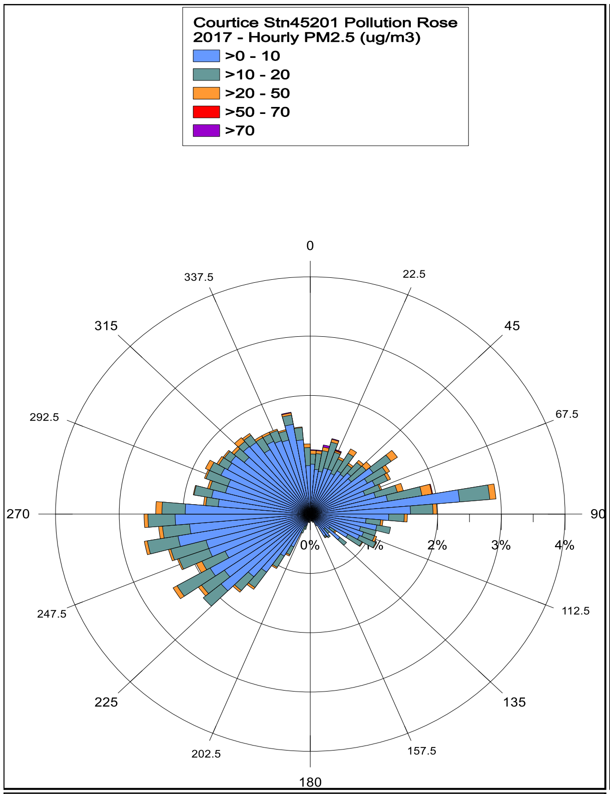
APPENDIX C - Pollution Roses

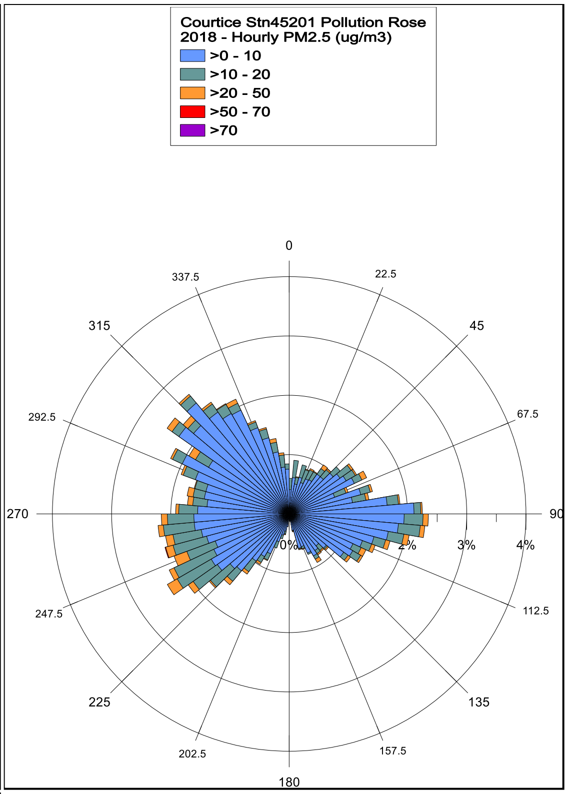
Figure C1 PM2.5 Hourly Pollution Roses – DYEC Monitoring Program - Courtice



Notes:
This Figure indicates that no wind is coming from the direction of 155-200 degrees at Courtice during the sampling periods.
Please note that the Courtice meteorological tower is set 10 metres above ground.

A pollution rose is a tool to illustrate the frequency of wind direction and pollutant concentration blowing from each direction. Each 'spike" in the pollution rose represents the pollutant concentration from a specific wind direction. The different colour segments within a "spike" illustrate the concentration levels measured from that direction. The length of the colour segment indicates the frequency at which the concentrations were measured.


Courtice Stn45201 Pollution Rose
2017 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
1%
2%
3%
4%


Courtice Stn45201 Pollution Rose
2018 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
2%
3%
4%

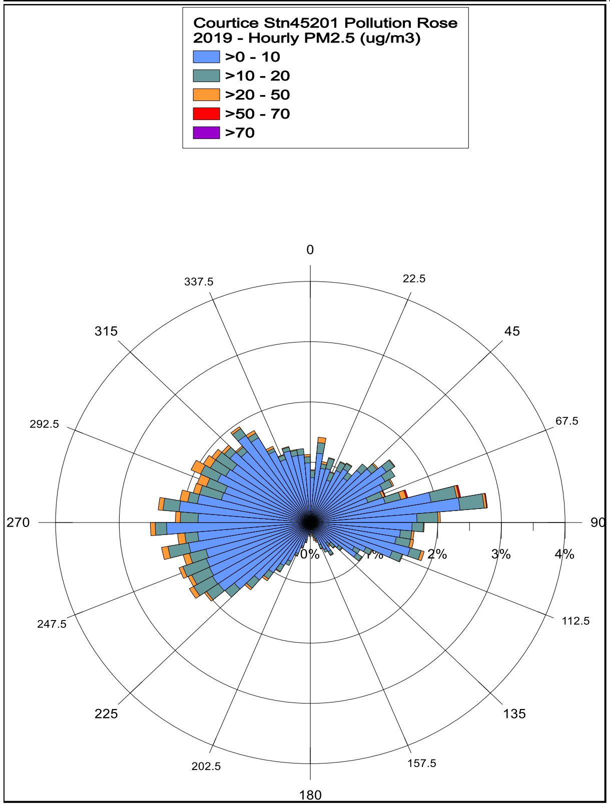
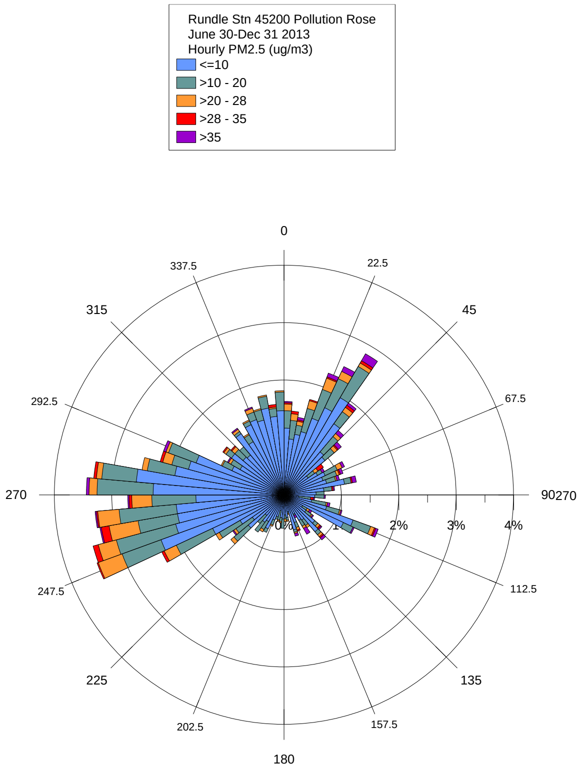
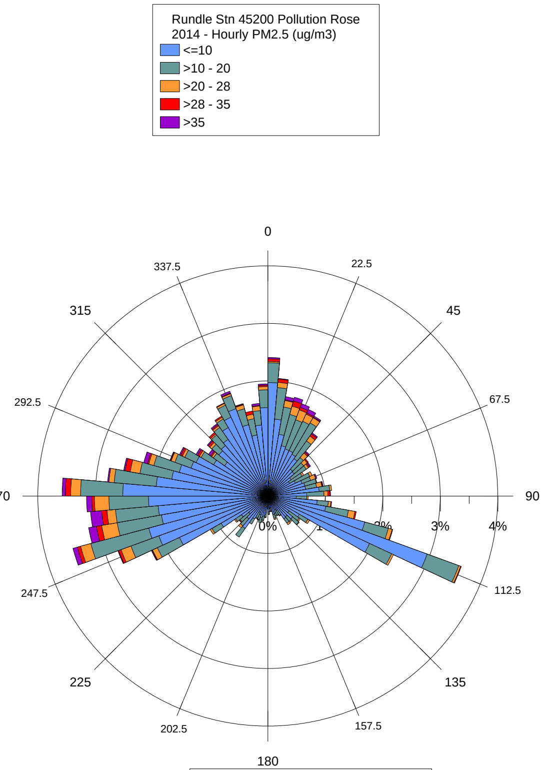
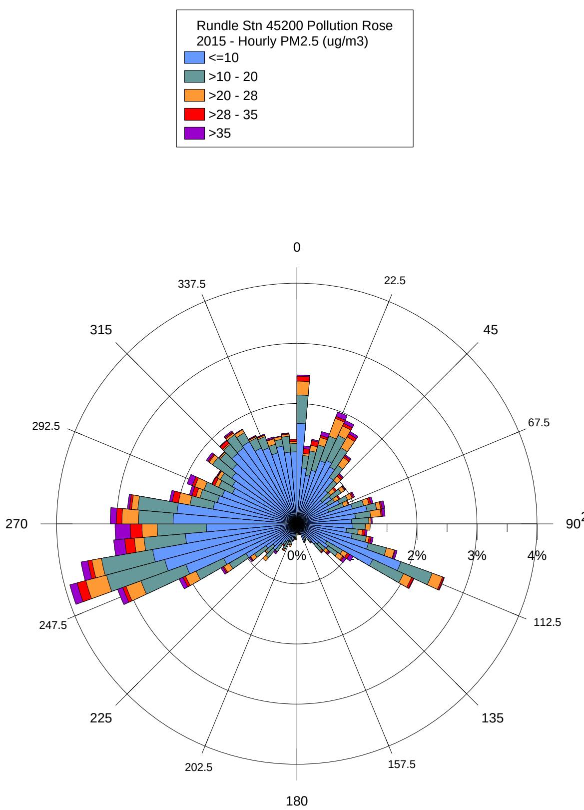
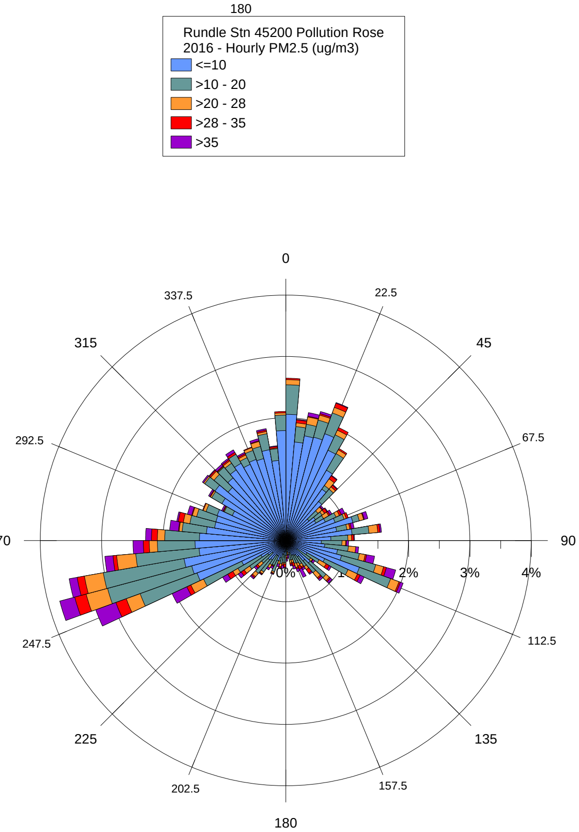

Courtice Stn45201 Pollution Rose
2019 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
1%
2%
3%
4%

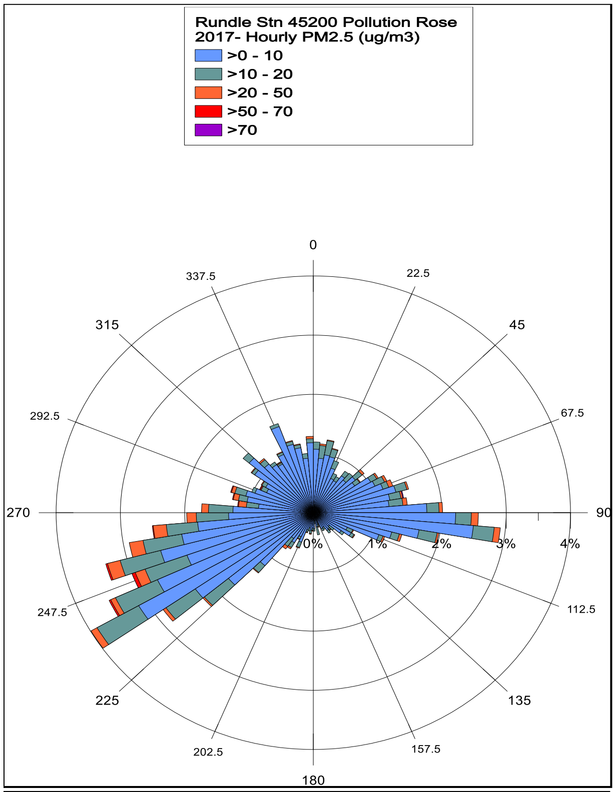
Figure C2 PM2.5 Hourly Pollution Roses – DYEC Monitoring Program - Rundle

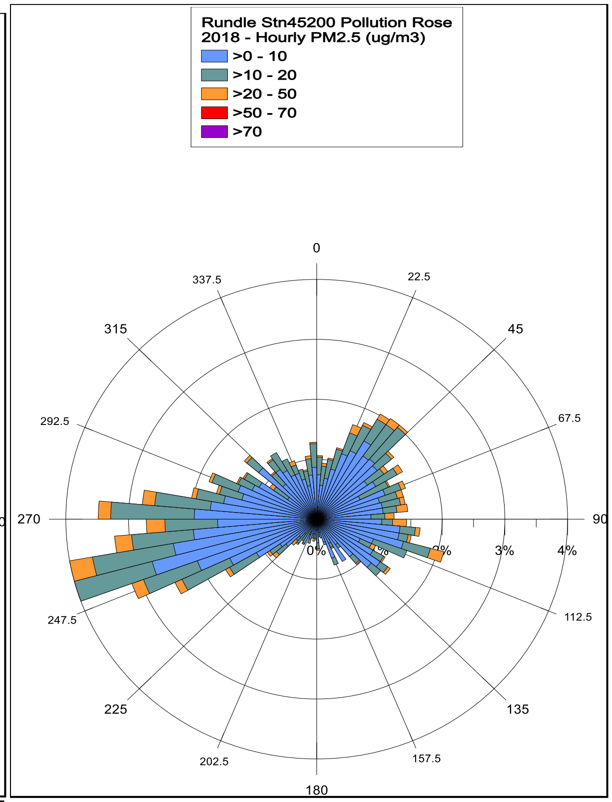


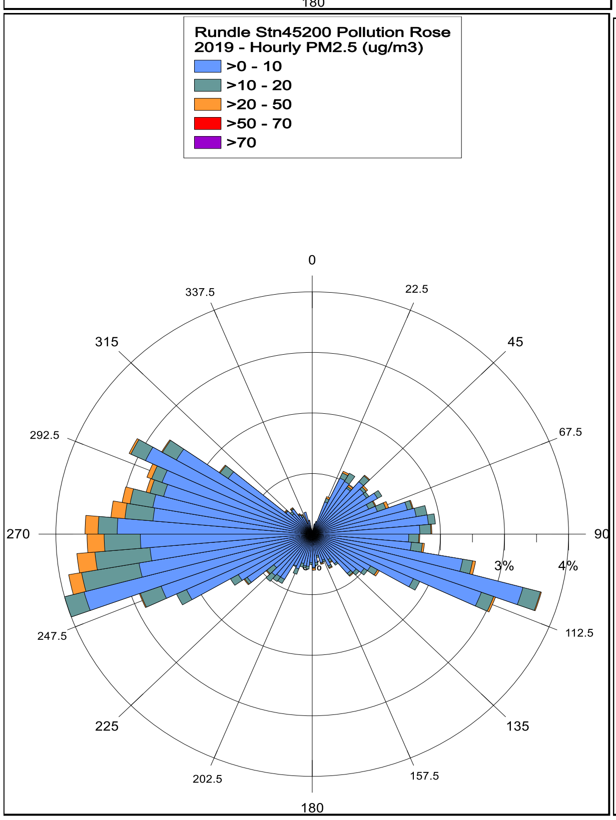







Rundle Stn 45200 Pollution Rose
2017- Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
1%
2%
3%
4%


