

Technical Memorandum

2016 Aamjiwnaang First Nation Air Quality Mobile Monitoring Survey



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Executive Summary

The Ministry of the Environment, Conservation and Parks' Southwest Region has conducted regular ambient air quality monitoring surveys using its mobile monitoring vehicle around the Aamjiwnaang First Nation since 2011. In 2016, twelve sets of volatile organic compounds (VOCs) were measured on a monthly basis at six sites. The monitoring instrument measured levels of sixteen different contaminants and detected ten of them.

Of the VOC detected, only benzene was seen at levels that were above a half-hour assessment value derived from the ministry's Ambient Air Quality Criteria. These "overages" were observed in 15% of the samples taken throughout the survey. The percent of benzene overages measured during mobile monitoring surveys in previous years (2011-2015) has ranged from 17% to 39%. In addition, though no overages were observed, naphthalene reached levels up to 81% of its assessment value.

On April 29, 2016, benzene, ethylbenzene, and styrene were measured at the highest values observed in the ministry's mobile monitoring surveys. The ministry is aware of and investigated an incident which occurred at a facility in the area on this day.

The spatial variability of the mobile monitoring survey results from 2011-2016 was assessed to determine whether concentrations of any contaminants tended to be higher at one or more sampling sites than the others. No single site consistently measured significantly higher concentrations of any one contaminant in comparison to all other sites. However, mobile monitoring surveys serve as "spot checks" at given points in time, for exploratory purposes, and continuous monitoring methods are better suited for comprehensively investigating spatial variability in contaminant concentrations.

Introduction

The Ontario Ministry of the Environment, Conservation and Parks (ministry) maintains a permanent air monitoring station at the Aamjiwnaang First Nation, which was established in the fall of 2008. The ministry reports on the air quality results from this station separately on an annual basis.

The ministry's Southwest Region (SWR) has conducted regular ambient air quality monitoring surveys using its mobile monitoring vehicle in the vicinity of the Aamjiwnaang First Nation since 2011. These surveys are conducted for exploratory purposes and to complement the data collected at the permanent air monitoring station. These "mobile monitoring surveys" consist of a series of half-hour measurements of volatile organic compounds (VOCs) taken at six locations around the Aamjiwnaang First Nation.

The results of the 2011-2015 surveys have been reported in previous Technical Memoranda. The results of the 2016 mobile monitoring survey are provided below.

Objectives

The objectives of the ministry's SWR 2016 mobile monitoring survey were to:

1. Measure ambient concentrations of select VOCs in the vicinity of the Aamjiwnaang First Nation;
2. Compare the results to assessment values based on Ontario's Ambient Air Quality Criteria (AAQC);
3. Compare the results to surveys conducted in previous years;
4. Assess the results for spatial variability, that is, any differences in the results between sampling locations.

Although this monitoring data is being compared with health-based values, this memorandum should not be interpreted as a health-based assessment.

Methodology

The ministry's Southwest Region (SWR) conducted a survey on twelve days between January and December 2016 (one day per month) in the vicinity of the Aamjiwnaang First Nation. Real-time air monitoring of VOCs was performed using the SWR mobile monitoring van, which is equipped with a gas-chromatograph/mass-spectrometer (INFICON HAPSITE ER).

On each survey day, consecutive half-hour measurements were taken at six locations, which are shown in Figure A1 of the Appendix. A total of 72 samples were collected in 2016. Sampling was conducted at the same six locations that were monitored in previous years (2011-2015) for comparison purposes. Sampling was performed at the same set of locations and in the same order on each occasion. Air was sampled for 30 minutes at 33-34mL/min for a total of approximately 1000 mL

through a tri-bed glass sorbent tube. Once sampling was completed, the sorbent tube was thermally desorbed and analyzed for the sixteen target VOCs (listed in Table 1 below).

The same 16 VOC measured in the 2012-2015 surveys were measured in 2016 for comparison purposes. The first mobile monitoring survey, in 2011, included acrylonitrile and carbon disulphide in place of trichloroethylene and tetrachloroethylene. The target list was updated in 2012 based on the 2011 monitoring results (acrylonitrile and carbon disulphide were not detected in 2011) and to better utilize the capabilities of the mobile monitor's instruments (by adding trichloroethylene and tetrachloroethylene to the target list).

Measurements of general air quality are normally compared to Ambient Air Quality Criteria (AAQC). The AAQC for the VOC sampled are based on 24-hour or annual averaging periods. In order to provide context to the half-hour measurements collected during the survey, results have been compared to half-hour "AAQC Assessment Values", which were calculated using a conversion formula prescribed in O. Reg. 419/05 [Section 17(3)], but which ministry staff use in other contexts, allowing the ministry to convert data between different averaging periods. Briefly, it is noted that conversion factors are typically used for modelling data; however, considering the assumption of continuous emission from area sources, it is not unreasonable to use conversion factors for the purposes within this report. Here, the concentration for one duration C_0 is multiplied by a factor:

$$C_1 = C_0 \cdot \left(\frac{t_0}{t_1}\right)^n$$

where t_0 is the averaging time of the original value, usually 24 hours for AAQC, and t_1 is the averaging time for which one wishes to make the comparison, one-half hour in this case. This conversion has the effect of increasing the assessment value (C_1) when going from longer averaging times to shorter ones, as was done for this survey.

Table 1 shows the target VOCs measured in the survey, the current 24-hour AAQC, and the derived assessment values that are used in this report.

Table 1: Target VOCs and Derived ½-hour Assessment Values		
	24-hour AAQC	½-hour Assessment Value
	(all values in µg/m ³)	
Propylene	4000	12000
Chloromethane	320	950
1,3-Butadiene	10	30
Hexane	2500	7400
Chloroform	1	3
Benzene	2.3	7
Carbon Tetrachloride	2.4	7
Cyclohexane	6100	18000
Trichloroethylene	12	35
Toluene	2000	6000
Tetrachloroethylene	360	1100
Ethylbenzene	1000	3000
m- & p- Xylene ¹	730	2200
Styrene	400	1200
o-Xylene ¹	730	2200
Naphthalene	22.5	67
¹ AAQC is based on total xylenes		

In cases where the values of the monitored data are over the ½-hour assessment values, they do not necessarily reflect a health risk. Rather, values that approach or are over ½-hr assessment values should be taken as indicators that longer term monitoring or other studies need to be undertaken, or compared to other existing long-term monitoring (see the Aamjiwnaang First Nation annual air monitoring reports). The ministry believes that a long and continuous record of environmental measurements, as in the multi-year data from the Aamjiwnaang station, is a more appropriate gauge of local long-term concentrations.

While the monitoring instrument reports measurements in parts per billion (ppb), the ministry publishes most standards and AAQC in micrograms per cubic metre (µg/m³). Since conversion between the two depends, in part, on temperature and pressure, and these varied between measurements, the individual results have been converted to µg/m³. Temperature and pressure data from the Environment and Climate Change Canada website (Sarnia station, Climate ID 6127510, for the hour that contained the majority of the 30-minute sampling period) were used to convert the results to µg/m³.

Wind speed and wind direction data referenced throughout the results was used from the Aamjiwnaang First Nation station (specifically, the hourly average wind speed and wind direction for the hour which contained the majority of the 30-minute sampling period).