Rundle Stn45200 Pollution Rose
2018 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
3%
4%


Rundle Stn45200 Pollution Rose
2019 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
4%

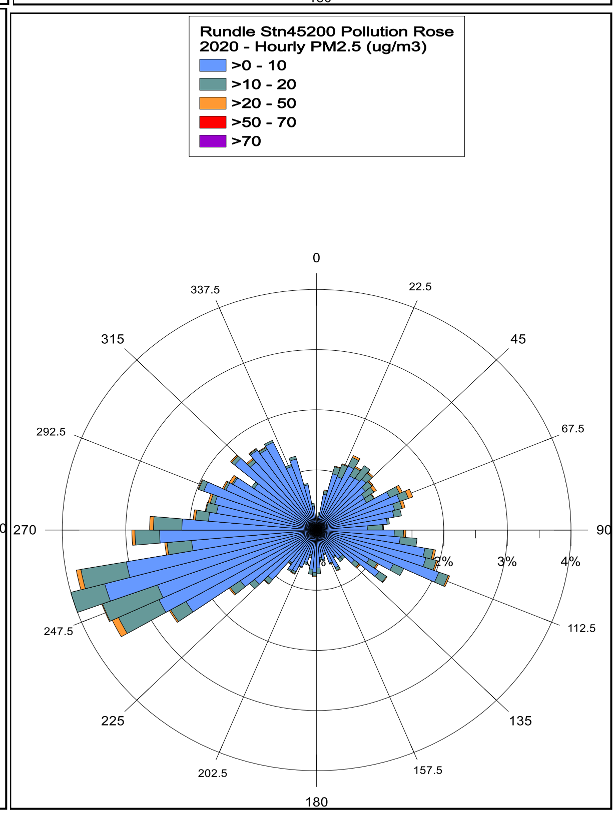
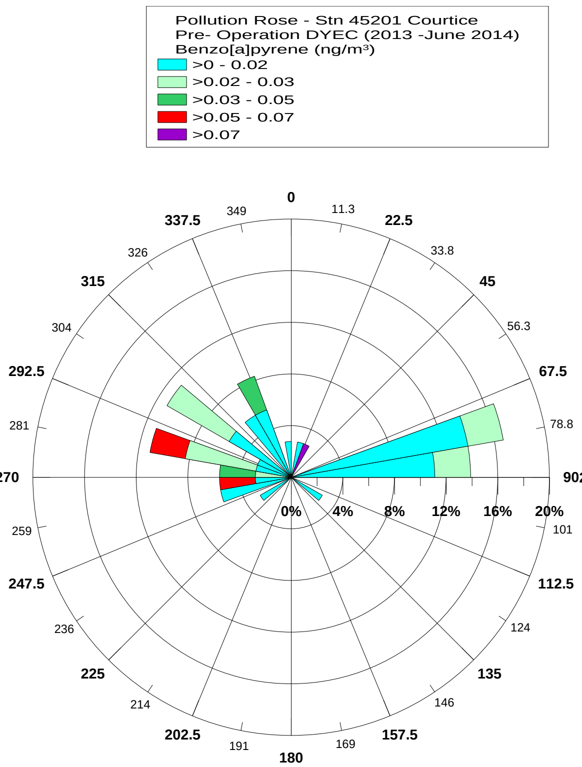
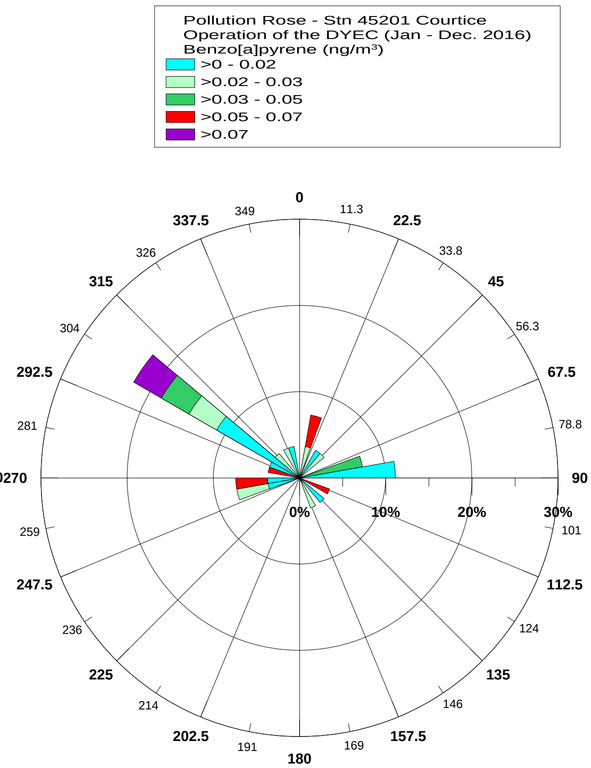
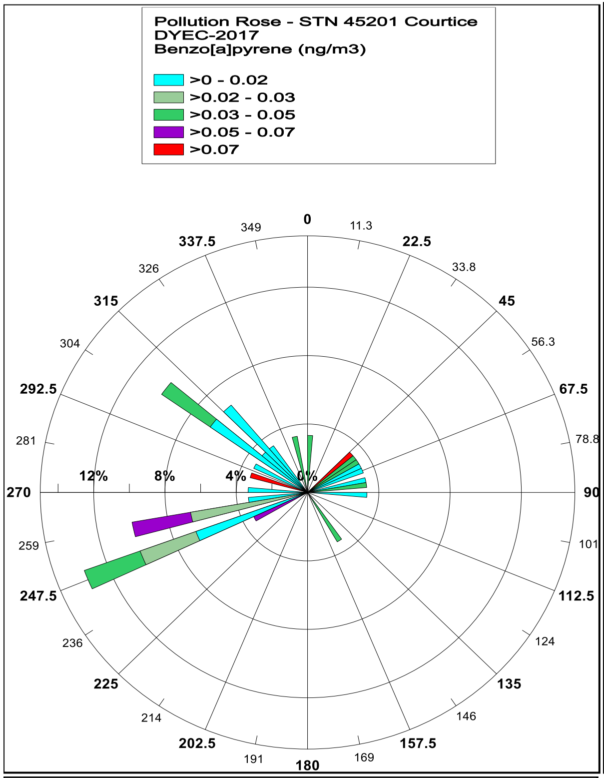

Rundle Stn45200 Pollution Rose
2020 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
4%

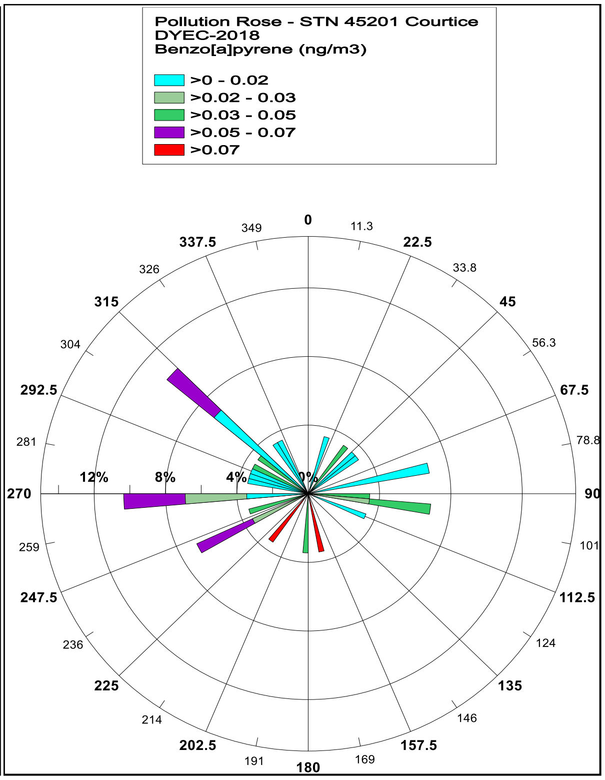
Figure C3 Benzo(a)pyrene 24-hour Average Pollution Roses – DYEC Monitoring Program - Courtice



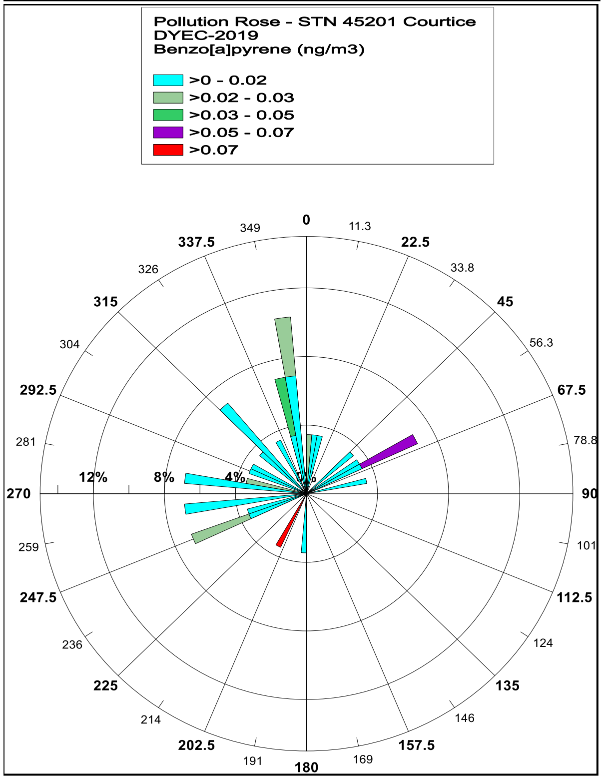




Pollution Rose - STN 45201 Courtice
DYEC-2017
Benzo[a]pyrene (ng/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.07
>0.07

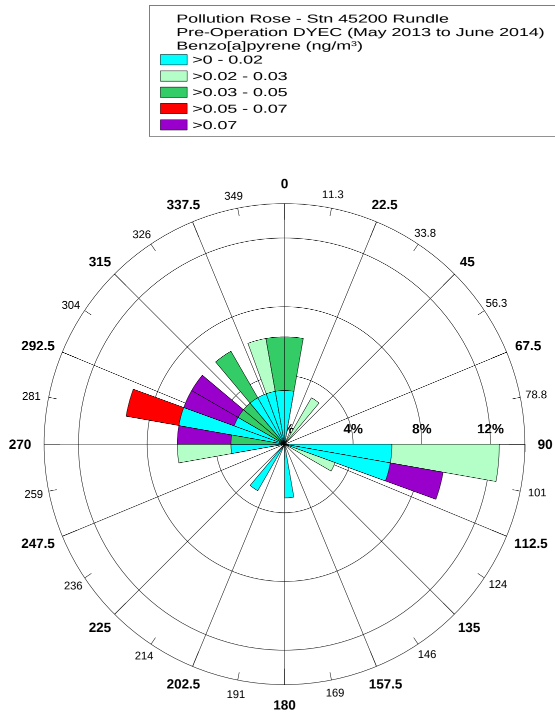


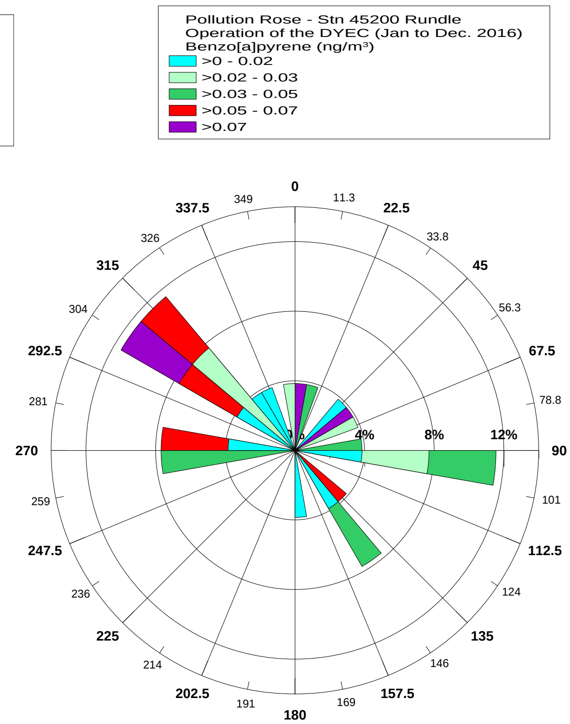
Pollution Rose - STN 45201 Courtice
DYEC-2018
Benzo[a]pyrene (ng/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.07
>0.07



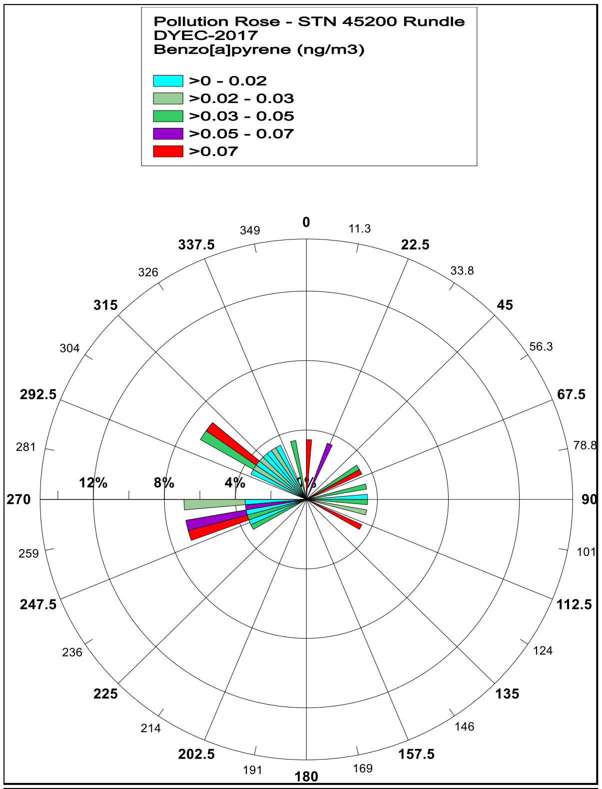
Pollution Rose - STN 45201 Courtice
DYEC-2019
Benzo[a]pyrene (ng/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.07
>0.07

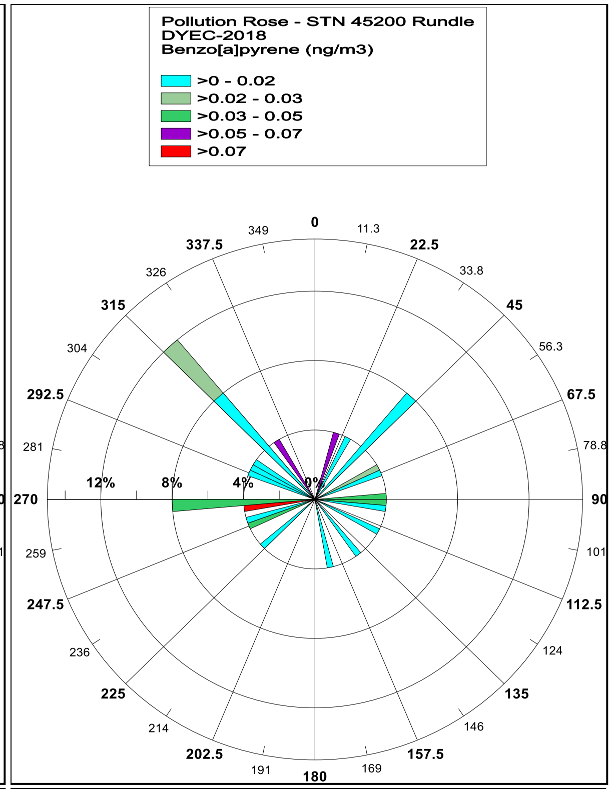
Figure C4 Benzo(a)pyrene 24-hour Average Pollution Roses – DYEC Monitoring Program - Rundle

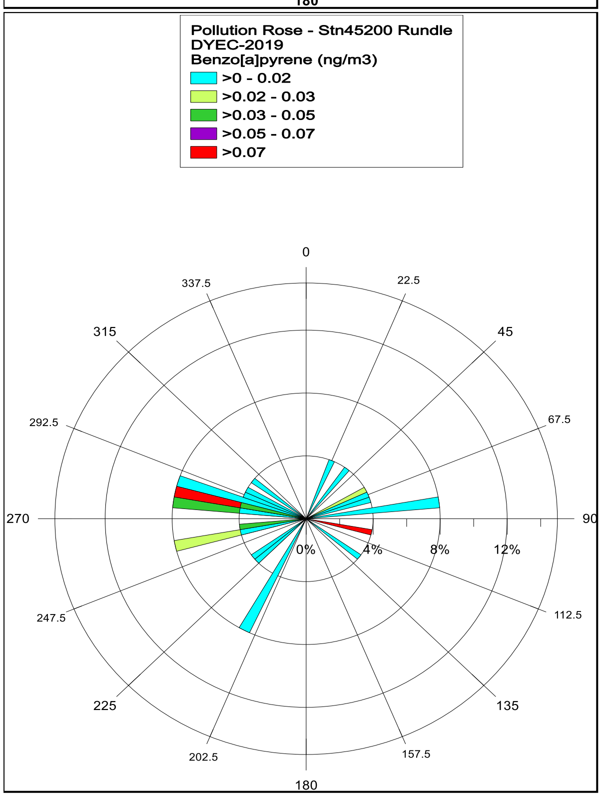




Notes:
24-hour average Pollution Roses are based on limited data set.
BaP 24-hour average AAQC = 0.05 ng/m^3


Pollution Rose - STN 45200 Rundle
DYEC-2017
Benzo[a]pyrene (ng/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.07
>0.07
0
11.3
22.5
33.8
45
56.3
67.5
78.8
90
101
112.5
124
135
146
157.5
169
180
191
202.5
214
225
236
247.5
259
270
281
292.5
304
315
326
337.5
349
12%
8%
4%
0%


Pollution Rose - STN 45200 Rundle
DYEC-2018
Benzo[a]pyrene (ng/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.07
>0.07
0
11.3
22.5
33.8
45
56.3
67.5
78.8
90
101
112.5
124
135
146
157.5
169
180
191
202.5
214
225
236
247.5
259
270
281
292.5
304
315
326
337.5
349
12%
8%
4%
0%


Pollution Rose - Stn45200 Rundle
DYEC-2019
Benzo[a]pyrene (ng/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.07
>0.07
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
4%
8%
12%

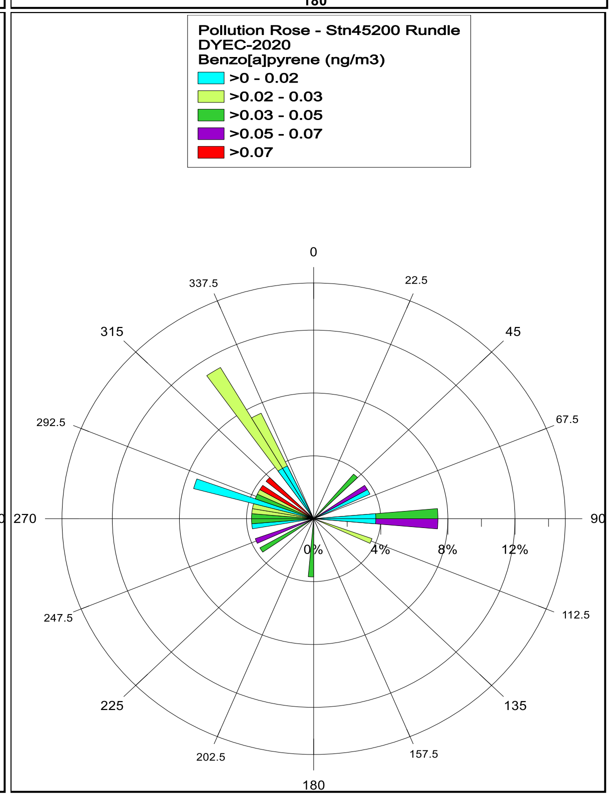

Pollution Rose - Stn45200 Rundle
DYEC-2020
Benzo[a]pyrene (ng/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.07
>0.07
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
4%
8%
12%

Figure C5 Dioxins and Furans 24-hour Average Pollution Roses – DYEC Monitoring Program - Courtice

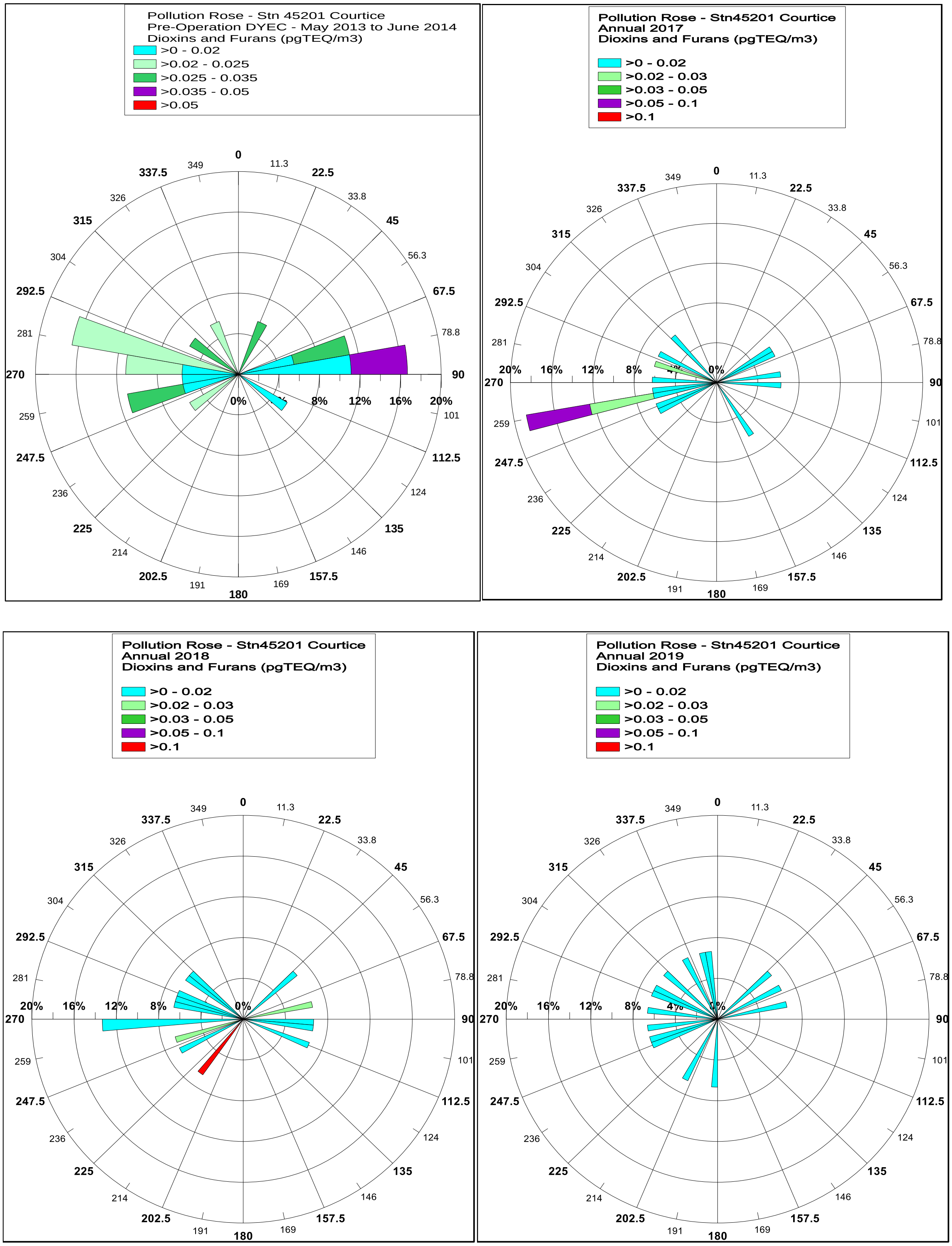
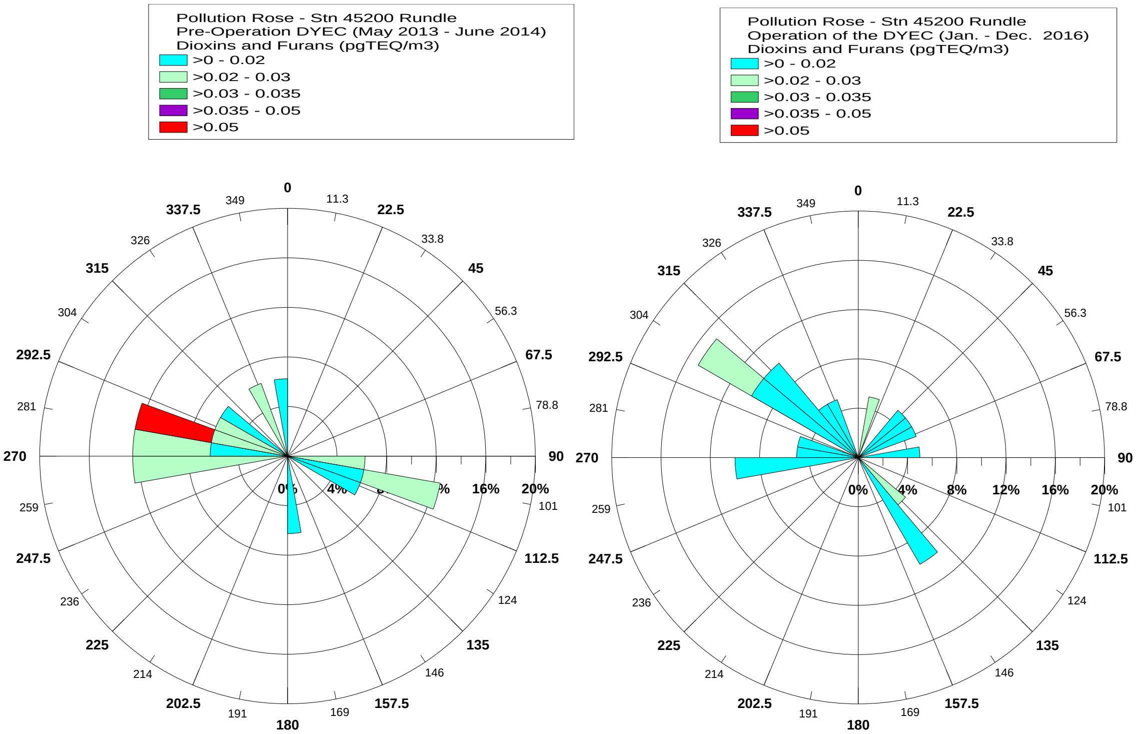
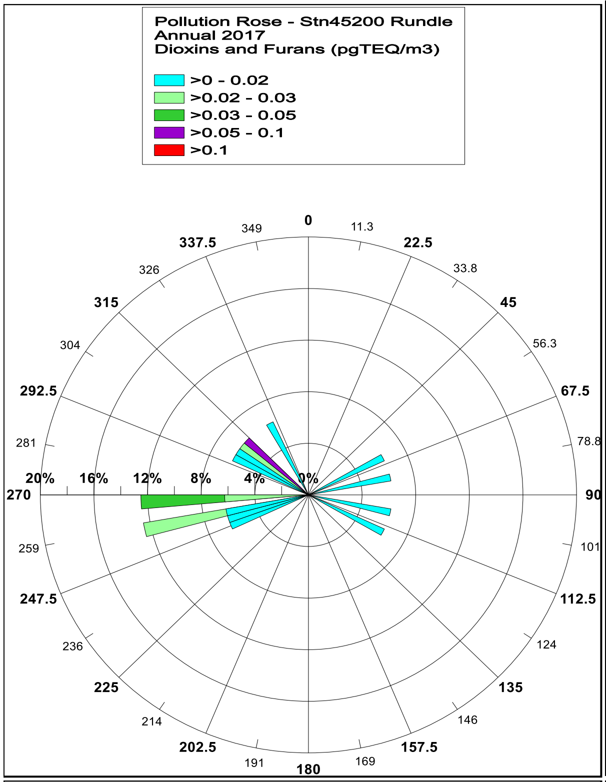
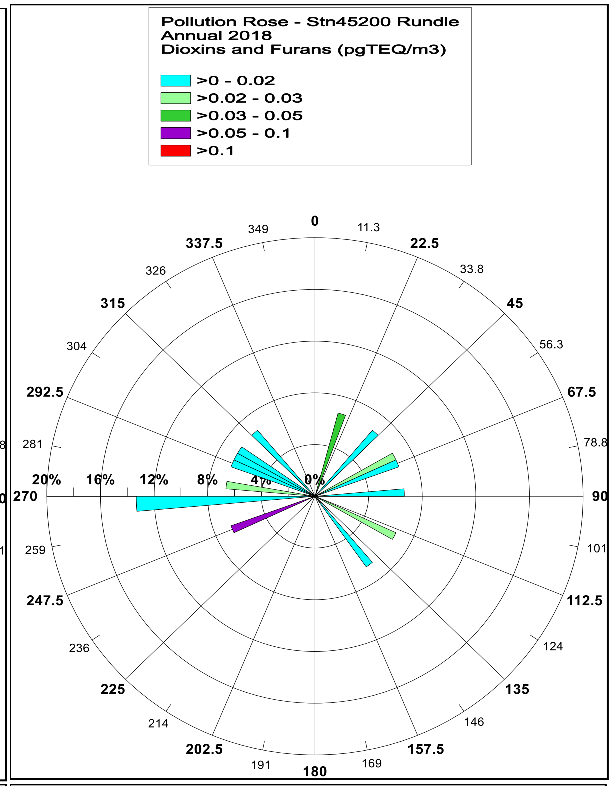


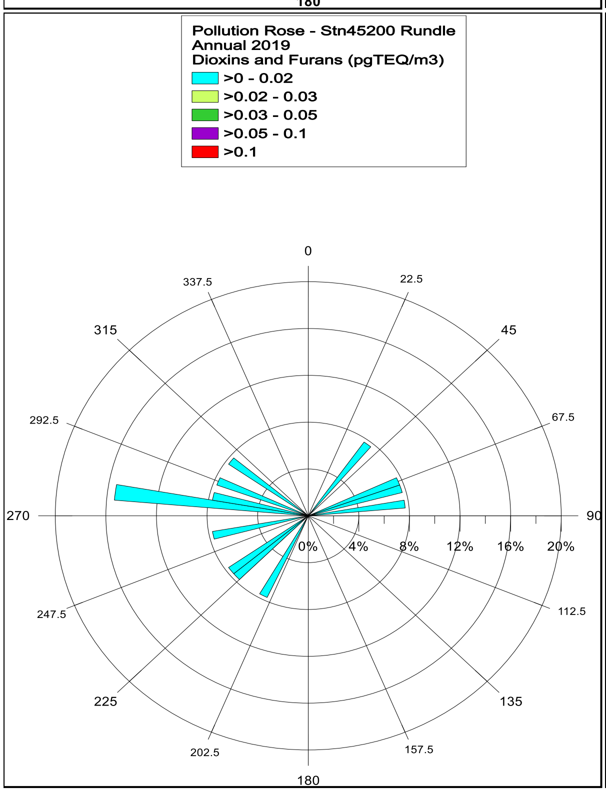
Figure C6 Dioxins and Furans 24-hour Average Pollution Roses – DYEC Monitoring Program - Rundle