To avoid confusion with the term “exceedance”, which is typically used in relation to published AAQC and O. Reg. 419/05 standards or benchmarks, any values in excess of the assessment values are referred to as “overages” throughout this report.

Measurements were made for all species at each location on each sampling day. Not all of the contaminants were detected in each sample. In cases where the concentration of a contaminant was below the detection limit of the monitoring instrument, the result is reported as “n/d” (not detected). This indicates that those contaminants were tested for, but the amount sampled was less than the minimum detectable limit of that methodology.

Rather than present averages, the ministry has included all the measurements. In situations where very few values are measured, averages may not be representative. It should also be noted that measurements reported in this survey should not be considered to represent ambient levels for a number of reasons:

- The detection limit for various substances is not determined (it varies between contaminants);
- The measurements do not represent a random sample, for the following reasons:
 - Sampling only occurred between Monday and Friday;
 - Sampling only occurred between 8:30 and 13:30 (Eastern Standard Time);
 - Samples were always taken in the same order, so samples at any site were always approximately at the same time of day;
- Samples were not simultaneous. Thus, care must be taken in comparing them for assessing spatial variability;
- Wind speed and direction were measured at the Aamjiwnaang air monitoring station and so may vary from conditions at the differing monitoring sites;
- In addition, wind speed and direction measurements are hourly averages and so may not accurately reflect the exact conditions for the half-hour sample;
- Similarly, temperature and pressure were taken from the Environment Canada climate site at the Sarnia airport and so may vary slightly from conditions at the measurement sites.

Thus, it is not necessarily appropriate to interpret long-term health risks using limited half-hour monitoring data, as many AAQC are based on long-term continuous exposure. The ministry prefers to rely on long-term monitoring at stations in the area, such as the permanent Aamjiwnaang station located at the Aamjiwnaang Health Centre (1300 Tashmoo Avenue, Sarnia, ON), which reflect the typical variation in concentration in locations where changes in exposure can potentially have an impact.

As a part of the non-continuous monitoring program at the Aamjiwnaang First Nation air monitoring station, 24-hour samples are collected using evacuated canisters and sent for VOC analysis at the Environment and Climate Change Canada laboratory. In 2016, these canister samples were collected every six days, and three of the sampling days coincided with the mobile monitoring survey: August 22, September 27, and December 20. The mobile monitoring survey Site #1 (Health Centre) is located by the permanent Aamjiwnaang air monitoring station, and so the mobile monitoring results from the Health Centre site were compared with canister results for these days for select contaminants.

2016 Monitoring Results

Ten of the sixteen VOC species selected for analysis were detected during the 2016 mobile monitoring program, and six species were not detected, as listed below:

VOC Species Detected

- Propylene
- Hexane
- Benzene
- Cyclohexane
- Toluene
- Ethylbenzene
- m- & p-xylene
- Styrene
- o-xylene
- Naphthalene

VOC Species Not Detected

- Chloromethane
- 1,3-butadiene
- Chloroform
- Carbon tetrachloride
- Trichloroethylene
- Tetrachloroethylene

Results are presented in the order in which they were analyzed by the instrument. The tables below provide the results for the ten detected VOC species, for each site and sampling date. The AAQC assessment values are given in brackets and values higher than their respective assessment value are indicated in bold font.

Measurements were made for all sixteen target contaminants at all the sites on all the sampling days. If the contaminant was not detected during a particular measurement, the results are labelled “n/d”.

Propylene

All values in µg/m ³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 26	n/d	n/d	n/d	n/d	n/d	n/d
Mar. 22	8.27	3.21	n/d	n/d	14.96	n/d
Apr. 29	15.01	7.64	13.26	n/d	n/d	n/d
May 31	n/d	n/d	n/d	n/d	n/d	n/d
Jun. 22	44.15	22.08	n/d	n/d	31.66	n/d
Jul. 28	9.69	n/d	21.73	n/d	n/d	n/d
Aug. 22	n/d	n/d	n/d	n/d	n/d	n/d
Sep. 27	11.65	n/d	n/d	4.36	n/d	n/d
Oct. 28	19.33	n/d	n/d	n/d	n/d	n/d
Nov. 28	n/d	n/d	n/d	n/d	n/d	n/d
Dec. 20	14.96	n/d	n/d	n/d	n/d	n/d

Propylene was detected in 15 of the 72 samples (21% of the samples). It was not detected at the Scott Road site. It was detected once at the Cemetery, and was observed intermittently at the other four sites. Propylene was detected most frequently at the Health Centre (7 of the 12 monthly samples, or 58% of the time). The maximum propylene concentration (44.15 µg/m³) was detected at the Health

Centre on June 22; this value is approximately 0.4% of the ½-hour AAQC assessment value of 12,000 µg/m³.

Propylene was not associated with a particular wind direction.

Chloromethane

Chloromethane was not detected in 2016. It has been detected once throughout the 2011-2016 survey years (1/318 samples).

1,3-butadiene

1,3-butadiene was not detected in 2016. It has not been detected in any of the 2011-2016 mobile monitoring surveys (0/318 samples).

1,3-butadiene was monitored at the permanent Aamjiwnaang air monitoring station on an hourly basis, and additionally, 24-hour samples were collected once every six days using evacuated canisters which were sent for analysis at the Environment and Climate Change Canada laboratory. In 2016, 1,3-butadiene was not detected by the hourly VOC monitor at the Aamjiwnaang station, and it was detected at low levels in the canister samples (the average and maximum 1,3-butadiene concentrations were approximately 0.08 µg/m³ and 0.70 µg/m³ respectively). This suggests that 1,3-butadiene was present at levels below the detection limit of the mobile monitoring instrument.

Hexane

Table 3: Hexane Half-Hour Concentrations (AAQC Assessment value = 7400 µg/m³)						
All values in µg/m³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 26	n/d	n/d	n/d	n/d	n/d	22.66
Mar. 22	n/d	n/d	36.98	n/d	n/d	n/d
Apr. 29	n/d	n/d	n/d	n/d	n/d	n/d
May 31	127.60	n/d	26.30	n/d	n/d	n/d
Jun. 22	n/d	15.43	n/d	n/d	n/d	n/d
Jul. 28	n/d	n/d	136.28	n/d	n/d	n/d
Aug. 22	n/d	n/d	n/d	n/d	n/d	n/d
Sep. 27	n/d	n/d	n/d	n/d	n/d	n/d
Oct. 28	n/d	n/d	n/d	n/d	n/d	n/d
Nov. 28	n/d	n/d	n/d	n/d	n/d	n/d
Dec. 20	n/d	n/d	n/d	n/d	n/d	n/d

Hexane was detected in 6 of the 72 samples (8% of the samples). It was detected once at the Health Centre, Community Centre, and Scott Road sites, three times at the Vidal Street South site, and was not detected at the Cemetery or Administration Building.

The maximum hexane concentration ($136.28 \mu\text{g}/\text{m}^3$) was detected at the Vidal Street South site; this value is approximately 1.8% of the ½-hour AAQC assessment value of $7,400 \mu\text{g}/\text{m}^3$.

Four of the six measureable hexane readings were observed during periods of north-northeast winds.

Chloroform

Chloroform was not detected in 2016. Chloroform was detected on four survey days in 2011, and was not detected in any of the other years (4/318 samples).