Notes:
24-hour average Pollution Roses are based on limited data set.
Dioxins and Furans 24-hour average AAQC = 0.1 pg TEQ/m^3


Pollution Rose - Stn45200 Rundle
Annual 2017
Dioxins and Furans (pgTEQ/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.1
>0.1
20%
16%
12%
8%
4%
0%


Pollution Rose - Stn45200 Rundle
Annual 2018
Dioxins and Furans (pgTEQ/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.1
>0.1
20%
16%
12%
8%
4%
0%


Pollution Rose - Stn45200 Rundle
Annual 2019
Dioxins and Furans (pgTEQ/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.1
>0.1
0%
4%
8%
12%
16%
20%

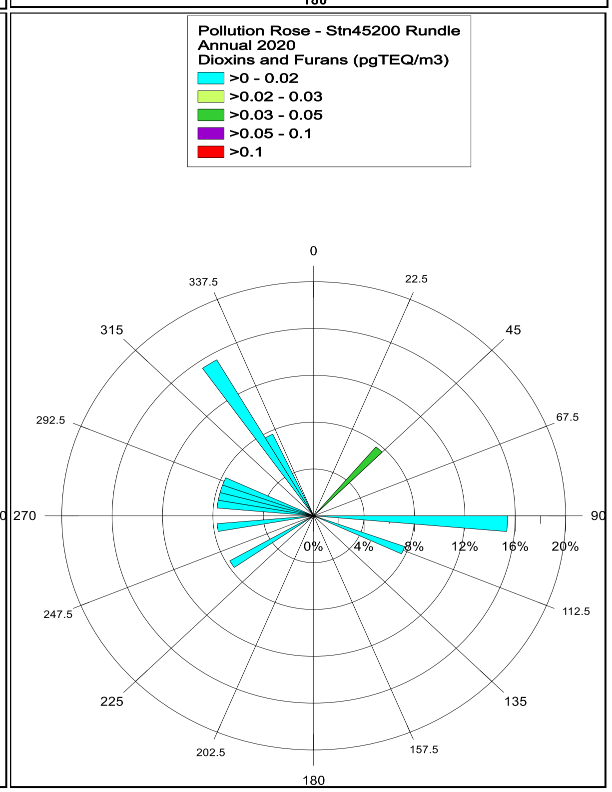
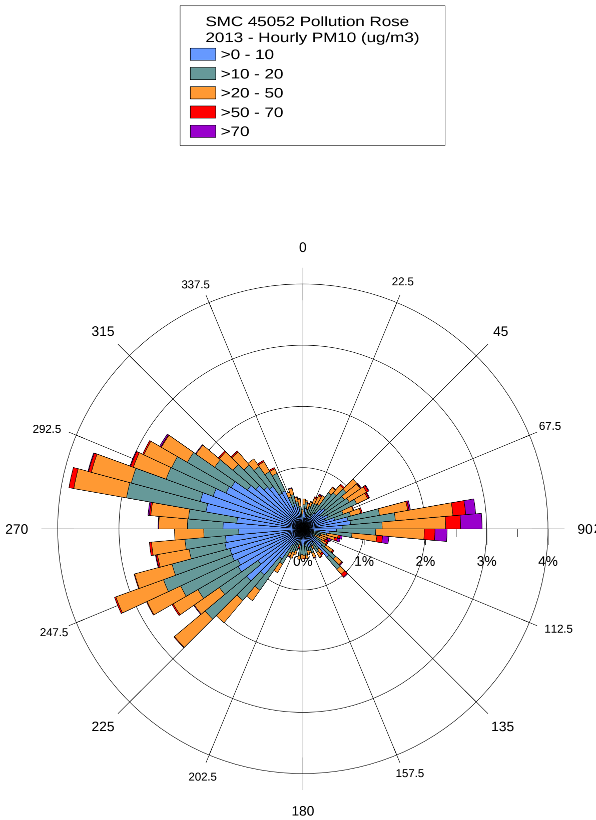
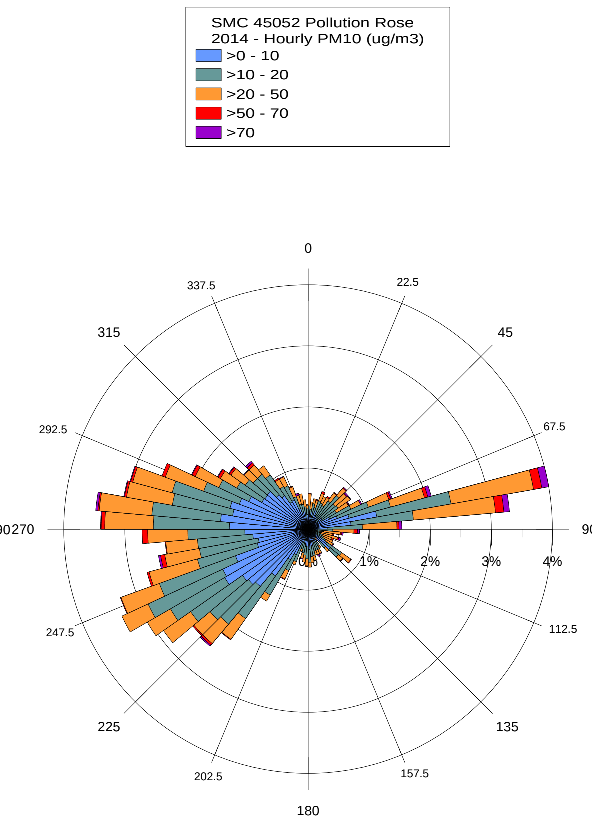
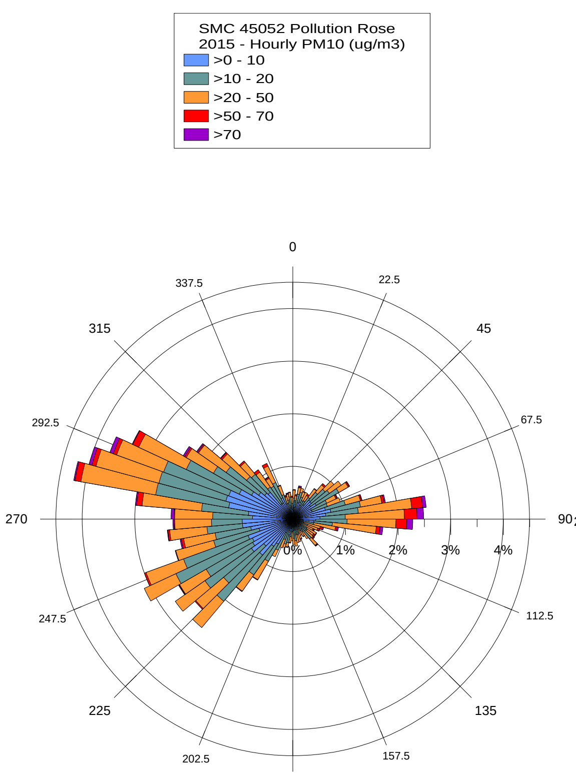
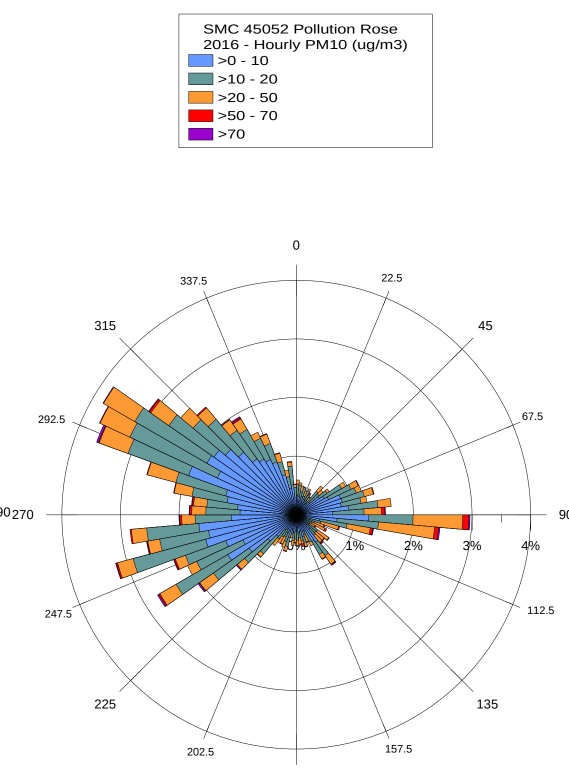

Pollution Rose - Stn45200 Rundle
Annual 2020
Dioxins and Furans (pgTEQ/m3)
>0 - 0.02
>0.02 - 0.03
>0.03 - 0.05
>0.05 - 0.1
>0.1
0%
4%
8%
12%
16%
20%

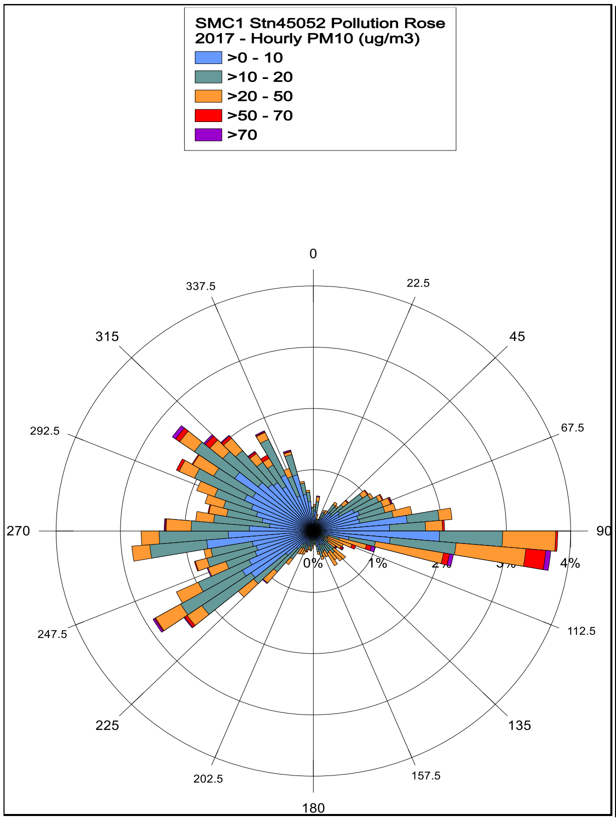
Figure C7 PM_{10} Hourly Pollution Roses– St. Mary's Cement Monitoring Program - SMC1 (45052)