Benzene

All values in $\mu\text{g}/\text{m}^3$						
Bold font indicates an overage (a value in excess of the AAQC Assessment value)						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	0.38	n/d	1.65	0.29	3.58	0.93
Feb. 26	13.23	6.45	4.33	3.87	4.76	4.67
Mar. 22	n/d	17.34	12.04	1.50	n/d	0.27
Apr. 29	0.80	n/d	n/d	n/d	169.09	1.48
May 31	n/d	n/d	2.12	n/d	9.36	0.41
Jun. 22	13.71	1.33	3.67	3.87	6.35	7.39
Jul. 28	5.93	n/d	n/d	n/d	38.31	n/d
Aug. 22	2.72	3.97	0.80	0.25	0.75	2.69
Sep. 27	1.50	0.59	2.24	1.61	1.84	0.23
Oct. 28	10.43	n/d	15.22	5.27	n/d	n/d
Nov. 28	n/d	27.05	3.99	0.09	n/d	n/d
Dec. 20	2.05	1.10	4.44	3.88	0.71	0.32

Benzene was detected in 53 of the 72 samples (74% of the samples). 11 of the samples, or about 15%, were above the AAQC assessment value of $7 \mu\text{g}/\text{m}^3$. In the 2015 survey, 17 of the samples, or about 24%, were above the assessment value. The percentage of benzene samples above the assessment value measured during mobile monitoring surveys in previous years (2011-2015) has ranged from 17% to 39%.

The maximum benzene concentration ($169.09 \mu\text{g}/\text{m}^3$) was detected on April 29 at the Administration Building site; the maximum survey concentration in 2015 ($29.04 \mu\text{g}/\text{m}^3$) was observed at this site as well. The 2016 maximum was the highest benzene concentration measured in the mobile monitoring surveys from 2011 to 2016. Winds were coming from the northeast at the time of this measurement. Benzene was detected at two other sites on this day (Health Centre and Scott Road $0.80 \mu\text{g}/\text{m}^3$ and

1.48 $\mu\text{g}/\text{m}^3$ respectively), at concentrations below the AAQC assessment value, and much lower than the concentration measured at the Administration Building.

The ministry confirmed that there was an incident occurring at a facility on April 29, 2016 that may have contributed to the benzene concentration of 169.09 $\mu\text{g}/\text{m}^3$ detected during the survey. Ministry follow up occurred, including evaluation of additional air monitoring that was undertaken.

The second highest benzene concentration (38.31 $\mu\text{g}/\text{m}^3$) was measured at the Administration Building on July 28. Winds were coming from the northeast at the time of this measurement.

24-hour samples were collected using evacuated canisters at the permanent Aamjiwnaang air monitoring station, near the Health Centre mobile monitoring site, once every six days in 2016. The canister results for the three days that coincided with the mobile monitoring survey (August 22, September 27, and December 20) were 1.303 $\mu\text{g}/\text{m}^3$, 0.560 $\mu\text{g}/\text{m}^3$, and 1.023 $\mu\text{g}/\text{m}^3$, and the mobile monitoring results were 2.72 $\mu\text{g}/\text{m}^3$, 1.50 $\mu\text{g}/\text{m}^3$, and 2.05 $\mu\text{g}/\text{m}^3$ respectively. This suggests that the half-hour mobile monitoring samples detected short-term peaks in benzene concentrations that were diluted over a 24-hour sampling duration (leading to lower 24-hour sample results).

Benzene was detected from a variety of wind directions depending upon time and sampling location. This is illustrated in Figure A2 in the Appendix. The two highest concentrations measured in the 2016 survey were associated with winds from the northeast, though measurements above the AAQC assessment value were observed with winds coming from a range of directions (including south, southwest, north-northwest). Overages were observed at every site except for the Cemetery.

Carbon Tetrachloride

Carbon tetrachloride was not detected in 2016. Carbon tetrachloride was detected on two survey days in 2011, once in 2014, and has not been detected in any other years (3/318 samples).

Cyclohexane

Table 5: Cyclohexane Half-Hour Concentrations (AAQC Assessment value = 18000 µg/m ³)						
All values in µg/m ³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 26	n/d	n/d	n/d	n/d	n/d	n/d
Mar. 22	n/d	1.59	54.15	2.82	n/d	n/d
Apr. 29	n/d	n/d	n/d	n/d	0.27	n/d
May 31	n/d	n/d	1.26	n/d	n/d	n/d
Jun. 22	n/d	0.56	n/d	n/d	n/d	n/d
Jul. 28	n/d	n/d	4.42	n/d	n/d	n/d
Aug. 22	n/d	n/d	n/d	n/d	n/d	n/d
Sep. 27	9.94	n/d	n/d	n/d	n/d	2.76
Oct. 28	125.76	n/d	n/d	n/d	26.61	n/d
Nov. 28	n/d	1.64	n/d	1.20	n/d	n/d
Dec. 20	n/d	n/d	n/d	n/d	n/d	n/d

Cyclohexane was detected in 13 of the 72 samples (18% of the samples). It was detected at all of the sites on at least one occasion.

The maximum cyclohexane concentration (125.76 µg/m³) was detected at the Health Centre site; this value is approximately 0.70% of the ½-hour AAQC assessment value of 18,000 µg/m³.

Cyclohexane detections were associated with southwest and north-northeast wind directions.

Trichloroethylene

Trichloroethylene was not detected in 2016. Trichloroethylene was added to the mobile monitoring survey target list in 2012. It has not been detected between 2012 and 2016 (0/264 samples).

Toluene

All values in µg/m ³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	0.39	n/d	0.96	0.28	0.19	0.28
Feb. 26	19.60	8.03	7.85	7.05	5.08	5.84
Mar. 22	2.52	8.69	4.47	1.10	0.42	0.18
Apr. 29	2.68	n/d	0.87	n/d	1.59	0.28
May 31	1.53	n/d	1.93	n/d	1.02	0.35
Jun. 22	1.27	6.03	3.22	2.31	1.17	5.98
Jul. 28	0.92	1.94	4.05	n/d	1.42	n/d
Aug. 22	2.46	22.54	6.60	2.25	0.27	2.77
Sep. 27	0.49	2.56	2.10	2.32	1.56	0.36
Oct. 28	12.66	1.14	8.67	4.01	2.39	n/d
Nov. 28	n/d	14.71	3.12	1.98	n/d	n/d
Dec. 20	0.35	0.33	1.30	0.99	n/d	0.24

Toluene was detected in 60 of the 72 samples (83% of the samples). Toluene was detected at least three times on every sampling day, and it was measured at all locations.

The maximum toluene concentration (22.54 µg/m³) was detected at the Community Centre site on August 22; this value is approximately 0.4% of the ½-hour AAQC assessment value of 6,000 µg/m³.

Detection occurred in all wind directions observed throughout the sampling program, with detections occurring most frequently during periods of winds from the southwest, northwest, and north-northeast.

Tetrachloroethylene

Tetrachloroethylene was not detected in 2016. Tetrachloroethylene has been detected on seven survey days since it was added to the monitoring list in 2012 (in 13/264 samples).

Ethylbenzene

All values in µg/m ³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	n/d	n/d	0.30	0.16	n/d	0.43
Feb. 26	1.97	1.16	1.39	1.06	1.13	1.10
Mar. 22	0.21	0.62	0.24	0.09	n/d	n/d
Apr. 29	1.18	n/d	0.25	n/d	87.20	n/d
May 31	0.20	n/d	0.68	n/d	0.17	0.13
Jun. 22	2.20	0.67	1.05	0.81	0.35	1.41
Jul. 28	0.19	0.55	2.77	n/d	0.29	n/d
Aug. 22	0.44	1.70	1.77	0.32	0.14	1.15
Sep. 27	0.26	0.34	0.23	1.24	0.42	0.16
Oct. 28	0.18	0.51	0.33	0.67	0.45	n/d
Nov. 28	n/d	0.56	0.17	0.13	n/d	n/d
Dec. 20	0.12	0.15	0.19	0.16	0.09	0.04

Ethylbenzene was detected in 56 of the 72 samples (78% of the samples). It was detected at least three times on every sampling day, and it was measured at all locations.

The maximum ethylbenzene concentration (87.20 µg/m³) was detected at the Administration Building on April 29. Winds were coming from the northeast at the time of this detection. Although this value is approximately 2.9% of the ½-hour AAQC assessment value of 3,000 µg/m³, this is the highest ethylbenzene concentration that has been measured in SWR's mobile monitoring surveys to date. This value was measured on the same day and location that the maximum benzene concentration of the 2016 survey was observed, during the incident previously referenced.

Ethylbenzene detections occurred with all wind directions observed throughout the sampling program. The most frequent detections were associated with winds from the northwest and north-northeast.

Styrene

All values in µg/m ³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	n/d	n/d	n/d	n/d	0.30	1.01
Feb. 26	10.88	4.00	4.77	4.74	n/d	n/d
Mar. 22	n/d	0.70	1.64	n/d	0.34	n/d
Apr. 29	n/d	0.59	n/d	n/d	572.97	5.09
May 31	1.47	n/d	0.67	n/d	21.45	n/d
Jun. 22	5.58	2.92	n/d	2.17	10.41	n/d
Jul. 28	0.32	n/d	1.16	n/d	50.04	n/d
Aug. 22	0.97	2.17	2.69	n/d	0.61	n/d
Sep. 27	n/d	n/d	1.02	n/d	0.55	n/d
Oct. 28	n/d	0.56	1.64	n/d	0.72	n/d
Nov. 28	n/d	0.52	n/d	n/d	n/d	n/d
Dec. 20	n/d	n/d	0.59	n/d	n/d	n/d

Styrene was detected in 33 of the 72 samples (46% of the samples). It was detected at least once on every sampling day, and it was measured at all locations.

The three highest styrene concentrations were measured at the Administration Building site. Similar to the benzene and ethylbenzene results, the maximum styrene concentration (572.97 µg/m³) was detected at the Administration Building on April 29 during winds from the northeast. This value is approximately 48% of the ½-hour AAQC assessment value of 1,200 µg/m³. This was the highest styrene concentration measured in the SWR mobile monitoring surveys from 2011 to 2016.

Total Xylenes

The AAQC for xylene is based upon the total of the three isomers (m-, p-, and o-xylene). The m-&p-xylene and o-xylene results have been summed and presented in the “Total Xylenes” table below for the purpose of comparison to the AAQC assessment value.

Table 9: Total Xylenes Half-Hour Concentrations (AAQC Assessment value = 2200 µg/m³)						
All values in µg/m³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	n/d	n/d	0.55	0.28	n/d	1.42
Feb. 26	13.7	7.76	10.71	6.86	5.63	5.36
Mar. 22	0.38	0.88	1.15	0.47	0.07	n/d
Apr. 29	4.95	n/d	0.44	n/d	0.2	n/d
May 31	0.36	n/d	0.85	n/d	0.3	0.23
Jun. 22	0.87	2.36	1.44	1.11	0.63	1.94
Jul. 28	0.34	0.73	3.3	n/d	0.51	n/d
Aug. 22	0.56	6.19	2.31	0.72	0.25	1.54
Sep. 27	0.48	0.61	1.01	1.34	0.57	0.17
Oct. 28	0.33	0.66	1.69	0.85	0.6	n/d
Nov. 28	n/d	0.76	0.73	0.44	n/d	n/d
Dec. 20	0.22	0.28	0.6	0.52	0.13	0.08

Xylenes were detected in 57 of the 72 samples (79%). Concentrations remained below 0.6% of the AAQC assessment values of 2200 µg/m³ throughout the survey. The maximum total xylene concentration of 13.7 µg/m³ was observed at the Health Centre site on February 26.

Detection occurred in all wind directions observed throughout the sampling program.

Naphthalene

All values in µg/m ³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 29	n/d	1.50	n/d	2.74	3.02	n/d
Feb. 26	43.97	50.04	54.16	13.08	6.44	n/d
Mar. 22	9.46	6.55	n/d	5.09	7.89	n/d
Apr. 29	5.80	n/d	3.48	n/d	7.86	n/d
May 31	2.19	n/d	2.60	n/d	6.02	n/d
Jun. 22	2.60	n/d	n/d	10.17	8.49	n/d
Jul. 28	2.22	n/d	4.54	n/d	6.87	3.89
Aug. 22	2.79	4.35	15.88	n/d	10.66	n/d
Sep. 27	n/d	2.05	5.85	n/d	6.09	n/d
Oct. 28	3.05	5.47	16.60	5.49	n/d	n/d
Nov. 28	n/d	3.89	8.24	5.50	3.96	n/d
Dec. 20	2.15	n/d	8.49	5.79	4.37	n/d

Naphthalene was detected in 44 of the 72 samples (61%). It was detected at least once at all the monitoring sites, the maximum (54.16 µg/m³) reaching 81% of the assessment value at the Vidal Street South site on February 26. The highest naphthalene concentrations measured at the Health Centre and Community Centre sites in 2016 were also observed on February 26.

Naphthalene detections occurred during a variety of wind directions ranging from southwest to northeast. The highest concentrations were associated with winds from the northwest.

The mobile monitoring results from the Health Centre site were compared to the 24-hour canister sample results collected at the permanent Aamjiwnaang station for the three days that canister sampling and the mobile monitoring survey coincided in 2016. On August 22, the 24-hour canister sample result was 0.019 µg/m³, and the mobile monitoring survey measured a ½-hour naphthalene concentration of 2.79 µg/m³. On September 27, the canister result was 0.024 µg/m³, and the mobile monitoring did not detect naphthalene. On December 20, the canister result was 0.020 µg/m³, and the mobile monitoring result was 2.15 µg/m³. The maximum 24-hour canister result for 2016 was 0.411 µg/m³. Naphthalene concentrations, when detected during the mobile monitoring survey, were often an order of magnitude (10x) greater than typical 24-hour canister results. This suggests that naphthalene is present intermittently, which is captured by ½-hour sample collection and possibly diluted over a 24-hour sampling duration (leading to lower 24-hour sample results), or that there are potential issues with the monitoring instrument. Previous SWR mobile monitoring surveys have detected naphthalene concentrations approaching and exceeding the AAQC assessment value; as such, further review of naphthalene monitoring data is warranted.

Spatial Variation (2011- 2016)

One of the objectives of the mobile monitoring survey was to assess the results for spatial variability; in particular to evaluate whether concentrations of any contaminants were regularly higher at one or more sampling sites than the others.