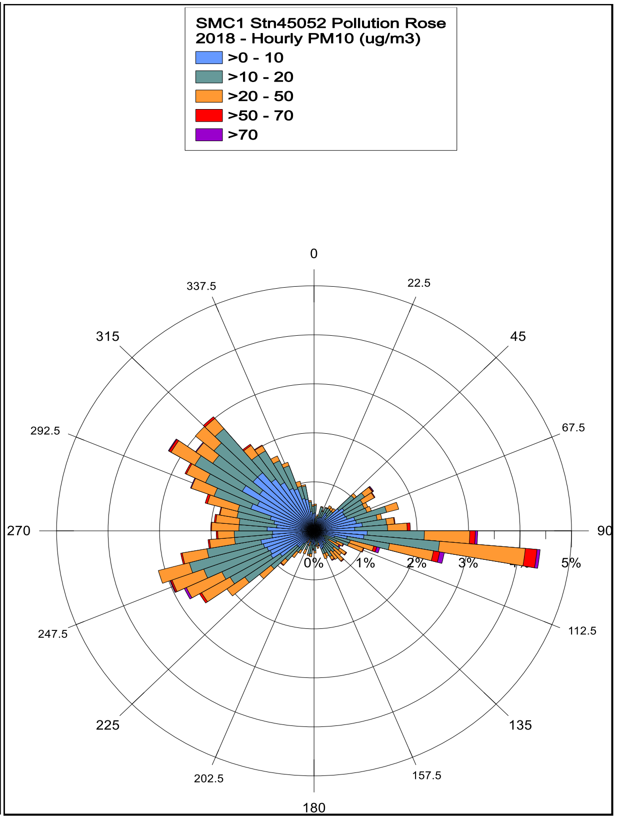


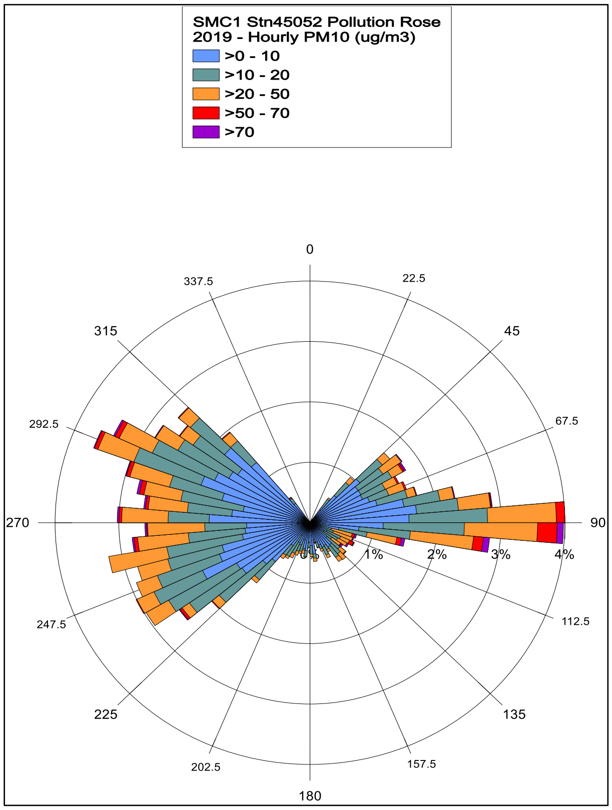


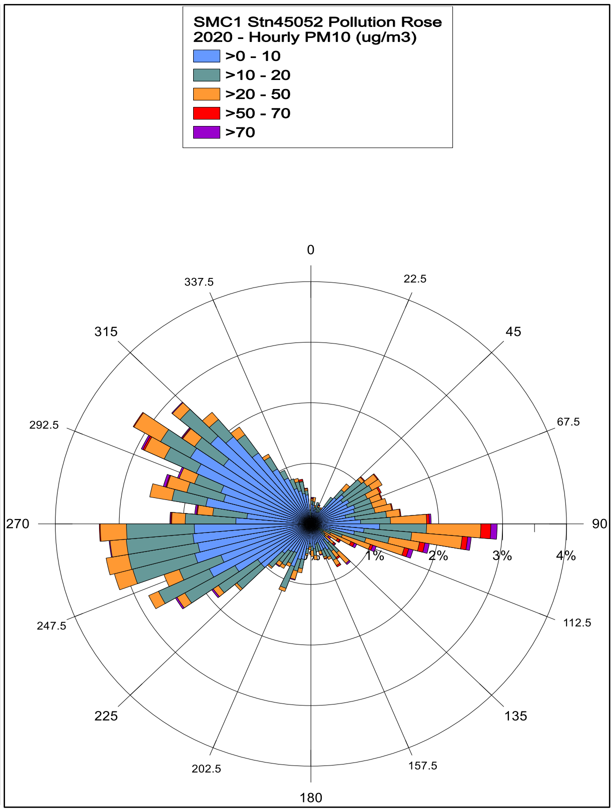






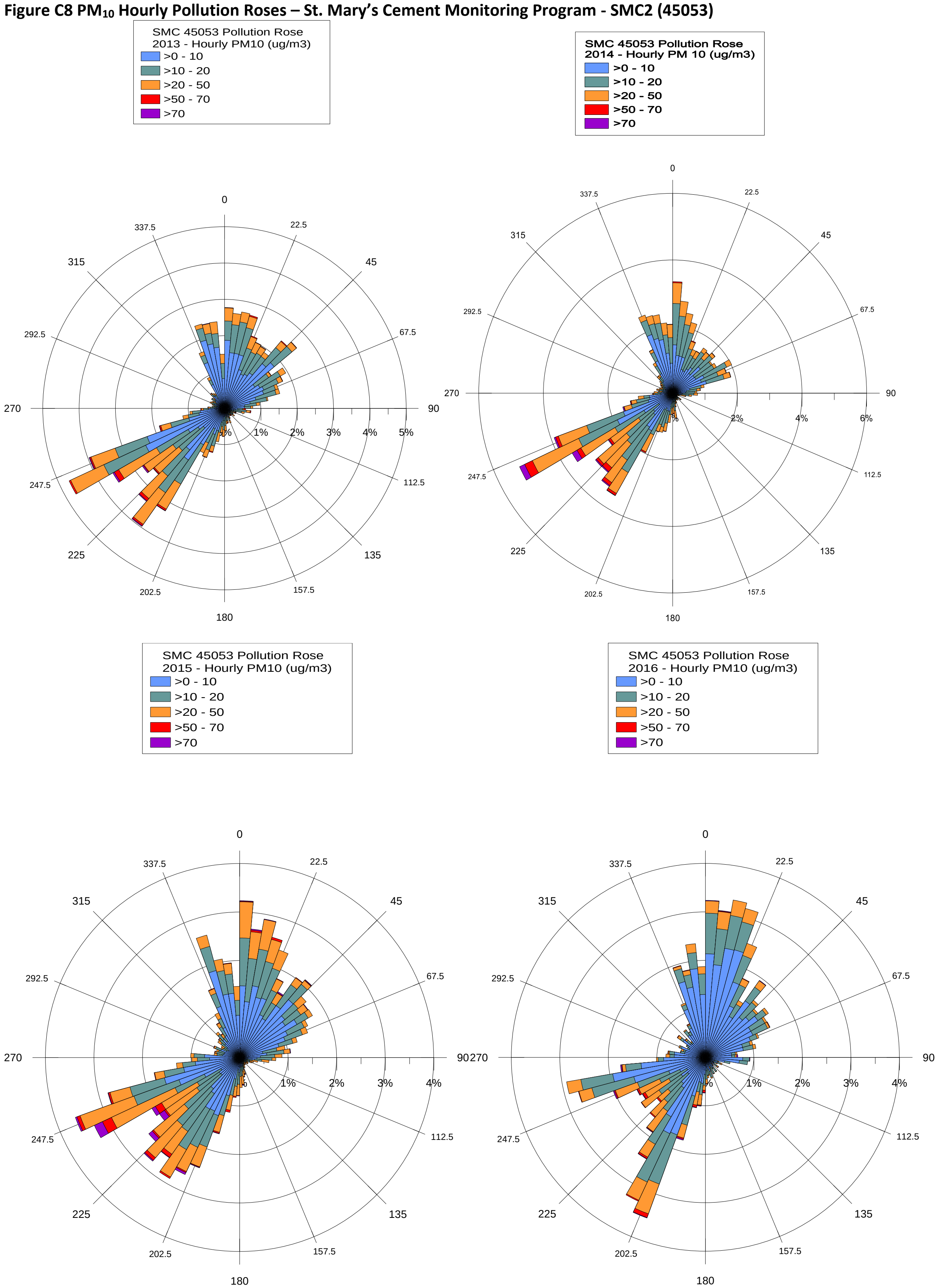


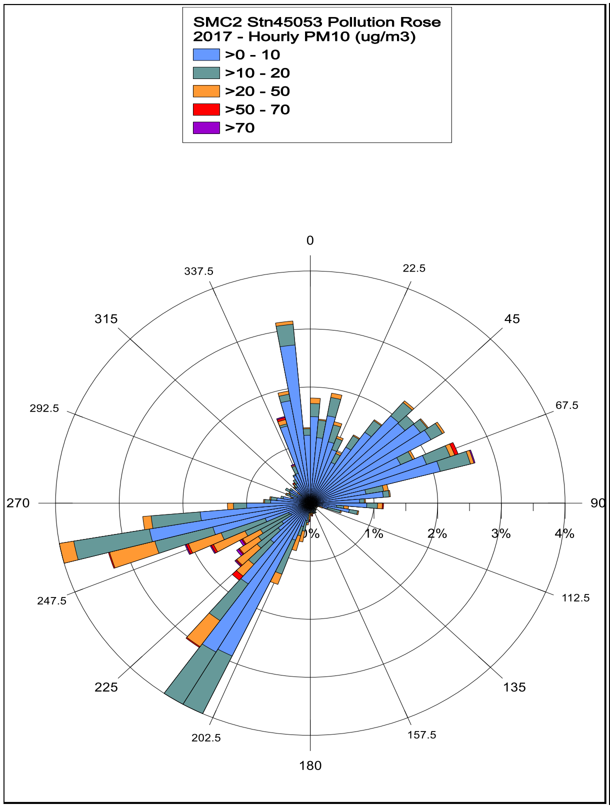


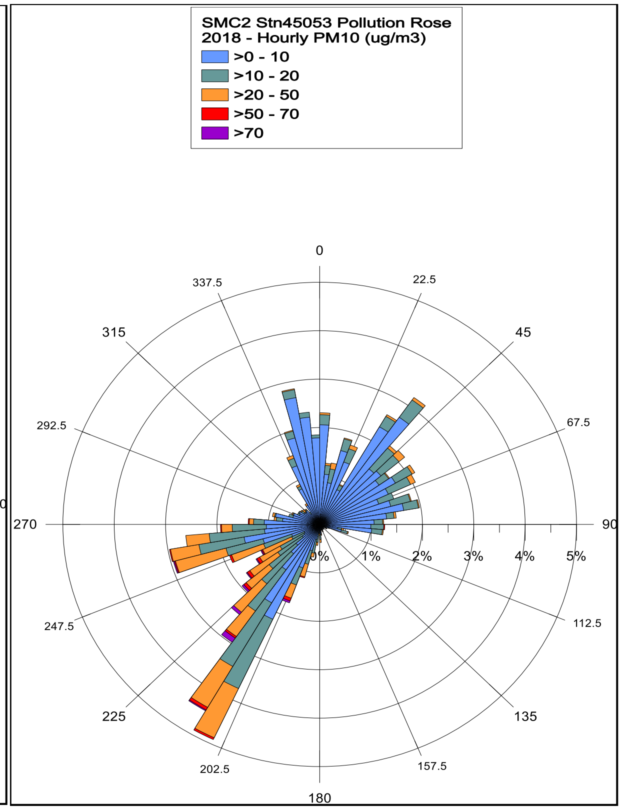


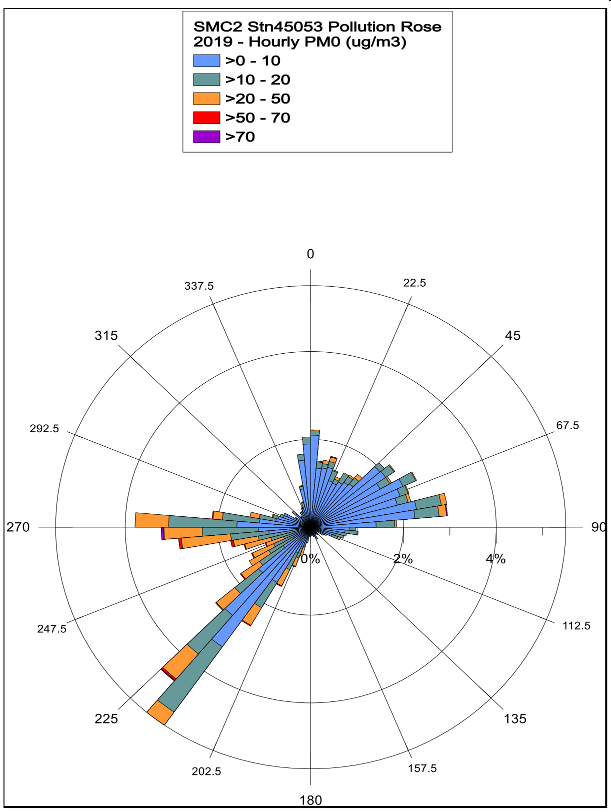
Note: Meteorological information for SMC1 is being displayed on the pollution rose for illustration purposes only. The ministry is currently working with the stakeholder on accuracy improvements to their meteorological data.

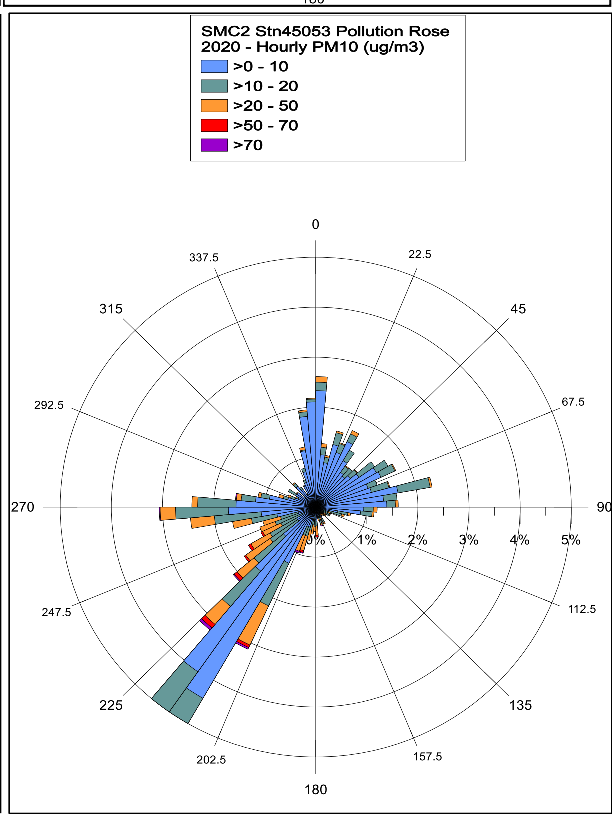
Figure C8 PM_{10} Hourly Pollution Roses – St. Mary's Cement Monitoring Program - SMC2 (45053)