A mobile monitoring survey is one means of assessing variation in air contaminant concentrations spatially. However, mobile monitoring surveys represent a “snapshot” within a given short-term time period, and emissions and meteorology may be different from one measurement period to the next. For this reason, air quality assessments employing monitoring methods that collect samples over a longer duration at permanently located monitors (including canisters or passive monitors) will provide a more in-depth analysis of spatial variability in contaminant concentrations around the Aamjiwnaang First Nation.

Data from all survey years (2011-2016) were included in the following spatial assessment, as a dataset spanning several years offers additional insight into the presence of any spatial trends. Specifically, approximately 53 data points per contaminant, per site were available using all the 2011-2016 results, in contrast to 12 data points per contaminant, per site with only the 2016 results. The assessment was completed using the original units reported by the instrument (ppb).

As previously mentioned, the instrument detection limit for the monitored contaminants is not determined. The instrument detection limit is the level at which the monitoring instrument can reliably distinguish a measured concentration from zero. The true concentration of a “non-detect” falls somewhere between zero and the detection limit. For the purpose of this spatial variation assessment, the detection limits have been estimated as listed in the table below, based on the lowest non-zero concentrations measured for each contaminant in the 2011-2016 surveys.

Any previously reported results that were less than the estimated detection limits were considered “below detection limit” for this assessment. This ensures that a value potentially less than the detection limit which may be arbitrarily reported by the instrument is not “treated” as higher than a non-detect in the statistical analysis. For example, an instrument with a detection limit of 0.3 ppb may report a “0.05 ppb”. There is no way of determining whether this is in fact higher or lower than a non-detect, whose true value ranges from 0 ppb to 0.3 ppb. The number of data points that were affected by censoring at the estimated detection limit (out of approximately 318 data points, per contaminant) are reported in the table below.

A detection limit has not been estimated for the contaminants which have been detected in less than 5% of the samples (or not at all); these are indicated as “n/a” in the table below. Similarly, a spatial variation assessment has not been completed for these contaminants.

Table 11 – Estimated detection limits for the mobile monitoring survey spatial variability assessment. Contaminants in italics were not spatially assessed.			
Compound	Estimated Detection Limit		Reported data points censored at estimated detection limit
	ppb	µg/m³	
Propylene	1.0	1.8	0
<i>Chloromethane</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
<i>1,3-butadiene</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Hexane	0.1	0.4	2
<i>Chloroform</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Benzene	0.1	0.3	9
<i>Carbon tetrachloride</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Cyclohexane	0.1	0.4	2
<i>Trichloroethylene</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Toluene	0.07	0.3	6
<i>Tetrachloroethylene</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Ethylbenzene	0.02	0.1	3
m- & p-Xylene	0.01	0.1	0
Styrene	0.04	0.2	2
o-Xylene	0.01	0.1	2
Naphthalene	0.1	0.6	0

The results for each parameter, from all sampling years (2011-2016), were evaluated with a contingency table analysis and the Kruskal-Wallis test using the statistical platform R. A contingency table analysis (Pearson’s chi-square test) was used to assess differences in the proportions of detections of each contaminant amongst the six sampling sites (i.e. to determine whether a contaminant was more frequently detected at one or more sites). The Kruskal-Wallis test is a non-parametric statistical test for differences among groups. This method was selected based on an interest in evaluating typical concentrations (i.e. medians) for each contaminant across the six sampling sites. In addition, this method does not assume that the data follows a particular distribution (such as the normal distribution), which is an appropriate consideration for assessing the mobile monitoring dataset, given the high percentage of values below the detection limit.

If the Kruskal-Wallis test showed a significant difference between concentrations at the sites at the $\alpha=0.05$ level, a multiple comparison test (the Pairwise Wilcoxon Test with a false discovery rate correction) was conducted to distinguish which sites were different from one another.

Chloromethane, 1,3-butadiene, Chloroform, Carbon Tetrachloride, Trichloroethylene, Tetrachloroethylene:

- Spatial variability has not been assessed, as these contaminants have been detected in less than 5% of the samples from 2011-2016 (or have never been detected).

Hexane, Ethylbenzene, m- & p- Xylene, and o- Xylene:

- No significant differences were found in frequency of detection or in concentrations across the survey sites.

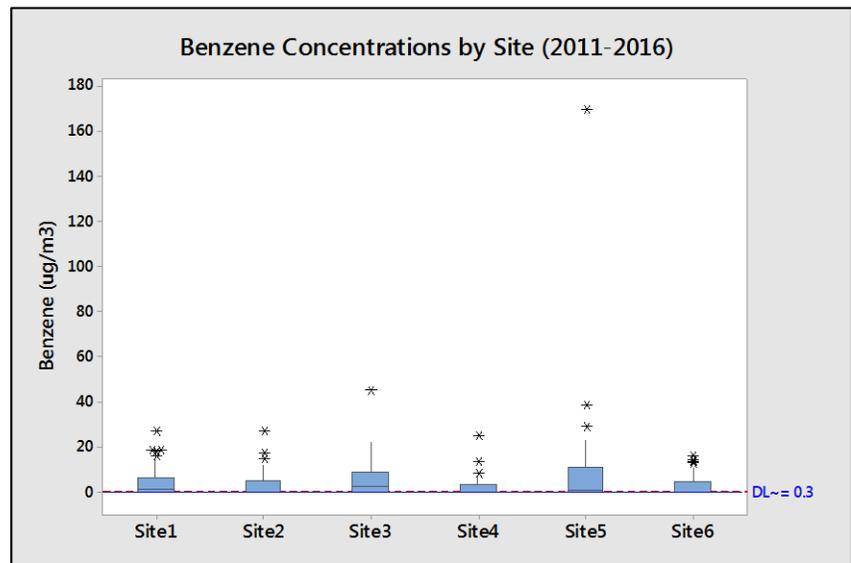
Propylene:

- Propylene was most frequently detected at Site 1 and least frequently detected at Site 6.
- Concentrations were found to be significantly higher at Site 1 in comparison to Site 6. No other significant differences in concentrations across the survey sites were found.

Benzene:

- There was no significant difference in the frequency of benzene detections across the six sampling sites.
- Concentrations were found to be significantly higher at Site 3 than at Site 4. No other significant differences in concentrations across the survey sites were found.

Figure 1 - Boxplot showing the distribution of benzene concentrations measured in the 2011-2016 surveys, by site. The horizontal line depicts the estimated detection limit ($\approx 0.3 \mu\text{g}/\text{m}^3$). Asterisks (*) represent outliers; that is, concentrations that were higher than the majority of the concentrations observed at each site.



Cyclohexane:

- Cyclohexane was most frequently detected at Sites 2, 3, and 4, and least frequently detected at Site 6.
- Cyclohexane concentrations were significantly lower at Site 6 in comparison to Sites 2, 3, and 4.

Toluene

- Toluene was most frequently detected at Site 3.
- Toluene concentrations were significantly higher at Site 4 in comparison to Sites 5 and 6.

Styrene:

- Styrene was most frequently detected at Sites 3 and 5 and least frequently detected at Sites 1 and 4.
- Styrene concentrations were significantly higher at Site 5 in comparison to Sites 1 and 4. There was no difference found in concentrations at Site 5 in comparison to Site 3.

Naphthalene:

- Naphthalene was most frequently detected at Site 5.
- Naphthalene concentrations were significantly higher at Site 5 in comparison to Sites 1, 2, and 6.

This spatial variability assessment shows that some contaminant concentrations were found to be higher or lower at some sites in comparison to others, but no single site consistently measured significantly higher concentrations of any one contaminant in comparison to all other sites. However, mobile monitoring surveys are better suited for short-term, exploratory sampling purposes, and offer limited insight into spatial variability that is observed over long-term time periods. Continuous monitoring methods are required for a comprehensive investigation of spatial variability in contaminant concentrations.

Appendix

Figure A1: 2016 Aamjiwnaang First Nation mobile monitoring survey sites.

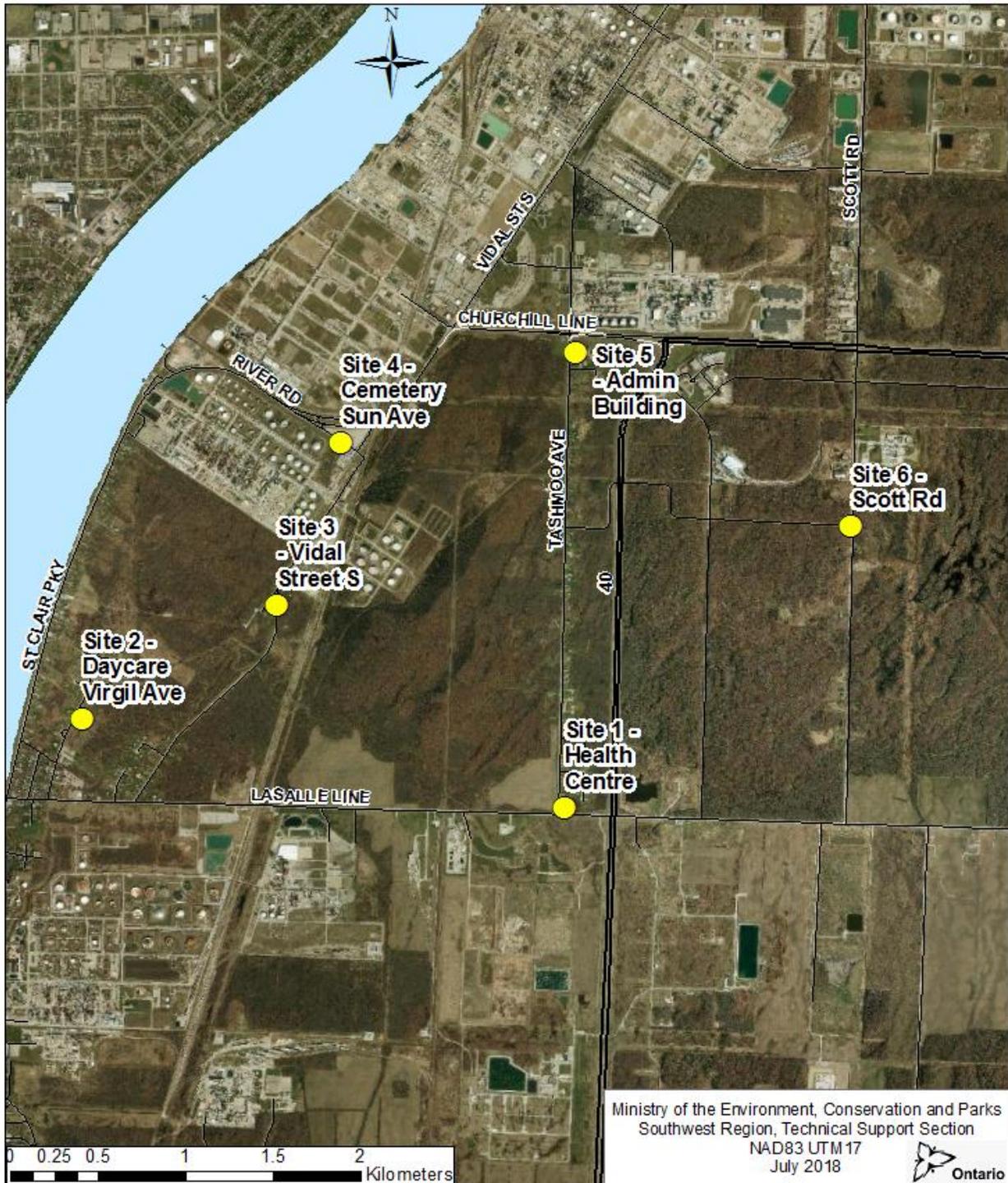


Figure A2: Benzene rose diagram for the 2016 Aamjiwnaang mobile monitoring survey. This diagram shows the relationship between detected benzene concentrations at each survey site and the direction from which the wind was blowing during the sampling hour.

In a rose diagram, each bin (or “petal”) depicts the percentage of time that wind was blowing from a particular direction for the various concentrations measured. The wind directions are given based on the direction from which the wind was blowing; that is, a west (270°) wind is a wind coming from the west (and travelling east). A west wind would be depicted by a petal positioned at “9:00” on a clock scale.

The colour scheme for the benzene concentrations is given in the legend at the bottom right of the figure.