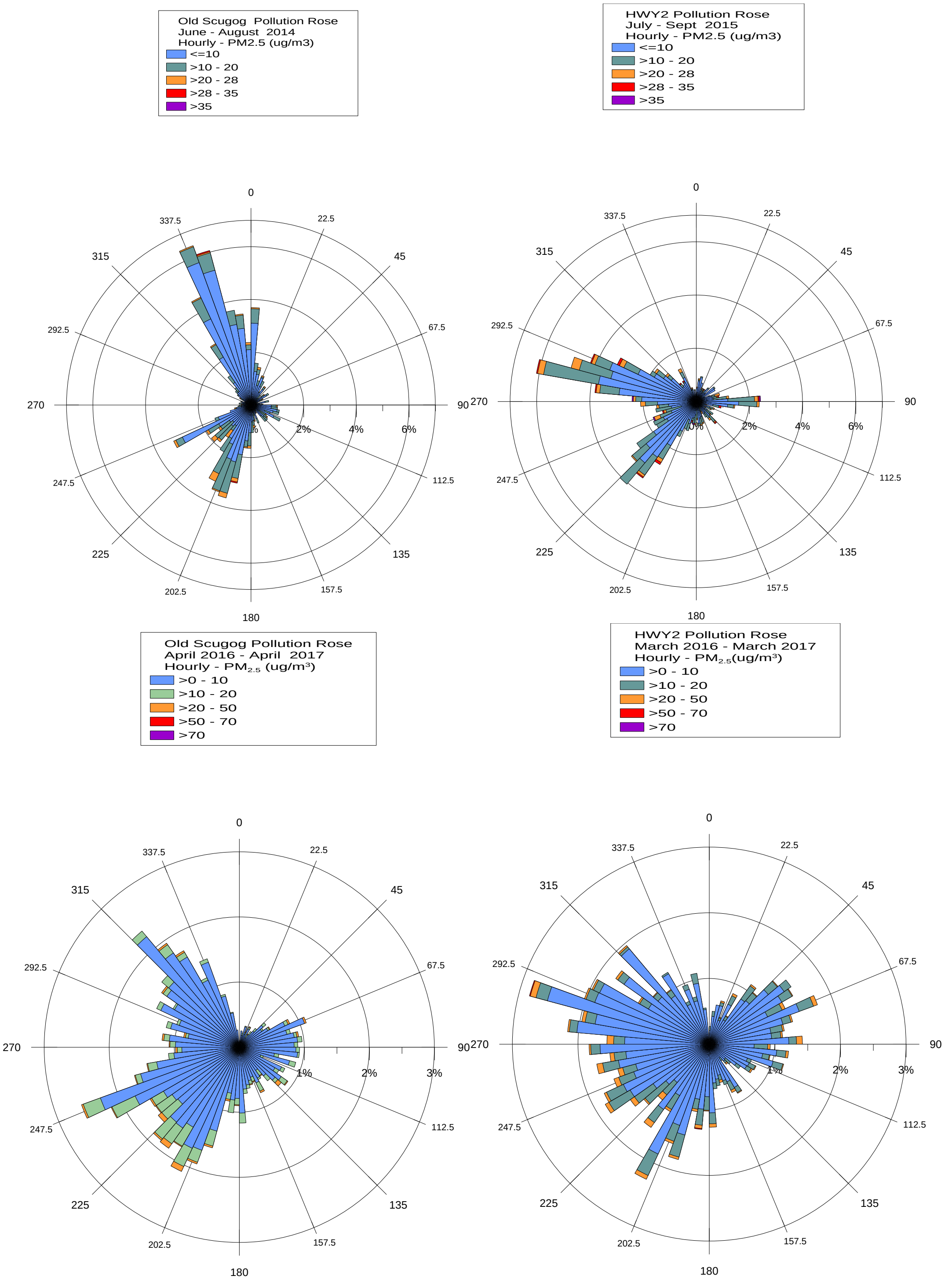






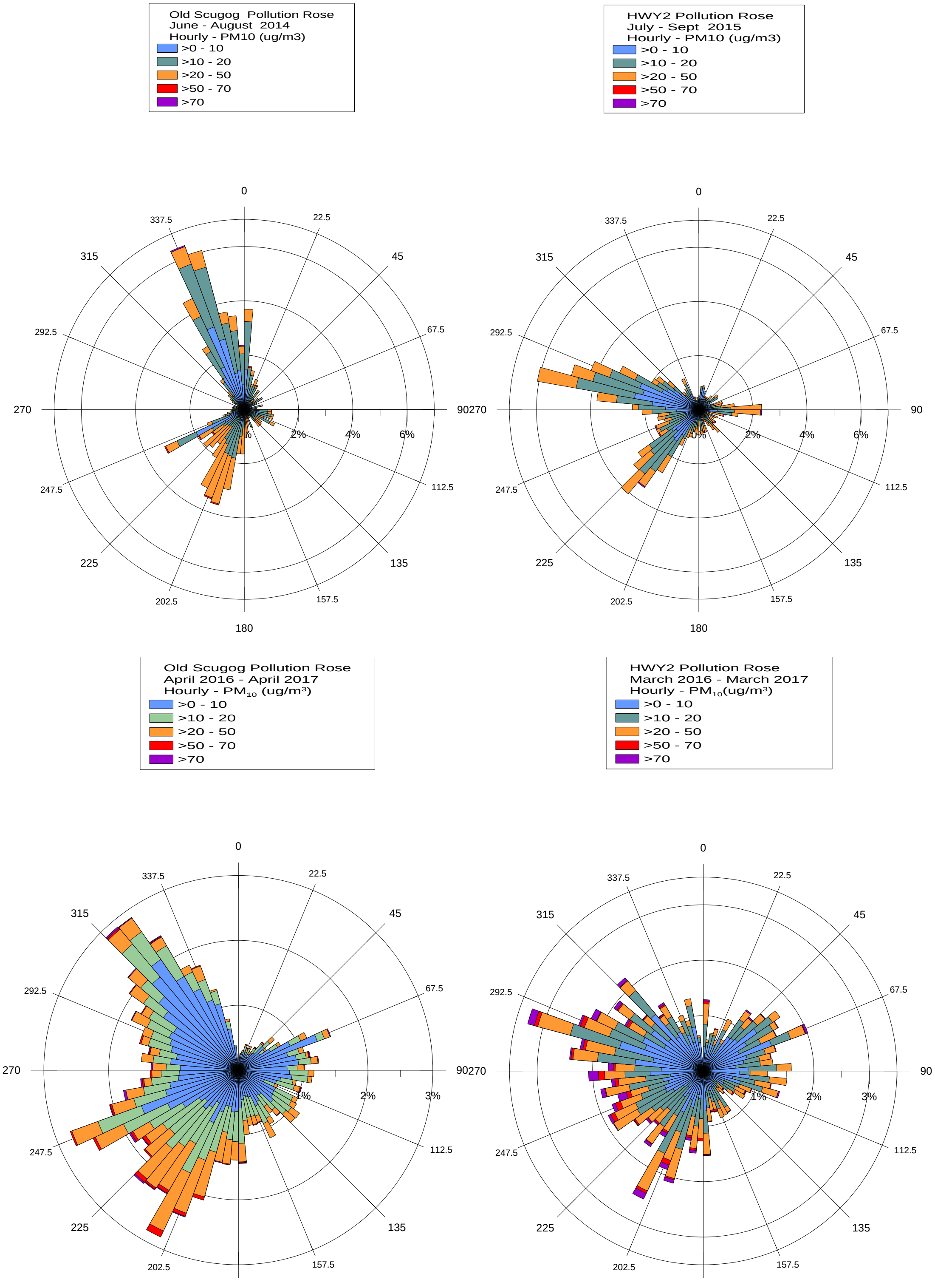
Note: Meteorological information for SMC2 is being displayed on the pollution rose for illustration purposes only. The ministry is currently working with the stakeholder on accuracy improvements to their meteorological data.

Figure C9 $PM_{2.5}$ – Hourly Pollution Roses – 407 East Construction Monitoring Program - Old Scugog and Hwy 2



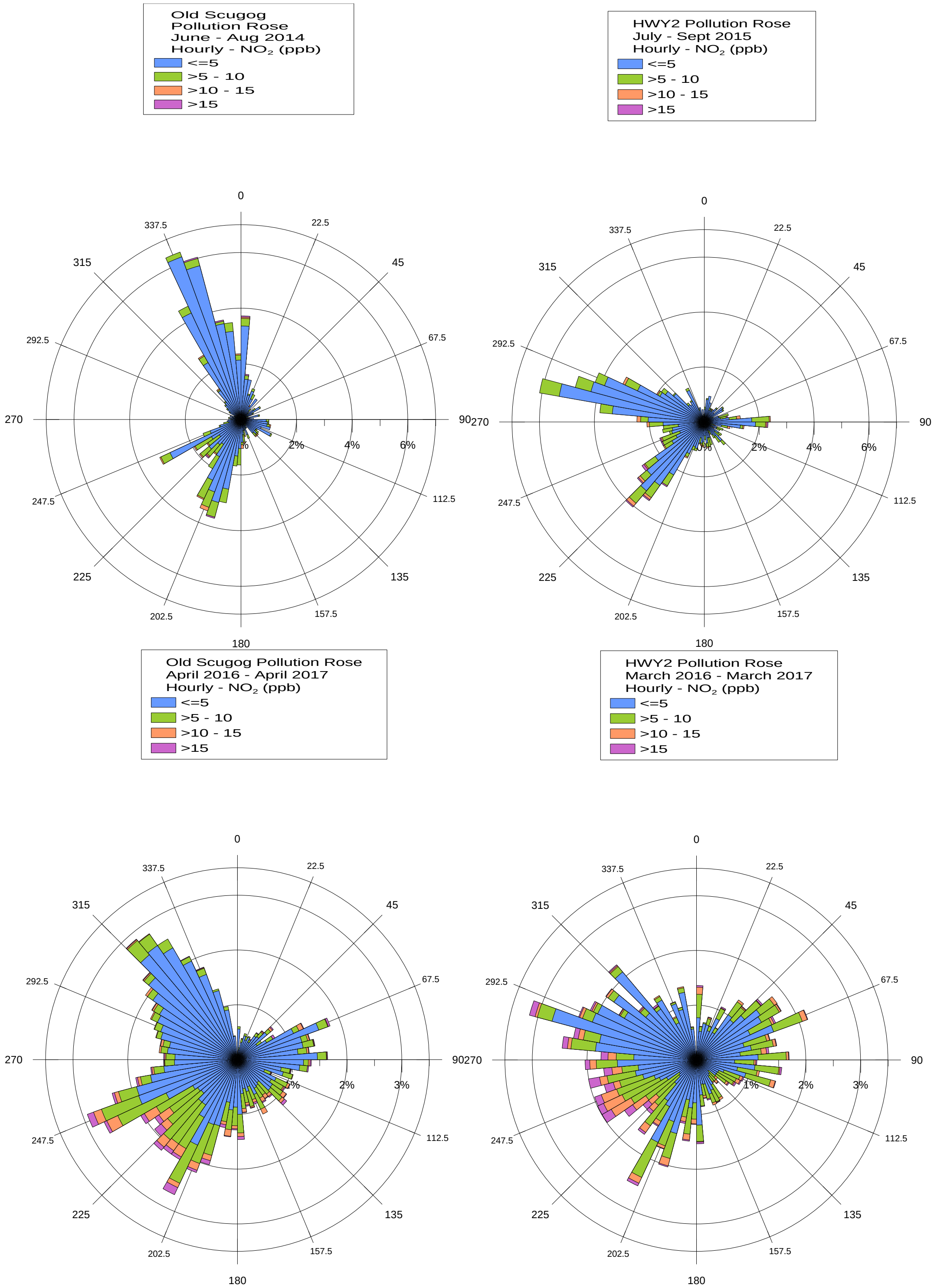
Notes:
The meteorological tower at Old Scugog and Highway 2 were relocated from the Pre-Construction period. Please note that during the Construction period, both Old Scugog and Highway 2 meteorological sensors were relocated to address the tree blockage from the Northeast and North-northeast directions, respectively. The meteorological towers were set at 10 meters above grade.

Figure C10 PM_{10} Hourly Pollution Roses - 407 East Construction Monitoring Program - Old Scugog and Hwy 2



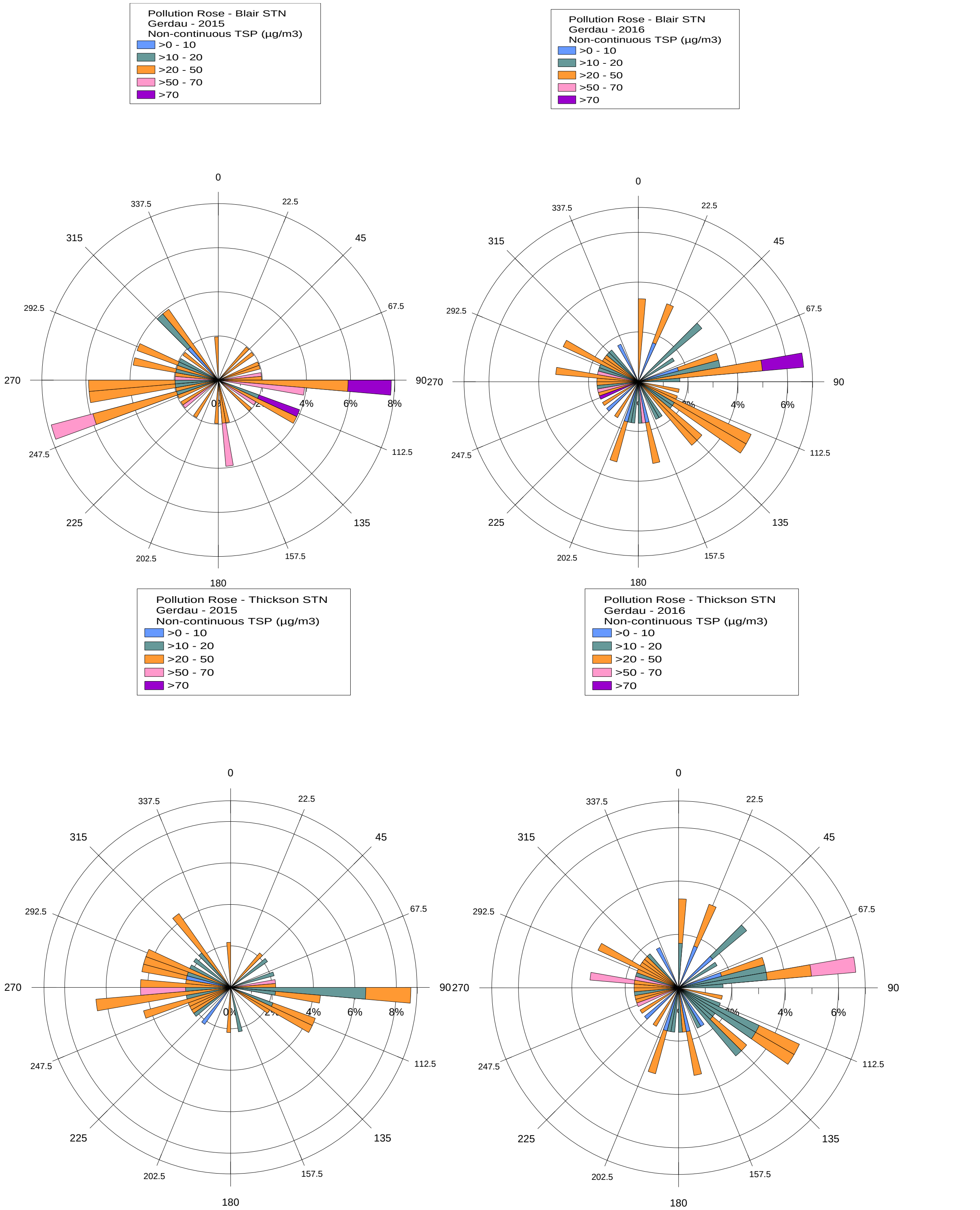
Notes:
The meteorological tower at Old Scugog and Highway 2 were relocated from the Pre-Construction period. Please note that during the Construction period, both Old Scugog and Highway 2 meteorological sensors were relocated to address the tree blockage from the Northeast and North-northeast directions, respectively. The meteorological towers were set at 10 meters above grade.

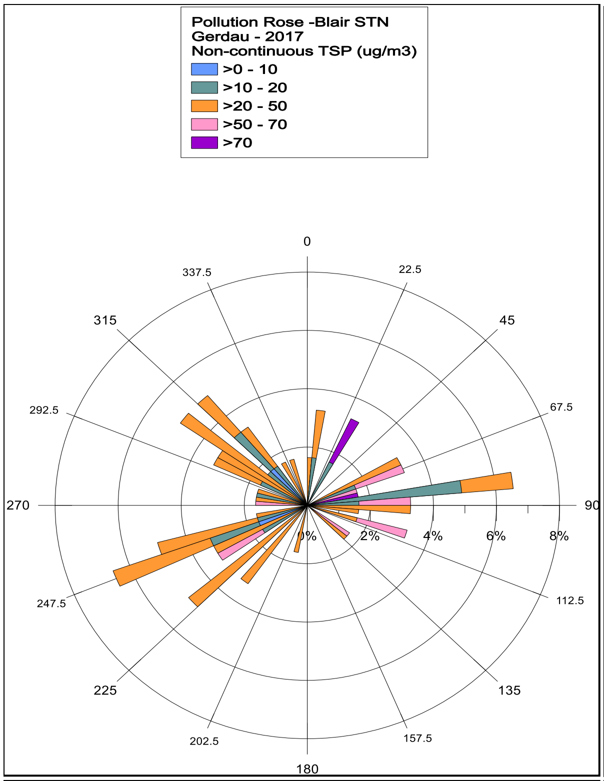
Figure C11 NO_2 Hourly Pollution Roses - 407 East Construction Monitoring Program -Old Scugog and Hwy 2

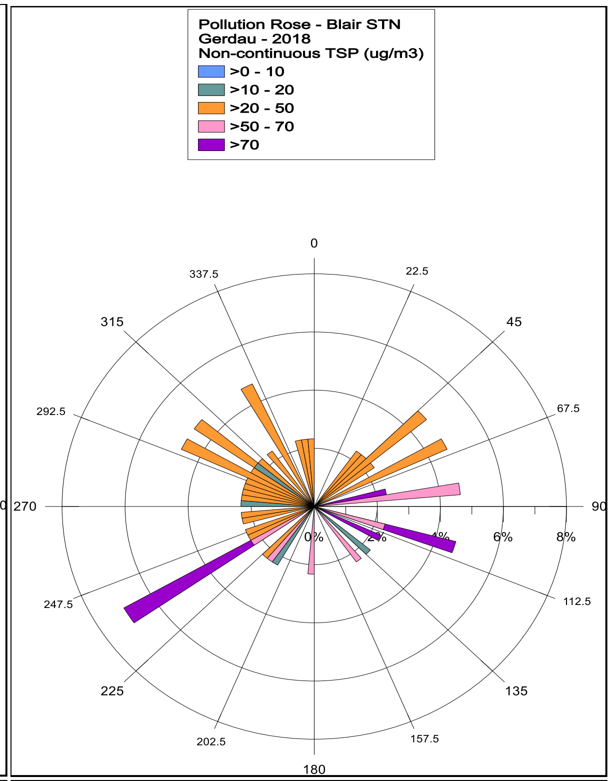


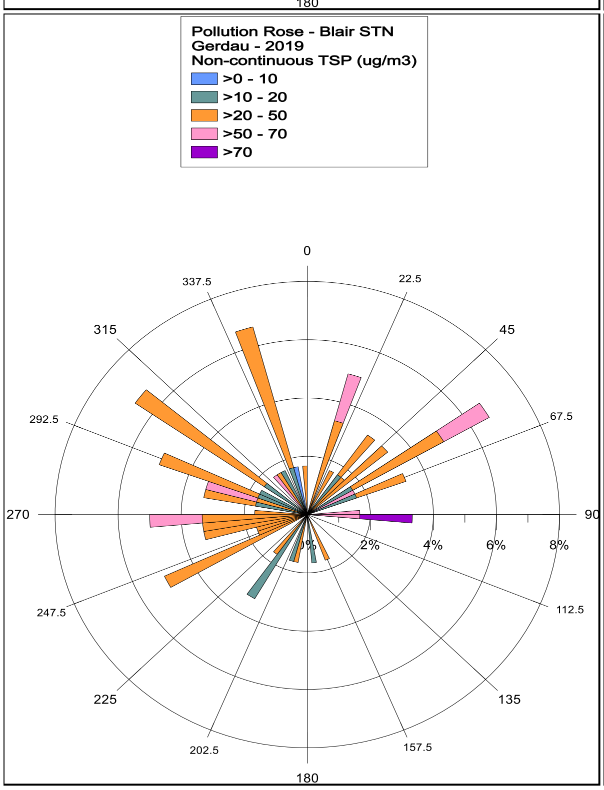
Notes:
The meteorological tower at Old Scugog and Highway 2 were relocated from the Pre-Construction period. Please note that during the Construction period, both Old Scugog and Highway 2 meteorological sensors were relocated to address the tree blockage from the Northeast and North-northeast directions, respectively. The meteorological towers were set at 10 meters above grade.