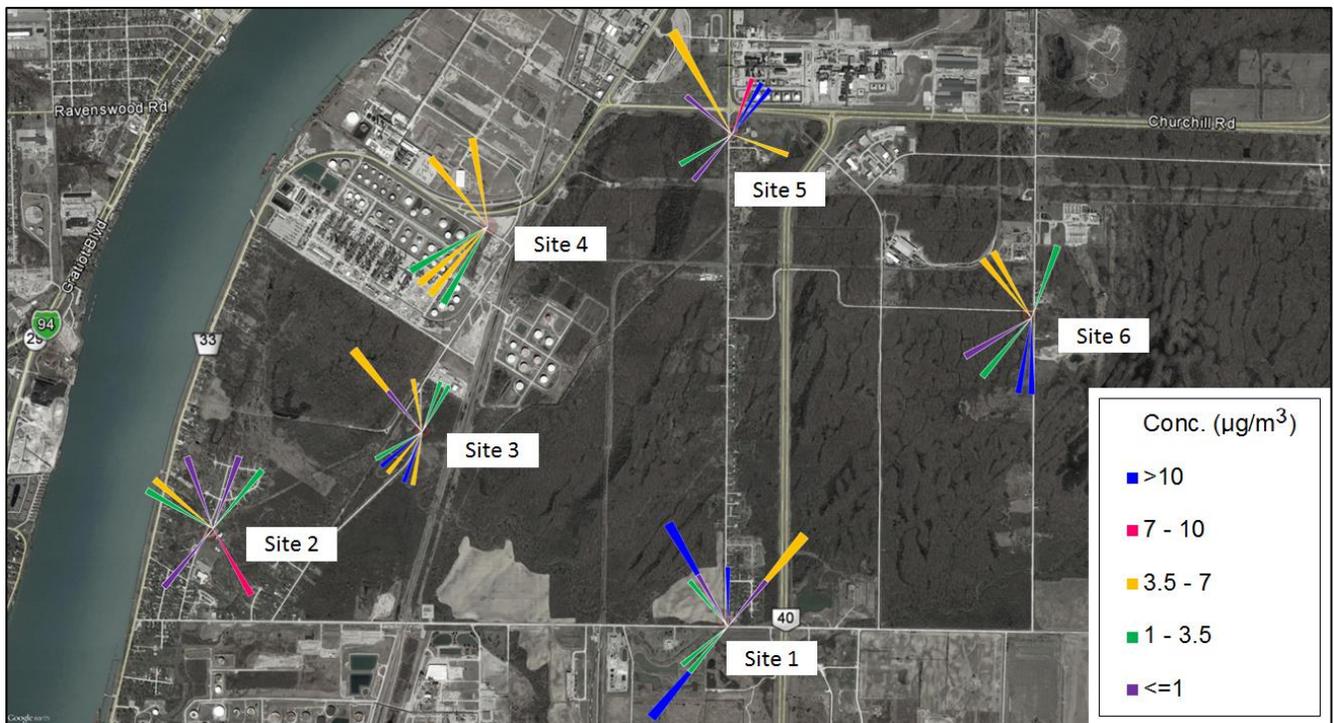


Table A1: Half-hour average concentrations ($\mu\text{g}/\text{m}^3$) of the sixteen VOC measured during the 2016 Aamjiwnaang First Nation mobile monitoring survey, along with temperature and pressure data from the Environment and Climate Change Canada Sarnia station, Climate ID 6127510, which were used to convert results from ppb to $\mu\text{g}/\text{m}^3$. Wind speed and wind direction data are from the Aamjiwnaang First Nation air monitoring station.

Date		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Jan. 29, 2016	Sample Start Time (EST)	10:20	10:56	11:32	12:07	12:45	13:22
	Temperature ($^{\circ}\text{C}$)	-6.7	-6.3	-6.3	-6.3	-5.7	-5.1
	Pressure (mb)	989.5	990.4	990.8	990.8	991	991
	Wind Speed (km/h)	20	21	21	19	19	12
	Wind Direction ($^{\circ}$)	326	323	32	331	331	338
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	0.38		1.65	0.29	3.58	0.93
	Carbon Tetrachloride						
	Cyclohexane						
	Trichloroethylene						
	Toluene	0.39		0.96	0.28	0.19	0.28
	Feb. 26, 2016	Sample Start Time (EST)	9:50	10:25	11:02	11:38	12:15
Temperature ($^{\circ}\text{C}$)		-5.4	-4.9	-4.9	-3.8	-3.8	-3.1
Pressure (mb)		1000.1	1000.4	1000.4	1000.8	1000.8	1000.6
Wind Speed (km/h)		14	15	16	16	15	14
Wind Direction ($^{\circ}$)		327	332	323	323	330	309
Propylene							
Chloromethane							
1,3-Butadiene							
Hexane							22.66
Chloroform							
Benzene		13.23	6.45	4.33	3.87	4.76	4.67
Carbon Tetrachloride							
Cyclohexane							
Trichloroethylene							
Toluene		19.60	8.03	7.85	7.05	5.08	5.84
Tetrachloroethylene							
Ethylbenzene	1.97	1.16	1.39	1.06	1.13	1.10	
m&p-Xylene	10.41	5.79	7.92	5.08	4.11	3.92	
Styrene	10.88	4.00	4.77	4.74			
o-Xylene	3.29	1.97	2.79	1.78	1.52	1.44	
Naphthalene	43.97	50.04	54.16	13.08	6.44		

Table A1 (continued): Half-hour average concentrations ($\mu\text{g}/\text{m}^3$) measured in the 2016 survey.

Date		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Mar. 22, 2016	Sample Start Time (EST)	9:05	9:40	10:16	10:55	11:35	12:11
	Temperature ($^{\circ}\text{C}$)	3.6	5	5	6.8	9.6	9.6
	Pressure (mb)	992	991.3	991.3	989.9	988.8	988.8
	Wind Speed (km/h)	15	15	14	18	18	16
	Wind Direction ($^{\circ}$)	191	191	201	207	207	228
	Propylene	8.27	3.21			14.96	
	Chloromethane						
	1,3-Butadiene						
	Hexane			36.98			
	Chloroform						
	Benzene		17.34	12.04	1.50		0.27
	Carbon Tetrachloride						
	Cyclohexane		1.59	54.15	2.82		
	Trichloroethylene						
	Toluene	2.52	8.69	4.47	1.10	0.42	0.18
	Tetrachloroethylene						
	Ethylbenzene	0.21	0.62	0.24	0.09		
m&p-Xylene	0.23	0.67	0.89	0.28			
Styrene		0.70	1.64		0.34		
o-Xylene	0.15	0.21	0.26	0.19	0.07		
Naphthalene	9.46	6.55		5.09	7.89		
Apr. 29, 2016	Sample Start Time (EST)	10:15	10:50	11:25	12:02	12:36	13:14
	Temperature ($^{\circ}\text{C}$)	6.3	6.2	6.3	6.3	7.8	7.8
	Pressure (mb)	996.4	997	997.5	997.5	997.2	997.2
	Wind Speed (km/h)	na	9	9	10	10	10
	Wind Direction ($^{\circ}$)	36	36	36	36	36	39
	Propylene	15.01	7.64	13.26			
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	0.80				169.09	1.48
	Carbon Tetrachloride						
	Cyclohexane					0.27	
	Trichloroethylene						
	Toluene	2.68		0.87		1.59	0.28
	Tetrachloroethylene						
	Ethylbenzene	1.18		0.25		87.20	
m&p-Xylene	4.09		0.26		0.12		
Styrene		0.59			572.97	5.09	
o-Xylene	0.86		0.18		0.08		
Naphthalene	5.80		3.48		7.86		

Table A1 (continued): Half-hour average concentrations ($\mu\text{g}/\text{m}^3$) measured in the 2016 survey.

Date		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
May 31, 2016	Sample Start Time (EST)	9:10	9:45	10:18	10:55	11:45	12:25
	Temperature (°C)	19	17.9	17.9	16.8	16.7	16.6
	Pressure (mb)	996.3	996.7	996.7	997.5	997.3	997.7
	Wind Speed (km/h)	9	9	9	8	9	9
	Wind Direction (°)	15	24	24	24	20	20
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane	127.60		26.30			
	Chloroform						
	Benzene			2.12		9.36	0.41
	Carbon Tetrachloride						
	Cyclohexane			1.26			
	Trichloroethylene						
	Toluene	1.53		1.93		1.02	0.35
	Tetrachloroethylene						
	Ethylbenzene	0.20		0.68		0.17	0.13
m&p-Xylene	0.22		0.73		0.18	0.14	
Styrene	1.47		0.67		21.45		
o-Xylene	0.14		0.12		0.12	0.09	
Naphthalene	2.19		2.60		6.02		
Jun. 22, 2016	Sample Start Time (EST)	8:40	9:15	9:50	10:27	11:05	11:45
	June 22 2016						
	Temperature (°C)	19.9	19.8	19.8	20.8	20.8	20.8
	Pressure (mb)	992.4	992.9	992.9	992.8	992.8	992.6
	Wind Speed (km/h)	5	3	0	0	4	3
	Wind Direction (°)	358	15	350	350	114	146
	Propylene	44.15	22.08			31.66	
	Chloromethane						
	1,3-Butadiene						
	Hexane		15.43				
	Chloroform						
	Benzene	13.71	1.33	3.67	3.87	6.35	7.39
	Carbon Tetrachloride						
	Cyclohexane		0.56				
	Trichloroethylene						
	Toluene	1.27	6.03	3.22	2.31	1.17	5.98
	Tetrachloroethylene						
Ethylbenzene	2.20	0.67	1.05	0.81	0.35	1.41	
m&p-Xylene	0.52	1.83	1.13	0.88	0.38	1.52	
Styrene	5.58	2.92		2.17	10.41		
o-Xylene	0.35	0.53	0.31	0.23	0.25	0.42	
Naphthalene	2.60			10.17	8.49		

Table A1 (continued): Half-hour average concentrations ($\mu\text{g}/\text{m}^3$) measured in the 2016 survey.

Date		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Jul. 28, 2016	Sample Start Time (EST)	9:30	10:10	10:45	11:27	12:05	12:45
	Temperature ($^{\circ}\text{C}$)	23.8	23.8	24.2	24.3	24.3	24.5
	Pressure (mb)	991.9	991.9	992	991.9	991.9	991.7
	Wind Speed (km/h)	5	7	7	9	6	6
	Wind Direction ($^{\circ}$)	38	21	21	12	27	27
	Propylene	9.69		21.73			
	Chloromethane						
	1,3-Butadiene						
	Hexane			136.28			
	Chloroform						
	Benzene	5.93				38.31	
	Carbon Tetrachloride						
	Cyclohexane			4.42			
	Trichloroethylene						
	Toluene	0.92	1.94	4.05		1.42	
	Tetrachloroethylene						
	Ethylbenzene	0.19	0.55	2.77		0.29	
m&p-Xylene	0.20	0.59	2.98		0.31		
Styrene	0.32		1.16		50.04		
o-Xylene	0.14	0.14	0.32		0.20		
Naphthalene	2.22		4.54		6.87	3.89	
Aug. 22, 2016	Sample Start Time (EST)	10:00	10:36	11:16	11:55	12:35	13:15
	Temperature ($^{\circ}\text{C}$)	20.2	21	21.4	21.4	21.5	22.4
	Pressure (mb)	1000.3	1000.6	1000.6	1000.6	1000.6	1000.3
	Wind Speed (km/h)	6	6	7	7	7	8
	Wind Direction ($^{\circ}$)	316	316	320	307	307	304
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	2.72	3.97	0.80	0.25	0.75	2.69
	Carbon Tetrachloride						
	Cyclohexane						
	Trichloroethylene						
	Toluene	2.46	22.54	6.60	2.25	0.27	2.77
	Tetrachloroethylene						
	Ethylbenzene	0.44	1.70	1.77	0.32	0.14	1.15
m&p-Xylene	0.47	5.24	1.91	0.34	0.15	1.24	
Styrene	0.97	2.17	2.69		0.61		
o-Xylene	0.09	0.95	0.40	0.38	0.10	0.30	
Naphthalene	2.79	4.35	15.88		10.66		

Table A1 (continued): Half-hour average concentrations ($\mu\text{g}/\text{m}^3$) measured in the 2016 survey.

Date		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Sep. 27, 2016	Sample Start Time (EST)	10:15	10:48	11:25	12:02	12:38	13:15
	Temperature ($^{\circ}\text{C}$)	17.7	18.3	19.6	19.6	18.8	19.2
	Pressure (mb)	985.8	985.4	984.8	984.8	984.9	984.6
	Wind Speed (km/h)	14	15	15	15	15	12
	Wind Direction ($^{\circ}$)	232	241	241	244	244	254
	Propylene	11.65			4.36		
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	1.50	0.59	2.24	1.61	1.84	0.23
	Carbon Tetrachloride						
	Cyclohexane	9.94					2.76
	Trichloroethylene						
	Toluene	0.49	2.56	2.10	2.32	1.56	0.36
	Tetrachloroethylene						
Ethylbenzene	0.26	0.34	0.23	1.24	0.42	0.16	
m&p-Xylene	0.29	0.36	0.80	1.34	0.45	0.17	
Styrene			1.02		0.55		
o-Xylene	0.19	0.25	0.21		0.12		
Naphthalene		2.05	5.85		6.09		
Oct. 28, 2016	Sample Start Time (EST)	9:50	10:24	10:58	11:35	12:11	12:46
	Temperature ($^{\circ}\text{C}$)	7	8.5	8.5	9.4	9.4	10.3
	Pressure (mb)	1004.5	1003.9	1003.9	1003.1	1003.1	1001.6
	Wind Speed (km/h)	8	8	8	8	10	12
	Wind Direction ($^{\circ}$)	221	221	230	230	212	210
	Propylene	19.33					
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	10.43		15.22	5.27		
	Carbon Tetrachloride						
	Cyclohexane	125.76				26.61	
	Trichloroethylene						
	Toluene	12.66	1.14	8.67	4.01	2.39	
	Tetrachloroethylene						
Ethylbenzene	0.18	0.51	0.33	0.67	0.45		
m&p-Xylene	0.20	0.54	1.37	0.72	0.49		
Styrene		0.56	1.64		0.72		
o-Xylene	0.13	0.12	0.32	0.13	0.11		
Naphthalene	3.05	5.47	16.60	5.49			

Table A1 (continued): Half-hour average concentrations ($\mu\text{g}/\text{m}^3$) measured in the 2016 survey.

Date		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Nov. 28, 2016	Sample Start Time (EST)	10:00	10:35	11:09	11:44	12:20	12:56
	Temperature (°C)	7.2	8.3	8.3	9.1	9.2	9.2
	Pressure (mb)	989.5	989.4	989.4	988.4	988.4	986.9
	Wind Speed (km/h)	14	14	15	15	14	16
	Wind Direction (°)	178	178	186	186	178	174
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene		27.05	3.99	0.09		
	Carbon Tetrachloride						
	Cyclohexane		1.64		1.20		
	Trichloroethylene						
	Toluene		14.71	3.12	1.98		
	Tetrachloroethylene						
Ethylbenzene			0.56	0.17	0.13		
m&p-Xylene			0.60	0.60	0.33		
Styrene			0.52				
o-Xylene			0.16	0.13	0.11		
Naphthalene			3.89	8.24	5.50	3.96	
Dec. 20, 2016	Sample Start Time (EST)	10:20	10:55	11:30	12:06	12:44	13:20
	Temperature (°C)	-5	-5	-4.5	-4.5	-3.9	-2.5
	Pressure (mb)	1001.1	1001.1	999.2	999.2	996.7	994.9
	Wind Speed (km/h)	19	20	20	20	20	22
	Wind Direction (°)	217	222	222	220	220	224
	Propylene	14.96					
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	2.05	1.10	4.44	3.88	0.71	0.32
	Carbon Tetrachloride						
	Cyclohexane						
	Trichloroethylene						
	Toluene	0.35	0.33	1.30	0.99		0.24
	Tetrachloroethylene						
Ethylbenzene	0.12	0.15	0.19	0.16	0.09	0.04	
m&p-Xylene	0.13	0.17	0.47	0.31	0.10	0.05	
Styrene			0.59				
o-Xylene	0.09	0.11	0.13	0.21	0.03	0.03	
Naphthalene	2.15		8.49	5.79	4.37		