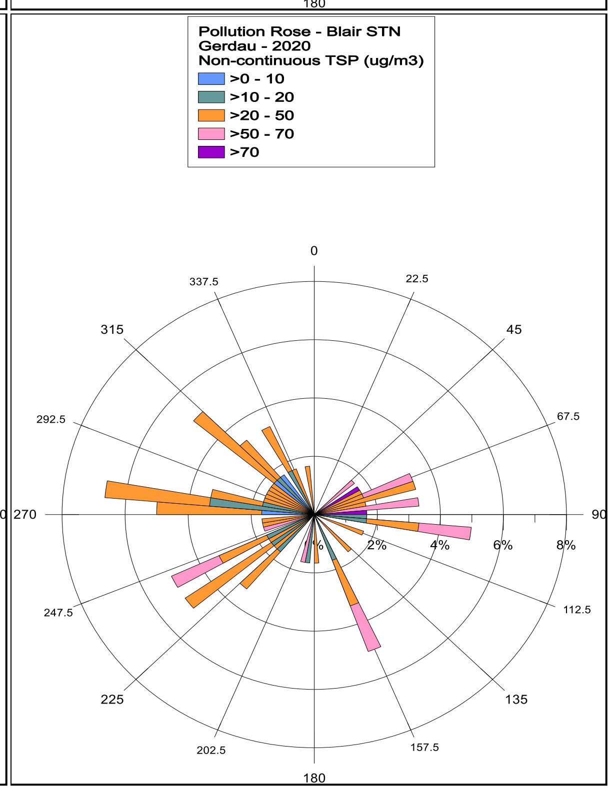
Figure C12 TSP 24-hour Average Pollution Roses – Gerdau Monitoring Program

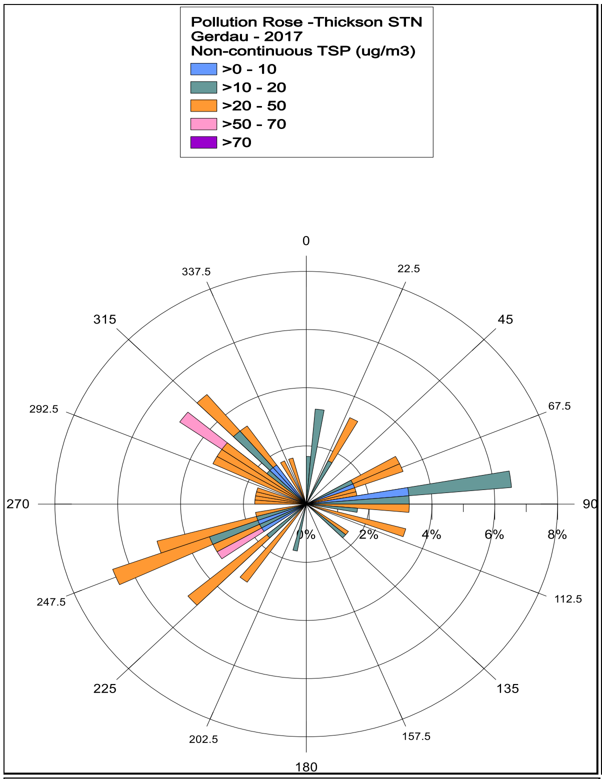


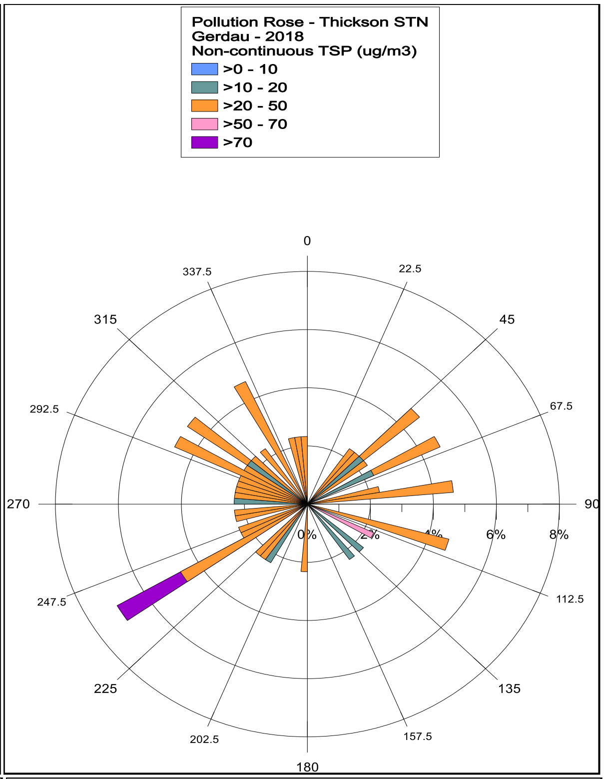

Pollution Rose -Blair STN
Gerdau - 2017
Non-continuous TSP (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
2%
4%
6%
8%

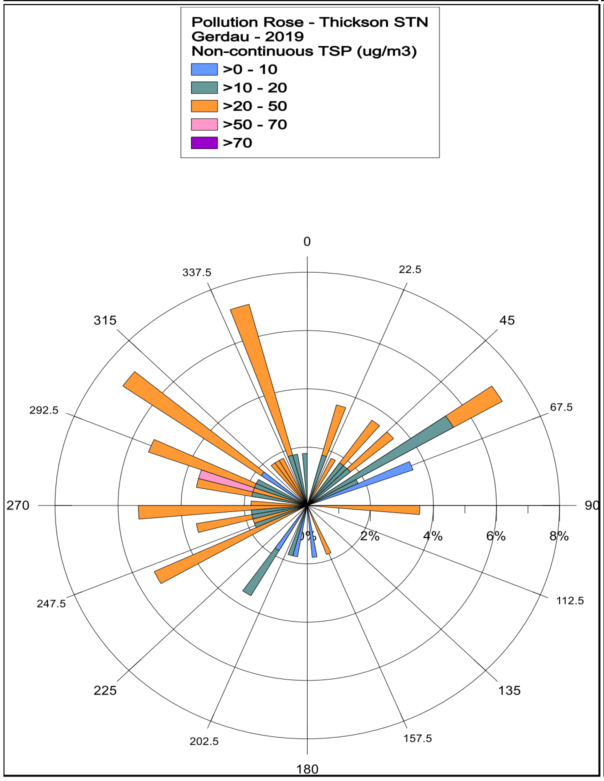

Pollution Rose - Blair STN
Gerdau - 2018
Non-continuous TSP (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
2%
4%
6%
8%

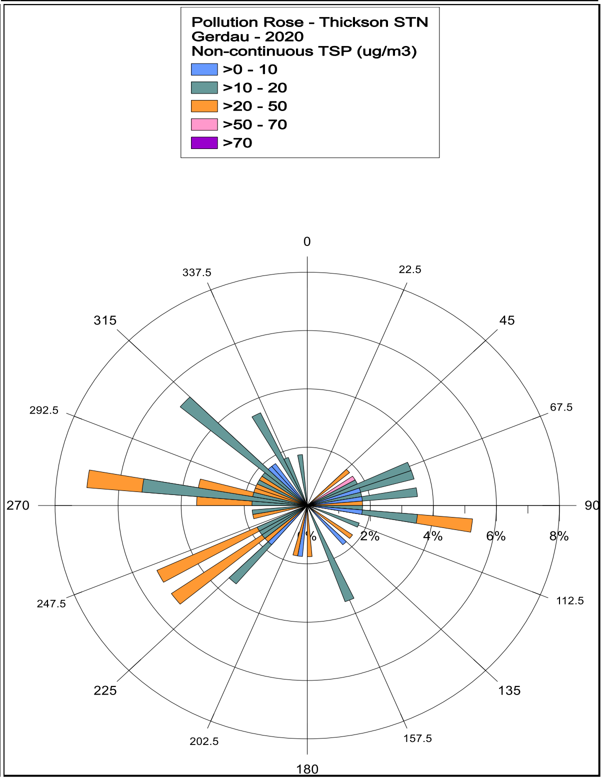

Pollution Rose - Blair STN
Gerdau - 2019
Non-continuous TSP (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
2%
4%
6%
8%


Pollution Rose - Blair STN
Gerdau - 2020
Non-continuous TSP (ug/m3)
>0 - 10
>10 - 20
>20 - 50
>50 - 70
>70
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
0%
2%
4%
6%
8%



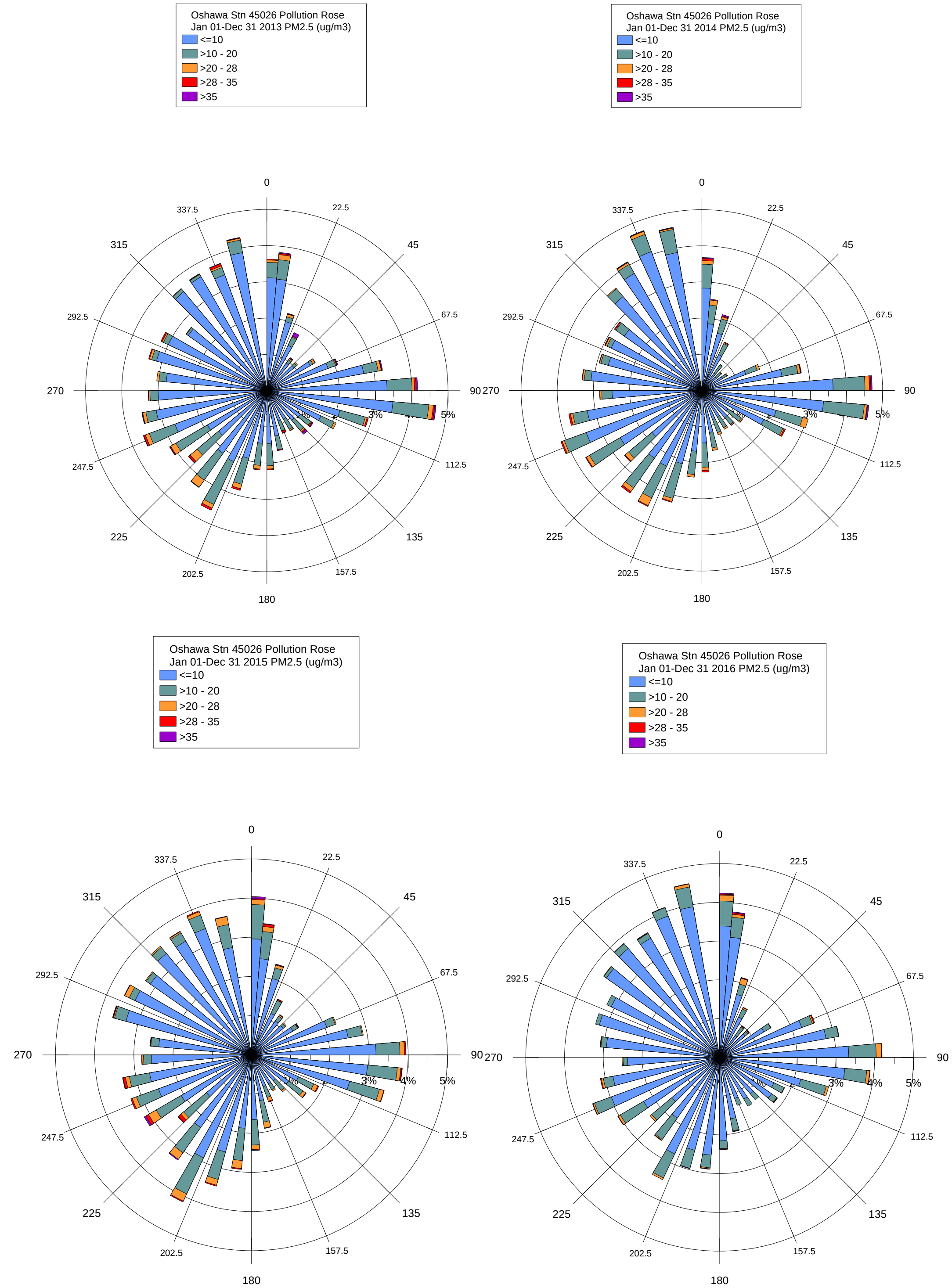


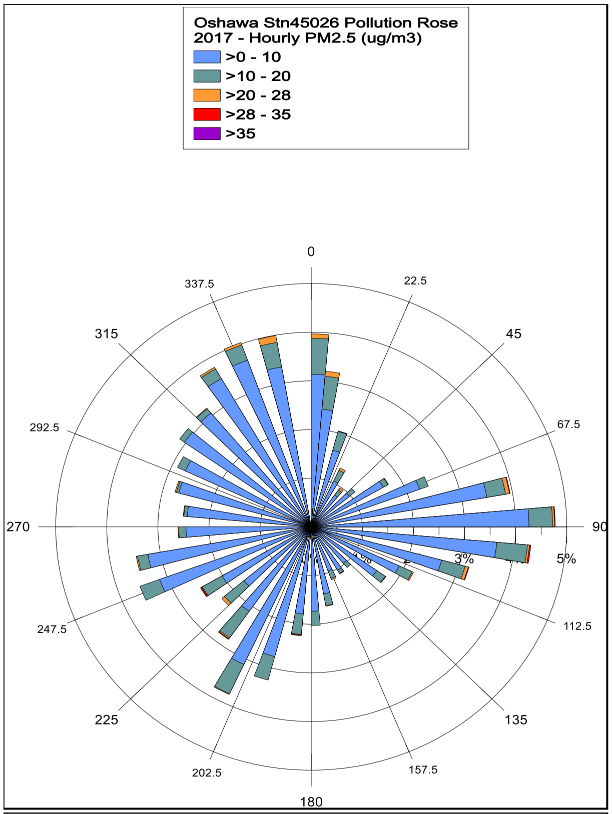


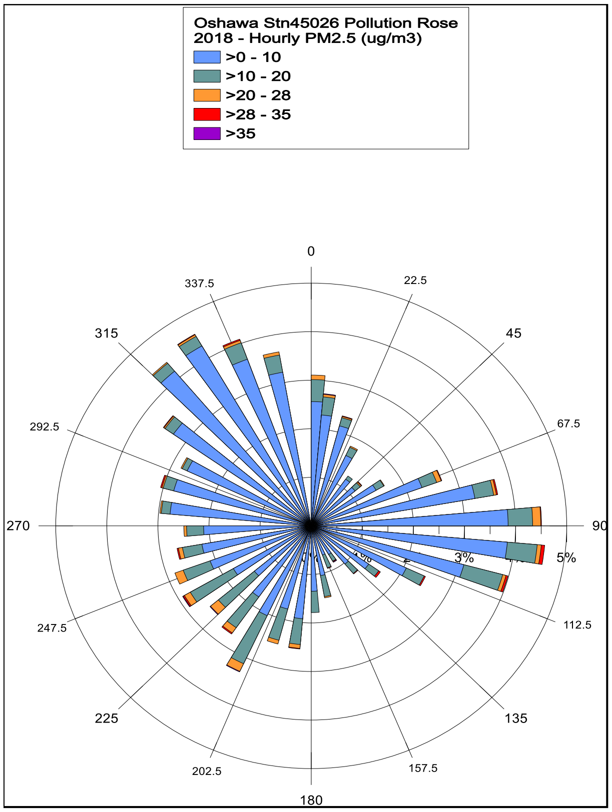


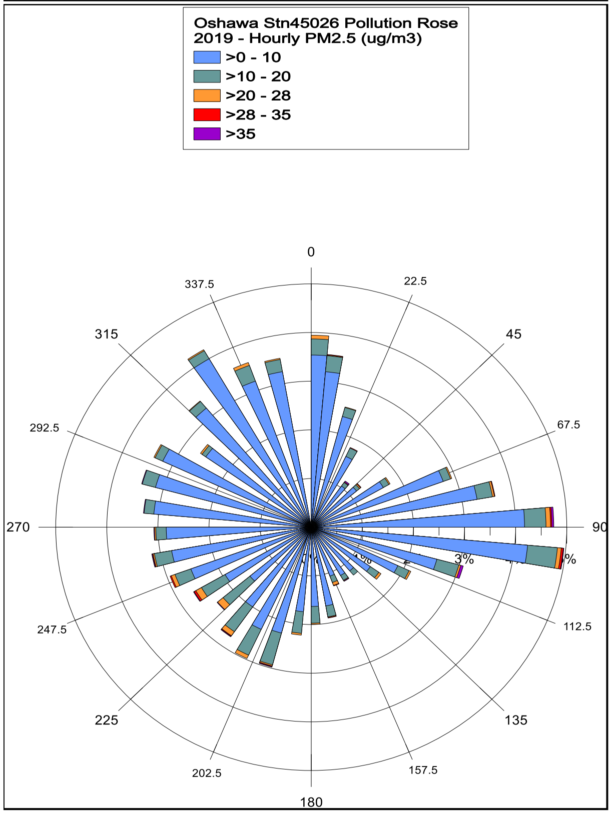
Note: 2017 meteorological data required an offset adjustment of 120 degrees as the equipment was not oriented to true north. 2018 meteorological data only has measurements from April to December.

Figure C13 Hourly $PM_{2.5}$ Pollution Roses – Oshawa AQHI Station




Oshawa Stn45026 Pollution Rose
2017 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 28
>28 - 35
>35
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
5%


Oshawa Stn45026 Pollution Rose
2018 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 28
>28 - 35
>35
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
5%


Oshawa Stn45026 Pollution Rose
2019 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 28
>28 - 35
>35
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%

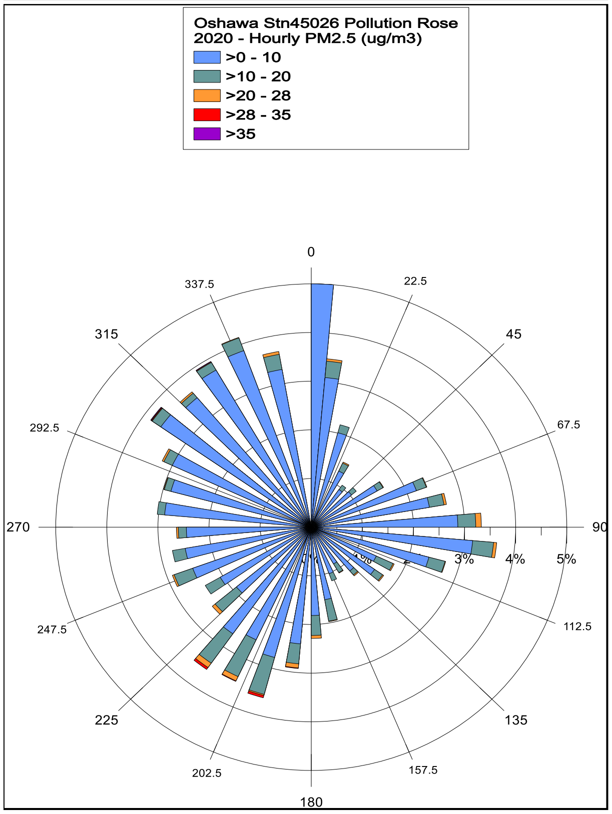
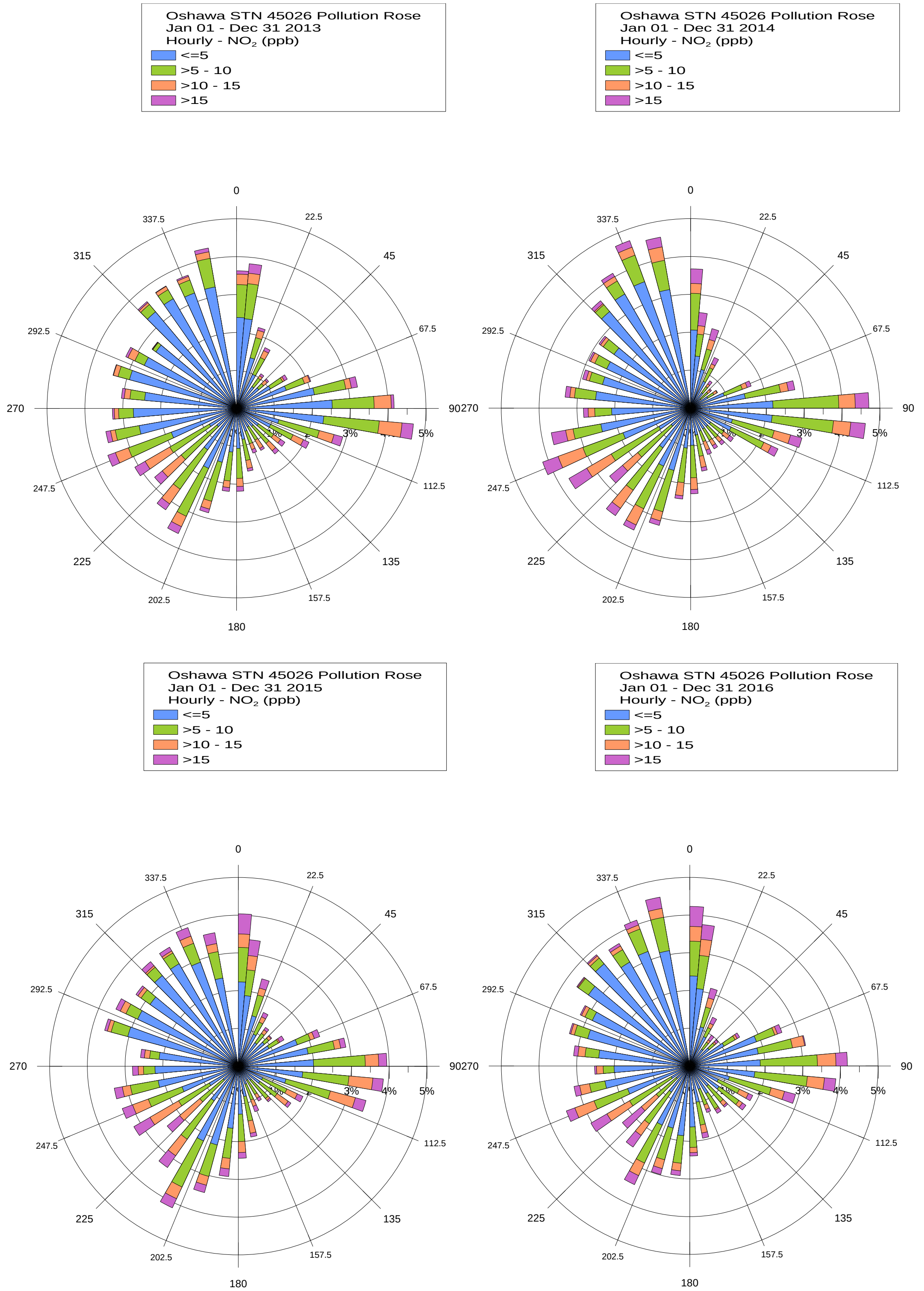
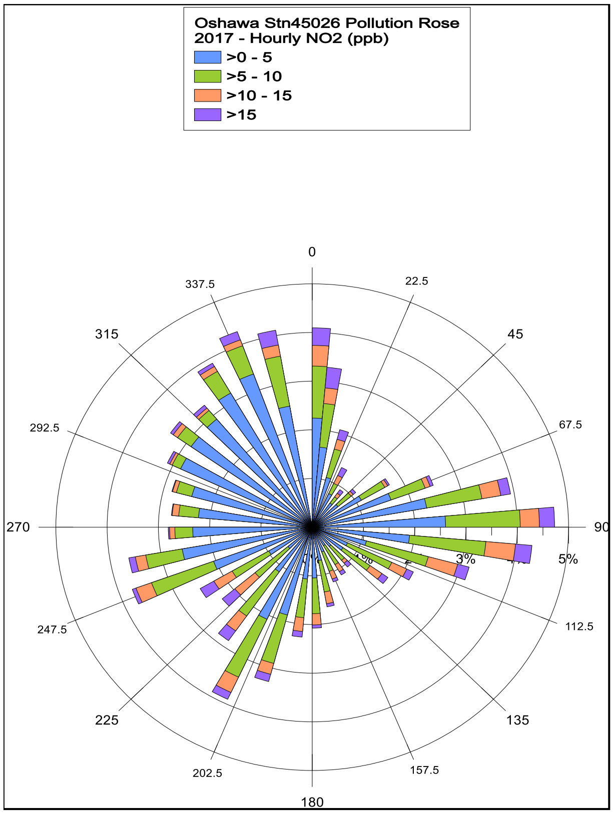
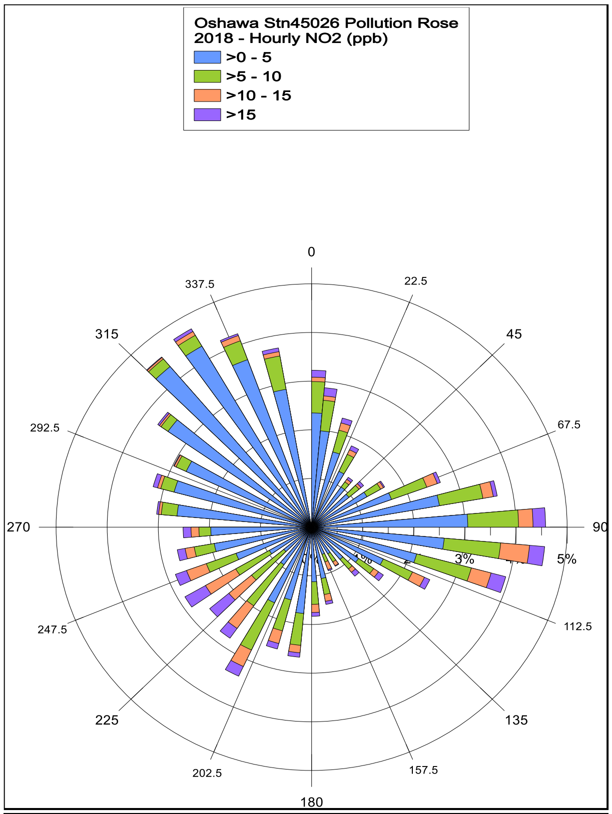
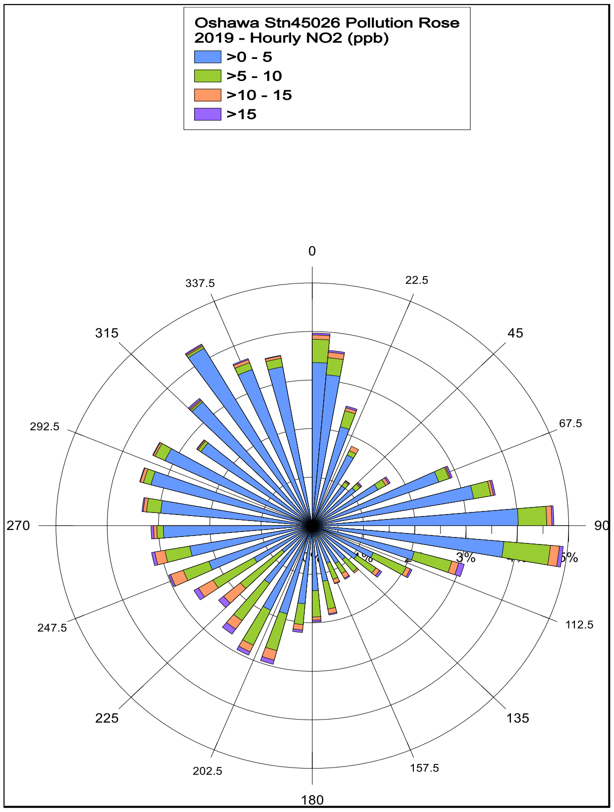

Oshawa Stn45026 Pollution Rose
2020 - Hourly PM2.5 (ug/m3)
>0 - 10
>10 - 20
>20 - 28
>28 - 35
>35
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
4%
5%

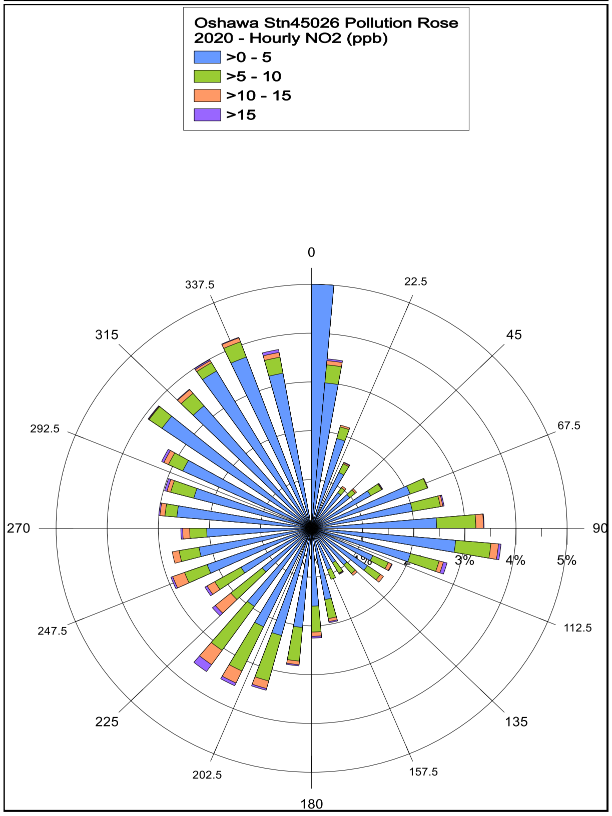
Figure C14 Hourly NO_2 Pollution Roses – Oshawa AQHI Station




Oshawa Stn45026 Pollution Rose
2017 - Hourly NO2 (ppb)
>0 - 5
>5 - 10
>10 - 15
>15
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
5%


Oshawa Stn45026 Pollution Rose
2018 - Hourly NO2 (ppb)
>0 - 5
>5 - 10
>10 - 15
>15
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
5%


Oshawa Stn45026 Pollution Rose
2019 - Hourly NO2 (ppb)
>0 - 5
>5 - 10
>10 - 15
>15
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%


Oshawa Stn45026 Pollution Rose
2020 - Hourly NO2 (ppb)
>0 - 5
>5 - 10
>10 - 15
>15
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
3%
4%
5%